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DOCUMENT USE

Estuaries are recognised 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), requires Estuarine Management Plans (EMPs)to be prepared for estuaries in order to create informed platforms for efficient and coordinated estuarine management. The Protocol, promulgated in May 2013, sets out the minimum requirements for individual EMPs.

In 2013/2014, a review was conducted by the Department of Environmental Affairs: Oceans and Coasts (DEA, 2014) on the existing management plans to ensure, *inter alia*, the alignment of these plans with the Protocol.

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

- Updating the terminology as per the Protocol;
- Including a summary of the Situation Assessment;
- Including a map of geographical boundaries based on Estuarine Functional Zone;
- Providing a more detailed resource monitoring plan; and
- Updating the description of the institutional capacity and arrangements as per the Protocol.

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 supplemented by new information when it 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, and supporting SAR, must not be considered a once-off compilation but rather a "living document" that should be regularly updated and amended as deemed necessary.

ACKNOWLEDGEMENTS

The proposals made in this plan are based on a series of discussions and workshops spanning the period from 2010 to 2013. They involved numerous individuals and organizations from relevant government agencies, research and academic institutions, non-governmental organizations and representatives of the local resident's associations. The active and enthusiastic participation in the process augurs well for the successful implementation of this plan and the rehabilitation of the estuary and I would like to thank all those involved for their very valuable contributions.

The contributions of Julian Conrad and Marilie Carstens of GEOSS are duly acknowledged. Although they were not directly involved in the updating process, most of their inputs to the 2010 version have been retained.

While all the publications cited are listed in the bibliography, much of the information was taken from a few more substantial reports which are listed below. In these cases, the extent of the quotations would have made it cumbersome to reference every point in the text. The primary sources of information are therefore acknowledge here:

Harding, W.R. (1999). Guidelines for the Management and Conservation of Sago Pondweed (Potamogeton pectinatus) in Zandvlei. Report prepared for South Peninsula Municipality. 36pp.

Ninham Shand (2000): Zandvlei Environmental Study. Final Report 3077/8957 plus Annexures. Submitted to the South Peninsula Municipality.

Thornton,J.A., Beekman, H., Boddington,G., Dick,R., Harding, W.R., Lief,M., Morrison,I.R. and Quick,A.J.R. (1995). The Ecology and Management of Zandvlei (Cape Province, South Africa), an Enriched Shallow African Estuary. In: McComb, A.J. (Ed) Eutrophic Shallow Estuaries and Lagoons. CRC Press, 240pp.

EXECUTIVE SUMMARY

Introduction

The efficient and coordinated management of estuaries in South Africa is undertaken in terms of the National Environmental Management: Integrated Coastal Management Act (No. 24 of 2008). The management of the Zandvlei estuary and the Zandvlei Estuary Nature Reserve is undertaken by the identified Responsible Management Authority, the City of Cape Town. The Zandvlei has a relatively small catchment comprising an area of 92 km^2 or 9,655 ha and is drained by a number of rivers and streams. The wetland area covers some 60 ha, while the main body of the vlei is 56 ha. In addition, the system includes a marina of 31 ha along its eastern margin, and an outlet channel of 9 ha which links to the sea on the north-western shore of False Bay. For purposes of the EMP, the geographical boundaries of the Zandvlei estuary are defined as the area from the estuary mouth, to the upstream end of the wetlands. Despite the modifications that have taken place in the system, the Zandvlei estuary remains highly valued for its natural attributes and the recreational opportunities it affords.

Summary of the Situational Assessment

A summary of the situational assessment is included and details a biophysical description of the system, the socio-economic importance of the estuary, the regulatory framework and finally, detail on the management of the estuary.

Vision and Objectives

The vision for the Zandvlei estuary is:

"Zandvlei estuary is a beautiful and important component of Cape Town's natural assets. It is valued by the local community and visitors alike for recreation, education and other uses. It is also home to a rich diversity of flora and fauna and is used in a way that balances conservation with the needs of the users for the benefit of present and future generations."

The Overall/Key objective for the Zandvlei estuary:

"*To manage Zandvlei estuary and its environs, including the catchment, in a balanced manner that promotes the rehabilitation and conservation of its biodiversity values, maintains its suitability for recreation and education, and mitigates flooding of adjacent property*".

Management objectives for the Zandvlei estuary are:

- To develop a mechanism to manage the hydrodynamics of the estuary in a manner which:
    - does not compromise its biological integrity;
    - maintains salinity at optimal levels for healthy estuarine functioning;

    - enhances the role of the estuary as a nursery for marine migrants;
    - maintains the competitive advantage of pondweed over phytoplankton;
    - promotes flushing for water quality improvement;
    - reduces siltation;
    - optimises water depth fluctuations for healthy estuarine functioning while minimising flood risk and damage to shoreline properties and meeting recreational needs; and
    - takes account of the potential impacts of sea-level rise.
- To prevent, reduce or minimise pollution from all sources so as to be able to restore the water quality to a standard suitable for supporting natural resources and human recreation;
- To create conditions suitable for the restoration and ongoing protection of Zandvlei and its biodiversity, including:
    - establishing a zonation plan which designates conservation areas, areas for different uses (boating, walking, swimming, etc.);
    - introducing, where possible, buffer zones between the estuary and surrounding urban areas;
    - preventing introduction of alien species and eradicating or controlling established invasive species;
    - improving water quality and increasing salinity through improved tidal exchange; and
    - promoting sustainable use of resources.
- To ensure that any relevant future planning and development decisions acknowledge the socio-economic value and conservation significance of the estuary and prevent any further development within the boundaries thereof;
- To promote and manage recreation, education and eco-tourism in the estuary in a manner compatible with its conservation status; and
- To establish a coordinated and streamlined monitoring programme linked to clear operational objectives and indicators within a framework, which facilitates adaptive management based on the monitoring results.

Since a number of the long-term objectives will not necessarily be achievable within this period, more detailed specific objectives, i.e. management priorities, which are intended to be met within the 5-year cycle, if not before, are included for the period 2017 – 2021. A summary of management priorities is detailed below.

Mouth Conditions, Water Levels, Salinity & Sedimentation
Priority A: Reduction of sedimentation at the mouth
Priority B: Increase recruitment of biota into the estuary
Priority C: Re-establishment of seasonal water level fluctuations on the central pans
Priority D: Monitoring of water levels, salinities, fish populations, etc.
Water Quality Management
Priority E: Water quality monitoring
Priority F: Assessment & reduction of pollution from sources in the catchment
Priority G: Reduction of pollution from stormwater discharges to the estuary
Priority H: Reduction of pollution from accidental spills

Priority I: Health warnings
Priority J: Improved understanding of environmental quality in the estuary
Pondweed Management
Priority K: Effective pondweed harvesting
Priority L: To improve understanding of pondweed dynamics
Priority M: Sufficient capacity available to manage pondweed effectively
Invasive Alien Species Management
Priority N: Integration of IAS management both within the reserve and with external initiatives
Priority O: Prevention of introductions of new alien species into Zandvlei
Priority P: Early detection of emergent species in Zandvlei
Priority Q: Management of priority species
Biodiversity, Conservation & Planning
Priority R: Further expansion of reserve to improve buffers and linkages
Priority S: Improve and expand biodiversity information
Priority T: Restoration/rehabilitation of sites within the ZENR
Priority U: Promote sustainable use of Zandvlei &adjacent areas
Education, Awareness-Raising & Communications
Priority V: To expand the environmental education and outreach programme
Priority W: Improved communications on matters related to the reserve

Spatial Zonation

The geographical boundaries of the Zandvlei estuarine system, as delineated by the 5 m are reflected, however, for purposes of the EMP, the geographical boundaries of the Zandvlei are defined as the area from the estuary mouth, to the upstream end of the wetlands. Both the northern and lateral boundaries encompass the 100-year floodline and conform to the boundaries of the long-established Zandvlei Estuary Nature Reserve.

Zones within the nature reserve are detailed as follows:

- Conservation Zones:
- High Intensity Use areas: and
- Low Intensity Use areas.

Management Strategies

Interventions proposed relate to:

- Environmental emergencies at Zandvlei estuary;
- Management of the mouth and water levels:
    - Mouth management plan;
    - Monitoring; and
    - Information requirements;
- Management of Central Pans;
- Sedimentation from the catchment;
- Management of water quality and litter:
    - Managing water quality (Proposed water quality objectives, water quality monitoring, addressing sources of pollution and health warnings);
    - Litter; and

    - Sediment quality;
- Pondweed management:
    - Harvesting protocol;
    - Refinement of the protocol; and
    - Challenges (harvesting capacity, demand and supply and other operational issues)
- Invasive species management:
    - Setting priorities;
    - Implementing the plan;
    - Prevention;
    - Early detection;
    - Eradication; and
    - Management and control;
- Biodiversity and conservation planning:
    - The ZENR boundaries and corridors;
    - Biodiversity information - status and management;
    - Rehabilitation and restoration;
    - Urban development and planning; and
    - Conservation, recreation and ecotourism development;
- Education and Awareness:
    - Environmental education programme;
    - Community outreach programme;
    - Community monitoring programmes;
    - Communications materials; and
    - Funding.

Management Priorities

The Situation Assessment Report highlighted significant problems in Zandvlei estuary, with the following being identified as priorities:

- Mouth conditions, water level management and salinity;
- Water quality;
- Pondweed management;
- Invasive species;
- Balancing recreation and conservation;
- Coordinated and cost-effective monitoring programme; and
- Environmental education.

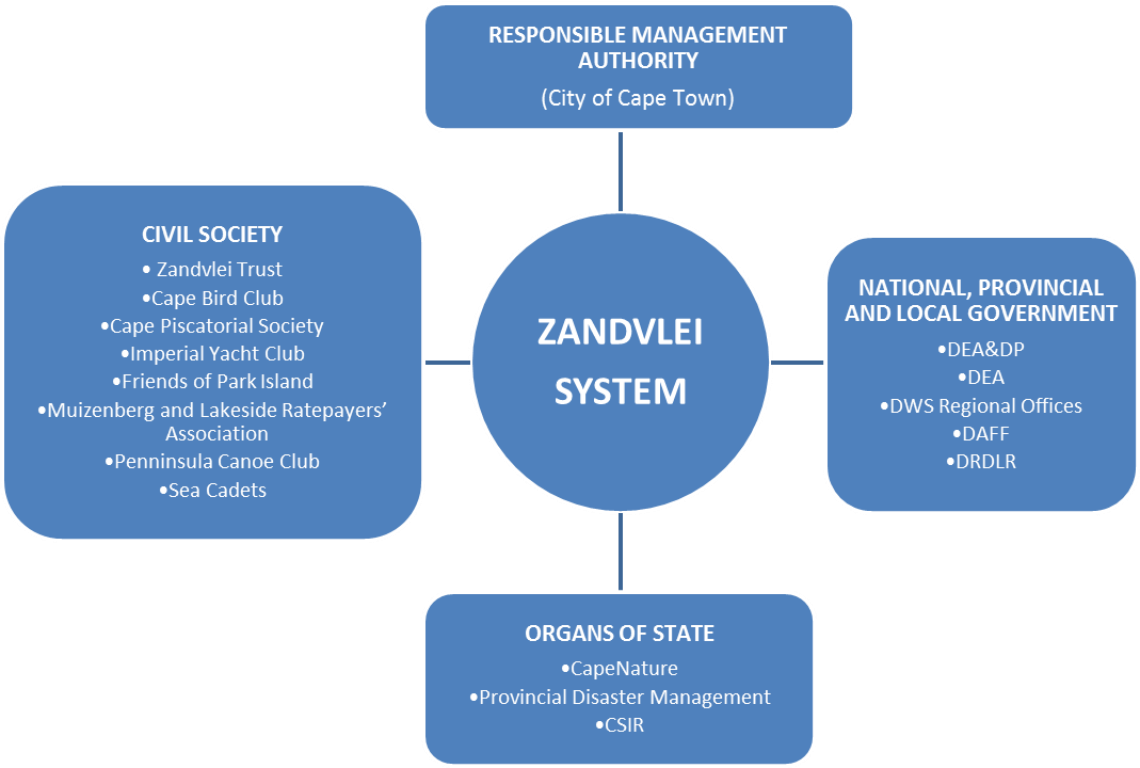
Additional, more specific priorities which have emerged include:

- the increasing sedimentation above the weir;
- coral worm; and
- law enforcement.

With the exception of law enforcement, the proposed management actions for the next period (2017 – 2021) are outlined in the priority action tables which provide a tentative time-frame and, where they are not covered by existing budgets, anticipated costs.

Implementation

Co-management and effective governance has already been identified as the keystone to the efficient and effective management of the Zandvlei system with key role players depicted below.



The Zandvlei Estuary Advisory Forum has been established and is now incorporated as a sub-committee of the Protected Area Advisory Committee.

Detail is included in respect to the resource capacity requirements for the implementation of the EMP. This relates to financing as well as the nature reserve staff and facilities.

Review and Evaluation

Evaluations and review of the EMP are the responsibility of the City of Cape Town who will determine which aspects of the EMP need to be altered in order to rectify any shortfalls as well as adapt management strategies and objectives or aspects of the action plans themselves. Monitoring programmes may also be altered to supply specific data to fill existing knowledge gaps.

The initial update of the EMP was made on the basis of a mid-term "mini-audit" of progress in the implementation, which was accompanied by revisions and/or refinements to the EMP and the action plans. The current revision was undertaken to bring the EMP in alignment with the Protocol. Thus, a more thorough audit is therefore still required.

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ABBREVIATIONS

ADU	Animal Demography Unit
AMSL	Above mean sea level
BMB	City of Cape Town: Biodiversity Management Branch
C.A.P.E.	Cape Action for People and the Environment
CARA	Conservation of Agricultural Resources Act (Act No. 43 of 1983)
CFR	Cape Floristic Region
CoCT	City of Cape Town Metropolitan Municipality
CMP	Catchment Management Plan
CSRM	City of Cape Town: Catchment, Stormwater, and River Management Branch
CSIR	Council for Scientific and Industrial Research
CWAC	Co-ordinated Waterbird Counts Annual Census
DAFF	Department of Agriculture, Forestry and Fisheries
DEA	Department of Environmental Affairs
DEA: EP	Department of Environmental Affairs: Environmental Programmes Branch
DEA: O&C	Department of Environmental Affairs: Oceans & Coasts Branch (formerly MCM)
DEA&DP	Western Cape Department of Environmental Affairs & Development Planning
DWS / DWAF	Department of Water and Sanitation (formerly DWAF)
EAF	Estuary Advisory Forum
EDRR	Early Detection & Rapid Response (Programme)
EFZ	Estuarine Functional Zone
EIA	Environmental Impact Assessment
EMP	Estuarine Management Plan(s)
EPWP	Extended Public Works Programme
ERMD	City of Cape Town: Environmental Resource Management Department
EZP	Estuary Zonation Plan
ha	hectares
IAS	Invasive Alien Species
ICM Act	National Environmental Management: Integrated Coastal Management Act (Act No. 24 of 2008)
IOI-SA	International Ocean Institute of South Africa
ISU	Invasive Species Unit
MCM	Directorate Marine and Coastal Management (now DEA:O&C)
MEC	Member of the Executive Council
MLRA	Marine Living Resources Act (Act No. 18 of 1998)
MOU	Memorandum of Understanding
NEMA	National Environmental Management Act (Act No. 107 of 1998)
NEM:BA	National Environmental Management: Biodiversity Act (Act No. 10 of 2004)
NEM:PPA	National Environmental Management: Protected Areas Act (Act No. 57 of 2003)
NGOs	Non-government Organisations
NIAF	National Italian American Foundation
The Protocol	National Estuarine Management Protocol
ppt / psu	Parts Per Thousand / Practical Salinity Units
PWD	Public Works Department
NWA	National Water Act (Act No. 36 of 1998)
RMA	Responsible Management Authority
SAMSA	South African Maritime Safety Authority
SANBI	South African National Biodiversity Institute
SANParks	South African National Parks
SAPS	South African Police Service
SARS	South African Revenue Service
SDF	Spatial Development Framework
SRP	Soluble Reactive Phosphate (Orthophosphate)

TPC	Threshold of Potential Concern
UCT	University of Cape Town
WESSA	Wildlife and Environment Society of South Africa
WHO	World Health Organisation
WRC	Water Research Commission
ZEAF	Zandvlei Estuary Advisory Forum (formerly ZEMF)
ZENR	Zandvlei Estuary Nature Reserve
ZT	Zandvlei Trust

1 INTRODUCTION

1.1 The management of estuaries in South Africa

The term estuary refers to the body of water which forms the interface between a river and the sea into which it flows. Estuaries may be permanently or periodically open to the sea. When open, they are characterized by fluctuations in water levels related to the tides, and by salinities which are measurably higher than freshwater as a result of seawater intrusion.

Estuaries are generally highly productive ecosystems and provide a range of goods and services ranging from nursery areas for juvenile fish, to stopovers for migrant birds, and recreational opportunities for local inhabitants. Their productivity, combined with their natural beauty and the shelter they provide also means that they are highly sensitive and vulnerable to development, with many towns and cities, ports and harbours being deliberately located in and around them. As a result, many estuaries have been seriously degraded.

South Africa has approximately 260 estuaries, of which 62 are located within the Cape Floristic Region (CFR). Despite the fact that their value – particularly from a biodiversity perspective – has long been recognized, there has been a lack of effective management, largely due to the fact that they did not fit clearly within the mandate of any one government department. This was highlighted during the development of the National Biodiversity Strategy and Action Plan which indicated that a high percentage of South Africa's estuaries are threatened (79% of the estuarine area). This gap was subsequently addressed through the inclusion and implementation of provisions on estuarine management in the National Environmental Management: Integrated Coastal Management Act (No. 24 of 2008, as amended by Act No. 36 of 2014) (ICM Act) and the South African National Estuarine Management Protocol (the Protocol), promulgated in May 2013 under the ICM Act, which sets out the minimum requirements for individual Estuarine Management Plans (EMPs).

1.2 Summary of legal framework

Chapter 4 of 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) EMPs for individual estuaries (Section 34).

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

a) The strategic vision and objectives for achieving effective integrated management of estuaries in South Africa;

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

One of the pillars of successful integrated coastal (including estuarine) management is the establishment of effective institutional arrangements to underpin both cooperative government and cooperative governance. Cooperative governance is a system that allows government and civil society to communicate and contribute to shared responsibility in respect of coastal management objectives and must be well-organized and widely representative of all coastal stakeholders. The ICM Act details the institutional arrangements that will contribute to cooperative coastal management in South Africa. These arrangements are made at national, provincial and municipal government levels, and the embodiment of cooperative coastal governance is vested in what will be known as coastal committees. The ICM Act provides for the permissive, i.e. if so required, establishment of municipal coastal committees, but at a national and provincial level however, the Minister and MECs of coastal provinces are directed to establish national and provincial coastal committees, respectively. Provincial coastal committees must be established within one year of the commencement of the ICM Act.

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

The lowest tier of institutional arrangements for estuarine management comprises the 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, so as to facilitate cooperative management and effective governance in terms of the EMPs, as well as facilitate and monitor implementation of an EMP.

1.3 Mandate and responsibilities of the Responsible Management Authority

The Protocol identifies the City of Cape Town (CoCT) as the management authority responsible for developing and co-ordinating implementation of the Zandvlei EMP, as the entire system is contained within the metropolitan municipal boundary (

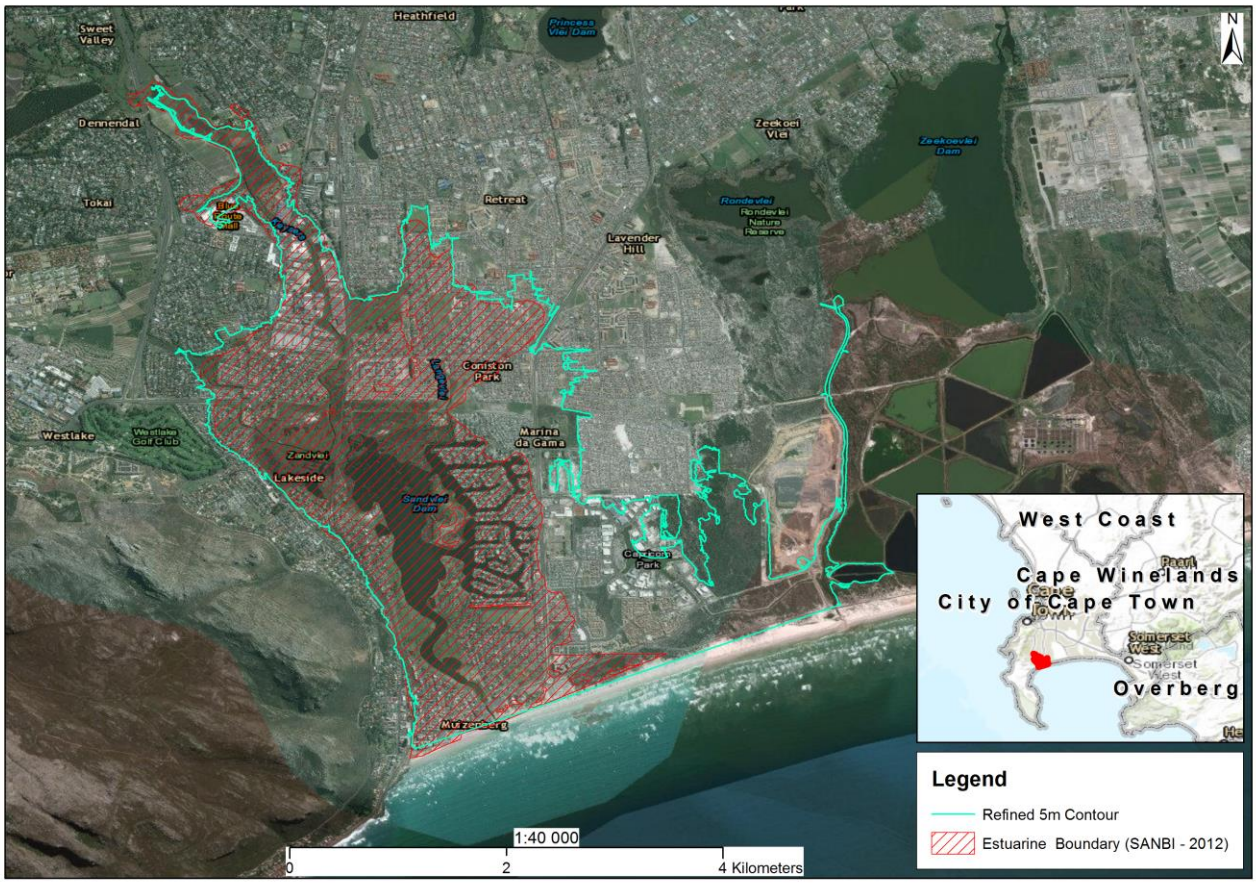

Figure 1).

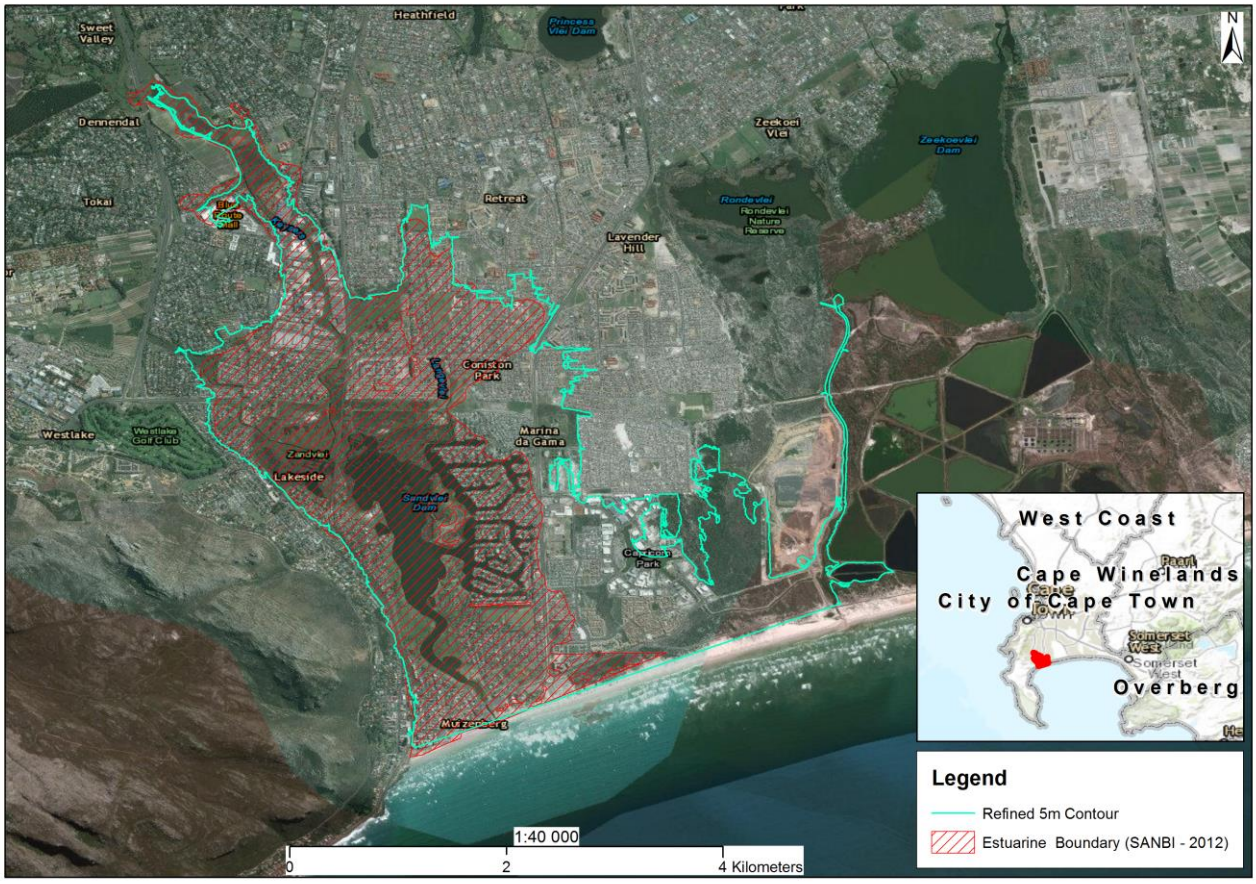

Figure 1: Location of the Zandvlei estuarine system within City of Cape Town municipal area

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(7)(e):	*"The identified responsible management authority to develop the EMP needs to **budget accordingly for the development of these plans**."*
Section 8(1):	*"The responsible management authority developing an EMP must **actively engage all the relevant stakeholders** including government departments, non-government organisations and civil society in the development and implementation of the EMP."*

Section 9.1(1) and 9.2:	*"…it **must obtain formal approval** for the EMP…" and "Once approved…the EMP shall be formally adopted by the responsible management authority and signed by the head of the responsible management authority."*

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

a) follow a public participation process in accordance with Part 5 of Chapter 6 of the ICM Act;
b) ensure that the EMP and the process by which it is developed are consistent with:
   i) the Protocol; and
   ii) the National CMP and with the applicable provincial CMP and CMP referred to in Parts 1, 2 and 3 of Chapter 6 of the ICM Act;
c) If applicable, ensure that relevant legislation is enacted to implement the EMP; and
d) Submit a annual report to the Minister on the implementation of the EMP, the legislation and any other matter.

Coordination of the implementation actions by the RMA and its strategic partners (CapeNature, DEA, Western Cape Provincial Government, Department of Water and Sanitation (DWS), Department of Agriculture, Forestry and Fisheries (DAFF)), will be supported by the existing forum, the Zandvlei Estuary Advisory Forum (ZEAF), a sub-committee of the Zandvlei Protected Area Advisory Committee, representing all key stakeholder groups on the estuary.

1.4 The management of the Zandvlei estuary

The Zandvlei catchment falls entirely within the boundaries of the CoCT, and is bordered by Muizenberg Mountain, Silvermine Plateau, Constantiaberg, Cecilia Ridge, Wynberg Hill, and a less conspicuous watershed along the eastern boundary. It is a relatively small catchment comprising an area of 92 km^2 or 9,655 ha and is drained by a number of rivers and streams of which the main ones are the Little Princess Vlei Stream, Westlake Stream, the Keysers River, Langvlei Canal and the Sand River Canal/Diep River.

These rivers converge on Zandvlei, with the Keysers River and Westlake Stream entering it through an extensive reed bed on its north-western margin, while the Sand River canal enters the vlei east of Wildwood Island. The wetland area covers some 60 ha, while the main body of the vlei is 56 ha. In addition, the system includes a marina of 31 ha along its eastern margin, and an outlet channel of 9 ha which links to the sea on the north-western shore of False Bay.

For purposes of the EMP, the geographical boundaries of the Zandvlei estuary are defined as the area from the estuary mouth, to the upstream end of the wetlands. Both the northern and lateral boundaries comprise the 100-year floodline as shown in Figure 2 below.

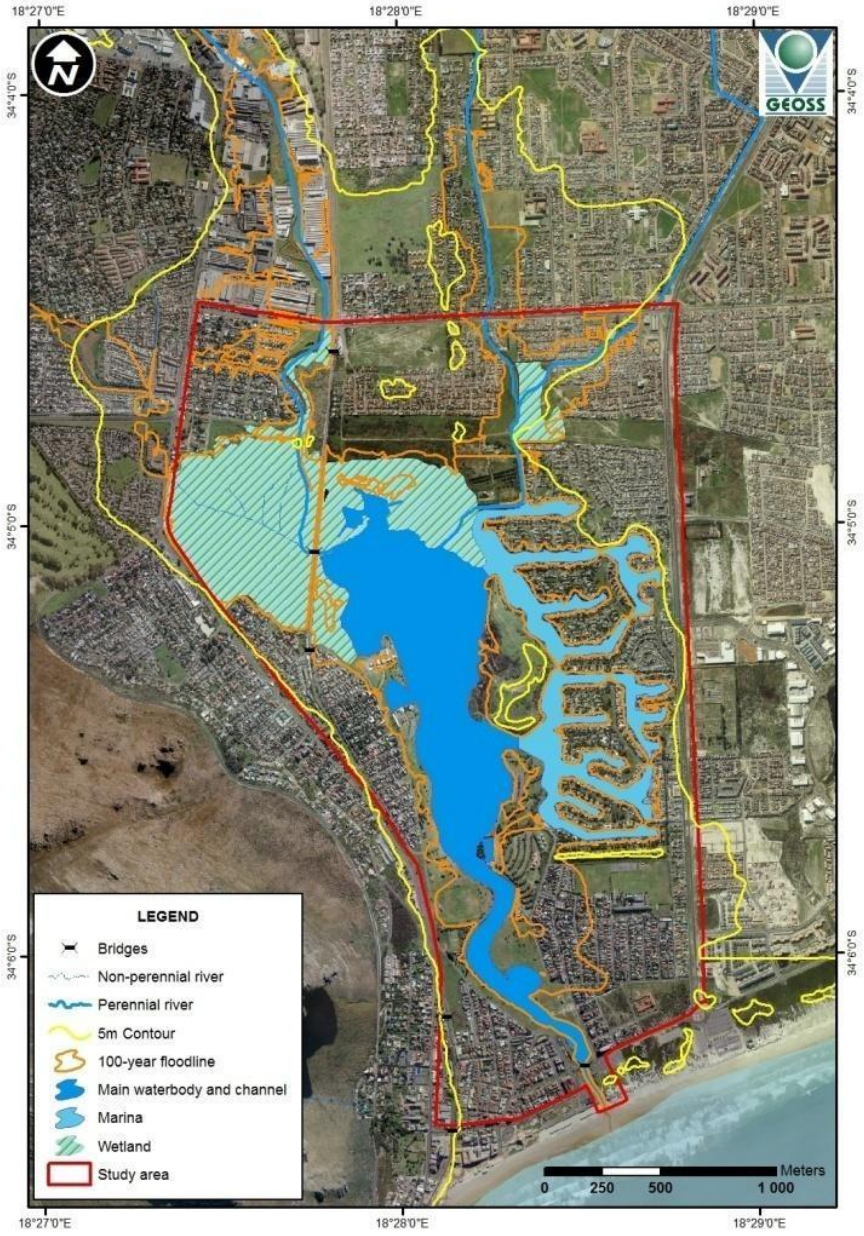

Figure 2: The Zandvlei estuary comprising the channel, vlei, marina and wetland

Land-use in the catchment is highly varied ranging from light industry to housing, agriculture, forestry and conservation. In general, the more heavily urbanised areas – including industrial and commercial areas and middle to lower-income housing – are situated in the eastern part of the catchment (42%) centering around the Diep and Sand Rivers and Langvlei Canal. Agricultural land, forested areas and middle to high-income housing are located in the west of the catchment (58%) along the Keysers River and Westlake Stream and their tributaries. The light industrial area of Retreat however, is adjacent to the Keysers River a short distance upstream of where it discharges into Zandvlei estuary. A map of land-use in the catchment, reproduced from the Sand River Catchment Management Plan is shown in Figure 3 below.

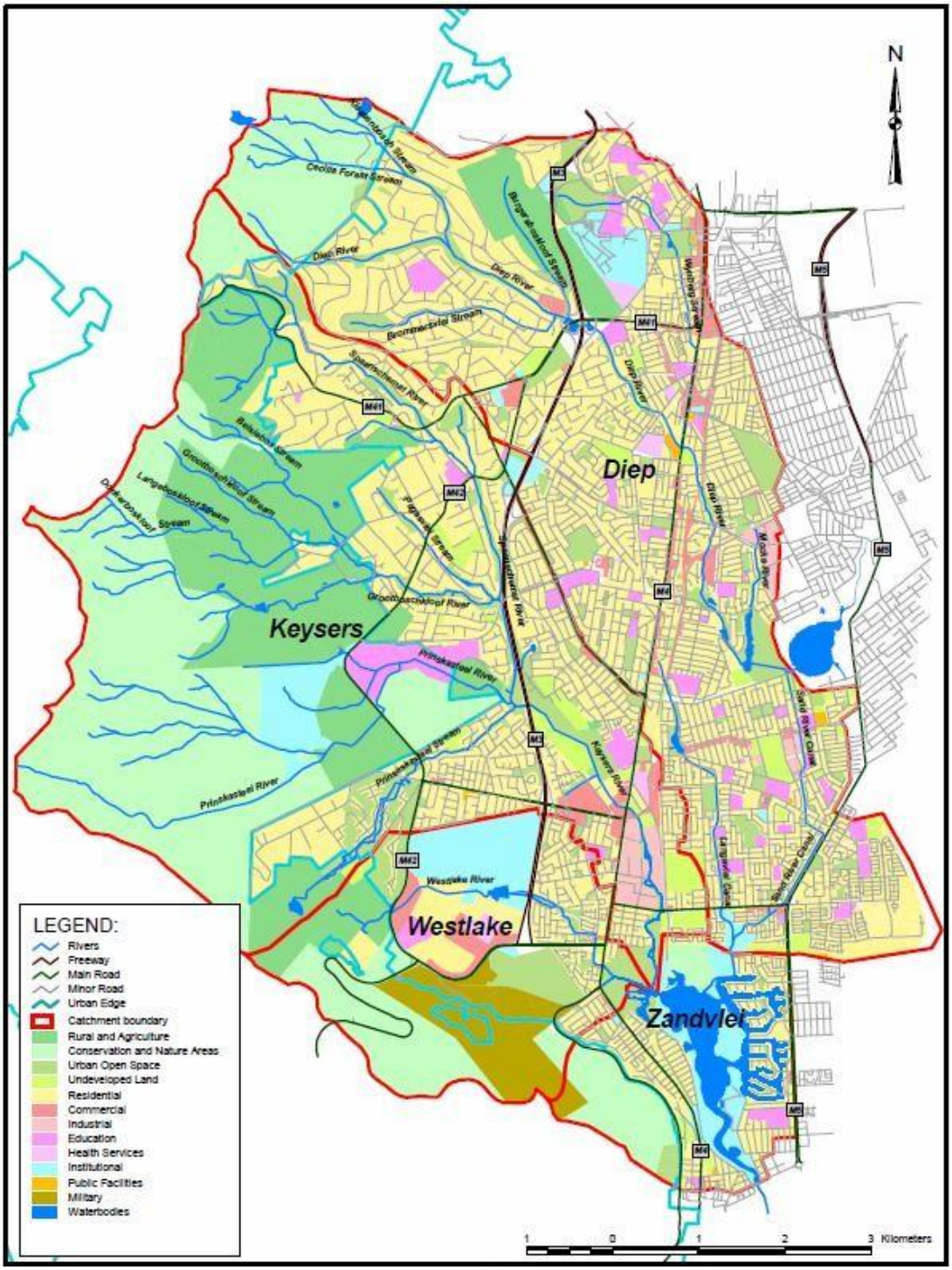

Figure 3: Land-use in the catchment (reproduced from the Catchment Management Plan (Jeffares & Green, 2003)

Although the catchment as a whole has a relatively low population, the eastern parts, together with lower reaches of the river – including the estuary – fall within a highly urbanised environment. The 1996 census data put the population figure at 10,472 for Muizenberg, Lakeside and Marina da Gama alone while the projections from Thornton et al (1995) quoted above, suggest that the population for the catchment as a whole could be of the order of 100,000.

Despite the modifications that have taken place, Zandvlei estuary remains highly valued for its natural attributes and the recreational opportunities which it affords. Recreational use includes various boating activities, picnicking, birdwatching, hiking and a limited amount of fishing, although bait collection is not permitted. It is regarded as being of regional importance in recreational terms and hosts a number of sports events including an international kite-flying competition, provincial canoe championships, and various yachting events. It was also used as a training venue by some international canoeing teams preparing for the 2012 Olympics.

There is also an increased understanding of the need to maintain the environmental health of Zandvlei estuary in order to optimize the recreational and conservation benefits. The Zandvlei Estuary Nature Reserve (ZENR) also has a strong environmental education programme involving both learners from local schools, and a number of environmental clubs, and local residents are actively involved in the management of the area.

1.5 The Zandvlei Estuarine Management Plan

According to the requirements of the former C.A.P.E. Estuaries Programme, the original version of this management plan was developed in two phases: i) a Situation Assessment Report; and ii) the EMP and action plan. The latter was developed through a consultative process including public meetings, the development of a Vision and Strategic Objectives, and the establishment of Technical Working Groups comprising experts and public representatives.

This updated version of the plan, which comprises the EMP and an action plan for the period 2017 – 2021, is largely based on the original plan, although the priority actions have been adjusted to take account of:

- Achievements during the initial implementation period (2011/2012) and since then including changes in mouth management;
- Problems – or new perspectives thereon - which emerged between 2012 and 2017;
- The discussions of the Technical Working Groups which were reconvened during 2012; and
- Some supplementary plans which have been developed, namely a Contingency Plan for Environmental Emergencies at Zandvlei, an Invasive Alien Species Management Plan for the nature reserve, and a Mouth Management Plan.

The plan should be read in conjunction with the Situation Assessment Report, which, provides useful historical information.

2 SUMMARY OF SITUATION ASSESSMENT

INTRODUCTION

The Zandvlei estuary, in the City of Cape Town, is fed by the Keysers River and Westlake Stream and Sand River The wetland area covers some 60 ha, while the main body of the vlei is 56 ha and includes a marina of 31 ha along its eastern margin, and an outlet channel of 9 ha which links to the sea on the north-western shore of False Bay. The extensive and well documented history of the estuary dates back to 1673 and is included in detail in the document. The socio-economic context of the system is also documented with this system being located in a transformed highly urbanised environment, whist remaining highly valued for its natural attributes and recreational value.

BIO-PHYSICAL DESCRIPTION OF THE ESTUARY

The Zandvlei estuary is described in terms of its bio-physical characteristics, geology; geohydrology, hydrology, sedimentation, mouth dynamics and water levels as well as physiochemical characteristics. The biodiversity of the estuary, which has been significantly altered as a result of various human interventions over the last two centuries is then detailed comprehensively highlighting microalgae and diatoms, macroalgae, aquatic, semi-aquatic and terrestrial vegetation. Invertebrates, fish, amphibians and reptiles, birds and mammals are thereafter described. Additional detail is provided in respect to both threatened and protected species, in particular the Western Leopard Toad (*Amietophrynus pantherinus*) which is a key focus of attention. Ten red data plants are also recorded. The significant changes to the systems biodiversity are thereafter expanded upon which are a result of primarily the physical alteration of the habitat including changes to the water levels and salinity of the estuary, increased nutrients, and the introduction of a variety of alien species.

The ecological health of the Zandvlei estuary was determined through the Berg Water Management Area Classification Study. The results indicated that the health of the Zandvlei estuary in terms of habitat integrity is affected by poor hydrodynamic functioning, water quality issues, and extensive alterations to physical habitat. Apart from macrophytes, all the ecological components were considered to be in fair condition. The overall health score of 45 translates into a PES of Category D, which is classed as a largely modified system. In terms of conservation importance, the estuary has statutory protection and is one of the national priority estuaries requiring formal protection. From a biodiversity importance perspective, the Zandvlei estuary it is deemed to be 'important to highly important', largely due to it being one of the last functional estuaries remaining in False Bay. Given that anthropogenic impacts on Zandvlei are almost all non-flow related for all components, and many would be difficult or nearly impossible to reverse, the Recommended Ecological Category/ Best Attainable State for the Zandvlei estuary is estimated to be a D category.

SOCIO-ECONOMIC IMPORTANCE OF THE ESTUARY

Estuaries provide a range of goods and services which, together with their attributes, contribute to the well-being of society. Direct use values for the system are discussed, considering both consumptive uses as well as non-consumptive uses (including property values, recreation and tourism). Indirect use values are also discussed highlighting nursery areas for fish, critical habitats and waste disposal and water purification. The section

concludes with a summary of the estuaries socio-economic importance and the need for conservation, reiterating the conclusion that the system is one of the core estuaries in terms of meeting set biodiversity targets, that the extent of protection be half, that 25% of the margin remains undeveloped, that it is assigned to class A or B in terms of minimum water requirements (with A being near natural), and that it be considered as high priority in terms of rehabilitation.

REGULATORY FRAMEWORK

There are a number of international agreements as well as national and provincial laws that are directly or indirectly relevant to the management of estuaries in South Africa. These, together with relevant municipal by-laws, management policies and strategies are summarized in various tables while the key legislation is discussed in more detail.

International obligations include the Convention on Wetlands of International Importance especially as Waterfowl Habitat, 1971 (Ramsar Convention); the Convention on the Conservation of Migratory Species of Wild Animals, 1979 (Bonn Convention); and the Convention on Biological Diversity, 1992. Key national legislation includes the National Environmental Management: Integrated Coastal Management Act as amended (Act 24 of 2008); the National Environmental Management Act (Act 107 of 1998), the National Environmental Management: Protected Areas Act (Act 57 of 2003); National Environmental Management: Biodiversity Act (Act 10 of 2004); the National Water Act (Act 36 of 1998); and finally, the Marine Living Resources Act as amended (Act 18 of 1998). Both provincial legislation and municipal by-laws are thereafter detailed with the latter section highlighting the By-Law Relating to the Control and Use of Vleis and Boating there on, 1980 as amended; the By-Law Relating to Stormwater Management, 2005 and the Dumping and Littering By-law, 2002. Institutional management plans and strategies are thereafter highlighted in conclusion.

MANAGEMENT OF THE ESTUARY

In October 2006 the 200 ha Greater Zandvlei Estuary Nature Reserve was formally established with local authority nature reserve status under Section 7 of the Cape Nature Conservation Ordinance 19 of 1974. It has since been recognized under the NEM: Protected Areas Act 57 of 2003. Zandvlei estuary– including the water body and the shoreline – and much of the catchment falls under the jurisdiction of the Cape Town City Council. However, responsibility for the management of the area – and/or activities which impact on the reserve – is split across a number of different departments within the City. The activities of the various departments are at present coordinated through the Zandvlei Action Committee.

The fact that Zandvlei estuary and its catchment have been progressively and extensively modified over the past 300 years has been well documented, as have the impacts of these modifications themselves and those of some of the management measures – in particular the management of water levels in the interests of protecting inappropriately sited residential areas and maintaining sufficient water depth for recreational purposes. Rather

than re-iterating these, this summary is intended rather to capture some of the other salient points that have emerged. These are:

- Despite the various management measures that have been implemented, few, if any, of the problems have been solved. Rather, they are being managed or mitigated on an ongoing basis with the current list of issues being much the same as those identified thirty or more years ago. These include:
    - The impact of the mouth/water level management regime on the natural functioning of the estuary (salinities, role as a fish nursery etc.);
    - Pondweed and other aquatic and semi-aquatic plants (alien or indigenous);
    - Other introduced and invasive species, including Mallard ducks; and
    - Water quality issues – nutrients, bacteriological contamination and litter;
- Over the years, there have been a number of initiatives to develop management plans which cover the broad spectrum of issues – in addition to issue-specific plans - but, while it is clear that certain components of those have been implemented, there has been a significant amount of institutional memory loss with staff being unaware of at least some of the earlier efforts. This is probably as a result of a combination of staff turnover and restructuring. As a result, there has not always been a proper assessment of the progress made – and effectiveness of – various management plans;
- There are a number of monitoring programmes in place and many more suggested. The responsibility for these lies with a number of divisions of the City and some other agencies. In a number of cases it seems that the information being generated is not being effectively utilized to assess and improve management measures. On the other hand, in some instances, the level of monitoring seems to be insufficient. It is therefore suggested that the monitoring be rationalized with better coordination between the various departments and with a clear understanding of the purpose thereof; and
- There is a relative paucity of information on some animal groups – for example, invertebrates, amphibians, reptiles and mammals. In a number of cases, the historical species "lists" are based on records in the general area rather than specific surveys, and even the ZENR database is a list of sightings. Given the higher conservation profile of the ZENR, this could be improved.

In conclusion, Zandvlei estuary is situated in a relatively small catchment all of which lies within the boundaries of the City of Cape Town – a big advantage from a management perspective. Given its limited size, it is not a significant source of water. Nor does it have any major effluents discharging directly into it – or even into the rivers making up the catchment. Moreover, there is already a Catchment Management Forum in place, as well as a Catchment Management Plan. In addition, there are a number of new broader developments and initiatives which are pertinent to the management of the estuary. Over and above the proclamation of the Greater Zandvlei Estuary Nature Reserve in 2006, these include the promulgation of the ICM Act in 2009, the CAPE Estuaries Programme, development of Invasive Species regulations under NEMBA, development of an Invasive Species Policy for the City and development of both catchment and species level invasive species strategies.

3 VISION & OBJECTIVES

3.1 Vision

The National Vision for estuarine management is as follows (the National Estuarine Mangement Protocol, 2013):

"The estuaries of South Africa are managed in a sustainable way that benefits the current and future generations".

In this context, the following more specific Vision (and accompanying Objectives) for the Zandvlei estuary is:

"Zandvlei estuary is a beautiful and important component of Cape Town's natural assets. It is valued by the local community and visitors alike for recreation, education and other uses. It is also home to a rich diversity of flora and fauna and is used in a way that balances conservation with the needs of the users for the benefit of present and future generations."

3.2 Objectives

3.2.1 National strategic objectives for estuarine management

The Protocol lists the national strategic objectives of estuarine management as follows:

- To conserve, manage and enhance sustainable economic and social use without compromising the ecological integrity and functioning of estuarine ecosystems;
- To maintain and/or restore the ecological integrity of South African estuaries by ensuring that the ecological interactions between adjacent estuaries; between estuaries and their catchments; and between estuaries and other ecosystems, are maintained;
- To manage estuaries cooperatively through all spheres of government; and to engage the private sector/ entities and civil society in estuarine management;
- To protect a representative sample of estuaries (such protection could range from partial protection to full protection) in order to achieve overall estuarine biodiversity targets as determined by the 2011 National Biodiversity Assessment and the subsequent updates;
- To promote awareness, education and training that relate to the importance, value and management of South African estuaries; and
- To minimize the potential detrimental impacts of predicted climate change through a precautionary approach to development in and around estuaries and with regard to the utilization of estuarine habitat and resources.

3.2.2 Management objectives for the Zandvlei estuary

Over the years, there have been numerous changes to the physical structure of Zandvlei and the influent rivers. These, in turn, have given rise to changes to the volumes and quality of water and associated sediments flowing into it – both from the rivers and the sea - as well as to the biological communities which originally inhabited it. Given the extent of the development in the catchment and immediate surrounds, including the physical presence of structures such as the marina, roads and the railway bridge, the system will never function as a completely natural system again. At the same time, the estuary remains highly valuable from both a conservation and socio-economic perspective. The primary objective is therefore to develop a management regime which will restore the system to the extent possible, with a view to maintaining and enhancing its current value.

3.2.2.1 Overall/key objectives

The Overall/Key objective for the Zandvlei estuary:

"*To manage Zandvlei estuary and its environs, including the catchment, in a balanced manner that promotes the rehabilitation and conservation of its biodiversity values, maintains its suitability for recreation and education, and mitigates flooding of adjacent property*".

3.2.2.2 Long term objectives

Long term objectives for the Zandvlei estuary are that:

- Zandvlei estuary should function optimally as an estuary with appropriate mouth conditions, tidal flows and salinity levels and with water levels showing sufficient variation to meet the needs of biota such as wading birds without compromising socio-economic values;
- Water quantity and quality should meet Resource Quality Objectives developed through the reserve determination process (interim water quality targets were based on the guidelines for recreation and freshwater and marine ecosystems as appropriate);
- Biological communities should be restored to as close to natural species composition and structure as possible; and
- There should be an appropriate balance between conservation, recreational use of the system and the rights of residents.

3.2.2.3 Management objectives

Management objectives for the Zandvlei estuary are:

- To develop a mechanism to manage the hydrodynamics of the estuary in a manner which:
    - does not compromise its biological integrity;
    - maintains salinity at optimal levels for healthy estuarine functioning;
    - enhances the role of the estuary as a nursery for marine migrants;

    - maintains the competitive advantage of pondweed over phytoplankton;
    - promotes flushing for water quality improvement;
    - reduces siltation;
    - optimises water depth fluctuations for healthy estuarine functioning while minimising flood risk and damage to shoreline properties and meeting recreational needs; and
    - takes account of the potential impacts of sea-level rise.
- To prevent, reduce or minimise pollution from all sources so as to be able to restore the water quality to a standard suitable for supporting natural resources and human recreation;
- To create conditions suitable for the restoration and ongoing protection of Zandvlei and its biodiversity, including:
    - establishing a zonation plan which designates conservation areas, areas for different uses (boating, walking, swimming, etc.);
    - introducing, where possible, buffer zones between the estuary and surrounding urban areas;
    - preventing introduction of alien species and eradicating or controlling established invasive species;
    - improving water quality and increasing salinity through improved tidal exchange; and
    - promoting sustainable use of resources.
- To ensure that any relevant future planning and development decisions acknowledge the socio-economic value and conservation significance of the estuary and prevent any further development within the boundaries thereof;
- To promote and manage recreation, education and eco-tourism in the estuary in a manner compatible with its conservation status; and
- To establish a coordinated and streamlined monitoring programme linked to clear operational objectives and indicators within a framework (guided by the Reserve Determination monitoring methods), which facilitates adaptive management based on the monitoring results.

3.3 Management priorities (Short-term)

Since a number of the long-term objectives will not necessarily be achievable within this period, more detailed specific objectives, i.e. management priorities, which are intended to be met within the 5-year cycle, if not before, are set out below. This EMP includes an action plan of these priorities for the period 2017 – 2021.

3.3.1 Water levels, mouth conditions and physico-chemical parameters

Attempts to manipulate the amount of water in the estuary go back to 1866 when a decision was taken to close off and drain it so as to use it for agricultural purposes. This failed and subsequent initiatives were instead focused on maintaining water levels for recreational boating and preventing flooding of the surrounding areas. The outlet channel was

canalized in the early 1950's and was followed by the construction of a concrete weir just below the Royal Road Bridge. The concrete weir collapsed and was eventually replaced with a rubble weir after extensive natural scour at the mouth caused damage to the concrete side walls and exposed the upstream sewer. The weir has also subsequently been used in the management of water levels in the estuary together with the artificial opening and closure of the mouth.

Management of the mouth and water levels is, unfortunately now a necessity, both to protect the housing and associated infrastructure around the estuary and to meet the requirements of the recreational users. However, these management actions themselves affect the ecosystem with impacts including:

- Reduced salinity levels, with consequential changes to the biodiversity much of which is now dominated by freshwater species. For example, vlei grasses such as *Ruppia maritima* and R. *cirrhosa* have been replaced by pondweed and there has been a decline of halotolerant species such as Enteromorpha intestinalis One exception is the fish population whose species diversity is still dominated by estuarine and estuary-dependent species, although the biomass is dominated by alien species (carp and catfish)[1] ;
- Increased sedimentation in the estuary generally, and in particular, upstream of the weir in the outlet channel;
- Although historically the estuary probably dried up in summer, it is now regarded as playing an important role as a nursery for certain species of commercially important and threatened fish. This role is diminished by some of the management actions;
- A reduction in the seasonal fluctuations of the water levels which – together with the creation of vertical embankments in much of the system – has led to a consequential loss of habitat for wading birds; and
- Reduced flushing/increased residence time of water in the system (or parts thereof) increasing the potential for accumulation of pollutants and increased anoxia particularly of the bottom sediments.

Efforts are therefore focused on trying to adjust the management regime to mitigate these impacts with a view to achieving the objectives outlined below for the physical parameters and in Section 3.3.6 for the biological targets and Appendix 1 for the Ecological Specifications and Thresholds of Potential Concern as per Reserve Determination Study (DWS, 2017).

3.3.1.1 Mouth conditions

Ideally, the mouth should be de-canalised so that it can function more naturally. Since the caissons on the south side of the outlet channel are already in a state of some disrepair this should be taken into consideration in the broader study which was proposed to investigate alternatives for the current mouth management regime (see Section 0).

[1] Stephen Lamberth, pers. comm.

In the short-term the proposed management priority is that the mouth should be kept open as much as possible during peak fish recruitment periods which are from August/September through November. The records of the opening and closing of the mouth – while intermittent – dis suggest that the mouth had been kept open for longer periods between 5 – 15 days/month over these months (Figure 4 below)[2]. However, it is noted that this is strongly influenced by the rainfall and associated water levels in the estuary. For example, in November 2013, the mouth was open most of the month due to late winter rainfall. It is proposed that efforts be made to try and achieve this on a regular basis, and possibly to try and extend this into the summer months (Dec/Jan), although it is noted that:

- Since this will increase sedimentation behind the weir, breaching should be adjusted to take account of wind and wave conditions; and
- This period conflicts with the yachting season, which runs from August through March/April, so that cognizance must be taken of their depth requirements.

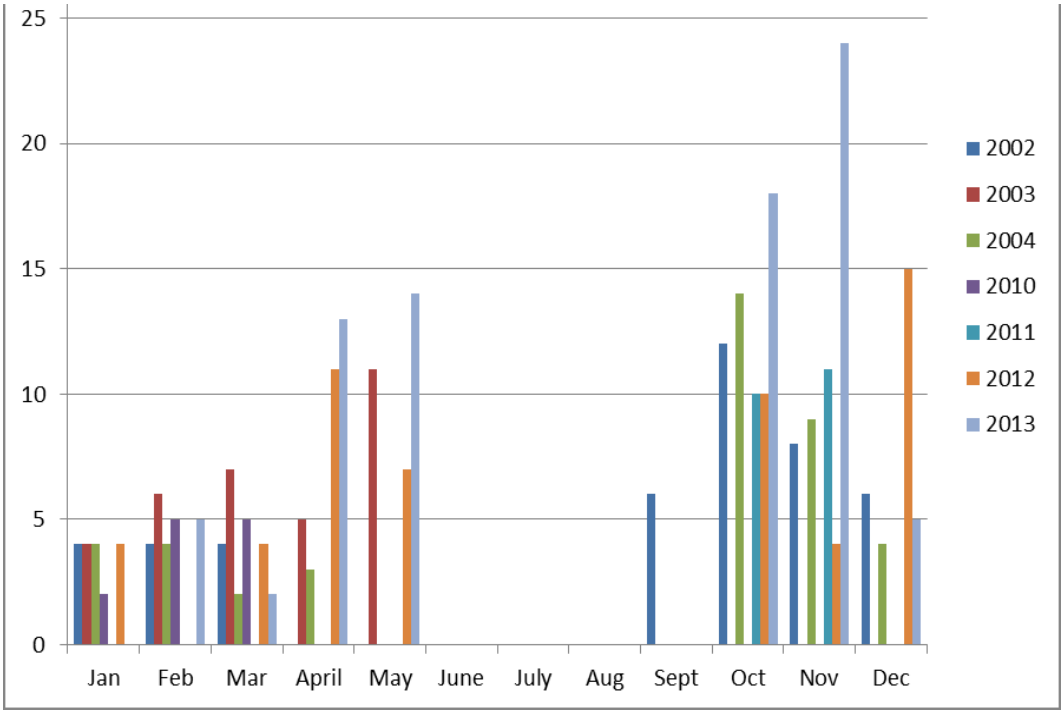

Figure 4: Number of days/month that the estuary mouth has been deliberately kept open (2002 to 2013)

3.3.1.2 Salinity

In general, the salinity regime in the system should be such that it allows the re-establishment of fish and benthic communities in those areas which they previously occupied. While the fish populations are quite tolerant of low salinities – as evidenced by the fact that they are still dominated by estuarine species - they generally do not like

[2] Information provided by CSRM - CoCT

hypersaline conditions. Invertebrates and plants on the other hand are more sensitive to salinity variations. The sandprawn *Callianassa*, for example, requires a salinity of between 16 - 17 ppt to be able to breed (although adults can tolerate lower levels), while the pondweed, *Stuckenia pectinata*[3] has been reported to be tolerant of salinities of between 5 and 20 ppt and has a competitive advantage over other macrophytes and phytoplankton at an ambient salinity of between 5 – 10 ppt. In contrast, *Phragmites,* cannot survive in salinities > 16 ppt for more than 3 months.

The ambient **target** salinities[4] as provided in 2013 were as follows:

- for the main body of the estuary:
    - in winter, between 5 ppt (surface) and 7 ppt (bottom); and
    - in summer 10 ppt throughout the water column;
- for the outlet channel:
    - in winter, 6 ppt (surface) and 18 ppt (bottom); and
    - in summer, 11 ppt (surface) and 13 ppt (bottom).

These targets will be retained until monitoring results from a more comprehensive salinity monitoring programme and the fish surveys are available, provided that:

- the outlet channel is understood to extend up to a point parallel to the downstream end of the marina; and
- the bottom salinity in summer be increased to 18 ppt[5].

3.3.1.3 Water levels

Under natural conditions water levels in the estuary are likely to have varied between 0 and 2.5/3 m aMSL. At present, the fluctuation in water levels is largely limited to a range of between 0.7 – 1.4 m amsl in order to prevent flooding, to protect the revetments in the marina (which were designed for an operating water level of 0.7 m) and some of the residences in the marina which are threatened at water levels of 1.4 m (and lower), and to ensure sufficient water depths for boating purposes (1 m). In addition, a depth of 0.8 m is required to operate the weed harvester.

It is proposed to extend the present range by:

- as far as possible, adjusting the breaching programme to take predicted wind and wave conditions into account; and

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[3] Previously known as *Potamogeton pectinatus*

[4] These are thought to have been based on the salinity required to ensure the competitive advantage of pondweed over other aquatic macrophytes and algae (Dick, 1992 quoted in Harding, 1999).

[5] Although *Callianassa* breeds primarily between May and August, in some areas there is a smaller breeding peak in December/January. Given that it is probably easier to achieve higher bottom salinities in summer; the chances of successful summer breeding should be maximized.

- allowing slightly higher water levels – noting that the lowest allowable development is 1.85 m amsl. However, prior to doing this, an audit would need to be undertaken to determine the lowest level of officially approved buildings.

The requirements of the yachting fraternity should continue to be catered for by timing events to coincide with periods that the mouth is closed.

Water levels on the central pan should be manipulated using the weir such that they simulate the natural condition, namely that they retain some water for most of the year but dry out for a short period in late summer.

The weir was lowered in June 2015 by 20 cm to 0.4 amsl and the mouth channel dredged and deepened by 0.5m resulting in net sediment loss annually over the last two years. It has also resulted in an increase in tidal range of about 0.45m (~22cm higher and lower) and a dramatic increase in salinity range and average salinity over the past two years (Josh Gericke[6], pers comm March 2017).

3.3.1.4 Sedimentation

Ninham Shand (2000) estimated that a total of 44 000 m^3 of sediment had accumulated in the vlei between 1988 and 2000. This equates to approximately 6.5 mm per year over the total vlei area or 77 mm for the 12-year period, compared with 50 mm (or 4.17 mm/year) for the 12-year period from 1958 to 1970. Most of the sedimentation took place in the "delta area" (where the Keysers and Westlake Rivers and Sand River canal enter the vlei) in spite of regular clearing of the lower reaches of the rivers.

In addition to the sediments from upstream, there is considerable encroachment of sea-borne sand (up to 6 000 m^3) into the Zandvlei estuary outlet channel (City of Cape Town, 1989) where it becomes trapped by the weir. This has been exacerbated since dredging was halted in 2001 following its inclusion into the list of activities for which an EIA is required. As shown by the images in Figure 5 below, the sandbar has not only migrated some 250 m upstream over this period, but all of the area downstream of the crest of this sandbar has largely been filled in to form sand flats with an estimated water depth of less than 0.5 m much of the time (A. Killick, 2013).

2002 **2005** **2009**

[6] J Gericke City of Cape Town official

Figure 5: Images from Google Earth showing the migration of the sandflats upstream from the mouth and up the Narrows. The Royal Road bridge can be seen in the lower right corner of each image (after Killick).

In this regard, it was recommended that a dredging programme be re-instituted – at least until another solution is found – with a view to maintaining the upper slipface of the sandbar at an agreed maximum distance upstream (for example, that shown in the 2002 image). A light dredging programme has since been instituted to complement and maximise the weir lowering and increase natural flushing ((Josh Gericke[7], pers comm March 2017).

The riverine siltation is caused primarily by erosion in the catchment. The target should be a reduction in annual rates of sedimentation. This would require the actual rates of sedimentation to be measured – for example by periodic bathymetric surveys. Such surveys would also take account of sediment entering via stormwater culverts which, cumulatively, could also make a significant contribution.

3.3.1.5 Circulation

Flows of water within the system should be optimised so as to improve flushing and to avoid the creation of stagnant areas with the potential for development of anoxic conditions. This is thought to be a problem in the channels of the marina which are generally deeper than the main body of the estuary, and where there are dense growths of pondweed which can result in the accumulation of decaying organic matter on the bottom. Circulation in and out of the Marina is also impeded by coral worm colonies particularly those around the bridges (e.g. Park Island Bridge).

Dissolved oxygen levels should meet water quality guidelines (see Section 3.3.2) and Ecological Specifications (Appendix 1).

[7] J Gericke City of Cape Town official

3.3.2 Water quality and litter

The long-term objective in terms of water quality should be to meet Resource Quality Objectives/Ecological Specifications developed in terms of the National Water Act (1998) specifically for Zandvlei estuary (DWS, 2017). These are included in Appendix 1. Proposed interim targets for parameters of particular concern, based on existing guidelines for freshwater or marine ecosystems and/or full contact recreation as appropriate, are outlined below. These exclude salinity, which was discussed in Section 3.3.1.

Management priorities are:

- To reduce the number of accidental discharges of wastewater per year (eg. from pump station failures) although it is noted that these are sometimes a result of vandalism;
- To reduce the frequency of overflows from blocked sewer manholes; and
- To reduce dumping of litter and other waste into the stormwater drain system[8].

3.3.2.1 Bacteriological targets

Although the most prevalent forms of recreation in the estuary are yachting and canoeing, people do swim there, some on a regular basis. The long-term targets for bacteriological parameters should therefore be based on those for full contact recreation (especially given the high prevalence of HIV in the country, and the consequential lowered immune system of a substantial proportion of the population). The most important of these is *E.coli*, with others being Faecal coliforms and *Enterococci* as follows:

- *E. coli* – which are more specific to warm-bodied animals and show a high correlation with swimming-related gastric illness, with a target range of 0 – 130 counts (based on the DWAF South African Water Quality Guidelines: Recreational Use (2nd Edition, 1996)). To meet the target, the range should not be exceeded by the geometric mean of fortnightly samples over a three-month period;
- Faecal coliforms (including *E.coli*) – which are used as an indicator of general faecal contamination - for which the target range should be between 0 – 100 counts per 100 ml (based on the 1995 South African Water Quality Guidelines for Coastal Marine Waters). To meet this target, 80% of samples taken from the water body should fall within this range (i.e. less than 100 counts); and 95% of samples should be below 2,000 counts; and

Enterococci – there are currently no guidelines for South Africa, but guidance is obtainable from the Blue Flag Programme and/or World Health Organisation recommendations.Table

[8] While records of litter removed from stormwater drains have been kept, they have not been analysed. It is suggested that a student project be used to generate the information required to set a numerical target for this objective.

1 below shows the relationship between similar targets recommended for application in coastal waters and the risk of contracting gastro-intestinal illnesses.

Table 1: Risk-based EQTs recommended for application in coastal waters used for (contact) recreation (adopted from DEA, 2011)[9]

Category	Estimated Risk per Exposure	Enterococci (Count per 100 Ml)	E. Coli (Count per 100 Ml)
Excellent	2.9% gastrointestinal (GI) illness risk	≤ 100 (95 percentile)	≤ 250 (95 percentile)
Good	5% GI illness risk	≤ 200 (95percentile)	≤ 500 (95 percentile)
Sufficient or Fair (minimum requirement)	8.5% GI illness risk	≤ 185 (90 percentile)	≤ 500 (90 percentile)
Poor (unacceptable)	>8.5% GI illness risk	> 185 (90 percentile)	> 500 (90 percentile)

The proposed management priority for the Zandvlei estuary is that, based on *E.coli* counts, all sections of the estuary which are zoned for recreational use should meet the requirement for the Department of Environmental Affairs' (DEA) "Sufficient or Fair" Category within 5 years (i.e. by the end of 2018). This will require an improvement in the sewer maintenance programme.

3.3.2.2 *Nutrient targets*

- The current guideline on dissolved inorganic nutrients for marine aquatic ecosystems is: "*Waters should not contain concentrations of dissolved nutrients that are capable of causing excessive or nuisance growth of algae or other aquatic plants or reducing oxygen concentrations below the target range*" (see below).
- The Coastal Water Quality Guidelines provide a more specific guideline for **Total Ammonia-N** – namely 600 μg/l - while the freshwater guideline for unionized ammonia (NH_3) – which is responsible for the toxicity of ammonia - is < 7 μg/l (DWAF, 1996). More recent guidelines developed by a Water Quality Index project (see Figure 5 below) indicate values of < 0.015 (Category A); 0.044 (Category B) and 0.058 mg/l (Category C) or 15 – 58 μg/l are acceptable. It is proposed that the target for Zandvlei be Category C.
- The DWAF Water Quality Guidelines: Aquatic Ecosystems (1996) provide a guideline for **total inorganic nitrogen** ($NH_3 + NH_4 + NO_2 + NO_3$) which states that:

[9] Department of Environmental Affairs (DEA) (2011). South African Water Quality Guidelines for Coastal Marine Waters. Volume 2: Interim guidelines for recreational waters. Final. Cape Town

- concentrations should not deviate by more than 15% from that of the local water body;
- the trophic status of the water body should not be increased; and
- that the amplitude and frequency of natural cycles should not be changed.

The Guidelines also state that concentrations below 0.5 mg/l indicate oligotrophic conditions, 0.5 – 2.5 mg/l mesotrophic, and 2.5 – 10 mg/l, eutrophic. However, according to Taljaard (pers. comm.) although only limited data is available for estuaries in South Africa, concentrations of 1- 2 mg/l were sufficient to stimulate dense macrophyte growth in the Sundays River estuary. More recent guidelines developed through the Water Quality Index project suggest 0.25 (Category A); 0.7 (Category B) and 1 mg/l (Category C). Category A is achievable for Zandvlei estuary and should be adopted as the target value.

- Phosphorus occurs in a number of forms, but that which is immediately available to aquatic biota is **Soluble Reactive Phosphate** (SRP) or ortho- phosphate. The recent guidelines developed through the Water Quality Index project suggest values of 0.005 mg/l (Category A); 0.015 mg/l (Category B); 0.025 mg/l (Category C); and 0.15mg/l (Category D). In this case, only Category D is achievable within the time frame.

The Ecological Specifications, and Thresholds of Potential Concern representative of a Category D for the Zandvlei estuary, are presented in Appendix 1.

3.3.2.3 Dissolved oxygen

The current guideline on dissolved oxygen for marine aquatic ecosystems is: "*For the east coast, the dissolved oxygen level should not fall below 10 % of the established natural variation. For the south and east coasts, the dissolved oxygen should not fall below 5 mg/l 99 % of the time, and below 6 mg/l 95 % of the time*." The recent guidelines developed through the Water Quality Index project suggests that values of between 6 – 8 mg/l are good and it is proposed that these be used as targets for Zandvlei estuary.

Category	Rating	Estuary									Vlei					
		Running Mean Annual Chl-a	TOTAL P	NH_3-N	DO	Mean EC				TIN	Running Mean Annual Chl-a	Monthly Chl-a	TOTAL P	NH_3-N	DO	TIN
						Threshold (min)			Max							
						Lower	Middle	Upper	All							
A	0	5	0.005	0.015	>8	3926.2	2469.2	1385.5	5307	0.25	5	5	0.005	0.015	>8	0.25
B	1	10	0.015	0.04375	>7	3208.7	2012.8	1224.5	5441	0.7	10	10	0.015	0.04375	>7	0.7
C	2	20	0.047	0.0725	>6	2469.2	1702.2	1061.4	5708	1	20	20	0.047	0.0725	>6	1
D	3	30	0.13	0.1	>4	2012.8	1385.5	895.9	5973	4	30	30	0.13	0.1	>4	4
E	4	40	1	0.12875	>2	1702.2	1061.4	727.5	6235	10	40	40	1	0.12875	>2	10
F	5	100	5	0.5	>0	1385.5	727.5	555.8	6620	20	100	400	5	0.5	>0	20
F+ /Z	6	> 100	>5	>0.5		0	0	0	9000	>20	>100	>400	>5	>0.5		>20

Figure 6: Estuary guidelines for nutrients and other parameters based on the Water Quality Index Project (provided by Candice Haskins) (Category A = no change from natural; Category B = small change from natural; Category C = moderate change from natural; Category D = large change from natural; Category E = serious change from natural; Category F = extreme change from natural; Category F+ = critical change from natural).

3.3.2.4 *Biological criteria*

In general, the water quality should be sufficient to support all biological communities. Targets for chlorophyll a (a measure of phytoplankton growth/ eutrophication) and Cyanophyta (blue-green algae) are outlined below, while those for other key indicator species are discussed in Section 3.3.6. Collectively, these are included in the Ecological Specifications as per the Reserve Determination study (DWS, 2017) in Appendix 1.

- Phytoplankton should not create nuisance conditions or produce surface scums. The values provided in the figure above are < 5 µg/l (Category A); 10 µg/l (Category B) and 30 µg/l (Category C) while, according to the DWAF WQ Guidelines, mean annual chlorophyll a concentrations should be < 15 µg/l. However, it is noted that these are not achievable in Zandvlei where the long- term average is in the region of 35 µg/l. Even at this level, though, it does not produce surface scums; and
- Cyanobacteria: there should be < 6 blue-green units[10] (DWAF WQ Guidelines), and <4 µg/l of cyanobacterial toxins (total microcystin-LR) for low probability of adverse health effects; 20 µg/l for moderate probability and presence of a scum for high probability (WHO guideline for full contact recreation). Toxin levels in Zandvlei are generally < 1 µg/l so the most stringent target is achievable.

3.3.3 Sediment Quality

Apart from the impacts of siltation on circulation, mouth conditions etc., sediments tend to be a sink for contaminants with consequential impacts especially on bottom- dwelling organisms. It is therefore also important to quantify and manage sediment quality.

The following objectives are proposed for sediment quality:

- In general, the sediment quality across the estuary should be sufficient to allow the re-establishment of benthic invertebrates such as *Callianassa (*see also Section 3.3.6);
- Bacteriological loads in the sediments should not pose a threat to human health; and
- Trace metals should meet the targets in the table below (based on the DEA guidelines)[11].

[10] This refers to the number of blue-green units (colonies and filaments) counted in a two- minute scan of 0.5 mR of water at x200 magnification

[11] The values given are those which trigger precautionary measures when dumping dredged materials. Updated guidelines are in the process of development.

Table 2: Targets for trace metals in marine sediment (DEA, 2011)

Trace Metal	Target (mg/kg dry weight)
Arsenic	< 30
Cadmium	< 1.5
Chromium	< 50
Copper	< 50
Lead	< 100
Mercury	< 0.5
Nickel	< 50
Zinc	< 150
Combined levels of Cd & Hg	< 1.0
Combined levels of As, Cr, Cu, Pb, Ni & Zn	< 50

3.3.4 Pondweed Management

The pondweed, *Stuckenia pectinata*, occurs naturally in Zandvlei estuary and is an important component of the ecosystem, providing habitat for a variety of organisms, reducing nutrient loading and oxygenating the water. However, as a result of the high nutrient conditions, pondweed has been a problem in Zandvlei estuary for many years, at times forming dense mats which restrict boating activities, exacerbate flooding, limit light penetration, restrict current flow and thus increase stagnation. When they start to decompose they cause unpleasant odours and raise nutrient levels. The pondweed in Zandvlei estuary has therefore been managed since 1976 by harvesting it using a mechanical harvester - an accepted practice around the world. Although the harvesting has been successful at times, there have been occasions when over- harvesting has led to collapses in the population (Harding, 1999) while at other times the excessive levels of pondweed have hindered recreational use of the estuary, created nuisance conditions and impacted on property values in the area. This situation continues despite the development of harvesting guidelines for the City by Southern Waters in 1999.

Given the ecological importance of pondweed, the overall objective of management efforts must be to achieve a sustainable level of pondweed in the system while at the same time preventing the development of conditions which affect the recreational use of the estuary, are a nuisance to residents or affect property values in the area. In other words, the pondweed levels must be sufficient to maintain the ecosystem services it normally provides (including habitat provision, oxygenation and nutrient sink services).

In recognition of the socio-economic benefits which Zandvlei estuary provides, the pondweed also needs to be managed so as to keep specified areas clear of pondweed, other nuisance plants and debris which tends to accumulate in some areas, especially the blind canals of the Marina. More specific objectives of pondweed management therefore include:

- The areas set aside for recreational activities (see Section 5.6) to be kept clear of pondweed to a depth of 0.5 m for all canals in the Marina, and to as deep as possible in the main body of the vlei – noting that the weed harvester can only cut to a depth of about one meter (and such cutting is very slow). Thus, the cutting schedule in the main vlei should be synchronised with the mouth opening schedule so that maximal depth cutting can be carried out when the water depth is at its shallowest;
- A healthy pondweed reserve of 30% of the estuary area should be maintained, of which 20% could be harvested during the senescent phase each year (see Figure 8 below);
- Adequate flow regimes within the system to prevent stagnation and nutrient build-up in localised areas does not occur - noting that there are other factors which contribute to these problems eg. Coral worm;
- An improved understanding of pondweed dynamics in Zandvlei.

On the logistical side, management priorities include:

- Reducing the downtime of the weed harvester through improved maintenance planning; and
- Increasing the manpower and equipment available to a level which is realistic in terms of the job.

Figure 7: The mechanical harvester at work in the marina

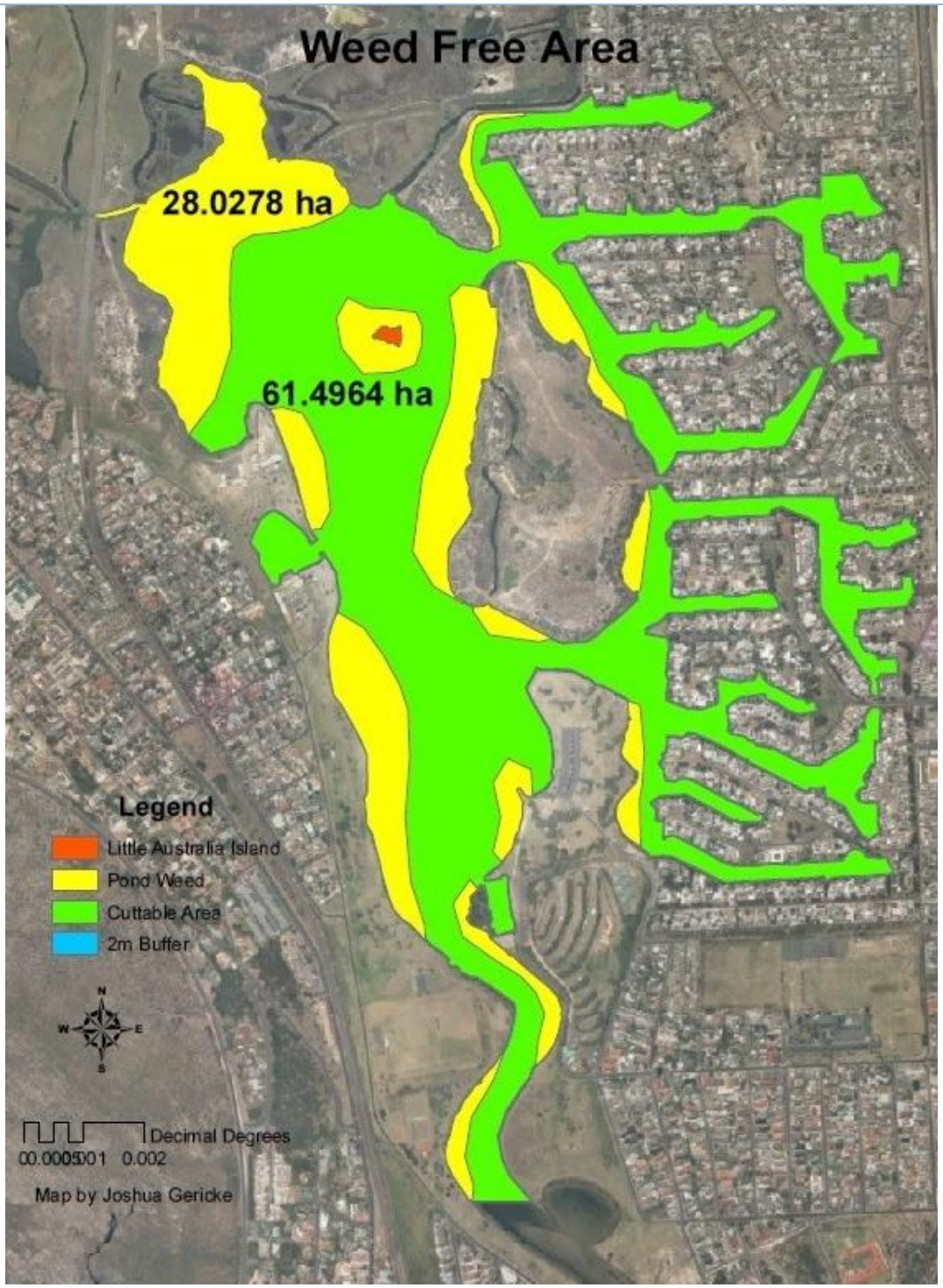

Figure 8: Pondweed reserve (yellow) and harvesting areas (green)

3.3.5 Invasive alien species management

A variety of both indigenous and alien invasive species have affected Zandvlei estuary and the surrounding areas, some for many years. These include terrestrial and aquatic species, plants and animals, vertebrates and invertebrates and species introduced deliberately as well as unintentionally. To date, efforts to manage this problem have been relatively *ad hoc* and uncoordinated with those in other parts of the City and beyond. However, an Invasive Species Management Plan has recently been completed for the ZENR with the following objectives:

- Provide an overview of the existing and potential threats posed by invasive species to the ZENR based on available information;
- Identify priority pathways, species and habitats within the reserve for short- term management action;
- Outline the actions required to prevent new invasions and the spread of newly established invaders;
- Detail the actions required to manage and control the priority species in particular in priority areas;
- Promote the restoration/rehabilitation of priority areas through the re- introduction/ re-establishment of indigenous species;
- Identify opportunities for collaboration and alignment with parallel initiatives at local, provincial and national levels; and
- Identify monitoring measures to enable evaluation of progress towards these objectives and to facilitate adaptive management.

Priorities and targets for the next five years include specific sites, species or groups of species, and the establishment of a monitoring/early detection programme as follows:

- Conservation and Biodiversity Priorities (Hot Spots):
    - Those terrestrial areas not yet cleared of woody species need to be cleared as soon as possible; and
    - The estuary as a whole: this requires ongoing management of pondweed and other aquatic weeds; coral worm, and alien fish. In addition, stands of woody species and Pampas grass which are invading the wetlands need to be identified and cleared;
- Recreational Areas:
    - The estuary is also a top priority in terms of recreation since this is negatively affected by excessive pondweed and other aquatic weeds as well as coral worm;
- Fire, Safety & Security, & Flooding:
    - The upper reaches of the estuary, and particularly Westlake Wetlands, is a priority in terms of safety and security issues with the aquatic weeds and reeds requiring ongoing management. The available options for reed management need to be investigated;
- High Risk Sites (to be included in regular monitoring programme):

    - Sites which are a high risk in terms of new invasions include:
        - Roads, walking trails, the caravan park, fishing access points, picnic sites etc.;
        - Disturbed areas – for example, around the CoCT offices;
        - The nursery;
        - Boat launching sites; and
        - Influent streams and canals.
- Woody Plants:
    - All areas within the Reserve to be cleared to maintenance levels by mid-2016 (first cut by the end of 2013); and
    - To identify the location of and remove stands of Sesbania, Manitoka and Brazilian Pepper in the areas surrounding Zandvlei which are the source of invasions of these species into the wetland by mid-2014;
- Aquatic Alien Invasive Plants:
    - Aquatic invasive alien plant species to be maintained at 5% cover of any particular water body.;
- Coral worm:
    - A coral worm management plan to be in place by 2015;
- Reedbeds:
    - Reed management plan to be in place by 2015[12];
- Alien Fish
    - To identify options for eradicating alien fish in the Sand River catchment and Zandvlei;
    - To increase awareness of the impacts of alien fish on indigenous fresh water fish especially amongst the fishing fraternity; and
    - As an interim measure, to reduce populations of alien fish in Zandvlei through fishing competitions (trial in 2014).
- Mallards:
    - To increase awareness of the impacts of Mallard ducks on the indigenous ducks;
    - To reduce populations of Mallards at Zandvlei once the National Strategy is implemented (tentatively 2014).
- Pampas grass:
    - To identify the location of and remove stands of Pampas grass in the areas surrounding Zandvlei which are the source of invasions of these species into the wetland by the end of 2013.
- *Other listed species (*i.e. other listed species which have been recorded at Zandvlei but are not covered by any of the above groups.):
    - Relevant species being managed in line with national and/or provincial initiatives;
- *Monitoring Programme:*
    - A monitoring programme involving active and passive components to be in place by mid-2014. Monitoring should cover:
        - All priority species listed above;

[12] NOTE: a plan based primarily on controlled burning was developed a few years ago. This needs to be reconsidered

        - Guttural toads; and
        - Squirrels;
    - All plant species listed on the Early Detection and Rapid Response Programmes (EDRR)target lists;
    - High risk sites including:
        - Roads, walking trails, the caravan park, fishing access points, picnic sites etc.;
        - Disturbed areas – for example, around the CoCT offices;
        - The nursery;
        - Boat launching sites; and
        - Influent streams and canals.

3.3.6 Biodiversity, conservation and planning

The establishment of the ZENR was a major step forward for conservation in this area. The objective now should be to further enhance this accomplishment by improving the understanding and protection of the biodiversity within and in the vicinity of the Nature Reserve. To this end, the following targets are proposed:

3.3.6.1 Extension of reserve boundaries

The boundaries of the reserve should be expanded with a view to:

- Improving the connectivity between Table Mountain National Park, the False Bay Nature Reserve, the coastal protection zone and the Kogelberg Biosphere Reserve;
- Including a 5 – 10 m buffer zone along the western shoreline of Zandvlei estuary;
- Upgrading other areas along the margins of the Reserve where possible; and
- Generally, protecting the estuary from future developments.

3.3.6.2 Biodiversity information – availability, management and use

There is a substantial amount of information available on certain groups of biota at Zandvlei estuary – for example, birds, fish and plants. On the other hand, inventories for other groups – such as most invertebrates, amphibians and reptiles – are primarily based on ad hoc observations. At the same time, even where information is available, it has not necessarily been consolidated and/or analysed. A variety of interventions have been proposed to improve this situation according to the following proposed targets:

- Ultimately, there should be comprehensive qualitative and quantitative information available on all the biodiversity of the reserve;
- An overview of trends for selected groups where there is sufficient data available (eg. birds) and an understanding of how they have been influenced by environmental parameters; and
- All relevant information consolidated and accessible to all stakeholders.

3.3.6.3 *Rehabilitation/Restoration Initiatives*

The populations of many different species have been altered over the years as a consequence of changes to the estuary, including water quantity and quality. Targets for the recovery of some of the key indicator species/ groups are as follows:

- Benthic populations of *Callianassa* should be restored to their original distribution range and densities as far as possible. The Southern Waters Baseline Biotic Monitoring Report (2001) reported that the sandprawn populations were largely confined to the southern end of the main body of the estuary and the outlet channel, with numbers ranging from 114/m^2 at the southern end, to 20/m^2 in the north. While the distribution range is probably reasonably consistent with historical patterns, Shelton (1975) reported numbers up to 576/m^2. Target densities should therefore be closer to the latter:
    - The nursery role of the estuary for marine fish should be re-established as per the following targets:
        - Size frequency distributions should indicate a number of different cohorts at any one time;
        - Species composition and abundance should reflect that of temporary open/closed systems of equivalent size in the cool/warm temperate biogeographical transition zone; and
        - There should be high numbers of new recruits in the system over peak recruitment periods (September/November).
- The habitat for waders should be restored with a view to:
    - Increasing the numbers of resident species already present: for example, Three banded Plovers, Pied Avocet, Black-winged Stilt;
    - Increasing breeding opportunities; and
    - Encouraging the return of waders previously present in the estuary: for example, Wood Sandpiper, Common Sandpiper, Marsh Sandpiper, Curlew Sandpiper, Common Greenshank, Little Stint, Sanderling, Common Whimbril, African Snipe, Kittlitz's Plover, and Common Ringed Plover.

There are also a number of areas within the nature reserve which are degraded, and which have been identified for rehabilitation/restoration (see Section 5.8.3).

3.3.6.4 *Conservation, recreation and ecotourism development*

The public should be encouraged to see Zandvlei estuary as an asset by:

- Improving the biodiversity experience for visitors to Zandvlei estuary;
- Provision of interpretive signage;
- Making ecotourism opportunities available for example, by advertising Zandvlei estuary as a primary birdwatching destination; and
- Improving facilities for visitors (e.g. biking and/or walking trails, a restaurant, canoe hire facility etc.).

3.3.7 Education and communications

The existing environmental education programme is entirely oriented towards learners, particularly from the schools in the adjacent suburbs. There are also two environmental clubs which meet on a relatively regular basis. The programme involves interacting with the learners to identify issues of concern and to develop possible solutions. These are then translated into active campaigns such as litter clean-up days, removal of alien vegetation, recycling initiatives, development of signboards etc. They have also been involved in the Leopard Toad project, and schools can request specific programmes.

In terms of a target for the learner programmes, it is recommended that:

- The number of schools visiting the Education Centre regularly be increased;
- The number of Environmental Clubs be expanded so that each school that organizes regular visits has a club; and
- Partnerships be established with other local initiatives such as the scouts, sea cadets and the development programme at the canoe club.

In addition:

- A community outreach programme targeting adults should be initiated by, for example, offering guided walks to members of community organisations;
- Links be established between local conservationists, user groups and the Early detection and rapid response (EDRR) Programmes at the City and South African National Biodiversity Institute (SANBI);
- New posters communicating information on the ZENR and particularly the issues being addressed through the EMP should be produced and placed on notice boards in Zandvlei estuary itself, and at local clubs, shopping centres etc.; and
- The environmental education/awareness-raising programme should be expanded to include a component aimed at invasive alien species with specific objectives including:
    - reducing deliberate, illegal introductions;
    - increasing the number of people actively involved in early detection and monitoring programmes such as the "spotter network" as well as clearing – such as hack groups;
    - reducing opposition to the humane culling of invasive animal species; and
    - developing an "adopt-a-patch" programme aimed at providing hands- on-training in early detection and involving volunteers from the environmental clubs and stakeholder groups.

Finally, a partnership should be developed with the Caravan Park with a view to using the camping facilities to extend experience of the learner's programmes to include overnight visits.

3.3.8 Summary of management priorities

Table 3 below lists the identified management priorities that are further detailed in Section 6.3.

Table 3: Summary of Management Priorities

Mouth Conditions, Water Levels, Salinity & Sedimentation
Priority A: Reduction of sedimentation at the mouth
Priority B: Increase recruitment of biota into the estuary
Priority C: Re-establishment of seasonal water level fluctuations on the central pans
Priority D: Monitoring of water levels, salinities, fish populations, etc.
Water Quality Management
Priority E: Water quality monitoring
Priority F: Assessment & reduction of pollution from sources in the catchment
Priority G: Reduction of pollution from stormwater discharges to the estuary
Priority H: Reduction of pollution from accidental spills
Priority I: Health warnings
Priority J: Improved understanding of environmental quality in the estuary
Pondweed Management
Priority K: Effective pondweed harvesting
Priority L: To improve understanding of pondweed dynamics
Priority M: Sufficient capacity available to manage pondweed effectively
Invasive Alien Species Management
Priority N: Integration of IAS management both within the reserve and with external initiatives
Priority O: Prevention of introductions of new alien species into Zandvlei
Priority P: Early detection of emergent species in Zandvlei
Priority Q: Management of priority species
Biodiversity, Conservation & Planning
Priority R: Further expansion of reserve to improve buffers and linkages
Priority S: Improve and expand biodiversity information
Priority T: Restoration/rehabilitation of sites within the ZENR
Priority U: Promote sustainable use of Zandvlei &adjacent areas
Education, Awareness-Raising & Communications
Priority V: To expand the environmental education and outreach programme
Priority W: Improved communications on matters related to the reserve

4 SPATIAL ZONATION

4.1 Background

4.1.1 Geographical Boundaries

The ICM Act 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 Authorisation.

The geographical boundaries of the Zandvlei estuarine system, as delineated by the 5 m contour are depicted in Figure 1. However, for purposes of the EMP, the geographical boundaries of the Zandvlei are defined as the area from the estuary mouth, to the upstream end of the wetlands. Both the northern and lateral boundaries encompass the 100-year floodline as indicated in Figure 2. The spatial zonation of estuarine related activities conforms to the boundaries of the long-established ZENR.

4.1.2 Zandvlei Estuary Nature Reserve

The northern part of the estuary around Wildwood Island was officially recognized as the Zandvlei Nature Reserve in 1977. This was expanded in 2006 from 22 ha to 200 ha by including Westlake Wetlands, Little Australia and Park Islands, the water body of the estuary up to the then recorded 1:100 year floodline, and some adjacent and nearby outlying areas, and is now known as the ZENR. The ZENR is administered by the CoCT.

However, historical records show that parts of the estuary have been utilized for recreational purposes for over a century, and nowadays it is regarded as a regional recreational centre. There are a number of recreational facilities on the banks of the estuary which are used by large numbers of visitors especially during peak holiday periods, while many residents use them on a more regular basis (see also Section 5.8).

One of the aims of this EMP is therefore to achieve an appropriate balance between conservation and recreational use of the estuary. An important tool in achieving this aim is zonation, or the delineation of different use zones. The proposed zonation plan for the ZENR is based on the CoCT's Guidelines for Visitor Use Zoning for Nature Reserves and Conservation Areas and is shown in Figure 9 below.

4.2 City of Cape Town Guidelines

The guidelines make provision for the following zones and associated management objectives:

- **Primary Conservation:** Natural areas should be kept intact in order to protect habitat required to meet biodiversity targets for various vegetation types and to provide undisturbed habitat for a range of species. Where possible degraded areas should be rehabilitated;
- **Conservation:** Natural areas should be kept intact in order to protect habitat required to meet biodiversity targets for various vegetation types and to provide undisturbed habitat for a range of species. Where possible degraded areas should be rehabilitated;
- **High Intensity Use:** The activities and infrastructure in these areas should be managed to minimize impacts on biodiversity and visitor experience in other zones. Where feasible, non-crucial infrastructure should over time be removed from the reserve and the sites rehabilitated;
- **Low Intensity Leisure:** Although some areas will be impacted by a range of activities and limited infrastructure, most areas should be kept largely intact and ecological processes should remain functioning. Where possible degraded areas should be rehabilitated; and
- **Utility Zones:** The activities and infrastructure in these areas should be managed to minimize impacts on biodiversity and visitor experience in other zones. Where feasible, non-crucial infrastructure should over time be removed from the reserve and the sites rehabilitated.

In addition, the guidelines make recommendations on the type of activities, frequency of use, group size, sophistication and type of facilities, user movement/transport and roads and footpaths. The specific details however, may vary from one reserve to the next, and the activities for Zandvlei estuary are outlined below.

4.3 Visitor Use Zones in Zandvlei[13]

Primary Conservation zones require controlled access which is not feasible in the ZENR, at least at present. The zones in Zandvlei estuary are therefore limited to three of the above, namely conservation, low intensity and high intensity use as shown in the map below (Figure 9). Within each of these zones, the specific activities allowed are detailed as follows, and as shown in Figure 10[14]:

4.3.1 Conservation zones

The conservation zones may be used for self-guided walks, bird watching, etc. Access to the land areas is pedestrian only, while the water body may be used by canoeists for relaxation purposes by individuals and small groups only i.e. not for competitive purposes. Moreover, canoes should not be launched or landed within these zones.

4.3.2 Low intensity use areas

Specific activities permitted in the low intensity use areas at Zandvlei estuary are as follows (with numbers corresponding to those on the map in Figure 10 below):

1. Keysers River Rehabilitation Block: this includes a small picnicking area on the NW border of the wetland;
2. Reedbed stand at the confluence of the Sand River and Langvlei Canal: this is used primarily as a thoroughfare rather than for recreation, although the general activities outlined above would be permitted;
3. Area adjacent to the Environmental Education and Resource Centres: this includes a small parking area for visitors as well as trails, bird-hides and picnicking areas.
4. Park Island: permitted activities include birdwatching, walking, running, and dogwalking on leashes only.
5. Lower West Bank: there are picnic spots (but no fires allowed) and children's playground facilities. Recreational fishing is permitted from the banks only.
6. Lower East Bank: permitted activities include walking, recreational fishing from the banks only, and dogwalking (dogs allowed to run free). There is also a playpark area, and special events (such as the Kite Festival) may be held with prior approval of the Reserve Manager.

[13] It should be noted that these proposals have been developed by the City and still need to go through a Public Participation process.

[14] It should be noted that in terms of the regulations, recreational fishing in the estuary is allowed and at this stage is not restricted to any particular zone.

4.3.1 High intensity use areas

Apart from the City's administrative offices in the north-eastern corner of the Reserve, the high intensity use areas within the boundaries of the ZENR are limited to parts of the water body. These are used for a variety of boating activities as shown on Figure 10 below and include regattas and other competitive events. Where these might impinge on the Conservation Zone, prior approval must be sought from the Reserve Manager.

In addition, there are areas and facilities along the western and eastern banks of the estuary which are used intensively for sport and recreation – including camping, picnicking and braaiing – which, although they are outside of the boundaries of the estuary, nevertheless have the potential to impact on it.

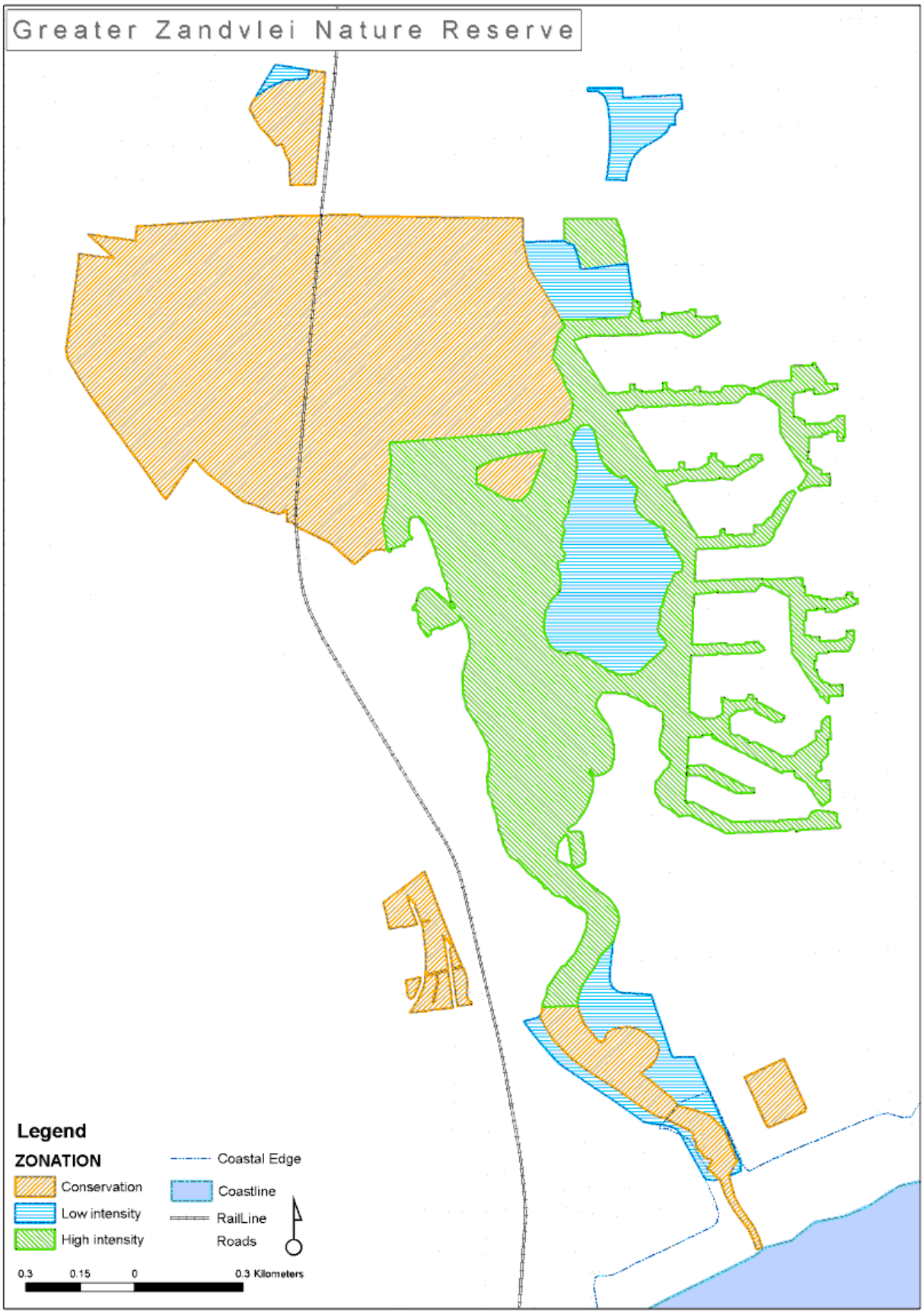

Figure 9: Visitor use zones in the ZENR (provided by CoCT)

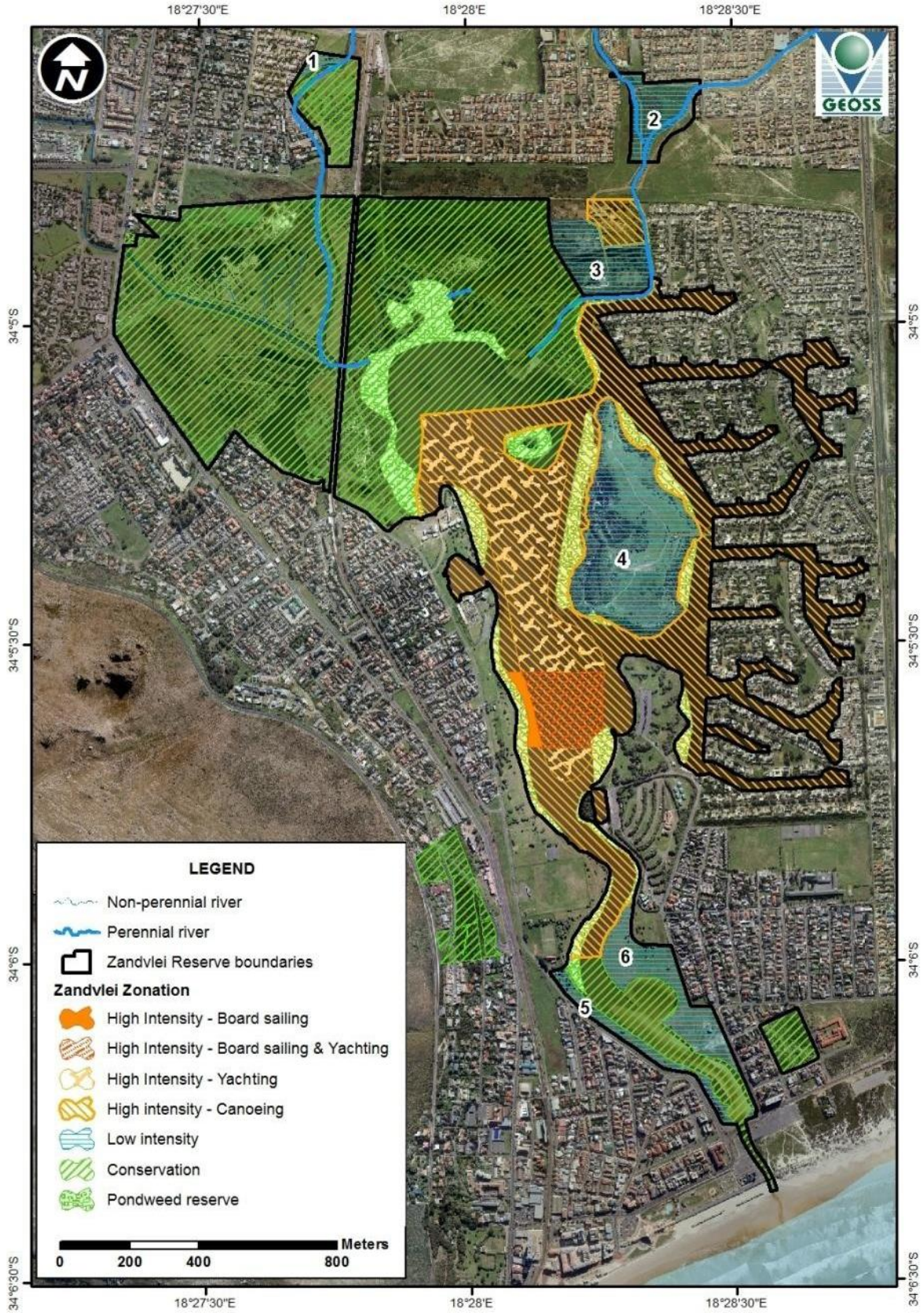

Figure 10: Areas zoned for high and low recreational activities at Zandvlei

5 MANAGEMENT STRATEGIES

Zandvlei and its catchment have been progressively and extensively modified over the past 300 years giving rise to a range of problems. Given the nature of the changes, few, if any, of the problems are likely to be permanently solved. Rather, they will require ongoing management - as is reflected in the fact that the current list of issues is much the same as those identified thirty or more years ago. These include:

- The impact of the mouth/water level management regime on the natural functioning of the estuary – including salinities, sedimentation, role as a fish nursery etc.;
- Water quality – nutrients, bacteriological contamination and litter;
- Pondweed and other aquatic and semi-aquatic plants which have become invasive - alien and indigenous species;
- Other alien and invasive species, including coral worm, fish, Mallard ducks etc.; and
- The need to balance recreational and conservation requirements.

The management interventions proposed below are intended to address these issues, to improve the protection of biodiversity, and to promote a balance between recreational and conservation needs. They are based on available information and may need to be modified in the light of future studies.

5.1 Environmental emergencies at Zandvlei estuary

Zandvlei estuary is subject to a variety of threats which may at times create situations which require emergency interventions. These include, for example, sewage spills, high phosphorus levels, oxygen depletion, and algal blooms of species such as the toxin-producing Golden Alga (*Prymnesium parvum*) which caused significant fish kills in 1973 and March/April 2012. In addition, physical alterations to the estuary and development in adjacent low-lying areas have created a situation in which property bordering parts of the estuary is prone to flooding. The most common of these are sewage spills although of these, only a few are classified as severe (see Table 4 below which records incidents between 2007 and 2013).

A Contingency Plan has therefore been developed to deal with such events. The objectives of this plan are to:

- Identify all those authorities which have a legal responsibility with regards the protection and management of Zandvlei estuary and adjacent communities;
- Outline the roles and responsibilities of the competent authorities;
- Promote co-operative governance across the different levels of government in order to enhance the efficiency of the response;
- Identify potential risks and develop appropriate response strategies;
- Ensure that adequate resources are available to support the response;

- Secure the support of all roleplayers for all elements of the plan before an emergency arises; and
- Ensure effective communications during such events.

A copy of this plan is available from the City of Cape Town.

Spills of hazardous substances are excluded from the plan as they require specialist expertise and are covered by the CoCT's Disaster Risk Management Centre's Hazmat Incident Management Plan in terms of which the Western Cape's S.O.R.T Team, comprising of selected, trained and equipped personnel form the Fire and Rescue Service, Emergency Medical Services and the SAPS, will act as the lead agency.

Table 4: Records of sewage spills from pump stations in the Zandvlei estuarine Area

Date	Location	Severity
2013		
10 Feb 2013	Bergvliet	Minor
18 Feb	Plumstead (Timour Hall PS)	Minor
20 Feb	Military Road, Retreat	Medium (Sand River PS into Langevlei Canal)
21 Jan	Military Road, Retreat	Severe (Sand River PS into Langevlei Canal - treated by Biosystems SA)
2012		
Feb 2012	Raapkraal, Kirstenhof	Severe – spilled into Westlake River & reached Zandvlei
2009		
21.4.2009	Retreat Main	Minor (into detention pond)
30.9.2009	Retreat Main	Minor (into detention pond)
2008		
1.2.2008	Military Rd, Retreat Uxbridge Rd, Marina da Gama 4 & 9 + others due to power outage	Minor (into Keyser's River & various stormwater drains)
17.5.2008	Military Road, Retreat	Level 1 (into Langevlei Canal)
20.6.2008	Marina 4 (Spearhead Quay)	Level 2 (minor, but into vlei)
20.8.2008	Retreat Main (Seawinds)	Level 1 (into bush?)
2007		
17.1.2007	Retreat Main (Vrygrond)	Low (retention pond)
19.9.2007	Military Road, Retreat	Medium (Langevlei Canal)
28.9.2007	Military Road, Retreat	Medium (Langevlei Canal)

5.2 Management of the mouth and water levels

5.2.1 Mouth Management Plan

Water levels in Zandvlei estuary have been managed for many years, primarily to provide water of sufficient depth for yachting and other recreational activities, and to prevent flooding in Marina da Gama. The required water levels have been maintained by manipulating conditions at the mouth using a weir just below the Royal Road Bridge originally built to protect a sewer line – in conjunction with a sand berm across the mouth. Concern over the resulting decrease in salinities in the estuary – and associated changes in the biodiversity – sedimentation, and restrictions on the movements of biota in and out of the estuary led to the implementation of a new mouth management regime from 2001 based on the recommendations of a study by Ninham Shand (2000). This included reducing the height of the weir from 0.9 to around 0.7 m, with more emphasis being placed on the manipulation of the sand berm at the mouth to manage water levels recorded in 2013 as follows:

- In the rainy winter months[15], the sandbar was kept open so as to avoid flooding of the surrounding areas – unless there was a particularly dry spell, in which case the sand berm could be closed for short periods to restore water levels so as to meet the needs of the recreational users; and
- During the summer months, the sand berm was kept closed except:
    - When water levels become too high (in excess of 1.0 m aMSL for long periods) since such levels destabilise the revetments in the marina); and
    - When there was a high spring tide. This occurs 5 – 6 times each summer when the mouth is opened to facilitate the intrusion of saline water and movement of fish into the estuary.

Since this does not always meet the water depth requirements for yachting (1 m), this is managed by scheduling the main yachting events for neap tide periods.

During the summer of 2010/11 the weir was lowered even further to 0.6m aMSL. In addition, the City developed a Mouth Management Plan as part of a Maintenance Management Plan for Zandvlei estuary. This was approved by Western Cape Department of Environmental Affairs & Development Planning (DEA&DP) in September 2011, thus exempting the City from possible EIA requirements related to the movement of sand to open or close the mouth. During the review of this document, an action proposed is for the CofCT to review its maintenance management plan taking consideration and guidance from the updated Zandvlei EMP as well as both the CSIR mouth management plan template and any future EMFIS templates.

The monitoring programme results suggest that salinities have increased significantly since the 1980's and 1990's when the mean declined as far as 5 ppt (see Figure 11 below). This

[15] Starting from the first heavy rain – varies between April and June.

can be attributed to increased seawater intrusion facilitated by the progressive lowering of the weir.

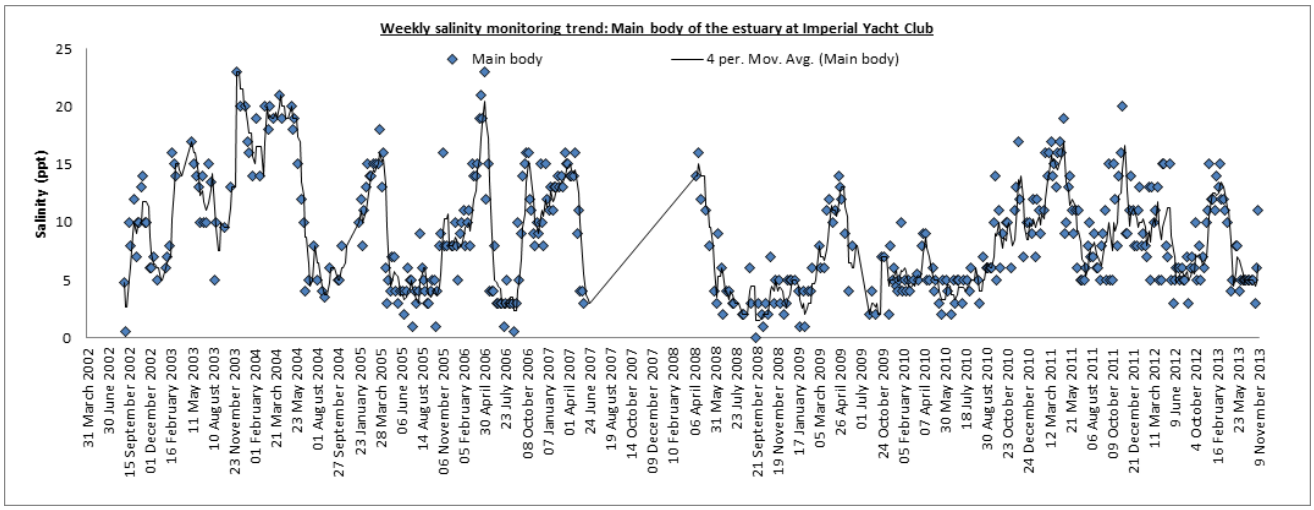

Figure 11: Salinities at ZAV 2 from 2002 to 2013

On the other hand, as shown in Figure 5 (Section 3.3.1), between 2001 and 2013 there was a significant increase in the accumulation of sediments to some distance upstream of the bridge, where they were trapped by the weir. Based on the images in Figure 5, Killick (2013) estimated that the crest of the sand bar had migrated some 232 m up the estuary over the period 2002 – 2009 while, at the same time most of the Narrows area behind the crest has been filled in and had effectively become a sandflat. In addition to the ecosystem concerns, the sandflat appeared to consist of unconsolidated sediments and posed a potential risk to visitors entering the estuary.

This landward migration of sediment occurred mainly during the summer months and raised concerns that lowering the weir more frequently during summer may be exacerbating the situation. However, it can also be attributed, at least in part, to the fact that dredging of the channel – which had previously been done on a fairly regular basis (every 4 to 5 years) – was stopped in 2001.

As previously mentioned the weir was lowered in June 2015 by 20 cm to 0.4 amsl and the mouth channel dredged and deepened by 0.5m resulting in net sediment loss annually over the last two years. It has also resulted in an increase in tidal range of about 0.45m (~22cm higher and lower) and a dramatic increase in salinity range and average salinity over the past two years. The mouth management plan was amended in 2014 and its implementation is proving to be very successful in combination with some light dreading. Zandvlei is now experiencing a net loss of sediment as measured by quarterly bathymetric survey of the sand bar at the mouth (Josh Gericke[16], pers. comm., March 2017). Accurate records must be kept of mouth opening and closing.

[16] J Gericke City of Cape Town official

Additional long-term solutions still to be considered include:

- The relocation of the sewer line;
- The widening of the mouth/inlet (in the context of the anticipated collapse of the caissons on the south bank in the next few years) and possible restoration to a more natural condition; and
- An assessment of potential implications of climate change/sea level rise for the management options[17].

The objective should be to produce a mouth management regime which addresses all the related issues including:

- Ecosystem impacts;
- Safety issues (quick sands);
- Collapse of caissons;
- Potential damage to infrastructure; and
- Increased flooding potential (caused by the sedimentation).

Consideration should be given to undertaking it as a joint initiative of a number of City departments (Environmental Resource Management Department (ERMD); Catchment, Stormwater and River Management (CSRM) and Water & Sanitation). Mechanisms to facilitate this should be explored with the Head of Departments.

5.2.2 Monitoring

The effectiveness or otherwise of these measures – and the mouth management regime as a whole – needs to be evaluated through an ongoing monitoring programme which includes monitoring salinity, water levels, mouth conditions and selected biological parameters. This should also be undertaken to meet the Reserve Determination requirements (DWS, 2017), taking the Resource Quality Objectives/ Ecological Specifications into account (Appendix 1)

Salinity is monitored on a monthly basis as part of the CoCT's water quality monitoring programme as well as on an approximately weekly basis through a Community Monitoring Programme.

In addition, DEA: Oceans and Coasts (DEA: O&C) installed two salinity – depth - temperature probes in September 2012 – one near the mouth and the second in the main body of the estuary adjacent to the yacht club. The probes continuously record salinity,

[17] It was noted that a high level catchment study is currently being undertaken and will include an assessment of the impacts of climate change on the system.

temperature and water depth, and require periodic removal to download data before being redeployed.

The initial results for the period covering Sept 2012 – Jan 2013 are as follows (Alan Boyd, *pers. comm.*):

***Channel*:**	• Temperature increased from September to January from 16 to 22.5°C. Temperatures were highest in December (approximately 25 °C). • Salinity increased from 9 to 11 psu on average, but the open mouth periods are clearly visible and here salinity went up to 20 - 30 psu for short periods (couple of hours). • Depth changes were accurate and showed a range of 0,5 m in winter increasing to 1m above lowest level at the time of retrieval when the mouth had been closed for more than a month. • Unlike salinity which shows tidal changes when the mouth was open, tidal range appears limited to 10 cm in the main, sometimes 20 cm.
Yacht Club:	• Temperature increased from September to January from 16 to 23 °C. Temperatures were highest in December (approximately 25°C). • Salinity increased from 2.5 - 3 psu to 10 psu over the record. Since late December the salinity decreased slightly to 9psu. • Depth changes were unfortunately not reliable after the end of October – but they showed the same trends to that point - as would be expected given the fact that the channel and yacht-club sensors are only about 1 km apart.

The dates and times of the opening and closing of the mouth – which are documented as part of the conditions of approval by DEA&DP for the mouth management programme – should be correlated with salinity records.

Water levels are measured by a water level recorder at Thesen's Bridge.

Sedimentation at the mouth: A detailed survey of the extent and depth of sedimentation was undertaken and will inform the dredging programme should the appropriate approval and funding be obtained.

Biological monitoring: While the Ninham Shand report recommended monitoring of a number of species/taxa, financial constraints make this impractical. What is currently being undertaken is:

- Monitoring of phytoplankton levels as part of the CoCT water quality monitoring programme; and
- Quarterly fish surveys being undertaken by DAFF (previously MCM) in collaboration with the Reserve staff.

However, there have been some problems related to the fish surveys, in particular access to and analysis of the data. Although an analysis of the recruitment of five fish species was undertaken by a Nature Conservation student in 2011, the analysis was not designed in such a way as to demonstrate achievement of the targets set out in this document (see Section 3.3.6– Rehabilitation Initiatives). It is therefore recommended that an MoU should be developed between the City (Reserve staff) and DAFF to ensure regular (quarterly) fish surveys are continued according to an agreed protocol which also allows the City access to the data on a regular basis. Alternatively, the City should purchase its own nets. This latter option would give more flexibility and enable the staff to undertake surveys in other parts of the system.

In addition:

- Basic annual surveys of *Callianassa* populations should be undertaken by Reserve staff; and
- A GIS map of the vegetation was produced in 2011 as part of the Reserve Management Plan. This should be updated on a regular basis (every 4 to 5 years) to provide an indication of salinities, fresh water occurrence, groundwater inflows etc.

5.2.3 Information requirements

While a lot of work has been done on Zandvlei estuary over the years, some additional information is required to support the management proposals. The following studies are proposed:

- A study of the hydrology and geohydrology of the estuary needs to be undertaken in order to be able to get a clear understanding of the water balance in the system, including any seasonal variations therein. This will require an accurate determination of all flows into (from the river, groundwater, stormwater and effluent) and out of the system, circulation patterns, residence time etc. Once complete, the study should be able to recommend an optimal water balance;
- A study of the quantity and quality of sediments and the rate of sedimentation needs to be undertaken (including core sampling of sediments) with a view to determining their impact on drainage patterns, bird habitats and the environmental health of the system generally;
- Periodic bathymetric surveys to facilitate management and, in particular to look at possible barriers to the intrusion of seawater – such as the remnants of a causeway which was present in the estuary in 1954 (see Figure 12 below); and
- Ultimately, a comprehensive reserve determination in terms of Chapter 3, Parts 2 and 3 of the National Water Act (1998) needs to be undertaken, noting that some of the above studies will contribute to this process.

Figure 12: 1954 photograph of Zandvlei (courtesy Gavin Lawson)

5.3 Management of Central Pans

Historically, the water levels in the pans at the northern end of the Nature Reserve fluctuated on a seasonal basis, more or less drying up during the summer months, with the residual water having high salinity levels. These conditions attracted Teal and other waders. However, in the mid-1990's birds in the central pan area started dying of botulism because of the stagnant conditions which had developed there – possibly as a result of siltation. In 1995/96 a channel was dug to reconnect the pan to the main body of the vlei, and in 1999/2000 a weir was constructed across this channel so as to be able to control the water levels in the pan.

After a relatively short period the concrete base of the weir broke. The weir was then repaired, and a protocol developed to manage its use. In summary, the weir should be closed at the beginning of December to allow the pan to dry out through late summer. During winter, the pan should be allowed to fill up with tidal flow and rain water, and the weir should then be released under conditions that would cause maximum flushing of the pans to enable movement of organic sediments out of the pan and exit canal. These

conditions would include an approaching or present rainstorm, high water levels in the pan and low water levels in the estuary (Josh Gericke[18], pers comm March 2017).

5.4 Sedimentation from the catchment

The primary cause of siltation in the upper reaches of Zandvlei estuary is erosion in the catchment. A number of general proposals to reduce erosion are included in the Sand River Catchment Management Plan. These include:

- Improvement of agricultural practices;
- Implementation of riverine buffer zones;
- Removal of alien vegetation (eg. Kikuyu) and restoration of riverine vegetation to improve riverbank stability; and
- Restoration/rehabilitation of altered water courses to a more natural state where possible.

The plan also lists a number of more specific projects, for example:

- Review and implementation of revised river maintenance programmes to eliminate undercutting and collapse of river banks in the Tokai and Constantia areas;
- Development and implementation of soil management guidelines/ regulations;
- Quantify silt removal requirements and construct silt traps at appropriate sites; and
- Quantify the silt load entering Zandvlei and design a dredging operation.

The implementation of these projects should be encouraged.

5.5 Management of water quality and litter

There are no permitted wastewater discharges either directly into Zandvlei estuary or the influent rivers. However, there are a variety of actual and potential sources of pollution which may reach the estuary as a result of run-off or via the stormwater drain system. These include contaminated discharges from residential, industrial and agricultural sources both in the catchment and immediately adjacent to the estuary. For example:

- Run-off from agricultural areas in the catchment – primarily vineyards in the Constantia Valley – is likely to contain fertilizers, organic waste and pesticides;
- There are 14 pump stations in the areas adjacent to Zandvlei estuary and although all pump stations are monitored by a telemetry system overflows do occur from time to time – see Table 4 (p.35) above and Figure 13 below. There is also a problem with blockages in the sewer system caused by people disposing of solid objects. These

[18] J Gericke City of Cape Town official

may also result in overflows, often into stormwater drains. The stormwater drains emanating from Pollsmoor Prison, for example, were found to be contaminated with high levels of *E. coli*;

- There is an extensive system of stormwater drains around Zandvlei estuary (see Figure 13 below) which discharge directly into the estuary while others discharge into the rivers in the catchment. Stormwater may become contaminated by a variety of domestic and other activities, for example, residents changing oil in their cars, washing paint brushes, cleaning wheelie bins etc.;
- The Retreat industrial area borders on the Keysers River a short distance before it discharges into Zandvlei estuary. This is a potential source of illegal discharges and contaminated stormwater runoff; and
- Both the western and eastern banks of the vlei are bordered in parts by public open space which is used for a variety of recreational activities. These, as well as residential areas upstream, are sources of litter.

Accidental spillages are dealt with in the Contingency/Emergency Response plan as described in Section 5.1 above. The strategies outlined below are intended to address ongoing low-level pollution from a variety of sources as well as litter. In addition, the extensive reeded wetland areas within the catchment help to an extent with assimilation of pollutants.

Figure 13: Overflow of sewage pump station in the Westlake area after being vandalized (Sept. 2010) (Courtesy C.Sheasby) (left); and network of stormwater drains around Zandvlei (right)

5.5.1 Managing water quality

Water quality is managed through a combination of measures:

- Setting water quality objectives which take into account both the ecosystem needs and those of any uses of the water body concerned (eg. recreational users);
- Monitoring water quality parameters in the waterbody to determine whether the objectives are being met; and
- Where objectives are not being met, identifying and addressing the source/s of the pollution as far as possible.

5.5.1.1 Water Quality Objectives

The national strategy for managing the water quantity and quality requirements of aquatic ecosystems is through the setting of Resource Quality Objectives/Ecological Specifications. This is provided for in the National Water Act (Act 36 of 1998) and the National Water Resource Strategy and is intended to be implemented through Catchment Management Strategies and Agencies. Ecological Specifications have been determined for Zandvlei estuary as part of the Water Resources Classification Study for the Berg Water Management Area (DWS, 2017). These are included in Section 3.3.2 and Appendix 1.

5.5.1.2 Water Quality Monitoring

The current monitoring programme should seek to fulfill the minimum requirements for ecological monitoring, as determined through the Reserve Determination study, for the Zandvlei estuary (DWS, 2017), which are provided in Appendix 2.

The water quality monitoring programme undertaken by the City includes nine stations in Zandvlei, Westlake Wetlands and the Marina. The locations are shown in the map below and include: ZAV 1 – north Zandvlei; ZAV 2 – main body opposite IYC; ZAV 5 – Zandvlei outlet channel; ZAV 10 – Westlake Wetland; Marina da Gama – The Anchorage, Spearhead Road, East Lake, Baalen Way and Park Island Bridge. Monthly samples are analysed for bacterial, chemical and algal constituents. Trends for some of these are shown below[19]:

<u>*Faecal bacteria:*</u> The primary concern in relation to levels of *E.coli* is human health. The target value for intermediate contact recreation, as shown in the graphs below, is 1000 counts/100 ml, while that for direct contact recreation (i.e. swimming) is up to 130 counts/100 ml.

With respect to intermediate contact recreation (i.e. canoeing and sailing) the monitoring results at the time of initial reporting indicated that:

[19] Provided by Catchment, Stormwater and River Management – City of Cape Town.

- In general, the main body of the estuary (ZAV 2) was compliant and had shown an improvement in recent years;
- The area in the north of the estuary (ZAV1) exhibited poorer water quality but was mainly compliant. However, there did appear to be an increasing trend which indicates deterioration This reflects the influence of the water quality of the inflowing rivers (particularly the Sand Canal);
- Water quality at the outlet channel (ZAV5) was also generally compliant and the long term trend also indicates an improvement;
- Microbiological water quality in the Marina da Gama canals was generally good with bacterial concentrations well below both the intermediate and full contact recreational guidelines. There does however appear to be a trend which indicates slight deterioration in water quality in the canals.

However, an important point is that in general, the water quality in Zandvlei estuary is NOT suitable for full contact recreation.

Figure 14: Current water quality monitoring being undertaken by Scientific Services on behalf of the City of Cape Town

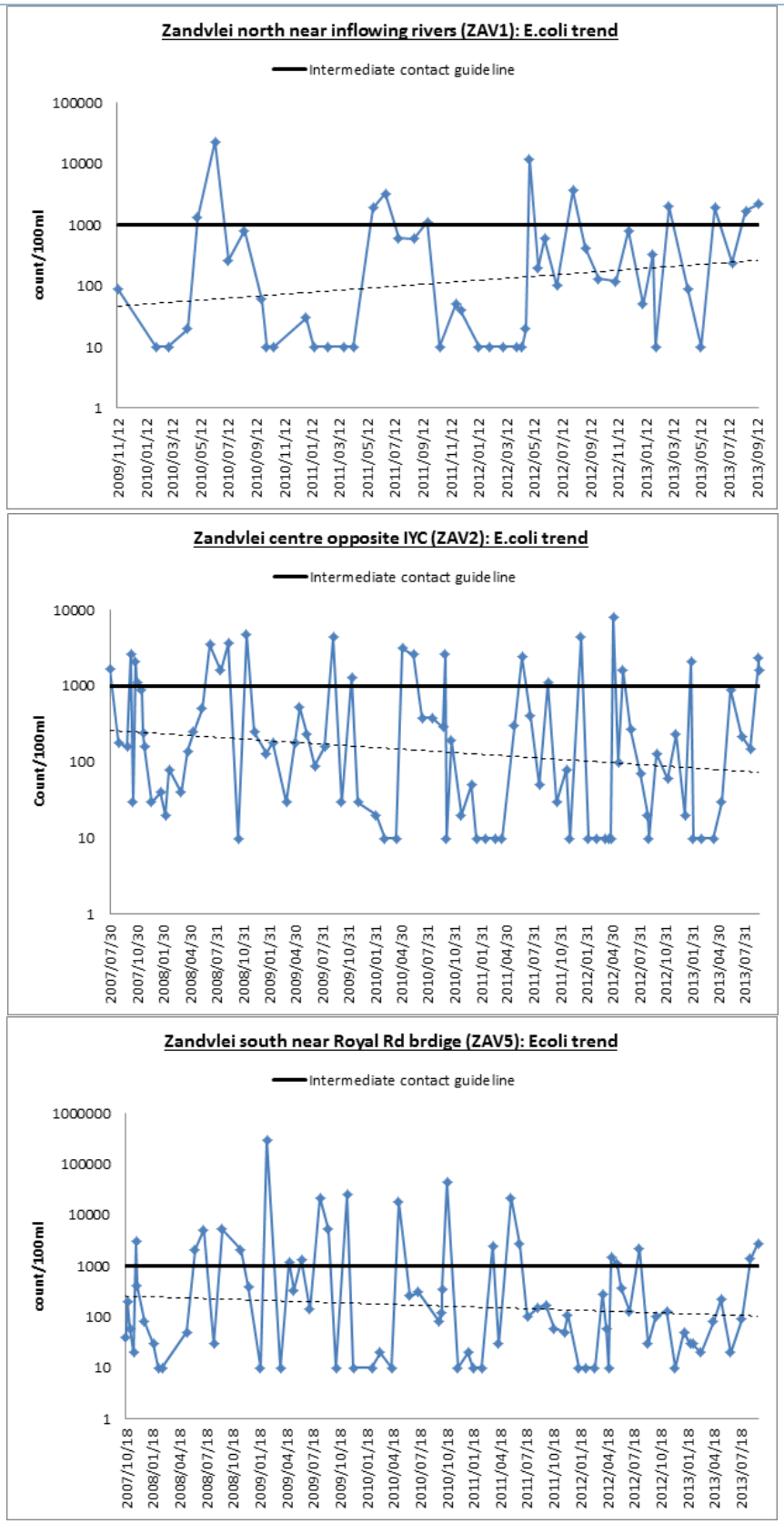

Figure 15: *E. coli* trends at 3 stations in Zandvlei estuary

Nutrients: A report to the Sand River Catchment Forum in February 2013 indicated that an analysis of total phosphorus and orthophosphate in samples from the area opposite the yacht club showed a gradual increase in concentrations between 1978 and 2012 (Figure 16). Moreover, the total phosphorus concentrations were indicative of eutrophic conditions and indicated that Zandvlei estuary falls into Category D of the Water Quality Index estuary threshold levels i.e. there is a large change from natural conditions.

The report also suggested that levels of phosphorus were likely to be greater in the Marina canals due to the decomposition of accumulated organic material such as pondweed.

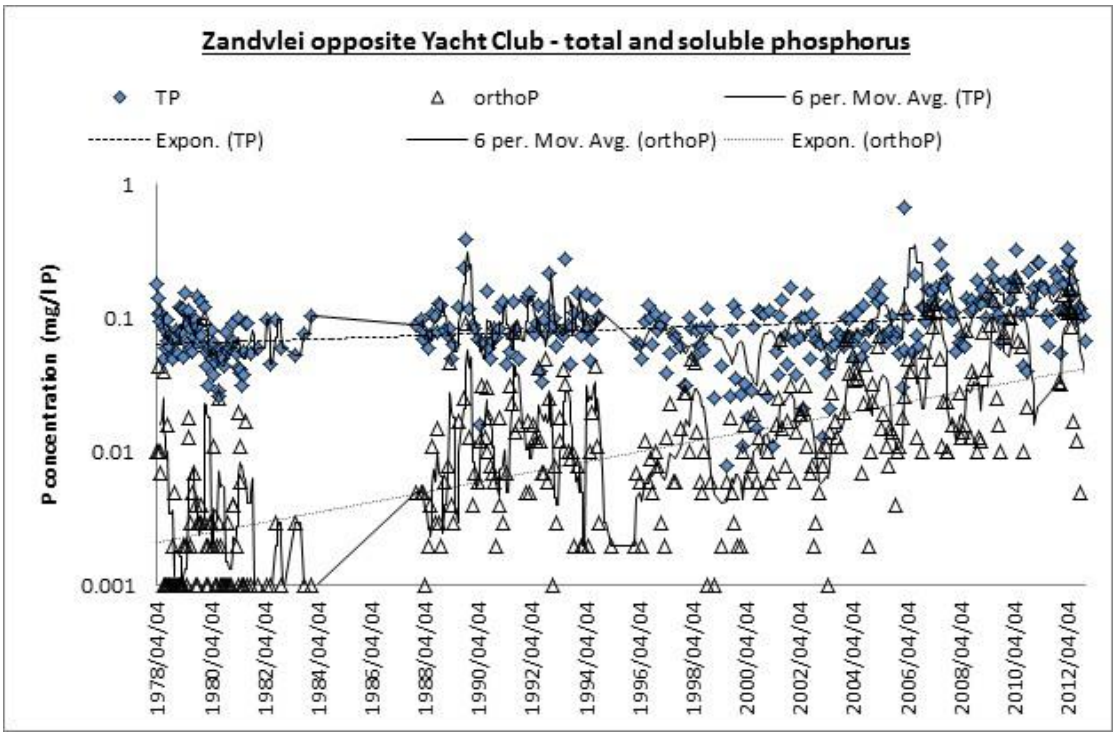

Figure 16: Total and soluble phosphorus in the main body of Zandvlei estuary

5.5.1.3 Addressing sources of pollution

Nutrients: The high levels of nutrients in the estuary remain an ongoing concern as they not only contribute to water quality problems, but also stimulate growth of pondweed, reedbeds, alien aquatic plants, and phytoplankton. In order to address the sources of nutrients, the first step is to undertake an assessment of the various sources to determine which are the biggest contributors to the overall load. Since there is already monitoring of the nutrient levels both in the estuary and at various locations in the catchment, a reasonably good estimate could be done by undertaking a flow study.

Sources in the Sand River Catchment: The Sand River Catchment Management Plan identifies the following sources of pollution in the catchment:

- Nutrient loading – runoff from urban areas, industrial waste, and fertilizers from agricultural lands and domestic gardens;
- Groundwater contamination;
- Bacteriological contamination from overflows of blocked sewers and informal ablutions;
- Litter and illegal dumping of refuse; and
- Commercial and industrial areas.

The potential for pollution, as well as the impacts on water quality, are exacerbated by flooding and the extensive infestations of alien vegetation in and around the rivers. Water quality problems are summarized in Figure 7 of the Catchment Management Plan.

The Catchment Management Plan lists a large number of proposals aimed at addressing the sources of the pollution including:

- Identification & quantification of the pollution from various areas including the wine farms, commercial and industrial areas and other water bodies eg. Langvlei Inlet, Sand River Canal, Little Princess Vlei;
- Reduction of fertilizer use;
- Formalisation of maintenance plans for sewer lines, manholes and stormwater drains along the rivers and dams;
- Development and implementation of pollution abatement plans; and
- Additional/alternative locations for litter traps.

Priority projects listed included:

- Conduct study to establish ecological reserve for rivers[20];
- Establish soil management & surveillance guidelines;
- Determine impact of industry & commerce on Keysers River;
- Determine impact of industry & commerce on Mocke River;
- Determine root causes of pollution at Langevlei; and
- Establish required pollution mitigation at Little Princess Vlei.

In addition, it is recommended that there should be engagement with the farming community - preferably through the DAFF – to improve land management practices.

The rehabilitation of particular areas of the catchment could also contribute to improving water quality. For example, the filtering function of the Westlake/Kirstenhof wetland could be enhanced by diverting the channels to pass through the wetland rather than bypassing it. Similarly, it is proposed that the Sand River should be rehabilitated in the Coniston area.

[20] Being undertaken in 2017

Unfortunately, to date a lack of resources has meant that the majority of recommendations in the Catchment Management Plan have not been implemented. Potential sources of funding for this purpose need to be identified.

Prevention of pollution from industry and commerce: As indicated above, there is limited information on pollution from industry and commerce. An assessment of this source should therefore be undertaken. In parallel with the assessment, there should be a campaign in collaboration with the City's Water Pollution Control Inspectors to improve housekeeping practices by industries, restaurants, complexes etc. In addition, it is recommended that the Keyser's River Partnership be re-activated should external support to the City become available.

Stormwater: The City's policy on minimizing impacts of stormwater on receiving waters (prepared by the CSRM Branch) – based on the concepts of Water Sensitive Urban Design and Sustainable Urban Drainage Systems – was being implemented at the time of reporting. This included the development of structural and non-structural best management practices for stormwater – such as retention ponds, vegetated swales, infiltration basins, bioretention cells, education, stormwater master planning etc., which were proposed to be implemented at site or regional level as appropriate.

In addition, the flows and pollution load of all existing stormwater discharges into the estuary need to be quantified with a view to prioritizing those having the greatest impact.

5.5.1.4 Health warnings

Given the levels of *E.coli* in the estuary, it is recommended that permanent signs warning of the health risks are posted at appropriate locations.

5.5.2 Litter

Despite ongoing efforts, there are large volumes of litter entering the system. Illegal dumping of solid waste (garden refuse and building rubble) remains widespread but is particularly problematic in the middle reaches of the Diep and Keysers sub- catchments (Catchment Management Plan). To a large extent, this is a social problem, and while there have been a number of initiatives in the past with only limited success, the following actions are proposed:

- The Solid Waste Department should be contacted with regard the possibility of a mass action campaign on litter similar to that held a few years ago which did reduce litter for around 6 months; and
- The City's Informal Settlement Task Team should be approached to look at service requirements for areas of Council-owned land on which there are – or are likely to

be – large numbers of backyard dwellers who at present are not catered for in terms of refuse removal and sanitation services.

It is noted that the Solid Waste Department were contacted but negotiations proved unsuccessful (J Gericke, pers comm March 2017)

Figure 17: Accumulated litter in the Sand Canal just above the point of discharge into Zandvlei estuary (left): and a litter trap on the Sand Canal

5.5.3 Sediment quality

There is very limited information on toxic contaminants in Zandvlei estuary or the catchment, although elevated levels of copper and zinc were reported in the lower Keyser's River in 2002. Since such contaminants tend to accumulate in sediments and biota, a survey of the sediments and biota of the estuary was proposed in the 2010 EMP.

Dr. Newman of the CSIR's Coastal Systems Research Group subsequently initiated a City wide study on the environmental chemistry of sediments and the link to human and ecosystem health risks. It built on previous studies which had been undertaken in Richards Bay, Durban, East London and Saldanha. A pilot study had already been completed in the Black River/Milnerton Lagoon where relatively low levels of contaminants were found.

The study in Zandvlei estuary was initiated in January 2013. The sampling locations for Zandvlei include four in the estuary itself and another five in the incoming rivers. The contaminants included in the study included DDT, dioxins, organochlorines, organophosphates, PCBs, flame retardants and metals. The majority of these were considered to be a health risk because of their tendency to bioaccumulate, and many are carcinogenic. The reported outcome of this study was that the system was that no

additional management action was needed beyond an update at a later stage to confirm this trend (J Gericke, pers comm March 2017).

5.6 Pondweed Management

5.6.1 The harvesting protocol

The harvesting guidelines developed in 1999 by Southern Waters recommended a harvesting frequency of 12 times a year in the recreational areas. However, during the period that harvesting was undertaken by City Parks, harvesting was carried out seven times annually (twice in Summer, twice in Autumn, once in Winter and twice in Spring). This approach was generally regarded as having been successful for those periods when these targets were met (i.e. when the harvester was able to complete the required work). On this basis, harvesting was proposed to be conducted asfollows:

- All the areas to be harvested to meet recreational or ecological needs (see Figure 8 in Section 3.3.4) should be cut seven times. This harvesting should be implemented according to a reasonably strict rotational schedule which should be planned well in advance and should as far as possible take into account tides, dates scheduled for opening of the mouth, recreational events etc. It should be carefully monitored so as to be able to assess the effectiveness of this protocol and to provide a basis for any future adjustments;
- Stakeholders may apply for clearing of particular areas, but such applications need to be made as far in advance of particular events as possible to allow for inclusion in the schedule. Cutting should be carried out close to the required dates to ensure that no re-growth occurs;
- Twenty percent of the pondweed reserve should be harvested once during the course of each year. Such harvesting should be carefully monitored;
- The schedule should include a strict and extensive harvesting effort at the start of the senescence at the end of summer. It should be noted that such harvesting is aimed at bulk removal of nutrients from the system and the removal of cut material needs to be ensured;
- Clearing within 2 m from the banks should be limited to securing access to the central channel and must be undertaken by residents. Requests from residents to use the harvester to cut pondweed within this area should not be entertained; and
- Projects on the monitoring and assessment of pondweed harvesting and growth should be undertaken in collaboration with CPUT. Other data which may be useful includes:
    - Weekly photographic monitoring from selected vantage sites such as Boyes Drive;
    - The number of harvested loads by area within the system; and
    - An initial review of nest building activity by Coot and or Great Crested Grebe as an indicator, at the monthly MyBirdPatch and quarterly Co- ordinated Waterbird Annual

Census (CWAC) counts will provide some data as proxy for the presence of pondweed biomass.

It should be noted that:

- The harvesting of pondweed can act as an important nutrient sink. Pondweed senescence at the end of summer, dying back and releasing nutrients to the water column. It is important that timing of harvesting considers the growth of the pondweed biomass (and the resultant stripping of the water column of nutrients) and that the biomass is removed as solid plant matter before the senescence occurs; and
- This protocol takes a symptomatic approach and does not address the causal factors of the extensive pondweed growth (the elevated nutrient loads within the system arising from its location within an urban setting) which are addressed elsewhere.

5.6.2 Refinement of the Protocol

The monitoring programme should be aimed at providing the data required to refine this protocol, including, for example, the required frequency of harvesting. Given the inter-annual variation in pondweed growth, the monitoring should be carried out as a multi-year programme and needs to consider the senescence and release of nutrients back to the water column.

5.6.3 Challenges

5.6.3.1 Harvesting Capacity: Demand and Supply

Based on the map in Figure 8, approximately 61.5 ha of Zandvlei estuary (recreational areas including the Marina canals) need to be cut seven times per year. In addition, 20 % of the pondweed reserve area should be cut once a year. This means that a total of 436.1 ha need to be cut per year.

Assuming a cutting rate of 0.14 ha/hour (Southern Waters), this means that 3115 machine hours/year are required to complete the schedule. In addition, provision needs to be made for maintenance and downtime as a result of weather conditions and machine failure. Based on records, the average number of operational hours achieved by the harvesting machine per day was between five and six for periods when the machine was actually functional. However, these records also indicate a 20 % downtime. On this basis, and assuming a 5-day week, the current complement of one harvesting machine and a single driver/operator delivers less than half of the hours required to complete the schedule. Realistically then, the only option available to meet the required schedule is to:

- Make a second machine and driver available;

- Have a relief driver so that harvesting is not affected by driver illness and, when necessary, can be extended into weekends or after hours (should the weather be conducive); and
- Reduce downtime by improving maintenance and addressing other operational issues such as establishing a stock of critical spares.

5.6.3.2 Other operational issues

The following must also be addressed:

- A GPS should be installed on the machine to monitor the time and locations at which the harvester is operating;
- The possibility of utilising barges to transport cut material from the harvester to the shore should be investigated with a view to increasing the time available for cutting. Such barges should be designed to be able to collect floating rafts of cut weed when these occur;
- Proper provision must be made to ensure that harvested material is removed from the banks of the estuary on a timeous basis; and
- A robust framework for monitoring and analyses of the efficacy of the harvesting schedule needs to be in place.

5.7 Invasive species management

Section 76 (2) of the National Environmental Management: Biodiversity Act (2004) (NEM:BA) requires all organs of state in all spheres of government to prepare invasive species monitoring, control and eradication plans for land under their control. In addition, management authorities of protected areas must prepare management plans for protected areas in terms of the Protected Areas Act, which must include invasive species control and eradication strategies; and prepare and submit to the MEC reports on the status of listed species in the protected areas.

As the Management Authority for the ZENR, the CoCT is thus responsible for the development and implementation of an Invasive Species Management Plan for the reserve. Such a plan was developed during 2013 and includes an Action Plan covering the period 2017 – 2021. A summary of the proposed management actions is provided below, while the full plan is available from the Biodiversity Management Branch of the City of Cape Town.

5.7.1 Setting priorities

The strategy for Invasive Alien Species (IAS) Management within a Protected Area should be based on both priority species and priority areas (eg. areas with the greatest biodiversity value and/or high risk sites). Priorities for the ZENR were based on the following criteria:

- The conservation goals and values of the nature reserve;
- Impacts on biodiversity;
- The recreational value of the ZENR;
- Fire and associated risks;
- Flooding potential;
- Provision of cover for criminals;
- Status of species under NEMBA and/or CARA;
- Invasion potential; and
- The identified priorities and targets or objectives are set out in Section 3.3.6 of this plan, and the Ecological Specifications (Appendix 1).

5.7.2 Implementing the Plan

The primary responsibility for implementation of the plan lies with the Biodiversity Management Branch (BMB) of the City, including the Reserve staff and the Invasive Species Unit while SANBI and CapeNature will play a supportive role. However, the intention is also to involve local stakeholders and users of the estuary particularly in community monitoring programmes as well as education and awareness-raising.

5.7.3 Prevention

In addition to prohibiting the deliberate introduction of any alien species to the reserve, the following prevention measures are recommended:

5.7.3.1 Aquatic species:

- Clearing/control/eradication of the plant species present in the catchment;
- The establishment of a "boat cleaning station" at the Zandvlei Sports Club, with cleaning measures to be applied to all boats that have been used in other water bodies in the Western Cape (or beyond) which support populations of aquatic weeds;
- Cleaning of pondweed harvesters should they be transferred to Zandvlei estuary from other sites (or *vice versa*);
- Participation in a City-wide educational campaign in collaboration with the pet trade and nursery industries to raise awareness of the dangers of releasing alien aquarium plants or animals into local water bodies, or of using alien aquatic plants in private gardens; and
- Participation in a City-wide educational campaign targeting fishermen and encouraging them not to transfer fish from one water body to another.

5.7.3.2 *Terrestrial species*

- Machinery being brought in from other sites should be checked and cleaned if necessary;
- The transport or movement of alien plants following clearing in the reserve should be done in such a way as to prevent the dispersal of seeds;
- Visitor vehicle movement on the reserve should be limited as far as possible;
- Materials brought onto site should be inspected to see if they are weed-free; and
- Rehabilitation of disturbed sites.

5.7.4 Early Detection

Early detection is enhanced by the establishment of monitoring programmes – both active and passive. The following activities are recommended for Zandvlei estuary:

5.7.4.1 *Active Monitoring:*

There should be regular surveys of high risk sites and annual surveys of other areas. These could be done by:

- Reserve staff;
- Volunteers from NGO's or the environmental clubs through an "adopt a patch" programme; or
- A combination of the above.

5.7.4.2 *Passive Monitoring:*

A public outreach or communications programme should be implemented to encourage Zandvlei estuary user groups, members of NGO's such as Zandvlei Trust and local residents to join the "Spotter Network" being run by the ISU (www.capetowninvasives.org.za) or to advise the Reserve Manager if/when they detect suspected target species or other invaders both within the confines of the Reserve, or in surrounding areas.

5.7.4.3 *Target Species:*

The Early Detection/Rapid Response (EDRR) Division at SANBI has a list of target plant species for early detection which is updated annually. This should be merged with that of the Invasive Species Unit (ISU) and provided to the Reserve Manager for circulation the Forum and all stakeholders.

5.7.5 Eradication

The detection of a new invader – or one on either of the target lists – may lead to a proposal to try to eradicate it from the Reserve (or broader area, depending on the subsequent assessment). Any eradication programmes proposed for the Reserve should be planned

and implemented by the ISU in collaboration with the Reserve Manager, and in consultation with SANBI, CapeNature, etc. as appropriate.

5.7.6 Management and control

Ongoing management or control will need to be exercised for those species (alien and indigenous) that are already established invaders in the Reserve and surrounds and for which there is little or no chance of eradication. In such cases, the objective is to maintain them at levels which do not have a significant impact on the values of the Reserve. Emphasis should be placed on those species identified as priorities.

In addition to continuing with ongoing management of a number of aquatic and terrestrial plants species, some specific proposals include:

- The development of a management plan for the reedbeds;
- The development of a management plan for coral worm including a trial implementation during 2017;
- Implementation of the National Mallard Strategy;
- Investigation of options for eradication of alien fish in the Sand River catchment;
- Organisation of regular (possibly annual) fishing days/competitions targeting aliens both to reduce numbers and to raise awareness of the negative impacts of alien fish amongst the fishing fraternity. This would be done in collaboration with local fishing clubs/organisations; and
- Development of an "adopt-a-patch" programme aimed at providing hands-on-training and involving volunteers from the environmental clubs and user groups.

5.8 Biodiversity and conservation planning

Despite the fact that Zandvlei estuary is, and will have to remain a highly managed system because of the historical modifications to it, it is clearly still important from a biodiversity and conservation perspective – as is evidenced by the declaration of the ZENR in October, 2006, expanding it from the 22 ha Zandvlei Nature Reserve to some 204 ha. The reserve is a key node in the City's biodiversity network and needs to be protected and promoted, especially in the face of proposed future developments in the area.

The management interventions proposed here are intended to enhance knowledge and understanding of the biodiversity of the Nature Reserve, to maintain and restore its integrity as far as possible; and to promote sustainable use and enjoyment thereof.

5.8.1 The ZENR boundaries and corridors

In the past few years, some additional satellite areas (eg. Grysbok Park, Bath Road site and a site below Boyes Drive) have been included as part of the proposal for proclamation of the reserve under the NEM: Protected Areas Act (Act No. 57 of 2003)(NEM:PAA) signed off in July 2016 although this was still pending. In addition, Zandvlei Trust, in collaboration with the Reserve Manager have planted indigenous plants in the Capricorn Park and Muizenberg East area to create corridors of local indigenous flora linking Bokmakierie Park, Grysbok Park, the pavements leading into Muizenberg East and the coastal strip down to the False Bay Nature Reserve and beyond.

In the future, consideration should also be given to including:

- A buffer zone along the western boundary of the estuary (between the Sports Clubs/ recreational area and the estuary). This should be a linear strip of 5 – 10 m with nodal points; and
- The road reserves adjacent to Military Road which is managed by the Reserve staff but has not been officially proclaimed.

In identifying additional land to be incorporated into the reserve, particular attention should be given to building biodiversity corridors between the reserve and other protected and natural or semi-natural areas such as Table Mountain, the coast, Rondevlei, Princess Vlei, False Bay Nature Reserve and even Pollsmoor dam and the dams on the wine farms.

5.8.2 Biodiversity information – status and management

It is proposed that biodiversity information collection is improved and expanded, and that better use is made of existing data as follows:

- The CWAC data should be analysed to look at trends in relation to various environmental factors – possibly through a student project;
- CWAC counts should be improved in terms of geographic coverage of the estuary, and, if possible, by increasing the counts to monthly even if only for a year or two;
- Protocols for baseline and ongoing surveys of groups for which there is limited data should be acquired (eg. from CapeNature) or developed in consultation with experts and implemented through student projects; and
- A GIS map of the vegetation should be produced using aerial photos and the updated every four to five years.

In terms of managing the information, there are a number of relevant existing databases – in particular the Biodiversity database (www.biodiversity.org.za), the Animal Demography Unit (ADU) website (http://cwac.adu.org.za/) which houses the CWAC data, and the ZIMP database (Zandvlei Inventory and Monitoring Project) which is accessible through the Zandvlei Trust website (www.zandvleitrust.org.za). Each of these play different roles with the latter being more for public use, while the Biodiversity database has a more scientific role.

It is proposed that:

- All historical, current and future data be consolidated on the Biodiversity database;
- When the data is analysed the results should be put into a more accessible format and made available through the Zandvlei Trust website; and
- Links be established between the various websites.

Biological monitoring using indicator species should also be put in place, and a photographic record of changes to the reserve vegetation should be kept based on aerial photos (especially for historical changes) and fixed-point photography (cf. the MCA system). The recommended minimum requirements for long term monitoring, based on the Resource Directed Measures methodology, should be implemented. These are prescribed in Appendix 1.

5.8.3 Rehabilitation and restoration

A number of restoration/rehabilitation projects had either been completed or were underway in 2013, both in and around Zandvlei estuary, and in the catchment. Projects which were ongoing or to be initiated in the period covered by this plan include:

- Rehabilitation of an area in the northern section of Zandvlei (Norfolk Park side adjacent to the Steenberg Road Extension road reserve);
- Rehabilitation of the additional land included into the reserve as indicated in 5.8.1 above;
- Ongoing relocation of plants of particular interest from degraded areas outside of the reserve to conservation areas – as done, for example, on the Chevron site along the M5;
- Depending on the availability of appropriate material, the "shallowing" of selected areas along the edges of the lower estuary - especially where the banks are steep - to provide additional habitat for wading birds; and
- Rehabilitation (replanting with indigenous plants) of the area between the sports clubs and the mouth is being undertaken by the Roads Department.

There are also a number of rehabilitation proposals in the Catchment Management Plan, many of them aimed at decreasing erosion and/or improving water quality. Some of these have been mentioned earlier in this plan, but for full details, the Catchment Management Plan should be consulted.

5.8.4 Urban development and planning

There were two development proposals of significant concern to the area in 2013:

- There is a long-standing proposal to build a new link between the M4 and M5 which would link up with Steenberg Road (Steenberg Road Extension). This is on the Spatial

Development Framework (SDF) maps and is supposed to happen within five to ten years. If it goes ahead, it could have a major impact on the estuary. However, there is a possibility that it is no longer a priority given the increased emphasis on provision of public transport; and

- The road reserve for the proposed R300 Toll Road is south of blocks 12, 10, 25, 22 and north of blocks 48. 3, 2. It would run between Main Road Lakeside in the west to Prince George (M5) in the east and then extend east of Prince George through Rondevlei, FBEP and Mitchells Plain to connect to the existing R300. However, there are also indications that this is unlikely to go ahead.

A watching brief should be kept on these initiatives.

5.8.5 Conservation, recreation and ecotourism development

Zandvlei estuary has been used for recreational purposes since at least 1884, and is regarded as a regional recreational centre. During peak holiday periods there are some 2,000 and 3,000 visitors a day with popular activities include picnicking, braaiing, walking, boardsailing and fishing. It is also popular with residents for a variety of recreational uses as shown in the table below[21] . Turpie and Clark (2007) estimated the recreational value of the estuary as between R 1 – 5 million/year.

Table 5: Recreational Use of the Zandvlei (October 2010)

Activity	Club/Institute	Number of Users
Canoeists/Kayakers		
Peninsula Canoe Club	Peninsula Canoe Club	232
Peninsula Canoe Club affiliates:	UCT	16
	Varsity College	8
	Bishop's School	10
Regular visitors from other clubs		119
Residents independent of clubs	Marina Da Gama only	379
	Total	**762**
Other Water-based Activities		
Residents with Pedalos	Marina Da Gama only	166
Stand Up Paddlers		41
Yacht Club		27
Wind surfers	estimated	30
Kite boarders	estimated	25
Sea Scouts/Girl Guides		?
Anglers	(in boats)	?

[21] Information provided by Ommund Sivertsen.

Land-based Activities		
Runners (Park Island only)	estimated	45
Bird Watchers		?
Anglers		?
Walkers		?
Dog-Walkers		?
Children's playgrounds		?

In the past few years, there has been a significant effort to improve the visitor experience at Zandvlei estuary including upgrading of the buildings, establishment of an "entrance" area to the circular walk, the provision of markers on the paths etc.

Additional initiatives underway in 2013 included:

- The development of a map to be placed at the northern entrance to the Reserve;
- Interpretive signage;
- Information booklets and brochures;
- Development of a walking/biking trail linking the northern part of the reserve to the western bank, mouth and eastern bank as far as the caravan park – and possibly to Park Island in the longer term. This includes planting and rehabilitation and has already been initiated in collaboration with the Muizenberg & Lakeside Ratepayers Association; and
- The Caravan Park is being redeveloped by the City's Amenities Branch and includes planting and rehabilitation in consultation with the Reserve In the longer term it may also include the provision of facilities such as a restaurant and hiring of pedaloes and/or canoes[22].

As can be seen from the table above, very limited information is available on fishing. Despite this, concerns have been raised about the secondary impacts of fishing on the nature reserve, primarily as a result of poor fishing practices – for example, impacts on birds caused by abandoned hooks, fishing line etc. It is therefore proposed that a Code of Conduct for fishermen be introduced.

The recommended minimum requirements for long term monitoring, based on the Resource Directed Measures methodology, should be implemented. These are prescribed in Appendix 1, and have been amended to include monitoring human use activities.

[22] The Cities Amenities Branch is being dissolved and the Caravan Park will be incorporated into ZENR (J Gericke, pers comm., March 2017).

5.9 Education and awareness

Public awareness and understanding of the role and importance of estuaries and wetlands are crucial for the effective implementation of management programmes both in the Nature Reserve and in surrounding areas. This is particularly true in the case of Zandvlei estuary where there is both a high level of recreational use, and low-income residential areas in relatively close proximity to the reserve and especially to the rivers flowing into it.

At present there is a well-established environmental education programme run by the Reserve staff with support from Zandvlei Trust (ZT). Moreover, members of the community are also involved in a salinity monitoring programme. The proposed actions below are intended to build on these existinginitiatives.

5.9.1 Environmental education programme

The existing schools programme should be continued and expanded in collaboration with Zandvlei Trust to include additional schools, and to encourage regular visits and the establishment of environmental clubs to foster those with a real interest in the issues.

Zandvlei Trust developed a funding proposal for submission to the National Lottery Fund and has recently had an indication that at least part of the funds (R 890,000) requested will be forthcoming subject to agreement on some modifications to the details of the project.

Links should also be established with the development programme initiated by the canoeing club, as well as the scouts and sea cadet programmes as a way of widening the learner's experience of the estuary.

5.9.2 Community outreach programme

A community outreach programme should also be established to target the adults in those sections of the adjacent communities who currently have limited empathy with the estuary/nature reserve and its benefits. Approaches should be made through:

- Churches and women's organisations;
- Schools and sports clubs – by requesting opportunities to provide input at PTA and other meetings; and
- Presentations in the local library/ies.

Activities could include, for example, guided walks through the reserve, picnics for mothers and babies/toddlers, establishment of food gardens, as well as the more common environmental programmes such as recycling. The programme also needs to address the problem of people throwing material into the sewer system which results in blockages and overflows.

5.9.3 Community monitoring programmes

Members of the Zandvlei community are already actively involved in a salinity monitoring programme. This active interest should be expanded to encourage people that regularly go out on the water or visit parts of the Reserve to play role in the early detection of alien invasive species (see Section 5.7.4 for further details). This should be initiated through a presentation/s by someone from the City's Invasive Species Unit, or the Early Detection and Rapid Response Unit at SANBI and the distribution of pamphlets and posters to raise awareness and facilitate identification of priority species.

5.9.4 Communications materials

The information/messages should primarily be communicated by posters rather than pamphlets and flyers which are costly and are often just discarded. Posters should be put up in a number of different areas such as:

- All-weather boards in the recreational areas on the west bank and on Park Island;
- Notice boards at the Zandvlei Sports Club, libraries, shopping centres (eg. on the Zandvlei Trust notice board at Woolworths, the Shoprite in Military Road, and the Pick 'n Pay in Capricorn Park);
- Provision has already been made for a number of new notice boards which will show the new boundaries of the reserve and provide general information on biodiversity. These should also be used to display the zonation map once complete as well as information on threats to biodiversity and health – such as pollution, invasive species and litter; and
- Articles should also be provided to the local newspapers and newsletters as well as to local organisations that could post them onto their websites (eg. Zandvlei Trust, the Marina da Gama Association, the Imperial Yacht Club etc.).

5.9.5 Funding

As mentioned above, Zandvlei submitted a funding proposal to the National Lottery Board. Part of this was approved (R 890,000) and supported some of the proposed activities.

Other potential sources of funding include the City (through the CTEET), Public Works Programme and the private sector – for example, companies distributing products with high volumes of packaging that contribute significantly to litter. While funding for projects can be accessed, sustained budget for long term maintenance in the reserve is harder to access.

6 MANAGEMENT PRIORITIES

6.1 Priority Issues

The Situation Assessment Report highlighted significant problems in Zandvlei estuary, with the following being identified as priorities:

- Mouth conditions, water level management and salinity;
- Water quality;
- Pondweed management;
- Invasive species;
- Balancing recreation and conservation;
- Coordinated and cost-effective monitoring programme; and
- Environmental education.

While there has been considerable progress in addressing these issues over the first few years of implementation of the first generation EMP (2011 – 2013) - amongst others putting more effective management systems in place - they remain as key priorities. Additional, more specific priorities which have emerged include:

- the increasing sedimentation above the weir;
- coral worm; and
- law enforcement.

With the exception of law enforcement, the proposed management actions for the next period (2017 – 2021) are outlined in Section 5 but are also are captured in the tables below and/or the supplementary plans which can be found in the Annexes. These also provide a tentative time-frame and, where they are not covered by existing budgets, anticipated costs.

It should, however, be noted that many of the impacts on Zandvlei estuary are a result of activities in the catchment. Relevant remedial actions are detailed in the Sand River Catchment Management Plan (2003), and for the most part are not repeated here, although they are crucial to the effective management of the estuary. Thus, although it is not included in the list of priorities below, the implementation of the Catchment Management Plan should be regarded as a priority, and it is of concern that to date relatively few of the proposals have been implemented because of a lack of funding.

6.2 Law Enforcement

Problems with law enforcement are an ongoing issue at the Reserve both with regard to compliance with environmental/marine resources-related legislation, and general security issues. The latter include the use of the cover provided by the reserve for a variety of criminal activities and need to be addressed in collaboration with the SAPS.

Some of the key environmental compliance issues along the 320 km's of coastline which falls within the City include:

- Little or no control at marine access points (slipways – a City responsibility);
- High levels of poaching and illegal resource extraction;
- High levels of illegal coastal activity (e.g 4X4 beach driving);
- Little coastal inshore "visible policing" presence by enforcement agencies;
- Multiple law enforcement agencies working independently (staff, resource and budget constraints);
- Conflict between users not managed or controlled effectively;
- Public loss of confidence in all agencies; and
- Many coastal locations have become unsafe areas for members of the public, with little or no compliance with laws, regulations or City by-laws.

Concerns around compliance with environmental/marine resources legislation came to a head at Zandvlei estuary during the Golden Alga bloom in March/April 2013, when a large number of fish were trapped in the Narrows and were illegally targeted by fishermen. Since then, there has been considerable progress in addressing this issue with the establishment of a Marine and Environmental Law Enforcement Unit within the City in December 2012.

The establishment of the Unit is part of "*an integrated coastal and marine law enforcement and compliance strategy to streamline a coordinated approach to coastal law enforcement in the City*". This is based on a coordinated approach including all responsible City departments and external agencies with a coastal law enforcement mandate – noting that Marine Law Enforcement is not a Municipal function. To this end, the City has been involved in the establishment of:

- A Coastal Compliance and Law Enforcement Task Team comprising, in addition to the City, DAFF, DEA, SAMSA, SANParks, SAPS, SARS (Customs) and CapeNature; and
- A City Marine and Environmental Law Enforcement Unit.

The Marine and Coastal Unit has conducted a number of successful operations in the Zandvlei area recently and should be the contact point for any compliance issues.

6.3 Priority actions: 2017 – 2021

Table 6: Management actions for mouth conditions, water levels, salinity & sedimentation

Actions	Date	Responsibility	Estimated Budget	Indicator
Priority A: Reduction of sedimentation at the mouth				
1. Maintain present weir level at 0.4m a.m.s.l.	Done	TCT Planning Department - Stormwater and Sustainability Branch District Manager: TCT – Asset Management and Maintenance (District 8)	Existing Asset TCT Planning Department - Stormwater and Sustainability Branch	Weir maintained at 0.4 m a.m.s.l
2. Dredging of sediment plume upstream of weir to commence and complete.	May 2015 – June 2020	TCT Planning Department - Stormwater and Sustainability Branch	Existing Asset TCT Planning Department - Stormwater and Sustainability Branch	Dredging completed as per the DEAD& P maintenance plan authorization.
3. Compile record of previous dredging activities in Zandvlei	June 2015	TCT Asset Management and Maintenance Department (District Manager)	No budget required	Record of dredging available as a hard copy and on Biodiversity Database.
4. Select a longer-term sustainable solution(s) for mouth management	June 2020	Managers: BMB, TCT Planning Department - Stormwater and Sustainability Branch & Water & Sanitation	Estimated budget for the EIA is R 450,000	Agreement on a longer term, sustainable solution for managing the mouth conditions at Zandvlei
5. Maintain and implement mouth management schedule as per authorization	Continuous	Managers: BMB, TCT Planning Department - Stormwater and Sustainability Branch & Water & Sanitation	Existing Asset TCT Planning Department - Stormwater and Sustainability Branch	Mouth management schedule maintained and implemented as per the authorization

Actions	Date	Responsibility	Estimated Budget	Indicator
Priority B: Increase recruitment of biota into the estuary				
1. Increase the number of days of open mouth conditions between August & November within the constraints of inflow & weather.	June 2015 Ongoing	BMB & TCT Planning Department - Stormwater and Sustainability Branch	Existing TCT Planning Department - Stormwater and Sustainability Branch budget	Increase number of days that the mouth is opened as reflected against the site on the Biodiversity Database.
Priority C: Re-establishment of seasonal water level fluctuations on the central pans				
1. Development and implementation of a protocol for management of the centre pan weir and water levels.	July 2015 – June 2020	Reserve Manager with input from Zandvlei Trust & Animal Demography Unit.	Existing BMB budget	Weir opened and closed as per protocol as reflected on the site Biodiversity database calendar.
Priority D : Monitoring of water levels, salinities, fish populations, etc.				
1. Monitoring of water levels with recorder at Thesen's Bridge.	Ongoing July 2015 – June 2020	Manager: TCT Planning Department - Stormwater and Sustainability Branch	Existing TCT Planning Department - Stormwater and Sustainability Branch budget	Water level records available with TCT Planning Department - Stormwater and Sustainability Branch
2. Accurate records to be kept of mouth opening & closing	Ongoing July 2015 – June 2020	Manager: TCT Planning Department - Stormwater and Sustainability Branch	Existing TCT Planning Department - Stormwater and Sustainability Branch budget	The number of days that the mouth is opened is reflected against the site on the Biodiversity Database.
3. Monitoring of sandbar/plume above the weir	Ongoing July 2015 – June 2020	Manager: TCT Planning Department - Stormwater and Sustainability Branch	Existing TCT Planning Department - Stormwater and Sustainability Branch budget	Information on size/migration etc of sandbar available through regular (e.g. 6 monthly) bathymetric surveys
4.Monitoring of salinity as part of City's water quality monitoring and community volunteer monitoring programme	Ongoing July 2015 – June 2020	Manager: TCT Planning Department - Stormwater and Sustainability Branch	Existing TCT Planning Department - Stormwater and Sustainability Branch budget	Salinity records available Existing TCT Planning Department - Stormwater and Sustainability Branch budget

Actions	Date	Responsibility	Estimated Budget	Indicator
5. Continuous salinity monitoring programme using 2 probes located upstream of mouth and near yacht club	Ongoing July 2015 – June 2020	DEA: Oceans and Coasts (Alan Boyd)	DEA budget	Salinity records available from DEA: Oceans & Coasts.
6. Development of an MoU between the City (BMB) and DAFF on fish surveys OR purchase of nets so that Reserve Manager can undertake surveys	July 2015	Reserve Manager/DAFF	No additional costs for MoU Estimated R 45,000 for new nets	Fish surveys completed on a regular basis and data available for analysis
7. Basic annual surveys of Callianassa to be undertaken by Reserve staff.	Ongoing July 2015 – June 2020	Reserve Manager	Existing BMB budget	Callianassa surveys completed on a regular basis according to protocol and information available on Biodiversity database.
8. GIS map of vegetation to be updated every 5 years.	2015	Reserve Manager	Existing BMB budget	Up-to-date vegetation map available on Biodiversity Database.

Table 7: Management actions for water quality management

Actions	Date	Responsibility	Estimated Budget	Indicator
Priority E : Water quality monitoring				
1. Monthly monitoring of bacteriology, nutrients, phytoplankton etc at 9 stations in Zandvlei, Westlake Wetland & Marina	Ongoing July 2015 – June 2020	Manager: TCT Planning Department - Stormwater and Sustainability Branch	Existing TCT Planning Department - Stormwater and Sustainability Branch budget	Comprehensive data available on water quality status. Annual report is submitted to the Sand Catchment Forum and can be forwarded to the Zandvlei Protected Area Advisory Committee.
Priority F : Assessment & reduction of pollution from sources in the catchment				
1.Assessment of nutrient loading from various sources	2015?	TCT Planning Department - Stormwater and Sustainability Branch	Existing TCT Planning Department - Stormwater and Sustainability Branch BMB budget or external (WRC)	Improved understanding of nutrient loading through graphic representations on a map.
Priority G : Reduction of pollution from stormwater discharges to the estuary				
1. Application of the City's Management of Urban Stormwater Impacts Policy in the evaluation of development applications in the entire Zandvlei catchment area.	Ongoing July 2015 – June 2020	Manager: TCT Planning Department - Stormwater and Sustainability Branch	N/A	Developments within the action manage their stormwater in terms of the Policy objectives.
Priority H: Reduction of pollution from accidental spills				
1. Implementation of the Contingency Plan including procedures for incident reporting, ad hoc monitoring etc.	Ongoing July 2015 – June 2020	Managers: BMB, TCT Planning Department - Stormwater and Sustainability Branch, Water and Sanitation Services, Disaster Management Lead agency BMB	Ad hoc allocations from relevant budgets	Annual report from BMB to Zandvlei Protected Areas Advisory Committee showing number of spills, duration and response.

Actions	Date	Responsibility	Estimated Budget	Indicator
Priority I : Health warnings				
1. Temporary signs warning against swimming in the estuary to be erected if necessary.	Ongoing July 2015 – June 2020	Manager: Environmental Health	Existing EH budget	Temporary sign boards erected and removed when necessary. BMB and Zandvlei Protected Area Advisory Committee informed if signs are erected.
Priority J : Improved understanding of environmental quality in the estuary				
1. Survey of toxic contaminants in the sediments.	2015	CSIR	External budget	Report on the levels of toxic contaminants in the sediments of the estuary.
2. Hydrological, mouth management, estuarine circulation and bathymetric survey.	Ongoing July 2015 – June 2020	Reserve Manager	Existing EH budget	Improved understanding of the estuary.

Table 8: Management actions for pondweed management

Actions	Date	Responsibility	Estimated Budget	Indicator
Priority K: Effective pondweed harvesting				
1. Implementation of the Pondweed Harvesting Protocol – see Annex 2	Ongoing July 2015 – June 2020	Reserve Manager	Existing BMB budget	Pond weed cut as per protocol. Healthy pondweed reserve. Pondweed not preventing water movement at identified spots.
2. Advance planning of harvesting schedule taking account of tides, scheduled breaching's, recreational events, weed harvester	Annual/ ongoing July 2015 – June	Reserve Manager	Existing BMB budget	Pondweed is cut as per harvesting schedule.
3. Timely removal of harvested material from banks	Ongoing July 2015 – June 2020	Reserve Manager	Existing BMB budget	Reduction in accumulation of decaying pondweed on the banks. Note: this indicator can only be achieved with the acquisition of suitable equipment ie. a grab truck and driver.
Priority L: To improve understanding of pondweed dynamics				
Accurate records to be kept of pondweed harvested (volumes, location, season etc.).	Ongoing	Reserve Manager	Existing BMB budget	Availability of information on pondweed dynamics to improve effectiveness of harvesting
Priority M: Sufficient capacity available to manage pondweed effectively				
1. Second machine & driver should be made available (by transfer from City Parks or acquisition of a new machine).	Summer 2017	Manager: BMB	A new machine is estimated at around R2.5 million.	Effective manage of pondweed
2. Logistical issues addressed (spare parts, training of operators, working conditions, maintenance programme etc.)	2017 ongoing	Reserve Manager in collaboration with Fleet Management	Existing budgets	Reduction in work days lost as a result of downtime of harvester, operators off etc.

Table 9: Management actions for invasive alien species management

Actions	Date	Responsibility	Estimated	Indicator
Priority N: Integration of IAS management both within the reserve and with external initiatives				
1. Implementation of IAS Management Plan for the ZENR – see Annex 2.	2017 ongoing	Reserve Manager & Invasive Species Unit (ISU)	Existing BMB budget & allocations from DEA: EP	Priority areas cleared High Risk sites effectively monitored Management plans in place for priority species
Priority O: Prevention of introductions of new alien species into Zandvlei				
2. Establish protocols for the cleaning of vehicles, machinery & equipment & inspection of materials before being brought on site	2017	Reserve Manager	Existing BMB budget	Reduction in new/repeat introductions
3. Educational campaign/s on various aspects of the IAS issue	2015 to 2020	Reserve Manager, Invasive Species Unit, Environmental Education Officer	Existing BMB budget	Increased awareness of the risk posed by invasive alien species. Numbers of learners reached/educated.
Priority P: Early detection of emergent species in Zandvlei				
1. Seminar/presentations to various stakeholders & user groups to secure participation in monitoring	2015 to 2020	Invasive Species Units and/or EDRR Unit of SANBI	No additional costs	Awareness-raising & identification of potential volunteers for monitoring
2. Establishment of a volunteer network for early detection in Zandvlei estuary	2015 to 2020	Invasive Species Units and/or EDRR Unit of SANBI	No additional costs	Early detection of priority emerging species.
3. Regular surveys of high risk sites	2015 to 2020	Reserve Manager	No additional costs	Early detection of priority alien species.
Priority Q: Management of priority species				
1. Ongoing management of aquatic weeds & woody species	Ongoing July 2015 – June 2020	Invasive Species Unit, Reserve Manager, TCT Planning Department - Stormwater and Sustainability Branch, Zandvlei Trust	Existing City budgets Grant from PenBev to Zandvlei Trust	Aquatic weeds reduced to 5% cover. Woody species in maintenance.
2. Development of reed section in invasive flora subsidiary plan	2016	Reserve Manager	Existing BMB budget	Plan adopted and implemented as far as possible

Actions	Date	Responsibility	Estimated	Indicator
3. Development of coral worm section in invasive fauna subsidiary plan	2016	Reserve Manager	Existing BMB budget	Plan adopted and implemented
4. Development on alien fish section in invasive fauna management plan	2016	Reserve Manager	Existing BMB budget	Management plan in place
5.Implementation of National Strategy on Mallards	Ongoing July 2015 – June 2020	Reserve Manager and ISU	Existing ISU and reserve budget	Mallard population reduced to zero.

Table 10: Management actions for biodiversity, conservation and planning

Actions	Date	Responsibility	Estimated Budget	Indicator
Priority R: Further expansion of reserve to improve buffers and linkages.				
1. Compile reserve expansion plan (subsidiary to management plan) and implement where possible	2016	Manager: BMB	No additional costs	Reserve expansion plan compiled and implemented
Priority S: Improve and expand biodiversity information				
1. Analysis of existing CWAC data in relation to environmental factors	2014 - 2015	ADU	ADU budget	Information on trends in wading birds available.
2. The GIS map of vegetation done in 2011 to be updated every 5 years, with the management plan.	Ongoing July 2015 – June 2020	Reserve Manager	GIS vegetation map is up to date and available	
3. Establish links between Biodiversity database, ADU/CWAC site and Zandvlei Trust website.	Ongoing July 2015 – June	Reserve and regional managers	N/A	User friendly hotlinks present
Priority T : Restoration/rehabilitation of sites within the ZENR				
1. Rehabilitate any land incorporated into the Reserve	Ongoing July 2015 – June	Reserve Manager	Existing BMB budget	Rehabilitation complete
2. Rehabilitation of channels in Westlake Wetlands	June 2020	Reserve Manager	Existing BMB budget	Rehabilitation complete
3. "Shallowing"/ rehabilitation of selected areas on banks of lower estuary	2015/2016	Reserve Manager	Existing BMB budget	Rehabilitation complete Additional bank habitat for wading birds
Priority U: Promote sustainable use of Zandvlei estuary &adjacent areas				
1. Development of internal rules for fishermen in terms of NEMPAA	2015 to 2016	Reserve Manager in collaboration with fishing clubs	Existing BMB budget	Rules developed and communicated by signage
2.Development of walking/biking trail linking northern part of Reserve with west & east banks	2015 to 2020	Reserve Manager in collaboration with MLRRA	Funds raised by MLRA	Enhanced visitor facilities available
3.Provision of maps, interpretive signage, information booklets etc	2015	Reserve Manager	Existing BMB budget	Relevant booklets and maps are available at trail and park island entrance huts

Table 11: Management actions for education, awareness-raising and communications

Actions	Date	Responsibility	Estimated Budget	Indicator
Priority V : To expand the environmental education and outreach programme				
1. Identify additional schools interested in regular environmental education programmes.	2017/2018	Reserve Manager & Education Officer & ZT & WESSA	In addition to existing BMB budget, Zandvlei Trust provisionally been allocated Lottery Funds of R890, 000	8 schools visiting Zandvlei estuary on at least an annual basis
2. Foster interested learners through environmental clubs	2017/2018	Reserve Manager & Education Officer		5 environmental clubs active on a weekly basis
3. Establish partnership with the Zandvlei Canoeing Club's development programme to broaden the learner's experience	2017/2018	Reserve Manager & Education Officer & Zandvlei Canoeing Club		A number of members of environmental clubs participating in the canoeing development programme, Sea Cadets etc.
4. Establish an adult outreach programme by offering guided walks in the Reserve to churches groups, women's organizations, schools (PTA), sports clubs etc.	2017/2018	Reserve Manager & Education Officer		Increased appreciation of Zandvlei estuary as a resource by members of local communities.
Priority W: Improved communications on matters related to the reserve				
1. All-weather boards erected in various areas (west bank, Park Island etc.)	2017	Reserve Manager	Existing BMB budget	Strategically located notice boards in place
2. Erection of notice-boards in clubs, libraries, shopping centres etc.	2017	Reserve Manager, Zandvlei Trust	Existing BMB budget	Strategically located notice boards in place
3. Relevant materials available for posting on notice-boards	2017 ongoing	Reserve Manager, ISU, EDRR (SANBI), Zandvlei Trust	Existing BMB budget	Material available and on display covering various topics (Zonation map, EMP, pollution, litter, invasive species etc.).
4. Articles provided to local newspapers, newsletters, websites etc.	2017 ongoing	Reserve Manager	No additional costs	Regular articles published.

7 IMPLEMENTATION

7.1 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 has already been identified as the keystone to the efficient and effective management of the Zandvlei system. Figure 18 displays the key role players that should be included in the management thereof.

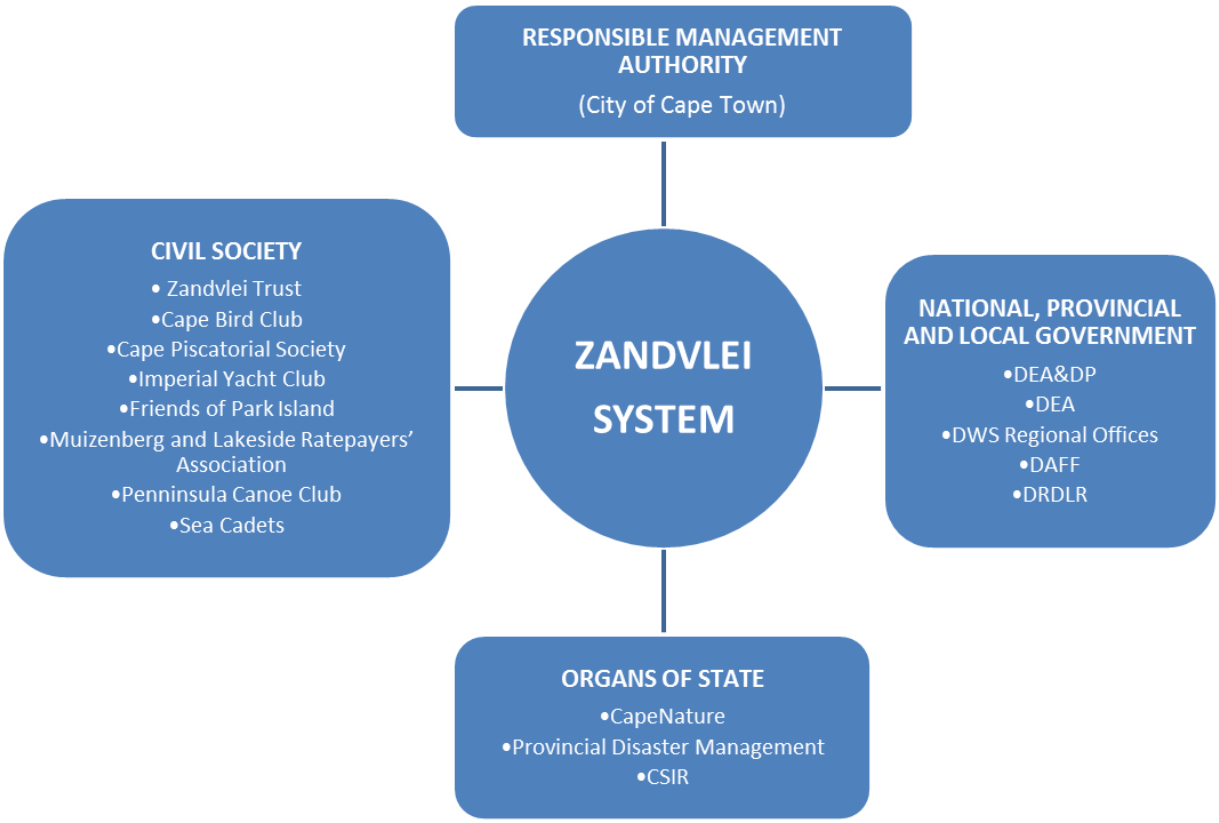

Figure 18: Key role players for the management of the Zandvlei estuarine system

7.1.1 Responsible Management Authority

The Protocol identifies the **COCT**, as the **Responsible Management Authority (RMA)**, responsible for the development of the Zandvlei EMP as well as being responsible for the co-ordination of its implementation. This function can be affected through a range of different forums and agencies.

Given the number of estuaries within the COCT, it is strongly recommended that an Estuarine Management Co-ordinator be appointed within the municipality to administer estuary-related matters at the local level. The RMA should hold the responsibility of chairing and facilitating the Estuary Advisory Forum meetings.

7.1.2 Zandvlei Estuary Advisory Forum

The Zandvlei Estuary Management Forum (now termed Estuary Advisory Forum (ZEAF) in line with the Protocol) was first convened early in 2012 under the first generation EMP and plays an advisory and oversight role with respect to the implementation of the EMP. While the Protocol does not specifically make provision for forums, it does recognize their valuable role in estuarine management in respect to cooperative governance, and thus it is strongly recommended that the RMA considers the continuation of any existing estuary forum. Given that the City's intention is to declare Zandvlei as a nature reserve under the NEM: Protected Areas Act – which does makes specific provision for the establishment of an Advisory Committee, it is recommended that once the proclamation has been made, ZEAF is transformed into such an Advisory Committee (to be chaired by the RMA). This will give it stronger legal basis.

Since its inception, ZEAF has met on ten occasions during 2012/2013, but will meet on a quarterly basis in future. The responsibility of the ZEAF is largely facilitating the implementation of the action plans and fostering stakeholder engagement. Moreover, the ZEAF is interpreted as being the hub, which links the broader community, including all stakeholders associated with the vlei, such as Ratepayers' Associations, surrounding industry, NGO's, community groups, and conservancies, etc. The principle functions of the ZEAF may include:

- Fostering stakeholder involvement;
- Promote 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;

- Promoting environmental awareness and capacity building with regard to estuarine issues;
- Keeping record of all forum meetings, decisions, and correspondence.

In addition, a number of Technical Working Groups were initially established (Figure 19) to provide more specific guidance to the implementation of relevant aspects of the plan. While the Protocol does not specify the formation of such groups, they may continue to meet on an *ad hoc* basis as required.

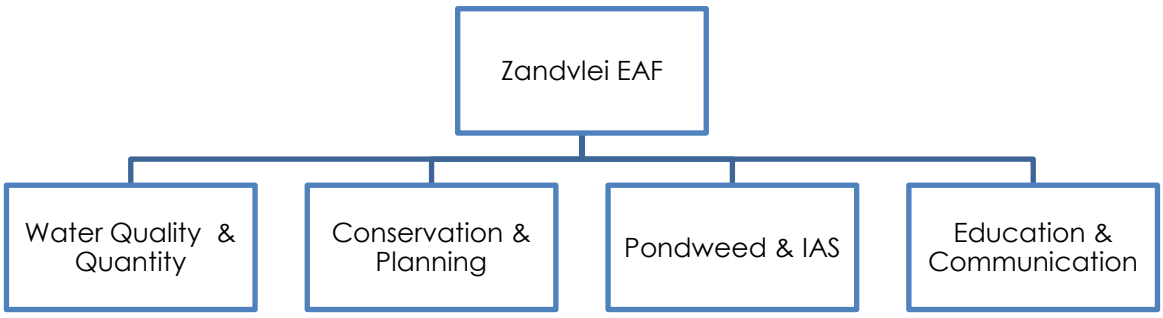

Figure 19: Technical Working Groups initially established under the initial Zandvlei Estuary Forum

7.1.3 Government Departments and Organs of State

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

- **City of Cape Town departments:** Responsible for fulfilling key municipal roles as well as the provision of management, technical and legislative support, and funding;
- **Western Cape Government departments**: Responsible for legislative support, including compliance, funding, research and monitoring, as well as education and awareness;
- **Relevant National Government departments,** especially Environmental Affairs, Water Affairs (via the regional office), Agriculture, Forestry & Fisheries, Rural Development and Land Reform; and
- **Organs of State,** such as the CSIR, who undertake research and regional monitoring programmes.

The National Department of Environmental Affairs is generally responsible for national standardisation of estuarine management and approval of provincially-led estuarine management plans. Direct involvement in individual estuaries, such as the Zandvlei, will occur via existing forums for intergovernmental coordination, such as the **Western Cape**

Provincial Coastal Committee, who will have the management of the various estuarine systems on their agenda from time to time.

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. Alternatively, department may fund other entities to undertake their necessary functions on their behalf.

7.2 Resource Capacity & Requirements

7.2.1 Finances

The majority of the activities listed in this plan are already part of the responsibilities of existing staff in the relevant departments or branches of the City. As such they are covered by existing budgets. These include:

- Pondweed Management - Reserve Staff: Biodiversity Management Branch
- Invasive Species Management – Invasive Species Unit (ISU -BMB) has an internal budget as well as a significant annual contribution from DEA: EP;
- The mouth management and water quality monitoring programmes which are implemented and funded by the Catchment, Stormwater and River Management Division of the City.

In addition, DEA: O&C is already funding a continuous salinity monitoring study; CSIR has funds for a survey of toxic contaminants in the sediments (Zandvlei being part of a City-wide programme); and SANBI has made funds available to IOI-SA for the development and trial implementation of a coral worm management plan. Zandvlei Trust has secured external funds for certain invasive species activities as well as an Eco-Camp programme, and the MLRRA is contributing funds for the development of the biking/walking trail.

However, there are also a number of new activities which have been proposed and for which funding has not yet been secured. Those which fall within the City's mandate should be motivated for in future budgets. These include:

- The proposed maintenance dredging of the channel (initially R 1 million);
- An Environmental Impact Assessment to look at long-term solutions for managing the mouth (estimated R 450,000 – which could be shared amongst the relevant departments);
- The purchase of trek nets (estimated R 45,000);

- The purchase of a new pondweed harvester (R 2.5 million) – although in this case it is noted that this was motivated for in a previous budget and was not approved. The alternative option – the transfer of an under-utilised machine from City Parks – is therefore preferred.

There are also a number of proposed studies – for example, the hydrology and geohydrology of the estuary, and an assessment of nutrient loading. In these cases, it is recommended that external sources of funding be sought – for example, from the Water Research Commission. The Biodiversity Management Branch should take the lead in such initiatives.

7.2.2 Nature Reserve Staff & Facilities

Permanent staff at the Nature Reserve include the Reserve Manager, an Environmental Education Officer, the operator of the pondweed harvester, a Foreman and a Field Ranger. This would be insufficient to cope with existing work, let alone the additional work which will be required for successful implementation of the EMP.

However, these numbers have been boosted at least on a temporary basis by the appointment/secondment of:

- An Assistant Manager
- 2 River Wardens;
- 7 Extended Public Works Programme (EPWP) employees (with 3 month rolling contracts depending on availability of funding); and
- 4 Security Rangers who work in shifts with 2 on duty at any particular time.

Moreover, some of the tasks are the responsibility of other Departments both within and outside of the City. For example, management of the mouth and water quality are the responsibility of the Catchment, Stormwater and River Management Branch, while DAFF undertakes regular fish surveys.

In addition, part of the work on invasive species is undertaken by contractors appointed by the City's Invasive Species Unit, while a number of NGO's assist, for example, with invasive plant hacks. Zandvlei Trust also provides significant support to the Environmental Education programme.

Nevertheless, other options for boosting the human resource capacity should continue to be investigated. These include raising funds and appointing staff in partnership with relevant NGO's and other organizations.

8 REVIEW AND EVALUATION

The Situation Assessment Report which preceded the development of this Estuarine Management Plan should be regarded as the first of 5-yearly evaluations in an ongoing cycle of planning for the management of the Zandvlei Estuary as shown in Figure 20 below (DEA, 2015).

Evaluations of the EMP will become the responsibility of the RMA (CoCT), supported by the ZEAF, 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.

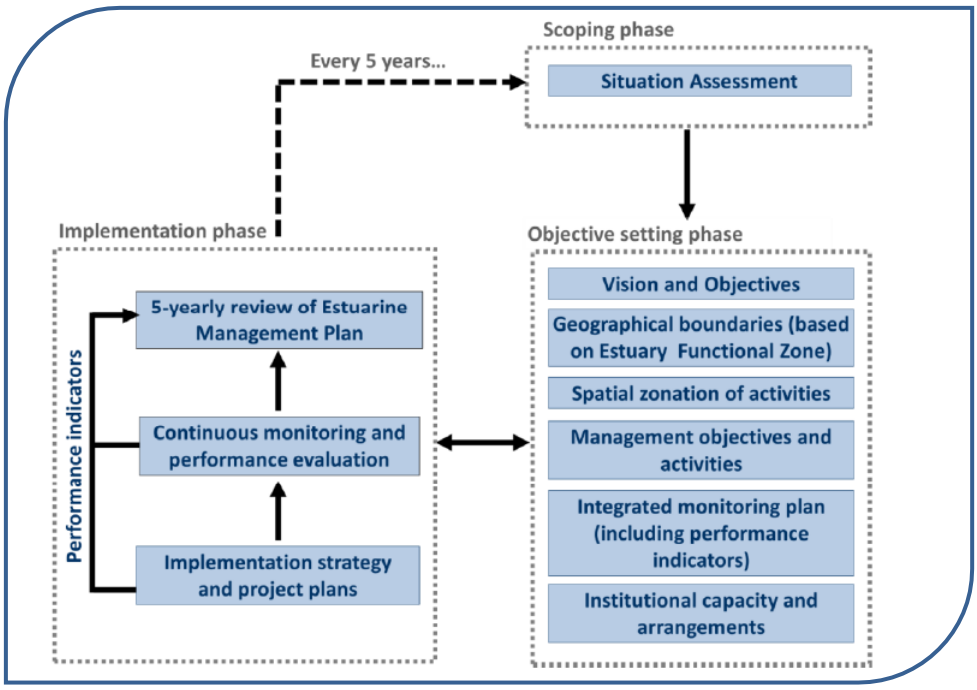

Figure 20: A framework for integrated estuarine management in South Africa

In a situation where these targets have not been achieved, the RMA and ZEAF 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.

However, particularly in the initial 5-year period, it is recommended that progress on the implementation of the EMP is audited on a more regular basis as follows:

- There should be quarterly meetings of the ZEAF with the minutes of these meetings being made available to an appropriate oversight body within the City, CapeNature, the Provincial Coastal Committee, and other relevant bodies.
- There should be annual report backs to an open Public Meeting on progress in terms of implementation of the EMP and management actions.

The initial update of the EMP was made on the basis of a mid-term "mini-audit" of progress in the implementation, which was accompanied by revisions and/or refinements to the EMP and the action plans. The current revision was undertaken to bring the EMP in alignment with the Protocol. Thus, a more thorough audit is therefore still required.

9 RECOMMENDATIONS

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

- Given the number of estuaries within the CofCT municipal area, it is strongly recommended that an Estuarine Management Co-ordinator be appointed within the municipality to administer estuary-related matters at the local level.
- During the review of this document, an action proposed was for the CofCT to review its maintenance management plan taking consideration and guidance from this updated Zandvlei EMP as well as both the CSIR mouth management plan template and any future EMFIS templates.

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See separate documents:

1. Contingency Plan
2. Invasive Species Management Plan (including Pond weed harvesting)

11 APPENDICES

11.1 Appendix 1: Ecological Specifications

Table 12: EcoSpecs and Thresholds of Potential Concern for the Zandvlei estuary (Category D)

Component	Ecological Specification	Threshold of Potential Concern
Invertebrates	A or BAS = D, current category. The estuary should maintain its population of *Callichirus kraussi* in the lower reaches and main basin in its current condition. In addition, the number of invertebrate species associated with soft sediment should not decrease below 10 species. At least three marine invertebrate species present near the mouth.	Loss of *Callichirus kraussi* populations from lower reaches and main basin. Less than 8 estuarine invertebrate species found utilizing the soft sediment in the main basin. Less than 2 marine dependant species present at the mouth.
Fish	Fish assemblage should include at least 5 estuarine breeding species (Category I) and 10 estuary dependent or associated marine species (Category II) Estuarine residents, estuary dependent marine species and marine vagrants (Category III) should all be present in the fish community and the relative abundance of estuary residents and estuary associated marine species may fluctuate but should not fall below 10% for either category.	Proportion of either estuary residents or estuary dependent marine species drops below 10 % numerically. Decrease in average diversity of indigenous fish species to < 15. Increase in proportion of alien freshwater species in the estuary (the alien sharptooth catfish are currently increasing in abundance).
Birds	The estuary should contain an avifaunal community that includes representatives of all original groups. A healthy population of migratory waders, a healthy breeding population of resident waders, a healthy and diverse population of wading birds and waterfowl should be present. The estuary should support thousands of birds in summer and in winter.	Numbers of bird species drop below 20 for three consecutive months.

11.2 Appendix 2: Recommended Resource Monitoring Plan

The following table provides a list of recommended abiotic and biotic parameters that should be monitored for the Zandvlei estuary as provided by the Reserve Determination Study (DWS, 2017). Priorities are highlighted in red. Additional recommendations have been included for monitoring estuarine usage.

ECOLOGICAL COMPONENT	MONITORING ACTION	TEMPORAL SCALE (FREQUENCY AND WHEN)	SPATIAL SCALE (NO. STATIONS)
Hydrodynamics	Record water levels	Continuous	At bridge
	Measure freshwater inflow into the estuary	Continuous	At Kraaibosch dam and Boesmans above the estuary
	Aerial photographs of estuary (spring low tide)	Every 3 years	Entire estuary
Sediment dynamics	Bathymetric surveys: Series of cross-section profiles and a longitudinal profile collected at fixed 500 m intervals, but in more detailed in the mouth (every 100m). The vertical accuracy should be about 5 cm.	Every 3 years	Entire estuary
	Set sediment grab samples (at cross section profiles) for analysis of particle size distribution (PSD) and origin (i.e. using microscopic observations)	Every 3 years (with invert sampling)	Entire estuary
Water quality	Collect data on conductivity, temperature, suspended matter/turbidity, dissolved oxygen, pH, inorganic nutrients and organic content in river inflow	Monthly continuous	At river inflow
	Assess and better quantify wastewater input (e.g. nutrients and organics) from diffuse sources (e.g. caravan park, WWTW).	Once-off detailed Possibly long-term (e.g. peak seasons) if input remains significant (preferably these should be mitigated)	In stream (source/s)

	Record longitudinal salinity and temperature profiles (and any other in situ measurements possible e.g. pH, DO, turbidity)	Seasonally, every year	Entire estuary (10 stns)
	Take water quality measurements along the length of the estuary (surface and bottom samples) for system variable (pH, dissolved oxygen, suspended solids/turbidity) and inorganic nutrients in addition to the longitudinal salinity and temperature profiles	Seasonal surveys, every 3 years or when significant change in water inflows or quality expected	Entire estuary (10 stns)
Microalgae	Counts (cell ml^{-1}) of dominant phytoplankton groups and species e.g. flagellates, dinoflagellates, diatoms 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. HPLC, fluoroprobe Measurements of water column microcystin (toxin) concentrations.	Monthly	Entire estuary (5 stns)
Macrophytes	Ground-truthed vegetation maps to check integrity of riparian zone, distribution of macrophyte habitats and extent of invasives. Vegetation survey to assess macrophyte species richness and abundance.	Summer survey every 3 years	Entire estuary (5 stns)
Benthic Invertebrates	Record species and abundance of zooplankton, based on samples collected across the estuary at each of a series of stations along the estuary. Record benthic invertebrate species and abundance, based on van Veen type grab samples in subtidal and core samples in intertidal at a series of stations up the estuary, and counts of hole densities. Measures of sediment characteristics at each station	Summer and winter survey every 3 years	Entire estuary (5 stns)
Zooplankton	Record species and abundance of zooplankton, based on samples collected across the estuary at each of a series of stations along the estuary.	Summer and winter every 3 years	Entire estuary (5 stns)
Fish	Record species and abundance of fish, based on seine net and gill net sampling.	Summer and winter survey every 3 years	Entire estuary (5 stns)

Birds	Undertake counts of all water associated birds, identified to species level.	A series of monthly counts, followed by winter and summer survey every year	Entire estuary (3 sections)
HUMAN USE	Conduct regular counts of users, collecting statistics on the profile (origin, sex, age, income category) and activities of visitors to the Zandvlei estuary using self-fill in questionnaires	Continuous	Visitor entry points and key sites of interest
	Conduct regular counts of users and boats, separated by type.	Twice per week	Entire estuary
	Survey visitor opinions on impacts of key management interventions.	Intensively (3x/week) every 5th year	Entire estuary
	Creel surveys of Catch, Effort and C.P.U.E. for shore and boat-based anglers, and surveys of illegal bait harvesting.	Intensively (3x/week) every 5th year	Entire estuary