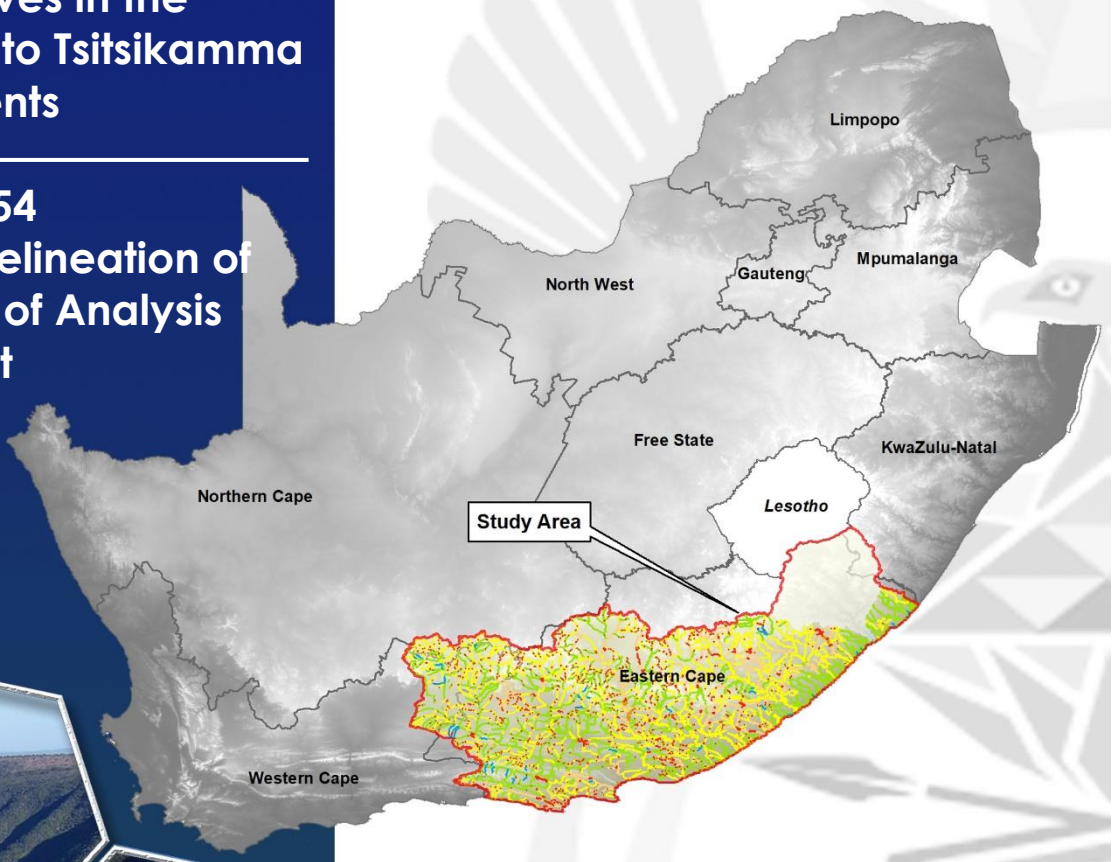
DEPARTMENT OF WATER AND SANITATION

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

WP11354
Status Quo and delineation of Integrated Units of Analysis Report



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Tel: (012) 336 7500/ +27 12 336 7500
Fax: (012) 336 6731/ +27 12 336 6731

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Prepared by:

GroundTruth: Water, Wetlands and Environmental Engineering

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Authors:	*M. Graham, K. Farrell, R. Stassen, C. Cowden, B. Grant, B. van der Waal, R. Rose, N. Forbes, J. Schroder, J. Crafford, J. MacKenzie, J. Schroder, G. de Jager*
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Approved for Groundtruth: Water, Wetlands and Environmental Engineering

…… …….

Dr Mark Graham *Date*

Director, GroundTruth

Supported by: **Recommended by:**

…… ……

Project Manager *Scientific Manager*

Approved for the Department of Water and Sanitation by:

……..

Director: Water Resource Classification

DOCUMENT INDEX

Reports as part of this project:

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INDEX	REPORT NUMBER	REPORT TITLE
1.0	WEM/WMA7/00/CON/RDM/0121	Inception Report
2.0	WEM/WMA7/00/CON/RDM/0222	Water Resources Information, Gap Analysis and Models Report
3.0	**WEM/WMA7/00/CON/RDM/0322**	**Status quo and delineation of Integrated Units of Analysis Report**

EXECUTIVE SUMMARY

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 and that the essential needs of individuals that are directly dependent on these water resources.

The Keiskamma and Fish to Tsitsikamma catchments (study area) within the Mzimvubu to Tsitsikamma Water Management Area (WMA7) are amongst many waters stressed catchments in South Africa (high water use from surface and groundwater, primarily for agricultural and domestic, ultimately 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 flow patterns, impacting on the aquatic biota. Furthermore, the study is also important from a conservation perspective, including protected areas, natural heritage, cultural and historical sites that require protection.

The determination of the Water Resource Classes is necessary to facilitate a balance between protection and use of water resources. In determining the class, it is important to recognise that different water resources will require different levels of protection which requires the consideration of the social and economic needs. The Water Resource Classification System (WRCS) is applied taking account of the local conditions, socio-economic imperatives and system dynamics within the context of the catchment. The process also requires a wide range of complex trade-offs to be assessed and evaluated at a number of scales. The first step of the Classification process is to assess the status quo of all water resources in the study area, and delineate the Integrated Units of Analysis (IUA) *i.e.* homogenous areas consisting of significant water resources for which Water Resource Classes are determined.

Therefore, this report forms part of step 2 of the integrated framework as developed by the DWS (DWS, 2017). The purpose of this report was to define the current status of the water resources in the study area in terms of the (i) water resources infrastructure (dams, transfers, water use, and weirs), (ii) the ecological and ecosystem characteristics of the rivers, wetlands, estuaries and groundwater, (iii) the water quality impacts on the water resources and (iv) the socio-economic condition, community well-being and ecosystem services and attributes.

The approach that was used for the delineation of the 19 IUAs was based on:

- the WRCS Guidelines, Volumes 1 and 2 (Overview and the 7-step classification procedure and ecological, hydrological and water quality guidelines for the 7-step classification procedure) (DWA, 2007b); and

- the development of procedures to operationalise Resource Directed Measures (chapter 6, Integrated Step 2) (DWS, 2017).

Therefore, the delineation of the IUAs is required as it would not be appropriate to set the same Water Resource Class for all water resources in a catchment. The delineation of a catchment into IUAs is done primarily according to a number of socio-economic criteria and drainage region (catchment area) boundaries. IUAs are thus a combination of socio-economic zones and watershed boundaries (DWA, 2007). Ecological information also plays a role in the delineation.

The following was considered for the delineation of IUAs within the study area:

- Socio-economic zones (SEZs);
- Catchment area boundaries (drainage regions and water resource systems);
- The resolution of the hydrological analysis and available water resource network configurations within the water resource models;
- Location of significant water resource infrastructure;
- Land use characteristics/protected areas/conservation areas;
- Distinctive functions of the catchments in context of the larger system;
- The Present Ecological State (PES) of each biophysical node was considered, the type of impacts and the homogeneity of the status and impacts;
- The practicalities of the existing model setup and network in terms of the scenario evaluation of each proposed IUA;
- Present status of water resources; and
- Stakeholder input (received during the public meeting held on 21 April 2022).

In conclusion, a total of 19 IUAs were identified for this study, which were described in terms of their status quo per component within each IUA. The IUA delineation was based on the information and data available from the assessment that formed part of the gaps analysis task (DWS, 2022). The data and information availability from previous studies, the various monitoring databases and GIS spatial layers for the study area and expert judgement were used to delineate the IUAs.

The 19 IUAs are illustrated in Figure 1 and described in Table 1 below.

Table 1: IUA descriptions for the Keiskamma and Fish to Tsitsikamma catchments

IUA	IUA code	Description	Main rivers, estuaries*	Quaternary Catchments
1	IUA_K01	Tsitsikamma and headwaters of Kromme to Kromme Dam	Tsitsikamma, upper Kromme	K80A-F, K90A-B
2	IUA_KL01	Kromme from Kromme Dam to estuary and Gamtoos	Kromme, Gamtoos	K90C-G, L90A-C
3	IUA_L01	Kouga to Kouga Dam, Baviaanskloof	Kouga, Baviaanskloof	L81A-D, L82A-J
4	IUA_M01	M primary catchment	Swartkops, Coega	M10A-D, M20A-B, M30A-B
5	IUA_LN01	Groot to Kouga confluence, Upper Sundays to Darlington Dam	Sout, Kariega, Groot, Upper Sundays	L11A-G, L12A-D , L21A-F, L22A-D, L23A-D, L30A-D, L40A-B, L50A-B, L60A-B, L70A-G, N11A-B, N12A-C, N13A-C, N14A-D, N21A-D, N22A-E, N23A-B, N24A-D, N30A-C
6	IUA_N01	Sundays downstream Darlington Dam	Lower Sundays	N40A-F
7	IUA_P01	P primary catchment	Boesmans, Kowie, Kariega	P10A-G, P20A-B, P30A-C, P40A-D
8	IUA_Q01	Fish	Little Brak, Upper Great Fish, Upper Little Fish	Q11A-D, Q14A-E, Q21A-B, Q22A-B, Q30A-B, Q80A-C

IUA	IUA code	Description	Main rivers, estuaries*	Quaternary Catchments
9	IUA_Q02	Great Fish	Great Fish, Tarka, Baviaans, Lower Little Fish	Q12A-C, Q13A-C, Q30C-E, Q41A-D, Q42A-B, Q43A-B, Q44A-C, Q50A-C, Q60A-C, Q70A-C, Q80D-G, Q91A-C, Q93A-D
10	IUA_Q03	Koonap and Kat	Koonap, Kat	Q92A-G, Q94A-F
11	IUA_R01	Keiskamma	Keiskamma, Tylomnqa	R10A-M, R40A-C, R50A-B
12	IUA_R02	Buffalo/ Nahoon	Buffalo, Nahoon, Kwelera, Gqunube	R20A-G, R30A-F
13	IUA_S01	Upper Great Kei	Indwe, White Kei, Tsomo, Great Kei	S10A-J, S20A-D, S40A-F, S50A-J
14	IUA_S02	Black Kei	Klipplaat, Klaas Smits, Black Kei	S31A-G, S32A-M
15	IUA_S03	Lower Great Kei	Kubusi, Great Kei	S60A-E, S70A-F
16	IUA_T01	Upper Mbashe, Upper Mthatha	Xuka, Mgwali, Upper Mbashe, Upper Mthatha	T11A-H, T12A-G, T20A
17	IUA_T02	Lower Mbashe	Lower Mbashe	T13A-E
18	IUA_T03	Lower Mthatha	Lower Mthatha	T20B-G

IUA	IUA code	Description	Main rivers, estuaries*	Quaternary Catchments
19	IUA_T04	Pondoland coastal	Mtentu, Msikaba, Mngazi, Mtakatye, Xora, Nqabara, Qhorha	T60A-K, T70A-G, T80A-D, T90A-G

The selection and evaluation of Resource Units (RU) to select priority RUs per water resource component, including integration between these components, and to identify biophysical nodes and hotspots (stressed RUs) will be undertaken per IUA as the next step.

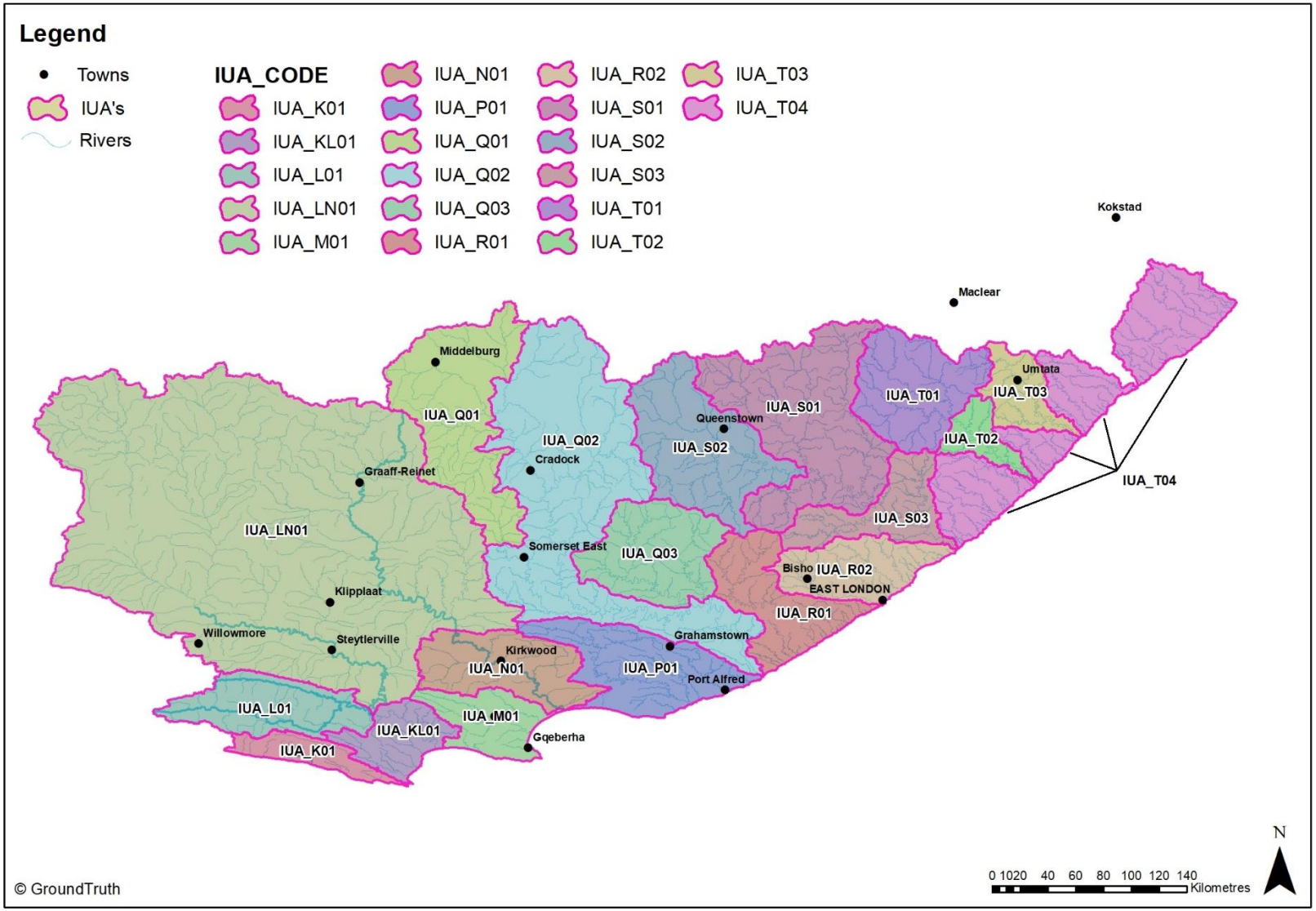


Figure 1: IUA delinetion for the Keiskamma and Fish to Tsitsikamma catchments

TABLE OF CONTENTS

Executive summary v
TABLE OF CONTENTS ii
LIST OF FIGURES iv
LIST OF TABLES v
LIST OF ACRONYMS vi
1. INTRODUCTION 8
1.1 Background 8
1.2 Purpose of this study 8
1.3 Purpose of this report 9
2. OVERVIEW OF STUDY AREA 10
2.1 Rivers, wetlands, groundwater and estuaries 10
2.2 Strategic Water Source Areas 11
2.3 Climate change considerations 12
2.4 Socio-economics and ecosystem services 16
3. STATUS QUO OF STUDY AREA 17
3.1 Rivers 17
3.1.1 Ecoregions 17
3.1.2 Present Ecological State 18
3.1.3 Ecological Importance and Sensitivity (EIS) 18
3.1.4 Protected areas/ NFEPA rivers and Critical Biodiversity Areas (CBA) 19
3.1.5 Geomorphological zonation 20
3.1.6 Vegetation 22
3.1.7 Water availability 23
3.1.8 Water resources infrastructure 33
3.1.9 Water use 38
3.1.10 Water quality impacts 51
3.2 Wetlands 54
3.2.1 Overview and general description of wetlands 54
3.2.2 General condition of wetlands 54
3.3 Groundwater 55
3.3.1 Overview and general description of groundwater 55
3.3.2 Geology 55
3.3.3 Hydrogeology, aquifer type and vulnerability 55

3.3.4 Recharge, water levels and contribution to baseflows 56
3.3.5 Groundwater use 56
3.3.6 Groundwater quality 56
3.4 Estuaries 57
3.4.1 Present Ecological State 57
3.4.2 Biodiversity Importance and Linkages to MPAs, or other Critical Biodiversity Areas. 57
3.4.3 Pressures on estuaries 58
3.5 Socio-economics and ecosystem services 58
3.5.1 Demographics and socio-economic profile 58
3.5.2 Economic sectors 58
3.5.3 Ecological infrastructure 58
3.5.4 Ecosystem Service Sensitivity 59
4. IUA DELINEATION 60
4.1 IUA_K01: Tsitsikamma and headwaters of Kromme to Kromme Dam 66
4.2 IUA_KL01: Kromme from Kromriver Dam to Estuary and Gamtoos 71
4.3 IUA_L01: Kouga to Kouga Dam, Baviaanskloof 76
4.4 IUA_M01: M primary catchment 81
4.5 IUA_LN01: Groot to Kouga confluence, Upper Sundays to Darlington Dam 86
4.6 IUA_N01: Sundays downstream Darlington Dam 92
4.7 IUA_P01: P primary catchment 96
4.8 IUA_Q01: Fish 101
4.9 IUA_Q02: Great Fish 105
4.10 IUA_Q03: Koonap and Kat 111
4.11 IUA_R01: Keiskamma 116
4.12 IUA_R02: Buffalo/ Nahoon 121
4.13 IUA_S01: Upper Great Kei 126
4.14 IUA_S02: Black Kei 130
4.15 IUA_S03: Lower Great Kei 134
4.16 IUA_T01: Upper Mbashe, Upper Mthatha 139
4.17 IUA_T02: Lower Mbashe 144
4.18 IUA_T03: Lower Mthatha 148
4.19 IUA_T04: Pondoland coastal 153
5. SUMMARY OF KEY IMPACTS PER IUA 158
6. CONCLUSIONS 165
7. REFERENCES 168
8. APPENDICES 170

LIST OF FIGURES

Figure 2-1: Projections of the possible impacts on precipitation of the UCE scenario 13
Figure 2-2: Projections of possible runoff impacts for the UCE scenario 14
Figure 2-3: Projections of possible runoff impacts for the L1S scenario 14
Figure 2-4: Projections of possible irrigation water requirement impacts for the UCE scenario 15
Figure 2-5: Projections of possible urban and irrigation water supply impacts in South Africa 16
Figure 3-1: Infrastructure of the Fish-Sundays Transfer Scheme 36
Figure 3-2: Key water resources infrastructure of the Amatola WSS 37
Figure 3-3: Water requirement projections for the Algoa WSS 51
Figure 3-4: Water requirements of the Amatola WSS (shown in the water balance 2012) 51
Figure 4-1: Delineated 19 IUAs throughout the study areas 65
Figure 8-1: Study area of the Keiskamma, Fish to Tsitsikamma 171
Figure 8-2: Ecosystem threat status (aquatics) 172
Figure 8-3: Strategic Water Source Areas (Lötter & Maitre, 2021) 173
Figure 8-4: Vegetation Biomes within the IUAs of the study area (from Mucina & Rutherford, 2018 update) 174
Figure 8-5: Vegetation Bioregions within the study area (from Mucina & Rutherford, 2018 update) 175
Figure 8-6: Map of threatened ecosytems in relation to IUAs within the study area (SANBI, 2011, remaining extent of natural vegetation) 176
Figure 8-7: Population density of the study area 177
Figure 8-8: Locality of ecological infrastructure within the Fish to Tsitsikamma catchment 178
Figure 8-9: Ecosystem Service Sensitivity Areas in the Fish-Tsitsikamma Catchment 179
Figure 8-10: The Algoa Water Supply System 180
Figure 8-11: Aquifer type and borehole yield 181
Figure 8-12: Geology 182
Figure 8-13: Groundwater recharge 183
Figure 8-14: Stressed catchments (groundwater) 184
Figure 8-15: Groundwater use 185
Figure 8-16: Groundwater quality 186

LIST OF TABLES

Table 3-1: Eco-regions that characterise the study area 17
Table 3-2: Summary of EIS per catchment in the study area 18
Table 3-3: Geomorphological zonation of South African river channels (copied from Rowntree and Wadeson, 1999) 21
Table 3-4: Water availability of the Algoa WSS 24
Table 3-5: Water availability of the Amatola WSS 25
Table 3-6: Summary of natural Annual Average flows per quaternary catchment and IUA 25
Table 3-7: Large Dams in the Study area 34
Table 3-8: Water users in the study area 39
Table 3-9: Water requirements of the Algoa WSS (2011 Reconciliation Strategy) 50
Table 3-10: Limits for selected water quality variables 52
Table 3-11: Specific water quality impacts per quaternary catchment where data is available 52
Table 4-1: IUAs delineated in the study area 61
Table 5-1: Summary of key impacts per IUA 158

LIST OF ACRONYMS

BHN	Basic Human Needs
CBA	Critical Biodiversity Areas
CD: WEM	Chief Directorate: Water Ecosystems Management
CVB	Channelled valley bottom
DRDLR	Department of Rural Development and Land Reform
DWS	Department of Water and Sanitation
EC	Electrical Conductivity
EFZ	Estuarine Functional Zone
EI	Ecological Importance
EIS	Ecological Importance and Sensitivity
ES	Ecological Sensitivity
ESA	Ecological Support Areas
EWR	Ecological Water Requirements
FEPA	Freshwater Ecosystem Priority Areas
FSA	Fish Support Area
GDP	Gross Domestic Product
GIS	Geographic Information System
GW	Groundwater
HGM	Hydro-geomorphic
IBA	Important Bird Areas
IES	Integrated Estuary Score
IUA	Integrated Unit of Analysis
LSRWUA	Lower Sundays River Water User Association
MAP	Mean Annual Precipitation
MPA	Marine Protected Areas
NBA	National Biodiversity Assessment
NMBM	Nelson Mandela Bay Municipality
NFEPA	National Freshwater Ecosystem Priority Areas
NWA	National Water Act
NWM5	National Wetland Map 5
PES	Present Ecological State
RDM	Resource Directed Measures
RQO	Resource Quality Objectives
RU	Resource Units
SANBI	South African National Biodiversity Institute

SWSA	Strategic Water Source Areas
SW	Surface water
UVB	Unchannelled valley bottom
WARMS	Water use Authorization and Registration Management System
WMA	Water Management Area
WR2012	Water Resources 2012
WRC	Water Research Commission
WRCS	Water Resources Classification System
WSS	Water Supply System
WWTW	Wastewater Treatment Works

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 economic development.

The provision of water required for the maintenance 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 and that the essential needs of individuals that are directly dependent on these water resources.

1.2 Purpose of this study

The Keiskamma and Fish to Tsitsikamma catchments within the Mzimvubu to Tsitsikamma Water Management Area (WMA7) are amongst many waters 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 flow patterns, impacting on the aquatic biota.

Thus, the main purpose of the study is to determine appropriate Water Resource Classes, the Reserve and 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,
- follow 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.

1.3 Purpose of this report

This report forms part of step 2 of the integrated framework as developed by the DWS (DWS, 2017).

Step 2: Describe status quo and delineate into IUAs

This status quo and delineation of Integrated Units of Analysis (IUA) report thus documents the baseline information available and required for the study area to determine the Water Resource Classes, Reserve requirements and set the associated RQOs. The purpose of this report was to define the current status of the water resources in the study area in terms of the (i) water resources infrastructure (dams, transfers, water use, and weirs), (ii) the ecological and ecosystem characteristics of the rivers, wetlands, estuaries and groundwater, (iii) the water quality impacts on the water resources and (iv) the socio-economic condition, community well-being and ecosystem services and attributes.

This information has been used to define the IUAs, which are presented in this report. IUAs are the spatial units that are defined as significant water resources and represents a homogenous socio-economic area which requires its own specification of a Water Resource Class.

Based on the IUAs, Resource Units (RUs) will be delineated and prioritised and biophysical nodes identified for different levels of Ecological Water Requirements (EWR) assessment and setting of RQOs (Step 1 of the integrated framework, DWS, 2017). A decision-making framework will be developed for the study area to assist with the determination of the Water Resource Classes and setting of the RQOs. Step 1 will be completed concurrently with the status quo and IUA delineation and presented in another report.

2. OVERVIEW OF STUDY AREA

2.1 Rivers, wetlands, groundwater and estuaries

The study area forms part of the Mzimvubu to Tsitsikamma Water Management Area (WMA7). The water resources of the Mzimvubu River (T31 – T36) are not included as part of the study area for the purposes of this study. Secondary catchments T40 (Mtamvuna) and T50 (Mzimkhulu) form part of WMA4 (Appendix A, Figure 8-1). A detailed overview of the study area in terms of the rivers, wetlands, estuaries and groundwater, water resource infrastructure and socio-economics has been presented in the inception report (DWS, 2021).

A short overview of each of the water resources components, namely rivers, wetlands, groundwater and estuaries in the study area are provided below. Detailed descriptions for each component will be provided as part of the results of the Integrated Units of Assessment delineation.

The rivers in the study area ranges from large perennial to semi-ephemeral systems as well as small coastal rivers that all drains towards the Indian Ocean (Appendix A, Figure 8-1). It consists of five large drainage basins with several smaller rivers in-between. The larger drainage basins are the:

- Mbashe River (part of drainage region T and includes T11, T12 and T13),
- Great Kei River (drainage region S),
- Great Fish (drainage region Q),
- Sundays (drainage region N), and
- Gamtoos River (drainage region L).

The smaller drainage regions include the:

i. Mthatha River (drainage region T20),
ii. Small coastal rivers in the Pondoland area (drainage regions T60 to T90),
iii. Keiskamma, Buffalo, Nahoon and Gqunube Rivers (drainage region R),
iv. Kowie, Kariega and Boesmans Rivers (drainage region P),
v. Koega and Swartkops Rivers (drainage region M),
vi. Krom and Seekoei Rivers (drainage region K90), and
vii. Tsitsikamma and small coastal rivers in drainage region K80.

The study area has been divided into 11 sub-catchments to provide broad management units within which wetland prioritisation and assessments will be undertaken and include the:

- Gamtoos (L catchment, channelled/ unchannelled valley bottom, depression, seepage-slope wetlands rare);
- Sundays (N catchment, depression and combination of channelled valley bottom and depression, seepage-slope wetlands rare);
- Fish (Q catchment, depression or channelled valley bottom);

- Tsitsikamma and Krom (K8 and K9 catchments, depression and channelled valley bottom);
- Algoa (M catchment, depression and channelled valley bottom);
- Bushmans (P catchment, depression);
- Kei (S catchment, seepage-slope, channelled valley bottom);
- Amatola (R catchment, channelled valley bottom and seepage);
- Mbashe (T11, T12, T13 catchment, seepage and channelled valley bottom);
- Mthatha (T2 catchment, channelled valley bottom); and
- Wild Coast (T6, T7, T8, T9 catchments, channelled valley bottom and unchannelled valley bottom).

The major aquifer systems associated with the Cape and Karoo Supergroups are mainly of a fractured type, where groundwater occurrence, is as a result of secondary deformation relating to faults, fissures, fractures, bedding planes and joints. The Karoo Supergroup also constitutes a fractured and intergranular aquifer over widespread areas associated with intrusive and extrusive igneous rocks, i.e. dolerite sills and dykes and well as basalt. The quaternary sand and alluvium constitute limited intergranular aquifers in the project area where groundwater occurrence is because of pore spaces between sand particles. Borehole yields in the fractured aquifers vary greatly depending on the lithological unit intersected during drilling and the arenacous: argillaceous ratio within the respective lithological units.

There are 251 coastal drainage systems within the study area, comprising 154 estuaries and a further 97 microsystems. Most of the estuaries in the study area are within the warm temperate marine bioregion (>60%) with the rest within the subtropical bioregion. A large number of estuaries are adjacent to Marine Protected Areas (MPA), including 25 systems in the warm temperature bioregion, such as the Tsitsikamma, the Great Kei and the Pondoland MPAs (Van Niekerk, *et al.,* 2019). Five of the nine different types of estuaries are present in the study area. These include:

i. Small temporarily closed systems,
ii. Large temporarily closed systems,
iii. Small fluvially dominated systems,
iv. Large fluvially dominated systems, and
v. Predominantly open estuaries.

2.2 Strategic Water Source Areas

Strategic Water Source Areas (SWSAs) in accordance with Le Maitre *et al.,* 2018 are described as areas of land that either:

a. Supply relatively large quantity of mean annual surface water runoff, being cognisant of their size and thus considered nationally important;
b. Have high groundwater recharge and where the groundwater forms a nationally important resource/ hotspot; or

c. Areas where surface and groundwater importance are integrated and whereby they include transboundary Water Source Areas that extend into Lesotho and Swaziland (Eswatini).

An update of the 2018 SWSAs have been undertaken in 2021 (Lötter & Maitre, 2021). This updated information has been used and the SWSAs within the study area were identified (see the map in Appendix A, Figure 8-3). The SWSAs are provided for surface water, groundwater and surface water-groundwater interaction. Most of the surface water SWSAs are present along the coast, especially in the Tsitsikamma (K80), Kromme (K90), Upper reaches of R10 (Keiskamma) and R20 (Buffalo), S60 (Kubusi) and the rivers in the T catchments (Mbashe, Mthatha, Pondoland Coastal Rivers). The groundwater SWSAs are scattered throughout the study area, with some inland in the drier Karoo area (upper reaches of Groot, Sundays and Fish Rivers) and along the coast.

2.3 Climate change considerations

Climate change considerations will be added on top of the existing climate variability which is a significant challenge in Southern Africa and the study area.

Suitable climate change literature from recent studies will be referred to, and provide guidelines on the possible impacts on water supply. A possible source is work conducted by the National Treasury and National Planning Commission for the Republic of South Africa (RSA), namely "Biophysical Modelling In Support Of the Systematic Analysis of Climate Resilient Economic Development of the Republic of South Africa". Aurecon in association with Aecon and Econologic and supported by the United National University World Institute for Economics Research (UNU-WIDER), the MIT Global Change Group and the Institute of Civil Systems (iCLICS) at the University of Colorado were involved in this analysis.

For the climate change scenarios, outputs form both Global General Circulation Models (GCMs) and Regional Models including both statistically (empirically) downscaled and dynamically downscaled models, were considered for the period up to mid-century (2050). For the GCMs the study consider all possible model outputs in the form of Hybrid Frequency Distributions (HFD) developed by the MIT Global Change Group (Schlosser, 2012). While the use of multiple climate futures presents significant challenges in terms of impact modelling, the significant advantage is that they provide decision makers with an estimate of the likely risk of a range of possible climate change impacts.

This study presented results for the unconstrained emissions (UCE) case, and a best-case greenhouse gas stabilization scenario in which an equivalent CO_2 concentration of ~480 ppm is achieved by the end of the century – and is referred to as the "Level 1 stabilization" (L1S) policy in Webster et al. (2011). The HFD scenarios are also compared to a number of regional South African climate models that are based on both statistical and dynamic downscaling of selected GCM outputs.

For both the UCE and L1S scenarios, a total of 367 individual 50-year monthly precipitation time-series data sequences were used which were derived in this study based on the Hybrid Frequency Distribution (HFD) methodology (Schlosser et al, 2012).

The projected results compared to the base case scenario (historical data from 1920 to 2000), is provided as follows:

i. Precipitation changes for the more severe UCE scenario in Figure 2-1.
ii. Runoff impacts for the UCE scenario in Figure 2-2, and for the L1S scenario in Figure 2-3.
iii. Irrigation water requirements for the UCE scenario in Figure 2-4. This shows an average impact of around 65 in the country. The L1S scenario impacts are around a 3% increase on average.
iv. Impacts of climate change on water supply potential, compared to the current supply potential, are shown in Figure 2-5, for urban and irrigation water supply for the worst case UCE scenario.

From these figures it can be seen that there are possible impacts in climate change, based on the distribution of the 367 climate change sequences (possible futures). The base-line scenario (current reality) is however typically close enough to the median for the climate change scenarios, which we can conclude is not a significant deviation in the trend of the climate change scenarios to suggest a meaningful impact in one direction or the other from the current water supply potential.

The impacts of climate change on irrigation could result in between a 3% and 6% change in irrigation water requirement, but this can be off-set with improvements in irrigation management, and in some areas by increased precipitation. It is recommended that the potential of increasing irrigation water requirements in the Fish to Tsitsikamma part of the study area are considered when conducting long term scenario analyses.

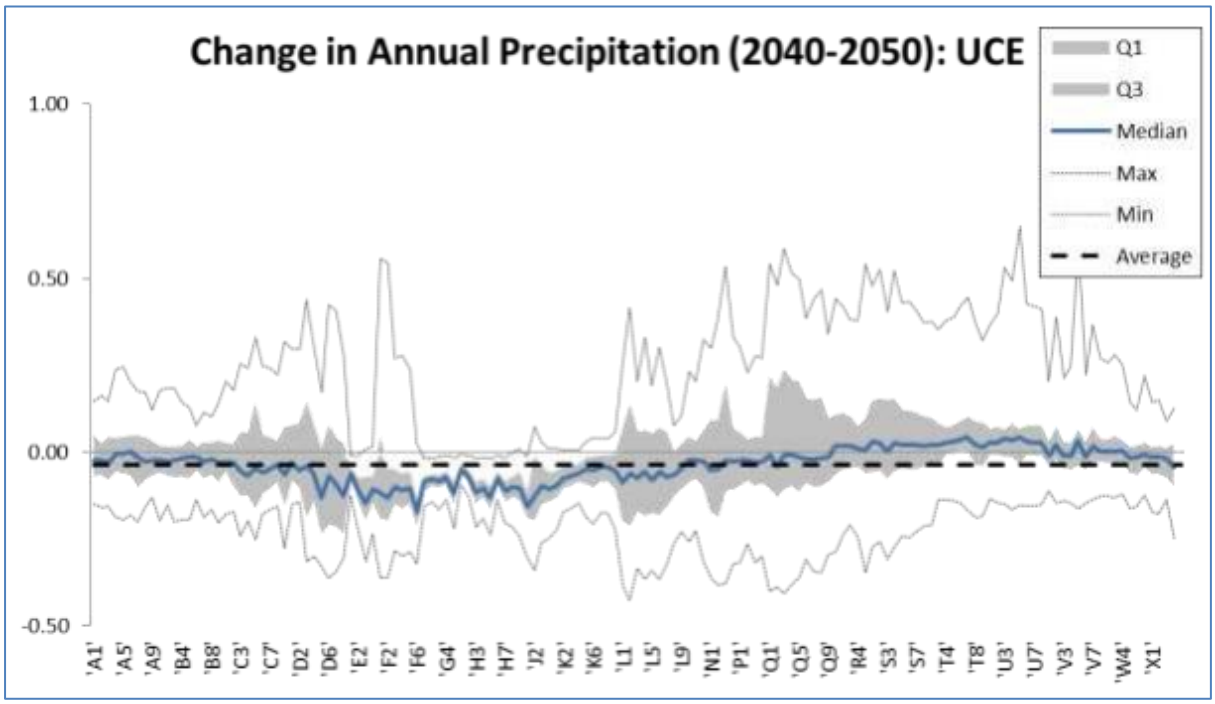


Figure 2-1: Projections of the possible impacts on precipitation of the UCE scenario

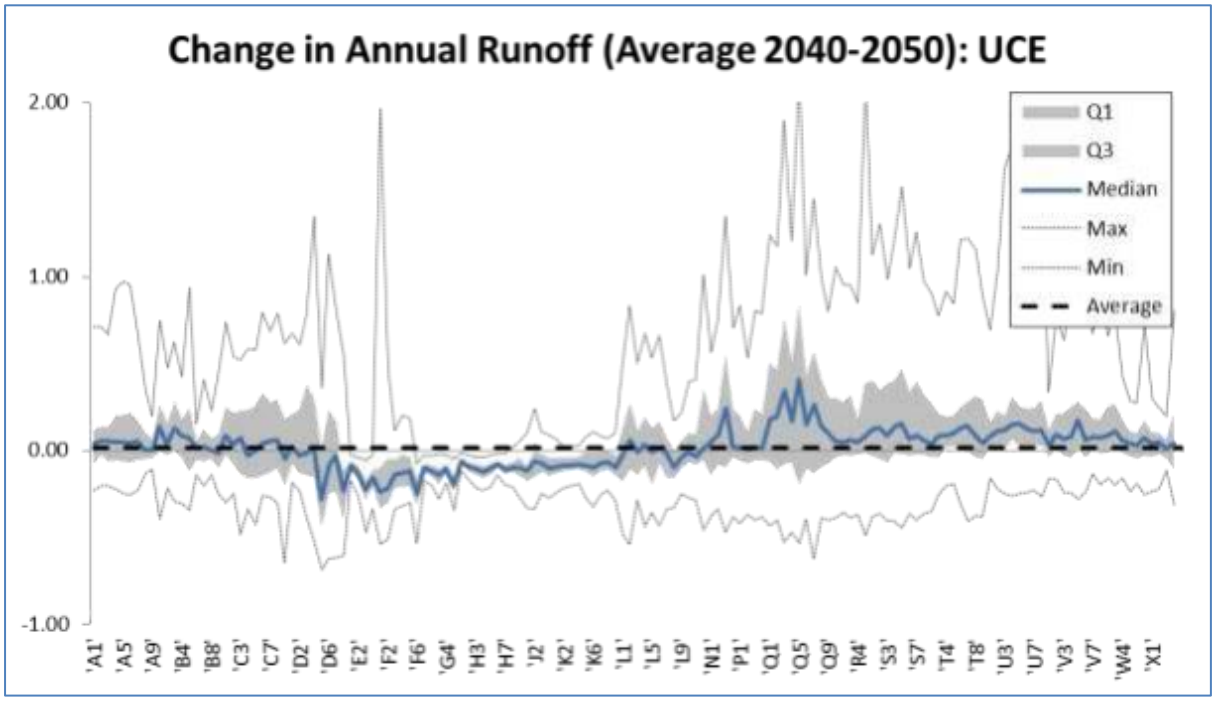


Figure 2-2: Projections of possible runoff impacts for the UCE scenario

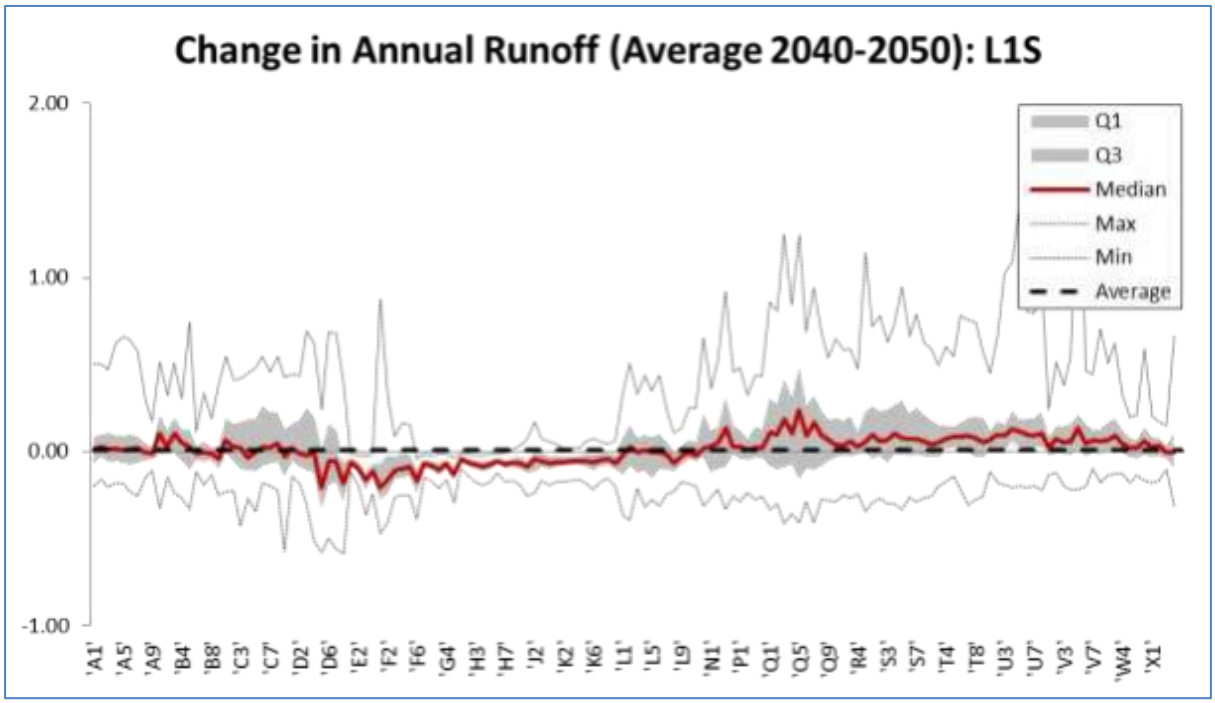


Figure 2-3: Projections of possible runoff impacts for the L1S scenario

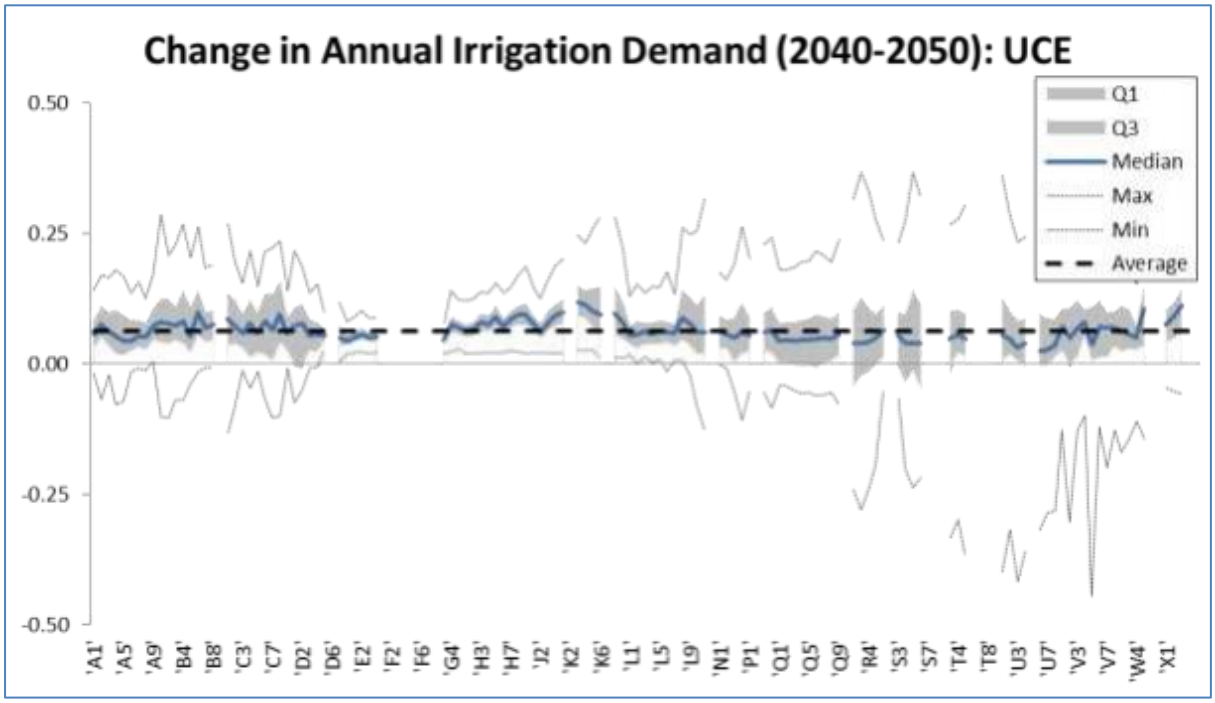
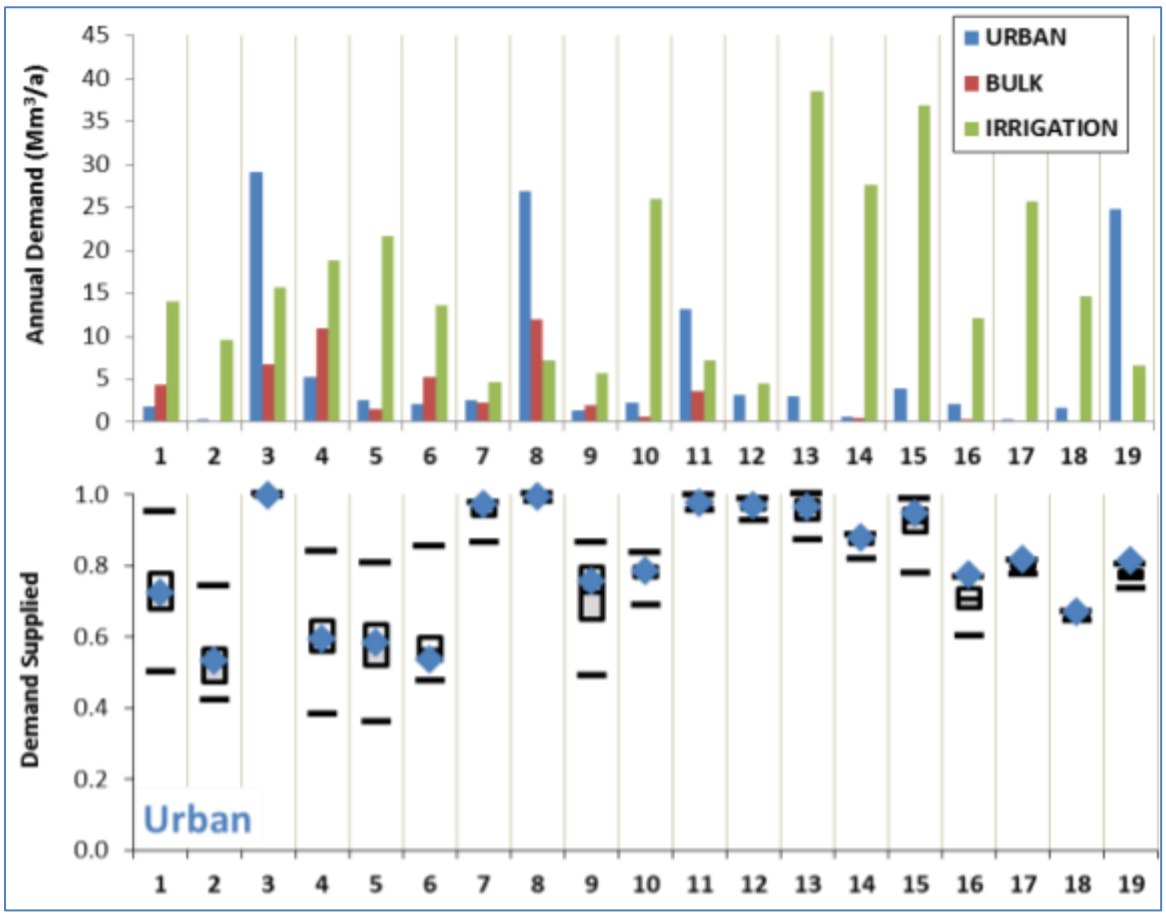


Figure 2-4: Projections of possible irrigation water requirement impacts for the UCE scenario



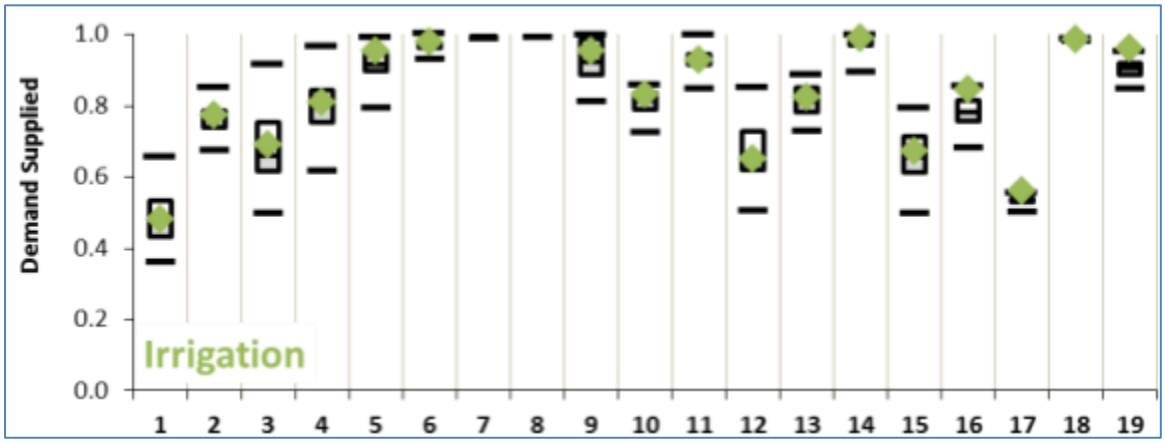


Figure 2-5: Projections of possible urban and irrigation water supply impacts in South Africa

2.4 Socio-economics and ecosystem services

The population of the Keiskamma and Fish to Tsitsikamma catchments was 5.87 million in 2021 (2011 Stats SA census adjustments) and the population is predominately Xhosa speaking. The catchment is mainly rural with a few urban areas in East London, Gqeberha (Port Elizabeth), and Makhanda (Grahamstown). According to Stats SA 2021, the Eastern Cape had the highest unemployment rate, at 47.1% and nationally it was at 34.9%.

The Eastern Cape contributed a GDP of approximately R230.3 billion in the last quarter of 2020, which is a contribution of 7.7% to the total national GDP (ECSECC, 2020). The economy of the Eastern Cape is mainly supported by the tertiary sector (wholesale and retail trade, tourism and communications), followed by the sectors of manufacturing (large proportion by the automotive sub-sector), agriculture and agro-processing.

Key sensitive ecosystem services in these catchments are preliminarily identified as the following:

- Water Provisioning Services provided by the network of rivers, dams and impoundments and Strategic Water Source Areas (SWSA) along the T and S drainage regions.
- Cultural services as indicated by the distribution of protected areas, tourism and community demographics.

3. STATUS QUO OF STUDY AREA

Due to the number of catchments and diversity in the water resources (aquatic ecosystems, groundwater systems, estuaries, wetlands, water infrastructure and socio-economic aspects) in the study area, a broad overview of the status quo of the study area is provided in this section, with the detailed descriptions of the status quo per delineated IUA.

3.1 Rivers

The rivers within the study area have been characterised based on ecoregions, present ecological state, ecological importance and sensitivity, other ecological considerations (fish, vegetation, etc.), hydrological character, geomorphological zonation, water resource infrastructure, water use and water quality impacts. These characteristics provided the basis for the IUA delineation from a river's perspective.

3.1.1 *Ecoregions*

Ecoregions are used to group rivers that are ecologically similar. Thirty-one level I Ecoregions have been delineated for South Africa (Kleynhans *et al*., 2005) based on the terrain and vegetation, altitude, rainfall, runoff variability, air temperature, geology and soil types. Level II ecoregions, which use the same attributes, but include more detail at a finer resolution was defined in 2007 (Kleynhans *et al*., 2007). The ecoregions identified for the study area are presented in Table 3-1.

Table 3-1: Eco-regions that characterise the study area

Ecoregion (Level I)	Ecoregion (Level II)	Description
15	15_6	Easter Escarpment Mountains
16	16_3 16_4 16_5 16_6 16_7	South Eastern Uplands
17	17_1 17_2	North Eastern Coastal Belt
18	18_1 18_2 18_3	Drought Corridor
19	19_1 19_2	Southern Folded Mountains
20	20_1 20_2	South Eastern Coastal Belt
21	21_5	Great Karoo
26	26_3	Nama Karoo

3.1.2 *Present Ecological State*

The Present Ecological State (PES) represents how the ecological condition/ health of a river has changed from its natural or reference conditions. The PES of a river is expressed in terms of various components, *i.e.* drivers (physico-chemical variables, geomorphology and hydrology) and biological responses (fish, riparian vegetation and aquatic macroinvertebrates), as well as in terms of an integrated present state, or the EcoStatus. Results are expressed as categories A to F, with Category A (unmodified) to Category F (severely modified).

In accordance with DWS, 2014, the PES of the river systems throughout the study area are primarily moderately modified (Category C) or largely natural with few modifications (Category B). Many of the river reaches which have a PES Category A (natural, near pristine) or B (largely natural with few modifications) occur within conservation areas.

Less than 10% of the rivers within the whole study area fall within a seriously (Category E) or critically (Category F) modified state.

3.1.3 *Ecological Importance and Sensitivity (EIS)*

The ecological importance (EI) was defined by Kleynhans (1999), and is regarded as an expression of the water resource's ability to maintain the ecological diversity and functioning on local and wider scales. The ecological sensitivity (ES) refers to the river's ability to recover from disturbance. The EI and ES range from low, moderate, high and very high. The results of the EI and ES from the desktop PES/EI/ES study (DWS, 2014) was used to determine the EIS by selecting the highest score of EI and ES. Table 3-2 below gives an indication of the EIS per catchment. Detailed EIS information will be provided per IUA.

Table 3-2: Summary of EIS per catchment in the study area

Catchment	EIS
K80, K90	Mostly high
L10-L70, L90	Moderate to high
L81, L82	Mostly high
M10, M30	Moderate
M20	High
N10	Moderate
N20, N30, N40	Moderate to high
P10	Mostly moderate
P20, P30	Moderate to high

Catchment	EIS
P40	Mostly high
Q10-Q70	Moderate to high
Q80, Q91, Q92, Q93	Moderate
Q94	Mostly high
R10, R40, R50	Mostly high
R20, R30	Moderate to high
S10-S70	Mostly moderate
T11, T12, T13, T20	Mostly moderate
T60-T90	Mostly high

3.1.4 *Protected areas/ NFEPA rivers and Critical Biodiversity Areas (CBA)*

The study area encompasses a range of biodiverse, conservation, national parks, nature reserves, protected areas and heritage sites, all resulting in high tourism (economic gain) within the study area. These include *inter alia*:

- National Parks (Addo Elephant, Tsitsikamma, Garden Route, Mountain Zebra);
- Provincial Nature Reserves (Mkambati, Hluleka, Dwesa-Cwebe, Hamburg, Great Fish, Mpofu, Groendal, Baviaanskloof, Formosa, Doubledrift);
- Private Nature Reserves (Black Eagle Nature Reserve);
- World Heritage Sites (Primary Catchment L includes portion of the Cape Floral Region); and
- Threatened Ecosystems (2011) (includes Langkloof Shael Renosterveld, Albany Alluvial Vegetation, Mount Thesiger Forest Complex, Algoa Sandstone Fynbos, Mthatha Moist Grassland, Ngongoni Veld, Transkei Coastal Forest, Mthatha Moist Grassland and some Midlands Mistbelt Grassland.

Critical Biodiversity Areas (CBA) are areas required to meet biodiversity targets for ecosystems, species and ecological processes, as per biodiversity plans. Ecological Support Areas (ESA) are not essential for meeting biodiversity targets but play an important role in supporting the ecological functioning of CBA and/or in delivering ecosystem services. These areas must be safeguarded in their natural or near-natural state owing to their importance and critical use for conserving biodiversity and maintaining ecosystem functioning (Driver *et al.,* 2012). Much of the study area is categorized as Ecological Support Areas (ESA). Most of the protected areas lie within sub-catchments Q (i.e. Mountain Zebra National Park and Great Fish River Nature Reserve), N (i.e. Camdeboo National Park and Addo Elephant National Park), P and L (i.e. Baviaanskloof Nature Reserve and Formosa Provincial Nature Reserve). Critical Biodiversity Areas one and two predominantly in sub-catchment S and northern parts of L, amongst other areas.

All water resource and future development and utilisations should take cognisance of these sites/ areas to ensure that activities do not threaten the integrity of these areas. This consideration is particularly pertinent where water resource development activities impact on the supply of water resources to these areas and hence their long-term ecological sustainability.

According to the current National Freshwater Ecosystem Priority Areas project, approximately 18% of the study area is categorized as riverine Freshwater Ecosystem Priority Areas (FEPAs), while 11% of the study area is categorized on the basis of supporting areas for fish species (i.e. as either fish support areas or as fish movement corridor) (Appendix A, Figure 8-2). A further 21% of the study area is categorized as Upstream Management Areas, while an additional 4% is categorized as Phase 2 FEPAs. Additionally, over 50% of the river reaches present within the study area are considered to be either Critically Endangered or Endangered according to the latest National Biodiversity Assessment (NBA, 2018), while several coastal river systems, and particularly those of the Mbashe, Mthatha and Wild Coast systems, are considered to be free-flowing rivers, with the Kobonqaba, Nqabarha, Mtakatye and Mtentu rivers categorized as Flagship rivers based on their representativeness of free-flowing rivers across the country, as well as their importance for ecosystem processes and biodiversity value.

The study area also extends across several freshwater ecoregions, including the Southern temperate Highveld, Amatolo-Winterberg Highlands, the Zambezian Lowveld, Karoo and the Cape Fold freshwater ecoregions. Consequently, the study area supports an array of fish fauna that display diverse affinities in most sub-catchments.

Fish sanctuaries for at least 15 indigenous fish species as well as their catchment support areas have been designated as part of the National Freshwater Ecosystem Priority Areas project, many of which are associated with the Amatolo-Winterberg Highlands and the Cape Fold freshwater ecoregions.

3.1.5 *Geomorphological zonation*

Geomorphology describes the physical habitat of the riparian and aquatic ecosystems, as it encompasses the physical processes which have shaped the river channel. Rivers and streams change naturally along their longitudinal profiles with respect to temperature, depth, current speed, substratum, turbidity and chemical composition. The longitudinal physical and chemical changes can be used to classify the reaches of rivers. Rowntree and Wadeson (1999) have developed a zonal classification system based on channel gradient for Southern African rivers.

The concept of river zonation recognises the longitudinal changes in river characteristics associated with the river long profile. Along most rivers, there is a natural progression from the steep mountain stream with coarse substrates through foothill streams with mixed beds to low gradient lowland rivers with wide floodplains and fine bed material. This progression might be disrupted by changes in lithology or tectonics. Based on channel gradient and channel features, the geomorphological zone classes have been defined and are described in Table 3-3. The zones are areas within a catchment that can be considered homogenous with respect to geomorphic processes and available physical habitats.

Table 3-3: Geomorphological zonation of South African river channels (copied from Rowntree and Wadeson, 1999)

Zone class	Zone	Gradient class	Characteristic Features
A	Mountain Headwater Stream	>0.1	A very steep gradient stream dominated by vertical flow over bedrock with waterfalls and plunge pools. Normally first or second order. Reach types include bedrock fall and cascades.
B	Mountain Stream	0.04 – 0.099	Steep gradient stream dominated by bedrock and boulders, locally cobble or coarse gravels in pools. Reach types include cascades, bedrock fall, step-pool.
C	Transitional	0.02 – 0.039	Moderately steep stream dominated by bedrock or boulder. Reach types include plane-bed, pool-rapid or pool-riffle. Confined or semi-confined valley floor with limited floodplain development.
D	Upper Foothills	0.005 – 0.019	Moderately steep, cobble-bed or mixed bedrock-cobble bed channel, with plane-bed, pool-riffle, or pool-rapid reach types. Length of pools and riffles/rapids similar. Narrow floodplain of sand, gravel or cobble often present.
E	Lower Foothills	0.001 – 0.005	Lower gradient mixed bed alluvial channel with sand and gravel dominating the bed, locally may be bedrock controlled. Reach types typically include pool-riffle or pool-rapid, sand bars common in pools. Pools of significantly greater extent than rapids or riffles. Floodplain often present.
F	Lowland River	0.0001 – 0.0009	Low gradient alluvial fine bed channel, typically regime reach type. May be confined, but fully developed meandering pattern within a distinct floodplain develops in unconfined reaches where there is an increased silt content in bed or banks.

The geomorphological zones that occur most frequently in the study area are the Upper Foothill and Lower Foothill, see the breakdown below. This means that the river courses (except for the small steeper headwaters) are largely in a partly confined valley setting and have a mixture of bedrock, cobble, gravel and sand on the bed with small inset benches and possibly sandbars present. Floodplains can occur but are not extensive along most rivers.

- Class A: Mountain Headwater Stream – 1.4%
- Class B: Mountain Stream – 3.4%
- Class C: Transitional – 8.7%
- Class D: Upper Foothills – 49.8%
- Class E: Lower Foothills – 34.8%
- Class F: Lowland River - 1.8%

The zones were included in the delineation of the IUAs, with statistics given of each IUA in Section 4.

3.1.6 *Vegetation*

The vegetation within the study area is highly variable, comprising eight vegetation biomes, seventeen bioregions and notable azonal vegetation (Appendix A, Figure 8-4, Figure 8-5 and Figure 8-6; Mucina & Rutherford, 2006; 2018), and ranges from Nama-Karoo to Forest and Indian Ocean Coastal Belt along a dry-wet gradient. These biomes include Nama- and Succulent Karoo, Fynbos, Albany Thicket, Savanna, Indian Ocean Coastal Belt, Grassland and Forest. The delineation of IUAs has resulted in less variation of vegetation within each IUA, with each IUA being dominated by 2 to 3 biomes at most, however there is additional variation when each biome is segmented into respective bioregions (Figure 8-5). Based on the remaining extent of natural vegetation a few of the IUAs also contain threatened ecosystems (Figure 8-6; SANBI, 2011), mostly variations of Fynbos or Grassland. In addition, primary catchments R, S and T occur within the Maputaland-Pondoland Region of plant endemism. Each IUA is discussed in more detail in the next chapter in respect of vegetation characteristics, threatened ecosystems and threatened species.

Table 3-3: Biome dominance within each IUA (% of total area within IUA).

IUA	Albany Thicket	Azonal Vegetation	Forests	Fynbos	Grassland	Indian Ocean Coastal Belt	Nama-Karoo	Savanna	Succulent Karoo
IUA_K01	2	0	3	95	0	0	0	0	0
IUA_KL01	10	3	0	86	0	0	0	1	0
IUA_L01	7	2	0	91	0	0	0	0	0
IUA_LN01	13	4	0	3	4	0	74	0	2
IUA_M01	53	2	0	40	0	0	0	3	0
IUA_N01	86	4	0	9	0	0	0	1	0
IUA_P01	70	2	2	8	0	0	7	11	0
IUA_Q01	0	1	0	0	11	0	87	0	0
IUA_Q02	18	1	0	0	20	0	60	0	0

IUA	Albany Thicket	Azonal Vegetation	Forests	Fynbos	Grassland	Indian Ocean Coastal Belt	Nama-Karoo	Savanna	Succulent Karoo
IUA_Q03	24	0	1	0	49	0	0	25	0
IUA_R01	32	0	2	0	27	0	0	39	0
IUA_R02	10	0	2	0	33	0	0	55	0
IUA_S01	0	0	0	0	91	0	0	9	0
IUA_S02	0	0	0	0	91	0	0	9	0
IUA_S03	1	0	0	0	60	1	0	38	0
IUA_T01	0	0	0	0	95	0	0	5	0
IUA_T02	0	0	0	0	55	5	0	39	0
IUA_T03	0	0	0	0	74	6	0	19	0
IUA_T04	0	0	1	0	38	12	0	48	0

3.1.7 *Water availability*

The water resources availability and use for the study area are summarised in this section. These water resources include the following which is summarised per quaternary catchment as well as per IUA (Section 4):

1. Natural mean annual runoff (MAR). This includes both incremental and cumulative runoff (with cumulative being relevant for some water use, e.g. larger point abstractions from the main stem rivers or dams);
2. Major dams volumes (water stored); and
3. Minor dams (e.g. farm dams) volumes.

The information has been obtained primarily from the WR2012 study and used as a consolidated single source for reporting purposes to understand the study area perspective. Where revised hydrology is being developed for specific areas within the study area, e.g. reconciliation strategy updates, these

will be incorporated into the more detailed modelling and analyses to be conducted as part of the overall classification process.

These natural annual flows per quaternary catchment and IUA are an indication of the original average flows that occurred before the influence of consumptive use and man-made infrastructure. Water availability for the environment and existing and potential future water users will need to take the following into account:

- Suitable levels of risk and non-supply considering climate variability; and
- Existing land-use and upstream development as provided.

These factors determine the sustainable yields of water available and will require the use of water resources models to confirm, and scenarios to assess the impacts. This has already been done extensively for the larger water supply systems, and the existing water resources availability established through these methods is shown for the Algoa WSS in Table 3-4. The yields of the main water resources as water availability in the Amatola WSS are shown in Table 3-5.

Please refer to Table 3-6 for a summary of naturalised annual average flows per quaternary catchment and IUA.

Table 3-4: Water availability of the Algoa WSS

Sources of supply	1 in 50 year yield or existing allocation/use (million m^3/a)	1 in 20 year yield or existing allocation/use (million m^3/a)
NMBM older dams	3.3	4.0
Groendal Dam	6.5	6.5
Uitenhage Springs	2.4	2.4
Churchill/Impofu dams	44.4	51.0
Kouga/Loerie dams	75.5	86.0
Sundays River GWS	25.6	25.6
Re-use	1.7	1.7
Combined Total Yield	**159.4**	**177.2**

Table 3-5: Water availability of the Amatola WSS

Dam	Yield (million m^3/a)	
	Scenario 1[6] Transfer when Wriggleswade Dam is Spilling	**Scenario 2[5]** Transfer from Wriggleswade Dam only when required
Maden	0.5	0.5
Rooikrantz	3.7	3.7
Gubu	2.9	2.9
Wriggleswade	93.6	87.3
Laing		
Bridledrift		
Nahoon		
Sub-total	**100.7**	**94.4**
Total yield including return flows	**106.4**	**100.1**

Notes:-
1. Yields are at 98% assurance of supply.
2. EWRs are not included.
3. Transfer losses from Wriggleswade Dam are included.
4. The possible impact of climate change is not included.
5. Current approved operating rules.
6. Operating rule put forward to DWA for consideration for implementation.

Table 3-6: Summary of natural Annual Average flows per quaternary catchment and IUA

IUA	IUA code	Quaternary	MAR	Cumulative MAR	Large Dams Storage Capacity	Small dams combined Capacity
			million m^3/a	million m^3/a	million m^3	million m^3
1	IUA_K01	K80A	62.86	62.86		
		K80B	88.5	88.5		0.10
		K80C	84.35	84.35		
		K80D	63.43	63.43		1.52
		K80E	54.91	54.91		6.44
		K80F	41.18	41.18	3.50	1.68
		K90A	27.85	27.85		0.19
		K90B	23.89	51.74	35.70	
		K90C	12.64	12.64		0.43
Total for IUA1			**459.61**		**39.20**	**10.37**
2	IUA_KL01	K90D	16.43	80.81	106.90	0.57
		K90E	11.83	92.64		0.38
		K90F	18.7	18.7	1.10	2.81
		K90G	16.46	16.46		0.90
		L90A	19.48	440.62		0.12
		L90B	38.03	478.65		0.10
		L90C	18.63	497.28	3.38	0.05
Total for IUA2			**139.56**		**111.38**	**4.92**
3	IUA_L01	L81A	17.8	17.8		
		L81B	8.91	26.71		

IUA	IUA code	Quaternary	MAR	Cumulative MAR	Large Dams Storage Capacity	Small dams combined Capacity
			million m^3/a	million m^3/a	million m^3	million m^3
		L81C	12.25	38.96		
		L81D	9.13	48.09		
		L82A	17.81	17.81	4.76	1.30
		L82B	35.83	53.64		1.55
		L82C	33.3	86.94		3.73
		L82D	42.76	129.7		1.96
		L82E	25.38	155.08		
		L82F	8	163.08		
		L82G	10.44	173.52		
		L82H	7.65	229.26	128.50	
		L82J	6.14	6.14		
Total for IUA3			**235.4**		**133.26**	**8.54**
4	IUA_M01	M10A	20.02	20.02	12.36	
		M10B	33.06	33.06		3.33
		M10C	38.41	91.49		
		M10D	7.68	99.17		0.10
		M20A	22.69	22.69		
		M20B	49.74	49.74		0.75
		M30A	6.05	6.05		
		M30B	4.98	11.03		
Total for IUA4			**182.63**		**12.36**	**4.18**
5	IUA_LN01	L11A	5.82	5.82		1.88
		L11B	6.97	12.79		0.09
		L11C	4.91	17.7		0.11
		L11D	8.78	8.78		0.85
		L11E	3.6	30.08		
		L11F	4.94	4.94		0.62
		L11G	9.58	44.6		
		L12A	2.4	2.4		3.97
		L12B	2.23	46.83		
		L12C	2.52	51.75		0.56
		L12D	2.95	54.7		0.76
		L21A	5.72	5.72		0.20
		L21B	9.68	15.4		
		L21C	10.04	10.04		1.55
		L21D	15.68	15.68		1.08
		L21E	6.4	32.12		0.25
		L21F	5.82	53.34		0.09
		L22A	8.17	61.51		0.50
		L22B	2.71	64.22		1.79
		L22C	6.01	6.01		
		L22D	6.57	76.8		0.53
		L23A	1.95	78.75		1.10
		L23B	6.54	85.29		0.19
		L23C	3.58	88.87		

IUA	IUA code	Quaternary	MAR	Cumulative MAR	Large Dams Storage Capacity	Small dams combined Capacity
			million m^3/a	million m^3/a	million m^3	million m^3
		L23D	2.79	91.66		
		L30A	1.62	1.62		2.18
		L30B	1.09	2.71		0.70
		L30C	0.96	147.32	90.83	1.08
		L30D	1.58	151.61		
		L40A	1.58	1.58		0.13
		L40B	1.83	3.41		
		L50A	2.4	2.4		1.15
		L50B	2.02	159.44		0.14
		L60A	1.88	1.88	1.81	
		L60B	1.46	3.34		
		L70A	1.69	1.69		
		L70B	0.82	165.29		
		L70C	1.66	166.95		
		L70D	1.73	168.68		0.24
		L70E	3.33	172.01		0.41
		L70F	2.11	174.12		
		L70G	11.62	185.74		
		N11A	7.32	7.32		1.29
		N11B	5.99	13.31	2.45	2.45
		N12A	7.64	7.64		0.19
		N12B	7.11	7.11		
		N12C	6.21	34.27		
		N13A	7.44	7.44		0.83
		N13B	6.09	13.53		0.25
		N13C	3.3	51.1	47.20	
		N14A	4.53	4.53		
		N14B	3.7	8.23		
		N14C	18.61	18.61		1.49
		N14D	4.51	31.35	16.00	
		N21A	3.79	86.24		0.27
		N21B	11.02	11.02		0.19
		N21C	9.74	20.76		1.18
		N21D	5.44	112.44		
		N22A	7.05	7.05		0.45
		N22B	3.48	3.48		
		N22C	3.54	148		
		N22D	5.24	5.24		
		N22E	2.55	155.79		
		N23A	*9.05*	9.05		
		N23B	*2.73*	197.31	187.00	
		N24A	5.84	5.84		0.36
		N24B	5.92	124.2		0.25
		N24C	7.53	131.73		0.19
		N24D	2.2	133.93		

IUA	IUA code	Quaternary	MAR	Cumulative MAR	Large Dams Storage Capacity	Small dams combined Capacity
			million m^3/a	million m^3/a	million m^3	million m^3
		N30A	17.69	17.69		0.53
		N30B	8.22	25.91		
		N30C	3.83	29.74		
Total for IUA5			**383.05**		**345.29**	**32.03**
6	IUA_N01	N40A	6.98	204.29		
		N40B	8.86	213.15		0.28
		N40C	14.59	227.74		0.48
		N40D	14.07	14.07		0.82
		N40E	4.02	245.83		0.24
		N40F	17.28	263.11		
Total for IUA6			**65.8**		**0.00**	**1.81**
7	IUA_P01	P10A	1.87	1.87		1.49
		P10B	4.65	6.52	4.70	0.57
		P10C	0.73	0.73		0.13
		P10D	2.23	9.48		0.22
		P10E	8.91	18.39		
		P10F	14.32	32.71		0.82
		P10G	10.38	43.09		0.08
		P20A	32.37	32.37		
		P20B	16.14	16.14		
		P30A	8.07	8.07		1.47
		P30B	12.09	20.16	5.62	7.88
		P30C	1.73	21.89		
		P40A	15.19	15.19		1.35
		P40B	8.54	23.73		0.60
		P40C	15.27	39	2.50	0.42
		P40D	14.47	14.47		0.32
Total for IUA7			**166.96**		**12.82**	**15.33**
8	IUA_Q01	Q11A	5.92	5.92		0.50
		Q11B	4.09	10.01		
		Q11C	3.81	3.81		
		Q11D	3.78	17.6		
		Q14A	6.27	6.27		
		Q14B	9.1	15.37		
		Q14C	8.36	23.73	1.67	0.13
		Q14D	3.04	26.77		3.56
		Q14E	3.01	29.78		0.32
		Q21A	7.3	7.3		0.59
		Q21B	2.9	18.34		0.12
		Q22A	6.01	6.01		
		Q22B	2.13	8.14		
		Q30A	5.94	5.94		
		Q30B	4.77	10.71		0.11
		Q80A	14.34	14.34		
		Q80B	16.55	30.89		0.62

IUA	IUA code	Quaternary	MAR	Cumulative MAR	Large Dams Storage Capacity	Small dams combined Capacity
			million m^3/a	million m^3/a	million m^3	million m^3
		Q80C	10.87	41.76		
Total for IUA8			**118.19**		**1.67**	**5.95**
9	IUA_Q02	Q12A	7.87	7.87		0.68
		Q12B	9.58	9.58		0.43
		Q12C	3.5	20.95		
		Q13A	8.4	46.95	46.20	
		Q13B	1.64	96.71		
		Q13C	3.68	100.39		0.06
		Q30C	4.49	115.59		0.11
		Q30D	3.76	119.35		0.09
		Q30E	4.03	123.38		0.10
		Q41A	7.44	7.44		0.43
		Q41B	7.89	15.33	0.88	
		Q41C	5.38	20.71		0.06
		Q41D	2.59	54.33	51.80	
		Q42A	9.28	9.28		0.21
		Q42B	6.2	15.48		
		Q43A	8.97	8.97		0.49
		Q43B	6.58	15.55		0.39
		Q44A	4.13	58.46		
		Q44B	3.1	61.56	29.25	
		Q44C	2.22	63.78		
		Q50A	8.34	195.5	6.99	
		Q50B	6.37	201.87		0.12
		Q50C	3.14	205.01		
		Q60A	5.06	5.06		0.19
		Q60B	6.95	12.01		
		Q60C	1.4	13.41		
		Q70A	4.63	223.05		0.21
		Q70B	5.99	229.04		0.06
		Q70C	2.81	231.85		0.93
		Q93A	4.14	510.32		
		Q93B	6.03	516.35	6.50	0.61
		Q93C	6.73	523.08		3.36
		Q93D	14.7	537.78		0.32
		Q80D	25.36	67.12		0.41
		Q80E	12.79	79.91	4.07	
		Q80F	7.54	7.54		
		Q80G	2.94	90.39		0.37
		Q91A	6.49	328.73		0.66
		Q91B	10.25	338.98		0.41
		Q91C	8.63	347.61		0.86
Total for IUA9			**261.02**		**145.69**	**11.56**
10	IUA_Q03	Q92A	21.25	21.25		0.10
		Q92B	11.19	32.44		

IUA	IUA code	Quaternary	MAR	Cumulative MAR	Large Dams Storage Capacity	Small dams combined Capacity
			million m^3/a	million m^3/a	million m^3	million m^3
		Q92C	16.64	49.08		1.38
		Q92D	10.76	10.76		1.82
		Q92E	3.42	63.26		
		Q92F	4.24	4.24		0.48
		Q92G	9.47	76.97		0.26
		Q94A	18.31	18.31	24.69	
		Q94B	11.22	29.53		
		Q94C	29.53	59.06		
		Q94D	8.21	67.27		
		Q94E	5.21	5.21		0.45
		Q94F	9.12	81.6		0.67
Total for IUA10			**158.57**		24.69	5.15
		R10A	10.52	10.52		
		R10B	33.39	43.91	0.82	
		R10C	9.12	53.03		
		R10D	9.8	62.83		
		R10E	6.03	68.86	0.78	
		R10F	20.17	20.17		
		R10G	6.45	26.62	2.94	
		R10H	6	32.62		
11	IUA_R01	R10J	3.9	105.38		
		R10K	13.85	119.23		
		R10L	12.71	131.94		
		R10M	9.84	141.78		
		R40A	41.72	41.72		
		R40B	22.58	22.58		
		R40C	17.37	39.95		
		R50A	19.36	19.36		
		R50B	20.51	20.51		
Total for IUA11			**263.32**		**4.54**	**0.00**
		R20A	40.65	40.65	0.76	
		R20B	13.41	63.3		
		R20C	9.24	9.24		
		R20D	6.98	70.28		
		R20E	12.56	82.84	2.04	
		R20F	27.44	110.28	7.46	
12	IUA_R02	R20G	13.6	123.88	0.17	1.70
		R30A	48.18	48.18		
		R30B	45.75	45.75		0.48
		R30C	24.63	24.63		0.82
		R30D	13.56	38.19		
		R30E	29.94	29.94	2.35	
		R30F	23.71	53.65		0.53
Total for IUA12			**309.65**		**12.78**	**3.53**
13	IUA_S01	S10A	6.02	6.02		

IUA	IUA code	Quaternary	MAR	Cumulative MAR	Large Dams Storage Capacity	Small dams combined Capacity
			million m^3/a	million m^3/a	million m^3	million m^3
		S10B	12.52	18.54		
		S10C	6.18	24.72		
		S10D	9.3	34.02		
		S10E	7.81	41.83	1.31	
		S10F	11.17	11.17	0.74	
		S10G	12.77	23.94		
		S10H	18.79	84.56		
		S10J	13.07	167.81		
		S20A	11.15	11.15	3.65	
		S20B	19.05	30.2		
		S20C	24.82	55.02	11.29	
		S20D	15.16	70.18		
		S40A	18.03	18.03		0.98
		S40B	18.46	18.46		
		S40C	14.22	50.71		
		S40D	7.72	394.34		
		S40E	28.05	473.1		
		S40F	20.64	493.74		
		S50A	19.39	19.39		
		S50B	39.97	39.97		
		S50C	23.57	82.93		
		S50D	29.62	112.55		
		S50E	55.53	168.08	13.92	
		S50F	4.42	4.42	2.36	
		S50G	24.24	196.74		
		S50H	19.03	19.03		
		S50J	44.51	260.28		
Total for IUA13			**535.21**		**33.27**	**0.98**
		S31A	11.07	11.07		
		S31B	10.56	21.63		
		S31C	8.91	8.91		1.85
		S31D	7.37	7.37		
		S31E	6.27	44.18		
		S31F	7.44	7.44	1.47	
		S31G	5.71	57.33		
		S32A	8.31	8.31	1.10	
14	IUA_S02	S32B	9.06	17.37	0.02	
		S32C	11.21	28.58		2.60
		S32D	33.51	33.51		
		S32E	24.56	58.07	2.61	
		S32F	13.57	13.57	0.55	
		S32G	5.88	77.52	2.20	
		S32H	5.28	111.38		
		S32J	9.06	9.06		
		S32K	12.71	190.48		

IUA	IUA code	Quaternary	MAR	Cumulative MAR	Large Dams Storage Capacity	Small dams combined Capacity
			million m^3/a	million m^3/a	million m^3	million m^3
		S32L	9.55	9.55		
		S32M	18.78	218.81		
Total for IUA14			**218.81**		**7.95**	**4.45**
15	IUA_S03	S60A	70.1	70.1	1.08	
		S60B	7.43	77.53	10.00	
		S60C	19.36	19.36		
		S60D	16.38	35.74		
		S60E	15.37	128.64		
		S70A	29.83	912.49		
		S70B	17.17	929.66		
		S70C	15.75	15.75	2.73	
		S70D	46.86	62.61		
		S70E	31.32	93.93	0.40	
		S70F	32.44	1056.03		
Total for IUA15			**302.01**		**14.21**	**0.00**
16	IUA_T01	T11A	33.78	33.78		
		T11B	45.58	45.58		
		T11C	66.54	145.9		
		T11D	58.33	58.33		
		T11E	51.33	51.33		
		T11F	56.85	166.51		
		T11G	36.9	203.41		
		T11H	24.8	374.11		
		T12A	36.98	36.98		
		T12B	23.93	60.91		
		T12C	27.4	27.4		
		T12D	31.18	58.58		
		T12E	42.43	42.43		
		T12F	37.65	199.57		
		T12G	26.06	225.63		
		T20A	122.49	122.49	0.52	2.10
Total for IUA16			**722.23**		**0.00**	**0.00**
17	IUA_T02	T13A	40.91	640.65		
		T13B	32.74	673.39		
		T13C	39.44	712.83		
		T13D	45.95	758.78		
		T13E	28.09	786.87		
Total for IUA17			**187.13**		**0.00**	**0.00**
18	IUA_T03	T20B	84.44	206.93	25.41	
		T20C	41.09	248.02		
		T20D	31.73	279.75	0.14	
		T20E	37.24	316.99	0.33	
		T20F	36.27	36.27		
		T20G	35.92	389.18		
Total for IUA18			**266.69**		**25.88**	**0.00**

IUA	IUA code	Quaternary	MAR	Cumulative MAR	Large Dams Storage Capacity	Small dams combined Capacity
			million m^3/a	million m^3/a	million m^3	million m^3
19	IUA_T04	T60A	74.35	74.35		
		T60B	77.98	77.98		
		T60C	64.37	142.35		
		T60D	104.16	246.51		
		T60E	28.81	28.81		
		T60F	93.56	122.37		
		T60G	101.56	223.93		
		T60H	128.27	128.27	0.26	
		T60J	80.27	80.27		
		T60K	61.93	61.93		
		T70A	38.61	38.61	0.26	
		T70B	53.51	92.12		
		T70C	30.91	30.91		
		T70D	69.86	100.77		
		T70E	24.8	24.8		
		T70F	41.05	65.85		
		T70G	43.55	43.55		
		T80A	43.16	43.16		
		T80B	38.02	38.02		
		T80C	32.02	32.02		
		T80D	50.96	82.98		12.13
		T90A	18.88	18.88		
		T90B	72.98	91.86		
		T90C	49.19	49.19		
		T90D	33.75	33.75		
		T90E	55.82	89.57		
		T90F	48.95	48.95		
		T90G	51.72	51.72		
Total for IUA19			**1613.0**		**0.52**	**12.13**

3.1.8 *Water resources infrastructure*

A number of large dams and transfers between catchments are present within the study area. The list of larger dams and their associated names and construction dates are provided in Table 3-7. This provides an indication of how long these ecological interruptions have been in place.

The largest transfer scheme is the water that is transferred into the study area from the Gariep Dam (Upper Orange) to the upper reaches of the Great Fish River (Grassridge Dam). The water is used mostly for irrigation within the Great Fish and lower Little Fish Rivers catchments, with some domestic use by the towns in the catchment. Further to the latter is the transfer of water to the Algoa System for domestic water use. These transfers and dams provide water for domestic, industrial and irrigation water use. There are numerous other smaller dams within the catchment, mainly for irrigation and local domestic and rural water use purposes. The effects of the numerous dams and transfers on the water resources in the study area, have impacted on the wellbeing of the water resources health.

The descriptions of the dams and transfers with possible impacts on the aquatic ecosystems will be described as part of each identified IUA.

The layout of the Fish-Sundays transfer scheme is provided in Figure 3-1. According to the Water Reconciliation Strategy study for the Algoa Water Supply Area (DWA 2011), the inter-basin water transfer from the Gariep Dam on the Orange River contributes about 560 million m^3/a to the Fish and Sundays Rivers, mainly for irrigation and to dilute the salinity levels in these rivers, when there is surplus water in the Orange River system. Current water supply for irrigation from the Orange River to the Lower Sundays River Water User Association (LSRWUA) is about 99 million m^3/a, and as an emergency measure the Nelson Mandela Bay Municipality (NMBM) is currently abstracting about 33 million m^3/a.

Table 3-7: Large Dams in the Study area

Quaternary Catchment	IUA	Major Dam Code and Name	River	Year Constructed
K80F	1	Klipdrif Dam	Klipdrif	1990
K90B	1	Kromme (Churchill) Dam (K9R001)	Krom	1943
K90D	2	Impofu Dam (K9R002)	Krom	1982
K90F	2	Zalverige Valley Dam	Palmiet	1999
L30C	5	Beervlei Dam (L3R001)	Groot	1975
L60A	5	Klipfontein Dam	Heuningklip	1957
L82A	3	Haarlem Dam	Groot	1991
L82H	3	Kouga Dam (L8R001)	Kougha	1969
L90C	2	Loerie Dam (L9R001)	Loerie	1971
M10A	4	Groendal Dam (M1R001)	Swartkops	1933
N11B	5	Bloemhof Dam	Rubidgespruit	1964
N13C	5	Nqweba Dam (N1R001)	Sundays	1922
N14D	5	De Hoop Dam	Kamdeboo	1964
N23B	5	Darlington Dam (N2R001)	Sundays	1922
P10B	7	New Years Dam / Nuwejaars (P1R003)	New Years	1959
P30B	7	Settlers Dam (P3R002)	Kariega	1962
P40C	7	Bathurst Stream Dam	Bathurst Stream	1986
Q13A	9	Grassridge Dam (Q1R001)	Great Brak	1924
Q14C	9	Kelly-Patterson Dam	Oompies	1951
Q41B	9	Nettle Grove Dam	Tarka tributary	1956
Q41D	9	Kommandodrift Dam (Q4R002)	Tarka	1956
Q44B	9	Lake Arthur (Q4R001)	Tarka	1924
Q50A	9	Elandsdrift Dam (Q5R001)	Great Fish	1977
Q80E	9	De Mistkraal Dam (Q8R001)	Little Fish	1987
Q93B	9	Glen Melville Dam	Brak	-
Q94A	10	Kat River Dam (Q9R001)	Kat	1969

Quaternary Catchment	IUA	Major Dam Code and Name	River	Year Constructed
T20A	16	Mabeleni (T2R002)	Unnamed	1995
T20B	18	Mtata Dam (T2R001)	Mtata	1977
T20D	18	Corona (T2R003)	Mtata	1996
T20D	18	Firstfalls	Mtata	1997
T20E	18	Secondtfalls	Mtata	1997
T60H	19	Magwa Dam (T6R001)	Mkosi	1978
T70A	19	Mhlanga Dam (T2R004)	Mngazi	1979
S10E	13	Xonxa Dam (S1R001)	Uitkei	1980
S10F	13	Macubeni Dam	Uitkei	1992
S20A	13	Doorn River Dam (S2R002)	Doorn	1970
S20C	13	Lubisi Dam (S2R001)	Doorn	1968
S31F	14	Bongolo Dam (S3R002)	Groot Kei	1908
S32A	14	Thrift Dam	Swartklei	1976
S32B	14	Tentergate Dam	Unnamed	1996
S32E	14	Waterdown Dam (S3R001)	Kliplaat	1957
S32F	14	Bushmanskrans Dam	Kliplaat	1983
S32G	14	Oxkraal Dam (S3R003)	Kliplaat	1989
S50E	13	Ncora Dam (S5R001)	Ncora	1976
S50F	13	Tsojana Dam (S5R002)	Tsomo	1978
S60A	15	Gubu Dam (S6R001)	Kubusi	1970
S60B	15	Wriggleswade Dam (S6R002)	Kubusi	1991
S70C	15	Xilinxa Dam /Xhina Dam (S7R002)	Gcuwa	1984
S70E	15	Gcuwa Dam (S7R001)	Gcuwa	1973
R10B	11	Cata Dam (R1R002)	Trib. Of Keiskamma	1990
R10B	11	Sandile Dam (R1R001)	Keiskamma	1982
R10B	11	Mnyameni Dam	Trib. Of Keiskamma	1975
R10E	11	Debe Dam	Keiskamma	1987
R10G	11	Pleasant View	Trib. Of Keiskamma	1984
R10G	11	Binfield Dam (R1R003)	Trib. Of Keiskamma	1986
R20A	12	Rooikrantz Dam (R2R002)	Buffels	1950
R20E	12	Laing Dam (R2R001)	Buffels	1948
R20F	12	Bridle Drift Dam (R2R003)	Buffels	1968
R20G	12	Umzoniana Dam	Trib.of Buffels	1922
R30E	12	Nahoon Dam (R3R001)	Nahoon	1966

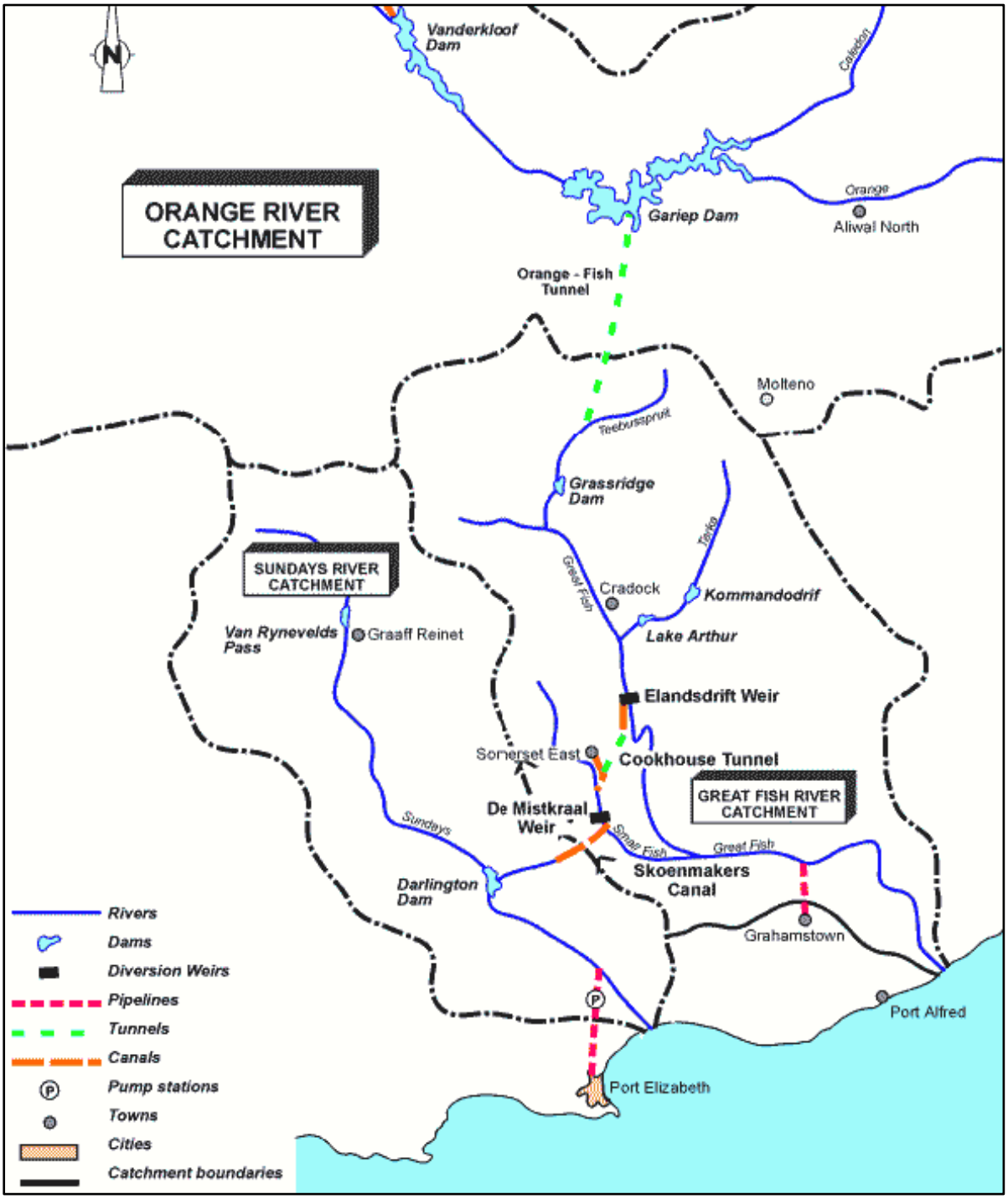


Figure 3-1: Infrastructure of the Fish-Sundays Transfer Scheme

The larger water supply systems also have considerable water conveyance infrastructure to deliver water to the metropolitan municipalities that serve the cities of Nelson Mandela Bay (Gqeberha/ Port Elisabeth) and Amatole (East London). The Nelson Mandela Bay system is known as the Algoa Water Supply Area and System, and is presented in Appendix C, Figure 8-10. The key transfer infrastructure of the Amatola Water supply system is shown in Figure 3-2.

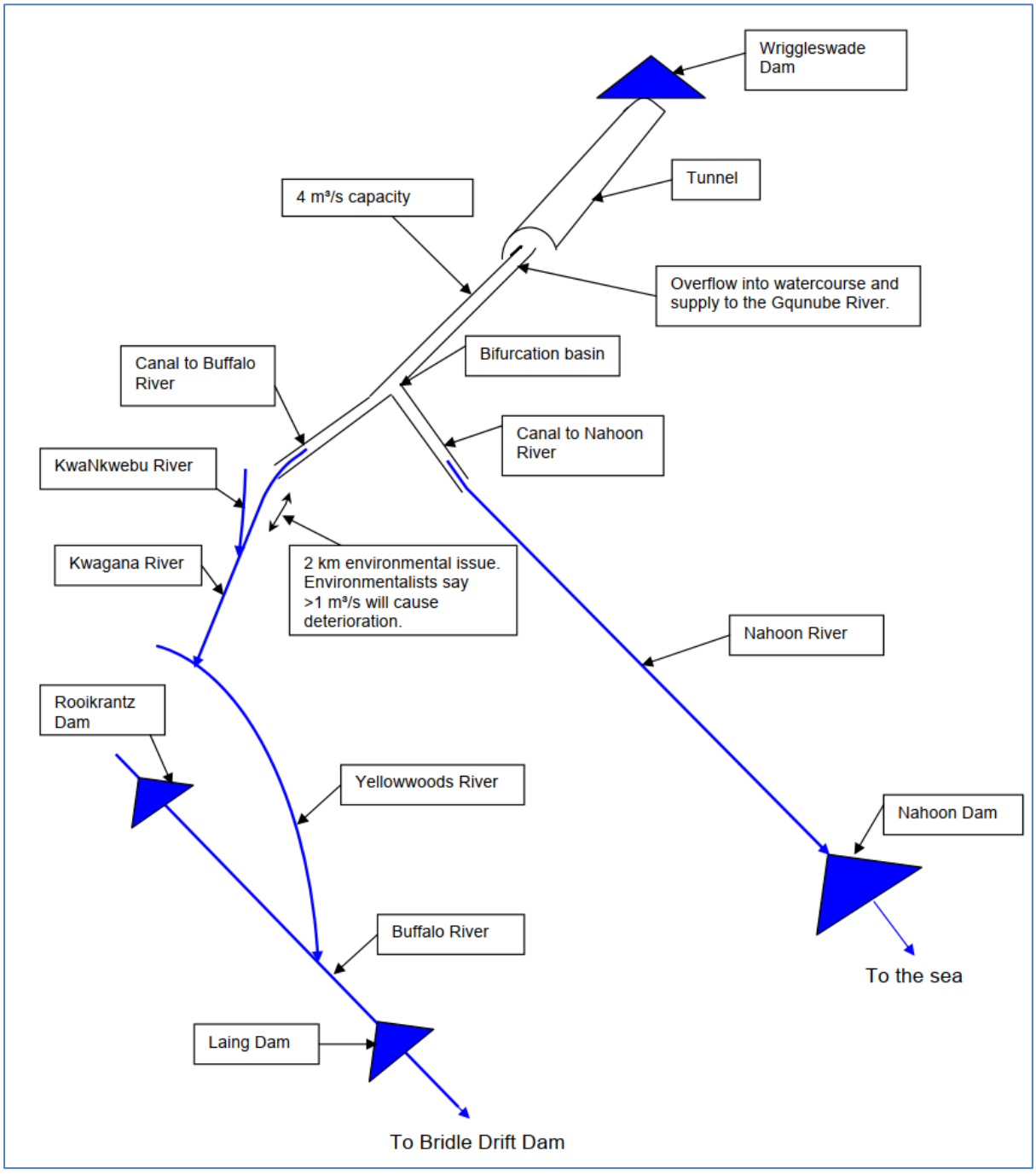


Figure 3-2: Key water resources infrastructure of the Amatola WSS

There are four existing hydropower plants in the study area that are of a scale notable to this study. These are:

- Colly Wobbles Hydropower Scheme.
- Ncora Hydropower Station
- 1st Falls Hydropower Station, and
- 2nd Falls Hydropower Station

Colly Wobbles Hydropower scheme

This scheme was built in 1985 and reportedly can generate up to 42 MW of power. It is located in the T13D quaternary catchment that lies in IUA17. The scheme makes use of around 2 m^3/s of water in the Mbashe River. The hydropower is generated through a 135m head because of bypassing a 34km stretch of river. Flows in the Mbashe River are supported through releases from the Ncora Dam (that are transferred from the Kei to the Mbashe catchment). The water diverted from the Ncora Dam catchment to the Mbashe River ranges between about 115 and 150 million cubic metres annually over the four years prior to 2008. The scheme can operate continuously in the summer months but drops down to around 70% utilisation with a focus on peaking power in the drier winter months. The scheme has some challenges with silt build up in the upstream storage of the penstock.

Ncora Hydropower

The Ncora Dam was built in 1972 and is located at the outlet of quaternary S50E (IUA13). This scheme is able to generate some power while the main purpose of the Ncora Dam is for irrigation supply, much of which is located in the headwaters of the Mbashe, i.e. T12C (IUA16). The scheme reportedly can generate up to 2 MW of peaking power. More information of the nature of the hydropower releases versus those transferred to the Mbashe River will be sought for the more detailed water resources modelling analyses.

1st and 2nd Falls hydropower

These two hydropower schemes are reportedly located near Mtata in quaternaries T20D and T20E with 6 and 11 MW output respectively. They are run of river schemes that utilise flows in the Mthatha River and those released form the Mthatha Dam. They are reportedly for peaking power, however, additional information will be required on their operation and releases from Mthatha Dam to better understand the impacts on the water resource.

3.1.9 *Water use*

The water use per quaternary catchment and summarised per IUA is provided in Table 3-8.

Table 3-8: Water users in the study area

IUA	IUA code	Quaternary	Registered Volume / Estimated water use						Contributing Area		
			WARMS Database		WR2012 Database				WR2012 Database		
			Water Use Sector						Water Use Sector		
			Agriculture (m^3/a)	Industry (m^3/a)	Domestic (m^3/a)	Afforestation (m^3/a)	Alien Veg (m^3/a)	Irrigation (m^3/a)	Afforestation Area (km^2)	Alien Vegetation Area (km^2)	Irrigation Area (km^2)
1	UIA_K01	K80A	0	93740	10240	3900000	360000	600000	39	3	1
		K80B	900500	540000	0	4500000	1080000	600000	45	9	1
		K80C	8531628	8950	993974	5100000	1200000	1800000	51	10	3
		K80D	19907867	159940	19200	2600000	1920000	600000	26	16	1
		K80E	17611760	151381	57061.9	2100000	1320000	600000	21	11	1
		K80F	11372228	387898	689581	0	3240000	0		27	
		K90A	4227928	0	250620.3	0	960000	1200000		8	2
		K90B	1730100	0	700	100000	960000	600000	1	8	1
		K90C	2597348	0	60310	0	960000	1200000		8	2
Total for IUA1			**66879359.3**	**1341909**	**2081687.2**	**18300000**	**12000000**	**7200000**	**183**	**100**	**12**
2	IUA_KL01	K90D	3417335	42000	78786	0	1080000	600000		9	1
		K90E	3366700	0	444730	0	4080000	600000		34	1
		K90F	11985933	40000	1242823	200000	720000	600000	2	6	1
		K90G	6891506.4	20334	2691323	0	240000	1200000		2	2
		L90A	4227928	0	250620.3	0	480000	19200000		4	32
		L90B	1730100	0	700	2900000	240000	13800000	29	2	23
		L90C	2597348.3	0	60310	6000000	600000	12000000	60	5	20
Total for IUA2			**34216850.7**	**102334**	**4769292.3**	**9100000**	**7440000**	**48000000**	**91**	**62**	**80**
3	IUA_L01	L81A	362300	0	0	0	720000	0		6	
		L81B	1006565	0	2190	0	1800000	0		15	
		L81C	2152001	0	322108	0	4560000	0		38	
		L81D	31200	0	0	0	4200000	0		35	
		L82A	13047043	58000	43992	100000	9960000	0	1	83	
		L82B	41372365	0	338798.49	100000	5160000	2568000	1	43	4.28
		L82C	5727678	0	23652	0	1800000	2256000		15	3.76
		L82D	29722676.1	0	2205112	0	2040000	13500000		17	22.50
		L82E	1159460.5	0	221500	0	1800000	5286000		15	8.81
		L82F	434612	0	0	0	1320000	1962000		11	3.27
		L82G	1739944	0	0	0	1560000	3090000		13	5.15
		L82H				0	588000	2712000		4.9	4.52
		L82J	60717853	0	0	0	0	1452000			2.42
Total for IUA3			**157473697.6**	**58000**	**3157352.49**	**200000**	**35508000**	**32826000**	**2**	**295.9**	**54.71**

IUA	IUA code	Quaternary	Registered Volume / Estimated water use						Contributing Area		
			WARMS Database			WR2012 Database			WR2012 Database		
			Water Use Sector						Water Use Sector		
			Agriculture (m^3/a)	Industry (m^3/a)	Domestic (m^3/a)	Afforestation (m^3/a)	Alien Veg (m^3/a)	Irrigation (m^3/a)	Afforestation Area (km^2)	Alien Vegetation Area (km^2)	Irrigation Area (km^2)
4	IUA_M01	M10A	310151	0	830	0	0	0			
		M10B	505197	0	21087.38	3300000	2160000	1200000	33	18	2
		M10C	1904893	1200	913730	200000	2400000	2400000	2	20	4
		M10D	9139005	14088	123945115	0	1200000	1200000		10	2
		M20A	1855104	805834	319409.2	0	1440000	1200000		12	2
		M20B	3063415	14600	34069	2600000	3480000	1200000	26	29	2
		M30A	2331984	10950	8601350.5	0	1680000	600000		14	1
		M30B	19500	1825	6750	0	1080000	600000		9	1
Total for IUA4			**19129248.54**	**848497**	**133842341.1**	**6100000**	**13440000**	**8400000**	**61**	**112**	**14**
5	IUA_LN01	L11A	471850	0	0	0	0	600000			1
		L11B	117410.5	0	0	0	120000	600000		1	1
		L11C	0	16000	0	0	0	600000			1
		L11D	524435	0	0	0	0	0			
		L11E	1420240	0	264056	0	0	1200000			2
		L11F	2123341	0	0	0	0	600000			1
		L11G	29924	0	0	0	0	600000			1
		L12A	1538695	80000	34288	0	120000	0		1	
		L12B	805220	0	0	0	0	1200000			2
		L12C	1243491	0	28343	0	0	2400000			4
		L12D	1201343	0	76068	0	0	0			
		L21A	541076	600	0	0	120000	0		1	
		L21B	1790864	0	0	0	0	1200000			2
		L21C	1264607	0	0	0	0	1200000			2
		L21D	650884	0	1788	0	0	1200000			2
		L21E	1551715	0	193490	0	0	0			
		L21F	823134	0	0	0	0	0			
		L22A	202387	0	0	0	0	0			
		L22B	152898	0	0	0	0	1200000			2
		L22C	820761	0	85678	0	0	1800000			3
		L22D	306119	0	3120	0	0	0			
		L23A	73478	0	0	0	0	600000			1
		L23B	1479773	0	0	0	0	1200000			2
		L23C	616726	0	0	0	0	1200000			2
		L23D	22635	0	28035	0	0	0			
		L30A	698626	0	803131	0	0	0			
		L30B	481590	0	73274	0	0	0			

IUA	IUA code	Quaternary	Registered Volume / Estimated water use							Contributing Area	
			WARMS Database		WR2012 Database					WR2012 Database	
			Water Use Sector							Water Use Sector	
			Agriculture (m^3/a)	Industry (m^3/a)	Domestic (m^3/a)	Afforestation (m^3/a)	Alien Veg (m^3/a)	Irrigation (m^3/a)	Afforestation Area (km^2)	Alien Vegetation Area (km^2)	Irrigation Area (km^2)
		L30C	6662010	0	17082	0	0	0			
		L30D	4152024	0	27857	0	0	600000			1
		L40A	736217.01	0	51240	0	0	600000			1
		L40B	512088	0	91092	0	0	600000			1
		L50A	644082	0	295	0	0	600000			1
		L50B	617372	0	3103	0	0	0			
		L60A	367881	0	0	0	0	0			
		L60B	508942	0	0	0	0	0			
		L70A	78915	0	15000	0	0	0			
		L70B	160616	0	0	0	0	1800000			3
		L70C	209434	0	22000	0	360000	2400000		3	4
		L70D	160283	0	376819	0	120000	1800000		1	3
		L70E	92345	0	0	0	0	0			
		L70F	28721	0	0	0	840000	0		7	
		L70G	1740948	0	251170	0	0	0			
		N11A	2237313	0	109484	0	0	3600000			6
		N11B	879775	0	4690640	0	120000	4800000		1	8
		N12A	1087957	0	1321543	0	120000	600000		1	1
		N12B	744023	0	49337	0	0	0			
		N12C	1470182	0	466964.8	0	120000	0		1	
		N13A	1361242	0	2145006	0	0	5400000			9
		N13B	2979328	0	4015	0	0	13200000			22
		N13C	758268.66	35040	11369.95	0	2040000	16200000		17	27
		N14A	1913662	0	4492	0	0	600000			1
		N14B	1212350	0	87400	0	0	4800000			8
		N14C	5258908	0	214891	0	0	12600000			21
		N14D	693298.33	0	10950	0	0	6000000			10
		N21A	381082	0	0	0	360000	7200000		3	12
		N21B	228042	116469.5	608812	0	0	1200000			2
		N21C	1926088	0	730	0	0	1800000			3
		N21D	426367	0	14604	0	0	0			
		N22A	119064	0	1295	0	0	1200000			2
		N22B	137923	0	46392	0	0	0			
		N22C	107286	0	300	0	0	0			
		N22D	21060	0	0	0	0	0			
		N22E	23156	0	9912.5	0	0	1200000			2

IUA	IUA code	Quaternary	Registered Volume / Estimated water use						Contributing Area		
			WARMS Database			WR2012 Database			WR2012 Database		
			Water Use Sector						Water Use Sector		
			Agriculture (m^3/a)	Industry (m^3/a)	Domestic (m^3/a)	Afforestation (m^3/a)	Alien Veg (m^3/a)	Irrigation (m^3/a)	Afforestation Area (km^2)	Alien Vegetation Area (km^2)	Irrigation Area (km^2)
		N23A	2564655	0	0	0	0	1800000			3
		N23B	143180	0	0	0	0	1200000			2
		N24A	396197	0	56420	0	0	600000			1
		N24B	528198.01	0	600	0	0	4200000			7
		N24C	548420	0	14491	0	0	2400000			4
		N24D	21145	0	20000	0	0	600000			1
		N30A	1432825	0	3181858	0	0	4800000			8
		N30B	1583678	0	5620	0	0	1800000			3
		N30C	70950	0	1095	0	0	600000			1
Total for IUA5			**68880723.51**	**248109.5**	**15525151.25**	**0**	**4440000**	**124200000**	**0**	**37**	**207**
6	IUA_N01	N40A	0	0	12045	0	0	0			
		N40B	2792795	0	46656	0	0	3600000			6
		N40C	181497060	0	1446473.5	0	240000	14400000		2	24
		N40D	353935	1825	76698664	0	0	15600000			26
		N40E	195000	0	1683562	0	0	23400000			39
		N40F	227550	50400	6825	0	960000	12600000		8	21
Total for IUA6			**185066340**	**52225**	**79894225.5**	**0**	**1200000**	**69600000**	**0**	**10**	**116**
7	IUA_P01	P10A	190404	8454	600	200000	600000	0	2	5	
		P10B	0	106580.8	33131	0	600000	1200000		5	2
		P10C	28494	40988.4	35494	0	0	600000			1
		P10D	188667	27325.6	407676	0	0	1200000			2
		P10E	317322	1164	1036356.05	0	120000	1200000		1	2
		P10F	254000	0	13840	0	1320000	1200000		11	2
		P10G	0	4495	9782	0	0	600000			1
		P20A	850770	0	816782	400000	6120000	0	4	51	
		P20B	0	0	2765	0	6840000	0		57	
		P30A	464960	9000	0	300000	2640000	600000	3	22	1
		P30B	1000596	0	182	0	600000	1200000		5	2
		P30C	50760	0	0	0	0	0			
		P40A	2488107	140000	47523	100000	4800000	0	1	40	
		P40B	108406	7040	252240	0	720000	0		6	
		P40C	564414	0	389400	0	1320000	0		11	
		P40D	195824	3920	1018543	0	1680000	0		14	
Total for IUA7			**6702724**	**348967.8**	**4064314.05**	**1000000**	**27360000**	**7800000**	**10**	**228**	**13**

IUA	IUA code	Quaternary	Registered Volume / Estimated water use							Contributing Area	
			WARMS Database		WR2012 Database					WR2012 Database	
			Water Use Sector							Water Use Sector	
			Agriculture (m^3/a)	Industry (m^3/a)	Domestic (m^3/a)	Afforestation (m^3/a)	Alien Veg (m^3/a)	Irrigation (m^3/a)	Afforestation Area (km^2)	Alien Vegetation Area (km^2)	Irrigation Area (km^2)
8	IUA_Q01	Q11A	601545	0	584	0	0	0			
		Q11B	612961	0	1296	0	0	1200000			2
		Q11C	508142	0	52498	0	0	0			
		Q11D	1241615	0	32316	0	0	3600000			6
		Q14A	2469211	0	106840	0	120000	6000000		1	10
		Q14B	1564892.6	0	5069737.1	0	480000	5400000		4	9
		Q14C	4099909	0	127912.6	0	0	3000000			5
		Q14D	932091	0	39059.5	0	0	1800000			3
		Q14E	185533	0	0	0	0	1800000			3
		Q21A	1842009	91250	7300	0	0	0			
		Q21B	2749733	1095	2500	0	120000	7200000		1	12
		Q22A	658300	0	121085	0	0	1800000			3
		Q22B	324213	0	349119	0	0	1800000			3
		Q30A	2633404	0	39254	0	0	0			
		Q30B	794372	0	45454.5	0	0	2400000			4
		Q80A	629136	0	29644	0	0	2400000			4
		Q80B	1528386	0	2728	0	0	2400000			4
		Q80C	1874542	0	9865	0	0	1200000			2
Total for IUA8			**25249995**	**92345**	**6037193**	**0**	**720000**	**42000000**	**0**	**6**	**70**
9	IUA_Q02	Q12A	1913248	0	3940	0	0	600000			1
		Q12B	18268122	0	125916	0	0	3000000			5
		Q12C	41937552.35	0	326058	0	0	16200000			27
		Q13A	1564212	0	117444	0	0	0			
		Q13B	11920050	0	42146	0	0	6000000			10
		Q13C	69067114	22241	0	0	0	16800000			28
		Q30C	433053	0	1460	0	0	6000000			10
		Q30D	80000	240	8190	0	120000	3600000		1	6
		Q30E	24819770	0	0	0	960000	17400000		8	29
		Q41A	948314	0	23800	0	0	1800000			3
		Q41B	3184400.6	547.5	0	0	0	2400000			4
		Q41C	461320	0	306395	0	0	0			
		Q41D	240693	0	1800	0	0	600000			1
		Q42A	857635	0	28525	0	0	0			
		Q42B	437413	0	0	0	0	0			
		Q43A	1585194	0	6750	0	0	1800000			3
		Q43B	1057026	0	3492	0	0	1200000			2

IUA	IUA code	Quaternary	Registered Volume / Estimated water use							Contributing Area	
			WARMS Database			WR2012 Database				WR2012 Database	
			Water Use Sector							Water Use Sector	
			Agriculture (m^3/a)	Industry (m^3/a)	Domestic (m^3/a)	Afforestation (m^3/a)	Alien Veg (m^3/a)	Irrigation (m^3/a)	Afforestation Area (km^2)	Alien Vegetation Area (km^2)	Irrigation Area (km^2)
		Q44A	12667557	0	0	0	0	3000000			5
		Q44B	222340	18600	4380	0	0	3000000			5
		Q44C	23696144	0	0	0	0	8400000			14
		Q50A	58119479	45726	2898500	0	480000	21600000		4	36
		Q50B	28277403	0	53200	0	0	9000000			15
		Q50C	26015000	59247	0	0	0	11400000			19
		Q60A	289620	0	0	0	0	0			
		Q60B	177800	0	0	0	0	0			
		Q60C	58800	0	0	0	0	0			
		Q70A	42780210	3650	800000	0	120000	7200000		1	12
		Q70B	27393637	0	1200	0	360000	26400000		3	44
		Q70C	743760	0	0	0	0	4200000			7
		Q93A	321250	2738	0	0	0	600000			1
		Q93B	4103610	0	15521	0	720000	1800000		6	3
		Q93C	10600096	70980	3000	0	240000	3000000		2	5
		Q93D	288997	0	485	0	1080000	600000		9	1
		Q80D	2240817	0	144000	0	120000	8400000		1	14
		Q80E	25979784	0	0	0	0	8400000			14
		Q80F	3620178	0	7300	0	0	4200000			7
		Q80G	16960500	0	0	0	0	4200000			7
		Q91A	450000	138000	0	0	0	600000			1
		Q91B	2765829	4586	635100	0	0	1200000			2
		Q91C	5101905	56000	7110000	0	840000	1800000		7	3
Total for IUA9			**471649833**	**422555.5**	**12668602**	**0**	**5040000**	**206400000**	**0**	**42**	**344**
10	IUA_Q03	Q92A	4389506	0	0	0	120000	3600000		1	6
		Q92B	3238449	0	2340	0	0	4200000			7
		Q92C	3060344	0	717756	0	0	3600000			6
		Q92D	1673608	0	600	300000	120000	1200000	3	1	2
		Q92E	2197643	0	337200	0	0	2400000			4
		Q92F	889870	156000	176220	0	0	600000			1
		Q92G	661972	0	1845	0	0	600000			1
		Q94A	20435	10444	150000	400000	1080000	0	4	9	
		Q94B	442936	39340	730	1200000	240000	0	12	2	
		Q94C	94728	66367	0	3000000	720000	600000	30	6	1
		Q94D	454180	0	0	300000	0	5400000	3		9
		Q94E	256609	0	0	2500000	480000	0	25	4	

IUA	IUA code	Quaternary	Registered Volume / Estimated water use						Contributing Area		
			WARMS Database		WR2012 Database				WR2012 Database		
			Water Use Sector						Water Use Sector		
			Agriculture (m^3/a)	Industry (m^3/a)	Domestic (m^3/a)	Afforestation (m^3/a)	Alien Veg (m^3/a)	Irrigation (m^3/a)	Afforestation Area (km^2)	Alien Vegetation Area (km^2)	Irrigation Area (km^2)
		Q94F	7820249	15000	2399422	0	0	5400000			9
Total for IUA10			**25200529**	**287151**	**3786113**	**7700000**	**2760000**	**27600000**	**77**	**23**	**46**
11	IUA_R01	R10A	0	0	324206	1000000	1560000	6000000	10	13	10
		R10B	14331991	0	36603300	1100000	1560000	6600000	11	13	11
		R10C	2362510	0	10200	1000000	480000	6000000	10	4	10
		R10D	1905045	0	6	600000	240000	0	6	2	
		R10E	2125894	0	1200	0	0	3600000			6
		R10F	0	0	14600	2800000	600000	16800000	28	5	28
		R10G	1252230	2160	2871828	100000	360000	600000	1	3	1
		R10H	2430418	1591	90473	0	0	0			
		R10J	268533	0	0	0	0	0			
		R10K	3547246	0	0	200000	0	1200000	2		2
		R10L	1077635	26000	0	0	0	0			
		R10M	0	2812.5	0	0	600000	0		5	
		R40A	2176125	0	411831.5	0	2040000	0		17	
		R40B	0	0	587.48	400000	0	2400000	4		4
		R40C	478668.75	19000	54960	100000	1320000	600000	1	11	1
		R50A	0	3032.5	286118	0	2160000	0		18	
		R50B	0	0	465010	0	1080000	0		9	
Total for IUA11			**31956295.75**	**54596**	**41134319.98**	**7300000**	**12000000**	**43800000**	**73**	**100**	**73**
12	IUA_R02	R20A	196643	0	438647	4800000	360000	28800000	48	3	48
		R20B	140962	1920	1200	1000000	240000	6000000	10	2	10
		R20C	13440	0	9010	500000	240000	3000000	5	2	5
		R20D	133400	2000	90625	0	0	0			
		R20E	437810	0	21982012	800000	480000	4800000	8	4	8
		R20F	1300000	0	48270156	400000	360000	2400000	4	3	4
		R20G	92000	0	0	0	0	2400000			4
		R30A	1294575	10000	3861725	0	0	0			
		R30B	3314030	433209.85	2623794.5	0	240000	0		2	
		R30C	936349.61	0	15115	0	600000	0		5	
		R30D	257107	975	16800.9	0	0	0			
		R30E	1008104	119475	8442195	100000	120000	600000	1	1	1
		R30F	1834393.53	7736.03	1748792	0	120000	0		1	
Total for IUA12			**10958814.14**	**575315.88**	**87500072.4**	**7600000**	**2760000**	**48000000**	**76**	**23**	**80**

IUA	IUA code	Quaternary	Registered Volume / Estimated water use						Contributing Area		
			WARMS Database		WR2012 Database				WR2012 Database		
			Water Use Sector						Water Use Sector		
			Agriculture (m^3/a)	Industry (m^3/a)	Domestic (m^3/a)	Afforestation (m^3/a)	Alien Veg (m^3/a)	Irrigation (m^3/a)	Afforestation Area (km^2)	Alien Vegetation Area (km^2)	Irrigation Area (km^2)
13	IUA_S01	S10A	297036	0	13584	0	0	0			
		S10B	273277	0	24481.77	0	0	0			
		S10C	37360	0	936859	0	0	0			
		S10D	0	2190	141029	0	0	0			
		S10E	0	0	9797757	0	0	0			
		S10F	0	10000	15714	0	0	0			
		S10G	25650	0	195020	200000	0	1200000	2		2
		S10H	202800	0	1438380.5	0	0	0			
		S10J	0	43800	74475	0	0	0			
		S20A	634428	0	2106950	0	0	0			
		S20B	144175	186191.5	2549285	0	0	0			
		S20C	0	0	628334.6	0	0	0			
		S20D	0	0	1580473.48	0	0	0			
		S40A	1199666	0	1496934	0	1680000	0		14	
		S40B	1975726	0	0	100000	9840000	0	1	82	
		S40C	718788	0	11506	0	1920000	0		16	
		S40D	79560	0	0	100000	0	600000	1		1
		S40E	516952	0	221106.5	800000	3600000	4800000	8	30	8
		S40F	46175	0	0	0	1080000	0		9	
		S50A	558366	0	0	0	0	0			
		S50B	392659	0	0	0	0	0			
		S50C	1430263	0	115000	200000	0	1200000	2		2
		S50D	24000	0	970641	300000	0	1800000	3		3
		S50E	21989832	0	115000	1800000	0	0	18		
		S50F	0	0	21024	200000	0	1200000	2		2
		S50G	2000	80	12108511	200000	0	1200000	2		2
		S50H	15640	0	225405.95	200000	0	1200000	2		2
		S50J	8080	0	147935	400000	0	2400000	4		4
Total for IUA13			**30572433**	**242261.5**	**34935406.8**	**4500000**	**18120000**	**15600000**	**45**	**151**	**26**
14	IUA_S02	S31A	176131	0	201506.03	0	0	0			
		S31B	455921	0	8288.5	0	0	0			
		S31C	945333	0	99110	0	0	0			
		S31D	242600	410	54269	0	0	0			
		S31E	1075858	26550	14380	0	0	0			
		S31F	622868	22287	6513910	0	0	0			
		S31G	1162078	80000	0	0	0	0			

IUA	IUA code	Quaternary	Registered Volume / Estimated water use						Contributing Area		
			WARMS Database			WR2012 Database			WR2012 Database		
			Water Use Sector						Water Use Sector		
			Agriculture (m^3/a)	Industry (m^3/a)	Domestic (m^3/a)	Afforestation (m^3/a)	Alien Veg (m^3/a)	Irrigation (m^3/a)	Afforestation Area (km^2)	Alien Vegetation Area (km^2)	Irrigation Area (km^2)
		S32A	45120	0	0	0	0	0			
		S32B	569164	10920	0	0	0	0			
		S32C	483654	0	187675	0	0	0			
		S32D	3528659	8.4	3290	1400000	0	8400000	14		14
		S32E	1036774	145000	102310	600000	0	3600000	6		6
		S32F	0	0	537236	200000	0	0	2		
		S32G	4187984	0	38	0	0	0			
		S32H	2591722	0	36097	0	0	0			
		S32J	605930	0	27	0	0	0			
		S32K	4250550	38400	5012	0	0	0			
		S32L	193074	0	0	0	0	0			
		S32M	446530	0	7300	0	0	0			
Total for IUA14			**22619950**	**323575.4**	**7770448.53**	**2200000**	**0**	**12000000**	**22**	**0**	**20**
15	IUA_S04	S60A	12400003	6600	1460091.03	9700000	5400000	58200000	97	45	97
		S60B	888387	0	14609313	1000000	4320000	6000000	10	36	10
		S60C	145883	0	0	3200000	6840000	19200000	32	57	32
		S60D	306850	0	6400	800000	1080000	4800000	8	9	8
		S60E	246000	0	328	0	240000	0		2	
		S70A	1371652.5	7400	5285341.4	100000	120000	600000	1	1	1
		S70B	292300	10000	681852	0	0	0			
		S70C	17000	0	385833	0	0	0			
		S70D	263150	0	120	1200000	120000	7200000	12	1	12
		S70E	10000	6570	193638.6	600000	0	3600000	6		6
		S70F	169572	1200	0	100000	120000	600000	1	1	1
Total for IUA15			**16110797.5**	**31770**	**22622917.03**	**16700000**	**18240000**	**100200000**	**167**	**152**	**167**
16	IUA_T01	T11A	1459238	10600	54034	5200000	0	0	52		
		T11B	1707375	0	3780	2100000	0	0	21		
		T11C	0	139600	4764216	800000	120000	600000	8	1	1
		T11D	122163	0	453071	1900000	0	0	19		
		T11E	251400	0	30744	2800000	120000	0	28	1	
		T11F	20000	0	158769	100000	0	0	1		
		T11G	272231	195000	40000	1200000	360000	1200000	12	3	2
		T11H	9853	0	0	500000	0	0	5		
		T12A	0	0	44410	3500000	0	0	35		
		T12B	0	0	205860	100000	0	0	1		
		T12C	1440	450	51548	1300000	0	600000	13		1

IUA	IUA code	Quaternary	Registered Volume / Estimated water use						Contributing Area		
			WARMS Database		WR2012 Database				WR2012 Database		
			Water Use Sector						Water Use Sector		
			Agriculture (m^3/a)	Industry (m^3/a)	Domestic (m^3/a)	Afforestation (m^3/a)	Alien Veg (m^3/a)	Irrigation (m^3/a)	Afforestation Area (km^2)	Alien Vegetation Area (km^2)	Irrigation Area (km^2)
		T12D	0	0	104812	700000	0	1200000	7		2
		T12E	0	0	741625	600000	0	0	6		
		T12F	0	80000	44843	900000	0	0	9		
		T12G	0	0	709585	0	0	0			
		T20A	7840	138000	18695	20500000	0	0	205		
Total for IUA16			**3851540**	**425650**	**7407297**	**21700000**	**600000**	**3600000**	**217**	**5**	**6**
17	IUA_T02	T13A	0	97920	25550	300000	0	0	3		
		T13B	323837	3600	507584	0	0	0			
		T13C	20000	18362	0	100000	0	0	1		
		T13D	0	0	6307	0	0	0			
		T13E	0	0	6307	0	0	0			
Total for IUA17			**343837**	**119882**	**545748**	**400000**	**0**	**0**	**4**	**0**	**0**
18	IUA_T03	T20B	329313	5000	55240376	2600000	0	0	26		
		T20C	197100	10342	296667	300000	0	0	3		
		T20D	733757	21189.8	2205121	400000	0	0	4		
		T20E	8780	0	260234	0	0	0			
		T20F	218730	0	289000	700000	0	0	7		
		T20G	0	0	1095000	100000	0	0	1		
Total for IUA18			**1487680**	**36531.8**	**59386398**	**4100000**	**0**	**0**	**41**	**0**	**0**
19	IUA_T04	T60A	184898	9900	737636	0	0	0			
		T60B	0	6000	94884	500000	360000	0	5	3	
		T60C	4145	3300	127400	0	0	0			
		T60D	0	90040	666384.8	0	0	0			
		T60E	171750	15000	93241	300000	240000	0	3	2	
		T60F	0	0	1445872	0	480000	0		4	
		T60G	0	7800	100001.5	0	0	0			
		T60H	30130	30870	1670	2000000	120000	0	20	1	
		T60J	60387	0	0	100000	0	0	1		
		T60K	72640	0	221555	0	120000	0		1	
		T70A	0	0	2025350	1200000	0	0	12		
		T70B	354752	28840	1471415	200000	960000	0	2	8	
		T70C	46950	500	281102	100000	120000	0	1	1	
		T70D	0	0	452078	0	0	0			
		T70E	4785	1000	894000	1300000	360000	0	13	3	
		T70F				0	0	0			
		T70G	0	0	283530	400000	0	0	4		

IUA	IUA code	Quaternary	Registered Volume / Estimated water use						Contributing Area		
			WARMS Database			WR2012 Database			WR2012 Database		
			Water Use Sector						Water Use Sector		
			Agriculture (m^3/a)	Industry (m^3/a)	Domestic (m^3/a)	Afforestation (m^3/a)	Alien Veg (m^3/a)	Irrigation (m^3/a)	Afforestation Area (km^2)	Alien Vegetation Area (km^2)	Irrigation Area (km^2)
		T80A	73	782	30	300000	120000	0	3	1	
		T80B	0	0	912506	100000	120000	0	1	1	
		T80C	53795	0	3763822	500000	0	0	5		
		T80D	0	0	464888	300000	120000	0	3	1	
		T90A	84055	0	3838079	600000	840000	0	6	7	
		T90B	0	19290	2532500	100000	0	0	1		
		T90C	878369	13850	113150	500000	120000	0	5	1	
		T90D	13690	0	0	400000	0	0	4		
		T90E	0	489	504228	300000	0	0	3		
		T90F	0	4560	0	400000	0	0	4		
		T90G	82260	73448	914851.7	400000	0	0	4		
Total for IUA19			**2042679**	**305669**	**21940174**	**10000000**	**4080000**	**0**	**100**	**34**	**0**

The water requirements as captured in these tables have been obtained from different sources namely:

(i) Registered water volumes are from the latest WARMS data as provided by the DWS.
(ii) The estimated water use volumes were obtained from applying the following consumption rates to the WR2012 study land-cover areas:

- Afforestation – 100 mm per year per hectare (based on an average use from neighbouring catchments);
- Alien Vegetation - 120 mm per year per hectare (based on an average use from neighbouring catchments); and
- Irrigation – 6000 m^3/ha /a (based on an average use from neighbouring catchments).

These estimates are based on the WR2012 data and consumption rates will need to be compared against the registered volumes from WARMS, as well as the information emanating from the latest Reconciliation Strategy updates. These consumption rates have been used to produce estimates for the purposes of understanding the level of utilisation in the catchments and IUAs. This will also assist with the prioritisation of the resource units within the IUAs. More accurate volumes will be determined by applying more thorough modelling approaches for the assessment of water resources impacts and scenarios.

A decision will then be made on the most suitable data to use once the modelling and analyses commences. As per the inception report, it is recommended that the latest Reconciliation Strategy information and models are used where available, and then the WR2012 and WARMS data is used where system specific models are not yet available.

The volumes of water use linked to the larger Reconciliation Strategies are currently being updated through parallel studies. Below in Table 3-9 and Figure 3-3 is a summary of those for the Algoa WSS, which primarily lies in IUA_KL01 and IUA_L01.

The water requirements for the Amatola WSS are shown in Figure 3-4, and is the main system in IUA_R02.

Table 3-9: Water requirements of the Algoa WSS (2011 Reconciliation Strategy)

Water Use	million m^3/a	%
Urban	103.0	68.0%
Irrigation	48.5	30.7%
Canal Losses	4.3	2.7%
Ecological Water Requirements	2.0	1.3%
TOTAL	**157.8**	**100.0%**

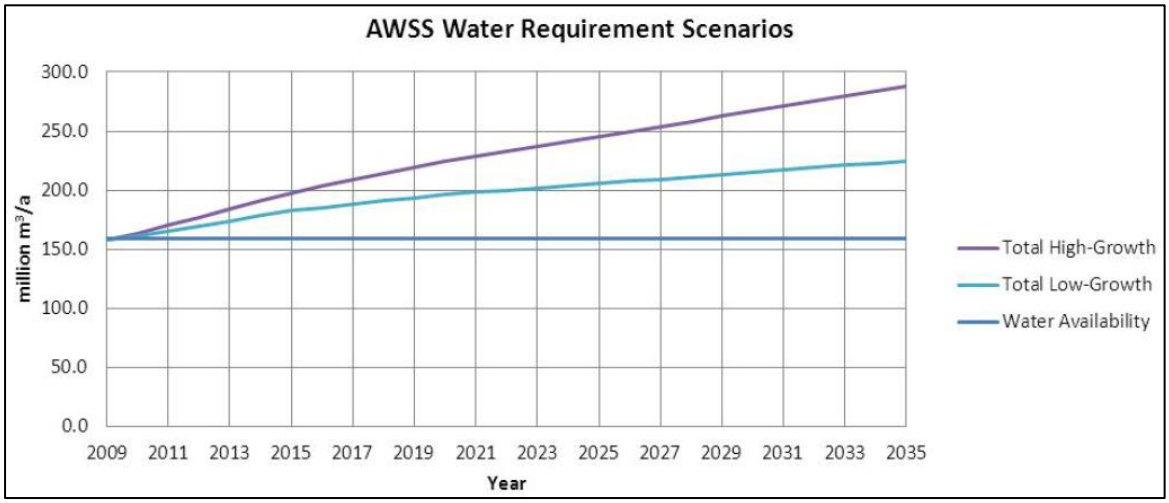


Figure 3-3: Water requirement projections for the Algoa WSS

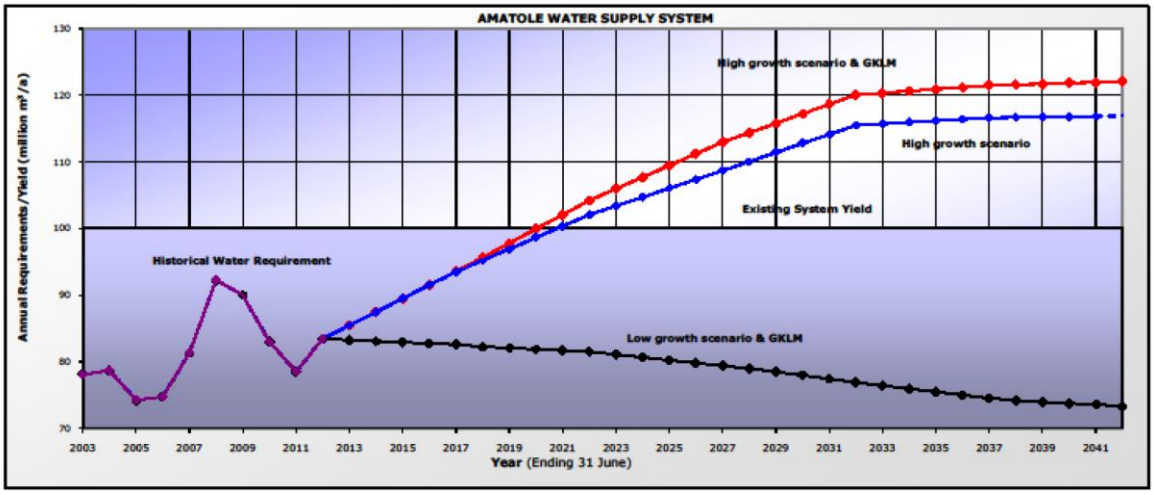


Figure 3-4: Water requirements of the Amatola WSS (shown in the water balance 2012)

3.1.10 *Water quality impacts*

Water quality data was sourced and interpreted from various sources. Principally from the DWS database of water quality monitoring data. Where appropriate and available, additional water quality information or GIS derived data has been sourced and was used in the interpretation and prediction of the water quality in the study area.

The state of water quality in the study area was derived from data records taken during the period January 2012 to December 2021. It is worth mentioning that there were cases where significant gaps occurred in the data records, where data was not recorded for months or even years. The state of the rivers was determined by making a comparison between recorded data and the acceptable limits of water quality for the catchments (tabulated below). These limits remained constant for all catchments in the study area.

Table 3-10: Limits for selected water quality variables

Acceptable Limits	Electrical Conductivity (mS/m)	pH	SO_4	PO_4, P	NO_3, NO_2, N
Minimum	0	6.5	0	0	0
Maximum	85	8.4	200	0.125	2.5

Refer to Table 3-11 for a summary of the water quality issues and/or impacts for some of the rivers and quaternary catchments. More detailed descriptions of the status of water quality is provided per IUA in Section 4.

Table 3-11: Specific water quality impacts per quaternary catchment where data is available

Quaternary catchment	River	Last recorded data	Impact Rating	Water Quality Issue/Impact
K80B	Storms	2013 & 2017	Moderate	• Some of the data is very outdated (2013); • Acceptable electrical conductivity, phosphate, ammonia recordings and salinity levels; • All pH readings below acceptable range; and • Surrounded by forestry. Points sampled between industrial park areas indicate no major impact on water quality.
K80C	Sanddrift	2017	Moderate	• All pH readings below acceptable range; • Acceptable salinity, electrical conductivity, phosphate, nitrate and ammonia levels at N2 Road Bridge after running through predominantly natural mountainous areas, and unacceptably low pH levels of about 4.2. This may be a natural phenomena linked to geology and catchment position; and • Further downstream after passing through agricultural areas, the river's pH has increased to about 4.5 and most other parameters remain unchanged.
K80C	Kruis	2018	Moderate	• Acceptable sulphate, electrical conductivity, phosphate, ammonia recordings and salinity levels; • All pH readings (except most recent in 2018) very far below acceptable range; and • The majority of the river runs through mountainous area, with only a small part through agricultural land.
K80D	Groot	2019	Moderate	• Data collection point at final discharge from Woodlands WWTW shows acceptable mean electrical conductivity; • At Rooiwal (close to confluence with Klip river): acceptable electrical conductivity, phosphate, sulphate and ammonia recordings; and

Quaternary catchment	River	Last recorded data	Impact Rating	Water Quality Issue/Impact
				• Nearly all pH readings below acceptable range.
M10C	Brak	2019	Large	• High salinity, electrical conductivity and ammonia levels; and • WWTWs discharges (Kwanobuhle). Industrial activities.
M10C	Elands	2018	Low	• Good water quality (but data may be outdated).
M10D	Chatty	2019	Serious	• Extremely high salinity, electrical conductivity and phosphate levels. Discharge from industrial activities, salt pans and power plant (Swartkops).
M20A	Bakens	2021	Moderate	• Electrical conductivity exceeds allowable levels; • Discharge from industrial activities; and • River runs into marina.
M20A	Papenkuils	2021	Large	• High salinity, unacceptable electrical conductivity and phosphate levels; and • Waste from incinerator and asphalt port.
P40A	Bloukrans	2019	Large	• Salinity, electrical conductivity, ammonia and phosphate levels above acceptable range; noticeable spike in ammonia levels downstream of Makhanda (Grahamstown) WWTW.
P10B	New Years	2017	Moderate	• Electrical conductivity, phosphate and nitrate levels exceed allowable range, d/s of Alicedale WWTW.
Q92A & Q94C	Balfour	2018	Low	• All readings were acceptable.
Q94E	Blinkwater	2018	Moderate	• Good salinity. River measurements are all acceptable, except pH, which exceeds acceptable value.
N40E	Coerney	2018	Serious	• Most recent data of electrical conductivity, pH, TDS, sodium, chloride and sulphate readings were at unacceptable/harmful levels; and • River is heavily surrounded by agricultural activities, and poor river quality may be the result of effluent runoff from pesticides/other agricultural products.

3.2 Wetlands

3.2.1 *Overview and general description of wetlands*

The study area contains a variety of Hydrogeomorphic (HGM) unit wetland types, listed as follows in order or frequency of occurrence: depressions (40%), seeps (23%), channelled valley bottoms (23%), unchannelled valley bottoms (8%), flats (5%) and floodplains (1%).

A total of 30 171 ha of wetland has been recorded in the overall study area, with the bulk of this (20 165 ha) contained in 4 of the 11 sub-catchments, namely the Kei, Mbashe, Tsitsikamma and Fish. Based on a few localized field-verified areas, it appears that wetlands have been greatly under-mapped in some sub-catchments such as Mthatha and Wild Coast, and the total extent of wetlands is therefore likely to be significantly higher than that currently recorded.

The extent and character of the wetlands are strongly influenced by the strong aridity gradient extending across the hinterland of the overall study area. It is generally most arid in the west (in the Gamtoos and Sundays) with Mean Annual Precipitation [MAP] in some areas <200 mm, and becoming progressively less arid eastwards, until east of the Kei, MAP is predominantly >800 mm.

In the arid west, dominated by Karoo bioregions, wetlands are generally limited in extent and channelled and unchannelled valley-bottom and depression wetland HGM (Hydrogeomorphic) units cover the largest extent, while seep HGM units are confined to a few localized high-altitude areas with localized higher MAP. In the eastern areas, dominated by grassland bioregions, the extent of wetlands is generally higher, seep HGM units are noticeably more widespread, and depressions, while being frequent in flatter areas towards the coast are less frequent in the hinterland with steeper, more broken topography.

3.2.2 *General condition of wetlands*

Overall, the wetlands are roughly equally distributed across the A/B, C and D/E/F ecological present state categories, but differ somewhat according to HGM unit type as follows:

Channelled valley-bottom:	A/B is 45%, **C** is 27% and **D/E/F** is 18%
Depression:	A/B is 47%, **C** is 13% and **D/E/F** is 40%
Flat:	A/B is 36%, **C** is 13% and **D/E/F** is 51%
Floodplain:	A/B is 36%, **C** is 15% and **D/E/F** is 49%
Seep:	A/B is 35%, **C** is 26% and **D/E/F** is 39%
Unchannelled valley-bottom:	A/B is 39%, **C** is 30% and **D/E/F** is 31%

The fact that flats and floodplains have the highest proportion in a D/E/F category is likely influenced by these areas often being favourable locations for various developments and agricultural production. In terms of spatial distribution, the greatest proportion of wetlands in a D/E/F category was found in the Tsitsikamma sub-catchment, where high impact land-uses associated with cultivation and plantation forestry are extensive, followed by Algoa sub-catchment, where high impact urban/ industrial land-uses are extensive.

3.3 Groundwater

3.3.1 *Overview and general description of groundwater*

Three 1:500 000 scale hydrogeological maps cover the majority of the catchment, i.e. Port Elizabeth, Queenstown and Beaufort West. The maps show groundwater occurrences in terms of three aquifer types, i.e. a) fractured, b) intergranular, and c) intergranular & fractured (Appendix D, Figure 8-11). The borehole yield ranges are as follows: 0-0.1l/s, 0.1-0.5l/s, 0.5-2.0l/s, 2.0-5.0l/s and >5.0l/s.

3.3.2 *Geology*

Basement rocks in the catchment is represented by the Precambrian aged Gamtoos Group consisting mainly of quartzite, limestone and phyllite. The Gamtoos Group is unconformably overlain by the Cape Supergroup, comprising of the Table Mountain, Bokkeveld and Witteberg Groups of alternating quartzitic sandstone and shale. The Cape Supergroup is overlain by the Karoo Supergroup, comprising of the Ecca, Beaufort, Stormberg and Drakensberg Groups.

The Karoo Supergroup consists of a sequence of units, mostly of non-marine origin, deposited between the Late Carboniferous and Early Jurassic age. Late Jurassic aged dolerite sills and dykes intruded into the main Karoo basin.

The Uitenhage Group unconformably overlies older deposits of the Cape Supergroup in small rift basins, i.e. Algoa and Gamtoos Basins and comprise of poorly sorted conglomerate and subordinate sandstone, siltstone and mudstone. These rift basins formed mainly due to normal faulting during the break-up of Gondwana. Unconsolidated to semi-consolidated, palaeo-coastal calcareous sand and conglomerate deposits of the Algoa Group occur within the eastern portion of the Algoa Basin and the Bushman's coastal plain. Significant alluvium deposits are associated with the major river systems like the Sundays River valley south of Kirkwood. Recent and reworked coastal sands occur within a narrow dune zone between Cannonvale and Port Alfred.

Refer to Appendix D, Figure 8-12 for a map illustrating the geology throughout the study area.

3.3.3 *Hydrogeology, aquifer type and vulnerability*

The major aquifer systems associated with the Cape and Karoo Supergroups are mainly of a fractured type, where groundwater occurrence is as a result of secondary deformation relating to faults, fissures, fractures, bedding planes and joints (Appendix D, Figure 8-11). The Karoo Supergroup also constitutes a fractured and intergranular aquifer over widespread areas associated with intrusive and extrusive igneous rocks, i.e. dolerite sills and dykes as well as basalt.

The Quaternary sand and alluvium constitute limited intergranular aquifers in the study area where groundwater occurrence is as a result of pore spaces between sand particles. Borehole yields in the fractured aquifers vary greatly depending on the lithological unit intersected during drilling and the arenacous: argillaceous ratio within the respective lithological units. Very high borehole yields (>5.0l/s) are associated with the fractured Karoo sediments in the vicinity of Aberdeen, Nelspoort and Rietbron. According to Murray *et al,* 2011 favourable geological conditions and drilling targets within the Karoo sediments are:

- Dolerite dykes
- Dolerite ring structures
- Dolerite sill margins (inclined sheets)
- Thick alluvial deposits
- Folded and faulted formations

Transmissivity values associated with the above geological settings are generally very high (250–500m^2/d) but may vary depending on whether the formation is predominantly arenaceous or argillaceous. Very low transmissivity values (<25m^2/d) generally indicate lower borehole yields and therefore low groundwater potential.

3.3.4 *Recharge, water levels and contribution to baseflows*

Groundwater recharge is spatially variable and generally decrease in a westerly direction. According to WR2012, the western half of the catchment receives <17.50mm of recharge per annum, which increases to >200mm/annum in the northeast. The spatial trend in the groundwater recharge reflects the rainfall pattern of the area which increases in an easterly direction. Refer to Appendix D, Figure 8-13 for a map illustrating the groundwater recharge throughout the study area.

Several stressed quaternary catchments have been identified in the area where the estimated groundwater use exceeds the sum of the estimated groundwater recharge, basic human needs and groundwater contribution to baseflow (Appendix D, Figure 8-14). Of the stressed quaternaries that exist, most of them are low to moderately stressed (0.0Mm^3/annum to -17Mm^3/annum), however there are also several highly stressed quaternaries (>-17Mm^3/annum to -38Mm^3/annum) in parts of the Karoo, southern coast and Mthatha area.

3.3.5 *Groundwater use*

According the DWS WARMS database, registered groundwater use is scattered across the catchment area (Appendix D, Figure 8-15). Groundwater use is from boreholes and springs. The majority of registered groundwater users use <29 300m^3/annum. The larger groundwater users appear to be focussed in the western half of the catchment, particularly in the Karoo, as well as the southern coastal areas. Groundwater use of >1 000 000m^3/annum is associated with town supply to towns of Pearston, Middelburg, Graaff-Reinet and Aberdeen. Current estimated groundwater use for the catchment is 149Mm^3/annum.

Several towns rely solely on groundwater. These include Nieu-Bethesda, Aberdeen, Jansenville, Riebeeck East, Alexandria, Boknes, Cannon Rocks, Paterson, Kenton-on-Sea, Tarkastad, Hofmeyr, Steynsburg and Middelburg.

3.3.6 *Groundwater quality*

Groundwater quality is generally good over most parts of the catchment area (Appendix D, Figure 8-16). The exceptions are found along parts of the coast and at some inland locations where the recharge is low and the geology is not favourable. The spatial distribution of Electrical Conductivity (EC) varies and reflects local recharge conditions and chemical processes in the aquifer systems. Low ECs (0 – 70 mS/m) and therefore fresher water can be observed along the north-eastern and southwestern parts of the catchment. The low ECs is a result of active recharge in predominantly

higher lying areas with higher rainfall. Large surface areas have ECs in the range of 70 – 300 mS/m mainly in the central parts of the catchment. Marginal ECs (300 – 1000 mS/m) to very high ECs (> 1000 mS/m) are observed in patches in the central and western parts of the catchment. The latter is likely to be related to argillaceous rock formations and areas with stagnant groundwater flow and low recharge. The very high ECs in the western parts of the catchment near Rietbron can be related to an evaporitic effect which can result in an accumulation of salts in the primary aquifer overlying the fractured Beaufort Group sediments.

3.4 Estuaries

The Water Management Area 7 (WMA 7) incorporates a vast number of estuaries with 155 of these between the Mtentwana, immediately south of the Mtamvuna which forms the southern boundary of KwaZulu-Natal, and the Lottering east of Plettenberg Bay. The frequency of estuaries per kilometre of coast line begins to increase to the east and north of East London. The estuaries within the study area have all been characterised based on Present Ecological State (PES), Biodiversity Importance and linkages with other significant areas such as MPAs, and the pressures or impacts on each system. These characteristics provided the basis for the IUA delineation from an estuary perspective.

3.4.1 *Present Ecological State*

There are estuaries present in twelve of this study's categorised IUAs. The PES represents how the ecological condition/ health of an estuary has changed from its natural or reference conditions. The PES used for the estuaries in this study area has come from the latest ratings provided in the National Biodiversity Assessment 2018 (van Niekerk *et al.* 2018). It considers the abiotic factors of hydrology, hydrodynamics, habitat and water quality and the biotic functioning of the plants, invertebrates, fish and birds. Results are expressed as categories A to F, with Category A (unmodified) to Category F (severely modified).

The results from this largely desktop analysis indicate that the PES of estuaries in the study area are predominantly in good condition with 76% of the total being in an A (natural, near pristine) or B (largely natural) category. Only 6% of the estuaries fall in a Category D or Largely modified category.

3.4.2 *Biodiversity Importance and Linkages to MPAs, or other Critical Biodiversity Areas.*

Linkages with MPAs and protected areas are quite strong in this region with 69 of the 136 scored estuaries having a linkage with one or more formally recognised important biodiversity areas. These included Marine Protected Areas (MPA), terrestrial Protected Areas (PA) at either national, provincial or municipal levels, recognised Important Bird Areas (IBA) or categorised important fish nursery areas.

Sixty-seven estuaries have no linkage at all with formally protected zones and this should be re-evaluated as some of these systems are flagged as priority systems in terms of the countries biodiversity targets. Fifty-four estuaries have at least one link to an important conservation area while 25 have two or more links.

3.4.3 *Pressures on estuaries*

Currently the estuaries in the study area are predominantly characterised with low impacts with 81% of the systems being rated at the lowest level of impact. However, some of the more urban systems have higher pressure rates with 12 being moderately stressed and seven being highly to severely impacted. Stress is generated by the changes to flow where systems have high abstraction (e.g. Kabeljous) or discharge, causeway and resort development and water quality declines.

3.5 Socio-economics and ecosystem services

3.5.1 *Demographics and socio-economic profile*

The majority of the study area falls within the Eastern Cape province, with small portions in 2 Local Municipalities of the Western Cape (Beaufort West and George LM) and one local municipality from Northern Cape (i.e., one ward in Ubuntu LM). The population of the catchment was 5.87 million in 2021 (2011 Stats SA census adjustments) and the population is predominately Xhosa speaking. According to Stats SA Community Survey 2016, the Eastern Cape had the highest households with no access to piped water, at 24.9% and nationally it was at 10.1% (Appendix B, Figure 8-7).

The catchment is mainly rural with a few urban areas in East London, Gqeberha (Port Elizabeth), and Makhanda (Grahamstown). According to Stats SA 2021, the Eastern Cape had the highest unemployment rate, at 47.1% and nationally it was at 34.9%. The province also had the highest agricultural households, at 27.9% and nationally it was at 13.8%. Subsistence agriculture is mainly livestock, poultry, food crops and vegetable production.

3.5.2 *Economic sectors*

The Eastern Cape contributed a GDP of approximately R230.3 billion in the last quarter of 2020, which is a contribution of 7.7% to the total national GDP (ECSECC, 2020). The largest contributors to the national GDP were Gauteng (35%) and KwaZulu-Natal (16%). The economy of the Eastern Cape is mainly supported by the tertiary sector (wholesale and retail trade, tourism and communications), followed by the sectors of manufacturing (large proportion by the automotive sub-sector), agriculture and agro-processing. In 2020 the tertiary sector accounted for 80.8% of the provincial gross value added (GVA) and the secondary sector 17.3% (largely the automotive manufacturing sector), followed by the primary sector (agriculture and to lesser extent mining) accounting for 1.9% (ECSECC, 2020).

In the Eastern Cape, the Sarah Baartman district municipality region (Kouga, Kou-Kamma, Dr Beyers Naude, Sundays River Valley, Blue Crane Route, Makana and Ndlambe local municipalities) has the largest contribution to the national commercial agriculture income at 3.9% (Stats SA, 2020). The Eastern Cape accounts for 12.3% in terms of land use area of the national commercial agricultural land.

3.5.3 *Ecological infrastructure*

Key water resources include various large wetland systems, rivers, dams and impoundments. Large rivers within the study area include the Great Kei, Sunday, Great Fish, Keiskamma, Buffalo, Tsitsikamma, Mthatha and Mbashe Rivers, as well as their many tributaries. The major dams and

impoundments include *inter alia* the uMtata, Darlington, Grassridge, Impofu, Kouga and Bridledrift dams.

The catchment houses large extents of protected landscapes including Addo Elephant and Camdeboo National Park in the N region and Mount Zebra National Park in the Q region, and numerous nature reserves (Appendix B, Figure 8-8).

3.5.4 *Ecosystem Service Sensitivity*

Ecosystem Service Sensitivity areas are identified at a high level through two general ways:

- Knowledge of benefits received through ecological infrastructure.
- Inferring the flow of ecosystem services through the spatial relationship of potential beneficiaries and ecological infrastructure.

General categories of ecosystem services are utilised to define sensitivity and include provisioning, regulating and cultural services. Additionally, due to the nature of the catchment classification process, the water provisioning service is highlighted to be included in the sensitivity analysis.

Key ecosystem services in the catchment are preliminarily identified as the following:

- Water Provisioning Services provided by the network of rivers, dams and impoundments and Strategic Water Source Areas (SWSA).
- Cultural services as indicated by the distribution of protected areas, tourism and community demographics.

Refer to Appendix B, Figure 8-9 for the ecosystem service sensitivity areas in the study area.

4. IUA DELINEATION

IUAs are spatial units consisting of significant water resources for which Water Resource Classes are determined. The delineation of a larger catchment into IUAs is done primarily according to a number of socio-economic criteria and the boundaries of water resource components or catchments, taking into consideration ecological information and biophysical characteristics. These IUAs will be used for the assessment of the ecological and socio-economic implications and/ or consequences of the different scenarios with the ultimate objective to determine Water Resource Classes.

The IUA delineation was based on the information and data available from the assessment that formed part of the gaps analysis task (DWS, 2022). The data and information availability from previous studies, the various monitoring databases and GIS spatial layers for the study area and expert judgement were used to delineate the IUAs.

The approach that was used for the delineation of IUAs is based on the following:

- the WRCS Guidelines, Volumes 1 and 2 (Overview and the 7-step classification procedure and ecological, hydrological and water quality guidelines for the 7-step classification procedure) (DWA, 2007b); and
- the development of procedures to operationalise Resource Directed Measures (chapter 6, Integrated Step 2) (DWS, 2017).

The following criteria has been analysed, assessed and reviewed for delineation of IUAs:

- Socio-economic zones (SEZs);
- Catchment area boundaries (drainage regions and water resource systems);
- Land use characteristics/ land-based activities;
- Water infrastructure (dams, channels, transfers, etc.);
- Ecoregions, geomorphology and vegetation;
- Conservation/ Protected Areas, Critical Biodiversity Areas;
- Fish sanctuaries, priority areas, Fish Support Areas (FSA) and corridors;
- Ecological information (PES, EI, ES), previous EWR study results;
- Strategic Water Source Areas;
- Status of water resources (quantity and quality);
- Any specific criteria for wetlands, estuaries or groundwater; and
- Stakeholder input.

This resulted in the delineation of the IUAs which are similar from a broad socio-economic, water resource component and catchment boundary perspective and can be managed as an entity. These IUAs form a logical unit for which management and operational scenarios can be considered and evaluated.

The IUAs delineated are listed in Table 4-1 and illustrated in Figure 4-1. The following sections provide the detailed status quo per identified IUA.

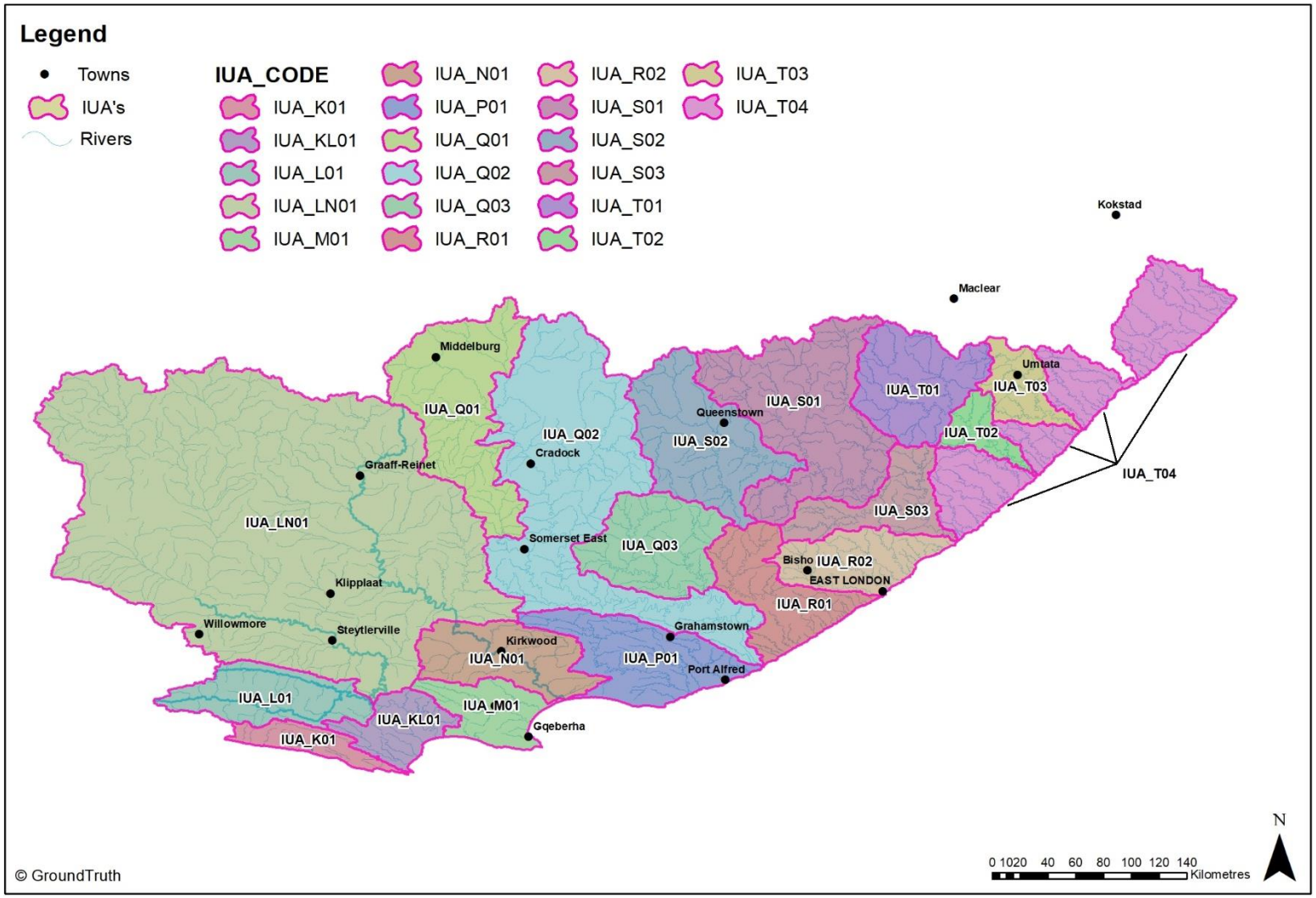
Table 4-1: IUAs delineated in the study area

IUA	IUA code	Description	Main rivers	Quaternary Catchments
1	IUA_K01	Tsitsikamma and headwaters of Kromme to Kromme Dam	Tsitsikamma, upper Kromme	K80A-F, K90A-B
2	IUA_KL01	Kromme from Kromme Dam to estuary and Gamtoos	Kromme, Gamtoos	K90C-G, L90A-C
3	IUA_L01	Kouga to Kouga Dam, Baviaanskloof	Kouga, Baviaanskloof	L81A-D, L82A-J
4	IUA_M01	M primary catchment	Swartkops, Coega	M10A-D, M20A-B, M30A-B
5	IUA_LN01	Groot to Kouga confluence, Upper Sundays to Darlington Dam	Sout, Kariega, Groot, Upper Sundays	L11A-G, L12A-D , L21A-F, L22A-D, L23A-D, L30A-D, L40A-B, L50A-B, L60A-B, L70A-G, N11A-B, N12A-C, N13A-C, N14A-D, N21A-D, N22A-E, N23A-B, N24A-D, N30A-C
6	IUA_N01	Sundays downstream Darlington Dam	Lower Sundays	N40A-F
7	IUA_P01	P primary catchment	Boesmans, Kowie, Kariega	P10A-G, P20A-B, P30A-C, P40A-D
8	IUA_Q01	Fish	Little Brak, Upper Great Fish, Upper Little Fish	Q11A-D, Q14A-E, Q21A-B, Q22A-B, Q30A-B, Q80A-C

IUA	IUA code	Description	Main rivers	Quaternary Catchments
9	IUA_Q02	Great Fish	Great Fish, Tarka, Baviaans, Lower Little Fish	Q12A-C, Q13A-C, Q30C-E, Q41A-D, Q42A-B, Q43A-B, Q44A-C, Q50A-C, Q60A-C, Q70A-C, Q80D-G, Q91A-C, Q93A-D
10	IUA_Q03	Koonap and Kat	Koonap, Kat	Q92A-G, Q94A-F
11	IUA_R01	Keiskamma	Keiskamma, Tylomnqa	R10A-M, R40A-C, R50A-B
12	IUA_R02	Buffalo/ Nahoon	Baffalo, Nahoon, Kwelera, Gqunube	R20A-G, R30A-F
13	IUA_S01	Upper Great Kei	Indwe, White Kei, Tsomo, Great Kei	S10A-J, S20A-D, S40A-F, S50A-J
14	IUA_S02	Black Kei	Klipplaat, Klaas Smits, Black Kei	S31A-G, S32A-M
15	IUA_S03	Lower Great Kei	Kubusi, Great Kei	S60A-E, S70A-F
16	IUA_T01	Upper Mbashe, Upper Mthatha	Xuka, Mgwali, Upper Mbashe, Upper Mthatha	T11A-H, T12A-G, T20A
17	IUA_T02	Lower Mbashe	Lower Mbashe	T13A-E
18	IUA_T03	Lower Mthatha	Lower Mthatha	T20B-G

IUA	IUA code	Description	Main rivers	Quaternary Catchments
19	IUA_T04	Pondoland coastal	Mtentu, Msikaba, Mngazi, Mtakatye, Xora, Nqabara, Qhorha	T60A-K, T70A-G, T80A-D, T90A-G

The selection and evaluation of Resource Units (RU) to select priority RUs, and to identify biophysical nodes and hotspots (stressed RUs) will be undertaken per IUA as the next step. The approaches per water resource component (rivers, wetlands, groundwater and estuaries) and the final priority RUs are presented in a separate report.


Legend
Towns
IUA's
Rivers
IUA_CODE
IUA_K01
IUA_KL01
IUA_L01
IUA_LN01
IUA_M01
IUA_N01
IUA_P01
IUA_Q01
IUA_Q02
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IUA_R01
IUA_R02
IUA_S01
IUA_S02
IUA_S03
IUA_T01
IUA_T02
IUA_T03
IUA_T04
Kokstad
Maclear
Middelburg
Umtata
Queenstown
Cradock
Graaff-Reinet
Somerset East
Bisho
EAST LONDON
Klipplaat
Willowmore
Steytlerville
Kirkwood
Grahamstown
Port Alfred
Gqeberha
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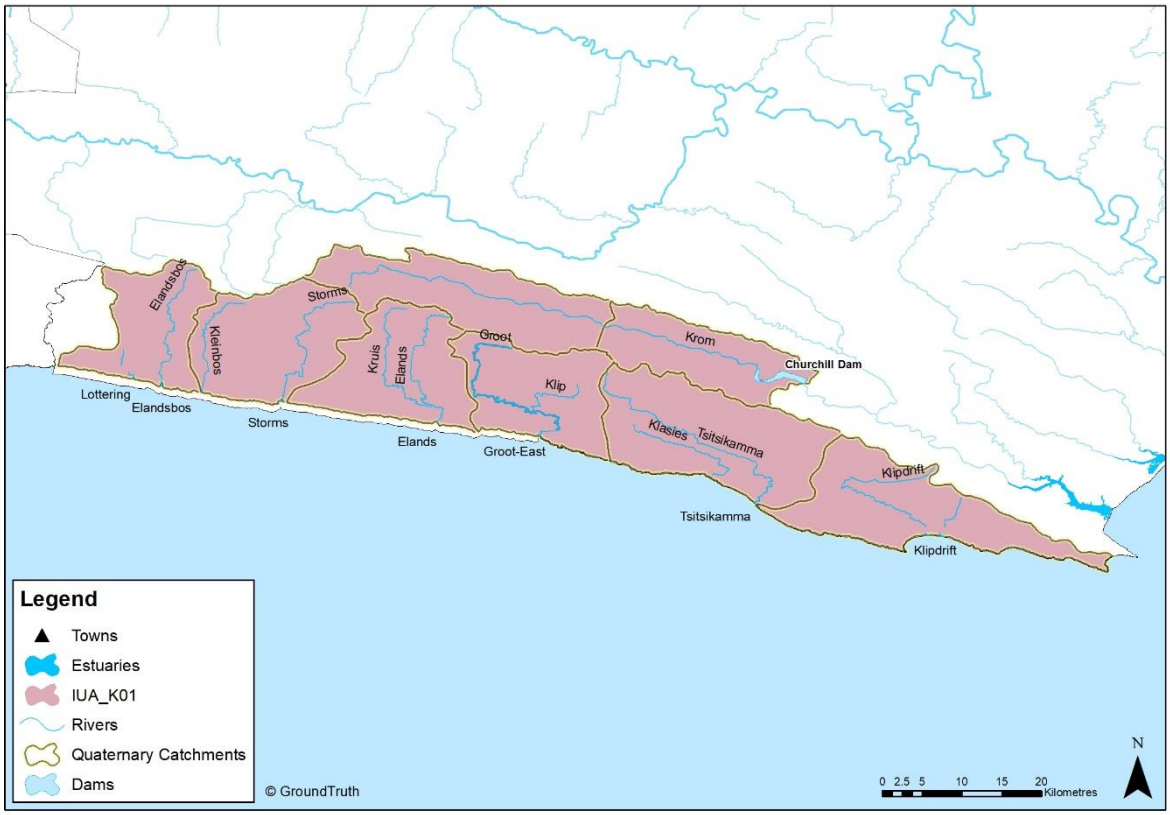
Kilometres
© GroundTruth

Figure 4-1: Delineated 19 IUAs throughout the study areas

4.1 IUA_K01: Tsitsikamma and headwaters of Kromme to Kromme Dam



Aspect	Status quo
Overview	This IUA covers the Tsitsikamma and smaller coastal rivers and the headwaters of Kromme River to Kromme Dam. The IUA delineation was based on biophysical characteristics, ecoregion, associated sensitivities which include the Tsitsikamma Nature Reserve and Formosa Provincial Nature Reserve. Owing to the vast land use activities and impacts (commercial farming, forestry, and high reliance on water resources from the municipality) it is a highly stressed catchment, although categorised as a SWSA for surface water (SW), groundwater (GW) and integrated SW-GW. The IUA includes various fish sanctuaries in the form of fish support areas (FSA).
Socio-economic profile	This IUA falls within Koukamma LM (wards 4, 5, 6) and Kouga LM (ward 1). The population in 2021 was 23 669 with employment rate at 52%. Approximately 31% of the population rely on water resources (mainly groundwater) to access basic water services. No large cities in this IUA. Main small towns include Kareedouw, Clarkson, Woodlands, Stormsriver and Oyster Bay. The key economic activities include tourism, forestry and agriculture (dairy, sheep and fruit).
SWSAs	SW: K90A and K90D
Water resource components:	

Aspect	Status quo	
Rivers	Main rivers	Elandsbos, Storms, Elands, Groot, Klipdrift, Tsitsikamma, upper Kromme
	Quaternaries	K80A-F, K90A-B
	Ecoregion	20_2: South Eastern Coastal Belt (20) ecoregion
	PES	Ranges from largely natural (category B) to largely modified (category D) ecological conditions
	EIS	EI: Moderate to High ES: High Overall EIS: Moderate to High.
	Fish	Fish Sanctuaries: Support Areas within the Krom River, Storms River, Groot River, Klip River, Tsitsikamma River.
	Vegetation	Dominant Biome/s: Fynbos with pockets of natural Forest Dominant Bioregion/s: Eastern Fynbos-Renosterveld with pockets of zonal and intrazonal Forests Threatened Ecosystems: CR (Langkloof Shale Renosterveld) and V (Eastern Coastal Shale Band Vegetation, Garden Route Shale Fynbos) Threatened / sensitive species: Threatened (*Cyathea capensis* [Decl], Ilex mitis var. mitis [Decl], *Crinum macowanii* [Decl]); Sensitive (*Prionium serratum*)
	Geomorphology	The rivers fall largely in the Upper Foothill and Lower Foothill geomorphic classes. The percentage of the river network falling in the various geomorphological zones are as follows: Mountain Headwater Stream - 4.1% Mountain Stream - 4.0% Transitional - 10.2% Upper Foothills - 46.8% Lower Foothills - 34.9% Lowland River – 0.0%
	EWR sites	Sanddtift and Kruis (K80C), Groot and Klip (K80D), Tsitsikamma and Palmiet (K80E), Klipdrift Oos and Slang (K80F), Krom (K90A)
Wetlands	HGM unit type	Total of 189 wetlands mapped; Channelled Valley Bottom Wetlands: 50% Depression Wetlands: 8% Hillslope Seep Wetlands: 16% Unchannelled Valley Bottom Wetlands: 26%
	PES per HGM unit type	Channelled Valley Bottom Wetlands - A/B: 16%; C: 40%; D/E/F: 44%.

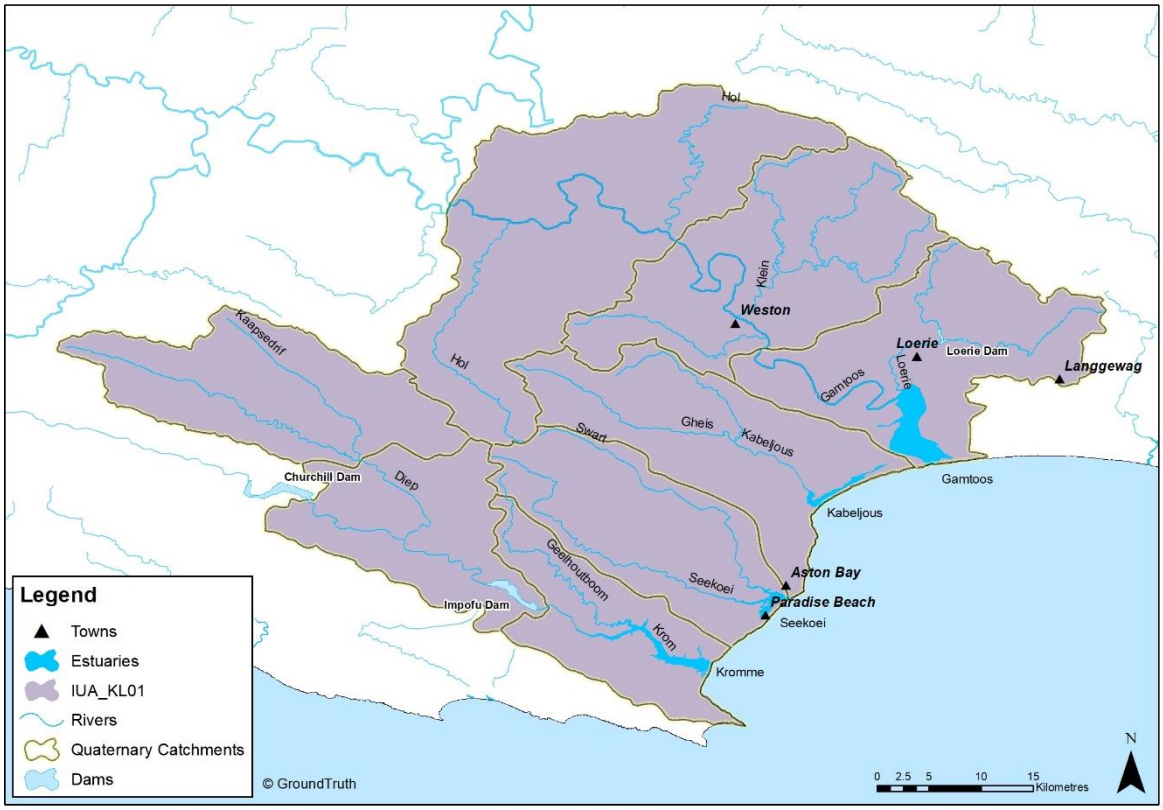
Aspect	Status quo	
		Depression Wetlands - A/B: 36%; C: 21%; D/E/F: 43%. Hillslope Seep Wetlands - A/B: 8%; C: 44%; D/E/F: 48%. Unchannelled Valley Bottom Wetlands - A/B: 15%; C: 20%; D/E/F: 65%.
	FEPA Wetlands1	A single FEPA wetland is present in IUA_K01 – namely the Kromme wetland.
	Ecosystem Services	**Supply:** Given that there predominant HGM unit types in IUA_K01 are valley bottom wetlands (CVB and UVB comprise 75% of the wetlands in IUA_K01), the supply of ecosystem services will generally be characterised by regulating and supporting services such as flood attenuation, sediment trapping and streamflow regulation services. Furthermore, water quality enhancement services are also generally supplied to a moderate or moderately high level by valley bottom wetlands - especially if there are significant lateral seepage inputs into those valley bottom wetlands. **Demand:** Generally, there is a vast area of agricultural land located along the coast down to Cape St Francis. The wetlands in this particular area therefore have a high demand for water quality enhancement services as well as sediment trapping services. There are a number of irrigation dams located in these areas as well as a number of larger water supply dams in the Kromme River valley. Therefore, there is also a demand for streamflow regulation.
Groundwater	Aquifer type	The aquifer is of a fractured type, mainly associated with the fractured Table Mountain Group Aquifer
	Stressed areas	The IUA is moderately to highly stressed
Estuaries	Estuary types	High proportion of pristine River Mouth estuaries interspersed with small Intermittently Open estuaries in good condition.
	PES	Ranges from natural (category A) to largely modified (category C/D).
	Integrated Estuary Score (IES)	The Storms and Elands have good linkages to protected or critical biodiversity areas which increases their IES score.

1 It should be noted that only FEPA wetlands that overlap spatially with the National Wetland Map 5 will be recorded here as it is recognised that there are some inherent problems with the NFEPA wetland coverage. Therefore, only those FEPA wetlands that have been 'confirmed' by the National Wetland Map 5 will be recorded here.

Aspect	Status quo	
		Overall IES: ranges from Low to High.
	Pressures	Low pressures Localised flow and quality impacts
Conservation areas/ priority systems/ etc.	Tsitsikamma Nature Reserve Formosa Provincial Nature Reserve	
Water use:		
Major dams	K9H001 (Kromriver Dam) at outlet of K90B	
Transfers/ hydro power generation	None	
Main activities (irrigation, forestry, etc.)	Agriculture: 62% Industry: 1% Domestic: 2% Afforestation: 17% Alien Veg: 11% Irrigation: 7%	
Groundwater	The current groundwater use in the IUA is about 9.4Mm^3/annum, of which 78% is for irrigation, 7% is for livestock watering and 6% is for municipal use.	
Water quality:		
Rivers	At the headwaters of the Krom (Kromme) River, data was last recorded in 2019. This data shows that at Low Bridge on Kammiesbos Farm (K90A), the pH level was within the acceptable range until 2019 when it fell below this range. The salinity, electrical conductivity, nitrate and ammonia levels were all acceptable. These conditions remained unchanged when measured downstream at the Melkhoutkraal Farm (K90B), an area surrounded largely by agricultural activity. From there, the river runs past a PG Bison timber mill as well as the town of Kareedouw (including Kareedouw WWTW) until it reaches the next sampling point at Low Water Bridge in Assegaaibosch Station (K90B). Acceptable salinity, electrical conductivity and nitrate levels were observed at this location. The pH reading was slightly below acceptable limit and phosphate was slightly above acceptable limit for part of 2018 and 2019. The peak in recent phosphate levels could be as a result of effluent from the Kareedouw WWTW contaminating the river, suggesting that the WWTW infrastructure may be degraded or unable to cope with the growth of the town. Negligible changes have occurred by the time the Krom River reaches a point below Assegaaibosch Station. After passing cultivated land areas, the Krom River is sampled at Farm de Wilgen (K90B) and acceptable salinity, electrical conductivity, phosphate and nitrate levels are observed. Varying pH levels are noted as not always falling within the acceptable range, with the most recent reading (in 2019) falling at an unacceptably low level. The Tsitsikamma River has available data from Geelhoutboom (K80E); however, the more recent data records only extend as far as 2017. The data reflects acceptable salinity, sulphate, nitrate and pH levels. The electrical conductivity was at an acceptable level until 2017 when it spiked dramatically to over the compliant limit;	

Aspect	Status quo	
	however, it did drop again to an acceptable level within the same year. Phosphate experienced a similar isolated peak in 2017 to an unacceptable level. Chloride has increased over the years and is no longer at an ideal level but is not yet considered too high – continuous monitoring is recommended. The Tsitsikamma River catchment is dominated by rural agricultural areas. At the mouth of the river, the water was last monitored in 2008 and shows poor water quality with nearly all parameters being beyond their acceptable limits. Determining the current water quality would require new monitoring to be done at multiple points along the Tsitsikamma River.	
Groundwater	The groundwater quality is good to excellent	
Ecosystem services:		
Ecosystem services	**Key Ecosystem Service**	**Key Ecological Infrastructure**
	Provisioning: • Water • Food • Raw materials	• Rivers • wetlands • ground, and surface SWRA
	Regulation: • water regulation • water quantity • erosion control/ soil stability • biological control	• rivers • wetland • estuaries
	Cultural: • Ecotourism & recreation • Landscape & amenity values	• Estuaries and coastline • Tsitsikamma nature reserve and other small nature reserves
Beneficiaries	• Significance to households that rely on ground water for water provisioning; • Significant commercial agriculture (dairy, sheep and fruit) in associated towns and their surroundings; and • Significant tourism industry in associated towns and communities.	
Impacts	• Commercial farming near the coastline, forestry and high reliance on water resources from the municipality; and • Tourism; and households.	

4.2 IUA_KL01: Kromme from Kromriver Dam to Estuary and Gamtoos



Aspect	Status quo
Overview	This IUA covers the Kromme River flowing downstream from the Kromme Dam to the estuary and Gamtoos River and is linked directly to the Algoa system. The IUA delineation was based on similar biophysical characteristics as per IUA1 (IUA_K01), ecoregion and economic activities. The land use and impacts within this IUA includes commercial farming and high reliance on water resources from the municipality. There are two (2) large dams (Kromme and Mpofu) in this IUA. Parts of some quaternary catchments include SWSA for SW and integrated SW-GW. Various fish sanctuaries occur throughout, both priority areas and FSA.
Socio-economic profile	This IUA falls within Kouga LM (ward 2-15) a. and Koukamma LM (ward 4). The population in 2021 was 117 009, with employment rate at 47%. Only 6% of the population rely on water resources to access basic water services. The main towns in this IUA are St Francis Bay, Humansdorp, Jeffreys Bay, Patensie, Hankey and Louerieheuwel. The economy of the area is largely centred on tourism and there are also agricultural activities including dairy and beef farming, field crops and citrus. Forestry activities in the Hankey area.
SWSAs	SW: K90D SW and integrated SW-GW: L90B – L90C:
Water resource components:	

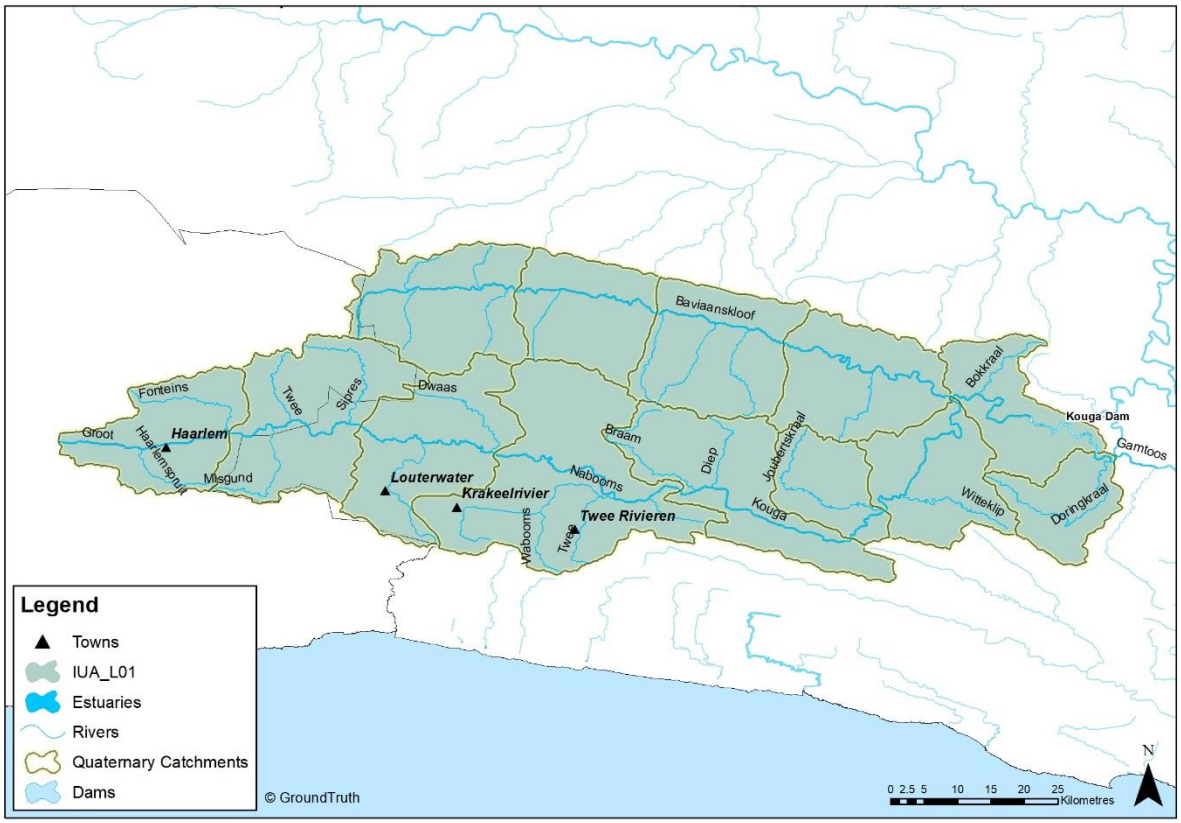
Aspect	Status quo	
Rivers	Main rivers	Kromme, Seekoei, Kabeljous, Gamtoos
	Quaternaries	K90C-G, L90A-C
	Ecoregion	20_2: South Eastern Coastal Belt (20) ecoregion 19:2: Southern Folded Mountains (19) ecoregion
	PES	Ranges from largely natural (category B) to largely modified (category D) ecological conditions
	EIS	EI: Moderate to High ES: High in the K catchment, Moderate to High in the L catchment Overall EIS: Moderate to High.
	Fish	Fish Sanctuaries: Priority Area (Swart River, Gheis River, Kabeljous River, Hol River, unnamed tributary of the Klein River) Fish Sanctuaries: Support Areas (Krom River, Diep River, Seekoei River, lower reaches of the Gamtoos, Klein River, Geelhoutboom River, unnamed tributary of the Loerie River)
	Vegetation	Dominant Biome/s: Fynbos and to a lesser degree Albany Thicket, with pockets of natural Forest and some Azonal Vegetation (Alluvial Vegetation). Dominant Bioregion/s: Eastern Fynbos-Renosterveld, Albany Thicket, Alluvial Vegetation (along the Gamtoos) and pockets of zonal and intrazonal Forests Threatened Ecosystems: E (Humansdorp Shael Renosterveld, Albany Alluvial Vegetation) V (Eastern Coastal Shale Band Vegetation) Threatened / sensitive species: Threatened (Cyathea capensis [Decl], Ilex mitis var. mitis [Decl]), *Crinum macowanii* [Decl]; Sensitive (*Prionium serratum*)
	Geomorphology	The rivers fall largely in the Upper Foothill and Lower Foothill geomorphic classes. The percentage of the river network falling in the various geomorphological zones are as follows: Mountain Headwater Stream - 1.5% Mountain Stream - 4.3% Transitional - 10.0% Upper Foothills - 43.1% Lower Foothills – 31.6% Lowland River – 9.5%
	EWR sites	Krom (K90D, K90E), Geelhoutboom (K90E), Seekoei and Swart (K90F), Diep (K90D)
Wetlands	HGM unit type	Total of 164 wetlands mapped; Channelled Valley Bottom Wetlands: 15% Depression Wetlands: 14%

Aspect	Status quo	
		Floodplain Wetlands: 1% Hillslope Seep Wetlands: 14% Unchannelled Valley Bottom Wetlands: 16%
	PES per HGM unit type	Channelled Valley Bottom Wetlands - A/B: 43%; C: 21%; D/E/F: 36%. Depression Wetlands - A/B: 43.5%; C: 13%; D/E/F: 43.5%. Flood Plain Wetlands: A/B: 100%. Hillslope Seep Wetlands - A/B: 50%; D/E/F: 50%. Unchannelled Valley Bottom Wetlands - A/B: 44%; C: 28%; D/E/F: 28%.
	FEPA Wetlands	A number of FEPA wetlands exist in IUA_KL01, many of them being small, isolated depression wetlands. However, a number of channelled and unchannelled valley bottom FEPA wetlands have been mapped in both the Krom and Swart River catchments.
	Ecosystem Services	**Supply:** IUA_K01 is generally characterised by smaller hillslope or hilltop wetlands such as seeps or depression wetlands. Generally, these types of HGM units supply limited streamflow regulation, erosion control and flood attenuation ecosystem services, but are instead far more effective at providing water quality enhancing ecosystem services. Therefore, it is more likely that the ecosystem services provided by wetlands in IUA_K01 are associated with water quality enhancement, biodiversity maintenance and carbon storage. **Demand:** There are vast tracts of agricultural land associated with the Gamtoos River, the Krom River and the Seekoei River in this IUA. Any wetlands in these areas would have a significant demand for water quality enhancement ecosystem services as well as sediment trapping ecosystem services. In addition, the Gamtoos, Krom, Seekoei and Swart Rivers feed fairly significant estuaries which highlights the demand for water quality enhancement ecosystem services.
Groundwater	Aquifer	The aquifer is of a fractured type, mainly associated with the fractured Table Mountain Group Aquifer
	Stressed areas	The IUA is moderately stressed in certain areas
Estuaries	Estuary types	Two large Temporarily closed estuaries One Permanently Open estuary, the Kromme which has been severely impounded and is considered highly impacted
	PES	Ranges from natural (category A) to largely modified (category D).
	IES	Biodiversity importance reflects one estuary in this IUA considered to be of High Importance (Kromme) and one

Aspect	Status quo	
		rated Very High (Gamtoos). The other two are rated as moderately important. Overall IES: ranges from Moderate to Very High.
	Pressures	Freshwater abstraction and other anthropogenic impacts such as inappropriate infrastructure and water quality declines threaten the systems in this IUA.
Conservation areas/ priority systems/etc.	Gamtoos river mouth nature reserve and other small nature reserves	
Water use:		
Major dams	Mpofu (K9R002), Loerie (L9R001)	
Transfers/ hydro power generation	Transfers of water within the catchments for water to the Gqeberha area	
Main activities (irrigation, forestry, etc.)	Agriculture: 33% Domestic: 5% Afforestation: 9% Alien Veg: 7% Irrigation: 46%	
Groundwater	The current groundwater use in the IUA is about 10.8Mm^3/annum, of which 57% is for irrigation, 26% is for municipal use and 7% is for livestock watering.	
Water quality:		
Rivers	Data for K90C-G is limited and only one survey point, at Impofu Dam (quaternary K90D), contained information pertaining to the Krom River. At this location, all river parameters fell within their respective acceptable ranges, indicating good river quality. However, data at Impofu Dam was last updated in 2017, and may not be representative of the current conditions of the Krom River. Prior to the Komdomo Road Bridge (L90A), data for the Gamtoos River indicates acceptable water quality. However, at Hankey (L90B), the electrical conductivity for the Gamtoos River exceeds recommended levels, while all other river parameters remain acceptable. Further downstream at the Buffelshoek Rail Bridge (L90C, data last updated in 2017), the electrical conductivity, sodium, potassium, chloride and sulphate measurements reach harmful levels, indicating a severe deterioration in river quality. The electrical conductivity readings for the Loerie and Klein Rivers (L90B), are less severe than the Gamtoos; however, measurements still exceeded acceptable levels for both rivers. More recent data may be required, as measurements for the Loerie River were last updated in 2015, and in 2019 for the Klein River. Agricultural activities are prevalent in this IUA, with sparsely spaced urban and rural settlements. Chemical runoff from pesticides may eventually drain into the river, explaining the poor river quality of rivers like the Gamtoos River. Monitoring of the Hankey Sewage Works is also required, as data recorded in 2019 revealed poor levels	

Aspect	Status quo	
	of ammonia in the effluent of the facility – likely to be discharging into the Kleinrivier, affecting water quality in the future.	
Groundwater	The groundwater quality varies from good to marginal	
Ecosystem services:		
Ecosystem services	**Key Ecosystem Service**	**Key Ecological Infrastructure**
	Provisioning: • Water • Food • Raw materials	• Impofu dam • Rivers, • wetlands, • ground, and surface SWRA
	Regulation: • water regulation • water quantity • erosion control/ soil stability • biological control • climate regulation	• rivers • wetlands • estuaries • forestry
	Cultural: • Ecotourism & recreation • Landscape & amenity values	• Estuaries and coastline • Gamtoos river mouth nature reserve and other small nature reserves
Beneficiaries	• Significance to households that rely on ground water and Impofu dam for water provisioning. • Significant commercial agriculture (dairy and beef farming, field crops and citrus). associated in Humansdorp and Loueriehеuwel • Significant tourism industry in associated towns and communities	
Impacts	• Commercial agriculture; tourism; and households	

4.3 IUA_L01: Kouga to Kouga Dam, Baviaanskloof



Aspect	Status quo
Overview	This IUA covers the Kouga River to Kouga Dam and Baviaanskloof. The IUA delineation is based on biophysical characteristics, ecoregion and sensitive land use (Baviaanskloof Nature Reserve and numerous fish sanctuaries, including priority areas and FSA). It is a highly stressed IUA with impacts including irrigation from SW and GW. This IUA is further linked to the Algoa system although parts of the quaternary catchments are categorized as SWSA for both SW, GW and integrated SW-GW.
Socio-economic profile	This IUA falls within Koukamma (ward 1-3), Dr Beyers Naude (ward 1) and George (ward 24) local municipalities. The population in 2021 was 36 787, with employment rate at 59%. Approximately 35% of the population rely on water resources (mainly ground water) to access basic water services. The main towns are Joubertina and Twee Riviers (Koukamma LM) and Haarlem (George LM). The main economic activity is tourism and agriculture. Agriculture includes livestock farming (goats and sheep) and there is a well-established deciduous fruit growing area in the Langkloof valley
SWSAs	SW: L81A SW and Integrated SW-GW: L82A -L82D
Water resource components:	

Aspect	Status quo	
Rivers	Main rivers	Kouga, Baviaanskloof
	Quaternaries	L81A-D, L82A-J
	Ecoregion	19_2: Southern Folded Mountains (19) ecoregion
	PES	Ranges mostly from unmodified (category A) to moderately modified (category C) ecological conditions throughout. With the exception of sub quaternary reaches L82A-08948 categorised as largely modified (category D) with the main driver being water quality and L82H-08862 categorised as seriously modified (category E), with the main driver being water quality.
	EIS	EI: Moderate to High ES: Moderate to High Overall EIS: Mostly High, with a few exceptions which are Moderate (L82H-08815, L82H-08862, L82D-08998, L82D-08977, L81C-08791 and L81C-08800).
	Fish	Fish Sanctuaries: Priority Area (Sipres River, Nabooms River, Wabooms River, Twee River, Baviaanskloof River, Braam River, Diep River, Joubertskraal River, Witteklip River, Bokkraal River) Fish Sanctuaries: Support Areas (Diep River)
	Vegetation	Dominant Biome/s: Fynbos and to a lesser degree Albany Thicket, with some Azonal Vegetation (Alluvial Vegetation). Dominant Bioregion/s: Eastern Fynbos-Renosterveld, Albany Thicket, Alluvial Vegetation along the Baviaanskloof Threatened Ecosystems: CR (Langkloof Shale Renosterveld), V (Eastern Coastal Shale Band Vegetation) and E (Albany Alluvial Vegetation) Threatened / sensitive species: Threatened (Cyathea capensis [Decl], Ilex mitis var. mitis [Decl], *Gunnera perpensa* [Decl], *Crinum macowanii* [Decl]); Sensitive (*Prionium serratum*)
	Geomorphology	The rivers fall largely in the Upper Foothill geomorphic class. The percentage of the river network falling in the various geomorphological zones are as follows: Mountain Headwater Stream - 4.7% Mountain Stream - 9.0% Transitional - 16.3% Upper Foothills - 43.6% Lower Foothills – 26.4% Lowland River – 0.1%
	EWR sites	N/A

Aspect	Status quo	
Wetlands	HGM unit type	Total of 38 wetlands mapped; Channelled Valley Bottom Wetlands: 65% Depression Wetlands: 26% Hillslope Seep Wetlands: 6% Unchannelled Valley Bottom Wetlands: 3%
	PES per HGM unit type	Channelled Valley Bottom Wetlands - A/B: 80%; C: 4%; D/E/F: 16%. Depression Wetlands - A/B: 90%; D/E/F: 10%. Hillslope Seep Wetlands - A/B: 50%; C: 50%. Unchannelled Valley Bottom Wetlands - A/B: 100%.
	FEPA Wetlands	N/A
	Ecosystem Services	**Supply:** Given that there predominant HGM unit types in IUA 1 are valley bottom wetlands (CVB and UVB comprise almost 70% of the wetlands in IUA 1), the supply of ecosystem services will generally be characterised by regulating and supporting services such as flood attenuation, sediment trapping and streamflow regulation services. Given the relatively intact and remote nature of many of these wetlands, it is likely that they will be intact and able to supply these ecosystem services with a high degree of efficacy. Furthermore, water quality enhancement services are also generally supplied to a moderate or moderately high level by valley bottom wetlands - especially if there are significant lateral seepage inputs into those valley bottom wetlands. **Demand:** The relatively mountainous and inaccessible nature of most of this IUA means it is unlikely that there will be large demands for ecosystem services other than ones relating to cultural and recreational services. Much of the land in this IUA is either designated to national or provincial protected areas or to private conservation. Therefore, the wetlands in IUA_L01 are generally utilised for recreational activities like birding and game watching and in some cases hunting. Therefore, the recreational, cultural and biodiversity maintenance ecosystem services will be the predominant services demanded in this IUA.
Groundwater	Aquifer	The aquifer is of a fractured type, mainly associated with the fractured Table Mountain Group Aquifer
	Stressed Areas	The IUA is mildly stressed in certain areas
Estuaries	EFZ	No estuaries
Conservation areas/ priority systems/etc.	Baviaanskloof Nature Reserve	
Water use:		
Major dams	Kouga (L8R001), Haarlem (L8R002)	

Aspect	Status quo	
Transfers/ hydro power generation	Transfers to Gqeberha	
Main activities (irrigation, forestry, etc.)	Agriculture: 69% Domestic: 1% Alien Veg: 15% Irrigation: 14%	
Groundwater	The current groundwater use in the IUA is about 6.0Mm^3/annum, of which 90% is for irrigation, 4% is for livestock watering and 3% is for municipal use.	
Water quality:		
Rivers	No information is available for rivers within the L81 catchment region. Within the L82 catchment the river quality of the Wabooms River was good upstream of Joubertina, albeit this data is very outdated (last recorded in 2015). More recent readings of the Wabooms River, recorded in 2018 at Diepkloof, revealed that the river pH was below the compliant range. Data for the Louterwater River was sparsely recorded, with a 6-year gap between the two most recent river quality surveys (2014-2020) taken at Louterwater. Data recorded at Louterwater (L82C quaternary, updated 2020) indicated that the Louterwater River's electrical conductivity and phosphate levels exceeded the acceptable values. River quality returned to acceptable levels at the R62 Bridge outside of Louterwater; however, this data was last updated in 2015 and therefore more updated data would be required. River quality for the Twee Rivieren River, taken downstream of the town of Joubertina and the Joubertina WWTW, was at an acceptable level for all parameters except ammonia – which exceeded the allowable threshold. The raised levels of ammonia could be attributed to effluent discharge from the Joubertina WWTW into the Twee Rivieren River which exceeded the allowable ammonia limit (as of 2019). As such, this WWTW should be closely monitored to proactively prevent contamination of the river. Data for the Jordaans River (L82A) and Kouga River (L82E) was last updated in 2018 and data indicated good river quality for both rivers (all river quality parameters fell within the acceptable range). Within the IUA, land use is divided into urban settlements and sprawling plots used for agricultural activities. River quality may be affected by the use of pesticides on surrounding farm plots, and effluent runoff from urban WWTWs, which eventually seeps into the rivers at several locations.	
Groundwater	The groundwater quality is excellent	
Ecosystem services:		
Ecosystem services	**Key Ecosystem Service**	**Key Ecological Infrastructure**
	Provisioning: • Water • Food • Raw materials	• Rivers, • wetlands

Aspect	Status quo	
	Regulation: • water regulation • water quantity • erosion control/ soil stability • biological control	• rivers • wetlands
	Cultural: • Ecotourism & recreation • Landscape & amenity values	• Baviaanskloof Nature Reserve
Beneficiaries	• Significance to households that rely on ground water for water provisioning; • Significant commercial agriculture (goats and sheep and fruit) in Twee Rivers, Krakeel River and their surrounding areas; and • Tourism industry in Baviaanskloof Nature Reserve area.	
Impacted sectors	• Commercial agriculture; tourism; and households	

4.4 IUA_M01: M primary catchment

Aspect	Status quo	
Overview	This IUA covers the entire M primary catchment and is based on a mixture of land uses and land use impacts, which include towns, settlements, high population numbers and industrial activities. There are SWSA for both SW and GW, as well as integrated SW-GW, with a few fish sanctuaries with both priority areas and FSA.	
Socio-economic profile	This IUA falls within the entire Nelson Mandela Bay MM and Sundays River Valley LM (ward 7, 8). The population in 2021 was 1 331 897, with employment rate at 37%. Only 2% of the population rely on water resources to access basic water service. This IUA has the city of Gqeberha (Port Elizabeth) and smaller towns of Kariega (Uitenhage), Despatch and Colchester. The main economic sectors in Nelson Mandela Bay metro are tourism, agriculture (sheep, angora goats, dairy and oranges) and the manufacturing sector, in particular the automotive manufacturing subsector which contributes over 54% of the Eastern Cape GVA from manufacturing. The IUA includes the Coega Industrial Zone (IDZ) with the saltworks. The metro also has two seaports, Port Elizabeth Harbour and Ngqura.	
SWSAs	SW: M20B SW and Integrated SW-GW: M10B	
Water resource components:		
Rivers	Main rivers	Swartkops, Coega

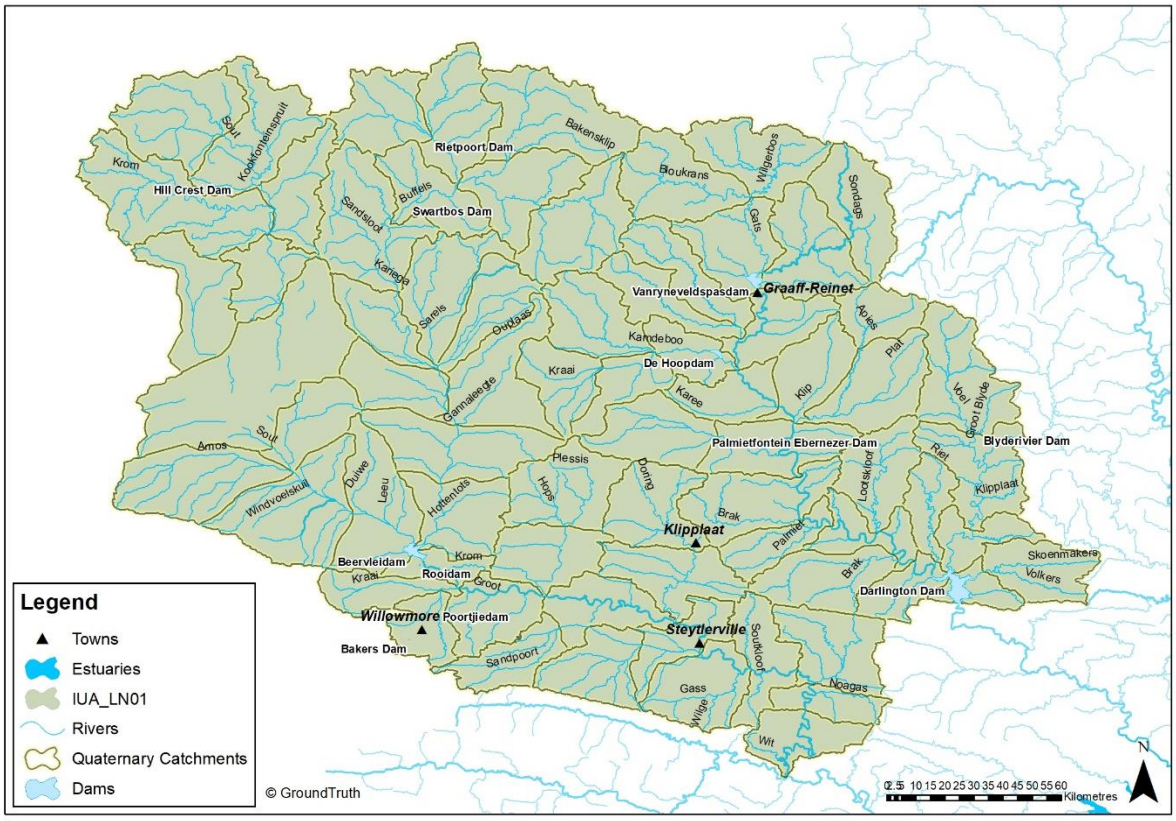
Aspect	Status quo	
	Quaternaries	M10A-D, M20A-B, M30A-B
	Ecoregion	20_2: South Eastern Coastal Belt (20) ecoregion 19_2: Southern Folded Mountains (19) ecoregion
	PES	Ranges mostly from moderately modified (category C) to largely modified (category D), with the exception of the sub-quaternary reach M10C-08926 which was categorized as unmodified (category A) as it is located within a protected area (Fernkloof) and thus there is limited modification and disturbances along this reach.
	EIS	EI: Moderate to High ES: Moderate to High Overall EIS: Moderate to High, with all of the M2 secondary catchment with a High EIS.
	Fish	Fish Sanctuaries: Priority Area (Sand River, KwaZungu River) Fish Sanctuaries: Support Areas (Elands River, Coega River, Swartkops River upstream of confluence with Elands River, Van Stadens River, Maitland River, Bakens River, Chatty River)
	Vegetation	Dominant Biome/s: Albany Thicket and Fynbos with some Azonal Vegetation Dominant Bioregion/s: Albany Thicket and Eastern Fynbos-Renosterveld Bioregion with some Alluvial Vegetation Threatened Ecosystems: V (Algoa Sandstone Fynbos) and E (Albany Alluvial Vegetation) Threatened / sensitive species: *Crinum campanulatum* (NT), *Marsilea schelpeana* (V), Sensitive (*Prionium serratum*), Ilex mitis var. mitis [Decl]
	Geomorphology	The rivers fall largely in the Upper Foothill geomorphic classes. The percentage of the river network falling in the various geomorphological zones are as follows: Mountain Headwater Stream - 1.3% Mountain Stream - 2.6% Transitional - 6.7% Upper Foothills – 52.5 Lower Foothills – 32.7% Lowland River – 4.2%
	EWR sites	N/A
Wetlands	HGM unit type	Total of 1337 wetlands mapped; Channelled Valley Bottom Wetlands: 8% Depression Wetlands: 40% Floodplain Wetlands: 1% Hillslope Seep Wetlands: 26% Unchannelled Valley Bottom Wetlands: 7%

Aspect	Status quo	
		Wetland Flat Wetlands: 18%
	PES per HGM unit type	Channelled Valley Bottom Wetlands - A/B: 21%; C: 43%; D/E/F: 36%. Depression Wetlands - A/B: 40%; C: 16%; D/E/F: 47%. Floodplain Wetlands - A/B: 17%; C: 8%; D/E/F: 75%. Hillslope Seep Wetlands - A/B: 21%; C: 24%; D/E/F: 55%. Unchannelled Valley Bottom Wetlands - A/B: 26%; C: 33%; D/E/F: 41%. Wetland Flat Wetlands - A/B: 29%; C: 16%; D/E/F: 55%.
	FEPA Wetlands	A small number of FEPA wetlands have been mapped in IUA_M01, most of which are isolated depression wetlands which are considered important from a biodiversity conservation point of view.
	Ecosystem Services	**Supply:** Generally, the mapped wetlands in IUA_M01 are located on the plains associated with the African Erosion Surface or the Algoa coastal bench. Depression and flat wetlands comprise almost 60% of the HGM units in the IUA. In addition, over 25% of the remaining wetlands are seep wetlands. Therefore it is expected that this IUA will be characterised predominantly by the supply of water quality enhancement ecosystem services as the movement of water through the low redox sub-soils in seep wetlands can act as a potent sink for nitrogen and phosphorus along with some toxicants. Since depression wetlands are often defined as being endorheic, they can also act as sinks for pollutants and toxicants. **Demand:** The northern and western portions of the IUA are predominantly characterised by mountainous areas associated with the large valleys carved out by the KwaZungu and Elands Rivers. These areas are generally characterised by conservation and therefore the immediate demand for ecosystem services is limited to recreational services relating to birding, animal watching and tourism. However, the southern and eastern portion of the IUA is characterised by the city of Port Elizabeth and its associated industrial area and urban sprawl. As such, the demand for ecosystems from wetlands that feed into this portion of the IUA relate more strongly to water quality enhancement ecosystem services, flood attenuation and erosion control. The Swartkops estuary is also a very important estuary which the Swartkops and KwaZungu rivers flow into, so any wetlands that flow into those rivers will also have a high demand for water quality enhancement ecosystem services.
Groundwater	Aquifer	The aquifer is of a fractured type, mainly associated with the fractured Table Mountain Group and Uitenhage Group. A small part of the IUA is also of an intergranular type, associated with Quaternary sands.

Aspect	Status quo	
	Stressed Areas	The IUA is mildly stressed in certain areas
Estuaries	Estuary types	Three large Temporarily closed estuaries, two small temporarily closed and one Predominantly Open estuary have been categorised in this IUA.
	PES	Estuary present condition ranges from near natural (category B) to critically threatened (category F). With only two in B or B/C category but three in an E to F.
	IES	Biodiversity importance reflects only one estuary in this IUA to be of High Importance (Swartkops) and together with its important linkages as an IBA, Important fish nursery and a local authority protected area associated, makes its overall IES high. Overall IES: estuaries range from low to high.
	Pressures	Major degradation as a result of canalisation, harbour development and high recreation use.
Conservation areas/ priority systems/ etc.	Groendal Nature reserve and other small nature reserves	
Water use:		
Major dams	Groendal (M1R001), Bulkrivier (M1R002), Sand River (M1R003), Upper and lower Van Stadens (M2R001 and M2R002)	
Transfers/ hydro power generation	None	
Main activities (irrigation, forestry, etc.)	Agriculture: 11% Domestic: 74% Afforestation: 3% Alien Veg: 7% Irrigation: 5%	
Groundwater	The current groundwater use in the IUA is about 8.4Mm^3/annum, of which 51% is for irrigation, 29% is for municipal use and 12% is for industrial use.	
Water quality:		
Rivers	The water quality of the Swartkops River varies greatly within the M10 drainage region. In 2019, sampling of the Swartkops River within Uitenhage revealed high levels of salinity, sodium, chlorides and electrical conductivity (rising as high as 2950mS/m). Data pertaining to mineral and heavy metal levels has not been recorded since 2008. The severe salinity, electrical conductivity and phosphate imbalance may be the result of contamination from the nearby Uitenhage WWTW (effluent data indicated unacceptable levels of electrical conductivity and ammonia content), or the salt pans and large industrial areas bordering the river outside Gqeberha.	

Aspect	Status quo	
	Similarly, the Coega River experiences high salinity and electrical conductivity levels - which continue to increase as the river approaches Gqeberha. Salinity and electrical conductivity are high in M30A quaternary, and reach harmful levels just upstream of a saltpan near Coega. Waste generated by the water users and the salt pan, may have contributed to the gradual deterioration of the Coega River water. Land use in the IUA primarily consists of small urban settlements surrounded by rural land, which is often used for agricultural activities. However, there is a dense concentration of urban and industrial areas that stretch from Uitenhage to Gqeberha. River quality becomes significantly poorer as rivers approach these urban and industrial areas – most likely due to the waste generated by industrial processes, urbanisation and WWTW return flows discharging into the rivers.	
Groundwater	The groundwater quality varies from good to marginal	
Ecosystem services:		
Ecosystem services	**Key Ecosystem Service**	**Key Ecological Infrastructure**
	Provisioning: • Water • Food	• Rivers, • wetlands, • ground, and surface SWRA
	Regulation: • water regulation • water quantity • erosion control/ soil stability • biological control • climate change regulation	• rivers • wetlands • estuary • forestry
	Cultural: • Ecotourism & recreation • Landscape & amenity values	• Estuaries and coastline • Groendal Nature reserve and other small nature reserves
Beneficiaries	• Significant commercial agriculture (sheep, angora goats, dairy and oranges). associated with towns and their surroundings • Significant tourism industry in associated towns and communities	
Impacted sectors	• Commercial agriculture; tourism; manufacturing, and households	

4.5 IUA_LN01: Groot to Kouga confluence, Upper Sundays to Darlington Dam



Aspect	Status quo
Overview	This IUA covers the Groot River to the confluence with the Kouga, including the upper Sundays to Darlington Dam. This large IUA is based on the fact that it is a highly stressed catchment, with agricultural activities, high irrigation, as well as important conservation areas requiring protection, namely Camdeboo National Park. Some fish sanctuaries which include priority areas, corridors and FSA. The IUA is groundwater driven (northern part of N and northern part of L where the dynamics of water use is similar and used for town supply). Some SWSA for groundwater.
Socio-economic profile	This IUA falls within the large portion of Dr Beyers Naude LM (ward 1), Blue Crane Route LM (ward 4 & 6), Beaufort West LM (ward 1 & 2) and Ubuntu LM (ward 3). The population in 2021 was 122 678, with employment rate at 40%. Approximately 23% of the population rely on water resources (mainly groundwater) to access basic water services. The main towns include Murraysburg (Beaufort West), Willowmore, Steytlerville, Aberdeen, Graaff-Reinet, Nieu-Bethesda, and Jansenville (Dr Beyers Naude). The IUA has nature reserves including the Riverdale Game reserve and Camdeboo National Park. The main economic activities are tourism and agriculture. Agriculture includes goat and sheep farming.
SWSAs	Mainly for groundwater in the upper reaches of the N catchment.

Aspect	Status quo	
Water resource components:		
Rivers	Main rivers	Sout, Kariega, Groot, Upper Sundays
	Quaternaries	L11A-G, L12A-D , L21A-F, L22A-D, L23A-D, L30A-D, L40A-B, L50A-B, L60A-B, L70A-G N11A-B, N12A-C, N13A-C, N14A-D, N21A-D, N22A-E, N23A-B, N24A-D, N30A-C
	Ecoregion	18_3: Drought Corridor (18) ecoregion 19_1: Southern Folded Mountains (19) ecoregion 21_5: Great Karoo (21) ecoregion 26_3: Nama Karoo (26) ecoregion
	PES	Ranges mostly from largely natural (category B) to largely modified (category D), with a few exceptions, namely the sub-quaternary reach L11E-07200, L11E-07247, L21B-06559, L23A-07632, L23A-07637, L30C-08235, L70C-08733 which are all categorized as unmodified (category A) due to limited transformation, small reaches and some with no activity within the reaches. Furthermore, N30A-07368, N30A-07497, N30A-07500 and N30A-07663 are also categorized as unmodified (category A), owing to high habitat diversity. Sub-quaternary reach L30C-08218 along the Scout River however was categorized as severely modified (category F) largely owing to parts of the reach within the inundation area of the Beervlei dam, and N12C-07239 categorized as seriously modified (category E), also primarily attributed to the entire reach being located within the Ngweba Dam.
	EIS	EI: Moderate to High ES: Moderate to High Overall EIS: Moderate to High, except for the Scouts River (L30C) and Sundays River (N12C) having a Low overall EIS
	Fish	Fish Sanctuaries: Priority Area (Bakensklip River, unnamed tributary of the Snyderskraal River, unnamed tributary of the Bakensklip River, unnamed tributary of the Buffels River, Krom River (x2), Davels River, Wilgerbros River, Diepkloof River, unnamed tributaries of the Bloukrans River (x2), Pienaars River, unnamed tributary of the Gats River, Groot Blyde River, unnamed tributary of the Kamdebo River, unnamed tributary of the Kraai River, Stefaansdrif River, Fish Sanctuaries: Corridor (Buffels River, Kariega River) Fish Sanctuaries: Support Areas (Snyderskraal River, Kariega River, unnamed tributary of the Kariega River, Groot River, Gats River, Bloukrans River, Sand River, Kraai River, Kamdeboo River,

Aspect	Status quo	
	Vegetation	Dominant Biome/s: Nama-Karoo and Albany Thicket with some Azonal Vegetation. Dominant Bioregion/s: Upper and Lower Karoo Bioregion with notable Inland Saline Vegetation Threatened / sensitive species: Ilex mitis var. mitis [Decl], *Gunnera perpensa* [Decl]
	Geomorphology	The rivers fall largely in the Upper Foothill and Lower Foothill geomorphic classes. The percentage of the river network falling in the various geomorphological zones are as follows: Mountain Headwater Stream - 1.2% Mountain Stream - 2.3% Transitional - 6.6% Upper Foothills – 53.0 Lower Foothills – 36.5% Lowland River – 0.4%
	EWR sites	N/A
Wetlands	HGM unit type	Total of 524 wetlands mapped; Channelled Valley Bottom Wetlands: 43% Depression Wetlands: 29% Hillslope Seep Wetlands: 8% Unchannelled Valley Bottom Wetlands: 15% Wetland Flat Wetlands: 5%
	PES per HGM unit type	Channelled Valley Bottom Wetlands - A/B: 66%; C: 14%; D/E/F: 20%. Depression Wetlands - A/B: 80%; C: 5%; D/E/F: 15%. Hillslope Seep Wetlands - A/B: 48%; C: 45% D/E/F: 7%. Unchannelled Valley Bottom Wetlands - A/B: 76%; C: 19% D/E/F: 5%. Wetland Flat Wetlands - A/B: 79%; C: 17%; D/E/F: 4%.
	FEPA Wetlands	A small number of FEPA wetlands have been mapped in IUA_LN01 – most of which are valley bottom wetlands.
	Ecosystem Services	**Supply:** Given that there predominant HGM unit types in IUA_LN01 are valley bottom wetlands (CVB and UVB comprise almost 60% of the wetlands in IUA_LN01), the supply of ecosystem services will generally be characterised by regulating and supporting services such as flood attenuation, sediment trapping and streamflow regulation services. Furthermore, water quality enhancement services are also generally supplied to a moderate or moderately high level by valley bottom wetlands - especially if there are significant lateral seepage inputs into those valley bottom wetlands. **Demand:** The relatively mountainous and inaccessible nature of most of this IUA means it is unlikely that there will be large

Aspect	Status quo	
		demands for ecosystem services other than ones relating to cultural and recreational services. Much of the land in this IUA is either designated to national or provincial protected areas or to private conservation. Therefore, the wetlands in IUA_LN01 are generally utilised for recreational activities like birding and game watching and in some cases hunting. Therefore, the recreational, cultural and biodiversity maintenance ecosystem services will be the predominant services demanded in this IUA.
Groundwater	Aquifer Type	The aquifer is of a fractured type, mainly associated with the fractured Upper Cape Supergroup (Bokkeveld and Witteberg Groups) and Lower Karoo Supergroup.
	Stressed Areas	The IUA is mildly to moderately stressed in certain areas
Estuaries	EFZ	No estuaries
Conservation areas/ priority systems/ etc.	Camdeboo national park Karoo and Noorsveld nature reserves	
Water use:		
Major dams	Beervlei (L3R001), Nqweba (N1R001), Darlington N2R001), Blyde River (N3R001)	
Transfers/ hydro power generation	Water is transferred from the Great Fish to Darlington Dam for irrigation purposes	
Main activities (irrigation, forestry, etc.)	Agriculture: 32% Domestic: 7% Alien Veg: 2% Irrigation: 58%	
Groundwater	The current groundwater use in the IUA is about 42.7Mm^3/annum, of which 65% is for irrigation, 30.7% is for municipal use and 1.9% is for schedule 1 use.	
Water quality:		
Rivers	Most of the available data for this IUA is outdated and there is no available data for areas L11A-G, L12A-D, L21A-F, L22A-D, L23A-D, L30A-D, L40A-B, and L50A-B. This IUA is characterised by mountainous terrain with some agricultural areas, but very little urbanisation/development overall. Data collected at Campherspoort along the Heuningklip River (before its confluence with the Groot River) illustrates large variances in sulphate, pH and phosphate levels with readings often being too high and only compliant with the acceptable range about 50% of the time in the years prior to 2016. Electrical conductivity and chloride readings tend to be slightly above acceptable limits whilst nitrate, ammonia and salinity levels are fair. The Groot River was sampled at Sandpoort (2016), and results revealed unacceptably high salinity and electrical conductivity levels. The pH levels were bordering on the	

Aspect	Status quo	
	upper allowable limit, with sulphate readings generally exceeding allowable thresholds. TDS, sodium and chloride readings also contributed to a poor water quality. Acceptable levels of phosphate and nitrate levels were observed. Downstream, at Grootrivierspoort (upstream of the Kouga confluence) all readings were very good and within their respective acceptable range. The upper section of the Sundays River contains data that was last recorded downstream of the Graaf-Reinet WWTW in 2013, where high electrical conductivity and ammonia levels were observed. This is likely to be a result of effluent from the WWTW, and is unlikely to have changed significantly in the interim, and probably worsened. This will need to be verified with updated data. Further downstream, after passing through the town of Jansenville, slightly more updated data (2016) is available. This data suggests that there are unacceptable levels of sulphates, electrical conductivity, sodium and chloride. Phosphate and pH thresholds are also sometimes exceeded. The towns of Graaf-Reinet and Jansenville may be contributing factors to the poor water quality in the upper reaches of the Sundays River. The state of the Riet River (data taken up until 2017) just before it feeds into the Sundays River is not ideal with unacceptable electrical conductivity and phosphate readings, despite the area being mostly undeveloped. The Voel River is another feeder to the Sundays, and data is collected at Riet Vley (upstream of the confluence). This data suggests that, as of 2018, the electrical conductivity is higher than the acceptable threshold and the pH is consistently slightly above the allowable limit. This could be attributed to the bordering irrigated fields that could have a detrimental effect on the river quality if harmful pesticides or agricultural by-products seep into the river. All other parameters are compliant at Riet Vley. The Sundays River then runs into the Darlington Dam, as does the Volkers River. Data collected (up to 2018) for the Volkers River reflects good water quality, with only the pH level being slightly elevated beyond the acceptable range.	
Groundwater	The groundwater quality varies from excellent to poor in certain areas	
Ecosystem services:		
Ecosystem services	**Key Ecosystem Service**	**Key Ecological Infrastructure**
	Provisioning: • Water • Food • Raw materials	• rivers, • wetlands, • ground water • Darlington and Nqweba dam
	Regulation: • water regulation • water quantity • erosion control/ soil stability • biological control	• rivers • wetlands
	Cultural: • Ecotourism & recreation • Landscape & amenity values	• Camdeboo national park • Karoo and Noorsveld nature reserves

Aspect	Status quo
Beneficiaries	• Significance to households that rely on ground water for water provisioning; • Significant commercial agriculture (goat and sheep farming) in associated towns and their surroundings; and • Significant tourism industry in associated towns and communities.
Impacted sectors	• Commercial agriculture; tourism; and households

4.6 IUA_N01: Sundays downstream Darlington Dam

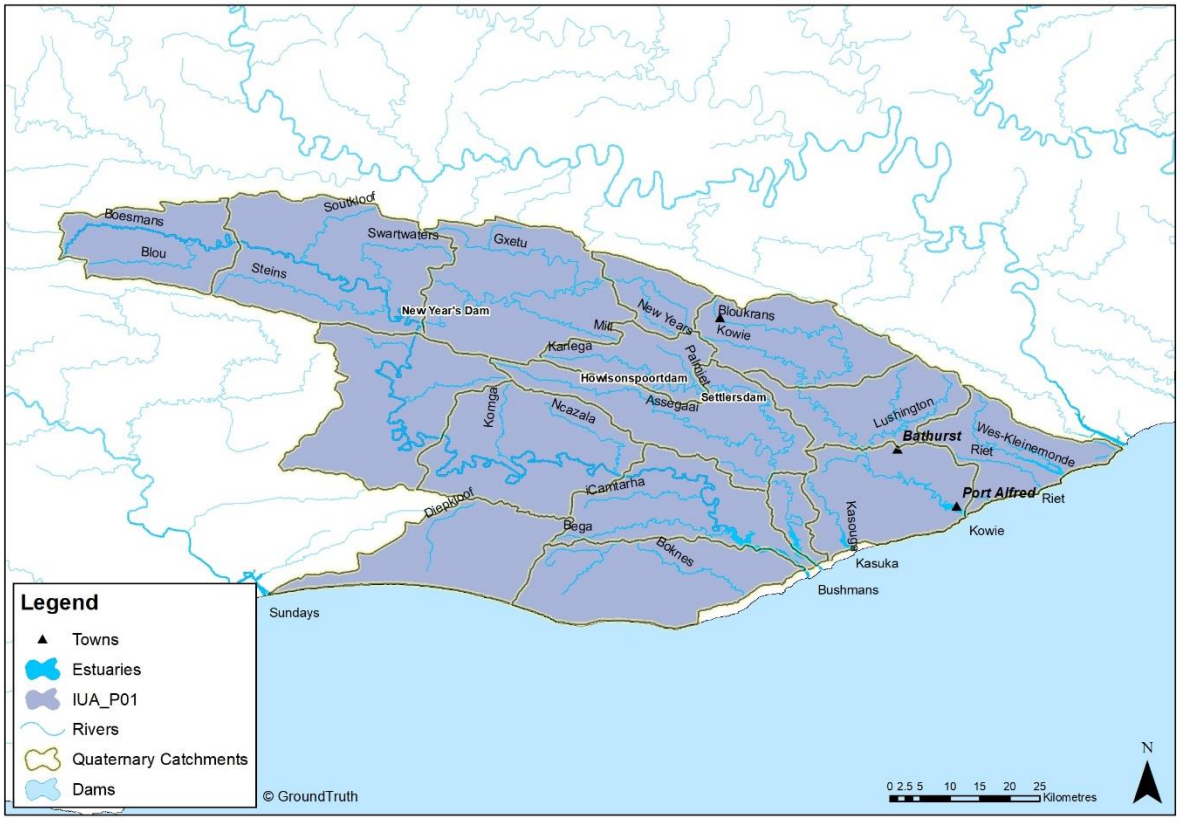
Aspect	Status quo	
Overview	This IUA covers the Sundays River downstream of Darlington Dam. The IUA delineation is based on biophysical characteristics, ecoregion and the associated sensitivity of these catchments i.e. Addo Elephant National Park, as well as land use and impacts namely commercial and irrigation. Several fish sanctuaries within priority areas and FSA.	
Socio-economic profile	This IUA falls within the Sundays River Valley LM (ward 1-6) and Blue Crane Route LM (ward 6). The population in 2021 was 43 549, with employment rate at 41%. Approximately 12% of the population rely on water resources (mainly groundwater) to access basic water services. The main towns in the IUA are Kirkwood and Addo. The economy is this IUA is driven by agriculture (citrus, cattle and goats), urban commercial trade and some tourism.	
SWSAs	None	
Water resource components:		
Rivers	Main rivers	Upper Sundays
	Quaternaries	N40A-F
	Ecoregion	20_1: South Eastern Coastal Belt (20) ecoregion 19_1: Southern Folded Mountains (19) ecoregion

Aspect	Status quo	
	PES	Ranges mostly from unmodified (Class A) to largely modified (Class D) ecological conditions throughout. With the exception of sub quaternary reaches N40C-08565 categorised as seriously modified (Class E) with the main driver being water quality and L82H-08862 categorised as seriously modified (Class E), with most of this reach converted to citrus plantations and off-channel dams.
	EIS	EI: Moderate to High ES: Moderate to High Overall EIS: Moderate to High
	Fish	Fish Sanctuaries: Priority Area (Kabougas River, Wit River, Beans River) Fish Sanctuaries: Support Areas (Uie River, Coerney River)
	Vegetation	Dominant Biome/s: Albany Thicket with some Azonal Vegetation Dominant Bioregion/s: Albany Thicket, Alluvial Vegetation and some Eastern Fynbos-Renosterveld Threatened Ecosystems: E (Albany Alluvial Vegetation) Threatened / sensitive species: *Marsilea schelpeana* (V), Sensitive (*Prionium serratum*), Ilex mitis var. mitis [Decl]
	Geomorphology	The rivers fall largely in the Upper Foothill and Lower Foothill geomorphic classes. The percentage of the river network falling in the various geomorphological zones are as follows: Mountain Headwater Stream - 0.7% Mountain Stream - 2.0% Transitional - 6.9% Upper Foothills – 50.7 Lower Foothills – 35.4% Lowland River – 4.2%
	EWR sites	N/A
Wetlands	HGM unit type	Total of 127 wetlands mapped; Channelled Valley Bottom Wetlands: 6% Depression Wetlands: 82% Hillslope Seep Wetlands: 4% Unchannelled Valley Bottom Wetlands: 3% Wetland Flat Wetlands: 5%
	PES per HGM unit type	Channelled Valley Bottom Wetlands - A/B: 71%; D/E/F: 29%. Depression Wetlands - A/B: 57%; C: 33%; D/E/F: 10%. Hillslope Seep Wetlands - C: 50% D/E/F: 50%. Unchannelled Valley Bottom Wetlands - C: 33% D/E/F: 67%. Wetland Flat Wetlands - A/B: 86%; D/E/F: 14%.

Aspect	Status quo	
	FEPA Wetlands	A total of six FEPA wetlands have been mapped in IUA_N01, all of which are depression wetlands and have been mapped for their endangered threat status.
	Ecosystem Services	**Supply:** The overwhelming majority of the wetlands mapped in IUA_N01 are depression wetlands. Depression wetlands generally supply limited ecosystem services but can supply flood attenuation to some degree as well as the removal of nitrates and toxicants. As such, the supply of ecosystem services in IUA_N01 is expected to be limited in extent and efficacy. **Demand:** There are vast tracts of agricultural land associated with the Sundays River in this IUA. Any wetlands in these areas would have a significant demand for water quality enhancement ecosystem services as well as sediment trapping ecosystem services.
Groundwater	Aquifer Type	The aquifer is mainly of a fractured type associated with the fractured Lower Karoo Supergroup and Uitenhage Group. A smaller part of the area is also of an intergranular type associated with Quaternary sand and alluvium
	Stressed Areas	There are no stressed areas in the IUA
Estuaries	Estuary types	Predominately open
	PES	Category C
	IES	Vulnerable
	Pressures	Moderate: mainly pollution
Conservation areas/ priority systems/etc.	Addo Elephant National Park Congas kraal nature reserve	
Water use:		
Major dams	Slagboom (N4R001)	
Transfers/ hydro power generation	Transfer from the lower Sundays to the Algoa WSS	
Main activities (irrigation, forestry, etc.)	Agriculture: 55% Domestic: 24% Irrigation: 21%	
Groundwater	The current groundwater use in the IUA is about 0.5Mm^3/annum, of which 68% is for irrigation, 10.7% is for industrial use and 9.6% is for municipal use.	
Water quality:		

Aspect	Status quo	
Rivers	Three sampling points along the Sundays River were analysed in quaternary N40E. This IUA is heavily utilised for agricultural activities, with the Sundays River predominantly running adjacent to cultivated land. The most recent data was collected between 2018 and 2021. At Korhaanspoort (2018), the river's pH readings exceeded the allowable threshold; however, all other parameters were within acceptable limits. Downstream of Korhaanspoort, the Sundays River runs alongside the Kirkwood Prison WWTW and Kirkwood WWTW - which have a negligible effect on the river, due to the facility's compliant effluent nutrient and mineral levels. At Selbourne (2021), measurements were taken upstream of the Addo WWTW, and the salinity, pH and nitrate contents of the river were at acceptable levels. However, the electrical conductivity and phosphate readings exceeded acceptable levels. Downstream of Addo WWTW (2018), the salinity, electrical conductivity, chloride, and sodium levels were poor; and the ammonia levels were particularly high. These parameters are indicative of chemical imbalances and poor water quality within this section of the Sundays River. The poor river state could be attributed to the close proximity and poor performance of the Addo WWTW, as well as chemical runoff from the surrounding agricultural areas.	
Groundwater	The groundwater quality varies from good to marginal	
Ecosystem services:		
Ecosystem services	**Key Ecosystem Service**	**Key Ecological Infrastructure**
	Provisioning: • Water • Food • Raw materials	• rivers, • wetlands • groundwater
	Regulation: • water regulation • water quantity • erosion control/ soil stability • biological control	• rivers • wetlands •
	Cultural: • Ecotourism & recreation • Landscape & amenity values	• Addo Elephant national park • Congas kraal nature reserve • Coastline
Beneficiaries	• Significance to households that rely on ground water for water provisioning. • Significant commercial agriculture (citrus, cattle and goats),) in associated towns and their surroundings • Tourism industry in associated towns and communities	
Impacted sectors	• Commercial agriculture; tourism; and households	

4.7 IUA_P01: P primary catchment



Aspect	Status quo	
Overview	This IUA covers the entire P primary catchment and is based on land use and social activities taking place, including important conservation areas, coupled with SWSA for both SW and integrated SW-GW.	
Socio-economic profile	This IUA falls within the Makana LM (ward 2-10; 12; 14), Blue Crane Route LM (ward 6), and Ndlambe LM (ward 10). The population in 2021 was 163 885, with employment rate at 36%. Approximately 11% of the population rely on water resources (mainly ground water and rainwater) to access basic water services. Makana includes the city of Makhanda (Grahamstown) and smaller towns of Alicedale, Sidbury and Riebeek East. Towns in Ndlambe include Port Alfred, Kenton on sea, Seafield and Alexandria. The IUA also includes the town of Paterson (Sundays River Valley). Economic activities include agriculture (dairy, beef, coffee and pineapples), tourism (University town of Makhanda with large number of natural heritage sites) and urban industrial trade. The IUA includes a large area of game farms.	
SWSAs	SW and integrated: P20A	
Water resource components:		
Rivers	Main rivers	Boesmans, Kowie, Kariega
	Quaternaries	P10A-G, P20A-B, P30A-C, P40A-D

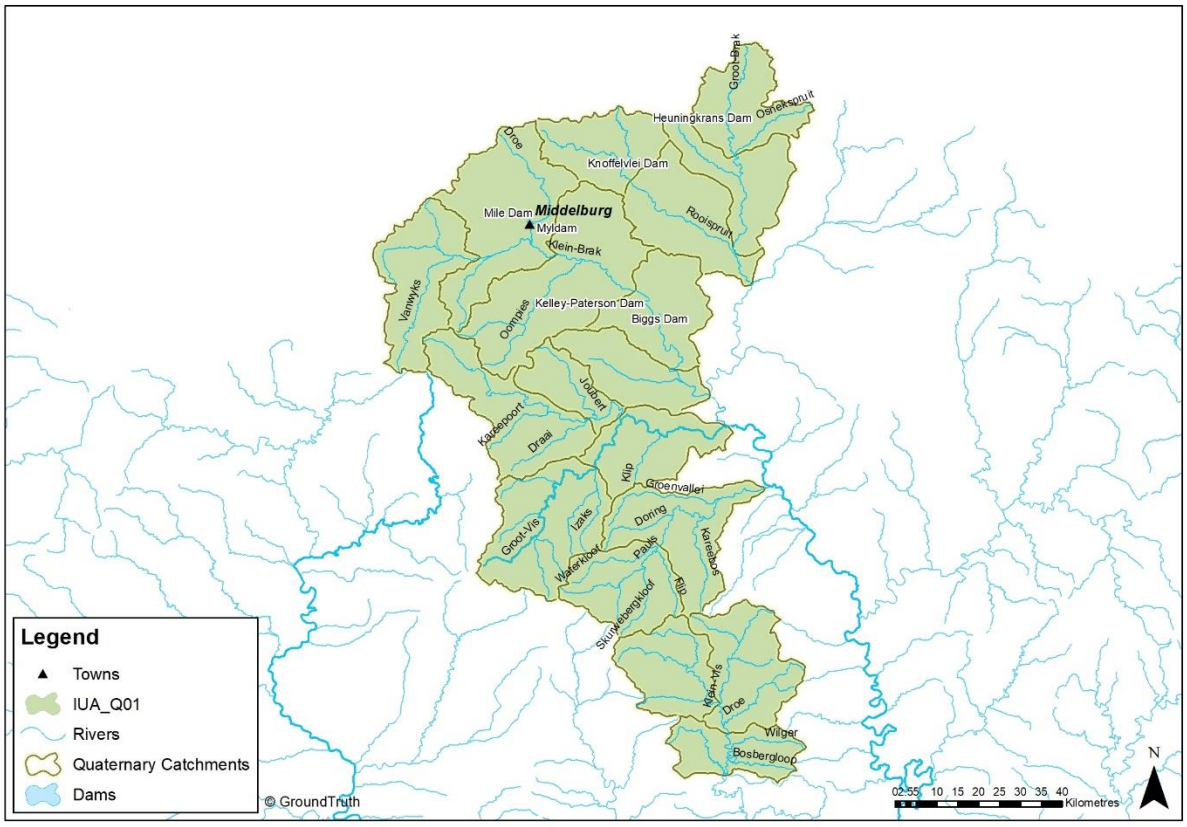
Aspect	Status quo	
	Ecoregion	20_1: South Eastern Coastal Belt (20) 19_1: Southern Folded Mountains (19)
	PES	Ranges mostly from largely natural (category B) to moderately modified (category C) ecological conditions throughout. With the exception of sub quaternary reach P10B-08431 categorised as unmodified (category A) owing to being a very small non-perennial headwater reach with little modifications. Only reaches P30B-08570 and P30B-08581 are categorized as largely modified (category D) owing to various modifications including weirs, off-channel dams and some of the reaches being within dams.
	EIS	EI: Moderate to High ES: Moderate to High Overall EIS: Moderate to High
	Fish	Fish Sanctuaries: Priority Area (Steins River, Swartwaters River, Palmiet River, Kariega River, Assegaai river, Bloukrans River, Lushington River) Fish Sanctuaries: Support Areas (Boesmans River, Kowie River, unnamed tributary of the Lushington River, Wes-Kleinmonde River)
	Vegetation	Dominant Biome/s: Albany Thicket with some Savanna and Fynbos and pockets of Forest Dominant Bioregion/s: Albany Thicket with some Eastern Fynbos-Renosterveld and Sub-escarpment Savanna Threatened / sensitive species: *Isoetes wormaldii* (CR), *Crinum campanulatum* (NT), *Marsilea schelpeana* (V), Sensitive (*Prionium serratum*), Ilex mitis var. mitis [Decl], *Gunnera perpensa* [Decl], *Cyathea capensis* [Decl], *Crinum macowanii* [Decl]
	Geomorphology	The rivers fall largely in the Upper Foothill and Lower Foothill geomorphic classes. The percentage of the river network falling in the various geomorphological zones are as follows: Mountain Headwater Stream - 0.2% Mountain Stream - 1.5% Transitional - 6.1% Upper Foothills – 40.0 Lower Foothills – 44.3% Lowland River – 7.9%
	EWR sites	N/A
Wetlands	HGM unit type	Total of 488 wetlands mapped; Channelled Valley Bottom Wetlands: 7% Depression Wetlands: 90% Floodplain Wetlands: 2%

Aspect	Status quo	
		Hillslope Seep Wetlands: 1%
	PES per HGM unit type	Channelled Valley Bottom Wetlands - A/B: 67%; C: 11%; D/E/F: 22%. Depression Wetlands - A/B: 51%; C: 33%; D/E/F: 16%. Floodplain Wetlands - A/B: 82% D/E/F: 18%. Hillslope Seep Wetlands - A/B: 50% D/E/F: 50%.
	FEPA Wetlands	All of the FEPA wetlands that have been mapped in IUA_P01 are depression wetlands and have been mapped for their endangered threat status.
	Ecosystem Services	**Supply:** The overwhelming majority of the wetlands mapped in IUA_P01 are depression wetlands. Depression wetlands generally supply limited ecosystem services but can supply flood attenuation to some degree as well as the removal of nitrates and toxicants from the water column. However, their ability to supply these services is related to their hydrological link to water sources that need enhancing. As such, the supply of ecosystem services in IUA_P01 is expected to be limited in extent and efficacy. **Demand:** There are scattered tracts of agricultural land located along the coastal areas on the southern and eastern portions of IUA_P01 as well as inland between Port Alfred and Makhanda. Any wetlands in these areas would have a significant demand for water quality enhancement ecosystem services as well as sediment trapping ecosystem services. Other than these agricultural areas, the towns of Makhanda, Port Alfred and Kenton-on-Sea fall into this IUA, all of which have rivers running through them and require regulating and supporting services such as streamflow regulation, sediment trapping and water quality enhancing ecosystem services.
Groundwater	Aquifer Type	The aquifer is mainly of a fractured type associated with the upper Cape Supergroup (Bokkeveld and Witteberg Groups) and Lower Karoo Supergroup. A smaller part of the area is also of an intergranular type associated with Quaternary sand and alluvium
	Stressed Areas	There are no stressed areas in the IUA
Estuaries	Estuary types	Twelve estuaries occur in this IUA. Three of these are Predominantly Open estuaries (Sundays, Bushmans and Kowie), and nine fit into the Temporarily closed category.
	PES	Estuary present condition is predominantly good with eight systems in a near natural category (B) and four in a C category.

Aspect	Status quo	
	IES	The Kariega and Kowie estuaries are the most important estuaries from a biodiversity perspective and the Kariega also has good linkages to protected areas. Overall IES: estuaries range from low to high.
	Pressures	Slightly higher-pressure levels on the estuaries in the IUA with moderate pressure dominating in six of the twelve estuaries and the remaining six rated as having low impacts. The Kowie has been rated with a significant degree of degradation in the estuary.
Conservation areas/ priority systems/etc.	Shamwari Game Reserve Indalo nature reserve and other small nature reserves	
Water use:		
Major dams	Jameson (P1R001), Milner (P1R002), Nuwejaars (P1R003), Howisonpoort (P3R001), Settlers (P3R002)	
Transfers/ hydro power generation	Glen Melville Dam, an off-channel dam fed by water transferred from the Fish River	
Main activities (irrigation, forestry, etc.)	Agriculture: 14% Industry: 1% Domestic: 9% Afforestation: 2% Alien Veg: 58% Irrigation: 16%	
Groundwater	The current groundwater use in the IUA is about 2.7Mm^3/annum, of which 70% is for municipal use, 15% is for irrigation and 5% is for schedule 1 use.	
Water quality:		
Rivers	There is no information available for rivers within P20 catchment. The Boesmans River was most recently surveyed outside of Alicedale (quaternary P10E, in 2018), and measurements indicated high salinities, coupled with electrical conductivity, pH, sodium and chloride levels that exceeded acceptable values. Alicedale is a small settlement with its own wastewater treatment plant – but no data is available for the plant. The region around the river is primarily rural, with minimal agricultural activity, and no clear cause that points to reasons for the river condition mentioned above, other than perhaps the WWTW. The Boesmans River eventually reaches Kenton-On-Sea (quaternary P10G), where the effluent from the Bushmans Oxidation Pond WWTW discharges into the river. Data recorded in 2019 indicated that effluent from this facility has high salinities, and unacceptable levels of ammonia and electrical conductivity, which is harmful to the river quality. This need further investigation to determine how the effluent quality of this facility can be improved in the future. A survey of the Kariega River was most recently conducted in 2018, at Smithfield (quaternary P30B). Survey samples revealed river quality was poor, with high salinities and unacceptable levels of TDS, pH and sodium. Furthermore, harmful levels	

Aspect	Status quo	
	of electrical conductivity and chloride were also noted. The Kariega River passes through rural farmland, and chemical contamination may occur as a side effect of the use of pesticides on the surrounding farming areas. The Kariega River eventually passes through Kenton-On-Sea, where the effluent from the Kenton-On-Sea WWTW discharges into the river. Data collected in 2019 indicated that effluent from this facility had high salinities, and unacceptable levels of electrical conductivity and ammonia. This effluent is likely contaminating the river, and urgent investigations into the state of this facility should be conducted. The Kowie River has high salinities, electrical conductivity and pH, based on data recorded in 2018. Chloride and sodium levels border on acceptable. The Kowie River passes through the Bathurst Nature Reserve, and more recent data is required at this location (last update was in 2011). The data that does exist indicated harmful levels of ammonia and electrical conductivity. Further downstream, effluent from the Port Alfred WWTW is discharged into the Kowie River. Effluent at the Port Alfred WWTW has high salinities, with levels of ammonia and electrical conductivity that exceed the allowable threshold – possibly leading to further contamination of the river at this point. Land use in this IUA is primarily rural, with stretches of agricultural activities adjacent to the rivers mentioned above. There are several urban settlements spread out within the IUA, such as Alicedale, Kenton-On-Sea and Port Alfred. River quality worsens dramatically once the rivers move downstream of a settlement's WWTW, and the generally poor river quality may be linked to the effluent quality of nearby WWTWs.	
Groundwater	The groundwater quality varies from good to marginal but excellent in localised areas	
Ecosystem services:		
Ecosystem services	**Key Ecosystem Service**	**Key Ecological Infrastructure**
	Provisioning: • Water • Food • Raw materials	• rivers, • wetlands, • ground water
	Regulation: • water regulation • water quantity • erosion control/ soil stability • biological control • climate change	• rivers • wetlands • estuaries • forestry
	Cultural: • Ecotourism & recreation • Landscape & amenity values	• Estuaries and coastline • Indalo nature reserve and other small nature reserves
Beneficiaries	• Significance to households that rely on ground water for water provisioning; • Significant commercial agriculture (dairy, beef, coffee and pineapples) in associated towns and their surroundings; and • Tourism industry in associated towns and Communities.	
Impacted sectors	• Commercial agriculture (including forestry); tourism industry; manufacturing, and households.	

4.8 IUA_Q01: Fish



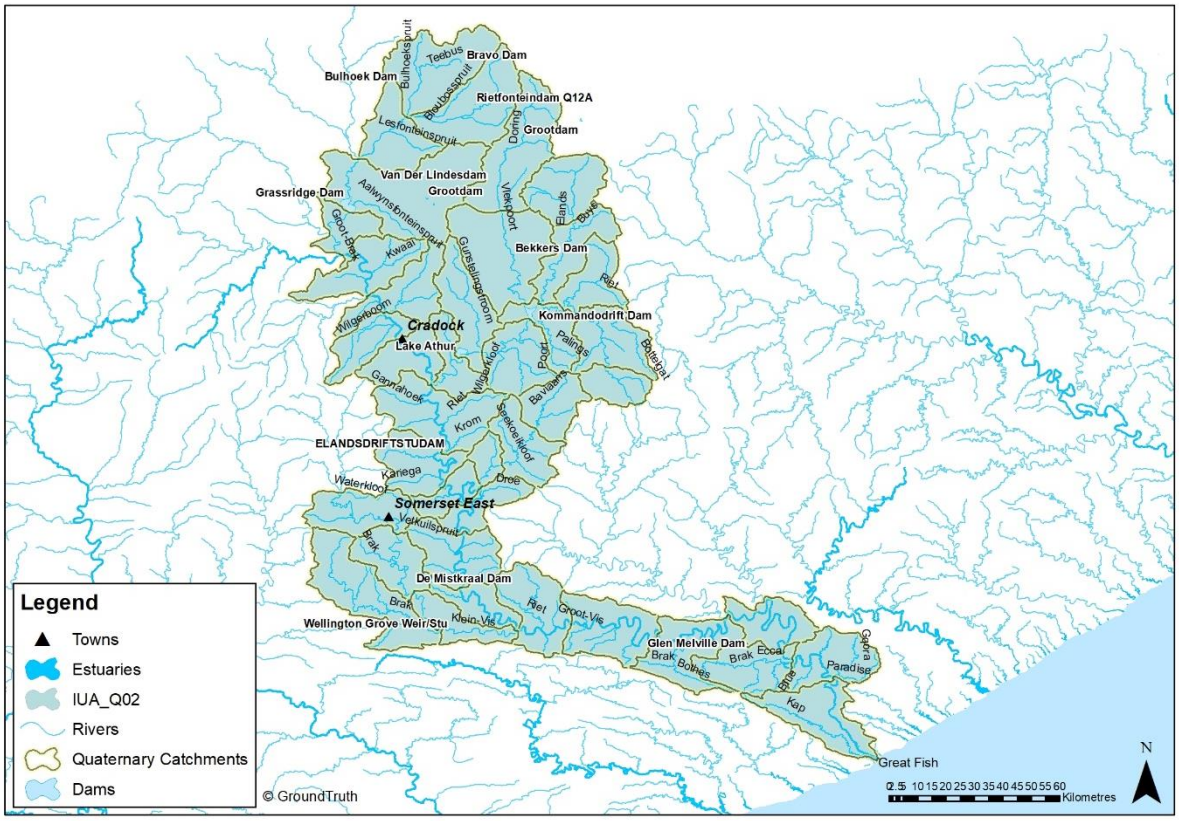
Aspect	Status quo	
Overview	This IUA covers the main stem Fish River before the transfer of water from the Orange River to the Great Fish River and some of the smaller tributaries of the upper Fish River. It is rural in nature throughout the catchments, and associated dry, ephemeral rivers. There are numerous fish sanctuaries, including priority areas and FSA.	
Socio-economic profile	This IUA falls within the Inxuba Yethu LM (ward 6-9), and Blue Crane Route LM (ward 4). The population in 2021 was 38 825, with employment rate at 43%. Approximately 36% of the population rely on water resources (mainly groundwater) to access basic water services. The main town is Middelburg. Economic sectors include trade and community services, finance, agriculture, and construction.	
SWSAs	None	
Water resource components:		
Rivers	Main rivers	Little Brak, Upper Great Fish, Upper Little Fish
	Quaternaries	Q11A-D, Q14A-E, Q21A-B, Q22A-B, Q30A-B and Q80A-C
	Ecoregion	18_1: Drought Corridor (18) ecoregion 18_3: Drought Corridor (18) ecoregion

Aspect	Status quo	
	PES	Ranges mostly from largely natural (category B) to largely modified (category D) ecological conditions throughout. With the exception of sub quaternary reaches Q21A-07165 categorised as seriously modified (category E) with most of the reach within a dam.
	EIS	EI: Moderate to High ES: Moderate to High Overall EIS: Moderate to High
	Fish	Fish Sanctuaries: Priority Area (Oompies River, Oompies-Noord River) Fish Sanctuaries: Support Areas (Oompies River)
	Vegetation	Dominant Biome/s: Nama-Karoo and Grassland Dominant Bioregion/s: Upper Karoo, Dry Highveld Grassland and Sub-escarpment Grassland with some Albany Thicket and Inland Saline Vegetation Threatened Ecosystems: Threatened / sensitive species: *Umtiza listeriana* (V), *Gunnera perpensa* [Decl]
	Geomorphology	The rivers fall largely in the Upper Foothill geomorphic class. The percentage of the river network falling in the various geomorphological zones are as follows: Mountain Headwater Stream - 2.2% Mountain Stream - 5.2% Transitional – 15.1% Upper Foothills – 57.9% Lower Foothills – 19.6% Lowland River – 0.0%
	EWR sites	N/A
Wetlands	HGM unit type	Total of 88 wetlands mapped; Channelled Valley Bottom Wetlands: 69% Depression Wetlands: 21% Hillslope Seep Wetlands: 7% Unchannelled Valley Bottom Wetlands: 3%
	PES per HGM unit type	Channelled Valley Bottom Wetlands - A/B: 57%; C: 6%; D/E/F: 37%. Depression Wetlands - A/B: 94%; D/E/F: 6%. Hillslope Seep Wetlands - A/B: 43%; C: 14%; D/E/F: 43%. Unchannelled Valley Bottom Wetlands - A/B: 33% D/E/F: 67%.
	FEPA Wetlands	A number of FEPA wetlands exist in IUA_KL01, many of them being small, isolated depression wetlands. However, a number of channelled and unchannelled valley bottom FEPA

Aspect	Status quo	
		wetlands have been mapped in both the Klein-Fish and Groot-Fish River catchments.
	Ecosystem Services	**Supply:** Given that there predominant HGM unit types in IUA_Q01 are valley bottom wetlands (CVB and UVB comprise over 70% of the wetlands in IUA_Q01), the supply of ecosystem services will generally be characterised by regulating and supporting services such as flood attenuation, sediment trapping and erosion control services. Furthermore, water quality enhancement services are also generally supplied to a moderate or moderately high level by valley bottom wetlands - especially if there are significant lateral seepage inputs into those valley bottom wetlands. **Demand:** The relatively mountainous, inaccessible and dry nature of most of this IUA means it is unlikely that there will be large demands for ecosystem services other than ones relating to cultural and recreational services. Much of the land in this IUA is either designated to national or provincial protected areas or to private conservation. Therefore, the wetlands in IUA_Q01 are generally utilised for recreational activities like birding and game watching and in some cases hunting. Therefore, the recreational, cultural and biodiversity maintenance ecosystem services will be the predominant services demanded in this IUA.
Groundwater	Aquifer Type	The aquifer is mainly of a fractured type associated with the Karoo Supergroup. Intergranular and fractured aquifers, owing to the presence of dolerite sills and dykes also exist, as well as localised intergranular aquifers associated with alluvial deposits
	Stressed Areas	The IUA is mildly to highly stressed in certain areas
Estuaries	EFZ	No estuaries
Conservation areas/ priority systems/ etc.	Mount Zebra national park Renosterberg nature reserve and other small nature reserves	
Water use:		
Major dams	Grassridge (Q1R001)	
Transfers/ hydro power generation	Receives water from the Upper Orange (Gariep Dam) system	
Main activities (irrigation, forestry, etc.)	Agriculture: 34% Irrigation: 21% Domestic: 8%	
Groundwater	The current groundwater use in the IUA is about 17.1Mm^3/annum, of which 57% is for irrigation, 30% is for municipal use and 8.5% is for livestock watering.	

Aspect	Status quo	
Water quality:		
Rivers	No information available for rivers in Q11, Q22 and Q80A-C catchments. As such, little is known about the water quality of the upper Little Fish River. There is also limited information (less than 1 data entry) available for rivers in the Q14 and Q21 quaternaries, and further investigation is required to elaborate on the river conditions in these quaternaries. The Klein Brak River was sampled at Zeeven Fonteynen (Q14E), and results revealed harmful levels of electrical conductivity, TDS, sulphate and chloride levels. Furthermore, more recent samples of the river are required, as data at this location was last updated in 2016. The Great Fish River has high electrical conductivity and pH levels at Zoutspans Drift (Q21B). All other river parameters were within their respective acceptable ranges. Pauls River, measured at Coutzenburg in 2018, has levels of electrical conductivity, phosphate, nitrate and pH that exceed the respective acceptable ranges. The land use within IUA_Q01 is primarily rural, with long stretches of cultivated land bordering the rivers mentioned above. Elevated nutrient, mineral, electrical conductivity or pH levels may be the result of agricultural practises, contaminating the rivers. Investigation into the Pauls River may be required. Long stretches of agricultural activities are also found alongside the Great Fish River, and these areas require monitoring to reduce any potential contamination occurring in the future.	
Groundwater	The groundwater quality varies from good to excellent	
Ecosystem services:		
Ecosystem services	**Key Ecosystem Service**	**Key Ecological Infrastructure**
	Provisioning: • Water • Food • Raw materials	• rivers, • wetlands, • ground water
	Regulation: • water regulation • water quantity • erosion control/ soil stability • biological control	• rivers • wetlands
	Cultural: • Ecotourism & recreation • Landscape & amenity values	• Mount Zebra national park • Renosterberg nature reserve and other small nature reserves
Beneficiaries	• Significance to households that rely on ground water for water provisioning; • commercial agriculture in associated towns and their surroundings; and • Tourism industry in associated towns and communities.	
Impacted sectors	• Commercial agriculture; tourism; and households.	

4.9 IUA_Q02: Great Fish



Aspect	Status quo	
Overview	This IUA was delineated owing to it being highly stressed and highly utilised catchments based on the transfer scheme from Gariep Dam to the Great Fish and lower Little Fish Rivers, and irrigation in the catchment areas. However, it is an important IUA in terms of conservation areas namely the Mountain Zebra National Park and the Great Fish Nature Reserve. There are parts of Q80D which have been categorised as SWSA for SW, as well as Q11C, Q14A-C and Q22A, categorized as GW SWSAs and all as integrated SW-GW SWSAs.	
Socio-economic profile	This IUA falls within the Blue Crane Route LM (ward 2-3; 5-6), Inxuba Yethemba LM (ward 1-6), Enoch Mgijima LM (ward 2-5), Ngushwa LM (ward 9-10) Makana LM (ward 1; 11), Walter Sisulu (ward 2), and Ndlambe LM (ward 6). The population in 2021 was 41 684, with employment rate of 31%. Approximately 11% of the population rely on water resources (mainly groundwater) to access basic water services. The main towns within the IUA include Steynsburg, Hofmeyer, Tarkastad, Cradock, Cookhouse, Somerset East and Peddie. Economic activity in the IUA includes commercial agriculture (irrigated field crops, and livestock farming), trade (wholesale, retail and catering) and community services sector activity.	
SWSAs	SW and GW	
Water resource components:		
Rivers	Main rivers	Great Fish, Tarka, Baviaans, Lower Little Fish

Aspect	Status quo	
	Quaternaries	Q12A-C, Q13A-C, Q30C-E, Q41A-D, Q42A-B, Q43A-B, Q44A-C, Q50A-C, Q60A-C, Q70A-C, Q80D-G, Q91A-C, Q93A-D
	Ecoregion	18_1: Drought Corridor (18) ecoregion 18_2: Drought Corridor (18) ecoregion 18_3: Drought Corridor (18) ecoregion 19_1: Southern Folded Mountains (19) ecoregion
	PES	Ranges mostly from largely natural (category B) to largely modified (category D) ecological conditions throughout. Except for sub quaternary reaches Q41D-07094 and Q44B-07158 categorised as severely (category F) and seriously modified (category E) respectively, owing to being completely changed from natural as most of both reaches are in dams. Furthermore, reaches Q50B-07569 and Q50B-07600 in the Great Fish River categorized as seriously modified (category E) owing to most the reaches being a dam and thus for all the above, expected temperature and oxygen fluctuations. Reach Q70A-07747 also categorized as seriously modified (category E) owing to a large diversion weir and extensive centre-pivot irrigation.
	EIS	EI: Moderate to High ES: Moderate to High Overall EIS: Moderate to High
	Fish	Fish Sanctuaries: Priority Area (Doring River (x2), unnamed tributary of the Elands River, Krimpfonteinspruit River, unnamed tributary of the Krimpfonteinspruit River, Buys River, Riet River, Bottelgat River, unnamed tributary of the Tarka River (x2), Poort River, Palings River, Gannahoek River, Leliekloof River, Wilgerkloof River, Kap River) Fish Sanctuaries: Support Areas (Vlekpoort River, unnamed tributary of the Vlekpoort River, Elands River, Leeufonteinsloot River, Gunstelingstroom River, Tarka River, Gannahoek River, unnamed tributary of the Tarka River)
	Vegetation	Dominant Biome/s: Nama-Karoo, Grassland and Albany Thicket Dominant Bioregion/s: Upper Karoo, Dry Highveld Grassland and Sub-escarpment Grassland with some Albany Thicket and Inland Saline Vegetation Threatened / sensitive species: *Crinum campanulatum* (NT), Sensitive (*Prionium serratum*), Ilex mitis var. mitis [Decl], *Gunnera perpensa* [Decl], *Crinum macowanii* [Decl]
	Geomorphology	The rivers fall largely in the Upper Foothill and Lower Foothill geomorphic classes. The percentage of the river network falling in the various geomorphological zones are as follows: Mountain Headwater Stream - 1.5%

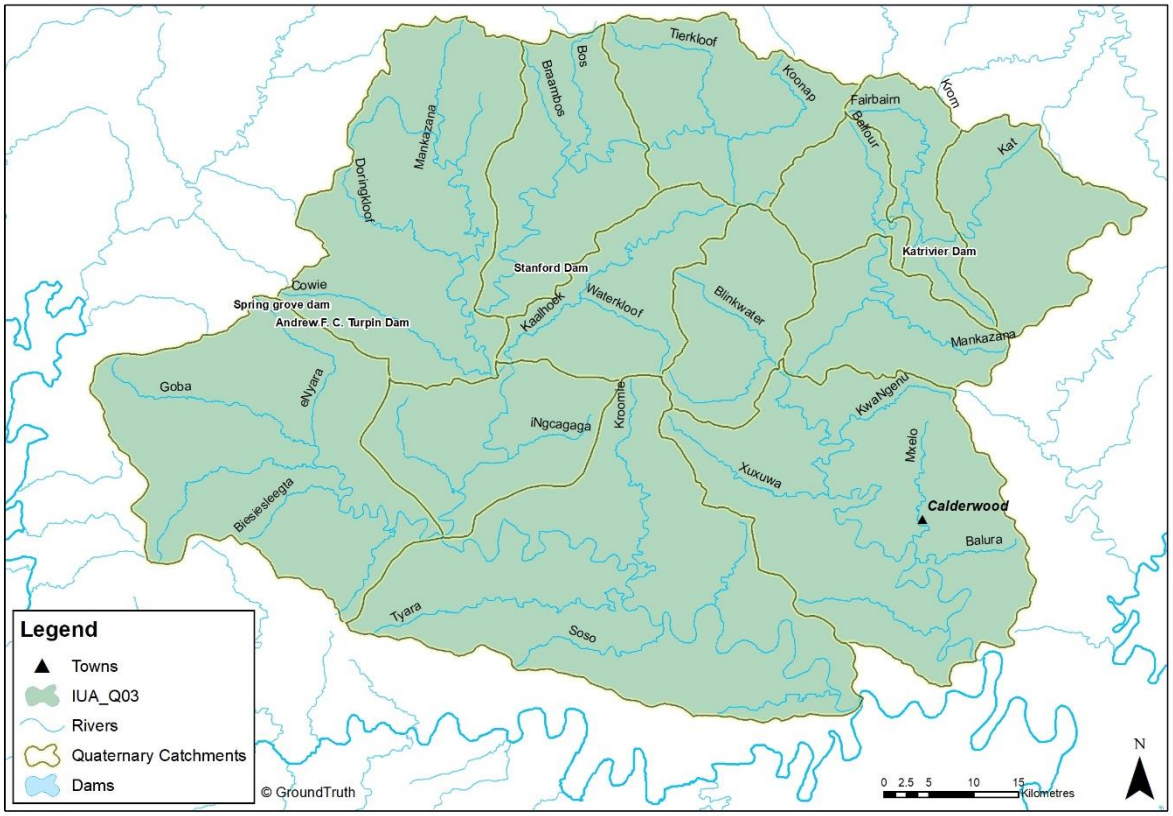
Aspect	Status quo	
		Mountain Stream - 3.8% Transitional - 9.1% Upper Foothills – 44.9 Lower Foothills – 38.9% Lowland River – 1.8%
	EWR sites	N/A
Wetlands	HGM unit type	Total of 262 wetlands mapped; Channelled Valley Bottom Wetlands: 36% Depression Wetlands: 45% Floodplain Wetlands: 0.5% Hillslope Seep Wetlands: 13% Unchannelled Valley Bottom Wetlands: 5.5%
	PES per HGM unit type	Channelled Valley Bottom Wetlands - A/B: 61%; C: 18%; D/E/F: 21%. Depression Wetlands - A/B: 63%; C: 10%; D/E/F: 27%. Floodplain Wetlands - C: 100%. Hillslope Seep Wetlands - A/B: 54%; C: 33%; D/E/F: 23%. Unchannelled Valley Bottom Wetlands - A/B: 50%; C: 17%; D/E/F: 33%.
	FEPA Wetlands	All of the FEPA wetlands that have been mapped in IUA_P01 are depression wetlands and have been mapped for their endangered threat status.
	Ecosystem Services	**Supply:** Given that there predominant HGM unit types in IUA_Q02 are a mix of valley bottom wetlands (CVB and UVB comprise over 40% of the wetlands in IUA_Q02) and depression wetlands, the supply of ecosystem services will generally be characterised by regulating and supporting services such as flood attenuation, sediment trapping and erosion control services. Furthermore, water quality enhancement services are also generally supplied to a moderate or moderately high level by valley bottom and depression wetlands. **Demand:** While much of the IUA is characterised by dry and mountainous terrain that is relatively inaccessible and has a very low frequency of wetlands, the portion of the IUA that is associated with the Groot-Fish River is characterised by a series of water supply dams and extensive agriculture. Therefore, the demand for ecosystem services from the wetlands that feed these areas and that are fed by these areas will be characterised predominantly by regulating and supporting services. The demand for flood attenuation, streamflow regulation, erosion control, sediment trapping and water quality enhancing ecosystem services will be high in those areas.

Aspect	Status quo	
Groundwater	Aquifer Type	The aquifer is mainly of a fractured type associated with the Karoo Supergroup. Intergranular and fractured aquifers, owing to the presence of dolerite sills and dykes also exist.
	Stressed Areas	The IUA is mildly to highly stressed in certain areas
Estuaries	Estuary types	The Great Fish is the only estuary in this IUA and is rated as a Large Permanently Open estuary.
	PES	The estuary's present condition is rated as a C.
	IES	Biodiversity importance and linkages are both rated as high pushing the overall IES score to high.
	Pressures	Changed flora and fauna as a result of inter-catchment transfers.
Conservation areas/ priority systems/ etc.	Mountain Zebra National Park The Great Fish Nature Reserve Commandodrift Nature Reserve	
Water use:		
Major dams	Lake Arthur (Q4R001), Kommandodrift (Q4R002), Elandsdrift (Q5R001), De Mistkraal (Q8R001), Glen Melville (water from Great Fish River)	
Transfers/ hydro power generation	Major transfer from the Gariep Dam (Upper Orange) to the upper reaches of the Great Fish River (Grassridge Dam)	
Main activities (irrigation, forestry, etc.)	Agriculture: 68% Domestic: 2% Alien Veg: 1% Irrigation: 30%	
Groundwater	The current groundwater use in the IUA is about 9.7Mm^3/annum, of which 89% is for irrigation, 8.1% is for municipal use and 1.8% is for schedule 1 use.	
Water quality:		
Rivers	There is little readily available information for rivers within the Q41, Q42 and Q43 quaternary. Only one data entry was available for the Q12, Q13, Q44, Q60, Q91 and Q93 quaternaries – as such, it is recommended that urgent data collection take place for rivers that fall within these quaternaries. The Great Fish River was recorded at several locations, with most of the river parameters falling within the acceptable ranges. The majority of data for the Great Fish River was recorded between 2018 and 2020, and updates will be required in the coming years. At Cradock (Q30E), river quality and salinity are acceptable; but at Katkop (Q13C) and Mortimer (Q50A), the river pH falls slightly above the acceptable range. At Leeuwe Drift (Q70A), the pH remains slightly above acceptable levels, and the electrical conductivity also reaches high levels. At Fort Brown Peninsula (Q91C), all river parameters fall within their acceptable ranges. However, data at this location	

Aspect	Status quo	
	was sparsely recorded (6-year interval, from 2014-2020, between two most recent data recordings) and more recent data may be required at this location. At Matomela Reserve (Q93C), the electrical conductivity and phosphate content exceeds allowable levels, but all other parameters are acceptable. At Tarka Bridge (Q44C), the electrical conductivity, nitrate and phosphate levels of the Tarka River exceed the allowable ranges. Data for this river was recorded 2021, excluding the sulphate levels, which were most recently updated in 2018 (but were acceptable). As such, it is recommended that the sulphate levels be re-measured and updated, to determine if these levels are still acceptable. The Baviaans River has good river quality and salinity at Botmansgat de Klerkdal (Q60C). At Melrose (Q60C), the river is surrounded by heavy agricultural activity, and urgent investigation is required to determine the effects, if any, of possible agricultural runoff into the river – particularly since river data at Melrose was last updated prior to 1981. The Little Fish River has electrical conductivity and pH levels that exceed acceptable ranges at Sout Vleij Sheldon, Doorn Kraal (Q80E) and Rietfontein Junction Drift (Q80G). At all other locations the river parameters are acceptable. The Little Fish River passes alongside the Somerset East WWTW, and this location might be worth investigating in the future (data for this WWTW indicated good quality effluent, although the data was captured in 2019 and may need to be updated). Land in this IUA is largely rural, and is primarily used for agriculture, with stretches of cultivated land occurring alongside the rivers mentioned above (particularly along the length of the Great Fish River). As such, it will be important to monitor the river conditions of the IUA in the future, to minimise the likelihood of pesticides, and other agricultural chemicals, contaminating the river water. Small settlements, such as Cradock, Bhongweni (Q70A) and Somerset-East are found within this IUA, but river quality tends to be unaffected by these settlements.	
Groundwater	The groundwater quality varies from good to marginal but excellent in localised areas.	
Ecosystem services:		
Ecosystem services	**Key Ecosystem Service**	**Key Ecological Infrastructure**
	Provisioning: • Water • Food • Raw materials	• rivers, • wetlands, • ground water • Grassridge dam
	Regulation: • water regulation • water quantity • erosion control/ soil stability • biological control	• rivers • wetlands
	Cultural: • Landscape & amenity values	• Commandodrift nature reserve

Aspect	Status quo
Beneficiaries	• Significance to households that rely on ground water for water provisioning; and • Significant commercial agriculture (irrigated field crops, and livestock farming) in associated towns and their surroundings.
Sectors	• Commercial agriculture; and households.

4.10 IUA_Q03: Koonap and Kat



Aspect	Status quo	
Overview	The IUA was delineated based on the area being wetter, with more local sources for irrigation down the entire Koonap and Kat Rivers.	
Socio-economic profile	This IUA falls within Raymond Mhlaba LM (ward 1-8; 20; 21), Blue Crane Route LM (ward 1), and Nxuba LM (ward 4). The population in 2021 was 64 090, with employment rate of 26%. Approximately 17% of the population rely on water resource (mainly groundwater and rainwater) to access basic water services. The main towns include Adelaide, Bedford, Fort Beaufort and Seymore. Subsistence farming is the main activity within the rural areas of this IUA. Other economic activity includes commercial agriculture.	
SWSAs	SW and GW (Q94A-C)	
Water resource components:		
Rivers	Main rivers	Koonap, Kat
	Quaternaries	Q92A-G, Q94A-F
	Ecoregion	16_7: South Eastern Uplands (16) ecoregion 18_2: Drought Corridor (18) ecoregion

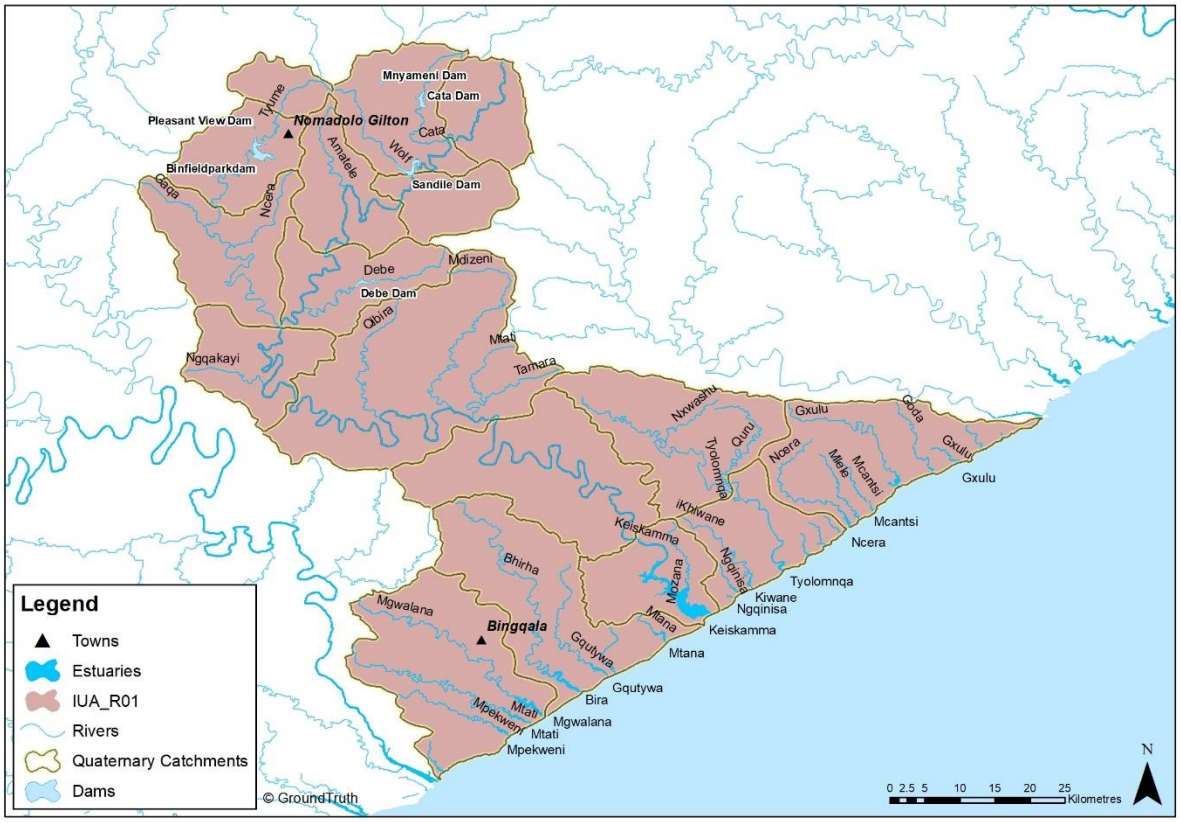
Aspect	Status quo	
	PES	Ranges mostly from largely natural (category B) to moderately modified (category C) ecological conditions throughout.
	EIS	EI: Moderate to High ES: Moderate to High Overall EIS: Moderate to High
	Fish	Fish Sanctuaries: Priority Area (unnamed tributary of the Kat River, Tyara River, Rietfonteinspruit River) Fish Sanctuaries: Support Areas (Kat River, Balfour River, nNyara River, Biesiesleegte River, Koonap River)
	Vegetation	Dominant Biome/s: Grassland, Albany Thicket and Savanna with pockets of Forest Dominant Bioregion/s: Drakensberg Grassland, Albany Thicket, Sub-escarpment Grassland and some Zonal and Intrazonal Forests Threatened / sensitive species: Ilex mitis var. mitis [Decl], *Gunnera perpensa* [Decl], *Cyathea capensis* [Decl], *Crinum macowanii* [Decl] Plant Endemism: Portion of IUA within Maputaland – Pondoland Region of plant endemism
	Geomorphology	The rivers fall largely in the Upper Foothill and Lower Foothill geomorphic classes. The percentage of the river network falling in the various geomorphological zones are as follows: Mountain Headwater Stream - 2.5% Mountain Stream - 6.4% Transitional - 12.3% Upper Foothills – 49.0% Lower Foothills – 29.9% Lowland River – 0%
	EWR sites	Kat River (Q94B, Q94D and Q94F), Balfour (Q94C)
Wetlands	HGM unit type	Total of 186 wetlands mapped; Channelled Valley Bottom Wetlands: 23% Depression Wetlands: 23% Floodplain Wetlands: 2% Hillslope Seep Wetlands: 44% Unchannelled Valley Bottom Wetlands: 8%
	PES per HGM unit type	Channelled Valley Bottom Wetlands - A/B: 44%; C: 35%; D/E/F: 65%. Depression Wetlands - A/B: 84%; C: 7%; D/E/F: 9%. Floodplain Wetlands - A/B: 50%; D/E/F: 50%. Hillslope Seep Wetlands - A/B: 40%; C: 16%; D/E/F: 44%. Unchannelled Valley Bottom Wetlands - A/B: 38%; C: 43%; D/E/F: 19%.

Aspect	Status quo	
	FEPA Wetlands	All of the FEPA wetlands that have been mapped in IUA_P01 are depression or hillslope seep wetlands and have been mapped for their endangered threat status.
	Ecosystem Services	**Supply:** Given that there predominant HGM unit types in IUA_Q03 are either depression wetlands or hillslope seep wetlands, the regulating services with will be supplied by these wetlands will generally be characterised by water quality enhancement ecosystem services which result from water passing through the low redox soil environment in seeps and depression wetlands. Hillslope seep wetlands do also generally provide some streamflow regulation services in the dry season and can provide sediment trapping services to some degree as well. **Demand:** The relatively mountainous and inaccessible nature of most of this IUA means it is unlikely that there will be large demands for ecosystem services other than ones relating to cultural and recreational services. Much of the land in this IUA is either designated to national or provincial protected areas or to private conservation. Therefore, the wetlands in IUA_Q03 are generally utilised for recreational activities like birding and game watching and in some cases hunting. Therefore, the recreational, cultural and biodiversity maintenance ecosystem services will be the predominant services demanded in this IUA. However, there are limited agricultural activities concentrated along the Kat River which would increase the demand for sediment trapping and water quality enhancement services in downstream wetlands.
Groundwater	Aquifer Type	The aquifer is mainly of a fractured type associated with the Karoo Supergroup. Intergranular and fractured aquifers, owing to the presence of dolerite sills and dykes also exist.
	Stressed Areas	There are no stressed areas in the IUA
Estuaries	EFZ	No estuaries
Conservation areas/ priority systems/etc.	Molweni nature reserve	
Water use:		
Major dams	Kat River (Q9R001)	
Transfers/ hydro power generation	None	
Main activities (irrigation, forestry, etc.)	Agriculture: 37% Afforestation: 11% Alien Veg: 4% Irrigation: 41%	

Aspect	Status quo	
Groundwater	The current groundwater use in the IUA is about 1.76Mm^3/annum, of which 76% is for irrigation, 10% is for municipal use and 9% is for power generation.	
Water quality:		
Rivers	Data last updated in 2018 indicates that the Koonap River (at the point where it passes through the town of Adelaide) was in a good condition with all parameters being within an acceptable range. Slightly further downstream of the town, the Koonap River appears to have deteriorated with the electrical conductivity, phosphate and nitrate readings exceeding acceptable levels (as of 2016). Only the river pH level remains acceptable. From here, the river continues past the Adelaide WWTW and data collected (2017) downstream of the WWTW indicates that the river quality was poor with unacceptably high levels of nutrient enrichment (phosphate and nitrate). This could be partly attributed to the effluent from the Adelaide WWTW entering the river which recorded poor nitrate measurements. Other WWTW effluent parameters were acceptable. Continuing much further downstream, after a long stretch of the Koonap River running through undeveloped mountainous areas, the river appears to have re-established its natural balance. All readings (last updated in 2015) taken at Fort Brown Farm, just before the confluence with the Great Fish River, are indicative of a healthy river with all parameters falling within their acceptable range. Monitoring done on the Kat River up until 2018 indicates that the water quality is good as the river enters Fort Beaufort. After passing through Fort Beaufort, the water quality (as of 2011) is not ideal with unacceptable ammonia measurements. This water quality state deteriorates further downstream of the Fort Beaufort WWTW with phosphate readings exceeding allowable limits (in 2021). This deterioration could be attributed to the WWTW which recorded high levels of ammonia in the effluent; however, more comprehensive data should be collected on the Fort Beaufort WWTW to be able to understand the full effect that contaminated effluent may have on the Kat River.	
Groundwater	The groundwater quality varies from good to excellent	
Ecosystem services:		
Ecosystem services	**Key Ecosystem Service**	**Key Ecological Infrastructure**
	Provisioning: • Water • Food • Raw materials	• rivers, • wetlands, • ground water
	Regulation: • water regulation • water quantity • erosion control/ soil stability • biological control • Climate change	• rivers • wetlands • Forestry
	Cultural: • Landscape & amenity values	• Molweni nature reserve

Aspect	Status quo
Beneficiaries	• Significance to households that rely on ground water for water provisioning. • Subsistence and commercial agriculture in associated towns and their surroundings
Impacted sectors	• Commercial agriculture (including forestry); and households

4.11 IUA_R01: Keiskamma



Aspect	Status quo	
Overview	This IUA covers the Keiskamma and is mostly based on ecoregion and catchment impacts namely subsistence farming, forestry and relatively rural and a number of large dams in the upper reaches of this system.	
Socio-economic profile	This IUA falls within the Raymond Mlhaba LM (ward 12-19), Amahlathi LM (ward 1-3; 10-11) and Buffalo City MM (ward 31-33). The population in 2021 was 200 403, with employment rate of 18%. Approximately 23% of the population rely on water resources (mainly rainwater and surface water) to access basic water services. The towns in the IUA include Hamburg, Dimbiza, Hogsback and Alice. Key economic activity within this IUA includes agriculture and tourism. Agriculture includes commercial (irrigated crops) and large areas of subsistence farming.	
SWSAs	SW: R10A, B, R10F, R40A	
Water resource components:		
Rivers	Main rivers	Keiskamma, Tylomnqa
	Quaternaries	R10A-M, R40A-C, R50A-B
	Ecoregion	16_7: South Eastern Uplands (16) ecoregion 17_2: North Eastern Coastal Belt (17) ecoregion 18_2: Drought Corridor (18) ecoregion

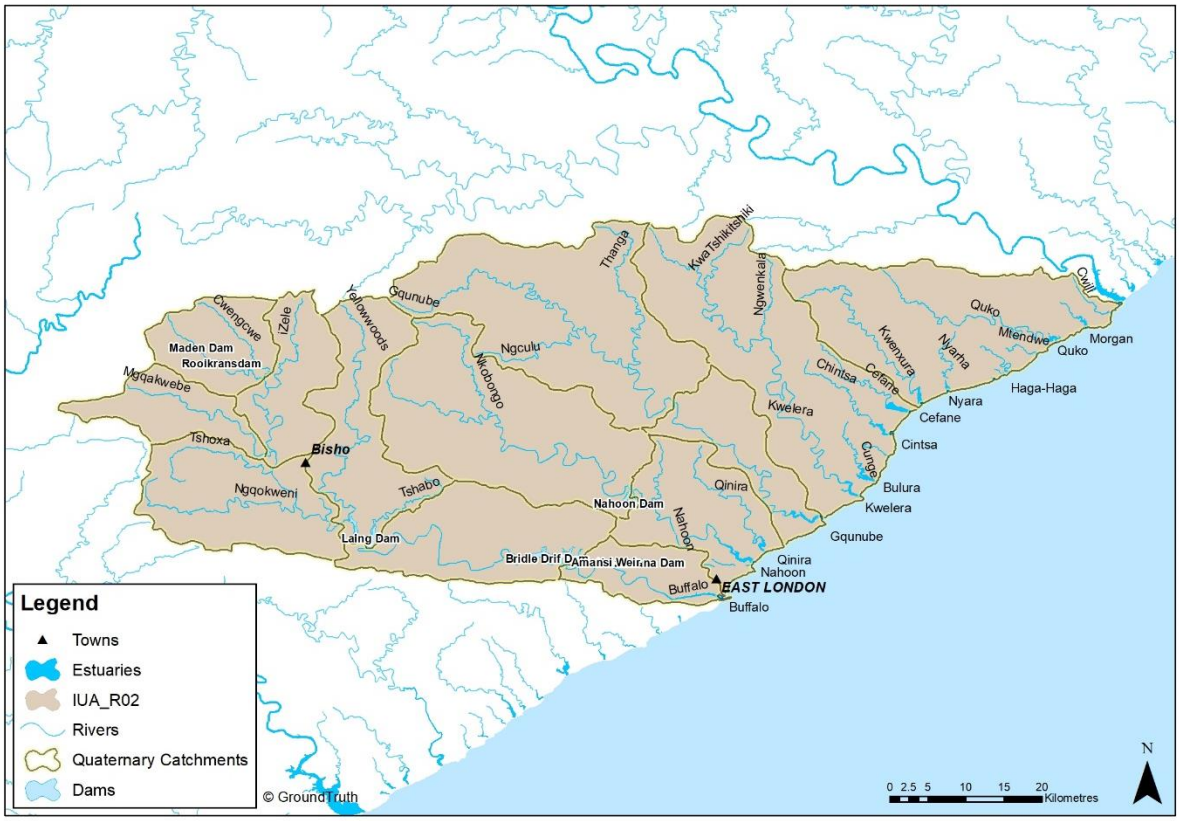
Aspect	Status quo	
	PES	Ranges mostly from largely natural (category B) to largely modified (category D) ecological conditions throughout.
	EIS	EI: Moderate to High ES: Moderate to High Overall EIS: Moderate to High
	Fish	Fish Sanctuaries: Priority Area (Ncera River, Amatele River, Wolf River, Cata River) Fish Sanctuaries: Support Areas (Gxulu River, Gaqa River, Tyume River, Keiskamma River)
	Vegetation	Dominant Biome/s: Albany Thicket and Savanna with pockets of Forest Dominant Bioregion/s: Albany Thicket, Sub-escarpment Savanna and some Drakensberg Grassland with Zonal and Intrazonal Forest Threatened / sensitive species: *Isoetes wormaldii* (CR), *Crinum campanulatum* (NT), *Crinum moorei* (V), *Umtiza listeriana* (V), Ilex mitis var. mitis [Decl], *Gunnera perpensa* [Decl], *Cyathea capensis* [Decl], *Crinum macowanii* [Decl] Plant Endemism: Portion of IUA within Maputaland – Pondoland Region of plant endemism
	Geomorphology	The rivers fall largely in the Upper Foothill and Lower Foothill geomorphic classes. The percentage of the river network falling in the various geomorphological zones are as follows: Mountain Headwater Stream - 1.6% Mountain Stream - 2.5% Transitional - 6.7% Upper Foothills – 45.2% Lower Foothills – 39.0% Lowland River – 5.0%
	EWR sites	Keiskamma (R10B and R10E)
Wetlands	HGM unit type	Total of 275 wetlands mapped; Channelled Valley Bottom Wetlands: 22% Depression Wetlands: 49% Floodplain Wetlands: 1% Hillslope Seep Wetlands: 26% Unchannelled Valley Bottom Wetlands: 2%
	PES per HGM unit type	Channelled Valley Bottom Wetlands - A/B: 36%; C: 16%; D/E/F: 48%. Depression Wetlands - A/B: 47%; C: 10%; D/E/F: 43%. Floodplain Wetlands - A/B: 50%; D/E/F: 50%. Hillslope Seep Wetlands - A/B: 24%; C: 8%; D/E/F: 68%. Unchannelled Valley Bottom Wetlands - A/B: 29%; D/E/F: 71%.

Aspect	Status quo	
	FEPA Wetlands	The majority of the FEPA wetlands mapped in IUA_R01 are hillslope seep wetlands. These seep wetlands have been mapped as being important due to their intactness.
	Ecosystem Services	**Supply:** Given that there predominant HGM unit types in IUA_R01 are either depression wetlands or hillslope seep wetlands, the regulating services with will be supplied by these wetlands will generally be characterised by water quality enhancement ecosystem services which result from water passing through the low redox soil environment in seeps and depression wetlands. Hillslope seep wetlands do also generally provide some streamflow regulation services in the dry season and can provide sediment trapping services to some degree as well. **Demand:** The majority of this IUA, especially in the northern and western portion of the IUA is characterised by mountainous landscapes that are used for conservation and recreation. Therefore, much of the demand for ecosystem services in these areas are associated with cultural and recreational services. However, closer to the coast, the landscape is characterised by rural settlements, subsistence farming and livestock rearing. The demand for ecosystem services in these portions of the IUA are more centred around provisioning services such as the cultivation of food, grazing for livestock, water for human consumption and harvestable resources. In addition, the demand for sediment trapping and flood attenaution will also be high in these areas.
Groundwater	Aquifer Type	The aquifer is mainly of a fractured type associated with the Karoo Supergroup. Intergranular and fractured aquifers, owing to the presence of dolerite sills and dykes also exist.
	Stressed Areas	There are no stressed areas in the IUA
Estuaries	Estuary types	21 estuaries occur in this IUA, mostly small and large temporary closed systems except for the Keiskamma that is a predominantly open system.
	PES	Estuary present condition ranges from near natural (category A/B, B) to moderately modified (B/C and C categories.
	IES	Biodiversity importance ranges from low to average with a number of highly important estuaries. Only five estuaries fall within a MPA or priority area. Overall IES: estuaries range from low to medium with two estuaries rated as high.
	Pressures	Pressures on the estuaries in this IUA is mainly low with high fishing efforts in the Keiskamma and Tyolomnqa estuaries.

Aspect	Status quo	
Conservation areas/ priority systems/ etc.	None	
Water use:		
Major dams	Sandile (R1R001), Cata (R1R002), Binfield (R1R003)	
Transfers/ hydro power generation	None	
Main activities (irrigation, forestry, etc.)	Agriculture: 23% Domestic: 30% Afforestation: 5% Alien Veg: 9% Irrigation: 32%	
Groundwater	The current groundwater use in the IUA is about 1.8Mm^3/annum, of which 54% is for municipal use, 17% is for irrigation and 15% is for recreation.	
Water quality:		
Rivers	No routine monitoring data appear to be available on the DWS database, although it is acknowledged that some of this data may be within regional offices databases. This latter data has been requested (if available) through the project management team. As such no direct comment can be made on the state of water quality in this IUA. The primary rivers in this catchment are the Keiskamma and Tylomnqa Rivers. Land use is largely rural, and some contamination of these rivers can be expected due to agricultural practices and activities of the small scattered settlements that are located in this IUA.	
Groundwater	The groundwater quality varies from good to marginal but excellent in localised areas	
Ecosystem services:		
Ecosystem services	**Key Ecosystem Service**	**Key Ecological Infrastructure**
	Provisioning: • Water • Food • Raw materials	• rivers, • wetlands, • ground water
	Regulation: • water regulation • water quantity • erosion control/ soil stability • biological control	• rivers • wetlands
	Cultural: • Ecotourism & recreation • Landscape & amenity values	• Estuary and coastline

Aspect	Status quo
Beneficiaries	• Significance to households that rely on water resource for water provisioning; • Subsistence and commercial agriculture (irrigated crops) associated with towns and their surroundings; and • Major Significance to the tourism industry and catchment associated towns and Communities.
Impacted sectors	• Commercial agriculture; tourism; households.

4.12 IUA_R02: Buffalo/ Nahoon



Aspect	Status quo	
Overview	This IUA covers the Buffalo and Nahoon Rivers and a few smaller coastal systems. The IUA delineation was based similarly on ecoregion and catchment impacts, which include commercial and subsistence farming, highly developed area around East London, with a high reliance of water resources from municipality – thus various catchments are stressed. These stresses further include the water transfers from the Kubusi River (Wriggleswade Dam) in the Kei system (S60) to the Amatola system.	
Socio-economic profile	This IUA falls within Buffalo City MM (ward 1-50), Great Kei LM (ward 1-6), and Amahlathi LM (ward 8, 9) The population in 2021 was 852 204, with employment rate at 36%. Only 4% of the population rely on water resources to access basic water services. The IUA includes the city of East London and towns of Zwelitsha, Phakamisa, Qonce (King Williams town), Bisho, Mdantsane and Gonubie. The main towns within the Great Kei municipality in this IUA include Morgan's Bay, Kei Mouth and Amatola Coastal. Key economic activities within the IUA include tourism, community services, agriculture and manufacturing. There is forestry activity in the Qonce area. The Buffalo City metro has a well-established manufacturing industry, and the automotive industry plays a large role. East London has South Africa's only commercial river port at the Buffalo River mouth	
SWSAs	SW: R20A, F	
Water resource components:		
Rivers	Main rivers	Buffalo, Nahoon, Kwelera, Gqunube

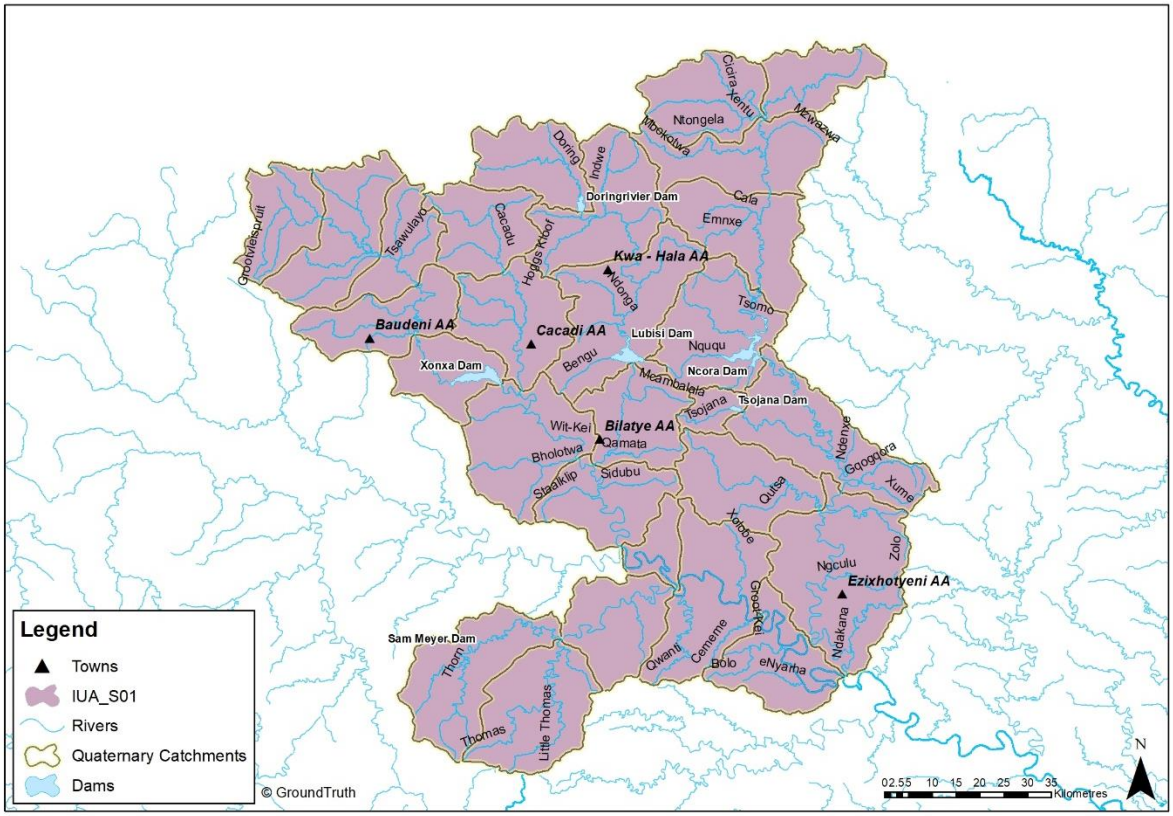
Aspect	Status quo	
	Quaternaries	R20A-G , R30A-F
	Ecoregion	16_7: South Eastern Uplands (16) ecoregion 17_2: North Eastern Coastal Belt (17) ecoregion
	PES	Ranges mostly from largely natural (category B) to largely modified (category D) ecological conditions throughout. Exceptions include sub-quaternary reaches R30A-07861, R30A-07837 and R30B-07687 categorized as unmodified (category A) and R30F-08165 categorized as seriously modified (category E) largely due to channel and hydrological modifications and water quality deterioration.
	EIS	EI: Moderate to High ES: Moderate to High Overall EIS: Moderate to High
	Fish	Fish Sanctuaries: Priority Area (Nkobongo River, unnamed tributary of the Nahoon River) Fish Sanctuaries: Support Areas (iZele River, Cwengcwe River, Tshoxa River, Buffalo River, Nahoon River, Yellowwoods River, Mgqakwebe River, Ngqokweni River)
	Vegetation	Dominant Biome/s: Savanna with linear portions of Albany Thicket and pockets of Forest Dominant Bioregion/s: Sub-escarpment Savanna and some Albany Thicket and Drakensberg Grassland with Zonal and Intrazonal Forest Threatened / sensitive species: *Isoetes wormaldii* (CR), *Crinum campanulatum* (NT), *Umtiza listeriana* (V), *Crinum moorei* (V), Ilex mitis var. mitis [Decl], *Gunnera perpensa* [Decl], *Cyathea capensis* [Decl], *Crinum macowanii* [Decl] Plant Endemism: IUA within Maputaland – Pondoland Region of plant endemism
	Geomorphology	The rivers fall largely in the Upper Foothill and Lower Foothill geomorphic classes. The percentage of the river network falling in the various geomorphological zones are as follows: Mountain Headwater Stream - 0.8% Mountain Stream - 2.8% Transitional - 5.9% Upper Foothills – 55.8% Lower Foothills – 33.7% Lowland River – 1.0%
	EWR sites	Buffalo (R20A, R20F and R20G), Yellowwoods (R20E)
Wetlands	HGM unit type	Total of 200 wetlands mapped; Channelled Valley Bottom Wetlands: 18% Depression Wetlands: 50%

Aspect	Status quo	
		Floodplain Wetlands: 0.5% Hillslope Seep Wetlands: 27.5% Unchannelled Valley Bottom Wetlands: 4%
	PES per HGM unit type	Channelled Valley Bottom Wetlands - A/B: 50%; C: 8%; D/E/F: 42%. Depression Wetlands - A/B: 45%; C: 18%; D/E/F: 37%. Floodplain Wetlands - D/E/F: 100%. Hillslope Seep Wetlands - A/B: 25%; C: 26%; D/E/F: 49%. Unchannelled Valley Bottom Wetlands - A/B: 22%; C: 45%; D/E/F: 33%.
	FEPA Wetlands	All of the FEPA wetlands that have been mapped in IUA_R02 are depression wetlands and have been mapped for their endangered threat status.
	Ecosystem Services	**Supply:** Given that there predominant HGM unit types in IUA_R02 are either depression wetlands or hillslope seep wetlands, the regulating services with will be supplied by these wetlands will generally be characterised by water quality enhancement ecosystem services which result from water passing through the low redox soil environment in seeps and depression wetlands. Hillslope seep wetlands do also generally provide some streamflow regulation services in the dry season and can provide sediment trapping services to some degree as well. **Demand:** The majority of this IUA, especially in the northern and eastern portion of the IUA is characterised by mountainous landscapes that are used for conservation and recreation. Therefore, much of the demand for ecosystem services in these areas are associated with cultural and recreational services. However, the southern and western portion of the IUA are characterised by the relatively populous settlements of East London and Bisho, both of which have fairly significant urban sprawl surrounding the main town centres. The Brindle Drift Dam is located outside of East London and is the cities water supply dam. Therefore, the demand for ecosystem services in these portions of the IUA will be more centred around regulating and supporting ecosystem services such as flood attenuation, sediment trapping, streamflow regulation and water quality enhancement.
Groundwater	Aquifer Type	The aquifer is mainly of a fractured type associated with the Karoo Supergroup. Intergranular and fractured aquifers, owing to the presence of dolerite sills and dykes also exist.
	Stressed Areas	The IUA is mildly stressed in certain areas
Estuaries	Estuary types	18 estuaries occur in this IUA.
	PES	Estuary present condition ranges from about five natural estuaries which are rated category A and A/B to critically

Aspect	Status quo	
		threatened (category F). Eight in category B (Largely natural), two category C (Moderately modified) and two category D (Largely modified). Therefore, the catchment is dominated by estuaries mostly in good condition.
	IES	Kwelera, Cefane and Qinira are rated as the most important estuaries in this IUA. Several estuaries including these three have more than one linkage to an important biodiversity area with local authority nature reserves and MPAs. Overall IES: estuaries range from low to high.
	Pressures	Hlazi, Blind and Buffalo estuaries has the highest pressure/impact rating in this IUA. Major degradation as a result of canalisation, harbour development and high recreation use.
Conservation areas/ priority systems/ etc.	Amathole marine protected area Nahoon nature reserve and other small reserves	
Water use:		
Major dams	Laing (R2R001), Rooikrantz (R2R002), Bridledrift (R2R003), Nahoon (R3R001)	
Transfers/ hydro power generation	Water is transferred from Wriggleswade Dam (Kei system) to the Buffalo and Nahoon Rivers	
Main activities (irrigation, forestry, etc.)	Agriculture: 7% Domestic: 56% Afforestation: 5% Alien Veg: 2% Irrigation: 30%	
Groundwater	The current groundwater use in the IUA is about 2.1Mm^3/annum, of which 38% is for municipal use, 35.6% is for irrigation and 20% is for industrial use.	
Water quality:		
Rivers	No routine monitoring data appear to be available on the DWS database, although it is acknowledged that some of this data may be within regional offices databases. This latter data has been requested (if available) through the project management team. The primary rivers in this catchment are the Buffalo, Nahoon and Kwelera rivers. These rivers flow through largely rural land areas, with small settlements, before reaching the coast. It can be expected that river quality remains acceptable in the rural areas. However, water contamination levels may become dangerously high upon approaching the dense, urban settlements along the coast, such as East London, Beacon Bay and Gonubie. It is recommended that river quality data be collected as soon as possible.	
Groundwater	The groundwater quality varies from good to marginal but excellent in localised areas	

Aspect	Status quo	
Ecosystem services:		
Ecosystem services	**Key Ecosystem Service**	**Key Ecological Infrastructure**
	Provisioning: • Water • Food • Raw materials	• rivers, • wetlands, • ground water • Bridle drift dam
	Regulation: • water regulation • water quantity • erosion control/ soil stability • biological control • climate change	• rivers • wetlands • forestry
	Cultural: • Ecotourism & recreation • Landscape & amenity values	• Amathole marine protected area • Coastline • Nahoon nature reserve and other small reserves
Beneficiaries	• Significance to households that rely on ground water for water provisioning; • Subsistence and commercial agriculture in associated towns and their surroundings; and • Tourism industry in associated towns and communities.	
Impacted sectors	• Commercial agriculture (including forestry); manufacturing; tourism; and households.	

4.13 IUA_S01: Upper Great Kei



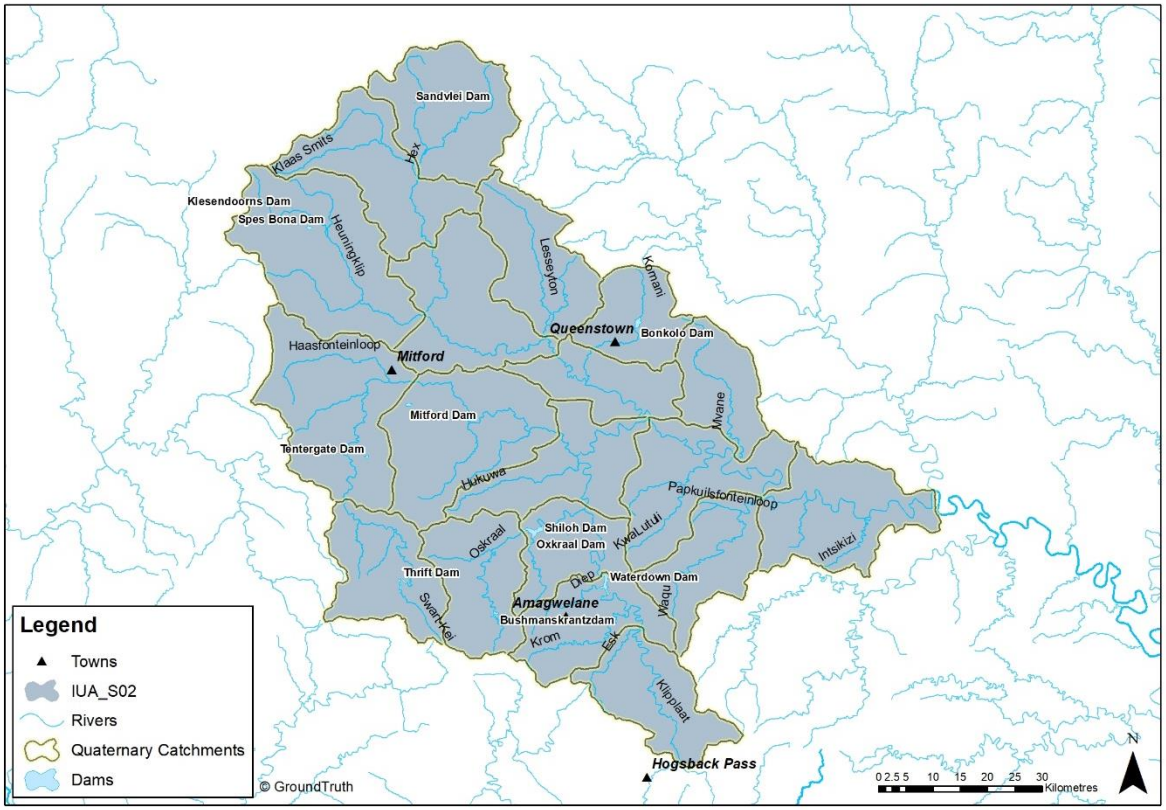
Aspect	Status quo	
Overview	This IUA covers the Upper reaches of the Great Kei and the delineation was primary based on impacts to the catchment including rural development, irrigation and large dams for water supply.	
Socio-economic profile	This IUA falls within Emalahleni LM (ward 1-17), Intsika Yethu LM (ward 3-21), Amahlathi LM (ward 4-6, 13), and Sakhisizwe (ward 6-9),). The population in 2021 was 308 136 with employment rate at 16%. 40% of the population rely on water resources (rivers and groundwater) to access water services. The main towns are Dordrecht, Indwe and Lady Frere (Emalahleni LM) and Cofimvaba and Tsomo (Intsika Yethu LM). A large portion of the IUA is rural and supported mainly by subsistence farming. The main market crop being sorghum and there is a developing wool production market. There is some commercial agriculture more in the northern areas of the IUA. Other economic sector activity is in the community services and trade sectors.	
SWSAs	S40A-B, S50A, B, D, E: SW and integrated SW-GW SWSA.	
Water resource components:		
Rivers	Main rivers	Indwe, White Kei, Tsomo, Great Kei
	Quaternaries	S10A-J, S20A-D, S40A-F, S50A-J
	Ecoregion	15_6: Easter Escarpment Mountains (15) ecoregion

Aspect	Status quo	
		16_4: South Eastern Uplands (16) ecoregion 16_5: South Eastern Uplands (16) ecoregion 16_6: South Eastern Uplands (16) ecoregion 18_2: Drought Corridor (18) ecoregion
	PES	Ranges mostly from largely natural (category B) to largely modified (category D) ecological conditions throughout. Exceptions include sub-quaternary reaches S10E-06699 on the White Kei, S10F-06448 on the Cacadu River, owing to serious catchment degradation, erosion and large instream dams with possible temperature and oxygen fluctuations. Furthermore, S40F-07391 and S40F-07426 categorized as unmodified (category A) owing to good habitat and flow diversity.
	EIS	EI: Moderate to High ES: Moderate to High Overall EIS: Moderate to High
	Fish	-
	Vegetation	Dominant Biome/s: Grassland and some Savanna Dominant Bioregion/s: Sub-escarpment Grassland with some Drakensberg Grassland and Sub-escarpment Savanna Threatened Ecosystems: V (Mthatha Moist Grassland) Threatened / sensitive species*: Umtiza listeriana* (V), Ilex mitis var. mitis [Decl], *Gunnera perpensa* [Decl], *Cyathea capensis* [Decl], *Crinum macowanii* [Decl] Plant Endemism: IUA within Maputaland – Pondoland Region of plant endemism
	Geomorphology	The rivers fall largely in the Upper Foothill and Lower Foothill geomorphic classes. The percentage of the river network falling in the various geomorphological zones are as follows: Mountain Headwater Stream - 1.3% Mountain Stream - 5.4% Transitional - 12.5% Upper Foothills – 49.0% Lower Foothills – 31.8% Lowland River – 0.0%
	EWR sites	White Kei (S10J)
Wetlands	HGM unit type	Total of 372 wetlands mapped; Channelled Valley Bottom Wetlands: 29% Depression Wetlands: 36% Floodplain Wetlands: 2% Hillslope Seep Wetlands: 28% Unchannelled Valley Bottom Wetlands: 5%
	PES per HGM unit type	Channelled Valley Bottom Wetlands - A/B: 44%; C: 28%; D/E/F: 28%.

Aspect	Status quo	
		Depression Wetlands - A/B: 67%; C: 11%; D/E/F: 22%. Floodplain Wetlands - A/B: 14%; C: 43%; D/E/F: 43%. Hillslope Seep Wetlands - A/B: 39%; C: 39%; D/E/F: 22%. Unchannelled Valley Bottom Wetlands - A/B: 30%; C: 45%; D/E/F: 25%.
	FEPA Wetlands	A number of FEPA wetlands exist in IUA_KL01, many of them being small, isolated depression wetlands. However, a number of channelled and unchannelled valley bottom FEPA wetlands have been mapped in the Groot-Kei River catchment.
	Ecosystem Services	**Supply:** Given that there predominant HGM unit types in IUA_S01 are either depression wetlands or hillslope seep wetlands, the regulating services with will be supplied by these wetlands will generally be characterised by water quality enhancement ecosystem services which result from water passing through the low redox soil environment in seeps and depression wetlands. Hillslope seep wetlands do also generally provide some streamflow regulation services in the dry season and can provide sediment trapping services to some degree as well. However, a large proportion of the wetlands in IUA_S01 are channelled valley bottom wetlands which are also characterised by their ability to supply flood attenuation and water quality enhancing ecosystem services. **Demand:** The majority of this IUA is characterised by rural settlements, subsistence farming and livestock rearing. The demand for ecosystem services in these portions of the IUA are more centred around provisioning services such as the cultivation of food, grazing for livestock, water for human consumption and harvestable resources. However, two large water supply dams do exist in the middle reaches of the IUA meaning that the demand for ecosystem services from wetlands upstream of these dams will be related to water quality enhancement services and sediment trapping.
Groundwater	Aquifer Type	The aquifer is of an intergranular and fractured type associated with the Karoo Supergroup, as well as the presence of dolerite sills and dykes.
	Stressed Areas	There are no stressed areas in the IUA
Estuaries	EFZ	No estuaries
Conservation areas/ priority systems/ etc.	None	
Water use:		
Major dams	Xonxa (S1R001), Lubisi (S2R001), Doringrivier (S2R002), Ncora (S5R001), Tsojana (S5R002)	

Aspect	Status quo	
Transfers/ hydro power generation	Ncora Hydropower (generates up to 2MW of peaking power) and transfers to upper Mbashe River (IUA_T01).	
Main activities (irrigation, forestry, etc.)	Agriculture: 29% Domestic: 34% Afforestation: 4% Alien Veg: 17% Irrigation: 15%	
Groundwater	The current groundwater use in the IUA is about 6.0Mm^3/annum, of which 89% is for municipal use, 3.8% is for irrigation and 3.3% is for schedule 1 use.	
Water quality:		
Rivers	No routine monitoring data appear to be available on the DWS database, although it is acknowledged that some of this data may be within regional offices databases. This latter data has been requested (if available) through the project management team. The primary rivers in this catchment are the Indwe, White Kei, Tsomo and Great Kei Rivers. It may be assumed that river quality in rural areas, which dominate the IUA, is fairly good – due to low sources of contamination. However, investigation of water quality is recommended near Queenstown, the IUA's largest urban settlement.	
Groundwater	The groundwater quality varies from good to excellent	
Ecosystem services:		
Ecosystem services	**Key Ecosystem Service**	**Key Ecological Infrastructure**
	Provisioning: • Water • Food • Raw materials	• rivers, • wetlands, • ground water SWRA • Lubisi, Ncora and Indwe dam
	Regulation: • water regulation • water quantity • erosion control/ soil stability • biological control	• rivers • wetlands • forestry
Beneficiaries	• Significance to households that rely on ground water for water provisioning; and • Significant subsistence agriculture in associated towns and their surroundings.	
Impacted sectors	• Households, and forestry	

4.14 IUA_S02: Black Kei



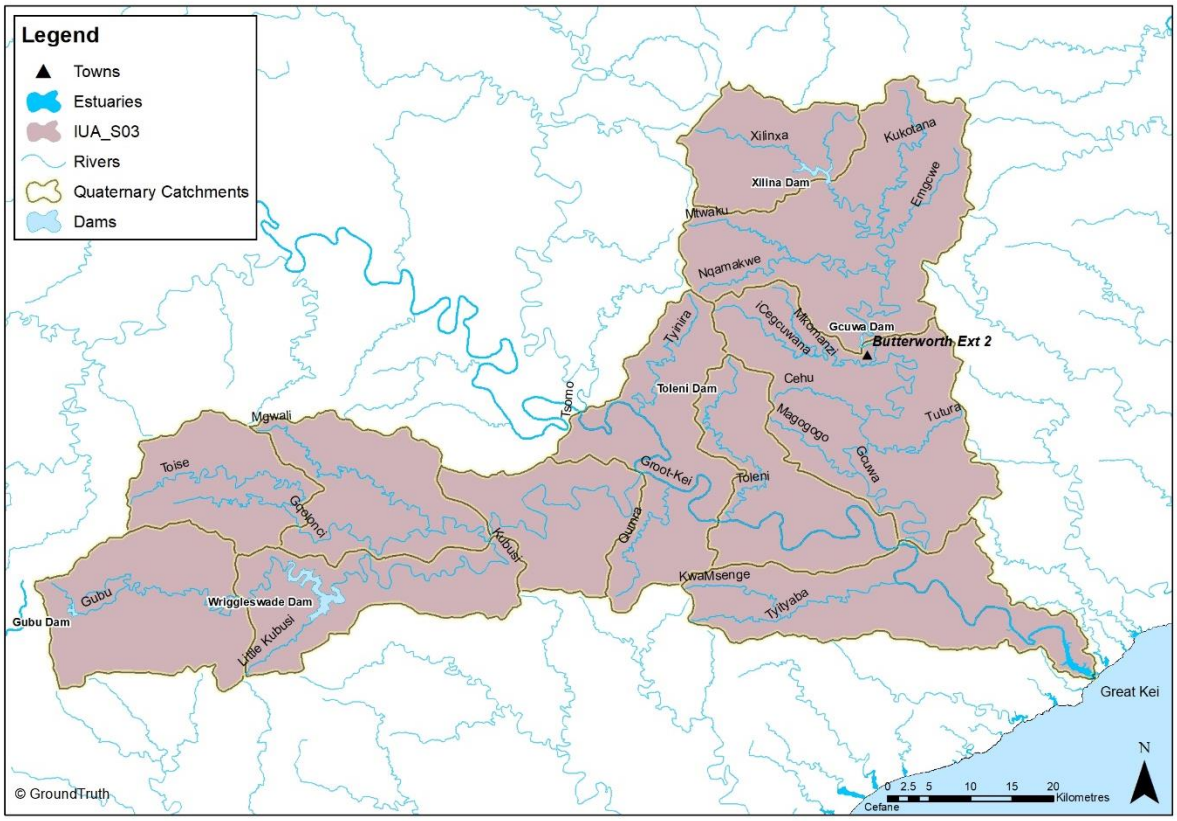
Aspect	Status quo	
Overview	The IUA includes the Klipplaat, Klaas, Smits and Black Kei River systems, which are highly stressed. The catchment pressures include irrigation and a few small dams.	
Socio-economic profile	This IUA falls within the Enoch Mgijima LM (ward 1-27), and Amahlathi LM (ward 4). The population in 2021 was 28 004, with employment rate at 28%. Approximately 12% of the population rely on water resource (mainly groundwater) to access basic water services. The main towns being Komani (Queenstown), Sterkstroom and Whittlesea. Economic activities include commercial agriculture and some subsistence farming. The IUA has a large rural area.	
SWSAs	SW: S32D	
Water resource components:		
Rivers	Main rivers	Klipplaat, Klaas Smits, Black Kei
	Quaternaries	S31A-G, S32A-M
	Ecoregion	18_2: Drought Corridor (18) ecoregion 16_7: South Eastern Uplands (16) ecoregion
	PES	Ranges mostly from largely natural (category B) to largely modified (category D) ecological conditions throughout.

Aspect	Status quo	
	EIS	EI: Moderate, except S32D-07439 which is High ES: Moderate, except S32M-07205 is High Overall EIS: Moderate, except the two above being High
	Fish	Fish Sanctuaries: Priority Area (Krom River) Fish Sanctuaries: Support Areas (Esk River, Klipplaat River)
	Vegetation	Dominant Biome/s: Grassland with some Savanna Dominant Bioregion/s: Sub-escarpment Grassland with some Drakensberg Grassland and Dry Highveld Grassland Threatened Ecosystems: V (Eastern Temperate Freshwater Wetlands) Threatened / sensitive species: Ilex mitis var. mitis [Decl], *Gunnera perpensa* [Decl], *Cyathea capensis* [Decl], *Crinum macowanii* [Decl] Plant Endemism: Portion of IUA within Maputaland – Pondoland Region of plant endemism
	Geomorphology	The rivers fall largely in the Upper Foothill and Lower Foothill geomorphic classes. The percentage of the river network falling in the various geomorphological zones are as follows: Mountain Headwater Stream - 1.3% Mountain Stream - 4.2% Transitional – 9.0% Upper Foothills – 43.1% Lower Foothills – 42.4% Lowland River – 0.1%
	EWR sites	Klipplaat (S32G), Black Kei (S32K and S32M)
Wetlands	HGM unit type	Total of 428 wetlands mapped; Channelled Valley Bottom Wetlands: 17% Depression Wetlands: 15% Floodplain Wetlands: 1% Hillslope Seep Wetlands: 52% Unchannelled Valley Bottom Wetlands: 15%
	PES per HGM unit type	Channelled Valley Bottom Wetlands - A/B: 41%; C: 22%; D/E/F: 37%. Depression Wetlands - A/B: 75%; C: 10%; D/E/F: 15%. Floodplain Wetlands - C: 33%; D/E/F: 67%. Hillslope Seep Wetlands - A/B: 52%; C: 17%; D/E/F: 31%. Unchannelled Valley Bottom Wetlands - A/B: 43%; C: 40%; D/E/F: 17%.
	FEPA Wetlands	There are a number of FEPA wetlands in the IUA_S02 that include channelled valley bottom, unchannelled valley bottom, hillslope seep and depression wetlands. Many of these have been identified as FEPA wetlands because they are known crane breeding/feeding sites or are located in key water supply areas in their catchment.

Aspect	Status quo	
	Ecosystem Services	**Supply:** Given that there predominant HGM unit types in IUA_S02 are hillslope seep wetlands, the regulating services with will be supplied by these wetlands will generally be characterised by water quality enhancement ecosystem services which result from water passing through the low redox soil environment in seeps and depression wetlands. Hillslope seep wetlands do also generally provide some streamflow regulation services in the dry season and can provide sediment trapping services to some degree as well. **Demand:** Much of the IUA_S02 is characterised by dry and flat land that does not host much wetland area. However, the large river systems that run through the IUA are characterised by high densities of wetland, both valley floor and valley side wetlands. There is scattered agricultural activity along these river systems as well as scattered irrigation and water supply dams. As such, the demand for sediment trapping and water quality enhancement services will be high in this IUA.
Groundwater	Aquifer Type	The aquifer is of an intergranular and fractured type associated with the Karoo Supergroup, as well as the presence of dolerite sills and dykes
	Stressed Areas	The IUA is mildly to moderately stressed in certain areas
Estuaries	EFZ	No estuaries
Conservation areas/ priority systems/ etc.	None	
Water use:		
Major dams	Waterdown (S3R001), Bonkolo (S3R002), Oxkraal (S3R003)	
Transfers/ hydro power generation	None	
Main activities (irrigation, forestry, etc.)	Agriculture: 50% Industry: 1% Domestic: 17% Afforestation: 5% Irrigation: 27%	
Groundwater	The current groundwater use in the IUA is about 3.2Mm^3/annum, of which 77.5% is for irrigation, 12% is for municipal use and 7% is for schedule 1 use.	
Water quality:		
Rivers	No routine monitoring data appear to be available on the DWS database, although it is acknowledged that some of this data may be within regional offices databases. This latter data has been requested (if available) through the project management team. The	

<table>
<tr><th>Aspect</th><th colspan="2">Status quo</th></tr>
<tr><td></td><td colspan="2">primary rivers in this catchment are the Klipplaat, Klaas Smits and Black Kei rivers. This IUA has largely rural land use, with an arid landscape. There are small settlements scattered throughout the IUA. It may be assumed that river quality is acceptable, due to the low sources of contamination. However, further investigation is still recommended, particularly for the Klaas Smits River, which may experience some contamination as it passes near the urban settlement of Queenstown.</td></tr>
<tr><td>Groundwater</td><td colspan="2">The groundwater quality varies from good to excellent</td></tr>
<tr><td colspan="3">Ecosystem services:</td></tr>
<tr><td rowspan="4">Ecosystem services</td><td>Key Ecosystem Service</td><td>Key Ecological Infrastructure</td></tr>
<tr><td>Provisioning:
• Water
• Food
• Raw materials</td><td>• rivers,
• wetlands,
• ground water</td></tr>
<tr><td>Regulation:
• water regulation
• water quantity
• erosion control/ soil stability
• biological control</td><td>• rivers
• wetlands</td></tr>
<tr><td colspan="2">Cultural:
• Landscape & amenity values</td></tr>
<tr><td>Beneficiaries</td><td colspan="2">• Significance to households that rely on ground water for water provisioning.
• Subsistence and commercial agriculture in associated towns and their surroundings</td></tr>
<tr><td>Impacted sectors</td><td colspan="2">• Commercial agriculture; and households</td></tr>
</table>

4.15 IUA_S03: Lower Great Kei



Aspect	Status quo	
Overview	This IUA delineation was based on catchment impacts namely irrigation, rural development, and the transfers from Wrigglewade Dam to the Buffalo (part of the integrated Amatola system).	
Socio-economic profile	This IUA falls within the Mquma LM (ward 1-21), Amahlathi LM (ward 14- 18), and Great Kei LM (ward 7). The population in 2021 was 182 201, with employment rate at 22%. Approximately 33% of the population rely on water resources (mainly rivers) to access basic water services. The main towns include Stutterheim, Komga, Gcuwa (Butterworth) and Ngqamakhwe. The main economic activities include agriculture (crops and livestock), plantation forestry and other sectors including community services, wholesale and retail trade and manufacturing.	
SWSAs	SW: S60A-C, S70A-B Integrated SW-GW: S70F	
Water resource components:		
Rivers	Main rivers	Kubusi, Great Kei
	Quaternaries	S60A-E, S70A-F
	Ecoregion	16_6: South Eastern Uplands (16) ecoregion

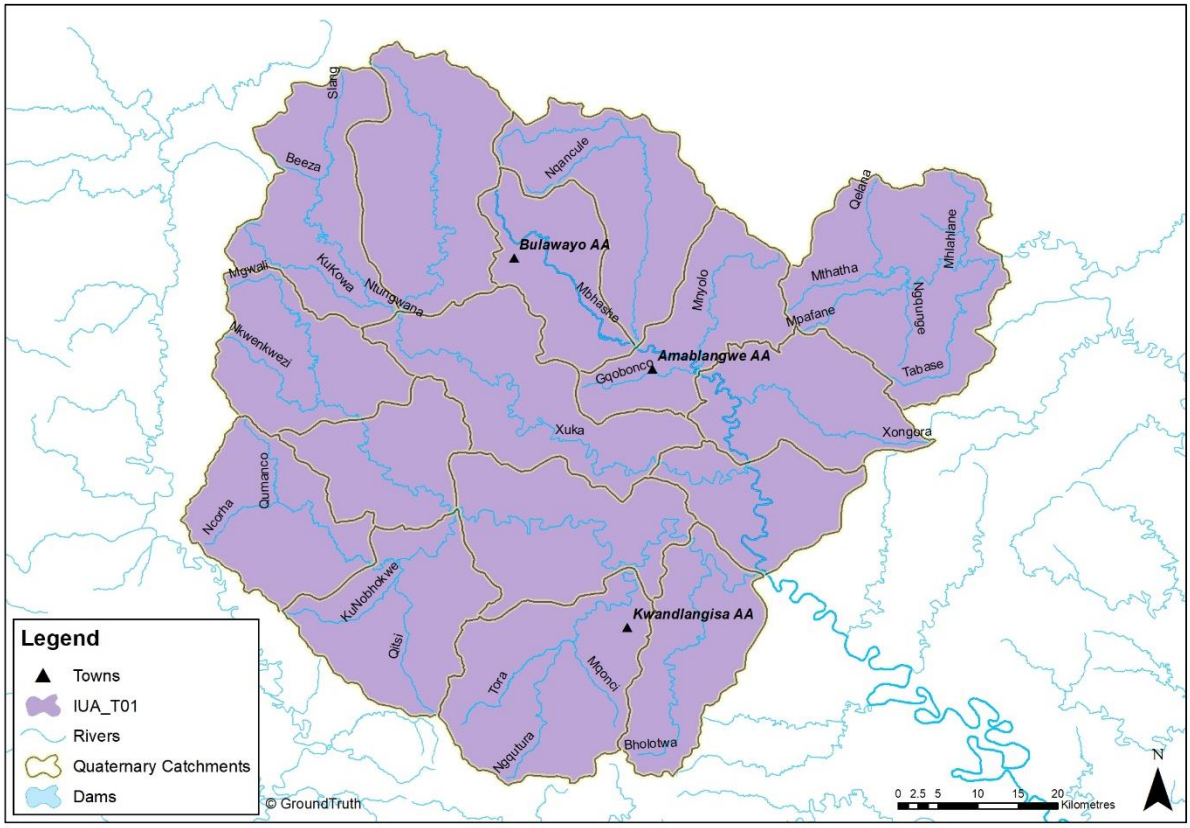
Aspect	Status quo	
		16_7: South Eastern Uplands (16) ecoregion
	PES	Ranges mostly from largely natural (category B) to largely modified (category D) ecological conditions throughout.
	EIS	EI: Moderate to High ES: Moderate to High Overall EIS: Moderate to High
	Fish	Fish Sanctuaries: Priority Area (KwaMsenge River, Tyityaba River) Fish Sanctuaries: Support Areas (Gubu River, Kubusi River)
	Vegetation	Dominant Biome/s: Grassland and Savanna with pockets of Forest Dominant Bioregion/s: Sub-escarpment Grassland and Sub-escarpment Savanna with some Drakensberg Grassland Threatened Ecosystems: V (Mthatha Moist Grassland, Transkei Coastal Forest) Threatened / sensitive species: *Crinum moorei* (V), *Umtiza listeriana* (V), Ilex mitis var. mitis [Decl], *Gunnera perpensa* [Decl], *Cyathea capensis* [Decl], *Crinum macowanii* [Decl] Plant Endemism: IUA within Maputaland – Pondoland Region of plant endemism
	Geomorphology	The rivers fall largely in the Upper Foothill and Lower Foothill geomorphic classes. The percentage of the river network falling in the various geomorphological zones are as follows: Mountain Headwater Stream - 0.4% Mountain Stream - 2.5% Transitional – 7.4% Upper Foothills – 49.9% Lower Foothills – 33.4% Lowland River – 6.4%
	EWR sites	Kubusi (S60A, S60B and S60E), Great Kei (S70A)
Wetlands	HGM unit type	Total of 438 wetlands mapped; Channelled Valley Bottom Wetlands: 23% Depression Wetlands: 37% Floodplain Wetlands: 1% Hillslope Seep Wetlands: 33% Unchannelled Valley Bottom Wetlands: 6%
	PES per HGM unit type	Channelled Valley Bottom Wetlands - A/B: 39%; C: 37%; D/E/F: 24%. Depression Wetlands - A/B: 29%; C: 11%; D/E/F: 60%. Floodplain Wetlands - A: 40%; D/E/F: 60%. Hillslope Seep Wetlands - A/B: 34%; C: 43%; D/E/F: 23%.

Aspect	Status quo	
		Unchannelled Valley Bottom Wetlands - A/B: 12%; C: 52%; D/E/F: 36%.
	FEPA Wetlands	All of the FEPA wetlands that have been mapped in IUA_S03 are either depression wetlands or hillslope seep wetlands and have been mapped for their endangered threat status.
	Ecosystem Services	**Supply:** Given that there predominant HGM unit types in IUA_S03 are either hillslope seep wetlands or depression wetlands, the regulating services with will be supplied by these wetlands will generally be characterised by water quality enhancement ecosystem services which result from water passing through the low redox soil environment in seeps and depression wetlands. Hillslope seep wetlands do also generally provide some streamflow regulation services in the dry season and can provide sediment trapping services to some degree as well. **Demand:** Much of the IUA_S03 is characterised by vast areas of rural settlement. These rural settlements are generally characterised by low to medium density rural areas where susbsitence farming and livestock rearing (predominantly cattle and goats) are common practice. Therefore, the demand for ecosystem services will be a mix of provisioning services such as water for human use, grazing areas for livestock and harvestable resources (such as reeds and sedges) for people to use for weaving. In addition, these areas generally produce a lot of sediment so the demand for erosion control and sediment trapping will be high as well.
Groundwater	Aquifer Type	The aquifer is of an intergranular and fractured type associated with the Karoo Supergroup, as well as the presence of dolerite sills and dykes
	Stressed Areas	The IUA is moderately stressed in certain areas
Estuaries	Estuary types	The Great Kei estuary is the only estuary in this IUA and is classified as a Large Fluvially Dominated estuary.
	PES	Present condition of this estuary is a C or Moderately modified.
	IES	It is considered an estuary with High Biodiversity Importance and is linked to a critical biodiversity area increasing this status. It is a very important recreational area, especially for anglers. Lot 2 Kei Mouth State Reserve
	Pressures	This estuary has been rated as receiving a moderate level of pressure
Conservation areas/ priority systems/etc.	Qacu nature reserve and other small nature reserves	

Aspect	Status quo	
Water use:		
Major dams	Gubu (S6R001), Wriggleswade (S6R002), Gcuwa (S7R001), Xilinxa (S7R002), Toleni (S7R003)	
Transfers/ hydro power generation	Transfer of water from Wriggleswade Dam to R20 (Buffalo) catchment for domestic use	
Main activities (irrigation, forestry, etc.)	Agriculture: 9% Domestic: 13% Afforestation: 10% Alien Veg: 10% Irrigation: 58%	
Groundwater	The current groundwater use in the IUA is about 0.36Mm^3/annum, of which 69% is for municipal use, 24.5% is for irrigation and 4.8% is for industrial use	
Water quality:		
Rivers	No routine monitoring data appear to be available on the DWS database, although it is acknowledged that some of this data may be within regional offices databases/hands. This latter data has been requested (if available) through the project management team. The primary rivers in this catchment are the Kubusi and Great Kei Rivers. The Great Kei River flows through a large portion of the IUA, but passes only rural landscape until it reaches the coast. The Kubusi River passes near Stutterheim, but water quality may be acceptable here, due to the small size of the settlement. There is also some agricultural land use in this IUA, and water samples should be taken to determine if any agricultural products have contaminated the rivers.	
Groundwater	The groundwater quality varies from good to excellent	
Ecosystem services:		
Ecosystem services	**Key Ecosystem Service**	**Key Ecological Infrastructure**
	Provisioning: • Water • Food • Raw materials	• rivers, • wetlands, • ground water SWRA • Wrigglewade dam
	Regulation: • water regulation • water quantity • erosion control/ soil stability • biological control • climate change	• rivers • wetlands • forestry
	Cultural: • Ecotourism & recreation • Landscape & amenity values	• Coastline • Qacu nature reserve and other small nature reserves

Aspect	Status quo
Beneficiaries	• Significance to households that rely on ground water for water provisioning; • Commercial and subsistence agriculture in associated towns and their surroundings; and • Tourism industry in associated towns and communities.
Impacted sectors	• Commercial agriculture (including forestry); tourism; and households.

4.16 IUA_T01: Upper Mbashe, Upper Mthatha



Aspect	Status quo	
Overview	This IUA covers the Upper Mbashe and Mthatha River systems. Much of the catchments are stressed with impacts associated with extensive subsistence agriculture. Many of the systems are degraded, indicating seriously to critically modified ecological conditions, although with a few fish sanctuaries present within priority, FSA and corridors.	
Socio-economic profile	This IUA falls within the entire Engcobo LM, Intsika Yethu LM (ward 11,12, 18), Mbashe LM (ward 5,31), King Sabata Dalindyebo LM (ward 34), and Sakhisizwe LM (ward 1). The population in 2021 was 248 996, with employment rate at 14%. Approximately 56 % of the population rely on water resources (mainly rivers) to access basic water services. The main towns are Ngcobo and Elliot. The area is largely rural with many rural towns. Commercial agriculture in the IUA lies in the northern part in the Sakhisizwe municipality and is mainly crop farming and some livestock farming. Other economic activity is from forestry plantations in the Sakhisizwe and Engcobo municipalities. A large portion of this IUA is supported by subsistence farming.	
SWSAs	SW: T11B, T11C, T11D, T11E, T12A-F, T20A Integrated SW-GW: T11C, T11E, T11F, T20A	
Water resource components:		
Rivers	Main rivers	Xuka, Mgwali, Upper Mbashe, Upper Mthatha
	Quaternaries	T11A-H, T12A-G, T20A

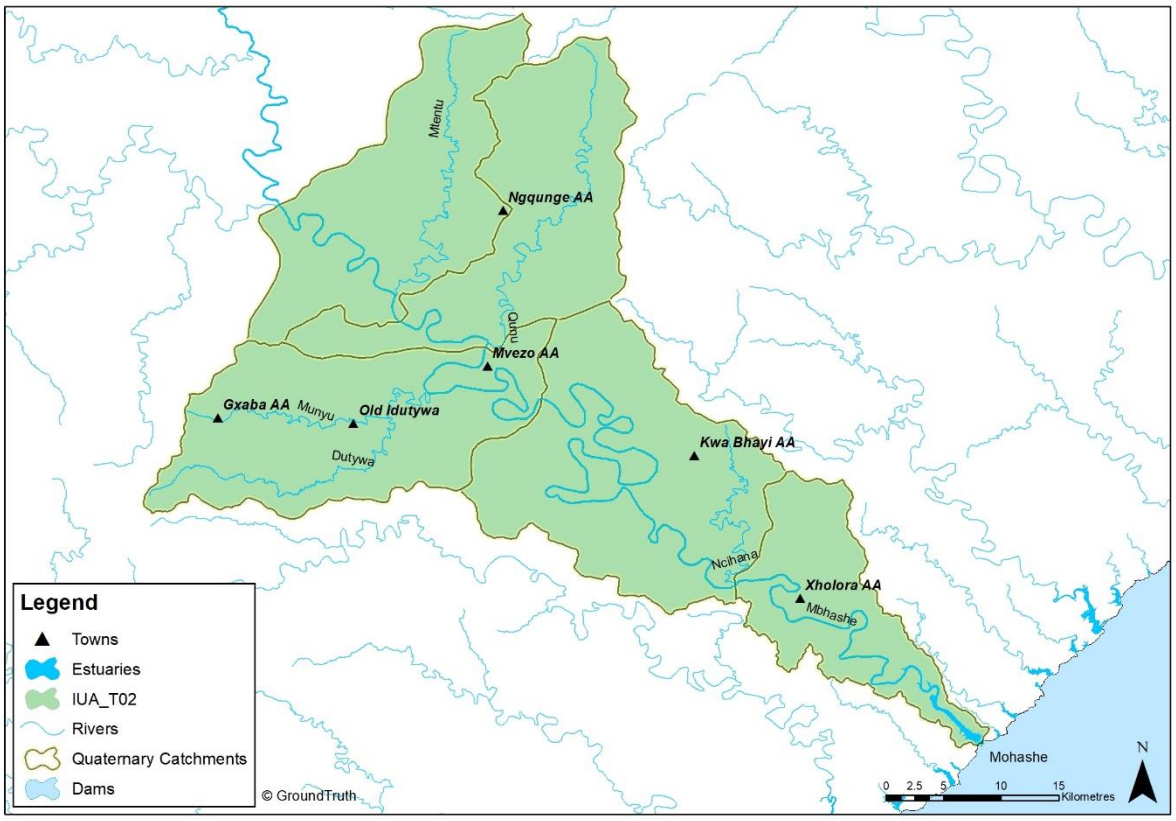
Aspect	Status quo	
	Ecoregion	16_4: South Eastern Uplands (16) ecoregion 16_5: South Eastern Uplands (16) ecoregion 16_6: South Eastern Uplands (16) ecoregion
	PES	Ranges mostly from unmodified (category A) to largely modified (category D) ecological conditions throughout.
	EIS	EI: Low to High ES: Moderate to High Overall EIS: Moderate to High
	Fish	Fish Sanctuaries: Priority Area (Beeze River, KuKowa River) Fish Sanctuaries: Corridor (Mbhashe River, Gqobonco River, Xuka River, Xongora River, Mnyolo River Fish Sanctuaries: Support Areas (Slang River, Xuka River, Kuntwanazana River, Nqancule River)
	Vegetation	Dominant Biome/s: Grassland with pockets of Forest Dominant Bioregion/s: Sub-escarpment Grassland with some Drakensberg Grassland and pockets of Zonal and Intrazonal Forest Threatened Ecosystems: V (Mthatha Moist Grassland) Threatened / sensitive species: *Umtiza listeriana* (V), Ilex mitis var. mitis [Decl], *Gunnera perpensa* [Decl], *Crinum macowanii* [Decl] Plant Endemism: IUA within Maputaland – Pondoland Region of plant endemism
	Geomorphology	The rivers fall largely in the Upper Foothill and Lower Foothill geomorphic classes. The percentage of the river network falling in the various geomorphological zones are as follows: Mountain Headwater Stream - 2.0% Mountain Stream - 4.7% Transitional – 9.7% Upper Foothills – 37.8% Lower Foothills – 43.3% Lowland River – 2.4%
	EWR sites	Xuka and Caca (T11C)
Wetlands	HGM unit type	Total of 257 wetlands mapped; Channelled Valley Bottom Wetlands: 30% Depression Wetlands: 32% Floodplain Wetlands: 8% Hillslope Seep Wetlands: 19% Unchannelled Valley Bottom Wetlands: 11%

Aspect	Status quo	
	PES per HGM unit type	Channelled Valley Bottom Wetlands - A/B: 51%; C: 26%; D/E/F: 23%. Depression Wetlands - A/B: 46%; C: 31%; D/E/F: 33%. Floodplain Wetlands - A: 29%; C: 15%; D/E/F: 57%. Hillslope Seep Wetlands - A/B: 62%; C: 26%; D/E/F: 12%. Unchannelled Valley Bottom Wetlands - A/B: 67%; C: 18%; D/E/F: 15%.
	FEPA Wetlands	There are a number of FEPA wetlands in the IUA_T01 that include channelled valley bottom, unchannelled valley bottom, hillslope seep, depression and floodplain wetlands. Many of these have been identified as FEPA wetlands because they are known crane breeding/feeding sites or are located in key water supply areas in their catchment. A number of the floodplain and unchannelled valley bottom wetlands have been identified by experts and have been included in the FEPA matrix.
	Ecosystem Services	**Supply:** Given that there predominant HGM unit types in IUA_T01 are either hillslope seep wetlands or channelled valley bottom wetlands, the regulating services with will be supplied by these wetlands will generally be characterised by water quality enhancement ecosystem services which result from water passing through the low redox soil environment in seeps and depression wetlands. Hillslope seep wetlands do also generally provide some streamflow regulation services in the dry season and can provide sediment trapping services, while channelled valley bottoms are able to supply flood attenuation and erosion control to some extent as well. **Demand:** Much of the southern portion of IUA_T01 is characterised by vast areas of rural settlement. These rural settlements are generally characterised by low to medium density rural areas where susbsitence farming and livestock rearing (predominantly cattle and goats) are common practice. Therefore, the demand for ecosystem services will be a mix of provisioning services such as water for human use, grazing areas for livestock and harvestable resources (such as reeds and sedges) for people to use for weaving. In addition, these areas generally produce a lot of sediment so the demand for erosion control and sediment trapping will be high as well. However, the northern portion of the IUA is characterised by agriculture and forestry. The demand for ecosystems in these areas will be characterised by provisioning and regulating services.
Groundwater	Aquifer Type	The aquifer is of an intergranular and fractured type associated with the Karoo Supergroup, as well as the presence of dolerite sills and dykes
	Stressed Areas	The IUA is mildly to highly stressed in certain areas
Estuaries	EFZ	No estuaries

Aspect	Status quo	
Conservation areas/ priority systems/etc.	None	
Water use:		
Major dams	Mabeleni (T2R002)	
Transfers/ hydro power generation	None	
Main activities (irrigation, forestry, etc.)	Agriculture: 10% Industry: 1% Domestic: 20% Afforestation: 58% Alien Veg: 2% Irrigation: 10%	
Groundwater	The current groundwater use in the IUA is about 1.2Mm^3/annum, of which 82% is for municipal use, 15% is for irrigation and 2% is for industrial use	
Water quality:		
Rivers	No routine monitoring data appear to be available on the DWS database, although it is acknowledged that some of this data may be within regional offices databases. This latter data has been requested (if available) through the project management team. The primary rivers in this catchment are the Xuka, Mgwali, Upper Mbashe and Upper Mthatha Rivers. Land use is largely rural, with sprawling urban settlements such as Mthatha located within the IUA. There is however some extensive commercial forestry in the catchment areas in the upper Mthatha River, but with good water quality from these areas. River quality in rural areas may be assumed to be acceptable, but should be investigated near urban settlements to determine if contamination has taken place due to WWTW return flows and poor treatment thereof, or industrial works.	
Groundwater	The groundwater quality varies from good to excellent	
Ecosystem services:		
Ecosystem services	**Key Ecosystem Service**	**Key Ecological Infrastructure**
	Provisioning: • Water • Food • Raw materials	• rivers, • wetlands, • ground water •
	Regulation: • water regulation • water quantity • erosion control/ soil stability • biological control • climate change	• rivers • wetlands • forestry •

Aspect	Status quo
Beneficiaries	• Significance to households that rely on surface water for water provisioning; and • Significant subsistence agriculture in associated towns and their surroundings.
Impacted sectors	• Households, and forestry

4.17 IUA_T02: Lower Mbashe



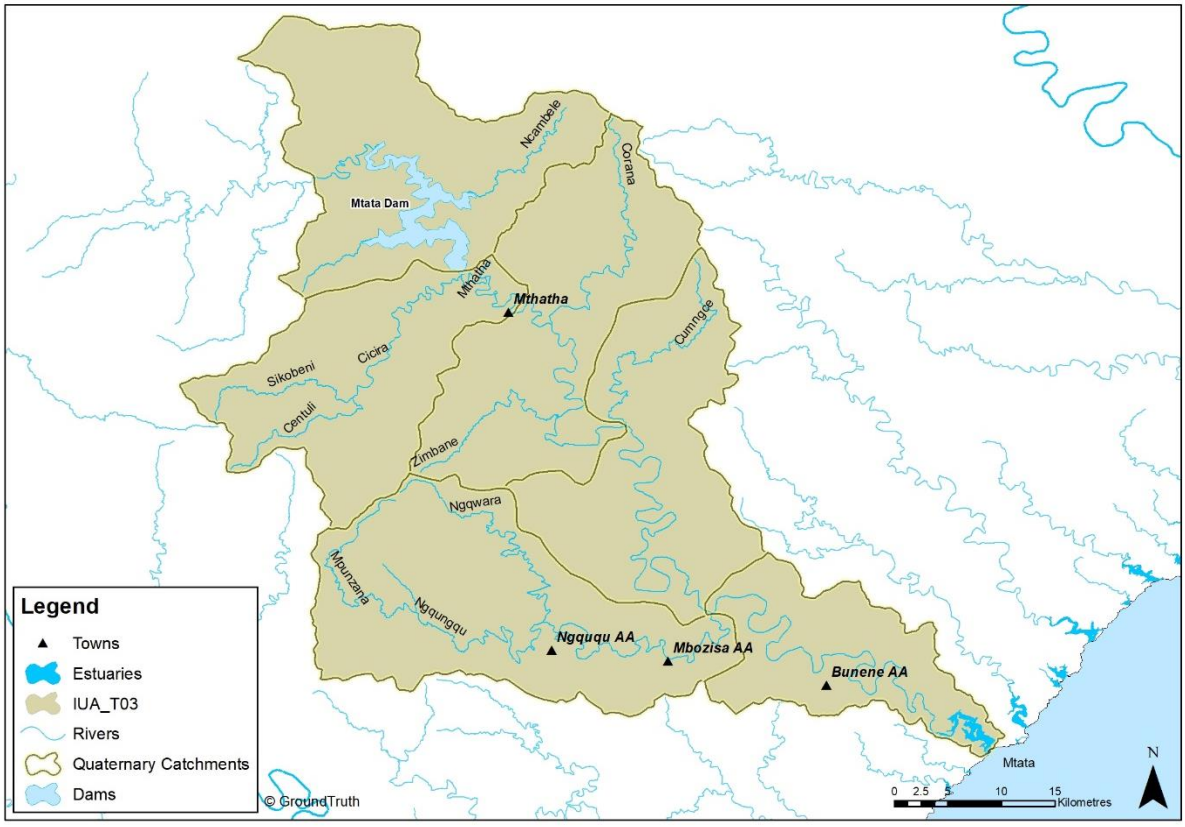
Aspect	Status quo	
Overview	The IUA delineation was based on biophysical characteristics, ecoregion, sensitive land uses namely the Pondoland Coastline, Dwesa-Cwebe Wildlife Reserve, and the important and endangered Mbhashe estuarine system. SW SWSA and integrated SW-GW SWSA,	
Socio-economic profile	This IUA falls within the Mbashe LM (ward 6-8; 13-16, 21, 24) and King Sabata Dalindyebo LM (ward 18-21, 31-32). The population in 2021 was 175 700, with employment rate at 10%. Approximately 60% of the population rely on water resources (mainly rivers) to access basic water services. The IUA is mainly a rural area with rural towns and is supported by subsistence farming.	
SWSAs	SW: T13A-E	
Water resource components:		
Rivers	Main rivers	Lower Mbashe
	Quaternaries	T13A-E
	Ecoregion	16_6: South Eastern Uplands (16) ecoregion 17_1: North Eastern Coastal Belt (17) ecoregion

Aspect	Status quo	
	PES	Ranges mostly from largely natural (category B) to largely modified (category D) ecological conditions throughout.
	EIS	EI: Moderate, except T13D-07016 and T13E-07090 is High ES: Moderate, except T13D-07016 is High Overall EIS: Moderate, except the above two are High
	Fish	Fish Sanctuaries: Support Areas (Mtentu River) Fish Sanctuaries: Corridor (Mbhashe River)
	Vegetation	Dominant Biome/s: Grassland and Savanna with pockets of Forest Dominant Bioregion/s: Sub-escarpment Savanna with some Sub-escarpment Grassland Threatened Ecosystems: V (Mthatha Moist Grassland) Threatened / sensitive species: *Crinum macowanii* [Decl] Plant Endemism: IUA within Maputaland – Pondoland Region of plant endemism
	Geomorphology	The rivers fall largely in the Upper Foothill and Lower Foothill geomorphic classes. The percentage of the river network falling in the various geomorphological zones are as follows: Mountain Headwater Stream - 0.1% Mountain Stream - 1.5% Transitional – 5.0% Upper Foothills – 38.8% Lower Foothills – 48.7% Lowland River – 5.8%
	EWR sites	N/A
Wetlands	HGM unit type	Total of 102 wetlands mapped; Channelled Valley Bottom Wetlands: 23% Depression Wetlands: 50% Hillslope Seep Wetlands: 25% Unchannelled Valley Bottom Wetlands: 2%
	PES per HGM unit type	Channelled Valley Bottom Wetlands - A/B: 39%; C: 49%; D/E/F: 22%. Depression Wetlands - A/B: 20%; C: 13%; D/E/F: 67%. Hillslope Seep Wetlands - A/B: 31%; C: 38%; D/E/F: 31%. Unchannelled Valley Bottom Wetlands - C: 100%.
	FEPA Wetlands	All of the FEPA wetlands that have been mapped in IUA_T02 are depression wetlands and have been mapped for their endangered threat status.
	Ecosystem Services	**Supply:** Given that there predominant HGM unit types in IUA_T02 are either hillslope seep wetlands or depression wetlands, the regulating services with will be supplied by

Aspect	Status quo	
		these wetlands will generally be characterised by water quality enhancement ecosystem services which result from water passing through the low redox soil environment in seeps and depression wetlands. Hillslope seep wetlands do also generally provide some streamflow regulation services in the dry season and can provide sediment trapping services to some degree as well. **Demand:** Much of the IUA_T02 is characterised by vast areas of rural settlement. These rural settlements are generally characterised by low to medium density rural areas where susbsitence farming and livestock rearing (predominantly cattle and goats) are common practice. Therefore, the demand for ecosystem services will be a mix of provisioning services such as water for human use, grazing areas for livestock and harvestable resources (such as reeds and sedges) for people to use for weaving. In addition, these areas generally produce a lot of sediment so the demand for erosion control and sediment trapping will be high as well.
Groundwater	Aquifer Type	The aquifer is of an intergranular and fractured type associated with the Karoo Supergroup, as well as the presence of dolerite sills and dykes
	Stressed Areas	The IUA is mildly stressed in certain areas
Estuaries	Estuary types	The Mbashe is the only estuary in this IUA and is classified as a Large Fluvially Dominated estuary.
	PES	Present condition of this estuary is a B or largely natural with few changes.
	IES	It is considered an estuary with High Biodiversity Importance. Mangrove species occur but are impacted by harvesting.
	Pressures	This estuary has been rated as receiving a low cumulative level of pressure but impacts from fishing effort and invasive alien fish species have been rated as Very High to High respectively.
Conservation areas/ priority systems/etc.	Dwesa-Cwebe marine protect area	
Water use:		
Major dams	None	
Transfers/ hydro power generation	• Colly Wobbles Hydropower scheme (generates up to 42MW of power) • Flows in the Mbashe are supported through releases from the Ncora Dam (that are transfered from the Kei system to the Mbashe catchment).	

Aspect	Status quo	
Main activities (irrigation, forestry, etc.)	Agriculture: 24% Industry: 9% Domestic: 39% Afforestation: 28%	
Groundwater	The current groundwater use in the IUA is about 0.5Mm^3/annum, of which 95% is for municipal use and 5% is for schedule 1 use	
Water quality:		
Rivers	No routine monitoring data appear to be available on the DWS database, although it is acknowledged that some of this data may be within regional offices databases. This latter data has been requested (if available) through the project management team. The primary river in this catchment is the Lower Mbashe River. The Lower Mbashe passes through mainly rural landscapes, before reaching the coast at Bashee. Water quality may be assumed to be acceptable for most sections of the river, due to low sources of contamination. There are some areas of the IUA that are used for agricultural practises, but even these appear to be small and sparsely located.	
Groundwater	The groundwater quality varies from good to excellent	
Ecosystem services:		
Ecosystem services	**Key Ecosystem Service**	**Key Ecological Infrastructure**
	Provisioning: • Water • Food • Raw materials	• rivers, • wetlands, • ground water
	Regulation: • water regulation • water quantity • erosion control/ soil stability • biological control	• rivers • wetlands
	Cultural: • Ecotourism & recreation • Landscape & amenity values	• Coastline • Dwesa-Cwebe marine protect area
Beneficiaries	• Significance to households that rely on rivers for water provisioning. • Subsistence farming in associated towns and their surroundings • Tourism industry in associated towns and communities	
Impacted sectors	• Subsistence agriculture; tourism; households	

4.18 IUA_T03: Lower Mthatha



Aspect	Status quo	
Overview	This IUA includes the lower Mthatha River reach from Mthatha Dam to the endangered Mthata Estuary. It is highly stressed in the upper parts of the catchment area with the Mthatha Dam (T20B) and releases for the hydropower scheme. This IUA has been identified as the most developed and most stressed from a quality and quantity perspective. Artificial flows occur during the winter periods, because of the hydropower scheme, having a knock-on effect on all aquatic biota.	
Socio-economic profile	The IUA falls within the King Sabata Dalindyebo LM (ward 7-9, 27-29) , Nyandeni LM (ward 9-14, 22-23, 26, 29), and Mhlontlo LM (ward 2, 4-5). The population in 2021 was 505 096, with employment rate at 24%. 33% of the population rely on water resources (mainly rivers) to access basic water services. The main towns in the IUA are Mthata and Mqanduli. The main economic sectors are trade and finance. In terms of agriculture the IUA is supported by subsistence agriculture.	
SWSAs	T20B-G	
Water resource components:		
Rivers	Main rivers	Lower Mthatha
	Quaternaries	T20B-G

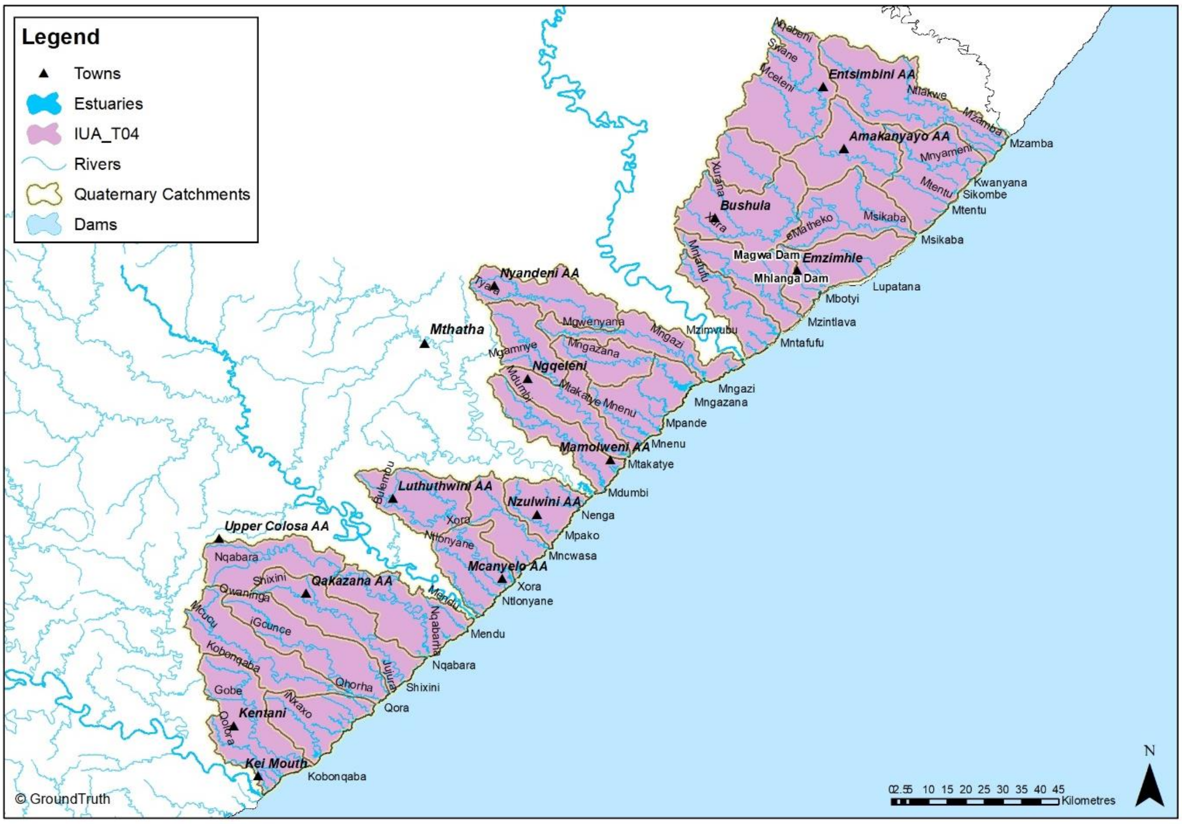
Aspect	Status quo	
	Ecoregion	16_5: South Eastern Uplands (16) ecoregion 16_6: South Eastern Uplands (16) ecoregion 17_1: North Eastern Coastal Belt (17) ecoregion
	PES	Ranges mostly from moderately modified (category C) to largely modified (category D) ecological conditions throughout, with the exception of T20B-06274, T20C-06527 and T20D-06560 categorized as seriously modified (category E) and T20B-06453 and T20B-06477 categorized as severely modified (category F). These categorizations are primarily attributed to some of the reaches being inundated by the Mthatha Dam, upstream urban impacts and high nutrient loads.
	EIS	EI: Low to High ES: Low to High Overall EIS: Mostly Moderate to High
	Fish	Fish Sanctuaries: Support Areas (Ngqwara River, Ngqungqu River)
	Vegetation	Dominant Biome/s: Grassland and Savanna with pockets of Forest Dominant Bioregion/s: Sub-escarpment Grassland and Sub-escarpment Savanna with pockets of Zonal and Intrazonal Forest Threatened Ecosystems: V (Mthatha Moist Grassland, Ngongoni Veld, Transkei Coastal Forest) Threatened / sensitive species: *Crinum moorei* (V), Ilex mitis var. mitis [Decl], *Crinum macowanii* [Decl] Plant Endemism: IUA within Maputaland – Pondoland Region of plant endemism
	Geomorphology	The rivers fall largely in the Upper Foothill and Lower Foothill geomorphic classes. The percentage of the river network falling in the various geomorphological zones are as follows: Mountain Headwater Stream - 0.3% Mountain Stream - 1.3% Transitional – 5.6% Upper Foothills – 46.7% Lower Foothills – 35.2% Lowland River – 10.9%
	EWR sites	Mthatha (T20E and T20G)
Wetlands	HGM unit type	Total of 151 wetlands mapped; Channelled Valley Bottom Wetlands: 21% Depression Wetlands: 50% Hillslope Seep Wetlands: 26% Unchannelled Valley Bottom Wetlands: 3%

Aspect	Status quo	
	PES per HGM unit type	Channelled Valley Bottom Wetlands - A/B: 35%; C: 52%; D/E/F: 13%. Depression Wetlands - A/B: 28%; C: 9%; D/E/F: 63%. Hillslope Seep Wetlands - A/B: 35%; C: 22%; D/E/F: 43%. Unchannelled Valley Bottom Wetlands - C: 50%; D/E/F: 50%.
	FEPA Wetlands	A number of channelled and unchannelled valley bottom wetlands have been given FEPA status in this IUA. These wetlands have been given FEPA status because they are either located within 500m of an important birding locality or due to their critically endangered threat status.
	Ecosystem Services	**Supply:** Given that there predominant HGM unit types in IUA_T03 are either hillslope seep wetlands or depression wetlands, the regulating services with will be supplied by these wetlands will generally be characterised by water quality enhancement ecosystem services which result from water passing through the low redox soil environment in seeps and depression wetlands. Hillslope seep wetlands do also generally provide some streamflow regulation services in the dry season and can provide sediment trapping services to some degree as well. **Demand:** Much of the IUA_T03 is characterised by vast areas of rural settlement. These rural settlements are generally characterised by low to medium density rural areas where susbsitence farming and livestock rearing (predominantly cattle and goats) are common practice. Therefore, the demand for ecosystem services will be a mix of provisioning services such as water for human use, grazing areas for livestock and harvestable resources (such as reeds and sedges) for people to use for weaving. In addition, these areas generally produce a lot of sediment so the demand for erosion control and sediment trapping will be high as well. The wetlands that are located upstream of the Mthatha Dam will have additional streamflow regulation, erosion control and sediment trapping demands for these ecosystem services.
Groundwater	Aquifer Type	The aquifer is of an intergranular and fractured type associated with the Karoo Supergroup, as well as the presence of dolerite sills and dykes
	Stressed Areas	The IUA is moderately stressed in certain areas
Estuaries	Estuary types	The Mthatha estuary is the only estuary in this IUA and is classified as a Predominantly open estuary.
	PES	Present condition of this estuary is a C or Moderately modified. Impacts in the upper catchment and operation of the hydropower scheme are adding to the declining condition.

Aspect	Status quo	
	IES	It is considered an estuary which is important.
	Pressures	This estuary has been rated as receiving a moderate level of pressure. Habitat loss, fishing pressure, mangrove harvesting and sand mining are all threats to the estuary condition.
Conservation areas/ priority systems/etc.	None	
Water use:		
Major dams	Umtata (T2R001), Corana (T2R003)	
Transfers/ hydro power generation	1st and 2nd Falls hydropower (generates up to 6 and 11M of power respectively)	
Main activities (irrigation, forestry, etc.)	Agriculture: 2% Domestic: 91% Afforestation: 6%	
Groundwater	The current groundwater use in the IUA is about 0.9Mm^3/annum, of which 98% is for municipal use and 1.5% is for industrial use	
Water quality:		
Rivers	No routine monitoring data appear to be available on the DWS database, although it is acknowledged that some of this data may be within regional offices databases. This latter data has been requested (if available) through the project management team. The primary river in this catchment is the Lower Mthatha River. The Lower Mthatha flows from the city of Mthatha, through rural landscapes, before reaching the ocean near Coffee Bay. The upper reaches of this section (below the city of Mthatha) are presumed to be highly polluted from poorly maintained sewerage infrastructure and poorly performing WWTW.	
Groundwater	The groundwater quality is good to excellent	
Ecosystem services:		
Ecosystem services	**Key Ecosystem Service**	**Key Ecological Infrastructure**
	Provisioning: • Water • Food	• Umtata dam, • rivers, • estuary, • ground, and surface SWRA, • wetlands
	Regulating: • Water quantity • Water quality • Erosion control • Biological control	• rivers, • wetlands

Aspect	Status quo	
	Cultural: • Ecotourism • Aesthetic appreciation and cultural inspiration	• Estuary • coastline
Beneficiaries	• Significance to rural communities as some households rely on rivers for water provisioning; • Hydropower in the catchment; • Subsistence agriculture (Livestock) associated with the town of Mthata and surroundings; and • Tourism industry in associated towns and communities.	
Impacted sectors	• Agriculture; Manufacturing; Electricity; Tourism; Households.	

4.19 IUA_T04: Pondoland coastal



Aspect	Status quo
Overview	This IUA covers the characteristics, ecoregion and sensitive land use (Pondoland marine protected area, Mkambati Nature Reserve). There are various ecological sensitive rivers and estuaries which have been categorized as endangered in this IUA (namely Ntlonyane, Nkanya, Xora, Bulungula and Nmcwasa estuaries (T80D), Mdumbi, Lwandile, Mtakatye, Mnenu, Mtonga, Mpande, Mngazana, Mngazi (T70B, D, F, G), Nkodusweni, Mntafufu, Mzintlava, Mtentu, Mnyameni and Mzamba (T60A, D, J, K). The IUA further includes free-flowing flagship rivers.
Socio-economic profile	The IUA falls within the Mbashe LM (ward 1-3, 10-12, 18-20, 22-23, 25-30); Mnquma LM (ward 22-28), Port St John LM (ward 10-12, 14-15, 19-20), Nyandeni LM (ward 2, 4, 6-8, 15-21, 24,25,27), Nguquza Hill LM (ward 2,4-7, 10-31), and Mbizana LM. The population in 2021 was 1 044 914 with employment rate of 12%. Approximately 57% of the population rely on water resources (mainly rivers) to access basic water services. The main towns within these respective municipalities are Elliotdale, rural towns, Ngqeleni, Libode, Port St Johns, Bizana and Lusikisiki. The main economic activity is from tourism (mainly along the coast), agriculture and some forestry (near Lusikisiki). Agriculture includes commercial agriculture (maize, soya, sugar beans and other) and subsistence farming in large areas.
SWSAs	SW: T60A–K, T70A–D, F–G, T80A-D, T90B-F Integrated SW-GW: T60F, J, K, T70B, C, T90D,F,G

Aspect	Status quo	
Water resource components:		
Rivers	Main rivers	Mtentu, Msikaba, Mngazi, Mtakatye, Xora, Nqabara, Qhorha
	Quaternaries	T60A-K, T70A-G, T80A-D, T90A-G
	Ecoregion	16_3: South Eastern Uplands (16) ecoregion 16_6: South Eastern Uplands (16) ecoregion 17_1: North Eastern Coastal Belt (17) ecoregion 17_2: North Eastern Coastal Belt (17) ecoregion
	PES	Ranges mostly from unmodified (category A) to largely modified (category D) ecological conditions throughout.
	EIS	EI: Moderate to High ES: Moderate to High Overall EIS: Moderate to High
	Fish	Fish Sanctuaries: Priority Area (Nqabarha River, Mbhanyana River, Mncwasa River, Mpako River, Mtakatye River, Mngazi River, Mntafufu River, Msikaba River, Mtentu River, Mnyameni River, Kulumbe River) Fish Sanctuaries: Support Areas (Bulumba River, Mgwenyana River, Xura River, Mnyameni River
	Flagship free-flowing rivers	Flagship free-flowing rivers (Kobonqaba River, Nqabarha River, Mtakatye River, Mtentu River)
	Vegetation	Dominant Biome/s: Savanna, Grassland and Indian Ocean Coastal Belt, with pockets of Forest Dominant Bioregion/s: Sub-escarpment Grassland and Sub-escarpment Savanna with Indian Ocean Coastal Belt and pockets of Zonal and Intrazonal Forest Threatened Ecosystems: E (Kobonqaba Forest Complex, Mangrove Forest, Mount Thesiger Forest Complex); V (Midlands Mistbelt Grassland, Mthatha Moist Grassland, Ngongoni Veld, Pondoland Scarp Forest, Transkei Coastal Forest) Threatened / sensitive species: *Impatiens flanaganiae* (V), *Maytenus oleosa* (V), *Eugenia simii* (V), *Jubaeopsis caffra* (V), *Gymnosporia bachmannii* (V), *Crinum moorei* (V), *Umtiza listeriana* (V), *Syzygium pondoense* (Rare), Sensitive (*Prionium serratum*), Ilex mitis var. mitis [Decl], *Gunnera perpensa* [Decl], *Crinum macowanii* [Decl] Plant Endemism: IUA within Maputaland – Pondoland Region of plant endemism
	Geomorphology	The rivers fall largely in the Upper Foothill geomorphic class. The percentage of the river network falling in the various geomorphological zones are as follows:

Aspect	Status quo	
		Mountain Headwater Stream - 0.7% Mountain Stream - 2.7% Transitional – 9.2% Upper Foothills – 63.5% Lower Foothills – 23.8% Lowland River – 0.1%
	EWR sites	Mzamba (T60A), Mtentu (T60C), Msikaba (T60E and T60G), Xura (T60F), Coastal Mzintlava (T60J), Mtanfufu (T60K), Mngazi (T70A), Mtakatye (T70E), Nenga, Mpako and Nzulwini (T80A), Xora (T80C), Mbanyana (T80D), Nqabara (T90B)
Wetlands	HGM unit type	Total of 562 wetlands mapped; Channelled Valley Bottom Wetlands: 36% Depression Wetlands: 28% Floodplain Wetlands: 1% Hillslope Seep Wetlands: 23% Unchannelled Valley Bottom Wetlands: 12%
	PES per HGM unit type	Channelled Valley Bottom Wetlands - A/B: 31%; C: 41%; D/E/F: 28%. Depression Wetlands - A/B: 13%; C: 11%; D/E/F: 76%. Floodplain Wetlands - A/B: 57%; C: 29%; D/E/F: 14%. Hillslope Seep Wetlands - A/B: 37%; C: 25%; D/E/F: 38%. Unchannelled Valley Bottom Wetlands - A/B: 42%; C: 33%; D/E/F: 24%.
	FEPA Wetlands	Multiple wetlands have been given FEPA status in IUA_T04 – predominantly for the fact that they are important crane breeding for feeding wetlands.
	Ecosystem Services	**Supply:** Given the wide range of wetland types across these four catchments, the supply of ecosystem services will be spread fairly evenly across the type of ecosystem services. As such it is envisaged that the wetlands across this IUA will supply flood attenuation, sediment trapping, erosion control, carbon storage, water quality enhancement, provisioning and cultural and recreational services. **Demand:** Again, much of the IUA_T04 is characterised by vast areas of rural settlement. These rural settlements are generally characterised by low to medium density rural areas where susbsitence farming and livestock rearing (predominantly cattle and goats) are common practice. Therefore, the demand for ecosystem services will be a mix of provisioning services such as water for human use, grazing areas for livestock and harvestable resources (such as reeds and sedges) for people to use for weaving. In addition, these areas generally produce a lot of sediment so the demand for erosion control and sediment trapping will be high as well. However, many of the river systems that run through these catchments enter the Indian Ocean through important and intact estuaries. Therefore, the demand

Aspect	Status quo	
		for water quality enhancement services as well as sediment trapping services are high in this IUA.
Groundwater	Aquifer Type	The aquifer is of an intergranular and fractured type associated with the Karoo Supergroup, as well as the presence of dolerite sills and dykes
	Stressed Areas	There are no stressed areas in the IUA
Estuaries	PES	There are a number of estuaries within this IUA totalling 62. Most of these are in good condition and are rated as Natural to Near Natural (either category A or A/B or category B). Only two estuaries are rated as moderately modified (category C). Sensitive estuaries occur within this IUA. These include Ntlonyane, Nkanya, Xora, Bulungula and Nmcwasa estuaries (T80D), Mdumbi, Lwandile, Mtakatye, Mnenu, Mtonga, Mpande, Mngazana, Mngazi (T70B, D, F, G), Nkodusweni, Mntafufu, Mzintlava, Mtentu, Mnyameni and Mzamba (T60A, D, J, K).
	Estuary types	Most of the estuaries in this IUA fall into either the small or large Temporarily closed estuary type. Seven are characterised as predominantly open.
	IES	The Mngazana and the Xora estuaries have the highest biodiversity rating which is echoed in the linkages scores for these systems. Linkages with other important areas are noted for the Nquabarha, iNxaxo, and Kobonquaba as well.
	Pressures	All estuaries in this IUA are considered to have very low pressures or impacts with the Mtentwana and Nenga being exception to this with a moderate pressure rating.
Conservation areas/ priority systems/ etc.	Pondoland protected area Dwesa-Cwebe protected area	
Water use:		
Major dams	Magwa (T6R001), Mlanga (T7R001), Bulolo	
Transfers/ hydro power generation	None	
Main activities (irrigation, forestry, etc.)	Agriculture: 5% Industry: 1% Domestic: 57% Afforestation: 26% Alien Veg: 11%	
Groundwater	The current groundwater use in the IUA is about 1.9Mm^3/annum, of which 90% is for municipal use, 6% is for industrial use and 1.5% is for livestock watering.	

Aspect	Status quo	
Water quality:		
Rivers	No routine monitoring data appear to be available on the DWS database, although it is acknowledged that some of this data may be within regional offices databases. This latter data has been requested (if available) through the project management team. The primary rivers in this catchment are the Mtentu, Msikaba, Mngazi, Mtakatye, Xora, Nqabara and Qhorha Rivers. A large number of small rural settlements are located alongside many of the rivers within this region, and rely on this water provided by these rivers. As such, sources of contamination may be low, but there is a large reliance on the rivers nonetheless. It is therefore recommended that river quality investigations be conducted for selected rivers, to determine the extent of contamination, if any.	
Groundwater	The groundwater quality is excellent	
Ecosystem services:		
Ecosystem services	**Key Ecosystem Service**	**Key Ecological Infrastructure**
	Provisioning: • Water • Food • Raw materials	• rivers, • wetlands, • ground-surface water SWRA
	Regulation: • water regulation • water quantity • erosion control/ soil stability • biological control	• rivers • wetlands • forestry
	Cultural: • Ecotourism & recreation • Landscape & amenity values	• Pondoland protected area • Dwesa-Cwebe protected area • coastlines
Beneficiaries	• Significance to households that rely on rivers for water provisioning; • Significant subsistence agriculture in associated towns and their surroundings; and • Tourism industry in associated towns and communities.	
Impacted sectors	• Tourism; households, and forestry.	

5. SUMMARY OF KEY IMPACTS PER IUA

Based on (i) the assessment of information and review of data availability and (ii) the status quo per IUA, the following key impacts (Table 5-1) were identified to be considered and addressed during the project to enable the determination of the Water Resource Classes, the Reserve and associated RQOs in the study area.

Table 5-1: Summary of key impacts per IUA

IUA	Component	Key water uses and impacts
IUA_K01	Wetlands	Large percentage (44%) of channelled valley botom wetlands in a D/E/F present state.
	Rivers	Kromriver Dam in K90B with extensive water use in most of the IUA for irrigation and transfers to Gqerberha. Forestry in the uppaer parts of the catchments. Some water quality impacts from local WWTW and irrigation, especially in the smaller coastal systems.
	Groundwater	Large percentage of total groundwater use is for irrigation (78%).
	Estuaries	Localised flow and quality impacts
IUA_KL01	Wetlands	Large percentage of all wetland types in D/E/F present state: Channelled Valley Bottom: 36% Depression: 43.5% Hillslope Seep: 50% Unchannelled Valley Bottom: 28%
	Rivers	Mpofu Dam on lower Krom River to supply water to irrigators and domestic and transfers to Gqerberha. Large percentage of water is used for irrigation (46%). Poor water quality in the lower reaches of the Gamtoos River, mainly due to irrigation.
	Groundwater	Large percentage of total groundwater use is for irrigation (57%) and 26% for municipal use. Groundwater qualities are good to marginal.
	Estuaries	High pressures on the Kromme, Kabeljous and Seekoei estuaries and low to moderate pressures for the rest of the systems owing to flow and quality, including some habitat loss in the Seekoei.
IUA_L01	Wetlands	Percentage per wetland types in D/E/F present state: Channelled Valley Bottom: 16% Depression: 10% Hillslope Seep and Unchannelled Valley Bottom wetlands still in fairly good present states.

IUA	Component	Key water uses and impacts
	Rivers	Kouga and Haarlem Dams are situated in this IUA to provide water for mainly irrigation as well as domestic. Irrigation use of water is 14% of total use with 15% being used by alien vegetation. Localised water quality impacts due to irrigation and small towns.
	Groundwater	90% of total groundwater use is for irrigation.
IUA_M01	Wetlands	Large percentage of wetlands per types in D/E/F present state: Channelled Valley Bottom: 36% Depression: 47% Floodplain: 75% Hillslope Seep: 55% Unchannelled Valley Bottom: 41% Wetland Flat: 55%.
	Rivers	Domestic water use is high (74%) as it is part of the Algoa WSS, with limited irrigation and forestry use. Water quality for some of the rivers is poor (Swartkops, Coega) due to WWTW or the salt pans.
	Groundwater	51% of the total groundwater use is for irrigation with 41% for domestic and industrial use.Stressed to an extent in some areas. Groundwater quality is ranging from good to marginal.
	Estuaries	High pressures (Bakens, Papkuils, Coega) due to flow modifications, habitat loss and pollution.
IUA_LN01	Wetlands	Most of the wetlands types occurring in this IUA is still in a good present state with limited impacts resulting in a D/E/F PES. Channelled Vally Bottom wetlands are the most impacted with 20% in a PES of D or lower.
	Rivers	A number of dams (mostly small) except for Darlington Dam in this IUA. Irrigation is the largest water user (58%). Water quality ranges from fairly good to poor in this IUA with some localised impacts from WWTW.
	Groundwater	65% of groundwater use is for irrigationand 31% for domestic. A number of towns in this area is solely dependant on groundwater with no other sources available. Localised poor groundwater qualities in the IUA.
IUA_N01	Wetlands	Percentage per wetland types in D/E/F present state: Channelled Valley Bottom: 29% Depression: 10% Hillslope Seep: 50% Unchannelled Valley Bottom: 67% Wetland Flat: 14%

IUA	Component	Key water uses and impacts
	Rivers	Sundays River impacted by the releases from Darlington Dam for irrigation. Irrigation and domestic water use is 24% and 21% respectively of the total water use. Water quality impacts along mainstem Sundays River due to extensive irrigation and localised at WWTW.
	Groundwater	Minimal groundwater use for irrigation, industrial and domestic.
	Estuaries	Moderate pressures, mainly pollution.
IUA_P01	Wetlands	Percentage per wetland types in D/E/F present state: Channelled Valley Bottom: 22% Depression: 16% Floodplain: 18% Hillslope Seep: 50%
	Rivers	A number of dams are situated on these smaller systems in this IUA. Water use is mainly for irrigation (16%) and domestic (9%). Alien vegetation is a large water user with 58% of the total water use in this IUA. Water quality is in general poor in this IUA and can be linked in most cases to WWTW.
	Groundwater	70% of the total groundwater use is for municipal and 15% for irrigation. Water quality is mostly good in this IUA.
	Estuaries	Low to moderate pressures due to flow modification, localised habitat loss and fish (efforts and alien).
IUA_Q01	Wetlands	Percentage per wetland types in D/E/F present state: Channelled Valley Bottom: 37% Depression: 6% Hillslope Seep: 43% Unchannelled Valley Bottom: 67%
	Rivers	Water use is mainly for irrigation (21%) and domestic (8%). Limited water quality data, but available information indicates poor water quality in most of the rivers.
	Groundwater	The IUA is moderately to highly stressed in some areas with 57% of the total groundwater use is for irrigation purposes and 30% for domestic.
IUA_Q02	Wetlands	Percentage per wetland types in D/E/F present state: Channelled Valley Bottom: 21% Depression: 27% Hillslope Seep: 23% Unchannelled Valley Bottom: 33%

IUA	Component	Key water uses and impacts
	Rivers	A number of dams and large weirs in this IUA, mainly associated with the transfer of water from the Orange River to the Great Fish. The bulk of the water is used for irrigation (30%) and the rest is transferred to the Little Fish and Sundays Rivers and to the Algoa WSS. Water quality is mainly acceptable, with some areas with unacceptable EC and pH levels.
	Groundwater	Some stressed groundwater areas in this IUA due to water use, mainly for irrigation in those areas not linked to the transfer scheme.
	Estuaries	Moderate pressures due to alien invasive fish species (very high), pollution and fishing effort.
IUA_Q03	Wetlands	Percentage per wetland types in D/E/F present state: Channelled Valley Bottom: 65% Depression: 9% Floodplain: 50% Hillslope Seep: 44% Unchannelled Valley Bottom: 19%
	Rivers	Kat River Dam is situated in this IUA for mainly irrigation water supply. Irrigation (41%) and forestry (11%) are the main water users in this catchment. Water quality acceptable, with localised areas of poor quality due to WWTW and irrigation.
	Groundwater	Groundwater use is limited in this IUA.
IUA_R01	Wetlands	Percentage per wetland types in D/E/F present state: Channelled Valley Bottom: 48% Depression: 43% Floodplain: 50% Hillslope Seep: 68% Unchannelled Valley Bottom: 71%
	Rivers	A number of dams are situated in this IUA for irrigation (32%) and municipal (30%) water supply. Forestry is present in the upper reaches of the rivers in this IUA. Limited data available on water quality.
	Groundwater	Groundwater use in this IUA is limited.
	Estuaries	Mostly low pressures. Keiskamma has low pressures although with high fishing effort and alien invasive fish species.
IUA_R02	Wetlands	Percentage per wetland types in D/E/F present state: Channelled Valley Bottom: 42% Depression: 37% Floodplain: 100%

IUA	Component	Key water uses and impacts
		Hillslope Seep: 49% Unchannelled Valley Bottom: 33%
	Rivers	A number of dams in this IUA on the Buffalo and Nahoon Rivers, mainly for water upply to East London and surrounding areas with 56% of domestic and 30% of irrigation use. Some forestry in the upper reaches of the rivers. Water is transferred from Wriggleswade Dam (Kei system) to this IUA. Limited water quality data available, but possible quality impacts due to large urban areas and industrial activities.
	Groundwater	Some stressed groundwater areas, although limited water use from groundwater.
	Estuaries	Mostly low pressures. Except, the Buffalo, Blind and Hlaze systems: high pressures due to flow modification, pollution and alien invasive fish species (Buffalo)
IUA_S01	Wetlands	Percentage per wetland types in D/E/F present state: Channelled Valley Bottom: 28% Depression: 22% Floodplain: 43% Hillslope Seep: 22% Unchannelled Valley Bottom: 25%
	Rivers	A number of dams for rural/ domestic (34%) and irrigation (15%) water supply. Large areas of alien vegetation (17%) of water use. Hydropower associated with the Ncora Dam and water transfer to the upper Mbashe River. Limited water quality data available. Localised impacts might occur linked to WWTW.
	Groundwater	Groundwater use is mostly for domestic/ rural water supply.
IUA_S02	Wetlands	Percentage per wetland types in D/E/F present state: Channelled Valley Bottom: 37% Depression: 15% Floodplain: 67% Hillslope Seep: 31% Unchannelled Valley Bottom: 17%
	Rivers	A number of dams, mainly for irrigation (27%) and domestic (17%) purposes. Limited water quality data available. Localised impacts might occur linked to WWTW.
	Groundwater	Limited groundwater use, although some stressed areas in this IUA.

IUA	Component	Key water uses and impacts
IUA_S03	Wetlands	Percentage per wetland types in D/E/F present state: Channelled Valley Bottom: 24% Depression: 60% Floodplain: 60% Hillslope Seep: 23% Unchannelled Valley Bottom: 36%
	Rivers	A number of large dams for irrigation (58%) and domestic (13%) water supply. Both forestry and alien vegetation water use is 10%. Water is transferred fronm the Wriggleswade Dam to the Buffalo River in R20 catchment (IUA_R02). Limited water quality data available. Localised impacts might occur linked to WWTW.
	Groundwater	Limited groundwater use, but some stressed areas in this IUA
	Estuaries	Moderate pressures due to flow modification, alien invasive fish species and high fishing effort pressure.
IUA_T01	Wetlands	Percentage per wetland types in D/E/F present state: Channelled Valley Bottom: 23% Depression: 33% Floodplain: 57% Hillslope Seep: 12% Unchannelled Valley Bottom: 15%
	Rivers	Forestry (58%)is the largest water user, with domestic (20%) and Irrigation (10%). Limited water quality data available. Localised impacts might occur linked to WWTW.
	Groundwater	Limited groundwater use in this IUA, but some highly stressed groundwater areas.
IUA_T02	Wetlands	Percentage per wetland types in D/E/F present state: Channelled Valley Bottom: 22% Depression: 67% Hillslope Seep: 31%
	Rivers	No major dams in this IUA, but transfers from Ncora Dam (Kei system) and hydropower scheme at Colly Wobbles in the Mbashe River. Forestry (28%) and domestic (39%) water uses are the largest in this IUA. Limited water quality data available, but seems to be acceptable due to limited water use.
	Groundwater	Limited groundwater use.

IUA	Component	Key water uses and impacts
	Estuaries	Low pressures, although with very high fishing effort and some alien invasive fish species.
IUA_T03	Wetlands	Percentage per wetland types in D/E/F present state: Channelled Valley Bottom: 13% Depression: 63% Hillslope Seep: 43% Unchannelled Valley Bottom: 50%
	Rivers	Major dam on the mainstem Mthatha River and hydropower scheme downstream of the dam. The main water use in this IUA is domestic water supply (91%) for Mthatha and surrounding areas. Water quality impacts associated with the WWTW.
	Groundwater	Limited groundwater use.
	Estuaries	Moderate pressures due to high pollution, fishing effort and very high alien invasive fish species.
IUA_T04	Wetlands	Percentage per wetland types in D/E/F present state: Channelled Valley Bottom: 28% Depression: 76% Floodplain: 14% Hillslope Seep: 38% Unchannelled Valley Bottom: 24%
	Rivers	Only small dams for domestic/ rural water supply. Domestic/ rural (57%) water supply the largest, with water use by forestry (26%) and alien vegetation (11%). Limited water quality data available, but localised impacts might occur.
	Groundwater	Limited groundwater use.
	Estuaries	Mostly low pressures. Moderate pressures on the Nenga and Mtentwana estuaries due to high habitat loss, moderate pollution and fishing efforts.

6. CONCLUSIONS

This report forms part of step 2 of the integrated framework as developed by the DWS (DWS, 2017). The purpose of this report was to define the current status of the water resources in the study area in terms of the (i) water resources infrastructure (dams, transfers, water use, and weirs), (ii) the ecological and ecosystem characteristics of the rivers, wetlands, estuaries and groundwater, (iii) the water quality impacts on the water resources and (iv) the socio-economic condition, community well-being and ecosystem services and attributes.

IUAs are spatial units consisting of significant water resources for which Water Resource Classes are determined. The delineation of a larger catchment into IUAs is done primarily according to a number of socio-economic criteria and the boundaries of water resource components or catchments, taking into consideration the ecological information and biophysical characteristics.

A total of 19 Integrated Units of Analysis (IUAs) were identified for this study, which were described in terms of their status quo per component within each IUA. The IUA delineation was based on the information and data available from the assessment that formed part of the gaps analysis task (DWS, 2022). The data and information availability from previous studies, the various monitoring databases and GIS spatial layers for the study area and expert judgement were used to delineate the IUAs.

The approach that was used for the delineation of the 19 IUAs was based on:

- the WRCS Guidelines, Volumes 1 and 2 (Overview and the 7-step classification procedure and ecological, hydrological and water quality guidelines for the 7-step classification procedure) (DWA, 2007b); and
- the development of procedures to operationalise Resource Directed Measures (chapter 6, Integrated Step 2) (DWS, 2017).

The 19 IUAs identified are as follows:

IUA	IUA code	Description	Main rivers, estuaries*	Quaternary Catchments
1	IUA_K01	Tsitsikamma and headwaters of Kromme to Kromme Dam	Tsitsikamma, upper Kromme	K80A-F, K90A-B
2	IUA_KL01	Kromme from Kromme Dam to estuary and Gamtoos	Kromme, Gamtoos	K90C-G, L90A-C

IUA	IUA code	Description	Main rivers, estuaries*	Quaternary Catchments
3	IUA_L01	Kouga to Kouga Dam, Baviaanskloof	Kouga, Baviaanskloof	L81A-D, L82A-J
4	IUA_M01	M primary catchment	Swartkops, Coega	M10A-D, M20A-B, M30A-B
5	IUA_LN01	Groot to Kouga confluence, Upper Sundays to Darlington Dam	Sout, Kariega, Groot, Upper Sundays	L11A-G, L12A-D , L21A-F, L22A-D, L23A-D, L30A-D, L40A-B, L50A-B, L60A-B, L70A-G, N11A-B, N12A-C, N13A-C, N14A-D, N21A-D, N22A-E, N23A-B, N24A-D, N30A-C
6	IUA_N01	Sundays downstream Darlington Dam	Lower Sundays	N40A-F
7	IUA_P01	P primary catchment	Boesmans, Kowie, Kariega	P10A-G, P20A-B, P30A-C, P40A-D
8	IUA_Q01	Fish	Little Brak, Upper Great Fish, Upper Little Fish	Q11A-D, Q14A-E, Q21A-B, Q22A-B, Q30A-B, Q80A-C
9	IUA_Q02	Great Fish	Great Fish, Tarka, Baviaans, Lower Little Fish	Q12A-C, Q13A-C, Q30C-E, Q41A-D, Q42A-B, Q43A-B, Q44A-C, Q50A-C, Q60A-C, Q70A-C, Q80D-G, Q91A-C, Q93A-D
10	IUA_Q03	Koonap and Kat	Koonap, Kat	Q92A-G, Q94A-F

IUA	IUA code	Description	Main rivers, estuaries*	Quaternary Catchments
11	IUA_R01	Keiskamma	Keiskamma, Tylomnqa	R10A-M, R40A-C, R50A-B
12	IUA_R02	Buffalo/ Nahoon	Baffalo, Nahoon, Kwelera, Gqunube	R20A-G, R30A-F
13	IUA_S01	Upper Great Kei	Indwe, White Kei, Tsomo, Great Kei	S10A-J, S20A-D, S40A-F, S50A-J
14	IUA_S02	Black Kei	Klipplaat, Klaas Smits, Black Kei	S31A-G, S32A-M
15	IUA_S03	Lower Great Kei	Kubusi, Great Kei	S60A-E, S70A-F
16	IUA_T01	Upper Mbashe, Upper Mthatha	Xuka, Mgwali, Upper Mbashe, Upper Mthatha	T11A-H, T12A-G, T20A
17	IUA_T02	Lower Mbashe	Lower Mbashe	T13A-E
18	IUA_T03	Lower Mthatha	Lower Mthatha	T20B-G
19	IUA_T04	Pondoland coastal	Mtentu, Msikaba, Mngazi, Mtakatye, Xora, Nqabara, Qhorha	T60A-K, T70A-G, T80A-D, T90A-G

The selection and evaluation of Resource Units (RU) to select priority RUs per water resource component, including integration between these components, and to identify biophysical nodes and hotspots (stressed RUs) will be undertaken per IUA as the next step.

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8. APPENDICES

Appendix A: Figures for the study area

Appendix B: Socio-Economics

Appendix C: Water Resource Infrastructure

Appendix D: Groundwater

Appendix A: Study area

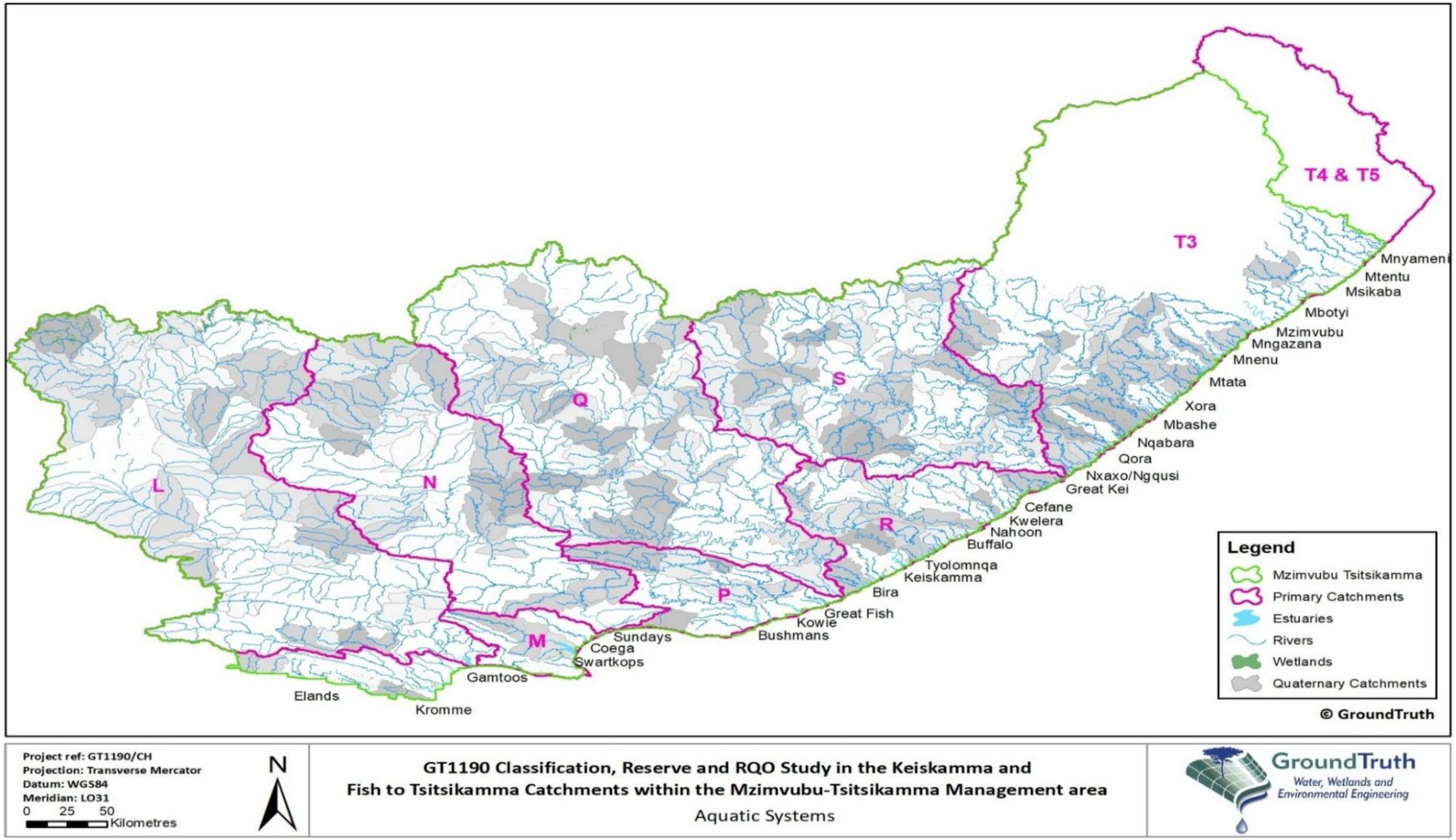

Figure 8-1: Study area of the Keiskamma, Fish to Tsitsikamma

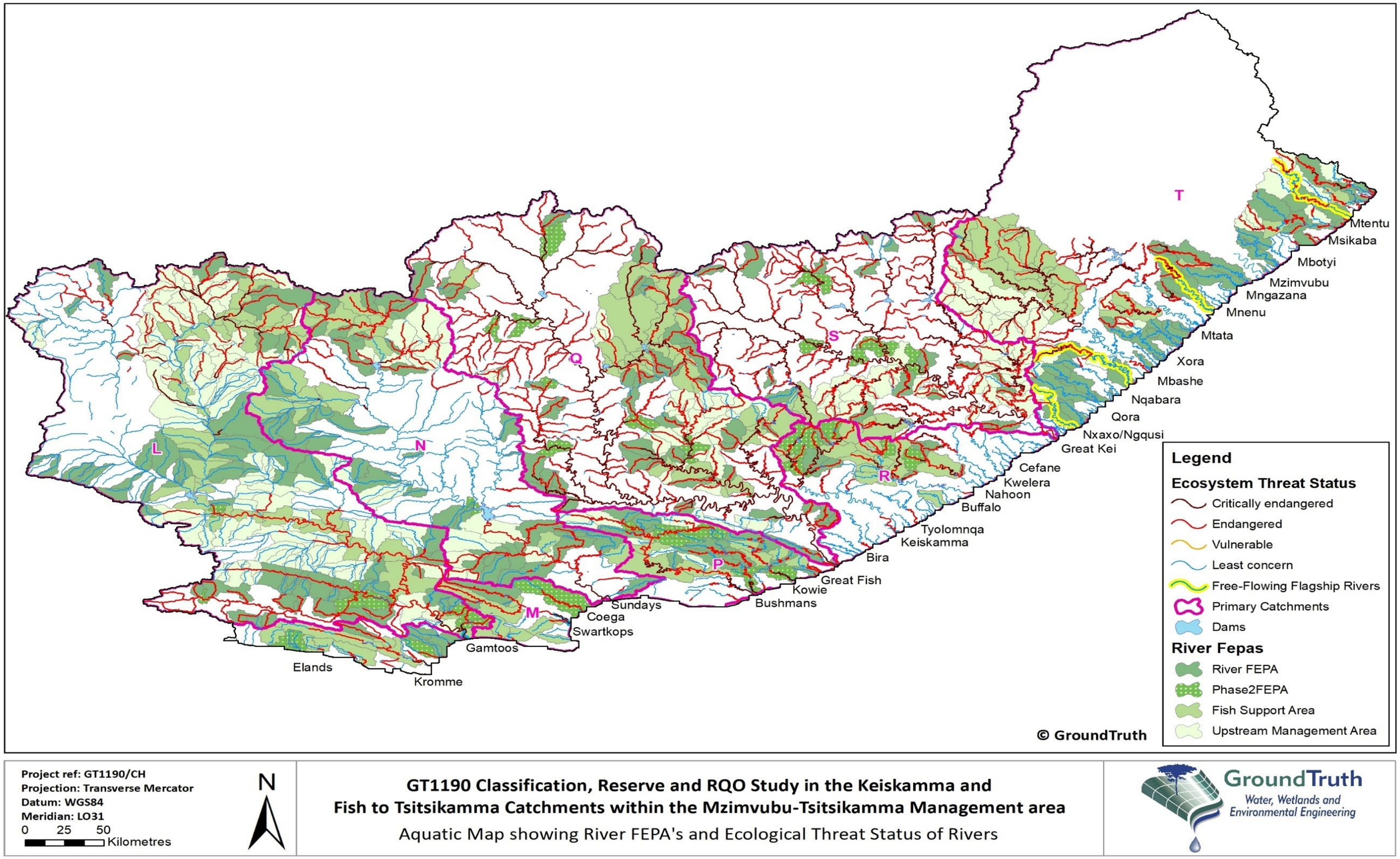

Figure 8-2: Ecosystem threat status (aquatics)

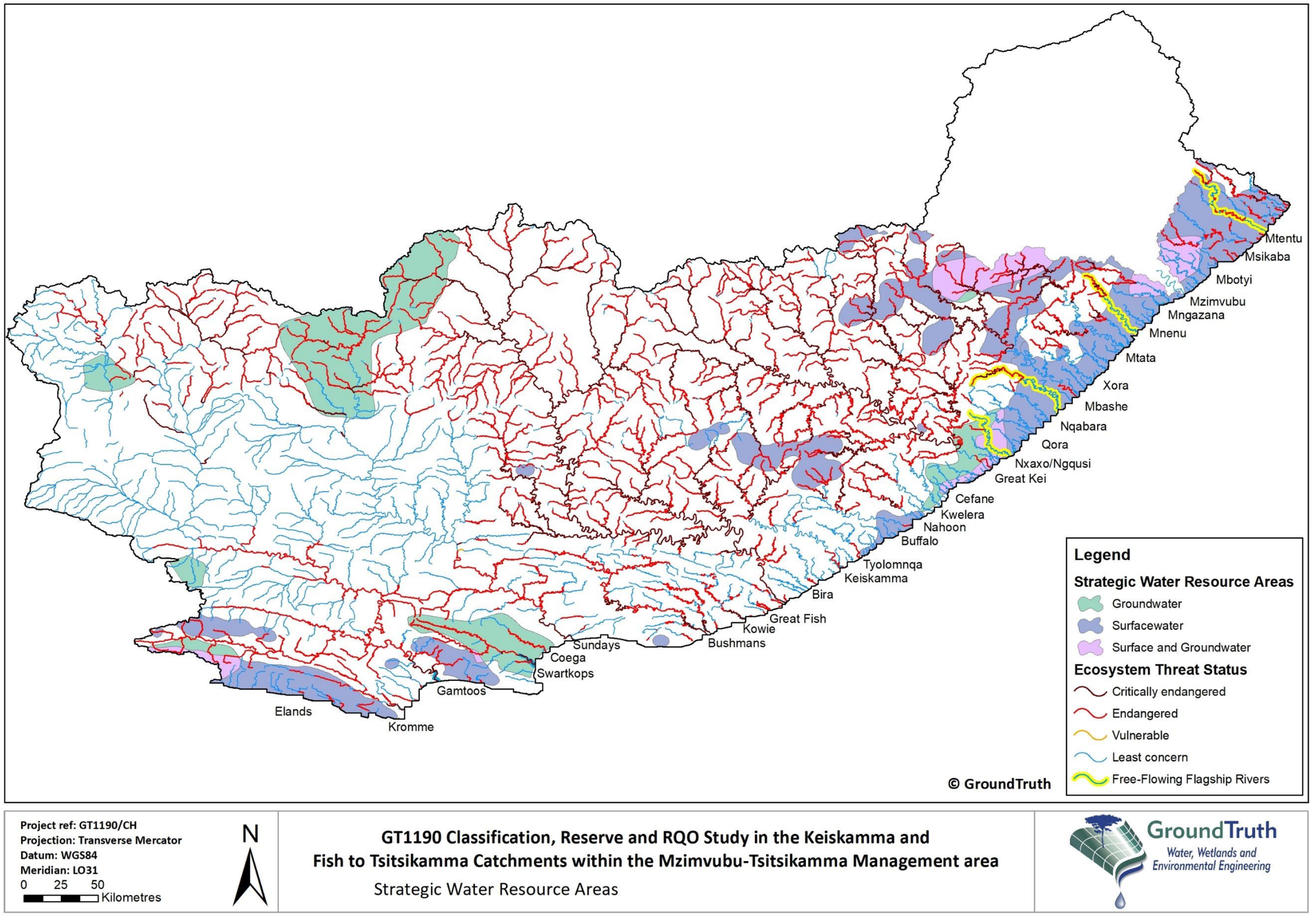

Figure 8-3: Strategic Water Source Areas (Lötter & Maitre, 2021)

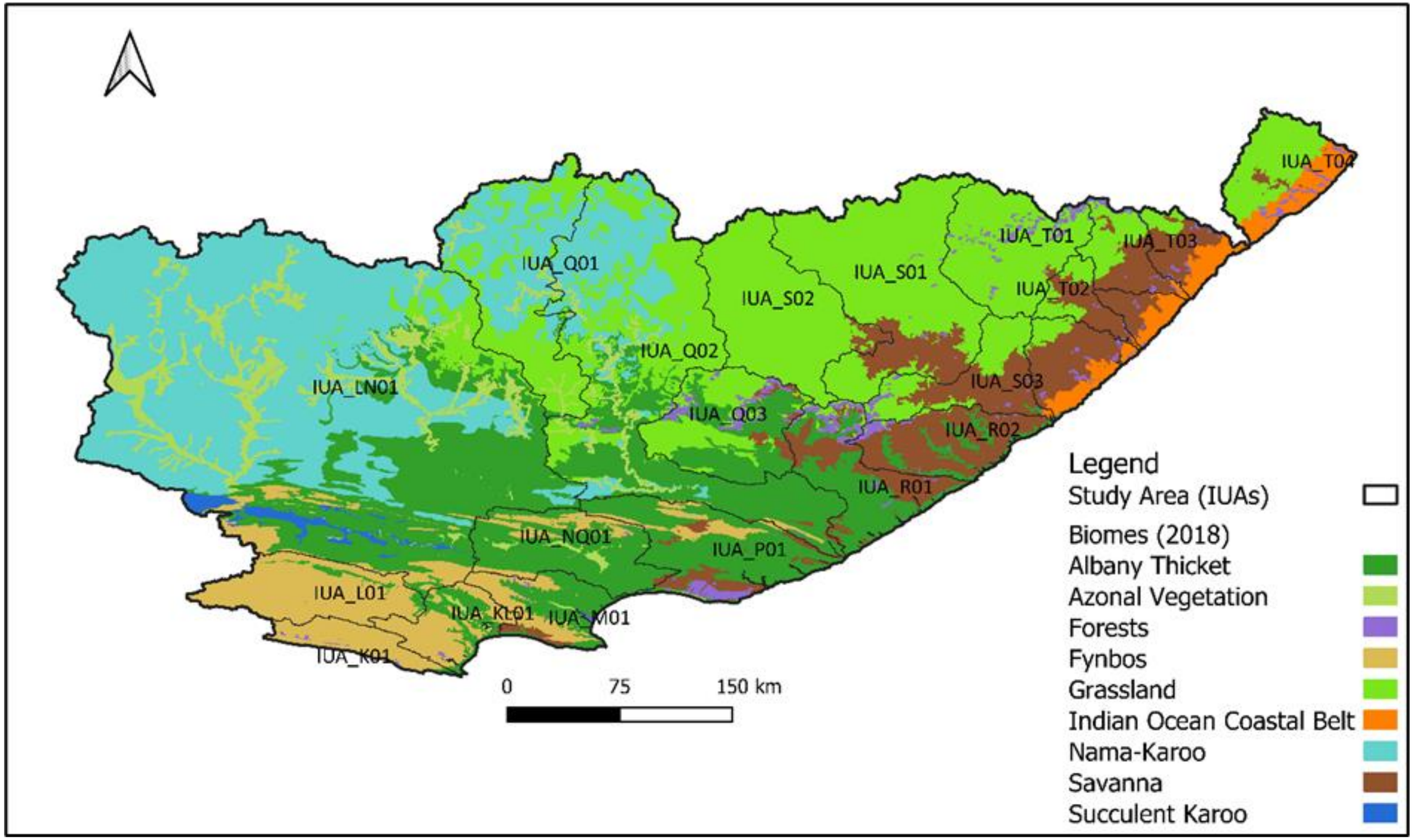

Figure 8-4: Vegetation Biomes within the IUAs of the study area (from Mucina & Rutherford, 2018 update)

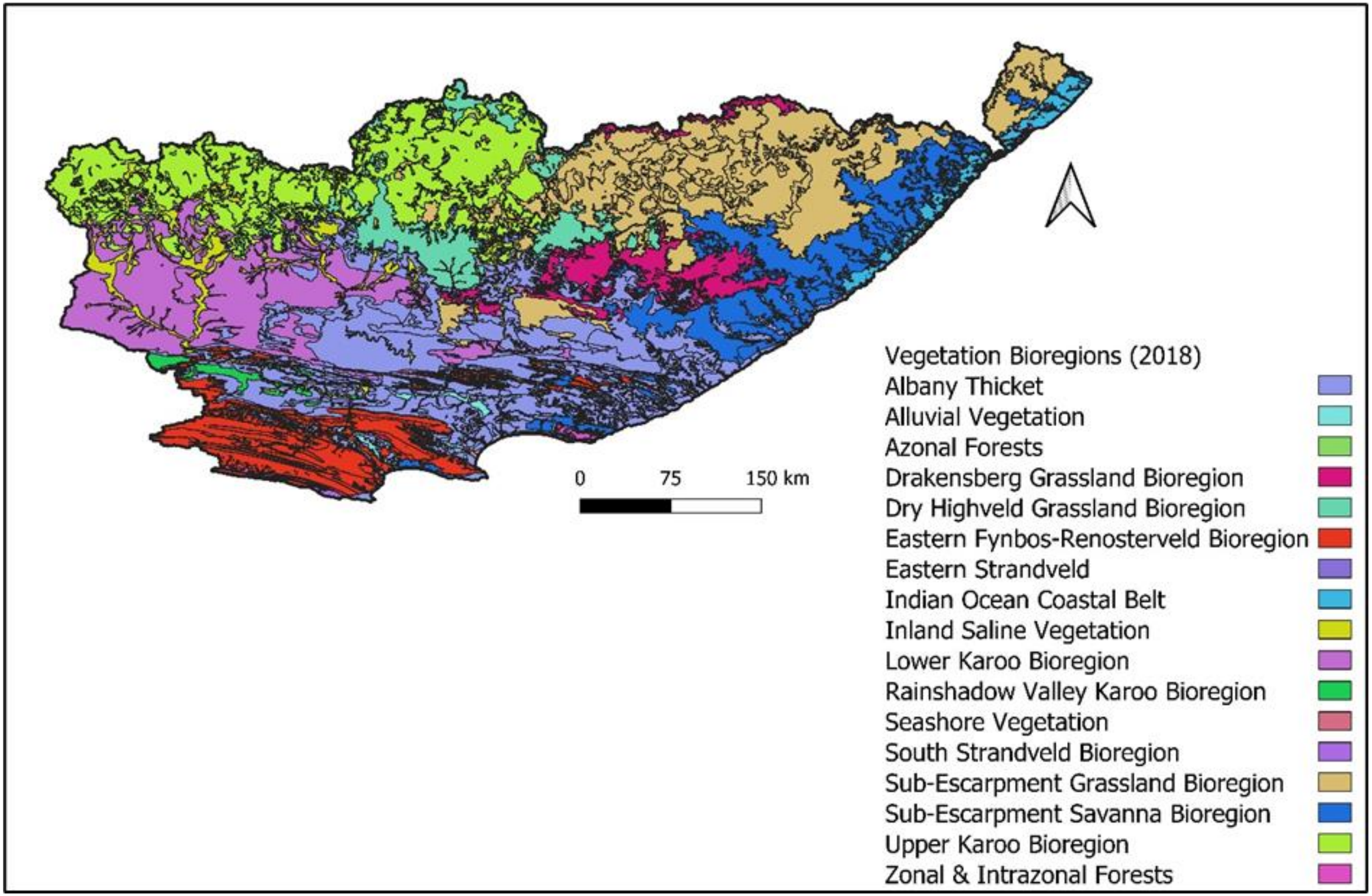

Figure 8-5: Vegetation Bioregions within the study area (from Mucina & Rutherford, 2018 update)

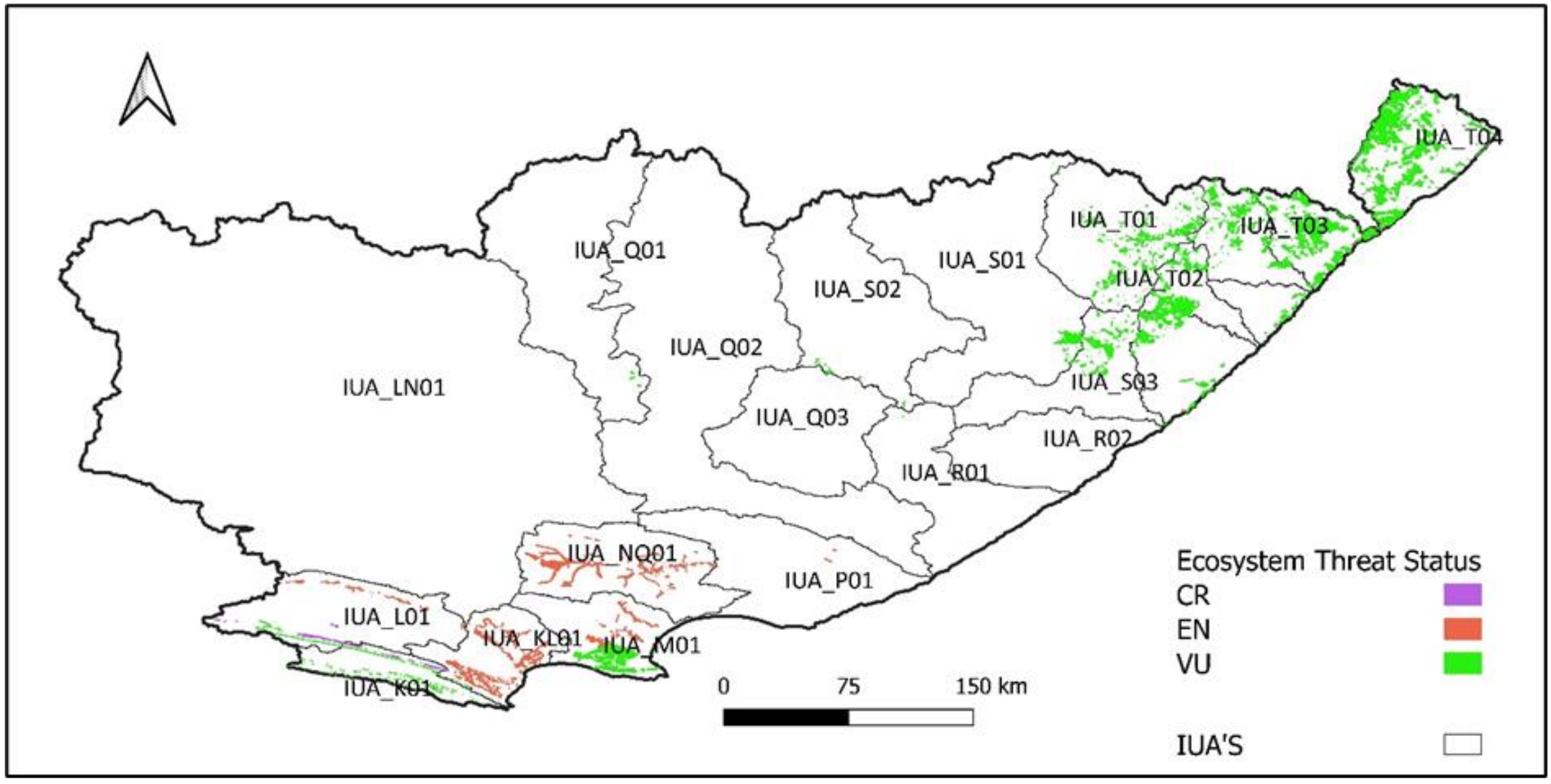

Figure 8-6: Map of threatened ecosytems in relation to IUAs within the study area (SANBI, 2011, remaining extent of natural vegetation)

Appendix B Socio-Economics

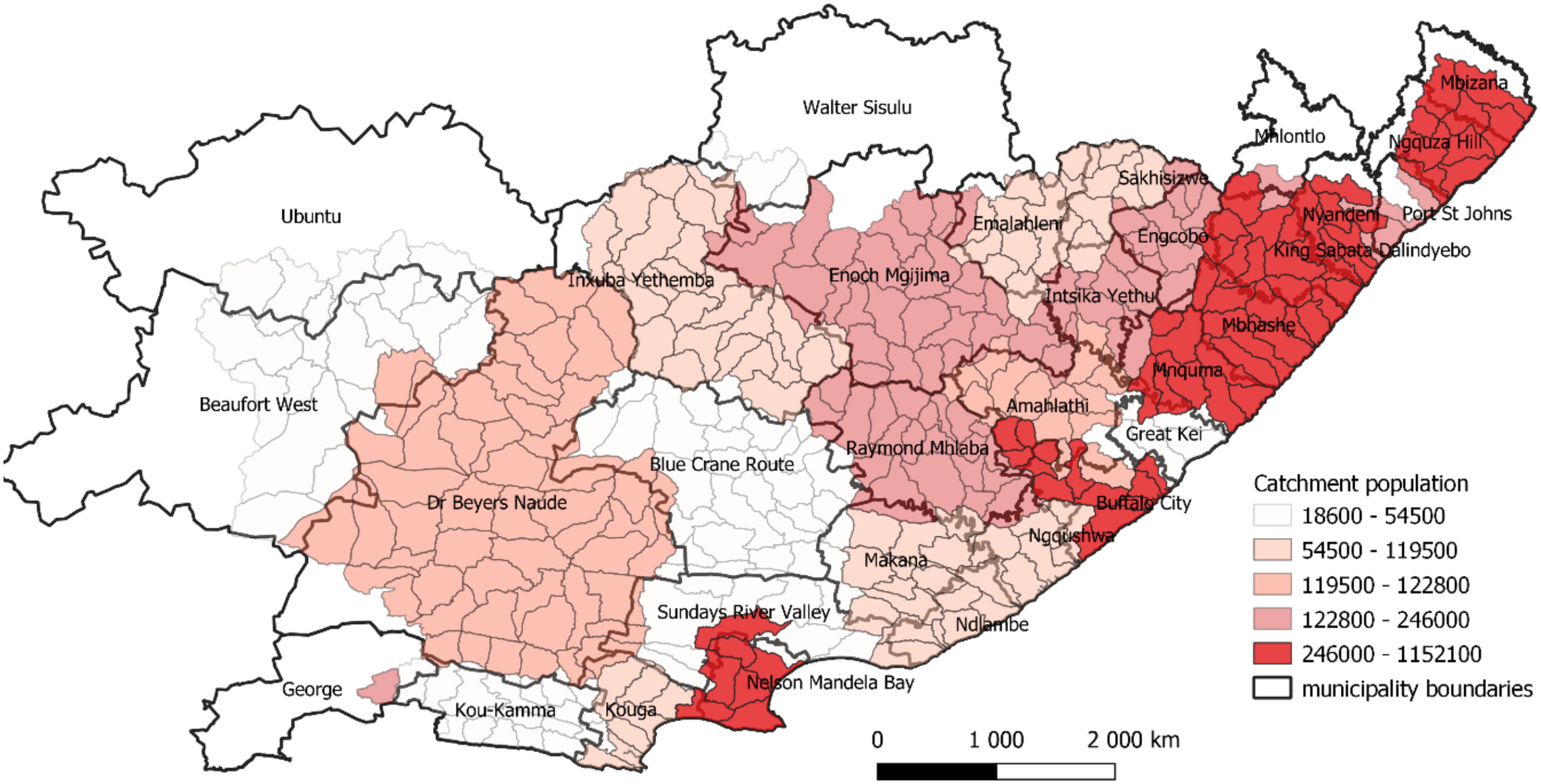

Figure 8-7: Population density of the study area

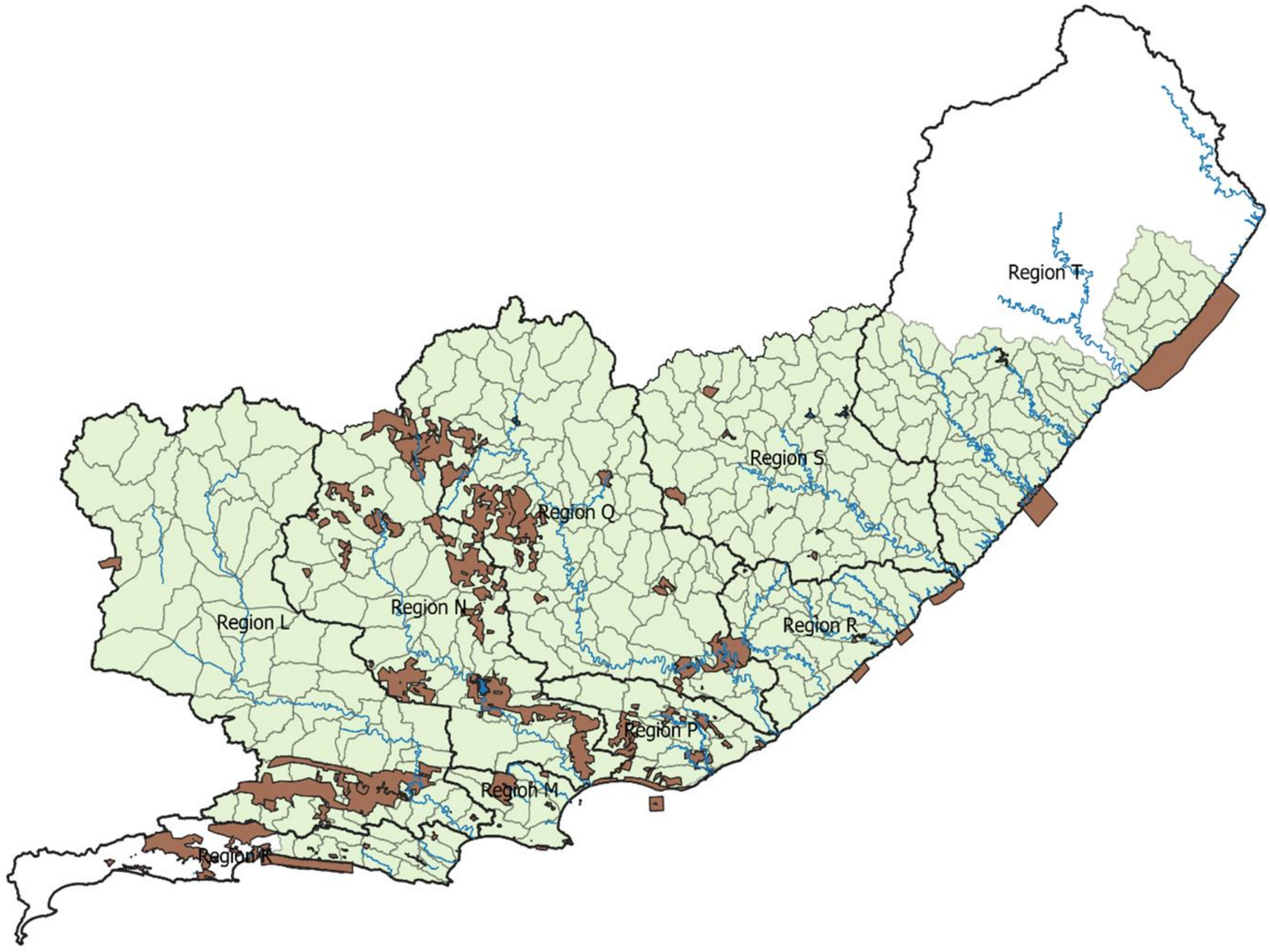

Figure 8-8: Locality of ecological infrastructure within the Fish to Tsitsikamma catchment

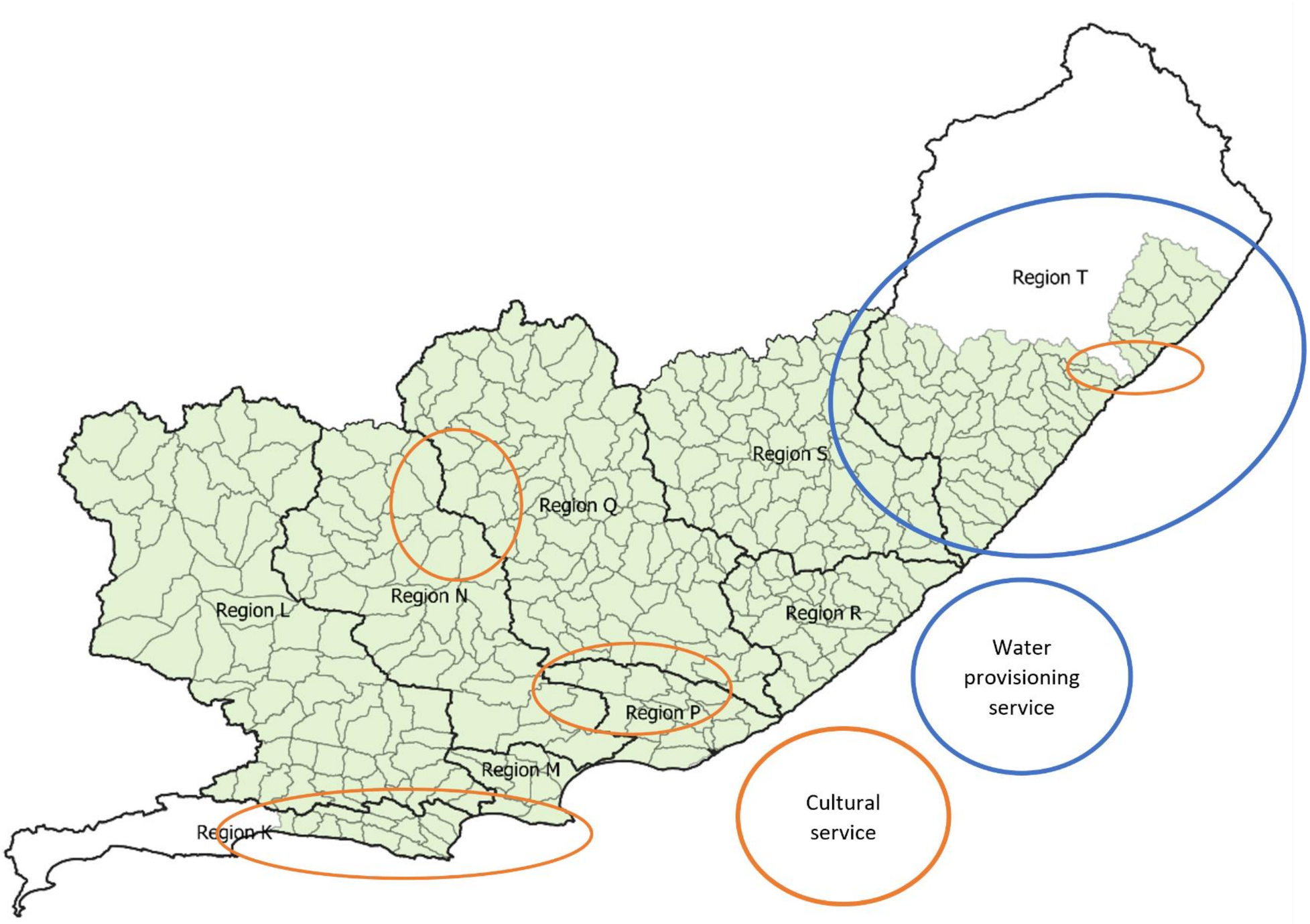

Figure 8-9: Ecosystem Service Sensitivity Areas in the Fish-Tsitsikamma Catchment

Appendix C: Water Resource Infrastructure

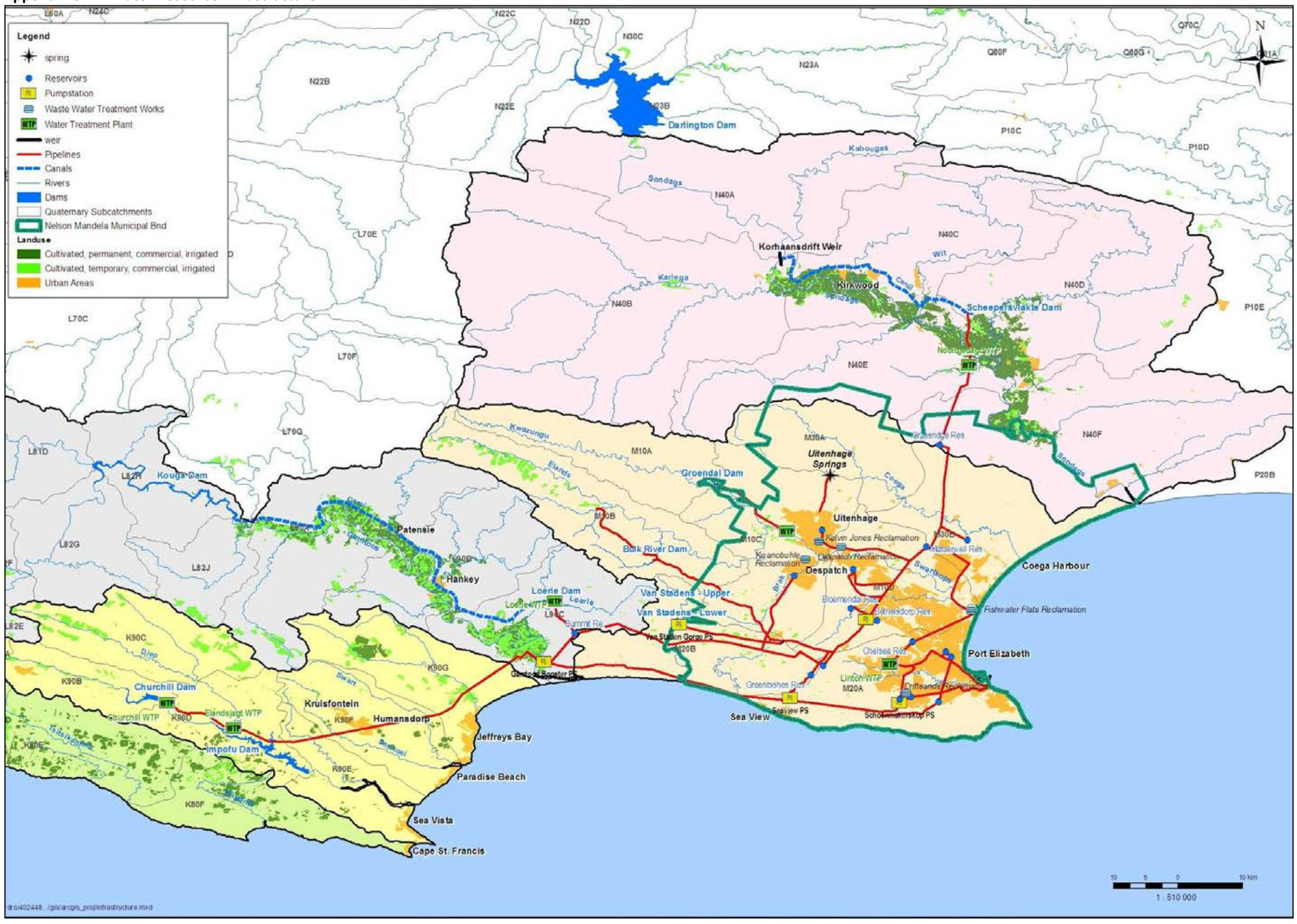

Figure 8-10: The Algoa Water Supply System

Appendix D: Groundwater

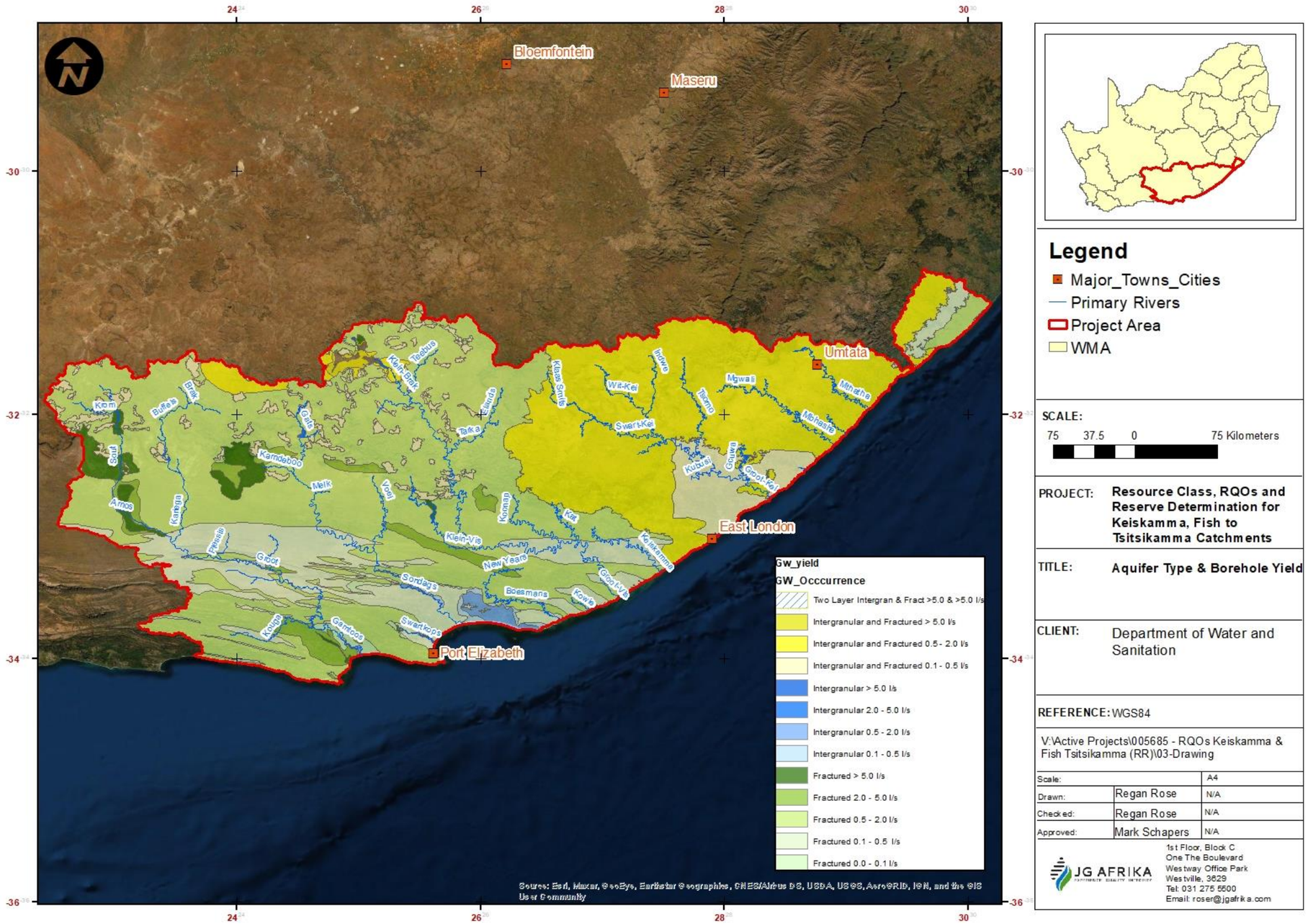

Figure 8-11: Aquifer type and borehole yield

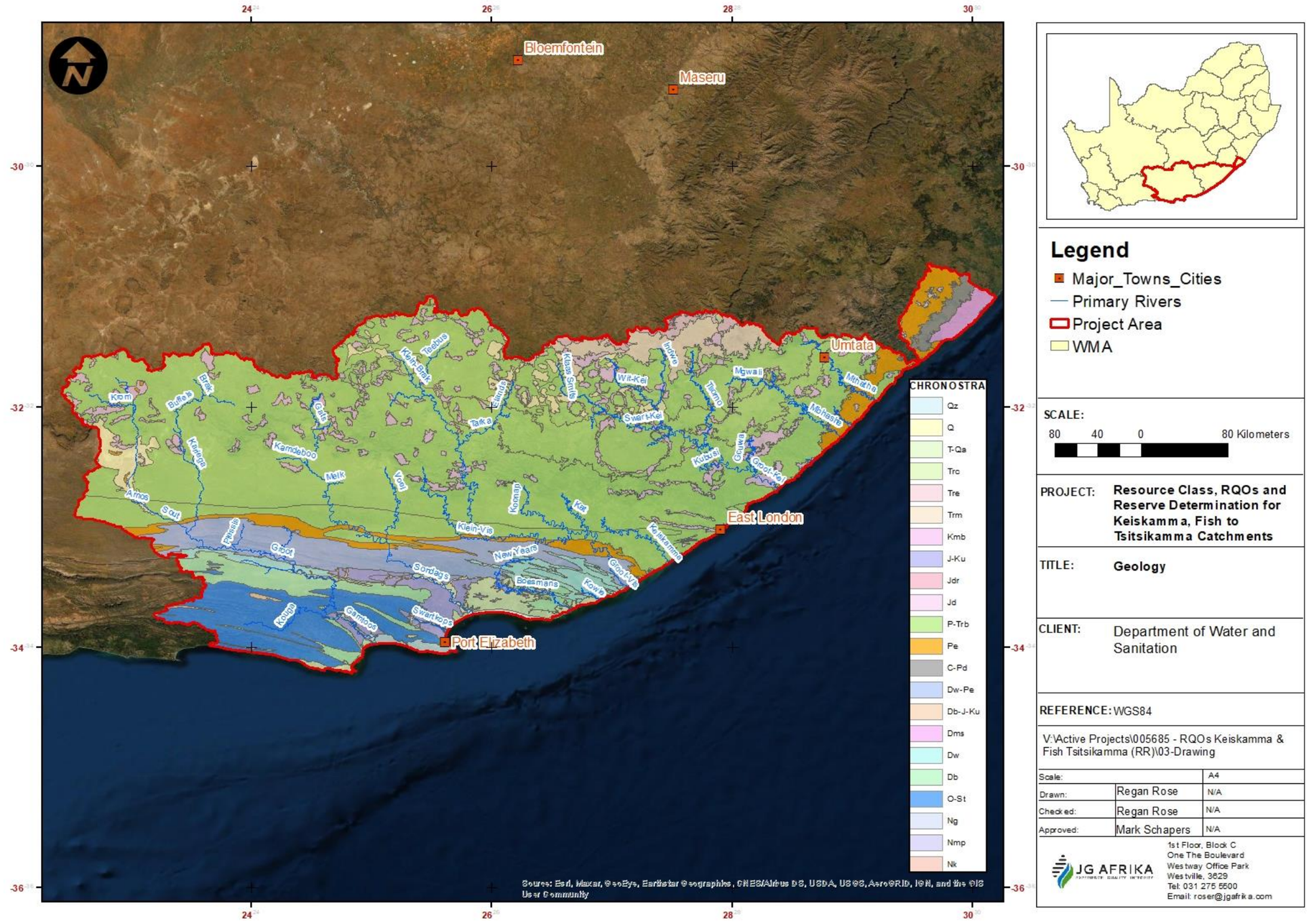

Figure 8-12: Geology

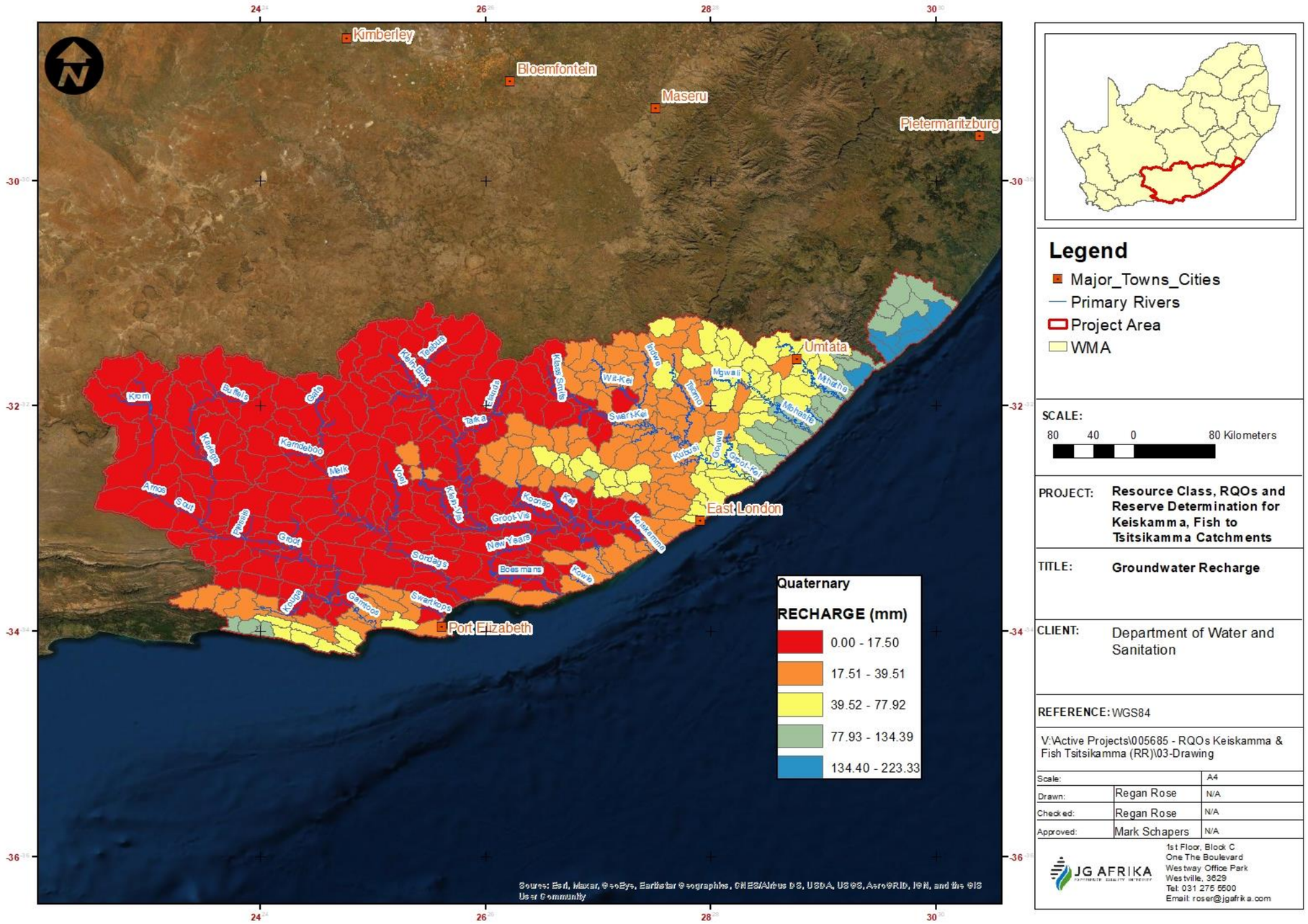

Figure 8-13: Groundwater recharge

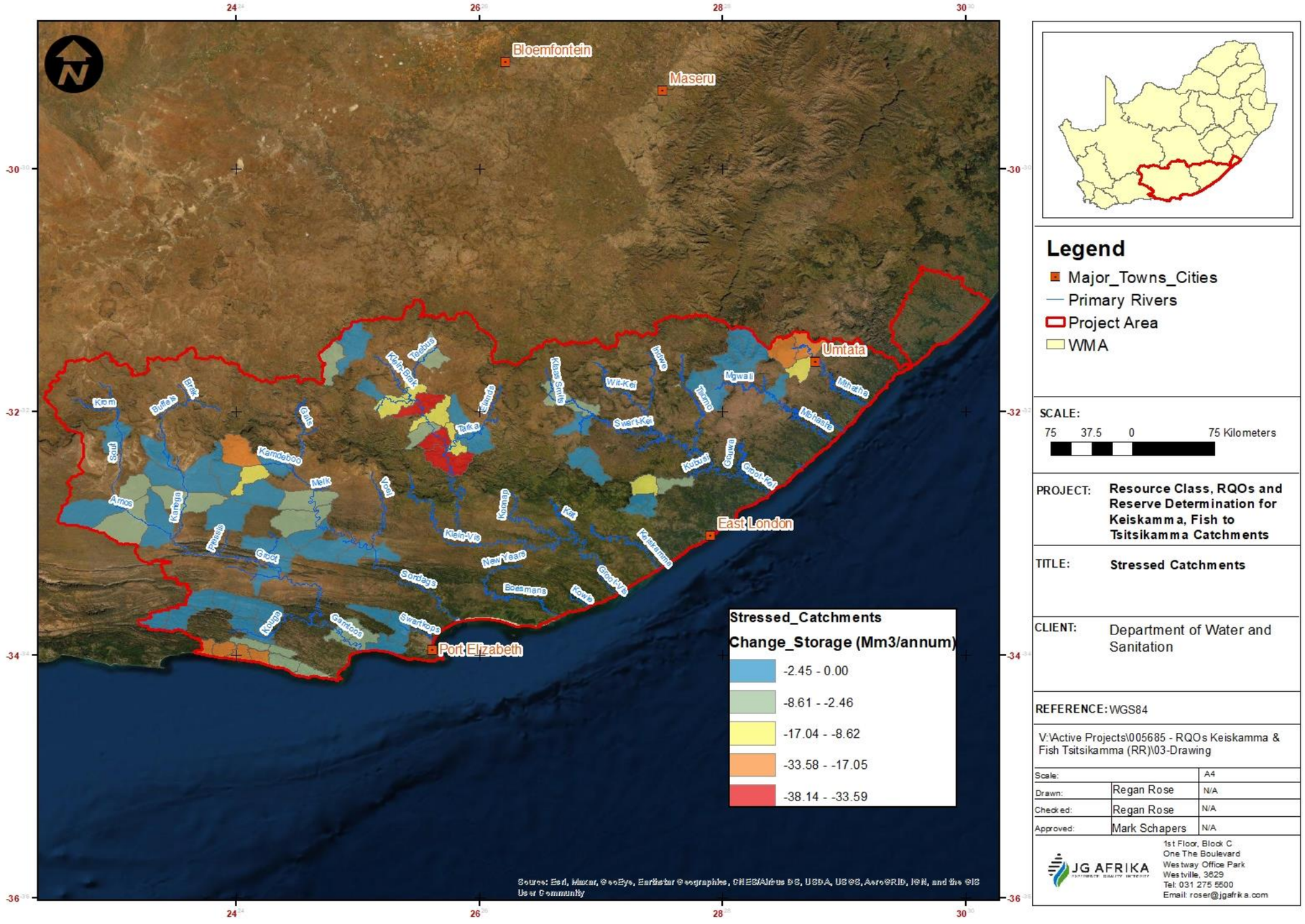

Figure 8-14: Stressed catchments (groundwater)

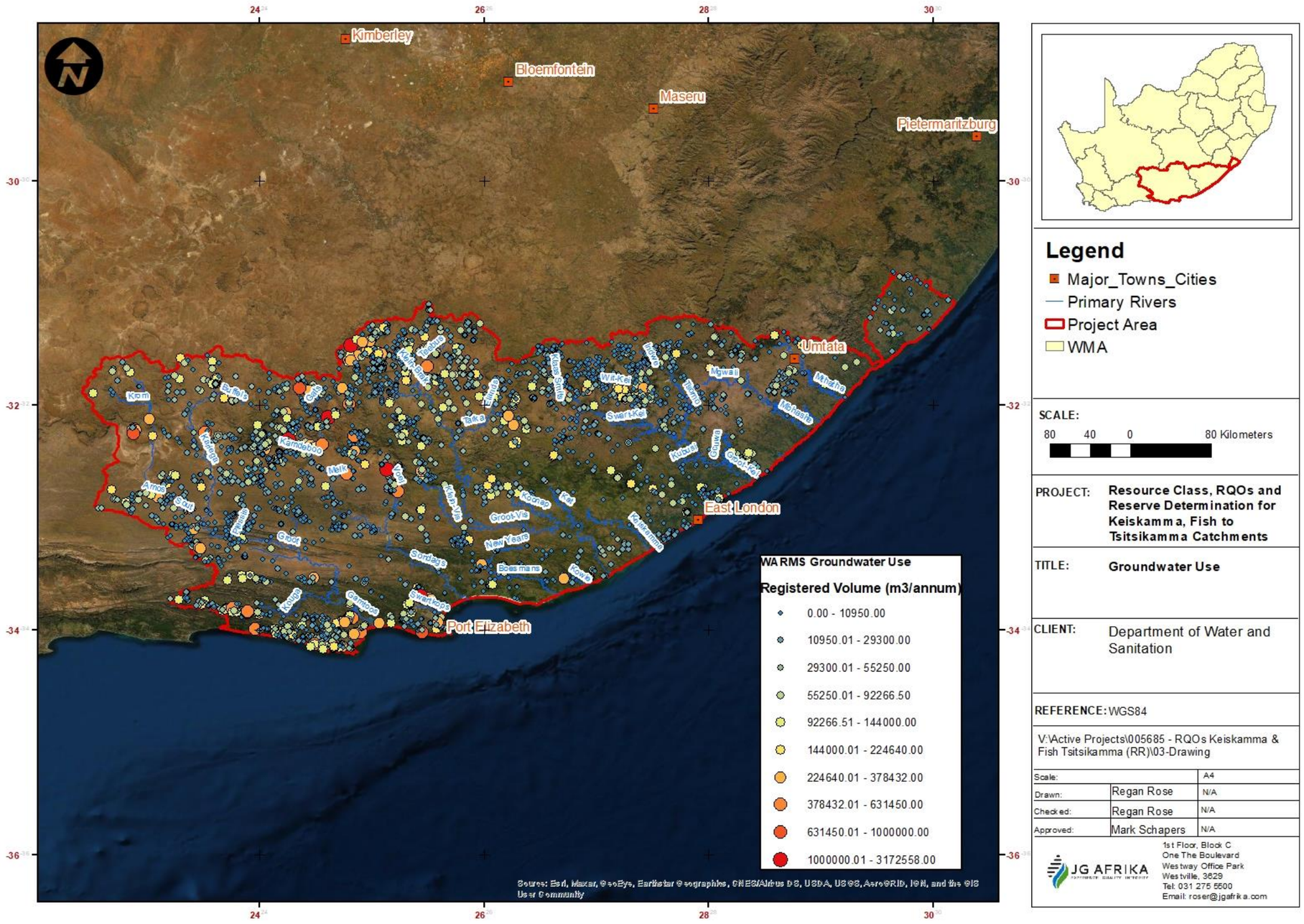

Figure 8-15: Groundwater use

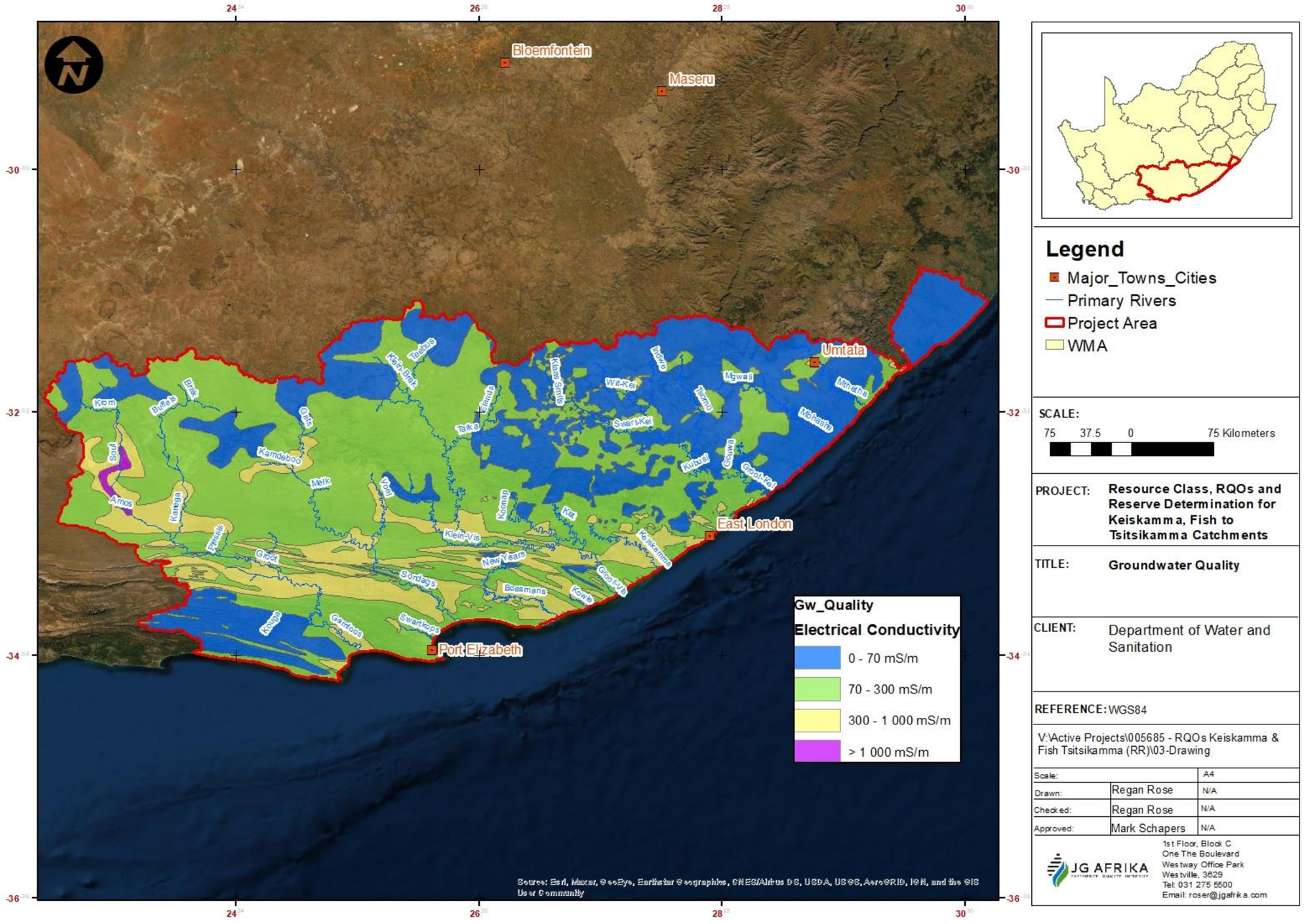

Figure 8-16: Groundwater quality