



ONRUS ESTUARINE MANAGEMENT PLAN



Final Draft
August 2016





ONRUS ESTUARINE MANAGEMENT PLAN

Final Draft

August 2016

Report Prepared by:

Anchor Environmental Consultants (Pty) Ltd

8 Steenberg House, Silverwood Close, Tokai 7945, South Africa

www.anchorenvironmental.co.za



Authors: Vera Massie & Barry Clark

Cover Photo: Barry Clark

TABLE OF CONTENTS

1	INTRODUCTION	1
1.1	BACKGROUND	1
1.2	PURPOSE AND SCOPE OF THE ONRUS ESTUARINE MANAGEMENT PLAN.....	1
1.3	DEVELOPMENT, ADOPTION AND IMPLEMENTATION OF THE ONRUS ESTUARINE MANAGEMENT PLAN	2
1.4	THE ONRUS ESTUARINE MANAGEMENT FORUM	2
2	SITUATION ASSESSMENT	4
2.1	GEOGRAPHIC AND SOCIO-ECONOMIC CONTEXT	4
2.2	ECOLOGICAL CHARACTERISTICS AND FUNCTIONING.....	4
2.3	ECOSYSTEM SERVICES.....	6
2.4	LEGISLATION AND MANAGEMENT ISSUES.....	6
3	THE EXTENT OF THE ONRUS ESTUARY	8
3.1.1	GEOGRAPHICAL EXTENT OF ESTUARIES.....	8
3.1.2	COASTAL MANAGEMENT LINES AND OVERLAY ZONES IN TERMS OF ICMA	9
3.1.3	THE ESTUARINE MANAGEMENT AREA.....	10
4	VISION	12
5	ESTUARY MANAGEMENT OBJECTIVES	12
5.1	ENHANCE RECREATIONAL UTILITY.....	12
5.2	IMPROVE ESTUARY HEALTH.....	12
5.3	RETAIN SENSE OF PLACE.....	13
5.4	INCREASE AWARENESS AND APPRECIATION	13
5.5	HARMONIOUS AND EFFECTIVE GOVERNANCE	13
6	STRATEGIES TO MEET MANAGEMENT OBJECTIVES	15
7	KEY RESULT AREAS AND MANAGEMENT ACTION PLANS	17
7.1	KEY RESULT AREA 1: IMPROVE ESTUARY HEALTH	17
7.2	KEY RESULT AREA 2: IMPROVE WATER QUALITY	20
7.3	KEY RESULT AREA 3: IMPROVE RECREATIONAL UTILITY.....	23
7.4	KEY RESULT AREA 4: RETAIN SENSE OF PLACE	26
7.5	KEY RESULT AREA 5: INCREASE AWARENESS AND APPRECIATION.....	26
7.6	KEY RESULT AREA 6: RESEARCH AND MONITORING.....	28
7.7	KEY RESULT AREA 7: HARMONIOUS AND EFFECTIVE GOVERNANCE.....	28
7.8	SUMMARY OF MANAGEMENT ACTIONS AND TIMING.....	33
8	APPENDICES	36
8.1	APPENDIX 1: PROPOSED ONRUS ZONATION PLAN	36
8.2	APPENDIX 2: RECOMMENDED MONITORING PROTOCOL FOR THE ONRUS ESTUARY.....	41
8.3	APPENDIX 3: LISTED ACTIVITIES FOR WHICH AN EIA IS REQUIRED FOR ESTUARIES IN THE WESTERN CAPE ACCORDING TO THE NATIONAL ENVIRONMENTAL MANAGEMENT ACT (NEMA).....	46
9	REFERENCES	50

GLOSSARY

Abiotic	Non-living chemical and physical parts of the environment that affect living organisms and the functioning of ecosystems
Biotic	Associated with or derived from living organisms
Estuarine resident fish species	Estuarine fish species, which breed in estuaries
Estuarine-dependent	Euryhaline marine species which usually breed at sea with the juveniles showing varying degrees of dependence on southern African estuaries
Euryhaline	The ability to adapt to a wide range of salinities
Eutrophication	Eutrophication is a process whereby water bodies, such as lakes, estuaries, or slow-moving streams receive excess nutrients that stimulate excessive plant growth (algae and nuisance plants & weeds). This enhanced plant growth, often an algal bloom, reduces dissolved oxygen in the water when dead plant material decomposes and can cause other organisms to die
Mean annual runoff	The mean of the the total quantity of water that is discharged ("runs off") from a drainage basin per year within a specified time period
Mean sea level	An average level for the surface of one or more of Earth's oceans from which heights such as elevations may be measured

LIST OF ABBREVIATIONS

ADU	Animal Demography Unit, University of Cape Town
BGCMA	Breede-Gouritz Catchment Management Agency
C.A.P.E.	Cape Action Plan for People and the Environment
CWAC	Coordinated Waterbird Counts
DEA	Department of Environmental Affairs
DEADP	Department of Environmental Affairs and Development Planning
DO	Dissolved Oxygen
DWAF	Department of Water Affairs and Forestry (now DWS)
DWS	Department of Water and Sanitation (previously DWAF)
EA	Environmental Authorisation
EIA	Environmental Impact Assessment
EMA	Estuarine Management Area
EMF	Estuarine Management Forum
EMP	Estuarine Management Plan
ICMA	National Environmental Management: Integrated Coastal Management Act (Act No 24 of 2008)
KRA	Key Result Area
MAR	Mean Annual Runoff
MSL	Mean Sea Level
NEMA	National Environmental Management Act (Act 107 of 1998)
NEMP	National Estuarine Management Protocol
NWA	National Water Act (Act No 36 of 1998)
ODM	Overberg District Municipality
OLM	Overstrand Local Municipality
Onrus EMF	Onrus Estuarine Management Forum
RMA	Responsible Management Authority
SANBI	South African National Biodiversity Institute
SAR	Situation Assessment Report

1 INTRODUCTION

1.1 Background

The Onrus Estuary is one of South Africa's approximately 289 functional estuaries and is one of 21 estuaries within the warm temperate biogeographic region classified as "temporarily open/closed" (Van Niekerk and Turpie 2012; Turpie, Wilson, and Van Niekerk 2012). It is a small estuary with a relatively small floodplain and covers approximately 15 ha in total. The Onrus Estuary ranks 94th of all South African estuaries in terms of its overall conservation importance and as such is not considered to be particularly important for estuarine biodiversity on a national scale. The Onrus Estuary is an important recreational area along the Cape south coast, however, and the small resident population of Onrus is bolstered considerably during holiday periods. The estuary faces pressures from reduced freshwater inflow due to the upstream De Bos Dam, increasing coastal development and tourism activities and deteriorating water quality.

This document is the Estuarine Management Plan for the Onrus Estuary (hereinafter referred to as Onrus EMP) and was compiled in accordance with the National Estuarine Management Protocol (NEMP) (Regulations in terms of the National Environmental Management Integrated Coastal Management Act No. 24 of 2008).

1.2 Purpose and scope of the Onrus Estuarine Management Plan

Drawing on the Situation Assessment prepared for the Onrus Estuary (Massie and Clark 2016), inputs from key stakeholders and other supporting documents prepared for the C.A.P.E. Estuaries Programme (e.g. Turpie and Clark 2007 - Cape Estuaries Classification, Prioritisation, Protection and Rehabilitation report), the Onrus EMP sets out the Vision and Management Objectives for the Onrus Estuary. It also identifies Strategies needed to meet these objectives, and indicates the main actions required in the next five years in order to achieve the overall vision. The Onrus EMP focuses on strategic priorities and should be seen as a flexible document that can be updated as required to achieve the overall vision and objectives for the estuary. While planning for some emergencies, e.g. low oxygen events, is part of this plan, it remains possible that unforeseen disasters could disrupt the prioritisation set out in the plan.

A set of Key Result Areas (KRAs) have been identified for the estuary for the next five years. A KRA is a priority area of action for the estuary and addresses one or more of the strategies required to meet the management objectives for the system. Each strategy will be implemented through a set of actions and will result in a number of deliverables. A plan of implementation is provided for each KRA.

It is important to recognize that this document is designed to focus management attention at a strategic level and does not provide detailed guidance on the day-to-day management actions required for management of the estuary. Progress towards achieving the objectives set out in this EMP should be reviewed on an annual basis by the Onrus EMF and focal efforts of the participating agencies adjusted to ensure targets are met within specified time frames. This Onrus EMP should be updated every five years in order to reflect goals that have been achieved and to accommodate changing priorities.

1.3 Development, adoption and implementation of the Onrus Estuarine Management Plan

Responsibilities for the development of Estuarine Management Plans (EMPs) are prescribed in Regulation 5 of the NEMP and specify that: “Where an estuary falls within the boundary of a single local municipality, the municipality must develop an EMP in consultation with the relevant government departments, except if the estuary is within the boundaries of a protected area or is identified as part of the protected area expansion strategy;”. The Onrus Estuary is located wholly within the Overstrand Local Municipal area and does not lie within the boundaries of a protected area, which means that according to the NEMP, the Overstrand Local Municipality (OLM) should be responsible for the development, approval and implementation of the Onrus EMP (i.e. the OLM would be considered the responsible management authority (RMA)). Furthermore, the RMA should review the EMP and consider any comments received during the public participation process (Regulation 9 of the NEMP) and submit the EMP to the Provincial Department of Environmental Affairs and Development Planning (DEADP) for approval (as per Regulation 9(a)).

However, at the time of writing, the Supreme Court of Appeal, in the case *Abott vs Overstrand Municipality* (99/2015) [2016] ZASCA 68 (20 May 2016), ruled that the OLM is currently not authorised to manage the Klein Estuary under the provisions of ICMA (i.e. the NEMP). The Supreme Court of Appeal Judgement found that: “[...] any powers which the municipality may wish to exercise with regard to the estuary have to be assigned to it by national or provincial legislation.” According to this judgement, no powers or duties regarding the management of the Klein Estuary had been assigned to the OLM. This ruling has repercussions with regards to the management of all estuaries in the OLM, including the Onrus Estuary. Consequently, at this point, neither the OLM nor the Overberg District Municipality (ODM) can take responsibility to coordinate the function of the RMA for the Onrus Estuary until the mandate has been devolved to one of the municipalities.

The OLM or ODM will accept the mandate to manage estuaries in terms of the NEMP once the DEADP/DEA has devolved the responsibility to either authority and has allocated sufficient funds and capacity to the RMA to perform this function effectively. Therefore, defining the RMA for the Onrus Estuary will be a crucial step in the successful implementation of the EMP and has been identified as the first strategy in the Management Action Plan (MAP) for achieving harmonious and effective governance (Section 7.7, Table 7).

1.4 The Onrus Estuarine Management Forum

Ensuring a sufficiently high level of integration and cooperation amongst all of the different agencies involved in the management of the Onrus Estuary extends beyond the mandate and capacity of a single RMA. The Onrus Estuarine Management Forum (Onrus EMF) provides a platform, which facilitates principal national, provincial and local government agencies to fulfil their respective mandates regarding the management of the Onrus Estuary by serving as a member of the Onrus EMF (hereinafter referred to as implementing agencies). These implementing agencies include as a minimum, the Department of Environmental Affairs Branch Oceans and Coasts (DEAO&C), the Department of Public Works (DPW), the Department of Water and Sanitation (DWS), the

Department of Environmental Affairs and Development Planning (DEADP), CapeNature, and the Breede-Gouritz Catchment Management Agency (BGCMA).

The Onrus EMF also includes representatives of key civil stakeholder groups. The purpose of the Onrus EMF will be to oversee the implementation of the Onrus EMP and to provide a body for stakeholders with an interest in the future of the Onrus Estuary to exchange information and ideas, and to reach agreement on actions for the effective management of the estuary. It is important to note that the Onrus EMF will be central in realising the appointment of the RMA.

Once the RMA has been appointed and the EMP has been adopted in terms of ICMA, the implementation of the EMP strategies and actions for the estuary by the RMA and implementing agencies will be overseen by the Onrus Estuary Management Forum (EMF) using indicators within a set time-frame. Despite the challenges that the forum faces regarding the appointment of an RMA and adoption of the EMP, the Onrus EMF is encouraged to commence with forum meetings and to start identifying priority actions to be carried out by the respective implementing agencies.

2 SITUATION ASSESSMENT

Recognising the importance of the Onrus Estuary and estuaries in South Africa more generally, the Overstrand Local Municipality (OLM) facilitated the appointment of Anchor Environmental Consultants (Pty) Ltd by the Onrus Lagoon Preservation Trust to prepare an Estuarine Management Plan (EMP) for the Onrus Estuary. The following executive summary is an extract from the Situation Assessment Report (SAR) which was drafted in March 2016 and which provided background material and the context for the development of the Onrus EMP.

2.1 Geographic and socio-economic context

The Onrus catchment lies within the OLM (part of the Overberg District Municipality – ODM) in the Western Cape Province and is included in the Breede-Gouritz Catchment Management Area. The Onrus River rises in the Babilonstoring Mountains and flows 16 km through the Hemel en Aarde Valley before crossing the narrow coastal plain to discharge into the sea via Onrus Lagoon, which is situated approximately 7 km northwest of Hermanus.

The catchment falls within the Fynbos Biome, but most of the area has been transformed through urban development, invasive alien vegetation and agriculture. The catchment is located within the winter rainfall region, although orographic rain originating from the mountain ranges close to the coast result in local concentrations of rainfall (Heineken and Damstra 1983). Rainfall on the coastal plain is generally lower than in the mountainous areas of the catchment, where Hermanus experiences a mean of approximately 600 mm per annum.

Agriculture (primarily viticulture) is the main land use in the valley, while urban development is limited to the coastal plain. The river course is heavily overgrown in places with invasive alien vegetation, including eucalypt plantations. The average annual growth rate of the OLM population based on the years from 2001 to 2011 is 3.8% and pressures on the Onrus River system and estuary are expected to increase over time.

2.2 Ecological characteristics and functioning

The channel and mouth dynamics of the Onrus Estuary have been strongly influenced by anthropogenic developments in the catchment and have not been formally managed since the commissioning of the De Bos dam in 1976. The Mean Annual Runoff (MAR) reaching Onrus Lagoon has been significantly reduced by water use in the catchment, mainly for agricultural activity, and the construction of the De Bos Dam. The annual 'compensation water' released from the dam should amount to 0.47 Mm³ for downstream water users along with a supplementary environmental release of 1.6 Mm³ per annum. However, as there is no gauge measuring outflow through the outlet pipe from the dam, which can be opened or closed with a valve, it is considered unlikely that enough water is released for the environmental reserve downstream of the dam.

The Onrus mouth is closed most of the time owing to a large sandbar that develops across the mouth, which reaches an average crest height of +2.8 m MSL (CSIR 1991). During the winter season,

following heavy rains, however, a narrow channel is formed typically in the western edge of the sandbar. This narrow channel serves as an overflow rather than a tidal inlet, and seawater only penetrates during high storm spring tides. With the arrival of sufficiently large floods, however, the overflow channel can scour more deeply, enough to allow for a brief period of tidal fluctuation in the estuary. The sandbar starts rebuilding on the seaward side as sand is deposited back on the beach by wave action and usually closes within ten days, reverting back to an overflow channel. The Onrus lagoon can therefore be regarded as being mainly supratidal (the sandbar is higher than the tidal reach).

Historical information suggests that the Onrus estuary has always been a freshwater-dominated system, where instantaneous salinity varied from 0-4 ppt during the closed state (Heinecken and Damstra 1983 S. Lamberth, Pers. Comment, Sue Matthews Overstrand Municipality 2013) and 31.7 ppt while the estuary was open to the sea (e.g. in 1994). Sewage contamination in the Onrus Estuary has been a long-standing concern and the estuary has had to be closed to swimming at times, often during the peak summer season. A sewage pipeline was constructed in 1996 to convey sewage from Kidbrooke Place, as well as any future development adjacent to the line, to the pump station on the northern shore of the Onrus Lagoon. This sewer line is located within the riparian zone, and in places, in the active channel. Sewage spilled from this pipeline affecting water quality in the lower reaches of the Onrus River and also the estuary. Environmental Authorisation was granted on 5 April 2016 for the upgrade the damaged and degraded existing sewer pipeline adjacent to the Onrus River below Bosplasié Crescent in the upper reaches of the Onrus Estuary (Reference: 16/3/1/E2/26/2091/14). The replacement of this sewer lines also involves the construction of two new pump stations and two rising main sewer lines. Construction is currently ongoing and once completed, this section of the Onrus Estuary will be rehabilitated in accordance with the Rehabilitation Plan and River Maintenance Management Plan (MacKenzie 2015).

The estuary is characterised by low gradients and extensive beds of *Phragmites australis*, which form persistent and dense monospecific stands that outcompete other indigenous estuary-associated species and encroach into the open water area of the Onrus Estuary. The spread of this species is thought to be facilitated by the historic shallowing of the lagoon through siltation and excess nutrient input. After considering a multitude of methods to remove the reeds, extensive dredging took place in 1993/1994 to remove the reeds, along with their roots and a good deal of sediment, to increase the depth of the lagoon. Approximately 30 000 m³ of organic material and sediment was removed at this time. It is evident that this operation was successful in that the reed edge has since not encroached significantly onto open water area of the Onrus Lagoon.

The north western bank is dominated by alien vegetation and/or is contained within private residential gardens where riparian vegetation has been largely cleared or altered on the estuary banks. The south eastern bank does not have residential gardens and alien vegetation has recently been cleared from this area. Working for Water first became involved in alien-clearing in the Onrus River catchment with the launch of the Greater Hermanus Water Conservation Programme in November 1996. Activities initially focused on the upper reaches of the catchment as a means of increasing runoff into the De Bos Dam, but since 2008, a new project was initiated to increase alien clearing efforts in the lower catchment. The project is funded by the Working for Water Programme to clear on private property within the project boundaries, and by the Overstrand Municipality from the Environmental Management Services budget to clear on municipal properties.

A total of 11 fish species have been recorded from the Onrus Estuary to date, which is considered to be low compared to other temporarily open/closed estuaries in the region. During a survey conducted in September 1994, a total of five species were recorded of which the southern mullet *Liza richardsonii* and flathead mullet *Mugil cephalus* dominated. This survey was undertaken during open mouth conditions and shortly after a large-scale dredging event in 1993/1994 for controlling the spread of *Phragmites*. In 2006, more than a decade after dredging, the estuary was sampled during closed mouth conditions. As expected, abundance of estuarine resident species was substantially higher (69% represented by Gilchrist's round herring *Gilchristella aestuaria* and Knysna sand gobi *Psammagobius knysnaensis*), while *L. richardsonii* remained dominant in terms of biomass. The dominance of estuarine-dependent marine species during open mouth conditions and the prevalence of estuarine resident species during closed mouth conditions indicate that the Onrus Estuary is fulfilling its basic ecological role.

A total of 81 water-associated bird species of 12 taxonomic orders have been recorded at the Onrus Estuary over the last two decades. The most species-rich taxonomic group is the Charadriiformes, which include the waders, gulls and terns. Due to the lack of tidal influence, the estuary is not particularly important for wader species. There are also no important populations of red data species on the estuary.

2.3 Ecosystem services

Estuaries provide a range of services that have economic or welfare value. In the case of the Onrus Estuary, the most important of these are the recreational and tourism services. The Onrus Lagoon and adjacent beach are a popular holiday destination, although its use for swimming and canoeing is somewhat constrained by concerns about poor water quality. The Onrus Estuary is not important for subsistence or recreational angling nor is it an important bait collecting site. Studies have shown that the high biomass production of *Phragmites* reed beds favours carbon sequestration, but also produces significant methane emissions. The role of *Phragmites*-dominated wetlands as a source or sink of carbon and their importance to greenhouse gas regulation is thus unclear. However, Onrus Lagoon's small size means that it would make a negligible contribution to climate regulation in any event.

2.4 Legislation and management issues

The Onrus Estuary is a highly disturbed system, which has been subjected to urban development, the spread of invasive alien vegetation and extensive dredging for the removal of the common reed *Phragmites australis* in 1993/1994. There are a number of factors that threaten the future health of the system and hence its conservation status and capacity to deliver ecosystem services. The main threats to the system or areas of potential conflict are as follows:

1. Water quantity and quality
 - a. Reduction in freshwater inflows due to water use in the catchment, mainly for agricultural activity, and the construction of the De Bos Dam in 1976;

- b. Nutrient enrichment and bacterial contamination due to an aged and damaged sewage system. Parts of the damaged sewer line traverse through the riparian zone and the active channel of the lower Onrus River and upper Onrus Estuary; and
 - c. Loss of open water area over time due to encroachment of the common reed *Phragmites australis* as a result of siltation and high nutrient levels in the water column and sediment.
2. Land-use and associated disturbance
- a. Existing and rapidly expanding residential/resort development around the estuary leading to change in sense of place and existence value, increased human disturbance of biota, and damage or loss of estuarine habitat; and
 - b. Unmanaged and non-strategic clearing of *Phragmites australis*

The Onrus Estuary was not identified as a priority area for the conservation of South Africa's estuarine biodiversity estate in the recent National Biodiversity Assessment (Van Niekerk and Turpie 2012) but this assessment did highlight a number of focal areas for the rehabilitation of the estuary, including alien plant clearance, increasing freshwater inflow and improving water quality. It has also been recommended that rehabilitation objectives focus on restoring the aesthetic and scenic value of the Onrus Estuary, which could, in part, be implemented in conjunction with a public awareness programme.

The Integrated Coastal Management Act, 2008 (ICMA) requires that a management plan be developed for each estuary in the country. The National Estuary Management Protocol (NEMP) gazetted in the in terms of the Integrated Coastal Management Act in 2013 and provides clear guidance for the management of estuaries through the development of individual estuarine management plans (such as this one). The NEMP also outlines a national vision for estuarine management in South Africa, lays out strategic objectives for effective integrated management of estuaries in this country, and prescribes standards for the management of estuaries. However, the fact that estuaries contain freshwater, terrestrial and marine components, and are heavily influenced by activities in a much broader catchment and adjacent marine area, means that they are also affected by other policies and laws. The National Departments of Water Affairs and Sanitation (DWS) and Environmental Affairs (DEA) are the primary agencies responsible for estuary management in South Africa with a small amount of responsibility (fisheries) attributable to the Department of Agriculture Forestry and Fisheries (DAFF). Environmental management in most instances is devolved to provincial level, aside from water resources and fisheries which remain a national competency. At a municipal level, by-laws are passed which cannot conflict with provincial and national laws. The Onrus Estuary lies wholly within the Overstrand Local Municipality, which falls within the Overberg District Municipality of the Western Cape Province.

3 THE EXTENT OF THE ONRUS ESTUARY

3.1.1 Geographical extent of estuaries

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

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

This is very similar to the definition included in the National Environmental Management: Coastal Management Act (2008) and listing notices 1 (GN R. 983), 2 (GN R. 984) and 3 (GN R. 985) regulations applicable to the Free State, Limpopo, Mpumalanga Provinces, Northern Cape and North West Province, published under the National Environmental Management Act (NEMA), Environmental Impact Assessment (EIA) Regulations (2014), which define an estuary as a body of surface water-

- a) that is 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

This definition of what constitutes estuarine habitat is considerably larger in terms of listing Notice 3 (GN R 985) applicable to the Western Cape, Eastern Cape and KwaZulu Natal and is published under the National Environmental Management Act (NEMA), Environmental Impact Assessment (EIA) Regulations (2014), where the definition of an estuary includes the estuarine functional zone as defined in the National Biodiversity Assessment: Estuary Component (Van Niekerk and Turpie 2012):

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

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

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

In each case, the estuary mouth was taken as the downstream boundary or, where the mouth was closed, the middle of the sand berm between the open water and the sea. The upstream boundary

was determined as the limits of tidal variation or salinity penetration. Lateral boundaries of each estuary were defined to include all associated wetlands, intertidal mud and sand flats, beaches and foreshore environments that are affected by riverine or tidal flood events whichever penetrates furthest, and were mostly plotted as the 5 m topographical contour surrounding each estuary.

The latter definition has been adopted as a starting point for defining the extent of the Onrus estuary for the purposes of this EMP.

3.1.2 Coastal Management Lines and Overlay Zones in terms of ICMA

The DEA&DP commissioned WSP Africa Coastal Engineers (Pty) Ltd to develop a methodology for defining and adopting coastal development management lines in the Western Cape. The final report entitled Development of a Methodology for Defining and Adopting Coastal Development Setback Lines guided the development of the Draft Coastal Management Lines and Coastal Overlay Zones for the Overberg District Municipality (WSP Africa Coastal Engineers 2010).

A Coastal Management Line (CML), as envisaged by the amended ICMA, is informed by the projections of risk, information on ecological or other sensitivities adjacent to the coast, as well as the location and extent of existing development and existing executable development rights. The CML is intended as a clear guideline for the management of development within risk areas, and the protection of coastal public property. The Draft Overberg CML therefore differentiates between areas along the coastline with existing development rights and/or part of future municipal development, and those areas that should be left undeveloped due to a high risk from dynamic coastal processes or as coastal public property. The CML also extends along estuaries, and in developed areas along the banks of the estuary, is aligned with the lower (water side) boundary of properties with existing development or development rights. In rural areas, the CML runs along the 5m above MSL contour around estuaries or landward of identified coastal (estuarine) sensitivities.

Coastal Management Overlay Zones on the other hand are collectively envisaged as the area close to the sea/estuary within which development should be managed in order to preserve coastal quality and protect property and lives. Development in these zones is possible under certain circumstances and after appropriate environmental and risk assessments have been undertaken. Restrictions in this area can be applied strictly and consistently, since it is informed by information on the level of risk emanating from coastal processes such as coastal erosion, storm surges, sea level rise and storm wave run-up that informed scientifically modelled hazard zones (high, medium and low risk zones).

With regards to estuaries, the risk-based zoning needs to be amended in order to accommodate the limited availability of information on localised estuarine dynamics. Consequently, a single risk zone is determined on the basis of inundation levels rather than wave impact risk. The risk zone is therefore considered to be the area below the 10 m contour around estuaries.

Together, these planning tools recognise existing development and development rights while directing development into the lower risk areas and informing how the development should be undertaken such that property, people and the integrity of the coast can be protected.

3.1.3 The Estuarine Management Area

For the management of the Onrus Estuary and the Zonation Plan, the geographical limits as defined in the National Biodiversity Assessment: Estuary Component (Van Niekerk and Turpie 2012) were extended by including the Onrus Beach and a 300 m long river stretch upstream of the Overberg Estuarine General Risk Overlay Zone, the Draft Overberg Coastal Management Line and the extent of the Draft Overberg Estuarine General Risk Overlay Zone (Source: DEADP 2016). The resulting area represents a meaningful management unit, which takes into account the importance of (1) monitoring and maintaining ecological integrity of the estuary (note that the WWF nature conservation area on the eastern bank has been included) (2) coastal public property (3) preserving coastal quality (4) protecting property and immovable structures within flood prone areas; and (5) integrated management of the Onrus Estuary and its beach. This new geographical management extent is hereinafter referred to as the Estuarine Management Area (EMA) for the Onrus estuary (Figure 1).

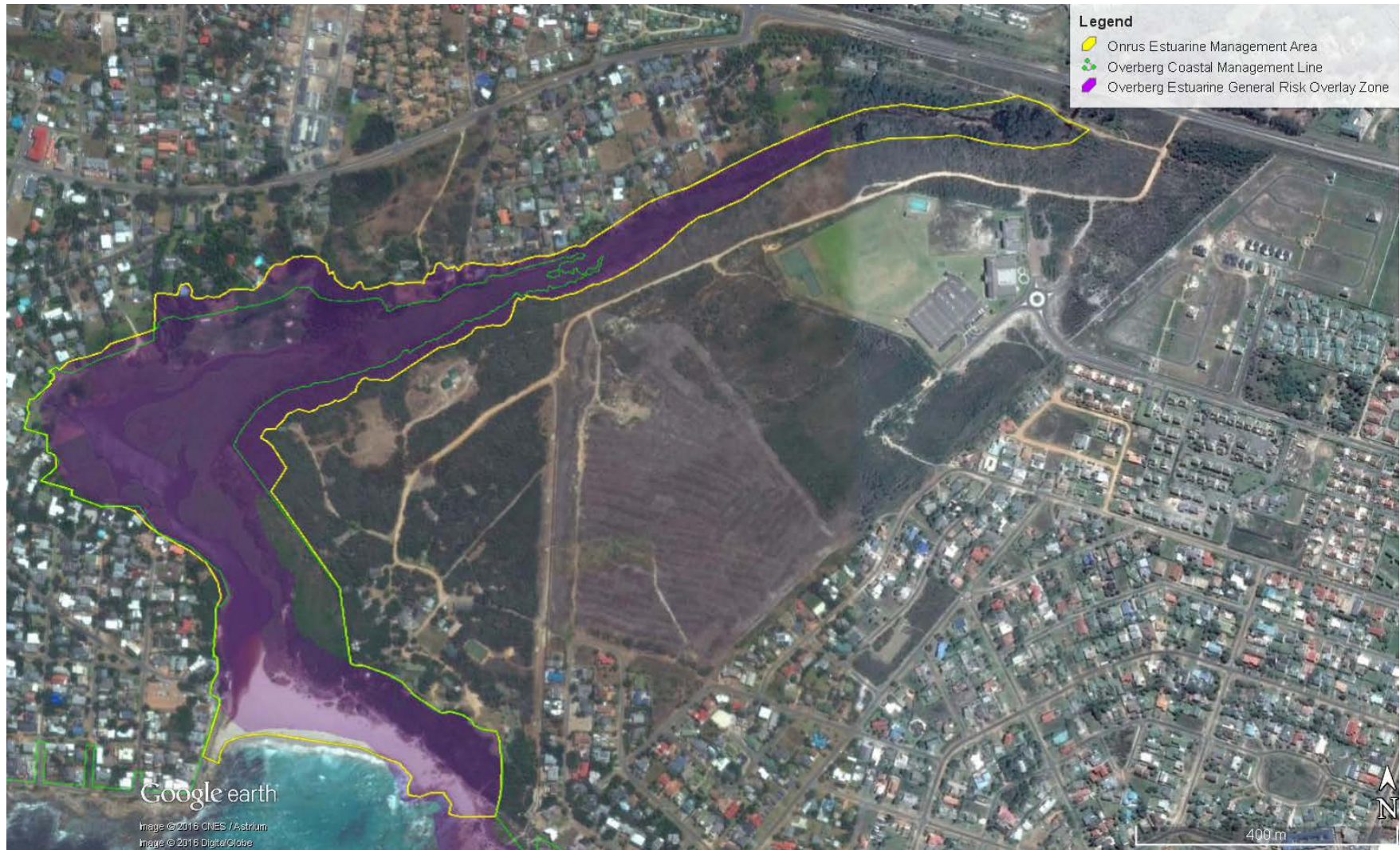


Figure 1 Geographical extent of the Onrus Estuarine Management Area. The area was delineated by considering the Overberg Coastal Management Line and the extent of the Estuarine General Risk Overlay Zone (Source: DEA&DP 2016, Google Earth image from 18 January 2016).

4 VISION

A vision is a high level statement which defines the strategic intent of a management intervention. The following draft vision was developed for the Onrus Estuary using stakeholder input collected from a multi-stakeholder meeting held in March 2016.

“The Onrus Estuary is a healthy and functioning ecosystem with good water quality that is safe for recreational use, contributes positively to the local sense of place, and together with the sandy beach at the estuary mouth, is effectively managed for the benefit of future generations”

5 ESTUARY MANAGEMENT OBJECTIVES

Key management objectives for the Onrus Estuary were identified at a stakeholder workshop held in Onrus, in March 2016. These objectives are listed below and displayed in the form of a circular diagram in Figure 2 as none are considered as being of greater importance than any other.

5.1 Enhance recreational utility

The Onrus Lagoon and adjacent beach are very popular for swimming, body boarding and surfing in the sea. Currently, the recreational utility of the lagoon is compromised and is often not safe for contact recreation due to poor water quality. Improving water quality is a key aspect in enhancing recreational utility of the estuary, along with management of reed encroachment where stakeholder requests for increased open water area should be balanced against the ecological requirements of the estuary.

5.2 Improve estuary health

Use of freshwater resources and land in the Onrus River catchment must be effectively managed to improve the quality and quantity of freshwater reaching the estuary. Continued clearing of alien invasive vegetation within the estuarine functional zone and its catchment will be important in restoring freshwater flows, reducing erosion of river and estuarine banks and enhancing biodiversity. Water quality within the estuary must also be managed through the upgrading of the sewage lines situated within the Onrus estuarine functional zone.

5.3 Retain sense of place

Further encroachment of development onto the estuary banks should be controlled to retain the sense of place in the Onrus Lagoon. Development should be guided by the proposed Zonation Plan (Appendix 1), which should incorporate applicable aspects from the Overstrand Environmental and Heritage Overlay Zones and associated regulations have been finalised.

5.4 Increase awareness and appreciation

Effective management of the Onrus Estuary will be dependent on stakeholder buy-in (through adequate consultation and communication) and visitors' appreciation of the management regulations. Education is also considered to be among the most important functions provided by estuaries. The Onrus Estuary is very popular recreational area and provides opportunities where the public are able to view species in their natural environments, and (preferably) to experience natural ecosystems.

5.5 Harmonious and effective governance

Owing to their position on the boundary between freshwater, terrestrial and marine environments, management of estuaries requires cooperation from a large number of separate national, provincial and local government agencies, each acting under a different legislative mandate. Institutional roles and responsibilities pertaining to the management of the estuary must be clearly defined, and coordination between responsible institutions improved and maintained.

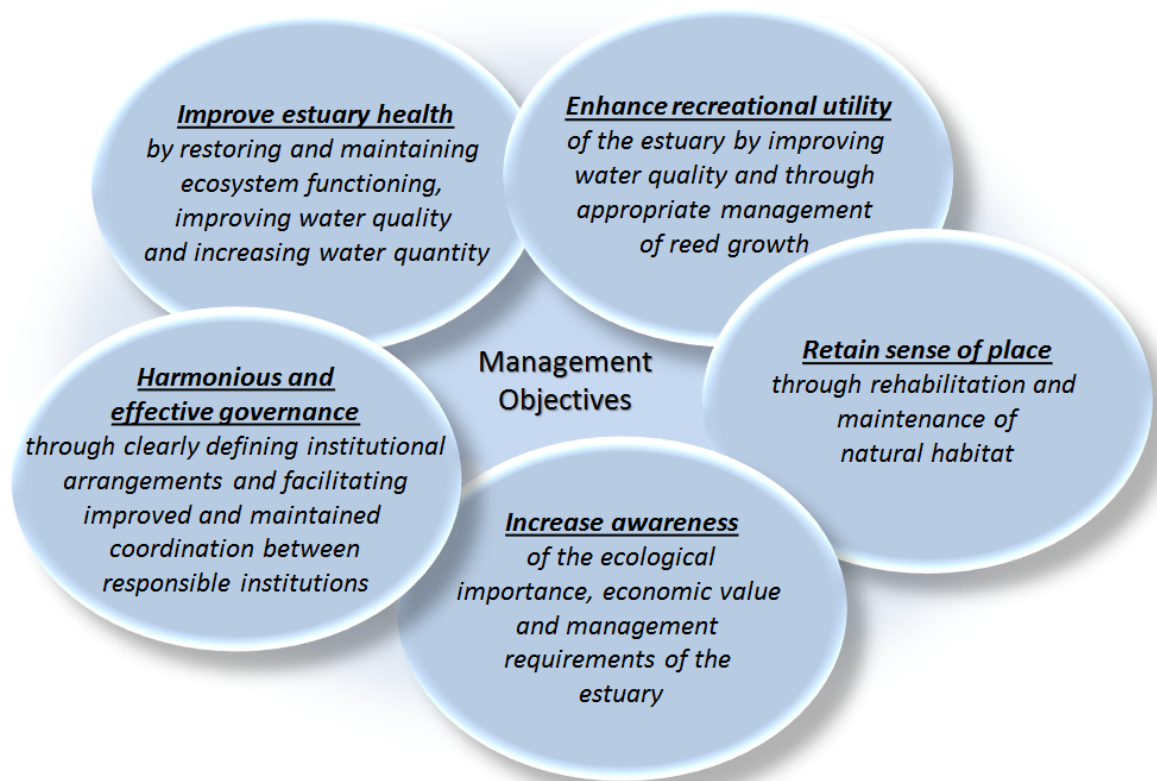


Figure 2 Strategic Management Objectives for the Onrus Estuary

6 STRATEGIES TO MEET MANAGEMENT OBJECTIVES

Strategies required for meeting the management objectives are summarized in Figure 3. Each management objective requires a number of strategies. Note that some of the management objectives form part of the strategy for achieving other management objectives.

The Onrus Lagoon and adjacent beach is a very popular holiday destination where young children and adults alike enjoy swimming, body boarding and surfing. Currently, the recreational utility of the lagoon is compromised due to poor water quality and does not always provide a safe environment for contact recreation. This is especially important in summer, when freshwater input from the catchment is lower, temperatures are higher and the lagoon is used by many people during the holiday season. Reducing pollution from overflowing pump stations and sewage lines and runoff from live-stock holdings into the estuary and lower catchment are considered to be the most important interventions for improving the recreational utility of the Onrus Estuary. Other interventions are also important, including appropriate management of reed encroachment (i.e. balancing stakeholder requests for open water area against ecological requirements) as well as the development of infrastructure that supports and directs low intensity recreational activities to the upper estuary and medium intensity recreational activities towards the mouth (see Zonation Plan in Appendix 1). Further encroachment of development onto the estuary should also be controlled to retain the sense of place and recreational utility of the Onrus Estuary.

Ecosystem health can be enhanced through improving water quality and restoring environmental flows, while also ensuring rehabilitation of habitats that have been damaged or degraded, e.g. by invasive alien invasive vegetation or informal pathways and access points to the water. Ecosystem health will also benefit if public awareness is improved, which in turn will require the provision of educational material and signage. The management and monitoring of the estuary area, the freshwater inflows and development in the surrounding area, will require cooperative governance among the local and district municipalities, catchment management agency, conservation agencies, and provincial and national government agencies. The estuary management forum comprising representatives from various stakeholder groups (e.g. the Onrus Conservancy, the Bird Club, farming associations in the catchment, etc.) and government agencies (local, provincial and national departments) responsible for management of the estuary will oversee and drive the implementation of the EMP, and will ensure that local communities and stakeholders have input into and are informed about the management of the estuary.

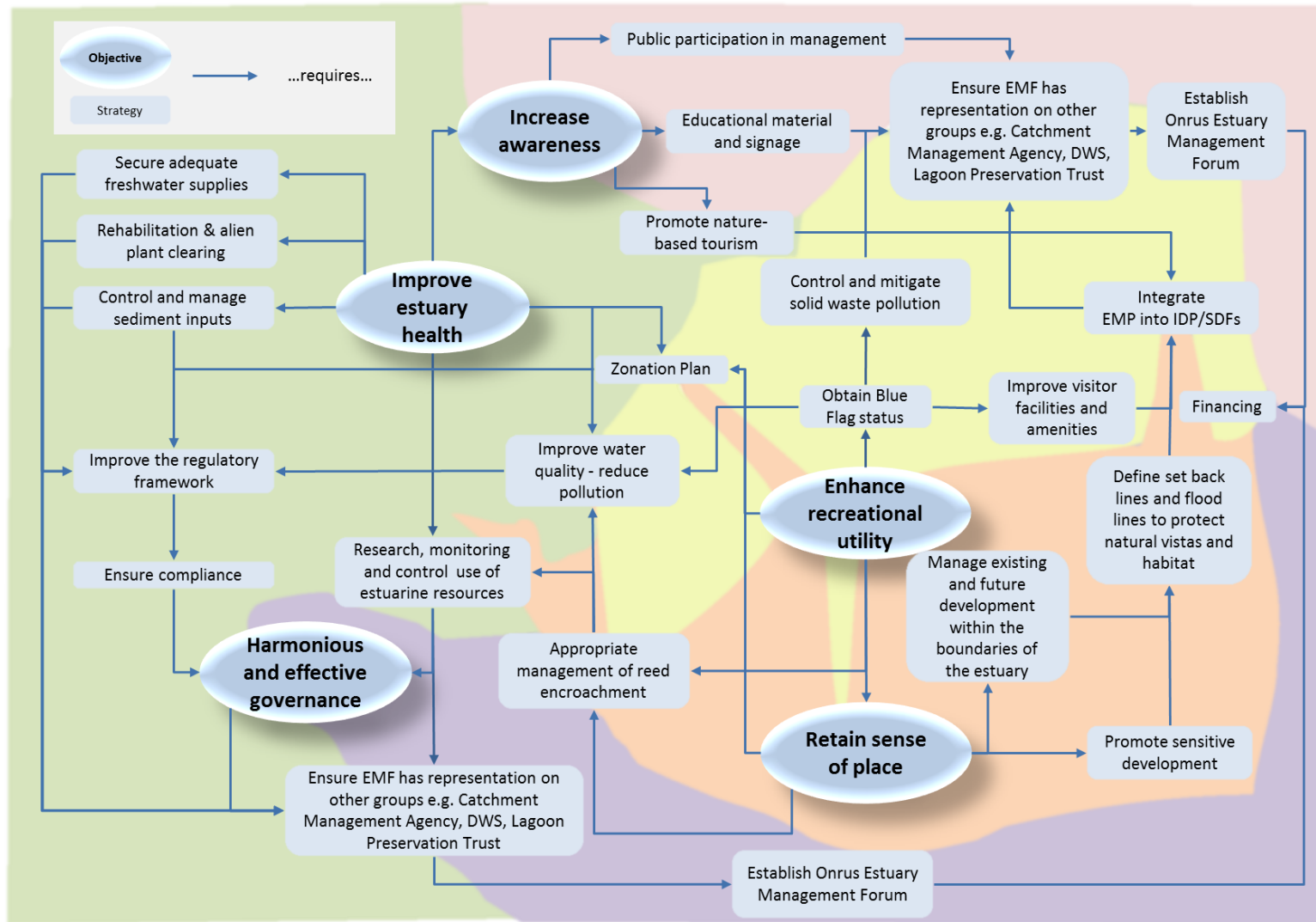


Figure 3 Strategies to meet management objectives for the Onrus Estuary.

7 KEY RESULT AREAS AND MANAGEMENT ACTION PLANS

Key result areas (KRAs) are strategic management objectives and strategies that were chosen to become focus areas for action. Management Action Plans (MAPs) have been compiled for each KRA, which details at least one KRA strategy that should be implemented through a range of actions and assessed using quantitative and measurable targets, limits or thresholds (Table 1 - Table 7). While the RMA will coordinate the approval and implementation of the Onrus EMP, the implementing authorities will be responsible for carrying out specific actions as indicated in the MAPs. Note that some actions will be implemented by the RMA itself (RMA is still to be appointed for the management of the Onrus Estuary (Section 1.3). The Onrus EMF will oversee this process and provide a platform, which facilitates principal national, provincial and local government agencies to fulfil their respective mandates regarding the management of the Onrus Estuary by serving as a member of the Onrus EMF.

The following KRAs were identified for the Onrus Estuary:

1. Improve estuary health
2. Improve water quality
3. Improve recreational utility
4. Retain sense of place
5. Increase awareness and appreciation
6. Research and monitoring
7. Harmonious and effective governance

7.1 Key Result Area 1: Improve estuary health

The Mean Annual Runoff (MAR) reaching Onrus Lagoon has been significantly reduced by water use in the catchment, mainly for agricultural activity, and the construction of the De Bos Dam. Hydrological functioning of the Onrus Estuary is considered to be poor as the natural MAR has since been reduced from around 14.5 Mm³ to less than 5 Mm³, representing a 66% decrease in MAR for the estuary (Van Niekerk and Turpie 2012). Although the frequency and magnitude of floods have been reduced significantly due to impoundment by the De Bos dam, larger floods still have the capacity to scour the estuary mouth.

The estuary would historically have been surrounded by Overberg Sandstone Fynbos, with some Overberg Dune Strandveld on the western and eastern shores. These vegetation types have been completely transformed on the northern and western shores and are now dominated by alien vegetation within private residential gardens, while riparian vegetation has been largely cleared or altered on the estuary banks. In the upper reaches of the estuary, the northern shoreline has been infilled with dredge spoil and builder's rubble to extend private golf chipping greens to the water's edge. Adjacent to this is a small grove of eucalypts, which also grow along the watercourse further upstream. Some white milkwoods still occur between and in front of the houses, however (MacKenzie 2015). On the eastern bank, land donated to WWF (then Southern African Nature Foundation) in the early 1990s and demarcated a bird sanctuary, still has a rich plant community with species representative of Overberg Dune Strandveld. The sanctuary was previously cleared of

invasive vegetation by the Onrus Lagoon Trust and municipality, but follow-up work has not taken place for some time. This area is fenced off from the adjoining Habonim property, which is heavily infested with invasive alien acacias. The estuary is also characterised by low gradients and extensive reed beds (*Phragmites australis*) which trap sediment and contribute to the gradual but slow shallowing of the lagoon over time. The De Bos Dam also acts as a sediment trap, and therefore management efforts to control sedimentation in the estuary should be focused on the catchment below the dam.

Monitoring ecosystem health is critical in guiding short-term and long-term management initiatives. For example early detection of low oxygen events and eutrophication risks relies on continued monitoring that is aligned with existing water quality sampling locations and methods of the BGCMA and OLM. KRA 6 – Research and monitoring – presents a more detailed action plan for the implementation of such a monitoring programme, while the recommended monitoring programme in Appendix 2 provides more details regarding temporal and spatial scales for biological, physical and chemical ecosystem health indicators.

Table 1 Management Action Plan to improve Onrus Estuary health.

Strategies	Actions	Deliverables/Indicators	Timing	Implementing agency	Indicative budget
1. Secure adequate freshwater supplies for the estuary	a. DWS/BGCMA to conduct a water audit of the Onrus catchment to establish the location, number and volumes of water abstracted by:	<ul style="list-style-type: none"> A database of all license holders detailing abstraction volumes is available Illegal water abstractions have been located and abstraction volumes have been determined and curtailed as far as possible An estimate of the total water volume that is abstracted from the Onrus catchment per annum has been calculated 	2017	BGCMA, DWS	N/A
	i. water use license holders				
	ii. illegal water abstractions				
	b. DWS/BGCMA to ensure compliance with water use licenses	<ul style="list-style-type: none"> Compliance monitoring records are available 	2016-		
	c. DWS/BGCMA to install flow gauge(s) at the outlet of the De Bos Dam	<ul style="list-style-type: none"> Environmental flow release records are available 	2017-		To be determined
d. Negotiate highest environmental release volume for the estuary with BGCMA/DWS.	N/A				
e. Develop operating rules for the De Bos Dam in accordance with the allocated environmental release volume	<ul style="list-style-type: none"> Operating rules for the De Bos Dam are in place 	2018			
2. Eradication/management of alien invasive species from Onrus Estuarine Management Area and catchment	a. Assess extent of alien invasive species	<ul style="list-style-type: none"> A plan of action for the clearing of alien invasive plants that prioritises certain species and areas 	2016	BGCMA, DEA, DEADP, SANBI, CapeNature, OLM, ODM	To be determined
	b. Prioritise areas for the clearing of alien invasive plants		2017		
	c. Secure funds to clear alien invasive plants	<ul style="list-style-type: none"> Records from alien clearing programmes (ha cleared of alien vegetation) 	2017		
	d. Clear alien invasive vegetation		2017-2021		
3. Manage and control sediment inputs from the catchment below the De Bos Dam	a. Assess current sediment sources (location, types of sediment and approximate volumes)	<ul style="list-style-type: none"> Reduced sedimentation rates as demonstrated in regular (every five years) bathymetric surveys (refer to monitoring protocol in Appendix 2) 	2016-	BGCMA, SANBI, CapeNature, OLM, ODM	To be determined
	b. Prioritise stretches of the Onrus River for rehabilitation				

7.2 Key Result Area 2: Improve water quality

The water quality characteristics of the Onrus Estuary are influenced by a number of factors the most important of which are runoff and mouth state. As long as the mouth of the estuary is open or runoff is sufficient to maintain adequate flushing in the system, water quality is generally good and poses no risk to human health or the health of the fauna or flora of the estuary. Following periods of prolonged closure, water quality characteristics can change rapidly and begin to pose a threat to human and/or ecosystem health.

High nutrient levels (nitrates, ammonia, phosphates) in the estuary, especially during closed mouth conditions, can lead to proliferation of macroalgae or blooms of microalgae in the estuary (phytoplankton or benthic microalgae) which are unsightly, can clog gills of fish, inhibit feeding by fish and birds, and frequently leads to occurrence of low oxygen events. Under natural conditions, dissolved oxygen (DO) typically ranges from 6-8 mg/l, and DO concentrations ≥ 5 mg/l are generally suitable for aquatic life (USEPA 2003). As DO decreases to concentrations < 5 mg/l, mobile organisms will attempt to escape the impacted area (Breitburg 2002; Wannamaker and Rice 2000). Prolonged exposure to such levels may lead to the death of less mobile organisms. Persistent levels of DO between 3-4 mg/l have severe consequences, while most organisms die when DO concentrations decrease to < 1.5 mg/l for a few days or more. Some benthic organisms are resistant to very low oxygen levels and consequently prolonged low DO concentrations can lead to a significant shift in benthic community structure (Diaz and Rosenberg 1995; Nixon 1995; Pearson and Rosenberg 1978; USEPA 2001, 2003).

High levels of indicator bacteria (*E. coli*, faecal coliforms and/or Enterococci) are indicative of the possible presence of pathogens or disease causing organisms in the estuary that can pose a risk to the health of recreational users.

Poor water quality in the Onrus Estuary can arise from direct inputs of waste water into the estuary and from contaminated runoff from the catchment (e.g. leaking or malfunctioning of sewage lines, pump stations or septic tanks, stormwater inputs, agricultural return flow that contain high levels of fertilizers). Currently, the BGCMA (assisted by the OLM) monitors bacterial contamination (*E. coli*, faecal coliform and/or *Enterococci*) at the estuary mouth and at five stations upstream of the estuary, including the De Bos Dam. Other water quality variables are measured by the Prekstoel Water Treatment Plant (OLM) in water sourced from the De Bos Dam, which is treated to produce potable water. Early detection of low oxygen events, eutrophication risks or bacterial contamination and their appropriate management actions (short to long-term interventions) rely on continued monitoring that is aligned with existing water quality sampling locations and methods of the BGCMA and OLM. KRA 6 – Research and monitoring – presents a more detailed action plan for the implementation of such a monitoring programme, while the recommended monitoring programme in Appendix 2 provides more details regarding temporal and spatial scales for different water quality variables.

The outlet pipe of the De Bos Dam is too small to perform a planned breach of the estuary by releasing large enough volumes to open and scour the estuary mouth when water quality is poor. It is therefore recommended that an emergency mouth management protocol is compiled instead, to mitigate the impacts of (1) low oxygen events and (2) the accidental release of large volumes of untreated sewage into the estuary via overflowing pump stations or damage to sewer lines, posing a

risk to human health. While the estuary should be breached immediately when high volumes of sewage are released, breaching in the case of a low oxygen event should only be conducted if a number of conditions are met. Firstly, DO concentrations in the estuary would have to be lower than 4 mg/l for more than two days and be followed by a further drop to ≤ 2 mg/l. Secondly, mouth breaching should only be undertaken during a spring tide cycle (four days before or three days after the maximum tidal range for the Spring Tide), and when the water level gauge measures at least 1.6 m above mean sea level (natural breaching level ranges from 1.6-2.0 m above MSL). Finally, breaching should not be implemented if storm surges are predicted to occur. Although emergency breaching is predicted to mitigate some of the impacts caused by water pollution, it is important, however, to recognise that emergency breaching is only considered a last resort and that much of the management efforts and resources should be directed towards preventing illegal breaching of the estuary and eliminating pollution at the source.

The MAP for improving water quality includes detailed actions concerning the management of pollutant sources, including identification, licensing, reducing pollutants and ensuring compliance. The drafting and approval of an emergency mouth management protocol has also been recommended as a strategy for improving water quality (Table 2).

Table 2 Management Action Plan to improve water quality of the Onrus Estuary

Strategies	Actions	Deliverables/Indicators	Timing	Implementing agency	Indicative budget
1. Identify pollution sources	a. DWS/BGCMA to conduct a water audit to identify any unlicensed discharges and establish the location and number of water use license holders and the amount of effluent that is discharged in the catchment	<ul style="list-style-type: none"> Water audit has been completed and a licence database is available 	2017	BGCMA, DWS, ODM, OLM	N/A
2. Reduce pollutants into the estuary	a. Lobby farmers to reduce application of inorganic fertilizer and to reduce runoff from livestock holding areas in the catchment	<ul style="list-style-type: none"> Improving water quality in the estuary as evidenced by water quality monitoring data <i>E. coli</i> and Enterococci counts comply with the ranges for good or excellent water quality in terms of the receiving water quality guidelines for recreational use (RSA DEA 2012) 	2016-	BGCMA, DWS, ODM, OLM	R500 000 p.a.
	b. Ensure that malfunctioning conservancy tanks are replaced/upgraded in the Estuarine Management Area				
	c. Improve treatment and diversion of waste water outside of the catchment				
	d. Ensure that sewage pump stations and sewage lines in the Estuarine Management Area are upgraded and maintained to prevent sewage spills				
	e. Improve compliance of water users regarding discharge limits (volume and pollutants) contained in water use licenses	<ul style="list-style-type: none"> Compliance monitoring records are available 	2017-		N/A
3. Compile and implement a mouth management protocol	a. Compile and submit a mouth management protocol for stakeholder review and sign-off	<ul style="list-style-type: none"> Mouth Management Protocol accepted and approved 	2016	RMA, appointed consultants	R150 000
	b. Conduct emergency breaches responsibly and transparently in accordance with the mouth management protocol	<ul style="list-style-type: none"> Post breaching reports are compiled timeously and the public has access to these reports Registered stakeholders are notified and kept up to date leading up to, during and after a breaching event 	2016-	RMA, DWS, CapeNature, DEA, DEADP, consulting specialists	To be determined
	c. Regular review of the Emergency Mouth Management Protocol by specialists	<ul style="list-style-type: none"> Review report is available and the Mouth Management Protocol has been amended accordingly 	2019-	RMA, DWS, CapeNature, DEA, DEADP, consulting specialists	R30 000 every three years

7.3 Key Result Area 3: Improve recreational utility

The Onrus Estuary forms part of an important recreational area along the Cape South Coast. The town of Onrus is home to a well-established resident community and also accommodates a large holidaying community. Onrus Lagoon and its beach together represent a popular recreational area, although its use is somewhat constrained by concerns about its pollution status. The shallow waters in the outlet channel provide a safe area for children to play and swim, while the main waterbody can be explored using craft such as lilos, pedalos, canoes and rowing boats. There is no demand for larger boats or kitesurfing due to the estuary's small size and sheltered location. The Onrus beach on the other hand provides youngsters and adults the opportunity to swim, body surf and surf in the sea. The Onrus Estuary and beach therefore represent a recreational destination for all members of a family and poor water quality are likely to impact on the cultural service provided by both the lagoon and the beach.

The Onrus beach currently does not have Blue Flag Status, which is an international award that is given to beaches, boats and marina's that meet excellence in the areas of safety, amenities, cleanliness and environmental standards. The strict criteria of the programme are set by the international coordinators of the Blue Flag campaign in Europe, the Foundation for Environmental Education (FEE). Obtaining this status could improve recreational value and utility of both the beach and the estuary, thereby also attracting a greater number of international visitors to the Onrus Town with socio-economic benefits to the wider Hermanus area. Currently, the recreational utility of the lagoon is compromised due to poor water quality and does not provide a safe environment for contact recreation. Improving water quality is a key aspect in enhancing recreational utility of the estuary and is dealt with in detail in Section 7.2 (KRA 2).

Appropriate management of reed encroachment should balance requests for open water area by stakeholders against ecological requirements of the estuary. It is recommended that a long-term maintenance and management plan for reed clearing should be drafted for approval by DEADP to negate the need of an Environmental Authorisation (EA) in terms of the NEMA EIA Regulations each time reed clearing is required. This plan should take into account the available budget for reed clearing and as a minimum, identify the reed cover required for ecosystem functioning, delineate the desired state, prioritise areas for clearing and/or delineate areas where ongoing maintenance (i.e. cutting and removal) should take place. The maintenance management plan should also identify the extent and water depth (i.e. sedimentation) which would warrant maintenance dredging.

Development of infrastructure relating to recreational use of the estuary should be implemented in such a way that it caters for and promotes low intensity recreational activities in the middle and upper reaches of the estuary (i.e. birding, hiking) and medium intensity recreational activities near the mouth (infrastructure for managing high densities of people) (see Zonation Plan in Appendix 1).

Table 3 Management Action Plan for improving recreational utility of the Onrus Estuary.

Strategies	Actions	Deliverables/Indicators	Timing	Implementing agency	Indicative budget
1. Establish and manage visitor facilities and promote nature-based tourism	a. Erect informative and educational signage at key access points that highlights the ecological importance and value of the estuary	<ul style="list-style-type: none"> Visitors are sensitive to and aware of activities affecting health and functioning of the estuary, and management regulations governing use of the estuary 	2016-	OLM, ODM	Budget as per KRA 5
	b. Develop appropriate nature friendly infrastructure for visitors to the estuary (ablutions, parking, bird hides, walking paths, nature trails, mountain bike trails) in collaboration with local communities that does not detract from sense of place of the area or impact on the environment. Consider guidelines as per proposed Zonation Plan in Appendix 1.	<ul style="list-style-type: none"> Visitor infrastructure and facilities have been erected, which direct and support medium intensity recreational activities at the mouth and low intensity activities in the middle and upper reaches of the estuary (as per Zonation Plan in Appendix 1). 	2017-		R2.3 M
	c. Ensure that visitor facilities are maintained in good condition at all times to maximise visitor experiences	<ul style="list-style-type: none"> Facilities receive good reviews 	2018-		R50 000 p.a.
2. Manage solid waste pollution in the EMA	a. Erect 'Do not litter' signs in popular recreational spots	<ul style="list-style-type: none"> Signs have been erected and rubbish bins are available and regularly emptied The Onrus Estuary is litter free 	2016-	OLM, ODM	R 15 000 p.a.
	b. Ensure that enough rubbish bins are available and regularly emptied in popular recreational spots				
	c. Ensure enforcement of the by-law relating to the keeping of cats and dogs (2008), which specifies that dog owners must remove and dispose of faeces in public spaces.				
	d. Conduct strategic and regular collection of rubbish in key areas within the EMA				
3. Appropriate and strategic management of reed encroachment	a. Compile and submit a long-term maintenance management plan to negate the need of Environmental Authorisation for each clearing event	<ul style="list-style-type: none"> Maintenance management plan approved 	2017	RMA, DEADP, appointed consultant	R50 000
	b. Implement and update applicable components of the monitoring protocol (Appendix 2)	<ul style="list-style-type: none"> Reed management is informed by data emanating from the monitoring programme 	2017-		Cost as per KRA 6

Strategies	Actions	Deliverables/Indicators	Timing	Implementing agency	Indicative budget
4. Award and maintain Blue Flag status for the Onrus beach	a. Ensure that the Onrus beach is eligible to obtain the Blue Flag status	<ul style="list-style-type: none"> All imperative and guideline requirements have been met 	2018	RMA, OLM, ODM, Wessa Blue Flag	To be determined
	b. Submit application to WESSA Blue Flag	<ul style="list-style-type: none"> Blue Flag status has been awarded 	2019		
	c. Ensure compliance with Blue Flag criteria and requirements to ensure that the status is maintained	<ul style="list-style-type: none"> Blue Flag status is maintained 	2019-		

7.4 Key Result Area 4: Retain sense of place

The Onrus catchment is largely transformed where viticulture is the main agricultural activity in the catchment along with orchards, olive groves, wheat fields and livestock-farming. There is currently relatively little development and use of the margins of the Onrus Estuary and land ownership, current zonation as well as future planning indicates that not much more additional development will occur. The town Onrus has been identified to hold medium potential for development with very low social needs. Furthermore, the Onrus Lagoon and the Onrus WWF Reserve were identified as special places in the Overstrand IDF, which recommends a management approach that aims to protect and manage the functioning of the Onrus River and Estuary as an ecological corridor and linear open space area. The only land that could potentially be developed within and directly adjacent to the estuarine functional zone is the private land on the north bank of upper estuary. This land is zoned agricultural and re-zoning would be necessary prior to development other than for agricultural purposes. Further encroachment of development onto the estuary banks should be prevented to retain the sense of place in the Onrus Lagoon (Table 4).

7.5 Key Result Area 5: Increase awareness and appreciation

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

Table 4 Management Action Plan for retaining the sense of place of the Onrus Estuary.

Strategies	Actions	Deliverables/Indicators	Timing	Implementing agency	Indicative budget
1. Prevent further encroachment by development into the EMA and/or ensure that development is environmentally sensible	a. Finalise and adopt environmental and heritage overlay zones and associated regulations (currently developed by Urban Dynamics Western Cape for the Overstrand Municipality)	<ul style="list-style-type: none"> Overlay Zones included in zoning scheme and regulations gazetted 	2016	OLM, ODM, Urban Dynamics	N/A
	b. Finalise and adopt the zonation plan (Appendix 1), incorporate environmental and heritage overlay zones and regulations once they have been adopted.	<ul style="list-style-type: none"> Final zonation plan ratified and adopted by all stakeholders 	2017	RMA, OLM, ODM	R 50 000

Table 5 Management Action Plan for increasing awareness and appreciation of the Onrus Estuary.

Strategies	Actions	Deliverables/Indicators	Timing	Implementing agency	Indicative budget
1. Create effective mechanisms for on-going communication with stakeholders	a. Develop an effective communication strategy	<ul style="list-style-type: none"> Communication strategy developed 	2016-	RMA, EMF	R 23 000 p.a.
	b. Maintain stakeholder database	<ul style="list-style-type: none"> Stakeholder database is maintained 			
	c. Explore alternative communication mechanisms (workshops, signage, radio etc.)	<ul style="list-style-type: none"> Record of communication is maintained 			
2. Develop an effective education and awareness programme to enhance visitor experiences	a. Establish a visitor centre at the estuary which will act as a focal point where visitors can go to learn more about the estuary, the ecology of the system, and the need for rationale behind existing management interventions	<ul style="list-style-type: none"> Visitors centre open to the public 	2017	OLM, ODM	R 290 000
	b. Source and/ or commission educational and informative material including signage, posters, pamphlets, and relevant literature that will be housed in appropriate localities that will enhance visitor experiences	<ul style="list-style-type: none"> Posters, pamphlets, signage, literature developed and distributed/displayed 	2017		
	c. Encourage field excursions to the estuary by local schools, community groups, and other stakeholder groupings	<ul style="list-style-type: none"> Field excursions undertaken 	2017-	RMA	

7.6 Key Result Area 6: Research and monitoring

The Onrus EMP was drafted based on current understanding of the functioning of the estuary. It is evident that ongoing research and monitoring is required to fill information gaps and to improve the management plan. Increasing use by visitors, development and changes in freshwater supply from the catchment, as well as climate and sea-level change could impact on the health and ecological functioning of the estuary, as well as its value at different spatial scales.

Monitoring and research is essential in enabling the respective agencies responsible for management of the Onrus Estuary to adapt management plans, operational plans and activities to changing circumstances. Key focal areas for monitoring and research associated with the Onrus Estuary include water quantity and quality, sediment dynamics and alien invasive clearing.

Recommended protocols for monitoring the health of the Onrus Estuary are included in Appendix 2. In addition to monitoring the biotic and abiotic health of the Onrus Estuary, it is also strongly recommended that visitor numbers, profiles, behaviour and opinions are monitored on a regular basis to gauge management effectiveness and user responses to management. Monitoring protocols for these aspects are also included in Appendix 2.

7.7 Key Result Area 7: Harmonious and effective governance

According to the National Estuarine Management Protocol (NEMP) the responsible management authority (RMA) for the Onrus Estuary is the Overstrand Local Municipality (OLM). However, at the time of writing, the Supreme Court of Appeal, in the case *Abott vs Overstrand Municipality* (99/2015) [2016] ZASCA 68 (20 May 2016), ruled that the OLM is currently not authorised to manage the Klein Estuary under the provisions of ICMA (i.e. the NEMP). This ruling has repercussions with regards to the management of all estuaries in the OLM, including the Onrus Estuary. Consequently, at this point, neither the OLM nor the Overberg District Municipality (ODM) can take responsibility to coordinate the function of the RMA for the Onrus Estuary until the mandate has been devolved to one of the municipalities. Therefore, defining the RMA for the Onrus Estuary will be a crucial step in the successful implementation of the EMP and has been identified as the first strategy in the Management Action Plan (MAP) for achieving harmonious and effective governance (Table 7).

Owing to their position on the boundary between freshwater, terrestrial and marine environments, management of estuaries requires cooperation from a large number of separate national, provincial and local government agencies, each of these acting under a different legislative mandate. As a minimum the following national government agencies are implicated in management of the Onrus Estuary: Department of Environmental Affairs Branch Oceans and Coasts (DEAO&C), Department of Public Works (DPW), Department of Water and Sanitation (DWS), the Department of Agriculture, Forestry & Fisheries (DAFF). Provincial and local government agencies implicated in management of the estuary include the Department of Environmental Affairs & Development Planning (DEADP), CapeNature, Breede-Gouritz Catchment Management Agency, Overberg District Municipality (ODM), and the OLM.

Ensuring a sufficiently high level of integration and cooperation amongst all of the different agencies involved in the management of the Onrus Estuary extends beyond the mandate and capacity of a

single RMA. The Onrus Estuarine Management Forum (Onrus EMF) provides a platform, which facilitates principal national, provincial and local government agencies to fulfil their respective mandates regarding the management of the Onrus Estuary by serving as a member of the Onrus EMF.

The Onrus EMF also includes representatives of key civil stakeholder groups. The purpose of the Onrus EMF will be to oversee the implementation of the Onrus EMP and to provide a body for stakeholders with an interest in the future of the Onrus Estuary to exchange information and ideas, and to reach agreement on actions for the effective management of the estuary. It is essential that all these agencies work co-operatively to ensure the vision and defined management objectives can be realised. Individual agencies may also have to make provision for the funding required to fulfil their management obligations in the medium and long-term.

Table 6 Management Action Plan for research and monitoring of the Onrus Estuary.

Strategies	Actions	Deliverables/Indicators	Timing	Implementing agency	Indicative budget
1. Promote scientific research	a. Identify information gaps and develop research programme(s) aimed at gathering/ consolidating ecological data	<ul style="list-style-type: none"> Research projects Scientific reports and publications 	2016-	RMA, Universities, research institutions, NGO's	-
	b. Engage local research institutes and universities to collaborate on priority research projects				
	c. Solicit research funding support				
2. Implement monitoring programme for biological, physical and chemical indicators of estuary health (Appendix 2)	a. Determine responsible agencies for each monitoring component (i.e. municipality, conservancies, service providers, CapeNature etc.)	<ul style="list-style-type: none"> Monitoring data and reports are available on a real time basis. Monitoring data and reports inform short-term and long-term management interventions (e.g. reed encroachment, mouth management, alien clearing) 	2016-	RMA, ODM, OLM, BGCMA, DWS, DEA: O&C	R 600 000 p.a.
	i. Lobby local bird club and the Animal Demography Unit (ADU) to incorporate the Onrus estuary into the CWAC programme				
	b. Ensure that each monitoring component has clearly defined methodology				
3. Monitor human use of the estuary	a. Carry out monitoring programme as outlined in Appendix 2				

Table 7 Management Action Plan for harmonious and effective governance.

Strategies	Actions	Deliverables/Indicators	Timing	Implementing agency	Indicative budget
1. Define the RMA for the Onrus Estuary	a. Ensure that a RMA is identified (ODM/OLM) and that responsibility, powers and duties (including access to funds) have been devolved.	<ul style="list-style-type: none"> Agreement in place 	2016	OLM, ODM, DEADP, DEA: O&C	-
	b. Define roles and responsibilities for RMA regarding the management of the Onrus Estuary	<ul style="list-style-type: none"> Roles and responsibilities are clearly defined 			
2. Constitute and maintain the Onrus Estuary Management Forum (Onrus EMF)	c. Invite representatives from stakeholder groups and government agencies to be members of the Onrus EMF	<ul style="list-style-type: none"> Maintain a list of members of the forum and their contact details 	2016	RMA, EMF	R12 000 p.a
	d. Elect a chair and secretary and conduct regular forum meetings	<ul style="list-style-type: none"> Meetings are chaired, minutes of all meetings are compiled, stakeholders are kept informed 	2016-		
3. Define co-operative governance arrangements for management of the Onrus Estuary	a. Onrus EMF to obtain agreement from participating agencies in respect of their roles and responsibilities	<ul style="list-style-type: none"> Signed letters of commitment from all agencies to be involved with the management of the Onrus Estuary 	2016	DEA:O&C, DWS, DPW, DAFF, DEADP, CapeNature, ODM, OLM	-
4. Secure financing	a. Individual government agencies to make provision for the necessary resources in the short, medium and long-term expenditure frameworks to create and fill posts, and acquire necessary infrastructure and resources	<ul style="list-style-type: none"> Provision made for estuary management in budgets and expenditure frameworks 	2016-	DEA:O&C, DWS, DPW, DAFF, DEADP, CapeNature, ODM, OLM	-
	b. Develop a long-term financing plan				
5. Develop adequate resources and capacity	a. Individual agencies to acquire access to necessary equipment (office equipment, water quality meter, boat, vehicle) to ensure effective management	<ul style="list-style-type: none"> Staff & resources are deployed for the management of the Onrus Estuary 	2017	DEA:O&C, DWS, DPW, DAFF, DEADP, CapeNature, ODM, OLM	-
	b. Individual agencies to identify and address training needs among staff	<ul style="list-style-type: none"> Training records 			

Strategies	Actions	Deliverables/Indicators	Timing	Implementing agency	Indicative budget
	involved in estuary management				
	c. Evaluate performance of staff, contractors and volunteers	<ul style="list-style-type: none"> Performance evaluation 	2018-		
6. Ensure that all stakeholders are informed regarding management progress and challenges faced	a. Create and administer a website for the Onrus EMF (upload minutes, photos, data, monitoring reports. Possibly include a blog to facilitate discussions)	<ul style="list-style-type: none"> Website is available and up to date 	2017	RMA, EMF (website to be administered as a part of the ODM/OLM?)	To be determined

7.8 Summary of management actions and timing

Table 8 provides a summary of the tasks to be carried out over the next 5 years for the implementation of the Onrus EMP. The RMA (to be determined) will be assisted by the Onrus EMF and a range of other government agencies including but not limited to the Breede Gouritz Catchment Management Agency (BGCMA), Department of Water and Sanitation (DWS), Department of Environmental Affairs - Branch Oceans and Coasts (DEA: O&C), Department of Agriculture, Forestry & Fisheries (DAFF), the Department of Environmental Affairs & Development Planning (DEADP), Cape Nature.

Table 8 Summary of actions and timing of actions pertaining to each of the key result areas over the period August 2016 – August 2021

Key Result Area	Action	Implementing agency	2016	2017	2018	2019	2020	2021
1. Improve estuary health	Assess water use (who, where and how much) in the catchment, negotiate highest environmental release volume for the estuary and install flow gauge(s) at the outlet of the De Bos Dam	BGCMA, DWS						
	Develop operating rules for the De Bos Dam							
	Ensure compliance with water use licenses							
	Assess extent of alien invasive species, prioritise areas and clear alien invasive species	BGCMA, DEA, DEADP, SANBI, CapeNature, OLM, ODM						
	Assess sediment sources and prioritise stretches of the Onrus River for rehabilitation	BGCMA, SANBI, CapeNature, OLM, ODM						
2. Improve water quality	Identify pollution sources, reduce pollutants	BGCMA, DWS, ODM, OLM						
	Compile, submit and approve an emergency mouth management plan	RMA, appointed consultants						
	Regular review of emergency mouth management plan	RMA, DWS, CapeNature, DEA, DEADP, consulting specialists						
3. Improve recreational utility	Erect informative and educational signage, develop appropriate nature friendly infrastructure, maintain facilities	ODM, OLM						
	Manage solid waste pollution by erecting signs, ensuring that enough rubbish bins are available, ensure compliance with by-laws, regular collection of rubbish	ODM, OLM						
	Compile, submit and approve a maintenance management plan for the clearing of reeds to negate the need of Environmental Authorisation	RMA, DEADP, appointed consultant						
	Obtain and maintain Blue Flag Status for the Onrus Estuary	RMA, OLM, ODM, Wessa Blue Flag						
4. Retain sense of place	Finalise and adopt environmental and heritage overlay zones and associated regulations	OLM, Urban Dynamics						
	Finalise and adopt the zonation plan	RMA, OLM, ODM						
5. Increase awareness and	Create effective mechanisms for on-going communication	RMA, EMF						

Key Result Area	Action	Implementing agency	2016	2017	2018	2019	2020	2021
appreciation	with stakeholders							
	Establish visitor centre, make educational and informative material accessible to stakeholders	OLM, ODM						
	Undertake field excursions to the estuary by local schools, community groups etc.	RMA						
6. Research and monitoring	Promote scientific research	RMA, Universities, research institutions, NGO's						
	Implement monitoring programme for biological, chemical and physical indicators of health, as well as human use of the estuary	RMA, ODM, OLM, BGCMA, DWS, DEA: O&C						
7. Harmonious and effective governance	Define RMA for the management of the Onrus Estuary and assign responsibilities	OLM, ODM, DEADP, DEA: O&C						
	Found and maintain the Onrus Estuary Management Forum	RMA, EMF						
	Secure financing with individual government agencies	DEA:O&C, DWS, DPW, DAFF, DEADP, CapeNature, ODM, OLM						
	Individual agencies to acquire access to necessary equipment and to train staff appointed for estuary management	DEA:O&C, DWS, DPW, DAFF, DEADP, CapeNature, ODM, OLM						
	Create and administer a website for the Onrus EMF	RMA, EMF						

8 APPENDICES

8.1 Appendix 1: Proposed Onrus Zonation Plan

The Onrus is a small estuary and is of low importance for estuarine biodiversity on a national scale, ranking 94th of all South African estuaries in terms of its overall conservation importance. Consequently the Onrus Estuary was not included on the list of estuaries that require partial or full protection in order to meet South Africa's biodiversity targets for conservation of estuarine biodiversity (Van Niekerk and Turpie 2012). Nevertheless, the Onrus Estuary is an important recreational area along the Cape South Coast. On the eastern bank, land donated to WWF (then Southern African Nature Foundation) in the early 1990s and a demarcated bird sanctuary still has a rich plant community with species representative of Overberg Dune Strandveld. The sanctuary was previously cleared of invasive vegetation by the Onrus Lagoon Trust and municipality, but follow-up work has not taken place for some time. This area is fenced off from the adjoining Habonim property, which is heavily infested with invasive alien acacias.

The estuary faces pressure from reduced freshwater inflow due to the upstream De Bos Dam, increasing tourism at the estuary mouth, deteriorating water quality and alien invasive vegetation. Although the Present Ecological State of the Onrus Estuary falls within an Ecological Category of D (MacKenzie 2015), it is likely that the estuary is on a negative trajectory of change if the situation remains unmanaged. Increasing developmental pressures in the Onrus resulting from increasing popularity as a holiday destination could have negative impacts on water quality and available water quantity for the ecological reserve.

A zonation plan has been prepared for the Onrus Estuary Management Area (Section 3.1.3) in accordance with the Integrated Coastal Management Act (2008) taking consideration of discussions with and submissions received from stakeholders engaged in the development of the Onrus Estuary Situation Assessment Report (Massie and Clark 2016). The objectives of this zonation plan are to:

1. Protect remaining natural habitat and facilitate rehabilitation of degraded areas; and
2. Manage recreational activities in the estuary;
3. Ensure user safety; and
4. Limit disturbance of sensitive species.

Five spatial management zones were defined for the EMA, namely Conservation 1, Conservation 2, Riparian Buffer Zone, Medium and Low Intensity Use Areas (Figure 4). The purpose of the management zones, goals to be achieved and management guidelines are detailed in Table 9. Note that no restrictions are placed on exploitation of living resources in the Onrus Estuary.

The zonation plan represents the best possible means of satisfying the various conflicting requirements of the different user groups and stakeholders who wish to enjoy the benefits provided by the Onrus Estuary. Zonation will allow for partitioning of activities (i.e. recreation, alien invasive plants clearing within the estuary, conservation efforts in the WWF nature reserve on the eastern bank) thus permitting their co-existence without one activity precluding or conflicting with another. It will also reduce management costs as it will focus activities in particular geographic areas and hence eliminate the need to deploy all types of management staff across the whole estuary at all times.

It should be noted that Urban Dynamics (Western Cape) were appointed by the Overstrand Municipality to compile Environmental and Heritage Overlay Zones for inclusion in the Overstrand Municipal Zoning Scheme. Overlay zones provide a mechanism for land use management, additional to the base zone controls of a property, whereby Council may give effect to specific guidelines in a spatial development framework or policy plan or address a specific management issue. Within specified areas these guidelines could promote development, require a limitation of land uses, define additional, stipulate more or less restrictive development rules, or identify specific development rules or administrative procedures. Overlay zones provide a mechanism for elevating specific policy guidelines to land use regulations. The draft overlay zones are currently being refined for delivery and once finalised, the Zonation Plan should be revisited to ensure compatibility with these overlay zones.



Figure 4 Draft Zonation Plan for the Onrus Estuarine Management Area.

Table 9 Details, purpose, goals and management guidelines for recommended spatial planning categories for the Onrus Estuary.

Spatial Management Zones	Description and Location	Purpose	Goals	Management Guidelines
Conservation 1	WWF Nature Reserve and Bird Sanctuary situated on the eastern bank of the estuary	Conservation of biodiversity	<ul style="list-style-type: none"> • <i>In situ</i> conservation of biodiversity, serving to attain the minimum target for conservation of 50% of the estuarine margin, as established in the Conservation Plan for Temperate South African Estuaries (Turpie and Clark 2007) • Only nature-friendly low-impact outdoor activities • Protect sense of place of the estuary 	<ul style="list-style-type: none"> • No further fragmentation of remaining vegetation by creating informal pathways due to the small size of the nature reserve • No development of permanent structures • Invasive alien vegetation management programme in place • No hardening of estuarine banks • No clearing of coastal vegetation or disturbance of dunes or dune vegetation
Conservation 2	Not formally protected Estuarine Management Area that is open water (i.e. including reed beds) or municipal land	Link relatively untransformed municipal land to Conservation 1 category areas and the river corridor	<ul style="list-style-type: none"> • Halt transformation of remaining untransformed natural environments • Rehabilitate degraded areas • Formalise access to the estuary to minimise fragmentation of remaining habitat • Protect sense of place of the estuary 	<ul style="list-style-type: none"> • No new development outside the existing footprint of transformed areas • No cultivation except where rehabilitation is underway • No clearing of indigenous vegetation on public land except for facilities in line with MAP for improving recreational value (e.g. boardwalks, bird hides, access points for fishing). Encourage private land owners to assist the rehabilitation process. • Rehabilitate transformed and degraded areas • Invasive alien vegetation management programme in place • No <i>in situ</i> sewage discharge or disposal of solid waste within 100 m of the estuary bank • No hardening of estuarine banks • No new slipways and access points to the estuary • No establishment of new informal paths, formalise selected existing paths
Riparian Buffer Zone	Not formally protected Estuarine Management Area that is open water or private land	Assist in maintaining ecological integrity of the Onrus Estuary	<ul style="list-style-type: none"> • Reduce sediment load surface run-off and leaching of pollutants into the estuary. • Control of invasive alien vegetation. 	<ul style="list-style-type: none"> • Invasive alien vegetation management programme in place where possible • No fertilisers or pesticides to be used • No hardening of estuarine banks

Spatial Management Zones	Description and Location	Purpose	Goals	Management Guidelines
			<ul style="list-style-type: none"> Mitigate visual impact of development. Protect sense of place of the estuary 	<ul style="list-style-type: none"> No septic tank, soakaway, solid or liquid waste disposal within 50 m of the river bank.
Medium Intensity Use Area	South of the separation line, i.e. lagoon, estuary mouth and beach	Promote well managed use of the estuary mouth during the peak holiday season (December-January)	<ul style="list-style-type: none"> Develop appropriate infrastructure that supports and caters for recreational activities Protect sense of place of the estuary 	<ul style="list-style-type: none"> Develop infrastructure that caters for and promotes low intensity recreational activities in the middle and upper reaches of the estuary (i.e. birding, hiking) and medium intensity recreational activities near the mouth (infrastructure for managing high densities of people)
Low Intensity Use Area	North of the separating line, i.e. remaining estuary	Promote nature-friendly outdoor activities like hiking and bird watching		

8.2 Appendix 2: Recommended Monitoring Protocol for the Onrus Estuary

Table 10 provides a list of recommended abiotic and biotic parameters to be monitored for the Onrus Estuary. These generic recommendations were sourced from RSA DWS (2015) and were adapted where necessary to reflect the specific needs of the Onrus Estuary and to align future monitoring with existing monitoring wherever possible. Currently, the BGCMA (assisted by the OLM) monitors bacterial contamination (*E. coli*, faecal coliform and/or *Enterococci*) at the estuary mouth and at five stations upstream of the estuary, including the De Bos Dam. Other water quality variables are measured by the Preekstoel Water Treatment Plant in water sourced from the De Bos Dam, which is treated to produce potable water.

Early detection of low oxygen events, eutrophication risks or bacterial contamination and their appropriate management actions (short to long-term interventions) rely on continued monitoring that is aligned with existing water quality sampling locations and methods of the BGCMA and OLM. Refer to Table 11 and Figure 5 for the location of the recommended water quality monitoring stations. In line with the recommendations by RSA DWS (2015), the monitoring programme includes a baseline survey and ongoing monitoring thereafter to assess changes in health of the system over time. Recommendations for monitoring of visitor numbers, profiles and opinions, and angler catch and effort required in terms of the management plan are also included here.

Table 10 Recommended baseline and long-term monitoring protocols for the Onrus Estuary. Monitoring parameters include biotic and abiotic components (Modified from the generic monitoring protocol in RSA DWS (2015)).

Ecological component	Monitoring Action	Temporal Scale (frequency and when)	Spatial Scale (No. Stations)
Hydrology	Record river inflow near the head of the estuary	Continuous	Install recorder at existing water quality monitoring station ON2
	Obtain control release volumes from the De Bos Dam	Monthly, once gauge has been installed	Control release point of the De Bos Dam
Hydrodynamics	Record water level in metres above mean sea level	Hourly	Existing recorder G4T011 – operational since 1994
	Aerial photography (or using high resolution satellite imagery i.e. 5x5 m pixel size, e.g. Google Pro or BirdEye)	Once-off (baseline), thereafter every three years	Entire EMA
	Monitor mouth state: <ul style="list-style-type: none"> Take at least one photo from the same angle each time Note whether the estuary is open, closed or overflowing Note whether there is evidence of illegal artificial breaching 	Bi-monthly	Mouth
Sediment dynamics	Monitor berm height using appropriate technologies (Lidar or topographic survey)	Quarterly	Mouth
	Bathymetric surveys. Series of cross section profiles and a longitudinal profile	Once-off (baseline), thereafter every five years and after large re-setting events	Entire EMA. Fixed 100 m intervals but in more detail at the mouth including the berm (every 50 m). Vertical accuracy at least 5 cm
	Collect sediment grab samples (at cross section profiles) for analysis of particle size distribution (and ideally origin, i.e. microscopic observations)	Once-off (baseline), thereafter every five years	Entire estuary
Water quality	Electrical conductivity	Monthly	At station ON2 Old Bridge
	Salinity and temperature profiles	Quarterly	At all stations except at ON2 Old Bridge
	Dissolved oxygen and surface water temperature (hand held instrument)	Every two weeks. If DO drops to 3-4 mg/l increase frequency to daily measurements until DO level >4 mg/l for more than two consecutive days. DO must be measured at or before sunrise (DO minimum	At all stations

Ecological component	Monitoring Action	Temporal Scale (frequency and when)	Spatial Scale (No. Stations)
		expected at night). Take daily measurements for 30 days after sewage pumps overflow or sewage lines leak.	
	pH, nitrate, nitrite, ammonia, phosphate, total suspended solids	Monthly	At all stations
	Measure pesticides/herbicides and metal accumulation in sediments (for metals investigate establishment of distribution models – see Newman and Watling (2007)).	Once-off (baseline), thereafter every three to six years if baseline results show contamination	At all stations and depositional areas (i.e. muddy areas, to be determined)
	<i>E. coli</i> and <i>Enterococci</i>	According to the existing sampling protocol. This protocol requires bi-monthly sampling and in the case of a spillage, international sampling guidelines are followed.	At all stations. In case of sewage leak only downstream station of the source.
Microalgae	Record relative abundance of dominant phytoplankton groups, i.e. flagellates, dinoflagellates, diatoms, chlorophytes and blue-green algae	Quarterly, preferably for two years. Thereafter every three years	Along length of estuary, minimum five stations
	Chlorophyll-a measurements taken at the surface, 0.5 m and 1 m depths, under typically high and low flow conditions using a recognised technique, e.g. spectrophotometer, HPLC, fluoroprobe.		
	Intertidal and subtidal benthic chlorophyll-a measurements (4 replicates each) using a recognised technique, e.g. sediment corer or fluoroprobe		
Macrophytes (including the common reed)	Map area covered by different macrophyte habitats using recent imagery. Conduct field survey to record total number of macrophytes habitats, identification and total number of macrophytes species, number of rare or endangered species, or those with limited populations. Assess extent of invasive species in EMA.	Once-off in summer (baseline). Thereafter every three years in summer	Entire EMA
	Map extent of common reed and bulrush	Annually	Entire EMA
Invertebrates	Collect duplicate zooplankton samples at night from mid-water levels using WP2 nets (190 um mesh) along estuary.	Quarterly, preferably for two years (baseline). Thereafter every	Minimum of three sites along length of entire estuary

Ecological component	Monitoring Action	Temporal Scale (frequency and when)	Spatial Scale (No. Stations)
	<p>Collect sled samples (day) at same zooplankton sites for hyper benthos (190 um).</p> <p>Collect grab samples (5 replicates) (day) from the bottom substrate in mid-channel areas at same sites as zooplankton (each samples to be sieved through 500 um).</p> <p>Intertidal invertebrate hole counts using 0.25 m² grid (5 replicates per site).</p> <p>Establish the species concerned (<i>Callichirus kraussi</i> or <i>Upogebia Africana</i>) using a prawn pump.</p> <p>Collect sediment samples using the grab for particle size analysis and organic content (at same sites as zooplankton) (preferably link with sediment dynamics)</p>	two years in mid-summer	For hole counts –three sites in each of muddy or sandy areas,
Fish	<ul style="list-style-type: none"> ▪ Record species and abundance of fish, based on seine net and gill net sampling. Sampling with a small beam trawl for channel fish should also be considered. ▪ Seine net specifications: 30 m x 2m, 15 mm bar mesh seine with a with a 5mm bar mesh 5 m either side and including the cod-end. ▪ Gill nets specifications: Set of gill nets each panel 30 m long by 2 m deep with mesh sizes of 44 mm, 48 mm, 51 mm, 54 mm, 75 mm, 100 mm and 145 mm ▪ Gill net sampling can be replaced by a large mesh seine (44 mm stretch mesh, 100 m x 2 m). ▪ Trawl specification: 2 m wide by 3 m long, 10 mm bar nylon mesh in the main net body and a 5 mm bar in the cod-end 	Once-off in spring/ summer and autumn/ winter (baseline). Thereafter bi-annually spring/summer and autumn/winter	3 stations (mouth-mid-top of EMA)
Birds	Undertake counts of all water-associated birds. All birds should be identified to species level and total number of each counted.	Conduct bi-annual CWAC counts	Entire EMA
Human use	Collect statistics on the profile (origin, sex, age, income category) and activities of visitors to the Onrus Estuary using self-fill in questionnaires	Continuous	Visitor entry points and key sites of interest
	Survey visitor and local opinions on impacts of key management interventions	Every two years	Entire EMA

Table 11 GPS location and status of recommended water quality monitoring stations and water level metre in the Onrus Estuarine Management Area.

Monitoring station	Status	Agency	GPS coordinates
ON1: Estuary mouth	Existing	BGCMA, assisted by OLM	34° 25.054'S 19° 10.712'E
Private golf course	New	BGCMA, assisted by OLM	34° 24.827'S, 19° 10.720'E
ON2: Old Bridge	Existing, Install water flow meter	BGCMA, assisted by OLM	34° 24.652'S, 19° 11.573'E
G4T011	Existing water level gauge 13 November 1994 - present	DWS	34° 24.983'S, 19° 10.683'E

**Figure 5** Recommended water quality stations and location of the water level gauge (DWS G4T011) in the Onrus Estuarine Management Area.

8.3 Appendix 3: Listed activities for which an EIA is required for estuaries in the Western Cape according to the National Environmental Management Act (NEMA)

GN R. 983: Listing Notice 1 – Basic Assessment

List No.	Activity description
17	<p>Development-</p> <ul style="list-style-type: none"> (i) in the sea; (ii) in an estuary; (iii) within the littoral active zone; (iv) in front of a development setback; or (v) if no development setback exists, within a distance of 100 metres inland of the high-water mark of the sea or an estuary, whichever is the greater; (vi) water mark of the sea or an estuary, whichever is the greater; <p>in respect of-</p> <ul style="list-style-type: none"> (a) fixed or floating jetties and slipways; (b) tidal pools; (c) embankments; (d) rock revetments or stabilising structures including stabilising walls; (e) buildings of 50 square metres or more; or (f) infrastructure with a development footprint of 50 square metres or more - <p>but excluding-</p> <ul style="list-style-type: none"> I. the development of infrastructure and structures within existing ports or harbours that will not increase the development footprint of the port or harbour; II. where such development is related to the development of a port or harbour, in which case activity 26 in Listing Notice 2 of 2014 applies; III. the development of temporary infrastructure or structures where such structures will be removed within 6 weeks of the commencement of development and where indigenous vegetation will not be cleared; or IV. where such development occurs within an urban area.
19	<p>The infilling or depositing of any material of more than 5 cubic metres into, or the dredging, excavation, removal or moving of soil, sand, shells, shell grit, pebbles or rock of more than 5 cubic metres from-</p> <ul style="list-style-type: none"> (i) a watercourse; (ii) the seashore; or (iii) the littoral active zone, an estuary or a distance of 100 metres inland of the high-water mark of the sea or an estuary, whichever distance is the greater – <p>but –</p> <p>excluding where such infilling, depositing, dredging, excavation, removal or moving-</p> <ul style="list-style-type: none"> (a) will occur behind a development setback; (b) is for maintenance purposes undertaken in accordance with a maintenance management plan; or (c) management plan; or (d) falls within the ambit of activity 21 in this Notice, in which case that activity applies.
54	<p>The expansion of facilities -</p> <ul style="list-style-type: none"> (i) in the sea; (ii) in an estuary; (iii) within the littoral active zone; (iv) in front of a development setback; or (v) if no development setback exists, within a distance of 100 metres inland of the high water mark of the sea or an estuary, whichever is the greater; <p>in respect of-</p> <ul style="list-style-type: none"> (a) fixed or floating jetties and slipways; (b) tidal pools; (c) embankments; (d) rock revetments or stabilising structures including stabilising walls; (e) buildings where the building is expanded by 50 square metres or more; or (f) infrastructure where the development footprint is expanded by 50 square metres or more, <p>but excluding-</p> <ul style="list-style-type: none"> I. the expansion of infrastructure or structures within existing ports or harbours that

List No.	Activity description
	II. will not increase the development footprint of the port or harbour; or (a) III. where such expansion occurs within an urban area.
55	Expansion- (i) in the sea; (ii) in an estuary; (iii) within the littoral active zone; (iv) in front of a development setback; or (v) if no development setback exists, within a distance of 100 metres inland of the high water mark of the sea or an estuary, whichever is the greater; in respect of- (a) facilities associated with the arrival and departure of vessels and the handling of cargo; (b) piers; (c) inter- and sub-tidal structures for entrapment of sand; (d) breakwater structures; (e) coastal marinas; (f) coastal harbours or ports; (g) tunnels; or (h) underwater channels; but excluding the expansion of infrastructure or structures within existing ports or harbours that will not increase the development footprint of the port or harbour.

GN R. 984 Listing Notice 2: Scoping & EIA

List No.	Activity description
	Development-- (i) in the sea; (ii) in an estuary; (iii) within the littoral active zone; (iv) in front of a development setback; or (v) if no development setback exists, within a distance of 100 metres inland of the high-water mark of the sea or an estuary, whichever is the greater; in respect of - (a) facilities associated with the arrival and departure of vessels and the handling of cargo; (b) piers; (c) inter- and sub-tidal structures for entrapment of sand; (d) breakwater structures; (e) coastal marinas; (f) coastal harbours or ports; (g) tunnels; or (h) underwater channels; but excluding the development of structures within existing ports or harbours that will not increase the development footprint of the port or harbour.

GN R. 985 Listing Notice 3: Basic Assessment

List No.	Activity description
4	The development of a road wider than 4 metres with a reserve less than 13,5 metres. (f) In Western Cape: i. Areas outside urban areas; I. Areas containing indigenous vegetation; II. Areas on the estuary side of the development setback line or in an estuarine functional zone where no such setback line has been determined; or ii. In urban areas: I. Areas zoned for conservation use; or I. II. Areas designated for conservation use in Spatial Development Frameworks adopted by

List No.	Activity description
	the competent authority.
5	<p>The development of resorts, lodges, hotels and tourism or hospitality facilities that sleep less than 15 people.</p> <p>(a) A protected area identified in terms of the NEMPAA;</p> <p>(b) Outside urban areas within 10 kilometres from national parks or world heritage sites or 5 kilometres from any other protected area identified in terms of NEMPAA or from the core area of a biosphere reserve;</p> <p>(h) In Western Cape:</p> <p>(i) Critical biodiversity areas as identified in systematic biodiversity plans adopted by the competent authority or in bioregional plans;</p> <p>(ii) Outside urban areas, in:</p> <p>I. Areas seawards of the development setback line or within 1 kilometre from the high-water mark of the sea if no such development setback line is determined;</p> <p>II. Areas on the watercourse side of the development setback line or within 100 metres from the edge of a watercourse where no such setback line has been determined; or</p> <p>III. Areas on the estuary side of the development setback line or within an estuarine functional zone where no such setback line has been determined.</p> <p>(iii) IV. Areas on the estuary side of the development setback line or within an estuarine functional zone where no such setback line has been determined.</p>
10	<p>The development of facilities or infrastructure for the storage, or the storage and handling of a dangerous good, where such storage occurs in containers with a combined capacity of 30 but not exceeding 80 cubic metres.</p> <p>(g) In Western Cape:</p> <p>i. All areas outside urban areas; or</p> <p>ii. Inside urban areas:</p> <p>I. Areas seawards of the development setback line or within 200 metres from the high-water mark of the sea if no such development setback line is determined;</p> <p>II. Areas on the watercourse side of the development setback line or within 100 metres from the edge of a watercourse where no such setback line has been determined; or</p> <p>iii. III. Areas on the estuary side of the development setback line or in an estuarine functional zone where no such setback line has been determined.</p>
13	<p>The development and related operation of facilities of any size for any form of aquaculture.</p> <p>(d) In Western Cape:</p> <p>i. Areas on the estuary side of the development setback line or in an estuarine functional zone where no such setback line has been determined;</p> <p>ii. In a Protected area identified in terms of NEMPAA; and</p> <p>iii. In an aquatic critical biodiversity area.</p>
14	<p>The development of-</p> <p>(i) canals exceeding 10 square metres in size ;</p> <p>(ii) channels exceeding 10 square metres in size;</p> <p>(iii) bridges exceeding 10 square metres in size;</p> <p>(iv) dams, where the dam, including infrastructure and water surface area exceeds 10 square metres in size;</p> <p>(v) weirs, where the weir, including infrastructure and water surface area exceeds 10 square metres in size;</p> <p>(vi) bulk storm water outlet structures exceeding 10 square metres in size;</p> <p>(vii) marinas exceeding 10 square metres in size;</p> <p>(viii) jetties exceeding 10 square metres in size;</p> <p>(ix) slipways exceeding 10 square metres in size;</p> <p>(x) buildings exceeding 10 square metres in size;</p> <p>(xi) boardwalks exceeding 10 square metres in size; or</p> <p>(xii) infrastructure or structures with a physical footprint of 10 square metres or more</p> <p>Where such development occurs –</p> <p>(a) Within a watercourse;</p> <p>(b) In front of a development setback; or</p> <p>(c) If no development setback has been adopted, within 32 metres of a watercourse, measured from the edge of a watercourse;</p> <p>Excluding the development of infrastructure or structure within existing ports or harbours that will not increase the development footprint of the port or harbour.</p>

List No.	Activity description
	(f) In Western Cape: i. Outside urban areas, in: <ol style="list-style-type: none"> I. A protected area identified in terms of NEMPAA, excluding conservancies; II. National Protected Area Expansion Strategy Focus areas; III. World Heritage Sites; IV. Sensitive areas as identified in an environmental management framework as contemplated in chapter 5 of the Act and as adopted by the competent authority; V. Sites or areas listed in terms of an International Convention; VI. Critical biodiversity areas or ecosystem service areas as identified in systematic biodiversity plans adopted by the competent authority or in bioregional plans; VII. Core areas in biosphere reserves; or VIII. VIII. Areas on the estuary side of the development setback line or in an estuarine functional zone where no such setback line has been determined.
18	The expansion and related operation of above ground cableways and funiculars where the development footprint will be increased. (f) In Western Cape: All areas outside urban areas: <ol style="list-style-type: none"> I. Areas containing indigenous vegetation; II. Areas on the estuary side of the development setback line or in an estuarine functional zone where no such setback line has been determined; or ii. In urban areas: <ol style="list-style-type: none"> I. Areas zoned for conservation use; or I. II. Areas designated for conservation use in Spatial Development Frameworks adopted by the competent authority.
21	The expansion of tracks or routes for the testing, recreational use or outdoor racing of motor powered vehicles excluding conversion of existing tracks or routes for the testing, recreational use or outdoor racing of motor powered vehicles, where the development footprint will be expanded. (g) In Western Cape <ol style="list-style-type: none"> I. Areas on the estuary side of the development setback line or in an estuarine functional zone where no such setback line has been determined; II. Seawards of the development setback line or within 200 metres from the high water mark of the sea if no such development setback line is determined; or II. III. Areas containing indigenous vegetation;
22	The expansion of facilities or infrastructure for the storage, or the storage and handling of a dangerous good, where such storage occurs in containers with a combined capacity of 30 but not exceeding 80 cubic metres. (g) In Western Cape: <ol style="list-style-type: none"> i. All areas outside urban areas; or ii. Inside urban areas: <ol style="list-style-type: none"> I. Areas seawards of the development setback line or within 200 metres from the high-water mark of the sea if no such development setback line is determined; II. Areas on the watercourse side of the development setback line or within 100 metres from the edge of a watercourse where no such setback line has been determined; or III. Areas on the estuary side of the development setback line or in an estuarine functional zone where no such setback line has been determined.
24	The expansion and related operation of facilities of any size for any form of aquaculture. (d) In Western Cape: <ol style="list-style-type: none"> i. Areas on the estuary side of the development setback line or in an estuarine functional zone where no such <ol style="list-style-type: none"> I. setback line has been determined; ii. In a Protected area identified in terms of NEMPAA; and II. iii. In an aquatic critical biodiversity area.

9 REFERENCES

- Breitburg, DL. 2002. "Effects of Hypoxia, and the Balance between Hypoxia and Enrichment, on Coastal Fishes and Fisheries." *Estuaries* 25:767–81.
- CSIR. 1991. *A Review of Potential Rehabilitation Options for Onrus Lagoon*. Cerff EC & Geustyn L (eds). CSIR Report EMA C91125. Council for Scientific and Industrial Research, Stellenbosch.
- Diaz, RJ and R. Rosenberg. 1995. "Marine Benthic Hypoxia: A Review of Its Ecological Effects and the Behavioral Responses of Benthic Macrofauna." *Oceanography and Marine Biology Annual Review* 33:245–303.
- Heineken, TJE and KstJ Damstra. 1983. *Estuaries of the Cape, Report No. 24 : Onrus. CSIR Research Report 423*. Council for Scientific and Industrial Research, Stellenbosch.
- MacKenzie, J. 2015. *Kidbrooke Sewer Upgrade and River Rehabilitation of the Lower Onrus River, Hermanus*. Mackenzie Ecological and Development Services, Report to Guillaume Nel Environmental Consultants Pty (Ltd) Paarl.
- Massie, V. and B. M. Clark. 2016. *Onrus Estuary Situation Assessment Report. Report Prepared for the Overstrand Municipality by Anchor Environmental Consultants (Pty) Ltd. 119 Pp.*
- Newman, BK and J. Watling. 2007. "Definition of Baseline Metal Concentrations for Assessing Metal Enrichment of Sediment from the South-Eastern Cape Coastline of South Africa." *Water SA* 33(5):675–92.
- Van Niekerk, L. and J. K. Turpie. 2012. *South African National Biodiversity Assessment 2011: Technical Report. Volume 3: Estuary Component*. CSIR Report Number CSIR/NRE/ECOS/ER/2011/0045/B. Council for Scientific and Industrial Research, Stellenbosch.
- Nixon, SW. 1995. "Coastal Marine Eutrophication: A Definition, Social Causes, and Future Concerns." *Ophelia* 41:199–219.
- Pearson, TH and R. Rosenberg. 1978. "Macrobenthic Succession in Relation to Organic Enrichment and Pollution of the Marine Environment." *Oceanography and Marine Biology Annual Revue* 163:229–311.
- RSA DWS. 2015. *Reserve Determination Studies for the Selected Surface Water, Groundwater, Estuaries and Wetlands in the Gouritz Water Management Area: Monitoring Report*. Prepared by Koekemoer Aquatic Services and Scherman Colloty & Associates cc.. Report no. RDM/WMA16/00/CON/1213.
- Turpie, J. K. and B. M. Clark. 2007. *The Health Status, Conservation Importance, and Economic Value of Temperate South African Estuaries and Development of a Regional Conservation Plan*. Anchor Environmental Consultants (Pty) Ltd, Report to CapeNature.
- Turpie, J. K., G. Wilson, and L. Van Niekerk. 2012. *National Biodiversity Assessment 2011: National Estuary Biodiversity Plan for South Africa*. Anchor Environmental Consultants Report No AEC2012/01, Cape Town. Report produced for the Council for Scientific and Industrial Research and the South African National Biodiversity Institute.
- USEPA. 2001. *Nutrient Criteria Technical Guidance Manual: Estuarine and Coastal Marine Waters*. EPA-822-B-01-003. Office of Water, Office of Science and Technology, Washington, D.C.
- USEPA. 2003. *Ambient Water Quality Criteria for Dissolved Oxygen, Water Clarity and Chlorophyll a*

for the Chesapeake Bay and Its Tidal Tributaries. EPA 903-R-03-002. US EPA Region III, Annapolis, MD, Region III Water Protection Division, Philadelphia, PA, and Office of Water, Office of Science and Technology, Washington, DC.

Wannamaker, CM and J. Rice. 2000. "Effects of Hypoxia on Movements and Behavior of Selected Estuarine Organisms from the Southeastern United States." *Journal of Experimental Marine Biology and Ecology* 249:145–63.

WSP Africa Coastal Engineers. 2010. *Development of a Methodology for Defining and Adopting Coastal Development Set-Back Lines*. Volume 1. Main report. Report prepared for Department of Environmental Affairs and Developing Planning, Western Cape Government, 81 pp.

