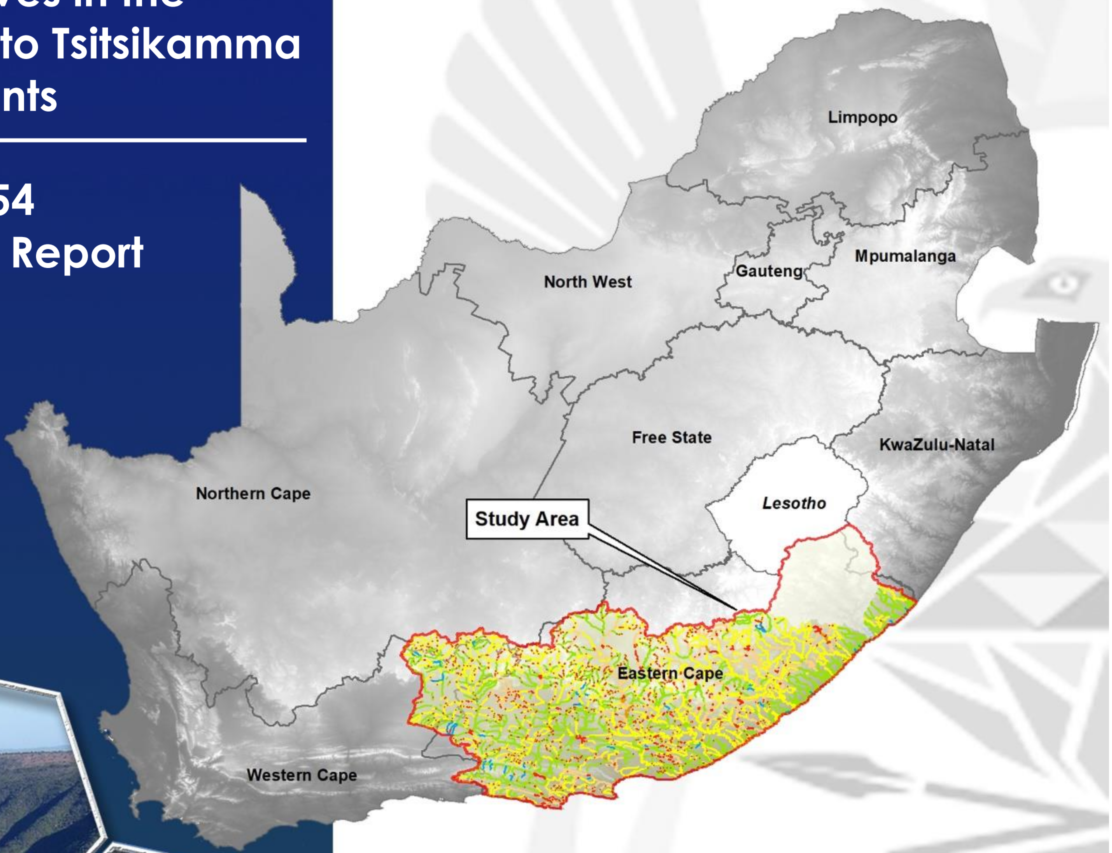
DEPARTMENT OF WATER AND SANITATION

Determination of Water Resource Classes, Reserve and the Resource Quality Objectives in the Keiskamma and Fish to Tsitsikamma Catchments

WP11354
Final Estuary Report



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GroundTruth

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DOCUMENT INDEX

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Bold type indicates this report

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LIST OF ACRONYMS

BAS	Best Attainable State
BHN	Basic Human Needs
CD: WEM	Chief Directorate: Water Ecosystems Management
DFFE	Department of Forestry, Fisheries and the Environment
DIN	Dissolved Inorganic Nitrate
DIP	Dissolved Inorganic Phosphate
DWA	Department of Water Affairs
DWAF	Department of Water Affairs and Forestry
DWS	Department of Water and Sanitation
EC	Ecological Category
EGSAs	Ecological Goods, Services and Attributes
EFR	Environmental flow Requirements
EFZ	Estuary Functional Zone
EHI	Estuarine Health Index
EI	Ecological Importance
EIS	Estuary Importance Score
ES	Ecological sensitivity
EWR	Ecological Water Requirements
GBF	2030 Global Biodiversity Framework
HABS	Harmful algal blooms
ICM	Integrated Coastal Management
IUA	Integrated Units of Analysis
IWRM	Integrated Water Resource Management
MAR	Mean Annual Runoff
MPA	Marine Protection Area
MSL	Mean Sea Level
NWA	National Water Act
N SWSA	National Strategic Water Source Areas
NWRCS	National Water Resource Classification System
PES	Present Ecological State
PMAR	Present Day Flow
RDM	Resource Directed Measures
REC	Recommended Ecological Category
RQO	Resource Quality Objectives
Snc	Scenario
N SWSA	National Strategic Water Source Areas
WRCS	Water Resource Classification System
WWTW	Waste Water Treatment Works

EXECUTIVE SUMMARY

Background and Purpose

This phase forms part of the following study: Determination of Water Resource Classes, Reserve and the Resource Quality Objectives in the Keiskamma and Fish to Tsitsikamma Catchments. The purpose of this study is to determine appropriate Water Resource Classes, the Reserve and associated Resource Quality Objectives (RQOs) for all significant water resources in the study area to facilitate sustainable use of the water resources while maintaining ecological integrity. The aim is to implement the Water Resource Classification System (WRCS) (as per Regulation 810, 2010) to determine the Water Resource Classes, following the integrated framework (DWS, 2017), undertake the 7-step process to determine and set RQOs, and determine the Reserve for the water resources of the study area. This will ultimately assist the DWS in the management of the water resources in the study area and making informed decisions regarding the authorisation of future water use and the magnitude of the impacts of proposed developments.

The initial phase of this study involved identifying 19 Integrated Units of Analysis (IUAs) and pinpointing "hotspots" to prioritise estuary sites for quantification. Scientific data were then collected on driver components (abiotic factors and water quality) and response components (fish, aquatic macroinvertebrates, macrophytes, birds, and microalgae) through three estuary surveys conducted in December 2023, April 2024, and May/June 2024. This data was compared to reference data and analysed to perform the eco-categorisation process for all prioritised estuaries, determining their ecological categories. Additionally, the estuarine water requirements were quantified, and the ecological consequences of identified scenarios were assessed for these priority estuaries.

The primary aim of this report is to summarise these findings, including the Present Ecological State (PES) and the Ecological Importance and Sensitivity (EIS) of all estuary systems within the study area.

Study Area and Location of Priority Estuaries

Overall, there are 155 estuaries in the study area. Ten of the estuaries in the Water Management Area (WMA) have been the focus of previous Environmental Flow Requirement or Ecological Water Requirements (EWR) studies, *albeit* it is of low confidence in some cases. An additional seven estuaries are being assessed in more detail as part of this study to address gaps in the water resources classification process, with the selection influenced by identified water resources pressure (current or future), estuary ecological importance, requests from other sectors of government, and available study resources. The priority estuaries for rapid/comprehensive EWR assessments that are being assessed in more detail include:

1. Mngazi;
2. Mbashe;
3. Great Kei;
4. Keiskamma;
5. Kariega;
6. Gamtoos; and
7. Kabeljous.

See **Figure 1** for an overview of the 7 priority estuary catchments.

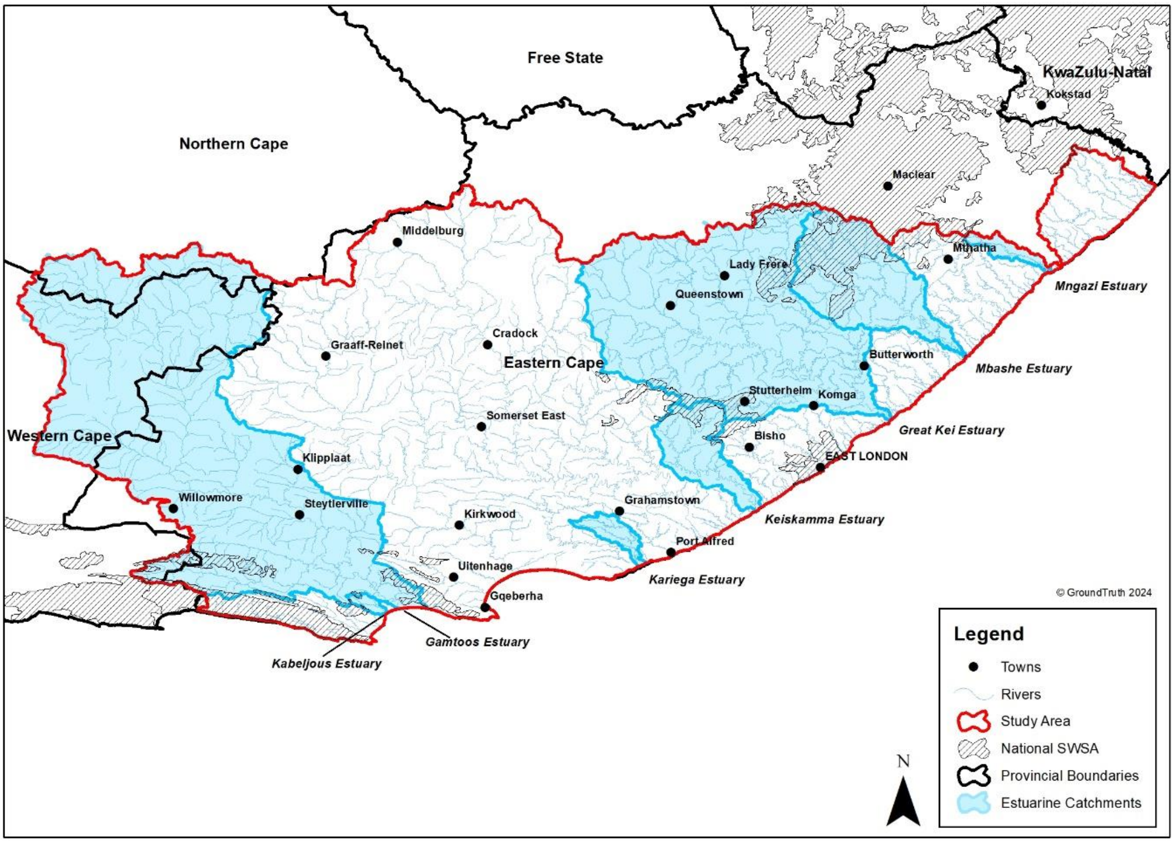

Figure 1: *Overview of the priority estuary catchments.*

Approach and Methodology

Methods to determine the ecological water requirements (EWRs) of estuaries were established soon after the promulgation of the National Water Act (NWA) in 1998. The "Preliminary Reserve Method" involves setting a Recommended Ecological Category (REC) (i.e. desired state), recommended Ecological Reserve (i.e. flow (quantity and quality) allocation to achieve the REC) and recommended RQOs for a resource on the basis of its present health status and its ecological importance. The official method for estuaries (Version 2), is documented in DWA (2008). In 2013, an unofficial Version 3 of the method was published, as part of a Water Research Commission study (Turpie *et al*., 2012a,b). The study uses Version 2 of the methodology (DWA, 2008), but with consideration of obvious improvements proposed in Version 3 (Turpie *et al*., 2012a,b) and Taljaard *et al*. (2022). The generic steps of the official "Ecological Reserve Method" for estuaries were applied as follows:

- Step 1: Initiate a study defining the study area, project team and level of study (confirmed in the **inception report** of this study).
- Step 2: Delineate the geographical boundaries of the resource units (confirmed in the **delineation report** of this study).
- Step 3a: Determine the **Present Ecological State** (PES) of resource health (water quantity, water quality, habitat and biota) assessed in terms of the degree of similarity to the reference condition (referring to natural, unimpacted characteristics of a water resource, and must represent a stable baseline based on expert judgement in

conjunction with local knowledge and historical data). An Estuarine Health Index (EHI) is used to evaluate the current condition of the estuary. The EHI scoring of the various variables is based on a review of historical data, as well as data collected during a field monitoring programme in 2023/4. Both abiotic and biotic variables are included as the relationships between the abiotic and biotic variables and this association are often not well understood because the biotic response to certain abiotic variables (the parameters that make up the habitat conditions in which the biotic factors live) can be lagging. The present estuarine health score can be expressed into one of six Ecological Categories (ECs) from A (Natural) to F (Highly degraded and changed from natural).

- Step 3b: Determine the **Estuary Importance Score (EIS)** that takes into account the size, the rarity of the estuary type within its biographical zone, habitat, biodiversity and functional importance of the estuary, rating an estuary from low to high importance as below:

EIS	Importance rating
81 – 100	Highly important
61 – 80	Important
0 – 60	Of low to average importance

- Step 3c: Set the **Recommended Ecological Category (REC)** which is derived from the PES and EIS (or the protection status allocated to a specific estuary) following the guidelines listed below:

Protection Status and Importance	REC	Policy basis
Protected area	A or BAS*	Protected and desired protected areas should be restored to and maintained in the best possible state of health.
Desired Protected Area (based on complementarity)		
Highly important	PES + 1, min B	Highly important estuaries should be in an A or B Category.
Important	PES + 1, min C	Important estuaries should be in an A, B or C Category.
Of low to average importance	PES, min D	The remaining estuaries can be allowed to remain either in a D Category with the option to manage it in a stable D or improve the PES if it is below a D ** (i.e. E or F) to atleast a D in the long term.

** Best Attainable State*

**An estuary cannot be allocated a REC below a Category “D”. Therefore, systems with a PES in Categories ‘E’ or ‘F’ need to be managed towards achieving at least a REC of “D” over time.

- Step 4: **Quantify the ecological consequences of various runoff scenarios** (including proposed operational scenarios) where the predicted future condition of the estuary is assessed under each scenario. As with the determination of the PES, the Estuarine Health Index (EHI) is used to assess the predicted condition in terms of the degree of similarity to the reference condition.

- Step 5: Quantify the (recommended) **Ecological Water Requirements (EWR)**, which represent the lowest flow scenario that will maintain the resource in the REC.
- Step 6: Estimate (recommended) **Resource Quality Objectives (i.e. Ecological Specification)** for the REC, as well as future monitoring requirements to improve the confidence of the EWR.
- The locality of all prioritised estuaries within the RU as identified during this study, is provided in **Figure 4-1.**

Summary of the Eco-categorisation and EWR results

The table below summarises the estuary type, the present condition (PES) and recommended condition (REC), the natural and present mean annual runoff (MAR), and the degree the MAR is similar to the natural flows. If relevant the component of flow most severely impacted (baseflows and/or floods) is also indicated. The table concludes by indicating the potential for water resource development. Where detailed studies were conducted the value is derived from the EWR assessment, alternatively a range is provided using estuary type as guide.

##	Name	Estuary Type	PES	REC	Natural MAR (m^3x10^6)	Present MAR (m^3x10^6)	% Similarity MAR	Base flows stress	Loss of resetting floods	Potential for water resource development from natural
1	Lottering	Small Fluvially Dominated	A/B	A - A/B	18.5	16.8	90.9			
2	Elandsbos	Small Fluvially Dominated	A/B	A - A/B	27.2	24.7	90.8			
3	Storms	Small Fluvially Dominated	A/B	A - A/B	54.1	47.9	88.5			95-99%
4	Elands	Small Fluvially Dominated	A/B	A - A/B	52.2	46.9	89.8			95-99%
5	Groot (Oos)	Small Fluvially Dominated	A/B	A - A/B	47.0	44.1	93.9			
6	Tsitsikamma*	Small Temporarily Closed	B/C	B	19.9	13.3	66.9	●		66.9% +5%🡅
7	Klipdrif (Oos)	Small Temporarily Closed	C	C	32.9	18.6	56.4			
8	Slang	Small Temporarily Closed	C/D	C/D	5.1	4.6	90.3			
9	Kromme*	Predominantly Open	C/D	C	72.2	36.8	51.0	●	●	51%
10	Seekoei	Large Temporarily Closed	D/E	C	20.3	11.4	56.0	●		
11	Kabeljous*	Large Temporarily Closed	B	B	5.3	4.7	89.2	●		89.3%
12	Gamtoos*	Predominantly Open	D	C	404.2	194.8	48.2	●		51.8%
13	Van Stadens	Large Temporarily Closed	B	A/B	17.2	15.6	90.9	●		
14	Maitland	Large Temporarily Closed	B/C	B	12.9	11.7	90.9	●		
15	Baakens	Small Temporarily Closed	E/F	E	4.1	3.6	87.5	●		
16	Papkuils	Small Temporarily Closed	F	E/F	2.9	2.9	99.0	●		
17	Swartkops*	Predominantly Open	D	C	56.9	80.3	70.9	●	●	123.9%
18	Coega (Ngqurha)	Large Temporarily Closed	E/F	D	10.1	8.6	85.1	●		
19	Sundays*	Predominantly Open	C/D	B	263.1	240.7	91.5	●		95%
20	Boknes	Small Temporarily Closed	C	C	14.4	14.4	99.6	●		
21	Bushmans	Predominantly Open	C	B	43.1	32.7	75.8	●		75.8 + 3%🡅
22	Kariega*	Predominantly Open	C	C	21.9	13.1	59.8	●		60%
23	Grant's	Small Temporarily Closed	C	C	2.4	2.2	92.9	●		
24	Kasouga	Large Temporarily Closed	B	B	4.3	4.3	99.1			
25	Kowie	Predominantly Open	C	B/C	31.4	28.0	89.1	●		89.1%
26	Rufane	Small Temporarily Closed	C	C	1.2	1.1	93.6	●		
27	Riet	Small Temporarily Closed	B	B	2.4	2.3	0.0			
28	West Kleinemonde	Large Temporarily Closed	B	B	6.0	5.5	90.9			
29	East Kleinemonde	Large Temporarily Closed	B	B	2.9	2.7	96.2			
30	Great Fish*	Predominantly Open	C	B/C	496.3	451.0	90.9	●		90.3%
31	Old Woman's	Large Temporarily Closed	B/C	B/C	1.1	0.9	84.6	●		
32	Mpekweni	Large Temporarily Closed	B	B	2.4	2.1	84.7	●		

##	Name	Estuary Type	PES	REC	Natural MAR (m^3x10^6)	Present MAR (m^3x10^6)	% Similarity MAR	Base flows stress	Loss of resetting floods	Potential for water resource development from natural
33	Mtati (Mthathi)	Large Temporarily Closed	B	B	6.0	5.1	84.5	●		
34	Mgwalana	Large Temporarily Closed	B	A/B	9.7	8.2	84.5	●		
35	Bira (Bhirha)	Large Temporarily Closed	B	A/B	12.0	10.0	83.1	●		
36	Gqutywa	Large Temporarily Closed	B	B	3.5	3.0	84.1	●		
37	Ngculura (Ngculurha)	Small Temporarily Closed	B	A/B	0.6	0.6	85.8	●		
38	Mtana	Small Temporarily Closed	B	B	1.1	0.9	84.3	●		
39	Keiskamma*	Predominantly Open	C	B	128.7	86.4	67.2	●		76.8%
40	Nqinisa	Small Temporarily Closed	A/B	A - A/B	1.2	1.2	99.4			
41	Kiwane (Khiwane)	Large Temporarily Closed	A/B	A - A/B	5.3	5.3	99.5			
42	Tyolomnqa	Large Temporarily Closed	B	A/B	35.6	34.5	97.1			
43	Shelbertsstroom	Small Temporarily Closed	B/C	B/C	0.6	0.6	99.4			
44	Lilyvale	Small Temporarily Closed	B	B	1.1	1.0	90.8			
45	Ross' Creek	Small Temporarily Closed	B	B	0.6	0.5	98.7			
46	Ncera (Ncerha)	Large Temporarily Closed	B	B	11.0	10.2	93.2	●		
47	Mlele	Small Temporarily Closed	B/C	B/C	2.0	1.9	93.1			
48	Mcantsi	Small Temporarily Closed	C	B	2.8	2.6	93.3			
49	Gxulu	Large Temporarily Closed	B/C	B/C	15.6	14.5	93.2			
50	Goda	Large Temporarily Closed	B	A/B	6.2	5.8	93.2	●		
51	Hlozi	Small Temporarily Closed	B	B	1.7	1.6	93.2			
52	Hickman's	Small Temporarily Closed	C	C	1.4	1.3	93.2			
53	Buffalo	Predominantly Open	D/E	D	96.0	18.7	19.5	●		95-99%
54	Blind	Small Temporarily Closed	D	D	0.7	1.1	58.0	●		
55	Hlaze (iHlanze)	Small Temporarily Closed	D	D	0.3	0.8	39.5	●		
56	Nahoon*	Predominantly Open	C/D	C	32.5	20.4	62.8	●	●	62.8%% + 5%↑
57	Qinira (Quinirha)	Large Temporarily Closed	B	B	8.4	8.3	98.3			98.3%
58	Gqunube	Predominantly Open	B/C	B	34.1	32.1	94.1			
59	Kwelera (Kwelerha)	Predominantly Open	B	A/B	34.8	32.8	94.2			
60	Bulura (Bulurha)	Large Temporarily Closed	B	B	3.7	3.5	94.3			
61	Cunge	Small Temporarily Closed	A/B	A/B	0.3	0.3	97.2			
62	Cintsa	Large Temporarily Closed	B	B	4.0	3.8	94.3			
63	Cefane	Large Temporarily Closed	B	B	4.0	3.2	81.0			
64	Kwenxura (Kwenxurha)	Large Temporarily Closed	A/B	A - A/B	16.9	16.6	98.1			
65	Nyara (Nyarha)	Large Temporarily Closed	A/B	A - A/B	4.3	4.3	98.1			
66	Imtwendwe (Mtwendwe)	Small Temporarily Closed	A/B	A - A/B	1.1	1.0	98.2			
67	Haga-haga	Small Temporarily Closed	B	B	2.1	2.1	98.0			
68	Mtendwe	Small Temporarily Closed	A/B	A - A/B	1.4	1.4	98.0			
69	Quko	Large Temporarily Closed	A/B	A - A/B	17.2	16.9	98.1			
70	Morgan	Large Temporarily Closed	B	B	2.7	2.7	98.1			
71	Cwili	Small Temporarily Closed	B	B	1.2	1.2	98.0			
72	Great Kei*	Large Fluvially Dominated	C	B/C	1040.7	742.0	71.3	●	●	74.1%
73	Gxara (Gxarha)	Large Temporarily Closed	A/B	A - A/B	3.4	3.4	98.0			
74	Ngogwane	Small Temporarily Closed	B	B	0.8	0.8	98.2	●		
75	Qolora (Qolorha)	Large Temporarily Closed	B	B	8.9	8.7	98.1			
76	Ncizele	Small Temporarily Closed	A/B	A - A/B	1.0	1.0	97.9			
77	Timba	Small Temporarily Closed	B	B	0.4	0.3	98.3	●		
78	Kobonqaba (Khobonqaba)	Predominantly Open	B	A/B	36.2	35.5	98.1	●		
79	Nxaxo/Ngqusi	Large Temporarily Closed	B	A/B	23.3	22.8	98.0			
80	Cebe	Large Temporarily Closed	A/B	A - A/B	5.7	5.6	98.0			
81	Gqunqe	Large Temporarily Closed	A/B	A - A/B	7.0	6.8	98.0			
82	Zalu	Small Temporarily Closed	B	B	1.7	1.7	98.0			
83	Ngqwara (Ngqwarha)	Large Temporarily Closed	A/B	A - A/B	5.2	5.1	98.0	●		
84	Sihlontlweni	Small Temporarily Closed	A/B	A - A/B	2.2	2.2	98.0			
85	Nebelele	Small Temporarily Closed	A/B	B	1.1	1.0	98.2			
86	Qora (Qhorha)	Predominantly Open	B	A/B	78.5	72.0	91.7			95-99%
87	Jujura (Jujurha)	Small Temporarily Closed	B	B	11.3	10.3	91.2	●		
88	Ngadla	Small Temporarily Closed	A/B	A - A/B	1.6	1.5	97.0			
89	Shixini	Predominantly Open	A/B	A - A/B	42.3	41.0	97.0			
90	Beechamwood	Small Temporarily Closed	B	B	0.5	0.5	97.2			

##	Name	Estuary Type	PES	REC	Natural MAR (m^3x10^6)	Present MAR (m^3x10^6)	% Similarity MAR	Base flows stress	Loss of resetting floods	Potential for water resource development from natural
91	Kwazlelitsha (Kwazwedala)	Small Temporarily Closed	A/B	A - A/B	0.6	0.6	96.8			
92	Kwa-Goqo	Small Temporarily Closed	A/B	A - A/B	1.0	1.0	96.9			
93	Ku-Nocekedwa	Small Temporarily Closed	A/B	A - A/B	1.1	1.1	97.0			
94	Nqabara/Nqabarana	Predominantly Open	B	A/B	76.4	75.9	99.3			95-99%
95	Ngomane (East)	Small Temporarily Closed	B	B	1.1	1.1	98.1			
96	Ngoma/Kobule	Small Temporarily Closed	A/B	A - A/B	6.3	6.2	98.0			
97	Mendu	Large Temporarily Closed	A/B	A - A/B	5.2	5.1	98.0			
98	Mendwana	Predominantly Open	A/B	A - A/B	1.4	1.3	98.1			
99	Mbashe*	Large Fluvially Dominated	B/C	B	786.9	861.2	91.4	●		108.5%
100	Ku-Mpenzu	Small Temporarily Closed	A/B	A - A/B	0.8	0.7	96.8			
101	Ku-Bhula (Mbhanyana)	Small Temporarily Closed	A/B	A - A/B	8.9	8.6	96.6	●		
102	Kwa-Suku	Large Temporarily Closed	A/B	A - A/B	0.7	0.7	96.7			
103	Ntlonyane	Large Temporarily Closed	B	A/B	13.6	13.2	96.6			
104	Nkanya	Large Temporarily Closed	B	A/B	2.5	2.4	96.6			
105	Sundwana	Small Temporarily Closed	A/B	A - A/B	0.8	0.8	96.7			
106	Xora	Predominantly Open	B/C	B	52.4	40.5	77.3		●	77.3% + 5%↑
107	Bulungula	Large Temporarily Closed	B	A/B	7.6	7.5	98.3			
108	Ku-Amanzimuzama	Small Temporarily Closed	A/B	A - A/B	1.6	1.6	98.4			
109	Nqakanqa	Small Temporarily Closed	B	B	0.8	0.8	98.0			
110	Mdikana	Small Temporarily Closed	B	B	0.2	0.2	100.0			
111	Mncwasa	Large Temporarily Closed	B	B	26.9	26.5	98.3			
112	Mpako	Small Temporarily Closed	B	B	21.7	21.6	99.4			
113	Nenga	Small Temporarily Closed	C	C	9.1	9.0	98.5			
114	Mapuzi	Large Temporarily Closed	B	B	5.5	5.5	98.6			
115	Mtata	Predominantly Open	C	B/C	392.2	319.0	81.3	●	●	90-95%
116	Thsani	Small Temporarily Closed	B	B	0.5	0.5	97.4			
117	Mdumbi	Predominantly Open	B	A/B	36.6	35.5	96.8			
118	Lwandilana	Small Temporarily Closed	B	B	1.4	1.4	97.6			
119	Lwandile	Large Temporarily Closed	A/B	A - A/B	3.4	3.3	96.9			
120	Mtakatye	Predominantly Open	B	A/B	63.4	61.7	97.4			95-99%
121	Hluleka	Small Temporarily Closed	B	A/B	4.3	4.2	97.6			
122	Mnenu	Large Temporarily Closed	A/B	A/B	19.7	19.2	97.5			
123	Mtonga	Large Temporarily Closed	C	A/B	4.0	3.9	97.7			
124	Mpande	Large Temporarily Closed	A/B	A - A/B	4.5	4.4	97.6			
125	Sinangwana	Small Temporarily Closed	B	B	11.5	11.2	97.6			
126	Mngazana	Predominantly Open	B	A/B	49.3	47.8	96.9	●		
127	Mngazi*	Large Temporarily Closed	B	B	87.3	83.5	95.7			95%
128	Gxwaleni	Small Temporarily Closed	A/B	A - A/B	1.6	1.6	97.3			
129	Bulolo	Small Temporarily Closed	B	B	1.6	1.6	97.4			
130	Mtumbane	Small Temporarily Closed	B	B	1.0	1.0	97.8	●		
131	Mzimvubu	Large Fluvially Dominated	B	B	2665.6	2552.0	95.7	●		92.7%
132	Ntlupeni	Small Temporarily Closed	A/B	A - A/B	3.8	3.8	98.3			
133	Nkodusweni	Large Temporarily Closed	B	A/B	8.2	8.1	98.3			
134	Mntafufu	Predominantly Open	B	A/B	44.5	43.8	98.3			
135	Ingo	Small Temporarily Closed	A/B	A - A/B	4.6	4.4	96.1			
136	Mzintlava	Predominantly Open	A/B	A - A/B	69.8	67.0	96.1			95-99%
137	Mzimpunzi	Small Temporarily Closed	B	A/B	9.2	8.5	92.6			
138	Kwanyambalala	Small Temporarily Closed	B	B	4.2	3.9	92.6			
139	Mbotyi	Small Temporarily Closed	B	B	11.1	10.3	92.6			
140	Mkozi	Small Temporarily Closed	A/B	A - A/B	15.7	14.6	92.6			
141	Sikatsha	Small Temporarily Closed	A/B	A - A/B	1.9	1.7	92.5			
142	Lupatana	Small Temporarily Closed	A/B	A - A/B	7.0	6.5	92.6			
143	Mkweni	Small Temporarily Closed	A/B	A - A/B	18.4	17.0	92.6			
144	Msikaba	Predominantly Open	A/B	A - A/B	212.4	199.3	93.8			93.8%
145	Mgwegwe	Small Temporarily Closed	A	A	1.2	1.2	97.7			
146	Mgwetyana	Small Temporarily Closed	A	A	1.8	1.8	97.9			
147	Mtentu	Predominantly Open	B	A/B	157.0	145.4	92.6	●		90-95%
148	Sikombe	Small Temporarily Closed	A/B	A - A/B	6.8	6.8	100.0			
149	Kwanyana	Small Temporarily Closed	A/B	A - A/B	4.0	3.9	97.7			
150	Mtolane	Small Temporarily Closed	A/B	A - A/B	1.8	1.8	100.0			
151	Mnyameni	Large Temporarily Closed	A/B	A - A/B	45.9	44.8	97.8			

##	Name	Estuary Type	PES	REC	Natural MAR (m^3x10^6)	Present MAR (m^3x10^6)	% Similarity MAR	Base flows stress	Loss of resetting floods	Potential for water resource development from natural
152	Mpahlanyana	Small Temporarily Closed	B	A/B	1.1	1.0	93.8			
153	Mpahlane	Small Temporarily Closed	B	A/B	2.7	2.5	93.2			
154	Mzamba	Predominantly Open	B	A/B	67.4	62.8	93.1			95-99%
155	Mtentwana	Small Temporarily Closed	B/C	B	1.3	1.2	93.7	●		

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1. INTRODUCTION

1.1 Background

The National Water Act, 1998 (No. 36 of 1998) (NWA) is founded on the principle that National Government has overall responsibility for and authority over water resource management for the benefit of the public without affecting the functioning of water resource systems. To achieve this objective, Chapter 3 of the NWA provides for the protection of water resources through the implementation of Resource Directed Measures (RDM). These measures are protection-based and include Water Resource Classification, determination of the Reserve and setting the associated Resource Quality Objectives (RQOs). These measures collectively aim to ensure that a balance is reached between the need to protect and sustain water resources, while allowing socio-economic development.

The provision of water required for the maintenance and protection of the natural functionality of the ecosystem and provision of Basic Human Needs (BHN) is the only right to water in the National Water Act (No. 36 of 1998) (NWA). The other water users from a strategic use who are second in line to other water users are subject to formal gazetted General Authorization and water use authorization as per Section 21 of the NWA.

The Department of Water and Sanitation, through the Chief Directorate: Water Ecosystems Management (CD: WEM) has initiated a study for the determination of Water Resource Classes, Reserve and associated Resource Quality Objectives for the identified significant water resources in the Keiskamma and Fish to Tsitsikamma catchments. The water resource components included for this study are rivers, wetlands, groundwater and estuaries. The Reserve determination include both the water quantity and quality of the Ecological Water Requirements (EWR) and Basic Human Needs (BHN). This will ensure the availability of water required to protect aquatic systems (i.e. the EWR) and that the essential needs of individuals that are directly dependent on these water resources (i.e. BHN) are met.

1.2 Purpose of this study

The Keiskamma and Fish to Tsitsikamma catchments within the Mzimvubu to Tsitsikamma Water Management Area (WMA) 7 are amongst many water stressed catchments in South Africa. These areas are important for conservation and have recognisable protected areas, natural heritage, cultural and historical sites that require protection. However, water use from surface as well as groundwater for agricultural and domestic purposes are high, especially in the more arid catchments, impacting on the availability of water resources for the protection of the aquatic ecosystems. Industrial practices and domestic water use are on the rise in some of these catchments, especially around the major towns and cities. Water transfers into the study area from adjacent WMAs and within the study area and numerous storage dams changes the natural flow patterns, impacting on the aquatic biota.

Thus, the main purpose of the study is to determine, appropriate Water Resource Classes, the Reserve and set associated RQOs for all significant water resources in the study area to facilitate sustainable use of the water resources while maintaining ecological integrity.

The aim is to:

- Implement the Water Resource Classification System (WRCS) (Regulation 810, 2010) to determine the Water Resource Classes (classes ranging from 1 – 3);
- Follow the integrated framework (DWS, 2017);
- Undertake the 7-step process to determine and set RQOs; and
- Determine the Reserve for the significant water resources in the study area.

This will ultimately assist the DWS in the management of the water resources in the study area and aid in the making of informed decisions regarding the authorisation of future water use and by assessing the magnitude of the impacts of proposed developments, and the risks it poses on meeting the REC. It must be noted that the protection and management of water resources should be done in an integrated manner, hence from source to sea. This illustrates the importance of realising that Integrated Water Resource Managemnent (IWRM) requires the co-operation and buy-in of stakeholders in the catchment and hence the forming of partnerships is essential i.e. water forums, catchment management agencies (CMA), Integrated Development Management Plans, Estuarine Management plans etc. The IWRM also relies heavily on co-operative governance. Representative participation on the platforms that the Department creates through studies such as this, is in the form of Project Steering Committees which is but one example, of inviting integrated participation.

1.3 Purpose of this report

This report aims to summarise the Ecological Categorisation (PES Eco-Categorisation) results for all identified priority estuaries within the Keiskamma and Fish to Tsitsikamma catchment areas. These findings are based on available data from previous studies and observed data collected during scheduled estuary surveys. Additionally, the report provides a summary of the Estuarine Water Requirement (EWR) quantification results, along with updates on the Present Ecological State (PES) and Ecological Importance and Sensitivity (EIS) of all estuaries within the study area.

1.4 Approach for the Eco-Categorisation Phase

The full project approach and methodology will be in accordance with the process as outlined in Regulation 810 (Government Gazette 33541) dated 17 September 2010, **as well as the methodologies as prescribed by the DWS for Reserve determinations of rivers, wetlands, groundwater and estuaries and the determination of Resource Quality Objectives (RQO).** The integrated steps as developed through the ‘Development of Procedures to operationalise Resource Directed Measures (DWS, 2017)’ will be used to guide the various activities (see **Figure 1-1**).

The Eco-Categorisation forms part of Step 3 of Figure 1-1 and Step 3 of the integrated steps for the determination of the Reserve (**Figure 1-2**).

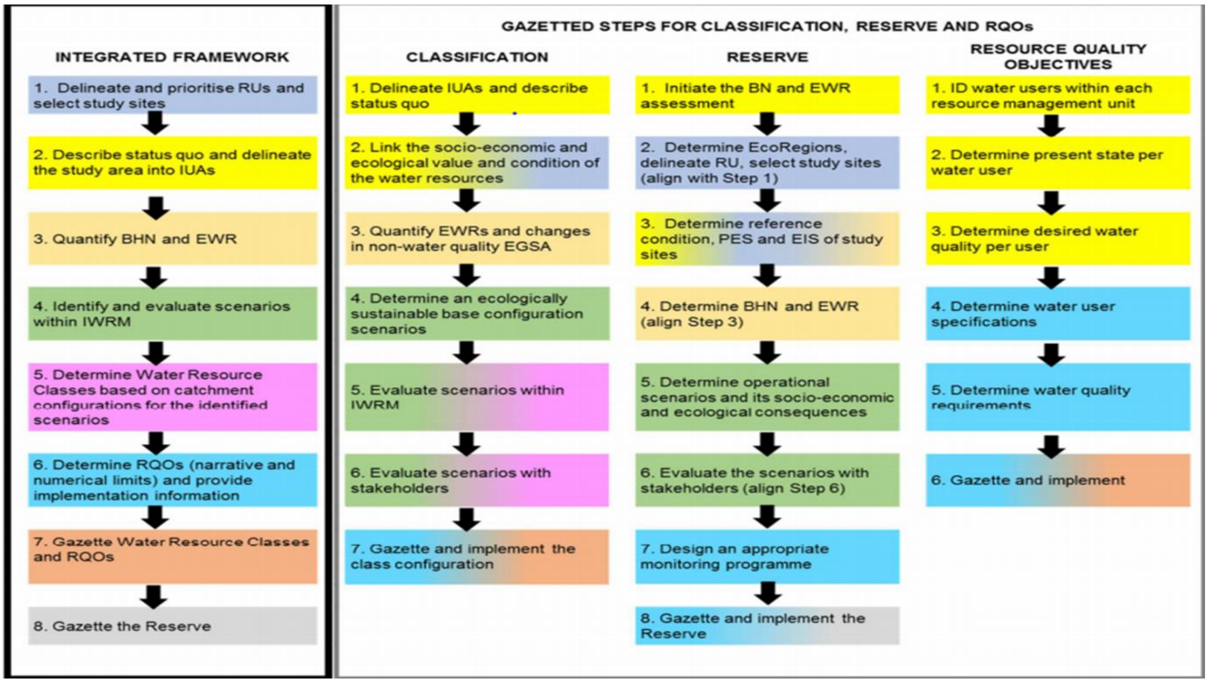

Figure 1-1: Integrated framework for determination of Water Resource Classes, Reserve and RQOs

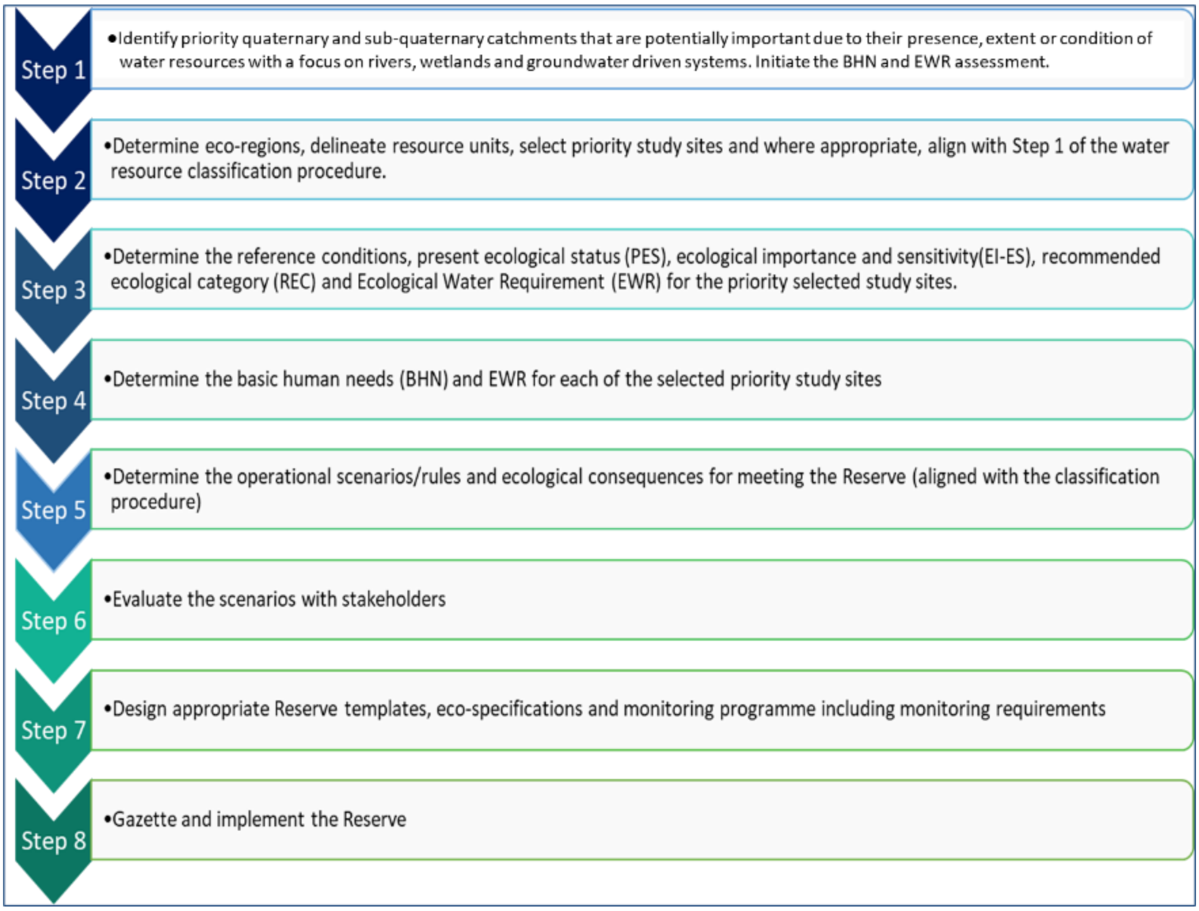

Figure 1-2: Integrated steps for the determination of the Reserve (DWS, 2017)

2. ECOLOGICAL WATER REQUIREMENT METHOD FOR ESTUARIES

Methods to determine the environmental flow requirement of estuaries were established soon after the promulgation of the National Water Act (NWA) in 1998. The "Preliminary Reserve Method" involves setting a REC, recommended Ecological Reserve (i.e. flow allocation to achieve the desired state) and recommended RQOs for a resource based on its present health status and its ecological importance.

The approach follows a generic methodology that can be carried out at different levels of effort (e.g. rapid, intermediate or comprehensive). The official method for estuaries (Version 2), is documented in DWA (2008). In 2013, an unofficial Version 3 of the method was published, as part of a Water Research Commission study (Turpie *et al*., 2012a,b). This study uses the official Version 2 of the methodology (DWA, 2008), but with consideration of obvious improvements proposed in Version 3 (Turpie *et al*., 2012a,b) and Taljaard *et al*. (2022). For water quality, the desktop assessment applied the screening method described in Taljaard *et al*. (2017) (for small refinements to this method, as applied here, see **Appendix F**) while the method of Taljaard *et al*. (2022) was applied for the detailed priority estuary assessments.

The generic steps of the official "Ecological Reserve Method" for estuaries were applied as follows:

- Step 1: Initiate study defining the study area, project team and level of study (confirmed in the **inception report** of this study).

- Step 2: Delineate the geographical boundaries of the resource units (confirmed in the **delineation report** of this study). See **Appendix A** for estuary location and **Appendix B** for delineation maps of the estuary functional zones (EFZ) in the WMA.

- Step 3a: Determine the **PES** of resource health (water quantity, water quality, habitat and biota) assessed in terms of the degree of similarity to the reference condition (referring to natural, unimpacted characteristics of a water resource, and must represent a stable baseline based on expert judgement in conjunction with local knowledge and historical data). **Appendix C** provides an overview of confidence in hydrology which is a key driver of the study. An Estuarine Health Index (EHI) is used to evaluate the current condition of the estuary (**Table 2-1**). The fact that the physical conditions in estuarine systems are more dynamic than those of other aquatic ecosystems means that severe degradation of an estuary may involve a shift from a dynamic to a more stable, or unidirectional, system. This means that the loss of dynamic function *per se* is an important indication of declining estuarine health (DWAF, 2008). Thus, in an estuarine health assessment, measures of these different states need to be sufficiently robust so that different practitioners/disciplines will arrive at the same categorisation.

  In the case of this assessment, the Estuarine Health Index (EHI) scoring of the various variables is based on a review of historical data, as well as data collected during a field monitoring programme in 2022 (See **Appendix D and Appendix E** for a summary of estuarine habitats and drivers of estuarine responses to flow changes). The assessment was undertaken by a multidisciplinary group of estuarine scientists in a workshop setting, based on their collective understanding of the likely impacts affecting each system. Expert knowledge and available information were all used to build up a "picture" of the present state of each estuary and the changes under these current conditions.

Table 2-1: Estuarine Health Index scoring system

Variable	Score	Weight	Weighted score
Hydrology	…	25	…
Hydrodynamics and mouth condition	…	25	…
Water quality	…	25	…
Physical habitat alteration	…	25	…
Habitat health score			**…**
Microalgae	…	20	…
Macrophytes	…	20	…
Invertebrates	…	20	…
Fish	…	20	…
Birds	…	20	…
Biotic health score			**…**
Estuary Health Score Mean (Habitat health, Biological health)			**…**

The EHI is applied to all levels of ecological water requirement studies (comprehensive, intermediate or rapid), with only the level of information supporting the study and level of confidence varying. For each variable, the conditions are estimated as a percentage (0 – 100%) of the pristine health. Scores are then weighted and aggregated so that the final score reflects the present health of the estuary as a percentage of the pristine state. Both abiotic and biotic variables are included as the relationships between the abiotic and biotic variables are often not well understood and because the biotic response to certain abiotic variables can be lagging.

The individual health scores were aggregated as illustrated in **Figure 2-1 and Table 2-2**.

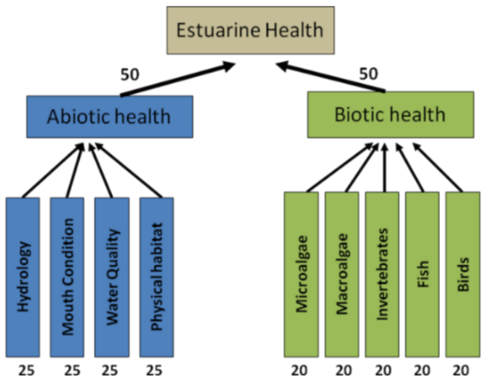

Figure 2-1: Components and weightings of the Estuarine Health Index (DWAF, 2008)

Table 2-2: Schematic illustration of the relationship between loss of ecosystem condition and functionality

Condition	≥91%	90-75	75 - 61	60 - 41	40-21	≤20
Category	A Natural	B Largely natural with few changes	C Moderately modified	D Largely modified	E Highly degraded	F Extremely degraded
State	Excellent	Good	Fair		Poor	
Functionality	Retain Process & Pattern (representation)		Loss of Process or Pattern		No Process & Pattern	

In estuaries, unlike in the terrestrial environment, degradation or loss of habitat seldom means a complete loss of an estuary. This can only happen if an estuary becomes completely degraded, e.g. changed into a parking lot, golf course or becomes canalised, mouth state completely altered etc. Degradation in estuaries means, amongst others, the loss of processes or loss of biological functionality, e.g. the estuarine space is filled with a different salinity condition or different species composition. This loss of functionality happens on a continuum, with estuaries which retain more than 90% of their natural processes and pattern being rated as excellent and estuaries degraded to less than 40% of their functionality rated as Poor. Severe changes in the characteristics of an estuary can be caused by dredging, mining the banks, building causeways into the estuary, and erecting marinas. However, less visible changes, but no less severe changes, can also be caused by the building of infrastructure that impedes freshwater inflow, discharges of municipal and industrial wastewater, bait collection, over exploitation of fish and mangrove.

The estuarine health score is translated into one of six Ecological Categories (ECs) provided below in **Table 2-3.**

Table 2-3: Translation of EHI score into Ecological Categories

EHI score	PES	General Description
91 – 100	**A**	Unmodified, or approximates natural condition; the natural abiotic template should not be modified. The characteristics of the resource should be determined by unmodified natural disturbance regimes. There should be no human induced risks to the abiotic and biotic maintenance of the resource. The supply capacity of the resource will not be used.
76 – 90	**B**	Largely natural with few modifications. A small change in natural habitats and biota may have taken place, but the ecosystem functions are essentially unchanged. Only a small risk of modifying the natural abiotic template and exceeding the resource base should not be allowed. Although the risk to the well-being and survival of especially intolerant biota (depending on the nature of the disturbance) at a very limited number of localities may be slightly higher than expected under natural conditions, the resilience and adaptability of biota must not be compromised. The impact of acute disturbances must be totally mitigated by the presence of sufficient refuge areas.
61 – 75	**C**	Moderately modified. A loss and change of natural habitat and biota have occurred, but the basic ecosystem functions are still predominantly unchanged. A moderate risk of modifying

EHI score	PES	General Description
		the abiotic template and exceeding the resource base may be allowed. Risks to the wellbeing and survival of intolerant biota (depending on the nature of the disturbance) may generally be increased with some reduction of resilience and adaptability at a small number of localities. However, the impact of local and acute disturbances must at least partly be mitigated by the presence of sufficient refuge areas.
41 – 60	**D**	Largely modified. A large loss of natural habitat, biota and basic ecosystem functions has occurred. Large risk of modifying the abiotic template and exceeding the resource base may be allowed. Risk to the well-being and survival of intolerant biota depending on (the nature of the disturbance) may be allowed to generally increase substantially with resulting low abundances and frequency of occurrence, and a reduction of resilience and adaptability at a large number of localities. However, the associated increase in the abundance of tolerant species must not be allowed to assume pest proportions. The impact of local and acute disturbances must at least to some extent be mitigated by refuge areas.
21 – 40	**E**	Seriously modified. The loss of natural habitat, biota and basic ecosystem functions is extensive.
0 – 20	**F**	Critically modified. Modifications have reached a critical level and the lotic system has been modified completely with an almost complete loss of natural habitat and biota. In the worst instances, the basic ecosystem functions have been destroyed and the changes are irreversible.

- Step 3b: Determine the **Estuary Importance Score (EIS[1])** that takes account the size, the rarity of the estuary type within its biographical zone, habitat, biodiversity and functional importance of the estuary into account (**Table 2-4 and Table 2-5**).

Table 2-4: Estuary Importance scoring system

Criterion	Score	Weight	Weighted Score
Estuary Size	…	15	**…**
Zonal Rarity Type	…	10	**…**
Habitat Diversity	…	25	**…**
Biodiversity Importance	…	25	**…**
Functional Importance (only priority estuaries)	…	25	**…**
Weighted Estuary Importance Score			**…**

Table 2-5: Estuarine Importance rating system

EIS	Importance rating
81 – 100	Highly important
61 – 80	Important
0 – 60	Of low to average importance

- Step 3c: Set the **REC** which is derived from the PES and EIS (or the protection status allocated to a specific estuary) following the guidelines listed in **Table 2-6.**

[1] Note that EIS does not have the same meaning as EIS for rivers, which refer to Ecological Importance and Sensitivity. For estuaries it only refers to estuary importance based on the four to five categories listed above.

Table 2-6: Guidelines to assign REC, based on protection status and importance, and PES of an estuary

Protection Status and Importance	REC	Policy basis
Protected area	A or BAS*	Protected and desired protected areas should be restored to and maintained in the best possible state of health.
Desired Protected Area (based on complementarity)		
Highly important	PES + 1, min B	Highly important estuaries should be in an A or B Category.
Important	PES + 1, min C	Important estuaries should be in an A, B or C Category.
Of low to average importance	PES, min D	The remaining estuaries can be allowed to remain in a D Category.

* Best Attainable State

An estuary cannot be allocated a REC below a Category “D”. Therefore, systems with a PES in Categories ‘E’ or ‘F’ need to be managed towards achieving at least a REC of “D”.

- Step 4: **Quantify the ecological consequences of various runoff scenarios** (including proposed operational scenarios) where the predicted future condition of the estuary is assessed under each scenario. As with the determination of the PES, the EHI is used to assess the predicted condition in terms of the degree of similarity to the reference condition.

- Step 5: Quantify the (recommended) **EWR**, which represent the lowest flow scenario that will maintain the resource in the REC.

- Step 6: Estimate **Resource Quality Objectives (RQO) (Ecological Specification)** for the REC, as well as future monitoring requirements to improve the confidence of the EWR.

Steps 1 to 6 is an integrated approach for estuaries, with results provided in detailed estuary EWR reports. Eco-Categorisation borrows from Steps 1 to 3 but requires Step 4 and 5 to be determined as it is an iterative process before PES and REC are determined.

3. OVERVIEW OF STUDY AREA

The study area forms part of the Mzimvubu to Tsitsikamma WMA7 as indicated in **Table 3-1**. The water resources of the Mzimvubu River (T31 – T36) are not included as part of the study. Secondary catchments T40 (Mtamvuna) and T50 (Mzimkhulu) form part of WMA 4. A detailed overview and status quo of the study area in terms of the rivers, wetlands, estuaries and groundwater, water resource infrastructure and socio-economics has been presented in the delineation of IUAs Report (Report Number: WEM/WMA7/00/CON/RDM/0322).

Table 3-1: Main catchments and rivers in the study area

Catchment	Major Rivers
K80	Tsitsikamma and small coastal rivers
K90	Krom, Seekoei rivers and small coastal rivers, also part of Algoa System
L10 - L90	Gamtoos with main tributaries Groot, Baviaanskloof and Kouga
M10 - M30	Koega, Swartkops and small coastal rivers, part of the Algoa System
N10 - N40	Sundays
P10 - P40	Kowie, Kariega, Boesmans and small coastal rivers (or Albany Coast)
Q10 - Q90	Fish River with main tributaries of Little Fish, Koonap and Kat
R10 - R50	Keiskamma, Buffalo, Nahoon and Gqunube Rivers (also known as the Amatole System)
S10 - S70	Great Kei River with main tributaries of Klipplaats, Indwe, White Kei, Black Kei
T10	Mbhashe
T20	Mthatha
T60	Small coastal rivers (Mtentu, Msikaba, Mzintlava), including estuaries of high conservation value
T70	Small coastal rivers (Mtakatye, Mngazi), including estuaries of high conservation value
T80 & T90	Small coastal rivers, including estuaries of high conservation value

The topography of the study area is hilly to mountainous with plains and hills of the Groot Karoo, with the Drakensberg Mountains along the north-eastern boundary of the study area. The rivers are deeply incised in the coastal strip.

The study area consists of 345 quaternary catchments**,** covering a total catchment area of more than 143 000 km2 (**Figure 3-1 and Figure 3-3**).

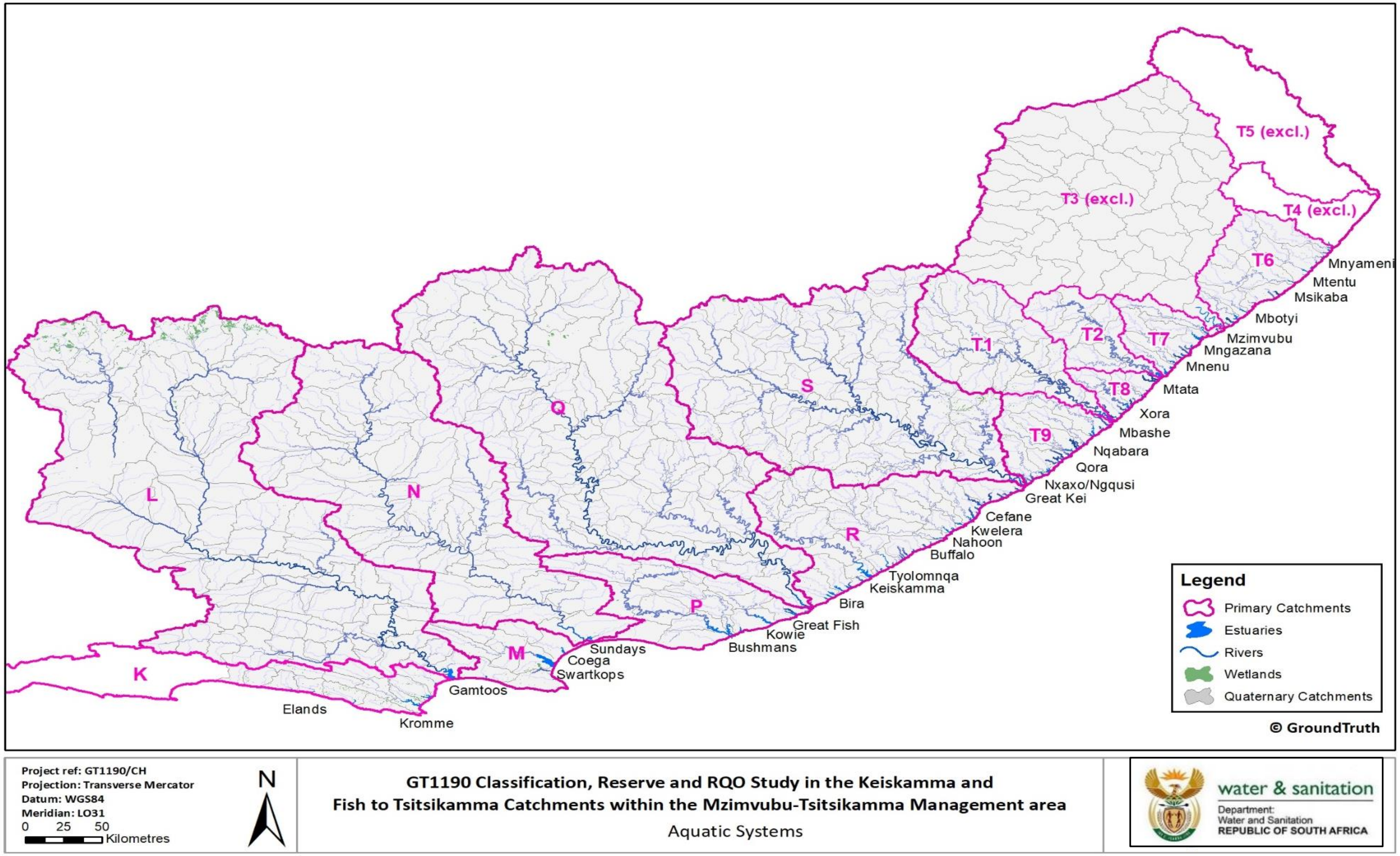

Figure 3-1: Study area of the Keiskamma, Fish to Tsitsikamma

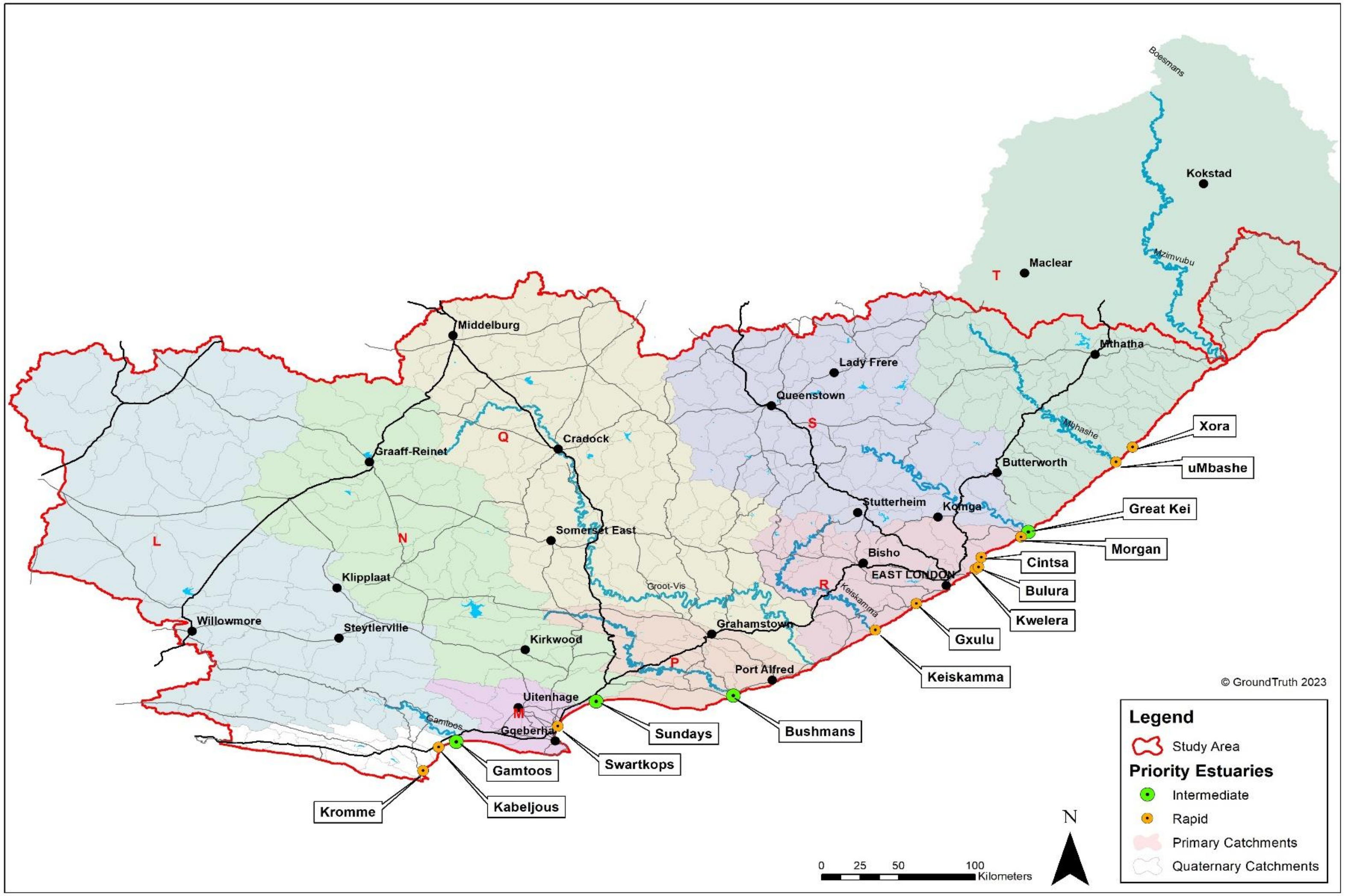

Figure 3-2: Overview of the greater study area (primary catchments)

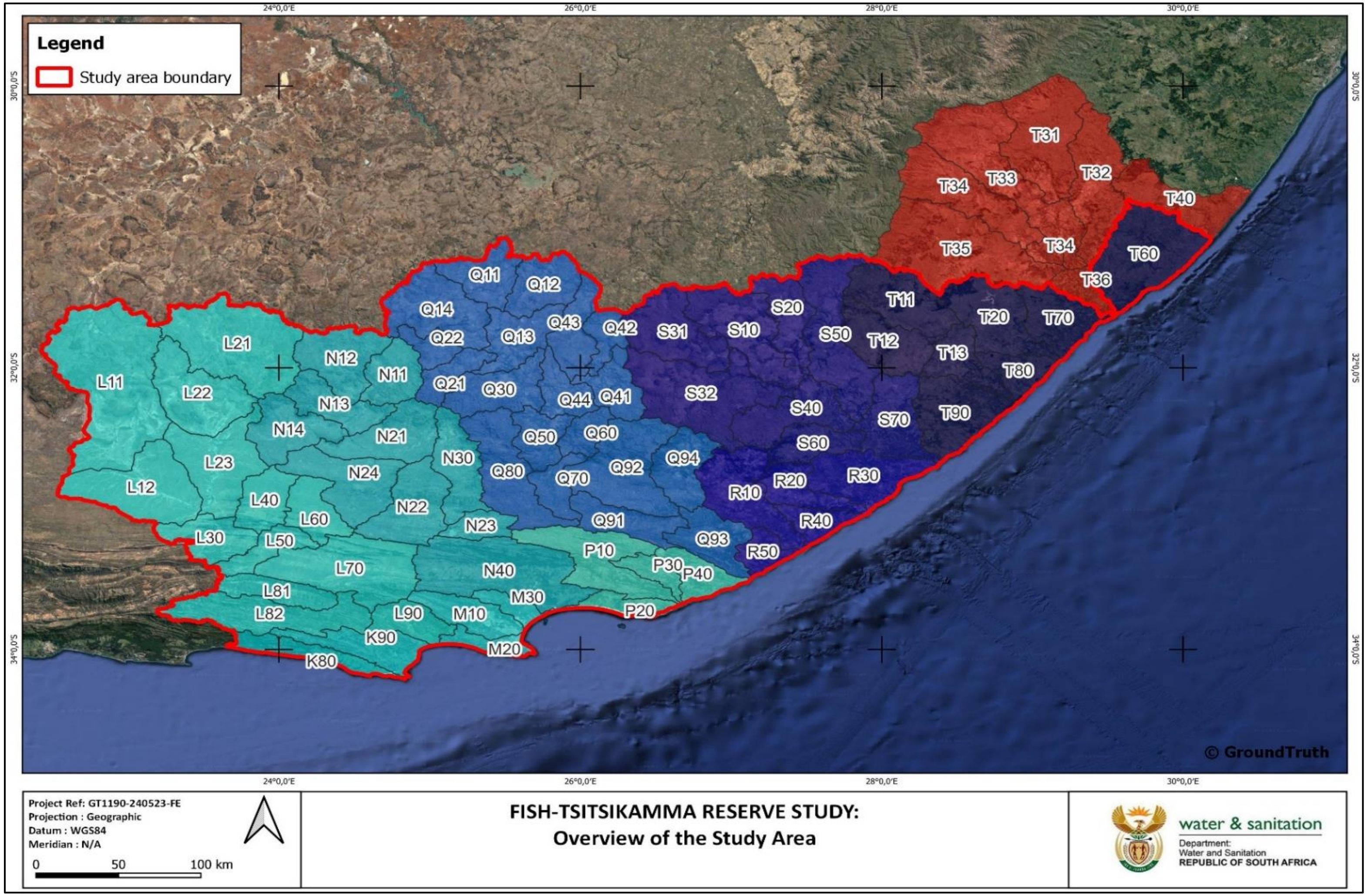

Figure 3-3: Overview of the greater study area (tertiary catchments)

4. OVERVIEW OF THE ESTUARIES

Table 4-1 provides a summary of the main estuaries in the sub-catchments within the study area. **Appendix A** lists the mouth location of all the estuaries in the region.

Table 4-1: Main estuaries in the sub-catchments within the study area

Primary catchment	Sub-catchment	Main River	Associated Rivers	Main Estuaries	Catchment Area (1) (km²)
K	K80A-F	Tsitsikamma	Elandsbos, Kleinbos, Storms, Elands, Groot, Klasies, Klipdrift	Tsitsikamma, Elandsbos, Storms, Elands, Groot	1 206
	K90A-G	Krom	Seekoei, Kabeljous	Krom, Seekoei, Kabeljous	1 558
L	L11, L12, L21, L22, L23, L30, L40, L50, L60, L70, L81, L82, L90	Gamtoos	Sout, Buffels, Kariga, Plessis, Heuningklip, Groot, Baviaanskloof, Kouga	Gamtoos, Buffels, Groot	34 816
M	M10, M20, M30	Swartkops	Van Stadens, Maitland, Bakens, Papkuils, Coega	Swartkops, Van Stadens, Maitland, Coega	2 630
N	N11, N12, N13, N14, N21, N22, N23, N24, N30, N40	Sundays	Kamdeboo, Gats, Melk, Bul, Voel, Kariega	Sundays	21 248
P	P10, P20, P30, P40	Boesmans	Diepkloof, Boknes, Kariega, Kowie, Kasouga, Riet, Wes-Kleinemonde, Oos-Kleinemonde	Boesmans, Boknes, Kariega, Kowie, Kasouga, Riet, Wes-Kleinemonde, Oos-Kleinemonde	5 322
Q	Q11, Q12, Q13, Q14, Q21, Q22, Q30, Q41, Q42, Q43, Q44, Q50, Q60, Q70, Q80, Q91, Q92, Q93, Q94	Great Fish	Groot-Brak, Pauls, Tarka, Baviaans, Koonap, Little Fish, Kat	Great Fish	30 243
R	R10, R20, R30, R40, R50	Keiskamma	Tyume, Buffalo, Nahoon, Qinira, Gqunube, Kwelera, Kwenxura, Quko, Tyolomnqa, Gxulu, Bhirha, Mgwalana	Keiskamma, Buffalo, Nahoon, Qinira, Gqunube, Kwelera, Kwenxura, Quko, Tyolomnqa, Gxulu, Bhirha, Mgwalana	7 936
S	S10, S20, S31, S32, S40, S50, S60, S70	Great Kei	White-Kei, Indwe, Klipplaat, Klaas Smit, Black-Kei, Tsomo, Kubusi, Gcuwa	Great Kei	20 485
T	T11, T12, T13, T20, T60, T70, T80, T90	Mbashe	Xuka, Mgwali, Mthatha, Mzamba, Mtentu, Msikaba, Mzintlava, Mntafufu, Mngazi, Mngazana, Mtakatye,	Mbashe, Mgwali, Mthatha, Mzamba, Mtentu, Msikaba, Mzintlava, Mntafufu, Mngazi, Mngazana,	17 938

Primary catchment	Sub-catchment	Main River	Associated Rivers	Main Estuaries	Catchment Area [1] (km^2)
			Mdumbi, Nenga, Mncwasa, Xora, Nqabarha, Shixini, Qhorha, Kobonqaba	Mtakatye, Mdumbi, Nenga, Mncwasa, Xora, Nqabarha, Shixini, Qhorha, Kobonqaba	
			Total catchment area		**143 382**

[1]*WR2012 Data*

Overall, there are 155 estuaries in the study area, with ten of these being the focus of previous Environmental Flow Requirement or EWR studies, albeit it at a desktop level in many cases (**Table 4-2**).

Table 4-2: Main estuaries in the sub-catchments within the study area

NAME	Quaternary Catchment	Historical Studies	Biodiversity Importance Rating
Tsitsikamma	K80B	Rapid 2003	**Low to Average Importance**
Kromme	K90E	Comprehensive 2006	**High Importance**
Seekoei	K90F	Rapid 2006	**Important**
Swartkops	M10D	Comprehensive 2021	**High Importance**
Sundays	N40F	Comprehensive 2008	**Important**
Bushmans	P20A	Intermediate 2003	**Important**
East Kleinemonde	P40D	Intermediate 2008	**Important**
Great Fish	Q93D	Rapid 2013	**High Importance**
Nahoon	R30F	EFR/Intermediate 2001	**Important**
Mtata	T20G	Rapid 2002	**Important**

An additional seven estuaries have been assessed in more detail as part of this study to address gaps in the water resources classification process, with selection of these estuaries influenced by the identified water resources pressure (current or future), estuary ecological importance, requests from other sectors of government, and available study resources.

The priority estuaries for rapid/comprehensive EWR assessments that were assessed in more detail are included in **Table 4-3**, along with the river EWR site that was also assessed from the river's components. For more information on the rivers eco-categorisation and EWR quantification results, please refer to Report No.'s: WEM/WMA7/00/CON/RDM/1723 and WEM/WMA7/00/CON/RDM/1923 respectively.

Table 4-3: Priority estuaries, along with river EWR sites

Priority estuary	Quaternary catchment	River flowing into estuary	Quaternary catchment	River EWR site	Quaternary catchment
Mngazi	T70B	Mngazi	T70B	MNGA01_R: Mngazi River	T70B
Mbashe	T13E	Mbashe	T13E	MBAS01_I: Mbhashe (Lower)	T13C
				MBHA02_R: Mbhashe (Upper)	T11H
Great Kei	S70F	Great Kei	S70F	GKEI01_I: Great Kei River	S70A
Keiskamma	R10M	Keiskamma	R10M	KEIS01_I: Keiskamma River (Upper)	R10E
				KEIS02_R: Keiskamma River (Lower)	R10L
Kariega	P30C	Kariega	P30C	-	-
Gamtoos	L90C	Gamtoos	L90C	GAMT01_I: Gamtoos River	L90A
Kabeljous	K90G	Kabeljous	K90G	KABE01_FV: Kabeljous River (Lower) *(only water quality)*	K90G

See **Figure 4-1** for the location and relative catchment size of the 7 priority estuaries.

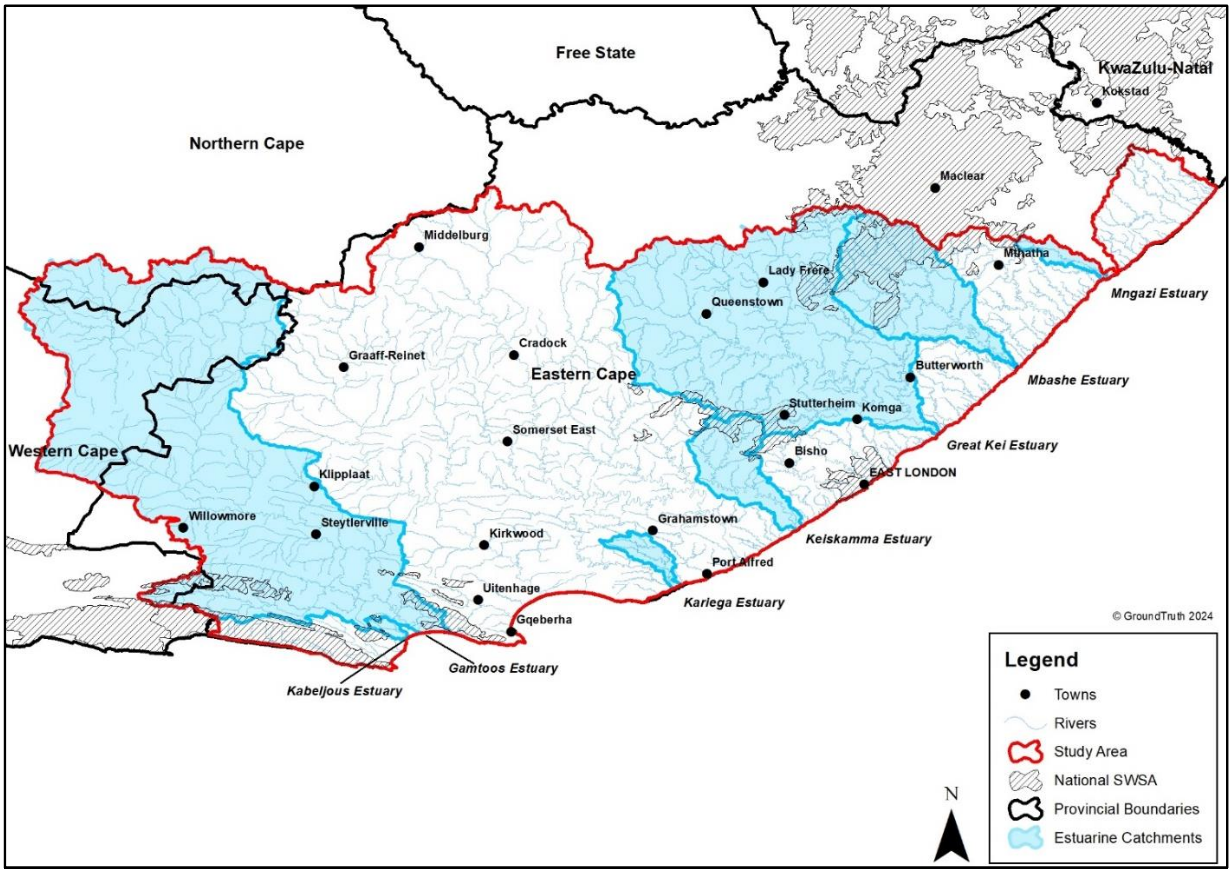

Figure 4-1: Overview of the priority estuary catchments

5. PRIORITY ESTUARIES

5.1 Present Ecological State of the Priority Estuaries

Table 5-1 provides a detailed summary of the Present Ecological State scores for the seven priority estuaries. Only two estuaries were in relatively good condition, Mngazi and Kabeljous. The highly important Great Kei, Keiskamma and Kariega were in a C Category, while the Mbashe was in a B/C Category. The Gamtoos Estuary was identified as being the estuary in the most degraded state being in a Category D.

Table 5-1: Summary of Present Ecological State scores for priority estuaries

Component	Mngazi	Mbashe	Great Kei	Keiskamma	Kariega	Gamtoos	Kabeljous
Hydrology	92	68	52	46	38	36	80
Hydrodynamics and mouth condition	94	78	79	81	62	68	84
Water quality	80	63	71	77	86	51	87
Physical habitat alteration	85	80	75	70	75	70	76
Habitat health score	**88**	**72**	**69**	**68**	**65**	**56**	**82**
Microalgae	82	80	74	79	83	51	76
Macrophytes	87	80	80	73	65	52	80
Invertebrates	80	76	54	55	60	46	71
Fish	75	60	70	60	70	55	70
Birds	81	79	58	59	72	53	77
Biotic health score	**81**	**75**	**67**	**65**	**70**	**51**	**75**
ESTUARINE HEALTH SCORE	**84**	**74**	**68**	**67**	**68**	**54**	**78**
PRESENT ECOLOGICAL STATUS	B	B/C	**C**	**C**	**C**	D	B

Most of the priority estuaries were of high biodiversity importance due to their size, habitat diversity, overall biodiversity importance and/or functional importance. Mbashe, Great Kei, Keiskamma and Kariega all rated as 'Highly Important', while Kabeljous rated as 'Important' (see **Table 5-2)**. The Mbashe and Great Kei estuaries support large stands of mangroves, while the Kariega and Keiskamma estuaries support large meadows for the endangered seagrass *Zostera capensis*. In addition, the Keiskamma and Gamtoos estuaries are also highly important systems for saltmarsh. Even though the Kabeljous estuary has a small open water area, it supports a surprisingly large, vegetated wetland between the Kabeljous and Gamtoos estuaries.

Table 5-2: Summary of Estuarine Importance Scores for priority estuaries

Estuarine Importance	Mngazi	Mbashe	Great Kei	Keiskamma	Kariega	Gamtoos	Kabeljous
Size	50	90	100	100	90	100	90
Zonal Type Rarity	10	50	50	20	20	20	10
Habitat diversity	20	90	90	100	80	100	80

Estuarine Importance	Mngazi	Mbashe	Great Kei	Keiskamma	Kariega	Gamtoos	Kabeljous
Biodiversity Importance (plants, Inverbrates, fish and birds)	76	86	83	97	97	99	85
Functional importance	50	100	100	100	100	90	80
ESTUARINE IMPORTANCE SCORE	**45**	**88**	**88**	**91**	**85**	**89**	**76**
ESTUARINE IMPORTANCE RATINGRATING	**Low to average**	**Highly Important**	**Highly Important**	**Highly Important**	**Highly Important**	**Highly Important**	**Important**

The Mbashe, Great Kei, Keiskamma and Gamtoos Estuaries are all rated as critically important fish nursery systems (Van Niekerk et al. 2019) (**Table 5-3 and Table 5-4**). These estuaries serve as important nurseries for dusky kob *Argyrosomus japonicus* (overexploited & collapsed, IUCN Red List endangered), white steenbras *Lithognathus lithognathus* (overexploited & collapsed), spotted grunter *Pomadasys commersonnii* (overexploited) and Zambezi sharks *Carcharhinus leucas* (IUCN Red List Near threatened). The Mbashe and Great Kei catchments also export large volumes of sediments, detritus and nutrients to the nearshore marine environment, thus maintaining the very rare subtidal deltas outside the estuary mouths (< 5% of habitat in South Africa) that serve as spawning habitats for white steenbras. These systems also serve as important movement corridors for fish breeding in the sea, specifically three species of catadromous eels (Anguillidae). These eels recruit as glass eels, moving high up into the catchments where they may spend 8-30 years before returning to spawn and die at abyssal depths in the sea.

The Kariega Estuary is important from a blue carbon and fish perspective as it supports large strands of the endangered seagrass *Zostera capensis* that occurs throughout the system and provides an important habitat for invertebrate and juvenile fish species. The Kariega Estuary seagrass beds support the Critically Endangered Estuarine pipefish *Syngnathus watermeyeri* (only recorded at present in two estuaries globally, the Kariega and Bushmans) and juveniles of important line fish species such as Cape stumpnose *Rhabdosargus holubi*, blacktail *Diplodus sargus*, and strepie *Sarpa salpa*. The Kabeljous Estuary is of high importance from a botanical (large wetland between it and the Gamtoos estuary) and bird perspective.

Table 5-3: Summary of functional importance scores for priority estuaries

	Mngazi	Mbashe	Great Kei	Keiskamma	Kariega	Gamtoos	Kabeljous
a) Export of organic material generated in the estuary (regional scale)	40	50	70	80	40	80	20
b) Nursery function for fish and crustaceans (marine /riverine)	50	100	100	100	100	90	40
c) Movement corridor for river invertebrates and fish breeding in sea	40	70	80	80	30	80	20
d) Roosting, foraging and/or nesting area for marine and coastal birds	50	60	60	70	40	80	80

	Mngazi	Mbashe	Great Kei	Keiskamma	Kariega	Gamtoos	Kabeljous
e) Catchment detritus, nutrients and sediments to sea	40	90	100	90	20	80	20
Functional importance score - Max (a to e)	**50**	**100**	**100**	**100**	**100**	**90**	**80**

Table 5-4: Summary of key ecosystem services that are of regional/national or global importance and need to be maintained/protected

	Mngazi	Mbashe	Great Kei	Keiskamma	Kariega	Gamtoos	Kabeljous
Nursery function	Medium	High	High	High	High	High	Medium
Blue Carbon sequestration	Low	High	High	High	High	High	High

The Mbashe Estuary is formally protected and is situated within the Dwesa-Cwebe Marine Protected Area (**Table 5-5**). In addition, the Great Kei, Keiskamma, Kariega, and Gamtoos estuaries are all desired protected areas to meet national and international conservation obligations. They form part of the core set of priority estuaries in need of protection to achieve biodiversity targets in the 2011 National Estuaries Biodiversity Plan (Turpie et al., 2012c) and for the 2030 Global Biodiversity Framework (South Africa's 30 x 30 Apex target). The National Estuaries Biodiversity Plan (van Niekerk and Turpie, 2012) recommended that the minimum Category for conservation priorities be an A or BAS as set out in the methods above.

Table 5-5: Summary of protected /desired protected area status

	Mngazi	Mbashe	Great Kei	Keiskamma	Kariega	Gamtoos	Kabeljous
Marine Protected Area / Protected Area		Dwesa-Cwebe MPA					
Desired PA/MPA needed to make Conservation targets			-NBA 2011 -GBF 2030	-NBA 2011 -GBF 2030	-NBA 2011 -GBF 2030	-NBA 2011 -GBF 2030	

Table 5-6 summarises the PES, Estuarine Importance Ratings and REC for the priority estuaries. The smaller Mngazi, Kariega and Kabeljous estuaries meet their conservation targets and only require non-interventions to maintain the PES. However, the larger Mbashe, Great Kei, Keiskamma and Gamtoos estuaries require flow and non-flow interventions to meet the RECs and restore critical ecosystem services (e.g. blue carbon and nursery function) and meet conservation obligations.

Table 5-6: Summary of PES and RECs of priority estuaries

	Mngazi	Mbashe	Great Kei	Keiskamma	Kariega	Gamtoos	Kabeljous
PES	B	B/C	C	C	C	D	B
Estuarine Importance Ratings	Low to average	Highly Important	Highly Important	Highly Important	Highly Important	Highly Important	Important
REC	B	B	B/C	B	C	C	B

5.2 Priority Estuaries EWRs

5.2.1 *Mngazi Estuary*

Description of hydrological scenarios

Table 5-7 provides a summary of a range of water resource development scenarios that could affect the Mngazi Estuary.

Table 5-7: Mngazi Estuary: Summary of flow scenarios

Scenarios	Description	MAR (X10^6 m^3)	% Similarity	Category
Reference	Natural (~1750)	87.31	100.0	A
Present	Present (no EWR)	83.52	95.7	B
Scenario 1	Present (with EWR)	83.52	95.7	B
Scenario 2	Mid-term (no EWR)	83.04	95.1	B
Scenario 3	Long-term (no EWR)	82.55	94.6	B
Scenario 4*	Dams (no EWR)	77.87	89.2	B/C

**Estuary EWR scenarios generated to assess estuary sensitivity to flow changes. Not formal operational/water resource development scenario*

The Mngazi Estuary's overall health score is estimated to be 84% similar to natural conditions, which translates into a **PES of a B Category**. Scenarios 1 to 3 maintain the same category as the present with no definable change in health condition. Under Scenario 4 the estuary decline a further 7% in condition to a Category B/C.

The PES and REC for the Mngazi Estuary is a B Category as the estuary meets its biodiversity and conservation targets, i.e. Important system and not listed as a conservation priority (National Estuaries Biodiversity Plan and not on the 30 x30 priority list).

Recommendations to maintain or improve estuary condition

Key interventions required to improve the condition of the Mngazi Estuary, which is on the edge of degrading further into a B/C Category, include:

- Develop an Estuary Management Plan for the Mngazi Estuary to identify key actions required to address the downward trajectory in estuary condition and coordinate restoration efforts where required (National Environmental Management: Integrated Coastal Management Act (No. 24 of 2008);
- Ensure maintenance of low-flow baseflow conditions to prevent prolonged periods of mouth closure that promote microalgal accumulation and the severity of bottom-water hypoxia (lack of oxygen);
- Manage nutrient inputs by implementing agricultural best management practices (e.g., prevent overfertilization and irrigation) and restoring indigenous riparian vegetation (buffer zones);
- Manage/reduce fishing pressure by managing access, increasing compliance and improving community awareness; and
- Prevent disturbance of riparian vegetation, including trampling by cattle, fire, and remove alien vegetation from the EFZ.

The Recommended Flow Scenario is Scenario 3 (Long-term development) coupled with the interventions listed above to address further decline. The flow requirements for the estuary are the same as those described for Scenario 3 and are summarised in **Table 5-8.**

Table 5-8: Mngazi Estuary: Summary of the monthly flow distribution (in m^3/s) for the Recommended Ecological Flow Scenario (i.e. Scenario 3: Long-term development).

%ile	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
99	25.21	25.11	16.08	12.95	16.57	37.41	26.41	10.41	20.09	27.39	9.95	28.95
90	5.50	9.25	7.50	3.72	7.72	13.81	10.43	4.03	3.00	3.29	2.00	3.85
80	2.17	5.94	3.95	2.23	3.97	7.38	5.62	2.15	1.51	1.25	1.16	1.34
70	1.49	2.67	2.44	1.40	1.40	4.69	2.90	1.37	1.23	1.09	0.96	0.98
60	1.03	1.73	1.54	1.04	1.22	3.50	2.15	1.15	0.96	0.90	0.79	0.89
50	0.95	1.14	1.03	0.89	1.06	1.78	1.32	0.99	0.86	0.80	0.72	0.75
40	0.84	1.04	0.88	0.77	0.88	1.19	1.08	0.85	0.73	0.66	0.62	0.68
30	0.70	0.85	0.69	0.69	0.80	1.00	0.98	0.73	0.62	0.58	0.56	0.63
20	0.62	0.75	0.57	0.58	0.72	0.76	0.74	0.63	0.56	0.50	0.49	0.55
10	0.50	0.62	0.49	0.49	0.55	0.58	0.55	0.53	0.43	0.39	0.39	0.43
1	0.30	0.32	0.29	0.26	0.32	0.24	0.29	0.27	0.26	0.28	0.24	0.26

5.2.2 *Mbashe estuary*

Description of hydrological scenarios

Table 5-9 provides a summary of a range of water resource development scenarios that could affect the Mbashe Estuary.

Table 5-9: Mbashe Estuary: Summary of flow scenarios

Scenarios	Description	MAR ($X10^6$ m^3)	% Similarity	Category
Reference	Natural	786.88	100.0	A
Present	Present (no River EWR)	861.16	109.4	B/C
Scenario 1	Mid-term (no River EWR)	858.15	109.1	B/C

Scenarios	Description	MAR ($X10^6$ m^3)	% Similarity	Category
Scenario 2	Long-term (no River EWR)	853.72	108.5	B/C
Scenario 3*	50 % reduction in the transfer scheme	819.21	104.1	B
Scenario 4*	No transfer scheme input	770.59	97.9	B
Scenario 5*	Dam development (no River EWR)	682.56	86.7	C
Scenario 6*	Scenario 2 Long-term (no River EWR) with additional estuary restoration interventions	853.72	108.5	B

**Estuary EWR scenarios generated to assess estuary sensitivity to flow changes. Not formal operational/water resource development scenario*

The present MAR into the Mbashe Estuary is 861.16 Million m^3. This is an **increase** of 9.4% compared to the natural MAR of 786.88 Million m^3 due to a transfer scheme. **The Mbashe Estuary's overall health score is estimated to be 74% similar to natural conditions, which translates into a PES of a B/C Category.**

Scenario 1 and 2 are similar to the present, resulting in a B/C Category, with Scenario 2 representing a slight improvement in condition. Scenarios 3 and 4 represent an improvement to a Category B, but some of the higher trophic levels (e.g. inverts and fish) are still in a degraded state. Scenario 5 represents a decline to a Category C. Scenario 6, which has a flow regime similar to Scenario 2 with additional estuary restoration interventions, improves the system to a Category B – thus meeting biodiversity requirements and restoring key ecosystem services such as nursery function (food security for the region) for and carbon sequestration (contribute to climate protection).

Recommendations to maintain or improve estuary condition

Given the high degree of land-use change in the Mbashe Catchment, the impact of the interbasin transfer scheme, and the present level of natural resource utilisation (fishing and grazing) the REC is set as a BAS of a B Category. Hence, scenario B was selected.

The Recommended interventions to address the ongoing decline in condition and achieve the REC:

- Develop an Estuary Management Plan to identify key management actions required to achieve the REC and coordinate restoration efforts;
- Significantly reduce fishing pressure by managing access, increased compliance and community interactions to achieve Marine Protected Area (MPA) protection objectives and REC;
- Manage nutrient inputs by implementing agricultural best management practices (e.g., prevent overfertilization and irrigation) and restoring indigenous riparian vegetation buffers;
- Prevent disturbance of riparian vegetation, including cattle trampling, occurrence of fire, and removal of alien vegetation in the EFZ and Mangroves;
- Especially limit trampling and browsing of salt marsh and browsing and harvesting of mangroves. Mangroves are legally protected by two separate pieces of legislation: National Forests Act (84 of 1998) and the Marine Resources Act (18 of 1998). The species *Bruguiera gymnorrhiza* and *Rhizophora mucronata* are further protected by the Protected Tree list (DWAF, 2010). All these would be addressed through an Estuary Management

Plan. The sustainable use of mangroves should be encouraged with the harvesting of mangroves and a maintenance plan for Mangrove harvesting should be developed; and

- Manage/reduce fishing pressure by managing access, increasing compliance and improving community awareness.

Ecological flow requirements

The flow requirements for the estuary are the same as those described for Scenario 6 (similar flow regime to Scenario 2 in terms of river inflow, but including estuary restoration intervention) below and are summarised in **Table 5-10.**

Table 5-10: Mbashe Estuary: Summary of the monthly flow distribution (in m^3/s) for the Recommended Ecological Flow Scenario (i.e. Scenario 6: Scenario 2 - Long-term with no River EWR with estuary restoration measures)

%ile	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
99	159.58	178.78	147.14	166.59	171.52	244.68	147.93	86.02	82.59	96.80	92.24	143.03
90	54.15	106.87	81.31	69.89	87.74	111.56	78.18	30.68	18.78	19.15	25.80	57.10
80	30.53	61.61	58.58	50.33	58.44	69.96	47.09	22.85	13.50	11.44	10.04	22.20
70	22.45	32.51	40.35	34.16	40.08	57.62	28.70	14.48	10.27	9.40	9.26	14.03
60	19.29	22.72	22.76	25.72	32.63	43.32	23.75	10.22	8.51	8.26	7.96	9.28
50	15.71	17.35	15.77	19.41	27.32	32.34	18.26	8.62	7.57	7.44	7.36	8.18
40	11.00	14.10	10.50	13.94	19.34	23.01	14.30	7.83	7.15	6.79	6.64	7.27
30	8.57	10.70	8.23	9.49	14.44	16.64	11.75	6.92	6.88	6.43	6.17	6.28
20	7.54	8.71	6.06	7.28	10.66	12.65	8.14	6.50	6.35	5.93	5.93	5.98
10	6.29	7.00	5.52	5.69	7.72	10.13	6.92	6.01	5.67	5.45	5.43	5.57
1	4.36	4.66	3.06	2.89	5.04	3.00	4.77	3.55	3.13	3.08	3.12	3.40

5.2.3 *Great Kei Estuary*

Description of hydrological scenarios

Table 5-11 provides a summary of a range of water resource development scenarios that could affect the Great Kei Estuary.

Table 5-11: Great Kei Estuary: Summary of flow scenarios

Scenarios	Description	MAR ($X10^6$ m^3)	% Similarity	
Reference	Natural	1040.71	100.0	A
Present	Present (no river EWR)	741.99	71.3	C
1*	Restoration (Present with river EWR + remove Invasive Aliens)	771.03	74.1	B/C
2	Present (with river EWR)	762.06	73.2	B/C
3	Mid-term (no river EWR)	742.24	71.3	C
4	Long-term (with river EWR)	754.82	72.5	B/C
5	Long-term (no river EWR)	734.80	70.6	C
6*	Long-term (no river EWR) and increased baseflow abstraction (3 m^3/s)	651.51	62.6	D

Scenarios	Description	MAR ($X10^6$ m^3)	% Similarity	
7*	Restoration (Present with river EWR + remove Invasive Aliens) with additional management interventions at the Estuary	771.03	74.1	B/C

**Estuary EWR scenarios generated to assess estuary sensitivity to flow changes. Not formal operational/water resource development scenario*

The present MAR into the Great Kei Estuary is 742 Million m^3. This is a decrease of 29% compared to the natural MAR of 1 041 Million m^3. **The Great Kei Estuary's overall health score is estimated to be 68% similar to natural conditions, which translates into a PES of a C Category.**

Scenarios 1, 2, and 4 (scenarios with River EWR release) improves the estuary condition to a B/C Category, but some of the ecosystem components, particularly the more complex or sensitive components like higher trophic levels (e.g. invertebrates, fish and birds) or certain habitats, remain degraded and do not contribute optimally to ecosystem services and conservation objectives. Under Scenario 7 (Scenario 1 with additional management measures at the estuary), the estuary health also improves to a B/C Category, and critical ecosystem services such as nursery function and carbon sequestration meet biodiversity and conservation objectives. **Overall, the estuary showed a ~6% improvement in health in response to the release of a river EWR across present and further development scenarios.** Under Scenarios 3 and 5 the estuary health remains similar to the present, i.e. shows little sensitivity to medium and long-term development scenarios. Under the 'worst-case' Scenario 6 the estuary declines further to a Category D – highlighting the estuary's sensitivity to flow reduction.

Recommendations to maintain or improve estuary condition

The PES for the Great Kei Estuary is a C Category, but as the estuary is of high biodiversity and conservation importance it should be in an A Category or BAS. **However, given the level of land use change in the catchment and the high level of resource use in and around the estuary, the REC was set at a BAS of a B/C Category.**

Key interventions required to improve the condition of the Great Kei Estuary include:

- Develop an Estuary Management Plan for the Great Kei Estuary to identify key actions required to address the ongoing decline in condition and coordinate restoration efforts;
- Reduce fishing and bait collection pressure by managing access, increased compliance and community interactions;
- Ensure maintenance of low-flow conditions to prevent prolonged periods of increased water residency that promote the accumulation of phytoplankton and benthic microalgal communities;
- Manage nutrient inputs by implementing agricultural best management practices (e.g., prevent overfertilization and irrigation) and restoring indigenous riparian vegetation;
- Prevent disturbance of riparian vegetation (especially mangroves), including trampling and grazing/browsing by cattle and fire;
- Remove alien vegetation within the EFZ; and
- Manage/control recreational activities (e.g. boating) in the lower and middle reaches, particularly along the shoreline on the seaside affecting bird abundance.

Ecological flow requirements

The Recommended Flow Scenario is Scenario 7 – similar in river inflow requirement to Scenario 1 (Present with river EWR release and additional removal of invasive alien plants from catchment) coupled with the estuary management interventions listed above. The flow requirements for the estuary are the same as those described for Scenario 1 and are summarised in **Table 5-12.**

Table 5-12: Great Kei: Summary of the monthly flow distribution (in m^3/s) for the Recommended Ecological Flow Scenario (i.e. Scenario 7: Restoration (Present with river EWR + remove Invasive Aliens from catchment) with additional management interventions at the Estuary).

%ile	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
99	230.3	328.5	197.0	189.0	318.3	513.5	230.6	146.2	77.6	101.8	160.7	164.8
90	51.1	124.4	87.0	106.6	109.5	135.9	78.9	41.5	20.4	15.6	26.8	46.9
80	28.4	68.4	63.8	65.6	83.8	96.0	49.8	21.7	13.4	13.2	11.5	20.7
70	20.4	28.4	42.6	38.7	62.0	62.3	37.8	14.2	10.3	9.8	9.6	13.8
60	15.9	21.3	25.6	30.6	42.1	37.8	26.7	11.7	9.4	8.2	8.2	11.6
50	13.1	15.3	18.7	20.4	32.6	34.2	19.4	10.1	8.0	7.6	7.2	9.0
40	10.4	13.1	14.1	17.4	23.0	27.4	16.3	9.1	7.2	6.6	6.6	7.2
30	8.9	10.8	9.7	12.6	16.4	24.0	12.8	7.5	6.6	6.2	6.3	6.5
20	6.8	9.0	7.0	7.0	13.0	17.0	10.1	6.6	6.0	5.7	5.7	5.6
10	5.2	6.8	5.1	5.2	9.1	11.4	7.9	5.8	5.2	5.1	5.0	5.1
1	3.7	3.7	3.5	2.6	3.4	4.3	4.6	4.7	4.0	3.7	3.6	3.7

5.2.4 *Keiskamma Estuary*

Description of hydrological scenarios

Table 5-13 provides a summary of a range of water resource development scenarios that could affect the Keiskamma Estuary.

Table 5-13: Keiskamma**:** Summary of flow scenarios

Scenarios	Description	MAR ($X10^6$ m^3)	% Similarity	Category
Reference	Natural	128.68	100.0	A
Present	Present (no River EWR)	86.43	67.2	C
1*	Restoration (Present with EWR + removal of invasive alien plants from catchment)	98.85	76.8	B
2	Present (with EWR)	88.48	68.8	B/C
3	Long-term (with EWR)	85.07	66.1	B/C
4	Mid-term (no EWR)	82.85	64.4	C
5	Long-term (no EWR)	82.44	64.1	C
6*	Worse case (Long-term no EWR, increased baseflow abstraction, large dams)	72.58	56.4	C/D
7*	Scenario 1: Restoration (Present with EWR + invasive alien plant eradication) with estuary management interventions	98.85	76.8	B

**Estuary EWR scenarios generated to assess estuary sensitivity to flow changes. Not formal operational/water resource development scenario*

The present MAR into the Keiskamma Estuary is 86.4 Million m3. This is a decrease of 33% compared to the natural MAR of 128.7 Million m3. The Keiskamma Estuary's overall health score is estimated to be 67% similar to natural conditions, which translates into a PES of a C Category.

Scenario 1 (Present with River EWR releases and invasive alien plant eradication from catchment) represents an improvement of the estuary health to a Category B, while Scenarios 2 and 3 represent only a half-category overall improvement. However, higher trophic levels (invertebrates, fish and birds) remains stressed under these scenarios as a result of present estuary resource use levels. Scenarios 4 and 5 are similar to the Present with only a slight decline in estuary condition. Scenario 6 represents a significant decline in estuary condition as a result of further flow reduction, increasing existing nutrient pressure. **Scenario 7 (Scenario 1: Present with EWR release and invasive alien plant eradication from catchment) coupled with estuary management interventions listed above) represents the only scenario in which all components of the ecosystem improve with a marked improvement in critical ecosystem services such as nursery function and carbon sequestration**.

Recommendations to maintain or improve estuary condition

The PES for the Keiskamma Estuary is a C Category, but as the estuary is degraded and of high biodiversity and conservation importance it should be in an A Category or BAS. **Given the land-use change in the Keiskamma Catchment and estuary environs, and the present level of natural resource utilisation of the estuary, the REC is set to meet the BAS of a B category.**

Key interventions required to improve the condition of the Keiskamma Estuary include:

- Develop an Estuary Management Plan for the Keiskamma Estuary to identify key actions require to address the ongoing decline in condition and coordinate restoration efforts;
- Reduce fishing and bait collection pressure by managing access, increase compliance and improve community interactions;
- Ensure maintenance of low-flow conditions to prevent prolonged periods of increased water residency that promote the accumulation of microalgal communities;
- Manage ever increasing nutrient inputs by implementing agricultural best management practices (e.g., prevent overfertilization and irrigation) and restoring indigenous riparian vegetation;
- Restore saltmarsh areas that are fallow at present;
- Prevent disturbance of riparian vegetation, including trampling and severe overgrazing by cattle in the EFZ; and
- Removal of alien vegetation from EFZ as well.

Ecological flow requirements

The REC for the Keiskamma Estuary is Category B. The Recommended Flow Scenario is Scenario 7 which is similar to Scenario 1: Present with EWR and invasive alien plant eradication from catchment) coupled with estuary management interventions listed above. The flow requirements for the estuary are the same as those described for Scenario 1 and are summarised in **Table 5-14**.

Table 5-14: Keiskamma Estuary: Summary of the monthly flow distribution (in m^3/s) for the Recommended Ecological Flow Scenario (i.e. Scenario 7: Present with EWR and invasive alien plant eradication) coupled with estuary management interventions.

%ile	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
99	29.6	60.9	27.5	19.1	20.0	45.2	23.2	19.6	14.4	22.3	54.0	24.2
90	7.7	12.5	11.1	8.9	10.1	13.4	8.7	4.4	3.1	3.1	4.7	8.1
80	5.4	7.0	6.9	5.1	6.6	6.9	5.0	2.5	2.2	2.3	2.2	4.0
70	3.6	4.4	4.5	3.9	4.2	5.3	3.3	2.0	1.7	1.8	1.9	2.6
60	3.0	3.5	3.3	2.7	3.3	4.0	2.8	1.7	1.5	1.6	1.6	1.8
50	2.3	2.7	2.5	2.3	2.3	2.9	2.4	1.5	1.3	1.3	1.4	1.6
40	1.9	2.3	1.9	1.7	1.9	2.2	1.9	1.3	1.3	1.2	1.3	1.4
30	1.7	2.0	1.7	1.4	1.6	1.9	1.6	1.1	1.1	1.1	1.2	1.3
20	1.4	1.7	1.2	1.0	1.5	1.5	1.2	1.0	1.0	1.0	1.0	1.1
10	1.1	1.3	0.9	0.7	0.9	1.2	0.9	0.8	0.9	0.9	0.9	0.9
1	0.8	0.6	0.5	0.5	0.6	0.6	0.6	0.7	0.7	0.6	0.7	0.7

5.2.5 *Kariega Estuary*

Description of hydrological scenarios

Table 5-15 provides a summary of a range of water resource development scenarios that could affect the Kariega Estuary.

Table 5-15: Kariega**:** Summary of flow scenarios

Scenarios	Description	MAR ($X10^6$ m^3)	% Similarity	Category
Reference	Natural	21.89	100.0	A
Present	Present (no river EWR)	13.08	59.8	C
1*	Restoration (strategic releases from the Settlers Dam (0.005 m^3/s) in the months in which the estuary does not receive incremental flows from below the dam,33% reduction in irrigation below the dam, and no support to Grahamstown from Settlers)	14.96	68.3	C
2	Medium/Long Term (no river EWR)	13.08	59.8	C
3*	Worse Case (full demand of Makhanda (Grahamstown) supplied from the Kariega, no Orange-Fish transfer)	9.89	45.2	D

**Estuary EWR scenarios generated to assess estuary sensitivity to flow changes. Not formal operational/water resource development scenario.*

The present MAR into the Kariega Estuary is 13.1 Million m^3. This is a decrease of 40% compared to the natural MAR of 21.9 Million m^3.

The Kariega Estuary's overall health score is estimated to be 68% similar to natural conditions, which translates into a **PES of a C Category**. Under Scenarios 1 and 2 the estuary is in a Category C, the same as the PES, with Scenario 1 only representing a slight 3% increase in condition with a major impact on water resource allocation in the catchment. Scenario 3 resulted in an additional 15% decline in condition, resulting in a Category D.

Recommendations to maintain or improve estuary condition

The PES for the Kariega Estuary is a C Category, but as the estuary is currently degraded and both of high biodiversity and conservation importance it should be in an A Category or at least BAS. **However, given the small size of the catchment; the degree of land-use change in the catchment and lower parts of the estuary; and the present level of natural resource utilisation of the Kariega Estuary the REC is set as a BAS of a C Category.**

Key interventions required to assist with species protection and to halt the further decline in the condition of the Kariega Estuary include:

- Increase the protection of the estuary to ensure the protection of Estuarine pipefish and seagrass, i.e. stewardship agreements with Private Nature Reserve adjacent to the system;
- Develop an Estuary Management Plan for the Kariega Estuary to identify key actions required to improve/protect the system and coordinate restoration efforts (requirement of National Environmental Management: Integrated Coastal Management Act (No. 24 of 2008) to coordinate management and restoration actions;
- Prevent further loss of low-flow conditions to limit the extent and duration of hypersalinity that leads to a loss of primary productivity. Increase base flows (e.g. through the removal of alien vegetation, unauthorised abstractions and/or forestry) to prevent mouth closure;
- Create interventions within the catchment and institute a buffer zone around the river and EFZ that would improve the nutrient status and help with sedimentation issues;
- Reduce fishing and bait collection pressure by managing access, increase compliance and improve community interactions to restore nursery function;
- Undertake restoration of the estuary floodplain and reduce agriculture impacts in the supratidal area of the system; and
- Prevent disturbance of indigenous riparian vegetation, including trampling, cattle, fire, and removal of alien vegetation.

Ecological flow requirements

The REC for the Kariega Estuary is Category C. Scenario 2 yields the same scores as the Present, thus the **Recommended Flow Scenario is Scenario 2 (Medium Term/Long Term development) coupled with the estuary management interventions** above. The flow requirements for the estuary are the same as those described for Scenario 2 and are summarised in **Table 5-16.**

Table 5-16: Kariega Estuary: Summary of the monthly flow distribution (in m^3/s) for the Recommended Ecological Flow Scenario (i.e. Scenario 2: Medium / Long term development)

%ile	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
99	7.767	11.136	4.886	1.388	1.297	8.587	7.097	6.468	9.654	5.122	11.310	10.232
90	0.501	0.494	0.605	0.209	0.160	0.554	0.451	0.386	0.205	0.247	0.662	1.213
80	0.341	0.221	0.167	0.048	0.062	0.285	0.183	0.107	0.090	0.060	0.097	0.296
70	0.206	0.120	0.068	0.027	0.033	0.082	0.117	0.053	0.051	0.045	0.051	0.062
60	0.086	0.054	0.037	0.019	0.021	0.046	0.080	0.037	0.040	0.034	0.034	0.040
50	0.052	0.041	0.026	0.009	0.017	0.034	0.033	0.030	0.031	0.026	0.026	0.027
40	0.032	0.031	0.011	0.004	0.004	0.026	0.023	0.022	0.027	0.022	0.019	0.023

%ile	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
30	0.018	0.014	0.000	0.000	0.000	0.011	0.015	0.015	0.019	0.018	0.015	0.019
20	0.007	0.004	0.000	0.000	0.000	0.004	0.003	0.007	0.015	0.011	0.010	0.011
10	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.004	0.008	0.007	0.004	0.000
1	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

5.2.6 *Gamtoos Estuary*

Description of hydrological scenarios

Table 5-17 provides provides a summary of a range of water resource development scenarios that could affect the Gamtoos Estuary.

Table 5-17: Gamtoos**:** Summary of flow scenarios

Scenario	Description	MAR (X 10^6 m^3)	% Similarity	Category
Reference	Natural	404.23	100.0	A
Present	Present (no River EWR)	194.82	48.2	D
1*	Restoration Scenario (Present with River EWR, irrigation demands 33% decreased on Kouga Dam, all alien invasives have been removed - except for the Groot)	219.71	54.4	C
2	Present (with River EWR)	209.19	51.8	C
3	Mid-term (no River EWR)	199.86	49.4	D
4	Long-term Desalination (no EWR)	199.59	49.4	D
5	Long-term Kouga Dam Raised (with River EWR)	198.60	49.1	D
6	Long-term Kouga Dam Raised (no River EWR)	192.57	47.6	D
7*	Long-term Worst case (Long-term demands, raised Kouga Dam, no EWR, no support from the Fish/ Sundays scheme)	175.04	43.3	D
8*	Scenario 2: Present (with River EWR) with Estuary Management interventions	209.19	51.8	C

**Estuary EWR scenarios generated to assess estuary sensitivity to flow changes. Not formal operational/water resource development scenario.*

The present MAR into the Gamtoos Estuary is 195 million m^3. This is a decrease of 52% compared to the natural MAR of 404 million m^3. **The Gamtoos Estuary's overall health score is estimated to be 54% similar to natural conditions, which translates into a PES of a D Category.** Scenarios 1 and 2 (both include River EWR releases) represent a nearly 10% improvement in the health of the Gamtoos Estuary resulting in a Category C. The difference between Scenario 1 and 2 is minimal in benefits to the estuary, even though Scenario 1 represents a 33% decrease in irrigation demand from the Kouga Dam and all invasive alien plants removed from most of the catchment). Indicating that little ecological benefit can be derived at the expense of existing water resource allocation. Scenarios 3 to 6 largely remain similar to the present, with an additional 8 % decline in the condition expected under Scenario 7, but with the system remaining in a D category. Scenario 8 (Present with River EWR releases and additional estuary management interventions) represents the scenario with the best ecological outcomes with important ecosystem services such as nursery function and carbon sequestration optimised even if conservation targets can not be met overall.

Recommendations to maintain or improve estuary condition

The PES for the Gamtoos Estuary is a D Category, but as the estuary is degraded and both of high biodiversity and conservation importance it should be in an A Category or BAS. **However, given the degree of land-use change, specifically agriculture, in the catchment and estuary floodplain; concerns regarding water quality; and the present very high level of natural resource utilisation of the Gamtoos Estuary the REC is a BAS of a C Category.**

Key interventions required to improve the condition of the Gamtoos Estuary include:

- Develop an Estuary Management Plan for the Gamtoos Estuary to identify key actions required to halt the ongoing degradation of estuary condition and restore and coordinate restoration efforts (requirement of National Environmental Management: Integrated Coastal Management Act (No. 24 of 2008);
- Increase base flows (e.g. through the removal of alien vegetation, unauthorised abstractions and/or forestry) to prevent mouth closure;
- Maintain a degree of natural hydrodynamic variability and periodic system flushing to prevent persistent eutrophic conditions (i.e., HABs, hypoxia, loss of species diversity);
- Reduce nutrient inputs by implementing agricultural best management practices (e.g., prevent overfertilization and irrigation) and restoring indigenous riparian vegetation;
- Institute a buffer zone around the river and EFZ that would improve the nutrient status and help with sedimentation issues;
- Develop and approve an Estuary Mouth/Maintenance Management Plan (required under the Environmental Impact Assessment regulations under the National Environmental Management Act (No. 107 of 1998)) to facilitate artificial breaching if required in future;
- Reduce fishing pressure by managing access, increase compliance and improve community interactions to restore nursery function;
- Prevent further disturbance of estuary riparian vegetation, including reducing trampling and grazing by livestock, the occurrence of fire, and remove alien vegetation from the EFZ; and
- Undertake active restoration of the degraded estuary floodplain and reduce agriculture impacts in the supratidal area of the system.

Ecological flow requirements

The REC for the Gamtoos Estuary is Category C. **The Recommended Flow Scenario is Scenario 8, which is a similar flow regime to Scenario 2: Present (with River EWR) coupled with estuary restoration interventions** listed above. The flow requirements for the estuary are are summarised in **Table 5-18.**

Table 5-18: Gamtoos Estuary: Summary of the monthly flow distribution (in m^3/s) for the Recommended Ecological Flow Scenario (i.e. Scenario 8: Present with River EWR with estuary restoration intervention)

%ile	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
99	32.9	69.9	57.2	68.2	97.8	122.3	57.8	54.2	48.1	37.1	112.3	48.1
90	7.8	8.9	7.2	6.2	20.8	32.4	20.7	5.6	5.1	8.7	26.1	30.4
80	5.1	4.3	3.1	3.0	6.0	12.5	6.6	2.6	2.3	2.4	5.5	9.0

%ile	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
70	3.3	3.4	2.5	2.0	3.1	7.6	3.4	2.1	1.9	2.0	3.6	3.7
60	2.1	2.9	1.9	1.7	2.2	6.6	1.9	1.7	1.7	1.7	3.0	2.7
50	1.7	2.6	1.5	1.2	1.7	4.0	1.5	1.3	1.4	1.5	2.4	2.2
40	1.4	2.2	1.2	0.8	1.3	2.7	1.3	1.1	1.2	1.2	1.9	1.7
30	1.2	1.4	1.0	0.5	1.0	2.0	1.0	1.0	1.0	1.1	1.6	1.2
20	1.0	1.2	0.9	0.4	1.0	1.5	0.9	0.9	0.9	1.0	1.3	1.1
10	0.9	1.0	0.9	0.4	0.8	1.0	0.6	0.7	0.8	0.8	1.1	0.9
1	0.4	0.7	0.7	0.3	0.5	0.8	0.4	0.4	0.4	0.6	0.8	0.8

5.2.7 *Kabeljous Estuary*

Description of hydrological scenarios

Table 5-19 provides a summary of a range of water resource development scenarios that could affect the Kabeljous Estuary.

Table 5-19: Kabeljous: Summary of flow scenarios

Scenario	Description	MAR	%Similarity	Category
Reference	Natural (with 33 % more groundwater input)	5.27	100	A
Present	Present (no EWR)	4.70	89.3	B
1*	Restoration (20% decrease in dams and corresponding irrigation)	4.90	93.0	B
2	Mid-term (no EWR)	4.72	89.6	B/C
3*	Worse case (~30% increase in dams and corresponding irrigation)	3.99	75.8	C
4.*	Present with 33% reduction in groundwater input	4.70	89.3	C

**Estuary EWR scenarios generated to assess estuary sensitivity to flow changes. Not formal operational/water resource development scenario*

The Kabeljous Estuary is fed by the Kabeljous and Gheis River, with a total length of approximately 30 km). The total catchment of the area is ~238 km^2 (Bickerton and Pierce, 1988). Historical studies have estimated the mean annual runoff of between 15 x 10^6 m^3 and 27 x 10^6 m^3 (Bickerton and Pierce, 1988; Klages, 2005), but this has recently been adjusted downwards in the Algoa Bay study. According to the hydrological data provided for this study team, the present MAR into the Kabeljous Estuary is 4.7 Million m^3. This is a decrease of 11% compared to the natural MAR of 5.27 Million m^3.

The Kabeljous Estuary's overall health score is estimated to be 78% similar to natural conditions, which translates into a PES of a B Category. Scenario 1 (Restoration: 20% decrease in dams and corresponding irrigation) represents only a 2% increase in estuary conditions despite its significant impact on the water allocation in the catchment. Scenario 2 (Medium-term development) represents a decline to a Category B/C, albeit only a 1% decline in overall condition. Scenario 3 (~30% increase in dams) and Scenario 4 (potential further 33% reduction in groundwater) both pose considerable risks to the estuary condition as they increase either the duration of hypersalinity conditions or the intensity of hypersalinity conditions, or both. Groundwater especially in closed shallow estuaries plays an important role in moderating the development of hypersalinity and water levels. The present reduction in groundwater is estimated to already play a role in the development of hypersalinity values of 55 to 60 (seawater = 35).

Recommendations to maintain or improve/maintain estuary condition

The PES and the REC for the Kabeljous Estuary is a B Category. However, given the degree of agriculture and development in the catchment and estuary environs; concerns regarding surface water and groundwater abstraction, declining water quality; and the high level of fishing effort the estuary is on a concerning negative trajectory.

Key interventions required to improve the condition of the Kabeljous Estuary include:

- Develop an Estuary Management Plan for the Kabejous Estuary to identify key actions needed to improve the condition and coordinate restoration efforts;
- Ensure maintenance of low-flow conditions (including groundwater) to prevent prolonged periods of mouth closure and the development of extreme hypersalinity that promotes microalgal and macroalgal accumulations;
- Increase base flows (e.g. through the removal of alien vegetation, unauthorised abstractions and/or forestry);
- Reduce nutrient inputs by implementing agricultural best management practices (e.g., prevent overfertilization and over-irrigation) and restoring riparian vegetation;
- Reduce fishing pressure by managing access, increase compliance and improve community interactions to restore nursery function;
- Prevent disturbance of riparian vegetation, including trampling by humans and cattle, fire, and removal of alien vegetation; and
- Prevent artificial breaching of the mouth (currently not a concern).

Ecological flow requirements

The REC for the Kabeljous Estuary is Category B. **The Recommended Flow Scenario is the present flow regime for surface and groundwater coupled with estuary management interventions listed above to halt the further decline in estuary condition.** The flow requirements for the estuary are the same as those described for the present day (PES) and are summarised in **Table 5-20.**

Table 5-20: Kabeljous Estuary: Summary of the monthly flow distribution (in m^3/s) for the Recommended Ecological Flow Scenario (i.e. Present)

%ile	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
99	2.862	1.807	0.711	0.164	0.543	0.627	0.311	1.288	1.073	0.534	8.318	8.460
90	0.318	0.202	0.080	0.035	0.027	0.038	0.059	0.132	0.116	0.171	0.254	0.475
80	0.199	0.140	0.065	0.026	0.021	0.028	0.035	0.054	0.081	0.105	0.163	0.204
70	0.164	0.119	0.046	0.024	0.019	0.016	0.027	0.041	0.060	0.080	0.120	0.147
60	0.123	0.092	0.039	0.020	0.014	0.011	0.019	0.029	0.051	0.061	0.095	0.118
50	0.107	0.076	0.032	0.015	0.010	0.009	0.015	0.021	0.033	0.051	0.075	0.104
40	0.092	0.061	0.025	0.014	0.010	0.009	0.011	0.015	0.028	0.044	0.060	0.076
30	0.073	0.054	0.023	0.011	0.007	0.008	0.009	0.014	0.024	0.036	0.051	0.061
20	0.054	0.043	0.017	0.009	0.006	0.006	0.009	0.012	0.016	0.029	0.040	0.051
10	0.041	0.035	0.014	0.006	0.006	0.003	0.006	0.006	0.012	0.021	0.030	0.043
1	0.005	0.018	0.007	0.003	0.003	0.002	0.003	0.002	0.003	0.006	0.007	0.021

Reducing either surface water or groundwater inputs to the Kabeljous Estuary poses considerable risks to the estuary condition as it will increase either the duration of hypersalinity conditions and/or the intensity of hypersalinity conditions. Groundwater, especially in closed shallow estuaries such as the Kabeljous, plays an important role in moderating the development of hypersalinity and water levels. The present potential reduction in groundwater in conjunction with surface water abstraction is estimated to already play a role in the development of hypersalinity values of 55 to 60 (seawater = 35). While this study was of low confidence, it indicated that any additional freshwater allocation, albeit surface or groundwater, would severely impact the ecological health of this system. If future allocations are to be considered, refinements to both the surface and groundwater models need to be made to guide allocations at the estuary process scale.

5.3 Restoration is required to address negative trajectories in estuary condition and achieve RECs

Table 5-12 provides a tabulated overview of key interventions required to maintain/ restore estuary conditions and key ecosystem services to coastal communities. In many cases, these do not require new management action but more an intensifying of existing mandates. In addition, the Gamtoos and Keiskamma estuaries have degraded saltmarsh areas in need of active restoration to improve the ability of these systems to contribute to carbon sequestration, a climate regulatory service provided by blue carbon habitats.

Table 5-21: Restoration interventions required to address trajectory of change and achieving the REC (Priority = ⬤ Action reguired= ●)

Estuary	PES (Trajectory of change)	REC	Flow			Water Quality			Non-flow intervention													
			Restore/protect base flows	Maintain/protect floods	Protect/restore groundwater	Manage/reduce stormwater & drainage from floodplain	Improve river water quality	Monitor & reduce/reuse WW	Restore connectivity/ hydrodynamic functioning	Improve mouth management	Rehabilitate riparian areas/ wetlands	Remove alien vegetation*	Reduce grazing (sheep, cattle, goats)	Manage browsing/ implement cattle exclusion zone	Control mangrove harvesting	Control boating activities impacting on seagrass and birds	Control recreational activities impacting saltmarsh and birds	Remove/reduce fishing pressure	Manage/reduce bait collection	Investigate eradication of alien fish	Restore/protect against impact of mining
Kabeljous	**B ↓**	**B**	●	●	⬤		Agric		●			●					⬤	⬤	●	●	
Gamtoos	**D ↓**	**C**	●	⬤		Agric	Agric				⬤	●	●			●		⬤	●	●	
Kariega	**C ↓**	**C**	●					●	⬤			●	●			⬤		⬤	⬤		
Keiskamma	**C ↓**	**B**	●	⬤			Urban				⬤	●	⬤			⬤		⬤	⬤	●	
Great Kei	**C ↓**	**B/C**	●	⬤				●			●	●	●	⬤	⬤	●	●	⬤	●	●	
Mbashe	**B/C ↓**	**B**	●	⬤								⬤	●	⬤	⬤	●	●	⬤	●	●	
Mngazi	**B ↓**	**B**									●	●				●		⬤	●		⬤

* Mbashe Estuary: *Tamarix ramosissima*, Great Kei: Spanish reeds

6. MZIMVUBU TO TSITSIKAMMA WATER MANAGEMENT AREA: SUMMARY OF THE PRESENT ECOLOGICAL STATE OF THE ESTUARIES

An assessment of the present condition of the estuaries clearly shows that most systems in the extensive rural parts of the study area, have limited pressures on them (**Table 6-1**). A few systems reflected the impact of urbanisation around the metros and larger towns. In most cases, inflowing-hydrology was still in relatively good condition. Exceptions include many of the urbanised systems where abstraction and dam development decrease base flows significantly. Excessive wastewater discharges has also increased baseflows in some systems, e.g. Swartkops. The hydrodynamics (mouth state) and salinity distributions therefore show a similar pattern.

In contrast to the hydrology, the water quality in a large number of estuaries in this WMA has been modified to some degree. This is largely attributed to diffuse agricultural runoff in rural areas (e.g. fertilizers, herbicides and pesticides) and contaminated stormwater runoff from urban development (e.g. nutrients and toxic substances). In some estuaries, water quality has been compromised by point source WWTW effluent being discharged into estuaries or into rivers near the head of estuaries, e.g. Swartkops. Except for the larger fast-flowing estuaries (e.g. Great Kei, Mbashe, Great Fish) a large number of systems along this stretch of coast are relatively small with a very high vulnerability to increased nutrient loading.

Agriculture along the banks of a large number of systems has led to the loss of marginal vegetation and natural estuarine buffers. Catchments of many of the estuaries in tribal areas are subjected to subsistence agricultural practice and overstocking, increasing sediment loads that contribute to sedimentation in estuaries. Urbanisation has led to significant habitat modification in some systems in densely populated areas. Road infrastructure has also impacted several systems, with bridge foundations, abutments and road berms causing infilling of systems and consequential habitat destruction, or development across floodplain and channel stabilisation impacting natural flow patterns resulting in localised scour and deposition. Coega and Buffalo estuaries, comprising operational ports, also stand out as highly transformed estuaries.

Macrophytes also reflected the effect of agriculture and urbanisation, with a significant number of systems showing signs of significant degradation of floodplain vegetation. Grazing and browsing have also severely impacted saltmarsh and mangroves in key systems. In many estuaries, there was also a significant loss of habitat due to the presence of bridge abutments and berms. In several systems, e.g. Swartkops and Sundays Estuaries, agricultural return flow, stormwater and/or nutrient input from wastewater treatment have caused eutrophication. Emergent species thrive under these conditions and invasive aquatic macrophytes such as water hyacinth (*Eicchornia crassipes*) and water cabbage (*Pistia stratiotes*) outcompete indigenous plants. Invasive terrestrial species are a further concern with seeds either introduced via floods or through habitat transformation on the floodplains. The category 1b invader *Tamarix ramossisima* occurs at the mouth of the Mbashe Estuary in what was salt marsh and mangrove mix. Deposition of sand at the mouth from sea storms have altered local topography and the establishment of this salt tolerant invader is taking place. Reduction in freshwater inflow to estuaries and an increase in the frequency and duration of closed mouth conditions is also a threat.

Microalgae have responded positively to increased nutrient loading compounded by increased retention due to reduced flows, but these effects were somewhat buffered by the fact that many of the systems are naturally turbid and/or fast-flowing for most of the year. Harmful algal blooms have been deterred in several important systems, with cascading effects on estuary food webs.

Changes in hydrology have also impacted invertebrate communities, especially marine invertebrates, both through reduced connectivity (increased closure) and therefore reduced opportunity to recruit into estuaries, and through changes to the salinity regimes in some systems. Declining water quality has also played a role in declining assemblages in several systems in this WMA and certainly in estuaries in densely populated urban areas. Small estuaries that are predominantly closed are especially prone to water quality impacts. Alteration and destruction of habitat have also contributed to impacts on estuarine invertebrate communities in some systems in the study areas. The invertebrates are primarily impacted by abiotic bottom-up pressures, hence many of the above impacts cascade in terms of invertebrate compositional changes and overall abundance fluctuations. These have arisen mostly due to the anthropogenic development of estuarine systems and the impact of bait collection. Finally, fishing pressure also impacted invertebrate megafauna populations such as mud crabs and prawns.

Fish communities overwhelmingly responded to very high fishing pressure, with illegal gillnets being the main pressure in several important nursery systems. In many estuaries, this was compounded by a reduction in flow which impacted marine connectivity (mouth state) and salinity regimes. Several estuaries in the study area also have experienced loss of estuarine habitat and loss of natural buffers on their perimeters and inflowing rivers. Critical habitat has been lost in some cases, which has resulted in marked reductions in fish diversity and nursery function. In this regard, the loss of submerged aquatic vegetation, especially the seagrass *Zostera capensis* played a significant role. In systems within the two metropolitan areas, subjected to inflow from WWTWs, stormwater runoff and agriculture (e.g. Sundays), water quality is increasingly becoming an issue. Fish kills have occurred in recent years in a small number of estuaries in the WMA (e.g. Swartkops). These kills have been related to eutrophication and/or low oxygen events, triggered by wastewater flows (due to infrastructure failure and/or overloading). Eutrophication and/or low oxygen events also leads to a reduced abundance and diversity of fish and habitat squeeze/loss in the productive middle and upper reaches of affected systems (e.g. Sundays and Swartkops).

Birds were very sensitive to human disturbance with most systems in urban areas or those subjected to high recreational use showing suppressed numbers. This was further exasperated in some systems by a reduction in food availability and suitable habitat.

Table 6-1: Key pressures on the estuaries in the Mzimvubu to Tsitsikamma Water Management Area (WMA 7)

No.	NAME	Reference MAR (m^3x10^6)	Present MAR (m^3x10^6)	% Similarity MAR	Pressure: Flow modification	Pressure: Pollution	Pressure: Habitat loss	Pressure: Fishing Effort 2024 (DFFE)	Pressure: Invasive alien plants	Pressure: Alien Fish	Artificial Breaching
1	Lottering	18.50	16.82	91	L[1]	L	L	L		N	
2	Elandsbos	27.16	24.67	91	L	L	L	L		N	
3	Storms	54.07	47.85	89	L	L	L	L		N	
4	Elands	52.20	46.90	90	L	L	L	L		N	
5	Groot (Oos)	46.99	44.12	94	L	L	L	L		N	
6	Tsitsikamma	19.90	13.31	67	M	M[2]	L	H[3]		N	

No.	NAME	Reference MAR (m^3x10^6)	Present MAR (m^3x10^6)	% Similarity MAR	Pressure: Flow modification	Pressure: Pollution	Pressure: Habitat loss	Pressure: Fishing Effort 2024 (DFFE)	Pressure: Invasive alien plants	Pressure: Alien Fish	Artificial Breaching
7	Klipdrif (Oos)	32.93	18.58	56	L	VH[4]	M	L		N	
8	Slang	5.07	4.58	90	L	VH	H	L		N	
9	Kromme	72.18	36.78	51	VH	L	H	VH		H	
10	Seekoei	20.27	11.36	56	H	H	VH	L	M	L	M
11	Kabeljous	5.27	4.7	89	L	L	L	VH	H	H	L (Past)
12	Gamtoos	404.23	194.82	48	VH	H	H	VH	M	VH	
13	Van Stadens	17.19	15.63	91	M	M	L	L	H	N	
14	Maitland	12.86	11.69	91	M	M	L	L	H	N	
15	Baakens	4.11	3.60	88	H	VH	VH	L		N	
16	Papkuils	2.92	2.89	99	H	VH	VH	L		N	
17	Swartkops	56.9	80.3	71	H	VH	VH	VH	H	H	
18	Coega (Ngqurha)	10.13	8.62	85	H	M	VH	L		H	
19	Sundays	263.1	240.73	91	L	VH	H	VH	H	H	
20	Boknes	14.44	14.38	100	VH	H	L	L		L	
21	Bushmans	43.08	32.66	76	VH	H	M	H		H	
22	Kariega	21.89	13.08	60	VH	L	M	VH		N	
23	Grant's	2.42	2.25	93	H	M	M	L		N	
24	Kasouga	4.30	4.26	99	L	M	L	M		N	
25	Kowie	31.37	27.95	89	L	L	H	VH	M	H	
26	Rufane	1.20	1.12	94	H	M	M	L		N	
27	Riet	2.4	2.3	96	L	L	L	L		N	
28	West Kleinemonde	6.00	5.45	91	L	M	L	L		N	
29	East Kleinemonde	2.86	2.75	96	L	M	L	L		N	
30	Great Fish	496.341	450.9999	91	L	H	L	VH	M	VH	
31	Old Woman's	1.11	0.94	85	M	L	M	L		N	
32	Mpekweni	2.44	2.07	85	M	L	L	M		N	
33	Mtati (Mthathi)	6.03	5.09	84	M	L	L	L		N	
34	Mgwalana	9.71	8.20	84	M	L	L	L		N	
35	Bira (Bhirha)	12.01	9.97	83	M	L	L	L		N	
36	Gqutywa	3.52	2.96	84	L	L	L	L		N	
37	Ngculura (Ngculurha)	0.65	0.56	86	M	L	L	L		N	
38	Mtana	1.06	0.90	84	L	L	L	L		N	
39	Keiskamma	128.68	86.43	67	H	M	M	VH		H	
40	Nqinisa	1.18	1.17	99	L	L	L	L		N	
41	Kiwane (Khiwane)	5.32	5.29	100	L	L	L	L		N	
42	Tyolomnqa	35.56	34.54	97	L	L	L	VH		N	
43	Shelbertsstroom	0.63	0.62	99	L	M	L	L	M	N	
44	Lilyvale	1.11	1.00	91	L	M	L	L		N	
45	Ross' Creek	0.55	0.54	99	L	M	L	L		N	
46	Ncera (Ncerha)	10.99	10.24	93	L	L	L	L		N	
47	Mlele	2.00	1.86	93	L	M	L	L		N	
48	Mcantsi	2.84	2.65	93	L	VH	L	L		N	
49	Gxulu	15.56	14.50	93	L	M	M	L		N	
50	Goda	6.19	5.76	93	L	M	L	L		N	
51	Hlozi	1.75	1.63	93	L	M	L	L		N	
52	Hickman's	1.42	1.33	93	M	VH	M	L		N	
53	Buffalo	96.03	18.70	19	VH	VH	M	VH		VH	
54	Blind	0.65	1.12	58	H	VH	M	L		N	
55	Hlaze (iHlanze)	0.32	0.80	39	VH	VH	M	L		N	
56	Nahoon	32.481	20.41	63	H	H	M	VH	H	H	
57	Qinira (Quinirha)	8.44	8.30	98	L	L	L	H		N	L
58	Gqunube	34.07	32.05	94	L	M	L	H		H	

No.	NAME	Reference MAR (m^3x10^6)	Present MAR (m^3x10^6)	% Similarity MAR	Pressure: Flow modification	Pressure: Pollution	Pressure: Habitat loss	Pressure: Fishing Effort 2024 (DFFE)	Pressure: Invasive alien plants	Pressure: Alien Fish	Artificial Breaching
59	Kwelera (Kwelerha)	34.83	32.80	94	L	L	L	H		L	
60	Bulura (Bulurha)	3.73	3.52	94	L	L	L	H		N	
61	Cunge	0.32	0.31	97	L	L	L	L	M	N	
62	Cintsa	3.99	3.76	94	L	L	M	M		N	
63	Cefane	3.95	3.20	81	L	L	L	M		N	
64	Kwenxura (Kwenxurha)	16.89	16.57	98	L	L	L	M		N	
65	Nyara (Nyarha)	4.34	4.26	98	L	L	L	L		N	
66	Imtwendwe (Mtwendwe)	1.07	1.05	98	L	L	L	L		N	
67	Haga-haga	2.15	2.10	98	L	L	L	L		N	
68	Mtendwe	1.41	1.39	98	L	L	L	L		N	
69	Quko	17.18	16.86	98	L	L	L	L		N	
70	Morgan	2.74	2.69	98	L	L	L	H		H	
71	Cwili	1.18	1.16	98	L	L	L	L		H	
72	Great Kei	1040.71	741.99	71	H	L	L	VH		VH	
73	Gxara (Gxarha)	3.44	3.38	98	L	L	L	L		N	
74	Ngogwane	0.79	0.77	98	L	L	L	L		N	
75	Qolora (Qolorha)	8.90	8.73	98	L	L	L	L		N	
76	Ncizele	1.00	0.98	98	L	L	L	L		N	
77	Timba	0.35	0.35	98	L	L	L	L		N	
78	Kobonqaba (Khobonqaba)	36.22	35.53	98	L	L	M	L		N	
79	Nxaxo/Ngqusi	23.27	22.80	98	L	L	M	H	M	N	
80	Cebe	5.69	5.57	98	L	L	L	L		N	
81	Gqunqe	6.96	6.82	98	L	L	L	L		N	
82	Zalu	1.69	1.66	98	L	L	L	L		N	
83	Ngqwara (Ngqwarha)	5.24	5.14	98	L	L	L	L		N	
84	Sihlontlweni	2.21	2.17	98	L	L	L	L		N	
85	Nebelele	1.05	1.03	98	L	L	L	L		N	
86	Qora (Qhorha)	78.52	72.00	92	L	L	L	VH		N	
87	Jujura (Jujurha)	11.27	10.28	91	L	L	L	L		N	
88	Ngadla	1.56	1.51	97	L	L	L	L		N	
89	Shixini	42.28	41.00	97	L	L	L	M		N	
90	Beechamwood	0.54	0.53	97	L	L	L	L		N	
91	Kwazlelitsha (Kwazwedala)	0.59	0.57	97	L	L	L	L		N	
92	Kwa-Goqo	0.99	0.95	97	L	L	L	L		N	
93	Ku-Nocekedwa	1.08	1.05	97	L	L	L	L		N	
94	Nqabara/Nqabarana	76.44	75.90	99	L	L	L	M	M	N	
95	Ngomane (East)	1.11	1.09	98	L	L	M	L		N	
96	Ngoma/Kobule	6.30	6.17	98	L	L	L	L		N	
97	Mendu	5.19	5.08	98	L	L	L	M		N	
98	Mendwana	1.35	1.33	98	L	L	L	M		N	
99	Mbashe	786.88	861.16	91	M	M	L	VH		H	
100	Ku-Mpenzu	0.76	0.73	97	L	L	L	L		N	
101	Ku-Bhula (Mbhanyana)	8.92	8.62	97	L	L	L	H		N	
102	Kwa-Suku	0.70	0.67	97	L	L	L	M		N	
103	Ntlonyane	13.63	13.17	97	L	L	L	M		N	
104	Nkanya	2.53	2.44	97	L	L	L	L		N	
105	Sundwana	0.81	0.78	97	L	L	L	L		N	
106	Xora	52.41	40.52	77	H	L	L	VH	M	N	
107	Bulungula	7.61	7.49	98	L	L	L	L	M	N	
108	Ku-Amanzimuzama	1.60	1.57	98	L	L	L	L		N	
109	Nqakanqa	0.84	0.82	98	L	L	L	L		N	
110	Mdikana	0.24	0.24	100	L	L	L	L		N	

No.	NAME	Reference MAR (m^3x10^6)	Present MAR (m^3x10^6)	% Similarity MAR	Pressure: Flow modification	Pressure: Pollution	Pressure: Habitat loss	Pressure: Fishing Effort 2024 (DFFE)	Pressure: Invasive alien plants	Pressure: Alien Fish	Artificial Breaching
111	Mncwasa	26.95	26.49	98	L	L	L	L		N	
112	Mpako	21.68	21.55	99	L	L	L	M		N	
113	Nenga	9.15	9.02	99	L	L	H	M		N	
114	Mapuzi	5.55	5.47	99	L	L	L	L		N	
115	Mtata	392.20	319.02	81	M	H	M	VH	M	VH	
116	Thsani	0.53	0.52	97	L	L	L	L		N	
117	Mdumbi	36.63	35.48	97	L	L	L	H	M	N	
118	Lwandilana	1.43	1.40	98	L	L	L	L		N	
119	Lwandile	3.40	3.30	97	L	L	L	L		N	
120	Mtakatye	63.36	61.70	97	L	L	L	H	M	N	
121	Hluleka	4.27	4.16	98	L	L	L	L		N	
122	Mnenu	19.69	19.21	98	L	L	L	M		N	
123	Mtonga	3.97	3.88	98	L	M	L	L		N	
124	Mpande	4.48	4.38	98	L	L	L	L		N	
125	Sinangwana	11.48	11.20	98	L	L	L	L		N	
126	Mngazana	49.34	47.79	97	L	L	M	VH		N	
127	Mngazi	87.31	83.52	96	L	M	L	H		N	?
128	Gxwaleni	1.64	1.60	97	L	L	L	L		N	
129	Bulolo	1.63	1.59	97	L	L	M	M		N	
130	Mtumbane	1.01	0.99	98	L	L	M	L		N	
131	Mzimvubu	2665.58	2552.00	96	L	M	L	H	M	VH	
132	Ntlupeni	3.82	3.76	98	L	L	L	L		N	
133	Nkodusweni	8.21	8.07	98	L	L	L	L		N	
134	Mntafufu	44.53	43.77	98	L	L	L	H	H	N	
135	Ingo	4.57	4.40	96	L	L	L	L		N	
136	Mzintlava	69.78	67.03	96	L	L	L	H		N	
137	Mzimpunzi	9.16	8.48	93	L	L	L	L		N	
138	Kwanyambalala	4.19	3.88	93	L	L	L	H		N	
139	Mbotyi	11.10	10.27	93	L	L	L	H		N	
140	Mkozi	15.74	14.57	93	L	L	L	L		N	
141	Sikatsha	1.85	1.71	93	L	L	L	L		N	
142	Lupatana	6.97	6.45	93	L	L	L	L		N	
143	Mkweni	18.36	17.01	93	L	L	L	L		N	
144	Msikaba	212.39	199.31	94	L	L	L	H	M	N	
145	Mgwegwe	1.22	1.19	98	L	L	L	L		N	
146	Mgwetyana	1.82	1.79	98	L	L	L	L		N	
147	Mtentu	157.03	145.36	93	L	L	L	H	M	H	
148	Sikombe	6.79	6.79	100	L	L	L	L		N	
149	Kwanyana	3.99	3.90	98	L	L	L	L		N	
150	Mtolane	1.78	1.78	100	L	L	L	L		N	
151	Mnyameni	45.87	44.84	98	L	L	L	M		N	
152	Mpahlanyana	1.11	1.04	94	L	L	L	M		N	
153	Mpahlane	2.73	2.54	93	L	L	L	M		N	
154	Mzamba	67.43	62.77	93	L	L	L	H	M	N	
155	Mtentwana	1.26	1.18	94	L	M	M	L		N	

[1]Low impact; [2]Medium impact; [3]Large impact; [4]Very High impact

The larger Mzimvubu to Tsitsikamma WMA 7 hosts some of South Africa's most important and pristine estuaries. An evaluation of the PES of the estuaries in the larger WMA indicates that a large number of the estuaries in the study area are still in a natural to near-natural state (**Table 6-2**). About a third of the systems (51) are in a PES of an A to A/B Category, while 42% (66) are in a PES of a

B Category. An additional 10 estuaries health state are in a B/C Category, with 15 systems in a C Category. Four systems are degraded to a C/D and D Category each.

Only 5 systems conditions are below a PES of a D Category (D/E=2, E/F=2, F=1) with all of these clustered around urban centres.

Table 6-2: Present Ecological State of the estuaries in the Mzimvubu to Tsitsikamma WMA7

No.	Estuary	Hydrology	Hydrodynamics	Water Quality: Salinity	Water Quality: General	Water Quality	Physical habitat Category	Habitat Score	Microalgae	Macrophytes	Invertebrates	Fish	Birds	Biological Category	PES 2024
1	Lottering	B	A	A	A	A	A	A	A	A	A	B	B	B	A/B
2	Elandsbos	B	A	A	A	A	A	A	A	A	A	B	B	B	A/B
3	Storms	B	A	A	A	A	A	A	A	A	A	B	B	B	A/B
4	Elands	B	A	A	B	B	A	B	B	A	A	B	B	B	A/B
5	Groot (Oos)	A	A	A	B	B	A	A	B	B	A	B	B	B	A/B
6	Tsitsikamma*	C	C	C	C	C	A	C	C	B	B	C	B	B	B/C
7	Klipdrif (Oos)	B	C	B	E	D	B	C	D	C	D	D	B	C	C
8	Slang	B	C	B	E	D	D	C	D	D	D	D	C	D	C/D
9	Kromme*	E	A	E	E	E	C	D	F	D	F	D	C	D	C/D
10	Seekoei*	D	E	E	D	E	C	D	E	E	E	E	E	E	D/E
11	Kabeljous*	C	C	B	C	C	C	C	C	C	C	C	B	C	B
12	Gamtoos*	C	A	B	C	C	C	B	C	D	B	D	B	D	D
13	Van Stadens	C	B	B	C	C	B	B	C	B	B	B	B	B	B
14	Maitland	C	B	B	C	C	B	B	C	B	C	C	B	B	B/C
15	Baakens	D	E	E	F	F	F	E	E	F	F	F	F	F	E/F
16	Papkuils	D	F	F	F	F	F	E	E	F	F	F	F	F	F
17	Swartkops*	E	B	B	E	D	D	D	D	E	E	E	D	D	D
18	Coega (Ngqurha)	D	F	F	C	D	F	E	D	F	F	F	E	F	E/F
19	Sundays*	C	A	C	F	E	B	C	E	D	D	E	D	D	C/D
20	Boknes	E	C	B	D	C	B	C	D	B	C	C	B	C	C
21	Bushmans	B	A	B	B	C	B	B	D	C	C	C	B	C	C
22	Kariega*	E	A	C	B	B	B	C	C	C	D	C	C	C	C
23	Grant's	D	C	C	C	C	C	C	C	C	C	C	C	C	C
24	Kasouga	B	A	A	C	B	B	B	B	B	B	B	B	B	B
25	Kowie	B	B	B	B	B	D	B	B	D	D	D	D	C	C
26	Rufane	D	C	B	C	C	D	C	C	C	C	C	B	C	C
27	Riet	B	B	B	B	B	B	B	B	B	B	B	B	B	B
28	West Kleinemonde*	A	B	B	C	C	B	B	B	B	B	B	B	B	B
29	East Kleinemonde	A	B	B	C	B	B	B	B	B	B	B	B	B	B
30	Great Fish*	B	B	B	D	D	B	B	D	B	D	D	C	C	C
31	Old Woman's	C	B	B	B	B	C	B	B	C	C	C	C	C	B/C
32	Mpekweni	C	B	B	B	B	B	B	B	B	C	B	B	B	B
33	Mtati (Mthathi)	C	B	B	B	B	B	B	B	B	B	B	B	B	B
34	Mgwalana	C	B	B	B	B	B	B	B	B	B	B	B	B	B
35	Bira (Bhirha)	C	B	B	B	B	B	B	B	B	B	B	B	B	B
36	Gqutywa	B	B	B	B	B	B	B	B	B	B	B	B	B	B
37	Ngculura (Ngculurha)	C	B	B	B	B	B	B	B	B	B	C	B	B	B
38	Mtana	B	B	B	B	B	A	B	B	A	B	B	B	B	B
39	Keiskamma*	B	A	C	C	C	C	B	B	C	C	D	B	C	C
40	Nqinisa	A	A	A	B	B	A	A	B	B	B	B	B	B	A/B
41	Kiwane (Khiwane)	A	A	A	B	B	A	A	B	B	B	B	B	B	A/B
42	Tyolomnqa	A	A	A	B	B	B	B	B	B	B	C	C	B	B
43	Shelbertsstroom	B	B	B	C	B	D	B	B	B	B	C	B	B	B/C

No.	Estuary	Hydrology	Hydrodynamics	Water Quality: Salinity	Water Quality: General	Water Quality	Physical habitat Category	Habitat Score	Microalgae	Macrophytes	Invertebrates	Fish	Birds	Biological Category	PES 2024
44	Lilyvale	B	C	B	C	B	B	B	C	B	B	B	B	B	B
45	Ross' Creek	A	A	A	C	B	B	B	B	B	B	B	B	B	B
46	Ncera (Ncerha)	B	B	B	A	A	B	B	B	B	B	B	B	B	B
47	Mlele	B	B	B	C	B	D	B	B	B	B	C	B	B	B/C
48	Mcantsi	B	C	B	F	D	C	C	D	B	C	C	B	C	C
49	Gxulu	B	C	B	C	B	C	B	C	C	C	C	B	C	B/C
50	Goda	B	B	B	C	B	B	B	B	B	B	B	B	B	B
51	Hlozi	B	B	B	C	B	B	B	B	B	B	B	B	B	B
52	Hickman's	C	C	B	E	D	B	C	D	C	C	C	B	C	C
53	Buffalo	F	C	D	E	E	E	E	E	C	E	E	E	D	D/E
54	Blind	D	C	C	F	E	D	D	D	C	D	D	D	D	D
55	Hlaze (iHlanze)	E	D	D	F	E	B	D	E	C	D	D	C	D	D
56	Nahoon	C	A	D	D	D	B	B	D	C	D	D	D	D	C/D
57	Qinira (Quinirha)	A	B	B	C	C	C	B	B	B	C	D	C	C	B
58	Gqunube	B	A	A	C	B	B	B	C	B	C	D	C	C	B/C
59	Kwelera (Kwelerha)	B	A	A	B	B	B	B	B	B	C	C	B	B	B
60	Bulura (Bulurha)	A	A	A	A	A	B	A	A	B	C	C	B	B	B
61	Cunge	A	A	A	B	B	B	A	B	B	B	B	B	B	A/B
62	Cintsa	B	B	A	B	B	C	B	B	C	B	C	B	B	B
63	Cefane	B	A	A	B	B	B	B	B	B	B	B	B	B	B
64	Kwenxura (Kwenxurha)	A	A	A	A	A	B	A	A	B	B	B	B	B	A/B
65	Nyara (Nyarha)	A	A	A	B	B	B	B	B	A	B	B	B	B	A/B
66	Imtwendwe (Mtwendwe)	A	A	A	A	A	B	A	A	B	B	B	B	B	A/B
67	Haga-haga	A	A	A	B	B	B	B	B	B	B	B	B	B	B
68	Mtendwe	A	A	A	B	B	B	A	B	B	B	B	B	B	A/B
69	Quko	A	A	A	B	B	A	A	B	A	A	B	B	B	A/B
70	Morgan	A	B	B	B	B	B	B	B	B	C	C	B	B	B
71	Cwili	A	B	B	A	A	C	B	A	B	B	B	B	B	B
72	Great Kei*	E	A	B	B	B	C	C	C	B	C	C	B	C	C
73	Gxara (Gxarha)	A	B	A	B	B	A	A	B	A	B	B	B	B	A/B
74	Ngogwane	B	B	A	B	B	B	B	B	B	B	B	B	B	B
75	Qolora (Qolorha)	A	B	B	A	B	B	B	B	B	B	B	B	B	B
76	Ncizele	A	A	A	A	A	B	A	A	B	B	B	B	B	A/B
77	Timba	B	B	B	B	B	B	B	B	B	B	B	B	B	B
78	Kobonqaba (Khobonqaba)	A	B	B	B	B	B	B	B	C	B	B	B	B	B
79	Nxaxo/Ngqusi	A	A	A	B	B	C	B	B	C	C	C	B	B	B
80	Cebe	A	A	A	B	B	B	A	B	A	A	B	B	B	A/B
81	Gqunqe	A	A	A	B	B	B	A	B	A	A	B	B	B	A/B
82	Zalu	A	B	A	B	B	B	B	B	B	B	B	B	B	B
83	Ngqwara (Ngqwarha)	A	A	A	B	B	B	B	B	B	B	B	B	B	A/B
84	Sihlontlweni	B	A	A	B	B	B	B	B	A	A	B	B	B	A/B
85	Nebelele	B	A	A	B	B	B	B	B	A	A	B	B	B	A/B
86	Qora (Qhorha)	B	A	A	B	B	B	B	B	B	B	C	B	B	B
87	Jujura (Jujurha)	B	B	B	B	B	B	B	B	A	B	B	B	B	B
88	Ngadla	A	A	A	B	B	B	A	B	A	A	B	B	B	A/B
89	Shixini	A	A	A	A	A	B	A	A	B	B	B	B	B	A/B
90	Beechamwood	A	A	A	B	B	C	B	B	A	A	B	B	B	B
91	Kwazlelitsha (Kwazwedala)	A	A	A	B	B	B	A	B	A	A	B	B	B	A/B

No.	Estuary	Hydrology	Hydrodynamics	Water Quality: Salinity	Water Quality: General	Water Quality	Physical habitat Category	Habitat Score	Microalgae	Macrophytes	Invertebrates	Fish	Birds	Biological Category	PES 2024
92	Kwa-Goqo	B	A	A	B	B	B	B	B	A	A	B	B	B	A/B
93	Ku-Nocekedwa	A	A	A	B	B	B	A	B	A	A	B	B	B	A/B
94	Nqabara/Nqabarana	A	A	A	B	B	B	A	B	B	B	B	B	B	B
95	Ngomane (East)	A	B	A	B	B	B	B	B	C	B	B	B	B	B
96	Ngoma/Kobule	A	A	A	A	A	B	A	A	B	B	B	B	B	A/B
97	Mendu	A	A	A	B	B	B	B	B	A	B	B	B	B	A/B
98	Mendwana	A	A	A	A	A	B	A	A	A	B	B	B	B	A/B
99	Mbashe*	A	A	A	B	B	B	B	B	B	B	D	B	C	B/C
100	Ku-Mpenzu	A	B	A	B	B	B	B	B	A	B	B	B	B	A/B
101	Ku-Bhula (Mbhanyana)	A	B	A	A	A	B	A	A	A	B	C	B	B	A/B
102	Kwa-Suku	A	A	A	B	B	A	A	B	A	B	B	B	B	A/B
103	Ntlonyane	A	B	B	B	B	B	B	B	B	C	C	B	B	B
104	Nkanya	A	B	A	B	B	B	B	B	B	B	B	B	B	B
105	Sundwana	A	A	A	A	A	B	A	A	A	B	B	B	B	A/B
106	Xora	B	A	A	A	A	B	A	A	B	B	C	B	B	B/C
107	Bulungula	A	B	A	B	B	B	B	B	B	B	B	B	B	B
108	Ku-Amanzimuzama	A	A	A	B	B	A	A	B	A	A	B	B	B	A/B
109	Nqakanqa	B	B	B	B	B	C	B	B	B	B	B	B	B	B
110	Mdikana	B	B	B	B	B	A	B	B	A	A	B	B	B	B
111	Mncwasa	A	B	A	B	B	B	B	B	B	B	B	B	B	B
112	Mpako	A	A	A	B	B	B	A	B	B	B	C	C	B	B
113	Nenga	A	B	A	B	B	D	B	B	D	D	C	D	C	C
114	Mapuzi	A	A	A	B	B	B	B	B	B	B	C	B	B	B
115	Mtata	C	A	B	D	C	C	C	C	C	D	D	C	C	C
116	Thsani	A	B	A	B	B	C	B	C	B	B	C	B	B	B
117	Mdumbi	A	A	B	B	B	B	B	B	B	B	C	B	B	B
118	Lwandilana	A	B	B	B	B	B	B	B	B	B	B	B	B	B
119	Lwandile	A	B	A	B	B	A	A	B	A	B	B	B	B	A/B
120	Mtakatye	A	A	A	B	B	B	A	B	B	B	C	B	B	B
121	Hluleka	A	A	A	B	B	B	B	B	B	B	B	B	B	B
122	Mnenu	A	B	A	B	B	A	A	B	A	B	B	B	B	A/B
123	Mtonga	A	E	D	C	C	D	C	C	B	C	C	C	C	C
124	Mpande	A	B	A	B	B	B	B	B	A	B	B	B	B	A/B
125	Sinangwana	A	B	A	B	B	B	B	B	B	B	B	B	B	B
126	Mngazana	A	A	A	B	B	B	B	B	C	D	D	B	C	B
127	Mngazi*	B	B	B	B	B	B	B	B	B	D	C	B	B	B
128	Gxwaleni	B	B	A	A	A	A	A	A	A	A	B	B	B	A/B
129	Bulolo	B	B	B	B	B	C	B	B	C	C	D	C	C	B
130	Mtumbane	B	B	B	B	B	C	B	B	C	A	C	C	B	B
131	Mzimvubu*	A	A	A	C	B	A	A	B	B	D	D	C	C	B
132	Ntlupeni	A	A	A	B	B	B	A	B	A	B	B	B	B	A/B
133	Nkodusweni	A	A	A	B	B	B	B	B	B	B	B	B	B	B
134	Mntafufu	A	A	A	B	B	B	B	B	B	B	C	B	B	B
135	Ingo	B	A	A	B	B	A	A	B	A	A	B	B	B	A/B
136	Mzintlava	A	A	B	B	B	B	A	B	B	B	C	B	B	A/B
137	Mzimpunzi	B	B	B	B	B	B	B	B	B	B	B	B	B	B
138	Kwanyambalala	A	B	B	A	A	B	B	A	B	C	C	B	B	B
139	Mbotyi	B	B	B	A	A	B	B	A	B	C	C	B	B	B
140	Mkozi	B	B	B	B	B	B	B	B	A	A	B	B	B	A/B
141	Sikatsha	B	B	A	A	A	A	A	A	A	A	B	B	B	A/B
142	Lupatana	B	B	A	A	A	B	B	A	A	A	B	B	B	A/B

No.	Estuary	Hydrology	Hydrodynamics	Water Quality: Salinity	Water Quality: General	Water Quality	Physical habitat Category	Habitat Score	Microalgae	Macrophytes	Invertebrates	Fish	Birds	Biological Category	PES 2024
143	Mkweni	A	A	A	A	A	A	A	A	A	A	B	B	B	A/B
144	Msikaba	B	A	B	A	A	B	A	A	A	A	C	B	B	A/B
145	Mgwegwe	A	A	A	A	A	A	A	A	A	A	B	B	A	A
146	Mgwetyana	A	A	A	A	A	A	A	A	A	A	B	B	A	A
147	Mtentu	B	A	B	B	B	B	B	B	B	B	C	B	B	B
148	Sikombe	A	A	A	B	B	B	A	B	B	B	B	B	B	A/B
149	Kwanyana	A	A	A	B	B	B	A	B	A	B	B	B	B	A/B
150	Mtolane	A	A	A	B	B	B	A	A	A	B	B	B	B	A/B
151	Mnyameni	A	A	B	B	B	B	A	B	B	B	B	B	B	A/B
152	Mpahlanyana	B	B	B	B	B	B	B	B	A	B	B	B	B	B
153	Mpahlane	B	B	B	B	B	B	B	B	A	B	B	B	B	B
154	Mzamba	B	A	B	B	B	B	B	B	B	B	C	B	B	B
155	Mtentwana	B	B	B	C	C	C	B	C	C	C	C	C	C	B/C

*Determined with a Rapid/Intermediate/Comprehensive Ecological Water Requirement study

7. MZIMVUBU TO TSITSIKAMMA WATER MANAGEMENT AREA: RECOMMENDED ECOLOGICAL CATEGORY

7.1 Conservation Importance

The National Biodiversity Assessment 2011 (NBA, 2011) (Van Niekerk and Turpie, 2012; Turpie et al. 2012) developed a biodiversity plan for the estuaries of South Africa by prioritising and establishing which of them should be assigned partial or full Protected Area status. This biodiversity plan followed a systematic approach that took pattern, process and biodiversity persistence into account. While the plan has not explicitly taken social and economic costs and benefits into consideration, it used ecosystem health as a surrogate for the former to some extent. This is because estuaries, where the opportunity costs of protection are likely to be high, are also likely to be heavily-utilised systems that are in a lower state of health.

The NBA 2011 plan focussed on achieving a 20% target for estuary type and key habitats; as well as some targets for endangered and economically important species. The National Estuary biodiversity plan indicates that on a national scale, 133 estuaries (61 require full protection and 72 require partial protection) including those already protected, would be required to meet biodiversity targets (Turpie et al. 2012). Of these, 73 fall within the WMA, with a subset of 36 estuaries requiring full protection (see **Table 7-1** for more detail). Fully protected estuaries are taken to be full no-take areas. Partial protection might involve zonation that includes no-take zones or limit fishing or bait collection, or it might address other pressures with other types of action. In both these cases, the management objective would be to protect 50% of the biodiversity features of the partially protected estuary. Fully protected and partially protected estuaries can be considered ‘Estuarine Protected Areas’. All estuaries require an Estuary Management Plan and these plans should be informed by the results of this assessment. The national priority list provides recommendations regarding the extent of protection required for each estuary, the recommended extent of the estuary perimeter that should be free from development to an appropriate setback line, and the preliminary REC (or recommended future health class) as required under the National Water Act (**Table 7-1**).

A 2018 spatial analysis showed that at present, 96 estuaries in the WMA are partially or fully situated in protected areas such as National Parks, Marine Protected Areas, nature reserves and under formal stewardship/contracted reserves albeit, small fractions of the estuarine area in some cases, e.g. only mouth and beach area.

South Africa, as a Party to the Convention on Biological Diversity (CBD), supports Target 3 (see below) of the 2030 Kunming-Montreal Global Biodiversity Framework (GBF 30X30 target) and is committed to expanding and enhancing its conservation areas to the maximum possible within its national capabilities and circumstances.

“Ensure and enable that by 2030 at least 30 per cent of terrestrial, inland water, and of coastal and marine areas, especially areas of particular importance for biodiversity and ecosystem functions and services, are effectively conserved and managed through ecologically representative, well-connected and equitably governed systems of protected areas and other effective area-based conservation measures, recognizing indigenous and traditional territories, where applicable, and integrated into wider landscapes, seascapes and the ocean, while ensuring that any sustainable use, where appropriate in such areas, is fully consistent with conservation outcomes, recognizing and respecting the rights of indigenous peoples and local communities, including over their traditional territories.

In South Africa, the global biodiversity framework will be implemented within the four goals of the White Paper on Conservation and Sustainable Use of South Africa's Biodiversity (Conservation, Sustainable Use, Fair and equitable sharing of benefits and Transformation) to fulfil the vision of the White Paper. As part of this process, several estuaries in the WMA were identified as 30x30 priorities to meet the expanded 30% protected areas targets, with a focus on estuaries that provide essential ecosystem services such as carbon sequestration (e.g. now include all mangrove estuaries >5 ha) and important nursery function.

Table 7-1: National priorities, the extent of protection required (Full = full no-take protection (modified from Turpie et al. 2012).

#	Estuary	In Marine /Protected Area	Priority set for national and/or Regional	Recommended extent of protection	Recommended extent of undeveloped margin	Provisional estimate of Recommended Ecological Category	2030 GBF 30%	Include Freshwater Plume at mouth	Possible Stewardship/OECM
1	Lottering	●	SA/CAPE	Full	1	A or BAS			
2	Elandsbos	●	SA/CAPE	Full	1	A or BAS			
3	Storms	●	SA/CAPE	Full	1	A or BAS			
4	Elands	●	SA/CAPE	Full	1	A or BAS			
5	Groot (Oos)	●	SA/CAPE	Full	1	A or BAS			
6	Tsitsikamma	●	SA	Full	0.5	B*			
7	Klipdrif (Oos)					D			
8	Slang					D			
9	Kromme	●	SA/CAPE	Partial	0.25	C*			
10	Seekoei	●	SA/CAPE	Partial	0.25	B*			
11	Kabeljous	●				B			
12	Gamtoos		SA/CAPE	Partial	0.5	A or BAS	30X30	30X30	
13	Van Stadens	●	SA/CAPE	Full	0.5	A or BAS			
14	Maitland	●	SA/CAPE	Full	0.75	C			
15	Baakens	●				D			
16	Papkuils					D			
17	Swartkops	●	SA/CAPE	Partial	0.25	B	30X30	30X30	30X30
18	Coega (Ngqurha)					D			
19	Sundays	●	SA/CAPE	Partial	0.5	A or BAS		0	
20	Boknes					C			
21	Bushmans	●	SA/CAPE	Partial	0.5	A*	30X30		
22	Kariega	●	SA/CAPE	Partial	0.5	B	30X30		
23	Grant's	●							
24	Kasouga	●				A	30X30		
25	Kowie	●				B			
26	Rufane	●				C			
27	Riet	●				A			
28	West Kleinemonde	●				A	30X30		
29	East Kleinemonde	●				B*	30X30		
30	Great Fish	●	SA/CAPE	Partial	0.5	B	30X30	30X30	30X30
31	Old Woman's	●				C			
32	Mpekweni	●				A			
33	Mtati (Mthathi)	●	CAPE	0	0	A			
34	Mgwalana		SA	Partial	0.5	A			
35	Bira (Bhirha)		SA	Partial	0.5	A			
36	Gqutywa		SA/CAPE	Full	0.75	A			
37	Ngculura (Ngculurha)					B			
38	Mtana	●				B			
39	Keiskamma	●	SA/CAPE	Partial	0.5	B	30X30	30X30	
40	Nqinisa	●	SA	Full	0.75	B			

#	Estuary	In Marine /Protected Area	Priority set for national and/or Regional	Recommended extent of protection	Recommended extent of undeveloped margin	Provisional estimate of Recommended Ecological Category	2030 GBF 30%	Include Freshwater Plume at mouth	Possible Stewardship/OECM
41	Kiwane (Khiwane)	●				B			
42	Tyolomnqa	●				A	30X30	30X30	
43	Shelbertsstroom	●				C			
44	Lilyvale	●				B			
45	Ross' Creek	●				B			
46	Ncera (Ncerha)	●	SA	Full	0.75	B			
47	Mlele	●				B			
48	Mcantsi	●				C			
49	Gxulu	●				B			
50	Goda	●	CAPE	Full	0.75	B			
51	Hlozi	●				B			
52	Hickman's	●				B			
53	Buffalo					C			
54	Blind					C			
55	Hlaze (iHlanze)	●				C			
56	Nahoon	●				B*			
57	Qinira (Quinirha)	●				A			
58	Gqunube	●	SA	Partial	0.5	A			
59	Kwelera (Kwelerha)	●	SA	Partial	0.5	A			
60	Bulura (Bulurha)	●				B			
61	Cunge	●				A			
62	Cintsa	●				C			
63	Cefane	●				A			
64	Kwenxura (Kwenxurha)	●	SA/CAPE	Full	0.75	A			
65	Nyara (Nyarha)	●				A			
66	Imtwendwe (Mtwendwe)	●				B			
67	Haga-haga	●				B			
68	Mtendwe	●				B			
69	Quko	●	SA/CAPE	Full	0.5	A	30X30		
70	Morgan	●				C			
71	Cwili	●				B			
72	Great Kei	●	SA/CAPE	Partial	0.5	B*	30X30	30X30	
73	Gxara (Gxarha)					B	30X30		
74	Ngogwane					B			
75	Qolora (Qolorha)					A			
76	Ncizele		SA	Full	0.75	B			
77	Timba					A			
78	Kobonqaba (Khobonqaba)					B			
79	Nxaxo/Ngqusi		SA/CAPE	Full	0.75	A	30X30		30X30
80	Cebe					B			
81	Gqunqe					A			
82	Zalu					A			
83	Ngqwara (Ngqwarha)		SA	Full	0.75	A			
84	Sihlontlweni					B			
85	Nebelele					A			
86	Qora (Qhorha)		SA/CAPE	Partial	0.75	A	30X30		
87	Jujura (Jujurha)					B			
88	Ngadla		SA	Full	0.75	A			
89	Shixini		CAPE	0	0	B			
90	Beechamwood					A			
91	Kwazlelitsha (Kwazwedala)					A			
92	Kwa-Goqo					A			
93	Ku-Nocekedwa					A			

#	Estuary	In Marine /Protected Area	Priority set for national and/or Regional	Recommended extent of protection	Recommended extent of undeveloped margin	Provisional estimate of Recommended Ecological Category	2030 GBF 30%	Include Freshwater Plume at mouth	Possible Stewardship/OECM
94	Nqabara/Nqabarana		SA	Partial	0.75	A	30X30		30X30
95	Ngomane (East)	●							
96	Ngoma/Kobule	●				A			
97	Mendu	●	SA	0	0	A			
98	Mendwana	●	SA	0	0	A			
99	Mbashe	●	SA/CAPE	Partial	0.75	A or BAS	30X30	30X30	
100	Ku-Mpenzu	●	SA/CAPE	Full	0.75	B			
101	Ku-Bhula (Mbhanyana)	●	SA/CAPE	Full	0.75	A			
102	Kwa-Suku	●	SA	0	0	B			
103	Ntlonyane	●	SA/CAPE	Full	0.75	B			
104	Nkanya		SA/CAPE	Full	0.75	B			
105	Sundwana		SA	Full	0.75	A			
106	Xora		SA	Partial	0.75	A	30X30		30X30
107	Bulungula					B			
108	Ku-Amanzimuzama					A			
109	Nqakanqa		SA	Full	0.75	A			
110	Mdikana					A			
111	Mncwasa					B			
112	Mpako					B			
113	Nenga					C			
114	Mapuzi					B			
115	Mtata		SA	Partial	0.5	C*			
116	Thsani					B			
117	Mdumbi		CAPE	0	0	A			
118	Lwandilana		SA	Full	0.75	A			
119	Lwandile					A			
120	Mtakatye		SA	Partial	0.75	B	30X30		30X30
121	Hluleka	●	SA	Full	0.75	A or BAS			
122	Mnenu	●				B			
123	Mtonga					B			
124	Mpande					B			
125	Sinangwana					B			
126	Mngazana		SA	Partial	0.5	B	30X30	30X30	30X30
127	Mngazi					C			
128	Gxwaleni	●				A			
129	Bulolo					B			
130	Mtumbane					B			
131	Mzimvubu	●	SA	Partial	0.5	C	30X30	30X30	
132	Ntlupeni	●				B			
133	Nkodusweni	●	SA	Partial	0.75	A or BAS			
134	Mntafufu	●	SA	Full	0.75	A or BAS	30X30		30X30
135	Ingo	●							
136	Mzintlava	●	SA	Full	0.75	A or BAS			
137	Mzimpunzi	●	SA	Full	0.75	B			
138	Kwanyambalala	●	SA	Partial	0.5	B			
139	Mbotyi	●	SA	Partial	0.5	A or BAS			
140	Mkozi	●	SA	Full	0.75	A			
141	Sikatsha	●	SA	Full	0.75	A			
142	Lupatana	●	SA	Full	0.75	A			
143	Mkweni	●	SA	Partial	0.75	A or BAS			
144	Msikaba	●	SA	Full	0.75	A or BAS	30X30		
145	Mgwegwe	●	SA	Partial	1	A			
146	Mgwetyana	●	SA	Partial	1	A			

#	Estuary	In Marine /Protected Area	Priority set for national and/or Regional	Recommended extent of protection	Recommended extent of undeveloped margin	Provisional estimate of Recommended Ecological Category	2030 GBF 30%	Include Freshwater Plume at mouth	Possible Stewardship/OECM
147	Mtentu	●	SA	Full	0.75	A or BAS	30X30		
148	Sikombe	●	SA	Partial	0.75	A			
149	Kwanyana	●	SA	Partial	0.75	B			
150	Mtolane	●	SA	Partial	0.75	A			
151	Mnyameni	●	SA	Partial	0.75	A or BAS	30X30		
152	Mpahlanyana	●	SA	Full	0.75	A			
153	Mpahlane	●	SA	Partial	0.75	A			
154	Mzamba	●	SA	Partial	0.75	A			
155	Mtentwana		SA	Full	0.75	C			

7.2 Estuary Biodiversity Importance

The Estuary Importance Score (EIS) for an estuary takes estuary size, the rarity of the estuary type within its biographical zone, habitat diversity, and biodiversity importance of the estuary into account (**Table 7-2**) (DWA 2008). Biodiversity importance, in turn, is based on the assessment of the importance of the estuary for plants, invertebrates, fish and birds, using rarity indices. These importance scores ideally refer to the system in its natural condition. The scores have been determined for all South African estuaries, apart from functional importance, which is scored by the specialists during EWR workshops for systems assessed in more detail (DWA 2008). Estuaries historically not assessed due to their small size are assigned to the 'Average importance' category as a default. **Overall, 13 estuaries were rated as very important, 29 estuaries as important, and the remaining 113 estuaries were rated as of Low to Average importance.**

Table 7-2: Estuary importance scores for the Mzimvubu to Tsitsikamma Water Management Area (WMA 7) estuaries calculated on a national scale (DWAF 2008, Turpie and Clark 2007, Turpie et al. 2002).

No.	Estuary	Size	Habitat	Zonal type rarity	Biodiversity Importance	Biodiversity Importance score	Biodiversity Importance
1	Lottering	50	10	50	25.5	34	**Ave Importance**
2	Elandsbos	30	10	50	18.5	24	**Ave Importance**
3	Storms	60	10	50	11.5	34	**Ave Importance**
4	Elands	10	10	50	11.5	14	**Ave Importance**
5	Groot (Oos)	10	10	50	11.5	14	**Ave Importance**
6	Tsitsikamma	10	20	10	45.5	21	**Ave Importance**
7	Klipdrif (Oos)	10	10	10	50.5	20	**Ave Importance**
8	Slang	10	0	10	11.5	8	**Ave Importance**
9	Kromme	100	90	20	95.5	88	**Very Important**
10	Seekoei	90	80	10	82.5	78	**Important**
11	Kabeljous	90	80	10	84.5	78	**Important**

No.	Estuary	Size	Habitat	Zonal type rarity	Biodiversity Importance	Biodiversity Importance score	Biodiversity Importance
12	Gamtoos	100	100	20	98.5	92	Very Important
13	Van Stadens	60	30	10	58	47	Ave Importance
14	Maitland	10	70	10	58	37	Ave Importance
15	Baakens	-	-	-	-	-	Ave Importance
16	Papkuils	-	-	-	-	-	Ave Importance
17	Swartkops	100	100	20	100	92	Very Important
18	Coega (Ngqurha)	40	40	10	76.5	46	Ave Importance
19	Sundays	90	70	20	89	78	Important
20	Boknes	60	50	10	72	56	Ave Importance
21	Bushmans	100	60	20	84.5	78	Important
22	Kariega	90	80	20	97	82	Very Important
23	Grant's	-	-	-	-	-	Ave Importance
24	Kasouga	70	70	10	58	61	Important
25	Kowie	90	80	20	88.5	80	Very Important
26	Rufane	10	10	10	57.5	22	Ave Importance
27	Riet	80	80	10	74.5	72	Important
28	West Kleinemonde	80	90	10	71	73	Important
29	East Kleinemonde	70	90	10	84	73	Important
30	Great Fish	100	100	20	98	92	Very Important
31	Old Woman's	60	50	10	76	57	Ave Importance
32	Mpekweni	90	100	10	92	85	Very Important
33	Mtati (Mthathi)	90	100	10	83	83	Very Important
34	Mgwalana	90	100	10	79	82	Very Important
35	Bira (Bhirha)	80	70	10	84	72	Important
36	Gqutywa	70	70	10	62	62	Important
37	Ngculura (Ngculurha)	20	30	10	61	32	Ave Importance
38	Mtana	-	-	-	-	-	Ave Importance
39	Keiskamma	100	100	20	97	91	Very Important
40	Nqinisa	50	60	10	56	50	Ave Importance
41	Kiwane (Khiwane)	-	-	-	-	-	Ave Importance
42	Tyolomnqa	80	60	10	81	68	Important
43	Shelbertsstroom	10	0	10	25	11	Ave Importance
44	Lilyvale	20	10	10	19	16	Ave Importance
45	Ross' Creek	10	0	10	25	11	Ave Importance
46	Ncera (Ncerha)	60	50	10	50	50	Ave Importance
47	Mlele	20	10	10	19	16	Ave Importance
48	Mcantsi	40	20	10	32	30	Ave Importance
49	Gxulu	70	50	10	71.5	59	Ave Importance
50	Goda	50	30	10	56	43	Ave Importance
51	Hlozi	10	10	10	39.5	17	Ave Importance
52	Hickman's	30	10	10	33.5	24	Ave Importance
53	Buffalo	80	40	20	64	60	Ave Importance

No.	Estuary	Size	Habitat	Zonal type rarity	Biodiversity Importance	Biodiversity Importance score	Biodiversity Importance
54	Blind	10	10	10	75	26	Ave Importance
55	Hlaze (iHlanze)	10	10	10	31.5	15	Ave Importance
56	Nahoon	80	60	20	87.5	71	Important
57	Qinira (Quinirha)	80	70	10	67.5	67	Important
58	Gqunube	70	50	20	77	62	Important
59	Kwelera (Kwelerha)	70	60	20	78	65	Important
60	Bulura (Bulurha)	70	50	10	57.5	56	Ave Importance
61	Cunge	10	10	10	18.5	12	Ave Importance
62	Cintsa	70	50	10	64.5	58	Ave Importance
63	Cefane	80	80	10	60	68	Important
64	Kwenxura (Kwenxurha)	70	50	10	72.5	60	Ave Importance
65	Nyara (Nyarha)	50	40	10	48	43	Ave Importance
66	Imtwendwe (Mtwendwe)A	-	-	-	-	-	Ave Importance
67	Haga-haga	20	20	10	25.5	20	Ave Importance
68	Mtendwe	40	40	10	19	32	Ave Importance
69	Quko	70	40	10	66.5	56	Ave Importance
70	Morgan	60	30	10	58	47	Ave Importance
71	Cwili	10	10	10	25	14	Ave Importance
72	Great Kei	100	70	20	83	80	Very Important
73	Gxara (Gxarha)	60	40	10	49.5	47	Ave Importance
74	Ngogwane	40	30	10	54	38	Ave Importance
75	Qolora (Qolorha)	60	90	10	64	64	Important
76	Ncizele	30	10	10	60.5	31	Ave Importance
77	Timba	-	-	-	-	-	Ave Importance
78	Kobonqaba (Khobonqaba)	60	50	20	57.5	53	Ave Importance
79	Nxaxo/Ngqusi	90	80	10	87.5	79	Important
80	Cebe	50	40	10	57	45	Ave Importance
81	Gqunqe	60	40	10	53	48	Ave Importance
82	Zalu	40	20	10	43	33	Ave Importance
83	Ngqwara (Ngqwarha)	60	40	10	46.5	47	Ave Importance
84	Sihlontlweni	40	20	10	52.5	35	Ave Importance
85	Nebelele	-	-	-	-	-	Ave Importance
86	Qora (Qhorha)	80	70	20	82.5	72	Important
87	Jujura (Jujurha)	30	10	10	55.5	29	Ave Importance
88	Ngadla	50	30	10	43	39	Ave Importance
89	Shixini	60	40	20	64	52	Ave Importance
90	Beechamwood	-	-	-	-	-	Ave Importance
91	Kwazlelitsha (Kwazwedala)	-	-	-	-	-	Ave Importance
92	Kwa-Goqo	-	-	-	-	-	Ave Importance
93	Ku-Nocekedwa	-	-	-	-	-	Ave Importance

No.	Estuary	Size	Habitat	Zonal type rarity	Biodiversity Importance	Biodiversity Importance score	Biodiversity Importance
94	Nqabara/Nqabarana	90	70	20	40	66	Important
95	Ngomane (East)	-	-	-	-	-	Ave Importance
96	Ngoma/Kobule	40	40	10	19	32	Ave Importance
97	Mendu	60	40	10	39	45	Ave Importance
98	Mendwana	-	-	-	-	-	Ave Importance
99	Mbashe	90	90	30	86	83	Very Important
100	Ku-Mpenzu	50	60	10	43.5	47	Ave Importance
101	Ku-Bhula (Mbhanyana)	30	70	10	49.5	43	Ave Importance
102	Kwa-Suku	-	-	-	-	-	Ave Importance
103	Ntlonyane	70	50	10	56	56	Ave Importance
104	Nkanya	50	50	10	50	46	Ave Importance
105	Sundwana	-	-	-	-	-	Ave Importance
106	Xora	90	80	30	82.5	80	Important
107	Bulungula	60	40	10	55.5	49	Ave Importance
108	Ku-Amanzimuzama	20	20	10	24	20	Ave Importance
109	Nqakanqa	-	-	-	-	-	Ave Importance
110	Mdikana	-	-	-	-	-	Ave Importance
111	Mncwasa	60	20	10	66.5	47	Ave Importance
112	Mpako	50	30	10	24.5	35	Ave Importance
113	Nenga	40	30	10	56	39	Ave Importance
114	Mapuzi	50	30	10	48.5	41	Ave Importance
115	Mtata	90	90	30	73	80	Important
116	Thsani	-	-	-	-	-	Ave Importance
117	Mdumbi	80	60	30	72.5	68	Important
118	Lwandilana	40	20	10	30.5	30	Ave Importance
119	Lwandile	60	40	10	71.5	53	Ave Importance
120	Mtakatye	90	70	30	56	71	Important
121	Hluleka	50	30	10	24.5	35	Ave Importance
122	Mnenu	80	60	10	44	59	Ave Importance
123	Mtonga	70	50	10	52.5	55	Ave Importance
124	Mpande	50	30	10	49.5	41	Ave Importance
125	Sinangwana	50	30	10	42	39	Ave Importance
126	Mngazana	100	100	30	92.5	91	Very Important
127	Mngazi	50	20	10	76	45	Ave Importance
128	Gxwaleni	-	-	-	-	-	Ave Importance
129	Bulolo	50	30	10	60	44	Ave Importance
130	Mtumbane	40	20	10	41.5	32	Ave Importance
131	Mzimvubu	90	90	30	73	80	Important
132	Ntlupeni	30	10	10	54	29	Ave Importance
133	Nkodusweni	70	40	10	49.5	51	Ave Importance
134	Mntafufu	60	70	30	77	64	Important
135	Ingo	-	-	-	-	-	Ave Importance

No.	Estuary	Size	Habitat	Zonal type rarity	Biodiversity Importance	Biodiversity Importance score	Biodiversity Importance
136	Mzintlava	60	50	30	50.5	52	**Ave Importance**
137	Mzimpunzi	30	20	10	51	31	**Ave Importance**
138	Kwanyambalala	-	-	-	-	-	**Ave Importance**
139	Mbotyi	70	70	10	80	67	**Important**
140	Mkozi	30	30	10	73	39	**Ave Importance**
141	Sikatsha	-	-	-	-	-	**Ave Importance**
142	Lupatana	20	40	10	54	33	**Ave Importance**
143	Mkweni	30	60	10	59.5	43	**Ave Importance**
144	Msikaba	50	50	30	76.5	55	**Ave Importance**
145	Mgwegwe	40	80	10	73	55	**Ave Importance**
146	Mgwetyana	20	10	10	64.5	28	**Ave Importance**
147	Mtentu	70	80	30	89	73	**Important**
148	Sikombe	40	50	10	46.5	41	**Ave Importance**
149	Kwanyana	30	10	10	57.5	30	**Ave Importance**
150	Mtolane	-	-	-	-	-	**Ave Importance**
151	Mnyameni	60	40	30	57.5	51	**Ave Importance**
152	Mpahlanyana	20	10	10	54	25	**Ave Importance**
153	Mpahlane	30	10	10	55.5	29	**Ave Importance**
154	Mzamba	80	80	30	90	78	**Important**
155	Mtentwana	40	20	10	65.5	38	**Ave Importance**

**Note: Blanks indicate estuaries not assessed due to their very small size.*

Many of the estuaries in this area represent a high biodiversity importance for estuarine invertebrates since these systems fall at the transition zone between South African coastal biogeographic zones, hence there is a high level of endemism in the region. Furthermore, in terms of responses to climate change drivers, it is likely in these estuaries that refugia and holdouts are to be found in terms of important climate change range shifts of species. This has for example already been observed in the fish community. Several systems are also known to support high abundances of invertebrates and waterbirds, and since some of these areas experiences comparatively lower impacts in terms of human activity on South Africa's coastline, this makes this unique and comparatively pristine stretch of coastline in terms of biodiversity heritage an area of estuaries where impacts should be kept to a minimum.

7.3 Recommended Ecological Category

The REC for the estuaries in the Mzimvubu to Tsitsikamma Water Management Area is listed in **Table 7-3**. Using the biodiversity importance, conservation importance and the need to maintain/protect key ecosystem services such as nursery function and carbon sequestration **50 estuaries were identified in need of restoration to achieve the REC.**

Table 7-3: The Recommended Ecological Category for the estuaries in the Mzimvubu to Tsitsikamma Water Management Area (WMA 7). Given the lack of historical data on a large number of the estuaries 'REC = A - A/B" indicates the requirement to maintain estuary in a natural to near natural state or improve a half class up from PES (2024)

No.	NAME	PES	REC	Biodiversity Importance Rating (Turpie et al. 2002, Turpie & Clark 2009)	Biodiversity priority core set (national and/or CAPE)	2030 GBF 30x30 Priority	Biodiversity priority Rating	In MPA or priority area	Adjacent terrestrial PA	Important Bird Areas	DAFF Important Fish Nurseries (Very High - Medium = Priority)	Blue Carbon sequestration(Very High - Medium = Priority)	Support *Zostera capensis*
1	Lottering	A/B	A - A/B	Low to Average Importance	SA/CAPE		Priority	YES	YES		Low	Low	
2	Elandsbos	A/B	A - A/B	Low to Average Importance	SA/CAPE		Priority	YES	YES		Low	Low	
3	Storms	A/B	A - A/B	Low to Average Importance	SA/CAPE		Priority	YES	YES		Low	Low	
4	Elands	A/B	A - A/B	Low to Average Importance	SA/CAPE		Priority	YES	YES		Low	Low	
5	Groot (Oos)	A/B	A - A/B	Low to Average Importance	SA/CAPE		Priority	YES			Low	Low	
6	Tsitsikamma	B/C	B	Low to Average Importance	SA		Priority				Low	Low	
7	Klipdrif (Oos)	C	C	Low to Average Importance							Low	Low	
8	Slang	C/D	C/D	Low to Average Importance							Low	Low	
9	Kromme	C/D	C	High Importance	SA/CAPE		Priority				High	High	High
10	Seekoei	D/E	C	Important	SA/CAPE		Priority				Medium	High	
11	Kabeljous	B	B	Important							Medium	High	
12	Gamtoos	D	C	High Importance	SA/CAPE	30X30	Priority		YES	YES	High	High	
13	Van Stadens	B	A/B	Low to Average Importance	SA/CAPE		Priority		YES	YES	Low	Low	
14	Maitland	B/C	B	Low to Average Importance	SA/CAPE		Priority			YES	Low	Low	
15	Baakens	E/F	E	Low to Average Importance							Low	Low	
16	Papkuils	F	E/F	Low to Average Importance							Low	Low	
17	Swartkops	D	C	High Importance	SA/CAPE	30X30	Priority			YES	High	High	High
18	Coega (Ngqurha)	E/F	D	Low to Average Importance							Low	Low	
19	Sundays	C/D	B	Important	SA/CAPE		Priority				High	Medium	
20	Boknes	C	C	Low to Average Importance							Low	Low	
21	Bushmans	C	B	Important	SA/CAPE	30X30	Priority				High	High	High
22	Kariega	C	C	High Importance	SA/CAPE	30X30	Priority				High	High	High
23	Grant's	C	C	Low to Average Importance							Low	Low	
24	Kasouga	B	B	Important		30X30	Priority				Medium	low	
25	Kowie	C	B/C	High Importance							High	High	High
26	Rufane	C	C	Low to Average Importance							Low	Low	
27	Riet	B	B	Important							Low	Low	
28	West Kleinemonde	B	B	Important		30X30	Priority	YES			Medium	High	

No.	NAME	PES	REC	Biodiversity Importance Rating (Turpie et al. 2002, Turpie & Clark 2009)	Biodiversity priority core set (national and/or CAPE)	2030 GBF 30x30 Priority	Biodiversity priority Rating	In MPA or priority area	Adjacent terrestrial PA	Important Bird Areas	DAFF Important Fish Nurseries (Very High - Medium = Priority)	Blue Carbon sequestration(Very High - Medium = Priority)	Support *Zostera capensis*
29	East Kleinemonde	B	B	Important		30X30	Priority	YES			Medium	Medium	
30	Great Fish	C	B/C	High Importance	SA/CAPE	30X30	Priority				High	High	
31	Old Woman's	B/C	B/C	Low to Average Importance							Low	Medium	
32	Mpekweni	B	B	High Importance							Medium	Low	
33	Mtati (Mthathi)	B	B	High Importance	CAPE		Priority				Medium	Medium	
34	Mgwalana	B	A/B	High Importance	SA		Priority				Medium	Medium	
35	Bira (Bhirha)	B	A/B	Important	SA		Priority				Medium	Medium	
36	Gqutywa	B	B	Important	SA/CAPE		Priority	YES			Medium	Medium	
37	Ngculura (Ngculurha)	B	A/B	Low to Average Importance				YES			Low	Low	
38	Mtana	B	B	Low to Average Importance				YES			Low	Low	
39	Keiskamma	C	B	High Importance	SA/CAPE	30X30	Priority	YES			High	High	High
40	Nqinisa	A/B	A - A/B	Low to Average Importance	SA		Priority	YES			Low	Low	
41	Kiwane (Khiwane)	A/B	A - A/B	Low to Average Importance							Medium	Low	
42	Tyolomnqa	B	A/B	Important		30X30	Priority				Medium	High	High
43	Shelbertsstroom	B/C	B/C	Low to Average Importance							Low	Low	
44	Lilyvale	B	B	Low to Average Importance							Low	Low	
45	Ross' Creek	B	B	Low to Average Importance					YES		Low	Low	
46	Ncera (Ncerha)	B	B	Low to Average Importance	SA		Priority				Low	Low	
47	Mlele	B/C	B/C	Low to Average Importance							Low	Low	
48	Mcantsi	C	B	Low to Average Importance							Low	Low	
49	Gxulu	B/C	B/C	Low to Average Importance					YES		Medium	Medium	
50	Goda	B	A/B	Low to Average Importance	CAPE		Priority		YES		Low	Low	
51	Hlozi	B	B	Low to Average Importance					YES		Low	Low	
52	Hickman's	C	C	Low to Average Importance					YES		Low	Low	
53	Buffalo	D/E	D	Low to Average Importance							Medium	Low	
54	Blind	D	D	Low to Average Importance							Low	Low	
55	Hlaze (iHlanze)	D	D	Low to Average Importance							Low	Low	
56	Nahoon	C/D	C	Important							Medium	Medium	High
57	Qinira (Quinirha)	B	B	Important							Low	Medium	
58	Gqunube	B/C	B	Important	SA		Priority		YES		Medium	Medium	High
59	Kwelera (Kwelerha)	B	A/B	Important	SA		Priority				Medium	Medium	High
60	Bulura (Bulurha)	B	B	Low to Average Importance							Low	Medium	Low

No.	NAME	PES	REC	Biodiversity Importance Rating (Turpie et al. 2002, Turpie & Clark 2009)	Biodiversity priority core set (national and/or CAPE)	2030 GBF 30x30 Priority	Biodiversity priority Rating	In MPA or priority area	Adjacent terrestrial PA	Important Bird Areas	DAFF Important Fish Nurseries (Very High - Medium = Priority)	Blue Carbon sequestration(Very High - Medium = Priority)	Support *Zostera capensis*
61	Cunge	A/B	A/B	Low to Average Importance							Low	Low	
62	Cintsa	B	B	Low to Average Importance							Low	Medium	
63	Cefane	B	B	Important							Medium	High	
64	Kwenxura (Kwenxurha)	A/B	A - A/B	Low to Average Importance	SA/CAPE		Priority				Medium	Low	
65	Nyara (Nyarha)	A/B	A - A/B	Low to Average Importance					YES		Low	Medium	
66	Imtwendwe (Mtwendwe)	A/B	A - A/B	Low to Average Importance							Low	Low	
67	Haga-haga	B	B	Low to Average Importance							Low	Low	
68	Mtendwe	A/B	A - A/B	Low to Average Importance							Low	Low	
69	Quko	A/B	A - A/B	Low to Average Importance	SA/CAPE	30X30	Priority				Medium	Low	
70	Morgan	B	B	Low to Average Importance							Medium	Low	
71	Cwili	B	B	Low to Average Importance							Low	Low	
72	Great Kei	C	B/C	High Importance	SA/CAPE	30X30	Priority				High	High	
73	Gxara (Gxarha)	A/B	A - A/B	Low to Average Importance		30X30	Priority	YES			Low	Low	
74	Ngogwane	B	B	Low to Average Importance				YES			Low	Low	
75	Qolora (Qolorha)	B	B	Important				YES			Low	Low	
76	Ncizele	A/B	A - A/B	Low to Average Importance	SA		Priority	YES			Low	Low	
77	Timba	B	B	Low to Average Importance							Low	Low	
78	Kobonqaba (Khobonqaba)	B	A/B	Low to Average Importance				YES			Medium	Medium	High
79	Nxaxo/Ngqusi	B	A/B	Important	SA/CAPE	30X30	Priority	YES			Medium	Medium	Low
80	Cebe	A/B	A - A/B	Low to Average Importance						YES	Low	Low	
81	Gqunqe	A/B	A - A/B	Low to Average Importance							Low	Medium	
82	Zalu	B	B	Low to Average Importance							Low	Low	
83	Ngqwara (Ngqwarha)	A/B	A - A/B	Low to Average Importance	SA		Priority	YES			Low	Low	
84	Sihlontlweni	A/B	A - A/B	Low to Average Importance				YES			Low	Low	
85	Nebelele	A/B	B	Low to Average Importance							Low	Low	
86	Qora (Qhorha)	B	A/B	Important	SA/CAPE	30X30	Priority				Medium	Medium	High
87	Jujura (Jujurha)	B	B	Low to Average Importance							Low	Low	
88	Ngadla	A/B	A - A/B	Low to Average Importance	SA		Priority	YES			Low	Low	
89	Shixini	A/B	A - A/B	Low to Average Importance	CAPE		Priority	YES			Low	Low	
90	Beechamwood	B	B	Low to Average Importance							Low	Low	
91	Kwazlelitsha (Kwazwedala)	A/B	A - A/B	Low to Average Importance							Low	Low	
92	Kwa-Gogo	A/B	A - A/B	Low to Average Importance							Low	Low	

No.	NAME	PES	REC	Biodiversity Importance Rating (Turpie et al. 2002, Turpie & Clark 2009)	Biodiversity priority core set (national and/or CAPE)	2030 GBF 30x30 Priority	Biodiversity priority Rating	In MPA or priority area	Adjacent terrestrial PA	Important Bird Areas	DAFF Important Fish Nurseries (Very High - Medium = Priority)	Blue Carbon sequestration(Very High - Medium = Priority)	Support *Zostera capensis*
93	Ku-Nocekedwa	A/B	A - A/B	Low to Average Importance							Low	Low	
94	Nqabara/Nqabarana	B	A/B	Important	SA	30X30	Priority	YES			Medium	Medium	Low
95	Ngomane (East)	B	B	Low to Average Importance							Low	Low	
96	Ngoma/Kobule	A/B	A - A/B	Low to Average Importance				YES			Low	Low	
97	Mendu	A/B	A - A/B	Low to Average Importance	SA		Priority	YES			Low	Low	
98	Mendwana	A/B	A - A/B	Low to Average Importance	SA		Priority				Low	Low	
99	Mbashe	B/C	B	High Importance	SA/CAPE	30X30	Priority	YES			High	Medium	High
100	Ku-Mpenzu	A/B	A - A/B	Low to Average Importance	SA/CAPE		Priority	YES			Low	Low	
101	Ku-Bhula (Mbhanyana)	A/B	A - A/B	Low to Average Importance	SA/CAPE		Priority	YES			Low	Low	
102	Kwa-Suku	A/B	A - A/B	Low to Average Importance	SA		Priority				Low	Low	
103	Ntlonyane	B	A/B	Low to Average Importance	SA/CAPE		Priority				Low	Low	
104	Nkanya	B	A/B	Low to Average Importance	SA/CAPE		Priority				Low	Low	
105	Sundwana	A/B	A - A/B	Low to Average Importance	SA		Priority				Low	Low	
106	Xora	B/C	B	Important	SA	30X30	Priority				Medium	Medium	Low
107	Bulungula	B	A/B	Low to Average Importance							Low	Low	
108	Ku-Amanzimuzama	A/B	A - A/B	Low to Average Importance							Low	Low	
109	Nqakanqa	B	B	Low to Average Importance	SA		Priority				Low	Low	
110	Mdikana	B	B	Low to Average Importance							Low	Low	
111	Mncwasa	B	B	Low to Average Importance							Low	Low	
112	Mpako	B	B	Low to Average Importance							Low	Low	
113	Nenga	C	C	Low to Average Importance							Low	Low	
114	Mapuzi	B	B	Low to Average Importance							Low	Low	
115	Mtata	C	B/C	Important	SA		Priority				Medium	High	
116	Thsani	B	B	Low to Average Importance							Low	Low	
117	Mdumbi	B	A/B	Important	CAPE		Priority				Medium	Medium	Low
118	Lwandilana	B	B	Low to Average Importance	SA		Priority				Low	Low	
119	Lwandile	A/B	A - A/B	Low to Average Importance							Low	Low	
120	Mtakatye	B	A/B	Important	SA	30X30	Priority				Medium	Medium	High
121	Hluleka	B	A/B	Low to Average Importance	SA		Priority				Low	Low	
122	Mnenu	A/B	A/B	Low to Average Importance							Medium	Medium	
123	Mtonga	C	A/B	Low to Average Importance							Low	Medium	
124	Mpande	A/B	A - A/B	Low to Average Importance							Low	Low	

No.	NAME	PES	REC	Biodiversity Importance Rating (Turpie et al. 2002, Turpie & Clark 2009)	Biodiversity priority core set (national and/or CAPE)	2030 GBF 30x30 Priority	Biodiversity priority Rating	In MPA or priority area	Adjacent terrestrial PA	Important Bird Areas	DAFF Important Fish Nurseries (Very High - Medium = Priority)	Blue Carbon sequestration(Very High - Medium = Priority)	Support *Zostera capensis*
125	Sinangwana	B	B	Low to Average Importance							Low	Low	
126	Mngazana	B	A/B	High Importance	SA	30X30	Priority				High	High	High
127	Mngazi	B	B	Low to Average Importance							Medium	Medium	High
128	Gxwaleni	A/B	A - A/B	Low to Average Importance							Low	Low	
129	Bulolo	B	B	Low to Average Importance							Low	Low	
130	Mtumbane	B	B	Low to Average Importance							Low	Low	
131	Mzimvubu	B	B	Important	SA	30X30	Priority				High	Medium	
132	Ntlupeni	A/B	A - A/B	Low to Average Importance							Low	Low	
133	Nkodusweni	B	A/B	Low to Average Importance	SA		Priority				Low	Low	
134	Mntafufu	B	A/B	Important	SA	30X30	Priority				Medium	Medium	
135	Ingo	A/B	A - A/B	Low to Average Importance							Low	Low	
136	Mzintlava	A/B	A - A/B	Low to Average Importance	SA		Priority				Medium	Low	
137	Mzimpunzi	B	A/B	Low to Average Importance	SA		Priority				Low	Low	
138	Kwanyambalala	B	B	Low to Average Importance	SA		Priority				Low	Low	
139	Mbotyi	B	B	Important	SA		Priority				Low	Low	
140	Mkozi	A/B	A - A/B	Low to Average Importance	SA		Priority				Low	Low	
141	Sikatsha	A/B	A - A/B	Low to Average Importance	SA		Priority				Low	Low	
142	Lupatana	A/B	A - A/B	Low to Average Importance	SA		Priority				Low	Low	
143	Mkweni	A/B	A - A/B	Low to Average Importance	SA		Priority				Low	Low	
144	Msikaba	A/B	A - A/B	Low to Average Importance	SA	30X30	Priority				Low	Low	
145	Mgwegwe	A	A	Low to Average Importance	SA		Priority				Low	Low	
146	Mgwetyana	A	A	Low to Average Importance	SA		Priority				Low	Low	
147	Mtentu	B	A/B	Important	SA	30X30	Priority				Medium	Low	
148	Sikombe	A/B	A - A/B	Low to Average Importance	SA		Priority				Low	Low	
149	Kwanyana	A/B	A - A/B	Low to Average Importance	SA		Priority				Low	Low	
150	Mtolane	A/B	A - A/B	Low to Average Importance	SA		Priority				Low	Low	
151	Mnyameni	A/B	A - A/B	Low to Average Importance	SA	30X30	Priority				Low	Medium	High
152	Mpahlanyana	B	A/B	Low to Average Importance	SA		Priority				Low	Low	
153	Mpahlane	B	A/B	Low to Average Importance	SA		Priority				Low	Low	
154	Mzamba	B	A/B	Important	SA		Priority				Medium	Medium	
155	Mtentwana	B/C	B	Low to Average Importance	SA		Priority				Low	Low	

7.3.1 *Blue Carbon*

Blue Carbon, carbon that is stored in mangroves, salt marsh and seagrasses, are recognised as one of the most valued ecosystems capturing 50% of the total carbon sequestered in ocean sediments (Raw et al. 2019). This includes the living and non-living biomass. The Paris Agreement withing the UN Framework Convention on Climate Change (UNFCCC) allows for the mitigation of greenhouse gases (GHG). Blue Carbon in South African estuaries are therefore important in South Africa's national greenhouse gas inventory as part of the Agriculture, Forestry and Other Land Use strategic framework. A number of estuaries in the WMA7 support the endangered seagrass Zostera capensis, the largest stands being in the Swartkops (59.8 ha). The top three estuaries with the largest salt marsh are the Swartkops (543.5 ha), Keiskamma (395.6 ha) and Great Fish (198 ha), while the largest mangrove stands occur in the Mngazana (147 ha), Mtata (50.9 ha) and Xora (22.5 ha).

7.3.2 *Estuarine nursery habitats*

The diverse habitats (such as seagrass, mangroves, salt marsh, sand and mud), shelter and abundance of food in estuaries makes estuaries ideal nursery areas for fishes, with South Africa's estuaries dominated by juvenile marine fish. Of the 164 species of fish that occur in South African estuaries, 73 are estuary-associated marine species (Whitfield 2019). These species spend their adult life at sea but use productive estuaries as nurseries for the first year or two of their lives. Many of these species are caught in South Africa's commercial, recreational and subsistence fisheries, with species that are entirely dependent on estuarine nurseries particularly vulnerable to growth overfishing (removal of juveniles before they are able to recruit to adult fish stocks), reduced freshwater flow and habitat degradation. As such, the stocks of four (dusky kob *Argyrosomus japonicus*, white steenbras *Lithognathus lithognathus,* leervis/garrick *Lichia amia* and estuarine bream *Acanthopagrus vagus*) of the seven estuary-dependent marine fishery species have collapsed and one (spotted grunter *Pomadasys commersonnii*) is overexploited.

Although there are ± 290 estuaries along South Africa's coast, many species have specific habitat requirements in their juvenile stages, which means that not all estuaries function equally as nurseries for particular fish species. Furthermore, the populations of fish species that are dependent on specific nursery habitats as juveniles may be seriously impacted by habitat loss and degradation of habitat features that promote juvenile fitness (Sundblad et al. 2014). Seagrass is a particularly important nursery habitat for many fishery species as it provides complex structure for shelter and food. In predominantly open South African estuaries with extensive seagrass beds, juvenile sparids or seabreams, which are omnivorous or herbivorous, particularly Cape stumpnose *Rhabdosargus holubi*, blacktail *Diplodus capensis* and strepie *Sarpa salpa*, are abundant and dominate this habitat (Mkhize et al. 2024). In the WMA, important sparid nurseries with extensive seagrass beds include the Kariega, Kromme, Bushmans and Swartkops (Figure 1).

The preferred nursery habitat for juvenile dusky kob *Argyrosomus japonicus* is deeper waters in very turbid estuaries with high freshwater input (James et al. 2022). In the WMA, particularly important dusky kob nursery estuaries include the Mbashe, Great Kei and Mtata. Juvenile spotted grunter *Pomadasys commersonnnii* also seem largely to prefer turbid systems, such as the Mzimvubu, Sundays, Great Fish, Great Kei and Gamtoos (Figure 1). Piscivorous leervis *Lichia amia*, which rely on visual foraging methods, are attracted to clear water systems such as the Kromme, Swartkops and Bushmans. Shallow intertidal and littoral areas in the sandy areas of estuaries are critical nursery habitats for the white Steenbras, *Lithognathus lithognathus*, with this largely driven by the availability of prey such as sand prawns *Callianassa krausii* (Bennett et al. 2015). Important white steenbras estuaries in the WMA include the Sundays, Gamtoos, Kromme, Swartkops, Great Fish and Seekoei.

Within the WMA, estuaries which are important nurseries for several fishery species with different nursery habitat requirements are the Kromme, Gamtoos, Seekoei, Swartkops, Sundays, Kariega, Kowie, Great Fish and Mngazana (**Figure 7-1**).

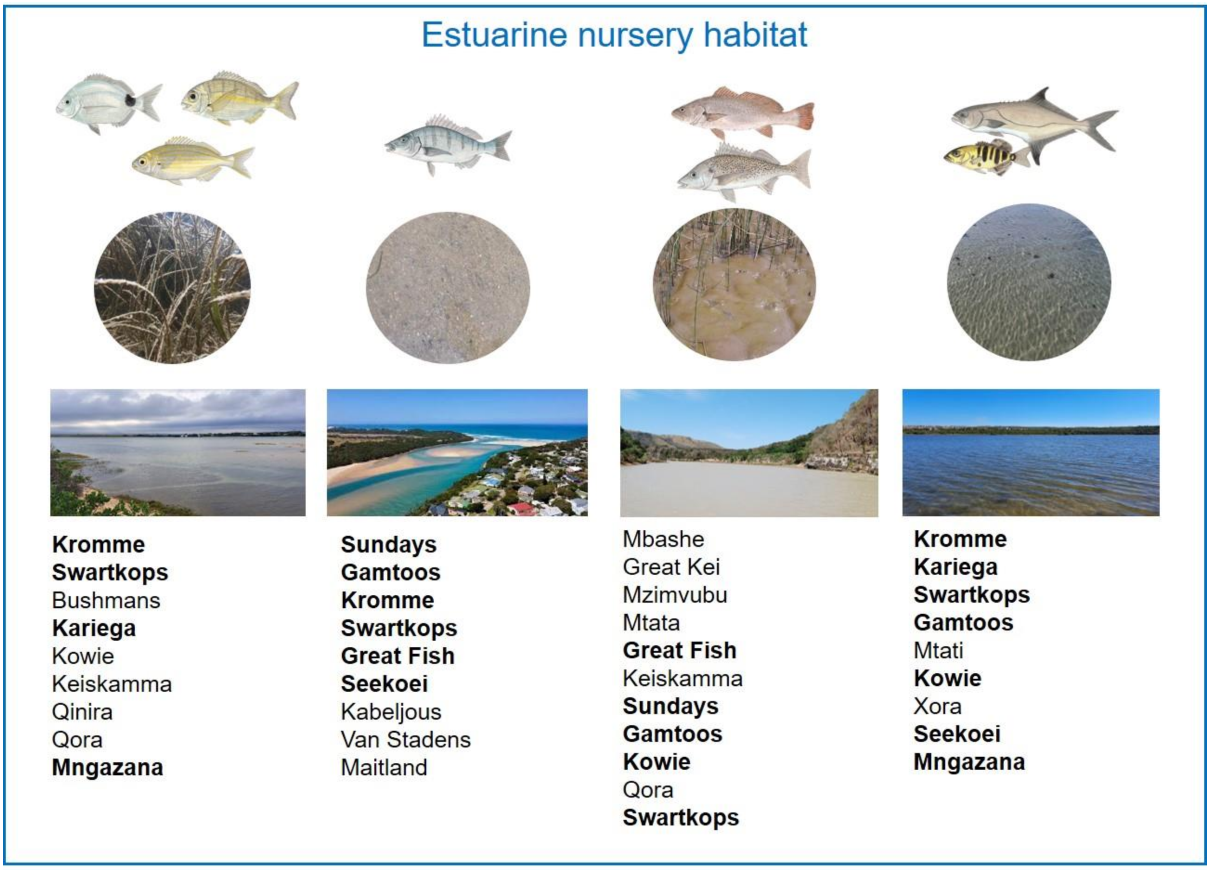

Figure 7-1: Important nursery estuaries within the WMA for fishery species, based on 1) area of available habitat, abundance of juveniles and expert opinion. Estuaries which are important nurseries to several species are in bold

8. MZIMVUBU TO TSITSIKAMMA WATER MANAGEMENT AREA: EWR RECOMMENDATIONS

8.1 Mitigation measures required to achieve the REC and restore/protect estuaries

Thirty-one percent (48 estuaries) of the 155 estuaries in the WMA had flow-related pressures on them, while 26% (41 estuaries) were under significant water quality pressure (**Table 8.1**). More than 21% (33 estuaries) had undergone significant habitat destruction. A third of the estuaries (49 estuaries) could benefit from some remedial actions and more proactive management of the main vectors of change.

In some of the estuaries, additional water resource development would be possible, as long as the baseflow (low flow regime) is maintained, e.g. the inflowing river can be targeted for off-channel development or runoff river abstraction. However, the majority of the catchments in the region are small and linked to temporarily open/closed estuaries that require a high percentage of the natural runoff to maintain marine connectivity and their required condition. Any increase or decrease in runoff to this type of system rapidly leads to changes in mouth state and related ecological degradation.

It should also be noted that the majority of these estuary mouths close from time to time and are therefore very sensitive to nutrient loading from the catchment or direct surrounding environment. Especially the smaller estuaries of WMA, during closure periods, will retain and accumulate nutrients with consequent impacts on water quality and the microalgae and macrophytes, with cascading ripple effects on all other trophic levels.

A third of estuaries (49 estuaries) had very high levels of fishing effort in the form of illegal gillnets which compromises nursery function and the ability of fish stock to recover in the region. This will require ongoing efforts to improve compliance, with a focus on the eradication of illegal gill nets. In several systems bait collection is done with spades (e.g. Swartkops Estuary), which is a highly destructive practice that damages seagrass beds (impacts nursery function and carbon sequestration) and also requires additional compliance efforts and ongoing community education.

The assessment of nutrient discharges from WWTWs into an estuary should consider the impact of this on the receiving environment; in this case an estuary, rather than relying on adherence to permitted discharge levels. In the case of estuaries, it appears that either general or special standards are applied to the wastewater streams and the impact of the associated nutrients and any organic material on the estuary appears not to be considered. Therefore, neither general nor special standards are sufficient to prevent a deterioration in overall estuarine health and the application of a receiving water quality evaluation is advocated when assessing the impacts of discharges on these systems. It is recommended that consideration should be given to the advisability of using intermittently open estuaries as conduits for wastewater.

Priority should be given to the removal of alien terrestrial vegetation. Species like *Tamarix ramosissima* stabilise sediment and with their rapid growth can potentially alter local topography and therefore hydrology to the detriment of intertidal habitat like salt marsh and mangroves. The rapid growth of aliens and high reproductive output outcompete indigenous vegetation resulting in loss of biodiversity.

Table 8-1 lists key flow and non-flow interventions required to achieve/maintain the REC. Note that the priority estuaries are discussed in more detail in Chapter 5 and thus excluded from this list.

Table 8-1: Estuary restoration and compliance measures required to achieve/maintain REC.

##	Estuary	PES	REC	Reference MAR (m^3x10^6)	Present MAR (m^3x10^6)	Restore/protect base flows	Restore floods	Improve urban runoff (stormwater)	Manage agricultural runoff (e.g. fertilizing, buffer zones)	Improve WWTW infrastructure/operations	Average WWTW volume (m^3/day)	Major Plastic Pollution	Restore connectivity/ hydrodynamic functioning	Improve mouth management	Rehabilitate riparian areas/ wetlands	Remove alien vegetation	Reduce grazing plan (sheep, cattle, goats)	Implement cattle exclusion zone (Browsing of mangroves)	Control mangrove harvesting	Control recreational activities impacting on birds	Remove/reduce fishing pressure/ bait collection	Investigate eradication of alien fish	Restore/protect against impact from mining
1	Lottering	A/B	A - A/B	18.5	16.8																		
2	Elandsbos	A/B	A - A/B	27.2	24.7																		
3	Storms	A/B	A - A/B	54.1	47.9																		
4	Elands	A/B	A - A/B	52.2	46.9																		
5	Groot (Oos)	A/B	A - A/B	47.0	44.1																		
6	Tsitsikamma	B/C	B	19.9	13.3	●			Catch.												●		
7	Klipdrif (Oos)	C	C	32.9	18.6																		
8	Slang	C/D	C/D	5.1	4.6				Catch.														
9	Kromme	C/D	C	72.2	36.8	●	●	EFZ	Catch.						●					●	●	●	
10	Seekoei	D/E	C	20.3	11.4	●			Catch.				●	●	●	●							
13	Van Stadens	B	A/B	17.2	15.6	●			Catch.							●							
14	Maitland	B/C	B	12.9	11.7	●			Catch.							●							
15	Baakens	E/F	E	4.1	3.6	●		EFZ/Catch		●	Pump stn	●											
16	Papkuils	F	E/F	2.9	2.9	●		EFZ/Catch		●	54 000	●											
17	Swartkops	D	C	56.9	80.3	●		EFZ/Catch	Catch.	●	24 808	●			●	●				●	●*	●	
18	Coega (Ngqurha)	E/F	D	10.1	8.6	●		Saltworks				●			●							●	
19	Sundays	C/D	B	263.1	240.7	●			Catch.			●			●	●				●	●	●	
20	Boknes	C	C	14.4	14.4	●																	
21	Bushmans	C	B	43.1	32.7	●				●	1 205						●			●	●*	●	
23	Grant's	C	C	2.4	2.2	●			Catch.														
24	Kasouga	B	B	4.3	4.3				Catch.												●		
25	Kowie	C	B/C	31.4	28.0	●			Catch.	●	1 200				●	●				●	●	●	
26	Rufane	C	C	1.2	1.1	●			Catch.														

##	Estuary	PES	REC	Reference MAR (m³x10⁶)	Present MAR (m³x10⁶)	Restore/protect base flows	Restore floods	Improve urban runoff (stormwater)	Manage agricultural runoff (e.g. fertilizing, buffer zones)	Improve WWTW infrastructure/operations	Average WWTW volume (m³/day)	Major Plastic Pollution	Restore connectivity/ hydrodynamic functioning	Improve mouth management	Rehabilitate riparian areas/ wetlands	Remove alien vegetation	Reduce grazing plan (sheep, cattle, goats)	Implement cattle exclusion zone (Browsing of mangroves)	Control mangrove harvesting	Control recreational activities impacting on birds	Remove/reduce fishing pressure/ bait collection	Investigate eradication of alien fish	Restore/protect against impact from mining
27	Riet	B	B	2.4	2.3																		
28	West Kleinemonde	B	B	6.0	5.5				Catch.														
29	East Kleinemonde	B	B	2.9	2.7																		
30	Great Fish	C	B/C	496.3	451.0	●			Catch							●				●	●	●	
31	Old Woman's	B/C	B/C	1.1	0.9	●																	
32	Mpekweni	B	B	2.4	2.1	●														●	●		
33	Mtati (Mthathi)	B	B	6.0	5.1	●																	
34	Mgwalana	B	A/B	9.7	8.2	●																	
35	Bira (Bhirha)	B	A/B	12.0	10.0	●																	
36	Gqutywa	B	B	3.5	3.0	●																	
37	Ngculura (Ngculurha)	B	A/B	0.6	0.6	●																	
38	Mtana	B	B	1.1	0.9	●																	
40	Nqinisa	A/B	A - A/B	1.2	1.2																		
41	Kiwane (Khiwane)	A/B	A - A/B	5.3	5.3																		
42	Tyolomnqa	B	A/B	35.6	34.5															●	●		
43	Shelbertsstroom	B/C	B/C	0.6	0.6				Catch.							●							
44	Lilyvale	B	B	1.1	1.0				Catch.														
45	Ross' Creek	B	B	0.6	0.5																		
46	Ncera (Ncerha)	B	B	11.0	10.2	●																	
47	Mlele	B/C	B/C	2.0	1.9				Catch.														
48	Mcantsi	C	B	2.8	2.6				Catch.	●	600												

##	Estuary	PES	REC	Reference MAR (m^3x10^6)	Present MAR (m^3x10^6)	Restore/protect base flows	Restore floods	Improve urban runoff (stormwater)	Manage agricultural runoff (e.g. fertilizing, buffer zones)	Improve WWTW infrastructure/operations	Average WWTW volume (m^3/day)	Major Plastic Pollution	Restore connectivity/ hydrodynamic functioning	Improve mouth management	Rehabilitate riparian areas/ wetlands	Remove alien vegetation	Reduce grazing plan (sheep, cattle, goats)	Implement cattle exclusion zone (Browsing of mangroves)	Control mangrove harvesting	Control recreational activities impacting on birds	Remove/reduce fishing pressure/ bait collection	Investigate eradication of alien fish	Restore/protect against impact from mining
49	Gxulu	B/C	B/C	15.6	14.5				Catch.														
50	Goda	B	A/B	6.2	5.8	●			Catch.														
51	Hlozi	B	B	1.7	1.6				Catch.														
52	Hickman's	C	C	1.4	1.3			Catch.															
53	Buffalo	D/E	D	96.0	18.7	●		EFZ/Catc		●	6 000	●									●	●	
54	Blind	D	D	0.7	1.1	●		Catch.															
55	Hlaze (iHlanze)	D	D	0.3	0.8	●		Catch.					●										
56	Nahoon	C/D	C	32.5	20.4	●	●	EFZ/Catc		●	680	●				●				●	●	●	
57	Qinira (Quinirha)	B	B	8.4	8.3			Catch.	Catch.					●							●		
58	Gqunube	B/C	B	34.1	32.1			Catch.	Catch.	●	Pump stn				●					●	●	●	
59	Kwelera (Kwelerha)	B	A/B	34.8	32.8																●		
60	Bulura (Bulurha)	B	B	3.7	3.5																●		●
61	Cunge	A/B	A/B	0.3	0.3											●							
62	Cintsa	B	B	4.0	3.8																●		
63	Cefane	B	B	4.0	3.2																●		
64	Kwenxura (Kwenxurha)	A/B	A - A/B	16.9	16.6										●	●					●		
65	Nyara (Nyarha)	A/B	A - A/B	4.3	4.3																		
66	Imtwendwe (Mtwendwe)	A/B	A - A/B	1.1	1.0																		
67	Haga-haga	B	B	2.1	2.1																		

##	Estuary	PES	REC	Reference MAR (m^3x10^6)	Present MAR (m^3x10^6)	Restore/protect base flows	Restore floods	Improve urban runoff (stormwater)	Manage agricultural runoff (e.g. fertilizing, buffer zones)	Improve WWTW infrastructure/operations	Average WWTW volume (m^3/day)	Major Plastic Pollution	Restore connectivity/ hydrodynamic functioning	Improve mouth management	Rehabilitate riparian areas/ wetlands	Remove alien vegetation	Reduce grazing plan (sheep, cattle, goats)	Implement cattle exclusion zone (Browsing of mangroves)	Control mangrove harvesting	Control recreational activities impacting on birds	Remove/reduce fishing pressure/ bait collection	Investigate eradication of alien fish	Restore/protect against impact from mining
68	Mtendwe	A/B	A - A/B	1.4	1.4																		
69	Quko	A/B	A - A/B	17.2	16.9																		
70	Morgan	B	B	2.7	2.7								●								●	●	
71	Cwili	B	B	1.2	1.2																	●	
73	Gxara (Gxarha)	A/B	A - A/B	3.4	3.4										●								
74	Ngogwane	B	B	0.8	0.8	●																	
75	Qolora (Qolorha)	B	B	8.9	8.7																		
76	Ncizele	A/B	A - A/B	1.0	1.0																		
77	Timba	B	B	0.4	0.3	●																	
78	Kobonqaba (Khobonqaba)	B	A/B	36.2	35.5	●									●			●	●				
79	Nxaxo/Ngqusi	B	A/B	23.3	22.8										●	●		●	●		●		
80	Cebe	A/B	A - A/B	5.7	5.6																		
81	Gqunqe	A/B	A - A/B	7.0	6.8																		
82	Zalu	B	B	1.7	1.7																		
83	Ngqwara (Ngqwarha)	A/B	A - A/B	5.2	5.1	●									●								
84	Sihlontlweni	A/B	A - A/B	2.2	2.2																		
85	Nebelele	A/B	B	1.1	1.0																		
86	Qora (Qhorha)	B	A/B	78.5	72.0										●			●			●		●
87	Jujura (Jujurha)	B	B	11.3	10.3	●																	
88	Ngadla	A/B	A - A/B	1.6	1.5																		
89	Shixini	A/B	A - A/B	42.3	41.0																●		
90	Beechamwood	B	B	0.5	0.5																		●

##	Estuary	PES	REC	Reference MAR (m^3x10^6)	Present MAR (m^3x10^6)	Restore/protect base flows	Restore floods	Improve urban runoff (stormwater)	Manage agricultural runoff (e.g. fertilizing, buffer zones)	Improve WWTW infrastructure/operations	Average WWTW volume (m^3/day)	Major Plastic Pollution	Restore connectivity/ hydrodynamic functioning	Improve mouth management	Rehabilitate riparian areas/ wetlands	Remove alien vegetation	Reduce grazing plan (sheep, cattle, goats)	Implement cattle exclusion zone (Browsing of mangroves)	Control mangrove harvesting	Control recreational activities impacting on birds	Remove/reduce fishing pressure/ bait collection	Investigate eradication of alien fish	Restore/protect against impact from mining
91	Kwazlelitsha (Kwazwedala)	A/B	A - A/B	0.6	0.6																		
92	Kwa-Goqo	A/B	A - A/B	1.0	1.0																		
93	Ku-Nocekedwa	A/B	A - A/B	1.1	1.1																		
94	Nqabara/Nqabarana	B	A/B	76.4	75.9										●	●		●		●	●		
95	Ngomane (East)	B	B	1.1	1.1																		
96	Ngoma/Kobule	A/B	A - A/B	6.3	6.2																		
97	Mendu	A/B	A - A/B	5.2	5.1																●		
98	Mendwana	A/B	A - A/B	1.4	1.3																●		
100	Ku-Mpenzu	A/B	A - A/B	0.8	0.7															●	●		
101	Ku-Bhula (Mbhanyana)	A/B	A - A/B	8.9	8.6	●									●	●		●			●		
102	Kwa-Suku	A/B	A - A/B	0.7	0.7																●		
103	Ntlonyane	B	A/B	13.6	13.2								●		●			●			●		●
104	Nkanya	B	A/B	2.5	2.4																		
105	Sundwana	A/B	A - A/B	0.8	0.8																		
106	Xora	B/C	B	52.4	40.5		●									●		●	●		●*		
107	Bulungula	B	A/B	7.6	7.5											●							
108	Ku-Amanzimuzama	A/B	A - A/B	1.6	1.6																		
109	Nqakanqa	B	B	0.8	0.8														●				
110	Mdikana	B	B	0.2	0.2																		
111	Mncwasa	B	B	26.9	26.5																		
112	Mpako	B	B	21.7	21.6																●		●

##	Estuary	PES	REC	Reference MAR (m^3x10^6)	Present MAR (m^3x10^6)	Restore/protect base flows	Restore floods	Improve urban runoff (stormwater)	Manage agricultural runoff (e.g. fertilizing, buffer zones)	Improve WWTW infrastructure/operations	Average WWTW volume (m^3/day)	Major Plastic Pollution	Restore connectivity/ hydrodynamic functioning	Improve mouth management	Rehabilitate riparian areas/ wetlands	Remove alien vegetation	Reduce grazing plan (sheep, cattle, goats)	Implement cattle exclusion zone (Browsing of mangroves)	Control mangrove harvesting	Control recreational activities impacting on birds	Remove/reduce fishing pressure/ bait collection	Investigate eradication of alien fish	Restore/protect against impact from mining
113	Nenga	C	C	9.1	9.0								●		●				●		●		
114	Mapuzi	B	B	5.5	5.5																		
115	Mtata	C	B/C	392.2	319.0	●	●		Catch.						●	●		●	●		●	●	●
116	Thsani	B	B	0.5	0.5																		●
117	Mdumbi	B	A/B	36.6	35.5										●	●		●	●		●		●
118	Lwandilana	B	B	1.4	1.4																		
119	Lwandile	A/B	A - A/B	3.4	3.3																		
120	Mtakatye	B	A/B	63.4	61.7							●			●	●		●	●		●		
121	Hluleka	B	A/B	4.3	4.2										●	●					●		
122	Mnenu	A/B	A/B	19.7	19.2																●		
123	Mtonga	C	A/B	4.0	3.9				Catch.				●										
124	Mpande	A/B	A - A/B	4.5	4.4																		
125	Sinangwana	B	B	11.5	11.2																		
126	Mngazana	B	A/B	49.3	47.8	●									●			●	●		●*		
128	Gxwaleni	A/B	A - A/B	1.6	1.6																		
129	Bulolo	B	B	1.6	1.6																●		
130	Mtumbane	B	B	1.0	1.0	●									●								
131	Mzimvubu	B	B	2665.6	2552.0	●			Catch.							●					●	●	
132	Ntlupeni	A/B	A - A/B	3.8	3.8																		
133	Nkodusweni	B	A/B	8.2	8.1										●								
134	Mntafufu	B	A/B	44.5	43.8										●	●			●	●	●		
135	Ingo	A/B	A - A/B	4.6	4.4																		
136	Mzintlava	A/B	A - A/B	69.8	67.0										●				●		●		
137	Mzimpunzi	B	A/B	9.2	8.5										●								
138	Kwanyambalala	B	B	4.2	3.9										●						●		

##	Estuary	PES	REC	Reference MAR (m^3x10^6)	Present MAR (m^3x10^6)	Restore/protect base flows	Restore floods	Improve urban runoff (stormwater)	Manage agricultural runoff (e.g. fertilizing, buffer zones)	Improve WWTW infrastructure/operations	Average WWTW volume (m^3/day)	Major Plastic Pollution	Restore connectivity/ hydrodynamic functioning	Improve mouth management	Rehabilitate riparian areas/ wetlands	Remove alien vegetation	Reduce grazing plan (sheep, cattle, goats)	Implement cattle exclusion zone (Browsing of mangroves)	Control mangrove harvesting	Control recreational activities impacting on birds	Remove/reduce fishing pressure/ bait collection	Investigate eradication of alien fish	Restore/protect against impact from mining
139	**Mbotyi**	B	B	11.1	10.3										●						●		
140	**Mkozi**	A/B	A - A/B	15.7	14.6														●				
141	**Sikatsha**	A/B	A - A/B	1.9	1.7																		
142	**Lupatana**	A/B	A - A/B	7.0	6.5																		
143	**Mkweni**	A/B	A - A/B	18.4	17.0																		
144	**Msikaba**	A/B	A - A/B	212.4	199.3											●					●		
145	**Mgwegwe**	A	A	1.2	1.2																		
146	**Mgwetyana**	A	A	1.8	1.8																		
147	**Mtentu**	B	A/B	157.0	145.4	●									●	●			●		●	●	
148	**Sikombe**	A/B	A - A/B	6.8	6.8										●								
149	**Kwanyana**	A/B	A - A/B	4.0	3.9																		
150	**Mtolane**	A/B	A - A/B	1.8	1.8																		
151	**Mnyameni**	A/B	A - A/B	45.9	44.8										●						●		
152	**Mpahlanyana**	B	A/B	1.1	1.0																●		
153	**Mpahlane**	B	A/B	2.7	2.5																●		
154	**Mzamba**	B	A/B	67.4	62.8											●					●		
155	**Mtentwana**	B/C	B	1.3	1.2	●		EFZ	Catch.				●		●				●				

8.2 Potential for water resource development

Table 8-2 provides a summary of the EWR for estuaries that have been assessed as part of this study or as part of detailed previous assessments (indicated by a *). Using historical EWR assessments, catchment size (MAR) and estuary types as guide, the potential for water development without significantly impacting on estuary condition in some of the larger catchments were also indicated – to be confirmed with more detailed assessment if significant abstraction or infrastructure development is planned. **Any reduction in river inflow to the smaller estuaries puts them at significant risk of decline, or further decline, in estuary condition as it will impact mouth state, salinity regimes and water quality with cascading effects into estuarine food webs.**

Table 8-2: Estuary EWRs

##	Name	Estuary Type	PES	REC	Reference MAR (m^3x10^6)	Present MAR (m^3x10^6)	% Similarity MAR	Base flows stress	Loss of resetting floods	Potential for water resource development from natural
1	Lottering	Small Fluvially Dominated	A/B	A - A/B	18.5	16.8	90.9			
2	Elandsbos	Small Fluvially Dominated	A/B	A - A/B	27.2	24.7	90.8			
3	Storms	Small Fluvially Dominated	A/B	A - A/B	54.1	47.9	88.5			95-99%
4	Elands	Small Fluvially Dominated	A/B	A - A/B	52.2	46.9	89.8			95-99%
5	Groot (Oos)	Small Fluvially Dominated	A/B	A - A/B	47.0	44.1	93.9			
6	Tsitsikamma*	Small Temporarily Closed	B/C	B	19.9	13.3	66.9	●		66.9% +5%↑
7	Klipdrif (Oos)	Small Temporarily Closed	C	C	32.9	18.6	56.4			
8	Slang	Small Temporarily Closed	C/D	C/D	5.1	4.6	90.3			
9	Kromme*	Predominantly Open	C/D	C	72.2	36.8	51.0	●	●	51%
10	Seekoei	Large Temporarily Closed	D/E	C	20.3	11.4	56.0	●		
11	Kabeljous*	Large Temporarily Closed	B	B	5.3	4.7	89.2	●		89.3%
12	Gamtoos*	Predominantly Open	D	C	404.2	194.8	48.2	●		51.8%
13	Van Stadens	Large Temporarily Closed	B	A/B	17.2	15.6	90.9	●		
14	Maitland	Large Temporarily Closed	B/C	B	12.9	11.7	90.9	●		
15	Baakens	Small Temporarily Closed	E/F	E	4.1	3.6	87.5	●		
16	Papkuils	Small Temporarily Closed	F	E/F	2.9	2.9	99.0	●		
17	Swartkops*	Predominantly Open	D	C	56.9	80.3	70.9	●	●	123.9%
18	Coega (Ngqurha)	Large Temporarily Closed	E/F	D	10.1	8.6	85.1	●		
19	Sundays*	Predominantly Open	C/D	B	263.1	240.7	91.5	●		95%
20	Boknes	Small Temporarily Closed	C	C	14.4	14.4	99.6	●		
21	Bushmans	Predominantly Open	C	B	43.1	32.7	75.8	●		75.8 + 3%↑
22	Kariega*	Predominantly Open	C	C	21.9	13.1	59.8	●		60%
23	Grant's	Small Temporarily Closed	C	C	2.4	2.2	92.9	●		
24	Kasouga	Large Temporarily Closed	B	B	4.3	4.3	99.1			
25	Kowie	Predominantly Open	C	B/C	31.4	28.0	89.1	●		89.1%
26	Rufane	Small Temporarily Closed	C	C	1.2	1.1	93.6	●		
27	Riet	Small Temporarily Closed	B	B	2.4	2.3	0.0			
28	West Kleinemonde	Large Temporarily Closed	B	B	6.0	5.5	90.9			
29	East Kleinemonde	Large Temporarily Closed	B	B	2.9	2.7	96.2			
30	Great Fish*	Predominantly Open	C	B/C	496.3	451.0	90.9	●		90.3%
31	Old Woman's	Large Temporarily Closed	B/C	B/C	1.1	0.9	84.6	●		
32	Mpekweni	Large Temporarily Closed	B	B	2.4	2.1	84.7	●		
33	Mtati (Mthathi)	Large Temporarily Closed	B	B	6.0	5.1	84.5	●		
34	Mgwalana	Large Temporarily Closed	B	A/B	9.7	8.2	84.5	●		
35	Bira (Bhirha)	Large Temporarily Closed	B	A/B	12.0	10.0	83.1	●		
36	Gqutywa	Large Temporarily Closed	B	B	3.5	3.0	84.1	●		
37	Ngculura (Ngculurha)	Small Temporarily Closed	B	A/B	0.6	0.6	85.8	●		
38	Mtana	Small Temporarily Closed	B	B	1.1	0.9	84.3	●		
39	Keiskamma*	Predominantly Open	C	B	128.7	86.4	67.2	●		76.8%

##	Name	Estuary Type	PES	REC	Reference MAR (m^3x10^6)	Present MAR (m^3x10^6)	% Similarity MAR	Base flows stress	Loss of resetting floods	Potential for water resource development from natural
40	Nqinisa	Small Temporarily Closed	A/B	A - A/B	1.2	1.2	99.4			
41	Kiwane (Khiwane)	Large Temporarily Closed	A/B	A - A/B	5.3	5.3	99.5			
42	Tyolomnqa	Large Temporarily Closed	B	A/B	35.6	34.5	97.1			
43	Shelbertsstroom	Small Temporarily Closed	B/C	B/C	0.6	0.6	99.4			
44	Lilyvale	Small Temporarily Closed	B	B	1.1	1.0	90.8			
45	Ross' Creek	Small Temporarily Closed	B	B	0.6	0.5	98.7			
46	Ncera (Ncerha)	Large Temporarily Closed	B	B	11.0	10.2	93.2	●		
47	Mlele	Small Temporarily Closed	B/C	B/C	2.0	1.9	93.1			
48	Mcantsi	Small Temporarily Closed	C	B	2.8	2.6	93.3			
49	Gxulu	Large Temporarily Closed	B/C	B/C	15.6	14.5	93.2			
50	Goda	Large Temporarily Closed	B	A/B	6.2	5.8	93.2	●		
51	Hlozi	Small Temporarily Closed	B	B	1.7	1.6	93.2			
52	Hickman's	Small Temporarily Closed	C	C	1.4	1.3	93.2			
53	Buffalo	Predominantly Open	D/E	D	96.0	18.7	19.5	●		95-99%
54	Blind	Small Temporarily Closed	D	D	0.7	1.1	58.0	●		
55	Hlaze (iHlanze)	Small Temporarily Closed	D	D	0.3	0.8	39.5	●		
56	Nahoon*	Predominantly Open	C/D	C	32.5	20.4	62.8	●	●	62.8%% + 5%↑
57	Qinira (Quinirha)	Large Temporarily Closed	B	B	8.4	8.3	98.3			98.3%
58	Gqunube	Predominantly Open	B/C	B	34.1	32.1	94.1			
59	Kwelera (Kwelerha)	Predominantly Open	B	A/B	34.8	32.8	94.2			
60	Bulura (Bulurha)	Large Temporarily Closed	B	B	3.7	3.5	94.3			
61	Cunge	Small Temporarily Closed	A/B	A/B	0.3	0.3	97.2			
62	Cintsa	Large Temporarily Closed	B	B	4.0	3.8	94.3			
63	Cefane	Large Temporarily Closed	B	B	4.0	3.2	81.0			
64	Kwenxura (Kwenxurha)	Large Temporarily Closed	A/B	A - A/B	16.9	16.6	98.1			
65	Nyara (Nyarha)	Large Temporarily Closed	A/B	A - A/B	4.3	4.3	98.1			
66	Imtwendwe (Mtwendwe)	Small Temporarily Closed	A/B	A - A/B	1.1	1.0	98.2			
67	Haga-haga	Small Temporarily Closed	B	B	2.1	2.1	98.0			
68	Mtendwe	Small Temporarily Closed	A/B	A - A/B	1.4	1.4	98.0			
69	Quko	Large Temporarily Closed	A/B	A - A/B	17.2	16.9	98.1			
70	Morgan	Large Temporarily Closed	B	B	2.7	2.7	98.1			
71	Cwili	Small Temporarily Closed	B	B	1.2	1.2	98.0			
72	Great Kei*	Large Fluvially Dominated	C	B/C	1040.7	742.0	71.3	●	●	74.1%
73	Gxara (Gxarha)	Large Temporarily Closed	A/B	A - A/B	3.4	3.4	98.0			
74	Ngogwane	Small Temporarily Closed	B	B	0.8	0.8	98.2	●		
75	Qolora (Qolorha)	Large Temporarily Closed	B	B	8.9	8.7	98.1			
76	Ncizele	Small Temporarily Closed	A/B	A - A/B	1.0	1.0	97.9			
77	Timba	Small Temporarily Closed	B	B	0.4	0.3	98.3	●		
78	Kobonqaba (Khobonqaba)	Predominantly Open	B	A/B	36.2	35.5	98.1	●		
79	Nxaxo/Ngqusi	Large Temporarily Closed	B	A/B	23.3	22.8	98.0			
80	Cebe	Large Temporarily Closed	A/B	A - A/B	5.7	5.6	98.0			
81	Gqunqe	Large Temporarily Closed	A/B	A - A/B	7.0	6.8	98.0			
82	Zalu	Small Temporarily Closed	B	B	1.7	1.7	98.0			
83	Ngqwara (Ngqwarha)	Large Temporarily Closed	A/B	A - A/B	5.2	5.1	98.0	●		
84	Sihlontlweni	Small Temporarily Closed	A/B	A - A/B	2.2	2.2	98.0			
85	Nebelele	Small Temporarily Closed	A/B	B	1.1	1.0	98.2			
86	Qora (Qhorha)	Predominantly Open	B	A/B	78.5	72.0	91.7			95-99%
87	Jujura (Jujurha)	Small Temporarily Closed	B	B	11.3	10.3	91.2	●		
88	Ngadla	Small Temporarily Closed	A/B	A - A/B	1.6	1.5	97.0			
89	Shixini	Predominantly Open	A/B	A - A/B	42.3	41.0	97.0			
90	Beechamwood	Small Temporarily Closed	B	B	0.5	0.5	97.2			
91	Kwazlelitsha (Kwazwedala)	Small Temporarily Closed	A/B	A - A/B	0.6	0.6	96.8			
92	Kwa-Goqo	Small Temporarily Closed	A/B	A - A/B	1.0	1.0	96.9			
93	Ku-Nocekedwa	Small Temporarily Closed	A/B	A - A/B	1.1	1.1	97.0			
94	Nqabara/Nqabarana	Predominantly Open	B	A/B	76.4	75.9	99.3			95-99%
95	Ngomane (East)	Small Temporarily Closed	B	B	1.1	1.1	98.1			
96	Ngoma/Kobule	Small Temporarily Closed	A/B	A - A/B	6.3	6.2	98.0			
97	Mendu	Large Temporarily Closed	A/B	A - A/B	5.2	5.1	98.0			

##	Name	Estuary Type	PES	REC	Reference MAR (m^3x10^6)	Present MAR (m^3x10^6)	% Similarity MAR	Base flows stress	Loss of resetting floods	Potential for water resource development from natural
98	Mendwana	Predominantly Open	A/B	A - A/B	1.4	1.3	98.1			
99	Mbashe*	Large Fluvially Dominated	B/C	B	786.9	861.2	91.4	●		108.5%
100	Ku-Mpenzu	Small Temporarily Closed	A/B	A - A/B	0.8	0.7	96.8			
101	Ku-Bhula (Mbhanyana)	Small Temporarily Closed	A/B	A - A/B	8.9	8.6	96.6	●		
102	Kwa-Suku	Large Temporarily Closed	A/B	A - A/B	0.7	0.7	96.7			
103	Ntlonyane	Large Temporarily Closed	B	A/B	13.6	13.2	96.6			
104	Nkanya	Large Temporarily Closed	B	A/B	2.5	2.4	96.6			
105	Sundwana	Small Temporarily Closed	A/B	A - A/B	0.8	0.8	96.7			
106	Xora	Predominantly Open	B/C	B	52.4	40.5	77.3		●	77.3% + 5%↑
107	Bulungula	Large Temporarily Closed	B	A/B	7.6	7.5	98.3			
108	Ku-Amanzimuzama	Small Temporarily Closed	A/B	A - A/B	1.6	1.6	98.4			
109	Nqakanqa	Small Temporarily Closed	B	B	0.8	0.8	98.0			
110	Mdikana	Small Temporarily Closed	B	B	0.2	0.2	100.0			
111	Mncwasa	Large Temporarily Closed	B	B	26.9	26.5	98.3			
112	Mpako	Small Temporarily Closed	B	B	21.7	21.6	99.4			
113	Nenga	Small Temporarily Closed	C	C	9.1	9.0	98.5			
114	Mapuzi	Large Temporarily Closed	B	B	5.5	5.5	98.6			
115	Mtata	Predominantly Open	C	B/C	392.2	319.0	81.3	●	●	90-95%
116	Thsani	Small Temporarily Closed	B	B	0.5	0.5	97.4			
117	Mdumbi	Predominantly Open	B	A/B	36.6	35.5	96.8			
118	Lwandilana	Small Temporarily Closed	B	B	1.4	1.4	97.6			
119	Lwandile	Large Temporarily Closed	A/B	A - A/B	3.4	3.3	96.9			
120	Mtakatye	Predominantly Open	B	A/B	63.4	61.7	97.4			95-99%
121	Hluleka	Small Temporarily Closed	B	A/B	4.3	4.2	97.6			
122	Mnenu	Large Temporarily Closed	A/B	A/B	19.7	19.2	97.5			
123	Mtonga	Large Temporarily Closed	C	A/B	4.0	3.9	97.7			
124	Mpande	Large Temporarily Closed	A/B	A - A/B	4.5	4.4	97.6			
125	Sinangwana	Small Temporarily Closed	B	B	11.5	11.2	97.6			
126	Mngazana	Predominantly Open	B	A/B	49.3	47.8	96.9	●		
127	Mngazi*	Large Temporarily Closed	B	B	87.3	83.5	95.7			95%
128	Gxwaleni	Small Temporarily Closed	A/B	A - A/B	1.6	1.6	97.3			
129	Bulolo	Small Temporarily Closed	B	B	1.6	1.6	97.4			
130	Mtumbane	Small Temporarily Closed	B	B	1.0	1.0	97.8	●		
131	Mzimvubu	Large Fluvially Dominated	B	B	2665.6	2552.0	95.7	●		92.7%
132	Ntlupeni	Small Temporarily Closed	A/B	A - A/B	3.8	3.8	98.3			
133	Nkodusweni	Large Temporarily Closed	B	A/B	8.2	8.1	98.3			
134	Mntafufu	Predominantly Open	B	A/B	44.5	43.8	98.3			
135	Ingo	Small Temporarily Closed	A/B	A - A/B	4.6	4.4	96.1			
136	Mzintlava	Predominantly Open	A/B	A - A/B	69.8	67.0	96.1			95-99%
137	Mzimpunzi	Small Temporarily Closed	B	A/B	9.2	8.5	92.6			
138	Kwanyambalala	Small Temporarily Closed	B	B	4.2	3.9	92.6			
139	Mbotyi	Small Temporarily Closed	B	B	11.1	10.3	92.6			
140	Mkozi	Small Temporarily Closed	A/B	A - A/B	15.7	14.6	92.6			
141	Sikatsha	Small Temporarily Closed	A/B	A - A/B	1.9	1.7	92.5			
142	Lupatana	Small Temporarily Closed	A/B	A - A/B	7.0	6.5	92.6			
143	Mkweni	Small Temporarily Closed	A/B	A - A/B	18.4	17.0	92.6			
144	Msikaba	Predominantly Open	A/B	A - A/B	212.4	199.3	93.8			93.8%
145	Mgwegwe	Small Temporarily Closed	A	A	1.2	1.2	97.7			
146	Mgwetyana	Small Temporarily Closed	A	A	1.8	1.8	97.9			
147	Mtentu	Predominantly Open	B	A/B	157.0	145.4	92.6	●		90-95%
148	Sikombe	Small Temporarily Closed	A/B	A - A/B	6.8	6.8	100.0			
149	Kwanyana	Small Temporarily Closed	A/B	A - A/B	4.0	3.9	97.7			
150	Mtolane	Small Temporarily Closed	A/B	A - A/B	1.8	1.8	100.0			
151	Mnyameni	Large Temporarily Closed	A/B	A - A/B	45.9	44.8	97.8			
152	Mpahlanyana	Small Temporarily Closed	B	A/B	1.1	1.0	93.8			
153	Mpahlane	Small Temporarily Closed	B	A/B	2.7	2.5	93.2			
154	Mzamba	Predominantly Open	B	A/B	67.4	62.8	93.1			95-99%
155	Mtentwana	Small Temporarily Closed	B/C	B	1.3	1.2	93.7	●		

8.3 Estuary long-term monitoring requirements in support of higher-level EWR studies

Recommended minimum monitoring requirements to ascertain the impacts of changes in freshwater flow to the estuary and any improvements or reductions therein are listed in **Table 8-3.**

Table 8-3: Recommended minimum requirements for long-term monitoring.

Component	Monitoring action	Temporal scale (frequency and when)	Spatial scale (no. stations)
Hydrodynamics	Record water levels	Continuous	At the mouth
	Measure freshwater inflow into the estuary	Continuous	Near head of estuary
	Aerial/Satellite photographs of estuary	Every1- 3 years	Entire estuary
Sediment dynamics	Bathymetric surveys: Series of cross-section profiles and a longitudinal profile collected at fixed 200-500 m intervals, but in more detail in the mouth (every 100 m). The vertical accuracy should be about 5 cm.	Every 3 years	Entire estuary
	Set sediment grab samples (at cross section profiles) for analysis of particle size distribution (PSD) and origin (i.e. using microscopic observations)	Every 3 years (with invert sampling)	Entire estuary
Water quality	Water quality (e.g. system variables (e.g. pH, oxygen, turbidity), nutrients and toxic substances) measurements on river water entering at the head of the estuary	Monthly continuous	Close proximity to head of estuary
	Longitudinal salinity and temperature profiles (in situ) collected over a spring and neap tide during high and low tide at: end of low flow season (i.e. period of maximum seawater intrusion) peak of high flow season (i.e. period of maximum flushing by river water)	Seasonally every year	Entire estuary (3-10 stations)
	In situ salinity probes near bottom waters	Continuous	2- 3 Stations (middle and upper)
	Water quality measurements (i.e. system variables, and nutrients) taken along the length of the estuary (surface and bottom samples)	Seasonal surveys, every 3 years or when significant change in water inflows or quality expected	Entire estuary (3-10 stations)
	Measurements of organic content and toxic substances (e.g. trace metals and hydrocarbons) in sediments along length of the estuary, where considered an issue.	Every 3- 5 years	Focus on sheltered, depositional areas
	Water quality (e.g. system variables, nutrients and toxic substances) measurements on near-shore seawater	Use available literature	Seawater adjacent to estuary mouth at salinity 35

Component	Monitoring action	Temporal scale (frequency and when)	Spatial scale (no. stations)
Macrophytes	Ground-truthed maps to document changes in macrophyte habitats over time; Record number of macrophyte habitats, identification and total number of macrophyte species, number of rare or endangered species or those with limited populations documented during a field visit; Document area covered by sensitive habitats i.e. mangroves and submerged macrophytes. Note extent of macroalgal blooms, floating aquatic macrophytes and area occupied by invasive vegetation Record salinity, water level, sediment moisture content and turbidity on a series of permanent transects along an elevation gradient; Take measurements of depth to water table and ground water salinity in supratidal marsh areas	Summer survey every 3 years	Entire estuary
Invertebrates	Record species and abundance of zooplankton, based on samples collected across the estuary at each of a series of stations along the estuary; Record benthic invertebrate species and abundance, based on subtidal and intertidal grab samples at a series of stations up the estuary, and counts of hole densities; or invertebrate macrofauna counts such as prawns, crabs and molluscs. Measures of sediment characteristics at each station	Summer and winter survey every 3 years	Entire estuary (3-10 stations)
Fish	Record species and abundance of fish, based on seine net and beam trawl sampling	Summer and winter survey every 3 years	Entire estuary (3-10 stations)
Birds	Undertake counts of all water-associated birds, identified to species level.	Annual winter (Jul/Aug) and summer (Jan/Feb) surveys	Entire estuary

8.4 Climate Change

Most of the estuaries in the study area showed a negative trajectory of change. Climate change with predicted increases in drought, floods, and hotter temperatures will only accelerate these trajectories. Maintaining a degree of natural hydrodynamic variability and estuarine abiotic configuration, together with preventing habitat degradation, loss and catchment degradation (e.g., erosion, nutrient enrichment), is particularly critical in the face of climate change where predicted increases in temperature, drought, floods and storminess are likely to confound biotic responses. For example, a 2°C increase in water temperature can increase the distribution and frequency of problematic and fast-growing primary producer communities (i.e., harmful algal blooms (HABs), invasive alien aquatic plants, and filamentous/floating macroalgae).

Climate change potentially exacerbates other anthropogenic impacts to estuarine systems, such as freshwater abstraction, habitat transformation and loss, overfishing and pollution. By reducing some of these non-climate change impacts on estuaries and associated species and conserving and rehabilitating important estuarine habitat we can to some extent promote resilience to the effects of climate change. Overall, the biggest threat to estuarine-dependent marine fish is not climate change but growth overfishing (removal of juveniles before they are able to recruit to adult fish stocks). Studies from marine protected areas and fished areas show that overfishing also makes fish less tolerant of extreme temperatures (by removing the fittest individuals) (Duncan et al. 2020), and as such, reducing growth overfishing in estuaries and establishing estuarine protected areas may also promote climate change resilience. Prolonged droughts and lower average rainfall associated with climate change have a much greater impact on estuaries where freshwater abstraction has already reduced the amount of freshwater flow reaching the estuary. This highlights the importance of maintaining adequate river flow into estuaries as a means to promote climate change resilience.

8.5 Management of non-flow related impacts

Most of the estuaries assessed in the study had significant non-flow related pressures that were driving ongoing decline in condition. Key concerns include the impact of over-exploitation of fish (especially illegal gill netting) impacting on nursery function and overgrazing of saltmash (e.g. Keiskamma) and browsing of mangroves (Mbashe and Great Kei) compromising the ability of blue carbon habitats to contribute to carbon storage being key concerns. Increased nutrient levels from agricultural activities are also an emerging concern (e.g. Gamtoos Estuary). In several systems, the local disturbance of bird forging and roosting areas by fishers and other reactional activities (e.g. boating) also contribute to the decline.

It is thus of critical importance that future EWR allocations be supported by the development of an Estuary Management Plan (requirement of National Environmental Management: Integrated Coastal Management Act (No. 24 of 2008) to coordinate the interventions required to improve/protect the systems and coordinate restoration efforts (**Table 8-4**).

8.6 Environmental flows to the marine environment

This study did not address the importance of the Mbashe, Great Kei, uMtata, Keiskamma and Gamtoos catchments in supplying sediments and detritus to the nearshore coastal environment where they play a critical role in maintaining beaches and nearshore spawning grounds of economically important marine species. It should be noted that any future large infrastructure development could impact this important catchment-to-coast process and should be evaluated before large infrastructure such as dams could reduce floods and sediment loads to the coast.

Table 8-4: Restoration interventions required to address trajectory of change and achieving the REC (Priority = ⬤ Action reguired= ●)

Estuary	PES (Trajectory of change)	REC	Flow			Water Quality			Non-flow intervention													
			Restore/protect base flows	Maintain/protect floods	Protect/restore groundwater	Manage/reduce stormwater & drainage from floodplain	Improve river water quality	Monitor & reduce/reuse WW	Restore connectivity/ hydrodynamic functioning	Improve mouth management	Rehabilitate riparian areas/ wetlands	Remove alien vegetation*	Reduce grazing (sheep, cattle, goats)	Manage browsing/ implement cattle exclusion zone	Control mangrove harvesting	Control boating activities impacting on seagrass and birds	Control recreational activities impacting saltmarsh and birds	Remove/reduce fishing pressure	Manage/reduce bait collection	Investigate eradication of alien fish	Restore/protect against impact of mining
Kabeljous	**B ↓**	**B**	●	●	⬤		Agric		●			●					⬤	⬤	●	●	
Gamtoos	**D ↓**	**C**	●	⬤		Agric	Agric				⬤	●	●			●		⬤	●	●	
Kariega	**C ↓**	**C**	●					●	⬤			●	●			⬤		⬤	⬤		
Keiskamma	**C ↓**	**B**	●	⬤			Urban				⬤	●	⬤			⬤		⬤	⬤	●	
Great Kei	**C ↓**	**B/C**	●	⬤				●			●	●	●	⬤	⬤	●	●	⬤	●	●	
Mbashe	**B/C ↓**	**B**	●	⬤								⬤	●	⬤	⬤	●	●	⬤	●	●	
Mngazi	**B ↓**	**B**									●	●				●		⬤	●		⬤

* Mbashe Estuary: *Tamarix ramosissima*, Great Kei: Spanish reeds

9. REFERENCES

BENNETT, R.H., COWLEY, P.D., CHILDS, A-R. & NÆSJE, T.F. (2015). Movements and residency of juvenile white Steenbras Lithognathus lithognathus in a range of contrasting estuaries. Estuarine, coastal and Shelf Science 152: 100-108.

BICKERTON I, PIERCE S. 1988. Part II Synopses of available information on individual systems: Report No 33 Krom (CMS45), Seekoei (CMS46) and Kabeljous (CMS 47). In: Heydorn, A., Morant, P. (Eds.), Estuaries of the Cape. Council for Scientific and Industrial Research, Stellenbosch, South Africa, p. 109.

DEPARTMENT OF WATER AFFAIRS AND FORESTRY. 1995. South African Water Quality Guidelines for Coastal Marine Waters. Volume 1: Natural Environment.

DEPARTMENT OF WATER AFFAIRS AND FORESTRY. 2008. Resource Directed Measures for Protection of Water Resources: Methodologies for the determination of ecological water requirements for estuaries. Version 2.0 Pretoria.

JAMES, N.C., CHILDS, A.R., KEMP, J., WILSNAGH, S. & EDWORTHY, C. (2022). Turbidity influences the recruitment of *Argyrosomus japonicus* to estuarine nurseries. Frontiers in Marine Science, p.1854.

KLAGES, N, 2005. Ecological Assessment of Laguna Bay (Portion 6 of the Farm 328 Kabeljouws River). Institute for Environmental and Coastal Management.

MKHIZE, T., ADAMS, J.A., PARKER-NANCE, S. & JAMES, N., (2024). Habitat use by juvenile fish in macroalgae and seagrass beds in a temperate South African seascape. http://dx.doi.org/10.2139/ssrn.4777316

SUNDBLAD, G.U., BERGSTRÖM, A., SANDSTRÖM, & EKLÖV, P. (2014). Nursery habitat availability limits adult stock sizes of predatory coastal fish. ICES Journal of Marine Science 71: 672–680.

TALJAARD, S, LEMLEY DA, VAN NIEKERK, L. 2022. A method to quantify water quality change in data limiting estuaries. *Estuarine Coastal and Shelf Science* 272: 107888.

TALJAARD S, SLINGER JH AND VAN NIEKERK L. 2017. A screening model for assessing water quality in small, dynamic estuaries. *Ocean & Coastal Management* 146: 1-14.

TURPIE, J.K., TALJAARD, S., ADAMS, J.B., VAN NIEKERK, L., FORBES, N., WESTON, B., HUIZINGA, P., & WHITFIELD, A. 2012a. Methods for the determination of the Ecological Reserve for estuaries. Version 3. Water Research Commission and Department of Water Affairs, Pretoria. WRC Report No. 1930/2/14.

TURPIE, J.K., TALJAARD, S., VAN NIEKERK, L., ADAMS, J.B., WOOLDRIDGE, T., CYRUS, D.P., CLARKE, B., FORBES, N., 2012b. The Estuary Health Index: a standardised metric for use in estuary management and determination of ecological water requirements. WRC Report No. 1930/1/12.

TURPIE, J.K., WILSON, G., VAN NIEKERK, L. 2012c. National Biodiversity Assessment 2011: National Estuary Biodiversity Plan for South Africa. Anchor Environmental Consulting, Cape Town. Report produced for the Council for Scientific and Industrial Research and the South African National Biodiversity Institute.

UNITED NATIONS ENVIRONMENT PROGRAMME, NAIROBI CONVENTION SECRETARIAT AND COUNCIL FOR SCIENTIFIC AND INDUSTRIAL RESEARCH. 2022. Western Indian Ocean: Guidelines for Setting Water and Sediment Quality Targets for Coastal and Marine areas. UNEP, Nairobi, Kenya. XXIV + 109 pp +Appendices.

WHITFIELD, A.K. (2019). Fishes of Southern African Estuaries: from species to systems. Smithiana Monograph No. 4

10. APPENDIX A: ESTUARY LOCATION

Appendix A (Table 10.1) provides the positions of the estuaries mouths in the Mzimvubu to Tsitsikamma Water Management Area (WMA 7). The lateral boundaries were taken as the 5 m contour above Mean Sea Level (MSL) along each bank as defined by the Estuarine Functional Zone.

Table 10-1: The mouth positions of the estuaries in the Mzimvubu to Tsitsikamma Water Management Area (WMA 7).

No.	IUA No.	IUA CODE	Estuary name	X-coordinate	Y-coordinate	Estuary Type	Size (ha)
1	1	IUA_K01	Lottering	23°44'9.41999"	33°59'43.836"	Small Fluvially Dominated	11.2
2	1	IUA_K01	Elandsbos	23°46'4.59120"	34°0'12.6467"	Small Fluvially Dominated	22.1
3	1	IUA_K01	Storms	23°54'10.7568"	34°1'15.5064"	Small Fluvially Dominated	12.4
4	1	IUA_K01	Elands	24°4'44.7096"	34°2'38.3387"	Small Fluvially Dominated	31.1
5	1	IUA_K01	Groot (Oos)	24°11'42.0683"	34°3'35.6219"	Small Fluvially Dominated	30.3
6	1	IUA_K01	Tsitsikamma	24°26'17.9736"	34°8'8.13480"	Small Temporarily Closed	67.4
7	1	IUA_K01	Klipdrif (Oos)	24°38'13.3764"	34°10'20.521"	Small Temporarily Closed	73.9
8	1	IUA_K01	Slang	24°39'13.3271"	34°10'26.864"	Small Temporarily Closed	43.2
9	2	IUA_KL01	Kromme	24°50'33.8208"	34°8'34.6811"	Predominantly Open	767.3
10	2	IUA_KL01	Seekoei	24°54'38.6748"	34°5'12.0119"	Large Temporarily Closed	325.9
11	2	IUA_KL01	Kabeljous	24°55'57.0108"	34°0'31.7051"	Large Temporarily Closed	362.6
12	2	IUA_KL01	Gamtoos	25°2'4.97040"	33°58'13.529"	Predominantly Open	2 134.8
13	4	IUA_M01	Van Stadens	25°13'13.2455"	33°58'13.994"	Large Temporarily Closed	101.8
14	4	IUA_M01	Maitland	25°17'31.0271"	33°59'16.933"	Large Temporarily Closed	67.6
15	4	IUA_M01	Baakens	25°37'48.0468"	33°57'49.427"	Small Temporarily Closed	13.5
16	4	IUA_M01	Papkuils	25°36'49.9896"	33°55'2.2548"	Small Temporarily Closed	80.4
17	4	IUA_M01	Swartkops	25°37'58.9619"	33°51'58.481"	Predominantly Open	2 861.0
18	4	IUA_M01	Coega (Ngqurha)	25°41'26.6604"	33°47'43.368"	Large Temporarily Closed	443.5
19	6	IUA_N01	Sundays	25°51'13.4100"	33°43'18.609"	Predominantly Open	824.0
20	7	IUA_P01	Boknes	26°35'10.5396"	33°43'37.822"	Small Temporarily Closed	47.5
21	7	IUA_P01	Bushmans	26°39'49.0392"	33°41'41.697"	Predominantly Open	888.8
22	7	IUA_P01	Kariega	26°41'11.0364"	33°40'57.975"	Predominantly Open	559.0
23	7	IUA_P01	Grant's	26°42'10.872"	33°40'10.412"	Small Temporarily Closed	16.3
24	7	IUA_P01	Kasouga	26°44'7.07280"	33°39'14.741"	Large Temporarily Closed	247.6
25	7	IUA_P01	Kowie	26°54'5.88240"	33°36'13.053"	Predominantly Open	484.9
26	7	IUA_P01	Rufane	26°56'8.97719"	33°34'50.995"	Small Temporarily Closed	24.7
27	7	IUA_P01	Riet	27°0'49.8671"	33°33'40.330"	Small Temporarily Closed	40.3
28	7	IUA_P01	West Kleinemonde	27°2'46.1471"	33°32'28.845"	Large Temporarily Closed	224.2
29	7	IUA_P01	East Kleinemonde	27°2'57.5699"	33°32'20.493"	Large Temporarily Closed	100.9
30	9	IUA_Q02	Great Fish	27°8'26.4624"	33°29'42.820"	Predominantly Open	524.3
31	11	IUA_R01	Old Woman's	27°8'53.0520"	33°28'57.975"	Large Temporarily Closed	23.3
32	11	IUA_R01	Mpekweni	27°13'52.2336"	33°26'16.843"	Large Temporarily Closed	83.1
33	11	IUA_R01	Mtati (Mthathi)	27°15'32.6591"	33°25'22.360"	Large Temporarily Closed	142.1
34	11	IUA_R01	Mgwalana	27°16'27.1704"	33°24'46.886"	Large Temporarily Closed	216.9

No.	IUA No.	IUA CODE	Estuary name	X-coordinate	Y-coordinate	Estuary Type	Size (ha)
35	11	IUA_R01	Bira (Bhirha)	27°19'33.7116"	33°23'1.5360"	Large Temporarily Closed	270.6
36	11	IUA_R01	Gqutywa	27°21'29.0844"	33°21'45"	Large Temporarily Closed	105.4
37	11	IUA_R01	Ngculura (Ngculurha)	27°22'4.49760"	33°21'29.077"	Small Temporarily Closed	36.6
38	11	IUA_R01	Mtana	27°25'55.7940"	33°19'6.9779"	Small Temporarily Closed	81.2
39	11	IUA_R01	Keiskamma	27°29'28.4388"	33°16'53.328"	Predominantly Open	1 402.0
40	11	IUA_R01	Nqinisa	27°31'40.5696"	33°15'9.8603"	Small Temporarily Closed	54.3
41	11	IUA_R01	Kiwane (Khiwane)	27°32'35.4012"	33°14'53.887"	Large Temporarily Closed	87.0
42	11	IUA_R01	Tyolomnqa	27°35'0.31560"	33°13'32.779"	Large Temporarily Closed	207.6
43	11	IUA_R01	Shelbertsstroom	27°36'56.3903"	33°12'25.527"	Small Temporarily Closed	15.0
44	11	IUA_R01	Lilyvale	27°38'12.8723"	33°11'34.270"	Small Temporarily Closed	33.7
45	11	IUA_R01	Ross' Creek	27°39'27.6192"	33°10'36.325"	Small Temporarily Closed	13.0
46	11	IUA_R01	Ncera (Ncerha)	27°40'5.54160"	33°10'12.417"	Large Temporarily Closed	77.9
47	11	IUA_R01	Mlele	27°40'47.8631"	33°9'34.963"	Small Temporarily Closed	20.2
48	11	IUA_R01	Mcantsi	27°42'7.11719"	33°8.'43.832"	Small Temporarily Closed	31.8
49	11	IUA_R01	Gxulu	27°43'53.3675"	33°7'8.0579"	Large Temporarily Closed	106.6
50	11	IUA_R01	Goda	27°46'30.1188"	33°6'3.9239"	Large Temporarily Closed	51.9
51	11	IUA_R01	Hlozi	27°48'42.7788"	33°5'8.1491"	Small Temporarily Closed	40.9
52	11	IUA_R01	Hickman's	27°50'22.8767"	33°4'14.984"	Small Temporarily Closed	25.9
53	12	IUA_R02	Buffalo	27°54'58.7448"	33°1'36.476"	Predominantly Open	137.5
54	12	IUA_R02	Blind	27°55'39.6983"	33°00'25"	Small Temporarily Closed	14.3
55	12	IUA_R02	Hlaze (iHlanze)	27°56'57.6816"	32°59'21.231"	Small Temporarily Closed	7.9
56	12	IUA_R02	Nahoon	27°57'6.13439"	32°59'11.176"	Predominantly Open	178.5
57	12	IUA_R02	Qinira (Quinirha)	27°57'53.3987"	32°58'27.130"	Large Temporarily Closed	110.7
58	12	IUA_R02	Gqunube	28°2'5.63639"	32°56'1.9535"	Predominantly Open	176.3
59	12	IUA_R02	Kwelera (Kwelerha)	28°4'37.2072"	32°54'26.495"	Predominantly Open	121.6
60	12	IUA_R02	Bulura (Bulurha)	28°5'36.2076"	32°53'28.805"	Large Temporarily Closed	135.4
61	12	IUA_R02	Cunge	28°6'37.5263"	32°51'39.157"	Small Temporarily Closed	8.7
62	12	IUA_R02	Cintsa	28°7'1.35839"	32°49'53.155"	Large Temporarily Closed	122.6
63	12	IUA_R02	Cefane	28°8.'13.5528"	32°48'34.070"	Large Temporarily Closed	176.5
64	12	IUA_R02	Kwenxura (Kwenxurha)	28°9'5.71680"	32°47'55.589"	Large Temporarily Closed	126.1
65	12	IUA_R02	Nyara (Nyarha)	28°10'55.2611"	32°47'6.8279"	Large Temporarily Closed	55.3
66	12	IUA_R02	Imtwendwe (Mtwendwe)	28°14'13.1135"	32°46'12.133"	Small Temporarily Closed	15.9
67	12	IUA_R02	Haga-haga	28°15'11.4659"	32°45'42.901"	Small Temporarily Closed	25.5
68	12	IUA_R02	Mtendwe	28°17'9.04920"	32°44'26.836"	Small Temporarily Closed	17.1
69	12	IUA_R02	Quko	28°18'34.3367"	32°43'32.303"	Large Temporarily Closed	102.1
70	12	IUA_R02	Morgan	28°20'38.5691"	32°42'30.949"	Large Temporarily Closed	83.5
71	12	IUA_R02	Cwili	28°22'25.4531"	32°41'27.214"	Small Temporarily Closed	14.7
72	12	IUA_R02	Great Kei	28°23'9.47040"	32°40'47.593"	Large Fluvially Dominated	572.6
73	19	IUA_T04	Gxara (Gxarha)	28°23'56.8679"	32°39'58.168"	Large Temporarily Closed	68.5
74	19	IUA_T04	Ngogwane	28°25'17.91"	32°38'55.31"	Small Temporarily Closed	22.5
75	19	IUA_T04	Qolora (Qolorha)	28°26'5.79"	32°37'47.70"	Large Temporarily Closed	69.3
76	19	IUA_T04	Ncizele	28°26'16.68"	32°37'42.50"	Small Temporarily Closed	22.9
77	19	IUA_T04	Timba	28°26'45.16"	32°37'31.65"	Small Temporarily Closed	9.2

No.	IUA No.	IUA CODE	Estuary name	X-coordinate	Y-coordinate	Estuary Type	Size (ha)
78	19	IUA_T04	Kobonqaba (Khobonqaba)	28°29'25.2924"	32°36'28.209"	Predominantly Open	115.1
79	19	IUA_T04	Nxaxo/Ngqusi	28°31'34.5323"	32°35'5.0315"	Large Temporarily Closed	269.5
80	19	IUA_T04	Cebe	28°35'8.97719"	32°31'16.273"	Large Temporarily Closed	82.1
81	19	IUA_T04	Gqunqe	28°35'22.2396"	32°31'7.6836"	Large Temporarily Closed	79.1
82	19	IUA_T04	Zalu	28°36'11.2572"	32°30'9.5183"	Small Temporarily Closed	68.8
83	19	IUA_T04	Ngqwara (Ngqwarha)	28°36'50.6016"	32°29'39.138"	Large Temporarily Closed	78.9
84	19	IUA_T04	Sihlontlweni	28°38'41.3627"	32°28'52.957"	Small Temporarily Closed	55.2
85	19	IUA_T04	Nebelele	28°39'21.3480"	32°27'45.575"	Small Temporarily Closed	29.8
86	19	IUA_T04	Qora (Qhorha)	28°40'24.4740"	32°26'46.932"	Predominantly Open	133.9
87	19	IUA_T04	Jujura (Jujurha)	28°41'38.2596"	32°25'51.960"	Small Temporarily Closed	30.3
88	19	IUA_T04	Ngadla	28°42'31.2515"	32°25'6.0599"	Small Temporarily Closed	40.7
89	19	IUA_T04	Shixini	28°43'31.8467"	32°24'11.163"	Predominantly Open	116.4
90	19	IUA_T04	Beechamwood	28°45'7.48439"	32°22'29.492"	Small Temporarily Closed	20.1
91	19	IUA_T04	Kwazlelitsha (Kwazwedala)	28°45'29.4371"	32°22'12.151"	Small Temporarily Closed	32.1
92	19	IUA_T04	Kwa-Goqo	28°45'41.4539"	32°21'59.050"	Small Temporarily Closed	30.9
93	19	IUA_T04	Ku-Nocekedwa	28°46'40.0655"	32°20'55.766"	Small Temporarily Closed	33.7
94	19	IUA_T04	Nqabara/Nqabarana	28°47'25.1915"	32°20'22.970"	Predominantly Open	307.7
95	19	IUA_T04	Ngomane (East)	28°49'46.22"	32°18'18.95"	Small Temporarily Closed	25.9
96	19	IUA_T04	Ngoma/Kobule	28°50'14.3195"	32°18'4.1868"	Small Temporarily Closed	88.8
97	19	IUA_T04	Mendu	28°52'40.0332"	32°16'51.297"	Large Temporarily Closed	107.4
98	19	IUA_T04	Mendwana	28°53'3.25679"	32°16'8.1336"	Predominantly Open	27.8
99	19	IUA_T02	Mbashe	28°54'6.84359"	32°14'59.946"	Large Fluvially Dominated	469.8
100	19	IUA_T04	Ku-Mpenzu	28°54'51.9012"	32°14'37.777"	Small Temporarily Closed	31.7
101	19	IUA_T04	Ku-Bhula (Mbhanyana)	28°55'40.8108"	32°13'41.185"	Small Temporarily Closed	58.7
102	19	IUA_T04	Kwa-Suku	28°56'48.78"	32°12'19.06"	Large Temporarily Closed	21.4
103	19	IUA_T04	Ntlonyane	28°57'23.9832"	32°11'40.930"	Large Temporarily Closed	89.7
104	19	IUA_T04	Nkanya	28°58'29.4888"	32°10'39"	Large Temporarily Closed	62.1
105	19	IUA_T04	Sundwana	28°58'55.1280"	32°10'24.330"	Small Temporarily Closed	25.2
106	19	IUA_T04	Xora	28°59'44.1059"	32°9.'31.082"	Predominantly Open	261.5
107	19	IUA_T04	Bulungula	29°0.'41.4647"	32°8.'16.828"	Large Temporarily Closed	67.4
108	19	IUA_T04	Ku-Amanzimuzama	29°2'0.17159"	32°6.'53.729"	Small Temporarily Closed	13.0
109	19	IUA_T04	Nqakanqa	29°3'44.7119"	32°5'55.1003"	Small Temporarily Closed	16.9
110	19	IUA_T04	Mdikana	29°4'9.60240"	32°5'18.9023"	Small Temporarily Closed	17.0
111	19	IUA_T04	Mncwasa	29°4'33.8772"	32°4.'57.741"	Large Temporarily Closed	116.7
112	19	IUA_T04	Mpako	29°6'27.7019"	32°2.'24.853"	Small Temporarily Closed	51.5
113	19	IUA_T04	Nenga	29°9'6.51600"	31°59'7.7460"	Small Temporarily Closed	33.6
114	19	IUA_T04	Mapuzi	29°10'7.37759"	31°58'11.812"	Large Temporarily Closed	12.2
115	19	IUA_T04	Mtata	29°11'1.52880"	31°57'10.666"	Predominantly Open	545.6
116	19	IUA_T04	Thsani	29°12'31.8960"	31°56'41.855"	Small Temporarily Closed	12.6
117	19	IUA_T04	Mdumbi	29°12'58.6763"	31°55'53.220"	Predominantly Open	254.9
118	19	IUA_T04	Lwandilana	29°14'38.1300"	31°53'46.312"	Small Temporarily Closed	49.6
119	19	IUA_T04	Lwandile	29°14'51.1296"	31°53'27.401"	Large Temporarily Closed	100.5
120	19	IUA_T04	Mtakatye	29°16'12.8892"	31°51'33.371"	Predominantly Open	247.7

No.	IUA No.	IUA CODE	Estuary name	X-coordinate	Y-coordinate	Estuary Type	Size (ha)
121	19	IUA_T04	Hluleka	29°18'13.0032"	31°49'38.668"	Small Temporarily Closed	30.1
122	19	IUA_T04	Mnenu	29°19'48.3239"	31°48'27.223"	Large Temporarily Closed	197.0
123	19	IUA_T04	Mtonga	29°20'53.8475"	31°47'35.739"	Large Temporarily Closed	56.2
124	19	IUA_T04	Mpande	29°21'25.7148"	31°45'44.096"	Large Temporarily Closed	51.3
125	19	IUA_T04	Sinangwana	29°22'11.6183"	31°45'1.7928"	Small Temporarily Closed	123.1
126	19	IUA_T04	Mngazana	29°25'22.2996"	31°41'31.837"	Predominantly Open	767.8
127	19	IUA_T04	Mngazi	29°27'47.2824"	31°40'37.862"	Large Temporarily Closed	434.3
128	19	IUA_T04	Gxwaleni	29°30'24.8148"	31°39'19.706"	Small Temporarily Closed	16.1
129	19	IUA_T04	Bulolo	29°31'3.89639"	31°39'2.4515"	Small Temporarily Closed	13.2
130	19	IUA_T04	Mtumbane	29°31'13.7316"	31.°38'52.306"	Small Temporarily Closed	15.5
131	19	IUA_T04	Mzimvubu	29°32'59.7443"	31°37'52.107"	Large Fluvially Dominated	842.7
132	19	IUA_T04	Ntlupeni	29°34'52.419"	31°36'32.263"	Small Temporarily Closed	30.8
133	19	IUA_T04	Nkodusweni	29°36'29.39"	31°35'39.42"	Large Temporarily Closed	100.0
134	19	IUA_T04	Mntafufu	29°38'15.8244"	31°33'45.068"	Predominantly Open	277.5
135	19	IUA_T04	Ingo	29°39'38.90"	31°32'56.92"	Small Temporarily Closed	34.7
136	19	IUA_T04	Mzintlava	29°41'23.2475"	31°31'21.518"	Predominantly Open	108.8
137	19	IUA_T04	Mzimpunzi	29°43'23.1816"	31°28'47.852"	Small Temporarily Closed	67.8
138	19	IUA_T04	Kwanyambalala	29°44'3.07"	31°28'5.0245"	Small Temporarily Closed	24.8
139	19	IUA_T04	Mbotyi	29°44'3.56"	31°28'0.624"	Small Temporarily Closed	64.1
140	19	IUA_T04	Mkozi	29°45'41.6663"	31°26'54.722"	Small Temporarily Closed	38.1
141	19	IUA_T04	Sikatsha	29°46'6"	31°26'42"	Small Temporarily Closed	13.3
142	19	IUA_T04	Lupatana	29°51'5.32440"	31°25'23.811"	Small Temporarily Closed	14.5
143	19	IUA_T04	Mkweni	29°52'22.20"	31°24'12.27"	Small Temporarily Closed	15.4
144	19	IUA_T04	Msikaba	29°58'3.74"	31°19'9.20"	Predominantly Open	142.0
145	19	IUA_T04	Mgwegwe	30°0.'40.9140"	31°17'15.554"	Small Temporarily Closed	19.4
146	19	IUA_T04	Mgwetyana	30°2'22.9775"	31°15'42.454"	Small Temporarily Closed	22.1
147	19	IUA_T04	Mtentu	30°2'46.5539"	31°14'55.885"	Predominantly Open	92.7
148	19	IUA_T04	Sikombe	30°4'9.86160"	31°13'19.333"	Small Temporarily Closed	102.1
149	19	IUA_T04	Kwanyana	30°6'17.6615"	31°11'10.791"	Small Temporarily Closed	57.8
150	19	IUA_T04	Mtolane	30°7'37.1135"	31°9'34.8192"	Small Temporarily Closed	46.5
151	19	IUA_T04	Mnyameni	30°8'1.60800"	31°9'7.67520"	Large Temporarily Closed	87.5
152	19	IUA_T04	Mpahlanyana	30°9'36.5831"	31°7'27.9768"	Small Temporarily Closed	24.1
153	19	IUA_T04	Mpahlane	30°9'53.4240"	31°7'9.99840"	Small Temporarily Closed	35.2
154	19	IUA_T04	Mzamba	30°10'26.3999"	31°6'31.8600"	Predominantly Open	110.7
155	19	IUA_T04	Mtentwana	30°11'15.1979"	31°5'17.8763"	Small Temporarily Closed	33.4

11. APPENDIX B: DELINATION OF THE ESTUARY FUNCTIONAL ZONE

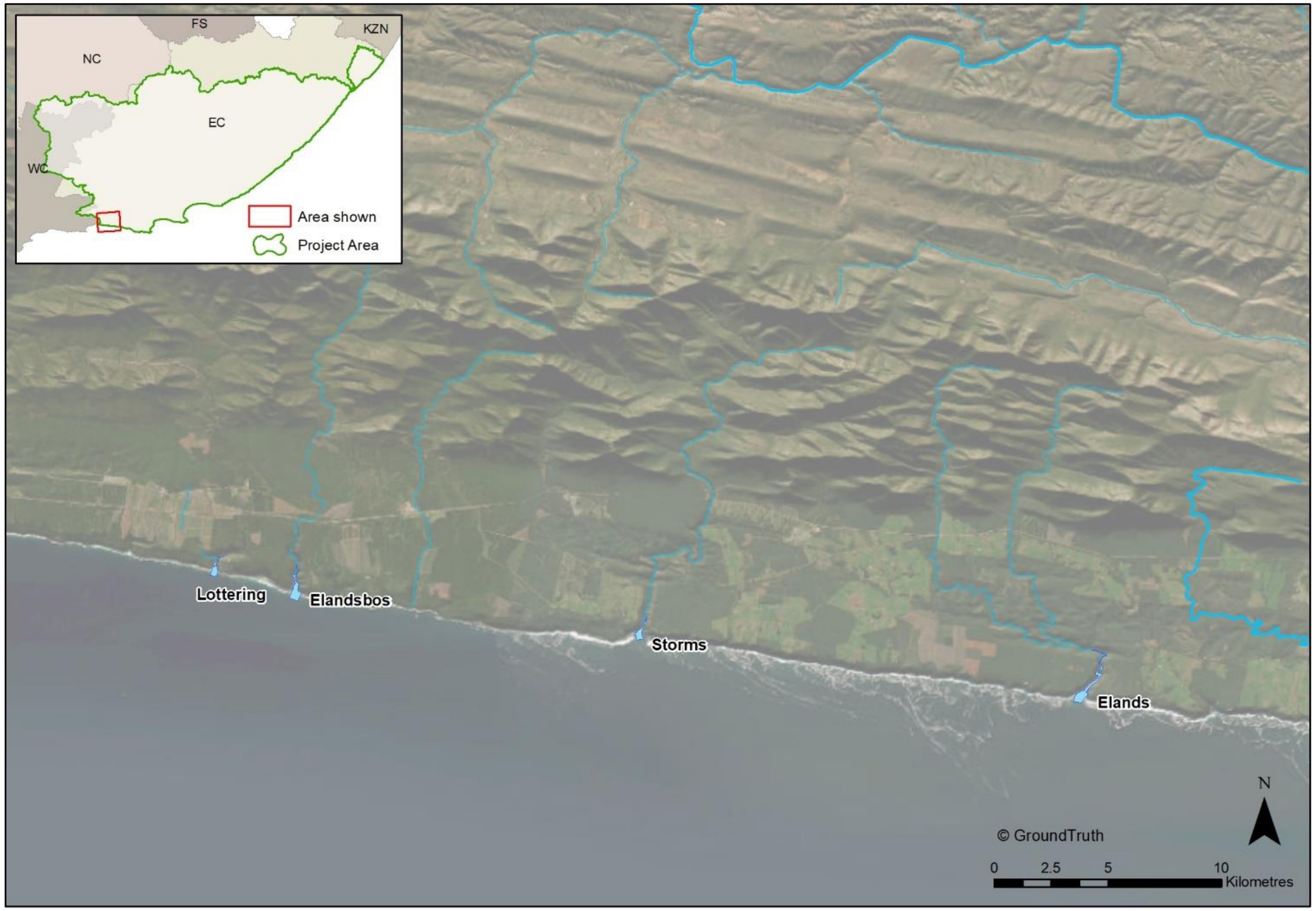

Figure 11-1: Estuary Functional Zones: Lottering to Elands

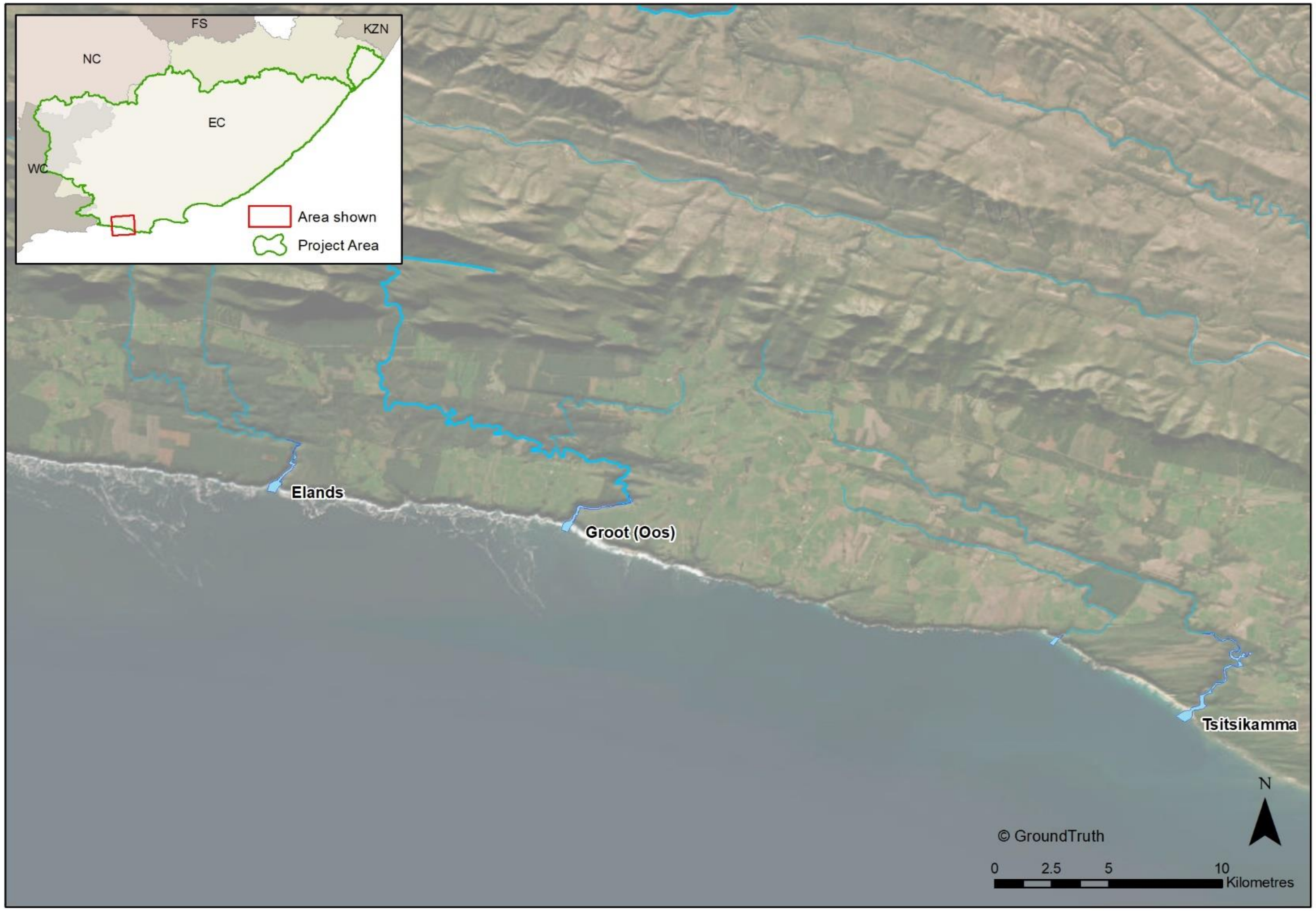

Figure 11-2: Estuary Functional Zones: Elands to Tsitsikamma

Figure 11-3: Estuary Functional Zones: Elands to Tsitsikamma

Figure 11-4: Estuary Functional Zones: Tsitsikamma to Kromme

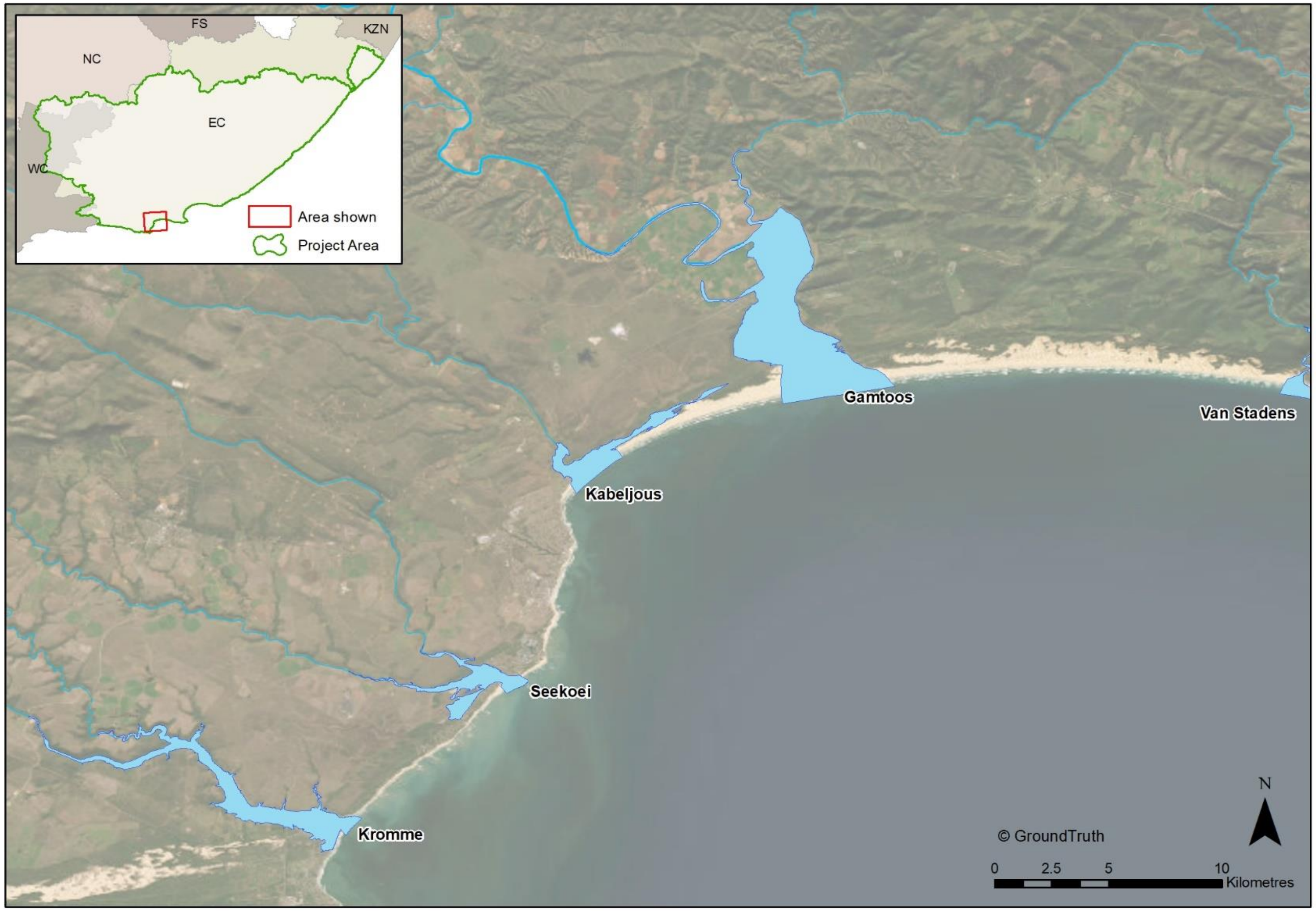

Figure 11-5: Estuary Functional Zones: Kromme to Van Stadens

Figure 11-6: Estuary Functional Zones: Van Stadens to Coega

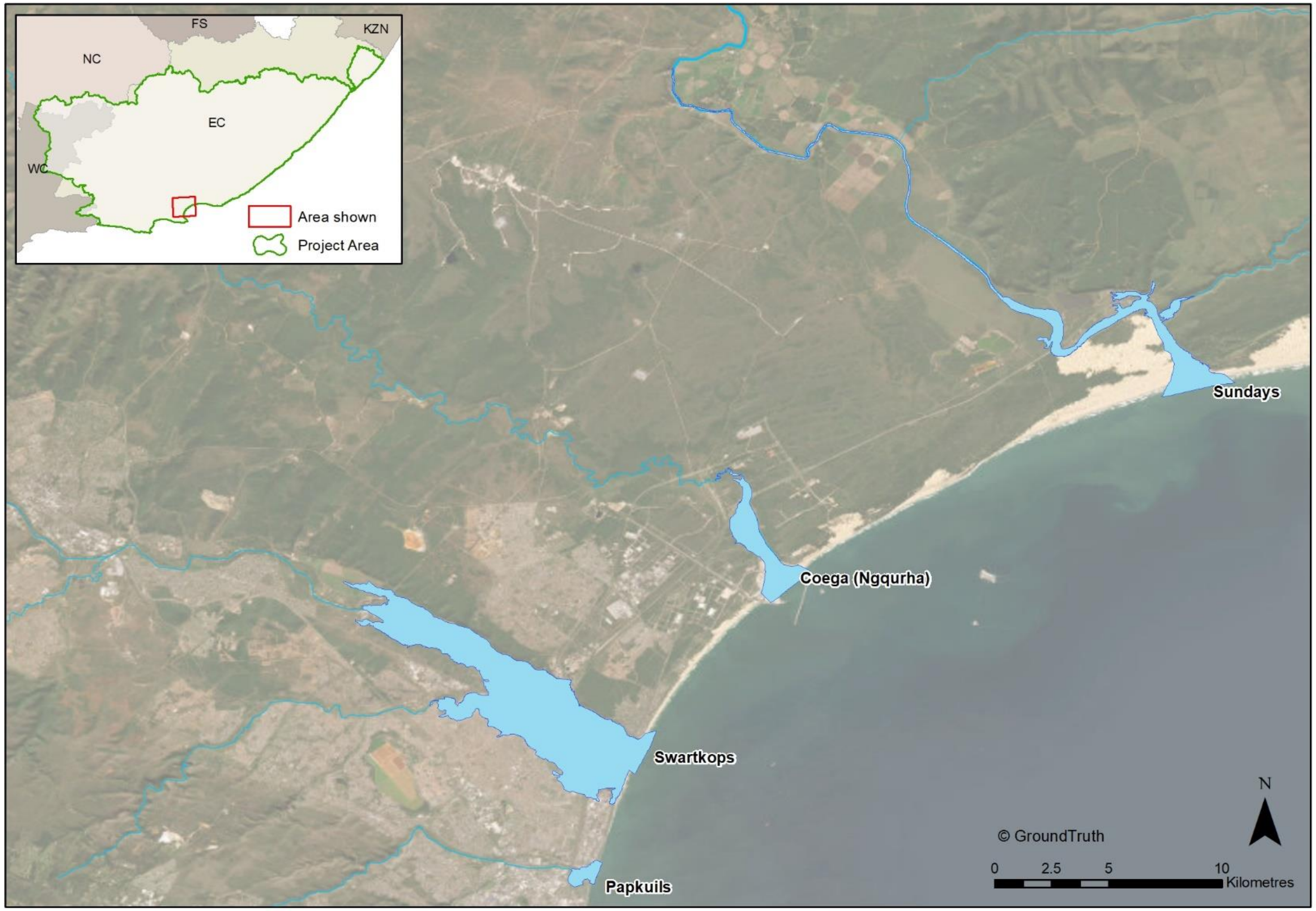

Figure 11-7: Estuary Functional Zones: Papkuils to Sundays

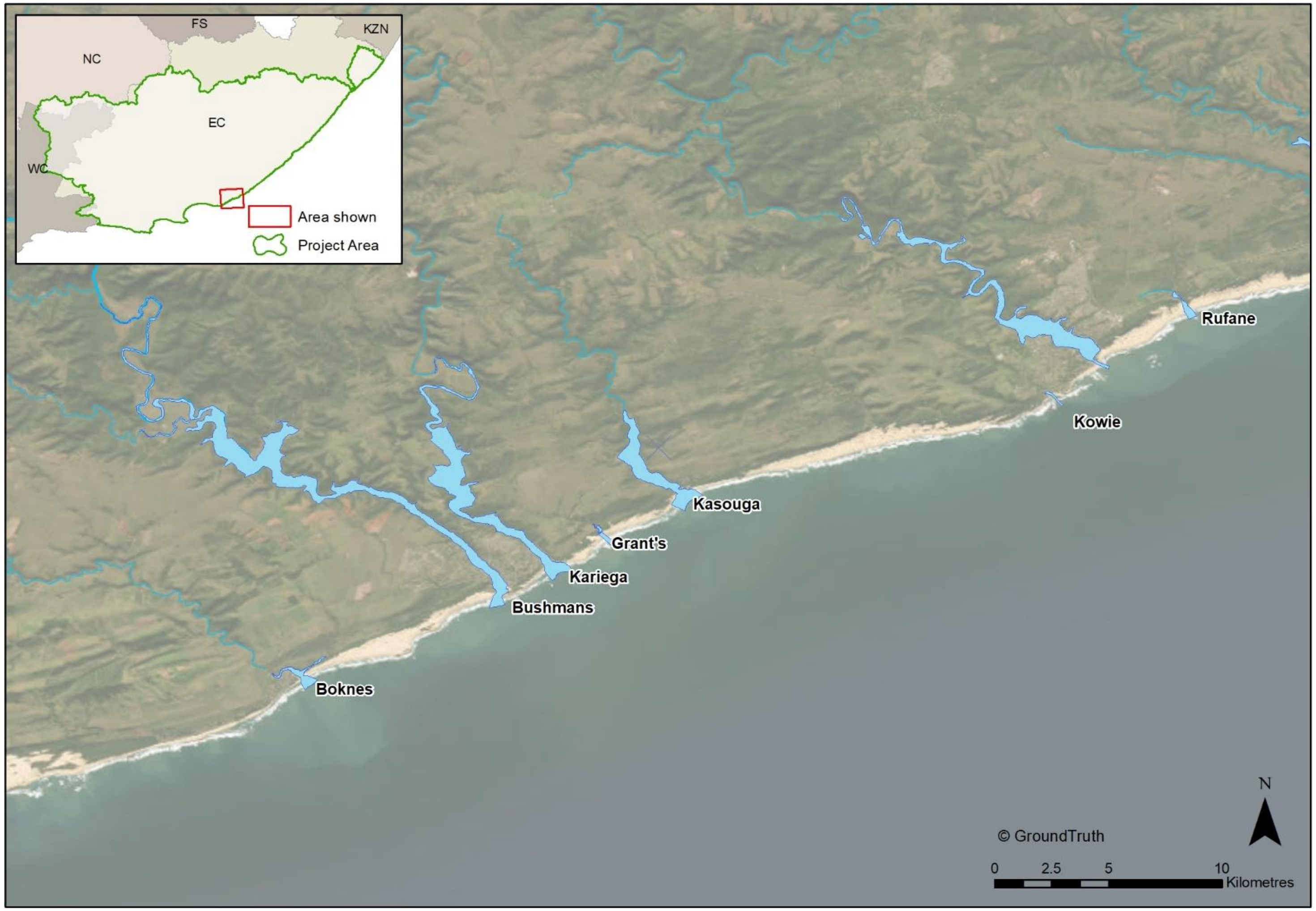

Figure 11-8: Estuary Functional Zones: Bokness to Rufane

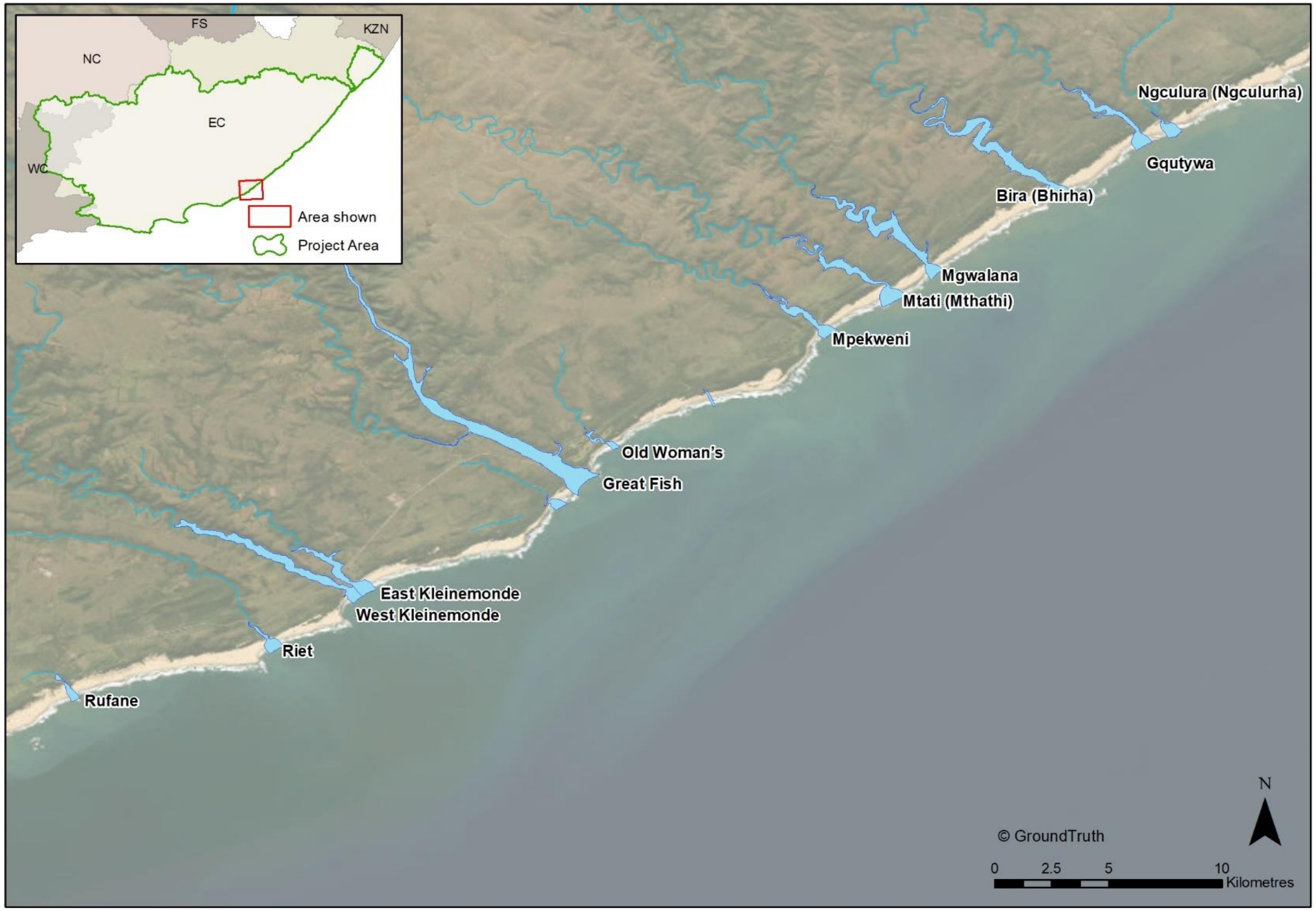

Figure 11-9: Estuary Functional Zones: Rufane to Ngculura

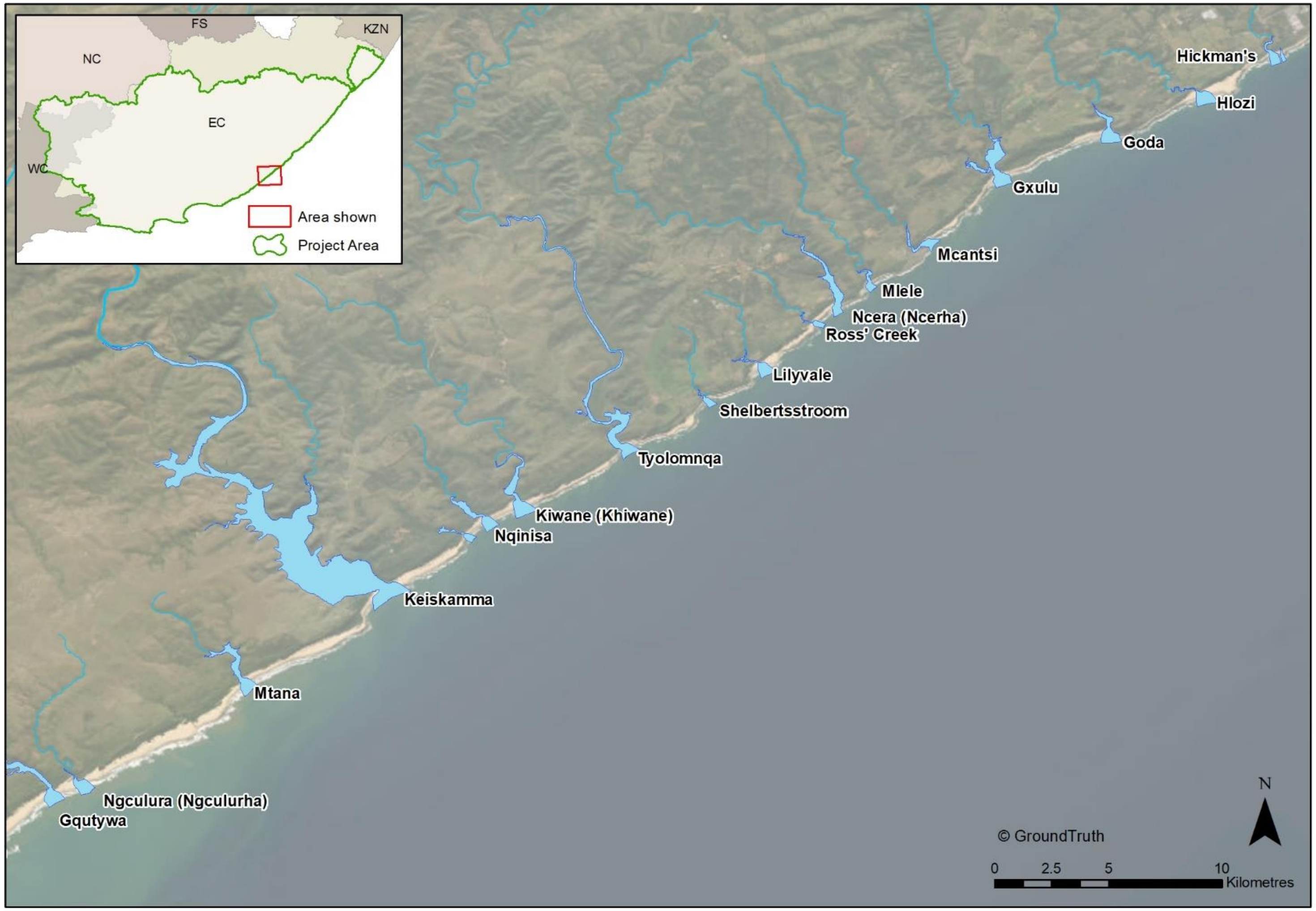

Figure 11-10: Estuary Functional Zones: Gqutywa to Hickman's

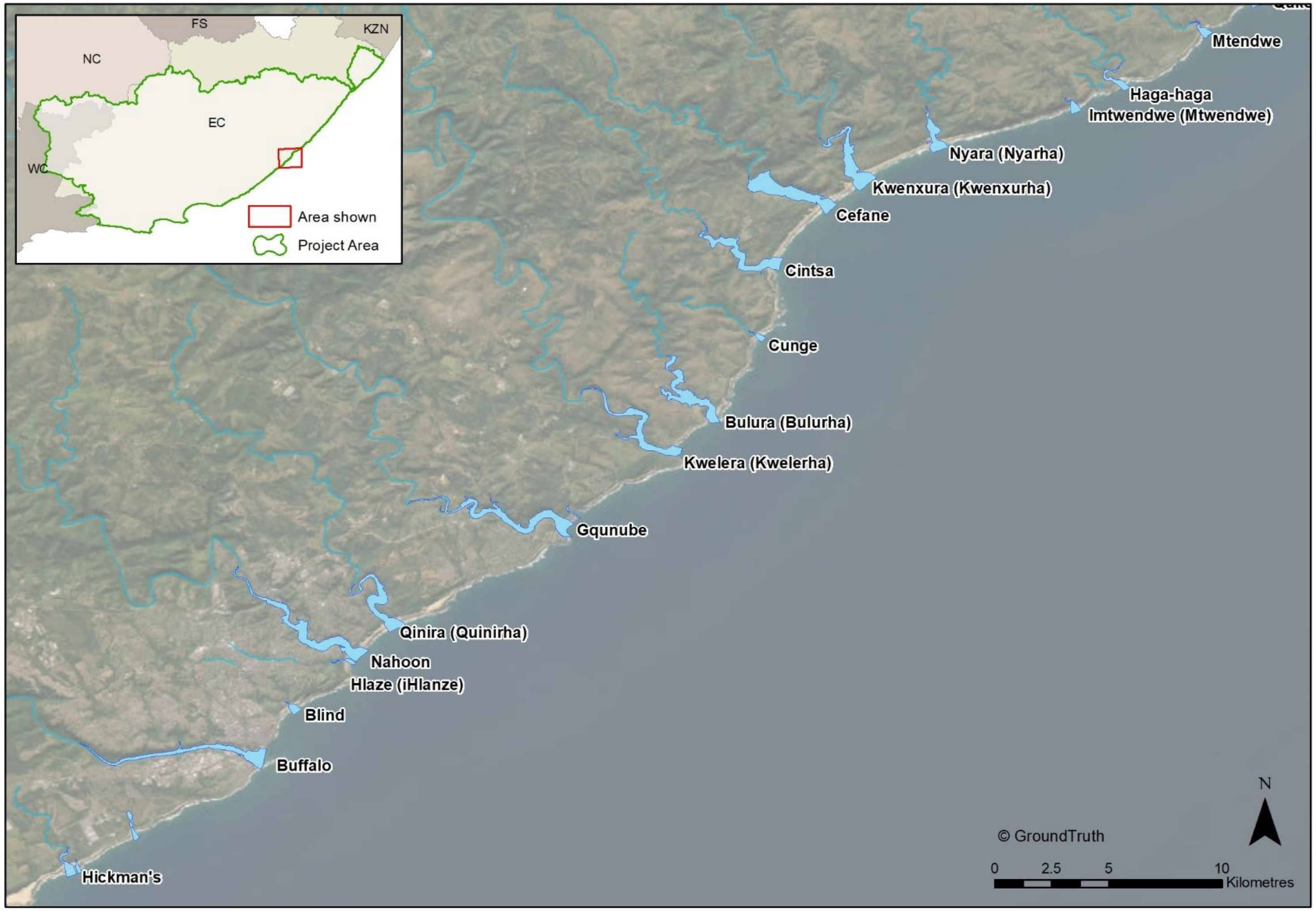

Figure 11-11: Estuary Functional Zones: Hickman's to Mtendwe

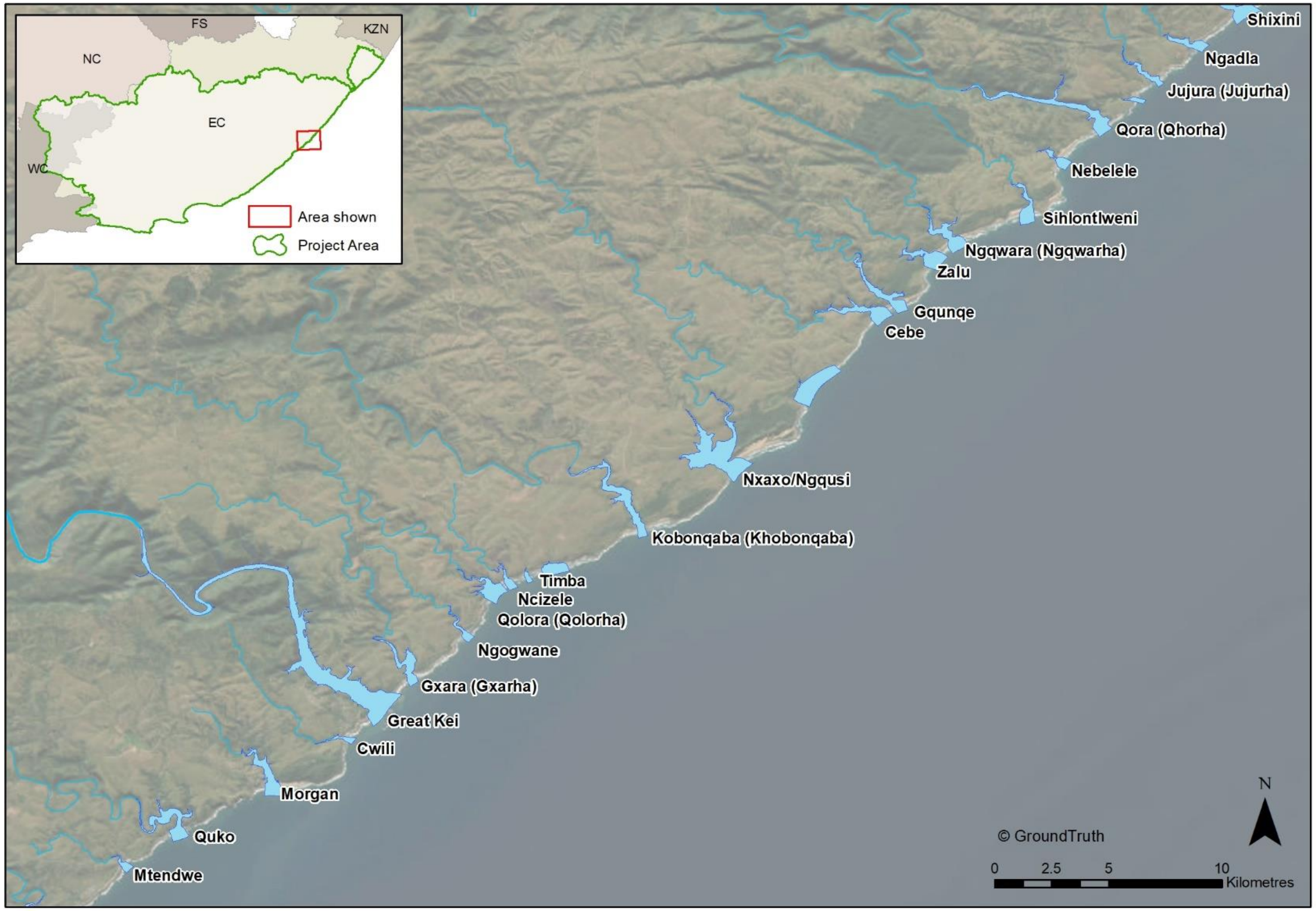

Figure 11-12: Estuary Functional Zones: Mtendwe to Shixini

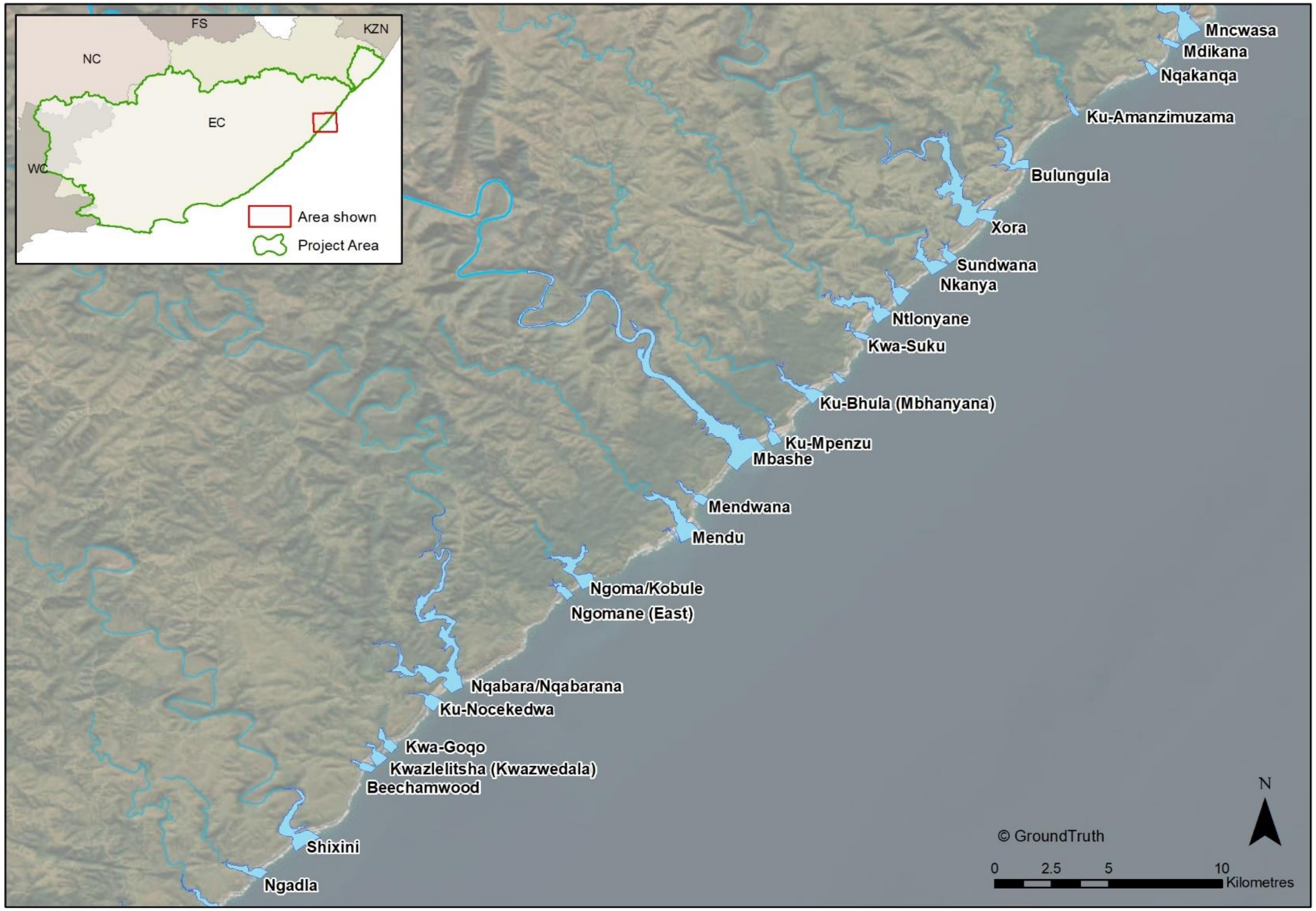

Figure 11-13: Estuary Functional Zones: Ngadia to Mncwasa

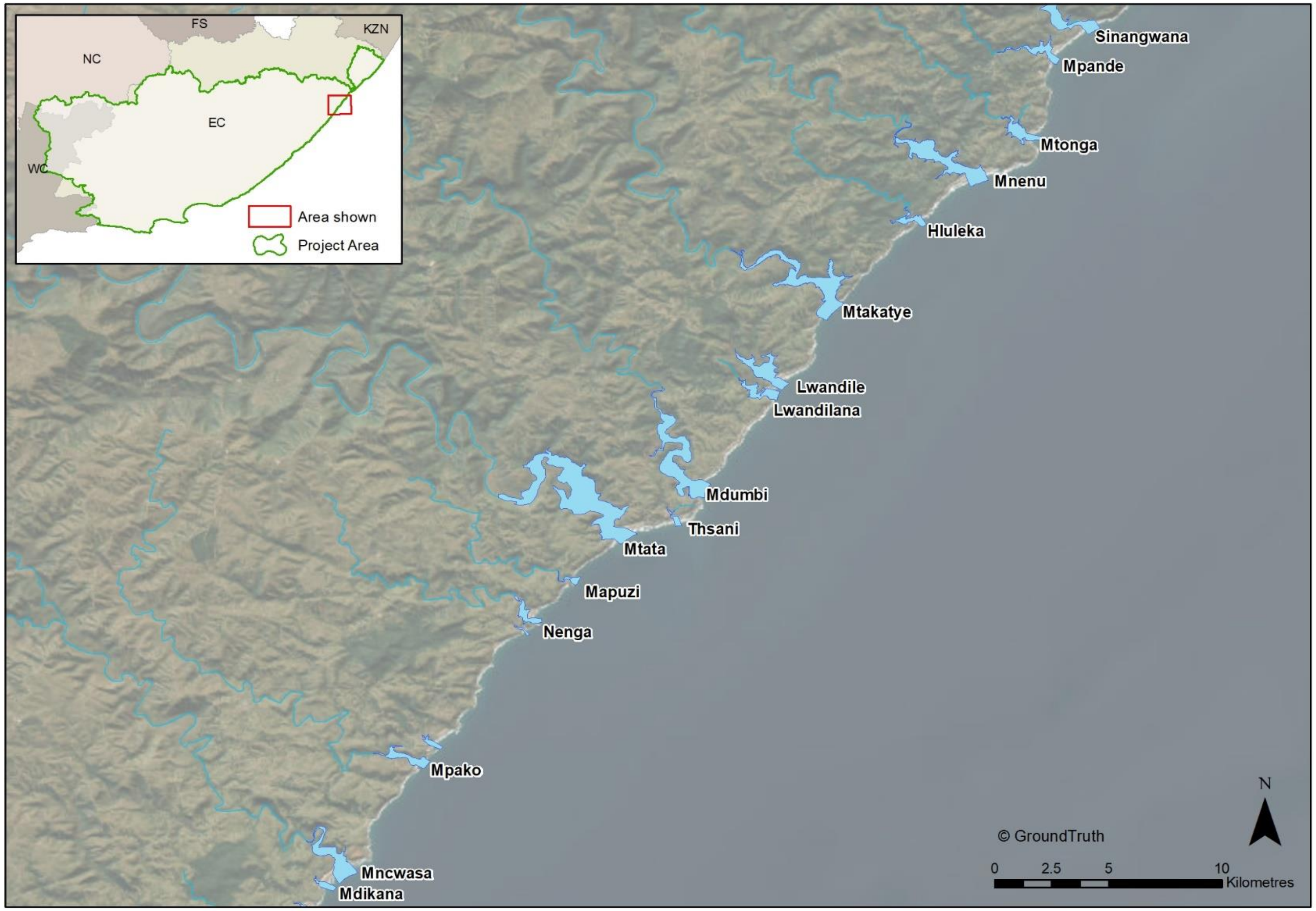

Figure 11-14: Estuary Functional Zones: Mdikana to Sinangwana

Figure 11-15: Estuary Functional Zones: Sinangwana to Lupatana

Figure 11-16: Estuary Functional Zones: Mkweni to Mtentwana

12. APPENDIX C: HYDROLOGY CONFIDENCE

Ecological water requirement studies are driven by flow and thus very much dependent on the degree of confidence in the simulated flow data. **Table 12-1** provides a summary of the confidence in the updated hydrology provided to the study team for selected estuaries Mzimvubu to Tsitsikamma Water Management Area (WMA 7).

Gauged: refers to whether there was a monitoring site for streamflows against which to calibrate and extrapolate the hydrology. Catchments with gauges lower down and good data were scored higher. Those with no gauge or a poor gauge regarding location or data were scored lower. This was the most important driver of the confidence.

Study: refers to the study that conducted the hydrology determination. The higher level national WR2012 info was given lower confidence while the bespoke studies related to the Algoa and Amatole were considered generally higher effort and detail studies.

Modelling: refers to the actual modelling of the present day and future flows and the confidence in the water requirements and level of modelling detail etc., and how well these capture reality on the ground.

Table 12-1: Confidence in hydrology provided to the study team for selected estuaries Mzimvubu to Tsitsikamma WMA 7.

Estuary	Confidence			
	Gauged	*Study*	*Modelling*	*Overall*
Bushmans	Medium	Medium	Medium	***Medium***
Gamtoos	High	High	High	***High***
Great Kei	High	Medium	High	***High***
Kabeljous	Low	Medium	Low	***Low***
Kariega	Medium	Medium	Medium	***Medium***
Keiskamma	High	Medium	Medium	***Medium***
Kowie	Medium	Medium	High	***Medium***
Kromme	High	High	High	***High***
Mbashe	High	Medium	High	***High***
Mngazi	Medium	Medium	High	***Medium***
Msikaba	Low	Medium	Medium	***Medium***
Nahoon	Medium	High	Medium	***Medium***
Qinira	Low	Medium	Low	***Low***
Sundays	Medium	Medium	Medium	***Medium***
Tsistikamma	High	Medium	High	***High***
Xora	Low	Medium	Medium	***Low***

13. APPENDIX D: ESTUARINE HABITAT

No.	Estuary_Name	Intertidal salt marsh	Supratidal salt marsh	Submerged macrophytes	Reeds & sedges	Mangroves	Swamp Forest	Rocks	Sand and mudbanks	Open water
1	Lottering	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	1.7
2	Elandsbos	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.0	2.1
3	Storms	0.0	0.0	0.0	0.0	0.0	0.0	2.0	0.1	5.4
4	Elands	0.0	0.3	1.2	0.0	0.0	0.0	4.0	0.0	22.4
5	Groot (Oos)	0.0	0.0	0.0	1.5	0.0	0.0	0.0	0.9	8.7
6	Tsitsikamma	0.0	0.4	0.0	1.5	0.0	0.0	0.0	0.5	4.5
7	Klipdrif (Oos)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5
8	Slang	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9	Kromme	68.1	36.2	41.7	13.0	0.0	0.0	0.0	89.7	189.3
10	Seekoei	0.0	8.5	27.1	26.4	0.0	0.0	12.6	22.8	77.9
11	Kabeljous	0.2	38.0	0.6	36.9	0.0	0.0	0.0	30.6	42.5
12	Gamtoos	92.9	84.2	4.2	61.0	0.0	0.0	0.2	103.9	547.0
13	Van Stadens	0.0	0.0	0.0	5.7	0.0	0.0	0.0	1.1	17.4
14	Maitland	0.0	0.0	0.0	4.5	0.0	0.0	2.5	0.3	11.4
15	Baakens	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
16	Papkuils	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
17	Swartkops	193.0	350.5	53.6	11.3	0.0	0.0	0.0	120.9	143.0
18	Coega (Ngqurha)	1.3	19.6	1.2	4.3	0.0	0.0	0.0	0.0	2.3
19	Sundays	0.0	17.5	0.0	31.5	0.0	0.0	0.0	118.4	314.0
20	Boknes	0.0	1.5	0.5	6.0	0.0	0.0	0.0	0.5	6.5
21	Bushmans	118.3	0.0	22.8	20.9	0.0	0.0	0.0	0.0	161.9
22	Kariega	26.5	25.1	25.1	0.0	0.0	0.0	4.7	27.7	110.8
23	Grant's	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
24	Kasouga	0.0	21.6	0.0	2.5	0.0	0.0	2.3	0.1	27.4
25	Kowie	26.4	16.3	6.6	6.4	0.0	0.0	0.0	29.7	129.5
26	Rufane	0.0	0.0	0.0	0.8	0.0	0.0	0.0	0.0	0.0
27	Riet	0.0	3.9	0.0	1.2	0.0	0.0	0.0	0.9	3.1
28	West Kleinemonde	9.2	23.0	51.3	4.1	0.0	0.0	8.4	0.8	19.2
29	East Kleinemonde	4.0	6.4	14.5	1.0	0.0	0.0	0.1	11.6	14.5
30	Great Fish	133.0	65.0	0.0	17.0	0.0	0.0	0.0	3.0	150.0
31	Old Woman's	0.0	0.0	0.0	14.2	0.0	0.0	0.2	0.1	10.7
32	Mpekweni	0.0	8.6	2.0	0.0	0.0	0.0	0.3	3.5	0.0
33	Mtati (Mthathi)	8.2	10.1	11.6	1.3	0.0	0.0	0.5	10.7	0.0
34	Mgwalana	0.0	18.5	3.0	18.7	0.0	0.0	0.0	0.0	0.0
35	Bira (Bhirha)	0.0	7.1	5.3	15.2	0.0	0.0	0.0	18.0	122.5
36	Gqutywa	0.0	1.2	5.7	3.8	0.0	0.0	1.6	4.5	38.1
37	Ngculura (Ngculurha)	0.0	0.0	0.0	0.7	0.0	0.0	0.0	1.2	0.5
38	Mtana	0.0	6.3	2.9	1.3	0.0	0.0	2.2	0.2	7.1
39	Keiskamma	189.8	205.8	27.7	7.7	0.0	0.0	4.5	26.5	135.9
40	Nqinisa	0.0	0.0	0.0	2.3	0.0	0.0	1.2	0.1	9.1
41	Kiwane (Khiwane)	0.0	0.0	3.6	4.6	0.0	0.0	1.6	0.2	9.0
42	Tyolomnqa	29.0	13.2	7.8	21.6	0.6	0.0	1.2	20.6	85.7
43	Shelbertsstroom	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5

No.	Estuary_Name	Intertidal salt marsh	Supratidal salt marsh	Submerged macrophytes	Reeds & sedges	Mangroves	Swamp Forest	Rocks	Sand and mudbanks	Open water
44	Lilyvale	0.0	0.0	0.0	0.5	0.0	0.0	0.0	0.0	1.8
45	Ross' Creek	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	1.0
46	Ncera (Ncerha)	0.0	2.9	1.6	0.9	0.0	0.0	0.0	6.7	16.9
47	Mlele	0.0	0.4	0.0	0.5	0.0	0.0	0.0	0.0	2.7
48	Mcantsi	0.0	0.5	0.0	4.0	0.0	0.0	0.0	0.5	4.0
49	Gxulu	1.0	11.9	0.0	0.6	0.0	0.0	0.0	4.0	31.0
50	Goda	0.0	1.9	0.0	1.1	0.0	0.0	0.0	0.6	13.6
51	Hlozi	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.4
52	Hickman's	0.0	0.8	0.0	0.4	0.0	0.0	0.0	0.0	3.1
53	Buffalo	0.0	0.1	0.0	0.2	0.0	0.0	0.0	0.0	97.7
54	Blind	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.4
55	Hlaze (iHlanze)	0.0	0.1	0.0	0.7	0.0	0.0	0.0	0.0	0.7
56	Nahoon	3.0	0.0	0.0	0.2	3.7	0.0	0.0	10.9	49.6
57	Qinira (Quinirha)	0.0	2.3	0.0	15.2	0.0	0.0	0.0	0.0	34.4
58	Gqunube	3.7	2.2	9.0	0.4	0.0	0.0	0.0	6.3	40.0
59	Kwelera (Kwelerha)	9.3	7.2	7.9	0.3	0.5	0.0	0.0	4.4	26.6
60	Bulura (Bulurha)	2.8	5.6	1.1	2.7	0.0	0.0	0.0	4.6	19.4
61	Cunge	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4
62	Cintsa	6.2	2.9	0.0	1.0	0.0	0.0	0.0	1.6	12.6
63	Cefane	20.0	7.0	8.4	1.9	0.0	0.0	0.0	8.8	22.5
64	Kwenxura (Kwenxurha)	0.0	3.3	0.0	2.6	0.0	0.0	0.0	5.0	18.2
65	Nyara (Nyarha)	1.1	6.3	0.0	0.6	0.0	0.0	0.0	1.7	7.4
66	Imtwendwe (Mtwendwe)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3
67	Haga-haga	0.0	0.3	0.0	0.4	0.0	0.0	0.0	1.4	1.3
68	Mtendwe	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2
69	Quko	3.9	0.0	0.0	1.2	0.0	0.0	0.0	0.1	31.0
70	Morgan	0.0	2.0	0.0	1.0	0.0	0.0	0.0	1.0	20.0
71	Cwili	0.0	0.0	0.0	0.6	0.0	0.0	0.0	0.0	0.6
72	Great Kei	5.1	45.9	0.0	53.5	1.6	0.0	3.5	42.0	153.1
73	Gxara (Gxarha)	0.0	1.9	0.0	6.3	0.0	0.0	0.0	1.5	14.2
74	Ngogwane	0.0	0.0	0.0	2.4	0.0	0.0	0.0	2.1	4.7
75	Qolora (Qolorha)	0.0	0.0	0.0	8.7	0.0	0.0	5.6	1.2	7.4
76	Ncizele	0.0	0.0	0.0	1.2	0.0	0.0	0.0	0.0	5.4
77	Timba	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
78	Kobonqaba (Khobonqaba)	2.3	4.5	3.7	2.4	0.1	0.0	0.0	4.6	11.1
79	Nxaxo/Ngqusi	4.3	3.3	0.8	4.7	16.4	0.0	0.0	6.6	124.3
80	Cebe	0.0	0.0	0.0	7.6	0.0	0.0	0.0	1.4	7.5
81	Gqunqe	0.0	0.0	6.6	9.2	0.0	0.0	0.0	0.9	7.9
82	Zalu	0.0	0.0		5.2	0.0	0.0	0.0	0.0	7.1
83	Ngqwara (Ngqwarha)	0.0	2.3	0.0	4.7	0.0	0.0	0.0	2.1	10.2
84	Sihlontlweni	0.0	0.0	0.0	2.6	0.0	0.0	0.0	0.1	8.4
85	Nebelele	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
86	Qora (Qhorha)	0.0	1.0	3.3	5.7	1.1	0.0	0.0	10.2	65.2
87	Jujura (Jujurha)	0.0	0.0	0.0	1.2	0.0	0.0	0.0	0.1	3.5
88	Ngadla	0.0	0.0	0.0	5.2	0.0	0.0	0.0	0.0	8.7
89	Shixini	0.0	0.0	0.0	5.6	0.0	0.0	0.0	5.2	11.2
90	Beechamwood	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

No.	Estuary_Name	Intertidal salt marsh	Supratidal salt marsh	Submerged macrophytes	Reeds & sedges	Mangroves	Swamp Forest	Rocks	Sand and mudbanks	Open water
91	Kwazlelitsha (Kwazwedala)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
92	Kwa-Goqo	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
93	Ku-Nocekedwa	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
94	Nqabara/Nqabarana	0.1	0.0	1.4	4.6	11.8	1.2	0.0	4.6	89.5
95	Ngomane (East)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
96	Ngoma/Kobule	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
97	Mendu	0.0	0.0	0.0	9.5	0.0	0.0	0.0	0.0	14.3
98	Mendwana	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
99	Mbashe	8.3	16.9	0.0	5.7	7.6	0.0	0.1	71.8	136.1
100	Ku-Mpenzu	0.0	0.0	0.0	4.3	0.0	0.0	1.3	1.2	6.5
101	Ku-Bhula (Mbhanyana)	0.0	0.0	0.0	2.7	0.0	0.0	2.3	0.0	2.6
102	Kwa-Suku	0.0	0.0	0.0	7.6	0.0	0.0	0.0	0.0	8.2
103	Ntlonyane	0.0	0.0	0.0	8.0	0.0	0.0	0.0	3.9	29.5
104	Nkanya	0.0	0.0	0.0	7.4	0.0	0.0	0.5	0.1	7.5
105	Sundwana	0.0	0.0	0.0	2.3	0.0	0.0	0.0	0.0	4.3
106	Xora	13.6	0.0	0.1	9.0	22.5	0.0	0.0	13.5	122.8
107	Bulungula	0.1	2.3	2.8	4.7	0.0	0.0	0.0	2.5	8.9
108	Ku-Amanzimuzama	0.0	0.0	0.0	1.2	0.0	0.0	0.0	1.1	1.4
109	Nqakanqa	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
110	Mdikana	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
111	Mncwasa	0.0	0.0	0.0	3.7	0.0	0.0	0.0	0.2	15.4
112	Mpako	0.0	0.0	0.0	5.1	0.0	0.0	0.0	1.0	7.4
113	Nenga	0.0	0.0	0.0	2.1	0.0	0.0	0.0	2.2	5.7
114	Mapuzi	0.0	0.0	0.0	7.5	0.0	0.0	0.0	0.0	8.5
115	Mtata	0.0	24.3	0.0	6.2	29.3	0.0	0.0	5.6	102.4
116	Thsani	0.0	0.0	0.0	1.2	0.0	0.0	0.0	0.0	2.8
117	Mdumbi	4.0	8.2	0.0	7.9	4.7	0.0	0.0	13.9	45.6
118	Lwandilana	0.0	0.0	0.0	2.4	0.0	0.0	0.0	0.1	7.2
119	Lwandile	0.0	0.0	0.0	7.4	0.0	0.0	0.0	2.4	12.4
120	Mtakatye	2.7	0.0	3.2	0.0	10.9	0.0	0.0	0.0	0.0
121	Hluleka	0.0	0.0	0.0	2.4	0.0	0.0	0.0	4.1	8.5
122	Mnenu	0.0	0.0	0.0	44.0	0.0	0.0	0.0	0.1	46.4
123	Mtonga	0.0	0.0	0.0	15.6	0.0	0.0	0.0	1.2	15.4
124	Mpande	0.0	0.0	0.0	6.7	0.0	0.0	0.0	0.5	7.8
125	Sinangwana	0.0	0.0	0.0	7.4	0.0	0.0	0.0	0.0	5.8
126	Mngazana	5.9	20.7	10.5	11.4	147.0	7.8	0.0	87.9	76.4
127	Mngazi	2.3	13.9	4.0	4.5	0.0	0.0	0.7	36.5	71.4
128	Gxwaleni	0.0	0.0	0.0	5.6	0.0	0.0	0.0	0.0	4.5
129	Bulolo	0.0	0.0	0.0	6.3	0.0	0.0	0.0	0.0	6.3
130	Mtumbane	0.0	0.0	0.0	5.4	0.0	0.0	0.0	0.1	5.4
131	Mzimvubu	0.1	0.0	0.0	16.0	0.0	5.0	0.0	26.0	345.0
132	Ntlupeni	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
133	Nkodusweni	0.0	0.0	0.0	4.7	0.0	0.0	0.0	5.5	22.4
134	Mntafufu	14.0	0.0	0.0	1.5	12.0	0.5	0.0	0.8	7.7
135	Ingo	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
136	Mzintlava	0.1	0.0	0.0	3.1	3.0	0.4	0.0	2.9	14.4
137	Mzimpunzi	0.0	0.0	0.0	1.4	0.0	0.0	0.0	0.6	3.1

No.	Estuary_Name	Intertidal salt marsh	Supratidal salt marsh	Submerged macrophytes	Reeds & sedges	Mangroves	Swamp Forest	Rocks	Sand and mudbanks	Open water
138	Kwanyambalala	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
139	Mbotyi	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.6
140	Mkozi	0.0	0.0	0.0	0.5	0.0	0.0	0.0	0.1	2.1
141	Sikatsha	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
142	Lupatana	0.0	0.0	0.0	0.2	0.0	0.5	0.0	0.2	2.7
143	Mkweni	0	0	0	0.34	0	1.32	0	0.15	5.19
144	Msikaba	0	0	0	0	0	0	0	0	0
145	Mgwegwe	0	0	0	0.15	0	4.45	0	0.8	3.39
146	Mgwetyana	0	0	0	0.27	0	0	0	0.56	2.45
147	Mtentu	0.1	0	0	4.76	0.5	3.67	0	8.08	34.95
148	Sikombe	0	0	0	0.3	0	1.18	0	0.79	9.21
149	Kwanyana	0	0	0	0.71	0	0	0	0.1	6.32
150	Mtolane	0	0	0	0	0	0	0	0.14	1.15
151	Mnyameni	7.4	0	2.62	8.46	3.5	0.01	0	2.34	17.11
152	Mpahlanyana	0	0	0	0.74	0	0	0	0.1	3.01
153	Mpahlane	0	0	0	0.66	0	0	0	0.29	2.97
154	Mzamba	1.81	0	0	24.11	0.4	4.74	0	3.97	37.87
155	Mtentwana	0	0	0	0	0	0	0	1.22	10.21
156	uMthavuna	0	0	0.0	7.1	0.2	0.1	0	11.6	76.9

14. APPENDIX E: DRIVER-RESPONSE MOTIVATIONS FOR BIOTIC CHANGE

14.1 Key factors influencing microalgae

Table 14-1 summarises the key responses of estuarine microalgae to changes in abiotic and other biotic components, while Table 13-2 translates these into expected responses to various estuarine processes.

Table 14-1: Microalgae: Response (i.e., increased or decreased abundance) of groupings in response to select abiotic variables.

Variable	Common phytoplankton groups						
	Raphido-phytes	Dino-phytes	Diatoms	Chloro-phytes	Cyano-phytes	Eugleno-phytes	Crypto-phytes
Nutrients (N & P)	↑	↑	↑	↑	↑	↑	↑
Salinity	↑	↑	↓↑	↓	↓	↓	↓
Stratification	↑	↑	↓	↓	↓	↓	↑
Tidal flushing	↓	↓	↓↑	↓	↓	↓	↓
Turbidity	↓↑	↓	↓	↓	-	-	↓

Variable	Dominant microphytobenthos groups			
	Diatoms (Epipelic)	Diatoms (Episammic)	Cyanophytes	Euglenophytes
Fines (silt & clay)	↑	↓	↑	↑
Organic loading	-	-	↑	↑
Nutrients (N & P)	↑	↑	↑	↑
Turbidity	↓	↓	↓	↓

Table 14-2: Microalgae: Effect of abiotic characteristics and processes, as well as other biotic components (variables) on various groupings

Variable	Grouping	
	Phytoplankton	Microphytobenthos (MPB)
Open water area	Proportional reduction of phytoplankton biomass with loss of open water area.	Proportional reduction of microalgal biomass with loss of open water area, with a shift from subtidal to intertidal dominance.
Salinity	Phytoplankton biomass is typically higher in brackish compared to marine conditions, with freshwater conditions being intermediate. Species composition will shift in response to salinity fluctuations. For example, chlorophytes typically favour freshwater, while dinoflagellates prefer brackish/marine waters.	Very little salinity effect on overall MPB biomass. Diatom community composition will however shift in response to salinity variations, i.e., fresh, brackish, marine species.

Variable	Grouping	
	Phytoplankton	**Microphytobenthos (MPB)**
Mouth condition	Phytoplankton biomass will be greatest in the brackish, REI zone characterised by vertical salinity gradients.	MPB biomass lower during open mouth conditions due to scouring effect/resuspension.
Water flow rate	High flow conditions will reduce phytoplankton biomass. Biomass recovers a few weeks after the initial flood/pulse event subsides.	High flow conditions will reduce MPB biomass.
Water retention time	Phytoplankton biomass elevated during periods of increased water retention. However, primary productivity may become benthically-driven during periods of prolonged mouth closure.	MPB biomass is elevated during periods of increased water retention.
Turbidity	High turbidity driven by floods or catchment activities hinders phytoplankton by limiting the availability of light.	Possible reduction in subtidal MPB productivity if water is very turbid, however, intertidal communities will be less affected.
Water quality	Low nutrient content - maximum species diversity with low biomass. Diversity decreases and biomass increases at high nutrient levels.	Low nutrient content - maximum species diversity with low biomass. Diversity decreases and biomass increases at high nutrient levels.
Macrophyte community structure	Increased contribution of epiphytic diatoms in the presence of macrophytes.	MPB biomass high with high density of rooted aquatic macrophytes. Food availability to juvenile fauna increases.
Oxygen levels	No effect on phytoplankton.	Low oxygen levels promote remineralisation of ammonium and phosphate that may support MPB growth; particularly subtidal communities.

14.2 Key factors influencing macrophytes

The factors influencing the macrophytes are shown in Table 14-3.

Table 14-3: Macrophytes: Effect of abiotic characteristics and processes, as well as other biotic components (variables) on estuarine habitat.

Variable	Grouping
Mouth conditions	Open mouth state and tidal inundation increases intertidal salt marsh and mangroves. Seagrasses also increase under tidal conditions.
Retention times of water masses	Increased mouth closure floods salt marsh in the lower reaches along with mangroves. Submerged macrophytes like Ruppia and Potamogeton increase under closed mouth conditions. ~~Submerged macrophytes increase in the blind lagoon.~~
Flow velocities (e.g. tidal velocities or river inflow velocities)	Tidal velocities affect the seagrass *Zostera capensis* and for this reason it is limited to areas < 0.1 m s^{-1}. Mechanical damage occurs at 0.5 m s^{-1} and removal > 1 m s^{-1}. River floods can remove submerged macrophyte beds.
Water level fluctuations	High water level floods salt marsh in the supratidal and floodplain zone.
Wave action	Wave action causes bank erosion and destabilisation of floodplain vegetation. It negatively affects submerged macrophyte beds due to their shallow and fragile root system.
Floods	Floods introduce fresh and turbid water to the estuary. These can affect the salt-marsh areas by depositing sediments – negatively in the short-term, but positively in the long-term as floods bring in new sediments and nutrients. Strong currents can remove species such as *Zostera capensis* or cause dieback due to a sudden freshwater or turbidity pulse.

Variable	Grouping
Salinity	Submerged macrophyte species are distributed longitudinally according to their salinity tolerance ranges with *Zostera* and *Ruppia* occurring in salinity range of 15 to 45, *Stuckenia pectinata* <15, and *Ceratophyllum* < 5 ppt. The salt marsh vegetation requires periodic flooding with salt water to deposit salt in the substrate and hence reduce competition from more terrestrial species.
Turbidity	Turbidity reduces light penetration and the ability to photosynthesise in submerged aquatic macrophytes. Floating macrophytes grow independent of turbidity whereas submerged species are light limited.
Dissolved oxygen	Overgrowth of alien aquatic vegetation could result in an increase of biomass which when dying, introduces large amount of nutrients into the system and depletes oxygen during decomposition.
Nutrients	Increased nutrients will promote the growth of alien aquatic vegetation. Reeds and sedges also indicate sites of nutrient enrichment.
Sediment characteristics (including sedimentation)	Sediment deposition favours the growth of reeds and sedges (*Phragmites australis*), due to shallowing of the estuary. Increased sediment input or turbidity decreases light availability for submerged aquatic macrophytes. Sediment deposition smothers sensitive mangrove pneumatophores.
Groundwater seepage	Groundwater seepage sites favour the growth of reeds such as *Phragmites australis, Schoenoplectus scirpoides* and *Typha capensis*.

14.3 Key factors influencing invertebrates

Key pressures imposed on invertebrates relate to their associated lifestyle. The zooplankton for example are influenced predominantly by abiotic forcing through factors within the water column such as salinity gradients, which promote diversity, or dissolved oxygen, which restrict diversity when conditions become anoxic, for example. Zoobenthic organisms similarly are influenced by water column features but also by sediment properties, which throughout South African estuaries are documented as an overarching structuring force for this community more so than any other abiotic feature (Teske and Wooldridge 2003). Hence upstream erosion pressures and subsequent sediment inundation, for example, can have direct and detrimental consequences for this community. More specific features affect specific types of organisms within these categories, for example, the hyperbenthos is dependent both on suitable features in the water column but also the presence of associated substrate or features such as rocky zones or established macrophyte/macroalgal beds, while the plankton would respond differently to high flow conditions compared to the nekton. Invertebrate megafauna that occur in the peritidal zone are closely linked to the forces that drive zonation patterns within this region and often bare similar pressures (e.g. coastal squeeze). This region of estuaries, because of its heavy utilisation by recreational and subsistence user groups, is especially prone to direct impacts.

The main factors affecting the abundance of the different invertebrate groups are summarised in **Table 14-4.**

Table 14-4: Invertebrates: Effect of abiotic characteristics and processes, as well as other biotic components on groupings

Factor	Affected categories
Mouth condition	Mouth closure would benefit the subtidal macrozoobenthos since the increase in benthic macroalgae would increase food availability. However, the intertidal community (particularly the mudprawn *Upogebia africana* and the marsh crabs) are likely to decline in abundance-biomass as available habitat becomes inundated. Some species such as the mudprawn *Upogebia africana* require a marine phase of development – the population could become extinct in the estuary should the mouth close for extended periods. Prolonged mouth closure would decrease species richness (absence of marine-

Factor	Affected categories
	associated species). Closure accompanied by freshwater inflow would increase dominance of freshwater species, whereas in the absence of freshwater inflow, hypersaline conditions may occur with dominance by halophilic crustacea e.g. brine shrimp *Artemia*. Hypersaline conditions are unlikely.
Retention times of water masses	Increased retention times of the water mass would benefit the planktonic assemblage by reducing the loss of larvae or adults through tidal flushing out of the estuary. An increase in retention times of water masses will increase the abundance of microalgae and favour estuarine residents and freshwater macrofauna tolerant of reduced salinity.
Flow velocities (e.g. tidal velocities or river inflow velocities)	As tidal velocities increase, loss of the zooplanktonic forms would increase, particularly among the copepods. Under high flow conditions, entire populations will be lost. Since zooplankton is a key component in the estuarine food web, the ripple effect would impact higher trophic levels directly. Similarly, the benthic assemblage would also be flushed from the system under high flow conditions. Strong tidal currents would also flush populations from the estuary, particularly near the mouth. Phytoplankton levels including harmful algae flourish at low flow velocities with an increase in the amount of food available to zooplankton.
Total volume and/or estimated volume of different salinity ranges	The presence of different salinity zones (~0-10, 10-30 and 30-35) ensures different habitats for organisms. These different zones also lead to increased species richness in the estuary. From a biomass perspective, the larger the 10-30 zone (volume), the higher the biomass of invertebrates present. A well-defined development of the REI zone will increase biomass, particularly among the euryhaline copepods, which are an important trophic link. A change in total volume of different salinity ranges would result in a corresponding change in habitat accessible to the invertebrate macrofauna. Associated species would respond accordingly – i.e. marine dominated species would increase with a greater marine volume component and estuarine resident species would retreat to the upper reaches, where there is less habitat available and vice versa.
Floods	Floods scour accumulated sediments from the estuary, particularly in the lower reaches. Tidal exchange is enhanced, and this leads to a resetting of the balance between the three major salinity zones. Because tidal exchange is more dynamic under open mouth conditions, coarser sediments (sand) in the lower estuary particularly are resuspended and fine material scoured from these lower reaches near the mouth. Floods will flush populations from the estuary and recovery might be slow. Some populations, particularly in unconsolidated sediments will be flushed from the estuary. A severe flood would form emergent channels and available habitat in the upper and supratidal reaches.
Salinities	The persistence of a full salinity gradient along the length of the estuary is an important characteristic and ensures a range of habitats available to organisms. An established salinity gradient will increase species richness and enable zonation patterns to develop.
Turbidity	Although naturally turbid, benthic organisms particularly become smothered under excessive loads of fine material in the water column. Increasing turbidity reduces predation pressure from visual hunters.
Dissolved oxygen	If values fall below ~50% of saturation, organisms become stressed. Sessile organisms particularly are affected, and high mortality can be expected if values begin to fall below the 50% saturation level. Some species such as the polychaete *Capitella* spp. will tolerate anoxia and a compositional shift in the community might occur.
Subtidal, intertidal and supratidal habitat	The availability of these three habitats is an important characteristic of the estuary, increasing species richness and biomass within these zones. Different benthic invertebrate macrofauna show differing affinities for intertidal and subtidal habitats and changes in the availability of these two habitat types will influence the relative abundance of these taxa. Decreased estuary depth will likely increase the intertidal area leading to new habitat becoming available to intertidal organisms, whereas an increase in depth (e.g., sea-level rise) will likely restrict intertidal area because of coastal development, therefore decrease in intertidal macrofauna.
Sediment characteristics (including sedimentation)	A range of sediment types (particularly sand and mud) provides habitat for those organisms that require specific sediment characteristics. Along the estuary (~10-30 salinity range), sediment is probably the single most important environmental variable that structures benthic communities. At the mouth and in the uppermost reaches of the estuary, salinity becomes increasingly important rather than sediment type. High organic

Factor	Affected categories
	content of the sediment favours species associated with the surface layers as the deeper layer tend to become anoxic. Benthic species distribution will change in accordance with the shift of habitat preference – sediment properties (mud versus sand) are closely linked to macrozoobenthos community composition.
Phytoplankton biomass	High phytoplankton biomass leads to increased biomass of invertebrates as the most important food component in this trophic link. An increase in phytoplankton biomass would lead to an increase in density of invertebrate populations – food. The exception might be if HABs form, which would deplete oxygen in the water column and potentially reduce zooplankton (and macrobenthos) abundance.
Benthic micro-algae biomass	As above. Increased microphytobenthic biomass will favour epifauna that graze on them.
Aquatic macrophyte cover	Macrophyte cover is important for the intertidal and supratidal invertebrate community (particularly crabs) as it provides protective habitat and detritus for consumption by the community. Detritus is also exported from the marsh, providing food resources for filter feeders in the estuary. Biomass and species composition of benthic populations particularly will increase significantly (hyperzoobenthos and epifauna), both in response to new habitat becoming available and the production of detritus as food. Aquatic macrophyte cover (e.g. reeds) provides refuge and foraging habitats, especially for epiphyte grazers.
Fish biomass	Increased predation on invertebrates if fish biomass increases.

14.4 Key factors influencing fish

The main factors affecting the abundance of the different fish groups are summarised in **Table 14-4.**

Table 14-5: Fish: Effect of abiotic characteristics and processes, as well as other

Factor	Ia. Estuarine residents (breed only in estuaries)	Ib. Estuarine residents (breed in estuaries and the sea)	IIa. Estuary dependent marine species	IIb and c. Estuary associated species	III. Marine migrants	IV & V. Freshwater species
Mouth condition	Resident species proliferate under closed mouth conditions		Abundance and richness of marine communities declines with frequent, aseasonal and prolonged mouth closure.			Increase in abundance at low salinity levels.
Retention times of water masses	Food (zooplankton) abundance for all groups increases with increased retention times. Prolonged mouth closure also favours resident and freshwater species over marine species.					
Flow velocities (e.g. tidal velocities or river inflow velocities)	Resident species move upstream when flow velocities increase.	Marine species exploit tidal currents when migrating into or out of the estuary or when feeding and following the tidal 'front' up the estuary. Eddies accumulate food and provide refugia for both adult and juvenile fish.				Freshwater species can get washed into the estuary by strong river currents.
Total volume and/or estimated	Increased volume translates to an increase in available habitat for all species, especially those that spend most of their time in the water column. Brackish water habitat is good for resident and estuary associated marine species while marine water is good for marine migrant/straggler					

Factor	Ia. Estuarine residents (breed only in estuaries)	Ib. Estuarine residents (breed in estuaries and the sea)	IIa. Estuary dependent marine species	IIb and c. Estuary associated species	III. Marine migrants	IV & V. Freshwater species
volume of different salinity ranges	species. High water levels that inundate supratidal areas are positive for juvenile marine fish and small estuarine resident species.					
Floods	The larvae of resident species are washed into the sea at the onset of floods	Juvenile marine and catadromous species use floodwaters entering the sea as a cue for locating and migrating into estuaries, whereas adults and sub-adults exit during floods . Major river flooding associated with high sediment loads can cause gill clogging and hypoxia for fish in the estuary. Large aggregations of kob and other fish with preferences for high turbidity often occur immediately adjacent to estuary mouths during floods.				High flow velocities may flush some individuals downstream into the estuary
Salinities	Resident and estuary dependent marine species very tolerant of salinities in the range 1-35 PSU.				Tend to stay as close to 35 PSU as possible. Stressed when salinities less than 20 PSU.	Highly variable and most prefer salinity < 10 PSU.
Turbidity	Tolerant of a wide range of turbidity.	Turbidity preferences and tolerances vary among species. High turbidity tolerance (physiological adaptation) among some species affords them refuge and access to a specialist ecological niche.			Generally prefer low turbidity	Tolerant of a wide range of turbidity.
Dissolved oxygen	Most resident and estuary associated marine species become stressed when oxygen drops below 4 $mg.l^{-1}$. However, surface respiration is an adaptation by most estuarine and freshwater species to overcome hypoxia. Skin respiration is also an adaptation in some species, e.g. mudskippers whereas sole gill-morphology allows survival in hypoxic conditions.				Little tolerance to low oxygen levels/hypoxia.	Surface respiration is an adaptation by some estuarine and freshwater species to overcome hypoxia. Some indigenous species adapted to low oxygen, e.g. air-breathing organs, skin respiration and aestivation e.g. Galaxiidae.
Subtidal, intertidal and supratidal habitat	With the obvious exception of mudskippers and to a lesser extent other gobies, blennies & clinids, most fish are confined to the subtidal at low tide but forage in the intertidal during high tide. Intertidal reaches are nonetheless extremely important foraging areas for most fish species. Shallow marginal areas tend to be warmer than deeper channel areas and are thus favourable for metabolic processes. Juveniles and small adults also use shallow water as a predation refuge.					

Factor	Ia. Estuarine residents (breed only in estuaries)	Ib. Estuarine residents (breed in estuaries and the sea)	IIa. Estuary dependent marine species	IIb and c. Estuary associated species	III. Marine migrants	IV & V. Freshwater species
Other abiotic components (temperature)	Low temperatures can increase the risk of mass mortalities at very low salinities. Growth rates and gonadal development tend to decrease either side of the optimal temperatures for individual species. Fish move according to their preferred temperature, constraints more in temporarily open/closed than permanently open estuaries.					
Sediment characteristics (including sedimentation)	Individual species preferences are highly variable and often related to preferred food sources. Burying ability and crypsis of some fish (e.g. sole *Heteromycteris capensis*) are governed by sediment characteristics. Some fish are directly and indirectly impacted e.g. *Psammogobius knysnaensis* are psammophyllic but have commensal/mutual relationships with burrowing invertebrates which are distributed according to their burrowing ability and sediment characteristics.					
Phytoplankton biomass	High phytoplankton production contributes to turbidity in estuaries and probably favours those species with higher turbidity preferences. Phytoplankton is also a food source for filter-feeding fish and invertebrates. Fish also benefit indirectly from proliferation of invertebrates that feed on phytoplankton. Omnivorous filter-feeding fish will out-compete selective feeders during periods of high phytoplankton biomass. Harmful algal blooms in estuaries, usually a result of eutrophication, have a number of direct (toxicity) and indirect (e.g. hypoxia) impacts on fish. Blue-green *Microcystis* blooms, common in SA estuaries, can cause both skin and/or organ lesions in fish resulting in poor health, reduced reproductive success and mortalities. Golden algae *Prymnesium parvum*, an invasive species recorded in Zandvlei, causes fatal gill haemorrhaging and induces abortion and premature spawning in fish.					
Benthic micro-algae biomass	Detritivores, especially mullet, benefit from high microphytobenthos biomass. South African fish biomass in estuaries is dominated by mullet (>60%) and therefore overall fish biomass is largely reflective of benthic algal biomass.					
Zooplankton biomass	Most juvenile fish in estuaries feed on zooplankton. Filter and particulate feeders benefit from increased zooplankton biomass. Many fish species are able to switch between filter and targeted feeding modes to take advantage of dominant zooplanktonic food sources. One caveat is that predatory marine zooplankters (e.g. chaetognaths) may have a devastating impact on recruiting fish larvae. Jellyfish may do the same.					
Aquatic macrophyte cover	Juveniles of most fish species find refuge in littoral macrophyte beds during the daytime but move into open water or to the surface during the night as oxygen levels drop in the littoral zone.					
Benthic invertebrate biomass	Many estuary associated fish species feed on benthic invertebrates and will thus benefit from increases in benthic invertebrate biomass. Burrow associated fish (e.g. gobies) diversity and numbers will vary according to that of benthic invertebrates (e.g. sand prawn).					

Factor	Ia. Estuarine residents (breed only in estuaries)	Ib. Estuarine residents (breed in estuaries and the sea)	IIa. Estuary dependent marine species	IIb and c. Estuary associated species	III. Marine migrants	IV & V. Freshwater species
Fish biomass	No major piscivorous species in these categories. Most of the fish biomass consists of planktivores and small zoobenthivores. Probably inter and intraspecific competition for space, habitat and food resources though.		Fish biomass dominated by estuary associated marine species that utilise different food chains, e.g. grooved mullet *Chelon dumerili* is a detritivore, spotted grunter *Pomadasys commersonnii* is a zoobenthivore and dusky kob *Argyrosomus japonicas* a piscivore. The piscivores benefit from the high biomass of estuarine resident and small marine migrants in the estuary.			Introduced freshwater fish may outcompete and eat estuary fish but also result in a substantial increase in biomass, e.g. the sharp tooth catfish *Clarias gariepinus* has invaded the Great Fish system via the Orange River water transfer scheme. Introduced species are usually more tolerant of poor water quality, thereby becoming the dominant fish in some systems.

14.5 Key factors influencing birds

Waterbirds are primarily restricted by food availability (macrophytes, macroalgae, invertebrates, fish) and, if utilising a habitat for breeding or roosting, nesting and refuge site suitability. The high proportion of Palearctic migrants typically occupying estuaries in South Africa makes foraging suitability a key determinant of site utilisation. These in part are restricted by density dependent forcing (i.e., competition amongst and between waterbird species). Site suitability and utilisation are also impacted by anthropogenic drivers such as disturbance, trampling, hunting or egg harvesting. A close coupling between seasonal utilisation of estuaries exists for many waterbird species using estuaries, especially those that are migratory.

The abovementioned ten groupings (**Table 14-6**) determine which factors might affect these different waterbird guilds, depending on their foraging preferences and ecology. This is in turn driven indirectly by those conditions which impact the food availability within different zones of the estuary, such as sediment supply or mouth closure and its impacts on intertidal salt marsh or submerged macrophytes. Pollution impacts (e.g., nutrients, heavy metals, plastic) have varying direct and secondary effects on waterbird populations, depending on the nature of ingestion or secondary impacts on other trophic and ecological components in the ecosystem.

Table 14-6: Birds: Effect of abiotic characteristics and processes, as well as other biotic components (variables) on bird groupings

Factor	Piscivores	Waterfowl	Planktivores	Benthivorous waders
Mouth condition	Indirectly, through influence on water level and prey (fish).	Indirectly, through influence on plankton and macrophytes; closed mouth negatively impacts planktivores as it reduces foraging opportunities in deeper water. Has an indirect effect through its influence on macrophytes, i.e. high salinities negative for such growth and low salinities positive. May be particularly positive when extensive back-flooding accompanies mouth closure.		Mouth closures have a negative effect on foraging opportunities in intertidal habitat.
	Mouth closure can impact roosting opportunities – affects intertidal area.			
Salinity	Affects species composition and densities of fish present in the estuary.	Certain species of waterfowl prefer lower salinity	Hypersaline conditions can improve foraging conditions	Some Palearctic waders are dependent on estuarine conditions for obtaining their food.
Turbidity	Negatively affects visibility for foraging	Might deplete growth conditions of macrophytes and thereby reduce food availability	Indirectly	Increases may impact on benthic macroinvertebrates but to a lesser extent negatively affect efficiency of foraging activities as many of these species, especially Palaearctic waders, are tactile foragers.
Intertidal area	Indirectly affects species composition and densities of fish present in the estuary.		This is the critically important habitat for waders, which rely almost exclusively on intertidal areas for feeding, especially estuarine-dependent Palearctic waders.	
Sediment characteristics (including sedimentation)		May enhance macrophyte growth, especially *Phragmites.*	Indirectly	Most waders prefer mud to fine sand; a few prefer coarse sand. Strong coupling between sediment characteristics and invertebrate (food) density.
Primary productivity	Indirectly though influence on food supply. Excessive primary productivity (e.g. HABs) might have negative consequences for waders, particularly planktivores.			
Submerged macrophytes abundance	Indirectly	Has positive influence on herbivorous waterfowl numbers	Indirectly	Indirectly
Abundance of reeds and sedges	Indirectly	Has positive influence on some herbivorous waterfowl species & rallids	Indirectly	Direct negative affect through the encroachment of macrophytes at the expense of the open

Factor	Piscivores	Waterfowl	Planktivores	Benthivorous waders
				intertidal habitats required by the waders.
Abundance of zooplankton	Indirectly	Assumed positive for some omnivorous species	Positive impact	Minor positive impact
Benthic invertebrate abundance	Indirectly	Assumed positive for some omnivorous species	Primary food source for invertebrate-feeding waders. Intertidal conditions particularly rich for this group, especially estuarine-dependent migratory waders.	
Fish biomass	Piscivores will increase with increasing numbers of small to medium-sized fish	None	Indirectly as some fish species may compete for benthic macroinvertebrates but abundance of both birds and fish probably primarily determined by abundance of benthic invertebrates	

15. APPENDIX F: WQ SCREENING MODEL ADJUSTMENT

The Desktop assessment of water quality (other than salinity) applied a screening model approach developed by Taljaard et al. (2017) using the 2020 national land cover data, except for slight modification in *Table 6c: Matrix for deriving the final overall WQ Similarity Rating, using the preliminary overall WQ Similarity Ratings from Tables 6a and 6b, by compensating for periods of mouth* (Taljaard et al. 2017) as follows:

Percentage mouth open	Interim Estuary WQ score					
	1	2	3	4	5	6
100-75	1	2	3	4	5	6
75-50	1	2	3	5	6	6
50-25	2	2	3	5	6	6
25-0	2	3	4	5	6	6

These refinements stem from learning gained through additional water quality assessment data gathered during EWR studies since the development of the screening model in 2017, allowing the authors to perform these incremental improvements to the original approach.