Keurbooms Estuary Estuarine Management Plan

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Date:

January 2023

I, Anton Bredell, Minister of Local Government, Environmental Affairs and Development Planning hereby approve the Keurbooms Estuary Estuarine Management Plan for implementation.

Anton Bredell

Digitally signed by Anton Bredell
Date: 2023.06.23 10:50:19 +02'00'

Disclaimer:

The Estuarine Functional Zone depicted in this estuarine management plan will be subject to change based on new data published from time to time.

DOCUMENT USE

The South African National Estuarine Management Protocol (the Protocol), promulgated in May 2013 and amended in 2021, 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 (EMPs).

In 2014, a review was conducted by the National Department of Environmental Affairs: Oceans and Coasts (DEA, 2014) on existing estuarine management plans which were products of the C.A.P.E. Estuaries Management Programme, to ensure, *inter alia*, the alignment of these plans with the Protocol.

The first revision of the Keurbooms Estuary Estuarine Management Plan (EMP), including the Situation Assessment Report was primarily a response to the DEA review process, to ensure compliance with the minimum requirements for estuarine management plans as per the Protocol. In summary, this entailed:

- Updating the preliminary assessment with NBA 2018 Desktop Assessment results.
- Including socio-economic information in the Situation Assessment Report.
- Updating the terminology as per the Protocol.
- Updating the summary of the Situation Assessment.
- Including map of geographical boundaries based on Estuarine Functional Zone.
- Provision of performance indicators for the management actions.
- 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.
- Embedding the Ecological Reserve and Catchment Classification (2021-2023) processes and results into updated EMP

The work of the original authors and input received from stakeholders remains largely unchanged. Historical information and data remain relevant and critically important for estuarine management in the long term and must be updated when new information becomes available. This revision does not represent, or replace, the full five-year review process required to re-evaluate the applicability of the plan and to provide new information. This full review process is therefore still urgently required and should be part of a future revision. Nonetheless, this EMP must be considered a living document that should be regularly updated and amended as deemed necessary.

In preparation for the final EMP approval process, the draft EMP was published for public comment from 28 January to 04 March 2022 (see appendix C : stakeholder consultation report). This was followed by a formal "Comment and Response" process which reviewed and addressed all comments submitted. Minor edits were made to the EMP where appropriate. This document is the final Keurbooms Estuary Estuarine Management Plan.

EXECUTIVE SUMMARY

Introduction

Estuaries are recognized as particularly sensitive and dynamic ecosystems, and therefore require above-average care in the planning and control of activities related to their use and management. For this reason, the National Environmental Management: Integrated Coastal Management Act (No. 24 of 2008, as amended by Act 36 of 2014) (ICM Act), via the prescriptions of the National Estuarine Management Protocol (the Protocol), require Estuary Management Plans to be prepared for estuaries in order to create informed platforms for efficient and coordinated estuarine management.

The National Biodiversity Assessment (NBA) conducted through 2018 comprehensively assesses the Keurbooms Estuary. This assessment can be seen in Table i. (NBA, 2018).

Table 1. Summary of National Biodiversity Assessment of 2018

Ecosystem Type		Warm Temperate – Predominantly Open
Threat Status		Vulnerable
Protection Levels		Moderate
Priority	**Biodiversity Importance Rating** (>80 =High Importance, 60 – 80 = Important >60 = Average Importance) (Turpie *et al*. 2002, Turpie and Clark 2009)	High Importance
	Biodiversity Priority Rating (5 =High priority)	Priority
	EBSA (Ecologically or Biologically Significant Marine Areas)	Adjacent
	DFFE Important Fish Nurseries (Very High - Medium = Priority)	High
Condition	**Estuary Condition Summary** (A = Unmodified, approximates natural condition; B = Near natural with few modifications; C = Moderately modified; D = Heavily modified; E = Severely modified and F = Critically modified)	
	NBA 2018 Condition Status	Near Natural
	Present Ecological State (PES) (2018)	A/B
	Hydrology	A
	Hydrodynamics	A
	Water Quality	A
	Physical habitat	B
	Microalgae	B
	Macrophytes	C
	Invertebrates	A
	Fish	C
	Birds	B
Pressures	**Cumulative Pressure level**	Low
	Pressure: Flow modification	Low
	Pressure: Pollution	Low
	Pressure: Habitat loss	Medium

	Pressure: Fishing Effort 2018 (DEFF)	Low
	Pressure: Invasive alien plants	Medium
	Pressure: Alien Fish	High
	Pollution: Noise	High
	DEFF Fishing Effort 2011	Low
	2018 DEFF Fishing Catches (tons)	23
	2011 DEFF Fishing Catches (tons)	23
	Bait collection	Yes
	# Alien or extralimital fish species	4
Restoration	**Recommended Ecological Category (REC)**	A/B
	DFFE Important Fish Nurseries	High
	Remove alien vegetation	Yes
	Control recreational activities impacting on birds	Yes
	Investigate eradication of alien fish	Yes

The Protocol identifies CapeNature as the Responsible Management Authority (RMA) responsible for developing and coordinating the implementation of the Keurbooms Estuary EMP. The estuary is situated within the municipal boundary necessitating strong collaboration with Bitou Local Municipality (LM). A significant portion of the estuary is already managed by CapeNature as the Keurbooms Nature Reserve while the rest of the estuary or parts thereof are listed in the Western Cape Protected Area Expansion Strategy.

Situation Assessment

The Keurbooms estuary is located close to Plettenberg Bay. The confluence of the Bitou river and Keurbooms arms of the estuary is approximately 3.5 km from the mouth. The Bitou River is 23 km long, with its source at Buffelsnek, and is tidal for 7.2 km from the confluence to the causeway at Wittedrift. The Keurbooms River is approximately 85 km long, with its source at Spitskop in the Outeniqua Mountains, and is tidal for approximately 8.5 km from the confluence. The combined catchment has been estimated at anywhere between 1085 and 1188 km^2.

Physical structures include road bridges, old causeways, picnic sites, jetties and a small-boat harbour. Physical properties of the estuarine system are detailed highlighting depth, sediment processes and characteristics, temperature, salinity, pH, dissolved oxygen, turbidity, nutrients and pollution. Freshwater as well as marine (storm) floods are detailed, and recommendations made in respect to future development. A biological description of the estuarine system is provided detailing flora (microalgae, macroalgae and the floodplain/wetland complex), fauna (zooplankton, benthic invertebrates, amphibians and reptiles, freshwater fish, marine and estuarine fish, birds and mammals).

A review of international agreements and strategies, all forms of national, regional and local legislation as well as municipal planning and development strategies and other conservation or development framework initiatives that may impact on the management of the Keurbooms estuary is undertaken.

The recreational uses of the Keurbooms estuary are detailed considering exploitation of living resources, tourism, and non-consumptive use. Water quality and quantity is also detailed making specific reference to the management and description of the catchment, ecological reserve determination process and ecological water requirements. A desktop reassessment of the 2008 rapid level Ecological Water Requirements (EWR) assessment was conducted. The PES was determined as Category A/B. The importance score of 88 translates into an importance rating of "Highly Important" (Bitou Municipality, 2008). The REC was set as Category A/B, similar to the PES. The Ecological Flow Scenario recommended remains as proposed in the 2008 study (Bitou Municipality, 2008), that is present flows (92.7% of Mean Annual Runoff (MAR) but including a 0.45 m^3/s diversion to Plettenberg Bay, a 0.145 m^3/s to Roodefontein and the recommended EWR for the river.

Detail is then provided in respect to the estuary's classification, economic value, protected area strategy (protection of habitat types, protection of fish and bird species, type or level of protection) and rehabilitation requirements. Based on the findings of Turpie and Clark (2007), the following can be said about the Keurbooms estuary with regards to requirements in terms of protection:

- The Keurbooms Estuary forms part of the core set of temperate estuaries required to meet the targets for biodiversity protection of estuarine resources;
- Targets for the protection of habitat types are as follows; supratidal salt marsh (20%); intertidal salt marsh (20%); reeds and sedges (20%); sand/mud banks (20%); submerged macrophytes (20%); and estuary channel (20%);
- The recommended extent of undeveloped margin is 50%; and
- The recommended minimum water requirement falls under the A/B management class.

Issues raised by stakeholders are detailed with the Situation Assessment Report (SAR) concluding with detail in respect to opportunities and constraints as follows:

- Potential for protection of the Keurbooms estuary;
- Potential for restoration; and
- Socio-economic development opportunities.

Vision and Objectives

The Vision for the Keurbooms estuarine system is as follows:

"From catchment to coast, the Keurbooms and Bitou systems will be harmoniously managed through active participation to maintain their biodiversity in order to attract visitors, promote education, create awareness, and preserve the cultural, natural and recreational heritage for the benefit of all South Africans."

There are seven key or overarching management objectives for the Keurbooms estuarine system.

Water Quality & Quantity	Resource Quality Objectives and the Ecological Reserve requirements are implemented to ensure that all ecological processes and livelihoods are sustained by maintaining a Category A/B classification.
Living Resources & Conservation	A sustainable balance is achieved between the conservation, protection and utilization of living and heritage resources.
Land Use & Infrastructure	Development and associated activities within the designated management area are controlled via legislation in such a way as to sustain existing livelihoods and ensure the maintenance of ecosystem functioning and services.
Institutional & Management Structures	The Keurbooms management area is managed cooperatively and effectively by relevant spheres of government and civil society.
Sustainable Livelihoods	Maintenance of existing activities and promoting additional opportunities, in a way that ensures compliance with legislation and the maintenance of ecosystem functioning and services.
Tourism & Recreational use	The tourism and recreational potential of the management area are utilized in a responsible manner so as to benefit all users while ensuring the maintenance of ecosystem functioning and services.
Education & Awareness	Awareness is enhanced through research and education, of the value of estuaries, a sense of ownership and the need for integrated, informed and cooperative management that will ensure the maintenance of ecosystem functioning and services.

Management Priorities

The EMP provides a set of detailed operational objectives accompanied by a range of management actions which need to be implemented via the various implementing agents, namely relevant government departments, and **coordinated by CapeNature as the Responsible Management Authority (RMA),** with the need for a strong partnership with Bitou Municipality. A summary of the operational objectives is provided below, which forms the basis of the action plans.

For each of the defined sectors, the respective action plan is preceded by a narrative of the Operational Objectives, and includes:

- The Operational Objective and Thresholds of Potential Concern (TPC) related to it;
- A list of management actions required.
- Related legal, policy and/or best practice requirements of relevance to specific management actions.
- Monitoring plans to measure effectiveness of actions. If TPCs are brought under control then management actions can be considered effective, however if they continue to be exceeded then changes need to be made (either to management actions, the zonation plan or operational objectives);
- A work plan identifying when each action should be initiated and by whom; and
- A resource plan detailing the human resources, the sources of funding and, where possible, the finances required to achieve these actions.

High, medium as well as low priority actions are summarized for ease of reference.

Spatial Zonation

The purpose of the Estuary Zonation Plan (EZP) is to identify areas along the estuary that have been designated for specific development or land use purposes, or for the delineation of different zones for specific visitor uses. As such the EZP mainly reflects the objectives devised for living resources and conservation, and land use & infrastructure.

In the case of the Keurbooms estuarine management area, which falls within the Cape Floral Region World Heritage Site, the EZP defines zones of Protection, which include the Keurbooms River Seagull Breeding Colony; Conservation (critical biodiversity areas/ ecological support areas); Multi-use (namely, wake free zones, skiing area, no-skiing & no swimming zones, vessel use areas and other zones); known jetties and slipways are indicated on the EZP (yellow dots on the map, some structures may be lumped as a single dot); Rehabilitation, and Eco-tourism nodes are also detailed.

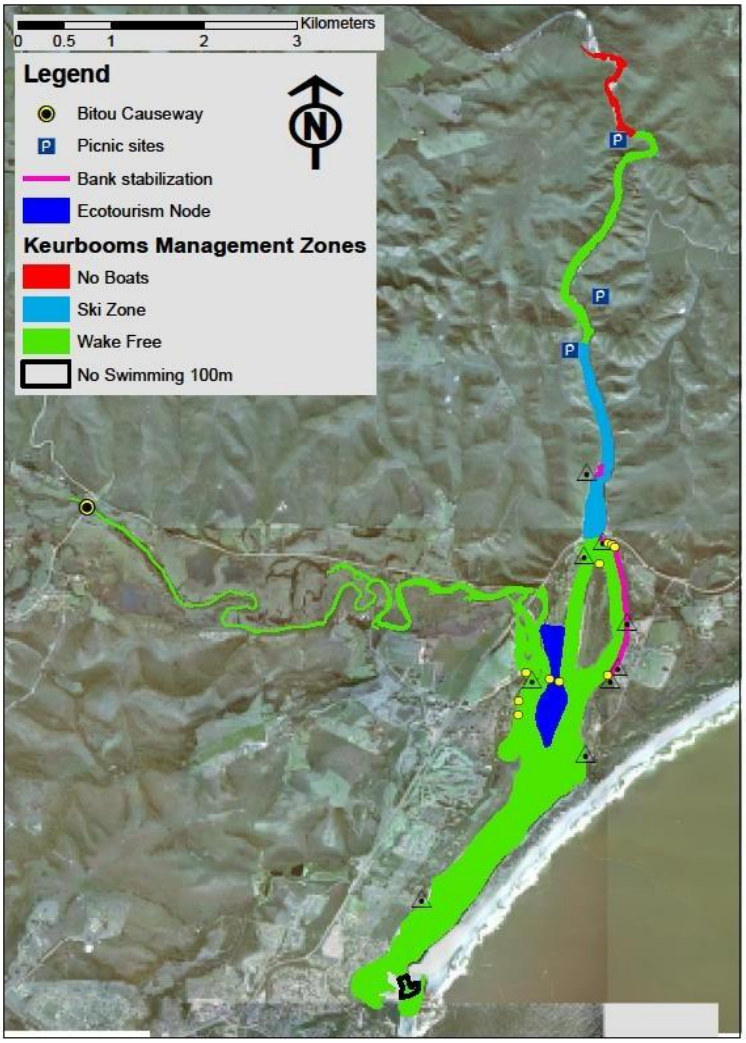

Figure 1. Proposed Estuary Zonation Plan for the Keurbooms estuary

Implementation

Co-management and effective governance have been identified as vital aspects to the efficient and effective management of the Keurbooms estuarine system. This co-management and effective governance is integrated with existing municipal, provincial and national coastal committee structures. The Protocol identifies CapeNature as the RMA, responsible for the development of the Keurbooms Estuary EMP as well as being responsible for the co-ordination of its implementation. However, the Bitou Municipality, as is the case with other Municipalities along the coast, is responsible for many aspects of estuarine management. This has specific reference to the part of the estuary that falls outside of the Keurbooms River Nature Reserve. The two entities should come to agreement via a signed Memorandum of Understanding to co-manage the estuary. Implementation of the EMP can be affected through a range of government departments, different agencies, and forums. The role of the Keurbooms Estuary Advisory Forum (KEAF) 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. Figure 2 displays the key role players that should be included in its management.

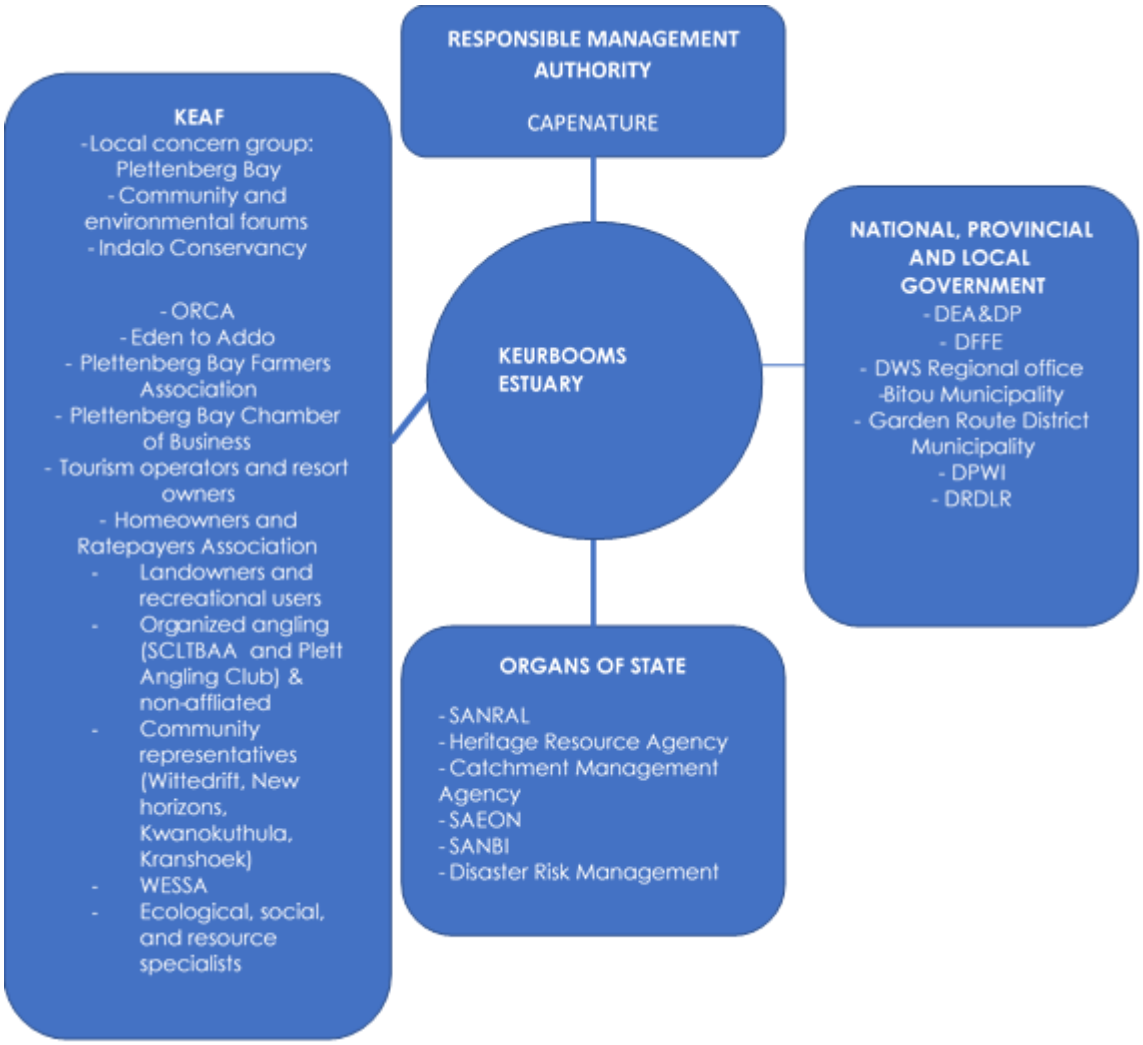

Figure 2. Key role players involved in the Keurbooms estuary

High, medium as well as low priority actions for implementation are summarized for ease of reference.

Integrated Monitoring Plan

The Keurbooms EMP proposes three forms of monitoring, the first two being baseline measurement programmes, e.g., intensive investigations of a wide range of parameters to obtain a better understanding of ecosystem functioning; and long-term monitoring programmes, referring to ongoing data-collection programmes that are done to evaluate continuously the effectiveness of management strategies and management actions within action plans that are designed to maintain a desired environmental state. The former includes a detailed description of the baseline requirements, spatial and temporal scales,

required resources and sampling & analysis techniques with regards to the Thresholds of Potential Concern referred to in the action plans. Long-term monitoring programmes tend to be the responsibility of government departments such as Department of Water and Sanitation (DWS) and DFFE who usually contract the services of tertiary & research institutes, and research initiatives themselves, such as the South African Environmental Observation Network (SAEON). However, the RMA and the KEAF can also be involved to ensure that programmes are undertaken and are beneficial to the effective implementation of the EMP. Long-term monitoring programmes for the following components are proposed, namely hydrology, sediment dynamics, hydrodynamics, water & sediment quality, microalgae, macrophytes, invertebrates, fish and birds.

The third form of monitoring evaluates the performance of the EMP in terms of the effectiveness with which planned management activities contained in the EMP are being performed and ultimately to gauge progress in achieving the vision and objectives. This is a similar process to the Management Effectiveness Tracking Tool (METT) that is already being implemented by CapeNature. This component utilizes the performance indicators included for the various actions, specifically the management priorities, and includes a temporal scale or the frequency of the collection of the performance data and the targets that should be achieved. **The CapeNature Estuary Governance Tool can be used to track implementation of EMP**.

Ultimately the EMP must be holistically reviewed every 5 years to assess whether that vision, objectives and targets are being achieved. This is the responsibility of the RMA, supported by Bitou Municipality, the KEAF and existing municipal, provincial and national coastal committee structures. Usually this will involve the adaptation of management strategies and objectives, or aspects of the action plans themselves, although the problem may be with implementation (capacity and finance). Ideally, representatives of the major components, namely conservation & living resources, social & cultural issues, land-use & infrastructure, and water quantity & quality, should evaluate the efficiency of the EMP in the context of their area of responsibility.

Research

Specific research projects were identified to fill the knowledge gaps and provide supplementary data for monitoring programmes. There may be a degree of overlap with the identified long-term monitoring programmes. These include, inter alia, water quality monitoring, a fishery survey, survey of invertebrate organisms, determination of carrying capacities, study of the effectiveness of sanctuary areas, a study of the effectiveness of the education and awareness programme, and long-term monitoring of habitats and community structures.

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ACRONYMS & ABBREVIATIONS

ADU	Animal Demography Unit from UCT
BGCMA	Breede-Gouritz Catchment Management Agency
C.A.P.E.	Cape Action for the People and the Environment
CapeNature	Western Cape Nature Conservation Board
CARA	Conservation of Agricultural Resources Act (Act 43 of 1983)
CBA	Critical Biodiversity Area
CC	Close Corporation
CFR	Cape Floristic Region
CMA	Catchment Management Agency
CML	Coastal Management Line
CMP	Coastal Management Programme
CMS	Catchment Management Strategy
CPUE	Catch-per-unit-effort
CPZ	Coastal Protection Zone
CSIR	Council for Scientific and Industrial Research
CWAC	Co-ordinated Water bird Counts
DEA	Department of Environmental Affairs (formerly Department of Environmental Affairs & Tourism
DEA&DP	Western Cape Department of Environmental Affairs & Development Planning
DFFE:O&C	DFFE: Oceans & Coasts Branch (formerly Marine & Coastal Management, MCM)
DEFF	Department of Environment, Forestry and Fisheries
DFFE	Department of Forestry, Fisheries and Environment
DIN	Dissolved inorganic nitrogen
DM	District Municipality
DIP	Dissolved Inorganic Phosphates
DO	Dissolved oxygen
DRP	Dissolved reactive phosphate
DRDLR	Department of Rural Development and Land Reform
DRS	Dissolved reactive silicate
DSL	Development Set-Back Line
DST	Department of Science and Technology
DWS / DWAF	Department of Water & Sanitation (formerly Department of Water Affairs & Forestry, DWAF)
EA	Environmental Authorization (formerly Record of Decision)
EAF	Estuarine Advisory Forum
EBSA	Ecologically or Biologically Significant Marine Areas
ECO	Environmental Control Officer
ECPB	Eastern Cape Parks Board
EFA	Enviro Fish Africa
EIA	Environmental Impact Assessment
EIS	Ecological Importance and Sensitivity
EMP	Estuarine Management Plan
EPA	Estuarine Protected Area
EPWP	Expanded Public Works Porgramme
EWR	Ecological Water Requirements

EZP	Estuarine Zonation Plan
GN R	Gazette Number Regulation
GRDS	Gouritz Reserve Determination Study
GRDM	Garden Route District Municipality
GRI	Garden Route Initiative
HWM	High Water Mark
I&AP	Interested & Affected Party
ICM Act	Integrated Coastal Management Act (Act 24 of 2008)
IDP	Integrated Development Plan
IUCN	International Union of Conservation of Nature
KEAF	Keurbooms Estuary Advisory Forum
KNR	Keurbooms Nature Reserve
KRDS	Keurbooms Rapid Determination Survey
KRSBC	Keurbooms River Seagull Breeding Colony
LED	Local Economic Development
LM	Local Municipality
LUPA	Land Use Planning Act (Act 3 of 2014)
MAR	Mean Annual Runoff
MCC	Municipal Coastal Committee
MEC	Member of the Executive Council
METT	Management Effectiveness Tracking Tool
MLRA	Marine Living Resources Act (Act 18 of 1998)
MLRF	Marine Living Resources Fund
MOU	Memorandum of Understanding
MPRA	Municipal Property Rates Act (Act 6 of 2004)
MSA	Municipal Systems Act (Act 32 of 2000)
MSL	Mean Sea Level
NBA	National Biodiversity Assessment
NEM: BA	National Environmental Management Biodiversity Act (Act 10 of 2004)
NEM:PAA	National Environmental Management protected Areas Act (57 of 2003)
NEMA	National Environmental Management Act (Act 107 of 1998)
NFA	National Forests Act (Act 84 of 1998)
NGO	Non-governmental Organization
NHRA	National Heritage Resources Act (Act 25 of 1999)
nMAR	Natural Mean Annual Runoff
NMLS	National Marine Linefish System
NRF	National Research Foundation
NSRI	National Sea Rescue Institute
NWA	National Water Act (Act 36 of 1998)
NWRS	National Water Resources Strategies
ORCA	Ocean Research Conservation Africa
PAMP	Protected Area Management Plan
PDC	Previously Disadvantaged Community
PES	Present Ecological State
Protocol	National Estuarine Management Protocol
RDM	Resource Directed Measures
REC	Recommended Ecological Category
REI	River Estuarine Interface
RHA	National River Health Program

RMA	Responsible Management Authority
RQO	Resource Quality Objectives
SA	Seashore Act (Act 21 of 1935)
SAEON	South African Environmental Observation Network
SAHRA	South African Heritage Resources Agency
SAIAB	South African Institute for Aquatic Biodiversity
SAMSA	South African Maritime Safety Authority
SANBI	South African National Biodiversity Institute
SANCOR	South African Network for Coastal and Oceanic Research
SANRAL	South African National Roads Agency Limited
SAR	Situation Assessment Report
SDF	Spatial Development Framework
STW	Sewage Treatment Works
SUDS	Sustainable Drainage Systems
TPC	Threshold of Potential Concern
UCT	University of Cape Town
WCG	Western Cape Government
WCPAES	Western Cape Protected Area Expansion Strategy
WCWF	Western Cape Wetlands Forum
WESSA	Wildlife and Environmental Society of South Africa
WfW	Working for Wetlands
WHS	World Heritage Site
WMA	Water Management Area
WSA	Water Services Act (Act 108 of 1997)
WUA	Water User Association
WWF-SA	World Wildlife Fund South Africa
WWTW	Waste Water Treatment Works

1 INTRODUCTION

Estuarine ecosystems are not isolated systems. They form an interface between marine and freshwater systems and are part of regional, national and global ecosystems either directly via water flows or indirectly through the movement of fauna. In addition to the biota that these estuaries support, they provide a range of goods and services (uses) to the inhabitants of the various regions. Disturbances in one estuary can influence a wide variety of habitats and organisms in the broader freshwater or marine ecosystem. Thus, the interaction between the systems and users creates a delicate balance, the sustainability of which needs to be addressed by some form of management plan.

In order to address this balance in a consistent manner in the Cape Floristic Region (CFR), the Cape Action for People and the Environment (C.A.P.E.) Estuaries Management Programme developed a holistic and inclusive management process representative of all stakeholders. The programme was governed by a Task Team comprising of officials from C.A.P.E., CapeNature, various government departments, Department of Environmental Affairs: Oceans & Coasts Branch (DEA: O&C) (formerly Marine and Coastal Management), the Department of Water & Sanitation (DWS) (formerly Water, Agriculture and Forestry, DWAF), the Eastern Cape Parks Board (ECPB) and the Council for Scientific and Industrial Research (CSIR), which provides technical support. Each management plan within this programme was developed via an interactive process that utilizes the knowledge and expertise of local stakeholders, whether they be in the private sector (includes civil associations, clubs, tourism etc.), professional, business or institutional (includes government, parastatals, NGOs, conservation bodies etc.).

The urgent need for EMPs became apparent during the development of the National Environmental Management: Integrated Coastal Management Act (Act No. 24 of 2008, as amended by Act No. 36 of 2014) (ICM Act). Estuaries and the management thereof have not been adequately addressed by past marine, freshwater and biodiversity conservation Acts. Estuaries and estuarine management were marginalized because they did not fit the ambit of any one government Department. Estuaries, and the management thereof, now form an integral part of the ICM Act (Chapter 4, Sections 33 and 34), which outlines the need for a National Estuarine Management Protocol (The Protocol). The Protocol identifies the need for the development of EMPs, as these would help to align and coordinate estuaries management at a local level.

Enviro-Fish Africa (Pty) Ltd. (EFA) was contracted by the C.A.P.E. Estuaries Programme in association with the Garden Route District Municipality (DM) to develop the initial EMP for the Keurbooms estuary, based on the Generic EMP Framework available at the time (Van Niekerk & Taljaard, 2007). This document follows on from the Situation Assessment Report and fulfils the requirements of Objective 2, namely the development of an EMP for the Keurbooms estuary and has subsequently been updated according to the 2021 Protocol and supporting EMP Guideline (DEA, 2015).

2 FRAMEWORK FOR THE DEVELOPMENT OF AN EMP

2.1 Approach

The Keurbooms Estuary EMP was initially developed based on the key components of the generic framework for EMPs, as proposed in Van Niekerk & Taljaard (2007). The current update places it in line with the Protocol. Figure 3 is a graphical representation of this framework. It is essential to understand that the EMP developed within this framework is not cast in stone but will instead become a 'living document' that can be adapted according to the changing requirements of the system itself and its users. A feedback system involving a regulated monitoring programme and a detailed situation assessment once every five years will allow for changes to be made by the working groups responsible for each sector.

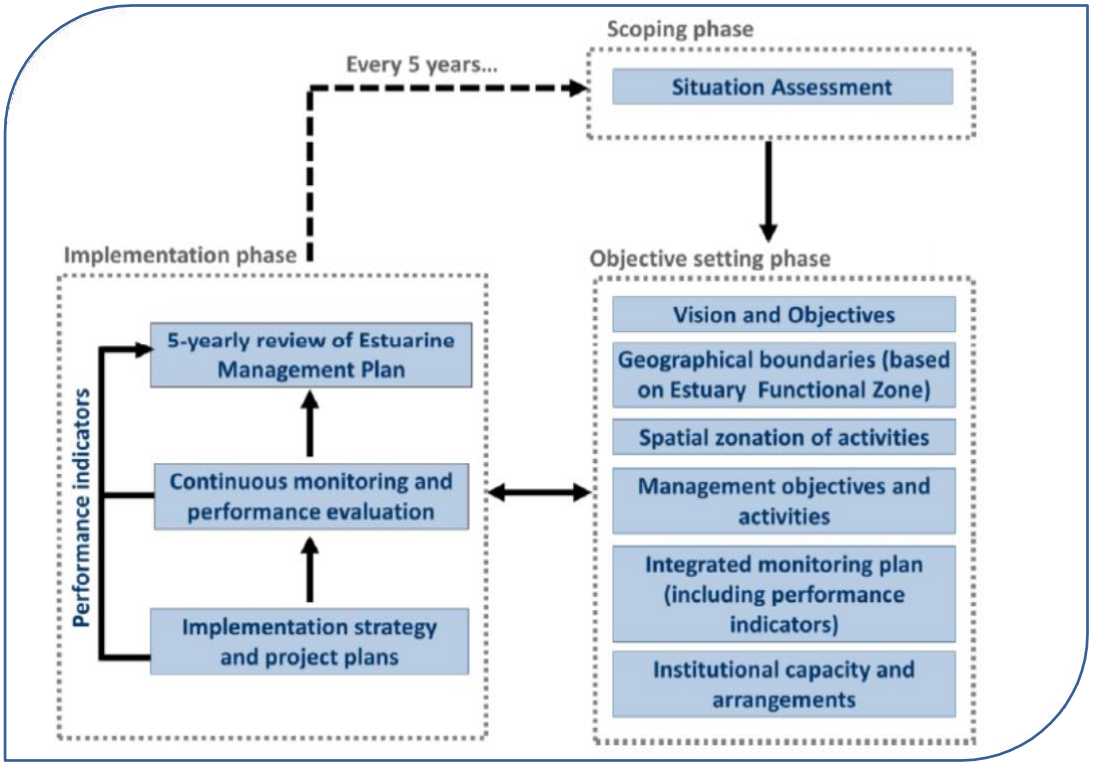

Figure 3. A framework for integrated estuarine management in South Africa

This EMP is a strategic planning document, and as such does not provide detailed, routine planning for the management of the estuary. Furthermore, the ICM Act provides for a report to be submitted to the Minister on an annual basis in respect to implementation once an EMP has been signed off and approved. The EMP should also be recognized as a dynamic document, whereby certain components could be revised as important new information becomes available and management priorities change. Adaptive management should be continually pursued through a process of annually reviewing the progress made in achieving the management objectives. Finally, the management plan should be subject to a comprehensive revision over a five-year cycle, as required by the

Protocol. **The CapeNature Governance Tool was developed to identify, monitor and track EMP implementation across all sectors.**

2.2 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 (EMPs) for individual estuaries (Section 34).

The Protocol, promulgated in 2013 and amended in 2021, 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 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 7) is established by the Minister, and its powers determined by notice in the Government Gazette. It is supported

administratively by the National Department of Environmental Affairs. 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 Member of Executive Council (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 Responsible Management Authority (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, to facilitate cooperative management and effective governance in terms of the EMPs, as well as facilitate and monitor implementation of an EMP.

2.3 Mandate and Responsibilities of the Responsible Management Authority

The Protocol identifies CapeNature as the RMA responsible for developing and coordinating implementation of the Keurbooms EMP. The Bitou Local Municipality also needs to be actively involved as the entire estuary is contained within the municipal

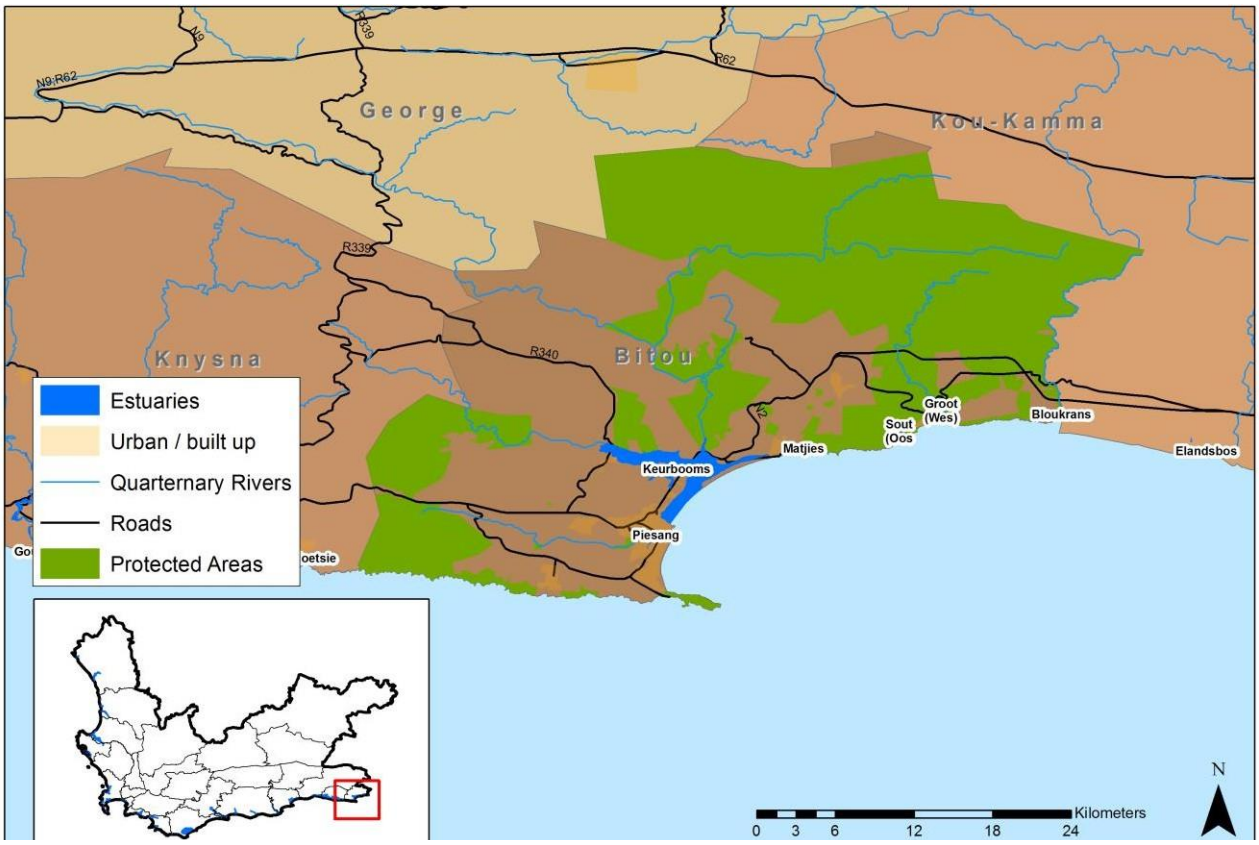

Figure 4. Location of the Keurbooms estuary within the Bitou Local Municipality

boundary (Figure 4). A significant portion is already managed by CapeNature within the Keurbooms World heritage Site (WHS) and the Keurbooms River Seagull Breeding Colony (KRSBC) area. The estuary is also listed within the Western Cape Protected Area Expansion Strategy.

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)"

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(e):	*"The identified responsible management authority to development 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… **Integrated**..." and "**incorporated** into that protected area's management plan as contemplated in section 39 of National Environmental Management: Protected Area Act (NEMPAA)."*

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 an 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 (Bitou Municipality, Garden Route District Municipality (GRDM), Western Cape Provincial Government, Department of Water and Sanitation (DWS), Department of Forestry, Fisheries and Environment (DFFE), will be supported by the Keurbooms Estuary Advisory Forum (KEAF) representing all key stakeholder groups on the estuary.

3 SUMMARY OF SITUATION ASSESSMENT

INTRODUCTION

Estuarine ecosystems are not isolated systems. They form an interface between marine and freshwater systems and are part of regional, national, and global ecosystems either directly via water flows or indirectly through the movement of fauna. In addition to the biota that these estuaries support, they provide a range of goods and services (uses) to the inhabitants of the various regions. The interaction between estuaries and users creates a delicate balance, the sustainability of which needs to be addressed by some form of management plan.

The Protocol promulgated in May 2013, and amended in 2021, under the ICM Act identifies the need for the development of EMPs and sets out the minimum requirements for individual EMPs, as these would help to align and coordinate estuaries management at a local level.

BIO-PHYSICAL DESCRIPTION

The Keurbooms estuary is located close to Plettenberg Bay.

The estuary is classified as a Predominantly Open estuary. The confluence of the Bitou and Keurbooms arms of the estuary is approximately 3.5 km from the mouth. The Bitou River is 23 km long, with its source at Buffelsnek, and is tidal for 7.2 km from the confluence to the causeway at Wittedrift. The Keurbooms River is approximately 84 km long, with its source at Spitskop in the Outeniqua Mountains, and is tidal for approximately 8.5 km from the confluence. A section of the Keurbooms and Bitou Rivers is currently under management of CapeNature and falls within the inscribed Garden Route Complex WHS. Further north, large parts of the Keurbooms River fall within the Garden Route National Park managed by SANParks and these sections also form part of the Garden Route Complex WHS. The combined catchment has been estimated at anywhere between 1 085 and 1 188 km^2. The estuary is listed as a conservation priority in the Western Cape Protected Area Expansion Strategy.

THE EXTENT OF THE ESTUARINE AREA

The exact upper limit of each estuary at any one time will vary depending on tidal flows in relation to the volume of freshwater entering from upstream and currently falls within the Keurbooms River WHS. The seaward extent of the Keurbooms Estuary is located at the mouth, which varies according to the location where floods breach the barrier and the subsequent rate of migration in a southwest direction.

PHYSICAL STRUCTURES

The road bridge over the Bitou Estuary at Wittedrift and the old causeway immediately downstream act as obstructions to water flow and essentially form the upper limit of tidal exchange in the estuary. The existing N2 bridge and embankment obstructs more than 45% of the river width of the Bitou Estuary. A low causeway is present across the Bitou Estuary approximately 1.5 km upstream of the N2 Bridge. This causes some constriction to tidal flows especially at low tides. The N2 bridge over the Keurbooms arm does not appear to affect the orientation of the channel but may contribute to increased sediment deposition immediately downstream. There are three picnic sites, administered by CapeNature, one on the eastern bank and two on the western bank of the Keurbooms estuary above the N2 bridge. There is one slipway above the N2 bridge on the Keurbooms arm and seven below the N2 bridge. There are no slipways upstream of the N2 bridge on the Bitou arm and no jetties upstream of the N2 on either the Bitou or Keurbooms Estuaries. There are two jetties and one boathouse/jetty on the western side of the Bitou channel below the N2 and a slipway on the eastern side. A single long jetty extends from Stanley's Island and a further 4 jetties exist on the eastern side of the eastern Keurbooms channel below the N2. A small-boat harbour, comprising mooring facilities for over 100 boats and a slipway are located on the western side below the N2 at the Plettenberg Bay Angling Club.

PHYSICAL PROPERTIES

Depth

The lower reaches of the Keurbooms estuary are approximately 3 m below Mean Sea Level (MSL) and becomes shallower towards the middle reaches. Upstream of the N2 bridge, average depth is considerably greater with some sections measuring more than 20 m below MSL. Tidal variation inside the mouth is 1.35 m and decreases to 0.95 m and 0.85 m at the N2 bridges on the Keurbooms arm and Bitou arm respectively. Although tidal variation occurs throughout the estuarine basin on the spring tide, active tidal exchange in which the entire water column is flushed occurs primarily in the lower reaches below the N2 bridges. There is no record of mouth closure occurring but the mouth sometimes becomes very shallow.

Sediment processes and characteristics

The surf zone is the main sediment source and river floods are important to temporarily scour open inlets and remove tidal-accumulated sediment from the lower reaches. The tidal prism is in the order of 1.8×10^6 m^3 and the mean spring tidal range in the bay is about 1.6 m. The neap tidal range is very small in the estuary due to the large accumulation of sand in the tidal inlet. Due to the constriction of the tidal inlet, the estuary is flood tide dominated. Annually about 1.5×10^4 m^3 of marine sand enters the back-barrier Keurbooms lagoon and the scour by tidal flows removes enough of the wave deposited sand to maintain the inlet channel and allowrestricted tidal exchange.

Temperature

There is little evidence of vertical temperature stratification, with surface and bottom temperatures measuring between 12 and 22.9 °C.

Salinity

Salinities range from 13 to 35 ppt, with highest salinities in the mouth region. Surface salinity ranges between 35 and 15.3 ppt and bottom salinities between 35 and 22.6 ppt. On average, the Bitou arm is more saline than the Keurbooms arm. Salinity levels will generally decrease over winter due to increased freshwater runoff. Tidal exchange occurs throughout the systems, but the entire water column is only flushed each spring tidal cycle below the N2 bridges.

pH

The pH in the system ranges from 6 to 8.6 with values decreasing upstream in the Keurbooms arm in lower salinities but showing an increase upstream in the Bitou arm. Riverine water in both systems is slightly acidic due to the leaching of humic acid.

Dissolved oxygen

Dissolved oxygen values in both estuaries may vary between 0 and 11.8 mg/l with the lowest values being associated with the deeper sections. These low concentrations may persist in times of prolonged reduced freshwater flow, as inflow is responsible for flushing these deeper sections.

Turbidity

Turbidity is very low, with Secchi disc readings averaging between 1.4 and 1.7 m and only reduced to < 1 m at times of flooding.

Nutrients

Dissolved inorganic nitrogen (DIN) and dissolved reactive phosphate (DRP) concentrations in the Keurbooms estuary are relatively low. Much of the catchment consists of Table Mountain Sandstone resulting in relatively little nutrient enrichment of the river water, while the inorganic nutrient concentrations typically measured in marine waters off the south coast of South Africa are also generally low. There are also no major anthropogenic sources of nutrients in the catchment, comprising largely undisturbed rural areas and limited agriculture development and no large urban or industrial areas. This also supports the suggestion that the Keurbooms estuary is still sufficiently flushed - through freshwater base flows and tidal exchange through the open mouth – to continuously replenish nutrient supplies to the estuary, albeit low. As expected, the river is a significant source of dissolved reactive silicate (DRS) to the estuary, as reflected in the DRS concentrations increasing with a decrease in salinity (depending upon catchment characteristics).

Pollution

Sewage - Treated sewage from the Bitou treatment facility is discharged in the Bitou estuary via the Gansvlei and Rietvlei wetland systems at the head of Ganse Vallei,

increasing the flux of nutrients into the system.

Industrial - No industrial activities take place in the catchment.

Metals - Concentrations of elements in water samples are considered average for similar southeastern Cape rivers, except for lead and cadmium, which are elevated but which may be of geochemical origin. Metals in surface sediments are considered average with the southwestern arm of the lagoon close to Poortjies and Plettenberg Bay exhibiting elevated levels due to contaminated urban runoff.

FLOODS

Freshwater floods

The Keurbooms estuary is prone to episodic flooding that has catastrophic consequences for landowners and infrastructure and poses a risk to human safety. Floodwaters cause extensive erosion, particularly in the lower reaches where land has been cleared to make way for residential developments and resorts. The removal of riparian vegetation weakens the banks' stability causing it to be undercut and ultimately collapse into the estuary. The effects of these floods have been exacerbated in recent times by the accumulation of debris in the catchment, mostly from forestry and alien clearing projects. The greatest damage occurs in the Keurbooms arm below the N2 bridge, as this is where the most development has occurred and where vegetation has been cleared. However, most structures adjacent to the estuary are affected to some extent. The Bitou arm suffers less direct structural damage to infrastructure and land, but dwellings are still prone to flooding.

Marine (Storm) floods

Flooding from the seaward side during extreme storm events can also cause widespread damage to property, infrastructure and the banks of the estuary that have been destabilized by developments.

Recommendations

The following recommendations are made:

- No new developments within the risk area – this could be the 1:100 year floodline or below the 5 m contour whichever one is the highest;
- Planting of vegetation along the estuary banks where it has been cleared;
- Clearing debris from the catchment by forestry and those responsible for alien clearing; and
- Bank stabilization to repair existing damage and to minimize impacts from future events.

BIOLOGICAL DESCRIPTION

FLORA

Microalgae

An increase in freshwater input causes a decrease in mean salinity, an increase in the horizontal gradient and an increase in nitrate and chlorophyll-a concentrations. This indicates that freshwater inflow stimulates microalgal growth and therefore primary productivity. Benthic microalgal biomass ranges from 106 – 191 mg/m^2 for intertidal sites and from 257 - 640 mg/m^2 for subtidal sites. Very low intertidal benthic microalgal biomass has also been recorded for the system (9.53 ± 0.78 µg/g) This value is low when compared to other permanently open estuaries sampled and is related to the sandy nature of the estuary and low sediment organic content compared. A more recent survey also yielded comparatively low microalgal biomass, with subtidal biomass ranging from 13.57 – 136.25 mg/m^2 and intertidal biomass ranging from 5.0 - 109.46 mg/m^2.

Macroalgae

Submerged macrophytes - *Zostera capensis* is the dominant submerged macrophyte in the Keurbooms arm and *Ruppia cirrhosa* is the dominant form in the Bitou arm.

Emergent macrophytes - reeds and sedges are limited to the supratidal marshes and areas of freshwater inflow. The Bitou arm is characterized by dense monospecific stands of *Schoenoplectus scirpoides* and *Phragmites australis* within the channel because of the low flow and restricted tidal action.

Intertidal saltmarsh - The dominant intertidal salt marsh species are *Spartina maritima*, *Sarcocornia perennis* and *Sarcocornia decumbens*. Salt marshes are not extensive due to the geomorphology of the system.

Supratidal saltmarsh - The elevated areas of the floodplains are covered with supratidal salt marsh vegetation, mainly *Sarcocornia pillansii*. The largest supratidal salt marshes are found on the floodplain of the Bitou arm. Mats of grasses such as brakgras and seaside quick dominate large sections of the disturbed upper marsh in both the Bitou and Keurbooms arms. The fringes of the floodplains are occupied by reeds, rushes and sedges, which are an indication of freshwater inflow.

Terrestrial plants - The terrestrial vegetation is grouped into five types, namely primary dune scrub, secondary dune scrub, hind dune scrub, fynbos and aliens. The upper reaches are characterized by dense indigenous forest interspersed with alien trees. Reference to the fine-scale vegetation map by Vlok *et al* (2008) details vegetation types.

The Bitou Floodplain/Wetland Complex

The Bitou wetlands located between the N2 road/bridge and the Bosfontein River are one of the last undeveloped floodplains along the Western Cape coast and comprise a series of typical open freshwater marsh systems, supra- and inter-tidal saltmarsh, river channels and the Bitou Estuarine channel itself. Floods are episodic, usually occurring in

spring/early summer and are vital for maintaining ecosystem functioning in combination with the twice-daily tidal cycles. The Bitou wetlands are the most valuable ecological resource of the entire catchment and are currently under severe threat of development on its perimeter. The wetland corridor provides a link between the SANParks Forest Reserve and the Keurbooms Nature Reserve and potentially allows for the movement of species between protected areas.

FAUNA

Zooplankton - Zooplankton displays high species richness with 39 species being recorded and a dry biomass of between 2.9 and 108 mg/m^3. *Pseudodiaptomus hessei* is the dominant copepod and is particularly abundant in lower salinity waters above the N2 bridge in the Keurbooms arm.

Benthic invertebrates - The largest proportion of the invertebrate fauna is either benthic or associated with the aquatic vegetation with sand prawn, bloodworm, pencil bait and mudprawn being the dominant forms. Macro-invertebrates such as *Nassarius*, *Natica* and *Diogenes* are common in the mid and distal flat areas while the mud crab is common amongst saltmarsh vegetation and *Zostera* beds. An abundance of crabs, either *Sesarme castenata* or *Cleistostoma edwardsii* are present amongst the mud and creek vegetation of Gansvlei. An important component of the soft sediment community is the pansy shell. Of the three main populations of pansy shell in South Africa, two are within Plettenberg Bay.

Subtidal benthic invertebrates were collected during the December 2013 survey. Seventeen taxa from seven major faunal groups were collected. The benthos was dominated by polychaete worms, followed by amphipod crustaceans and molluscs. Polychaetes were most abundant at sites closer to the mouth, while amphipods were more prevalent further from the mouth. As with the hyperbenthos, the density of species was well below expected levels and species richness was also low.

Amphibians and reptiles - Fourteen amphibian species, twenty-seven snake species, three species of tortoise and one terrapin species are likely to be associated with the Keurbooms estuary.

Freshwater fish - The Keurbooms redfin is an endangered species found in the Kransbos, Diep and Langbos Rivers of the catchment and has been identified as requiring special conservation attention. In addition, the following indigenous species are known to occur; forest redfin, Cape galaxias, Cape kurper and longfin eel. Alien species include rainbow trout, brown trout and large-mouth bass. Two marine- migrant species, namely Cape moony and freshwater mullet have been found in the riverine region above the estuary. (Keurbooms Protected Area Management Plan (PAMP), unpublished)

Marine and estuarine fish - A total of 29 species of fish have been recorded in the Keurbooms estuary. The Cape stumpnose is numerically dominant followed by juvenile mullet. Dusky kob dominates the community in terms of biomass followed by the mullet Liza richardsonii. The fish fauna is dominated by marine-migrant species reflecting the

importance of this system as a nursery area. In addition to dusky kob, the system is home to other important and over-exploited linefish species such as white steenbras, spotted grunter and leervis. The Knysna seahorse is known to occur here and its threat status is Endangered. The estuary exists in close proximity to the Robberg Marine Protected Area.

Birds - A total of 64 species have been recorded by the Coordinated Waterbird Counts (CWAC) programme. The kelp gull is by far the most dominant species, followed by the swift (great crested) tern, grey plover, reed cormorant, curlew sandpiper, sacred ibis and common whimbrel. A total of 503 of the endangered African black oystercatchers have been counted. The Bitou wetlands system, which is considered vital from a bird (breeding and biodiversity) point of view and in need of protection due to decreasing numbers attributed to pollution from effluent, pesticides and fertilizers, damage to habitat by livestock, siltation of the estuary, reed encroachment and residential development. The Keurbooms River Seagull Breeding Colony has the largest breeding colony in the region, with approximately 1450 breeding pairs recorded in 2003. In addition, the African black oystercatcher and several tern species are also thought to breed and roost within the sanctuary.

Mammals - Common mammals that may be spotted within the Keurbooms Nature Reserve and in close association with the estuaries include the bushpig, dassie, caracal, genet, baboon, vervet monkey, blue duiker, bushbuck, grysbok, leopard, mongoose and the Cape clawless otter.

LEGISLATION AND PLANNING & DEVELOPMENT STRATEGIES

The purpose of this section is to review all forms of legislation that may have an impact on the management of the Keurbooms estuary. This review incorporates international agreements and strategies, all forms of national, regional and local legislation as well as municipal planning and development strategies and other conservation or development framework initiatives. Specific reference is made to the requirements of the ICM Act and the Protocol. CapeNature is identified as the Responsible Management Authority.

Existing management plans, development strategies, policies and conservation initiatives detailed include the Western Cape Provincial Spatial Development Framework, the Climate change strategy and action plan for the Western Cape, the Western Cape Provincial Coastal Management Programme, the Garden Route District Coastal Management Programme, the Bitou LM Integrated Development Plan and Spatial Development Framework as well as other regional initiatives.

RECREATIONAL USE

EXPLOITATION OF LIVING RESOURCES

A survey undertaken in 2003/2004 as well as anecdotal evidence revealed numerous issues about the fishery on the Keurbooms estuary. In summary, fishers were

predominantly male, formally employed local residents that were not affiliated to any club with effort being higher over weekends and public holidays and highest below the N2 bridges. Subsistence fishers, recorded at only 2%, fished for substantially longer periods. Fourteen species were recorded in catches with the majority being under the minimum legal size and with knowledge of fish regulations being poor. Bait used was varied and collected from various sources. Angler perceptions were that abundance and mean size of bait organisms has declined, with a third attributing this to over exploitation.

Anecdotal information related to the diversity of the fishery, comprising shore and boat-based anglers using a variety of gear types. Conflict between user groups was not considered a major concern and no-take sanctuary zones were recognized as important if based on sound scientific data. No fishing competitions take place on the estuary and stakeholders felt that this should not change.

TOURISM AND NON-CONSUMPTIVE USE

A host of non-consumptive activities take place primarily on the lagoon and Keurbooms estuary; the Bitou arm is not easily accessible by boat above the N2 bridge. Plettenberg Bay and its surrounds are one of the major tourist destinations in South Africa, and yet despite this, the Keurbooms estuary is not specifically marketed as a tourist destination. Several resorts are available to the tourist and numerous B&Bs and guesthouses also provide accommodation. Many tourists own property close to the estuaries and are frequent visitors throughout the year. There are also a large proportion of permanent residents who choose to live here.

WATER QUANTITY AND QUALITY

MANAGEMENT OF THE CATCHMENT

The Keurbooms/Bitou catchment's management structures consist of several national, local and municipal structures. These include the National Department of Forestry, Fisheries and Environmental, inclusive of the Oceans and Coasts Branch, the Provincial Department of Environmental Affairs and Development Planning, the National and Provincial Department of Water Affairs, other National and Provincial offices of departments/directorates, e.g., Agriculture, Land Affairs, Tourism, and the Bitou LM within the GRDM, SANParks.

CATCHMENT DESCRIPTION

The Keurbooms and Bitou river catchments are located in the Gouritz Water Management Area (WMA) 16. The catchments of these two rivers have been measured at between 1 085 and 1 270 km^2, with the Keurbooms River being estimated at 84 km in length and the Bitou River at 23 km. The rivers drain the K60 catchment, which includes quaternary catchments K60A, B C, D, E and F. A small tributary which falls within K60G also forms part of the Bitou catchment and flows directly through the Plettenberg Bay

Sewage Treatment Works (STW) at Gansevalei. It should be noted that the Piesang River also forms part of K60G, but it is an independent catchment and estuary and not part of this management plan.

Plettenberg Bay receives rainfall all year round with peaks in autumn and spring. The rain is mainly cyclonic and orographic, while thunderstorms are rare. The only major dam in the catchment is the Roodefontein Dam. Land-use in the upper catchment is predominantly natural forest, mountain fynbos and grasslands, many swathes in Protected Conservation areas, while the middle and lower catchments are used more extensively for agriculture, residential and recreational purposes.

The catchment is in the process of being classified in terms of resource quality and specific Resource Quality Objectives will be developed for sections of the river as well as the estuary. These will be published in a National Gazette by DWS. These will become law and monitoring the implementation of these flow and non-flow related objectives will become critical into the future.

ECOLOGICAL STATUS

Rivers

The Ecological Reserve has been calculated for the catchment and estuary (see detail later in document). Biological monitoring activities of the Keurbooms and Bitou Rivers were undertaken as part of a provincial initiative between Department of Water and Sanitation (DWS) and CapeNature in order to fulfil the objectives of the National River Health Programme (RHP). Results of the monitoring activities at two sites are presented in detail.

WETLANDS

A large number of freshwater wetlands are found within both the river catchments, with 58 wetlands having been surveyed.

WATER QUANTITY

The Keurbooms estuary is considered oligotrophic, meaning that increases in nutrients (i.e., organic materials) could have negative effects on the biogeochemistry of the system.

ECOLOGICAL WATER REQUIREMENTS

Keurbooms River Reserve Assessment

In 2008, a Rapid level Ecological Water Requirement (EWR) ('Reserve') assessment was conducted on the Keurbooms estuary. Due to concerns raised by stakeholders a desktop re-assessment of the study that added in improving the confidence of the Keurbooms Reserve Determination Study (KRDS) assessment and further catchment classification process where Resource Quality Objectives were legislated for in 2020 (RQOs).

The PES of the Keurbooms estuary was determined as Category A/B. Based on additional data collected by DWS confidence in the results improved to medium. The importance score of the system with its score of 88 translates into an importance rating of "Highly Important". The Recommended Ecological Category (REC) was set as Category A/B, similar to the Present Ecological State (PES). The Ecological Flow Scenario recommended remains as proposed in the 2008 study, that is present flows (92.7% of Mean Annual Run-off (MAR)) but including a 0.45 m^3/s diversion to Plettenberg Bay, a 0.145 m^3/s to Roodefontein and the recommended EWR for the river.

As recommended in the 2008 study, the following actions should be undertaken as soon as possible to stabilize and improve the health state of this estuary (as per the Keurbooms/Bitou Estuarine Wetland Assessment) (highest priority mitigation measures are highlighted):

- *Bitou Drift*: The drift through the Bitou River should be removed in total including all foreign rock material.
- *Northern floodplain of the lower Bitou Estuary*: Remove all exotic invasive trees from the flood plain. No further development should be allowed on the floodplain to prevent further loss of floodplain functionality. Remove the old gravel road to the south of the R340.
- *Southern floodplain of the lower Bitou Estuary*: Remove all exotic invasive plant species from the floodplain, remove the infilling, create a buffer zone (~10 m wide separating the wetland from the agricultural activities on the floodplain).
- *Road Bridge across the lower Bitou Estuary*: Remove concrete piers of the old road bridge to facilitate flow and tidal exchange in the Bitou Estuary and investigate **establishing connection with old Bitou channel**.
- *Middle reaches of the Keurbooms Estuary*: Remove all alien trees from the banks and The Island. Establish a buffer adjacent to the estuary and restrict new development on the banks of the estuary.
- *Upper reaches of the Ganse Spruit*: Remove all exotic vegetation from the stream bed.
- *The Ganse Spruit Wetlands*: Install a sufficient number of large culverts in the roads bisecting the wetlands to allow the free flow of surface water through the wetlands and remove all exotic invasive tree species.
- *Earthen barricades across tidal channels in the Bitou Arm*: **Completely remove all earthen barricades to restore connectivity on the supratidal marsh**. Maintain freshwater flow from the northern sections into the supratidal marsh south of the R340.
- *Middle reaches of the Bitou Estuary*: Remove all exotic tree species from this area, allow the artificial canal to naturally silt up, allow salt marsh to naturally re-colonize the extensive *Stenotaphrum* grasslands, insert culverts below the road bisecting the floodplain to link up the old channels.

SOCIO-CULTURAL IMPORTANCE

Although the Keurbooms estuary is of significant value to local inhabitants with regard resource use and recreational pursuits, no information was available on the socio-cultural importance of the freshwater systems, other than the rivers being an important source of agricultural and domestic water supply for the region.

PRESSURES/RISKS/THREATS

Pressures currently contributing to the present state of the Keurbooms estuary, in terms of water quantity and quality issues are fishing and bait collecting activities, human disturbance in and around the estuary (wastewater discharge; recreational activities), structures in the intertidal and supratidal (floodplain) area and flow reduction from the Keurbooms and Bitou catchments (abstraction and impoundments/dams).

CLASSIFICATION, ECONOMIC VALUE, PROTECTION AND REHABILITATION

CLASSIFICATION

The Keurbooms has been ranked as the 18th most important estuary in South Africa in terms of biodiversity with an overall importance score of 88 out of a possible 100. An A/B management class has also been ascribed to the system based on the freshwater requirements. To maintain the system in the A/B class, the Rapid Reserve Determination study recommends a scenario where abstraction or diversion of freshwater (to Plettenberg Bay) can be increased to 0.45 m^3/s from the present diversion of 0.1 m^3/s. However, all flow reduction activities must be carefully considered prior to approval.

A botanical rating system that takes functional importance, species richness, plant community type richness and plant community type rarity into account resulted in the Keurbooms system being ranked 27th out of 30 warm-temperate estuaries, with a rating of 235. The top ranked warm-temperate estuary is Knysna with a rating of 360. The Keurbooms system does not rank in the top 36 estuaries in the country in terms of botanical importance.

ECONOMIC VALUE

The following economic values have been placed on the Keurbooms estuary (Turpie and Clark, 2007):

- Subsistence - ranked 7th amongst temperate systems with a value of R379 006 per annum.
- Property – ranked 10th amongst temperate systems in terms of property value related to estuaries with a value of R399 million.
- Tourism – ranked 2nd amongst temperate systems in terms of tourism value attributed to estuaries with a value of R400 million per year.
- Nursery (protection of juvenile organisms) – ranked 11th amongst temperate systems with a value of R13.8 million per annum.

- Existence – the Keurbooms does not rank amongst the top 40 temperate estuaries.

PROTECTED AREA STRATEGY AND POTENTIAL

Protection of Habitat Types

Targets for the protection of estuarine habitat types (as a percentage of the total estuarine habitat measured in hectares) found in the Keurbooms are supratidal salt marsh (20%); intertidal salt marsh (20%); reeds and sedges (20%); sand/mud banks (20%); submerged macrophytes (20%); and estuary channel (20%). The overall percentage of all habitat types combined that should be protected is 20% of the total available 90 844 ha.

Protection of Fish and Bird Species

Targets for the protection of fish and bird species (as a percentage of the total population) have been set at 50% of the population of red data (threatened) species; 40% of the population of exploited species; and 30% of the population of all other species. Amongst the bird species, it is only the African black oystercatcher that is a listed threatened species, with the remaining assemblage falling under the 30% protection target. Amongst the fish, it is only the Knysna seahorse that is endangered, and all fish assumed to feature prominently in fishermen's catches, such as dusky kob, spotted grunter, white steenbras and bait species such as mullet are targeted for 40% protection of the population.

Type or Level of Protection

In order for conservation targets and goals to be achieved, 80% of temperate estuaries needed some form of partial protection rather than a few with total protection. The partial protection of 80% of estuaries is deemed desirable from a management perspective, in that it would facilitate the introduction of an almost universal sanctuary zone in each estuary, which is marked by standard markers, which in turn would facilitate public awareness about the estuarine protection system.

The zonation strategy means that individual estuaries may contain a fully protected (sanctuary) area, which would include terrestrial margins, and a conservation area that would be zoned according to the vision and objectives/requirements for that estuary. Sanctuary areas would fulfil the same function as an Estuarine Protected Area (EPA) and as such would have to be set up and managed by an organ of the state. Conservation areas may be managed by a wide variety of styles within a co-management setup where the community and an Estuary Advisory Forum are the main role players.

The Keurbooms estuary in Perspective

Based on the findings of Turpie and Clark (2007), the following can be said about the Keurbooms estuary with regards to requirements in terms of protection:

- The Keurbooms is one of the core set of temperate estuaries required to meet

the targets for biodiversity protection of estuarine resources;

- Targets for the protection of habitat types are as follows; supratidal salt marsh (20%); intertidal salt marsh (20%); reeds and sedges (20%); sand/mud banks (20%); submerged macrophytes (20%); and estuary channel (20%);
- The recommended extent of undeveloped margin is 50%; and
- The recommended minimum water requirement falls under the A/B management class.
- **Keurbooms estuary included in the Western Cape Protected Area Expansion Strategy (WCPAES)**

RESTORATION/REHABILITATION

In early assessments, the most important requirement for rehabilitation on the Keurbooms estuary was clearing of alien vegetation. The recent establishment of the Keurbooms Ecological Infrastructure Investment Framework Working Group and the imminent development of a Management Unit Clearing Plan to address the alien vegetation in the catchment invasions will improve rehabilitation of the system. No mention was made of the rehabilitation of eroded or unstable banks, but following several significant flood events, effective bank stabilization (not infill) is now considered as critical to protect infrastructure and restore riverine functions. The rehabilitation of the Bitou wetlands is also seen as a priority and can be accomplished in cooperation with landowners and NGOs such as Working for Wetlands and Working for the Coast. Recommendations from the EWR study also include removal of hard structures, infrastructure and installation of culverts to improve flow.

CLIMATE CHANGE

There are several threats associated with climate change that are of particular relevance to estuaries, their users and the surrounding area. These include decreased rainfall (drought), increased rainfall and frequency of freshwater floods, increased water temperature (marine/estuary), sea-level rise and increased frequency and intensity of storm events.

THE WAY FORWARD

THE ESTUARINE MANAGEMENT PLAN

Key to the formulation of an EMP was the organization of a stakeholder workshop in order to develop a vision and objectives for the Keurbooms estuary based on the Situation Assessment (this report) and the future needs and desires of the stakeholders. These outcomes together with the assessment provided by Turpie and Clark (2007), the Reserve Determination study and the C.A.P.E. Generic Framework for EMPs was used to formulate the first-generation EMP. This has been updated with recent important documents including the outcomes of the 2011 National Biodiversity Assessment, updated Reserve Determination, and the Protocol and associated guidelines.

ISSUES RAISED BY STAKEHOLDERS

Numerous issues identified during stakeholder meetings and these are proposed to be addressed in the EMP. In short, these issues relate to zonation, estuary specific by-laws, implementation of ecological reserve, rehabilitation, water quality and quantity, monitoring and compliance, fishing, bait collecting, capacity, cooperation, and education to name a few.

OPPORTUNITIES AND CONSTRAINTS

POTENTIAL FOR PROTECTION OF THE KEURBOOMS ESTUARY

The Keurbooms estuarine system is one of 88 temporarily open/closed estuaries in the Warm Temperate zone. The Estuary importance was signified as a highly important estuary and is listed as a Desired Protected Area in the C.A.P.E. Estuaries Conservation Plan for the temperate areas of South Africa. Furthermore, the Keurbooms estuary is included in the Western Cape Protected Area Expansion Strategy. Achievement of formal protected status will certainly facilitate improved management of key physio-chemical drivers of estuarine health such as the quantity and quality of freshwater reaching the estuary, and protection of the estuary from encroaching developments and overexploitation of living marine resources.

POTENTIAL FOR RESTORATION

The environmental reserve determination study conducted for the Keurbooms estuarine system in 2007 identified that the estuary had been significantly degraded through anthropogenic activities. This includes infill, inappropriate stabilization, various roads, old bridge piers and transformation of riverine vegetation buffers. Restoration of critical areas is thus an important recommendation toward restoring estuarine integrity.

SOCIO-ECONOMIC DEVELOPMENT OPPORTUNITIES

The biophysical characteristics as well as the aesthetic appeal of the Keurbooms estuary denote potential opportunities for local socio-economic development. There are multiple resorts, B&Bs and guesthouses to visit in the Keurbooms estuary. To improve the recreational and ecotourism value typically requires suitable tourist development such as accommodation, retail businesses and provision of eco-tourism activities. There are additional opportunities for employment through environmental management initiatives for the estuary. An environmental education centre with trained staff will help with educating school groups and other interest groups.

4 VISION & OBJECTIVES

The above Situation Assessment Report provided a sound basis from which to set a realistic and achievable Vision, as well as Management Objectives for the Keurbooms management area. It also ensured that, at the time of the stakeholder workshop, expectations were aligned with the opportunities and constraints of the ecological and socio-economic environments prevailing at the time. The objectives are listed in priority order to guide subsequent management decisions and the detailed management objectives form the foundation for quantitative, operational objectives.

4.1 Vision

The Vision should be inspirational, representing a higher-level statement of strategic intent, and should take into account the overall Vision set for estuaries within the greater CFR.

The Vision for estuaries in the CFR is:

> ***"The estuaries of the CFR will continue to function as viable systems which are beautiful, rich in plants and animals, attract visitors, sustain our livelihoods and uplift our spirits."***

The Vision for the Keurbooms estuarine system is as follows:

> ***"From catchment to coast, the Keurbooms and Bitou systems will be harmoniously managed through active participation to maintain their biodiversity in order to attract visitors, promote education, create awareness, and preserve the cultural, natural and recreational heritage for the benefit of all South Africans."***

4.2 Objectives

The key or overarching management objectives are generally qualitative statements of the values defined in the Vision and should be statements of outcomes rather than means of achievement. The following key sectors need to be specifically addressed in terms of the main objectives:

Figure 5. Objectives for the Keurbooms Estuarine Management Plan

The vision and overarching or key objectives may be achieved through various management strategies and these should be investigated and evaluated so as to optimally utilize financial and human resources that are detailed in the Action Plans. Detailed management objectives are available for achieving the key objectives for the various sectors.

4.2.1 Water Quality & Quantity

Resource Quality Objectives and the Ecological Reserve requirements are implemented to ensure that all ecological processes and livelihoods are sustained by maintaining a Category A/B classification[1].

- Enforce existing legislation in terms of the National Water Act (Act 36 of 1998; NWA) with respect to water use (Ch. 4, Parts 1 to 6), catchment management (Ch. 2, Part 2) and water quality (Ch. 3, Part 4), and the Eden DM Health By-laws (water quality).
- A Rapid EWR ('Reserve') Assessment[2] (and subsequent re-assessment) has been

[2] An ecological category classification of A/B means that there should be no further change to the system, i.e., it represents a largely natural state with few modifications, and ecosystem functions are essentially unchanged.

[2] *A Catchment Management Strategy (CMS) is developed by the CMA in accordance with the NWA (Ch. 2, Part 2) for the protection, use, development, conservation, management and control of water resources within its water management area. Specifically, this includes the classification of the water resource and the resource quality objectives (RQOs; NWA Ch. 3, Parts 1 & 2) aligned with that particular classification, i.e., Reserve Study. The Breede-Gouritz CMA (BGCMA), was formed in 2014 following the amalgamation of the Breede-Overberg and Gourtiz WMA.*

conducted and stated that the Recommended Ecological Category for the Keurbooms should be A/B. In order to achieve this, 92.2% of the mean annual runoff (MAR) should be allowed to enter the estuarine systems but including a 0.45 m^3/s diversion to Plettenberg Bay, a 0.145 m^3/s to Roodefontein and the recommended EWR for the river. There should be no off-channel storage (see Section 5.1.1 for option of off-channel storage of water on the Bitou).

- Undertake water quality monitoring, according to the reserve determination methods and taking the Resource Quality Objectives (RQOs) into account. RQOs have been set in legislation during catchment classification process.

4.2.2 Living Resources & Conservation

A sustainable balance is achieved between the conservation, protection and utilization of living and heritage resources.

- Retain the designated wake-free zone, which provides protection for submerged vegetation and associated fauna.
- Ensure more effective compliance monitoring to afford bait organisms sufficient protection.
- Maintain the existing Keurbooms WHS and the Keurbooms River Seagull Breeding Colony (KRSBC) and restrict/control access to the latter to reduce disturbance.
- Establish the Bitou Wetland Corridor in cooperation with landowners, to link the Keurbooms WHS and Garden Route National Park and provide protection for the sensitive wetlands and associated fauna above the N2 bridge[3].
- Implement Municipal by-laws (e.g., River By-law and Public Amenities By-law) to protect habitats or resources[4].
- Increase capacity of law enforcement and/or monitoring officers, both within existing structures (e.g. CapeNature, DEA&DP, DFFE and Municipality) and in the form of trained volunteers from within the affected community/stakeholder base appointed in terms Ch. 2, Section 9 of the MLRA), and enforce existing legislation that pertains to activities that impact on terrestrial (riparian area) and estuary ecosystems (in terms of the Marine Living Resources Act (Act 18 of 1998; MLRA), National Environmental Management Act (Act 107 of 1998; NEMA) and associated EIA Regulations, NWA, Conservation of Agricultural Resources Act (Act 43 of 1983; CARA), National Forests Act (Act 84 of 1998; NFA), the ICM Act and Municipal by-laws). Note that law enforcement must be done in combination with education and awareness initiatives.
- Only consider future fishing competitions if based on a catch-and-release format, where fish are measured and not weighed to reduce stress, damage and to minimize post-release mortality.

[3] *The Keurbooms Estuary Advisory Forum (KEAF) should play a major role in the future of this venture*

[4] *For example - restrict the number of boats according to carrying capacity within designated zones; wake-free zones; and areas where no powered vessels are allowed.*

- Increase the number of estuarine areas with conservation status in line with the Western Cape Protected Area Expansion Strategy.
- Protect and rehabilitate sensitive estuary riparian areas and estuary-associated habitats – these would include all saltmarshes (inter- and supra-tidal), the seaward half of the Anath Peninsula, the CapeNature picnic sites in the upper reaches of the Keurbooms arm, the Bitou wetlands above the N2 bridge, the Gansvlei wetlands and the Tshokwane wetlands. This can be achieved by controlling development, access by boats, vehicles, people (walking and dumping) and cattle to reduce impacts and erosion. The extent of this area and control measures on privately owned land will need to be discussed and agreed upon with the landowners.
- Develop and implement an Estuary Zonation Plan (EZP) that denotes certain activities and structures within certain zones, e.g., jetties & slipways, moorings, water skiing & power boating, access points, priority conservation areas (all undisturbed and sensitive areas located within the coastal protection zone – including the Gansvlei, Tshokwane and Bitou wetlands), floodlines and rehabilitation areas.
- Promote low-impact, non-consumptive activities such as walking trails, bird watching, canoeing, sailboarding, open water swimming and other eco-friendly sports events.
- No commercial fisheries or maricultural operations should be considered.
- Remove invasive alien vegetation within the catchment and estuary management area.
- Enforce the provisions of the National Heritage Resources Act (Act 25 of 1999; NHRA) for sites and structures of cultural and historical significance.

4.2.3 Land Use & Infrastructure

Development and associated activities within the designated management area are controlled via legislation in such a way as to sustain existing livelihoods and ensure the maintenance of ecosystem functioning and services.

- Regulate all activities within 100 m of the high-water mark in accordance with the EIA Regulations, within the Coastal Management Line (CML) in accordance with the ICM Act and its Regulations as well as the Seashore Act[5].
- Enforce the provision of the Western Cape Provincial Spatial Development Framework (SDF) with regards coastal (includes estuaries) development and floodlines[6].

[5] *This strategy would include the licensing, operation (or closure) and maintenance of jetties and slipways and the leasing of structures below the high-water mark.*

[6] *The provision states that: "No further urban development shall be permitted on open coast lines that are vulnerable to erosion, inlets that are susceptible to increased storm activity, river banks that are liable to flooding, coastal buffer zones and ecological setback lines in estuaries and below the 1:50 year floodlines (erven) and the 1:100 year floodline (building platform)."*

- Extend Coastal Public Property, as defined in the ICM Act, along the estuarine margins to enhance protection.
- Promote equitable and controlled access to coastal public property, including designation of coastal access land. This will include controlled access to the KRSBC.
- Promote agricultural practices in accordance with the CARA so as to avoid (minimize) erosion and damage to sensitive habitats and indigenous vegetation (includes the catchment).
- Develop and enforce an EZP that regulates land use and development (as defined in the ICM Act[8]) within the terrestrial portion of the designated estuarine area. As can be seen from the definition of "development"[7], this does NOT refer to farming activities such as planting and grazing, unless it involves the removal of indigenous vegetation. If this is the case, then an assessment will need to be conducted to determine the impact and methods of minimizing this impact.
- Ensure adequate services for sanitation treatment and disposal in accordance with the Water Services Act (Act 108 of 1997; WSA), Municipal Systems Act (Act 32 of 2000; MSA) and the Bitou LM By-laws pertaining to water supply, sanitation services and industrial effluent.
- Incorporate the recommendations (including the EZP) from this EMP into the Municipal SDF, which in turn will inform the Integrated Development Plan (IDP).
- Manage structures and privately owned and developed land in such a way as to prevent further bank erosion, siltation of the estuary and damage during flood events. This encompasses almost all of the management area, from Poortjies at the mouth to the picnic sites at the top of the Keurbooms and structures in the upper Bitou.
- Develop a strategy to deal with the threat of sea-level rise and permanent flooding of riparian land and property. The strategy will need to be based on the principles and protocols described in the National Climate Change Response Strategy and will in all likelihood be developed at the National level; it will need to consider aspects such as relocation (of people, structures and infrastructure) and compensation.
- Provide incentives (e.g., rates rebates; Municipal Property Rates Act 6 of 2004; MPRA) for landowners or lessees to manage portions of their land as conservation areas to protect biodiversity and/or provide for educational initiatives (e.g., the Bitou Wetland Corridor initiative and the leased portion of the Anath Peninsula could conceivably consider this approach).

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[7] ***"development"***, *in relation to a place, means any process initiated by a person to change the use, physical nature or appearance of that place, and includes—*
(a) the construction, erection, alteration, demolition or removal of a structure or building:
(b) a process to rezone, subdivide or consolidate land;
(c) changes to the existing or natural topography of the coastal zone; and
(d) the destruction or removal of indigenous or protected vegetation.

- No future harbour development or marina facilities should be allowed within the defined management area.
-

4.2.4 Institutional & Management Arrangements

The Keurbooms - Bitou estuary is managed cooperatively and effectively by relevant spheres of government and civil society.

- RMA to support and chair the local estuarine forum (Keurbooms Estuary Advisory Forum (KEAF).
- RMA to have oversight of all relevant spheres of government and civil society, to ensure the implementation of the EMP; this includes ensuring that relevant government departments fulfil their obligations (e.g. DEA&DP, DFFE and DWS – assisted by the Breede-Gouritz Catchment Management Agency, BGCMA) and that the ideals of the EMP are captured within all relevant management and planning documents, e.g. SDF, IDP and a Catchment Management Strategy (CMS) that includes the setting of RQOs.
- Create awareness and ensure accountability amongst government institutions that have a mandate to enforce all forms of legislation applicable to the management area.
- Ensure that all arrangements between government departments with regards administering legislation are made clear to all affected stakeholders.
- Ensure that all government institutions and their staff comply with all relevant legislation and regulations, e.g., certificate of competence (skippers ticket) for staff responsible for estuary patrols.
- Ensure that all government institutions make provisions in terms of funds and human resources to undertake priority management actions according to their legislated mandate (e.g., DFFE and deployment of voluntary compliance officers/fisheries inspectors).
- Identify and implement strategies for local generation of funds to support implementation of the EMP.
- Consider Expanded Public Works Program (EPWP) in support of EMP implementation.

4.2.5 Sustainable Livelihoods

Support existing activities and promote additional opportunities are managed in a way that ensures compliance with legislation and the maintenance of ecosystem functioning and services.

- Ensure compliance of all existing activities (e.g., recreational fishery and tourism-based operations such as ferry operations and fishing charters) with legislation and

management plans that regulate against potential impacts on the management area, its inhabitants and users.

- Promote the development of new initiatives that will benefit previously disadvantaged communities (e.g., ferry across the Keurbooms Lagoon to the KRSBC) and that will comply with legislation and management plans that regulate against potential impacts on the management area, its inhabitants and users.

4.2.6 Tourism & Recreational Use

The tourism and recreational potential of the management area are utilized in a responsible manner to benefit all users while ensuring the maintenance of ecosystem functioning and services.

- Market and promote the Keurbooms estuary as an eco-friendly destination that is part of the greater Garden Route experience and highlight conservation initiatives and the importance of biodiversity protection.
- Promote non-consumptive recreational activities within the management area that include activities for the general public, as well as organized sporting events, e.g., open water swimming, sailing, kite boarding, windsurfing (sailboarding), canoeing and kayaking, rowing, bird watching, walking trails, diving (snorkeling) trails, abseiling and mountain biking (some of these would include terrestrial areas such as the Keurbooms Nature Reserve and Bitou wetlands).
- Ensure that all recreational and tourist activities comply with Municipal By-laws, the EZP and all legislation.

4.2.7 Education & Awareness

Awareness is enhanced through research and education, of the value of estuaries, a sense of ownership and the need for integrated, informed and cooperative management that will ensure the maintenance of ecosystem functioning and services.

- Facilitate educational workshops for local authorities, in particular town planners and directors, about the value of estuaries (ecological, social and economic), the EMP and its context within all forms of legislation (e.g., MLRA, ICM Act, NEMA & EIA Regulations, NWA and CARA) and planning schemes (e.g., SDF and IDP) and the consequences of irresponsible development within the estuarine area.
- Facilitate training courses for estuarine and terrestrial reserve managers, municipal authorities, local management institution members, catchment management agencies and water user association members.
- Implement a public awareness campaign (estuary value/natural heritage, biodiversity, threats and conservation efforts) via pamphlets, notice boards, direct engagement with users by compliance authorities, school tour groups and illustrated

talks given by relevant specialists. Ensuring cooperation by users through education and awareness initiatives and not only through direct application of the law (e.g., fines and arrests) has the potential to be more effective in the long run.

- Empower CapeNature field rangers, government officials (includes river control) and municipal authorities through an education initiative involving relevant national and regional legislation, local by-laws, zoning of the estuary and general knowledge of fauna and flora within the management area.
- Encourage research projects (tertiary institutions) aimed at enhancing the existing knowledge and filling in knowledge gaps of the Keurbooms estuary. These projects can be used to enhance the efficacy of the EMP through amended Management actions and monitoring programmes.

5 MANAGEMENT PRIORITIES

A full range of management actions has been identified to facilitate the achievement of the detailed management objectives given per sector; actions related to Living Resources and Conservation have been separated. These actions relate to more refined Operational Objectives. The Operational Objectives specify quantitative, measurable standards, target values and limits or thresholds of potential concern (TPCs[8]) for indicators relevant to issues within each of the main sectors. These need to take into account any existing standards, regulations (legislation), operational policies or guidelines, as well as available resources. Table 2 overleaf provides a summary of the Operational Objectives. **CapeNature has developed a Governance Tool to identify, monitor and track the cooperative implementation of objectives.**

For each of the defined sectors, the respective action plan is preceded by a narrative of the Operational Objectives, and includes:

- The Operational Objective and TPC related to it;
- A list of management actions required;
- Related legal, policy and/or best practice requirements of relevance to specific management actions;
- Monitoring plans to measure effectiveness of actions. If TPCs are brought under control then management actions can be considered effective, however if they continue to be exceeded then changes need to be made (either to management actions, the zonation plan or operational objectives);
- A work plan identifying when each action should be initiated and by whom; and
- A resource plan detailing the human resources, the sources of funding and, where possible, the finances required to achieve these actions.

The action plans are detailed in Table 4 to Table 14.

Several National acts contain provisions that dictate to authorities (including managers), landowners and recreational users with regards to activities that are allowed, or at least should be regulated, within estuaries or within prescribed distances from estuaries. It must be clearly understood that all management recommendations (including aspects of the Spatial Zonation – see Section 6.1, made in this EMP are based on this existing legislation. As such, all existing activities, whether within urban, rural or the immediate estuarine areas, should conform to these recommendations. This EMP merely serves to create an awareness of what activities should be considered according to the existing legislation. In so doing, the sustainable use of land and resources should be optimized to benefit all user groups and

[8] TPCs are defined as measurable end-points related to specific indicators that, if reached, prompt management intervention. In essence, TPC end-points should be defined in such a way that they provide early warning signals of potential non-compliance with operational objectives (Taljaard & Van Niekerk 2007a). Relevant indicators and recommended TPCs for many of the operational objectives detailed below have been taken from McGwynne & Adams (2004).

the estuarine ecosystem itself.

In the absence of a comprehensive ecological reserve assessment, and ongoing research efforts that continue to provide new information on many aspects of biology and ecology of the management area, some of the action plans must be considered preliminary and may change as more information becomes available.

Table 2. Summary of Operational Objectives

Water Quantity & Quality
W1: Ecological Reserve and instream flow
W2: Pollutants
W3: Microbial organisms and pathogens
W4: Revision of the RQOs through a comprehensive EWR assessment
W5: Prevention of negative impacts from the proposed desalination plant
W6: Ensure that allocated flows reach the Keurbooms estuary
Biodiversity (Conservation)
B1: Maintenance of plant communities
B2: Eradication of alien vegetation
B3: Maintenance of intertidal invertebrate species (mudprawn, sand prawn) and Knysna seahorse
B4: Maintenance of water bird populations partially or highly dependent on estuaries
B5: Maintenance of fish populations
B6: Protection and rehabilitation of wetlands and saltmarsh areas
B7: Restoration of original flow regime above Bitou N2 Bridge
B8: Control access to the Keurbooms River Seagull Breeding Colony
B9: Increase the number of estuarine areas with formal protected status
B10: Inform stakeholders informed of all ongoing and proposed conservation initiatives
Human Activities (Conservation)
HA1: Ensure carrying capacity of estuary is not exceeded
HA2: Regulate bait collection activities
HA3: Regulate the number of fishing competitions and format
HA4: Regulate human activities within the KRSBC
Law Enforcement (Conservation)
LE1: Improve law enforcement capacity
LE2: Enforce & monitor developments in the context of their Environmental Authorizations
LE3: Enforce adherence to EZP, Municipal By-laws and other relevant legislation
LE4: Formalize the delegation of powers by Bitou LM to CapeNature for administration of EZP and By-laws
Heritage Resources (Conservation)
HR1: Identify and preserve heritage resources and sites of cultural significance
Sustainable Utilisation of Living Resources
E1: Protect of birds (and eggs) within the KRSBC
E2: Regulate bait collecting activities
E3: Regulate recreational fishing activities
E4: Regulate number and format of fishing competitions and ensure compliance
E5: Ensure availability of recreational fishing permits

E6: Formalize the delegation of powers by MLRA to CapeNature (FCOs)
Land Use & Infrastructure
LU1: Regulate the nature & extent of land-use & infrastructure
LU2: Monitor the number of applications for development and/or rezoning of land within the management area and catchment
LU3: Establishment of an eco-tourism node on the Anath Peninsula
LU4: Ensure the use of planning and management tools to guide development
LU5: Streamline application and authorization process for repairs to flood damage and standardize methods used for rehabilitation
LU6: Ensure equitable and controlled access to Coastal Public Property
LU7: Increase capacity of the sewerage reticulation system at Keurboomstrand and Poortjies
LU8: Ensure capacity of Bitou WWTW is sufficient to cope with future needs
LU9: Assess feasibility of the removal of excess sediment by dredging
LU10: Assess potential threat of sea-level rise, flooding and storm events
LU11: Determine SANRAL's intentions for the use of the servitude across the Anath peninsula
Institutional & Management Structures
IMS1: Reconstitute the Estuary Advisory Forum
IMS2: Ensure the integration of estuarine and catchment management related processes
IMS3: Ensure compliance by CapeNature with skipper's license requirements (undergo certification)
IMS4: Appointment of a regional Estuarine Management Co-Ordinator for the Bitou Local Municipality
IMS5: Secure funding for priority management actions from appropriate government departments and implementing agents **(CapeNature Governance Tool)**
Sustainable Livelihoods
SL1: Existing activities compliant with all forms of legislation and planning frameworks
SL2: Promote non-consumptive enterprises involving previously disadvantaged communities which are compliant with all forms of legislation and planning frameworks
Tourism & Recreational Use
T1: Recognition of the Keurbooms management area as a premier eco-tourism destination
T2: Promote organized sporting events
Education & Awareness
EA1: Initiate educational workshops on the value of the management area, its context within planning frameworks and legislation and consequences of poor decision making
EA2: Develop and enable an interactive public awareness campaign
EA3: Identify key research projects to be undertaken by tertiary & research institutions and government departments

5.1.1 Water Quantity & Quality

The NWRS provides for the development of a Catchment Management Strategy (CMS) by a CMA or Water User Association (WUA), which will ensure both the classification of the water resource (Keurbooms) and the required RQOs. The RQOs for a catchment and its associated riverine and estuarine systems relate to the following aspects:

- the water quantity of freshwater inflow into the estuary (ecological reserve); and
- the water quality of freshwater inflow at the head of the estuary and water quality within the estuary.

The Desktop (Rapid) EWR Assessment (and subsequent re- assessment) for the Keurbooms estuary (comprising both the Keurbooms and Bitou arms) classified the various components as follows:

- Present Ecological State (PES) – Category A/B[9];
- Ecological Importance and Sensitivity (EIS) – High; and
- Recommended Ecological Category (REC) – Category A/B (Category A cannot be attained due to existing developments, infrastructure and activities).

The following components, listed in Ch. 3 (Section 13) of the NWA, form the basis of all Resource Quality Objectives (RQO) determinations:

- The Ecological Reserve for human needs (e.g., irrigation and household use) and the ecological requirements of the estuary;
- the instream flow;
- the water level;
- the presence and concentration of particular substances in the water (nutrients, physical variables and toxic substances);
- the characteristics and quality of the water resource and the instream and riparian habitat;
- the characteristics and distribution of aquatic biota; and
- any other characteristic of the water resource in question.

The recommended TPCs for the above components, based on the updated rapid level (desktop) assessment, are provided in Table 3.

[9] Category A/B indicates a system that is between A (unmodified; natural) and B largely natural with few modifications; small change to habitat and biota, but ecosystem functioning remains essentially unchanged

Table 3. Recommended TPCs for components of RQO determinations

Ecological Reserve[10]	• The TPC for estuary requirements is <92.2% of the combined (Keurbooms and Bitou catchments) MAR (takes a 0.45 m^3/s diversion into account; assumes there will be no of-channel storage; and allocates 0.145 m^3/s to Roodefontein Dam). • The recommendation from the Ecological reserve is that the river inflow to the Bitou arm should remain similar to the present state because it comprises an important, ecologically sensitive wetland and baseflows are low; any abstraction could therefore remove all flow to the estuary. • The construction of any new storage dams in either catchment would be covered by this issue. • A comprehensive EWR assessment is required as a matter of urgency; the TPC would be if management of the estuaries continued to be based on the Rapid (desktop) assessment.
Instream flow	• A minimum river flow of 0.3 m^3/s, i.e., TPC is flow of < 0.3 m^3/s. • This flow must be measured below the lowest (downstream) abstraction point, i.e., if abstraction is allowed below the existing DWS measuring weir [K6H19] then an additional measuring station must be erected at that site to ensure the minimum flow required for the ecological reserve. In the Bitou arm, this must be at the head of the estuary. • Any abstraction that reduces the availability of water to the Reserve may be declared a stream flow reduction activity (NWA; Ch. 4, Section 36) and may be temporarily controlled, limited or prohibited by a CMA in accordance with Schedule 3, Item 6 of the NWA (this can include abstraction for activities such as golf estates).
Pollutants	• TPCs expressed in appropriate units (standards set by the EcoSpecs (Appendix 1), and by DWAFs' Water Quality Guidelines for the Natural Marine Environment – see Appendix 2; DWAF 1995[11]) for physical/chemical variables, inorganic nutrients and toxic substances (includes heavy metals, nitrates and phosphates[12] and petroleum-based products).

[10] Note that under extreme conditions (e.g., severe drought), emergency measures may allow for an increase in the diversion amount required to meet human needs, and as such the river flow may fall below the TPC. Human needs do not include abstraction for residential, golfing or equestrian/polo estates (NWA; Chapter 6, Section 67; Schedule 1)

[11] These guidelines are currently under review and will be updated in the near future

[12] This will include most products that contaminate freshwater runoff from farmlands and commercial forestry plantations

Microbial organism and pathogens	• TPCs expressed in appropriate units (standards set by DEA's Water Quality Guidelines for Recreational Use, DEA 2012). • For example, the TPC for *E. coli* is a range of >100units /100 ml in 80% of samples and 2 000 units/100 ml in 95% of samples for full and intermediate contact recreation for marine (and estuarine) waters.
Characteristics and distribution of key **aquatic invertebrate biota** (mudprawns, sandprawns and pencilbait) as indicators of water quality problems	• A TPC of 30% deviation from baseline counts should be set. This is dealt with under the Conservation (Biodiversity and Human Activities) and Living Resources Operational Objectives detailed below. • Caution is advised as decreases may be due to factors other than water quality or quantity (freshwater inflow), such as poor recruitment, natural predation, utilization by humans or flooding/storm events.
Desalination Plant	• The proposed desalination plant must not impact negatively on the estuary; primarily the discharged brine stream may alter salinity regimes to the extent that biota is affected. Brine therefore needs to be discharged offshore and not in the estuary or estuary mouth. • The TPC would be if the change in salinity was > 5‰ (DWAF Water Quality Guidelines for the Natural Marine Environment – see Appendix 2; DWAF 1995) and if selected estuary-associated biota in the vicinity of the discharge point were to be altered beyond the baseline structures. • Baseline structures and values need to be determined by detailed surveys (at discharge site and selected control sites for comparison) prior to the issuing of an authorization for the plant.
Off channel storage	• Ensure compliance with EWR assessment by ensuring that allocated flows reach the estuaries and that off-channel storage is monitored. • This needs to be considered in cooperation with BGCMA, DWS, DFFE, and landowners. • The TPC would be non-compliance with EWR assessment resulting in reduced flows below recommended levels, and if off channel storage was not monitored.

Table 4. Management Actions for Water Quantity and Quality

Management Actions	Legal Requirements	Monitoring Plans	Work Plan	Resource Plan
Operational Objective W1: Ecological Reserve and instream flow; TPC is if < 92.2% of combined MAR enters the estuaries or if flow rate decreases below 300 l/s.				
Ensure that the minimum flow requirements for the estuary are maintained via restricting water abstraction and impoundment activities in the catchment.	NWA - Ch. 3 (Parts 1 and 2)	A flow station to be constructed below the lowest abstraction point and data monitored monthly. All water use activities and licenses in the catchment to be assessed for compliance with Reserve requirements. All future water use licenses to be considered in the context of the Reserve requirements. Monthly basic water quality parameters need to be monitored, e.g., salinity, do, temperature, turbidity etc. in order to identify the different estuarine states, the ecological reserve implementation as well as significant changes in water quality due to lack of freshwater inflows.	DWS is responsible; it should be initiated immediately due to drought risks and development (demand) pressure. Consideration must be given to the Roodefontein developers assisting in funding and construction of a downstream flow station. Bitou LM to be involved as they rely on abstraction to supply Plettenberg Bay and surrounds.	**Human-** DWS: Resource Protection; Roodefontein developers; Bitou LM: Town Engineer Division. **Financial-** DWS (Resource Protection); Roodefontein developers.
If the Ecological Reserve requirements are not being met, abstraction activities may be declared as streamflow reduction activities and temporarily controlled, limited or prohibited.	NWA - Ch. 4 (Section 36; Schedule 3 (Item 6)			
Operational Objective W2: Pollutants; TPCs will vary according to pollutants and DWS water quality guidelines.				
Identify source of pollution and take steps to remedy or mitigate. Sources may include contaminated runoff (stormwater, agricultural return flows, fertilizers from residential	NWA - Ch.3 (Part4), and RQOs (Ch.3, Parts1and 2); DWAF Water Quality Guidelines (Recreational Use-marine); Municipal	Regular water quality monitoring at set stations along the length of each estuary (including point sources, e.g., angling club marina) and in the rivers above the head of each estuary. Water quality monitoring according to RDM methods	Joint responsibility between CapeNature, Bitou LM and DWS (CapeNature should take long-term lead role). Monitoring is ongoing and needs to be done monthly or if contamination is visible. Basic pollution response to be	**Human-** DWS: Water Quality/Pollution; Bitou LM: Municipal Services. **Financial-** DWS to assist with start-up funding, thereafter Bitou LM (Financial Services) must source and provide funds.

Management Actions	Legal Requirements	Monitoring Plans	Work Plan	Resource Plan
properties and estates), outboard engines and fuel spills. Investigate use of Sustainable Drainage Systems (SUDS) for stormwater runoff.	by- laws (Waste Management and Municipal Health).	and taking RQOs into account.	developed locally and coordinated with provincial response (GRDM to lead)	
Operational Objective W3: Microbial organisms and pathogens; TPCs will vary according to microbial organism or pathogen and DWAF water quality guidelines.				
Identify source and type of contamination and take steps to remedy or mitigate (provision and maintenance of basic services and infrastructure). Main sources are spills from Bitou WWTW, urban runoff and overflowing sewerage infrastructure at Keurboomstrand. Potential contamination from cattle grazing on Bitou floodplain.	NWA-Ch.3 (Part4) and RQOs (Ch.3, Parts1and 2); Ch.4 (Discharge, pipelines, outfalls etc.); ICM Act (Ch. 8, Section 69); DWAF Water Quality Guidelines (marine); Municipal by- laws (Waste Management and Municipal Health).	Regular water monitoring at known point sources to specifically detect microbial and pathogen infestations. Monitoring should include extra sampling during times of heavy rains (increased runoff) and before organized sporting events. Licenses to discharge treated waste into the estuaries need to be assessed. Water quality monitoring according to RDM methods and taking RQOs into account.	DWS is the lead authority on water quality but this function should be fulfilled by Bitou LM who are also responsible for sewerage infrastructure. Basic pollution response to be developed locally and coordinated with provincial response	**Human-** DWS: Water Quality/Pollution; Bitou LM: Municipal Services and Infrastructure Development. **Financial-** Bitou LM (Financial Services) must source and provide funds for infrastructure upgrade and maintenance.
Operational Objective W5: Revision of the RQOs through a Comprehensive EWR assessment; TPC is if the RQOs are not revised through a comprehensive EWR assessment.				
Monitor and refinement of RQOs through a Comprehensive EWR assessment (includes estuary and river specific water quality parameters and estuary- and river-specific water	NWA; CMS (Ch.2 Part2), RQOs (Ch.3, Parts1and 2)	Monitor the revision of the RQOs for the catchment and estuary. Once these have been developed then the estuary- and river-specific parameters (water volume and physical parameters) can be monitored.	Critically important and must be initiated immediately – a detailed assessment may take up to five years. The DWS has overall responsibility, but this is also the function of the BGCMA. This EMP is to be embedded in the CMS.	**Human-** DWS: Catchment Manager and Resource Protection. Consultants or research institutions may be appointed to update the RQOs. The RMA collaborative structure is to assist with field work (e.g.) monitoring **Financial-** cost of updating the RQOs may vary.

Management Actions	Legal Requirements	Monitoring Plans	Work Plan	Resource Plan
quantity requirements).				
Operational Objective W6: Prevention of negative impacts from the desalination plant; TPC is if salinity levels vary >5 units from baseline levels and if selected estuary-associated biota in the vicinity of the discharge point is affected.				
Undertake a survey of key biota (mudprawns, sand prawns, zooplankton, phytoplankton and submerged macrophytes) and salinity regimes near the discharge site prior to the operational phase and monitor for change. Location of discharge site must be in area where least impact will occur.	NEMA: EIA Regulations for the required EIA and associated studies, mitigation measures and monitoring; DWAF Water Quality Guidelines (Recreational Use - marine).	Initial EIA must determine the location of the discharge site where it will have least impact. Annual survey of selected biota and if the desalination plant suffers a catastrophic failure. Control sites will need to be included as well.	Surveys and location of discharge site to be conducted as part of EIA prior to the issuing of authorization for the plant. Monitoring to be done annually or after incidents. Responsibility is Bitou LM, but likely to be outsourced to consultants. Alternatives for plant location and brine discharge points are to be assessed in the planning and permitting studies.	**Human-** Bitou LM: Infrastructure Development and Strategic Services to appoint consultants to conduct EIA, survey of biota and ongoing monitoring. **Financial-**Bitou LM (Financial Services) to fund EIA (minimum of R300 000) and ongoing monitoring (R50 000/ annum).
Operational Objective W7: Ensure that allocated flows reach the Keurbooms estuary and that off-channel storage is monitored; TPC is if non-compliance with the Reserve Assessment and reduced flow to the estuaries.				
Ensure compliance with Reserve Assessment by ensuring that allocated flows reach the estuary and that off-channel storage is monitored.	NWA; CMS (Ch.2 Part2), RQOs (Ch.3, Parts1and 2)	Monitor water inflows to estuary, existing abstractions and applications for new abstractions. A water level recorder needs to be installed in the estuary.	Critically important and must be initiated immediately- detailed assessment may take up to five years. The DWS has overall responsibility, but this is also the function of the BGCMA, RMA and Agri-Western Cape should also be involved. The water level recorder is the responsibility of DWS, and should be in place by as early as 2019 to start a monitoring record.	**Human-** DWS: Resource Protection and Water Licensing; BGCMA; DEA&DP: Environmental Management & Protection and Development Planning Divisions; Agri-Western Cape. **Financial-** costs for monitoring existing stations are within the operational budget. Construction of installation of gauging station above Bitou arm will incur costs.

5.1.2 Conservation

Operational objectives for conservation purposes should be targeted at protecting biodiversity within the management area by ensuring that the diversity, distribution and abundance of aquatic plant, bird, fish and benthic invertebrate communities is maintained or restored. These objectives can be defined in terms of TPCs for a range of indicators that firstly reflect aspects of biodiversity itself, secondly are aimed at controlling human activities that may impact on habitats and living resources, and thirdly deal with enforcement issues. The conservation of heritage resources is also dealt with under this sector.

5.1.2.1 Biodiversity

- The presence and extent of plant communities.
  The recommended TPC is a 10% reduction in area covered by each plant community type. Baseline data on coverage can be obtained from aerial photographs or reference photographs from elevated vantage points along the estuary. The water is sufficiently clean to allow for monitoring of submerged macrophytes using photographs in the Bitou arm, the Keurbooms Lagoon and the Keurbooms arm as far as Forever Resorts. Diving surveys may be used for the more important macrophytes, namely *Ruppia cirrhosa* and *Zostera capensis*.
- Clearing of areas infested by alien vegetation and removal of debris.

  The TPC is an area >10% of the total indigenous vegetation that is occupied by alien invasives. Baseline and reference data for infested areas can be obtained from conservation initiatives, aerial photographs, on-site line transects and local knowledge.
- Densities of intertidal invertebrate species, primarily mudprawn and sand prawn but including bloodworm and pencil bait.
  Under normal conditions (excluding mouth closure events and complete loss of populations due to flooding), invertebrate densities of each of the four numerically dominant benthic species should not deviate from average baseline levels (as determined in the eight visits undertaken quarterly in the first two years) by more than 30% in each season (DWS, 2015). Baseline data can be obtained from regular seasonal counts of burrows using random quadrats over an initial two-year period.
- Presence and extent of the Knysna seahorse population.
  The seahorse is an endangered species (IUCN Red List) and as such the TPC under normal conditions should be quite high; a reduction of 10% in baseline population estimates is recommended. Baseline estimates will need to be done by diving surveys over a two-year period and possible extrapolation based on available habitat (primarily the submerged macrophyte *R. cirrhosa*). The seahorse population is not thought to be extensive as recovery from flooding events, when it is likely that the resident population is washed out to sea, is very slow. This may need to be considered in a regional context, where the populations of Swartvlei and

Knysna are also monitored to provide an indication of the health of the species throughout its known distributional range.

- The presence and abundance of water bird communities, with a focus on red-data species, those that are highly or partially dependent on estuaries, breeding aggregations or activity and the presence of nests.
  Since rare birds or those requiring very specific habitats are usually the first to be affected by change, the TPC for species richness should be the loss of a single species over a short period of time. The TPC for species diversity should be a 30% loss over a long (5-6 year) period. There are two TPCs for numbers of birds; a drop of 30% for resident species over a five-year period; and a drop in 50% for migratory species over a 10-year period. Baseline data should be in the form of data from the Avian Demography Unit's (ADU; based at the University of Cape Town (UCT)) Coordinated Water bird Counts (CWAC).
- Maintenance of fish populations/abundance as measured by catch-per-unit-effort (cpue).
  There are currently no recommended TPCs for *cpue* probably because catch data is not widely available for individual estuaries, however it is recommended that a decrease of >10% from baseline values for dusky kob, white steenbras and leervis and a decline of >20% from baseline values for all other species be adopted. This is a difficult objective to achieve on an estuary-specific basis; if the TPC is attained on a single system, it must be noted that the cause cannot be attributed to fishing pressure in that estuary alone as we are dealing with a national resource. Declines can be due to fishing pressure elsewhere or recruitment failure due to natural events. Nevertheless, the TPC may be used to detect trends at a national level and prompt intervention at a higher level.
- Rehabilitation of wetland and saltmarsh areas
  Rehabilitation by restricting access, creating a buffer zone (must be reflected in SDF) and improving flow conditions via removal of barriers, drifts and/or installation of culverts. Much of the Bitou wetland area is private property and is currently used for small-scale farming activities. As such, any initiative will need to have the cooperation and buy-in from landowners and they will need to be consulted and all possible scenarios discussed. The TPC would be if no action to improve these areas were taken or if an arrangement with regards the Bitou wetlands could not be made with landowners.
- Restoration of the original flow regime above the N2 Bridge across the Bitou.
  This recommendation was part of the Ecological reserve study, and while flow may be improved, the cost involved may be prohibitive since it is linked with the removal of the old road concrete pylons. The TPC would be if this issue was at least not considered by the Municipality, CapeNature, DEA&DP and DWS.
- Access Points.
  Establishment of several (three to four) access points in the form of boardwalks that allow people access to the beach through the KRSBC. These access points may be serviced by a

ferry for people who do not have their own. The TPC would be if uncontrolled access across and into the Colony were allowed.

- Protected Area Expansion.
  Increase the number of estuarine areas with conservation status. This process is captured in the Western Cape Protected Area Expansion Strategy and will be administered by CapeNature. This may involve formal stewardship agreements with landowners, conservation servitudes or the expropriation of land. The TPC would be if no additional land within the EFZ was formally protected or included in CPP
- Conservation Initiatives.
  Remain informed of all conservation initiatives that affect the immediate management area (e.g., Bitou Ecological Corridor) and the catchment (e.g., middle and upper Keurbooms catchment corridor initiatives). The TPC would be if stakeholders were unaware of ongoing and proposed conservation initiatives.

5.1.2.2 Human Activities

- Number of persons visiting the estuary and their activity, i.e., carrying capacity.
  The physical, social (includes cultural and psychological aspects) and ecological carrying capacities (together grouped as recreational carrying capacity) have not been calculated for the Keurbooms, and a comprehensive study is required to determine these values; once calculated the TPCs for each would be any value in excess of that capacity. Baseline data can be collected during a survey that records the different types of activities and the respective number of participants on the water and on the bank and the number of registered and unregistered boats on the water. Carrying capacity for boats can be calculated according to a DWS model but may also be regulated by estuary stakeholders in line with the estuary Vision. A sub-issue within this objective is whether or not houseboats should be allowed, and if so, how many and what the conditions for their operation should be. The TPC for this aspect specifically would be if houseboats were allowed to operate uncontrolled.
- Bait collecting, including number of collectors (legal and illegal), collecting methods and adherence to MLRA regulations
  The TPC for any bait organism is a 30% reduction in population size under normal conditions due to collecting activities, which include legal and illegal methods and the associated trampling of the substrate. Baseline data can be obtained from an initial detailed survey (summer and winter sampling to determine distribution, densities and population structure) followed by regular seasonal counts of burrows using random quadrats over an initial two-year period. The TPC for compliance with the MLRA regulations should be very high, i.e., a single person operating outside the law should be cause for concern (see law enforcement and living resources below). Additional baseline data can be collected as part of a more detailed fishery survey and should include numbers of collectors, collecting sites, methods used and number of bait

organisms taken.

- Number of fishing competitions.
  Since no competitions take place on the estuary there is no TPC. However, the RMA must consider applications to host competitions in the future, it will be up to them to determine a TPC (number allowed per year and format, e.g., catch-and-release). The additional impact on bait populations should also be considered.
- Human disturbance within the KRSBC.
  No dogs should be allowed to enter the Colony, but may pass through the access points (demarcated boardwalks) with owners provided they are on a leash. No walking allowed through the Colony, unless it is through the access points to the beach. Due to the significant impact either of these can have on roosting and nesting (breeding) birds, the TPC must be high; a single occurrence should be cause for concern.

5.1.2.3 Law Enforcement

- Capacity of law enforcement or compliance monitoring
  Capacity for law enforcement or compliance monitoring must be increased. Authority institutions need to train and appoint additional staff to conduct regular patrols and/or site visits, and recreational users need to take an active interest and undergo training to be appointed as voluntary compliance officers. The TPCs would be no additional compliance staff in key departments, no voluntary compliance officers and the continued incidence of non-compliant activities. The desired result would be to ultimately reduce the number of incidents or offenders to zero or at least reduce them significantly from what they are now.
- Enforcement and monitoring of conditions in terms of Environmental Authorisations (EA) for developments and activities as the result of the EIA process.
  Due to the sensitive nature of estuarine systems, all development will have some degree of a negative impact (direct and indirect) on their functioning, irrespective of intentions. The TPC for this objective must be very high and even a single offence must be seen as unacceptable. Baseline data is set out in the form of the conditions of the EA; these conditions must be complied with and enforced by an independent environmental control officer (ECO) in order to reduce impacts.
- Adherence to the EZP and revised Municipal By-laws.
  The zoning and By-law provisions regulate activities to ensure the safety of the public, the maintenance of ecosystem functioning and the protection of sensitive shallow water habitats (e.g., submerged macrophytes and associated fauna, including Knysna seahorse). As such the TPC should have 10 incidents/week outside of peak holiday season and five incidents/day during peak season.
- Formal agreement between Bitou LM to CapeNature for administration of the EZP, formulation and enforcement of By-laws and funding.
  This would involve a contractual arrangement and the possible reinstatement of an annual fee that used to be paid to CapeNature but has since been discontinued. The TPC

would be if no formal arrangement existed and if funding was not made available.

5.1.2.4 Heritage Resources

- The identification, evaluation and preservation of all heritage resources in terms of the NHRA.
  This would include sites and buildings or structures of historical and/or cultural significance. According to Section 34 of the NHRA, no structure older than 60 years may be altered or demolished without a permit issued by the Provincial Heritage Resources Agency (PHRA – Western Cape Provincial Office of SAHRA). The TPC should be high, and damage or removal of structures older than 60 years should not be permitted unless they are in such a state of deterioration that they pose a health and safety risk or impact on the aesthetics of the area. The issuing of repair or removal orders under the ICM Act for structures below the HWM needs to abide by the requisite provisions of the NHRA as well.
- Education & Awareness
  Educational workshops hosted by the RMA should be organized at least once a year in order to educate local authorities, in particular town planners, municipal managers and estuary managers about the value of the management area, the EMP and its context within planning strategies, key legislation and the consequences of irresponsible development within the management area. Potential TPCs would be no workshops, poor attendance at workshops and ongoing poor decision making with regards issues affecting estuaries (e.g. water abstraction for golf estates that threatens the Ecological Reserve). A simple questionnaire for local authorities would provide baseline data as to their current awareness level with regards estuarine management.
- An interactive public awareness campaign should be introduced and aimed at all user groups and age groups.The TPCs would be a lack of easily accessible information (sign boards, pamphlets), poor attendance of workshops or environmental awareness lectures by target groups (e.g. school groups, estuary users and fishermen) and a general poor level of understanding of estuaries and associated legislation by the general public (this latter aspect would be reflected in the reduction of non-compliance incidents and would continue CapeNature's aim to educate rather than fine first-time offenders). Baseline data should comprise the extent of visual aids within the estuarine area, public interaction with the RMA and the local KEAF and level of knowledge of regulations (e.g. recreational fishing regulations). Organizations such as CapeNature, Wildlife and Environment Society of South Africa (WESSA), World Wildlife Fund (WWF-SA) and ORCA can be approached to assist with interacting with DEA to raise awareness.
- Tertiary and research institutions as well as government departments need to be involved in research projects that will address specific management concerns, monitoring requirements and gaps in knowledge.
  The TPCs would either be a lack of research, a decrease in the number of research projects or the continued lack of

data required to inform monitoring programmes. Baseline data should comprise the number of tertiary institutions involved in research, the areas of research and the aspects that need to be addressed through directed research.

Table 5. Management Actions for Biodiversity (Conservation)

Management Actions	Legal Requirements	Monitoring Plans	Work Plan	Resource Plan
Operational Objective B1: Maintenance of Plant communities; TPC of 10% reduction in surface area of any plant community type is exceeded.				
If declines are due to water quality, then proceed as for actions detailed in Table 4 (W2 and W3), e.g., provision and maintenance of infrastructure, use of SUDS for stormwater.	Water quality legislation as for W2 and W3.	Aerial or fixed-point photographs or on-site visual census can be used to determine vegetation type and cover. Water quality monitoring as for W2 and W3). Monitoring according to RDM methods and taking RQOs into account.	Plant cover monitoring to be done once a year by tertiary institute or organizations such as Ocean research Conservation Africa (ORCA) with help from RMA and/or KEAF members. Water quality work plan and mandate as for W2 and W3.	**Human-** As for W2 and W3 if water quality is the cause; ORCA; tertiary institute students or scientists. **Financial-** As for W2 and W3, if water quality is the cause; monitoring costs from corporate funding or research funding.
If cause is due to human disturbance, then enforce Municipal by-laws and EZP to reduce trampling and damage from boat wakes and propeller-wash; enforce National legislation to prevent clearing of indigenous riparian vegetation and damage to salt marshes.	Municipal by-laws (for Zonation Plans); NEMA (Ch. s1&5; EIA Regulations); Seashore Act (Sections 3&10); NFA (Ch.3, Section1); NEM: BA (Ch. 4, Part 1).	Aerial or fixed point photographs or on-site visual census can be used to determine vegetation type and cover. Compliance w.r.t. Municipal by-laws and National legislation.	Plant cover monitoring to be done once a year by tertiary institutes/ RMA and/or KEAF members. Management actions to be reviewed and amended if they prove to be ineffective, i.e., if TPC is attained. Responsible agents are DEA, DEA&DP, CapeNature and Bitou LM.	**Human-** DEA: Biodiversity & Conservation, and Environmental Quality & Protection Directorates; DEDEA: Environmental Management & Development Planning Divisions; Bitou LM: Development Planning. **Financial-** existing budgets from National (DEA) & Provincial (DEA&DP) government; Bitou LM (Strategic Services); monitoring costs from corporate or research funding.
Operational Objective B2: Eradication of alien vegetation; TPC of >10% of riparian vegetation infested by alien vegetation is exceeded.				
Contracted service providers to initiate clearing of vegetation in affected areas and removal of debris from cleared sites (use for firewood, wood chips	NEM: BA (Ch.5, Part2); NEMA; CARA (Sections 6 & 8)	Ensure eradication of alien vegetation to levels below the TPC – on site inspections or aerial photographs can be used.	As soon as TPC is attained; Lead agent is DFFE but in cooperation with DWS, landowners and initiatives like Eden to Addo.	**Human-** Primarily DFFE: Land Care with contracted service providers; private landowners; Eden to Addo. **Financial-** DEA (Working for Water, WfW); funds need to be approved for landowners to conduct eradication/ control using their own resources.

Management Actions	Legal Requirements	Monitoring Plans	Work Plan	Resource Plan
Private landowners to clear vegetation and remove (use) debris using their own resources (labor) with funding from DFFE.				
Operational Objective B3: Maintenance of intertidal invertebrate species (mudprawn and sand prawn) and Knysna seahorse; TPC is densities below 30% of baseline counts for invertebrates and below 90% of baseline estimates for Knysna seahorse.				
If declines are due to water quality, then proceed as for actions detailed for W2 and W3, e.g., improved provision and maintenance of infrastructure, use of SUDS for stormwater.	Water quality legislation as for W2 and W3.	Water quality monitoring as for W2 and W3; bi-annual quadrat counts or line transects over two-year period for baseline data. Monitor recovery period after decline. Monitoring according to RDM methods and taking RQOs into account.	Invertebrate and seahorse monitoring to be done bi-annually by tertiary institute or possibly WESSA. Water quality workplan and mandate as for W2 and W3.	**Human-** As for W2 and W3 if water quality is the cause; tertiary institutes; WESSA. **Financial-** As for W2 and W3 if water quality is the cause; monitoring costs from research or donor funding.
If cause is from human disturbance, then increase capacity to enforce By-laws and EZP to reduce trampling of habitat and disturbance of submerged and intertidal habitat by boat wakes and prop wash; improve capacity to enforce National legislation to limit bait collection according to regulations and prevent collection of seahorses.	Municipal By-laws and EZP; MLRA (Ch.3, Section 14); NEM: BA (Ch. 4, Part 2).	Compliance w.r.t. by-laws, EZP and National legislation; baseline data from bi-annual quadrat counts or line transects.	All forms of legislation and EZP need to be enforced immediately. If TPC is attained, then capacity to enforce needs to be addressed. Responsible agents are CapeNature rangers and DFFE officials appointed in terms of MLRA for compliance; DEA for NEM: BA compliance (may devolve to CapeNature; and Bitou LM or CapeNature for By-laws (EZP); baseline estimates and monitoring by tertiary institutions or organizations such as WESSA.	**Human-** CapeNature; DFFE to train and appoint voluntary compliance officers; DEA: Biodiversity & Conservation and Oceans & Coast; Bitou LM or CapeNature for By-laws (EZP); tertiary institutions and WESSA for assessment and monitoring. **Financial-**DFFE (Marine Living Resources Fund (MLRF)) and DEA for compliance funding; Bitou LM (Financial Services-funding for CapeNature to enforce By-laws and EZP); research funds and donor funding.

Management Actions	Legal Requirements	Monitoring Plans	Work Plan	Resource Plan
Operational Objective B4: Maintenance of water bird populations partially or highly dependent on estuaries; TPC for species richness is one species; TPC for diversity is 30% loss over 5/6 years; TPC for number of resident birds is 30% loss over 5 years; TPC for migratory birds is 50% loss over 10 years.				
If decline is due to human activities, then prevent disturbance and loss of habitat and food source- enforce National legislation and municipal By-laws pertaining to EZP and human activities (includes restricted access to KRSBC); prevent loss of habitat by restricting development (EIAs and SDF).	MLRA (Sections 14 & 43); NEM: BA (Ch.4, Part1); Sea Birds and Seals Protection Act (Act 46 of 1973; Section 3b); NEMA (Ch. s1&5; EIA Regulations); Municipal By-laws (pertaining to EZP); SDF.	Compliance with National legislation, SDF and Municipal By-laws (EZP); birds need to be monitored by bi-annual bird counts. Monitoring according to RDM methods and taking RQOs into account.	As soon as any of the TPCs are attained. Responsible authorities for legislation compliance are DEA, DEA&DP, CapeNature and Bitou LM; tertiary institutions and other organizations for bird monitoring, e.g., UCT's ADU (for CWAC counts) and Birdlife Plett.	**Human-** DEA: Biodiversity & Conservation, Environmental Quality & Protection, and Oceans & Coast Directorates); DEA&DP: Development Planning and Environmental Protection & Planning; CapeNature; Bitou LM: Strategic Services; ADU; Birdlife Plett. **Financial-** compliance monitoring costs part of responsible authority's annual budgets for estuary management; research funds for CWAC counts.
If declines are due to water quality, then proceed as for actions detailed for W2 and W3.	Water quality legislation as for W2 and W3.	Bi-annual bird counts; water quality monitoring as for W2 and W3. Monitoring according to RDM methods and taking RQOs into account.	Bi-annual bird counts to be done by UCT's ADU (CWAC counts); water quality workplan and mandate as for W2 and W3.	**Human-** As for W2 and W3 if water quality is the cause; UCT's ADU; Birdlife Plett. **Financial-**As for W2 and W3 is water quality is the cause; research funds for CWAC counts.
Operational Objective B5: Maintenance of fish populations; TPC for dusky kob & white steenbras is >10% decrease from baseline values and >20% from baseline values for all other species.				
Address levels of fishing effort, and ensure compliance with regulations	MLRA (Sections 14&43); NEM: BA (Ch. 4, Part 2).	Compliance with legislation; levels of effort and cpue to be measured by dedicated fisheries survey. Monitoring according to RDM methods and taking RQOs into account.	Continuous from implementation of EMP. DFFE is responsible National authority with help from MLRA appointed officers; tertiary institutions to conduct fishery survey.	**Human-** MLRA appointed CapeNature rangers; DFFE appointed voluntary compliance officers; research students. **Financial-** DFFE (MLRF); boat registration / launch fees, permit levies etc. to assist voluntary compliance officers; research funds for fishery survey.

Management Actions	Legal Requirements	Monitoring Plans	Work Plan	Resource Plan
Operational Objective B6: Protection and rehabilitation of wetlands and saltmarsh areas; TPC is if these areas are not protected or rehabilitated.				
Create single access points to all intertidal saltmarshes to restrict trampling and erosion.	Municipal By-laws; EZP; ICM Act-Ch.2, Section13 for access, and Ch.2, Part2 (coastal protection zone).	Monitor compliance in terms of use of access points.	Municipality and CapeNature to establish access points (signboards) and monitor compliance. Must be addressed within the first two years.	**Human-** Bitou LM: Corporate Services; CapeNature. **Financial-** Bitou LM (Financial Services- for sign boards and assistance to CapeNature for monitoring).
Investigate ways to rehabilitate the Bitou wetland areas used for agricultural activities and minimize impacts in the future; create riparian buffer zone around sensitive areas.	ICM Act-Ch.2, Section 13 (for access), and Ch.2, Part 2 (coastal protection zone); CARA (includes Sections 6,8&12); Municipal SDF for restoration of wetlands.	Monitor recovery of impacted areas and establishment of riparian buffer zones in cooperation with landowners. Monitoring according to RDM methods and taking RQOs into account.	KEAF to facilitate cooperation with landowners. RMA, DFFE, DEA, Working for Wetlands (WfW) and Western Cape Wetlands Forum (WCWF). Municipality responsible for adherence to SDF ideals. Will also be accomplished under the Eden to Addo Bitou Ecological Corridor initiative. Must be addressed within the first two years.	**Human-** Affected landowners in cooperation with RMA; DFFE: LandCare and Support & Development; DEA: Biodiversity & Conservation and Oceans &Coast; Bitou LM: Development Planning; Eden to Addo; WfW. **Financial-** DFFE and DEA to assist with rehabilitation costs; costs for rehabilitation due to illegal activities must be covered by landowner.
Restrict access to the Tshokwane wetlands; (Only access by walking along the periphery); establish 10m buffer zone; no development allowed (Must be reflected as Critical Area in SDF); and no interference with flow into the Keurbooms Estuary.	ICM Act-Ch.2, Section 13(for access), and Ch.2, Part2 (coastal protection zone); Municipal SDF for buffer and no-go development zone; NWA (Ch.4-water use, including activities that impact on watercourses, resources and flow).	Monitor compliance in terms of access, establishment of buffer zones and no-go development areas in SDF and compliance with NWA provisions.	Bitou LM must ensure SDF reflects the wetlands as Critical no-go areas and create buffer zone; also erect signboards. CapeNature and landowners can assist with compliance monitoring. Must be done in the first two years.	**Human-** Bitou LM: Strategic Services; CapeNature; involves WfW, WCWF and residents in Keurboomstrand. **Financial-** Bitou LM for signboards and assistance to CapeNature for monitoring.

Management Actions	Legal Requirements	Monitoring Plans	Work Plan	Resource Plan
Operational Objective B7: Restoration of original flow regime above Bitou N2 Bridge; TPC is if this is not at least considered by all relevant parties.				
The removal of the old N2 Bridge pylons and restoration of the original channel was a recommendation of the Ecological Reserve study; the feasibility of accomplishing these needs to be investigated.	Various aspects of Ch.4 of the NWA (stream flow reduction activities and restoration); EIA Regulations for associated activity.	Monitor progress of discussions between relevant authorities. If undertaken, then EIA process and operational phase must be closely followed.	The RMA must facilitate discussions between DWS, DEA&DP, South African National Roads Agency Limited (SANRAL) and Bitou LM. Process can be initiated within the first two years.	**Human-** RMA together with DEA&DP: Development Planning; DWS: Resource Protection; SANRAL; **Financial-** No cost for meeting; costs for EIA, removal of pylons and restoration of flow may be prohibitive (likely several millions).
Operational Objective B8: Control access to the Keurbooms River Seagull Breeding Colony; TPC is if uncontrolled access is allowed.				
Create a single access point, identified by signboards, opposite the Keurbooms Lagoon Caravan Park that allows access to the beach; no access within the colony (Include details on access signboard).	No management plan exists for the KRSBC so this can be covered under the EZP and the revised Municipal By-laws (Public Amenities). Access to coastal public property (e.g. beach) is covered by ICM Act (Ch. 2, Section 13).	Monitor erection of sign boards and compliance in terms of human activities within the KRSBC.	Implement immediately; Bitou LM is responsible for signboards, but compliance monitoring is likely to be done by CapeNature.	**Human-** Bitou LM: Corporate Services in cooperation with CapeNature. **Financial-** Bitou LM for costs of signboards and assistance to CapeNature for compliance monitoring.
Operational Objective B9: Increase the amount of estuarine area with conservation status; TPC is if no additional land within the EFZ was conserved.				
Investigation of formal protection mechanisms to obtain conservation status for land parcels within or spanning the EFZ (e.g. stewardship agreements,	NEM: PAA; CapeNature Conservation Board Act, CapeNature and Conservation Ordinance	Monitor progress of discussions between relevant authorities and landowners	CapeNature to engage with land owners and Bitou LM with regards to suitable conservation mechanisms	**Human-** CapeNature to run with the Process (WCPAES). **Financial-** Part of operational costs. Expropriation of land to add to PA (if feasible) will incur costs.

Management Actions	Legal Requirements	Monitoring Plans	Work Plan	Resource Plan
conservation servitude, extension of PA)				
Operational Objective B10: Inform stakeholders of all ongoing and proposed conservation initiatives; TPC is if stakeholders are unaware of ongoing and proposed initiatives.				
RMA to keep stakeholders informed of all ongoing and proposed activities; RMA can be informed by government departments and service providers (Implement CapeNature Governance Tool)	Not applicable.	Not applicable.	RMA to engage government representatives (over the next two years), primarily DEA&DP, DEA, and Municipality (Local and District) with regards ongoing and proposed initiatives and then disseminate information to stakeholders.	**Human-** RMA take the initiative and engage relevant government institutions. **Financial-** No costs.

Table 6. Management Actions for Human Activities (Conservation

Management Actions	Legal Requirements	Monitoring Plans	Work Plan	Resource Plan
Operational Objective HA1: Ensure carrying capacity of estuary is not exceeded; TPC is when numbers exceed carrying capacity.				
Regulate number of boats launching or using the estuary at any specific time. The DWS models are quite restrictive and are unlikely to provide a realistic estimate due to the high use demands over peak periods and weekends; the RMA will need to determine how to regulate numbers in line with the Vision; primarily an issue during peak holidays.	Operational Policy for Recreational Water Use (DWAF; August 2004) as a base.	There are multiple launch sites (including private) as well as areas where boats are permanently moored, so, launch records are not useful. Monitor boat numbers in use to determine threshold for safety and confrontation amongst users. Boat registrations can be used to determine potential number of users.	The RMA can initiate this immediately in cooperation with Bitou LM.	**Human-** RMA in cooperation with Bitou LM. **Financial-**No costs involved.
Operational Objective HA2: Regulate bait collection activities; TPC is a 30% decrease in population size of any bait organism; and a single user that is non-compliant.				
Enforce MLRA regulations to ensure compliance.	MLRA (Section 14; Ch. 6)	Initial detailed survey (summer/winter to determine distribution, abundance and population structure) followed by bi-annual random quadrats within designated sites for population density estimates; Monitor bait collectors (recreational and subsistence).	Ongoing from time of EMP inception; lead agent is DFFE for compliance (delegated to CapeNature and MLRA appointed officers); Bitou LM and CapeNature for revised EZP if required; tertiary institutions for population density estimates.	**Human-** CapeNature (and MLRA appointed rangers); DFFE: Resource Management (training and appointing voluntary compliance officers); CapeNature and Bitou LM: Strategic Services for revised EZP; research students. **Financial-** DFFE (MLRF); independent research funds; boat registration/ launch levies to assist voluntary compliance officers.
Consider additional control of collection activities by establishing closed bait areas; this should only be considered if the resource is under threat in future.	MLRA-Ch.3, Section15 (special management areas); revised EZP to include closed areas.			

Management Actions	Legal Requirements	Monitoring Plans	Work Plan	Resource Plan
Operational Objective HA3: Regulate the number of fishing competitions and format; TPC (number and adherence to format) will need to be determined by RMA.				
If competitions are considered in future, the RMA will need to regulate the number of fishing competitions and determine a format (e.g., catch and release) in cooperation with organized angling bodies. This EMP, however, recommends that no competitions be allowed.	Municipal By-laws (regulating recreational activities on estuary); policies of angling clubs or organizations.	Monitor number of competitions and adherence to format.	Implement only if competitions are considered in future. Bitou LM & CapeNature in cooperation with organized angling bodies such as Plett Angling Club and South African Deep Sea Angling Association.	**Human-** CapeNature to lead and engage with organized angling; Bitou LM: Corporate Services to revise By-laws. **Financial -** No costs involved.
Operational Objective HA4: Regulate human activities within the KRSBC; TPC is if a single activity is allowed to impact on the bird colony.				
Enforce the existing By-law requiring dogs to be on a leash at all times.	Bitou LM Public Amenities By-laws (Section 10, Part 2).	Monitor compliance in terms of access and human activities (includes	Implement immediately to protect resident and breeding birds. Bitou LM responsible for amending By-laws	**Human-** Bitou LM: Corporate Services (Legal); CapeNature. **Financial-**no costs for amending By-laws; Bitou LM (Financial
Revise existing Public Amenities By-laws to regulate access and activities within the KRSBC. No access beyond single access point to the beach.	Revised By-laws.	dogs) in accordance with the By-laws.	and CapeNature for compliance monitoring.	Services) to assist CapeNature with compliance monitoring costs.

Table 7. Management Actions for Law Enforcement (Conservation)

Management Actions	Legal Requirements	Monitoring Plans	Work Plan	Resource Plan
Operational Objective LE1: Improve law enforcement capacity; TPCs are non-compliant users and a low conviction rate.				
Appoint and train two additional CapeNature rangers and establish agreements with other institutions to enforce a variety of legislation on their behalf.	No legislation covers the appointment of rangers but they need to be appointed to enforce the MLRA (on behalf of DFFE), the NWA (on behalf of DWS), the ICM Act (on behalf of DEA) and the Municipal By-laws and EZP (on behalf of the Bitou LM) .	Monitor the process of appointing additional rangers; and number of incidents of non-compliance.	Initiate immediately. CapeNature is responsible for appointment, training and liaising with other institutions with regards enforcing legislation on their behalf. Bitou LM needs to be active in supporting CapeNature.	**Human-** CapeNature in cooperation with relevant government departments. **Financial-** each additional ranger should cost in the region of R60000/annum (includes training and running costs).
Appointment of voluntary coastal officers from amongst estuary users in terms of ICMA; officers to liaise and coordinate amongst each other and authorities on combined operations.	Appointed in terms of the MLRA (Ch. 2, Section 9).	Monitor number of new appointed voluntary compliance officers and their activities.	Voluntary compliance officers need to be trained and appointed as a matter of urgency. Training is by DFFE who also monitor their activities. This can be encouraged from the start but will be ongoing as volunteers become available.	**Human-** DFFE: Monitoring, Control & Surveillance. **Financial-** costs to be carried by individuals; some running costs for voluntary compliance officers may be covered by boat registration/ launch fees and levies.
Appointment of a regional Estuarine Management Co-Ordinator with the RMA to work closely with the Bitou LM and KEAF.	MSA (Ch.7, Sections 66,67 & 68).	Monitor process of appointment and activities.	RMA is responsible and this is a matter of urgency.	**Human-** RMA: Corporate Services (Human Resources). **Financial-** Bitou LM: Financial Services (annual salary of R120000 plus running costs to perform duties @R30000/annum).

Management Actions	Legal Requirements	Monitoring Plans	Work Plan	Resource Plan
Operational Objective LE2: Enforce & monitor developments in the context of their EAs; TPC is any non-compliance with the EA conditions.				
Enforce compliance with EA conditions and report any infringements.	All legislation referred to in EA - this will vary according to the nature of development or activity; EIA regulations	Inspections of all sites where activities or developments are taking place; ensure independent environmental control officer is appointed.	Regular (weekly) from the time an activity or development is authorized; responsible authority is mostly DEA&DP but may include other government agencies such as DWS; DEA, or DFFE, independent environmental control officer.	**Human-** DEA&DP: Development Planning and Environmental Management & Protection; independent environmental control officer. **Financial-** costs will vary depending on the scope of project, but developer must cover the costs.
Operational Objective LE3: Enforce adherence to EZP and Municipal By-laws; TPC is 10 incidents/week outside of peak season and 5/day in peak season.				
Enforce provisions of the EZP and Municipal By-laws.	MSA (Ch.3); delegation of authority (Ch.7, Section 59).	Monitor number of incidents of non-compliance.	Bitou LM is responsible for enforcing By-laws and EZP but this is likely to be delegated to CapeNature. This must be implemented immediately and will be ongoing.	**Human-** Bitou LM: Corporate Services or CapeNature. **Financial-** Bitou LM: Financial Services (running costs in the region of R20000/ annum).
Operational Objective LE4: Formalise the delegation of powers by Bitou LM to CapeNature for administration of EZP and By-laws; TPC is if no formal arrangement was made and if funding was not provided.				
Memorandum of Understanding (MOU) to be signed between Bitou LM and CapeNature detailing delegation of powers relating to by-laws and funding arrangements.	MSA (Ch. 7, Section 59).	Monitor progress and content with regards to the contract between the parties.	Bitou LM in conjunction with CapeNature. Must happen immediately.	**Human-** Bitou LM: Corporate Services (Legal) and CapeNature. **Financial-** financial assistance required in the region of R20 000/ annum.

Table 8. Management Actions for Heritage resources (Conservation)

Management Actions	Legal Requirements	Monitoring Plans	Work Plan	Resource Plan
Operational Objective HR1: Identify and preserve heritage resources and sites of cultural significance; TPC is if resources are not identified and protected or if they are ignored by other legislation.				
Identify, list and evaluate all heritage resources in the management area (including all structures older than 60 years) and ensure they are preserved and protected. Ensure NHRA is applied in conjunction with other legislation. Align with management planning and processes of the Cape Floral Region World Heritage Site.	NHRA - Ch. 2 (Sections 27 to47); Ch.3 (Sections 48 to 51).	Monitor compilation of heritage resources and structures list and any activities that involve or may impact on these resources and structures.	Western Cape Provincial Office of SAHRA in cooperation with owners and lessees. This is not a high priority issue and can be implemented within 5 years, i.e., before the 5-year re-evaluation period.	**Human-** SAHRA: Western Cape Provincial office in cooperation with the Bitou LM: Corporate Services and KEAF (representing landowners and lessees). **Financial-** costs to be covered by SAHRA for listings; maintenance of resources to be covered by owners or lessees.

5.1.3 Sustainable Utilisation of Living Resources

Operational objectives for the sustainable use of living resources should be targeted at enforcing the existing Protected Areas that fall within the management area (Keurbooms Nature Reserve (KNR) and KRSBC), local By-laws and the EZP that protect habitats or resources, existing legislation (e.g., MLRA) and the issuing of recreational fishing licenses. If fishing competitions are introduced, then these will need to be regulated as well.

5.1.3.1 Protected Areas

- Protection of birds (and eggs) within the KRSBC.

  This is included in CapeNature's management plan for the reserve. Of primary concern with regards to the KRSBC is the disturbance of birds by free ranging dogs, poaching of eggs off nests during the breeding season, and perhaps the hunting of birds using dogs. All forms of use within this area are illegal. The TPC for compliance should be very high, i.e., a single person operating outside the law should be cause for concern.

5.1.3.2 Sustainable use of bait organisms

- All individuals collecting bait organisms in the estuary must adhere to regulations promulgated in accordance with the provisions of the MLRA, e.g., bag limits, collection methods, licenses and no-sale.

  The TPC for compliance should be high; a single incident of non-compliance as well as the occurrence of repeat offenders should be cause for concern.
- Subsistence bait fishery.

  No subsistence bait fishery must be considered for the Keurbooms unless a detailed study can prove that it will be sustainable and not impact significantly on the bait organisms and their habitat.

5.1.3.3 Sustainable utilization of fish resources

- All fishers must be in possession of valid recreational licenses and adhere to all regulations.

  The TPC for compliance with these regulations should be very high due to the threatened nature of many fish stocks, i.e., a single person operating outside the law should be cause for concern.

5.1.3.4 Fishing competitions

- If competitions are allowed to take place in future, all competitive angling structures (e.g., South African Deep Sea Angling Association or local clubs) hosting the event must adhere to the conditions specified by the RMA (e.g., catch and release format) and the provisions of the MLRA.

  There is no defined TPC for this indicator as fishing competitions alone are unlikely to be the direct cause of the reduction in fish populations on a national scale. However, the TPC for

compliance to the MLRA and estuary specific regulations during competitions should be very high, i.e., a single person operating outside the law should be cause for concern, possibly resulting in a moratorium on all future events.

5.1.3.5 Availability of licenses

- Recreational permit (license) is required by all fishers who catch or collect fish and/or bait organisms.

  These permits are currently available at branches of the South African Post Office, which means they are not available after hours, on public holidays or over weekends, which poses a problem for many tourists and charter operators. This issue has been raised at other venues and is clearly not specific to the Keurbooms. It needs to be addressed at a higher level, and meetings have already been held between the South African Federation of Sport & Sea Angling and DFFE (Directorate: Monitoring, Surveillance and Control and the Assistant Director: Marine Living Resources Fund Revenue Management). However, representation is needed from those fishers who are not affiliated with organized angling bodies. The KEAF will need to engage with DFFE on behalf of stakeholders in this regard.

Table 9. Management Actions for Sustainable Utilization of Living Resources

Management actions	Legal Requirements	Monitoring plans	Work plan	Resource plan
Operational Objective E1: Protect birds (and eggs) within the KRSBC; TPC is a single act of non-compliance by a person or activity.				
Enforce EZP and Municipal By-laws pertaining to access and activities within the KRSBC to prevent poaching of birds and eggs.	EZP; and revised Municipal Public Amenities By-laws; existing By-laws (Section10, Part 2).	Monitor compliance in terms of access and human activities (including dogs) in accordance with By-laws.	Implement immediately to protect resident and breeding birds. Bitou LM is responsible for amending By-laws and CapeNature for compliance monitoring; KEAF and estuary users can assist by reporting incidents of non-compliance.	**Human-** Bitou LM: Corporate Services (Legal); CapeNature. **Financial-**no costs for amending By-laws; Bitou LM (Financial Services).
Operational Objective E2: Regulate bait collection activities; TPC is a single incident of non-compliance or a single repeat offender.				
Enforce legislation pertaining to bait collection (includes possession of recreational permit)	MLRA (Ch. 2, Section 13 and Ch. 3, Section 14; Ch. 6).	Monitor levels of compliance with regards to MLRA regulations.	Continuous from implementation of EMP; DFFE is lead agent but delegated to CapeNature; voluntary compliance officers and Bitou Environmental Officer to assist once appointed. Enforcement personnel to operate regular monitoring non- compliance; estuary users can assist by reporting incidents of non-compliance.	**Human-** CapeNature (and MLRA appointed rangers); voluntary compliance officers and Bitou Environmental Officer once appointed. **Financial-** DFFE to assist CapeNature from MLRF; voluntary compliance officers may be assisted from boat registration/ launching fees or levies.
Operational Objective E3: Regulate recreational fishing activities; TPC is a single incident of non-compliance.				
Enforce legislation in the form of MLRA regulations (includes possession of recreational permit). Carry out the national marine line fish surveys.	MLRA (Ch. 2, Section 13 and Ch. 3, Section 14; Ch. 6).	Monitor levels of compliance with regards to MLRA regulations. Follow up with DFFE on night fishing ban on all estuaries	Continuous from implementation of EMP; DFFE is lead agent but delegated to CapeNature; voluntary coastal officers and Bitou Environmental Officer to assist once appointed.	**Human-** CapeNature (and MLRA appointed rangers); voluntary compliance officers and Bitou Environmental Officer once appointed. **Financial-** DFFE to assist CapeNature from MLRF; voluntary compliance officers may be assisted from

Management actions	Legal Requirements	Monitoring plans	Work plan	Resource plan
			Enforcement personnel to operate daily monitoring of non-compliance; estuary users can assist by reporting incidents of non-compliance	boat registration/ launching fees or levies.
Operational Objective E4: Regulate number and format of competitions and ensure compliance; TPC is a single incident of non-compliance.				
Regulate number and format of fishing competitions if they are considered in future; a catch-and-release format should be enforced together with the MLRA Regulations.	MLRA (Section14 & Ch.6); Municipal By-laws for organized events; organized angling (local clubs and SA Deep Sea Angling Association) policies.	Number of competitions to be determined and monitored; participants to be assessed for compliance with MLRA regulations and competition specific rules.	It would depend on when and if competitions are allowed; the Municipality is the authority that may grant permission to hold competitions under the provisions of By-laws; RMA to coordinate with organized angling structures to investigate feasibility of catch-and-release format.	**Human -** organized angling bodies in coordination with RMA **Financial-** no cost apart from levy that may be applied by Council to hold competitions.
Operational Objective E5: Ensure availability of recreational fishing licenses; TPC would be if licenses continued to be unavailable over weekends and public holidays.				
Engage with DFFE to determine the way forward; recommend licenses be available through organized angling institutions, selected tackle shops and possibly the RMA. Coordinate with SAFSSA who have already entered negotiations with DFFE.	License required under MLRA (Ch.2, Section13) but no legislation applicable to availability.	Monitor progress of negotiations.	The RMA can facilitate this on behalf of estuary users and institutions interested in selling licenses. Can be initiated immediately to dove-tail with SAFSSA's efforts.	**Human-** RMA liaise with SAFSSA and DFFE: Monitoring, Surveillance & Control and MLRF Revenue Management; DEA&DP: Licenses & permits. **Financial-** no cost for negotiations; may be a levy applied to enable the selling of licenses.

5.1.4 Land-use & Infrastructure

- Nature and extent of land use and infrastructure associated with the estuary and catchment.
  The TPCs for this objective are not in the form of target values or quantitative, measurable standards but are instead broad statements of intent as follows:
  - Planning should allow for the maintenance of a riparian zone along the length of the estuary where sensitive habitats (e.g., wetlands, supratidal saltmarsh and indigenous vegetation) occur. The implementation of the CML, CPZ, floodlines and inclusion of Critical Biodiversity Areas within all planning schemes should allow for this.
  - Preferably no additional development (structures) on the floodplain (CPZ; 1:100 year flood line) for safety reasons and sense of place. Agricultural activities within this area are at risk from floods, but compensation for damage is at least covered by the CARA.
  - Development and land use in the catchment and estuarine area should not lower water quality or interfere with normal hydrodynamic or sedimentary processes and cycles; the issues of contamination from the Bitou Waste Water Treatment Works (WWTW), the remnants of the old N2 Bridge on the Bitou and the discharge from the proposed Desalination Plant would be dealt with under this statement.
  - Development proposals should be evaluated through the EIA procedure and guided by the EMP specifically and the broader, soon to be completed, Breede- Gouritz CMS.
  Baseline data would be in the form of town planning schemes or development frameworks (e.g., SDF and IDP) that would need to be compared to a visual display (map) of all activities and infrastructure within the defined estuarine area to ascertain compliance and conformity with the estuary Vision.
- Number of applications for new development and/or rezoning of land associated with the management area and catchment (particular relevance to water abstraction and the impact on the Ecological Reserve requirements).
  There is currently no quantitative value defining a TPC for this objective's indicator but any increase in the number of applications compared to the last five years should be cause for concern. All applications should be guided by the EIA process. Should applications receive a favorable EA, the development should be assessed by an independent environmental auditor approved by both the DEA&DP and the local Advisory to ensure compliance. Any deviations from the EA conditions should be regarded as unacceptable and viewed as non-compliant. Baseline data in the form of development/rezoning applications can be obtained from the Bitou LM or DEA&DP; ideally the number of applications should decrease, as the Vision of the estuary becomes a reality.
- The southern portion of the Anath Peninsula should be developed into an eco-tourism node, with the details such as leasing, structures, access (control and maintenance) and a caretaker to be determined.
  The EIA process is to be followed for any listed activities. The TPC would be if the site was not developed as an eco-tourism node

or if development took place without EIA authorization, without consideration for the restrictions on development below the 1:100 year floodline or without addressing the access and security concerns as well as the property values of Twin Rivers Estate.

- The inclusion of the management area in planning and management tools.
  The TPC would be if the defined management area were not considered at all in planning and management documents. The functioning and value of the Keurbooms estuary needs to be reflected in the SDF and IDP, and should be a significant factor in any EIA assessment. All decisions regarding development and planning in the management area need to be guided by these planning and management tools. Baseline data is available in the form of current SDF and IDP documents, this EMP, both the Keurbooms and Keurboomstrand Preliminary EMFs, the Bitou Valley Wetland & Catchment Report (Eden to Addo) and the Eden District Coastal Management Programme (CMP).

- Streamline the application and authorisation process for the repair of flood damaged land and infrastructure and institute a standardized protocol that would determine rehabilitation methods.
  A process to ensure funding, design (rock and wire mesh gabions), labor and authorization through DEA&DP must be undertaken should financial support from landowners be obtained. The TPC would be if no arrangement could be reached and if landowners continued to either struggle to obtain authorization or continued to operate illegally.

- Equitable and controlled access to the coastal public property for all estuary users, including the disabled (wheelchair access).
  This would require an assessment of existing access points and an identification of either additional access points, upgrading for wheelchair access or closure of existing points (if they are detrimental to the well-being of the system, e.g., multiple access points and pathways through supratidal saltmarsh and wetland areas). TPC would be if equitable and controlled access were not achieved.

- Upgrading the condition and increasing the capacity of the sewerage reticulation systems at Keurboomstrand and Poortjies.
  These systems are either outdated and poorly maintained or cannot cope with the load during peak holiday periods, resulting in spillage and runoff into the estuary. The TPC would be if contaminated runoff continued to enter the estuary.

- Determine the capacity of the Bitou WWTW to cope with any future development.
  The TPC would be if this was not determined and if the WWTW could not cope with the envisaged expansion of any residential or informal settlements/estates.
- Investigate the feasibility of dredging to alleviate the excessive sediment loads in the lower sections of the estuary.
  A precautionary approach should be adopted, as there are many issues (natural environment, social and financial) associated with this practice. The TPC would be if the issue was

not addressed on behalf of stakeholders affected by the sediment loads. This refers primarily to riparian landowners whose access to the water's edge has been affected and to the blind lagoon opposite Strandmeer that has become isolated (and stagnant) from the estuary.

- Initiate discussions for the development and implementation of a strategy to cope with the potential threat of sea-level rise, flooding and storm events on low-lying areas (people, property and infrastructure).
  This strategy would need to be based on the National Climate Change Response Strategy for South Africa, which highlights the implications of climate change, identifies key issues and problems and details strategic objectives, principles and proposals. Recommendations as to what this strategy should contain are beyond the scope of this EMP; nevertheless, there are thousands of people and billions of rands worth of property and infrastructure that would be affected. As such this EMP recommends that the RMA engages with the government now to determine a way forward. The TPC would be if discussions were not initiated with National DEA and Provincial DEA&DP and if a strategy was not in place within the next five to ten years.[13]
- Engage with the South African National Roads Agency Limited (SANRAL)

If a new N2 bypass were to be developed on this servitude, it could be potentially disastrous for the functioning of the systems. The TPC would be if clarification was not obtained from SANRAL or if the bypass was to be built in the future.

[13] The following document may also be useful as a starting point for discussion: Umvoto Africa. (2010). Sea Level Rise and Flood Risk Assessment for a Select Disaster Prone Area along the Western Cape Coast. Phase 1 Report: Eden District Municipality Sea Level Rise and Flood Risk Literature Review. Prepared by Umvoto Africa (Pty) Ltd for the Provincial Government of the Western Cape Department of Environmental Affairs and Development Planning: Strategic Environmental Management (May 2010).

Table 10. Management Actions for Land Use & Infrastructure

Management actions	Legal requirements	Monitoring plans	Work plan	Resource plan
Operational Objective LU1: Regulate the nature & extent of land-use & infrastructure; TPCs are broad statements of intent (management actions).				
Implement the CPZ and CML, floodlines and Critical Biodiversity Areas - ensure all activities taking place are in accordance with relevant legislation; offer incentives (rates rebates) for private landowners to manage areas as conservation zones.	NEM: BA (Ch. 4, Part 1); NEMA (Ch. 5; EIA Regulations); ICM Act (Ch. 2 Section 16); CARA (Section6); Municipal SDF.	Compliance with legislation controlling activities in this zone; monitor applications for activities within the zone.	Initiate as soon as EMP is implemented and integrate with SDF; DFFE, DEA&DP, CapeNature and Bitou LM are responsible; DFFE in catchment; KEAF members can register as I&APs in any applications	**Human-** DEA&DP: Environmental Management & Planning; DFFE: Land Care; DFFE: Biodiversity & Conservation and O&C; CapeNature; Bitou LM: Strategic Services. **Financial-** DFFE, DEA&DP and Bitou LM budgets- part of existing responsibilities.
No additional development (structures) on the floodplain within the 1:100 floodline and coastal protection zone (this includes Critical Biodiversity Areas)-enforce recommendations in planning frameworks (SDF); offer incentives (rates rebates) for private landowners to manage areas as conservation zones.	NEM: BA (Ch. 4, Part 1); NEMA (Ch. 5; EIA Regulations); ICM Act (Ch. 2, Section 16; Ch. 3, Section 28); SDF/IDP; CARA (Section 6); Western Cape Provincial SDF; Municipal SDF.	Compliance with legislation restricting activities in this zone; monitor applications for activities within the CPZ, floodplain or 1:100 floodline.		
Developments and land use in the catchment and estuarine area should not lower water quality or interfere with normal hydrodynamic or sedimentary processes-ensure all developments and activities do not impact negatively on water quality by enforcing relevant legislation.	NWA (Sections 19&21); NEMA (Ch.5; EIA Regulations); ICM Act (Ch.8, Section 69); CARA (Sections 6 & 12); Municipal SDF/IDP.	Monitor EIA process to ensure all impacts are adequately mitigated; ensure compliance with EA conditions; monitor water quality parameters according to RQOs (as for W2 and W3); ensure compliance with legislation and planning frameworks.	Initiate as soon as EMP is implemented and integrate with SDF; DEA&DP, DWS and Bitou LM are responsible agents; DFFE in catchment; KEAF, CMA and WUA can monitor infringements and register as I&APs for any applications within estuarine area. Bitou LM to provide and maintain basic services	**Human-** DEA&DP: Environmental Management & Protection, DWS: Resource Protection; DFFE: Land Care; Bitou LM: Strategic Services and Infrastructural Development. **Financial-** developers to cover costs of EIA and monitoring of EA conditions; Bitou LM (Infrastructural Development) for supply and maintenance of basic services.

Management actions	Legal requirements	Monitoring plans	Work plan	Resource plan
			to avoid contaminated runoff (see W2 and W3).	
Proposed development should be guided by the EIA procedure and the EMP specifically and the broader catchment management plan - register as I&AP for all development applications and ensure compliance with all legislation.	All legislation controlling aspects of development within the EIA process - this will vary according to nature of activity but will include aspects covered by the NWA (Section 19; Ch. 4), NFA (Ch. 3, Section 1), NEMA (Ch. 5; EIA Regulations); CARA (Sections 6 & 12); HRA (Ch.2, Parts1&2), ICM Act (Ch.2, Section16; Ch.3, Section 28) & Municipal SDF/IDP.	Monitor the EIA process for each application and ensure compliance with all legal requirements.	Initiate immediately-for all new applications and review of applications currently under consideration; DEA&DP is EIA authority.	**Human**- DEA&DP: development Planning is lead agent; guided by EMP and Bitou LM: Strategic Services and RMA. **Financial-** no additional cost to existing running costs of DEA&DP or Bitou LM.
Operational Objective LU2: Monitor the number of applications for development and/or rezoning of land within management area and catchment; there are no quantitative TPCs but an increase in applications over a five-year period should be cause for concern.				
KEAF to be used as a source of I&APs for all development and rezoning applications and ensure compliance with all legislation and planning frameworks.	All legislation controlling aspects of development within the EIA	Record numbers of new applications for comparison to recent years; monitor the EIA process for each application to ensure it fulfils	Applicable KEAF members[14] to register as Interested & Affected Parties (I&AP) for all new applications and check municipal records for	**Human-** DEA&DP: Development Planning and Environmental Management & Protection is lead agent with various departments from DWS and DFFE depending on

[14] The KEAF cannot register as an I&AP as an institution as it will comprise representatives of the various commenting authorities, who thus cannot act as I&Aps as well as decision-makers.

Management actions	Legal requirements	Monitoring plans	Work plan	Resource plan
	process-this will vary according to nature of development or activity but will include aspects covered by the NWA (Section19; Ch.4), NFA (Ch.3, Section1), NEMA (Ch.5; EIA Regulations), CARA (Sections 6&12), NHRA (Ch.2, Parts1&2), ICM Act (Ch.2, Section 16; Ch.3, Section 28) & Municipal SDF/IDP	legal requirements.	compliance regarding older applications; DEA&DP, DWS DFFE and Bitou LM are responsible for ensuring correct procedures are followed.,	application or activity; guided by EMP and Bitou LM: Strategic Services and KEAF. **Financial-** no additional cost to existing running costs (budgets), i.e., part of existing responsibilities
Operational Objective LU3: Establishment of an eco-tourism node on the Anath Peninsula; TPC is if this did not happen, if EIA process was not followed (includes floodline restrictions) and if concerns about access (control, security and maintenance) and property values at Twin Rivers Estate were not addressed.				
Undertake an EIA to establish an eco-tourism node on the Anath Peninsula; specific details of the activities, infrastructure and operational requirements to be determined by CapeNature, Bitou LM, Twin Rivers Estate and other interested stakeholders.	EIA Regulations; Western Cape Provincial SDF (floodlines); Municipal SDF and IDP.	Monitor EIA process, adherence to EA conditions and ongoing operations.	Bitou LM will be the lead agent to liaise with CapeNature, DEA&DP and stakeholders (must include Twin Rivers Estate) with regards EIA and operational requirements. Timing will depend on finances, but should be addressed over the next three years.	**Human-** Bitou LM: Corporate Services, Development Planning and Community Services in cooperation with CapeNature and DEA&DP: Development Planning, KEAF and stakeholders. **Financial-** Bitou LM: Strategic or Financial Services to fund EIA (R100 to R200 000); operational costs and infrastructure to be determined (possibly corporate or donor funding).

Management actions	Legal requirements	Monitoring plans	Work plan	Resource plan
Operational Objective LU4: Ensure the use of planning and management tools to guide development; TPC would be the exclusion of the Keurbooms management area in any of these frameworks.				
Ensure that the management area is specifically addressed in all planning and management frameworks and considered in all EIAs.	ICM Act (Ch.4); SDF/IDP (in the form of specific management plans (e.g., this EMP and the future CMS); SEAs or Conservation Development Frameworks.	Review of all existing planning and management frameworks for inclusion of management area; monitor progress of all new management & planning documents through direct participation (KEAF).	Planning and management consultants together with RMA are responsible for addressing management area in frameworks and policies.	**Human-** Bitou LM: Strategic Services (Development Planning). **Financial-** Bitou LM: Financial or Strategic Services for developing frameworks
Operational Objective LU5: Streamline application and authorization process for repairs to flood damage and standardize methods used for rehabilitation; TPC would be the ongoing difficulty with the authorization process and hap-hazard rehabilitation efforts.				
Establish a protocol to deal with bank stabilization and rehabilitation after flood events and adopt a standardized methodology.	Aspects of the EIA Regulations, including exemption from the application process once authorization has been granted previously.	Monitor progress of initiative – once landowners buy-in to the process and agree to pay for materials it can be initiated.	Initiate immediately. Bitou LM and CapeNature to liaise with DEA&DP, DFFE (structural engineers). If landowners buy in, then this aspect can be initiated immediately. CapeNature can secure funding and liaise with government departments and landowners.	**Human-** RMA and affected riparian landowners; CapeNature; DEA&DP: Environmental Management & Protection; DEA:O&C); DFFE: Land Care. **Financial-** DEADP to secure funds for design and labor; landowners to cover costs of material.
Operational Objective LU6: Ensure equitable and controlled access to Coastal Public Property; TPC would be if this was not achieved or addressed.				
Review existing access points and ensure they are not in sensitive areas and have wheelchair access (primarily Keurbooms Lagoon	ICM Act (Ch.2, Section13).	Monitor upgrading of access points to include wheelchairs; recovery of impacted areas after closure of uncontrolled	CapeNature and DEA&DP to assess access points; CapeNature and Bitou LM to control and upgrade	**Human-** CapeNature; DFFE:O&C; DEA&DP: Environmental Management & Protection; Bitou LM: Corporate Services. **Financial-** Bitou

Management actions	Legal requirements	Monitoring plans	Work plan	Resource plan
Caravan Park); assess feasibility of additional access or closure of existing points.		access sites.	access points. Can be done over the next three years.	LM: Financial and Corporate Services for costs of survey, control and upgrading of access points.
Operational Objective LU7: Increase capacity of the sewerage reticulation system at Keurboomstrand; TPC would be if it continued to fail during peak holiday periods.				
Upgrade the system at Keurboomstrand to cope with additional loads during peak holiday periods. Upgrades may be required to cope with additional load from stormwater runoff.	WSA (Ch.1, Section3); MSA (Ch.8, Part2); Bitou LM By-laws (water supply, sanitation services and industrial effluent); IDP for allocation of budget.	Monitor effectiveness of upgrade to cope with additional loads (spills, run off into the estuary and bad odors are indicators of a problem).	Implement by the next IDP review cycle (2 years); Bitou LM is responsible.	**Human-** Bitou LM: Strategic Services (IDP) and Infrastructure Development. **Financial-** Bitou LM: Financial Services.
Operational Objective LU8: Ensure capacity of Bitou WWTW is sufficient to cope with future needs; TPC would be if expansion was allowed and the WWTW could not cope.				
Bitou LM to provide assurance of WWTW capacity to cope with projected demands.	MSA- Ch.8, Part2 (For provision of services).	RMA to review estimates and validate WWTW capacity if necessary.	Within the next two years. Bitou LM responsible for providing assurances; RMA/ CapeNature and KEAF to liaise with Municipality.	**Human-** Bitou LM: Municipal Services & Infrastructure Development; **Financial-** no costs.
Operational Objective LU9: Assess feasibility of the removal of excess sediment by dredging; TPC would be if this option was not at least discussed with the authorities.				
Approach authorities and discuss feasibility and options with regards to dredging in the lower reaches of the Keurbooms River estuary.	Dredging is covered by EIA Regulations and aspects of Ch. 4 of the NWA.	RMA to initiate meetings and monitor progress of negotiations.	Not a priority; to be considered within the next five years; RMA, DEA&DP and DWS are relevant parties.	**Human-** RMA to liaise with DEA&DP: Environmental management & Planning and DWS: Resource Protection. **Financial-** no costs for feasibility meetings; cost of dredging operation (including EIA) will run into millions of rands (Bitou LM may be liable for costs).

Management actions	Legal requirements	Monitoring plans	Work plan	Resource plan
Operational Objective LU10: Assess potential threat of sea-level rise, flooding and storm events; TPC would be if such a strategy was not at least discussed with the authorities.				
RMA to engage with government to determine a way forward i.to. of responding to the potential threat of sea-level rise, flooding and storm events on low-lying areas	ICM Act	RMA to initiate meetings and monitor progress of negotiations.	Within the next five to ten years. RMA, DFFE and DEA&DP are relevant parties.	**Human-** RMA to liaise with DFFE: O&C and DEA&DP: Environmental management & Planning. **Financial-** no costs for strategy meetings.
Operational Objective LU11: Determine SANRAL's intentions for the use of the servitude across the Anath peninsula; TPC would be if clarification was not received or if bypass were to be built in future.				
Initiate a meeting with SANRAL to discuss options.	Government Gazette 213 of 1985. If by pass were to be built then controlling legislation would apply (e.g., EIA Regulations, ICM Act; NEM: BA and By-laws to a lesser extent).	RMA to initiate meetings and monitor the progress of negotiations.	Not a priority; to be considered within the next five years. SANRAL, DEA&DP, CapeNature, DFFE and Bitou LM are relevant parties.	**Human-** RMA to liaise with SANRAL, DEA&DP, DFFE:O&C; CapeNature and Bitou LM: Strategic Services. **Financial-** no costs for facilitating meetings; costs covered by all attending parties.

5.1.5 Institutional & Management Arrangements

- Keurbooms Estuary Advisory Forum (KEAF)
  The TPC would clearly be the absence of such a Forum. Any such Forum needs to reflect the needs and aspirations of all stakeholders and should be based on democratic principles to represent all stakeholder groups and local, regional and national government institutions. This would ensure that a cooperative and not a prescriptive approach to management would be adopted and should secure long-term commitment from government.

- Integration of estuarine and catchment management related processes.
  Essentially CMAs develop and implement strategies for water resource use, on behalf of its members, according to the NWRS; this would include the RQOs needed to manage water quantity & quality aspects of the EMP. The Keurbooms estuary falls under the jurisdiction of the BGCMA. The TPC for the Keurbooms catchments would be the lack of interaction between catchment and estuary associations. Such agencies or associations need to reflect the needs and aspirations of all stakeholders and should be represented by all civil society groups and local, regional and national government institutions.

- Compliance by all government institutions and their staff with all legislation and regulations.
  This primarily refers to the operation of vessels by CapeNature and Bitou LM officials without a certificate of competence (skippers' ticket) as required by the Merchant Shipping (National Small Vessel Safety) Regulations of 2007 (Section 10 of Marine Notice No. 13 of 2007). The TPC would be if officials continued to be non-compliant.

- Co-operative government arrangements.
  Ensure that all arrangements between government departments with respect to administering legislation are made clear to all stakeholders, e.g., CapeNature's administration of the MLRA, Municipal By-laws and Merchant Shipping Regulations on behalf of DFFE, the Municipality and the South African Maritime Safety Authority (SAMSA) respectively. The TPC would be if stakeholders were not aware of who was responsible for administering legislation.

- Appointment of a regional Estuarine Management Co-Ordinator for the Bitou LM.
  Only the District Municipality has an environmental officer. The TPC would be if no official were appointed.

- Secure the funds from appropriate government departments and implementing agents required for priority management actions.
  CapeNature needs to ensure that individual agencies allocate resources, create and fill posts (including project champions), acquire necessary infrastructure, resources and equipment, and confirm future budget allocation to fulfil their mandates. The TPC would be if government departments and implementing agents did not secure funds

to fulfill management actions related to their mandates.

Table 11. Management Actions for Institutional & Management Structures

Management actions	Legal requirements	Monitoring plans	Work plan	Resource plan
Operational Objective IMS1: Reconstitute the Estuary Advisory Forum; TPC would be the absence of such an institution.				
Reconstitute the Keurbooms Estuary Advisory Forum (KEAF) so that all management issues pertaining to the management area can be discussed with all stakeholders and relevant authorities can be held accountable; integrate with Municipal Coastal Committee (MCC) and BGCMA.	ICM Act (Ch. 4), the Protocol	Monitor progress of RMA and ensure it fulfils its obligations; ensure integration with MCC and BGCMA.	Initiate immediately - assemble members and elect chairman and committee; constitute KEAF and set mandate and responsibilities. CapeNature or Bitou LM will be lead authority and chair; appointed consultants to facilitate this process.	**Human-** appointed consultants for implementation phase and all stakeholders. **Financial-** implementation phase budget from combination of CapeNature, Eden District and Bitou LM.
Operational Objective IMS2: IMS2: Ensure the integration of estuarine and catchment management related processes; TPC would be if no integration and interaction existed between relevant institutions.				
Integrate BGCMA and KEAF activities through representation on both bodies by selected representatives (ideally respective chair persons)	None that specifically deals with integration, but this is advisable to ensure effective cooperative governance from catchment to coast.	Ensure integration and keep record of number and types of projects or management scenarios that are resolved or addressed cooperatively.	Initiate immediately; integrate KEAF and BGCMA and identify opportunities to interact (interaction will primarily be about water quality& quantity and land-use issues). Institutions are themselves responsible for integration assisted by DWS. EMP to be embedded in CMS.	**Human-** BGCMA and KEAF chairpersons; assistance from DWS and RMA or CapeNature/Bitou LM. **Financial-** DWS (RDM) and Bitou LM: Strategic Services.
Operational Objective IMS3: Compliance by CapeNature with skippers license requirements; TPC would be if rangers operated without the required license.				
All CapeNature and Bitou LM officials who will be conducting patrols and compliance monitoring to undergo	Merchant Shipping Regulations (Section 10 of Marine Notice 13).	Ensure compliance.	Rangers to undergo inland skippers course and examination. SAMSA is the lead authority but courses and examination are delegated to accredited institutions or individuals.	**Human-** CapeNature rangers; accredited service providers and SAMSA: Mossel Bay Office. **Financial-** CapeNature (R1100 per individual for course and certification).

Management actions	Legal requirements	Monitoring plans	Work plan	Resource plan
certification.			Initiate in first year.	
Operational Objective IMS4: Appointment of a regional Estuarine Management Co-Ordinator within the RMA. The TPC would be if no official were appointed.				
Appointment of a Regional Estuarine Management Co-Ordinator within the RMA to work closely with Bitou LM and the KEAF.	MSA (Ch.7, Sections 66,67 & 68).	Monitor process of appointment and activities.	RMA is responsible and this is a matter of urgency.	**Human-** CapeNature (Human Resources). **Financial-** Bitou LM: Financial Services (annual salary of R120000 plus running costs to perform duties @R30000/annum).
Operational Objective IMS5: Secure funding for priority management actions from appropriate government departments and implementing agents; TPC would be if government departments and implementing agents did not secure funds to fulfil their management actions.				
Individual agencies to allocate resources, create and fill posts (including project champions), and acquire necessary infrastructure, resources and equipment of fulfil their mandates, and confirm future budget allocations	A variety of legislation will apply depending on the authority and participating agencies	Monitor progress of discussions with relevant institutions	Within the first two years (negotiations and legalities may take time); the RMA can take the lead role.	**Human-** CapeNature/Bitou LM to coordinate with all management authorities, government departments and participating agencies; **Financial**- minimal costs for interaction and discussion.

5.1.6 Sustainable Livelihoods

- Existing activities all comply with legislation, management plans and planning documents that regulate against potential impacts on the management area, its inhabitants and users.

  The TPC should be a single activity that does not comply with legislation, management plans or planning documents. Baseline data would need to be acquired from a variety of sources including DEA&DP (for EA on developments; jetty and slipway licenses), the Bitou LM (for land-use authorizations and compliance with the SDF, IDP and By-laws), DWS (water quality), DFFE and CapeNature Development (LED) structures in combination with civic-based organizations. An audit of all activities The TPC would be if no activities should be conducted by an independent assessor in order to determine compliance and the need for corrective measures. This objective includes aspects such as the issuing of licenses for operations such as fishing charters and commercial river cruises.

- Encourage the initiation of non-consumptive activities that involve previously disadvantaged communities (PDCs) and that comply with legislation, management plans and planning documents.

  Potential opportunities include the operation of a ferry (non-powered vessels such as canoes) to transport people across the Keurbooms Lagoon to access the beach through the KRSBC and maintenance staff for the proposed eco-tourism node on the Anath Peninsula. Additional opportunities will need to be identified by the Municipality through their Local Economic and developments involving PDCs were initiated and if those that were initiated failed to comply with legislation, management plans or planning documents.

Table 12. Management Actions for Sustainable Livelihoods

Management actions	Legal requirements	Monitoring plans	Work plan	Resource plan
Operational Objective SL1: Existing activities compliant with all forms of legislation and planning frameworks; TPC would be any activity not complying with these regulations.				
Engage relevant government authorities to address activities that do not comply with legislation and planning frameworks.	Applicable legislation is contained in the NWA (Sections 19 & 21); NEMA (Ch. 5; EIA Regulations); MLRA (Ch. 3); NFA (Ch. 3, Sections 1&2); ICM Act (Ch. 2, Section16; Ch. 3, Section 28); CARA (Section 6); NHRA (Ch. 2, Parts 1&2);NEM: BA (Ch. 4); NEM: PAA (Ch. 4),SDF/IDP; municipal by-laws and local management plans	Review all existing activities for compliance with legislation and planning frameworks; monitor all proposed new activities for compliance; monitor rehabilitation where applicable.	Initiate within first two years; RMA to advise municipality and government departments such as DEA&DP, DWS, DFFE irt applicable legislation and planning frameworks.	**Human-** RMA/Bitou LM to engage government representatives from DEA&DP, DWS and DFFE **Financial -** no costs.
Operational Objective SL2: Promote non-consumptive enterprises involving previously disadvantaged communities which are compliant with all forms of legislation and planning frameworks; TPC would be no new initiatives and non-compliance with these regulations.				
Engage community representatives, Bitou LM (LED initiatives) and civic organizations to identify opportunities and ensure they are compliant with all forms of legislation. Two potential opportunities area ferry operation across the Keurbooms Lagoon to the KRSBC and maintenance staff or the proposed Anath Peninsula eco-	Applicable legislation is contained in the NWA (Sections 19&21); NEMA (Ch.5; EIA Regulations); NFA (Ch.3, Sections 1&2); ICM Act(Ch.2, Section16; Ch.3, Section28); CARA (Section6); NHRA (Ch.2, Parts1&2); NEM: BA (Ch.4); SDF/IDP; Municipal By-laws and local management	Monitor progress with regards to initiation of new activities and their compliance with regulations.	Initiate within two years; Bitou LM (possibly CapeNature) and community leaders to engage all stakeholders (including DFFE) to identify opportunities and draft operational frameworks to ensure compliance.	**Human-** Bitou LM: Strategic Services (LED); DFFE: Coastal Livelihoods; community leaders; advice from CapeNature. **Financial-** Bitou LM: LED; National Government (poverty alleviation fund).

Management actions	Legal requirements	Monitoring plans	Work plan	Resource plan
tourism node. Initiatives aimed at non-consumptive activities should be encouraged to alleviate pressure on living resources.	plans.			

5.1.7 Tourism & Recreational Use

- Actively market the Keurbooms estuary as an eco-tourism destination by highlighting aspects such as biodiversity importance and recreational opportunities.
  Many tourism websites already highlight Robberg, the greater Plettenberg Bay area and the Garden Route as tourist attractions, but specific reference to the estuary is required. Despite extensive development in the lower reaches, the area is aesthetically appealing and has a lot to offer both local and international tourists. The TPC would be if this did not happen.
- Promote organized sporting events in addition to the ones already taking place so as to increase exposure and attract visitors.
  Although the Keurbooms estuary already hosts the South African Canoe Marathon Championships, the TPC would be if no new events (e.g., trail running, adventure racing, rowing, swimming, kite boarding and windsurfing) were to take place or if existing ones were to stop.
- Implement all aspects of the EZP that apply to recreational use and enforce all legislation and Municipal Public Amenities and River By-laws pertaining to recreational activities.
  The TPC would be if recreational users did not abide by the EZP (use areas) and contravened legislation and by-laws. (This aspect is covered under Conservation –Human Activities as well as Law enforcement).
- Regulation of kite boarding and boating.
  Kite boarding is restricted to the Keurbooms Lagoon area, which as a designated wake-free zone, should reduce the safety issues with regards to other users. In addition, all skippers should be in possession of a skipper's license and therefore be familiar with safety precautions and the rules of the road (right of way). (This aspect is covered under Conservation – Human Activities as well as Law enforcement).

Table 13. Management Actions for Tourism & Recreational Use

Management Actions	Legal Requirements	Monitoring Plans	Work Plan	Resource Plan
Operational Objective T1: Recognition of the Keurbooms management area as a premier eco-tourism destination; TPC would be if this were not to happen.				
Lobby Bitou LM tourism to market the area on their website and in brochures; lobby tourist operators, guesthouses / B&Bs, Plett Chamber of Business and local media to promote the area on their websites and in their publications.	None.	Monitor websites, tourism office, tourist facilities and local newspapers for information, brochures, articles etc.	Initiate over a three-year period. RMA to advise Bitou LM tourism, tourist industry, local media and Plett Chamber of Business.	**Human**- RMA, representatives from tourism industry and Bitou LM: Tourism, editors of local media publications and Plett Chamber of Business. **Financial**- No significant cost to RMA (e-mail, phone calls, internet searches); Bitou LM: Tourism; advertising in the media.
Operational Objective T2: Promote organized sporting events; TPC would be if no additional events took place or if existing events were cancelled.				
Bitou LM to promote the area as a sporting venue and ensure a safe and healthy environment; engage sporting organizations.	None per se but aspects detailed in water quality actions will apply indirectly here as well.	SA Canoe Marathon Championships already occur, but additional are required. Monitor the number of new events being held. Need to ensure events are not lost due to health risks associated with water quality.	Initiate over a three-year period. Bitou LM to interact with sports bodies; safe and healthy environment needs to be ensured (see water quality actions; W2 and W3).	**Human-** Bitou LM: Community Services (Parks & Recreation) and sporting bodies. **Financial-** costs to host events covered by sporting bodies, Bitou LM (Community Services) and sponsors.

5.1.8 Education & Awareness

- Educational workshops hosted by the Bitou LM should be organized at least once a year in order to educate local authorities, in particular town planners, municipal managers and estuary managers about the value of the management area, the EMP and its context within planning strategies, key legislation and the consequences of irresponsible development within the management area.
  Potential TPCs would be no workshops, poor attendance at workshops and ongoing poor decision making with regards issues affecting estuaries (e.g., water abstraction for golf estates that threatens the Ecological Reserve). A simple questionnaire for local authorities would provide baseline data as to their current awareness level with regards estuarine management.
- An interactive public awareness campaign should be introduced and aimed at all user groups and age groups.
  The TPCs would be a lack of easily accessible information (sign boards, pamphlets), poor attendance of workshops or environmental awareness lectures by target groups (e.g., school groups, estuary users and fishermen) and a general poor level of understanding of estuaries and associated legislation by the general public (this latter aspect would be reflected in the reduction of non-compliance incidents and would continue CapeNature's aim to educate rather than fine first-time offenders). Baseline data should comprise the extent of visual aids within the estuarine area, public interaction with the RMA and the local KEAF and level of knowledge of regulations (e.g., recreational fishing regulations). Organizations such as WESSA, WWF-SA and ORCA can be approached to assist with interacting with DFFE to raise awareness.
- Tertiary and research institutions as well as government departments need to be involved in research projects that will address specific management concerns, monitoring requirements and gaps in knowledge.
  The TPCs would either be a lack of research, a decrease in the number of research projects or the continued lack of data required to inform monitoring programmes. Baseline data should comprise the number of tertiary institutions involved in research, the areas of research and the aspects that need to be addressed through directed research.

Table 14. Management Actions for Education & Awareness

Management actions	Legal requirements	Monitoring plans	Work plan	Resource plan
Operational Objective EA1: Initiate educational workshops on the value of the management area, its context within planning frameworks and legislation and consequences of poor decision making; TPCs would be no workshops, poor attendance or continued poor decision making that affects estuaries.				
Initiate series of workshops with help from DFFE, DWS, Bitou LM and organizations such as WESSA.	White Paper for Sustainable Coastal Development (Section C, Ch.10); ICM Act (Ch. 5, Section 38).	Keep record of number of workshops and attendance by government department and Bitou LM staff; participants to submit to a questionnaire to test awareness, understanding and effectiveness of workshop.	Initiate over a two-year period; ongoing. DFFE is responsible for marine / coastal education on a national level but the workshops can be hosted by the RMA/Bitou LM, KEAF, or WESSA.	**Human-** DFFE: Environmental Quality & Protection and O&C and Bitou LM (Environmental Officer); participating government and municipal staff; WESSA; specialists from tertiary & research institutions. **Financial-** primarily DFFE and Bitou LM
Operational Objective EA2: Develop and enable an interactive public awareness campaign; TPCs would be no visual aids, lack of public interest and poor level of understanding of estuaries and the regulations that govern their well-being.				
Ensure that visual aids (notice boards) are erected at key-points (launch sites and resorts); host school groups and tourist groups for interactive tours of the management area; educate fishermen about regulations during compliance monitoring patrols (verbal and pamphlets); utilize the Anath Peninsula eco-tourism facilities for education workshops or awareness initiatives.	White Paper for Sustainable Coastal Development (Section C, Ch.10); ICM Act (Ch. 5, Section 38).	Monitor placing of notice boards and ensure their content is relevant to the Keurbooms management area scenario; provide school groups and general public (distribute through organizations or clubs) with a questionnaire to determine effectiveness of the programme.	Initiate over a two-year period. DFFE is responsible for education on a national level and should coordinate visual content of sign boards with Bitou LM and CapeNature; KEAF, WESSA and ORCA can host school and tourist groups at eco-tourism facilities on Anath Peninsula; CapeNature fisheries inspectors and voluntary compliance officers to educate fishermen.	**Human-** DFFE: Environmental Quality & Protection and O&C to supply notice boards with Bitou LM (Environmental Officer) and CapeNature input; WESSA, ORCA; specialists from tertiary and research institutions. **Financial-** primarily DFFE and Bitou LM; investigate corporate sponsorship; cost of additional signage R50 000.

Management actions	Legal requirements	Monitoring plans	Work plan	Resource plan
Operational Objective EA3: Identify key research projects by tertiary & research institutions and government departments; TPCs would be no research projects or the continued lack of information/data required for monitoring programmes and addressing management concerns.				
Identify key areas where research efforts should be concentrated (e.g., water quality & quantity; fishery survey; rehabilitation areas/methods; actively engage government and tertiary & research institutions to initiate projects.	None	Monitor progress of all research activities concerned with the Keurbooms management area and ensure that outcomes are practical and effectively used in long term monitoring programmes that will guide the implementation of the EMP.	Initiate immediately; Bitou LM and CapeNature can interact with government and tertiary & research institutions (includes South African Network for Coastal and Oceanic Research (SANCOR) and National Research Foundation (NRF) facilities). Government departments such as DWS and DFFE may initiate projects on their own and institutions such as CSIR and SAEON can be involved in long term monitoring projects. Members of organizations such as ORCA, Plett Angling Club and Plett Community and Environmental Forum can also participate in monitoring programmes.	**Human-** Bitou LM and CapeNature to liaise with government departments and identify research needs in cooperation with tertiary institutions. **Financial-** major research programmes are funded from a variety of sources- may be direct from government departments or through institutions such as the NRF, CSIR or SANCOR; corporate sponsors may also be approached.

6 SPATIAL ZONATION

Management objectives for the Keurbooms estuary have been translated into an Estuarine Zonation Plan (EZP) and applicable operational objectives which provide further detail to the management objectives described above. However, this is not applicable to all management objectives, as clearly the EZP cannot include the strategies for aspects of water quantity & quality, education & awareness programmes, institutional & management structures and sustainable livelihoods. As such, the EZP mainly reflects the objectives devised for living resources & conservation and land use & infrastructure.

6.1 Estuarine Zonation Plan

The spatial zonation of the Keurbooms estuary is represented visually in Figure 6 - Figure 8 and comprises the following:

6.1.1 Estuarine Boundaries

Historically, the C.A.P.E. Estuaries Programme considered the NWA definition of an estuary as the most appropriate. It reads as follows; "*a partially or fully enclosed water body that is open to the sea permanently or periodically, and within which the seawater can be diluted, to an extent that is measurable, with freshwater drained from land*."

For the purposes of determining the Resource Directed Measures (RDM), DWS defines the geographical boundaries of an estuary as follows; "*the seaward boundary is the estuary mouth and the upper boundary the full extent of tidal influence or saline intrusion, whichever is furthest upstream, with the five meter above mean sea level (MSL) contour defined as the lateral boundaries*."

The ICM Act further defines an estuary as "*a body of surface water -*

a) 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 body of surface water is open to the sea; or
c) in respect of which the salinity is higher than fresh water as a result of the influence of the sea, and where there is a salinity gradient between the tidal reach and the mouth of the body of surface water".

The 5 m topographic contour encapsulates the Estuarine Functional Zone (EFZ), which in turn is defined by 2014 EIA Regulations (GNR 985) under the National Environmental Management Act (NEMA 1998) as "*the area in and around an estuary which includes the open water area, estuarine habitat (such as sand and mudflats, rock and plant communities) and the surrounding floodplain area…*". In this way, certain activities are not permitted within an estuary without prior Environmental Authorization. It provides a useful guideline for a coastal management line, as much of the land below this mark is currently subject to flooding or may be in the future due to climate change (sea-level rise and

increased flooding). Although the 5 m contour falls well within the 1 000 m Coastal Protection Zone (CPZ); it must be included in all planning documents. The EFZ of the Keurbooms system is depicted below in Figure 6.

For the purposes of this EMP, the geographical boundaries of the tidal portion of the Keurbooms estuary have been defined in terms of the NWA definition, with the terrestrial management component being defined by the extent of the CPZ as defined in the ICM Act (Figure 7). The location of the 1:50 and 1:100-year floodlines are also shown and should also be used to inform the development of future planning documents (Figure 8). Historically, documents have stated that the extent of the tidal influence on the Keurbooms arm was located a few hundred meters beyond Whiskey Creek. However, it appears to extend at least 1.5 km beyond this area and is shown as such until the exact extent of the River-Estuarine Interface (REI), where fresh and saltwater mix, can be determined. The upper extent of the Bitou arm is taken at the causeway on the Wittedrift road (Figure 7).

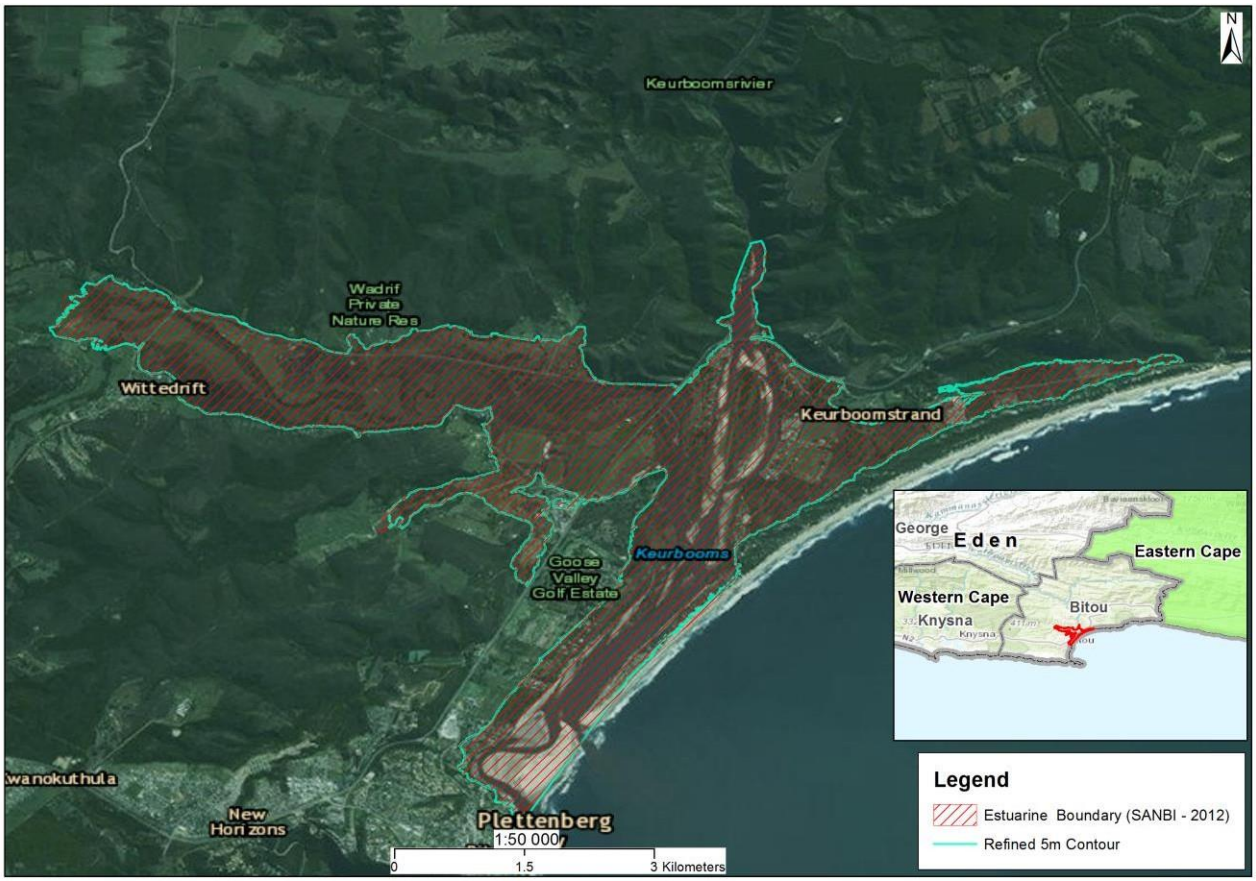
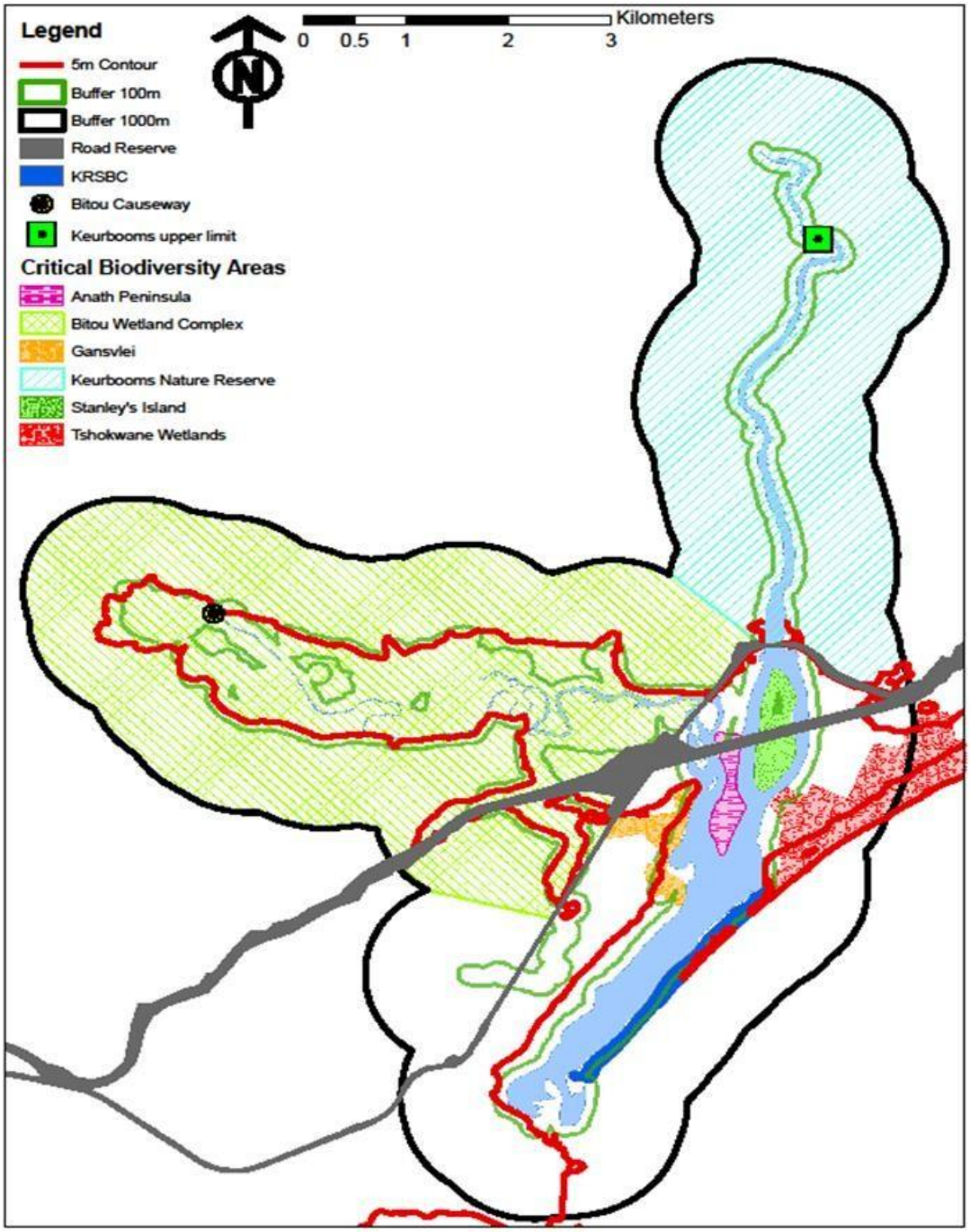


Figure 6. Map of the geographical boundaries of the Keurbooms estuarine system according to the 5m topographical contour, and defining the EFZ (Sanbi National Estuaries layer)



*KRSBC = Keurbooms River Seagull Breeding Colony

Figure 7. Map of the geographical boundaries, buffer zones and Critical Biodiversity Areas of the Keurbooms estuarine system

6.1.2 Coastal Protection Zone and proposed Coastal Management Line

The ICM Act defines a default **Coastal Protection Zone (CPZ)** which, in essence, consists of a continuous strip of land, starting from the High Water Mark (HWM) and extending 100m inland in developed urban areas zoned as residential, commercial, or public open space,

or 1 000m inland in areas that remain undeveloped or that are commonly referred to as rural areas. It also includes certain sensitive or at-risk land such as estuaries, littoral active zones and protected areas. The Tshokwane wetlands located to the northeast of the Keurbooms Estuary are included in the designated management area in their entirety as indicated in Figure 7. As such, management recommendations made in this EMP that are associated with sensitive ecosystems and habitats will include all of the Tshokwane wetlands.

The Provincial MEC, in consultation with the Local Municipalities, is required to refine and formally adopt the CPZ. **A process is currently underway to formally establish a CPZ as part of the Western Cape Coastal Management Line (CML) process**. In accordance with provisional delineation of the CPZ for estuaries in the Eden, as per draft delineations recommended in the Coastal Set-back / Management Lines for the Eden District project (WCG, 2015), the CPZ is informed by a coastal risks zone approximated by the **10 m above msl contour or 1:100yr floodline** around an estuary, whichever is wider. In respect to the latter, floodlines serve as important guidelines for land-use and town planning, in that they indicate areas of high risk where development should not be allowed. Not only must future town planning schemes take these into account, but they would also provide an indication to landowners with regards existing activities or structures that are at risk. The 1:100-year floodline is depicted in Figure 8.

The ICM Act also provides for the establishment of a **Coastal Management Line (CML)**, designed to limit development in ecologically sensitive or vulnerable areas, or an area where dynamic natural processes pose a hazard or risk to humans. A CML, as envisaged by the amended ICM Act, is informed by the projections of risk emanating from dynamic coastal processes such as sea level rise or erosion, information on ecological or other sensitivities adjacent to the coast, as well as the location and extent of existing development and existing executable development rights. The CML is a continuous line, seawards of which lies:

- Areas of biophysical or social sensitivities such as sensitive coastal vegetation identified as priority conservation areas and formal protected areas,
- those areas that should be left undeveloped, or only be granted appropriately restricted development rights, due to a high risk from dynamic coastal processes, or
- coastal public property.

In estuaries, the CML is delineated by the 5 m above msl contour or 1:100yr floodline, whichever is wider, to differentiate a zone where formal development should be discouraged.

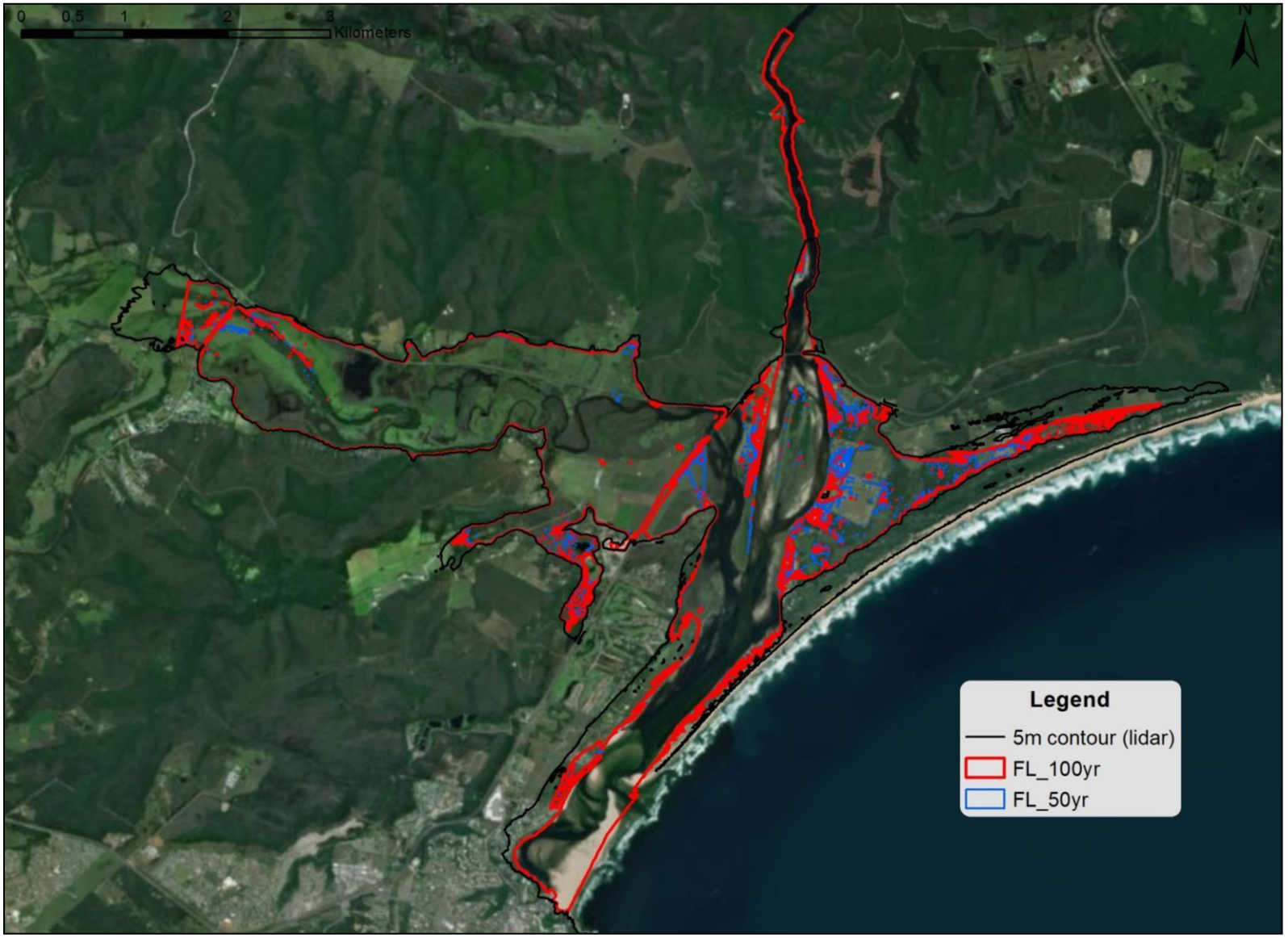


Figure 8. Map illustrating the 1:50 year and 1:100 year flood relative to the geographical boundaries of the Keurbooms estuarine system

6.1.3 Environmental Impact Assessment regulatory line

In respect of the EIA regulatory scheme, an additional line called the Development Set-Back Line (DSL) needs to be differentiated as it relates to the 'development set-back' referred to in the EIA regulations[15] rather than the coastal management lines described in the ICM Act. However, as part of the on-going process of defining coastal management lines for the Western Cape, it is currently **proposed that the CML, as defined under ICMA, also be used as the DSL**.

Reference to development setbacks is found in the so-called EIA Listing Notices that list a range of activities that require different levels of environmental impact assessment and the issuing of an environmental authorization prior to being undertaken.

Typically, an activity would be listed in the form of a range of thresholds which, if exceeded, trigger the need for an environmental impact assessment in the form of a Basic Assessment or full-blown EIA. In some cases, however, a development set-back line is used as spatial reference to include or exclude activities. The EIA regulations indicate that: "*development setback" means a setback line defined or adopted by the competent authority*". This implies that if such a setback is defined, the setback delineation replaces the default parameters for an activity, as read within the context of that activity. The competent authority in the Western Cape is DEA&DP or the National Department of Environmental Affairs.

The EIA regulations also refer to whether a development is in front or behind the line – for a coastal development set-back this equates to any development seaward of the line being 'in front of', whilst landward of the line being 'behind'.

An important further point to note is that the development setbacks are usually linked to the presence of urban built-up areas. The regulations indicate that ""*urban areas" means areas situated within the urban edge (as defined or adopted by the competent authority), or in instances where no urban edge or boundary has been defined or adopted, it refers to areas situated within the edge of built-up areas*". These exclusion areas create *de facto* islands in the area below the DSL, within which the specifically excluded EIA triggers don't apply.

The Western Cape Government, as designated competent authority, considers the area below/seaward of existing development as falling outside of the 'built-up area'. Therefore, any exclusions based on a listed activity taking place within the built-up area would not apply to this strip of coastal land, and the prescriptions for environmental assessments related to the particular activity will apply. For example, the beach in front of seafront houses is not considered 'built-up' and environmental authorizations will be required to execute any listed activities on that beach.

[15] The Environmental Impact Assessment Regulations, 2014, published under Government Notice No. 982 in Gazette No. 3822 of 4 December 2014, in terms of sections 24(5) and 44 of the National Environmental Management Act, 1998 (Act No. 107 of 1998)

6.1.4 Protected & Conservation Zones

6.1.4.1 Protected Zones

The declaration of Protected Areas within the water body of either estuary need to be evaluated (up to the spring HWM), as the sensitive submerged aquatic vegetation habitats, and their associated fauna need to be protected. This will partly be achieved by virtue of the wake-free and no-go boat areas. The two existing terrestrial reserves, namely the Keurbooms Nature Reserve (KNR) and the Keurbooms River Seagull Breeding Colony (KRSBC) should be retained, with access and activities strictly controlled by the management authority (CapeNature). While the KNR is already managed by CapeNature, the KRSBC needs to be addressed specifically with regards access and activities that disturb roosting and nesting (breeding) birds.

If the Bitou Ecological Corridor is established, a significant amount of the management area above the N2 Bridge on the Bitou arm will be included. Implementation of this initiative will require the establishment of the following structures (Eden to Addo 2010):

1) A Closed Corporation (CC) for the community projects;
2) A Section 21 Company for the conservation, research, training and education projects (this structure will allow projects to access funding from agencies, businesses, individuals, etc.); and
3) A Company for the envisaged Bitou Wetland Centre (part profits to be derived from this will support the Section 21 Company, in part, through donations).

There is a significant degree of overlap between the proposed Bitou Ecological Corridor management initiatives and the action plans detailed in this EMP. In addition, it will also deal with issues such as fire prevention (establishment of a Fire Protection Agency), cattle grazing, fencing and poaching (snares).

6.1.4.2 Conservation or Multi-Use Management Zones

The water body of both arms of the estuary, their associated habitats and the terrestrial areas set 100 and 1 000 m from the highwater mark are proposed as Multi-use Management Zones or Conservation Areas. Much of the management area has been classified as either Critical Biodiversity Area (CBA) or Ecological Support Area by the Garden Route Initiative (GRI; Holness *et al*. 2010). These areas represent the biodiversity priority areas, which should be maintained in a natural to near natural state (obviously excluding those areas already developed). Essentially this means no additional loss of habitat or area and that degraded areas should be rehabilitated. These remaining undeveloped areas will need to be highlighted in Municipal planning policies (e.g. SDF and ultimately the IDP) as CBAs and agreements will need to be entered into with landowners and lessees where applicable. The key CBAs that are highlighted are the Gansvlei, Bitou and Tshokwane wetlands, the southern portion of the Anath Peninsula, Stanley's Island and the KNR.

This does NOT mean that activities within these Multi-use management / conservation zones

are not allowed, but they will need to be strictly regulated according to legislation, and in consultation with landowners, to ensure sound environmental practices that benefit the users and the estuary. The 1:100 year flood line, which can also be used as a guideline to limit activities, should also be considered.

Examples of activities that would need to be controlled or restricted to specific areas include wake-free zones, skiing/power boating areas, swimming areas, kite boarding and windsurfing areas, organized sporting events, the use of jet-skis, building of jetties, slipways and other permanent structures (developments), bird watching and access to the water's edge (estuary and coastal) for people and vehicles.

The following activity zones are proposed (Figure 9):

Wake free zones

The wake-free zones are[16]:

the entire Bitou arm;
the Keurbooms Lagoon; and
the following areas on the Keurbooms arm:

- from the confluence to the N2 Bridge;
- from the first CapeNature picnic site to the head of the estuary (beyond Whiskey Creek); and
- within the designated skiing area outside of the skiing times (10h00 to 16h00).

Additional recommendations of this EMP, to be included in the future revisions of the Bitou Municipality River By-law are as follows:

- The 10 km/h and 5 km/h speed limit indicated on the wake-free zone marker buoys should be changed to read "wake-free";
- No vessels may operate above a wake-free speed within 10 m of a slipway, jetty, other vessel (includes non-powered vessels such as canoes, but does not apply within the designated skiing area) or swimmer;
- No vessel may operate above a wake-free speed between sunset and sunrise;
- Vessels gaining access to the sea or returning from the sea may operate above a wake-free speed only in the immediate vicinity (100 m) of the mouth (must be clearly marked);
- Vessels engaged in emergency operations (e.g. NSRI rescue vessels, CapeNature and SAPS during hot pursuit) should be exempt from the wake-free ruling; and
- All navigational hazards (such as submerged reef and sandbanks) near the mouth should be clearly marked. Buoys and signboards can be used but notice boards at launch sites must also contain this information. Due to the dynamic nature of the mouth region locations of navigational hazards will likely change on a regular basis.

[16] The recently published Bitou Municipal River By-law has adopted the river use zones currently implemented by CapeNature for the section below the N2 Bridge. This then provides legal status to wake free zones below the N2 Bridge. Wake-free zoning above the N2 Bridge is authorized under CapeNature Ordinance as a part of the Keurbooms Nature Reserve Management Plan.

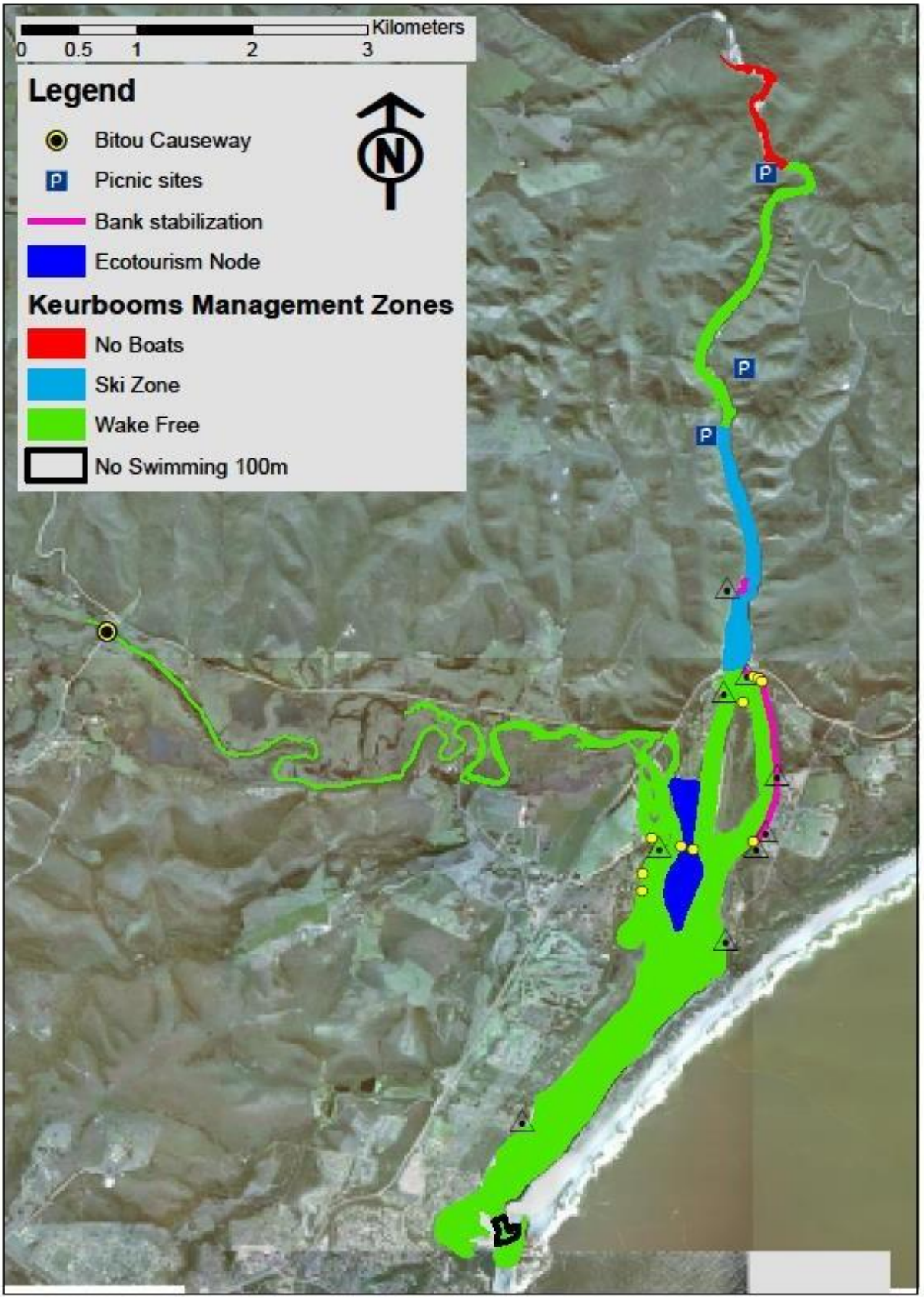


Figure 9. Keurbooms Estuary Zonation Plan illustrating designated management zones

Skiing area

- Located from the N2 Bridge to the first CapeNature picnic site on the Keurbooms arm (Figure 9).
- A hazard marker should be placed on the sandbank immediately above the N2 Bridge.
- Skiing times are between 10h00 and 16h00.

This area is regulated by CapeNature.

No-skiing and no-swimming zones

- No swimming in the designated skiing area within the designated skiing times (10h00 to 16h00).
- No swimming within 20 m of any jetty or slipway.
- No swimming within 100 m of the estuary mouth. This is for safety reasons due to tidal currents and boats entering and exiting the mouth at speed. This should exclude water users such as surfers, paddlers, kite boarders and sailboarders who regularly use the area in the immediate vicinity of and adjacent to the mouth (irrespective of its location).
- No skiing in any of the wake-free zones or within the designated skiing area outside of the stipulated times (10h00 to 16h00).

Motorized vessel areas

- No motorized vessels may operate on the Keurbooms arm above the markers located approximately 250 m upstream of Whiskey Creek.
- This would not apply in emergency situations where access is required in order to facilitate rescue and pursuit operations.

Other

- *Jet-skis*
  - No jet-skis can operate on the system[17].

- *SANRAL N2 road reserve (servitude)*
  A 29 km servitude for an alternate N2 route has been proclaimed via Government Gazette No. 213 of 1985 (22 November 1985) in terms of the National Roads Act (Act 54 of 1971). between Hillview and Bloukranz.

- *Organized sporting events*
  - Organised sporting events may take place with approval from either the Municipality or CapeNature and should not conflict with the EZP with regards the wake-free zones

[17] According to the Bitou Municipal River By-law, the use of jet-skis under 3m in length in specifically demarcated areas is permitted. However, the adopted CapeNature zonation in terms of Section 5 of the by-laws does not allow for the use of jet-skis and other jet-propelled craft, and they are thus prohibited from the Keurbooms estuary system.

and times.

- Kite boarding and sailboarding are restricted to the Keurbooms Lagoon area between the confluence and the mouth location and beyond out to sea.

- *Angling and Bait Harvesting*
  - Angling, with a valid saltwater permit, may take place anywhere within the water body.

It is recommended that the Bitou Municipal River By-laws include the following provisions:

- No spearfishing.
- No fishing in skiing zone during skiing times (10h00 – 16h00)
- Restriction of bait collection to daylight hours to avoid trampling of substrate at night when larval release and post-larval settlement are at a peak (mudprawns)

- *Jetties and slipways*
  - All known jetties and slipways are indicated on the EZP (yellow dots on the map in Figure 9).
  - No additional jetties or slipways will be allowed. However, consideration of a slipway closer to the mouth could be facilitated.

6.1.5 Rehabilitation Zones

Rehabilitation, primarily in the form of alien vegetation removal (estuary and catchment area), bank stabilization, rehabilitation of flood damaged structures, properties threatened by sea-level rise and floods and improving degraded saltmarsh/wetland areas are addressed.

Although the removal of alien vegetation within the riparian area is seen as a priority this must not be done to the detriment of bank stability. Many sections of the Keurbooms arm, where residential development has taken place, show signs of severe erosion and collapse. While floodwaters are largely responsible for this, the situation may have been exacerbated through the initial removal of stabilizing vegetation. There are some sections where alien removal has been done, but an agreement between landowners and DFFE needs to be reached whereby landowners can undertake to remove aliens using their own resources provided funding is made available. The removal of debris after clearing must be stressed, otherwise it accumulates and poses a potentially catastrophic destructive force when carried downstream by floodwaters.

Most of the eastern shore of the Keurbooms arm below the N2 Bridge, where residential estates have been developed, and the western shore at Forever Resorts, have been or are currently being rehabilitated. These activities have met with varying degrees of success. A process to streamline the application process to undertake rehabilitation is proposed to standardize the method used, and provide provision for maintenance or repairs after storm/flood damage. Areas of the CapeNature picnic sites in the upper reaches of the

Keurbooms arm have been damaged by floodwaters and also need to be repaired.

The predicted rise in sea-level combined with freshwater floods and extreme storm events is likely to place much of the existing low-lying areas (developed and undeveloped) within the management area under threat. As water levels rise and floods become more frequent or severe, actions such as rehabilitation, constructing berms or sea walls, realigning access and residential roads and relocating infrastructure (sewerage, electricity and telecommunications) may suffice over the short term, but ultimately a relocation strategy may need to be considered for the long term. This should be considered within the context of the Municipal IDP and in the framework of a Disaster Management Plan.

The Bitou wetlands above the N2 Bridge are in particular need of attention. Much of this area is currently used by landowners, primarily for grazing and limited residential or tourism-based activities. Agreements with landowners need to be reached to ensure a buffer zone along the riparian edge and to minimize damage caused by grazing, trampling and vehicle tracks. These activities cannot be stopped altogether as they are an historical and integral part of the small-scale agricultural industry in the area. Any paths, causeways or earthen barricades that impede the natural flow through the wetland system need to be adapted to allow for a more natural flow regime (e.g., large culverts).

Access to all intertidal saltmarsh areas and the Gansvlei and Tshokwane wetland systems must be restricted to single footpaths to reduce damage caused by trampling and to allow for the natural rehabilitation or recovery of these areas. Culverts should be installed in the road that bisects this wetland to facilitate the free flow of surface water.

All designated CBAs should be regarded as rehabilitation zones as past activities have led to the degradation of the habitat to some degree.

6.1.6 Eco-Tourism Nodes

An eco-tourism node located on the southern portion of the Anath Peninsula has been identified. The old derelict "Greig" House should be renovated to house an environmental education center. This can be used by any organization (e.g., CapeNature, WESSA, WWF-SA, ORCA) for the purposes of education and awareness programmes. The remaining area needs to be revamped to include braai and ablution facilities and refuse disposal bins. Access will need to be controlled and an onsite caretaker/manager appointed to prevent vandalism and theft of infrastructure.

The design for the node, leasing arrangements and appointment of a caretaker must be implemented by the Bitou LM in cooperation with CapeNature. Should any of the proposed activities (or structures) be listed under the EIA Regulations, the EIA process must be adhered to. In addition, the location of the Peninsula is in all likelihood below the 1:50 (and also the 1:100-year) flood line and as such all restrictions with regards development below these flood lines must be considered – this may mean that no new structures may be developed, but existing infrastructure or structures could be renovated or refurbished.

Consideration also needs to be given to the existing access servitude that runs through the Twin Rivers Estate, specifically how access will be controlled and who will be responsible for the maintenance of the access road. An improvement of facilities and development of an education center will mean increased traffic and therefore increased wear and tear on the road. In addition, an increase in visitors may pose a security risk to Twin Rivers Estate homeowners and concerns have been raised about resulting negative impacts on property values.

7 IMPLEMENTATION

7.1 Institutional Arrangements

7.1.1 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 project plans and the implementation thereof.

Co-management and effective governance have been identified as vital aspects to the efficient and effective management of the Keurbooms estuarine system. CapeNature has developed a Governance Tool to address this. Figure 10 displays the key role players that should be included in its management.

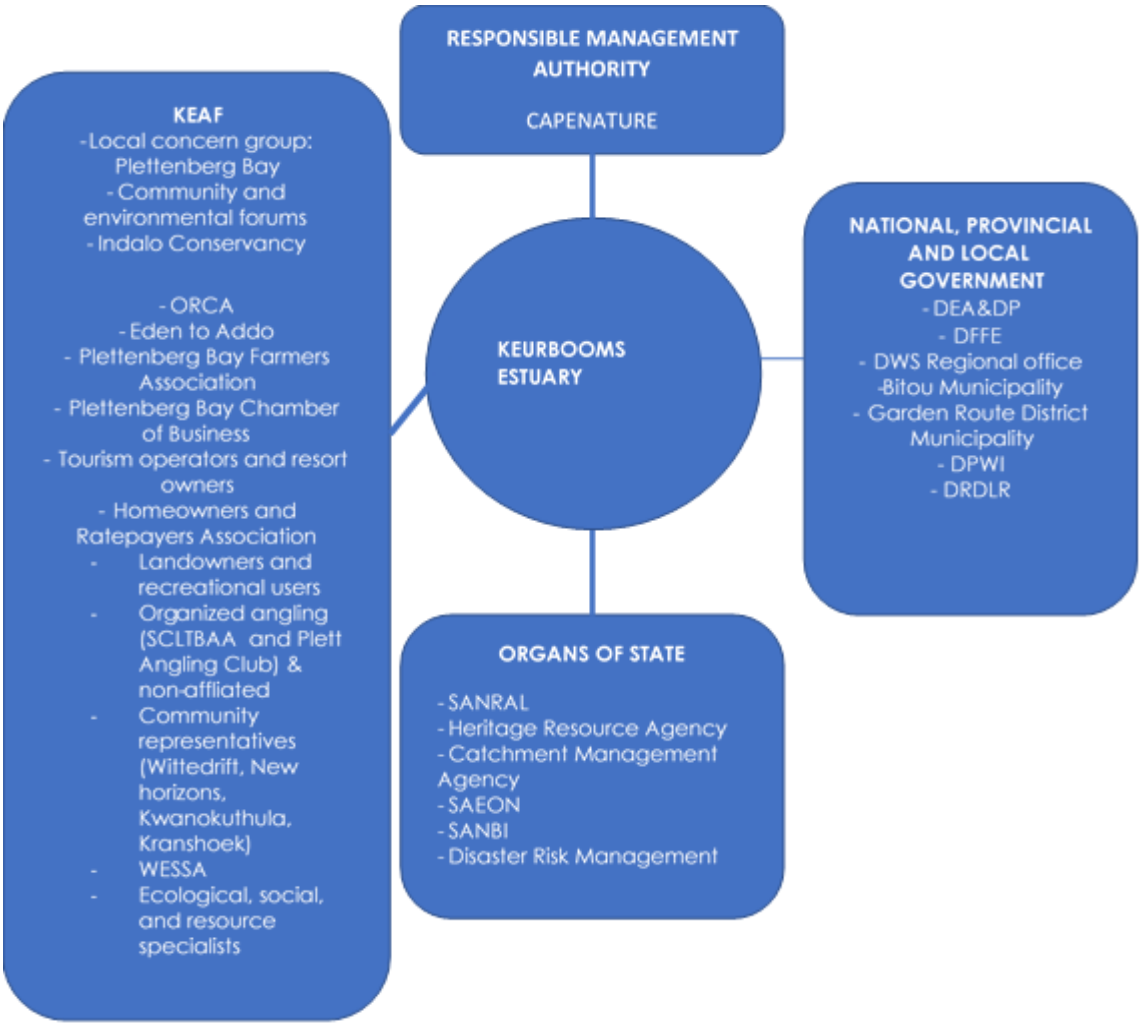


Figure 10. Key role players for the management of the Keurbooms estuary system

7.1.2 Responsible Management Authority

The Protocol identifies **CapeNature** as the **Responsible Management Authority (RMA)**, responsible for the development of the Keurbooms EMP as well as being responsible for the co-ordination of its implementation. **CapeNature** is already responsible for the management of the Keurbooms Nature Reserve and for many aspects of estuarine management. The Bitou Municipality and CapeNature should come to agreement via a signed Memorandum of Understanding to co-manage the estuary. Implementation of the EMP can be affected through a range of different forums and agencies. The RMA should hold the responsibility of chairing and facilitating the Estuary Advisory Forum meetings.

7.1.3 Keurbooms Estuary Advisory Forum

According to the Protocol, the role of the **Keurbooms Estuary Advisory Forum (KEAF)** 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 KEAF. This includes Ratepayers' Associations, NGO's, community groups, conservancy, etc., and representatives from surrounding industry and agriculture. Local members will play an invaluable role in providing on the ground local insight and support to the authorities. Representatives are obliged to raise issues identified by their constituents and to provide feedback to the constituents. Importantly, the Forum will not represent or supplant the individual positions of its members unless specifically mandated to do so.

More specifically, the KEAF should consist of the following:

1. A **chairperson** representing the RMA who will take the lead in coordinating and facilitating the forum;
2. **Government Representatives** of the major management sectors/areas with executive powers in terms of respective legislation:
    a. Conservation & Living Resources;
    b. Land-use and infrastructure development;
    c. Water quantity and quality; and
    d. Social (and cultural) issues.
3. Representatives of all the above **remaining institutions and interest groups**. Existing institutions such as CMAs, WUAs or catchment forums and conservancies may be used instead of establishing a new separate forum, but these would need to be expanded to include representatives from all interest groups.

The KEAF serves to keep all stakeholders informed of the progress and effectiveness of the EMP, identifies areas of concern and makes management recommendations that may need to be incorporated into the EMP, liaises with government departments, through the RMA, to ensure they fulfil their legal obligations and interacts with tertiary and research

institutions to help coordinate research programmes. The principal functions of the KEAF may include:

- Promoting co-operative governance between stakeholders;
- Providing the platform to voice concerns and raise issues;
- Assisting the RMA leveraging funding for implementation of various actions and project plans
- Motivating for supportive legislation (by-laws) for estuarine management;
- Disseminating information and providing feedback to stakeholders on estuary-related issues; and
- Promoting environmental awareness and capacity building with regard to estuarine issues.

The KEAF and its members may also be directly involved with monitoring programmes by collecting data (physical measurements or visual observations) and can act as the eyes and ears for law enforcement authorities. All members of the KEAF must be provided with a list of contact numbers for government department representatives who have the mandate to act so that they may be contacted whenever stakeholders observe activities that do not comply with the EMP requirements.

7.1.4 Government Departments and Organs of State

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

- CapeNature as Responsible Management Authority is responsible for general conservation in the region, including the Keurbooms Nature Reserve, biological monitoring, compliance management and facilitating rehabilitation;
- Bitou LM, and Garden Route DM: Responsible for fulfilling key municipal roles, as well as the provision of management and technical support;
- Western Cape Government departments: Responsible for legislatively mandated responsibilities as well as support, including compliance, funding, and monitoring (e.g., DEA&DP, Department of Transport and Public Works, etc.);
- Relevant National Government departments especially DFFE, DWS (via the regional office), Department of Rural Development and Land Reform (DRDLR); and Department of Science and Technology (DST); and
- Organs of State, such as BGCMA and the CSIR.

The DFFE is responsible for national standardization of estuarine management and approval of provincially-led EMPs. Direct involvement in individual estuaries, such as the Keurboom estuarine system, will occur via existing forums for intergovernmental coordination. These forums will have the management of the various estuarine systems on their agenda from time to time.

- The Garden Route District Coastal Committee: Responsible for facilitating co-management, effective governance and district level co-ordination of coastal and

estuarine management issues; and

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

A crucial element towards achieving the vision and objectives of this plan, is to ensure that the responsible authorities and their constituent departments fulfil their roles and responsibilities as identified within the EMP. In terms of practical implementation of the EMP, each responsible government department is required to produce internal project plans linked to the identified management actions, and in line with their legislative mandates. Funding and staff resources will need to be sourced within each respective sector, department and/or institute. Alternatively, departments may fund other entities to undertake their necessary functions on their behalf. The CapeNature Governance Tool will be used to track and report on these activities.

7.2 Recommended Priority Actions

It is recommended that the following actions of the EMP be implemented as a matter of priority (i.e., **HIGH PRIORITY)**.

- Ensure the KEAF is democratic and representative of all stakeholders, interest groups and government departments.
- Ensure that the EMP is accepted by the Municipality, CapeNature, and the MEC and then Gazetted and incorporated into the Municipal SDF and IDP frameworks (as well as CMS).
- Ensure compliance with EWR assessment by ensuring that allocated flows reach the estuaries and that off-channel storage is monitored
- Carry out basic monthly water quality monitoring, e.g., salinity, DO, temperature, turbidity, water level, etc. at Reserve sites.
- Coordinate a meeting with relevant stakeholders to resolve the issue surrounding applications and authorizations for repair work due to flood damage.
- All aspects related to water quality and quantity.
- Determine the carrying capacity (boating vessels) of the estuaries in line with the Vision.
- Land-use & infrastructure Actions LU1, 2, 4 & 5.
- Compliance monitoring in respect of living resources.
- Increase CapeNature's capacity for compliance monitoring and encourage volunteers to be trained and appointed as voluntary compliance officers.
- Formal arrangement between Bitou LM and CapeNature for administration of By-laws and EZP.
- Restrict access to and activities in the KRSBC.
- Appointment of a regional Estuarine Management Co-Ordinator within the Bitou LM.
- Availability of recreational fishing licenses.
- Ensure integration between the BGCMA with KEAF.
- Skipper's certification for CapeNature personnel.

- Inform stakeholders of inter-governmental arrangements pertaining to administration of legislation.
- Identification and prioritization of research requirements.

The following aspects of the EMP should be addressed as a matter of **MEDIUM PRIORITY.**

- Establish the spatial zoning of the estuary in accordance with the EZP.
- Compliance with EZP and amended By-laws.
- Identification of monitoring and research requirements (priority must be given to sustainability of resources; and the effects of poor water quality on ecosystem health and functioning).
- Protection and rehabilitation of saltmarshes and wetlands (includes establishing a buffer zone in cooperation with landowners and protection of Tshokwane wetland area).
- Feasibility of removal of the old bridge pylons and restoration of flow on the Bitou.
- Inform stakeholders of all ongoing and planned conservation initiatives.
- Upgrade capacity of sewerage reticulation system at Keurboomstrand.
- Determine capacity of Bitou WWTW to cope with future demand.
- Secure funding from relevant government departments.
- Management Actions for sustainable livelihoods (compliance of existing activities and identification new activities to benefit PDCs).
- Educational workshops and public awareness campaign.

The following aspects of the EMP should be addressed as a matter of **LOW PRIORITY.**

- Investigate the feasibility of conducting a comprehensive EWR assessment. Although this will need to be implemented immediately, it is an exhaustive process and will need to be done over a long period of time.
- Evaluate the establishment of an eco-tourism node on the Anath Peninsula.
- Equitable and controlled access to Coastal Public Property.
- Management Actions for tourism & recreational use.

The following management actions are considered to be a lower priority and can be addressed within timeframes (to be agreed).

- Engage Provincial government in terms of a strategy to deal with property and people affected by sea-level rise, flooding and storm events (CML process).
- Regulation of existing livelihoods and the identification of additional opportunities involving members of previously disadvantaged communities.
- Develop the eco-tourism nodes within the terrestrial reserves.
- A fishery survey (comprising both fish and bait aspects) should be conducted every three years.
- Identification, evaluation and protection of heritage and cultural resources.
- Feasibility of a dredging operation to remove sediment loads.
- Determine SANRALs plans for the servitude across the Anath Peninsula.
- Regulation of fishing competitions (number and format) if these are allowed in the future; due to the added pressure this will place on bait resources as well as the illegal selling of bait, it is recommended that competitions not be considered in the future

and that the National Marine Linefish System (NMLS) is implemented to assess angling pressure.
- Enforce compliance by developers in respect of the EA conditions as they become available.

The EMP in its current form should be reviewed **after five years**. It will be the responsibility of the RMA to revisit the Situation Assessment Report. This will be followed by a round of revision and/or refinements of the Objective-setting and Implementation phases as and where necessary, e.g., it may be necessary to adjust aspects of an action plan or monitoring programme (See Section 8.2).

8 INTEGRATED MONITORING PLAN

8.1 Monitoring

There are two components to monitoring, namely baseline measurement programmes and long-term monitoring programmes, and it is important to note the difference between them in the context of the EMP framework (Taljaard & van Niekerk 2007b).

8.1.1 Baseline measurement programmes

Baseline measurement programmes usually refer to short-term or once-off, intensive investigations of a wide range of parameters to obtain a better understanding of ecosystem functioning; they may also involve the investigation of non-ecological data to determine an existing situation with regards to compliance, land-use patterns, institutional & management structures, alternative livelihoods and education & awareness initiatives. These programmes would normally be a part of the Situation Assessment and the Objective-Setting Phases within the framework. In the context of this EMP, baseline data is required in order to determine the state of many issues in relation to the TPCs described in the action plans.

A detailed description of the baseline requirements, spatial and temporal scales, required resources and sampling & analysis techniques with regards the TPCs referred to in the action plans is provided in Appendix 3 (see McGwynne & Adams 2004 for rational behind monitoring). Baseline monitoring programmes are not required for all aspects of the EMP, e.g., identification and evaluation of heritage resources and the management actions for the Institutional & Management Structures section. Some aspects of these baseline programmes, e.g., *cpue* and population (invertebrates and birds) monitoring will also form part of long-term programmes (see below).

8.1.2 Long-term Resource Monitoring

Long-term monitoring refers to ongoing data-collection programmes that are done to evaluate continuously the effectiveness of management actions within action plans that are designed to maintain a desired environmental state. Data from these programmes are

used to determine or anticipate when particular TPCs have been or will be exceeded so that responses to potentially negative impacts, including cumulative effects, can be implemented in good time. Long-term programmes usually involve biotic and abiotic components concerned with the biophysical aspects such as water quantity & quality, conservation and living resources. However, accumulated data from baseline programmes associated with land-use & infrastructure, management & institutional structures, sustainable livelihoods and education & awareness can be analysed over the long-term as well to ensure that the Vision for the Keurbooms management area is achieved and maintained. Long-term programmes often form part of detailed scientific surveys or research projects conducted by tertiary and research institutions, but they may also take the form of less complex initiatives such as records of compliance with legislation and records of activities in the context of the EZP or Municipal By-laws.

The long-term monitoring programme described in Appendix 4 (Table 27) was initially developed to determine the requirements for the Ecological Reserve and then to assess the effectiveness of the prescribed reserve (see Taljaard & Van Niekerk 2007a). However, in most instances data from this programme can also be used as indicators of other management concerns where the ecological reserve specifically is not responsible for the observed pattern or scenario. For example, the long-term monitoring of fish could reveal a decline in biodiversity or species richness that could be due to RQO parameters but could equally be due to human activities such as fishing, episodic events causing habitat change, seasonal migrations, national trends in fish populations or large-scale fluctuations in climate.

The details of the long-term monitoring programme have been amended by the updated EWR Assessment (DWS, 2015). The following components were included hydrology, sediment dynamics, hydrodynamics, water & sediment quality, microalgae, macrophytes, invertebrates, fish and birds.

Long-term monitoring programmes tend to be the responsibility of government departments such as DWS and DFFE who usually contract the services of tertiary & research institutes such as CSIR, SAIAB, SAEON and Universities. However, the RMA and KEAF can also be involved so as to ensure that programmes are undertaken and are beneficial to the effective implementation of the EMP.

8.2 Performance Review and Evaluation

Evaluation of the EMP will become the responsibility of the RMA. This is to assess the effectiveness with which planned management activities contained in the EMP are being performed and ultimately to gauge progress in achieving the vision and objectives. This component utilises the performance indicators included for the various actions, specifically the management priorities, and includes a temporal scale or the frequency of the collection of the performance data and the targets that should be achieved (METT). The CapeNature Governance Tool will be used to identify, monitor and track the implementation of management objectives.

Ultimately the EMP must be holistically reviewed every 5 years from the date it was adopted, ideally in line with the review cycles of the applicable IDP, SDF, CMS, WCPAES, NBA, RQOs and/or CMP. This review is the responsibility of the RMA. This is to assess whether that vision, objectives and targets are being achieved. This 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. Data from the monitoring programmes will also indicate whether the management objectives have been achieved. In a situation where these targets have not been achieved, the RMA will need to determine which aspects of the EMP need to be altered in order to rectify these shortfalls. Usually this will involve the adaptation of management strategies and objectives or aspects of the action plans themselves, although the problem may be with implementation (capacity and finance). Monitoring programmes may also be altered to supply specific data to fill existing knowledge gaps.

Ideally, representatives of the major components, namely conservation & living resources, social & cultural issues, land-use & infrastructure, and water quantity & quality, should evaluate the efficiency of the EMP in the context of their area of responsibility. It is essential that representatives from the BGCMA are included within the KEAF structure to address the RQO-related issues.

An audit should be undertaken alongside the evaluation to determine and grade the success and failures with the implementation of the management plan according to the specified performance indicators.

9 RESEARCH PRIORITIES

The following research needs that should fill the knowledge gaps and provide supplementary data for monitoring programmes have been identified and should be initiated as soon as possible. The RMA, CapeNature, should play a leading role in prioritizing these research needs and motivating for the required studies to be implemented. Although a wealth of information is available, particularly for the Keurbooms arm, much of it is outdated, and new research efforts are needed to update our knowledge of the system. The RMA may approach tertiary and research institutions such as Universities, the CSIR and NRF institutions such as SANCOR, SAIAB and SAEON to create an awareness of what is required. There may be a degree of overlap with the long-term monitoring programmes defined in Section 8 above.

- Fishery survey comprising bait organisms and fish. Key elements include fishing/collecting effort, *cpue*, user dynamics, target fish species, catch composition, bait utilization in relation to existing regulations (waste), motivation for using resources, economic value of the fishery, degree of compliance and conflict between different fishing fraternities.
- Invertebrate organisms - key elements should include densities, recovery periods after disturbance (collecting and trampling that alter habitat; flood events), impact of various collecting methods (pumps vs. digging), community structures before and after disturbance, effect of pollutants in the sediment, mortality due to birds foraging after collection activities, effect on birds by bait collectors and larval settlement times & location along the tidal cross-section.
- The carrying capacity of the estuary needs to be determined so that the RMA can make an informed decision about the numbers of users utilizing the system at any given time. Some data can be collected as part of the fishery survey, but some aspects such as sense of place, pollution due to engine emissions and incidents of confrontation between all user groups will need to be addressed by a dedicated project.
- A social based project to determine the effectiveness of the education & awareness programme and the attitude toward the EMP and those management actions which have directly affected users, e.g., controlled access to sanctuary areas, skiing areas, no swimming zones etc.
- A Comprehensive EWR assessment to substantiate the results from the desktop revaluation that was conducted (DWS,2015). This will be required if the Vision of a Category A/B system is to be realized.
- Long term monitoring of habitats and community structures in relation to RQOs to determine requirements and effectiveness of the ecological reserve.
- The effect of poor water quality (sewerage and heavy metals) on ecosystem functioning.
- Tidal flows, salinity intrusion and freshwater inflow in the upper reaches, i.e., the extent and importance of the REI.
- The impact of poor water quality on the nursery function of the estuary – this will

include the impact of the proposed desalination plant.

- A collation of long-term monitoring data that provides information about the birds and animals (abundance, location etc.) that occur in these unique systems. This should be linked with all available similar information on the river systems so as to provide a more complete picture.
- Impact of sea-level rise, flooding and storm events on the low-lying areas, with the goal of developing a relocation strategy for affected people, properties and infrastructure.

10 RECOMMENDATIONS

The following recommendations are made to assist/ improve management of the Keurbooms estuary:

- Future revisions of the zonation plan should also consider flexible recreational use areas as well as peak user days regulations.
- Liaise with DWS to undertake a comprehensive, detailed EWR study, including an up-to-date survey of biota, in support of the Classification process, supported by detailed monitoring and numerical modelling studies.

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APPENDIX 1: ECOSPECS AND ASSOCIATED TPCS

The EcoSpecs (preliminary Resource Quality Objectives for ecological aspects only) and associated TPCs representative of a **Category A/B for the Keurbooms Estuary, as per the updated EWR study (DWS, 2015)** are presented in Table 15. These may need to be refined as new data become available on the system.

Table 15. EcoSpecs and associated TPCs for the Keurbooms Estuary (Category A/B)(DWS, 2015)

Ecological component	EcoSpecs	Thresholds of Potential Concern
Hydrology	▪ Maintain flow regime	▪ Varies more than 10% of present MAR ▪ Inflow < 1.0 m^3/s for more than 10% of the time over a five-year period.
Hydrodynamics	▪ Maintain mouth state to create the required habitat for birds, fish, macrophytes, microalgae and water quality	▪ Mouth closure occurs ▪ Average water level change by more than 20% from present ▪ Mouth entrance channel becomes <1.0 m deep
Water quality	▪ Salinity distribution does not cause exceedance of TPCs for fish, invertebrates, macrophytes and microalgae ▪ Turbidity and Dissolved oxygen not to cause exceedance of TPCs for biota ▪ DIN/DIP (Dissolved inorganic phosphates) concentrations do not cause exceedance of TPCs for macrophytes and microalgae ▪ Toxic substances not to cause exceedance of TPCs for biota	▪ Average salinity > 10 at the top of the estuary in the Keurbooms and/or Bitou Arms. ▪ Average salinity > 20 along the length of the system (to be confirmed by monitoring) ▪ Dissolved oxygen (DO) < 5 mg/ℓ in estuary ▪ Turbidity > 10 NTU in low flow ▪ Secchi: to bottom ▪ DIN > 100 ug/ℓ once-off ▪ DIP > 20 ug/ℓ once-off ▪ Concentrations in water column exceed target values as per SA Water Quality Guidelines for coastal marine waters (DWAF,

Ecological component	EcoSpecs	Thresholds of Potential Concern
		1995) ▪ Concentrations in sediment exceed target values as per West Indian Ocean Region guidelines (UNEP/Nairobi Convention Secretariat and CSIR, 2009)
Sediment dynamics	▪ Flood regime to maintain the sediment distribution patterns and aquatic habitat (instream physical habitat) so as not to exceed TPCs for biota ▪ Changes in sediment grain size distribution patterns not to cause exceedance of TPCs in benthic invertebrates ▪ Change in average sediment composition and characteristics ▪ Change in average bathymetry	▪ Average sediment composition (% fractions) along estuary change from baseline (to be measured) by 30% (per survey) ▪ Average depth along main channel change from 30% of baseline (to be determine) (system expected to significant fluctuation in bathymetry between flood and extended closed periods)
Microalgae	▪ Maintain median phytoplankton/ benthic microalgae biomass ▪ Prevent formation of phytoplankton blooms	▪ Phytoplankton > 3.5 ug/ℓ (median) ▪ Benthic microalgae > 11 mg/m^2 (median) ▪ Phytoplankton > 20 ug/ℓ and/or cell density >10 000 cells/ml (once-off)
Macrophytes	▪ Maintain the distribution of sensitive macrophyte habitats (e.g. salt marsh, submerged macrophytes, reeds & sedges) (off special importance is the submerged macrophytes in the Bitou Arm as habitat for the endangered seahorses *Hippocampus capensis*) ▪ Rehabilitate the Bitou wetlands by removing weirs, berms, old bridges ▪ Limit the spread of invasive plants	▪ Greater than 20% change in the area covered by salt marsh, submerged macrophytes and reeds & sedges ▪ No weirs, berms, old bridges in the Bitou wetlands ▪ Invasive plants cover less than 5% of the total estuarine area ▪ Unvegetated cleared areas along the banks caused by human disturbance

Ecological component	EcoSpecs	Thresholds of Potential Concern
	▪ Maintain the integrity of the riparian zone	
Invertebrates	▪ Maintain high biomass and diversity of benthic invertebrates in the lagoon area in the lower estuary. ▪ Maintain rich invertebrate communities associated with the REI zone in the upper estuary (zooplankton and benthos).	▪ Invertebrate densities of each of the three numerically dominant benthic species should not deviate from average baseline levels (as determined in the eight visits undertaken quarterly in the first two years) by more than 30% in each season. ▪ The dominant species in the zone (zooplankton and benthos) should not deviate from average baseline levels (as determined in the eight visits undertaken quarterly in the first two years) by more than 30% in each season.
Fish	Fish assemblage should comprise the five estuarine association categories in similar proportions (diversity and abundance) to that under the reference (see 2008 EWR report). Numerically assemblage should comprise: ▪ Ia estuarine residents (50-80% of total abundance) ▪ Ib marine and estuarine breeders (10-20%) ▪ IIa obligate estuarine-dependent (10-20%) ▪ IIb estuarine associated species (5-15%), IIc marine opportunists (20-80%) ▪ III marine vagrants (not more than 5%) ▪ IV indigenous fish (1-5%) ▪ V catadromous species (1-5%) Category Ia species should contain viable populations of at least four species (*G.aestuaria, Hyporamphus capensis, Omobranchus woodii*).	▪ Ia estuarine residents < 50% ▪ Ib marine and estuarine breeders < 10% ▪ IIa obligate estuarine-dependent < 10% ▪ IIb estuarine associated species < 5% ▪ IIc marine opportunists < 20% ▪ III marine vagrants > 5% ▪ IV indigenous fish < 1% ▪ V catadromous species < 1% Abundance of *Hippocampus capensis* deviate by more than 10 % from baseline (Project Seahorse studies, e.g. Lockyear *et al.* 2006; Bell *et al.* 2003).

Ecological component	EcoSpecs	Thresholds of Potential Concern
	Category IIa obligate dependents should be well represented by large exploited species (*A. japonicus, L. lithognathus, P. commersonii, Lichia amia*). REI species dominated by both *Myxus capensis* and *G. aestuaria*	
Birds	▪ Maintain population of original groups of birds present on the estuary	▪ Number of birds in any group, other than species that are increasing regionally such as the Egyptian Goose, drops below the baseline median (determined by past data and or initial surveys) number of species and/or birds counted for three consecutive summer or winter counts.

APPENDIX 2: WATER QUALITY GUIDELINES

Table 16. Water Quality Guidelines - Targets for the Natural Marine Environment (DWAF 1995). See Reference List for Sources (EEC - Water Research Centre)

	Canada	US-EPA	EEC (after UK)	Australia	DWAF (1995a)
Physico-chemical Properties					
Salinity				Change should be < 5 units from background levels.	
pH	6.5 to 8.5		6 to 9	5 to 9	No target value selected but 6.5 to 8.5 is optimal.
Floating matter (including oil and grease)	Free of substances that form objectionable deposits or that float (debris, scum, oil and nuisance organisms).	Free of substances that form objectionable deposits or that float (debris, scum and oil).	Floating materials such as wood, plastic articles, etc. should be absent	Oil and petrochemicals should not be noticeable as a visible film.	No floating particulate matter, debris, oil, grease, wax, scum, foam and residues from land-based sources that may cause nuisance.
	Should not be present in concentrations that could be visible, detected by odour or deposited on the shoreline (oil and grease).		No visible film on surface of the water (oil).	Nuisance organisms (phytoplankton scum, macrophytes) should not be present in excessive amounts.	No material from non-natural land-based sources, which will settle to form putrescence.
			No lasting foam.		No submerged objects ad other sub-surface hazards, which arise from non-natural origins and which would be a danger, cause nuisance or interfere with any designated or recognized use.
Suspended solids					No increase by >10% of ambient concentration.
Colour/turbidity/clarity	Turbidity should not be increased > 5 NTU over natural turbidity when turbidity is low (< 50 NTU).	Water should be free from substances producing objectionable colour or turbidity.	No abnormal change in colour.	Natural clarity should not be reduced by more than 20%.	Turbidity and colour acting singly or in combination should not reduce photic zone by >10 % of background levels.
	Clarity (Secchi disc) - 1.2 m; swimming areas clear to the bottom.		Secchi disc depth - 1 m (90%ile; guide) and 2 m (95%ile; mandatory).	Natural reflectance should not be changed by more than 50%.	Colour (substances in solution) of water should not exceed background levels by > 35 Hazen units.
	Colour - maximum limit of 100 Pt-Co counts.			Horizontal sighting of a 200 mm black disc should exceed 1.6 m.	
Dissolved oxygen			80 to 120% saturation (90%ile).		

	Canada	US-EPA	EEC (after UK)	Australia	DWAF (1995a)
Nutrients					
General	Waters should be free of substances that produce undesirable aquatic life.	Waters should be free of substances that produce undesirable or nuisance aquatic life.			
Nitrate				No single value. Levels at which problems have been experienced are between 10 and 60 ug/l.	
Phosphate				No single value. Levels at which problems have been experienced are between 1 and 10 ug/l.	
Total phosphorous		0.1 ug/l (elemental).			
Inorganic nutrients					
Cyanide				0.1 mg/l.	
Hydrogen sulphide			40 ug/l (24 hr max average).		No target value - can cause unpleasant odours.
Gypsum					
Arsenic			500 ug/l total (95%ile).	0.05 mg/l.	
Cadmium				0.005 mg/l.	
Chromium			500 ug/l total (95%ile).	0.05 mg/l.	
Copper			500 ug/l total (95%ile).		
Iron			3 000 ug/l total (95%ile).		
Lead			500 ug/l total (95%ile).	0.05 mg/l.	
Mercury				0.001mg/l.	
Nickle			500 ug/l total (annual arithmetic mean).	0.1 mg/l.	
Silver				0.05 mg/l.	
Zinc			500 ug/l total (95%ile).		
Inorganic nutrients					
Total petroleum hydrocarbons			0.3 mg/l 90%ile (mineral oils).		
Polycyclic aromatic hydrocarbons				0.01 ug/l.	

APPENDIX 3: BASELINE MONITORING PROGRAMMES

Table 17. Baseline monitoring programmes for Water Quality (Hydrodynamic & Sedimentary processes)

Objective	Indicator & TPC	Resources	Spatial	Temporal	Sampling & Analysis
WHS1: Record freshwater inflow at head of estuary.	Recommended inflow according to the Ecological Reserve requirement (0.3m³/s); TPC is inflow volume less than the recommendation.	**Human** - DWS. **Budget** – DWS - cost of flow gauging station installation and analysis of data, additional contribution by Roodefontein Developers	Flow gauging station above head of estuary at a site below the lowest abstraction point	Data is logged daily.	Flow data logged daily and collected bi-annually for analysis or monthly during times of drought. XY graphs off low against time. Decrease flow could indicate increased abstraction or impoundment but could be natural cycle.
WHS2: Frequency and duration of episodic events (floods and storms)	Type of event (flood) and duration; this is a natural phenomenon and TPCs are not relevant.	**Human** – Bitou LM budget. **Budget** – no costs	The estuarine area.	Whenever the events occur.	Record the event, its duration and time of year. These data are important as they help explain sedimentation patterns, scouring, duration periods for recovery and mouth dynamics.
WHS3: Changes in bathymetry as a measure of long-term sedimentation processes.	Depth profile of estuary at selected sites; TPC is a bathymetric profile that varies significantly from historical records.	**Human** – estuarine sediment dynamics specialist (consultant or from tertiary/ research institution). **Budget** - research funding from tertiary institutions.	Water body within the designated estuarine area.	Every three years or after episodic events.	Graphic display of bathymetry at sites overtime. Sediment accumulation could indicate increased erosion due to bad land-use practices or increased input from marine and Aeolian origins; could ultimately lead to mouth closure or reduced access for boats.

Table 18. Baseline monitoring programmes for Water Quality

Objective	Indicator & TPC	Resources	Spatial	Temporal	Sampling & Analysis
WQ1: Concentrations of water quality parameters in river inflow.	Levels of sediment (silt), nutrients and pollutants. TPCs are determined by safety & health standards.	**Human** - DWS. **Budget** - DWS- cost of water sampling and analysis from above head of estuary.	Sample station at a site above the head of the estuary.	Monthly, with additional samples prior to sporting events; also, if suspected contamination is reported.	Water sample analysis and presentation of data in XY graphs to show temporal fluctuations of each parameter. Values outside the norm can indicate pollution or contamination of water.

Objective	Indicator & TPC	Resources	Spatial	Temporal	Sampling & Analysis
WQ2: Frequency and location of fish & invertebrate kills; macro- and micro-algal blooms; non-natural floating objects and surface contaminants; and areas with bad smells.	Observe the occurrence and location of these aspects. TPCs are not defined per se but are exceeded when indicators are visible.	**Human** – CapeNature, Municipal environmental officer, KEAF, and river users. **Budget** - none for observations; DWS or Municipal for investigation of cause.	Designated estuarine area.	Observations can be made during normal daily activities or responsibilities.	Occurrence and location to be recorded; cause to be investigated by DWS or Bitou LM (possibly delegated to CapeNature). Analysis could show pollution by effluent discharge, nutrient enrichment or low oxygen levels; cause may also be natural, e.g. low temperature.
WQ3: Concentration of bacteriological contaminants.	Total coliform (*E. coli*) counts. TPC for estuary-counts in 80% of samples over time should be <100counts/100ml; and <2000 counts/100 ml in 95% of samples.	**Human** – Bitou LM. **Budget** – operating budget from Community Protection Services.	Waterbody within the designated estuarine area; may be at known point source sites.	Weekly samples; prior to organized sporting events; when bad odors or sewage spills are noticed or suspected.	Plot *E. coli* counts as XY graphs against time for each station. Increase in counts to above the TPC indicates contamination and hence a health hazard to estuary users.
WQ4: Concentrations of constituents that determine water quality.	All water quality parameters, e.g. salinity, oxygen, nutrients, turbidity and heavy metals. TPCs are the values recommended by the DFFE Water Quality Guidelines for the natural marine environment (Recreational Use – DEA, 2012))	**Human** – specialists either from KEAF or research/tertiary institution. **Budget** – Bitou LM or funding from tertiary/research institution.	Several stations (every 1-2km) along estuary including mouth and head region; must also include discharge site for desalination plant	At least seasonally (monthly if possible); at high tide during neap tide cycle allowing for tidal lag for stations upstream of the mouth.	Natural variability to be determined over 5-year period (can use data from Ecological reserve study as historical record). Plot data as XY graph against time for each station and constituent. Increased levels of most constituents could indicate or lead to increased eutrophication, algal blooms or contamination. Low oxygen could lead to or explain mass mortalities and indicate eutrophication. Abnormal salinity can indicate problems with the desalination plant.

Table 19. Baseline monitoring programmes for Biodiversity (Conservation)

Objective	Indicator & TPC	Resources	Spatial Scale	Temporal	Sampling & Analysis
B1: Maintenance of plant communities	Area of cover; TPC is 10% reduction in area covered by any plant community type	**Human** – Cape Nature rangers, members of KEAF, organisation such as ORCA and municipal environmental officer. **Budget** – cost of aerial and/or reference photographs.	The designated management area, should include concentrate on saltmarshes, wetlands and areas dominated by submerged macrophytes.	Aerial photographs every 5 years for Situation Assessment Report; reference photographs bi-annually for seasonal variation at selected sites	Aerial photos from Dept. of Surveys & Mapping; reference photos from fixed elevated positions at low tide. Initial ground trothing may be required. Surface area of each community type plotted on a map; habitat type and plant cover at reference sites plotted; Reduction could indicate pollution or episodic event; increase could also indicate pollution (blooms) or successful rehabilitation efforts or optimum environmental conditions.
B2: Control of alien vegetation	Area of cover; TPC is if more than 10% of management area (and catchment) is infested with alien vegetation	**Human** – DWS and DFFE. **Budget** – cost of aerial photographs and reference transects.	Concentrate on immediate estuarine management area and riparian areas in catchment.	Aerial photographs every 5 years for Situation Assessment Report; reference transects at disturbed sites annually.	Aerial photos from Dept. of Surveys & Mapping; reference transects at disturbed or cleared sites. Surface area of indigenous & alien vegetation plotted on a map every 5 years; XY graphs of vegetation type against year in disturbed areas to track recovery
B3: Maintenance of invertebrate populations (primarily mudprawn and sandprawn) and Knysna seahorse	Population densities; TPC is densities below 30% of baseline counts for invertebrates and below 90% for seahorse.	**Human** – students or staff from tertiary or research institute; members of KEAF; ORCA and WESSA. **Budget** – research funding from tertiary or research institutions; corporate donors.	Several representative habitats for sandprawn, mudprawn and seashore to account for natural variability within the system.	Bi-annual.	Prawns: Random quadrats above low spring tide level where number of burrows are counted; sampling to include breeding and recruitment seasons. Seahorse line transect (snorkelling). Baseline data set may be set up after 2 years; plot XY graphs of number of burrows again time of year. Reasons for decrease may not be human induced and could be due to natural variation or episodic events.
B4: Maintenance of waterbird populations	Species richness: TPC is loss of a single species. Species diversity: TPC is 30%loss over 5 years.	**Human** – CapeNature, members of KEAF, birding clubs; ADU from UCT for CWAC counts.	KRSBC in mouth region; Bitou wetland complex; and CWAC reference site (Code: 34022324)	Twice yearly (winter (June-July) and summer (January-February).	Counts to be done over spring low tide period and outside peak disturbance periods and record prevailing conditions; counting areas mapped and

Objective	Indicator & TPC	Resources	Spatial Scale	Temporal	Sampling & Analysis
	Bird numbers: TPC is 30% decrease for resident species over 5 years and decrease of 50% for migratory species over 10 years	**Budget** – own costs for bird clubs or KEAF members; ADU from UCT			representative of a range of estuary habitat types. Plot species richness, diversity and number again time of year and habitat type; long term period (5-10 years) is required to allow for detection of natural fluctuations; detailed analysis to be done by CWAC.
B5: Maintenance of fish populations	CPUE: TPC for dusky kob, white steenbras and leervis is 10% reduction in baseline values; TPC for all other species is 20% reduction in baseline values	**Human** – student from tertiary research institute to conduct fishery survey. **Budget** – research funding from tertiary or research institutions.	Water body within the designated estuarine area	Fishery survey to be conducted every 5 years.	Survey to be in the form of roving creel surveys and access point inspections. Data to include catch (number & weight) and time fished. CPUE to be plotted against time for each species; Declines can be due to water quality issues in the system or stock declines at National level.
B6: Protection and rehabilitation of wetlands.	Loss or degradation of wetland or saltmarsh area in the indicator; the TPC is any loss or decline from present levels	**Human** – members of KEAF or estuarine Co-Ordinator. **Budget** –cost of aerial and/or reference photographs (already accounted for in B1)	Concentrate on Bitou wetland complex, Tshokwane wetlands and Gansvlei.	Annual survey.	Survey can be done on site or reference photographs can be used. Compare to historical record to detect loss of habitat or damage. Declines can be due to human disturbance or episodic events.
B7: Restoration of original flow regime above Bitou N2 Bridge	Reduced or impeded flow; TPC is if this is not at least considered by all relevant parties	**Human-** RMA together with DEA&DP: Development Planning; DWS: Resource Protection; SANRAL; **Budget-** No cost for meeting; costs for EIA, removal of pylons and restoration of flow may be prohibitive (likely several millions).	Wetland and estuarine area above Bitou N2 bridge	Annual progress report on discussions until conclusion reached.	Review of meeting minutes and actions. Once conclusion is reached, monitor of flow according to RDM procedures.
B8: Control access to the Keurbooms River Seagull Breeding Colony	Disturbance to colony and destruction of breeding habitat; TPC is if uncontrolled access is allowed	**Human-** Bitou LM: Corporate Services in cooperation with CapeNature. **Budget -** Bitou LM for costs of signboards and assistance to CapeNature for compliance monitoring.	Focused on Keurbooms River Seagull Breeding Colony at mouth on barrier dune	Monthly visitor surveys, increased during peak breeding season and increased visitor periods	Visitor counts to be done and high impact points identified; compared with detailed analysis to be done by CWAC, to ascertain human impact.

Objective	Indicator & TPC	Resources	Spatial Scale	Temporal	Sampling & Analysis
B9: Increase the amount of estuarine area with conservation status.	Estuarine area with conservation status; TPC is if no additional land within the EFZ was conserved	**Human-** CapeNature to run with the process. **Budget -** Part of operational costs. Expropriation of land and declaration of PA will incur costs.	Entire estuarine area.	Survey of cadastre/ property boundaries will be required, and this may take several years Annual progress update on stewardship agreements	Assessment of all potential land parcels in terms of property boundaries and ownership. Survey to be done by surveyor general. Ownership of land to be determined through deeds office.

Table 20. Baseline monitoring programmes for Human Activities (Conservation)

Objective	Indicator & TPC	Resources	Spatial	Temporal	Sampling & Analysis
HA1: Ensure carrying capacity of estuary is not exceeded	Number of powered vessels in use; TPC is when carrying capacity is exceeded.	**Human** – CapeNature river patrols. **Budget** – part of normal daily activities and running costs.	Designated estuarine area; can be limited to specific zones based on type of activity in accordance with EZP	Twice a month outside of peak periods (weekday and weekend day) and once a week during peak holiday periods	Count number of boats in use on the water in the various zones and compare to carrying capacity determined by CapeNature, Bitou LM and KEAF.
HA2: Control human activities that impact on invertebrate (bait organism) populations	Compliance with regulations (bag limits, collecting methods, licenses, closed areas); TPC is continued instances of non-compliance	**Human** – CapeNature and voluntary compliance officers for compliance. **Budget** – MLRF for CapeNature; voluntary compliance officers funded from boat launchor registration fees.	Designated estuarine area	Compliance monitoring to be done daily.	Number of incidents of non-compliance to be recorded if there is no decline then capacity for monitoring is insufficient or awareness of Regulations is poor
HA3: Regulate activities impacting on integrity of the Keurbooms River Seagull Breeding Colony	Indicators are people and dogs within the confines of the KRSBC; TPC is a single occurrence	**Human** – CapeNature (primarily) but assisted by all estuary users (report incidents). Budget – Bitou LM to provide funds for CapeNature activities.	The KRSBC.	Daily as part of routine estuary patrols.	Record number of incidents and compare on a monthly basis to detect trends. Impacts will also be reflected in number, diversity and breeding success of birds (see B4 above).

Table 21. Baseline monitoring programmes for Law Enforcement (Conservation)

Objective	Indicator & TPC	Resources	Spatial	Temporal	Sampling & Analysis
LE1: Improve law enforcement capacity	Incidence of non-compliance and high conviction rates; TPC is an increase in incidents of non-compliance with key legislation (e.g. MLRA, CARA, NEMA & EIA Regulations and NWA, also EZP and By-laws) and a decrease in conviction rate	**Human** – All authority institutions tasked with administering legislation; voluntary compliance officers **Budget** – individual govt departments; Bitou LM to fund CapeNature activities, voluntary compliance officers funded from locally generated revenue.	Management Area	Capacity should be improved within 2 years of EMP implementation.	Record number of law enforcement personal after 2 years and compare to existing numbers. Record numbers of incidents of non-compliance and successful convictions and compare between years.
LE2: Compliance with EAs issued as part of EIA process	Incidence of non-compliance; TPC is any form of non-compliance	**Human** – Primarily DEA&DP, but also DWS, DFFE and Bitou LM; independent environmental control officer appointed in terms of EA, KEAF members as registered I&APs. **Budget** –part of normal responsibilities for government depts; developer pays for environmental control officer	Management Area	Initiate immediately upon implementation of EMP.	Record number and type of developments approved; note activities of environmental site officer and incidents of non-compliance with EA conditions. Data should be tabulated and presented to authorities for analysis and further action against non-compliant developers

Table 22. Baseline monitoring programmes for Sustainable Utilization of Living Resources

Objective	Indicator & TPC	Resources	Spatial	Temporal	Sampling & Analysis
E1: Protection of birds (and eggs) within the KRSBC	Number of people active within the KRSBC; TPC is if public are activity in the colony (a single occurrence is unacceptable).	**Human** – CapeNature. **Budget** – Bitou LM to assist with funding for CapeNature activities.	The KRSBC.	Daily as part of routine estuary patrols.	Record number of incidents and compare on a monthly basis to detect trends. Impacts will also be reflected in number, diversity and breeding success of birds (see B4 above)
E2: Ensure maintenance of bait organism and fish populations through compliance with regulations	Number of incidents of non-compliance with MLRA Regulations; TPCis either an increase in incidents or no decline from existing levels	**Human** – CapeNature and MLRA appointed voluntary compliance officers. **Budget** – CapeNature funds (supported by MLRF); Voluntary compliance officers can be supported from locally generated revenue.	Management Area.	Daily as part of routine estuary patrols.	Record number of incidents and compare on a monthly basis to detect trends. Impacts will also be reflected in number and density of invertebrates and possibly CPUE for fish (may be due to other factors; see B3 and B5 above).

Table 23. Baseline monitoring programmes for Land Use & Infrastructure

Objective	Indicator & TPC	Resources	Spatial	Temporal	Sampling & Analysis
LU1: Maintenance of demarcated 100m and 1000m buffer zones, CMLs and CBAs.	Compliance with legislation applicable to the various zones; TPC is any infringements within these zones.	**Human -** DEA&DP, DWS DFFE and CapeNature officials; Environmental Control Officer (ECO) appointed in terms of the EAs for EIA; municipal environmental officer and town planning; members of KEAF. **Budget** - part of normal responsibilities for government departments; developer pays for ECO and rehabilitation	Designated management area.	Visual monitoring can be done on an ad hoc basis during normal daily activities or responsibilities.	Land-use patterns adjacent to the estuary to be mapped; records kept of applications for activities that will infringe on this riparian zone and registration of the KEAF as an I&AP; amount of bank erosion and habitat degradation in the vicinity of existing developments to be noted; non-compliance with regards the buffer zone and CBAs to be noted.
LU2: Restrict additional development (structures) on the floodplain or within 1:100-year floodline.	Number of applications for new developments within the floodplain or 100-year flood line; TPC is any new applications for development.		Flood plain or100-year flood line within the designated management area.		Land-use patterns adjacent to the estuary to be mapped; records kept of applications for activities that will infringe on the flood plain area and registration of the KEAF as an I&AP. Number of new applications for development or activities to be noted.

Objective	Indicator & TPC	Resources	Spatial	Temporal	Sampling & Analysis
LU3: No alteration of water quality and normal hydrodynamic & sedimentary cycles due to development and land-use.	RQO parameters; TPC would be any activity that negatively impacts on the RQOs.	**Human** - DEA&DP and DWS personnel; ECO appointed in terms of the EAs. **Budget** – part of normal responsibilities for government departments; developer pays for ECO.	Designated management area and catchment.	Bi-annual for DWS (may form part of more detailed long-term monitoring programme) and ongoing for DEA&DP and ECO as activities are approved and EA issued.	DWS to perform regular sampling of RQOs and analyse in the context of activities that may have negative impacts. DEA&DP and ECO to ensure conditions and mitigation detailed in EAs are complied with.
LU4: Land-use & development proposals evaluated through EIA procedure and guided by planning and management frameworks (eg. SDFs, CMS, and this EMP).	Compliance with EIA procedures and adherence to strategies and management plans; TPC is non-compliance in this regard and lack of regard for management framework recommendations.	**Human -** DEA&DP, DWS, DFFE, CapeNature and Bitou LM (Town Planning) personnel; representatives of KEAF and BGCMA. **Budget** - part of normal Responsibilities for government departments; no cost to KEAF for monitoring processes.	Kerubooms-bitou management area and catchment.	Ongoing; exact timing will depend on when applications for activities are received by DEA&DP, DWS or DFFE	All activities to be reported to DEA&DP, DWS, DFFE, Bitou LM to determine whether they comply with EIA requirements and existing management frameworks. KEAF to register as I&AP for all proposed activities to ensure procedure is followed and ideals of planning and management frameworks are considered in assessment and decision-making process. Number of applications to be noted and number of applications approved without adhering to planning and management framework recommendations to be noted.

Table 24. Baseline monitoring programmes for Sustainable Livelihoods

Objective	Indicator & TPC	Resources	Spatial	Temporal	Sampling & Analysis
Sustainable Livelihoods					
SL1: Ensure all existing and proposed future activities and livelihoods dependant on or may impact on the estuary (tourism, business, agriculture) comply with legislation, management plans and frameworks.	Compliance with legislation and planning & management frameworks; TPC would be any non-compliance or conformity.	**Human** – Various national/provincial and municipal departments; CapeNature; PDC leaders; tourism operators and representatives; KEAF. **Budget** – Monitoring compliance is part of department running costs (Bitou LM to assist funding for CapeNature).	Designated Keurbooms management area and catchment area.	Ongoing – all existing activities can be reviewed for compliance over 2 years; new activities reviewed as they evolve.	Assess all existing activities in the context of legislation (e.g. MLRA, NEMA & EIA regulations, NWA, NFA, CARA, NHRA) and frameworks (e.g. SDF/IDP, EMP and CMS). Record are as of non-compliance and report to responsible authorities (e.g. municipal planning, DWS or DEA&DP) then monitor response from authorities .

Table 25. Baseline monitoring programmes for Tourism and Recreational Use

Objective	Indicator & TPC	Resources	Spatial	Temporal	Sampling & Analysis
Sustainable Livelihoods					
T1: Recognition of the Keurbooms management area as an eco-tourism destination.	Websites and brochures featuring the management area; TPC is if this didn't happen or if occurrence was low.	**Human-** Bitou LM tourism in cooperation with KEAF and tourist operators and associated businesses. **Budget-** costs insignificant (mainly time).	Initially the immediate Bitou LM area, but can expand to Provincial and finally National.	Initial stage after three years, leading up to National exposure after five to 10 years.	Record number of websites and/or brochures that specifically mention the Keurbooms management area and its attraction for tourists. An increase in the number of tourists, brochures and "hits" on websites per year to illustrate improvement.
T2: Promotion of organized sporting events.	Number of events held per annum; TPC would be no increase or a reduction.	**Human-** KEAF with Bitou LM and organized sports representatives. **Budget -** no costs (mainly time).	Initially locally (e.g. school events), then expand to include more Provincial and National events.	Initiate over a three-year period after EMP implementation.	Record number of organized sporting events in past decade and compare to number over the 5 years after EMP implementation. If there is no increase, the reasons for decline in number of events must be ascertained (e.g. water quality).

Table 26. Baseline monitoring programmes for Education and Awareness

Objective	Indicator & TPC	Resources	Spatial	Temporal	Sampling & Analysis
EA1: Increase awareness of estuaries and their value amongst government and municipal workers and managers; also, awareness of responsibilities for management in terms of legislation	Attendance at workshops and questionnaire; TPC would be poor workshop attendance and poor evaluation results reflected in the questionnaire.	**Human** – Primarily DFFE:O&C, CapeNature, and Bitou LM with assistance from KEAF and specialists from govt dept. and tertiary & research institutes. **Budget** – National government (DFFE), Bitou LM and corporate donors.	Initially Bitou LM but can expand to include Eden District.	Once a year.	Attendance at workshops and successful completion of questionnaires to be recorded. Analysis should show a steady attendance record and an increase in the level of understanding of the importance of estuaries and awareness of responsibilities.
EA2: Increased public awareness of the Keurbooms management area.	Number of public notice boards, number of school groups and questionnaire; TPC would be no visible notice boards, few	**Human** – KEAF and CapeNature can monitor signage; levels of awareness through questionnaires can be coordinated amongst	Keurbooms management area.	Notice boards and signage to be erected within two years of EMP implementation; educational drive can start immediately with	Assess placement of notice boards and their content; record number of school tour groups; and assess completion of questionnaires. Analysis should show an increase level of understanding through successful completion of questionnaires

	school tour groups and continued public ignorance.	institutions hosting workshops. **Budget –** DFFE to cover costs of questionnaires; corporate donors to assist funding of education center (venue).		courses or tours being run on demand.	and a steady attendance by school groups (includes return visits from schools each year).
EA3: Research projects initiated that fill knowledge gaps and provide **information for monitoring programmes.**	Number of research projects; TPCs would be few research projects and continued lack of data for monitoring programmes.	**Human** – CapeNature, Bitou LM and KEAF to monitor number of research projects. **Budget** – No costs involved for monitoring.	Keurbooms management area.	Initiate immediately, assessment of ongoing research projects and outstanding requirements can be done once a year.	Number and type of research projects to be recorded and related to areas of concern with regards to knowledge gaps and monitoring data. Must ensure interaction between Bitou LM, KEAF and tertiary & research institutions and a sharing of knowledge.

APPENDIX 4: RECOMMENDED LONG-TERM MONITORING PROGRAMME

The former monitoring programmes have been updated/replaced by the EWR monitoring programme (DWS, 2015).

The recommended monitoring programme to improve the confidence of the EWR study, as well as to monitoring implementation in terms of meeting ecological RQOs is presented in Table 27. Specifically, the following crucial monitoring should continue/commence as soon as possible: Continuous water level recordings at the mouth and at the N2 Bridges in the Keurbooms Estuary to monitoring mouth state and tidal variation;

- Proper gauging of the river flow and water quality from the Keurbooms and Bitou rivers for at least a **3-5-year period that includes both extreme low flow periods and high flow event;**
- Monitoring of salinity structure and water quality (e.g. nutrients and dissolved oxygen) under various river flow conditions **for at least a 3-5-year period, especially covering extreme low flow periods in both the Keurbooms and Bitou arms;**
- Bathymetric survey of the Keurbooms Estuary between the N2 bridges and the mouth, as well as the Bitou flood plain
- Invertebrates and fish surveys including both the Bitou and Keurbooms arms.

The implementation of the monitoring programme should be undertaken through collaboration by various responsible departments in Department of Water and Sanitation (DWS), as well as other national and provincial departments and institutions responsible for estuarine resource management such as Department of Forestry, Fisheries and Environment (DFFE), Department of Environmental Affairs (DFFE: Oceans and Coasts), South African National biodiversity Institute (SANBI), CapeNature, as well as relevant municipal authorities. It is recommended that the estuarine management planning process and the associated institutional structures (as required under the Integrated Coastal Management Act, 2008) be used as a mechanism to coordinate and execute this long-term monitoring programme.

Table 27. Recommended monitoring programme for the Keurbooms Estuary (priorities are highlighted)

Ecological component	Monitoring action	Spatial scale	Temporal scale
Hydrology	For larger systems record river inflow at head of estuary (smaller systems hydrology to be simulated every 10 years)	Head of estuary in Bitou arm (to be confirmed) and Keurbooms arm [K6H19]	Continuous
Hydrodynamics	Record water levels (to record mouth state and tidal variation)	Near mouth (K6T018)	Continuous
	Aerial photography (or using high resolution satellite imagery i.e. 5x5 m pixel size, e.g. Google Pro or BirdEye) (e.g. to map mouth position over time)	Entire estuary	Annual
Sediment dynamics	Monitoring Berm height using appropriate technologies	Mouth	Quarterly
	Bathymetric surveys: Series of cross section profiles and a longitudinal profile collected at fixed (e.g. 300-500 m intervals) but in more detail in mouth including berm (every 100 m). Vertical accuracy at least 5 cm	Entire estuary	Every three years (and after large resetting event)
	Set sediment grab samples (at cross section profiles) for analysis of particle size distribution (and ideally origin, i.e. microscopic observations)	Entire estuary	Every three years
Water quality	Electrical conductivity, pH, inorganic nutrients and organic content (e.g. TP and Kjeldahl N) in river inflow *(preferably also suspended solids and temperature)*	Head of estuary in Bitou River (to be confirmed) and Keurbooms River [station K6H19]	Monthly continuous (as in DWS monitoring programme)
	Salinity and temperature profiles (and any other in situ measurements possible e.g. pH, DO, turbidity)	12-15 stations along length of estuary (include additional station into the Bitou arm towards head of estuary)	Ideally monthly for the first year and then quarterly

Ecological component	Monitoring action	Spatial scale	Temporal scale
	Inorganic nutrient concentrations (together with above)	12-15 stations along length of estuary (include additional station into the Bitou arm towards head of estuary)	Every three years (high and low flows) or when significant change in water quality expected
	Measure pesticides/herbicides and metal accumulation in sediments (for metals investigate establishment of distribution models – see Watling and Newman, 2007).	Entire estuary, including depositional areas (i.e. muddy areas)	Once-off, then every three – six years, if results show contamination
Microalgae	Record relative abundance of dominant phytoplankton groups, i.e. flagellates, dinoflagellates, diatoms, chlorophytes and blue- green algae. Chlorophyll-*a* measurements taken at the surface, 0.5 m and 1 m depths, under typically high and low flow conditions using a recognised technique, e.g. spectrophotometer, HPLC, fluoroprobe. Intertidal and subtidal benthic chlorophyll-*a* measurements (four replicates each) using a recognised technique, e.g. sediment corer or fluoroprobe.	Along length of estuary minimum five stations	Quarterly, for first two years and then low flow surveys every three years
Macrophytes	Map area covered by different macrophyte habitats using recent imagery. Conduct field survey to record total number of macrophytes habitats, identification and total number of macrophytes species, number of rare or endangered species, or those with limited	Entire estuary (mapping) Where there is salt marsh (minimum three transect sites)	Every three years in summer

Ecological component	Monitoring action	Spatial scale	Temporal scale
	populations. Assess extent of invasive species in EFZ. Where there are salt marsh areas greater than 1 ha measure % plant cover along elevation gradient. Sediment samples collected along the transect and analysed in the laboratory for sediment moisture, organic content, EC, pH and redox potential. In the field measure depth to water table and ground water salinity.		
Invertebrates	Collect duplicate zooplankton samples at night from mid-water levels using WP2 nets (190 um mesh) along estuary. Collect sled samples (day) at same zooplankton sites for hyper benthos (190 um). Collect grab samples (five replicates) (day) from the bottom substrate in mid-channel areas at same sites as zooplankton (each samples to be sieved through 500 um). Collect sediment samples using the grab for particle size analysis and organic content (at same sites as zooplankton) (*preferably link with sediment dynamics*)	Minimum of three sites along length of entire estuary including the Keurbooms and Bitou arms	Every 2 years. Will require partnership
	Intertidal invertebrate hole counts using 0.25 m^2 grid (five replicates per site). Establish the species concerned *(Callichirus kraussi* or *Upogebia Africana)* using a prawn pump.	For hole counts –three sites in each of muddy or sandy areas	Quarterly, for first two years and then every two years mid-summer

Ecological component	Monitoring action	Spatial scale	Temporal scale
Fish	Record species and abundance of fish, based on seine net and gill net sampling. Sampling with a small beam trawl for channel fish should also be considered Seine net specifications: 30 m x 2 m, 15 mm bar mesh seine with a 5 mm bar mesh with a 5mm bar mesh 5 m either side and including the cod-end Gill nets specifications: Set of gill nets each panel 30 m long by 2 m deep with mesh sizes of 44 mm, 48 mm, 51 mm, 54mm, 75 mm, 100 mm and 145 mm Gill net sampling can be replaced by a large mesh seine (44 mm stretch mesh, 100 m x 2 m) Trawl specification: 2 m wide by 3 m long, 10 mm bar nylon mesh in the main net body and a 5 mm bar in the cod-end	12-15 stations along length of estuary (include additional station into the Bitou arm towards head of estuary)	Quarterly, over at least one year to account for the seasons, then twice annually spring/ summer and autumn/ winter
	Knysna seahorse –visual census by snorkelling over submerged macrophyte beds. Record number of individuals, distribution and breeding activity or success. Due to the bias involved and the inherent difficulty in spotting seahorses, this may not provide an accurate reflection of the total population, but will provide data which can be used to compare relative abundance between years.	Concentrate in areas where the seahorse has historically been recorded- confluence area and Bitou arm below the N2 Bridge.	Bi-annually in winter and summer. Immediately after flood events and monthly thereafter for 6 months.
Birds	Undertake counts of all non- passerine water birds, identified to species level.	Entire estuary (approximately seven sections)	Quarterly, over at least one year to account for the seasons, then twice annually summer and winter