

Comprehensive Reserve Determination Study for Selected Water Resources (Rivers, Groundwater and Wetlands) in the INKOMATI WATER MANAGEMENT AREA, MPUMALANGA

PROJECT NO: WP 9133

Resource Unit Delineation Report



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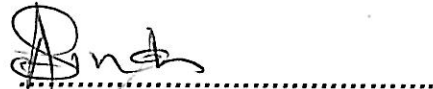
COMPREHENSIVE RESERVE DETERMINATION STUDY FOR SELECTED
WATER RESOURCES (RIVERS, GROUNDWATER AND WETLANDS) IN
THE INKOMATI WATER MANAGEMENT AREA, MPUMALANGA.

SABIE AND CROCODILE SYSTEMS: RESOURCE UNIT DELINEATION:
FINAL

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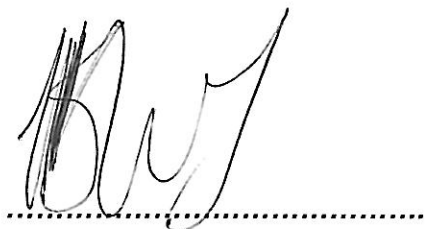


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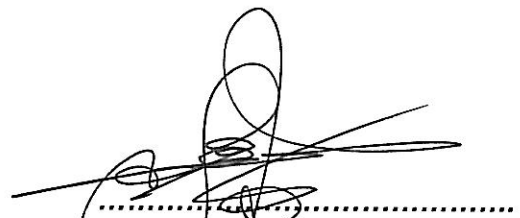


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Reports as part of this project:

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26/8/3/10/12/001	Comprehensive Reserve Determination Study for selected water resources in the Inkomati WMA, Mpumalanga: Inception report
26/8/3/10/12/002	Comprehensive Reserve Determination Study for selected water resources in the Inkomati WMA, Mpumalanga: Desktop EcoClassification report
26/8/3/10/12/003	Newsletters
26/8/3/10/12/004	Comprehensive Reserve Determination Study for selected water resources in the Inkomati WMA, Mpumalanga: Basic Human Needs Reserve report
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26/8/3/10/12/011	Comprehensive Reserve Determination Study for selected water resources in the Inkomati WMA, Mpumalanga: Operation scenarios and consequences report
26/8/3/10/12/012	Comprehensive Reserve Determination Study for selected water resources in the Inkomati WMA, Mpumalanga: EcoSpecs report
26/8/3/10/12/013	Comprehensive Reserve Determination Study for selected water resources in the Inkomati WMA, Mpumalanga: Socio Economic Present State Evaluation Report
26/8/3/10/12/014	Comprehensive Reserve Determination Study for selected water resources in the Inkomati WMA, Mpumalanga: Training audit and report
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REFERENCES

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EXECUTIVE SUMMARY

INTRODUCTION

The CD:RDM identified the Inkomati Water Management Area (WMA) as requiring a comprehensive Reserve assessment in light of the initiation of the Compulsory Licensing Process in the WMA and the proposed Montrose and Mountain View Dams. These studies require higher levels of confidence in the Reserve determination results as is currently available in certain of the catchments, such as the Sabie-Sand and Crocodile River catchments. This will assist the DWAF to make informed decisions regarding the authorisation of future water use and the magnitude of the impacts of the present and proposed developments.

The study area for the Reserve determination is the Inkomati system as represented by WMA 5.

The Inkomati WMA is largely located within the Mpumalanga Province. It can be considered to consist of three largely independent catchments, the Komati, Crocodile (East) and Sabie–Sand River catchments. All these rivers drain the WMA and confluence to form the Inkomati River in Mozambique which flows into the Indian Ocean.

The focus of this study is the Crocodile (East) and Sabie-Sand River catchments as the Inkomati system has already been dealt with during a previous Reserve assessment study (Afridev 2006)

DELINEATION APPROACH

Resource Units (RUs) are required as it would not be appropriate to set the same numerical Reserve for the headwaters of a river as for the lowland reaches. The breakdown of a catchment into RUs for the purpose of determining the Reserve for rivers is therefore done primarily on a biophysical basis within the catchment and called Natural Resource Units (NRUs). Management requirements (DWAF, 1999, volume 3) also play a role in the delineation. Furthermore, the type of disturbance/impact on the river plays a role to select homogenous river reaches from a biophysical basis under present circumstances. These are called Management Resource Units (MRUs). MRUs can be further delineated in even smaller assessment units called Reserve Assessment Units (RAUs). It is preferable to select a EWR site within each MRU, and if possible, be selected within the RAU.

The following is considered for selection of MRUs:

- EcoRegions (Level II)
- Geomorphic zones
- Land cover
- Presence of dams and other operational aspects
- Water quality
- Groundwater
- Local knowledge

DELINEATION RESULTS

The results are tabled below.

MRU	Delineation	Quat
CROCODILE RIVER		
MRU Croc A	Origin of river to upper reaches of Kwena Dam	X21A, X21B
MRU Croc B	Kwena Dam Wall to the Elands River confluence	X21D, X21E
	Elands River confluence to Nelspruit	X22B, X22C, X22J, X22K
MRU Croc C		
MRU Croc D	Nelspruit to border of KNP	X22J, X22K, X24C
RUA Croc D.1	Gorge	X22K, X24C
MRU Croc E	KNP border to Komati confluence	X24D, X24E, X24G, X24H
KAAP RIVER		
MRU Kaap A	Confluence of the Noord and Suid Kaap to confluence with the Crocodile	X23G, X32H, X23B
RAU Kaap A.1	Start and end of Upper Foothills	X23H, X23G
SABIE RIVER		
MRU Sabie A	Origin of the river to the Marite confluence.	X31A, X31B, X31D
RAU Sabie A.1	Source of river to end of the Mountain Stream.	X31A
RAU Sabie A.2	Mac-Mac confluence to Marite confluence	X31D
MRU Sabie B	Marite confluence (start of 3.07 EcoRegion) to KNP entrance.	X31M, X31K
MRU Sabie B.1	Point where river forms the border of the KNP to the Kruger Gate	X31M, X31K
MRU Sabie C	Kruger Gate to border of KNP with Mozambique	X31M, X33A, X33B, X33D
RAU Sabie C.1	Kruger Gate to Sand confluence	X31M
SAND & MUTLUMUVI		
MRU Sand A	Origin of river to confluence with Mutlumuvi	X32A, X32C
MRU Mutlumuvi A	Origin of river to confluence with Sand	X32D, X32F
MRU Sand B	Confluence with the Mutlumuvi to the confluence with the Sabie	X32G, X32H, X32J
RAU Sand B.1	Border of the Sabie Sand to the confluence with the Sabie	X32G, X32H, X32J

EWR SITES

The selection of EWR sites is guided by a number of considerations. The key considerations are:

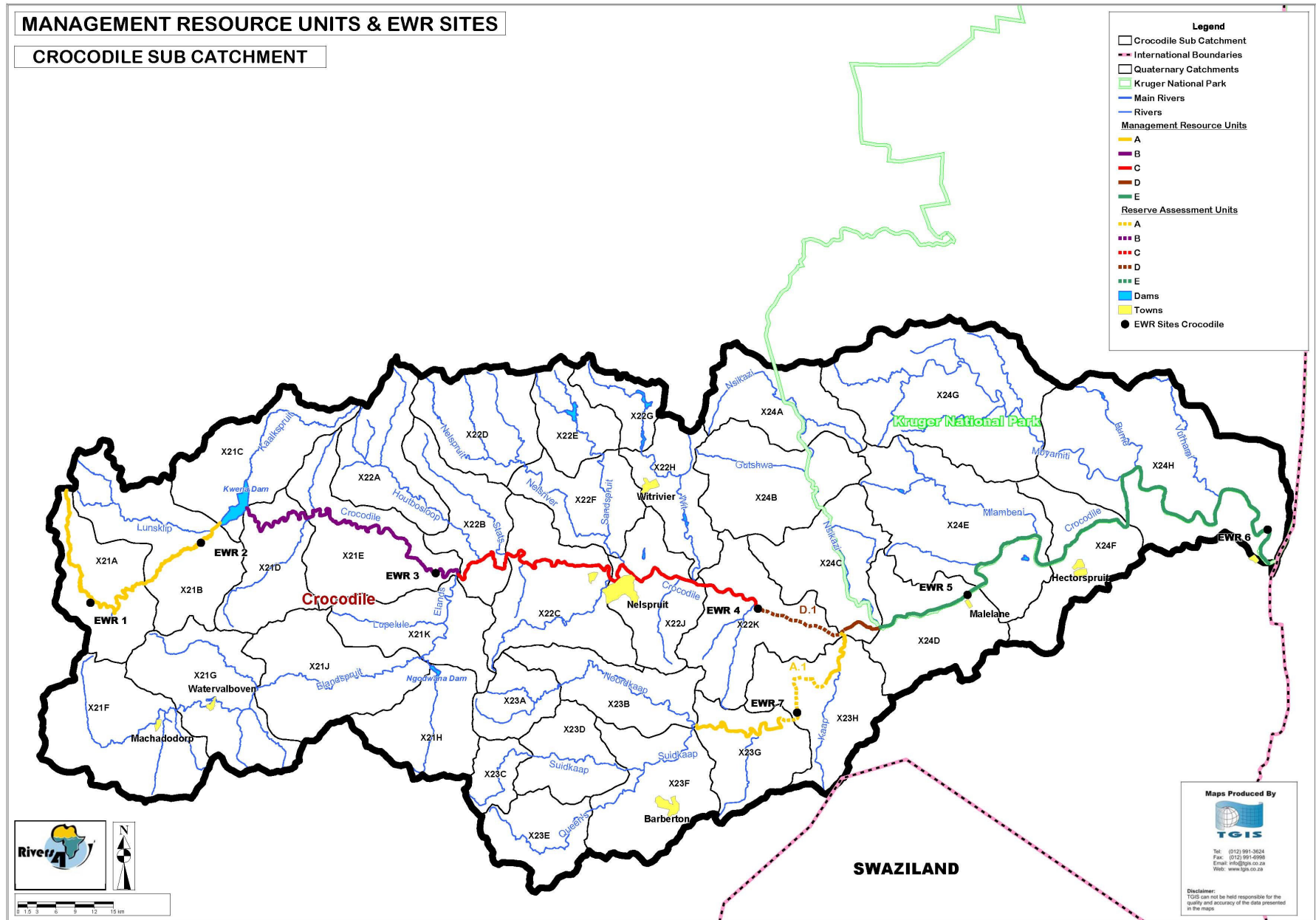
- The suitability of the sites for accurate hydraulic modelling throughout the range of possible flows, especially low flows.
- Accessibility of the sites.
- An area or site that could be critical for ecosystem functioning. These are often represented by riffle units, where low flow conditions or the cessation of flow constitutes a break in the functioning of the river, and consequently, the biota dependant on this habitat and/or perennial flow are adversely affected. Pools are not considered critical habitats in perennial system since they are still able to function or at least maintain life during periods of no flow.

During a previous Intermediate EWR study (Godfrey, 2002), 6 EWR sites in the Crocodile River and one in the Kaap River were selected. These EWR sites will be used during this study as all the benchmarks have been found. Data collected during the 2002 study on the hydraulics and biological information will be used during the current study.

During a 1996 Instream Flow Requirements (IFR) study, 4 sites were selected in the Sabie, 1 in the Marite, 1 in the Mutlumuvi and 2 in the Lower Sand River. After the 2000 floods, most of the benchmarks were moved or covered and the nature and character of some of the sites changed completely. During this study, cognisance would be taken of the locality of the sites and where appropriate, the same sites would be used. Furthermore, the focus of the 1996 study was also on the Kruger Park and sections outside of the Kruger Park were mostly ignored.

Details regarding the sites selected are provided in the table below and illustrated in the figure below.

EWR site number	EWR site name	River	Decimal Min S	Decimal Min E	EcoRegion (Level II)	Geomorphic Zone	Altitude (m)	RU	Quat	Gauge
CROCODILE EAST SYSTEM										
EWR 1	Valyspruit	Crocodile	S25 29.647	E30 08.656	9.02	Upper Foothills	1852	MRU Croc A	X21A	
EWR 2	Goedenhoop	Crocodile	S25 24.555	E30 18.955	9.04	Upper Foothills	1207	MRU Croc A	X21B	
EWR 3	Poplar Creek	Crocodile	S25 27.127	E30 40.865	10.02	Lower Foothills	834	MRU Croc B	X21E	X2H013
EWR 4	KaNyamazane	Crocodile	S25 30.146	E31 10.919	4.04	Lower Foothills	472	MRU Croc D RUA Croc D.1	X22K	X2H032
EWR 5	Malelane	Crocodile	S25 28.972	E31 30.464	3.07	Lower Foothills	286	MRU Croc E	X24D	S2H046
EWR 6	Nkongoma	Crocodile	S25 23.430	E31 58.467	12.01	Lower Foothills	135	MRU Croc E	X24H	X2H016
EWR 7	Honeybird	Kaap	S25 38.968	E31 14.572	4.04	Upper Foothills	470	MRU Kaap A	X23H	
SABIE SAND SYSTEM										
EWR1	UpperSabie	Sabie	S25 04.424	E30 50.924	4.04	Upper Foothills	862	MRU Sabie A	X31B	-
EWR2	Sabie AandeVliet	Sabie	S25 01.675	E31 03.099	4.04	Lower Foothills	463	MRU Sabie A RAU Sabie A.2	X31D	X3H023
EWR3	Kidney	Sabie	S24 59.256	E31 17.572	3.07	Lower Foothills	369	MRU Sabie B	X31K	X3H021
EWR4	MacMac	MacMac	S25 00.800	E31 00.243	4.04	Upper Foothills	582	MRU Mac A	X31C	-
EWR5	Marite	Marite	S25 01.077	E31 07.997	4.04	Upper Foothills	457	MRU Mar A	X31G	-
EWR6	Mutlumuvi	Mutlumuvi	S24 45.352	E31 07.923	3.05	Upper Foothills	503	MRU Mut A	X32F	-
EWR7	Tlulandziteka	Tlulandziteka (Sand)	S24 40.829	E31 05.188	3.07	Lower Foothills	543	MRU Sand A	X32C	-
EWR8	Sand	Sand	S24 58.045	E31 37.641	3.07	Lower Foothills	250	MRU Sand B RAU Sand B.1	X32J	-



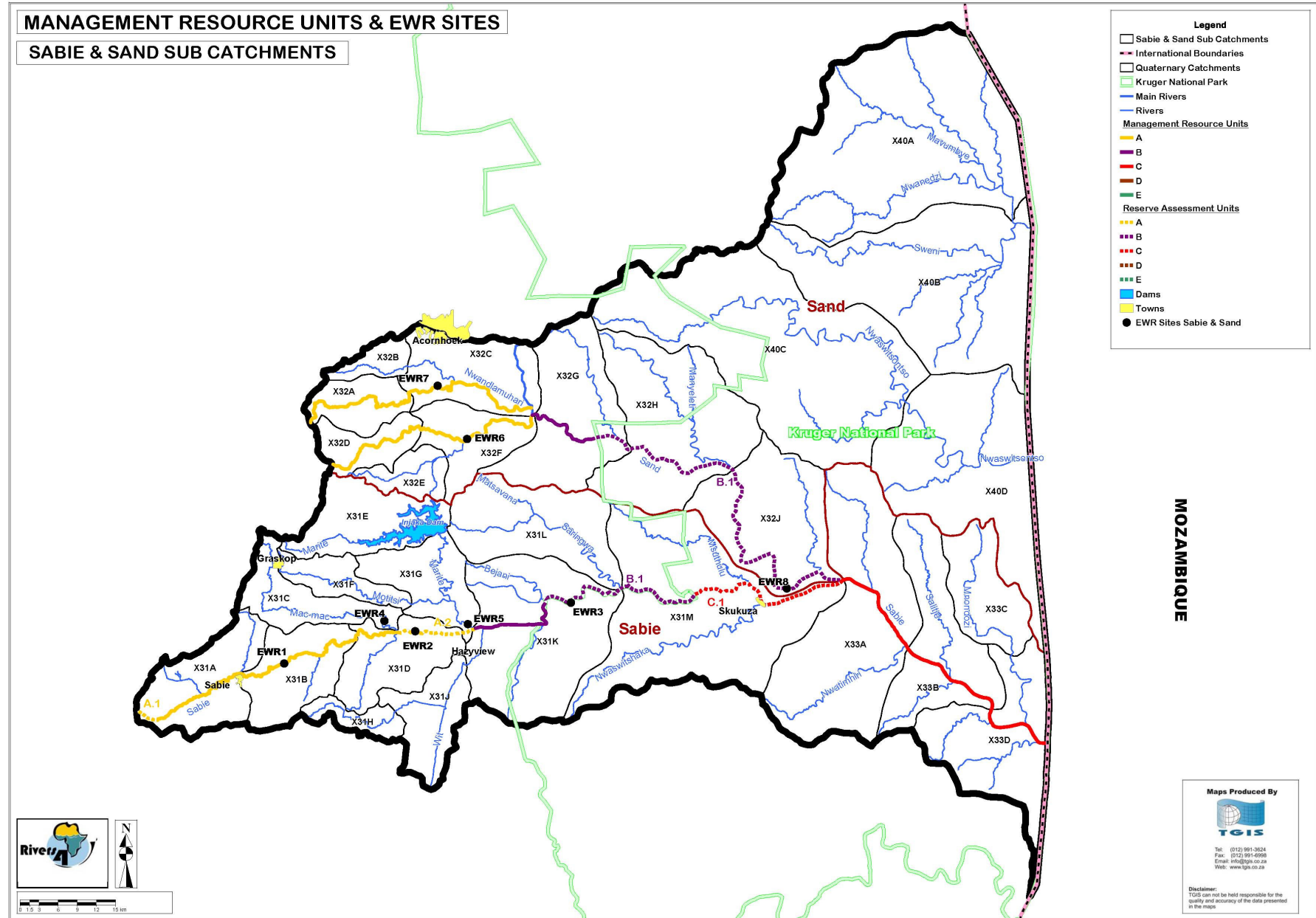


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TERMINOLOGY AND ACRONYMS

BBM	Building Block Methodology
CD: RDM	Chief Directorate: Resource Directed Measures
CMA	Catchment Management Agency
D:RQS	Directorate: Resource Quality Services
DRIFT	Downstream Response to Imposed Flow Transformation
DTM	Digital Terrain Model
DWAF	Department of Water Affairs and Forestry
EC	Ecological Category
EcoSpecs	Ecological Specifications
EIS	Ecological Importance and Sensitivity
EPA	Environmental Protection Agency
EWR	Ecological Water Requirements
FRAI	Fish Response Assessment Index
GAI	Geomorphological Driver Assessment Index
GDP	Gross Domestic Product
GIS	Geographic Information System
GGP	Gross Geographic Product
HAI	Hydrological Driver Assessment Index
HFSR	Habitat Flow Stressor Response
IFR	Instream Flow Requirements
IHI	Index of Habitat Integrity
MAP	Mean Annual Precipitation
MIRAI	Macroinvertebrate Response Assessment Index
MRU	Natural Resource Units
NGO	Non Governmental Organization
NWA	National Water Act
NWRS	National Water Resource Strategy
PAI	Physico Chemical Driver Assessment Index
PES	Present Ecological State
PMT	Project Management Team
PSP	Professional Service Provider
REC	Recommended Ecological Category
RQO	Resource Quality Objectives
RU	Resource Unit
SANBI	South African National Biodiversity Institute
SCI	Socio Cultural Importance
SPATSIM	Spatial and Time Series Information Modelling
ToR	Terms of Reference
TPC	Threshold of Potential Concern
VEGRAI	Riparian Vegetation Response Assessment Index
WHI	Wetland Health Index
WMA	Water Management Area
WRYM	Water Resource Yield Model

1 INTRODUCTION

1.1 BACKGROUND

The National Water Act (NWA, Act No. 36 of 1998, Section 3) requires that the Reserve be determined for water resources, i.e. the quantity, quality and reliability of water needed to sustain both human use and aquatic ecosystems, so as to meet the requirements for economic development without seriously impacting on the long-term integrity of ecosystems. It is therefore imperative that the Reserve be determined and requirements met before other economic activities can be satisfied. As the Department of Water Affairs and Forestry (DWAF) is the trustee of the nation's water resources, it is their responsibility to ensure the adequate protection and effective management of these resources. The Chief Directorate: Resources Directed Measures (CD:RDM) of DWAF is tasked with the responsibility of ensuring that Reserve assessments take place before licensing can proceed.

The CD:RDM identified the Inkomati Water Management Area (WMA) as requiring a comprehensive Reserve assessment in light of the initiation of the Compulsory Licensing Process in the WMA and the proposed Montrose and Mountain View Dams. These studies require higher levels of confidence in the Reserve determination results as is currently available in certain of the catchments, such as the Sabie-Sand and Crocodile River catchments. This will assist the DWAF to make informed decisions regarding the authorisation of future water use and the magnitude of the impacts of the present and proposed developments.

1.2 STUDY AREA

The study area for the Reserve determination is the Inkomati system as represented by WMA 5.

The Inkomati WMA is largely located within the Mpumalanga Province. It can be considered to consist of three largely independent catchments, the Komati, Crocodile (East) and Sabie-Sand River catchments. All these rivers drain the WMA and confluence to form the Inkomati River in Mozambique which flows into the Indian Ocean.

Topographically the WMA is divided by the Great Escarpment (which runs roughly along the Graskop, Sabie, Nelspruit, Barberton axis) into a western plateau and sub-tropical Lowveld in the East. Rainfall varies from over 1200mm per annum in the mountains and the plateau in the west to as low as 400mm per annum in the lower eastern part of the WMA.

The focus of this study is the Crocodile (East) (excluding the Elands River which has been addressed during previous studies (Hill, 2004)) and Sabie-Sand River catchments. The Komati system has already been dealt with during a previous Reserve assessment study (Afridev 2006)

1.3 PURPOSE OF THIS REPORT

The purpose of this report is:

- To provide the information used to define the Resource Units (RUs).
- To provide the delineation of the RUs in the study areas
- To describe the EWR sites selected within the RUs.

1.4 REPORT STRUCTURE

This report combines various aspects of the study area (see Chapter 2) that relates to delineation of the resource units and EWR sites. An introduction is followed by the delineation approach, the delineation results, and the EWR sites (locality, characteristics and suitability).

2 RIVER REACH DEMARCATION AND DELINEATION

2.1 APPROACH

If an Ecological Reserve determination is required, for a whole catchment, it is necessary to delineate the catchment into Resource Units (RUs). These are each significantly different to warrant their own specification of the Reserve, and the geographic boundaries of each must be clearly delineated. (DWAF, 1999, volume 3).

RUs are required as it would not be appropriate to set the same numerical Reserve for the headwaters of a river as for the lowland reaches. These sections of a river frequently have different natural flow patterns, react differently to stress according to their sensitivity, and therefore require individual specifications of the Reserve appropriate for that reach. The breakdown of a catchment into RUs for the purpose of determining the Reserve for rivers is therefore done primarily on a biophysical basis within the catchment and called Natural Resource Units (NRU). The more detailed approach is described in Appendix A.

Management requirements (DWAF, 1999, volume 3) also play a role in the delineation. An example could be where large dams and/or transfer schemes occur. Furthermore, the type of disturbance/impact on the river plays a role to select homogenous river reaches from a biophysical basis under present circumstances. These are called Management Resource Units (MRU) and the more detailed approach is described in Appendix A.

The delineation process considers all of the above issues. Overlaying all the data does not necessarily result in a logical and clear delineation and expert judgement, a consultative process and local knowledge are required for the final delineation. The practicalities of dealing with numerous reaches within one study must also be considered to determine a logical and practical suite of MRUs.

MRUs can be further delineated in even smaller assessment units and the approach for this is described in Appendix A.

The Ecological Water Requirements (EWRs) are determined for each MRU by means of either the following (Louw & Hughes, 2002):

- An EWR site is selected within the MRU and represents a critical site within the relevant river section. Results generated at the EWR site will then be relevant for the MRU as a whole.
- No EWR site is selected within the MRU and extrapolated results from adjacent MRU with EWR sites are used. The reasons for an EWR site not being selected within the MRU can be the following:
 - The characteristics of the river within the MRU do not meet the criteria for EWR sites.
 - Due to the number of MRUs within the study area, it is not practical and/or cost-effective to address EWR sites within each RU.

2.2 RESOURCE UNIT CONSIDERATIONS

2.2.1 EcoRegions (Level II)

The EcoRegion typing approach developed in the USA (Omernik, 1987) was applied and tested at a preliminary level in South Africa. EcoRegional classification or typing will allow the grouping of rivers according to similarities based on a top-down approach. The purpose of this approach is to simplify and contextualise assessments and statements on Ecological Water Requirements. One of the advantages of such a system is the extrapolation of information from data rich rivers to data poor rivers within the same hierarchical typing context.

The current effort, used available information to delineate EcoRegion boundaries at a very broad scale (i.e. Level I) for South Africa. Attributes such as physiography, climate, rainfall, geology and potential natural vegetation were evaluated in this process and 18 Level I EcoRegions were identified (Kleynhans *et al.*, 2005). The next Level II (Kleynhans *et al.*, 2007), used the same attributes but in more detail. Physiography can for example, be explored in more detail by considering terrain morphological classes, slopes, relief, altitude, etc. The EcoRegions are illustrated in Figure 2.1.

2.2.2 Geomorphological zonation

Rowntree and Wadeson (1999) have developed a zonal classification system for Southern African rivers modified from Noble and Hemens (1978). In their classification an attempt was made to give each zone a geomorphological definition in terms of distinctive channel morphological units and reach types. After working in a number of different rivers around the country it has become clear that channel gradient is a good indicator of channel characteristics and that probable or expected difference can be identified from an analysis of gradients (Table 2.1). This classification was used and is illustrated in Figure 2.1 and 2.2.

Table 2.1 Geomorphological Zonation of River Channels (adapted Rowntree and Wadeson, 1999)

Longitudinal zone	Characteristic channel features	
	Zone class	Description
Mountain stream	B	Steep gradient stream dominated by bedrock and boulders, locally cobble or coarse gravels in pools. Reach types include cascades, bedrock fall, step-pool, Approximate equal distribution of 'vertical' and 'horizontal' flow components.
Transitional	C	Moderately steep stream dominated by bedrock or boulder. Reach types include plain-bed, pool-rapid or pool riffle. Confined or semi-confined valley floor with limited flood plain development.
Upper Foothills	D	Moderately steep, cobble-bed or mixed bedrock-cobble bed channel, with plain-bed, pool-riffle or pool-rapid reach types. Length of pools and riffles/rapids similar. Narrow flood plain of sand, gravel or cobble often present.
Lower Foothills	E	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. Flood plain often present.
Lowland river	F	Low gradient alluvial fine bed channel, typically regime reach type. May be confined, but fully developed meandering pattern within a distinct flood plain develops in unconfined reaches where there is an increased silt content in bed or banks.

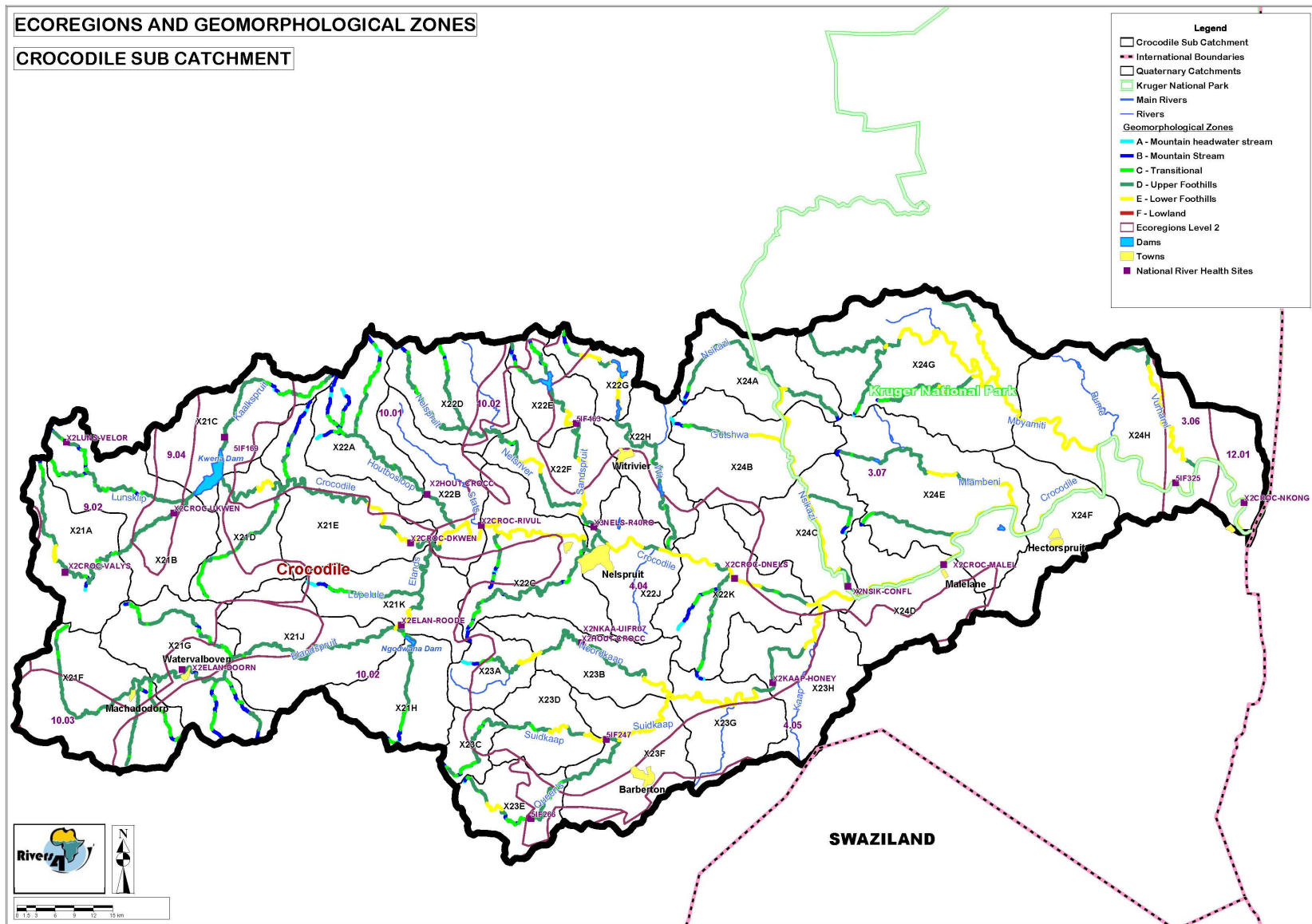


Figure 2.1 Crocodile subcatchment: Geomorphological zones and EcoRegions

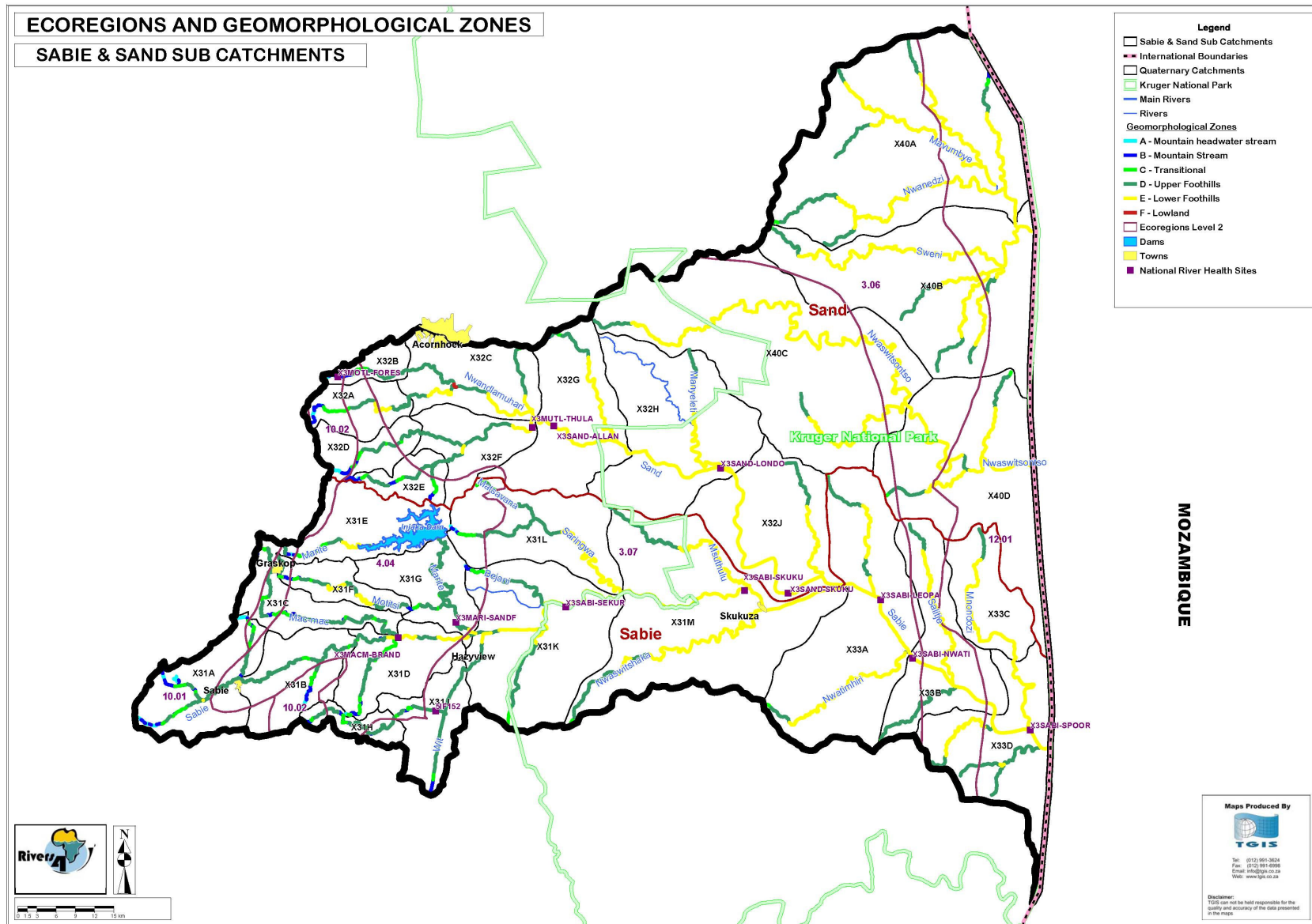


Figure 2.2 Sabie-Sand subcatchment: Geomorphological zones and EcoRegions

2.2.3 Land cover¹

The land cover per 500 m strip on both sides of the river is provided electronically as maps (26/8/3/10/12/016) with the associated Excel spreadsheets (Appendix B). This information is used to determine homogeneity of impacts and used in the decision-making regarding the MRUs.

The land cover in the Crocodile system within the 500 m zone is predominantly grassland (upper) and woodland, thickets, bus etc in the area below Kwena Dam. Although the land cover indicates natural bush, the presence of exotics within natural bush cannot be identified, and as is well known from ground-truthing, exotic vegetation is present in most areas.

The Sabie system is dominated by forest plantations for most of the system. From X31C, the dominant cover is indigenous forest and wood thicket which will also be dotted with exotic vegetation.

2.2.4 System operation

A qualitative systems operation description has been provided with specific emphasis of the locality and type of infrastructure (formal and informal) that could impact on the hydrological characteristics of the river.

Crocodile River:

Compared to most catchments in South Africa, the Crocodile River catchment is relatively undeveloped in terms of water supply infrastructure. While there are several dams in the catchment, their combined storage is less than one fifth of the natural runoff from the catchment. The most significant dam is the Kwena Dam located in the upper reaches of the Crocodile River catchment. Water is released from the dam when required to supplement water supply to irrigators located along the Crocodile River. The Kwena Dam also ensures a high assurance supply to the towns of Nelspruit, KaNyamazane, Matsula and Malelane located near the Crocodile River.

There are several smaller dams located in the vicinity of White River which mostly supply water to irrigators but also supply the urban requirements of the town of White River.

The Elands River, a major tributary of the Crocodile River, is largely unregulated with limited irrigation in the middle reaches of the sub-catchment. The Ngodwana Dam, located on a tributary of the Elands River, supplies water to Sappi's paper mill. Effluent return flows from this mill results in poor water quality in the lower Elands River but the effluent is sufficiently diluted from the confluence with the Crocodile since the flow in the Crocodile is always relatively high due to releases from the Kwena Dam.

The Kaap River, another major tributary of the Crocodile River, is largely unregulated. Unlike the Elands River catchment however, irrigation in this sub-catchment is practiced intensely and the run-of-river flow is fully utilised. Water is transferred into the Kaap River catchment from the upper Lomati River catchment from two small dams, the Lomati Dam, which supplements the water supply to Barberton, and the Shiyalonguba Dam which supplies water to the Louws Creek Irrigation Board.

¹ Data was generated and provided in GIS format by J Moolman from RQS, DWAF

The Crocodile River is operated by the Crocodile Irrigation Board by means of releases from the Kwena Dam and abstraction control, although DWAF's Mpumalanga's Regional Office is the administrative authority in the catchment. This authority is currently being transferred to the Catchment Management Agency. Other important role players are the White River Irrigation Board who operate the dams in the White River areas and the Kaap River Irrigation Board who operate the Kaap River catchment.

Agreements are in place with Mozambique and Swaziland which specify minimum cross-border flows which should be supplied from the Crocodile River system. These minimum flows have not always been met in the past but there seems to be an increasing trend towards compliance. This could be due to a move towards metering of major irrigators in the catchment. A list of significant dams in the Crocodile River catchment is provided in Table 2.2.

Table 2.2 Significant dams in the Crocodile River

Dam	MAR (million m ³ /a)	Full supply capacity		Full supply area (km ²)
		Million m ³	% MAR	
Kwena	127.8	159.0	124%	12.5
Witklip	19.2	12.3	64%	1.9
Klipkopjes	20.9	12.1	58%	3.8
Ngodwana	63.5	10.4	16%	0.87
Longmere	29.4	4.2	14%	0.94
Primkop	13.7	2.0	15%	0.41

Sabie/Sand River catchment

As with the Crocodile River, regulation of the Sabie River catchment is also limited, with the only large dam being the recently completed Inyaka Dam, which was constructed largely to ensure that the ecological requirements of the Sabie River are met, especially in the lower reaches where it flows through the Kruger National Park. Detailed operating rules have been developed for this dam but never fully implemented. The current operating rule is to make a constant release of approximately 0,5 m³/s.

There is extensive and intense irrigation in the upper Sabie catchment supported by the Da Gama Dam and numerous farm dams in the Sabane sub-catchment.

The town of Sabie obtains its water from groundwater while Hazyview abstracts directly from the Sabie River. Bushbuckridge and numerous villages in both the Sabie and Sand River catchment are supplied via a complex water supply scheme from the Inyaka Dam. This is being continually expanded to improve the rural water supply and is planned to eventually transfer up to 25 million m³/annum from the Inyaka dam to the Sand River catchment. Some of this water was earmarked to supply the Ecological Reserve and was being released into the Mutlumuvi, although more recently it seems as if these releases have been terminated. This rural water supply scheme is not well managed and many villages are still not obtaining a reliable water supply. The problems appear to be institutional rather than technical.

There is some irrigation in the Sand River catchment from run-of-river, diverted from weirs into canals, many of which are poorly maintained. There is little control over the irrigators in the Sand River catchment and they often divert the full low flow to the detriment of the ecology of the river.

There are several small dams in the Sand River catchment which mostly supply small irrigation schemes. A list of dams in the Sabie/Sand catchment is provided in Table 2.3.

Table 2.3 Summary of significant dams in the Sabie/Sand River catchment

Dam	MAR (million m ³ /a)	Full supply capacity		Full supply area (km ²)
		Million m ³	% MAR	
Inyaka	104.5	123.0	118%	8.1
Da Gama	17.8	13.6	76%	1.3
Witklip	19.2	12.3	64%	1.9
Maritsane	39.7	2.1	5.3%	0.5
Orinoco	2.7	1.62	60%	0.20
Kasteel	3.2	1.35	42%	0.16
Edinburgh	3.9	2.42	62%	0.6

2.2.5 Physico chemical sub-units

Physico chemical sub-units is normally called Water Quality subunits. Water quality sub-units (WQSUs) define areas of homogenous water quality. Changes in water quality may be natural e.g. input of water from tributaries, or man-made, e.g. abstractions and discharges, towns, tributaries, industries, Sewage Treatment Works etc. All these factors therefore suggest changes in water quality and define WQSUs.

Delineation was based on the following factors:

- Literature regarding water quality issues in the catchments
- The perusal of 1: 50 000, and 1: 250 000 maps of the study area, depicting land use activities, point and diffuse sources of pollution, and catchment characteristics such as towns, tributaries, gauging weirs, etc.
- The EcoRegion (level 2) classification of the area
- A field survey of the study area undertaken in November 2007. Water quality measurements were taken at specific points, including the EWR sites. Samples were also taken for diatom analysis at Potchefstroom University and periphyton samples for chlorophyll-a analysis at Rhodes University.
- A meeting with representatives of DWAF regional offices (Stanford Macavele, Kenneth Masindi, Vincent Leshabane), to access information about point and diffuse sources of pollution and available water quality data
- Liaison with the national DWAF office and obtaining available water quality information from the DWAF-WMS (Water Management System) database

Table 2.4 Water Quality Sub Units

WQSU NO. (MRU NO.)	DESCRIPTION AND MAP NO.	MONITORING POINTS	LAND USE ACTIVITIES
Crocodile River			
1 (MRU A)	WQSU 1 stretches from the source of the Crocodile River to above Dullstroom.		Land-cover is largely grassland. Verlorenvlei Nature Reserve is found in the area.

WQSU NO. (MRU NO.)	DESCRIPTION AND MAP NO.	MONITORING POINTS	LAND USE ACTIVITIES
2 (MRU A)	WQSU 2 stretches from Dullstroom to Kwena Dam.	This stretch contains two EWR sites, EWR1 (Valyspruit) and EWR2 (Goedehoop), with on-site water quality samples taken on 16/11/07. DWAF undertook water quality sampling at X2H074Q01 from 1992-1994.	Land-cover is largely grassland with some agricultural, forestry and urban activities, e.g. trout-farming around Dullstroom.
3 (MRU B)	WQSU 3 stretches from below Kwena Dam to the confluence with the Elands River.	This stretch contains one EWR site, EWR3 (Poplar Creek), with on-site water quality samples taken on 12/11/07. DWAF monitoring point, X2H013Q01 at Montrose is present in this WQSU, with monitoring from 1959-2007.	Land-cover is farming (largely citrus), with alien vegetation, plantations and urban settlements present. Sappi Ngodwana is located on the Elands River system, with associated pollution problems.
4 (MRU C / D)	WQSU 4 stretches from the confluence with the Elands River to below Nelspruit and KaNyamazane, and includes the confluence with the Wit River.	This stretch contains one WQ site at Rivulets, with on-site water quality samples taken on 12/11/07, and one EWR site, EWR4 (KaNyamazane). On-site water quality samples were taken from EWR4 on 13/11/07. DWAF monitoring points, X2H006Q01 at Karino, and X2H032Q01 at Weltevrede are present in this WQSU, with monitoring from 1929-2007 and 1968-2007 respectively.	Land-cover is farming (largely citrus), with extensive alien vegetation, plantations and urban settlements and associated activities present, i.e. Nelspruit and KaNyamazane. A number of hazardous waste sites, mines and processing plants are found in the area. The polluted Wit River enters the Crocodile River in this WQSU.
5 (MRU D)	WQSU 5 stretches from below KaNyamazane to the confluence with the Kaap River, and includes Krokodilrivierspoort (RAU 1).		The river goes through Krokodilrivierspoort.
6 (MRU E)	WQSU 6 stretches from the Kaap River confluence to the confluence with the Komati River.	This stretch contains two EWR sites, i.e. EWR5 at Malelane and EWR6 at Nkongoma, with on-site water quality samples taken on 13/11/07. DWAF monitoring points, X2H048Q01 at Malelane bridge and X2H050Q01 at Crocodile bridge, are present in this WQSU. Monitoring took place from 1983-2005.	Land-cover is urban areas and associated impacts, extensive irrigation of sugar-cane, Selati sugar mill, forestry, agriculture e.g. banana and citrus plantations, citrus processing, conservation activities i.e. KNP, recreation i.e. lodges.
Kaap River			
8	WQSU 7 is defined by the Kaap River from the confluence of the Noord and Suid Kaap to the confluence with the Crocodile River.	This stretch contains one EWR site, EWR7 at Honeybird, with on-site water quality samples taken on 13/11/08. DWAF monitoring points, X2H031Q01 on the Suidkaap at Bornmans Drift, and X2H022Q01 at Dolton on the Noord Kaap, area present above the WQSU, with monitoring from 1960-2007 and 1966-2007 respectively.	Land-cover is farming (e.g. paw-paws, bananas, sugar cane), sawmill and pole treating in the vicinity, and mining upstream. Pollution sources from upstream users include irrigation, urban areas and old gold mining activities.
Sabie River			
1	WQSU 1 stretches from the top of the catchment to Sabie town.		Land-use is predominantly forestry, plantations and some mining (e.g. quarries).
2 (MRU A)	WQSU 2 stretches from Sabie town to the confluence with the MacMac River.	This stretch contains one EWR site, EWR1 at Upper Sabie (below Sabie town), with on-site water quality samples taken on 15/11/07.	Land-use is forestry, plantations, irrigation of crops, urban settlements (e.g. Sabie town) and associated activities, including possible return flows from old mines.
3 (MRU A)	WQSU 3 stretches from the confluence with the MacMac River to Hazyview.	This stretch contains one EWR site, EWR2 at Aan de Vliet (before Hazyview), with on-site water quality samples taken on 15/11/07.	

WQSU NO. (MRU NO.)	DESCRIPTION AND MAP NO.	MONITORING POINTS	LAND USE ACTIVITIES
4 (MRU C)	WQSU 4 stretches from the confluence with the Marite River to the KNP border.		Land-cover is agriculture and urban / rural settlements with associated activities.
5 (MRU C)	WQSU 5 stretches from the KNP border to the confluence with the Sand River.	This stretch contains one EWR site, EWR3 at Kidney. DWAF monitoring point, X3H021Q01 at Kruger Gate, with monitoring from 1990-2007.	Conservation (KNP)
6 (MRU C)	WQSU 6 stretches from the confluence with the Sand River to the Mozambiquan border.	This WQSU contains one DWAF monitoring point, X3H015Q01 at Lower Sabie, with monitoring from 1986-2007.	Conservation (KNP)
Mutlumuvi / Sand River			
1 (MRU A, Mutlumuvi)	WQSU 1 (Mut) covers the Mutlumuvi River to the confluence with the Upper Sand River.	This WQSU contains one EWR site, EWR6 on the Mutlumuvi, with on-site water quality samples taken on 14/11/07.	Land-cover is forestry, extensive urban / rural settlements, and subsistence farming.
2 (MRU A, Sand system)	WQSU 2 (Sand) covers the upper Tlulandziteka tributary of the Sand River to the confluence with the Mutlumuvi River.	This WQSU contains one EWR site, EWR7 on the Tlulandziteka, with on-site water quality samples taken on 14/11/07.	Land-cover is extensive urban / rural settlements, forestry, subsistence farming and agriculture. Site is downstream of an instream dam.
3 (MRU B, Sand)	WQSU 3 (Sand) covers the Sand River from the confluence with the Mutlumuvi to the KNP border.	DWAF monitoring point, X3H008Q01 at Exeter, is found in this area, with monitoring from 1967-2007.	Land-cover is extensive urban / rural settlements, and subsistence farming.
4 (MRU B, Sand)	WQSU 4 (Sand) covers the Sand River within the KNP to the confluence with the Sabie River.	This WQSU contains one EWR site, EWR8 (Lower Sand) in the KNP.	Conservation (KNP).
Marite and MacMac rivers			
1 (MRU Marite)	WQSU 1 (Marite) covers the upper Marite River above Inyaka Dam.		Extensive forestry, rural settlements with associated activities.
2 (MRU Marite)	WQSU 2 (Marite) covers the Marite River below Inyaka Dam to the confluence with the Sabie.	This WQSU contains one EWR site, EWR5, with on-site water quality samples taken on 15/11/07. DWAF monitoring point, X3H011Q01, is found in this area.	Land-cover is extensive urban / rural settlements with associated activities, irrigation of crops, particularly extensive citrus cultivation.
1 (MRU MacMac)	WQSU 1 (MacMac) covers the MacMac River from the top of the catchment to the confluence with the Sabie.	This WQSU contains one EWR site, EWR4, with on-site water quality samples taken on 15/11/07.	Forestry, including commercial plantations and Venus sawmill.

3 DELINEATION RESULTS

3.1 CROCODILE RIVER (EAST) RESOURCE UNITS

3.1.1 Crocodile River (East) Natural Resource Units

The EcoRegions and geomorphic zones are described in the map below (Fig 3.1). Further subdivision in primary and secondary units are described and the rationale for all delineations are provided in Table 3.1. Derived from the EcoRegions and the geomorphic zones, the NaturalResource Units are delineated.

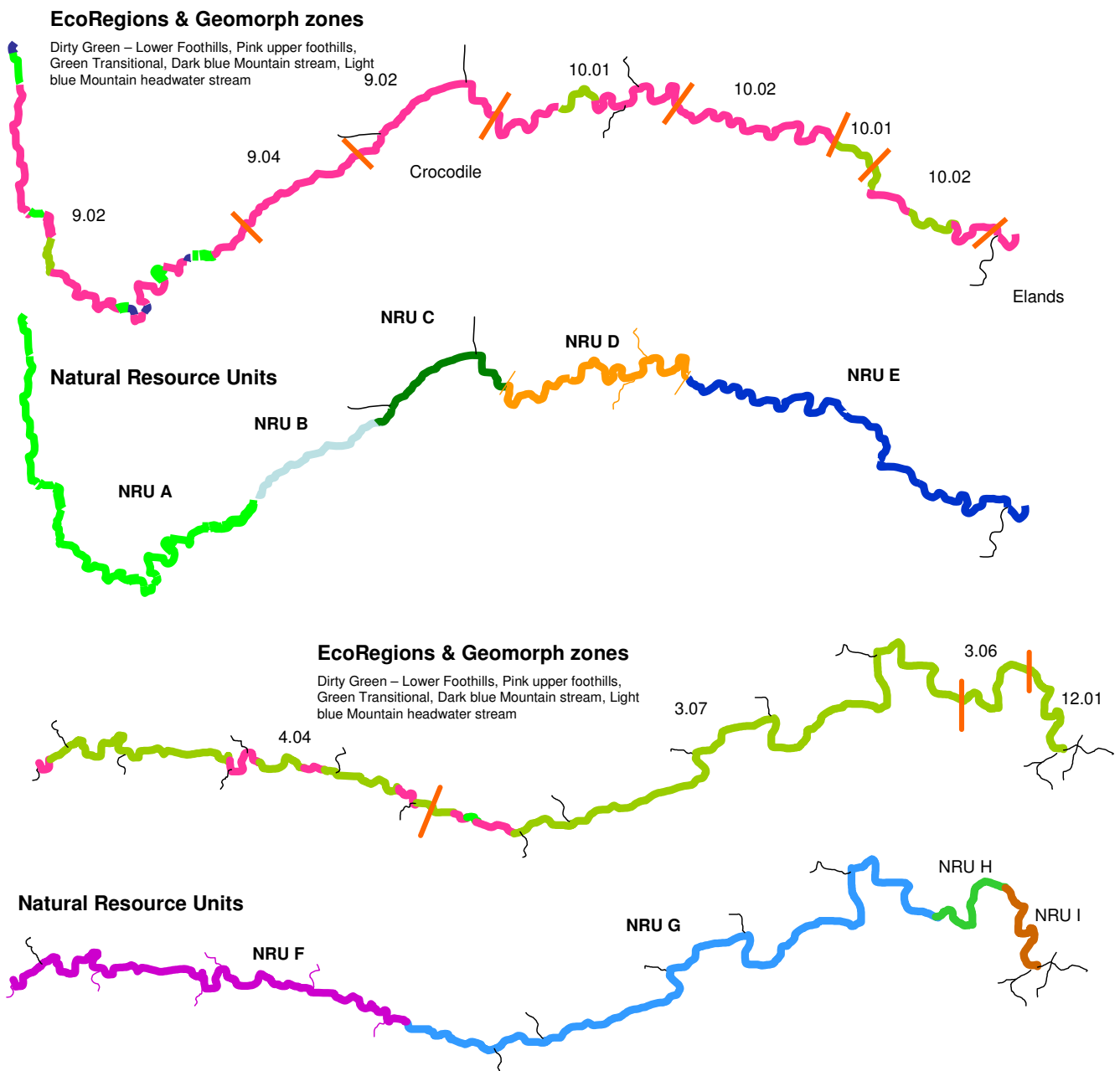


Figure 3.1 Natural Resource Units: Crocodile River

Table 3.1 Description and rationale for the Crocodile River Natural Resource Units

NRU	EcoRegion Level 2	Geomorphic zone	Rationale	Delineation
Primary NRU Croc A	9.02 (100%)	Mountain Stream (3%) Transitional (7%) Upper Foothills (87%) Lower Foothills (3%)	EcoRegions the major consideration and defines the NRU.	Origin of the river to the end of 9.02 30.1074;-25.3380. 30.2474;-25.4502
Primary NRU Croc B	9.04 (100%)	Upper Foothills (100%)	EcoRegions the major consideration and defines the NRU.	End of 9.02 to end of 9.04. 30.2474;-25.4502 30.3237; -25.4015
Primary NRU Croc C	9.02 (100%)	Upper Foothills (100%)	EcoRegions the major consideration and defines the NRU.	End of 9.04 to end of 9.02 30.3237; -25.4015 30.4024; -25.3783
Primary NRU Croc D	10.01	Upper Foothills (80%) Lower Foothills (10%)	EcoRegions the major consideration and defines the NRU.	End of 9.02 to end of 10.01 30.4024; -25.3783 30.5168;-25.3733
Primary NRU Croc E	10.02 10.01	Upper Foothills (60%) Lower Foothills (40%)	EcoRegions the major consideration and defines the NRU. The small section of 10.01 was deemed to short to warrant its own	End of 10.01 to Elands confluence 30.5168;-25.3733 30.7156; -25.4527
Primary NRU Croc F	4.04(100%)	Upper Foothills (30%) Lower Foothills (70%)	EcoRegions the major consideration and defines the NRU.	Elands confluence to end of 4.04. 30.7156;-25.4527 31.2089; -25.5103
Primary NRU Croc G	3.07 (100%)	Upper Foothills (8%) Lower Foothills (90%) Transitional (2%)	EcoRegions the major consideration and defines the NRU.	End of 4.04 to end of 3.07. 31.2089; -25.5103 31.8509; - 25.3777
Primary NRU Croc H	3.06 (100%)	Upper Foothills (100%)	EcoRegions the major consideration and defines the NRU.	End of 3.07 to end of 3.06. 31.8509;-25.3777 31.9359; -25.3390
Primary NRU Croc I	12.01	Lower Foothills (100%)	EcoRegions the major consideration and defines the NRU.	End of 3.06 to Komati confluence 31.9359; -25.3390 31.9766; -25.4377

3.1.2 Crocodile River (East) Management Resource Units

The river is divided into MRUs and illustrated in Figure 3.2. The description of the MRUs and the rationale for selection is provided in Table 3.2.

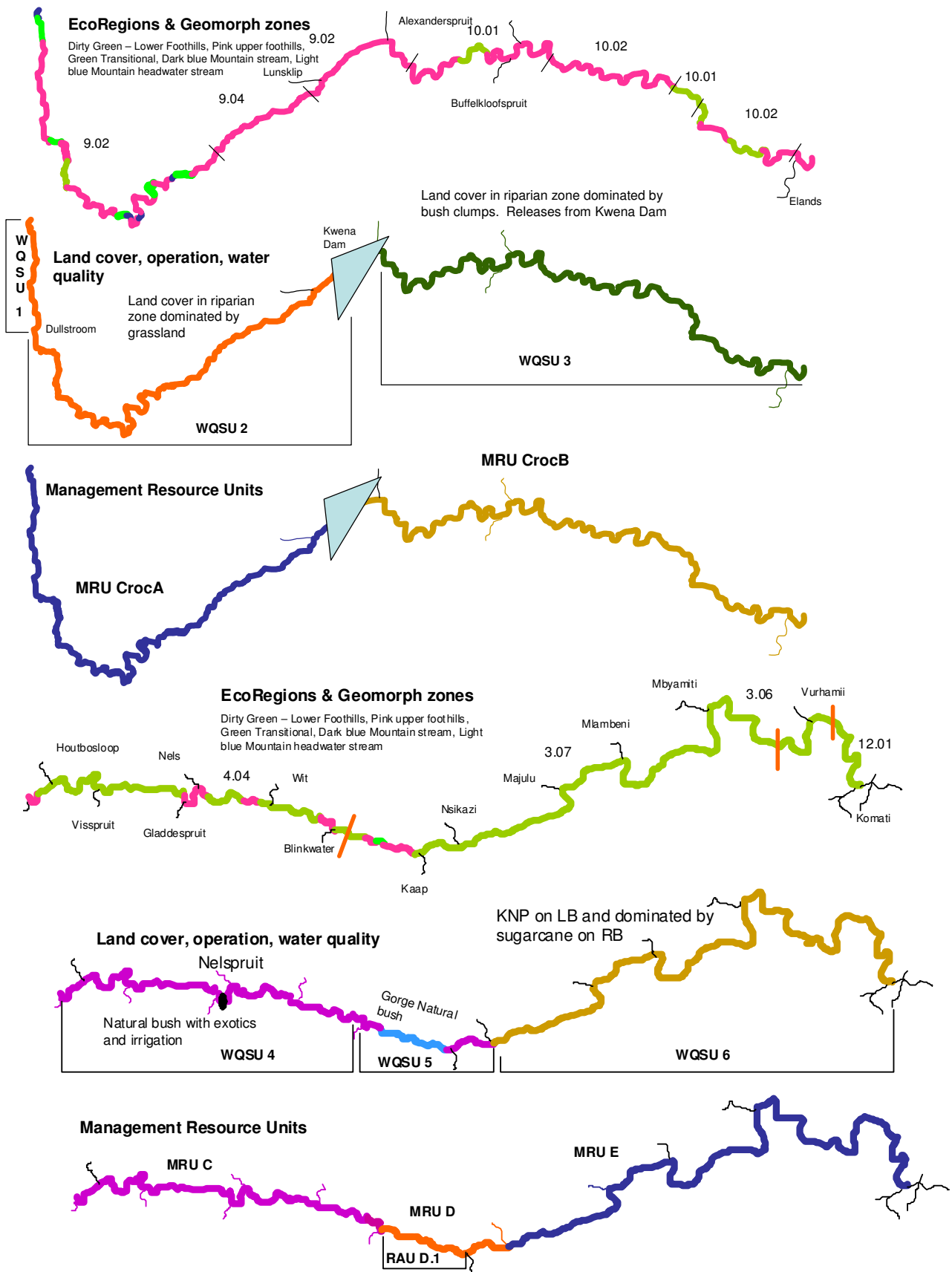


Figure 3.2 Crocodile River Management Resource Units

Table 3.2 Description and rationale of the Crocodile River Management Resource Units

MRU	EcoRegion Level 2	Geomorphic zone	Land cover 500 m both banks	Rationale	Delineation	Quat
MRU Croc A	9.02 (70%) 9.04 (30%)	Mountain Stream (1%) Transitional (6%) Upper Foothills (90%) Lower Foothills (3%)	Dominated by grassland	The river is dominated by EcoRegion 9.02 and Upper Foothills, has similar land cover and land use and includes to WQSU (1 & 2). The Kwena Dam is the operational break in the MRU. The MRU = primary NRU A, B and C.	Origin of river to upper reaches of Kwena Dam 30.1074;-25.3380. 30.3443;-25.3821	X21A X21B
MRU Croc B	10.02 (15%) 4.04 (5%) 3.07 (80%)	Lower foothills (20%) Upper foothills (80%)	Riparian zone dominated by bush clumps. Operation to Elands River dominated by releases (unseasonal) from Kwena	The river is dominated by EcoRegion 3.07, & Upper Foothills. The releases from Kwena Dam forms a change from the natural hydrology and 1 EWR site in this reach will represent the reach. Water quality is homogenous. The Elands River (largest tributary) forms a hydrological break as it introduces a more natural diversity of flow at times. The MRU = primary NRU C and E = WQSU3.	Kwena Dam Wall to the Elands River confluence 30.3862; -25.3590. 30.7156; -25.4527	X21D X21E
MRU Croc C	4.04 (100%)	Upper Foothills (2%) Lower Foothills (98%)	Riparian indigenous bush with exotics and irrigation	Consists of EcoRegion 4.04 & Lower Foothills. Land cover & use similar with Nelspruit & adjacent KaNyamazane a logical break due to water quality impacts. (forms 1 WQSU 4). The MRU= primary NRU F=WQSU 4	Elands River confluence to Blinkwater confluence 30.7156;-25.4527 31.18018; -25.4996	X22B X22C X22J X22K
MRU Croc D	3.07 (100%)	Upper Foothills (47%) Lower Foothills (47%) Transitional (6%)	Riparian indigenous bush with exotics .	Breaks are indicated by change in land use and a distinctive gorge. The lower border indicates the change of sugarcane on the RB and Kruger Park on the LB.	Blinkwater confluence to border of KNP 31.18018; - 25.499631.3714; - 5.5278	X22K X24C
RAU Croc D.1	3.06 (100%)	Upper Foothills (90%) Lower Foothills (9%) Transitional (1%)	Gorge with a railway and tar roads flanking it with indigenous riparian bush with exotics	This section of river is protected by being flanked by mountains. Ecological indicators more intact. The steeper gradient makes this section more sensitive to decreased flows and an EWR site within this section will be recommended	Gorge 31.2026 -25.5090 31.3164; -25.5328	X22K X24C
MRU Croc E	3.06 (15%) 3.07 (70%) 12.01 (15%)	Lower Foothills (100%)	Natural bush (KNP) on LB and irrigation/lodges on RB	RU consist of Lower Foothills and the same land cover & use and water quality. The logical breaks are therefore from the point where the KNP borders the Crocodile River to the Komati River confluence	KNP border to Komati confluence 31.3714; -25.5278 31.9359; -25.3390	X24D X24E X24F X24H

All the MRUs are illustrated on maps in Figures 4.1 and 4.2.

3.2 KAAP RIVER RESOURCE UNITS

3.2.1 Kaap River Natural Resource Units

The EcoRegions and geomorphic zones are described in the map below (Fig 3.3). Further subdivision in primary and secondary units are described and the rationale for all delineations are provided in Table 3.3. The NRUs are derived from the EcoRegions and the geomorphic zones.

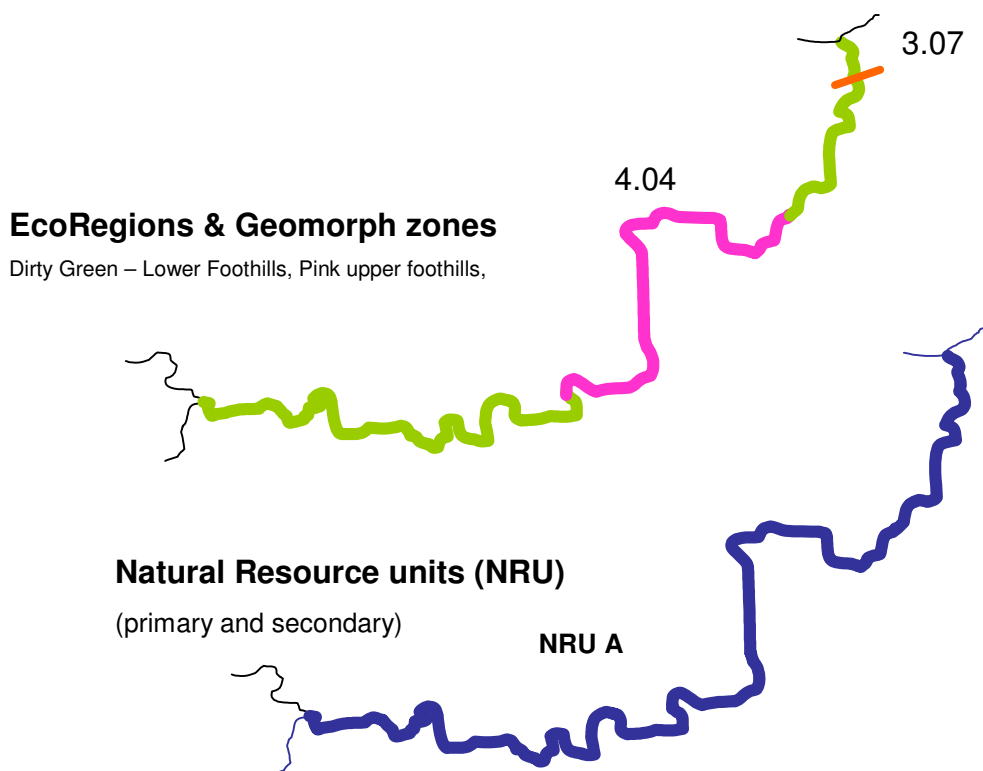


Figure 3.3 Kaap River Natural Resource Units

Table 3.3 Description and rationale for the Kaap River Natural Resource Units

NRU	EcoRegion Level 2	Geomorphic zone	Rationale	Delineation
Primary NRU Kaap A	4.04 (98%) 3.07 (2%)	Upper Foothills (30%) Lower Foothills (70%)	EcoRegions the major consideration and defines the NRU.	Confluence of the Noord and Suid Kaap to confluence with the Crocodile. 31.0838; -25.6659 31.3120; -25.5371

3.2.2 Kaap River Management Resource Units

The river is divided into MRUs and illustrated in Figure 3.4. The description of the MRUs and the rationale for selection is provided in Table 3.4.

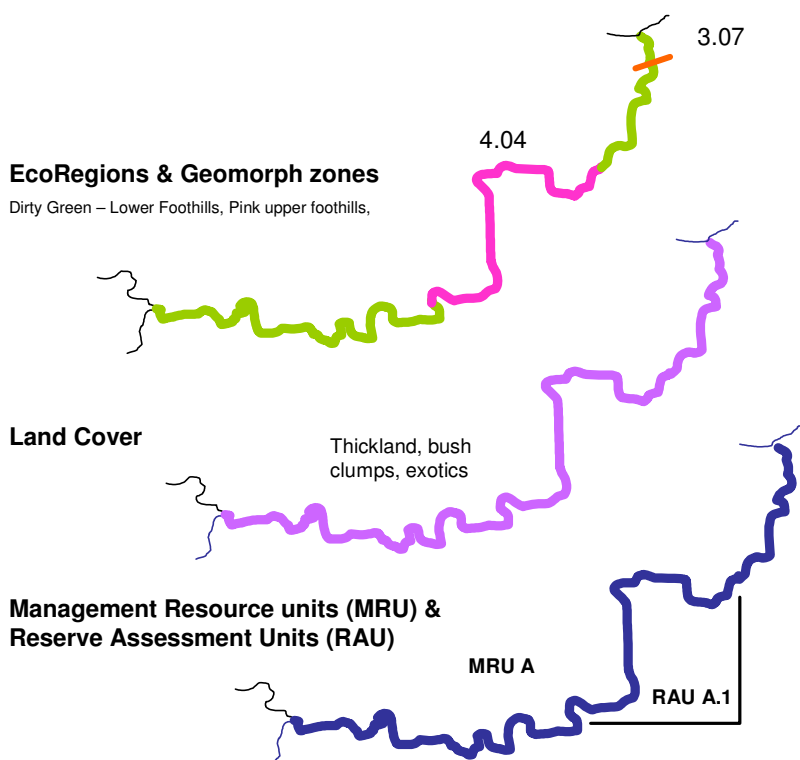


Figure 3.4 Kaap River Management Resource Units

Table 3.4 Description and rationale for the Kaap River Management Resource Units

MRU	EcoRegion Level 2	Geomorphic zone	Land cover 500 m both banks	Rationale	Delineation	Quat
MRU Kaap A	4.04 (98%) 3.07 (2%)	Upper Foothills (30%) Lower Foothills (70%)	Thickets, bush clumps, exotics bush	The river is dominated by EcoRegion 4.04 and Lower Foothills, has similar land cover and land use. The NRU = MRU A = WQSU 7	Confluence of the Noord and Suid Kaap to confluence with the Crocodile. 31.0838; -25.6659 31.3120; -25.5371	X23G X23H
RAU Kaap A.1	4.04 (100%)	Upper Foothills (100%)	Gorge	This area forms an inaccessible gorge as indicated by the different geomorphic zone. This section could be a different (higher) PES than the rest of the unit and it would therefore be preferable to select an EWR site within this RAU (depending on access). An EWR set here will cater for the rest of the MRU.	Start and end of Upper Foothills 31.2126;-25.6609 31.2920;-25.6003	X23H X23G

All the MRUs are illustrated in Fig 4.1 and 4.2.

3.3 SABIE RIVER DELINEATION

The MacMac and Marite rivers were not delineated as the borders of the management resource units were obvious. The Marite river is delineated upstream by the Inyaka dam. The MacMac river is delineated upstream by the MacMac falls.

3.3.1 Sabie River Natural Resource Units (Primary and Secondary)

The EcoRegions and geomorphic zones are described in the map below (Fig 3.5). Further subdivision in primary and secondary units is described and the rationale for all delineations are provided in Table 3.5. The Natural Resource Units are derived from the EcoRegions and the geomorphic zones.

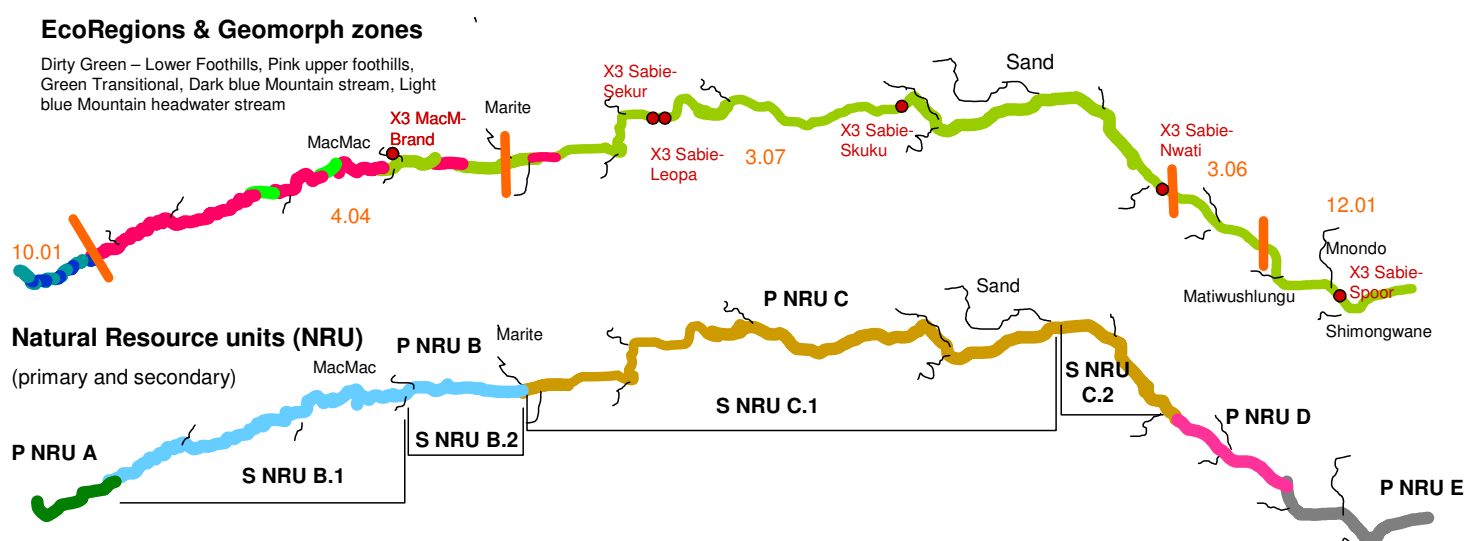


Figure 3.5 Sabie River Natural Resource Units

Table 3.5 Description and rationale for the Sabie River Natural Resource Units

NRU	EcoRegion Level 2	Geomorphic zone	Rationale	Delineation
Primary NRU Sabie A	10.01 (100%)	Mountain Headwater Stream (50%) and Mountain Stream (50%)	EcoRegions the major consideration and defines the NRU.	Origin of the river to the end of 10.01 30.6224; -25.1420 30.7406; -25.1057
Primary NRU Sabie B	4.04 (100%)	Transitional (10%) Upper Foothills (80%) Lower Foothills (10%)	EcoRegions the major consideration and defines the NRU. Geomorphic zone dominated by Upper Foothills	Marite confluence (start of 3.07 EcoRegion) to Kruger Gate. 31.1456; -25.1521 31.250; -25.0178
Secondary NRU Sabie B.2	4.04 (100%)	Upper Foothills (20%) Lower Foothills (80%)	A secondary NRU was identified within NRU B which is due to a different dominance of geomorphic zone and the inflow of the Mac-Mac, one of the major tribs.	MacMac confluence to Marite confluence 31.0258; -25.0295 31.1456; -25.0230
Secondary NRU Sabie B.1	The rest of the Primary NRU B			

NRU	EcoRegion Level 2	Geomorphic zone	Rationale	Delineation
Primary NRU Sabie C	3.07 (100%)	Lower Foothills (100%)	EcoRegions the major consideration and defines the NRU. One geomorphic zone.	Start and end of EcoRegion 3.07 31.1267; -25.0291 31.8343; -25.0666
Secondary NRU Sabie C.2	3.07 (100%)	Lower Foothills (100%)	The Sand River comes in with a different hydrology (lower flows – dryer catchment) and brings in a lot of sand.	Start of the Sand River and end of 3.07 31.7136; -24.9552 31.8343; -25.0666
Secondary NRU Sabie C.1	The rest of the Primary NRU C			
Primary NRU Sabie D	3.06 (100%)	Lower Foothills (100%)	EcoRegions the major consideration and defines the NRU. One geomorphic zone	Start and end of EcoRegion 3.06 31.8343; -25.0666 31.9335; -25.1222
Primary NRU Sabie E	12.01 (100%)	Lower Foothills (100%)	EcoRegions the major consideration and defines the NRU. One geomorphic zone	Start and end of EcoRegion 12.01 31.9335; -25.1222 32.0307; -25.1815

3.3.2 Sabie River Management Resource Units

The river is divided into MRUs and illustrated in Figure 3.6. The description of the MRUs and the rationale for selection is provided in Table 3.6. The sites illustrated in pink are National and Provincial River Health sites.

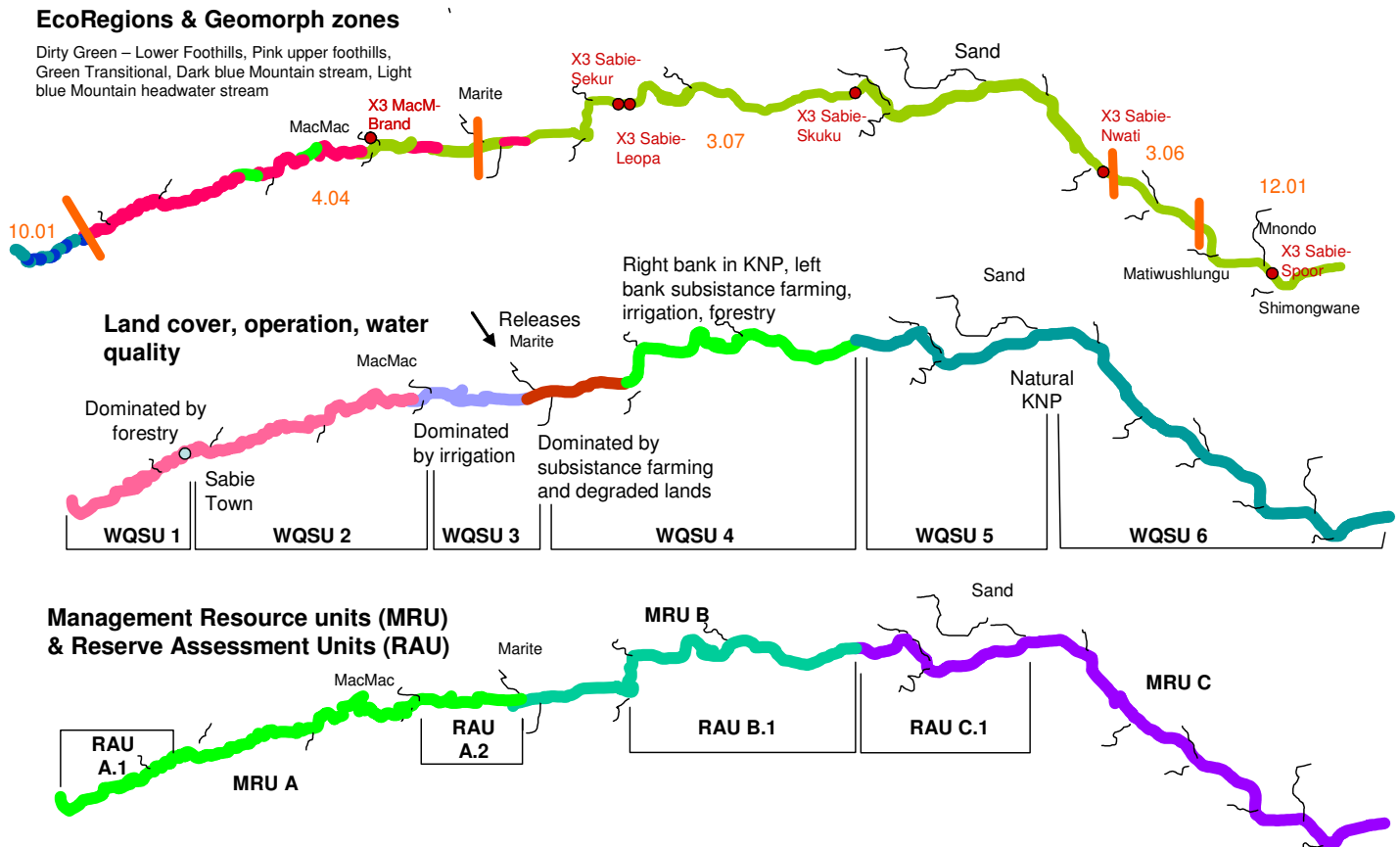


Figure 3.6 Management Resource Unit

Table 3.6 Description and rationale for Management Resource Units

MRU	EcoRegion Level 2	Geomorphic zone	Land cover 500 m both banks	Rationale	Delineation	Quat
MRU Sabie A	10.01 (15%) 4.04 (75%)	Mountain Headwater Stream and Mountain Stream (15%) Transitional (10%) Lower foothills (5%) Upper foothills (70%)	Dominated by forestry	Dominated by Upper foothills with a small section of mountain headwater mixed with Mountain stream. Approximately 75% of the unit falls into EcoRegion 4.04. Land cover is mostly forestry with some natural areas in the upper catchment. Sabie town is situated in the upper reaches.	Origin of the river to the Marite confluence. 30.6224; -25.1420 31.1456; -25.1521 NRU A is combined with NRU as NRU A is too short to warrant its own RU.	X31A X31B X31D
RAU Sabie A.1	10.01 (100%)	Mountain Headwater Stream (50%) and Mountain Stream (50%)	Land cover dominated by natural fynbos.	This area is likely in excellent condition as minimal impacts apart from forestry. This section therefore in a different EcoStatus than the RU and, as it is a small river in this section, will require a different EWR. Recommendation: As there is unlikely to be any demand on this section, no EWR site and EcoClassification recommended.	Source of river to end of the Mountain Stream. 30.6224; -25.1420 30.6535; -25.1521 RAU Sabie A.1 = NRU Sabie A	X31A
RAU Sabie A.2	4.04 (100%)	Upper Foothills (20%) Lower Foothills (80%)	Land cover dominated by forestry	Critical area downstream of Mac-Mac due to dilution effect to ameliorate Sabie impacts. EcoStatus could be in a higher category than the river downstream of Sabie Town. EWR site will cater for the rest of the RU. Recommendation: If a site meeting to EWR site criteria can be found, it is recommended that it be situated between the MacMac and the Marite. The EcoClassification must be undertaken for this section.	Mac-Mac confluence to Marite confluence 31.0258; -25.0295 31.1456; -25.0230 RAU Sabie A.2 = NRU Sabie B.2	X31D
MRU Sabie B	3.07 (100%)	Lower Foothills (95%) Upper Foothills (5%)	Dominated by irrigation. About 70% includes the KNP on the right bank.	RU represents a smaller section than the 3.07 EcoRegion and the Lower Foothills zone due to the change of land use at the KNP entrance. From this point the Sabie falls wholly within the KNP.	Marite confluence (start of 3.07 EcoRegion) to KNP entrance. 31.1456; -25.1521 31.48601,-24.98177	X31K X31M
RAU Sabie B.1	3.07 (100%)	Lower Foothills (100%)	The KNP on the RB with irrigation and recreational areas on LB.	Better condition than rest of the MRU as the river borders the KNP and is mostly enclosed in the KNP. Recommendation: EWR site in this MRU be situated within the RAU.	Point where river forms border of KNP to Kruger gate. 31.24485; -25.0187 31.48601,-24.98177	X31K X31M
MRU Sabie C	3.07 (60%) 3.06 (20%) 12.01 (20%)	Lower Foothills (100%)	All relatively natural as in the KNP	Logical RU due to homogeneity of landuse and similar geomorphic zone.	Kruger Gate to border of KNP with Mozambique 31,250; -25.0178 32,0307; 25,1815	X33A X33B X33D X31M
RAU Sabie C.1	3.07 (100%)	Lower Foothills (100%)	All relatively natural as in the KNP	The inflow from the Sand brings about subtle changes as more alluvial than the Sabie. Prior to the 2000 floods, the Sabie upstream of the confluence was much rockier and therefore provided more critical habitat. Recommendation: The critical habitat is still present, and, the EWR site should be situated in the RAU.	Kruger Gate to Sand confluence 31,250; -25.0178 31,7136 ; -24,9552 RAU Sabie C.1 = NRUC.2	X31M

All the MRUs are illustrated on maps in Figure 4.1 and 4.2.

3.4 SAND RIVER DELINEATION

3.4.1 Sand River Natural Resource Units (Primary and Secondary)

The EcoRegions and geomorphic zones are described in the map below (Fig 3.7). Further subdivision in primary and secondary units are described and the rationale for all delineations are provided in Table 3.7. The Natural Resource Units are derived from the EcoRegions and the geomorphic zones.

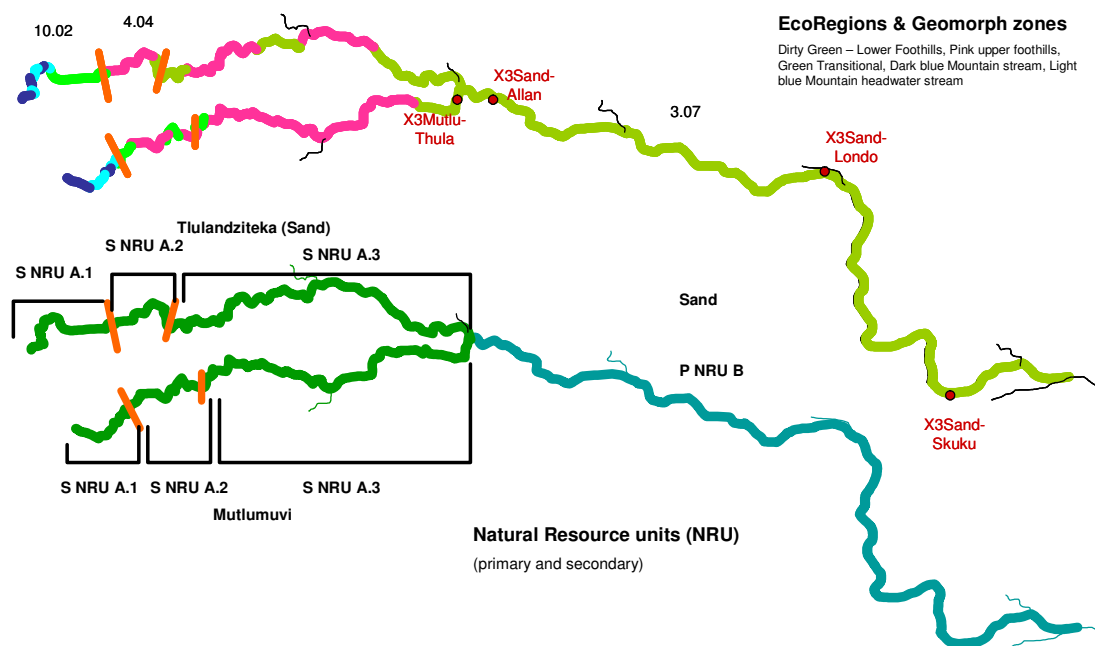


Figure 3.7 Sand River Natural Resource Units

Table 3.7 Description and rationale for Sand River Natural Resource Units

NRU	EcoRegion Level 2	Geomorphic zone	Rationale	Delineation
Secondary NRU Sand A.1	10.02 (100%)	Mountain Stream and Mountain Headwater Stream (80%) Transitional (60%)	The upper Sand River (Tlulandziteka) forms the primary NRU dominated by EcoRegion 3.07. Two other EcoRegions are present in the primary NRU, but as they are reasonably short, they form secondary NRUs rather than a division within 3 Primary NRUs. The NRU A.1 consists of the 10.02 EcoRegion which forms the boundary.	Origin of the river to end of 10.02 EcoRegion 30.8900; -24.7333 30.9468; -24.7083
Secondary NRU Sand A.2	4.04 (100%)	Upper Foothills (100%)	EcoRegions the major consideration and defines the Secondary NRU. One geomorphic zone	Start and end of EcoRegion 4.04 30.9468; -24.7083 30.9975; -24.7089
Secondary NRU Sand A.3	3.07 (100%)	Upper Foothills (45%) Lower Foothills (55%)	EcoRegion the major consideration and defines the Secondary NRU.	Start of 3.07 to confluence with Mutlumuvi 30.9975; -24.7089 31.2338; -24.7221
Secondary NRU Mut A.1	10.02 (100%)	Mountain Stream and Mountain Headwater Stream (95%) Transitional (5%)	The Mutlumuvi forms the primary NRU dominated by EcoRegion 3.07. The situation is similar to that described for the Upper Sand.	Origin of the river to end of 10.02 EcoRegion 30.9243; -24.7921 30.9562; -24.7877

Secondary NRU Mut A.2	4.02 (100%)	Upper Foothills (70%) Transitional (30%)	EcoRegions the major consideration and defines the Secondary NRU.	Start and end of EcoRegion 4.04 30.9562; -24.7877 31.0231; -24.7577
Secondary NRU Mut A.3	3.07 (100%)	Upper Foothills (85%) Lower Foothills (15%)	EcoRegion the major consideration and defines the Secondary NRU.	Start of EcoRegion 3.07 to confluence with Sand 31.0231; -24.7577 31.2338; -24.7221
Primary NRU Sand B	3.07 (100%)	Lower Foothills (100%)	EcoRegions the major consideration and defines the NRU. One geomorphic zone	Confluence of Mutlumuvi to Confluence with the Sabie 31.2338; -24.7221 31.7120; -24.9559

3.4.2 Sand River Management Resource Units

The river is divided into MRUs and illustrated in Figure 3.8. The description of the MRUs and the rationale for selection is provided in Table 3.8.

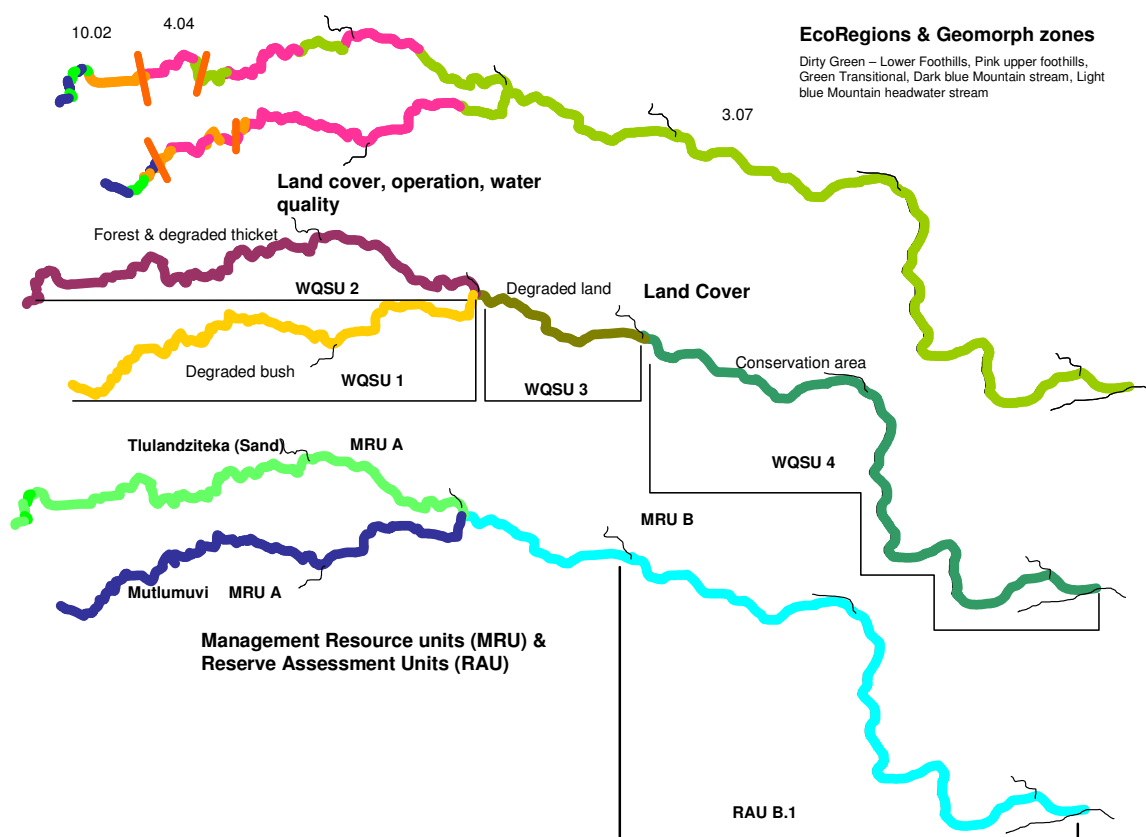


Figure 3.8 Sand River Management Resource Units

Table 3.8 Description and rationale for Sand River Management Resource Units

MRU	EcoRegion Level 2	Geomorphic zone	Land cover 500m both banks	Rationale	Delineation	Quat
MRU Sand A	10.02 (15%) 4.04 (5%) 3.07 (80%)	Mountain Headwater Stream (5%) Mountain Stream (5%) Transitional (10%) Lower foothills (40%) Upper foothills (40%)	Indigenous forest and degraded bush	The river is dominated by EcoRegion 3.07, has similar land cover and land use. The upper river will be different, but this will not warrant a separate RAU as too small. The confluence of the Mutlumuvi river forms a logical end of the MRU due to the change in hydrology. The MRU = primary NRU = WQSU 2.	Origin of river to confluence with Mutlumuvi 30.8900; -24.7333 31.2338; -24.7221	X32A X32C

MRU	EcoRegion Level 2	Geomorphic zone	Land cover 500m both banks	Rationale	Delineation	Quat
MRU Mutlumuvi A.	10.02 (15%) 4.04 (5%) 3.07 (80%)	Mountain Headwater Stream (2.5%) Mountain Stream (2.5%) Transitional (2%) Lower foothills (8%) Upper foothills (85%)	Degraded bush	The river is dominated by EcoRegion 3.07, Upper Foothills and degraded bush. The upper river will be different, but this will not warrant a separate RAU as to small. The confluence with the Sand River forms a logical end of the MRU due to the change in hydrology. The MRU = primary NRU = WQSU1.	Origin of river to confluence with Sand 30.9243; -24.7921 31.2338; -24.7221	X32D X32F
MRU Sand B	3.07 (100%)	Lower Foothills (100%)	Mostly within the conservation areas with the upper areas of the MRU covered with the degraded bush	The river is dominated by EcoRegion 3.07, and conservation areas. Includes both WQSU 3 & 4.	Confluence with the Mutlumuvi to the confluence with the Sabie 31.2338; -24.7221 31.7120; -24.9559	X32G X32H X32J
RAU Sand B.1	3.07 (100%)	Lower Foothills (100%)	Within the conservation areas	A RUA was selected due to the change in the landuse. The RAU will be a different (higher) PES than the rest of the MRU due to its protected status. It would be preferable to have a EWR situated in this section as the indicators for EWR assessment will be intact and catering for this RAU will also cater for the rest of the MRU. RAU B.1 = WQSU4	Border of Sabie Sand to confluence with the Sabie 31.3576-24.7539 31.7120; -24.9559	X32G X32H X32J

All the MRUs are illustrated on maps in Figures 4.1 and 4.2.

4 EWR SITE SELECTION

4.1 CRITERIA FOR SITE SELECTION

EWR sites (previously called IFR sites) are selected through a multi-disciplinary process consisting of evaluating an aerial video (if available) or Google Earth images of the river to identify a range of possible sites, and groundtruthing to make a final selection from the various options. An EWR site consists of a length of river which includes one or various cross-sections for both hydraulic and ecological purposes (modified from Louw *et al.*, 1999).

EWRs are determined at each of the EWR sites, and it is therefore vital that:

- The sites are selected to provide as much information as possible about the variety of conditions in a river reach.
- The specialists that need to use these sites to set flow requirements for their discipline can relate to the habitat the sites represented.
- The persons involved in selecting the sites understand and are experienced in the use of sites in EWR studies.

The selection of EWR sites is guided by a number of considerations, including:

- The locality of gauging weirs with good quality hydrological data.
- The locality of the proposed and existing developments.
- The locality and characteristics of tributaries.
- The habitat integrity or PES of the different river reaches.
- The boundaries of Level II EcoRegions within the study area.
- The reaches where people depend directly on a healthy river ecosystem.
- The suitability of the sites for follow-up monitoring.
- The locality of geomorphologically representative sites.
- The habitat diversity for aquatic organisms, marginal and riparian vegetation.
- **The suitability of the sites for accurate hydraulic modelling throughout the range of possible flows, especially low flows.**
- **Accessibility of the sites.**
- **An area or site that could be critical for ecosystem functioning. These are often represented by riffle units, where low flow conditions or the cessation of flow constitutes a break in the functioning of the river, and consequently, the biota dependant on this habitat and/or perennial flow are adversely affected. Pools are not considered critical habitats in perennial system since they are still able to function or at least maintain life during periods of no flow.**

The criteria in bold are the most important and therefore the overriding criteria.

4.2 CROCODILE EWR SITES

During a previous Intermediate EWR study (Godfrey, 2002), 6 EWR sites in the Crocodile River and one in the Kaap River were selected. Due to the hydraulics and biological information available, these EWR sites would be used in this study if the benchmarks could be found. The sites were visited and the benchmarks were all found.

4.2.1 Locality and description of sites


The locality of the EWR sites within the MRUs as identified during this study is provided in Table 4.1.





Table 4.1 MRUs and EWR sites



MRUs	Recommendation (see chapter 3)	EWR site
Crocodile River		
MRU A	One EWR site	EWR1 - Valyspruit EWR2 - Goedenhoop Two EWR sites originally selected. Both serve a purpose as the one is upstream in the more grassveld wetland type area whereas the downstream one is situated immediately upstream of the dam, i.e. it represents all upstream impacts
MRU B	One EWR site	EWR3 – Poplar Creek The releases from Kwena Dam forms a change from the natural hydrology and one EWR site will represent the reach.
MRU C	One EWR site	No EWR site is situated in this RU. During a 1999 study and the 2002 study (Godfrey 2002), no site suitable for EWR assessment, especially from a hydraulic viewpoint, could be found.
MRU D	The steeper gradient makes the RAU more sensitive to decreased flows and an EWR site within this section will be recommended	EWR 4: KaNyamazane Site is situated at the start of RAU D1. No site further downstream in the RAU was available.
MRU E	One EWR site	EWR 5 – Malelane EWR 6 – Nkongoma Two sites were originally selected. Due to the increasing impacts between the sites, both sites play an important role in the management of the system
Kaap River		
MRU A	One EWR site in the RAU as it could be a higher PES than the rest of the RU due to the presence of indicators for EWR assessment	EWR 7 – Kaap Site is situated at the entrance of the gorge in the RAU.

The locality and characteristics of the EWR sites are provided in Table 4.2.

Table 4.2 Locality and characteristics of the Crocodile EWR sites.

Site information	EWR sites	Illustration
<i>EWR nr & name</i> <i>River</i> <i>Previous IFR site</i> <i>National RHP site</i> <i>Decimal Degrees</i> <i>Decimal Minutes</i> <i>EcoRegion (Level II)</i> <i>Geomorphic Zone</i> <i>Altitude (m)</i> <i>RU</i> <i>Quaternary</i> <i>Farm name</i> <i>Hydrological gauge</i>	EWR 1 Valyspruit Crocodile EWR 1 X2Croc-Valys -25.49412, 30.14427 S25 29.647, E30 08.656 9.02 Upper Foothills 1852 MRU Croc A X21A Valyspruit -	

Site information	EWR sites	Illustration
<p><i>EWR nr & name</i> <i>River</i> <i>Previous IFR site</i> <i>National RHP site</i> <i>Decimal Degrees</i> <i>Decimal Minutes</i> <i>EcoRegion (Level II)</i> <i>Geomorphic Zone</i> <i>Altitude (m)</i> <i>RU</i> <i>Quaternary</i> <i>Farm name</i> <i>Hydrological gauge</i></p>	<p>EWR 2 Goedenhoop Crocodile EWR 2 X2CROC-UKWEN -25.40925, 30.31592 S25 24.555, E30 18.955 9.04 Upper Foothills 1207 MRU Croc A X21B Goedenhoop -</p>	
<p><i>EWR nr & name</i> <i>River</i> <i>Previous IFR site</i> <i>National RHP site</i> <i>Decimal Degrees</i> <i>Decimal Minutes</i> <i>EcoRegion (Level II)</i> <i>Geomorphic Zone</i> <i>Altitude (m)</i> <i>RU</i> <i>Quaternary</i> <i>Farm name</i> <i>Hydrological gauge</i></p>	<p>EWR 3 Poplar Creek Crocodile EWR 3 X2CROC-DKWEN -25.45211, 30.68108 S25 27.127, E30 40.865 10.02 Lower Foothills 834 MRU Croc B X21E Mooifontein X2H013</p>	
<p><i>EWR nr & name</i> <i>River</i> <i>Previous IFR site</i> <i>National RHP site</i> <i>Decimal Degrees</i> <i>Decimal Minutes</i> <i>EcoRegion (Level II)</i> <i>Geomorphic Zone</i> <i>Altitude (m)</i> <i>RU</i> <i>Quaternary</i> <i>Farm name</i> <i>Hydrological gauge</i></p>	<p>EWR 4 KaNyamazane Crocodile EWR 4 X2CROC-DNELS -25.50243, 31.18198 S25 30.146, E31 10.919 4.04 Lower Foothills 472 MRU Croc D X22K State ground X2H032</p>	
<p><i>EWR nr & name</i> <i>River</i> <i>Previous IFR site</i> <i>National RHP site</i> <i>Decimal Degrees</i> <i>Decimal Minutes</i> <i>EcoRegion (Level II)</i> <i>Geomorphic Zone</i> <i>Altitude (m)</i> <i>RU</i> <i>Quaternary</i> <i>Farm name</i> <i>Hydrological gauge</i></p>	<p>EWR 5 Malelane Crocodile EWR 5 X2CROC-MALEL -25.48287, 31.50773 S25 28.972, E31 30.464 3.07 Lower Foothills 286 MRU Croc E X24D KNP S2H046</p>	

Site information	EWR sites	Illustration
<i>EWR nr & name</i> <i>River</i> <i>Previous IFR site</i> <i>National RHP site</i> <i>Decimal Degrees</i> <i>Decimal Minutes</i> <i>EcoRegion (Level II)</i> <i>Geomorphic Zone</i> <i>Altitude (m)</i> <i>RU</i> <i>Quaternary</i> <i>Farm name</i> <i>Hydrological gauge</i>	EWR 6 Nkongoma Crocodile EWR 6 X2CROC-NKONG -25.39050,31.97444 S25 23.430, E31 58.467 12.01 Lower Foothills 135 MRU Croc E X24H KNP X2H016	
<i>EWR nr & name</i> <i>River</i> <i>Previous IFR site</i> <i>National RHP site</i> <i>Decimal Degrees</i> <i>Decimal Minutes</i> <i>EcoRegion (Level II)</i> <i>Geomorphic Zone</i> <i>Altitude (m)</i> <i>RU</i> <i>Quaternary</i> <i>Farm name</i> <i>Hydrological gauge</i>	EWR 7 Honeybird Kaap EWR 7 X2Kaap-Honey -25.64947, 31.24286 S25 38.968, E31 14.572 4.04 Upper Foothills 470 MRU Kaap A X23H Lovedale -	

The locality of sites is illustrated in Figure 4.1.

4.2.2 Site suitability

The site suitability of each site was assessed and is provided in Table 4.3 and 4.4. The detail assessment per component is provided in Appendix B. All scores are out of 5 with 5 referring to very high suitability.

Table 4.3 Biophysical Site suitability for the Crocodile system

EWR sites	Geomorph	Riparian veg	Fish	Inverts	Average	Median	Max	Min	Comments
EWR 1	3.8	3.9	2.5	3.4	3.4	3.4	3.90	2.5	Fish is lower suitability as only semi reophyllics are naturally present. This provides difficulties for setting flow requirements for fish during the dry season. This does not mean that there are better sites available.
EWR 2	3.5	4.1	4.0	3.8	3.9	3.9	4.10	3.5	Not easy to relate geomorphological cues to cross-section
EWR 3	3.8	4.2	4.5	3.6	4.0	4.0	4.50	3.6	Lack of diverse hydraulic habitat for invertebrates.
EWR 4	3.6	4.2	4.0	4.0	4.0	4.0	4.20	3.6	Disturbed banks problematic for geomorphological assessment

EWR sites	Geomorph	Riparian veg	Fish	Inverts	Average	Median	Max	Min	Comments
EWR 5	3.4	4.2	3.5	4.1	3.8	3.8	4.30	3.4	No clear terraces present - problematic for geomorph assessment
EWR 6	3.3	4.0	4.0	3.7	3.8	3.8	4.00	3.3	No clear terraces present - problematic for geomorph assessment
EWR 7	3.0	3.6	4.5	4.3	3.9	3.9	4.50	3	Impacts worse at site than rest of RU, bridge has impact, presence of bedrock - problematic for geomorph assessment

The above table illustrates the site suitability from a biophysical point of view. Any comments regarding outliers are also provided. From a biophysical point of view, the sites were mostly high suitability.

Hydraulic suitability is however crucial as this converts the biophysical requirements to flow. For the purposes of determining flow requirements, the low flows and high flows are evaluated separately. Geomorphology and vegetation usually are the most crucial components for high flows and fish and invertebrate for low flows.

The suitability of the sites are therefore evaluated for both low and high flows and compared to the corresponding suitability for low and high flow hydraulics. It must be noted that the hydraulic suitability is much higher than normal. This is because the sites were selected previously, and good calibrations have already been obtained.

Table 4.4 Integrated Site suitability for the Crocodile system

EWR SITES	Biophysical Hydraulics				Suitability		Comment
	Low flows	High flows	Low flows	High flows	Low flows	High flows	
EWR 1	4	3	4	5	4	4	Highly suitable from both low and high flow perspective and both biophysical and hydraulic perspective
EWR 2	4	4	4	4	4	4	Highly suitable from both low and high flow perspective and both biophysical and hydraulic perspective
EWR 3	4	4	3	4	4	4	Highly suitable from both low and high flow perspective and both biophysical and hydraulic perspective
EWR 4	4	4	3	3	3	4	Highly suitable for high flows, slightly less suitable for low flows due to the complicated hydraulics. A low flow cross-section might have to be added to address the complications associated with the very steep rapid selected during the previous studies.
EWR 5	4	4	4	5	4	4	Highly suitable from both low and high flow perspective and both biophysical and hydraulic perspective
EWR 6	4	4	2	4	3	4	Highly suitable for high flows, slightly less suitable for low flows due to the complicated hydraulics.
EWR 7	3	4	2	2	3	3	Moderate suitability for both low and high flows. Low suitability for hydraulics due to rapidly varied flow conditions and large scale roughness due to bedrock influence in this gorge.

In conclusion, the low flow suitability is high apart from at EWR 4, 6 and 7 (due to lack of hydraulic suitability). The suitability for high flow determination is high at all sites apart from EWR 7 (due to lack of hydraulic suitability)

4.3 SABIE-SAND EWR SITES

During a 1996 Instream Flow Requirements (IFR) study, 4 sites were selected in the Sabie, 1 in the Marite, 1 in the Mutlumuvi and 2 in the Lower Sand River. After the 2000 floods, most of the benchmarks were moved or covered and the nature and character of some of the sites changed completely. During this study, cognisance would be taken of the locality of the sites and where appropriate, the same sites would be used. Furthermore, the focus of the 1996 study was also on the Kruger Park and sections outside of the Kruger Park were mostly ignored.

4.3.1 Locality and description of sites

The locality of the EWR sites within the RUs as identified during this study is provided in Table 4.4.

Table 4.4 RUs and EWR sites





RUs	Recommendation (see chapter 3)	EWR site
Sabie River		
MRU A RAU A.2	If a site answering to EWR site criteria can be found, it is recommended that it be situated between the MacMac and the Marite.	EWR 1 – Upper Sabie EWR 2 - AandeVliet An additional site was selected upstream of the MacMac due to the following: An existing site with a habitat model was available and the benchmarks were found. This site would therefore provide valuable detailed information and the EWR can be assessed in the area before the impacts of Sabie town and forestry are in some way ameliorated by the Mac-Mac confluence. As recommended, a site downstream of the MacMac confluence at Aan de Vliet Lodge was selected. A riffle with biomonitoring data is available and the site is situated near a gauge which aids with flow measurements.
MRU B RAU B.1	One EWR site	No EWR site was selected in this section as the study only caters for a limited number of sites. The EWR 3 however is situated immediately downstream of this RU and therefore caters for this RU.
MRU C RAU C.1	One EWR site	EWR 3 - Kidney The RAU is different from the downstream MRU C as the inflow from the Sand brings about subtle changes as more alluvial than the Sabie. Prior to the 2000 floods, the Sabie upstream of the confluence was much rockier and therefore provided more critical habitat. Recommendation: Some remnants of the critical habitat could still be in place and the EWR site should be situated in the RAU. The area where the 1996 IFR 3 was situated was visited as one of the few areas where riffles occur post-2000 flood. A site was selected with the cross-section traversing 5 channels. Although the site was very complicated a ladar survey of the system is available and this will aid in undertaking the hydraulics of this site.
MacMac		
MacMac	One EWR site	EWR 4 – MacMac This river was not delineated into RUs. The EWR site therefore needs to be selected as far downstream as possible to cater for the upstream river. A site was selected approximately 10 km upstream of the confluence. The constraint in selecting sites in the MacMac was mostly linked to lack of access. However, this site is highly suitable and EWRs will cater for the upstream river as well as the short section downstream of the site.




Marite River		
Marite	One EWR site	<i>EWR 5 - Marite</i> This river was not delineated into RUs. The EWR site therefore needs to be selected as far downstream as possible to cater for the upstream river. The 1996 IFR site was selected approximately 1 km upstream of the confluence. Due to the benchmarks not being available, a new cross-section was surveyed at more or less the same cross-section.
Mutlumuvi system		
MRU A	One EWR site	<i>EWR 6 - Mutlumuvi</i> The 1996 site was visited as it would be a suitable site to use again. Due to the complexity of the site, it was essential however that the benchmarks be found. These were found during the Sept 2007 site visit, however, only one benchmark on the cross-section was found and it is very difficult to line the cross-section up to match the previous cross-section.
Sand system		
MRU A	One EWR site	<i>EWR 7 - Upper Sand</i> It was very difficult to find a suitable site in this river due to access and the extent of exotic and Phragmites growth.
MRU B RAU B.1	One EWR site	<i>EWR 8 - Lower Sand</i> A RUA was selected due to the change in the landuse. The RAU will be a different (higher) PES than the rest of the MRU due to its protected status. It would be preferable to have a EWR situated in this section as the indicators for EWR assessment will be intact and catering for this RAU will also cater for the rest of the MRU. The best area for the site would be in the more perennial and rocky section situated in the Londolozzi area. However due to the logistical problems of working in the Sabie Sand area, a site in the KNP close to the confluence was selected. This site is close to the 1996 IFR site. The same cross-section could not be selected however as the river is completely overgrown with Phragmites. The defined channel previously available was now overgrown and the bridge also complicated the hydraulics at this point. A relatively more open section of river downstream of the bridge was selected.

The locality and characteristics of the EWR sites are provided in Table 4.5.

Table 4.5 Locality and characteristics of the Sabie Sand EWR sites.

Site information	EWR sites	Illustration
<i>EWR nr & name</i>	EWR1 UpperSabie	
<i>River</i>	Sabie	
<i>Previous IFR site</i>	-	
<i>National RHP site</i>	-	
<i>Decimal Degrees</i>	-25.0737, 30.84874	
<i>Decimal Minutes</i>	S25 04.424, E30 50.924	
<i>EcoRegion (Level II)</i>	4.04	
<i>Geomorphic Zone</i>	Upper Foothills	
<i>Altitude (m)</i>	862	
<i>RU</i>	MRU Sabie A	
<i>Quaternary</i>	X31B	
<i>Farm name</i>	-	
<i>Hydrological gauge</i>	-	

Site information	EWR sites	Illustration
<p><i>EWR nr & name</i> River <i>Previous IFR site</i> <i>National RHP site</i> <i>Decimal Degrees</i> <i>Decimal Minutes</i> <i>EcoRegion (Level II)</i> <i>Geomorphic Zone</i> <i>Altitude (m)</i> <i>MRU</i> <i>Quaternary</i> <i>Farm name</i> <i>Hydrological gauge</i></p>	<p>EWR2 Sabie_Aan de Vliet Sabie - X3Sabie-Brand -25.0279, 31.05166 S25 01.675, E31 03.099 4.04 Lower Foothills 463 MRU Sabie A, RAU A.2 X31D Evert 5 X3H023</p>	
<p><i>EWR nr & name</i> River <i>Previous IFR site</i> <i>National RHP site</i> <i>Decimal Degrees</i> <i>Decimal Minutes</i> <i>EcoRegion (Level II)</i> <i>Geomorphic Zone</i> <i>Altitude (m)</i> <i>RU</i> <i>Quaternary</i> <i>Farm name</i> <i>Hydrological gauge</i></p>	<p>EWR3, Kidney Sabie IFR 3 X3Sabie-Sekur -24.9876, 31.29287 S24 59.256, E31 17.572 3.07 Lower Foothills 369 MRU Sabie B.1 X31K KNP X3H021</p>	
<p><i>EWR nr & name</i> River <i>Previous IFR site</i> <i>National RHP site</i> <i>Decimal Degrees</i> <i>Decimal Minutes</i> <i>EcoRegion (Level II)</i> <i>Geomorphic Zone</i> <i>Altitude (m)</i> <i>RU</i> <i>Quaternary</i> <i>Farm name</i> <i>Hydrological gauge</i></p>	<p>EWR4 MacMac MacMac -25.0133, 31.00405 S25 00.800, E31 00.243 4.04 Upper Foothills 582 MRU Mac A X31C Richmond 573 -</p>	
<p><i>EWR nr & name</i> River <i>Previous IFR site</i> <i>National RHP site</i> <i>Decimal Degrees</i> <i>Decimal Minutes</i> <i>EcoRegion (Level II)</i> <i>Geomorphic Zone</i> <i>Altitude (m)</i> <i>RU</i> <i>Quaternary</i> <i>Farm name</i> <i>Hydrological gauge</i></p>	<p>EWR5, Marite Marite IFR1 X3Mari-Sandf -25.018, 31.13328 S25 01.077, E31 07.997 4.04 Upper Foothills 457 MRU Mar A X31G 291/33 -</p>	

Site information	EWR sites	Illustration
<i>EWR nr & name</i> <i>River</i> <i>Previous IFR site</i> <i>National RHP site</i> <i>Decimal Degrees</i> <i>Decimal Minutes</i> <i>EcoRegion (Level II)</i> <i>Geomorphic Zone</i> <i>Altitude (m)</i> <i>RU</i> <i>Quaternary</i> <i>Farm name</i> <i>Hydrological gauge</i>	EWR6 Mutlumuvi Mutlumuvi IFR 6 X3Mutl-Thula -24.7559, 31.13205 S24 45.352, E31 07.923 3.05 Upper Foothills 503 MRU Mut A X32F New Forest 234 -	
<i>EWR nr & name</i> <i>River</i> <i>Previous IFR site</i> <i>National RHP site</i> <i>Decimal Degrees</i> <i>Decimal Minutes</i> <i>EcoRegion (Level II)</i> <i>Geomorphic Zone</i> <i>Altitude (m)</i> <i>RU</i> <i>Quaternary</i> <i>Farm name</i> <i>Hydrological gauge</i>	EWR7 Upper Sand Tlulandziteka (Sand) -24.6805, 31.08647 S24 40.829, E31 05.188 3.07 Lower Foothills 543 MRU Sand A X32C -	
<i>EWR nr & name</i> <i>River</i> <i>Previous IFR site</i> <i>National RHP site</i> <i>Decimal Degrees</i> <i>Decimal Minutes</i> <i>EcoRegion (Level II)</i> <i>Geomorphic Zone</i> <i>Altitude (m)</i> <i>RU</i> <i>Quaternary</i> <i>Farm name</i> <i>Hydrological gauge</i>	EWR8 Lower Sand Sand IFR 8 X3Sand-Skuku -24.9674, 31.62734 S24 58.045, E31 37.641 3.07 Lower Foothills 250 MRU Sand B, RAU B.1 X32J KNP -	

The locality of sites are illustrated in Figure 4.2.

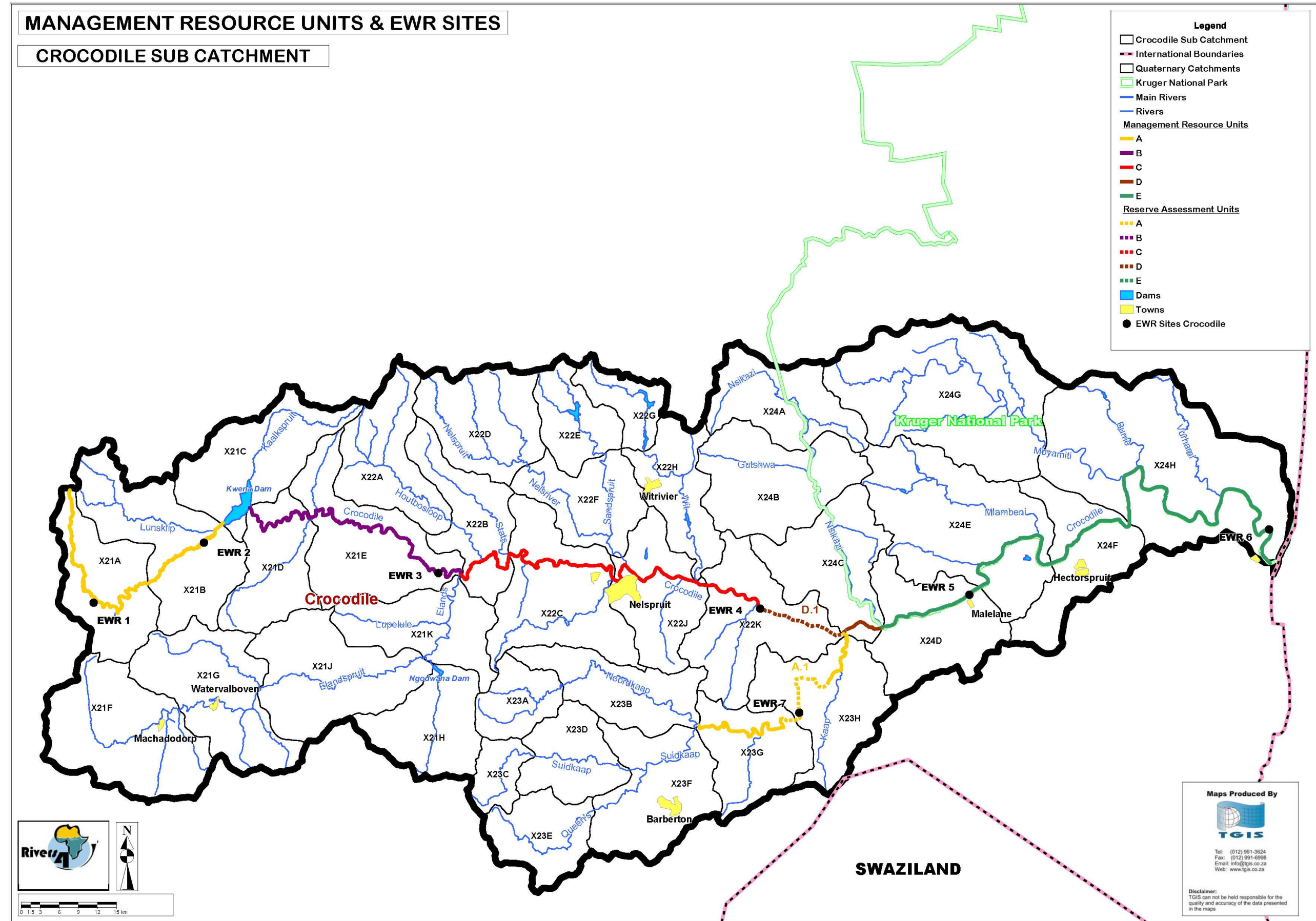


Figure 4.1 Locality of the Crocodile EWR sites

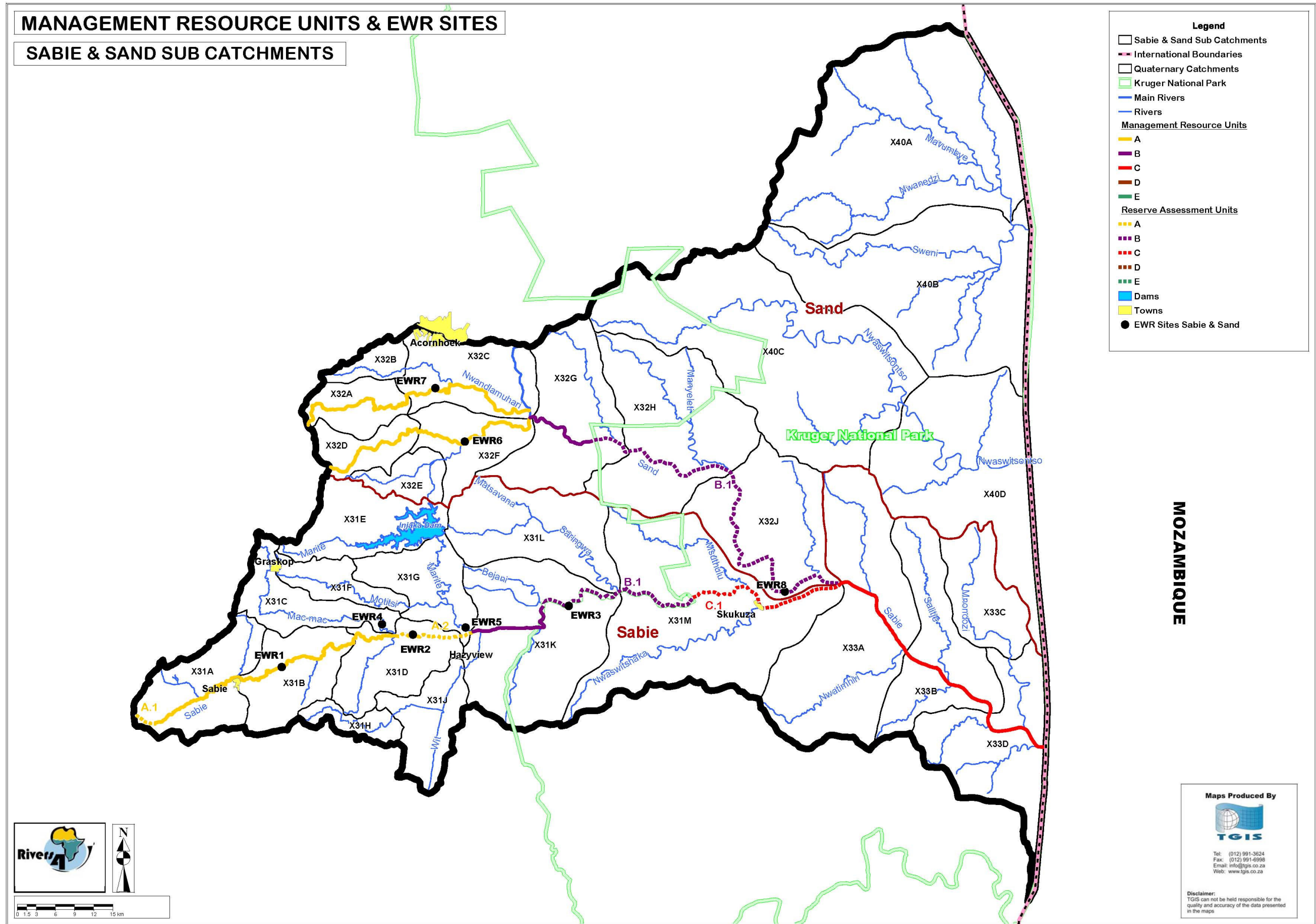


Figure 4.2 Locality of the Crocodile EWR sites

4.3.2 Site suitability

The site suitability of each site was assessed and is provided in Table 4.6 and 4.7. The detail assessment per component is provided in Appendix B. All scores are out of 5 with 5 referring to very high suitability.

Table 4.6 Biophysical Site suitability for the Sabie system

Sites	Geomorph	Riparian veg	Fish	Inverts	Average	Median	Max	Min	Comments
EWR 1	2.70	3.80	4.50	3.70	3.68	3.70	4.50	2.7	This is a bedload system and requires sediment transport modelling to evaluate the geomorphology. As this will not be undertaken at this site, the geomorph suitability is low.
EWR 2	2.60	4.20	4.50	4.60	3.98	4.20	4.60	2.6	See above
EWR 3	3.40	4.20	4.50	4.20	4.08	4.20	4.50	3.4	No true morphological cues
EWR 4	2.60	4.40	4.50	4.00	3.88	4.00	4.50	2.6	No true morphological cues. This is a bedload system and requires sediment transport modelling to evaluate the geomorphology. As this will not be undertaken at this site, the geomorph suitability is low.
EWR 5	3.30	4.30	4.00	4.50	4.03	4.03	4.50	3.3	No true morphological cues and sediment transport modelling will have to be undertaken
EWR 6	3.10	4.60	3.00	3.20	3.48	3.20	4.60	3.1	
EWR 7	3.20	3.80	3.00	4.10	3.53	3.53	4.10	3	
EWR 8	3.80	4.60	2.50	3.50	3.60	3.60	4.60	2.5	

From a biophysical point of view, these sites are all highly suitable

Table 4.7 Integrated Site suitability for the Sabie system

Sites	BIOPHYSICAL		HYDRAULICS		Overall Low	Overall High	Comment
	Low flows	High flows	Low flows	High flows			
EWR 1	4	3	3.00	4.00	3	4	Highly suitable for high flows, less suitable for low flows due to the complicated hydraulics.
EWR 2	5	3	4.00	2.00	4	3	Highly suitable for low flows, less suitable for high flows due to the complicated hydraulics.

Sites	BIOPHYSICAL		HYDRAULICS				Comment
	Low flows	High flows	Low flows	High flows	Overall Low	Overall High	
EWR 3	4	4	2.00	3.00	3	3	Moderate suitability for both low and high flows due to complicated hydraulics
EWR 4	4	4	3.00	2.00	4	3	Highly suitable for low flows, less suitable for high flows due to the complicated hydraulics.
EWR 5	4	4	3.00	4.00	4	4	Highly suitable from both low and high flow perspective and both biophysical and hydraulic perspective
EWR 6	3	4	2.00	3.00	3	3	Moderate suitability for both low and high flows
EWR 7	4	4	4.00	4.00	4	4	Highly suitable from both low and high flow perspective and both biophysical and hydraulic perspective
EWR 8	3	4	3.00	4.00	3	4	Highly suitable for high flows, less suitable for low flows due to the complicated hydraulics.

In general the site suitability is moderate and high. The major reasons for the moderate suitability are the complicated hydraulics at some of the sites.

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APPENDIX A RIVER REACH DEMARCATION, DELINEATION AND SUITABILITY

RIVER REACH DEMARCATION, DELINEATION AND SITE SUITABILITY

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September 2007

RATIONALE

This document defines and describes the different units according to which a river should be investigated and studied for the purpose of ecological reserve determination. The objective is to demarcate and delineate river reaches² following a hierarchical approach according to the following considerations:

- Broad natural physical reaches that constitute the river from its source downstream. These reaches are the result of the various drivers of the system under reference conditions, *viz.* Hydrology, Geomorphology and Physico-chemical attributes. It follows that the biota responded and adapted to these reference conditions (i.e., the broad natural habitat template) in a dynamic way depending on natural climatic variation. The boundaries between different broad natural reaches are not necessarily crisp and clear. However, where marked and rapid changes occur due to geology (e.g. geomorphology and physico-chemical changes) and hydrology (e.g. large tributaries or a change in climate) these boundaries may be easy to identify.
- Smaller natural reaches may be distinguished within these large reaches. Depending on the characteristics of the biological group and taxa considered, the distribution of biota will broadly coincide with the demarcation of the natural reaches. However, depending on the attributes (e.g. preferences and intolerances) of the biota they may be limited to smaller natural reaches within the broad natural physical reaches. These will result in so-called biological habitat segments (e.g. fish habitat segments, Kleynhans 1999). Depending on the life-history requirements of the biota and the dynamic nature of the ecosystems, the boundaries of the habitat segments can vary temporally and spatially. Some biota may be limited to particular smaller reaches within the broad natural reach; others may be present throughout the broad natural reach while others may be present across two or more broad natural reaches. This must be considered when defining the reference biological assemblage for a particular river reach.
- Superimposed on these natural reaches are the changes brought about by anthropogenic activities. These activities may result in a homogenous impact throughout the length of a broad natural reach or their impact may be heterogeneous and result in smaller distinguishable sub-reaches. Physical driver changes as well as biological change agents (e.g. alien biota) may be involved.

Reference conditions (in terms of natural reaches, drivers and biota) need to be considered when the reserve is determined as these provide the natural evolutionary setting that indicate the

² For the purpose of this document, "reach" is broadly defined as "a specified segment of a stream's path" (www.wwnorton.com/college/geo/earth2/glossary/r.htm).

resilience of the system to various forms of modification and stress. However, pragmatic considerations that come into the picture include anthropogenic changes to the system that are within the medium and long term not likely to change. These may include modifications to the system such as impoundments, agricultural, urbanization and forestry. Such modifications brings about changes in the natural reach characteristics in terms of the system drivers and biota and indicates changed reaches that needs particular consideration in order to manage them according to ecological reserve considerations (eco-classification) that encompass, *inter alia*, ecological importance and sensitivity, present ecological state, the recommended category and sustainability. This rationale also enables the setting of resource quality objectives, ecological specifications and monitoring objectives and specifications.

Following this approach, the following classification of reaches is distinguished in terms of the setting of the ecological reserve for particular river reaches:

- Natural Resource Units (NRU)
- Management Resource Units (MRU)
- Reserve Assessment Units (RAU)
- The Ecological Reserve is determined at a specific point in the river, *viz.* the Ecological Water Requirement Site (EWR Site)

The EWR sites are identified within a system context where reference conditions are formulated in context of a NRU according to physical drivers and biota. A hierarchical demarcation process is followed to select and define EWR within this system context. This is described in the following sections and the process is diagrammatically illustrated in Figure A.1 and A.2.

NATURAL RESOURCE UNIT (NRU)

The guiding principle is that if the hydrology, geomorphic characteristics (i.e. geomorphic zone), physico-chemical attributes and river size remains relatively similar, a NRU can be demarcated.

Two levels can be distinguished:

- Primary NRUs that are demarcated according to ecoregions including relevant components of an ecoregion that may contribute to the demarcation of NRUs, This will determine the broad ecological context (climate, geomorphology, hydrology and the broad physico-chemical profile) within which the river is situated
- Secondary NRUs can be indicated and if present, are nested within the Primary NRU and are defined according to a significant change in:
 - Geomorphic zones (slopes and geological attributes), which will determine the potential presence of certain habitats.
 - Hydrology which may be due to the flow contribution (in volume or seasonality) of tributaries or a change in ground water contribution.
 - Physico-chemical conditions which may be the result of a change in hydrology or geology. This will result in a specific meso-habitat that can influence the presence and abundance of species (e.g. biological habitat segments).

Figure A.1 provides a hypothetical example to illustrate the described delineation. An explanation of the hypothetical delination in table form (Table A.1) is also provided.

NATURAL RESOURCE UNITS

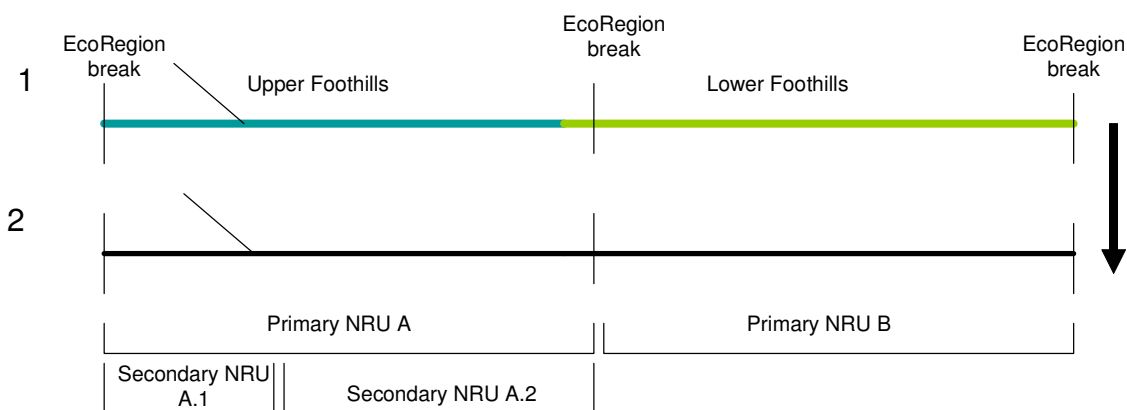


Figure A.1 Delineation of National Resource Units

Table A.1 Description of the rationale for the delineation of the National Resource Unit for the Figure A.1

UNIT	RATIONALE	DELINEATION
Primary NRU A	EcoRegions main determinant. As most of the EcoRegion also consists of one geomorphic zone, this provides additional motivation for the delineation	Start to end of EcoRegion
Secondary NRU A.1	The tributary provides sediment (alluvial) and different hydrology. This provides further delineation. The temperature is also different.	Start of EcoRegion to confluence of the tributary.
Secondary NRU A.2	Different hydrology and physico-chemical characteristics from the upstream section	Confluence of tributary to end of EcoRegion

MANAGEMENT RESOURCE UNIT (MRU)

The purpose of distinguishing MRUs is to identify a management unit within which the EWR can be implemented and managed based on one set of identified flow requirements.

The following provides the concept of Management Resource Units (MRUs):

- MRUs are based on the principle of homogeneity of impacts in the demarcated NRU.
- This may include the modification of flows in the system due to abstraction, regulation by impoundments and development along the NRU and upstream from the NRU which may influence the geomorphology and physico-chemical conditions.
- This can cause specific changes in the system drivers which will subdivide the NRU into MRUs.
- Modifications to a river reach may homogenize adjacent NRUs to the extent that they may constitute a single MRU.

MRUs are homogenous units which are sufficiently different from adjacent areas to warrant a separate EWR assessment being undertaken (Louw & Hughes, 2002). This means that an EWR set in the MRU, according to the EWR site selection criteria in context of the MRU, will provide for the whole MRU. Hydrological changes due to incremental runoff must obviously be taken into account.

The following information is used to demarcate a MRU in relation to the NRU:

- Land cover or land use data
- Index of Habitat Integrity data if available
- System driver information as obtained from EcoStatus assessments. This may include information on hydrological changes in system operation

If there are no anthropogenic changes or modifications present along or upstream from a particular NRU, such a NRU will logically constitute a Management Resource Unit (MRU).

RESERVE ASSESSMENT UNIT (RAU)

The Reserve Assessment Unit (RAU) is situated within a MRU and it is used to demarcate and describe a reach of river within the MRU with the most critical habitat in the MRU. It has bearing upon the following:

- “Critical” refers to habitat being particularly responsive to changes in flow (and the associated physico-chemical and geomorphic conditions) and which can be related to critical phases in the life-cycle of biota.
- Additionally, if critical habitats are present in a particular reach, the EWR set to protect such habitat and its associated biota will also protect less critical habitat (and the associated biota).
- If habitat with the same level of “critical” are present over the whole of the MRU (i.e. in all reaches within the MRU), the reach selected as the RAU should preferably be the one that are in the best present ecological state.
- To provide for an eventual management monitoring context, the RAU can be defined in terms of biological habitat segments that represent the presence of a homogenous biological assemblage. This is important when reference conditions are formulated.
- The demarcation of the RAU is particularly important as it plays a decisive role of where EWR sites should be located.

Figure A.2 provides a hypothetical example to illustrate the described delineation. An explanation of the hypothetical delineation in table form (Table 2) is also provided. The figure and table shows the delineation into MRU, RAUs and also indicate where the EWR site should be situated (process described below).

MANAGEMENT RESOURCE UNITS

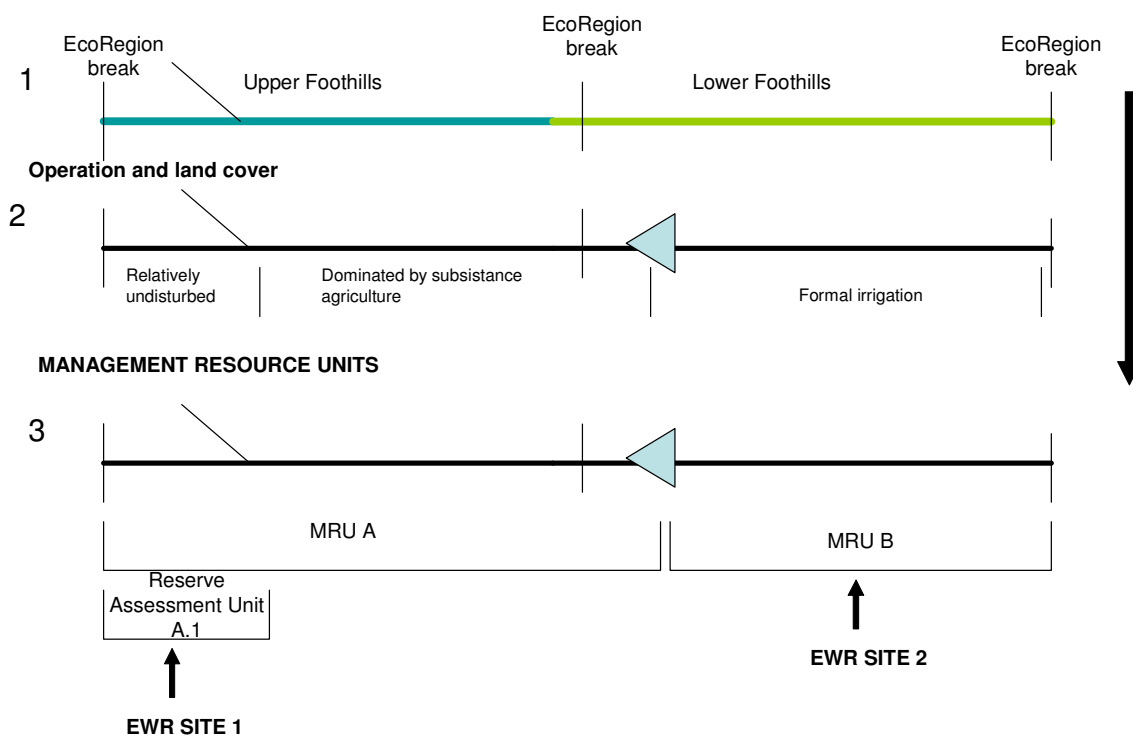


Figure A.2 Delineation of Management Resource Units

Table A.2 Description of the rationale for the delineation of the Management Resource Unit for the Figure A.2

UNIT	RATIONALE	DECISION	DELINEATION
MRU A	Consists of mostly one EcoRegion Consists mostly one Geomorphic zone Land use dominated by subsistence agriculture Dam provides an operational break.	MRU larger than NRU to include short section to the dam.	Start of EcoRegion to Dam
RAU A.1	RAU provides critical habitat for species that prefer colder temperatures as the tributary brings in warmer water. As area is isolated, critical vegetation habitat such as marginal and overhanging vegetation present to provide cover. In area downstream from the tributary, this habitat has been removed by grazing and bush clearing.	Assessment of RAU for EcoClassification and EWR assessment important as forms the critical section in the MRU	Start of EcoRegion to confluence of tributary (coincides with NRU A.1)
Recommendation: RAU A.1: EcoClassification + EWR assessment therefore EWR site if possible to be situated within RAU A.1 MRU A (excluding RAU A.1): EcoClassification			
MRU B	Consists of one EcoRegion Consists one Geomorphic zone Land use dominated by formal irrigation End of EcoRegion provides logical break	MRU similar to NRU apart from the short section of NRU B which is above the dam.	Dam wall to end of EcoRegion
Recommendation: EcoClassification + EWR assessment As no RAU identified within the MRU, the EWR site to be selected anywhere in the MRU. If there are any areas that are potentially in a better state than the rest of the MRU, it is recommended that the EWR be placed within that.			

ECOLOGICAL WATER REQUIREMENT SITE (EWR SITE)

“Site” refers to “features of a place related to the immediate environment on which the place is located (e.g. terrain, soil, subsurface, geology, groundwater) (www.geographic.org/glossary.html). Linked to this is the concept of “locality” which refers to the geographic area in which a collecting event occurs (porites.geology.uiowa.edu/entity.htm).

Ecological Water Requirement (EWR) sites are localities in a stream within the descending hierarchy of Primary NRU→Secondary NRU→MRU→RAU→EWR site. An EWR site is therefore a locality where measurements to determine the ecological water requirements of river will be done.

The selection of EWR sites should consider the following physical attributes:

- Hydraulic cross section(s) will be established here. The purpose of hydraulic measurements and the consequent modelling is to provide an interpretive link between flows at different stages and the resulting aquatic habitats at the site. In some cases a digital terrain model (“habitat model”) will be developed to provide a more accurate and detail perspective of the response of various habitat features to changes in flow.
- Preferably the EWR site should be representative of the RAU within which it is situated. “Representative” specifically refers to the hydraulics units at the site which should occur in similar proportions and with similar characteristics to that which occur at the majority of sites in the RAU. Generally, however, the more complicated the site is in terms of hydraulic units (e.g. diversity of bed material and multiple channels), the more difficult hydraulic modelling of the site becomes. This detrimentally influences the accuracy of the hydraulic model and thus the prediction of habitat at various discharges. As a result, a compromise needs to be found between the representativeness of the EWR site and the accuracy of the hydraulics model.
- In addition to an ideal EWR site being representative of the RAU, it should also be sensitive in terms of its response to changes in water level (discharges). This will make the EWR site useful for future monitoring and the confidence in the interpretation of monitoring results.
- The ultimately ideal site would therefore be representative, practical and safe to measure and to model reasonably accurately, be accessible and be sensitive to changes in discharge to make it useful for habitat prediction.

Despite the above physical considerations, the following attributes are essential determinants of the suitability of a EWR site for specifying the ecological flow requirements of biota, interpretation and eventually monitoring in terms of fish:

- The presence and abundance of rheophilics. If this group is present and abundant enough to make them useful in terms of monitoring, they would be the ideal subject to use for determining flow requirements as they are sensitive to a cessation of flow (usually fast flow) during all life-stages. If large³ (about >20 cm in length) rheophilics are present and abundant enough, they would usually be preferable to small rheophilics due to the larger amount of flowing habitat required which would indicate higher discharges. In cases where small rheophilics and large semi-rheophilics occur there may be a requirement for rheophilics during the dry season, but another requirement for large semi-rheophilics during the periods in the wet season when they breed.

³ Size of any of the groups do not necessarily refer to a particular species: Different life-stages of the same species may, for example, be classified as large or small. In some case the adults semi-rheophilics may vary in size with the smaller adults also occurring in smaller streams.

- The presence of semi-rheophilics. If rheophilics are absent, semi-rheophilics should be used as the subject to determine flow requirements. Semi-rheophilics require flowing water (usually fast) during the breeding season. However, flowing water do not necessarily have to be present during the whole duration of the wet season. Duration of flow for rheophilics during the wet season will be determined by the length of time required for successful spawning, hatching and growth of larvae to juveniles. The size of the semi-rheophilics considered is also important as this will have an influence on the dimensions of the habitat requirements.
- The presence of limnophilics. If rheophilics and semi-rheophilics are absent, the requirements of limnophilics can be considered. This group do not require flowing water during any stage of their life-cycle. However, they do respond positively to improved habitat conditions (e.g. cover and feeding areas) caused by increased flows. In particular circumstances, the requirements of some limnophilics need to be considered where a drop in the water level in pools may result in a loss for example, of overhanging vegetation which may form an essential cover feature for some species to survive.

The following Tables provide a simple framework to interpret the suitability of a site in terms of the habitats available, velocity-depth fish guilds present and their size at the site compared to the RAU⁴:

Table A.3 Comparison of velocity-depth ratings for RAU and the EWR site

	FISH VELOCITY-DEPTH CLASSES (Abundance: 0=absent; 1=rare; 2=sparse; 3=moderate; 4=abundant; 5=very abundant) (SD=slow deep; SS=slow shallow; FD=fast deep; FS=fast shallow)			
	SD	SS	FD	FS
RAU				
SITE				
BRAY -CURTIS SIMILARITY				

Table A.4 Comparison of cover ratings for RAU and the EWR site (UB=undercut banks and root wads;OV=overhanging vegetation; SUB=substrate; AM=aquatic macrophytes; WC=water column)

	COVER (Abundance: 0=absent; 1=rare; 2=sparse; 3=moderate; 4=abundant; 5=very abundant)										
	SD		SS		FD		FS				
	SITE	RAU	SITE	RAU	SITE	RAU	SITE	RAU			
UB			UB			UB			UB		
OV			OV			OV			OV		
SUB			SUB			SUB			SUB		
AM			AM			AM			AM		
WC			WC			WC			WC		
BRAY - CURTIS SIMILARITY			BRAY - CURTIS SIMILARITY			BRAY - CURTIS SIMILARITY			BRAY - CURTIS SIMILARITY		

⁴ Where appropriate the similarity between a RAU and the potential site is determined by the Bray-Curtis index, where similarity of 1 indicates complete similarity and 0 no similarity. The categorization of similarities is according to the following: 0=None;0.1-0.20=Very low; 0.20-0.40=Low;0.40-0.60=Moderate;0.60-0.80=High; 0.80-1.0=Very high

Table A.5 Comparison between sizes of various velocity-depth guilds at a EWR site. Large >20 cm; Small <20 cm

	VELOCITY-DEPTH GUILDS (Indicate number for flow guild per size)							
	SD		SS		FD		FS	
	LARGE	SMALL	LARGE	SMALL	LARGE	SMALL	LARGE	SMALL
RHEOPHILICS								
SEMI-RHEOPHILICS								
LIMNOPHILICS								

Table A.6 Relative abundances of different flow guilds in RAU and at EWR sites.

	RELATIVE ABUNDANCE (Abundance: 0=absent; 1=rare; 2=sparse; 3=moderate; 4=abundant; 5=very abundant)	
	RAU	SITE
RHEOPHILICS		
SEMI-RHEO		
LIMNOPHILICS		
BRAY -CURTIS SIMILARITY		

At this stage: the information summarized above should be used to provide a considered and informed decision as to the suitability of the EWR site for the interpretation of environmental flow requirements of fish compared to the RAU. This should be ranked according to:

- 0: Not suitable
- 1.0-2.0: very low suitability
- 2.0-3.0: Moderate suitability
- 3.0-4.0: High suitability
- 4.0-5.0: Very high suitability

This suitability rating should be considered in conjunction with suitability ratings for other biota as well as the hydraulic suitability to provide an overall suitability rating.

APPENDIX B LANDCOVER

CROCODILE (EAST) SYSTEM - X21A to X24H: LANDCOVER					
FREQUENCY	QUAT	LEVEL 2 ECOREGION	ID	LANDCOVER	HA
3	X21A	9.02	6	Natural Grassland (previously termed Unimpro	3405.615000
4	X21A	9.02	3	Thicket, Bushland, Bush Clumps, High Fynbos	70.186000
18	X21A	9.02	8	Forest Plantations (Eucalyptus spp)	46.926000
2	X21A	9.02	32	Urban / Built-up (residential, formal suburb	46.542000
3	X21A	9.02	26	Cultivated, temporary, commercial, irrigated	28.037000
6	X21A	9.02	13	Waterbodies	27.575000
8	X21A	9.02	27	Cultivated, temporary, commercial, dryland	26.021000
2	X21A	9.06	6	Natural Grassland (previously termed Unimpro	18.871000
4	X21A	9.02	9	Forest Plantations (Pine spp)	12.731000
7	X21A	9.02	14	Wetlands	10.341000
1	X21A	9.02	43	Urban / Built-up, (commercial, mercantile)	7.925000
3	X21A	9.02	11	Forest Plantations (Other / mixed spp)	3.973000
1	X21A	9.06	32	Urban / Built-up (residential, formal suburb	0.311000
2	X21A	9.06	8	Forest Plantations (Eucalyptus spp)	0.157000
10	X21B	9.04	6	Natural Grassland (previously termed Unimpro	759.375000
14	X21B	9.02	6	Natural Grassland (previously termed Unimpro	477.086000
12	X21B	9.04	26	Cultivated, temporary, commercial, irrigated	149.254000
18	X21B	9.04	27	Cultivated, temporary, commercial, dryland	133.739000
11	X21B	9.02	27	Cultivated, temporary, commercial, dryland	106.218000
11	X21B	9.02	3	Thicket, Bushland, Bush Clumps, High Fynbos	51.056000
1	X21B	9.02	13	Waterbodies	36.946000
12	X21B	9.04	3	Thicket, Bushland, Bush Clumps, High Fynbos	26.353000
3	X21B	9.02	26	Cultivated, temporary, commercial, irrigated	7.530000
1	X21B	9.02	14	Wetlands	0.503000
1	X21C	9.02	13	Waterbodies	462.333000
1	X21C	9.02	6	Natural Grassland (previously termed Unimpro	47.305000
2	X21D	10.01	3	Thicket, Bushland, Bush Clumps, High Fynbos	1130.804000
2	X21D	9.02	6	Natural Grassland (previously termed Unimpro	220.336000
11	X21D	10.01	6	Natural Grassland (previously termed Unimpro	179.118000
1	X21D	9.02	3	Thicket, Bushland, Bush Clumps, High Fynbos	88.991000
1	X21D	9.02	13	Waterbodies	11.938000
3	X21D	10.01	1	Forest (indigenous)	10.427000
3	X21D	10.02	6	Natural Grassland (previously termed Unimpro	6.612000
3	X21D	10.02	3	Thicket, Bushland, Bush Clumps, High Fynbos	3.640000
6	X21E	10.02	3	Thicket, Bushland, Bush Clumps, High Fynbos	2183.979000
9	X21E	10.01	3	Thicket, Bushland, Bush Clumps, High Fynbos	952.577000
11	X21E	10.01	1	Forest (indigenous)	158.097000
1	X21E	4.04	3	Thicket, Bushland, Bush Clumps, High Fynbos	114.580000
5	X21E	10.02	1	Forest (indigenous)	83.379000
5	X21E	10.02	40	Urban / Built-up (smallholdings, thicket, bu	68.036000

CROCODILE (EAST) SYSTEM - X21A to X24H: LANDCOVER					
FREQUENCY	QUAT	LEVEL 2 ECOREGION	ID	LANDCOVER	HA
18	X21E	10.02	8	Forest Plantations (Eucalyptus spp)	57.971000
3	X21E	10.02	30	Urban / Built-up	56.045000
1	X21E	10.02	26	Cultivated, temporary, commercial, irrigated	32.728000
2	X21E	10.01	8	Forest Plantations (Eucalyptus spp)	16.132000
3	X21E	10.01	40	Urban / Built-up (smallholdings, thicket, bu	15.429000
3	X21E	10.02	27	Cultivated, temporary, commercial, dryland	10.504000
3	X21E	10.02	14	Wetlands	8.360000
4	X21E	10.02	11	Forest Plantations (Other / mixed spp)	5.480000
1	X21E	10.01	27	Cultivated, temporary, commercial, dryland	2.141000
1	X21E	4.04	30	Urban / Built-up	1.906000
1	X21E	10.02	9	Forest Plantations (Pine spp)	1.795000
1	X21E	10.01	11	Forest Plantations (Other / mixed spp)	0.837000
1	X21E	4.04	8	Forest Plantations (Eucalyptus spp)	0.160000
1	X21E	10.01	6	Natural Grassland (previously termed Unimpro	0.089000
1	X21K	4.04	3	Thicket, Bushland, Bush Clumps, High Fynbos	9.098000
7	X22B	4.04	3	Thicket, Bushland, Bush Clumps, High Fynbos	1136.644000
11	X22B	4.04	23	Cultivated, permanent, commercial, irrigated	66.792000
19	X22B	4.04	8	Forest Plantations (Eucalyptus spp)	56.887000
10	X22B	4.04	26	Cultivated, temporary, commercial, irrigated	52.987000
1	X22B	4.04	1	Forest (indigenous)	48.589000
1	X22B	4.04	12	Forest Plantations (clearfelled)	16.645000
6	X22B	4.04	27	Cultivated, temporary, commercial, dryland	10.522000
34	X22C	4.04	3	Thicket, Bushland, Bush Clumps, High Fynbos	1099.436000
37	X22C	4.04	23	Cultivated, permanent, commercial, irrigated	336.767000
6	X22C	4.04	25	Cultivated, permanent, commercial, sugarcane	309.790000
45	X22C	4.04	26	Cultivated, temporary, commercial, irrigated	266.584000
32	X22C	4.04	27	Cultivated, temporary, commercial, dryland	89.723000
30	X22C	4.04	8	Forest Plantations (Eucalyptus spp)	86.466000
7	X22C	10.02	3	Thicket, Bushland, Bush Clumps, High Fynbos	72.670000
7	X22C	10.02	23	Cultivated, permanent, commercial, irrigated	31.345000
2	X22C	4.04	46	Urban / Built-up, (industrial / transport :	21.213000
9	X22C	10.02	26	Cultivated, temporary, commercial, irrigated	12.841000
4	X22C	10.02	27	Cultivated, temporary, commercial, dryland	11.312000
1	X22C	4.04	30	Urban / Built-up	8.642000
1	X22C	4.04	40	Urban / Built-up (smallholdings, thicket, bu	8.604000
2	X22C	4.04	14	Wetlands	3.846000
1	X22C	10.02	25	Cultivated, permanent, commercial, sugarcane	0.626000
1	X22H	4.04	3	Thicket, Bushland, Bush Clumps, High Fynbos	8.809000
2	X22H	4.04	26	Cultivated, temporary, commercial, irrigated	3.008000
21	X22J	4.04	3	Thicket, Bushland, Bush Clumps, High Fynbos	1282.648000
23	X22J	4.04	23	Cultivated, permanent, commercial, irrigated	172.386000
29	X22J	4.04	8	Forest Plantations (Eucalyptus spp)	132.896000
4	X22J	4.04	46	Urban / Built-up, (industrial / transport :	110.541000

CROCODILE (EAST) SYSTEM - X21A to X24H: LANDCOVER					
FREQUENCY	QUAT	LEVEL 2 ECOREGION	ID	LANDCOVER	HA
28	X22J	4.04	26	Cultivated, temporary, commercial, irrigated	103.178000
3	X22J	4.04	43	Urban / Built-up, (commercial, mercantile)	90.578000
5	X22J	4.04	25	Cultivated, permanent, commercial, sugarcane	45.272000
1	X22J	4.04	37	Urban / Built-up (residential, informal town	29.380000
3	X22J	4.04	13	Waterbodies	11.964000
7	X22J	4.04	27	Cultivated, temporary, commercial, dryland	10.254000
1	X22J	4.04	19	Degraded Thicket, Bushland, etc	1.300000
1	X22J	4.04	14	Wetlands	0.078000
26	X22K	4.04	3	Thicket, Bushland, Bush Clumps, High Fynbos	744.114000
6	X22K	3.07	1	Forest (indigenous)	443.708000
15	X22K	3.07	3	Thicket, Bushland, Bush Clumps, High Fynbos	355.824000
48	X22K	4.04	2	Woodland (previously termed Forest & Woodlan	198.201000
45	X22K	3.07	2	Woodland (previously termed Forest & Woodlan	132.897000
33	X22K	4.04	26	Cultivated, temporary, commercial, irrigated	128.868000
12	X22K	3.07	13	Waterbodies	88.279000
2	X22K	4.04	36	Urban / Built-up (residential, formal townsh	65.460000
1	X22K	4.04	1	Forest (indigenous)	64.314000
18	X22K	4.04	25	Cultivated, permanent, commercial, sugarcane	64.121000
6	X22K	3.07	25	Cultivated, permanent, commercial, sugarcane	60.155000
19	X22K	4.04	13	Waterbodies	58.481000
4	X22K	4.04	27	Cultivated, temporary, commercial, dryland	15.653000
7	X22K	4.04	19	Degraded Thicket, Bushland, etc	14.535000
4	X22K	3.07	19	Degraded Thicket, Bushland, etc	14.156000
5	X22K	4.04	23	Cultivated, permanent, commercial, irrigated	12.595000
2	X22K	3.07	36	Urban / Built-up (residential, formal townsh	10.751000
2	X22K	3.07	23	Cultivated, permanent, commercial, irrigated	9.865000
1	X22K	4.04	14	Wetlands	6.727000
2	X23H	3.07	3	Thicket, Bushland, Bush Clumps, High Fynbos	2.375000
1	X23H	3.07	25	Cultivated, permanent, commercial, sugarcane	2.518000
20	X24C	3.07	3	Thicket, Bushland, Bush Clumps, High Fynbos	237.541000
3	X24C	3.07	36	Urban / Built-up (residential, formal townsh	212.389000
15	X24C	3.07	25	Cultivated, permanent, commercial, sugarcane	127.631000
19	X24C	3.07	2	Woodland (previously termed Forest & Woodlan	49.127000
8	X24C	3.07	13	Waterbodies	42.820000
8	X24C	3.07	18	Degraded Forest & Woodland	30.069000
6	X24C	3.07	19	Degraded Thicket, Bushland, etc	13.662000
2	X24C	3.07	23	Cultivated, permanent, commercial, irrigated	9.490000
2	X24C	3.07	15	Bare Rock and Soil (natural)	3.895000
1	X24C	3.07	1	Forest (indigenous)	1.836000
31	X24D	3.07	2	Woodland (previously termed Forest & Woodlan	737.231000
55	X24D	3.07	3	Thicket, Bushland, Bush Clumps, High Fynbos	374.995000
20	X24D	3.07	25	Cultivated, permanent, commercial, sugarcane	340.732000
15	X24D	3.07	13	Waterbodies	176.085000
10	X24D	3.07	23	Cultivated, permanent, commercial, irrigated	72.140000

CROCODILE (EAST) SYSTEM - X21A to X24H: LANDCOVER					
FREQUENCY	QUAT	LEVEL 2 ECOREGION	ID	LANDCOVER	HA
4	X24D	3.07	30	Urban / Built-up	30.432000
6	X24D	3.07	15	Bare Rock and Soil (natural)	15.149000
1	X24D	3.07	19	Degraded Thicket, Bushland, etc	0.974000
44	X24E	3.07	2	Woodland (previously termed Forest & Woodlan	1072.575000
58	X24E	3.07	3	Thicket, Bushland, Bush Clumps, High Fynbos	431.825000
6	X24E	3.07	13	Waterbodies	332.384000
7	X24E	3.07	25	Cultivated, permanent, commercial, sugarcane	185.012000
5	X24E	3.07	23	Cultivated, permanent, commercial, irrigated	114.810000
9	X24E	3.07	15	Bare Rock and Soil (natural)	71.616000
4	X24E	3.07	7	Planted Grassland (previously termed Improve	70.872000
5	X24E	3.07	14	Wetlands	16.258000
1	X24E	3.07	32	Urban / Built-up (residential, formal suburb	12.969000
1	X24E	3.07	30	Urban / Built-up	6.916000
1	X24E	3.07	16	Bare Rock and Soil (erosion : dongas / gulli	0.774000
25	X24F	3.07	2	Woodland (previously termed Forest & Woodlan	933.717000
36	X24F	3.07	3	Thicket, Bushland, Bush Clumps, High Fynbos	210.210000
6	X24F	3.07	13	Waterbodies	198.234000
7	X24F	3.07	25	Cultivated, permanent, commercial, sugarcane	127.204000
6	X24F	3.07	15	Bare Rock and Soil (natural)	71.175000
11	X24F	3.07	26	Cultivated, temporary, commercial, irrigated	61.356000
4	X24F	3.07	23	Cultivated, permanent, commercial, irrigated	42.015000
2	X24F	3.07	1	Forest (indigenous)	13.005000
42	X24H	3.07	2	Woodland (previously termed Forest & Woodlan	1124.946000
38	X24H	12.01	3	Thicket, Bushland, Bush Clumps, High Fynbos	722.232000
82	X24H	3.07	3	Thicket, Bushland, Bush Clumps, High Fynbos	485.234000
41	X24H	3.06	3	Thicket, Bushland, Bush Clumps, High Fynbos	446.265000
5	X24H	3.07	13	Waterbodies	397.543000
34	X24H	3.06	2	Woodland (previously termed Forest & Woodlan	345.806000
6	X24H	3.06	23	Cultivated, permanent, commercial, irrigated	337.449000
39	X24H	12.01	2	Woodland (previously termed Forest & Woodlan	291.135000
6	X24H	12.01	25	Cultivated, permanent, commercial, sugarcane	258.693000
2	X24H	12.01	13	Waterbodies	252.792000
7	X24H	3.07	23	Cultivated, permanent, commercial, irrigated	236.939000
4	X24H	3.06	13	Waterbodies	225.313000
8	X24H	3.07	25	Cultivated, permanent, commercial, sugarcane	169.811000
16	X24H	3.07	15	Bare Rock and Soil (natural)	147.121000
10	X24H	3.06	25	Cultivated, permanent, commercial, sugarcane	65.195000
10	X24H	12.01	15	Bare Rock and Soil (natural)	54.726000
8	X24H	3.06	15	Bare Rock and Soil (natural)	51.295000
2	X24H	12.01	32	Urban / Built-up (residential, formal suburb	29.852000
2	X24H	12.01	23	Cultivated, permanent, commercial, irrigated	24.594000
1	X24H	12.01	30	Urban / Built-up	4.041000
1	X24H	3.07	28	Cultivated, temporary, subsistence, dryland	1.308000
1	X24H	3.06	14	Wetlands	1.143000

CROCODILE (EAST) SYSTEM - X21A to X24H: LANDCOVER					
FREQUENCY	QUAT	LEVEL 2 ECOREGION	ID	LANDCOVER	HA
1	X24H	12.01	18	Degraded Forest & Woodland	1.068000

SABIE (EAST) SYSTEM - X31A to X33 B: LANDCOVER					
FREQUENCY	QUAT	LEVEL 2 ECOREGION	ID	LANDCOVER	HA
22	X31A	10.01		Forest Plantations (Pine spp)	606.066000
18	X31A	10.01		Forest Plantations (clearfelled)	393.803000
3	X31A	4.04		Thicket, Bushland, Bush Clumps, High Fynbos	231.036000
10	X31A	10.01		Forest (indigenous)	185.611000
3	X31A	4.04		Urban / Built-up	131.956000
18	X31A	10.01		Thicket, Bushland, Bush Clumps, High Fynbos	115.476000
5	X31A	10.01		Forest Plantations (Eucalyptus spp)	90.220000
5	X31A	4.04		Forest Plantations (Pine spp)	80.467000
3	X31A	10.01		Natural Grassland (previously termed Unimproved Gras	57.360000
8	X31A	4.04		Natural Grassland (previously termed Unimproved Gras	37.409000
2	X31A	10.01		Wetlands	29.506000
4	X31A	4.04		Forest Plantations (clearfelled)	27.688000
1	X31A	4.04		Urban / Built-up, (industrial / transport : light	23.382000
3	X31A	10.01		Urban / Built-up	21.670000
4	X31A	10.01		Urban / Built-up, (industrial / transport : light	11.857000
1	X31A	4.04		Forest Plantations (Eucalyptus spp)	4.756000
1	X31A	10.01		Mines & Quarries (surface-based mining)	2.866000
1	X31A	4.04		Planted Grassland (previously termed Improved Grassl	1.883000
1	X31A	4.04		Urban / Built-up (residential, informal township	1.242000
1	X31A	10.01		Waterbodies	1.061000
1		0.00			0.000000
11	X31B	4.04		Forest Plantations (clearfelled)	781.829000
22	X31B	4.04		Forest (indigenous)	573.682000
27	X31B	4.04		Forest Plantations (Eucalyptus spp)	452.667000
16	X31B	4.04		Forest Plantations (Pine spp)	418.260000
17	X31B	4.04		Thicket, Bushland, Bush Clumps, High Fynbos	101.594000
4	X31B	4.04		Urban / Built-up	30.092000
6	X31B	4.04		Natural Grassland (previously termed Unimproved Gras	7.453000
1	X31B	4.04		Urban / Built-up (smallholdings, thicket, bushland ?	7.285000
1	X31B	10.02		Forest Plantations (clearfelled)	7.147000
1	X31B	4.04		Mines & Quarries (surface-based mining)	5.315000
2	X31B	10.02		Forest Plantations (Pine spp)	3.940000
1	X31B	4.04		Urban / Built-up, (commercial, education, health, IT	2.539000
2	X31B	4.04		Urban / Built-up, (industrial / transport : light	2.285000
1	X31B	10.02		Thicket, Bushland, Bush Clumps, High Fynbos	0.446000
1	X31C	4.04		Forest (indigenous)	6.722000
1	X31C	4.04		Forest Plantations (Eucalyptus spp)	2.851000
2	X31C	4.04		Forest Plantations (clearfelled)	1.324000
1	X31C	4.04		Thicket, Bushland, Bush Clumps, High Fynbos	0.492000

9	X31D	4.04	Forest Plantations (Eucalyptus spp)	671.292000
13	X31D	4.04	Thicket, Bushland, Bush Clumps, High Fynbos	461.593000
19	X31D	4.04	Cultivated, permanent, commercial, irrigated	364.972000
14	X31D	4.04	Forest (indigenous)	257.266000
4	X31D	4.04	Cultivated, temporary, commercial, irrigated	64.044000
4	X31D	4.04	Forest Plantations (clearfelled)	50.896000
2	X31D	4.04	Planted Grassland (previously termed Improved Grassl	28.104000
1	X31D	3.07	Thicket, Bushland, Bush Clumps, High Fynbos	15.477000
1	X31D	4.04	Urban / Built-up	6.384000
2	X31D	4.04	Urban / Built-up (smallholdings, thicket, bushland ?	0.564000
1	X31G	3.07	Thicket, Bushland, Bush Clumps, High Fynbos	124.576000
1	X31G	3.07	Planted Grassland (previously termed Improved Grassl	27.748000
1	X31G	3.07	Wetlands	0.602000
1	X31G	3.07	Cultivated, permanent, commercial, irrigated	10.639000
1	X31G	4.04	Thicket, Bushland, Bush Clumps, High Fynbos	14.943000
75	X31K	3.07	Thicket, Bushland, Bush Clumps, High Fynbos	1187.527000
95	X31K	3.07	Woodland (previously termed Forest & Woodland)	1021.864000
7	X31K	3.07	Waterbodies	405.940000
49	X31K	3.07	Cultivated, temporary, subsistence, dryland	193.193000
3	X31K	3.07	Degraded Forest & Woodland	167.086000
2	X31K	3.07	Urban / Built-up (residential, informal township	57.546000
4	X31K	3.07	Urban / Built-up (residential, formal township)	50.281000
4	X31K	3.07	Degraded Thicket, Bushland, etc	13.427000
2	X31K	3.07	Bare Rock and Soil (natural)	4.911000
2	X31K	3.07	Urban / Built-up	3.644000
1	X31K	3.07	Planted Grassland (previously termed Improved Grassl	3.200000
1	X31K	3.07	Wetlands	0.228000
3	X31L	3.07	Woodland (previously termed Forest & Woodland)	16.974000
3	X31L	3.07	Thicket, Bushland, Bush Clumps, High Fynbos	6.705000
1	X31L	3.07	Waterbodies	6.184000
2	X31L	3.07	Cultivated, temporary, subsistence, dryland	9.662000
1	X31L	3.07	Urban / Built-up (residential, formal township)	11.970000
77	X31M	3.07	Thicket, Bushland, Bush Clumps, High Fynbos	2137.750000
113	X31M	3.07	Woodland (previously termed Forest & Woodland)	986.830000
9	X31M	3.07	Waterbodies	538.866000
11	X31M	3.07	Cultivated, permanent, commercial, irrigated	154.708000
18	X31M	3.07	Bare Rock and Soil (natural)	108.295000
6	X31M	3.07	Cultivated, temporary, commercial, irrigated	62.115000
2	X31M	3.07	Urban / Built-up (residential, formal township)	45.759000
4	X31M	3.07	Cultivated, temporary, subsistence, dryland	17.610000
1	X31M	3.07	Wetlands	1.104000
1	X31M	3.07	Urban / Built-up (rural cluster)	0.022000
6	X32J	3.07	Woodland (previously termed Forest & Woodland)	15.138000
3	X32J	3.07	Thicket, Bushland, Bush Clumps, High Fynbos	13.249000

3	X32J	3.07	Waterbodies	2.773000
1	X32J	3.07	Bare Rock and Soil (natural)	0.279000
46	X33A	3.07	Thicket, Bushland, Bush Clumps, High Fynbos	667.330000
52	X33A	3.07	Woodland (previously termed Forest & Woodland)	474.806000
3	X33A	3.07	Waterbodies	360.888000
20	X33A	3.07	Bare Rock and Soil (natural)	108.934000
21	X33B	3.06	Thicket, Bushland, Bush Clumps, High Fynbos	622.405000
32	X33B	3.06	Woodland (previously termed Forest & Woodland)	373.593000
5	X33B	3.06	Waterbodies	193.265000
8	X33B	12.01	Woodland (previously termed Forest & Woodland)	111.323000
6	X33B	3.07	Thicket, Bushland, Bush Clumps, High Fynbos	105.480000
10	X33B	12.01	Thicket, Bushland, Bush Clumps, High Fynbos	100.571000
7	X33B	3.07	Woodland (previously termed Forest & Woodland)	65.909000
2	X33B	3.07	Waterbodies	63.543000
1	X33B	12.01	Waterbodies	44.080000
6	X33B	3.06	Bare Rock and Soil (natural)	35.223000
4	X33B	3.07	Bare Rock and Soil (natural)	19.600000
3	X33B	12.01	Bare Rock and Soil (natural)	5.215000
1	X33B	3.06	Wetlands	2.590000
23	X33D	12.01	Thicket, Bushland, Bush Clumps, High Fynbos	616.530000
3	X33D	12.01	Waterbodies	345.913000
46	X33D	12.01	Woodland (previously termed Forest & Woodland)	283.120000
13	X33D	12.01	Bare Rock and Soil (natural)	63.656000

SAND SYSTEM : LANDCOVER				
FREQUENCY	QUAT	LEVEL 2 ECOREGION	LANDCOVER	HA
6	X31M	3.07	Woodland (previously termed Forest & Woodland)	32.925000
5	X31M	3.07	Thicket, Bushland, Bush Clumps, High Fynbos	7.631000
1	X31M	3.07	Waterbodies	13.199000
2	X31M	3.07	Bare Rock and Soil (natural)	6.675000
1	X32C	3.07	Woodland (previously termed Forest & Woodland)	0.990000
4	X32C	3.07	Thicket, Bushland, Bush Clumps, High Fynbos	26.535000
2	X32C	3.07	Waterbodies	2.310000
4	X32C	3.07	Cultivated, temporary, subsistence, dryland	22.374000
3	X32C	3.07	Urban / Built-up (residential, formal township)	1.617000
2	X32C	3.07	Urban / Built-up (residential, informal township)	6.501000
6	X32D	4.04	Degraded Thicket, Bushland, etc	306.661000
6	X32D	3.07	Degraded Thicket, Bushland, etc	263.421000
9	X32D	10.02	Forest (indigenous)	208.031000
5	X32D	4.04	Thicket, Bushland, Bush Clumps, High Fynbos	182.523000
5	X32D	3.07	Thicket, Bushland, Bush Clumps, High Fynbos	151.070000
4	X32D	3.07	Urban / Built-up (residential, informal township)	137.055000
5	X32D	10.02	Forest Plantations (Pine spp)	102.238000
1	X32D	4.04	Urban / Built-up (residential, informal squatter cam	96.743000

SAND SYSTEM : LANDCOVER				
FREQUENCY	QUAT	LEVEL 2 ECOREGION	LANDCOVER	HA
2	X32D	4.04	Forest Plantations (Pine spp)	92.402000
5	X32D	4.04	Cultivated, temporary, subsistence, irrigated	72.845000
4	X32D	10.02	Forest Plantations (Eucalyptus spp)	72.026000
1	X32D	4.04	Bare Rock and Soil (erosion : sheet)	66.504000
4	X32D	4.04	Bare Rock and Soil (natural)	45.857000
1	X32D	4.04	Forest Plantations (clearfelled)	27.348000
3	X32D	3.07	Cultivated, temporary, subsistence, dryland	26.402000
1	X32D	10.02	Forest Plantations (clearfelled)	21.114000
1	X32D	10.02	Thicket, Bushland, Bush Clumps, High Fynbos	19.123000
1	X32D	4.04	Forest Plantations (Eucalyptus spp)	13.034000
3	X32D	4.04	Urban / Built-up (residential, informal township)	7.871000
2	X32D	3.07	Urban / Built-up (residential, formal township)	7.551000
3	X32D	4.04	Forest (indigenous)	3.008000
1	X32D	4.04	Wetlands	1.971000
37	X32F	3.07	Thicket, Bushland, Bush Clumps, High Fynbos	843.343000
32	X32F	3.07	Degraded Thicket, Bushland, etc	510.086000
52	X32F	3.07	Cultivated, temporary, subsistence, dryland	426.496000
18	X32F	3.07	Urban / Built-up (residential, informal township)	280.513000
5	X32F	3.07	Cultivated, temporary, subsistence, irrigated	108.649000
14	X32F	3.07	Urban / Built-up (residential, formal township)	69.918000
5	X32F	3.07	Woodland (previously termed Forest & Woodland)	12.611000
4	X32F	3.07	Waterbodies	9.231000
1	X32F	3.07	Bare Rock and Soil (natural)	6.033000
3	X32F	3.07	Degraded Forest & Woodland	5.846000
1	X32F	3.07	Wetlands	1.723000
39	X32G	3.07	Thicket, Bushland, Bush Clumps, High Fynbos	737.544000
68	X32G	3.07	Woodland (previously termed Forest & Woodland)	496.165000
41	X32G	3.07	Cultivated, temporary, subsistence, dryland	316.651000
29	X32G	3.07	Degraded Forest & Woodland	137.241000
18	X32G	3.07	Bare Rock and Soil (natural)	63.624000
19	X32G	3.07	Waterbodies	56.565000
5	X32G	3.07	Urban / Built-up (residential, formal township)	55.147000
2	X32G	3.07	Urban / Built-up (residential, informal township)	37.720000
2	X32G	3.07	Degraded Thicket, Bushland, etc	3.145000
30	X32H	3.07	Thicket, Bushland, Bush Clumps, High Fynbos	872.322000
60	X32H	3.07	Woodland (previously termed Forest & Woodland)	732.412000
7	X32H	3.07	Cultivated, temporary, commercial, dryland	110.433000
13	X32H	3.07	Bare Rock and Soil (natural)	88.241000
12	X32H	3.07	Waterbodies	49.628000
2	X32H	3.07	Urban / Built-up, (industrial / transport : light	2.332000
59	X32J	3.07	Thicket, Bushland, Bush Clumps, High Fynbos	2109.607000
124	X32J	3.07	Woodland (previously termed Forest & Woodland)	1381.519000
32	X32J	3.07	Waterbodies	175.836000
37	X32J	3.07	Bare Rock and Soil (natural)	162.604000

SAND SYSTEM : LANDCOVER				
FREQUENCY	QUAT	LEVEL 2 ECOREGION	LANDCOVER	HA
2	X32J	3.07	Urban / Built-up, (industrial / transport : light	11.843000
1	X33A	3.07	Woodland (previously termed Forest & Woodland)	0.707000
1	X33A	3.07	Thicket, Bushland, Bush Clumps, High Fynbos	0.147000

APPENDIX C FLUVIAL GEOMORPHOLOGY SITE SUITABILITY

SABIE SYSTEM:

EWR 1: UPPER SABIE

Site suitability

This provides an assessment of the suitability of the site for EWR determination studies					Notes
	SCORES:			SCORE	
	5	2	1		
Representivity of the site for the reach				3.5	
How well does the <i>morphology</i> of the site represent that of the reach?	Very well	Don't know	Poorly	4.0	Morphology representative, but condition may be poor due to recent extensive fires and excessive sediment input from forestry, and burnt, areas
To what extent is the <i>condition</i> of the site representative of the general condition of the reach?	Representative	Don't know	Very different	3.0	
Morphological Cues				2.3	
Is the site a bedrock or alluvial dominated section?	Alluvial	Mixed	Bedrock	2.0	Mixed bedrock/alluvial site. Terraces on the one bank, the other bank is a steep cut bank with bedrock influence. Terraces are not paired.
Are there good morphological clues that can be related to flood levels?	Very good	Don't know	Bad	3.0	
If these are present, are the terraces paired?	Yes	Don't know	No	2.0	
Sediment Transport Modelling				2.3	This is a bedload system and PBMT modelling would be appropriate, but the budget only allows for priority sites to be modelled in this way. Priority is likely to lie further down the catchment (i.e. near or inside the Kruger National Park).
Is the river a bedload dominated system (i.e. is potential bed material transport modelling suitable)	Yes	Don't know	No	5.0	
Is potential bed material transport modelling going to be undertaken at this site?	Yes	Don't know	No	1.0	
OVERALL SCORE:				2.7	

EWR 2: SABIE AANDEVLEIT

Site suitability

This provides an assessment of the suitability of the site for EWR determination studies					Notes
	SCORES:			SCORE	
	5	2	1		
Representivity of the site for the reach				3.0	
How well does the <i>morphology</i> of the site represent that of the reach?	Very well	Don't know	Poorly	3.0	Morphology not very representative (wide floodplain is atypical), and condition may be poorer due to bank modification and vegetation removal associated with the resort.
To what extent is the <i>condition</i> of the site representative of the general condition of the reach?	Representative	Don't know	Very different	3.0	
Morphological Cues				2.5	
Is the site a bedrock or alluvial dominated section?	Alluvial	Mixed	Bedrock	3.0	Mixed bedrock/alluvial site. Floodplain on the one bank, the other bank is a steep cut bank. Terraces are not paired.
Are there good morphological clues that can be related to flood levels?	Very good	Don't know	Bad	2.5	
If these are present, are the terraces paired?	Yes	Don't know	No	2.0	
Sediment Transport Modelling				2.3	This is a bedload system and PBMT modelling would be appropriate, but the budget only allows for priority sites to be modelled in this way. Priority is likely to lie further down the catchment (i.e. near or inside the Kruger National Park).
Is the river a bedload dominated system (i.e. is potential bed material transport modelling suitable)	Yes	Don't know	No	5.0	
Is potential bed material transport modelling going to be undertaken at this site?	Yes	Don't know	No	1.0	
OVERALL SCORE:				2.6	

EWR 3: KIDNEY

Site suitability

This provides an assessment of the suitability of the site for EWR determination studies					Notes
	SCORES:			SCORE	
	5	2	1		
Representivity of the site for the reach				4.0	
How well does the <i>morphology</i> of the site represent that of the reach?	Very well	Don't know	Poorly	4.0	Site is within a BA channel segment, although at the cross-section there is extensive alluvial influence (almost MA in character). Typical of these types of reaches
To what extent is the <i>condition</i> of the site representative of the general condition of the reach?	Representative	Don't know	Very different	4.0	
Morphological Cues				1.2	No true morphological cues. The "terrace" at the site could be an old BCB now forming part of a lateral bar. It is unlikely that the seasonal channel on the far edge of the floodplain is contemporary - the Breonadia are more than 1.5m in diameter and very far from the channel. Probably tapping in to subsurface flows along the old seasonal channel pathway?
Is the site a bedrock or alluvial dominated section?	Alluvial	Mixed	Bedrock	1.5	
Are there good morphological clues that can be related to flood levels?	Very good	Don't know	Bad	1.0	
If these are present, are the terraces paired?	Yes	Don't know	No	1.0	
Sediment Transport Modelling				5.0	Excellent candidate for PBMT modelling - bedload (sand, gravel, cobbles) system. PBMT to be undertaken at this site due to its high priority status (low in the catchment to assess flood requirements; sedimentation in the Sabie a longstanding concern and site is within the KNP).
Is the river a bedload dominated system (i.e. is potential bed material transport modelling suitable)	Yes	Don't know	No	5.0	
Is potential bed material transport modelling going to be undertaken at this site?	Yes	Don't know	No	5.0	
OVERALL SCORE:				3.4	

EWR 4: MAC MAC

Site suitability

This provides an assessment of the suitability of the site for EWR determination studies					Notes
SCORES:				SCORE	
	5	2	1		
Representivity of the site for the reach					3.8
How well does the <i>morphology</i> of the site represent that of the reach?	Very well	Don't know	Poorly	3.5	In terms of condition, the site is likely to be representative - few impacts are evident along this river.
To what extent is the <i>condition</i> of the site representative of the general condition of the reach?	Representative	Don't know	Very different	4.0	
Morphological Cues					1.7
Is the site a bedrock or alluvial dominated section?	Alluvial	Mixed	Bedrock	1.5	No true morphological cues. The "terrace" at the site could be an old BCB now forming part of a lateral bar. It is unlikely that the seasonal channel on the far edge of the floodplain is contemporary - the Breonadia are more than 1.5m in diameter and very far from the channel. Probably tapping in to subsurface flows along the old seasonal channel pathway.
Are there good morphological clues that can be related to flood levels?	Very good	Don't know	Bad	2.5	
If these are present, are the terraces paired?	Yes	Don't know	No	1.0	
Sediment Transport Modelling					2.3
Is the river a bedload dominated system (i.e. is potential bed material transport modelling suitable)	Yes	Don't know	No	5.0	Excellent candidate for PBMT modelling - bedload (sand, gravel, cobbles, boulder) system. However budget limitations prevent PBMT from being undertaken at this site. Only priority (probably KNP) site/s to have sed transport modelling done.
Is potential bed material transport modelling going to be undertaken at this site?	Yes	Don't know	No	1.0	
OVERALL SCORE:					2.6

EWR 5: MARITE

Site suitability

This provides an assessment of the suitability of the site for EWR determination studies					Notes
SCORES:				SCORE	
	5	2	1		
Representivity of the site for the reach					4.0
How well does the <i>morphology</i> of the site represent that of the reach?	Very well	Don't know	Poorly	4.0	Morphologically representative. In terms of condition, the site appears to be representative (from Google Earth imagery) - few impacts are evident along this river.
To what extent is the <i>condition</i> of the site representative of the general condition of the reach?	Representative	Don't know	Very different	4.0	
Morphological Cues					1.7
Is the site a bedrock or alluvial dominated section?	Alluvial	Mixed	Bedrock	1.5	No true morphological cues - upstream of the site there are apparent terraces, but these are not paired and seem to be composed of sand waves - not really reflecting long term flood histories.
Are there good morphological clues that can be related to flood levels?	Very good	Don't know	Bad	2.5	
If these are present, are the terraces paired?	Yes	Don't know	No	1.0	
Sediment Transport Modelling					4.3
Is the river a bedload dominated system (i.e. is potential bed material transport modelling suitable)	Yes	Don't know	No	5.0	Good candidate for PBMT modelling - bedload (sand, gravel) system. Must undertake PBMT from being undertaken at this site as there are no morphological cues to use to assess flood requirements.
Is potential bed material transport modelling going to be undertaken at this site?	Yes	Don't know	No	4.0	
OVERALL SCORE:					3.3

EWR 6 MUTLUMUVI

Site suitability

This provides an assessment of the suitability of the site for EWR determination studies					Notes
SCORES:				SCORE	
	5	2	1		
Representivity of the site for the reach					4.0
How well does the <i>morphology</i> of the site represent that of the reach?	Very well	Don't know	Poorly	4.0	Morphologically representative. In terms of condition, the site appears to be representative (from Google Earth imagery) - few impacts are evident along this river.
To what extent is the <i>condition</i> of the site representative of the general condition of the reach?	Representative	Don't know	Very different	4.0	
Morphological Cues					1.5
Is the site a bedrock or alluvial dominated section?	Alluvial	Mixed	Bedrock	2.0	One possible terrace on one bank, but not paired. The site is strongly bedrock influenced.
Are there good morphological clues that can be related to flood levels?	Very good	Don't know	Bad	1.5	
If these are present, are the terraces paired?	Yes	Don't know	No	1.0	
Sediment Transport Modelling					3.8
Is the river a bedload dominated system (i.e. is potential bed material transport modelling suitable)	Yes	Don't know	No	3.5	A fair candidate for PBMT modelling - bedload (sand, gravel) system - high energy section as the bedrock base active channels are largely free of sediment. Must undertake PBMT from being undertaken at this site as there are no morphological cues to use to assess flood requirements.
Is potential bed material transport modelling going to be undertaken at this site?	Yes	Don't know	No	4.0	
OVERALL SCORE:					3.1

EWR 7: THULANDZITEKA

Site suitability

This provides an assessment of the suitability of the site for EWR determination studies					Notes
	SCORES:			SCORE	
	5	2	1		
Representivity of the site for the reach				4.0	Upstream of the site the river is predominantly undisturbed. Downstream of the site there is encroachment from farming along the banks. At the site the effects of the road and bridge have impacted the river.
How well does the <i>morphology</i> of the site represent that of the reach?	Very well	Don't know	Poorly	4.0	
To what extent is the <i>condition</i> of the site representative of the general condition of the reach?	Representative	Don't know	Very different	4.0	
Morphological Cues				1.5	Cut bank on left; terrace on right bank which becomes paired going upstream away from the bridge.
Is the site a bedrock or alluvial dominated section?	Alluvial	Mixed	Bedrock	2.0	
Are there good morphological clues that can be related to flood levels?	Very good	Don't know	Bad	1.5	
If these are present, are the terraces paired?	Yes	Don't know	No	1.0	
Sediment Transport Modelling				4.0	An good candidate for PBMT modelling - bedload (sand, gravel) system, although site is upstream of a bridge and downstream the sediments are slightly coarser downstream.
Is the river a bedload dominated system (i.e. is potential bed material transport modelling suitable)	Yes	Don't know	No	4.0	
Is potential bed material transport modelling going to be undertaken at this site?	Yes	Don't know	No	4.0	
OVERALL SCORE:				3.2	

EWR 8: SAND

Site suitability

This provides an assessment of the suitability of the site for EWR determination studies					Notes
	SCORES:			SCORE	
	5	2	1		
Representivity of the site for the reach				4.5	Site is representative of the reach - largely undisturbed, sandy system with bedrock outcrops
How well does the <i>morphology</i> of the site represent that of the reach?	Very well	Don't know	Poorly	4.5	
To what extent is the <i>condition</i> of the site representative of the general condition of the reach?	Representative	Don't know	Very different	4.5	
Morphological Cues				2.2	Cues are not paired or clear - multiple channel site.
Is the site a bedrock or alluvial dominated section?	Alluvial	Mixed	Bedrock	3.5	
Are there good morphological clues that can be related to flood levels?	Very good	Don't know	Bad	2.0	
If these are present, are the terraces paired?	Yes	Don't know	No	1.0	
Sediment Transport Modelling				4.7	An excellent candidate for PBMT modelling - priority because it is low down in the catchment.
Is the river a bedload dominated system (i.e. is potential bed material transport modelling suitable)	Yes	Don't know	No	4.0	
Is potential bed material transport modelling going to be undertaken at this site?	Yes	Don't know	No	5.0	
OVERALL SCORE:				3.8	

CROCODILE SYSTEM:**EWR 1: VALYSPRUIT**

Site suitability

This provides an assessment of the suitability of the site for EWR determination studies					Notes
	SCORES:			SCORE	
	5	2	1		
Representivity of the site for the reach				3.8	Morphology representative, and impacts at site (grazing, roads) representative of the catchment.
How well does the <i>morphology</i> of the site represent that of the reach?	Very well	Don't know	Poorly	4.0	
To what extent is the <i>condition</i> of the site representative of the general condition of the reach?	Representative	Don't know	Very different	3.5	
Morphological Cues				3.7	Alluvial (meandering floodplain) site with bedrock control downstream. Levees and cut off meanders are present. However not easy to relate these cues to flows on a cross section
Is the site a bedrock or alluvial dominated section?	Alluvial	Mixed	Bedrock	5.0	
Are there good morphological clues that can be related to flood levels?	Very good	Don't know	Bad	3.0	
If these are present, are the terraces paired?	Yes	Don't know	No	3.0	
Sediment Transport Modelling				4.0	This is predominantly a bedload system and PBMT modelling is therefore appropriate and has already been conducted in a previous study. Will use these results for this study.
Is the river a bedload dominated system (i.e. is potential bed material transport modelling suitable)	Yes	Don't know	No	4.0	
Is potential bed material transport modelling going to be undertaken at this site?	Yes	Don't know	No	4.0	
OVERALL SCORE:				3.8	

EWR 2: GEODENHOOP

Site suitability

This provides an assessment of the suitability of the site for EWR determination studies					Notes
	SCORES:			SCORE	
	5	2	1		
Representivity of the site for the reach					3.3
How well does the <i>morphology</i> of the site represent that of the reach?	Very well	Don't know	Poorly	4.0	Morphology representative, and impacts at site (grazing, roads, incision) generally representative of the catchment.
To what extent is the <i>condition</i> of the site representative of the general condition of the reach?	Representative	Don't know	Very different	2.5	
Morphological Cues					3.3
Is the site a bedrock or alluvial dominated section?	Alluvial	Mixed	Bedrock	5.0	Alluvial (meandering floodplain) site with bedrock control downstream. Levees and cut off meanders are present. However not easy to relate these cues to flows on a cross section
Are there good morphological clues that can be related to flood levels?	Very good	Don't know	Bad	2.0	
If these are present, are the terraces paired?	Yes	Don't know	No	3.0	
Sediment Transport Modelling					4.0
Is the river a bedload dominated system (i.e. is potential bed material transport modelling suitable)	Yes	Don't know	No	4.0	This is predominantly a bedload system and PBMT modelling is therefore appropriate and has already been conducted in a previous study. Will use these results for this study.
Is potential bed material transport modelling going to be undertaken at this site?	Yes	Don't know	No	4.0	
OVERALL SCORE:					3.5

EWR 3: POPLAR CREEK

Site suitability

This provides an assessment of the suitability of the site for EWR determination studies					Notes
	SCORES:			SCORE	
	5	2	1		
Representivity of the site for the reach					3.8
How well does the <i>morphology</i> of the site represent that of the reach?	Very well	Don't know	Poorly	4.0	Morphology representative, and impacts at site (cut banks, incision and erosion) are generally representative of the catchment. Vegetation might be slightly better than average
To what extent is the <i>condition</i> of the site representative of the general condition of the reach?	Representative	Don't know	Very different	3.5	
Morphological Cues					3.7
Is the site a bedrock or alluvial dominated section?	Alluvial	Mixed	Bedrock	4.0	Alluvial with limited bedrock and boulders present. Narrow floodplain and terraces are present.
Are there good morphological clues that can be related to flood levels?	Very good	Don't know	Bad	3.5	
If these are present, are the terraces paired?	Yes	Don't know	No	3.5	
Sediment Transport Modelling					4.0
Is the river a bedload dominated system (i.e. is potential bed material transport modelling suitable)	Yes	Don't know	No	4.0	This is predominantly a bedload system and PBMT modelling is therefore appropriate and has already been conducted in a previous study. Will use these results for this study.
Is potential bed material transport modelling going to be undertaken at this site?	Yes	Don't know	No	4.0	
OVERALL SCORE:					3.8

EWR 4: KANYAMAZANE

Site suitability

This provides an assessment of the suitability of the site for EWR determination studies					Notes
	SCORES:			SCORE	
	5	2	1		
Representivity of the site for the reach					3.8
How well does the <i>morphology</i> of the site represent that of the reach?	Very well	Don't know	Poorly	4.0	Morphology representative, and impacts at site (grazing, limited wood harvesting) are generally representative of the catchment.
To what extent is the <i>condition</i> of the site representative of the general condition of the reach?	Representative	Don't know	Very different	3.5	
Morphological Cues					3.0
Is the site a bedrock or alluvial dominated section?	Alluvial	Mixed	Bedrock	3.5	Alluvial with large bedrock boulders are present. Extensive terraces are present on one bank; other bank is highly disturbed.
Are there good morphological clues that can be related to flood levels?	Very good	Don't know	Bad	3.5	
If these are present, are the terraces paired?	Yes	Don't know	No	2.0	
Sediment Transport Modelling					4.0
Is the river a bedload dominated system (i.e. is potential bed material transport modelling suitable)	Yes	Don't know	No	4.0	This is predominantly a bedload system and PBMT modelling is therefore appropriate and has already been conducted in a previous study. Will use these results for this study.
Is potential bed material transport modelling going to be undertaken at this site?	Yes	Don't know	No	4.0	
OVERALL SCORE:					3.6

EWR 5: MALELANE

Site suitability

This provides an assessment of the suitability of the site for EWR determination studies					Notes
	SCORES:			SCORE	
	5	2	1		
Representivity of the site for the reach					3.8
How well does the <i>morphology</i> of the site represent that of the reach?	Very well	Don't know	Poorly	4.0	Morphology representative, and impacts at site (bank disturbance outside KNP) are generally representative of the catchment; although possibly slightly better at this site
To what extent is the <i>condition</i> of the site representative of the general condition of the reach?	Representative	Don't know	Very different	3.5	
Morphological Cues					2.2
Is the site a bedrock or alluvial dominated section?	Alluvial	Mixed	Bedrock	3.5	Macro-channel with alluvial dominated active channel. No clear terraces are present.
Are there good morphological clues that can be related to flood levels?	Very good	Don't know	Bad	2.0	
If these are present, are the terraces paired?	Yes	Don't know	No	1.0	
Sediment Transport Modelling					4.3
Is the river a bedload dominated system (i.e. is potential bed material transport modelling suitable)	Yes	Don't know	No	5.0	This is a bedload system and PBMT modelling is therefore appropriate and has already been conducted in a previous study. Will use these results for this study.
Is potential bed material transport modelling going to be undertaken at this site?	Yes	Don't know	No	4.0	
OVERALL SCORE:					3.4

EWR 6: NKONGOMA

Site suitability

This provides an assessment of the suitability of the site for EWR determination studies					Notes
	SCORES:			SCORE	
	5	2	1		
Representivity of the site for the reach					3.8
How well does the <i>morphology</i> of the site represent that of the reach?	Very well	Don't know	Poorly	4.0	Morphology representative, and impacts at site (limited vegetation disturbance on the bank outside KNP) are generally representative of the catchment; although possibly slightly better at this site.
To what extent is the <i>condition</i> of the site representative of the general condition of the reach?	Representative	Don't know	Very different	3.5	
Morphological Cues					1.7
Is the site a bedrock or alluvial dominated section?	Alluvial	Mixed	Bedrock	2.0	Bedrock dominated section of the river, with alluvial deposits in the channel. No clear terraces are present.
Are there good morphological clues that can be related to flood levels?	Very good	Don't know	Bad	2.0	
If these are present, are the terraces paired?	Yes	Don't know	No	1.0	
Sediment Transport Modelling					4.3
Is the river a bedload dominated system (i.e. is potential bed material transport modelling suitable)	Yes	Don't know	No	5.0	This is a bedload system and PBMT modelling is therefore appropriate and has already been conducted in a previous study. Will use these results for this study.
Is potential bed material transport modelling going to be undertaken at this site?	Yes	Don't know	No	4.0	
OVERALL SCORE:					3.3

EWR 7: HONEYBIRD

Site suitability

This provides an assessment of the suitability of the site for EWR determination studies					Notes
	SCORES:			SCORE	
	5	2	1		
Representivity of the site for the reach					2.8
How well does the <i>morphology</i> of the site represent that of the reach?	Very well	Don't know	Poorly	3.0	Morphology representative, but impacts (alien vegetation, bank disturbance) at site are possibly slightly worse at this site due to historic disturbance along and near the road crossing. Bridge will have backup effect at high flows
To what extent is the <i>condition</i> of the site representative of the general condition of the reach?	Representative	Don't know	Very different	2.5	
Morphological Cues					2.0
Is the site a bedrock or alluvial dominated section?	Alluvial	Mixed	Bedrock	3.0	Bedrock dominated section of the river, with lateral alluvial deposits. Terrace may be an artefact of backup effects and old bank disturbance.
Are there good morphological clues that can be related to flood levels?	Very good	Don't know	Bad	2.0	
If these are present, are the terraces paired?	Yes	Don't know	No	1.0	
Sediment Transport Modelling					4.3
Is the river a bedload dominated system (i.e. is potential bed material transport modelling suitable)	Yes	Don't know	No	5.0	This is a bedload system and PBMT modelling is therefore appropriate and has already been conducted in a previous study. Will use these results for this study.
Is potential bed material transport modelling going to be undertaken at this site?	Yes	Don't know	No	4.0	
OVERALL SCORE:					3.0

APPENDIX D AQUATIC INVERTEBRATES SITE SUITABILITY

SABIE SYSTEM:

EWR 1: UPPER SABIE

Site suitability

EWR1_Sabie upstream of Hazyview					
SITE SUITABILITY FOR EWR, SITE REPRESENTIVITY WITHIN RESOURCE ASSESSMENT UNIT					
NO	CRITERIA FOR SUITABILITY	RELEVANCE	EXPECTED (SITE)	OBSERVED (SITE)	COMPARATIVE
	GENERAL HYDRAULIC HABITATS				
	Diverse hydraulic habitats (FFCS, SCS, FFS, SFS, MV)	1	1	1	
	COARSE SEDIMENTS				
	Coarse sediments dominated by cobble	1	1	0.5	
	Plentiful FFCS	1	1	1	
	Highly moveable CS	1	1	0	
	Upper and lower surfaces of CS clear of silt and algae	1	1	0	
	FINE SEDIMENTS				
	Fine sediments (sand) with moderate to high depth	0	0	0	
	Plentiful FFFS	0	0	0	
	Highly moveable FS	1	1	1	
	Upper surfaces of FS clear of algae	1	1	1	
	VEG				
	Plentiful Inundated Marginal Vegetation	1	1	0.5	
	PROXIMITY TO HUMAN STRUCTURES				
	Adequate distance from built instream structures	1	1	1	
	BANKS				
	No change to natural bank stability LB	1	1	1	
	No change to natural bank stability RB	1	1	1	
	LB High percentage natural cover throughout Rzone	1	1	1	
	RB High percentage natural cover throughout Rzone	1	1	0.5	
	CLARITY				
	High water clarity	1	1	1	
	LANDUSE				
	Minimum visible effects of local landuse	1	0.5	0.5	
	Total Score	15	14.5	11	
	Score out of 5		4.8	3.7	0

EWR 2: SABIE AANDEVLEIT

Site suitability

EWR2_Mac Mac River					
SITE SUITABILITY FOR EWR, SITE REPRESENTIVITY WITHIN RESOURCE ASSESSMENT UNIT					
NO	CRITERIA FOR SUITABILITY	RELEVANCE	EXPECTED (SITE)	OBSERVED (SITE)	COMPARATIVE
	GENERAL HYDRAULIC HABITATS				
	Diverse hydraulic habitats (FFCS, SCS, FFS, SFS, MV)	1	1	1	
	COARSE SEDIMENTS				
	Coarse sediments dominated by cobble	1	1	1	
	Plentiful FFCS	1	1	1	
	Highly moveable CS	1	1	1	
	Upper and lower surfaces of CS clear of silt and algae	1	1	0.25	
	FINE SEDIMENTS				
	Sediments dominated by sand and or bedrock	1	0	0	
	Plentiful FFFS	1	0	0	
	Highly moveable FS	1	1	0	
	Upper surfaces of FS clear of algae	1	1	0.5	
	VEG				
	Plentiful Inundated Marginal Vegetation	1	1	0.5	
	PROXIMITY TO HUMAN STRUCTURES				
	Adequate distance from built instream structures	1	1	1	
	BANKS				
	No change to natural bank stability LB	1	1	1	
	No change to natural bank stability RB	1	1	1	
	LB High percentage natural cover throughout Rzone	1	1	1	
	RB High percentage natural cover throughout Rzone	1	1	1	
	CLARITY				
	High water clarity	1	1	1	
	LANDUSE				
	Minimum visible effects of local landuse	1	1	0.75	
	Total Score	17	15	12	0
	Score out of 5		4.4	4.0	0

EWR 3: KIDNEY

Site suitability

SABIE EWR 3 - Sabie in KNP					
SITE SUITABILITY FOR EWR, SITE REPRESENTIVITY WITHIN RESOURCE ASSESSMENT UNIT					
NO	CRITERIA FOR SUITABILITY	RELEVANCE	EXPECTED (SITE)	OBSERVED (SITE)	COMPARATIVE
	GENERAL HYDRAULIC HABITATS				
	Diverse hydraulic habitats (FFCS, SCS, FFS, SFS, MV)	1	1	1	
	COARSE SEDIMENTS				
	Coarse sediments dominated by cobble	1	1	0	
	Plentiful FFCS	1	1	1	
	Highly moveable CS	1	0	0	
	Upper and lower surfaces of CS clear of silt and algae	1	1	0	
	VEG				
	Plentiful Inundated Marginal Vegetation	1	1	1	
	PROXIMITY TO HUMAN STRUCTURES				
	Adequate distance from built instream structures	1	1	1	
	BANKS				
	No change to natural bank stability LB	1	1	1	
	No change to natural bank stability RB	1	1	1	
	LB High percentage natural cover throughout Rzone	1	1	1	
	RB High percentage natural cover throughout Rzone	1	1	1	
	CLARITY				
	High water clarity	1	1	1	
	LANDUSE				
	Minimum visible effects of local landuse	1	1	1	
	Total Score	13	12	10	
	Score out of 5		4.615384615	4.166666667	0

EWR 4: MAC MAC

Site suitability

EWR 4 - Sand River in Kruger Park					
SITE SUITABILITY FOR EWR, SITE REPRESENTIVITY WITHIN RESOURCE ASSESSMENT UNIT					
NO	CRITERIA FOR SUITABILITY	RELEVANCE	EXPECTED (SITE)	OBSERVED (SITE)	COMPARATIVE
	GENERAL HYDRAULIC HABITATS				
	Diverse hydraulic habitats (FFCS, SCS, FFS, SFS, MV)	1	0	0	
	COARSE SEDIMENTS				
	Coarse sediments dominated by cobble	0	0	0	
	Plentiful FFCS	0	0	0	
	Highly moveable CS	0	0	0	
	Upper and lower surfaces of CS clear of silt and algae	0	0	0	
	FINE SEDIMENTS				
	Sediments dominated by sand and or bedrock	1	1	1	
	Plentiful FFFS	1	1	1	
	Highly moveable FS	1	1	1	
	Upper surfaces of FS clear of algae	1	1	0.5	
	VEG				
	Plentiful Inundated Marginal Vegetation	1	1	0.5	
	PROXIMITY TO HUMAN STRUCTURES				
	Adequate distance from built instream structures	1	0	0	
	BANKS				
	No change to natural bank stability LB	1	1	1	
	No change to natural bank stability RB	1	1	1	
	LB High percentage natural cover throughout Rzone	1	1	1	
	RB High percentage natural cover throughout Rzone	1	1	1	
	CLARITY				
	High water clarity	1	0	0	
	LANDUSE				
	Minimum visible effects of local landuse	1	1	1	
	Total Score	13	10	9	0
	Score out of 5		3.8	3.5	0

EWR 5: MARITE

Site suitability

EWR5 - Sabie R at Aan de Vliet					
SITE SUITABILITY FOR EWR, SITE REPRESENTIVITY WITHIN RESOURCE ASSESSMENT UNIT					
NO	CRITERIA FOR SUITABILITY	RELEVANCE	EXPECTED (SITE)	OBSERVED (SITE)	COMPARATIVE
	GENERAL HYDRAULIC HABITATS				
	Diverse hydraulic habitats (FFCS, SCS, FFS, SFS, MV)	1	1	1	
	COARSE SEDIMENTS				
	Coarse sediments dominated by cobble	1	1	1	
	Plentiful FFCS	1	1	1	
	Highly moveable CS	1	0	0	
	Upper and lower surfaces of CS clear of silt and algae	1	1	1	
	VEG				
	Plentiful Inundated Marginal Vegetation	1	1	1	
	PROXIMITY TO HUMAN STRUCTURES				
	Adequate distance from built instream structures	1	1	1	
	BANKS				
	No change to natural bank stability LB	1	1	1	
	No change to natural bank stability RB	1	1	1	
	LB High percentage natural cover throughout Rzone	1	1	1	
	RB High percentage natural cover throughout Rzone	1	1	1	
	CLARITY				
	High water clarity	1	1	1	
	LANDUSE				
	Minimum visible effects of local landuse	1	1	1	
	Total Score	13	12	12	0
	Score out of 5		4.615384615	4.615384615	0

EWR 6 MUTLUMUVI

Site suitability

EWR 6 Mutlumuvi River					
SITE SUITABILITY FOR EWR, SITE REPRESENTIVITY WITHIN RESOURCE ASSESSMENT UNIT					
NO	CRITERIA FOR SUITABILITY	RELEVANCE	EXPECTED (SITE)	OBSERVED (SITE)	COMPARATIVE
	GENERAL HYDRAULIC HABITATS				
	Diverse hydraulic habitats (FFCS, SCS, FFS, SFS, MV)	1	0.5	0.5	
	COARSE SEDIMENTS				
	Coarse sediments dominated by cobble	1	1	1	
	Plentiful FFCS	1	0	0	
	Highly moveable CS	1	1	1	
	Upper and lower surfaces of CS clear of silt and algae	1	0	0	
	FINE SEDIMENTS				
	Fine sediments plentiful	1	1	1	
	Plentiful FFFS	1	0	0	
	Highly moveable FS	1	1	1	
	Upper surfaces of FS clear of algae	1	1	1	
	VEG				
	Plentiful Inundated Marginal Vegetation	1	1	0.25	
	PROXIMITY TO HUMAN STRUCTURES				
	Adequate distance from built instream structures	1	0	0	
	BANKS				
	No change to natural bank stability LB	1	1	1	
	No change to natural bank stability RB	1	1	1	
	LB High percentage natural cover throughout Rzone	1	1	1	
	RB High percentage natural cover throughout Rzone	1	1	1	
	CLARITY				
	High water clarity	1	0	0	
	LANDUSE				
	Minimum visible effects of local landuse	1	1	1	
	Total Score	17	11.5	10.75	0
	Score out of 5		3.4	3.2	0

EWR 7: THULANDZITEKA

Site suitability

EWR7 - Nwandmamuhari River					
SITE SUITABILITY FOR EWR, SITE REPRESENTIVITY WITHIN RESOURCE ASSESSMENT UNIT					
NO	CRITERIA FOR SUITABILITY	RELEVANCE	EXPECTED (SITE)	OBSERVED (SITE)	COMPARATIVE
	GENERAL HYDRAULIC HABITATS				
	Diverse hydraulic habitats (FFCS, SCS, FFS, SFS, MV)	1	1	1	
	COARSE SEDIMENTS				
	Coarse sediments dominated by cobble	1	1	1	
	Plentiful FFCS	1	1	1	
	Highly moveable CS	1	1	1	
	Upper and lower surfaces of CS clear of silt and algae	1	1	1	
	FINE SEDIMENTS				
	Sediments dominated by sand and or bedrock	0	0	0	
	Plentiful FFFS	1	1	1	
	Highly moveable FS	1	0.5	0.5	
	Upper surfaces of FS clear of algae	1	1	1	
	VEG				
	Plentiful Inundated Marginal Vegetation	1	1	1	
	PROXIMITY TO HUMAN STRUCTURES				
	Adequate distance from built instream structures	1	0	0	
	BANKS				
	No change to natural bank stability LB	1	1	1	
	No change to natural bank stability RB	1	1	0.5	
	LB High percentage natural cover throughout Rzone	1	1	1	
	RB High percentage natural cover throughout Rzone	1	1	1	
	CLARITY				
	High water clarity	1	1	1	
	LANDUSE				
	Minimum visible effects of local landuse	1	0.5	0	
	Total Score	16.0	14.0	13.0	0.0
	Score out of 5		4.4	4.1	0.0

EWR 8: SAND

Site suitability

EWR 8_ MARITE RIVER					
SITE SUITABILITY FOR EWR, SITE REPRESENTIVITY WITHIN RESOURCE ASSESSMENT UNIT					
NO	CRITERIA FOR SUITABILITY	RELEVANCE	EXPECTED (SITE)	OBSERVED (SITE)	COMPARATIVE
	GENERAL HYDRAULIC HABITATS				
	Diverse hydraulic habitats (FFCS, SCS, FFS, SFS, MV)	1	1	1	
	COARSE SEDIMENTS				
	Coarse sediments dominated by cobble	1	1	1	
	Plentiful FFCS	1	1	1	
	Highly moveable CS	1	1	0.5	
	Upper and lower surfaces of CS clear of silt and algae	1	0.5	0.5	
	FINE SEDIMENTS				
	Fine sediments (sand) with moderate to high depth	1	1	1	
	Plentiful FFFS	1	1	1	
	Highly moveable FS	1	1	1	
	Upper surfaces of FS clear of algae	1	1	1	
	VEG				
	Plentiful Inundated Marginal Vegetation	1	1	1	
	PROXIMITY TO HUMAN STRUCTURES				
	Adequate distance from built instream structures	1	1	1	
	BANKS				
	No change to natural bank stability LB	1	1	1	
	No change to natural bank stability RB	1	1	1	
	LB High percentage natural cover throughout Rzone	1	1	1	
	RB High percentage natural cover throughout Rzone	1	1	0	
	CLARITY				
	High water clarity	1	1	1	
	LANDUSE				
	Minimum visible effects of local landuse	1	0	0	
	Total Score	17	15.5	14	
	Score out of 5		4.6	4.5	0

CROCODILE SYSTEM:

EWR 1: VALYSPRUIT

Site suitability

EWR1 Valyspruit						
SITE SUITABILITY FOR EWR, SITE REPRESENTIVITY WITHIN RESOURCE ASSESSMENT UNIT						
NO	CRITERIA FOR SUITABILITY	RELEVANCE	EXPECTED (SITE)	OBSERVED (SITE)	COMPARATIVE	COMMENTS
GENERAL HABITAT						
1	Diverse hydraulic habitat present (FFCS, SCS, FFS, SFS, MV)	1	1	0.5		Expected more MV and stronger riffles
3	Diversity of habitats will be maintained or improved with increase in flows	1	1	1		Improved MV with 10cm water and faster SIC
	Diversity of habitats will be maintained or improved with decrease in flows	1	0	0		Can't tolerate much decrease
COARSE SEDIMENTS (CS)						
5	FFCS represents critical habitat for EWR purposes	1	1	1		Good cobble Size
6	Coarse sediments are dominated by cobble	1	1	1		High mobility, less so in SOOC
7	Coarse sediments are mobile	1	1	1		
	Upper and lower surfaces of CS are clear of silt and algae	1	1	0		High algae, lots of fines
FINE SEDIMENTS						
9	Sand and/or gravel are present at adequate depth to provide habitat	1	1	0.5		Not much sand as expected
10	River substrate dominated by sand and or bedrock	0	0	0		Not expected in upland stream
VEGETATION						
12	MV, instream veg or aquatic veg present	1	1	0.5		Very little MV and no AV
13	Greater proportion of leafy veg than stems	1	1	0		Very little leafy veg
14	MVIC represents critical habitat for EWR purposes at current flows	1	0	0		MV Barely inundated
15	Marginal or Instream Vegetation inundated at current flows and providing habitat	1	1	0		MV Barely inundated
	MV or instream veg will remain adequately inundated at reduced flows (say 10cm loss of depth)	1	1	0		Will not
PROXIMITY TO HUMAN STRUCTURES						
16	No visible effects of built instream structures	1	0	0		Bridge has some damming effect
BANKS						
18	No change to natural bank stability Left Bank	1	1	1		
19	No change to natural bank stability Right Bank	1	1	1		
20	LB High percentage natural cover throughout Rzone	1	1	1		95% Cover on both banks, Mostly Natural
	RB High percentage natural cover throughout Rzone	1	1	1		
CLARITY						
21	Water clear	1	1	1		Very Clear
LANDUSE						
22	Minimum visible effects of local landuse	1	1	1		Open
Total Score		20	17	11.5		
Score out of 5			4.3	3.4	0.0	

EWR 2: GEODENHOOP

Site suitability

EWR2 Goedenhoop						
SITE SUITABILITY FOR EWR, SITE REPRESENTIVITY WITHIN RESOURCE ASSESSMENT UNIT						
NO	CRITERIA FOR SUITABILITY	RELEVANCE	EXPECTED (SITE)	OBSERVED (SITE)	COMPARATIVE	COMMENTS
GENERAL HABITAT						
1	Diverse hydraulic habitat present (at least 3 / 4 of FFCS, SCS, FFS, SFS, MV)	1	1	1		Good diversity of habitat and flow types
	Diversity of habitats will be maintained or improved with increase in flows	1	1	1		More inundation of veg than EWR1, and better SIC
	Diversity of habitats will be maintained or improved with decrease in flows	1	0	0		Cannot tolerate much flow reduction
COARSE SEDIMENTS (CS)						
1	FFCS represents critical habitat for EWR purposes	1	1	1		
5	Coarse sediments are dominated by cobble	1	1	1		Small upper catchment stream - expected
4	Coarse sediments are mobile	1	1	1		Ditto
	Upper and lower surfaces of CS are clear of silt and algae	1	1	0		Fair amt of fines and algae on stones
FINE SEDIMENTS						
	Sand and/or gravel are present at adequate depth to provide habitat	1	1	0.5		No real sand just fines and gravel
	River substrate dominated by sand and or bedrock	0	0	0		
VEGETATION						
	MV, instream veg or aquatic veg present	1	1	0.5		No aquatic veg, MV limited
	Greater proportion of leafy veg than stems	1	1	0.5		Only Kikuyu inundated. No aquatic veg.
3	MVIC represents critical habitat for EWR purposes at current flows	1	1	1		(MU _ Does not sound like it - not much inundation. However SASS scores high for MV)
	Marginal or Instream Vegetation inundated at current flows and providing habitat	1	1	0.5		Not great deal of inundation (however clearly good habitat)
2	MV or instream veg will remain adequately inundated at reduced flows (say 10cm loss of depth)	1	1	0.5		Canot tolerate much flow reduction
PROXIMITY TO HUMAN STRUCTURES						
	No visible effects of built instream structures	1	0.5	0		Some influence expected from low water bridge
BANKS						
	No change to natural bank stability Left Bank	1	1	1		95% cover on both banks. Mostly natural Veg
	No change to natural bank stability Right Bank	1	1	1		
	LB High percentage natural cover throughout Rzone	1	1	1		
	RB High percentage natural cover throughout Rzone	1	1	1		
CLARITY						
	Water clear	1	1	0.5		Slight blue-green tinge
LANDUSE						
	Minimum visible effects of local landuse	1	1	1		
Total Score		20	18.5	14		
Score out of 5			4.6	3.8	0.0	

EWR 3: POPLAR CREEK

Site suitability

EWR2 Goedenhoop						
SITE SUITABILITY FOR EWR, SITE REPRESENTIVITY WITHIN RESOURCE ASSESSMENT UNIT						
NO	CRITERIA FOR SUITABILITY	RELEVANCE	EXPECTED (SITE)	OBSERVED (SITE)	COMPARATIVE	COMMENTS
1	GENERAL HABITAT					
	Diverse hydraulic habitat present (at least 3 / 4 of FFCS, SCS, FFS, SFS, MV)	1	1	0		
	Diversity of habitats will be maintained or improved with increase in flows	1	1	1		
	Diversity of habitats will be maintained or improved with decrease in flows	1	1	1		
	COARSE SEDIMENTS (CS)					
1	FFCS represents critical habitat for EWR purposes	1	1	1		
5	Coarse sediments are dominated by cobble	1	1	0.5		
4	Coarse sediments are mobile	1	1	0.5		
	Upper and lower surfaces of CS are clear of silt and algae	1	1	0.5		
	FINE SEDIMENTS					
	Sand and/or gravel are present at adequate depth to provide habitat	1	1	0		
	River substrate dominated by sand and or bedrock	0	0	0		
	VEGETATION					
	MV, instream veg or aquatic veg present	1	1	0.5		
	Greater proportion of leafy veg than stems	1	1	0.5		
3	MVIC represents critical habitat for EWR purposes at current flows	1	1	1		
	Marginal or Instream Vegetation inundated at current flows and providing habitat	1	1	0.5		
2	MV or instream veg will remain adequately inundated at reduced flows (say 10cm loss of depth)	1	1	1		
	PROXIMITY TO HUMAN STRUCTURES					
	No visible effects of built instream structures	1	0.5	1		
	BANKS					
	No change to natural bank stability Left Bank	1	0.5	1		
	No change to natural bank stability Right Bank	1	0.5	1		
	LB High percentage natural cover throughout Rzone	1	0.5	1		
	RB High percentage natural cover throughout Rzone	1	0.5	1		
	CLARITY					
	Water clear	1	1	0.5		
	LANDUSE					
	Minimum visible effects of local landuse	1	0	1		
	Total Score	20	16.5	14.5		
	Score out of 5	5	4.1	3.6		

EWR 4: KANYAMAZANE

Site suitability

EWR4 KaNyamazane						
SITE SUITABILITY FOR EWR, SITE REPRESENTIVITY WITHIN RESOURCE ASSESSMENT UNIT						
NO	CRITERIA FOR SUITABILITY	RELEVANCE	EXPECTED (SITE)	OBSERVED (SITE)	COMPARATIVE	COMMENTS
1	GENERAL HABITAT					
	Diverse hydraulic habitat present (at least 3 / 4 of FFCS, SCS, FFS, SFS, MV)	1	1	0.5		
	Diversity of habitats will be maintained or improved with increase in flows	1	1	1		
	Diversity of habitats will be maintained or improved with decrease in flows	1	1	1		
	COARSE SEDIMENTS (CS)					
1	FFCS represents critical habitat for EWR purposes	1	1	1		
5	Coarse sediments are dominated by cobble	1	1	1		
4	Coarse sediments are mobile	1	1	1		
	Upper and lower surfaces of CS are clear of silt and algae	1	1	0.5		
	FINE SEDIMENTS					
	Sand and/or gravel are present at adequate depth to provide habitat	1	1	0		
	River substrate dominated by sand and or bedrock	0	0	0		
	VEGETATION					
	MV, instream veg or aquatic veg present	1	1	1		
	Greater proportion of leafy veg than stems	1	1	1		
3	MVIC represents critical habitat for EWR purposes at current flows	1	1	1		
	Marginal or Instream Vegetation inundated at current flows and providing habitat	1	1	1		
2	MV or instream veg will remain adequately inundated at reduced flows (say 10cm loss of depth)	1	1	1		
	PROXIMITY TO HUMAN STRUCTURES					
	No visible effects of built instream structures	1	1	1		
	BANKS					
	No change to natural bank stability Left Bank	1	1	1		
	No change to natural bank stability Right Bank	1	1	1		
	LB High percentage natural cover throughout Rzone	1	1	1		
	RB High percentage natural cover throughout Rzone	1	1	1		
	CLARITY					
	Water clear	1	1	0		
	LANDUSE					
	Minimum visible effects of local landuse	1	1	0		
	Total Score	20	20	16		
	Score out of 5	5	5.0	4.0		

EWR 5: MALELANE

Site suitability

EWR5 Malelane						
SITE SUITABILITY FOR EWR, SITE REPRESENTIVITY WITHIN RESOURCE ASSESSMENT UNIT						
NO	CRITERIA FOR SUITABILITY	RELEVANCE	EXPECTED (SITE)	OBSERVED (SITE)	COMPARATIVE	COMMENTS
1	GENERAL HABITAT					
	Diverse hydraulic habitat present (at least 3 / 4 of FFCS, SCS, FFS, SFS, MV)	1	1	1		
	Diversity of habitats will be maintained or improved with increase in flows	1	1	1		
	Diversity of habitats will be maintained or improved with decrease in flows	1	1	1		
	COARSE SEDIMENTS (CS)					
1	FFCS represents critical habitat for EWR purposes	1	1	0.5		
5	Coarse sediments are dominated by cobble	1	1	0.5		
4	Coarse sediments are mobile	1	1	0.5		
	Upper and lower surfaces of CS are clear of silt and algae	1	1	0.5		
	FINE SEDIMENTS					
	Sand and/or gravel are present at adequate depth to provide habitat	1	1	1		
	River substrate dominated by sand and or bedrock	0	0	0		
	VEGETATION					
	MV, instream veg or aquatic veg present	1	1	1		
	Greater proportion of leafy veg than stems	1	1	1		
3	MVIC represents critical habitat for EWR purposes at current flows	1	1	1		
	Marginal or Instream Vegetation inundated at current flows and providing habitat	1	1	1		
2	MV or instream veg will remain adequately inundated at reduced flows (say 10cm loss of depth)	1	1	1		? Check ref
	PROXIMITY TO HUMAN STRUCTURES					
	No visible effects of built instream structures	1	1	1		
	BANKS					
	No change to natural bank stability Left Bank	1	1	1		
	No change to natural bank stability Right Bank	1	1	1		
	LB High percentage natural cover throughout Rzone	1	0.5	0.5		
	RB High percentage natural cover throughout Rzone	1	0.5	0.5		
	CLARITY					
	Water clear	1	0.5	0.5		
	LANDUSE					
	Minimum visible effects of local landuse	1	1	1		
	Total Score	20	18.5	16.5		
	Score out of 5		4.6	4.1		

EWR 6: NKONGOMA

Site suitability

EWR6 Nkongoma						
SITE SUITABILITY FOR EWR, SITE REPRESENTIVITY WITHIN RESOURCE ASSESSMENT UNIT						
NO	CRITERIA FOR SUITABILITY	RELEVANCE	EXPECTED (SITE)	OBSERVED (SITE)	COMPARATIVE	COMMENTS
1	GENERAL HABITAT					
	Diverse hydraulic habitat present (at least 3 / 4 of FFCS, SCS, FFS, SFS, MV)	1	1	1		
	Diversity of habitats will be maintained or improved with increase in flows	1	1	1		
	Diversity of habitats will be maintained or improved with decrease in flows	1	0	0		Check ref
	COARSE SEDIMENTS (CS)					
1	FFCS represents critical habitat for EWR purposes	1	1	0		
5	Coarse sediments are dominated by cobble	1	1	0		
4	Coarse sediments are mobile	1	1	1		
	Upper and lower surfaces of CS are clear of silt and algae	1	1	0.5		
	FINE SEDIMENTS					
	Sand and/or gravel are present at adequate depth to provide habitat	1	1	1		
	River substrate dominated by sand and or bedrock	1	1	1		
	VEGETATION					
	MV, instream veg or aquatic veg present	1	1	1		
	Greater proportion of leafy veg than stems	1	1	0		
3	MVIC represents critical habitat for EWR purposes at current flows	1	1	1		
	Marginal or Instream Vegetation inundated at current flows and providing habitat	1	1	1		
2	MV or instream veg will remain adequately inundated at reduced flows (say 10cm loss of depth)	1	0.5	0.5		Check Ref
	PROXIMITY TO HUMAN STRUCTURES					
	No visible effects of built instream structures	1	1	1		
	BANKS					
	No change to natural bank stability Left Bank	1	1	1		
	No change to natural bank stability Right Bank	1	1	1		
	LB High percentage natural cover throughout Rzone	1	1	1		
	RB High percentage natural cover throughout Rzone	1	1	1		
	CLARITY					
	Water clear	1	0.5	0.5		
	LANDUSE					
	Minimum visible effects of local landuse	1	1	1		
	Total Score	21	19	15.5		
	Score out of 5	5	4.5	3.7		

EWR 7: HONEYBIRD

Site suitability

EWR7 Honeybird						
SITE SUITABILITY FOR EWR, SITE REPRESENTIVITY WITHIN RESOURCE ASSESSMENT UNIT						
NO	CRITERIA FOR SUITABILITY	RELEVANCE	EXPECTED (SITE)	OBSERVED (SITE)	COMPARATIVE	COMMENTS
GENERAL HABITAT						
1	Diverse hydraulic habitat present (at least 3 / 4 of FFCS, SCS, FFS, SFS, MV)	1	1	0.5		
	Diversity of habitats will be maintained or improved with increase in flows	1	1	1		
	Diversity of habitats will be maintained or improved with decrease in flows	1	1	1		
COARSE SEDIMENTS (CS)						
1	FFCS represents critical habitat for EWR purposes	1	1	1		
5	Coarse sediments are dominated by cobble	1	1	1		
4	Coarse sediments are mobile	1	1	0.5		
	Upper and lower surfaces of CS are clear of silt and algae	1	1	0.5		
FINE SEDIMENTS						
	Sand and/or gravel are present at adequate depth to provide habitat	1	0	1		
	River substrate dominated by sand and or bedrock	1	1	1		
VEGETATION						
	MV, instream veg or aquatic veg present	1	1	0.5		
	Greater proportion of leafy veg than stems	1	1	0.5		
3	MVIC represents critical habitat for EWR purposes at current flows	1	1	0.5		
	Marginal or Instream Vegetation inundated at current flows and providing habitat	1	1	1		
2	MV or instream veg will remain adequately inundated at reduced flows (say 10cm loss of depth)	0	0	0		? Check ref
PROXIMITY TO HUMAN STRUCTURES						
	No visible effects of built instream structures	1	1	1		
BANKS						
	No change to natural bank stability Left Bank	1	1	1		
	No change to natural bank stability Right Bank	1	1	1		
	LB High percentage natural cover throughout Rzone	1	1	1		
	RB High percentage natural cover throughout Rzone	1	1	1		
CLARITY						
	Water clear	1	1	1		
LANDUSE						
	Minimum visible effects of local landuse	1	1	1		
	Total Score	20	19	17		
	Score out of 5		4.8	4.3		

APPENDIX E RIPARIAN VEGETATION SITE SUITABILITY

SABIE SYSTEM:

EWR 1: UPPER SABIE

Site suitability

Site Suitability for the Assessment of Environmental Flows		
Habitat availability	Rate	Motivation where applicable
Presence / absence of the marginal zone	1	marginal completely present
Proportion of marginal zone that is able to be sampled	0	entire marginal zone was sampled
Channel morphology		
Channel bank stabilization	0	impact not observed along site
Channel manipulation	1	slight manipulation towards bridge
Profile distance too long to effectively conduct VEGRAI	1	entire profile assessed
Vegetation		
Occurrence of obligate, marginal zone riparian species	1	more than sufficient obligate riparian species in sufficient obligate riparian species in non-marginal zone, although abundance affected by recent fire
Occurrence of obligate, non-marginal zone riparian species	2	obligates present, so unrated
Occurrence of species that are (regional) indicators of the riparian zone, or wetness		extensive recent fires on RHB (which proportionally was a much larger bank than LHB)
Recent fire/s at site	4	about 20% exotic overall
Exotic species at the site	1	banks similar, but LHB steep & short, RHB long and gentle, therefore veg proportions are different
Left and right-hand banks have riparian vegetation in similar condition	2	6 points for each bank
Able to obtain sufficient survey points of indicator species for flow requirements	1	despite fire, identification was not a problem
Plant species easily identifiable i.e. leaves or flowers present at time of site visit	0	
Hydraulic control		
unnatural up/downstream control affecting site	1	site slightly affected by bridge supports downstream
Overall Site Suitability Rating	1.2	

where: 0 - suite highly suitable
 1 - site very suitable
 2 - site moderately suitable
 3 - site unsuitable
 4 - site extremely unsuitable
 5 - site not to be used

EWR 2: SABIE AANDEVLEIT

Site suitability

Site Suitability for the Assessment of Environmental Flows		
Habitat availability	Rate	Motivation where applicable
Presence / absence of the marginal zone	1	marginal completely present
Proportion of marginal zone that is able to be sampled	0	entire marginal zone was sampled
Channel morphology		
Channel bank stabilization	0	less than 20% undercutting, and stabilized by roots
Channel manipulation	1	slight, some dumping from recreational activities
Profile distance too long to effectively conduct VEGRAI	1	entire profile assessed
Vegetation		
Occurrence of obligate, marginal zone riparian species	1	more than sufficient obligate riparian species in marginal zone
Occurrence of obligate, non-marginal zone riparian species	1	more than sufficient obligate riparian species in non-marginal zone, although structure affected by veg removal
Occurrence of species that are (regional) indicators of the riparian zone, or wetness		obligates present, so unrated
Recent fire/s at site	1	burns have occurred, but not recent
Exotic species at the site	1	about 20% or less exotic overall
Left and right-hand banks have riparian vegetation in similar condition	2	banks similar, but LHB steep & short, RHB long and gentle, therefore veg proportions are different
Able to obtain sufficient survey points of indicator species for flow requirements	1	min 6 points for each bank
Plant species easily identifiable i.e. leaves or flowers present at time of site visit	0	despite fire, identification was not a problem
Hydraulic control		
unnatural up/downstream control affecting site	0	not observed
Overall Site Suitability Rating	0.8	

EWR 3: KIDNEY

Site suitability

Site Suitability for the Assessment of Environmental Flows		
Habitat availability	Rate	Motivation where applicable
Presence / absence of the marginal zone	0	marginal completely present
Proportion of marginal zone that is able to be sampled	0	entire marginal zone was sampled
Channel morphology		
Channel bank stabilization	0	some (natural) undercutting, but stabilized by roots
Channel manipulation	0	none
Profile distance too long to effectively conduct VEGRAI	1	entire profile assessed
Vegetation		
Occurrence of obligate, marginal zone riparian species	0	obligate riparian species abundant in marginal zone
Occurrence of obligate, non-marginal zone riparian species	0	obligate riparian species abundant in non-marginal zone
Occurrence of species that are (regional) indicators of the riparian zone, or wetness		obligates present, so unrated
Recent fire/s at site	0	none
Exotic species at the site	1	<10% exotic overall
Left and right-hand banks have riparian vegetation in similar condition	1	similar banks to vegetation
Able to obtain sufficient survey points of indicator species for flow requirements	0	more than 8 points per bank and other critical areas
Plant species easily identifiable i.e. leaves or flowers present at time of site visit	0	identification was not a problem
Hydraulic control		
unnatural up/downstream control affecting site	0	none
Overall Site Suitability Rating	0.2	

EWR 4: MAC MAC

Site suitability

Site Suitability for the Assessment of Environmental Flows		
Habitat availability	Rate	Motivation where applicable
Presence / absence of the marginal zone	0	marginal completely present
Proportion of marginal zone that is able to be sampled	0	entire marginal zone was sampled
Channel morphology		
Channel bank stabilization	0	some (natural) undercutting, but stabilized by roots
Channel manipulation	1	effects of downstream low-level bridge minimal
Profile distance too long to effectively conduct VEGRAI	1	entire profile assessed
Vegetation		
Occurrence of obligate, marginal zone riparian species	1	obligate riparian species more than sufficient in marginal zone
Occurrence of obligate, non-marginal zone riparian species	0	obligate riparian species abundant in non-marginal zone
Occurrence of species that are (regional) indicators of the riparian zone, or wetness		obligates present, so unrated
Recent fire/s at site	0	none
Exotic species at the site	1	<10% exotic overall
Left and right-hand banks have riparian vegetation in similar condition	1	similar banks to vegetation
Able to obtain sufficient survey points of indicator species for flow requirements	2	LHB only 3 points due to short length, RHB > 8 points
Plant species easily identifiable i.e. leaves or flowers present at time of site visit	0	identification was not a problem
Hydraulic control		
unnatural up/downstream control affecting site	1	effects of downstream low-level bridge slight
Overall Site Suitability Rating	0.6	

EWR 5: MARITE

Site suitability

Site Suitability for the Assessment of Environmental Flows		
Habitat availability	Rate	Motivation where applicable
Presence / absence of the marginal zone	1	marginal completely present
Proportion of marginal zone that is able to be sampled	0	entire marginal zone was sampled
Channel morphology		
Channel bank stabilization	1	some undercutting, but predominantly natural and stabilized by roots
Channel manipulation	0	channel banks (marginal zone) unmanipulated
Profile distance too long to effectively conduct VEGRAI	0	entire profile assessed
Vegetation		
Occurrence of obligate, marginal zone riparian species	1	more than sufficient obligate riparian species in marginal zone
Occurrence of obligate, non-marginal zone riparian species	1	more than sufficient obligate riparian species in non-marginal zone
Occurrence of species that are (regional) indicators of the riparian zone, or wetness		obligates present, so unrated
Recent fire/s at site	2	approx 30% of Site (RHB) recently burnt
Exotic species at the site	1	<20% throughout, but >0%
Left and right-hand banks have riparian vegetation in similar condition	0	banks similar, not different in vegetation type
Able to obtain sufficient survey points of indicator species for flow requirements	2	only 3 on RHB, but sufficient for bank morphology
Plant species easily identifiable i.e. leaves or flowers present at time of site visit	0	despite fire, identification was not a problem
Hydraulic control		
unnatural up/downstream control affecting site	0	site not affected by unnatural hydraulic controls
Overall Site Suitability Rating	0.7	

EWR 6 MUTLUMUVI

Site suitability

Site Suitability for the Assessment of Environmental Flows		
Habitat availability	Rate	Motivation where applicable
Presence / absence of the marginal zone	0	marginal completely present
Proportion of marginal zone that is able to be sampled	0	entire marginal zone was sampled
Channel morphology		
Channel bank stabilization	0	no destabilization observed
Channel manipulation	0	none
Profile distance too long to effectively conduct VEGRAI	1	entire profile assessed
Vegetation		
Occurrence of obligate, marginal zone riparian species	1	obligate riparian species more than sufficient in marginal zone
Occurrence of obligate, non-marginal zone riparian species	1	obligate riparian species more than sufficient in non-marginal zone
Occurrence of species that are (regional) indicators of the riparian zone, or wetness		obligates present, so unrated
Recent fire/s at site	0	none
Exotic species at the site	1	<20% exotic overall
Left and right-hand banks have riparian vegetation in similar condition	1	similar banks to vegetation
Able to obtain sufficient survey points of indicator species for flow requirements	0	more than 8 points per bank and instream features
Plant species easily identifiable i.e. leaves or flowers present at time of site visit	0	identification was not a problem
Hydraulic control		
unnatural up/downstream control affecting site	0	none
Overall Site Suitability Rating	0.4	

EWR 7: THULANDZITEKA

Site suitability

Site Suitability for the Assessment of Environmental Flows		
Habitat availability	Rate	Motivation where applicable
Presence / absence of the marginal zone	1	marginal completely present, some deposition near bridge
Proportion of marginal zone that is able to be sampled	0	entire marginal zone was sampled
Channel morphology		
Channel bank stabilization	0	bank erosion observed, but minimal
Channel manipulation	1	unmanipulated
Profile distance too long to effectively conduct VEGRAI	1	entire profile assessed
Vegetation		
Occurrence of obligate, marginal zone riparian species	2	obligate riparian species sufficient in marginal zone
Occurrence of obligate, non-marginal zone riparian species	2	obligate riparian species sufficient in non-marginal zone
Occurrence of species that are (regional) indicators of the riparian zone, or wetness		obligates present, so unrated
Recent fire/s at site	2	most of RHB recently burnt (high intensity fire)
Exotic species at the site	3	60-80% exotics in upper zone, less in lower and marginal zones
Left and right-hand banks have riparian vegetation in similar condition	1	similar banks to vegetation
Able to obtain sufficient survey points of indicator species for flow requirements	1	6-7 points per bank
Plant species easily identifiable i.e. leaves or flowers present at time of site visit	0	identification was not a problem
Hydraulic control		
unnatural up/downstream control affecting site	1	downstream effect of bridge pillars increased sediment deposition slightly, but localised
Overall Site Suitability Rating	1.2	

EWR 8: SAND

Site suitability

Site Suitability for the Assessment of Environmental Flows		
Habitat availability	Rate	Motivation where applicable
Presence / absence of the marginal zone	0	marginal completely present
Proportion of marginal zone that is able to be sampled	0	entire marginal zone was sampled
Channel morphology		
Channel bank stabilization	0	no destabilization noted
Channel manipulation	1	unmanipulated
Profile distance too long to effectively conduct VEGRAI	1	entire profile assessed
Vegetation		
Occurrence of obligate, marginal zone riparian species	0	obligate riparian species abundant in marginal zone
Occurrence of obligate, non-marginal zone riparian species	0	obligate riparian species abundant in non-marginal zone
Occurrence of species that are (regional) indicators of the riparian zone, or wetness		obligates present, so unrated
Recent fire/s at site	0	no recent
Exotic species at the site	1	present, but <10% on all zones
Left and right-hand banks have riparian vegetation in similar condition	1	similar banks to vegetation
Able to obtain sufficient survey points of indicator species for flow requirements	0	>8 points per bank
Plant species easily identifiable i.e. leaves or flowers present at time of site visit	0	identification was not a problem
Hydraulic control		
unnatural up/downstream control affecting site	1	upstream effect of low-level bridge minimal localised deposition
Overall Site Suitability Rating	0.4	

CROCODILE SYSTEM:

EWR 1: VALYSPRUIT

Site suitability

Site Suitability for the Assessment of Environmental Flows		
Habitat availability	Rate	Motivation where applicable
Presence / absence of the marginal zone	1	marginal zone predominantly present, localised bank cutting (steep) with no marginal zone
Proportion of marginal zone that is able to be sampled	0	entire marginal zone was sampled
Channel morphology		
Channel bank stabilization	2	approx 40-60% of marginal zone undercut, frequently with overhanging root
Channel manipulation	1	unmanipulated
Profile distance too long to effectively conduct VEGRAI	1	entire profile assessed
Vegetation		
Occurrence of obligate, marginal zone riparian species	2	obligate riparian species sufficient in marginal zone
Occurrence of obligate, non-marginal zone riparian species	2	obligate riparian species sufficient in non-marginal zone
Occurrence of species that are (regional) indicators of the riparian zone, or wetness		obligates present, so unrated
Recent fire/s at site	1	localised, recent remnant
Exotic species at the site	1	present, but <10% on all zones
Left and right-hand banks have riparian vegetation in similar condition	0	similar banks to vegetation
Able to obtain sufficient survey points of indicator species for flow requirements	1	up to 7 points per bank
Plant species easily identifiable i.e. leaves or flowers present at time of site visit	1	some annuals not in flower, some fire damage with coppice only
Hydraulic control		
unnatural up/downstream control affecting site	1	upstream effect of bridge minimal localised deposition
Overall Site Suitability Rating	1.1	

where: 0 - suite highly suitable
 1 - site very suitable
 2 - site moderately suitable
 3 - site unsuitable
 4 - site extremely unsuitable
 5 - site not to be used

EWR 2: GEODENHOOP

Site suitability

Site Suitability for the Assessment of Environmental Flows		
Habitat availability	Rate	Motivation where applicable
Presence / absence of the marginal zone	1	marginal zone predominantly present, localised bank cutting (steep) with no marginal zone
Proportion of marginal zone that is able to be sampled	0	entire marginal zone was sampled
Channel morphology		
Channel bank stabilization	2	approx 40-60% of marginal zone undercut, frequently with overhanging root
Channel manipulation	1	unmanipulated
Profile distance too long to effectively conduct VEGRAI	0	entire profile assessed
Vegetation		
Occurrence of obligate, marginal zone riparian species	2	obligate riparian species sufficient in marginal zone
Occurrence of obligate, non-marginal zone riparian species	2	obligate riparian species sufficient in non-marginal zone
Occurrence of species that are (regional) indicators of the riparian zone, or wetness		obligates present, so unrated
Recent fire/s at site	0	none
Exotic species at the site	1	present, but <10% on all zones
Left and right-hand banks have riparian vegetation in similar condition	0	similar banks to vegetation
Able to obtain sufficient survey points of indicator species for flow requirements	2	up to 4 points per bank
Plant species easily identifiable i.e. leaves or flowers present at time of site visit	0	identification of indicators was possible
Hydraulic control		
unnatural up/downstream control affecting site	1	upstream effect of bridge minimal localised deposition
Overall Site Suitability Rating	0.9	

EWR 3: POPLAR CREEK

Site suitability

Site Suitability for the Assessment of Environmental Flows		
Habitat availability	Rate	Motivation where applicable
Presence / absence of the marginal zone	1	marginal zone slightly inundated, but present
Proportion of marginal zone that is able to be sampled	0	entire marginal zone was sampled
Channel morphology		
Channel bank stabilization	0	banks stable
Channel manipulation	1	road through LHB and agricultural disturbance to within upper zone
Profile distance too long to effectively conduct VEGRAI	1	entire profile assessed
Vegetation		
Occurrence of obligate, marginal zone riparian species	2	obligate riparian species sufficient in marginal zone
Occurrence of obligate, non-marginal zone riparian species	1	obligate riparian species more than sufficient in non-marginal zone
Occurrence of species that are (regional) indicators of the riparian zone, or wetness		obligates present, so unrated
Recent fire/s at site	0	none
Exotic species at the site	2	<10% in marginal zone, but high (up to 40%) in lower and upper zone woody
Left and right-hand banks have riparian vegetation in similar condition	1	similar banks to vegetation
Able to obtain sufficient survey points of indicator species for flow requirements	1	up to 7 points per bank
Plant species easily identifiable i.e. leaves or flowers present at time of site visit	0	identification of indicators was possible
Hydraulic control		
unnatural up/downstream control affecting site	0	no localised effect
Overall Site Suitability Rating	0.8	

EWR 4: KANYAMAZANE

Site suitability

Site Suitability for the Assessment of Environmental Flows		
Habitat availability	Rate	Motivation where applicable
Presence / absence of the marginal zone	1	marginal zone slightly inundated, but present
Proportion of marginal zone that is able to be sampled	0	entire marginal zone was sampled
Channel morphology		
Channel bank stabilization	0	banks stable, some slumping due to trampling and cobble/sand mining (small-scale)
Channel manipulation	1	rail along RHB
Profile distance too long to effectively conduct VEGRAI	1	entire profile assessed
Vegetation		
Occurrence of obligate, marginal zone riparian species	1	obligate riparian species more than sufficient in marginal zone
Occurrence of obligate, non-marginal zone riparian species	1	obligate riparian species more than sufficient in non-marginal zone
Occurrence of species that are (regional) indicators of the riparian zone, or wetness		obligates present, so unrated
Recent fire/s at site	2	LHB 60% recent burns
Exotic species at the site	2	up to 40% exotics, all zones
Left and right-hand banks have riparian vegetation in similar condition	2	probably due to fires and livestock on LHB and not RHB
Able to obtain sufficient survey points of indicator species for flow requirements	0	8 or more points per bank
Plant species easily identifiable i.e. leaves or flowers present at time of site visit	0	identification of indicators was possible
Hydraulic control		
unnatural up/downstream control affecting site	0	no localised effect
Overall Site Suitability Rating	0.8	

EWR 5: MALELANE

Site suitability

Site Suitability for the Assessment of Environmental Flows		
Habitat availability	Rate	Motivation where applicable
Presence / absence of the marginal zone	1	marginal zone fairly inundated, but present
Proportion of marginal zone that is able to be sampled	0	about 10% not sampled due to deep water
Channel morphology		
Channel bank stabilization	0	banks stable
Channel manipulation	1	RHB with constructed homes , decks and walls
Profile distance too long to effectively conduct VEGRAI	2	RHB marginal zone too deep to survey
Vegetation		
Occurrence of obligate, marginal zone riparian species	1	obligate riparian species more than sufficient in marginal zone
Occurrence of obligate, non-marginal zone riparian species	1	obligate riparian species more than sufficient in non-marginal zone
Occurrence of species that are (regional) indicators of the riparian zone, or wetness		obligates present, so unrated
Recent fire/s at site	0	none
Exotic species at the site	2	up to 40% exotics in marginal zone, lower and upper zones less
Left and right-hand banks have riparian vegetation in similar condition	1	similar
Able to obtain sufficient survey points of indicator species for flow requirements	2	upt o 5 points per bank and instream features
Plant species easily identifiable i.e. leaves or flowers present at time of site visit	0	identification of indicators was possible
Hydraulic control		
unnatural up/downstream control affecting site	0	no localised effect
Overall Site Suitability Rating	0.8	

EWR 6: NKONGOMA

Site suitability

Site Suitability for the Assessment of Environmental Flows		
Habitat availability	Rate	Motivation where applicable
Presence / absence of the marginal zone	1	marginal zone fairly inundated, but present
Proportion of marginal zone that is able to be sampled	2	only LHB sampled by foot, RHB not by access
Channel morphology		
Channel bank stabilization	0	banks stable
Channel manipulation	0	none
Profile distance too long to effectively conduct VEGRAI	2	RHB not sampled
Vegetation		
Occurrence of obligate, marginal zone riparian species	2	obligate riparian species more than sufficient in marginal zone
Occurrence of obligate, non-marginal zone riparian species	2	obligate riparian species more than sufficient in non-marginal zone
Occurrence of species that are (regional) indicators of the riparian zone, or wetness		obligates present, so unrated
Recent fire/s at site	0	none
Exotic species at the site	1	less than 10% overall
Left and right-hand banks have riparian vegetation in similar condition	1	similar, LHB high proportion of exposed bedrock
Able to obtain sufficient survey points of indicator species for flow requirements	2	> 8 points LHB only
Plant species easily identifiable i.e. leaves or flowers present at time of site visit	0	identification of indicators was possible
Hydraulic control		
unnatural up/downstream control affecting site	0	no localised effect
Overall Site Suitability Rating	1.0	

EWR 7: HONEYBIRD

Site suitability

Site Suitability for the Assessment of Environmental Flows		
Habitat availability	Rate	Motivation where applicable
Presence / absence of the marginal zone	1	fair proportion of exposed, steep bedrock with no marginal zone
Proportion of marginal zone that is able to be sampled	0	entire marginal zone sampled
Channel morphology		
Channel bank stabilization	0	banks stable
Channel manipulation	1	close proximity of road works and agricultural activities
Profile distance too long to effectively conduct VEGRAI	0	with difficulty due to density of exotic vegetation on LHB
Vegetation		
Occurrence of obligate, marginal zone riparian species	2	obligate riparian species more than sufficient in marginal zone
Occurrence of obligate, non-marginal zone riparian species	2	obligate riparian species more than sufficient in non-marginal zone
Occurrence of species that are (regional) indicators of the riparian zone, or wetness		obligates present, so unrated
Recent fire/s at site	0	none
Exotic species at the site	4	up to 80% exotics on upper zone, less on lower and marginal zones, but still high proportions
Left and right-hand banks have riparian vegetation in similar condition	3	RHB is seep zone with some wetland species, LHB typically riparian, but with exotics
Able to obtain sufficient survey points of indicator species for flow requirements	3	RHB up to 7 points, LHB too dense to survey beyond marginal and lower part of lower zone
Plant species easily identifiable i.e. leaves or flowers present at time of site visit	0	identification of indicators was possible
Hydraulic control		
unnatural up/downstream control affecting site	0	bedrock control interesting, but natural
Other		
please specify	3	RHB seep zone with wetland indicator species occurring
Overall Site Suitability Rating	1.4	

1. APPENDIX F – FISH SITE SUITABILITY

According to Kleynhans and Louw (2007), “site” refers to “features of a place related to the immediate environment on which the place is located (e.g. terrain, soil, subsurface, geology, groundwater) (www.geographic.org/glossary.html). Linked to this is the concept of “locality” which refers to the geographic area in which a collecting event occurs (porites.geology.uiowa.edu/entity.htm). Ecological Water Requirement (EWR) sites are localities in a stream within the descending hierarchy of Primary NRU→Secondary NRU→MRU→RAU→EWR site. An EWR site is therefore a locality where measurements to determine the ecological water requirements of river will be done. The information gathered at the EWR site furthermore provides the primary information for the ecoclassification process. It is therefore essential that the EWR site must be suitable to meet the above mentioned objectives.

The selection of EWR sites should consider the following physical attributes (Kleynhans & Louw, 2007):

- Hydraulic cross section(s) will be established here. The purpose of hydraulic measurements and the consequent modelling is to provide an interpretive link between flows at different stages and the resulting aquatic habitats at the site. In some cases a digital terrain model (“habitat model”) will be developed to provide a more accurate and detailed perspective of the response of various habitat features to changes in flow.
- In addition to an ideal EWR site being representative of the RAU, it should also be sensitive in terms of its response to changes in water level (discharges). This will make the EWR site useful for future monitoring and the confidence in the interpretation of monitoring results.
- The ultimately ideal site would therefore be representative, practical and safe to measure and to model reasonably accurately, it would be accessible and sensitive to changes in discharge to make it useful for habitat prediction.

A two tiered approach to site suitability determinations was followed regarding fish assessments. The suitability of the selected sites both as an Ecological Water Requirements site, as well as its suitability for the application of the FRAI was assessed.

SITE SUITABILITY FOR EWR DETERMINATION (Kleynhans & Louw, 2007):

Defined as the suitability of the site in terms of the ability to interpret:

1. The response of the various velocity-depth classes and associated cover at different discharges.
2. The presence of fish species that respond to different discharges and the associated velocity-depth and cover classes. This would be associated with rheophilic, semi-rheophilic and limnophilic species as well as the size of the species involved.

Confidence is correlated with suitability, e.g., the higher the suitability of a site in terms of EWR, the higher the confidence in the EWR specification.

Criticality: A site is critical when it has a high suitability in terms of EWR specifications (or the highest suitability compared to other sites in the RAU).

SITE SUITABILITY FOR FRAI:

A site is highly suitable for FRAI determination if the velocity-depth and cover classes at the site occur in similar proportions as in the RAU. If a site is not representative of the RAU, it means that the FRAI may need to be 'tweaked' in order to make the site data more representative of the RAU. It is also recommendable that under such conditions, other site/s may have to be sampled to cover all habitats present in RAU adequately to ensure representative results.

It therefore follows that a site may be suitable for EWR determination but not completely suitable for FRAI determination.

This report describes the methodology followed and the results of a site suitability assessment of the selected EWR sites in the Sabie and Crocodile (east) catchments, used for the purpose of the Inkomati Comprehensive Reserve determination.

2. METHODOLOGY

According to Kleynhans & Louw (2007) the following attributes are essential determinants of the suitability of an EWR site for specifying the ecological flow requirements of biota, interpretation and eventually monitoring in terms of fish:

- The presence and abundance of rheophilics. If this group is present and abundant enough to make them useful in terms of monitoring, they would be the ideal subject to use for determining flow requirements as they are sensitive to a cessation of flow (usually fast flow) during all life-stages. If large⁵ (about >20 cm in length) rheophilics are present and abundant enough, they would usually be preferable to small rheophilics due to the larger amount of flowing habitat required which would indicate higher discharges. In cases where small rheophilics and large semi-rheophilics occur there may be a requirement for rheophilics during the dry season, but another requirement for large semi-rheophilics during the periods in the wet season when they breed.
- The presence of semi-rheophilics. If rheophilics are absent, semi-rheophilics should be used as the subject to determine flow requirements. Semi-rheophilics require flowing water (usually fast) during the breeding season. However, flowing water does not necessarily have to be present during the whole duration of the wet season. Duration of flow for rheophilics during the wet season will be determined by the length of time required for successful spawning, hatching and growth of larvae to juveniles. The size of the semi-rheophilics considered is also important as this will have an influence on the dimensions of the habitat requirements.
- The presence of limnophilics. If rheophilics and semi-rheophilics are absent, the requirements of limnophilics can be considered. This group does not require flowing water during any stage of their life-cycle. However, they do respond positively to improved habitat conditions (e.g. cover and feeding areas) caused by increased flows. In particular circumstances, the requirements of some limnophilics need to be considered where a drop

⁵ Size of any of the groups do not necessarily refer to a particular species: Different life-stages of the same species may, for example, be classified as large or small. In some case the adults semi-rheophilics may vary in size with the smaller adults also occurring in smaller streams.

in the water level in pools may result in, for example, a loss of overhanging vegetation which may form an essential cover feature for some species to survive.

The selection of EWR site in terms of FRAI application should furthermore consider the following physical attributes (Kleynhans & Louw, 2007):

- Preferably the EWR site should be representative of the RAU within which it is situated. “Representative” specifically refers to the hydraulics units at the site which should occur in similar proportions and with similar characteristics to that which occur at the majority of sites in the RAU. Generally, however, the more complicated the site is in terms of hydraulic units (e.g. diversity of bed material and multiple channels), the more difficult hydraulic modelling of the site becomes. This detrimentally influences the accuracy of the hydraulic model and thus the prediction of habitat at various discharges. As a result, a compromise needs to be found between the representativeness of the EWR site and the accuracy of the hydraulics model.

The following tables provide a simple framework to interpret the suitability of a site in terms of the habitats available, velocity-depth fish guilds present and their size at the site compared to the RAU:

Comparison of velocity-depth ratings for RAU and the EWR site

	FISH VELOCITY-DEPTH CLASSES			
	Slow-Deep	Slow-Shallow	Fast-Deep	Fast-Shallow
RAU				
EWR SITE				

Abundance: 0=absent; 1=rare; 2=sparse; 3=moderate; 4=abundant; 5=very abundant

Comparison of cover ratings for RAU and the EWR site.

	COVER					
	Slow-Deep				Slow-Shallow	
	RAU	SITE			RAU	SITE
Undercut banks/Rootwads				Under cut banks/Rootwads		
Overhanging vegetation				Overhanging vegetation		
Substrate				Substrate		
Aquatic macrophytes				Aquatic macrophytes		
Water column				Water column		
	Fast-Deep				Fast-Shallow	
	RAU	SITE			RAU	SITE
	Undercut banks/Rootwads				Under cut banks/Rootwads	
Overhanging vegetation				Overhanging vegetation		
Substrate				Substrate		
Aquatic macrophytes				Aquatic macrophytes		
Water column				Water column		

Abundance: 0=absent; 1=rare; 2=sparse; 3=moderate; 4=abundant; 5=very abundant

Comparison of different fish species and size groups of various velocity-depth guilds at a EWR site (Large >20 cm; Small <20 cm).

EXPECTED SPECIES	Slow-Deep		LARGE	Slow-Shallow		LARGE	SMALL	Fast-Deep		LARGE	SMALL
	LARGE	SMALL		SMALL	SMALL						
RHEOPHILICS											
Species 1								Species 1			Species 1
Species 2											Species 2
SEMI-RHEOPHILICS											
Species 3	Species 3							Species 3			Species 3
Species 4		Species 4			Species 4						
LIMNOPHILICS											
Species 5		Species 5			Species 5						

The following general steps were followed to determine the site suitability in terms of fish for EWR determinations:

1. Determine the preliminary expected fish species assemblage for the RAU (the expected species list should be optimised after sampling has been completed).
2. Categorise the species according to large (>20cm) and small (<20cm) rheophilics, semi-rheophilics and limnophilics (Table 3).
3. Decide on the category of fish that could best be used to set ecological water requirements / flows for the RAU. Generally rheophilics will provide the best measure, thereafter semi-rheophilics and then limnophilics. Large species will have preference over small species as they will require deeper habitats, and thus more water.
4. Determine the habitat preference of the key EWR group (i.e. all expected rheophilic species), and draw up an optimal habitat profile for this group.
5. The suitability of the EWR site can now be measured based on its compliance to these habitats, i.e. if this habitat profile is optimally available at the EWR site to support the selected component (i.e. rheophilic) at all life stages, the site will have very high suitability as an EWR site (EWR suitability score of 4 to 5). If none of the habitats available at the EWR site comply to the requirements of the selected component under any of their life stages, the site is not suitable for EWR determinations (this will obviously require selection of different sites).

The following general steps were followed to determine the suitability of an EWR site for the application of the FRAI:

1. Assess the habitat composition at the EWR site (velocity-depth class composition, cover, etc.) (Table 1)
2. Estimate the expected habitat composition of the entire RAU (velocity-depth class composition, cover etc.) (Table 1)
3. If all the habitat components of the RAU are adequately represented at the EWR site, the site will have a high suitability for FRAI application (FRAI suitability score of 4-5). If the site is not comparable at all, or lacks representivity of selected (important) habitat components, the site will have low suitability and another site may have to be selected and sampled to supplement the EWR site data for optimal FRAI application for the RAU. The information on comparability of the EWR site in terms of the RAU can furthermore help to indicate which aspects need to be tweaked for improved confidence in the FRAI application (i.e. limited FS habitat available at a site, and limited fish with preference for FS were sampled, it should be considered in the application of the FRAI, both in terms of expected species, as well as observed species for this habitat type).

At this stage the information summarized above could be used to provide a considered and informed decision as to the suitability of the EWR site for the interpretation of environmental flow requirements of fish compared to the RAU, as well as its suitability for FRAI application in terms of the entire RAU. This should be ranked according to:

- 0: Not suitable
- 1.0-1.9: Very low suitability
- 2.0-2.9: Moderate suitability
- 3.0-3.9: High suitability
- 4.0-5.0: Very high suitability

3. RESULTS & DISCUSSION

Study Area

Eight preliminary EWR sites were selected in the Sabie River Catchment and seven in the Crocodile River Catchment for the purpose of a Comprehensive Reserve Determination (See tables below).

EWR sites of the Sabie River Catchment.

EWR site number	EWR site name	River	Previous IFR Site	National RHP site	Decimal Min S	Decimal Min E	EcoRegion (Level II)	Geomorphic Zone	Altitude (m)	RU	Quat	Farm names
EWR1	Upper Sabie	Sabie	-		S25 04.424	E30 50.924	4.04	Upper Foothills	862	MRU A	X31B	
EWR2	Sabie-Aan de Vliet	Sabie	-	X3Sabie-Brand	S25 01.675	E31 03.099	4.04	Lower Foothills	463	RAU A.2	X31D	Evert 5
EWR3	Kidney	Sabie	IFR 3	X3Sabie-Sekur	S24 59.256	E31 17.572	3.07	Lower Foothills	369	MRU B	X31K	KNP
EWR4	MacMac	MacMac			S25 00.800	E31 00.243	4.04	Upper Foothills	582	MRU MacA	X31C	Richmond 573
EWR5	Marite	Marite	IFR1	X3Mari-Sandf	S25 01.077	E31 07.997	4.04	Upper Foothills	457	MRU MarA	X31G	291/33
EWR6	Mutlumuvi	Mutlumuvi	IFR 6	X3Mutl-Thula	S24 45.352	E31 07.923	3.05	Upper Foothills	503	MRU MutA	X32F	New Forest 234
EWR7	Tlulandziteka	Tlulandziteka (Sand)			S24 40.829	E31 05.188	3.07	Lower Foothills	543	MRU Tluland A	X32C	

EWR8	Sand	Sand	IFR 8	X3Sand-Skuku	S24 58.045	E31 37.641	3.07	Lower Foothills	250	RAU Sand B.1	X32J	KNP
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Site Suitability
Sabie River Catchment

EWR site 1 (Upper Sabie)

A large rheophilic species, namely *Varincorhinus nelspruitensis* (VNEL) is expected to occur in this RAU (A.1) (Table below). As a large rheophilic species, it holds priority for use as an indicator for EWR determinations for this resource unit. This species has a high preference for fast-deep (FD) and fast-shallow (FS) velocity-depth categories, with a very high preference for substrate as cover (only cover type preferred by species). According to the table below, FD and FS habitats are in abundance at the site, while substrate is also the abundant cover present at both these velocity-depth categories. The optimally preferred habitats for VNEL are therefore adequately represented at this EWR site, and also compare well to the expected distribution of these habitats throughout the entire RAU. Two small rheophilic species, as well as one semi-rheophilic and two limnophilic species are also expected in this RAU, and their habitat requirements are also met at the EWR site. EWR site 1 (Upper Sabie) can therefore be classified as having *very high suitability* (score = 4.5) for EWR application.

The relative abundance of flow-depth categories as well as the cover features at the EWR site also compare very well to the estimated habitats of the entire RAU. There may be slightly fewer slow habitats and slightly more fast habitats at the site, compared to the entire RAU (attributed to the selection of an EWR site in rapid area). Overall, the general similarity in habitat components between the site and RAU makes it very highly suitable (score=4.0) for the use of this site in the application of the FRAI for the entire RAU. As a result of the relative narrowness of the stream and one fast area (rapid/riffle) being available, other sites in the same RAU will have to be sampled for increased confidence of this critical habitat. The only possible limiting factors at this site include extensive forestry activities, mostly outside the riparian zone, which may alter the natural runoff and result in increased siltation. Excessive algal growth (possibly associated with nitrification from Sabie town WWTW effluent) on the substrates may decrease sampling to some extent.

Expected fish species of RAU classified according to flow-depth preference and requirements for flow (rheophilic, semi-rheophilic, limnophilic).

EXPECTED SPECIES	Slow-Deep		Slow-Shallow		Fast-Deep		Fast-Shallow	
	LARGE	SMALL	LARGE	SMALL	LARGE	SMALL	LARGE	SMALL
RHEOPHILICS								
AURA						AURA		AURA
CANO								CANO
VNEL					VNEL		VNEL	
SEMI-RHEOPHILICS								
AMOS	AMOS				AMOS		AMOS	
LIMNOPHILICS								
BBRI		BBRI		BBRI				
TSPA		TSPA		TSPA				

Comparison of velocity-depth categories and cover features of the EWR site and the RAU.

	FISH VELOCITY-DEPTH CLASSES			
	Slow-Deep	Slow-Shallow	Fast-Deep	Fast-Shallow
RAU	3	3	3	3
SITE	2	2	4	4
Abundance: 0=absent; 1=rare; 2=sparse; 3=moderate; 4=abundant; 5=very abundant				

	COVER				
	Slow-Deep			Slow-Shallow	
RAU	SITE	RAU		SITE	
Overhanging vegetation	2.5	2	Overhanging vegetation	2	2
Undercut banks/Rootwads	2.5	3	Undercut banks/Rootwads	2	2
Substrate	3	3	Substrate	3	3
Aquatic macrophytes	1	1	Aquatic macrophytes	1	1
Water column	4	4	Water column	2	2

	Fast-Deep			Fast-Shallow	
	RAU	SITE		RAU	SITE
Overhanging vegetation	1	0.5	Overhanging vegetation	1	1
Undercut banks/Rootwads	1	0.5	Undercut banks/Rootwads	1	1
Substrate	4	4	Substrate	4	4
Aquatic macrophytes	1	0.5	Aquatic macrophytes	1	0
Water column	3	3	Water column	2.5	2

Abundance: 0=absent; 1=rare; 2=sparse; 3=moderate; 4=abundant; 5=very abundant

Suitability scores of site in terms of EWR and FRAI application.

SUITABILITY SCORES	
EWR SUITABILITY	4.5
FRAI SITE SUITABILITY	4

0: Not suitable, 1-2: very low suitability, 2-3: Moderate suitability,
 3-4: High suitability, 4-5: Very high suitability.

EWR site 2 (Sabie_Aan de Vliet)

A large rheophilic species, namely *Varincorhinus nelspruitensis* (VNEL) is expected to occur in this RAU (A.2) (Table below). As a large rheophilic species, it holds priority for use as an indicator for EWR determinations for this resource unit. This species has a high preference for fast-deep and fast-shallow velocity-depth categories, with a very high preference for substrate as cover (only cover type preferred by species). According to Table 10, these FD habitats are in moderate abundance at this EWR site, while FS habitats are abundant, while substrate is abundant at both these flow-depth categories. The optimally preferred habitats for VNEL are therefore adequately represented at this EWR site, and also compares well to the expected distribution of these habitats throughout the entire RAU. Four smaller rheophilic species, as well as various other semi-rheophilic and limnophilic species are also expected in this RAU, and their habitat requirements are also met at the EWR site. Aspects that potentially decrease the suitability of this site as an EWR site include the limited clearing of vegetation for recreational purposes on the right bank, but this is thought to have a minimal impact on the fish habitats. In general, EWR site 2 (Sabie-Aan de Vliet) can be classified as having a *very high suitability* (score = 4.5) for EWR application (Table below).

The relative abundance of flow-depth categories, as well as the cover features at the site also compare very well to the estimated habitats of the entire RAU (Table below). There may have been slightly fewer slow habitats and more fast habitats at the site, compared to the entire RAU.

Overall, the general similarity in habitat components between the site and RAU makes it highly suitable for the application of the FRAI for the entire RAU.

Expected fish species of RAU classified according to flow-depth preference and requirements for flow (rheophilic, semi-rheophilic, limnophilic).

EXPECTED SPECIES	Slow-Deep		Slow-Shallow		Fast-Deep		Fast-Shallow	
	LARGE	SMALL	LARGE	SMALL	LARGE	SMALL	LARGE	SMALL
RHEOPHILICS								
AURA						AURA		AURA
CANO								CANO
CSWI								CSWI
OPER								OPER
VNEL					VNEL		VNEL	
SEMI-RHEOPHILICS								
AMOS	AMOS				AMOS		AMOS	
BEUT		BEUT		BEUT				
BTRI		BTRI		BTRI				
BUNI		BUNI		BUNI				
BPOL	BPOL				BPOL		BPOL	
BMAR	BMAR				BMAR		BMAR	
LMOL	LMOL				LMOL		LMOL	
LCYL	LCYL				LCYL		LCYL	
CPAR					CPAR		CPAR	
MACU	MACU				MACU		MACU	
LIMNOPHILICS								
BBRI		BBRI		BBRI				
CGAR	CGAR		CGAR					
MMAC		MMAC		MMAC				
PCAT		PCAT		PCAT				
PPHI		PPHI		PPHI				
TSPA		TSPA		TSPA				

Comparison of velocity-depth categories and cover features of the EWR site and the RAU.

	FISH VELOCITY-DEPTH CLASSES			
	Slow-Deep	Slow-Shallow	Fast-Deep	Fast-Shallow
RAU	3.5	3.5	1.5	3
SITE	3	2	2.5	4

Abundance: 0=absent; 1=rare; 2=sparse; 3=moderate; 4=abundant; 5=very abundant

	COVER					
	Slow-Deep			Slow-Shallow		
	RAU	SITE		RAU	SITE	
Undercut banks/Rootwads	3	3	Undercut banks/Rootwads	2.5	2.5	
Overhanging vegetation	2	1.5	Overhanging vegetation	2	2	
Substrate	2	1.5	Substrate	2	1.5	
Aquatic macrophytes	2	1	Aquatic macrophytes	2.5	2.5	
Water column	3	2.5	Water column	2	2	
	Fast-Deep			Fast-Shallow		
	RAU	SITE		RAU	SITE	
	Undercut banks/Rootwads	1.5	1	Undercut banks/Rootwads	1	1
Overhanging vegetation	1	1	Overhanging vegetation	1	1	
Substrate	4	4	Substrate	4	4	
Aquatic macrophytes	0.5	0.5	Aquatic macrophytes	1	1	
Water column	3	2	Water column	2	2	

Abundance: 0=absent; 1=rare; 2=sparse; 3=moderate; 4=abundant; 5=very abundant

Suitability scores of site in terms of EWR and FRAI application.

SUITABILITY SCORES	
EWR SUITABILITY	4.5
FRAI SITE SUITABILITY	3.5

0: Not suitable, 1-2: very low suitability, 2-3: Moderate suit
3-4: High suitability, 4-5: Very high suitability.

EWR site 3 (Kidney)

Four small rheophilic species, namely *Amphilius uranoscopus*, *Chiloglanis anoterus*, *Chiloglanis swierstrae* and *Opsaridium peringueyi* are expected to occur in this RAU (C.1) (Table below). As no large rheophilic species are expected, small rheophilic species will be the next priority for use as an indicator for EWR determinations for this resource unit. All these species have a high preference for fast-shallow velocity-depth categories, while *A. uranoscopus* also prefers fast-deep habitats. All species except OPER have a very high preference for substrate as cover while OPER prefers water columns as cover. According to the table below, these preferred habitats of the rheophilic species are in abundance at the site, which makes site EWR3 (Kidney) very highly suitable (score of 4.5) as an EWR site for setting of flows.

Due to the selection of the EWR site where critical habitats (flow dependant) occur, the EWR site was not necessarily reflective of the entire RAU. The EWR site included a higher abundance of fast habitats and less slow habitats than are present in the RAU (Table below). Cognisance should therefore be taken regarding this aspect when the fish sampling results gained at this EWR site are applied in the FRAI for this RAU. This EWR site is therefore considered to be only moderately suitable (score = 2.5) for FRAI application.

Expected fish species of RAU classified according to flow-depth preference and requirements for flow (rheophilic, semi-rheophilic, limnophilic).

EXPECTED SPECIES	Slow-Deep		Slow-Shallow		Fast-Deep		Fast-Shallow	
	LARGE	SMALL	LARGE	SMALL	LARGE	SMALL	LARGE	SMALL
RHEOPHILICS								
AURA						AURA		AURA
CANO								CANO
CSWI								CSWI
OPER								OPER
SEMI-RHEOPHILICS								
AMOS	AMOS				AMOS		AMOS	
BFRI		BFRI		BFRI				
BANN		BANN						
BARG						BARG		BARG
BEUT		BEUT		BEUT				
BIMB		BIMB						
BTRI		BTRI		BTRI				
BUNI		BUNI		BUNI				
BRAD		BRAD		BRAD				
BTOP		BTOP		BTOP				
BPAU		BPAU		BPAU				
BVIV		BVIV		BVIV				
BMAR	BMAR				BMAR		BMAR	BMAR
CGAR	CGAR		CGAR	CGAR				
SINT	SINT	SINT		SINT				
SZAM		SZAM		SZAM				
SMER	SMER			SMER				
TREN	TREN			TREN				
HVIT	HVIT				HVIT			
LCON	LCON				LCON			
LMOL	LMOL				LMOL		LMOL	
LCYL	LCYL				LCYL		LCYL	
LROS	LROS							
CPAR					CPAR		CPAR	
MBRE		MBRE		MBRE				
MACU	MACU				MACU		MACU	
LIMNOPHILICS								
OMOS	OMOS			OMOS				
MMAC		MMAC		MMAC				
PCAT		PCAT		PCAT				
PPHI		PPHI		PPHI				
TSPA		TSPA		TSPA				

Comparison of velocity-depth categories and cover features of the EWR site and the RAU.

	FISH VELOCITY-DEPTH CLASSES					
	Slow-Deep	Slow-Shallow	Fast-Deep	Fast-Shallow		
	RAU	4	4	2	3	
SITE	2	2	3	4		
Abundance: 0=absent; 1=rare; 2=sparse; 3=moderate; 4=abundant; 5=very abundant						
	COVER					
	Slow-Deep		Slow-Shallow			
	RAU	SITE	RAU	SITE	RAU	SITE
Overhanging vegetation	3	2.5	Overhanging vegetation	3	3	
Undercut banks/Rootwads	3	0.5	Undercut banks/Rootwads	2	2	
Substrate	2	2.5	Substrate	2	3	
Aquatic macrophytes	3	2	Aquatic macrophytes	3	2	
Water column	4	3	Water column	3	2	
	Fast-Deep		Fast-Shallow			
	RAU	SITE	RAU	SITE	RAU	SITE
	Overhanging vegetation	1	3	Overhanging vegetation	2	2
Undercut banks/Rootwads	1	1	Undercut banks/Rootwads	1	1	
Substrate	4	4	Substrate	4	4	
Aquatic macrophytes	1	0.5	Aquatic macrophytes	1	1	
Water column	2	3	Water column	3	3	
Abundance: 0=absent; 1=rare; 2=sparse; 3=moderate; 4=abundant; 5=very abundant						

Suitability scores of site in terms of EWR and FRAI application.

SUITABILITY SCORES	
EWR SUITABILITY	4.5
FRAI SITE SUITABILITY	2.5

0: Not suitable, 1-2: very low suitability, 2-3: Moderate suitability,
 3-4: High suitability, 4-5: Very high suitability.

EWR site 4 (Mac-Mac)

A large rheophilic species, namely *Varincorhinus nelspruitensis* (VNEL) is expected to occur in this RAU (Table below). As a large rheophilic species, it holds priority for use as an indicator for EWR determinations for this resource unit. This species has a high preference for fast-deep and fast-shallow velocity-depth categories, with a very high preference for substrate as cover (only cover type preferred by species). According to the table below, some (sparse) FD habitats were present while FS habitats were abundant at the EWR site. Substrate was also abundant at both these flow-depth categories. The optimally preferred habitats for VNEL are therefore adequately represented at this EWR site, and also compare well to the expected distribution of these habitats throughout the entire RAU. Three small rheophilic species are also expected in this RAU, and their habitat requirements are also met at the EWR site. Aspects that potentially decrease the suitability of this site as an EWR site include extensive forestry activities. In general, EWR site 4 (Mac-Mac) can be classified as having a *very high suitability* (score = 4.5) for EWR application (Table below).

The relative abundance of flow-depth categories, as well as the cover features at the site also compare very well to the estimated habitats of the entire RAU (Table below). Some areas may have higher abundance of deep habitats and more overhanging and aquatic vegetation as cover. In general, this site is however expected to be very highly suitable (score=4) for the application of the FRAI for the entire RAU.

Expected fish species of RAU classified according to flow-depth preference and requirements for flow (rheophilic, semi-rheophilic, limnophilic).

EXPECTED SPECIES	Slow-Deep		Slow-Shallow		Fast-Deep		Fast-Shallow	
	LARGE	SMALL	LARGE	SMALL	LARGE	SMALL	LARGE	SMALL
RHEOPHILICS								
AURA						AURA		AURA
CANO								CANO
OPER								OPER
VNEL					VNEL		VNEL	
SEMI-RHEOPHILICS								
AMOS	AMOS				AMOS		AMOS	
BEUT		BEUT		BEUT				
LIMNOPHILICS								
BBRI		BBRI		BBRI				
PPHI		PPHI		PPHI				
TSPA		TSPA		TSPA				

Comparison of velocity-depth categories and cover features of the EWR site and the RAU.

	FISH VELOCITY-DEPTH CLASSES			
	Slow-Deep	Slow-Shallow	Fast-Deep	Fast-Shallow
RAU	2	2	2	4
SITE	0.5	2	2	4
Abundance: 0=absent; 1=rare; 2=sparse; 3=moderate; 4=abundant; 5=very abundant				

	COVER			
	Slow-Deep		Slow-Shallow	
	RAU	SITE	RAU	SITE
Undercut banks/Rootwads	3	2	2	1
Overhanging vegetation	3	3	2	1
Substrate	2	0	3	3
Aquatic macrophytes	1	0	1	0
Water column	3	2	2	2
	Fast-Deep		Fast-Shallow	
	RAU	SITE	RAU	SITE
Undercut banks/Rootwads	1	0	1	1
Overhanging vegetation	1	0.5	1	1
Substrate	4	4	4	4
Aquatic macrophytes	1	0	0.5	0
Water column	3	2	2	2
Abundance: 0=absent; 1=rare; 2=sparse; 3=moderate; 4=abundant; 5=very abundant				

Suitability scores of site in terms of EWR and FRAI application.

SUITABILITY SCORES	
EWR SUITABILITY	4.5
FRAI SITE SUITABILITY	4

0: Not suitable, 1-2: very low suitability, 2-3: Moderate suitability,
 3-4: High suitability, 4-5: Very high suitability.

EWR site 5 (Marite)

A large rheophilic species, namely *Varincorhinus nelspruitensis* (VNEL) is expected to occur in this RAU (Table below). According to the table below, FD habitats were present in moderate abundance while FS habitats were abundant at the EWR site. Substrate was also abundant at both these flow-depth categories. The optimally preferred habitats for VNEL are therefore adequately represented at this EWR site, and also compare well to the expected distribution of these habitats throughout the entire RAU. Five small rheophilic species are also expected in this RAU, and their habitat requirements are also met at the EWR site. Aspects that potentially decrease the suitability of this site as a EWR site include livestock farming activities that reduce overhanging vegetation as cover and cause increased bank erosion. In general, however, site EWR site 5 (Marite) can be classified as having a *very high suitability* (score = 4) for EWR application (Table below).

The relative abundance of flow-depth categories as well at the cover features at the site also compare very well to the estimated habitats of the entire RAU (Table below). Some areas may have a higher abundance of deep habitats and more overhanging and aquatic vegetation as cover. In general this site is however expected to be highly suitable (score=3.5) for the application of the FRAI for the entire RAU (Table below).

Expected fish species of RAU classified according to flow-depth preference and requirements for flow (rheophilic, semi-rheophilic, limnophilic).

EXPECTED SPECIES	Slow-Deep		Slow-Shallow		Fast-Deep		Fast-Shallow	
	LARGE	SMALL	LARGE	SMALL	LARGE	SMALL	LARGE	SMALL
RHEOPHILICS								
AURA						AURA		AURA
ANAT						ANAT		ANAT
CANO								CANO
CSWI								CSWI
VNEL					VNEL		VNEL	
OPER								OPER
SEMI-RHEOPHILICS								
AMOS	AMOS				AMOS		AMOS	
AMAR	AMAR				AMAR		AMAR	
BEUT		BEUT		BEUT				
BTRI		BTRI		BTRI				
BUNI		BUNI		BUNI				
BMAR	BMAR				BMAR		BMAR	BMAR
CGAR	CGAR		CGAR	CGAR				
MMAC		MMAC		MMAC				
PCAT		PCAT		PCAT				
LMOL	LMOL				LMOL		LMOL	
LCYL	LCYL				LCYL		LCYL	
CPAR					CPAR		CPAR	
MACU	MACU				MACU		MACU	
LIMNOPHILICS								
OMOS	OMOS			OMOS				
PPHI		PPHI		PPHI				
TSPA		TSPA		TSPA				
TREN	TREN			TREN				

Comparison of velocity-depth categories and cover features of the EWR site and the RAU.

	FISH VELOCITY-DEPTH CLASSES			
	Slow-Deep	Slow-Shallow	Fast-Deep	Fast-Shallow
RAU	2	3	2.5	3.5
SITE	2	2.5	3	4

Abundance: 0=absent; 1=rare; 2=sparse; 3=moderate; 4=abundant; 5=very abundant

	COVER						
	Slow-Deep				Slow-Shallow		
	RAU	SITE			RAU	SITE	
Overhanging vegetation	2	2			Overhanging vegetation	2	2
Undercut banks/Rootwads	3	2.5			Undercut banks/Rootwads	2	2
Substrate	2	2			Substrate	2	2
Aquatic macrophytes	2.5	2.5			Aquatic macrophytes	2	2
Water column	3	3			Water column	2	2
	Fast-Deep				Fast-Shallow		
	RAU	SITE			RAU	SITE	
Overhanging vegetation	2	2			Overhanging vegetation	2	2
Undercut banks/Rootwads	1	0.5			Undercut banks/Rootwads	1	1
Substrate	4	4			Substrate	4	4
Aquatic macrophytes	2	1			Aquatic macrophytes	2	2
Water column	3	3			Water column	2	2

Abundance: 0=absent; 1=rare; 2=sparse; 3=moderate; 4=abundant; 5=very abundant

Suitability scores of site in terms of EWR and FRAI application.

SUITABILITY SCORES	
EWR SUITABILITY	4
FRAI SITE SUITABILITY	3.5

0: Not suitable, 1-2: very low suitability, 2-3: Moderate suitability,
 3-4: High suitability, 4-5: Very high suitability.

EWR site 6 (Mutlumuvi)

Three small rheophilic species, namely *Chiloglanis anoterus*, *Chiloglanis swierstrae* and *Opsaridium peringueyi* are expected to occur in this RAU (Table below). As no large rheophilic species are expected, small rheophilic species will be the next priority for use as an indicator for EWR determinations for this resource unit. All these species have a high preference for fast-shallow velocity-depth categories. All species except OPER has a very high preference for substrate as cover while OPER prefers water columns as cover. According to the table below, these preferred habitats of the rheophilic species were present in moderate abundance at the site. The optimal preferred habitats of various semi-rheophilic species were also available at the site. The above-mentioned aspects made site EWR6 (Mutlumuvi) a highly suitable (score = 3) EWR site (Table below).

It is expected that the habitats at the site were representative of the habitats of the entire RAU. This EWR site is therefore considered to be highly suitable (score = 3.5) for FRAI application for the entire RAU.

Expected fish species of RAU classified according to flow-depth preference and requirements for flow (rheophilic, semi-rheophilic, limnophilic).

EXPECTED SPECIES	Slow-Deep		Slow-Shallow		Fast-Deep		Fast-Shallow	
	LARGE	SMALL	LARGE	SMALL	LARGE	SMALL	LARGE	SMALL
RHEOPHILICS								
CANO								CANO
CSWI								CSWI
OPER								OPER
SEMI-RHEOPHILICS								
BFRI		BFRI		BFRI				
BANN		BANN						
BEUT		BEUT		BEUT				
BTRI		BTRI		BTRI				
BUNI		BUNI		BUNI				
BRAD		BRAD		BRAD				
BTOP		BTOP		BTOP				
BPAU		BPAU		BPAU				
BVIV		BVIV		BVIV				
BMAR	BMAR				BMAR		BMAR	BMAR
CGAR	CGAR		CGAR	CGAR				
SINT	SINT	SINT		SINT				
SMER	SMER			SMER				
MMAC		MMAC		MMAC				
PCAT		PCAT		PCAT				
LMOL	LMOL				LMOL		LMOL	
LCYL	LCYL				LCYL		LCYL	
CPAR					CPAR		CPAR	
MBRE		MBRE		MBRE				
MACU	MACU				MACU		MACU	
LIMNOPHILICS								
OMOS	OMOS			OMOS				
PPHI		PPHI		PPHI				
TREN	TREN			TREN				
GGUI		GGUI		GGUI				

Comparison of velocity-depth categories and cover features of the EWR site and the RAU.

	FISH VELOCITY-DEPTH CLASSES					
	Slow-Deep	Slow-Shallow	Fast-Deep	Fast-Shallow		
RAU	2	3	0	2		
SITE	2	4	0	2		
Abundance: 0=absent; 1=rare; 2=sparse; 3=moderate; 4=abundant; 5=very abundant						
	COVER					
	Slow-Deep			Slow-Shallow		
	RAU	SITE		RAU	SITE	
Overhanging vegetation	1	1	Overhanging vegetation	1	1	
Undercut banks/Rootwads	1	1	Undercut banks/Rootwads	2	2	
Substrate	2	2	Substrate	2	2	
Aquatic macrophytes	1	1	Aquatic macrophytes	1	1	
Water column	2	2	Water column	2	2	
	Fast-Deep			Fast-Shallow		
	RAU	SITE		RAU	SITE	
Overhanging vegetation	0	0	Overhanging vegetation	1	1	
Undercut banks/Rootwads	0	0	Undercut banks/Rootwads	0.5	0.5	
Substrate	0	0	Substrate	2	2	
Aquatic macrophytes	0	0	Aquatic macrophytes	1	1	
Water column	0	0	Water column	1	1	
Abundance: 0=absent; 1=rare; 2=sparse; 3=moderate; 4=abundant; 5=very abundant						

Suitability scores of site in terms of EWR and FRAI application.

SUITABILITY SCORES	
EWR SUITABILITY	3
FRAI SITE SUITABILITY	3.5

0: Not suitable, 1-2: very low suitability, 2-3: Moderate suitability,

3-4: High suitability, 4-5: Very high suitability.

EWR site 7 (Tlulandziteka - Sand)

Three small rheophilic species, namely *Chiloglanis anoterus*, *Chiloglanis swierstrae* and *Opsaridium peringueyi* are expected to occur in this RAU (Table below). All these species have a high preference for fast-shallow velocity-depth categories. All species except OPER have a very high preference for substrate as cover while OPER prefers water columns as cover. According to the table below, the preferred habitats of these rheophilic species were present in moderate abundance at the site. The optimal preferred habitats of various semi-rheophilic species were also available at the site. The above-mentioned aspects made site EWR7 (Tlulandziteka - Sand) a highly suitable (score = 3) EWR site (Table below).

It is expected that the habitats at the site were representative of the habitats of the entire RAU. This EWR site is therefore considered to be highly suitable (score = 3.5) for FRAI application for the entire RAU.

Expected fish species of RAU classified according to flow-depth preference and requirements for flow (rheophilic, semi-rheophilic, limnophilic).

EXPECTED SPECIES	Slow-Deep		Slow-Shallow		Fast-Deep		Fast-Shallow	
	LARGE	SMALL	LARGE	SMALL	LARGE	SMALL	LARGE	SMALL
RHEOPHILICS								
CANO								CANO
CSWI								CSWI
OPER								OPER
SEMI-RHEOPHILICS								
BFRI		BFRI		BFRI				
BANN		BANN						
BEUT		BEUT		BEUT				
BTRI		BTRI		BTRI				
BUNI		BUNI		BUNI				
BRAD		BRAD		BRAD				
BTOP		BTOP		BTOP				
BPAU		BPAU		BPAU				
BVIV		BVIV		BVIV				
BMAR	BMAR				BMAR		BMAR	BMAR
CGAR	CGAR		CGAR	CGAR				
SINT	SINT	SINT		SINT				
SMER	SMER			SMER				
MMAC		MMAC		MMAC				
PCAT		PCAT		PCAT				
LMOL	LMOL				LMOL		LMOL	
LCYL	LCYL				LCYL		LCYL	
CPAR					CPAR		CPAR	
MBRE		MBRE		MBRE				
MACU	MACU				MACU		MACU	
LIMNOPHILICS								
OMOS	OMOS			OMOS				
PPHI		PPHI		PPHI				
TREN	TREN			TREN				
GGUI		GGUI		GGUI				

Comparison of velocity-depth categories and cover features of the EWR site and the RAU.

	FISH VELOCITY-DEPTH CLASSES			
	Slow-Deep	Slow-Shallow	Fast-Deep	Fast-Shallow
RAU	3	3	0	2
SITE	3	3	0	3

Abundance: 0=absent; 1=rare; 2=sparse; 3=moderate; 4=abundant; 5=very abundant

	COVER					
	Slow-Deep			Slow-Shallow		
	RAU	SITE		RAU	SITE	
Overhanging vegetation	2	2	Overhanging vegetation	2	2	
Undercut banks/Rootwads	3	3	Undercut banks/Rootwads	3	3	
Substrate	1	1	Substrate	1	1	
Aquatic macrophytes	2	2	Aquatic macrophytes	2	2	
Water column	3	3	Water column	2	2	
	Fast-Deep			Fast-Shallow		
	RAU	SITE		RAU	SITE	
	Overhanging vegetation	0	0	Overhanging vegetation	2	2
Undercut banks/Rootwads	0	0	Undercut banks/Rootwads	2	2	
Substrate	0	0	Substrate	3	3	
Aquatic macrophytes	0	0	Aquatic macrophytes	1	1	
Water column	0	0	Water column	1	1	

Abundance: 0=absent; 1=rare; 2=sparse; 3=moderate; 4=abundant; 5=very abundant

Suitability scores of site in terms of EWR and FRAI application.

SUITABILITY SCORES	
EWR SUITABILITY	3
FRAI SITE SUITABILITY	3.5

0: Not suitable, 1-2: very low suitability, 2-3: Moderate suitability,
 3-4: High suitability, 4-5: Very high suitability.

EWR site 8 (Sand)

Three small rheophilic species, namely *Chiloglanis anoterus*, *Chiloglanis swierstrae* and *Opsaridium peringueyi* are expected to occur in this RAU (Table below). All these species have a high preference for fast-shallow velocity-depth categories. All species except OPER have a very high preference for substrate as cover while OPER prefers water columns as cover. These habitats can be expected at the EWR site during flowing conditions, which would enable the use of the site as a EWR site. It was therefore expected to be moderately suitable (score = 2.5) as a EWR site (Table below).

It is expected that the habitats at the site are relatively representative of the habitats of the entire RAU. This EWR site is therefore considered to be highly suitable (score = 3) for FRAI application for the entire RAU.

Expected fish species of RAU classified according to flow-depth preference and requirements for flow (rheophilic, semi-rheophilic, limnophilic).

EXPECTED SPECIES	Slow-Deep		Slow-Shallow		Fast-Deep		Fast-Shallow	
	LARGE	SMALL	LARGE	SMALL	LARGE	SMALL	LARGE	SMALL
RHEOPHILICS								
CANO								CANO
CSWI								CSWI
OPER								OPER
SEMI-RHEOPHILICS								
AMOS	AMOS				AMOS		AMOS	
AMAR	AMAR				AMAR		AMAR	
BFRI		BFRI		BFRI				
BANN		BANN						
BIMB		BIMB						
BTRI		BTRI		BTRI				
BUNI		BUNI		BUNI				
BRAD		BRAD		BRAD				
BTOP		BTOP		BTOP				
BVIV		BVIV		BVIV				
BMAR	BMAR				BMAR		BMAR	BMAR
CGAR	CGAR		CGAR	CGAR				
SINT	SINT	SINT		SINT				
SMER	SMER			SMER				
MMAC		MMAC		MMAC				
PCAT		PCAT		PCAT				
LMOL	LMOL				LMOL		LMOL	
LCYL	LCYL				LCYL		LCYL	
LROS	LROS							
CPAR					CPAR		CPAR	
MBRE		MBRE		MBRE				
MACU	MACU				MACU		MACU	
LIMNOPHILICS								
OMOS	OMOS			OMOS				
PPHI		PPHI		PPHI				
TREN	TREN			TREN				
GGUI		GGUI		GGUI				

Comparison of velocity-depth categories and cover features of the EWR site and the RAU.

		FISH VELOCITY-DEPTH CLASSES			
		Slow-Deep	Slow-Shallow	Fast-Deep	Fast-Shallow
RAU		3	5	1	1
SITE		3	5	1	1
Abundance: 0=absent; 1=rare; 2=sparse; 3=moderate; 4=abundant; 5=very abundant					

		COVER									
		Slow-Deep		Slow-Shallow		Fast-Deep		Fast-Shallow			
		RAU	SITE	RAU	SITE	RAU	SITE	RAU	SITE		
Overhanging vegetation		3	3	Overhanging vegetation		3	3	Overhanging vegetation		2	2
Undercut banks/Rootwads		4	4	Undercut banks/Rootwads		4	4	Undercut banks/Rootwads		2	2
Substrate		2	1	Substrate		1	1	Substrate		2	2
Aquatic macrophytes		3	3	Aquatic macrophytes		3	3	Aquatic macrophytes		3	3
Water column		2	2	Water column		4	4	Water column		2	2
Abundance: 0=absent; 1=rare; 2=sparse; 3=moderate; 4=abundant; 5=very abundant											

Suitability scores of site in terms of EWR and FRAI application.

EWR SUITABILITY	2.5
FRAI SITE SUITABILITY	3

0: Not suitable, 1-2: very low suitability, 2-3: Moderate suitability, 3-4: High suitability, 4-5: Very high suitability.

5.1.1 Crocodile River Catchment

EWR site 1 (Valyspruit)

No rheophilic species are expected in this RAU, with only one expected species, namely *Barbus anoplus*, a semi-rheophilic species (Table below). This species has a high preference for slow-deep and slow-shallow, with overhanging substrate and aquatic vegetation as cover. These habitats were very well represented at the EWR site. The fact that only one fish species, it being only a semi-rheophilic species is expected at the site, should be considered during the setting of flows for this RAU. It may mean that fish will be required to carry a much lower weight than other biotic components (esp. invertebrates) for EWR/”Flow stressor response” application. The site is therefore only moderately suitable (score = 2.5) for EWR application (Table below).

The relative abundance of flow-depth categories as well as the cover features at the EWR site compare very well to the estimated habitats of the entire RAU (Table below). This makes the site very suitable for the application of the results to the FRAI as an assessment of the entire RAU (Table below). Again it must be stressed that the confidence of the FRAI application may be somewhat lower as a result of a single fish species being expected.

Expected fish species of RAU classified according to flow-depth preference and requirements for flow (rheophilic, semi-rheophilic, limnophilic).

EXPECTED SPECIES	Slow-Deep		Slow-Shallow		Fast-Deep		Fast-Shallow	
	LARGE	SMALL	LARGE	SMALL	LARGE	SMALL	LARGE	SMALL
RHEOPHILICS								
SEMI-RHEOPHILICS								
BANO		BANO		BANO				
LIMNOPHILICS								

Comparison of velocity-depth categories and cover features of the EWR site and the RAU.

	FISH VELOCITY-DEPTH CLASSES			
	Slow-Deep	Slow-Shallow	Fast-Deep	Fast-Shallow
RAU	3	4	1	3
SITE	3	4	0.5	3

Abundance: 0=absent; 1=rare; 2=sparse; 3=moderate; 4=abundant; 5=very abundant

	COVER			
	Slow-Deep		Slow-Shallow	
	RAU	SITE	RAU	SITE
Overhanging vegetation	3	3	3	3
Undercut banks/Rootwads	3	3	3	3
Substrate	3	3	3	3
Aquatic macrophytes	2	1	2	1
Water column	5	5	1	1

	Fast-Deep		Fast-Shallow	
	RAU	SITE	RAU	SITE
Overhanging vegetation	1	1	2	2
Undercut banks/Rootwads	1	1	1	1
Substrate	4	4	4	4
Aquatic macrophytes	1	1	1	1
Water column	3	3	1	1

Abundance: 0=absent; 1=rare; 2=sparse; 3=moderate; 4=abundant; 5=very abundant

Suitability scores of site in terms of EWR and FRAI application.

SUITABILITY SCORES	
EWR SUITABILITY	2.5
FRAI SITE SUITABILITY	4.5

0: Not suitable, 1 - 1.9: very low suitability, 2 - 2.9: Moderate suitability,
 3 - 3.9: High suitability, 4 - 5: Very high suitability.

EWR site 2 (Goedenhoop)

Four small rheophilic species are expected in this RAU (Table below). All these species have a high preference for fast-shallow and fast-deep velocity-depth categories with substrate as cover. Fast-shallow habitats are very well represented at the EWR site, and some fast-deep habitats can be expected during higher flows. The fact that the optimally preferred habitats of these indicator species are very well represented at the site makes it a highly suitable site (score = 4) for EWR application (Table below).

The relative abundance of flow-depth categories as well as the cover features at the EWR site compares very well to the estimated habitats of the entire RAU (Table below). This makes the site

very suitable for the application of the results to the FRAI as an assessment of the entire RAU (Table below).

Expected fish species of RAU classified according to flow-depth preference and requirements for flow (rheophilic, semi-rheophilic, limnophilic).

EXPECTED SPECIES	Slow-Deep		Slow-Shallow		Fast-Deep		Fast-Shallow	
	LARGE	SMALL	LARGE	SMALL	LARGE	SMALL	LARGE	SMALL
RHEOPHILICS								
AURA						AURA		AURA
ANAT						ANAT		ANAT
CBIF						CBIF		CBIF
CPRE						CPRE		CPRE
SEMI-RHEOPHILICS								
BANO		BANO		BANO				
BNEE		BNEE		BNEE				
BARG						BARG		BARG
KAUR				KAUR				
LIMNOPHILICS								
PPHI		PPHI		PPHI				
TSPA		TSPA		TSPA				

Comparison of velocity-depth categories and cover features of the EWR site and the RAU.

	FISH VELOCITY-DEPTH CLASSES					
	Slow-Deep	Slow-Shallow	Fast-Deep	Fast-Shallow		
RAU	2	3	0.5	4		
SITE	1	3	0.5	4		
Abundance: 0=absent; 1=rare; 2=sparse; 3=moderate; 4=abundant; 5=very abundant						
	COVER					
	Slow-Deep		Fast-Deep		Fast-Shallow	
	RAU	SITE	RAU	SITE	RAU	SITE
Overhanging vegetation	3	3	3	3	3	3
Undercut banks/Rootwads	1	1	1	1	1	0
Substrate	3	3	3	3	4	4
Aquatic macrophytes	2	2	2	2	2	2
Water column	4	4	4	4	1	1
	Fast-Deep		Fast-Shallow		Fast-Shallow	
	RAU	SITE	RAU	SITE	RAU	SITE
Overhanging vegetation	1	1	1	1	2	2
Undercut banks/Rootwads	1	1	1	1	1	1
Substrate	4	4	4	4	4	4
Aquatic macrophytes	0.5	0.5	0.5	0.5	1	1
Water column	3	3	3	3	1	1
Abundance: 0=absent; 1=rare; 2=sparse; 3=moderate; 4=abundant; 5=very abundant						

Suitability scores of site in terms of EWR and FRAI application.

SUITABILITY SCORES	
EWR SUITABILITY	4
FRAI SITE SUITABILITY	4

0: Not suitable, 1 - 1.9: very low suitability, 2 - 2.9: Moderate suitability,
 3 - 3.9: High suitability, 4 - 5: Very high suitability.

EWR site 3 (Poplar Creek)

Three small rheophilic species are expected in this RAU (Table below). All these species have a high preference for fast-shallow and fast-deep velocity-depth categories with substrate as cover. Fast-shallow habitats are very well represented at the EWR site, and some fast-deep habitats can

be expected during higher flows. The fact that the optimally preferred habitats of these indicator species are very well represented at the site makes it a highly suitable site (score = 4.5) for EWR application (Table below).

The relative abundance of flow-depth categories as well as the cover features at the EWR site compare very well to the estimated habitats of the entire RAU (Table below). This makes the site very suitable (score=4.5) for the application of the results to the FRAI as an assessment of the entire RAU (Table below).

Expected fish species of RAU classified according to flow-depth preference and requirements for flow (rheophilic, semi-rheophilic, limnophilic).

EXPECTED SPECIES	Slow-Deep		Slow-Shallow		Fast-Deep		Fast-Shallow	
	LARGE	SMALL	LARGE	SMALL	LARGE	SMALL	LARGE	SMALL
RHEOPHILICS								
AURA						AURA		AURA
CBIF						CBIF		CBIF
CPRE						CPRE		CPRE
SEMI-RHEOPHILICS								
AMOS	AMOS				AMOS		AMOS	
BARG						BARG		BARG
CGAR	CGAR		CGAR	CGAR				
LIMNOPHILICS								
PPHI		PPHI		PPHI				
TSPA		TSPA		TSPA				

Comparison of velocity-depth categories and cover features of the EWR site and the RAU.

	FISH VELOCITY-DEPTH CLASSES						
	Slow-Deep	Slow-Shallow	Fast-Deep	Fast-Shallow			
RAU	3	2	3	3			
SITE	2	2	4	4			
Abundance: 0=absent; 1=rare; 2=sparse; 3=moderate; 4=abundant; 5=very abundant							
	COVER						
	Slow-Deep		Fast-Deep		Slow-Shallow		
	RAU	SITE	RAU	SITE	RAU	SITE	
Overhanging vegetation	3	3			Overhanging vegetation	3	3
Undercut banks/Rootwads	2	1			Undercut banks/Rootwads	1	1
Substrate	3	3			Substrate	4	4
Aquatic macrophytes	1	1			Aquatic macrophytes	1	1
Water column	5	5			Water column	1	1
	Fast-Deep		Fast-Shallow				
	RAU	SITE	RAU	SITE			
Overhanging vegetation	2	2			Overhanging vegetation	2	2
Undercut banks/Rootwads	1	0			Undercut banks/Rootwads	1	0
Substrate	5	5			Substrate	5	5
Aquatic macrophytes	1	1			Aquatic macrophytes	1	1
Water column	4	4			Water column	1	1
Abundance: 0=absent; 1=rare; 2=sparse; 3=moderate; 4=abundant; 5=very abundant							

Suitability scores of site in terms of EWR and FRAI application.

SUITABILITY SCORES	
EWR SUITABILITY	4.5
FRAI SITE SUITABILITY	4

0: Not suitable, 1 - 1.9: very low suitability, 2 - 2.9: Moderate suitability,
 3 - 3.9: High suitability, 4 - 5: Very high suitability.

EWR site 4 (KaNyamazane)

Three small rheophilic species are expected in this RAU (Table below). All these species have a high preference for fast-shallow and fast-deep velocity-depth categories. All species except OPER have a very high preference for substrate as cover while OPER also prefers water columns as cover. According to the table below these preferred habitats of the rheophilic species are in abundance at the site, which makes site EWR4 (KaNyamazane) very highly suitable (score of 4.0) as an EWR site for setting of flows for this RAU (Table below).

The relative abundance of flow-depth categories as well as the cover features at the EWR site compares very well to the estimated habitats of the entire RAU (Table below). This makes the site very suitable (score=4.0) for the application of the results to the FRAI as an assessment of the entire RAU (Table below).

Expected fish species of RAU classified according to flow-depth preference and requirements for flow (rheophilic, semi-rheophilic, limnophilic).

EXPECTED SPECIES	Slow-Deep		Slow-Shallow		Fast-Deep		Fast-Shallow	
	LARGE	SMALL	LARGE	SMALL	LARGE	SMALL	LARGE	SMALL
RHEOPHILICS								
AURA						AURA		AURA
CPRE						CPRE		CPRE
OPER						OPER		OPER
SEMI-RHEOPHILICS								
AMOS	AMOS				AMOS		AMOS	
BEUT		BEUT		BEUT				
BTRI		BTRI		BTRI				
BUNI		BUNI		BUNI				
BPAU		BPAU		BPAU				
BMAR	BMAR				BMAR		BMAR	BMAR
BVIV		BVIV		BVIV				
CGAR	CGAR		CGAR	CGAR				
MMAC		MMAC		MMAC				
MACU	MACU				MACU		MACU	
PCAT		PCAT		PCAT				
LMOL	LMOL				LMOL		LMOL	
LCYL	LCYL				LCYL		LCYL	
LIMNOPHILICS								
OMOS	OMOS			OMOS				
PPHI		PPHI		PPHI				
TSPA		TSPA		TSPA				
TREN	TREN			TREN				

Comparison of velocity-depth categories and cover features of the EWR site and the RAU.

	FISH VELOCITY-DEPTH CLASSES					
	Slow-Deep	Slow-Shallow	Fast-Deep	Fast-Shallow		
RAU	3	3	4	4		
SITE	2	2	4	4		
Abundance: 0=absent; 1=rare; 2=sparse; 3=moderate; 4=abundant; 5=very abundant						
	COVER					
	Slow-Deep		Slow-Shallow		Fast-Shallow	
	RAU	SITE	RAU	SITE	RAU	SITE
Overhanging vegetation	3	2	3	2	3	2
Undercut banks/Rootwads	2	1	2	1	2	1
Substrate	3	3	4	4	4	4
Aquatic macrophytes	3	4	4	5	4	5
Water column	5	5	2	2	2	2
	Fast-Deep		Fast-Shallow		Fast-Shallow	
	RAU	SITE	RAU	SITE	RAU	SITE
Overhanging vegetation	2	2	3	2	3	2
Undercut banks/Rootwads	2	1	2	1	2	1
Substrate	4	4	5	5	5	5
Aquatic macrophytes	3	3	3	3	3	3
Water column	5	5	5	5	5	5
Abundance: 0=absent; 1=rare; 2=sparse; 3=moderate; 4=abundant; 5=very abundant						

Suitability scores of site in terms of EWR and FRAI application.

SUITABILITY SCORES	
EWR SUITABILITY	4
FRAI SITE SUITABILITY	4

0: Not suitable, 1 - 1.9: very low suitability, 2 - 2.9: Moderate suitability,
3 - 3.9: High suitability, 4 - 5: Very high suitability.

EWR site 5 (Malelane)

Three small rheophilic species are expected in this RAU, namely CPRE, CSWI and OPER (Table below). All these species have a high preference for fast-shallow velocity-depth categories, while CPRE also prefers fast-deep habitats. CPRE prefers cobbles and stones as substrate, CSWI prefers sand and gravel while OPER also prefers water columns as cover. According to the table below, these preferred habitats of the rheophilic species are in moderate abundance at the site. It is furthermore estimated that the site has slightly more fast-shallow and less slow-deep than found throughout the rest of the RAU (Table below). Site EWR5 (Malelane) is however rated as being highly suitable (score of 3.5) as a EWR site for setting of flows for this RAU (Table below).

The relative abundance of flow-depth categories as well as the cover features at the EWR site compares well to the estimated habitats of the entire RAU (Table below). As mentioned above, the EWR site may have slightly more fast-shallow and less slow-deep than found in the rest of the RAU. This should be considered when using the fish data of this site for FRAI application for the RAU. The site is however considered to be highly suitable (score=3.0) for the application of the results to the FRAI as an assessment of the entire RAU (Table below).

Expected fish species of RAU classified according to flow-depth preference and requirements for flow (rheophilic, semi-rheophilic, limnophilic).

EXPECTED SPECIES	Slow-Deep		Slow-Shallow		Fast-Deep		Fast-Shallow	
	LARGE	SMALL	LARGE	SMALL	LARGE	SMALL	LARGE	SMALL
RHEOPHILICS								
CPRE						CPRE		CPRE
CSWI								CSWI
OPER								OPER
SEMI-RHEOPHILICS								
AMOS	AMOS				AMOS		AMOS	
AMAR	AMAR				AMAR		AMAR	
BFRI		BFRI		BFRI				
BANN		BANN						
BEUT		BEUT		BEUT				
BIMB		BIMB						
BTRI		BTRI		BTRI				
BUNI		BUNI		BUNI				
BRAD		BRAD		BRAD				
BTOP		BTOP		BTOP				
BPAU		BPAU		BPAU				
BVIV		BVIV		BVIV				
BMAR	BMAR				BMAR		BMAR	BMAR
CGAR	CGAR		CGAR	CGAR				
SINT	SINT	SINT		SINT				
SZAM		SZAM		SZAM				
MMAC		MMAC		MMAC				
PCAT		PCAT		PCAT				
HVIT	HVIT				HVIT			
LCON	LCON				LCON			
LMOL	LMOL				LMOL		LMOL	
LCYL	LCYL				LCYL		LCYL	
LROS	LROS							
LRUD	LRUD							
CPAR					CPAR		CPAR	
MBRE		MBRE		MBRE				
MACU	MACU				MACU		MACU	
LIMNOPHILICS								
OMOS	OMOS			OMOS				
PPHI		PPHI		PPHI				
TSPA		TSPA		TSPA				
TREN	TREN			TREN				
GGUI		GGUI		GGUI				

Comparison of velocity-depth categories and cover features of the EWR site and the RAU.

	FISH VELOCITY-DEPTH CLASSES			
	Slow-Deep	Slow-Shallow	Fast-Deep	Fast-Shallow
RAU	4	3	3	2
SITE	2	3	3	3

Abundance: 0=absent; 1=rare; 2=sparse; 3=moderate; 4=abundant; 5=very abundant

	COVER					
	Slow-Deep			Slow-Shallow		
	RAU	SITE		RAU	SITE	
Overhanging vegetation	3	3	Overhanging vegetation	3	3	
Undercut banks/Rootwads	3	3	Undercut banks/Rootwads	3	3	
Substrate	2	2	Substrate	2	2	
Aquatic macrophytes	4	4	Aquatic macrophytes	5	5	
Water column	5	5	Water column	1	1	
	Fast-Deep			Fast-Shallow		
	RAU	SITE		RAU	SITE	
	Overhanging vegetation	3	2	Overhanging vegetation	3	3
Undercut banks/Rootwads	2	2	Undercut banks/Rootwads	2	2	
Substrate	3	3	Substrate	3	3	
Aquatic macrophytes	3	3	Aquatic macrophytes	3	2	
Water column	4	4	Water column	2	2	

Abundance: 0=absent; 1=rare; 2=sparse; 3=moderate; 4=abundant; 5=very abundant

Suitability scores of site in terms of EWR and FRAI application.

SUITABILITY SCORES	
EWR SUITABILITY	3.5
FRAI SITE SUITABILITY	3

0: Not suitable, 1 - 1.9: very low suitability, 2 - 2.9: Moderate suitability, 3 - 3.9: High suitability, 4 - 5: Very high suitability.

EWR site 6 (Nkongoma)

Three small rheophilic species are expected in this RAU, namely CPRE, CSWI and OPER (Table below). All these species have a high preference for fast-shallow velocity-depth categories, while CPRE also prefers fast-deep habitats. CPRE prefers cobbles and stones as substrate, CSWI prefers sand and gravel while OPER also prefers water columns as cover. According to the table below, these preferred habitats of the rheophilic species are highly abundant at the site. It is furthermore estimated that the site has slightly more fast-shallow and fast-deep, and less slow-deep than found throughout the rest of the RAU (Table below). As a result of the abundance of the preferred habitats of the rheophilic species at the site, is rated as being very highly suitable (score of 4.0) as a EWR site for setting of flows for this RAU (Table below).

The relative abundance of flow-depth categories and especially the cover features at the EWR site compare well to the estimated habitats of the entire RAU (Table 46). As mentioned above, the EWR site may have slightly more fast-shallow and fast-deep and less slow-deep than found in the rest of the RAU. This should be considered when using the fish data of this site for FRAI application for the RAU. The site is therefore considered to have a high suitability (score=3.0) for the application of the results to the FRAI as an assessment of the entire RAU (Table below).

Expected fish species of RAU classified according to flow-depth preference and requirements for flow (rheophilic, semi-rheophilic, limnophilic).

EXPECTED SPECIES	Slow-Deep		Slow-Shallow		Fast-Deep		Fast-Shallow	
	LARGE	SMALL	LARGE	SMALL	LARGE	SMALL	LARGE	SMALL
RHEOPHILICS								
CPRE						CPRE		CPRE
CSWI								CSWI
OPER								OPER
SEMI-RHEOPHILICS								
AMOS	AMOS				AMOS		AMOS	
AMAR	AMAR				AMAR		AMAR	
ALAB	ALAB				ALAB		ALAB	
BFRI		BFRI		BFRI				
BANN		BANN						
BIMB		BIMB						
BTRI		BTRI		BTRI				
BUNI		BUNI		BUNI				
BRAD		BRAD		BRAD				
BPAU		BPAU		BPAU				
BVIV		BVIV		BVIV				
BMAR	BMAR				BMAR		BMAR	BMAR
CGAR	CGAR		CGAR	CGAR				
SINT	SINT	SINT		SINT				
SZAM		SZAM		SZAM				
MMAC		MMAC		MMAC				
PCAT		PCAT		PCAT				
HVIT	HVIT				HVIT			
LCON	LCON				LCON			
LMOL	LMOL				LMOL		LMOL	
LCYL	LCYL				LCYL		LCYL	
LROS	LROS							
LRUD	LRUD							
CPAR					CPAR		CPAR	
MBRE		MBRE		MBRE				
MACU	MACU				MACU		MACU	
LIMNOPHILICS								
OMOS	OMOS			OMOS				
PPHI		PPHI		PPHI				
TREN	TREN			TREN				
GGUI		GGUI		GGUI				

Comparison of velocity-depth categories and cover features of the EWR site and the RAU.

		FISH VELOCITY-DEPTH CLASSES					
		Slow-Deep	Slow-Shallow	Fast-Deep	Fast-Shallow		
RAU		4	3	3	3		
SITE		3	3	4	5		
Abundance: 0=absent; 1=rare; 2=sparse; 3=moderate; 4=abundant; 5=very abundant							
		COVER					
		Slow-Deep		Slow-Shallow			
		RAU	SITE	RAU		SITE	
Overhanging vegetation		4	4	Overhanging vegetation	4	4	
Undercut banks/Rootwads		3	3	Undercut banks/Rootwads	3	3	
Substrate		2	2	Substrate	2	2	
Aquatic macrophytes		4	4	Aquatic macrophytes	4	4	
Water column		5	5	Water column	2	2	
		Fast-Deep		Fast-Shallow			
		RAU	SITE	RAU		SITE	
Overhanging vegetation		2	2	Overhanging vegetation	3	3	
Undercut banks/Rootwads		1	1	Undercut banks/Rootwads	1	1	
Substrate		4	4	Substrate	4	4	
Aquatic macrophytes		2	2	Aquatic macrophytes	2	2	
Water column		5	5	Water column	1	1	
Abundance: 0=absent; 1=rare; 2=sparse; 3=moderate; 4=abundant; 5=very abundant							

Suitability scores of site in terms of EWR and FRAI application.

SUITABILITY SCORES	
EWR SUITABILITY	4
FRAI SITE SUITABILITY	3

0: Not suitable, 1 - 1.9: very low suitability, 2 - 2.9: Moderate suitability, 3 - 3.9: High suitability, 4 - 5: Very high suitability.

EWR site 7 (Honeybird)

Three small rheophilic species are expected in this RAU, namely CPRE, CSWI and OPER (Table below). All these species have a high preference for fast-shallow velocity-depth categories, while CPRE also prefers fast-deep habitats. CPRE prefers cobbles and stones as substrate, CSWI prefers sand and gravel while OPER also prefers water columns as cover. According to the table below, these preferred habitats of the rheophilic species are highly abundant at the site. It is furthermore estimated that the site has slightly more fast-shallow and less slow-deep than found throughout the rest of the RAU (Table below). As a result of the abundance of the preferred habitats of the rheophilic species at the site, is rated as being very highly suitable (score of 4.5) as a EWR site for setting of flows for this RAU (Table below).

The relative abundance of flow-depth categories and especially the cover features at the EWR site compare well to the estimated habitats of the entire RAU (Table below). As mentioned above, the EWR site may have slightly more fast-shallow and fast-deep and less slow-deep than found in the rest of the RAU. This should be considered when using the fish data of this site for FRAI application for the RAU. The site is therefore considered to have a high suitability (score=3.0) for the application of the results to the FRAI as an assessment of the entire RAU (Table below).

Expected fish species of RAU classified according to flow-depth preference and requirements for flow (rheophilic, semi-rheophilic, limnophilic).

EXPECTED SPECIES	Slow-Deep		Slow-Shallow		Fast-Deep		Fast-Shallow	
	LARGE	SMALL	LARGE	SMALL	LARGE	SMALL	LARGE	SMALL
RHEOPHILICS								
CPRE						CPRE		CPRE
CSWI								CSWI
OPER								OPER
SEMI-RHEOPHILICS								
AMOS	AMOS				AMOS		AMOS	
BEUT		BEUT		BEUT				
BTRI		BTRI		BTRI				
BUNI		BUNI		BUNI				
BMAR	BMAR				BMAR		BMAR	BMAR
CGAR	CGAR		CGAR	CGAR				
MMAC		MMAC		MMAC				
LROS	LROS							
LMOL	LMOL					LMOL		LMOL
LCYL	LCYL					LCYL		LCYL
CPAR						CPAR		CPAR
LIMNOPHILICS								
OMOS	OMOS			OMOS				
PPHI		PPHI		PPHI				
TREN	TREN			TREN				

Comparison of velocity-depth categories and cover features of the EWR site and the RAU.

	FISH VELOCITY-DEPTH CLASSES						
	Slow-Deep	Slow-Shallow	Fast-Deep	Fast-Shallow			
RAU	3	2	3	4			
SITE	2	2	3	5			
Abundance: 0=absent; 1=rare; 2=sparse; 3=moderate; 4=abundant; 5=very abundant							
	COVER						
	Slow-Deep		Fast-Deep		Slow-Shallow		
	RAU	SITE	RAU	SITE	RAU	SITE	
Overhanging vegetation	1	0			Overhanging vegetation	2	2
Undercut banks/Rootwads	2	2			Undercut banks/Rootwads	2	2
Substrate	4	4			Substrate	5	5
Aquatic macrophytes	1	0			Aquatic macrophytes	2	2
Water column	5	5			Water column	2	2
	Fast-Deep		Fast-Shallow				
	RAU	SITE	RAU	SITE	RAU	SITE	
Overhanging vegetation	1	1			Overhanging vegetation	2	2
Undercut banks/Rootwads	1	1			Undercut banks/Rootwads	1	1
Substrate	5	5			Substrate	5	5
Aquatic macrophytes	1	1			Aquatic macrophytes	2	2
Water column	3	3			Water column	1	1
Abundance: 0=absent; 1=rare; 2=sparse; 3=moderate; 4=abundant; 5=very abundant							

Suitability scores of site in terms of EWR and FRAI application.

SUITABILITY SCORES	
EWR SUITABILITY	4.5
FRAI SITE SUITABILITY	4

0: Not suitable, 1 - 1.9: very low suitability, 2 - 2.9: Moderate suitability,
 3 - 3.9: High suitability, 4 - 5: Very high suitability.

4. SUMMARY & CONCLUSIONS

In general, most of the EWR sites selected in the Sabie and Crocodile River Catchments have a high to very high suitability for EWR application, as well as FRAI application (Table below). A few sites were considered to be of moderate suitability for FRAI application, and cognisance should be taken of certain habitat differences during FRAI application for the entire RAU.

Summarised EWR site suitability for Sabie River Catchment (Fish).

Variable	Suitability	Comments
EWR1: SabbieUpper		
EWR	4.5 – Very high	<ul style="list-style-type: none"> ➢ Habitat for large rheophilic (VNEL), as well as small rheophilic, semi-rheophilic and limnophilic species. ➢ Limiting factor may be extensive forestry activities and aggravated algal growth which limits sampling success.
FRAI	4.0 – Very high	<ul style="list-style-type: none"> ➢ Fish habitats (velocity-depth categories and associated cover) at site highly similar to expected habitats of the RAU. ➢ Limiting factor is slightly less slow habitats and slightly more fast habits at EWR site in comparison to RAU.
EWR2: Sabie-Aan de Vliet		
EWR	4.5 – Very high	<ul style="list-style-type: none"> ➢ Habitat for large rheophilic (VNEL), as well as small rheophilic, semi-rheophilic and limnophilic species. ➢ Limiting factor is some vegetation removal on right bank for recreation purposes.
FRAI	3.5 – High	<ul style="list-style-type: none"> ➢ Fish habitats (velocity-depth categories and associated cover) at site highly similar to expected habitats of the RAU. ➢ Limiting factor is slightly less slow habitats and slightly more fast habits at EWR site in comparison to RAU.
EWR3: Kidney		
EWR	4.5 – Very high	<ul style="list-style-type: none"> ➢ Habitat for small rheophilic species well represented at site.
FRAI	2.5 - Moderate	<ul style="list-style-type: none"> ➢ Fish habitats (velocity-depth categories and associated cover) at site slightly different from RAU, and should be considered during application of results to FRAI.
EWR4: MacMac		
EWR	4.5 – Very high	<ul style="list-style-type: none"> ➢ Habitat for large rheophilic (VNEL), as well as small rheophilic, well represented at site. ➢ Limiting factor may be extensive forestry activities.
FRAI	4.0 – Very high	<ul style="list-style-type: none"> ➢ Fish habitats (velocity-depth categories and associated cover) at site highly similar to expected habitats of the RAU. ➢ Limiting factor may be slightly less deep habitats and vegetation as cover.
EWR5: Marite		
EWR	4.0 – Very high	<ul style="list-style-type: none"> ➢ Habitat for large rheophilic (VNEL), as well as small rheophilic, well represented at site. ➢ Limiting factor may be livestock farming activities impacting on fish habitat.
FRAI	3.5 - High	<ul style="list-style-type: none"> ➢ Fish habitats (velocity-depth categories and associated cover) at site very similar to expected habitats of the RAU.
EWR6: Mutlumuvi		
EWR	3.0 – High	<ul style="list-style-type: none"> ➢ Habitat for small rheophilic species and some semi-rheophilic species well represented at site.
FRAI	3.5 - High	<ul style="list-style-type: none"> ➢ Fish habitats (velocity-depth categories and associated cover) at site expected to be similar to expected habitats of the RAU.
EWR7: Tlulandziteka		
EWR	3 - High	<ul style="list-style-type: none"> ➢ Habitat for small rheophilic species and some semi-rheophilic species represented at site.
FRAI	3.5 - High	<ul style="list-style-type: none"> ➢ Fish habitats (velocity-depth categories and associated cover) at site expected to be similar to expected habitats of the RAU.
EWR8: Sand		
EWR	2.5 - Moderate	<ul style="list-style-type: none"> ➢ During flowing conditions, habitat for small rheophilic species will be present at site.
FRAI	3 - High	<ul style="list-style-type: none"> ➢ Fish habitats (velocity-depth categories and associated cover) at site expected to be similar to expected habitats of the RAU.

0 – 0.9: Not suitable 1.0-1.9: very low suitability 2.0-2.9: Moderate suitability 3.0-3.9: High suitability 4.0-5.0: Very high suitability

Summarised EWR site suitability for Crocodile River Catchment (Fish).

Variable	Suitability	Comments
EWR1: Valyspruit		
EWR	2.5 – Moderate	<ul style="list-style-type: none"> ➤ The optimally preferred habitat for the only expected fish species , namely semi-rheophilic BANO very well represented at site. ➤ As only one fish species, and it being only semi-rheophilic, fish weighting of fish in EWR process may have to be lower than other biotic components.
FRAI	4.5 – Very high	<ul style="list-style-type: none"> ➤ Fish habitats (velocity-depth categories and associated cover) at site highly similar to expected habitats of the RAU. ➤ Limiting factor for FRAI application may be presence of single expected fish species.
EWR2: Goedenhoop		
EWR	4.0 – Very high	<ul style="list-style-type: none"> ➤ Habitat for small rheophilic species very well represented at EWR site.
FRAI	4.0 – Very High	<ul style="list-style-type: none"> ➤ Fish habitats (velocity-depth categories and associated cover) at site highly similar to expected habitats of the RAU.
EWR3: Poplar Creek		
EWR	4.5 – Very high	<ul style="list-style-type: none"> ➤ Habitat for small rheophilic species very well represented at site.
FRAI	4.0 – Very high	<ul style="list-style-type: none"> ➤ Fish habitats (velocity-depth categories and associated cover) at site highly similar to expected habitats of the RAU.
EWR4: KaNyamazane		
EWR	4.0 – Very high	<ul style="list-style-type: none"> ➤ Habitat for small rheophilic species very well represented at site.
FRAI	4.0 – Very high	<ul style="list-style-type: none"> ➤ Fish habitats (velocity-depth categories and associated cover) at site highly similar to expected habitats of the RAU.
EWR5: Malelane		
EWR	3.5 – High	<ul style="list-style-type: none"> ➤ Habitat for small rheophilic species in adequate abundance at site.
FRAI	3.0 - High	<ul style="list-style-type: none"> ➤ Fish habitats (velocity-depth categories and associated cover) at site fairly similar to expected habitats of the RAU. ➤ Estimated that the site have slightly more fast-shallow and less slow-deep than RAU, which should be considered in FRAI application.
EWR6: Nkongoma		
EWR	4.0 – Very high	<ul style="list-style-type: none"> ➤ Habitat for small rheophilic species in adequate abundance at site.
FRAI	3.0 - High	<ul style="list-style-type: none"> ➤ Fish habitats (velocity-depth categories and associated cover) at site fairly similar to expected habitats of the RAU. ➤ Estimated that the site have slightly more fast-shallow and fast-deep and less slow-deep than RAU, which should be considered in FRAI application.
EWR7: Honeybird		
EWR	4.5 – Very high	<ul style="list-style-type: none"> ➤ Habitat for small rheophilic species very well represented at site.
FRAI	4.0 – Very high	<ul style="list-style-type: none"> ➤ Fish habitats (velocity-depth categories and associated cover) at site expected to be similar to estimated habitats of the RAU.

0 – 0.9: Not suitable 1.0-1.9: very low suitability 2.0-2.9: Moderate suitability 3.0-3.9: High suitability 4.0-5.0: Very high suitability

5. REFERENCES

- Kleynhans, C.J. & Louw, M.D. (2007). River reach demarcation and delineation (Sabie River Catchment). Draft working document.
- Kleynhans, C.J., Louw, M.D., Moolman, J. (2007). Reference frequency of occurrence of fish species in South Africa. Report produced for the Department of Water Affairs and Forestry (Resource Quality Services) and the Water Research Commission

Expected fish species of the Sabie and Crocodile River Catchments and their relevant preference for velocity-depth category, cover and relative tolerance to no-flow.

SPECIES	PREFERENCE: FD	PREFERENCE:FS	PREFERENCE:SD	PREFERENCE:SS	INTOLERANT: NO-FLOW (>4)	MODERATELY INTOLERANT: NO FLOW (>3-4)	MODERATELY TOLERANT: NO FLOW (>2-3)	TOLERANT: NO FLOW (1-2)	OVERHANGING VEGETATION: HIGH-> VERY HIGH (>3)	BANK UNDERCUT: HIGH-> VERY HIGH (>3)	SUBSTRATE: HIGH-> VERY HIGH (>3)	AQUATIC MACROPHYTES: HIGH-> VERY HIGH (>3)	WATER COLUMN: HIGH-> VERY HIGH (>3)
ALAB	FALSE	FALSE	4.60	FALSE	FALSE	FALSE	2.80	FALSE	FALSE	4.00	4.20	FALSE	FALSE
AMAR	FALSE	FALSE	4.40	FALSE	FALSE	FALSE	2.80	FALSE	FALSE	3.90	4.20	FALSE	FALSE
AMOS	3.40	3.30	3.40	FALSE	FALSE	FALSE	2.80	FALSE	FALSE	4.10	4.90	FALSE	FALSE
ANAT	5.00	4.70	FALSE	FALSE	4.90	FALSE	FALSE	FALSE	FALSE	FALSE	5.00	FALSE	FALSE
AURA	4.60	4.60	FALSE	FALSE	4.80	FALSE	FALSE	FALSE	FALSE	FALSE	5.00	FALSE	FALSE
BANN	FALSE	FALSE	5.00	FALSE	FALSE	FALSE	2.80	FALSE	FALSE	FALSE	FALSE	FALSE	4.70
BANO	FALSE	FALSE	4.10	4.30	FALSE	FALSE	2.30	FALSE	4.00	FALSE	FALSE	3.20	FALSE
BARG	3.70	4.30	FALSE	FALSE	4.60	FALSE	FALSE	FALSE	FALSE	FALSE	5.00	FALSE	FALSE
BBRI	FALSE	FALSE	3.30	4.30	4.10	FALSE	FALSE	FALSE	4.70	4.10	FALSE	FALSE	FALSE
BEUT	4.30	4.70	FALSE	FALSE	4.60	FALSE	FALSE	FALSE	4.10	4.40	4.10	FALSE	FALSE
BFRI	FALSE	FALSE	4.70	4.30	FALSE	FALSE	2.80	FALSE	FALSE	FALSE	FALSE	FALSE	4.00
BIMB	FALSE	FALSE	4.70	FALSE	FALSE	FALSE	3.00	FALSE	FALSE	FALSE	FALSE	FALSE	4.70
BMAR	4.10	4.40	4.40	3.40	FALSE	3.20	FALSE	FALSE	FALSE	FALSE	4.50	FALSE	4.10
BNEE	FALSE	FALSE	3.30	4.70	FALSE	3.40	FALSE	FALSE	3.90	3.30	4.40	FALSE	FALSE
BPAU	FALSE	FALSE	3.90	3.90	FALSE	FALSE	2.30	FALSE	4.20	FALSE	FALSE	3.60	3.50
BPOL	3.70	4.30	4.20	FALSE	FALSE	3.30	FALSE	FALSE	FALSE	FALSE	5.00	FALSE	3.60
BRAD	FALSE	FALSE	4.70	5.00	FALSE	FALSE	2.80	FALSE	4.70	FALSE	FALSE	FALSE	FALSE
BTOP	FALSE	FALSE	3.30	4.30	FALSE	FALSE	FALSE	1.10	4.70	FALSE	FALSE	FALSE	FALSE
BTRI	FALSE	FALSE	3.90	3.20	FALSE	FALSE	2.70	FALSE	3.90	FALSE	FALSE	FALSE	FALSE
BUNI	FALSE	FALSE	5.00	4.30	FALSE	FALSE	2.30	FALSE	4.60	FALSE	FALSE	FALSE	FALSE
BVIV	FALSE	FALSE	FALSE	4.80	FALSE	FALSE	2.30	FALSE	4.90	FALSE	FALSE	3.20	FALSE
CANO	4.30	4.90	FALSE	FALSE	4.80	FALSE	FALSE	FALSE	FALSE	FALSE	4.90	FALSE	FALSE
CBIF	5.00	3.30	FALSE	FALSE	4.90	FALSE	FALSE	FALSE	FALSE	FALSE	5.00	FALSE	FALSE
CBRE	FALSE	FALSE	4.70	3.70	FALSE	FALSE	FALSE	1.30	4.70	FALSE	FALSE	FALSE	FALSE
CGAR	FALSE	FALSE	4.30	3.40	FALSE	FALSE	FALSE	1.70	FALSE	FALSE	FALSE	FALSE	FALSE

SPECIES	PREFERENCE: FD	PREFERENCE:FS	PREFERENCE:SD	PREFERENCE:SS	INTOLERANT: NO-FLOW (>4)	MODERATELY INTOLERANT: NO FLOW (>3-4)	MODERATELY TOLERANT: NO FLOW (>2-3)	TOLERANT: NO FLOW (1-2)	OVERHANGING VEGETATION: HIGH->VERY HIGH (>3)	BANK UNDERCUT: HIGH->VERY HIGH (>3)	SUBSTRATE: HIGH->VERY HIGH (>3)	AQUATIC MACROPHYTES: HIGH->VERY HIGH (>3)	WATER COLUMN: HIGH->VERY HIGH (>3)
CPAR	4.20	4.90	FALSE	FALSE	FALSE	3.20	FALSE	FALSE	FALSE	FALSE	4.90	FALSE	FALSE
CPRE	4.30	4.90	FALSE	FALSE	4.80	FALSE	FALSE	FALSE	FALSE	FALSE	4.90	FALSE	FALSE
CSWI	FALSE	4.70	FALSE	FALSE	4.80	FALSE	FALSE	FALSE	FALSE	FALSE	4.90	FALSE	FALSE
GGIU	FALSE	FALSE	FALSE	4.60	FALSE	FALSE	FALSE	1.70	FALSE	FALSE	4.90	FALSE	FALSE
HVIT	3.60	FALSE	4.70	FALSE	FALSE	FALSE	2.70	FALSE	3.40	FALSE	FALSE	FALSE	4.90
KAUR	FALSE	FALSE	FALSE	4.20	FALSE	FALSE	2.50	FALSE	4.70	FALSE	3.60	FALSE	FALSE
LCON	5.00	FALSE	5.00	FALSE	FALSE	3.30	FALSE	FALSE	FALSE	FALSE	5.00	FALSE	3.40
LCYL	3.40	4.80	FALSE	FALSE	FALSE	3.10	FALSE	FALSE	FALSE	FALSE	4.90	FALSE	FALSE
LMOL	3.30	4.30	3.70	FALSE	FALSE	3.30	FALSE	FALSE	FALSE	FALSE	4.70	FALSE	FALSE
LROS	FALSE	FALSE	4.70	FALSE	FALSE	FALSE	2.50	FALSE	FALSE	FALSE	5.00	FALSE	FALSE
LRUD	FALSE	FALSE	4.70	FALSE	FALSE	FALSE	2.90	FALSE	FALSE	FALSE	4.70	FALSE	FALSE
MACU	FALSE	FALSE	4.30	4.30	FALSE	3.10	FALSE	FALSE	3.10	FALSE	FALSE	FALSE	4.00
MBRE	FALSE	FALSE	4.30	4.20	FALSE	FALSE	FALSE	1.10	FALSE	FALSE	FALSE	FALSE	5.00
MMAC	FALSE	FALSE	4.20	3.70	FALSE	FALSE	3.00	FALSE	3.80	5.00	FALSE	FALSE	FALSE
OMOS	FALSE	FALSE	4.60	3.80	FALSE	FALSE	FALSE	0.90	FALSE	FALSE	FALSE	FALSE	3.90
OPER	3.20	FALSE	3.30	FALSE	4.90	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	4.40
PCAT	FALSE	FALSE	4.70	4.30	FALSE	FALSE	2.80	FALSE	3.30	5.00	FALSE	FALSE	FALSE
PPHI	FALSE	FALSE	FALSE	4.30	FALSE	FALSE	FALSE	1.00	4.50	3.20	FALSE	FALSE	FALSE
SINT	FALSE	FALSE	5.00	FALSE	FALSE	FALSE	FALSE	1.30	FALSE	FALSE	FALSE	FALSE	4.70
SZAM	FALSE	FALSE	5.00	FALSE	FALSE	FALSE	FALSE	1.80	FALSE	5.00	FALSE	FALSE	FALSE
TREN	FALSE	FALSE	4.90	3.90	FALSE	FALSE	FALSE	1.80	4.30	FALSE	FALSE	4.10	FALSE
TSPA	FALSE	FALSE	FALSE	4.30	FALSE	FALSE	FALSE	0.90	4.50	FALSE	FALSE	3.60	FALSE
VNEL	5.00	5.00	FALSE	FALSE	FALSE	3.60	FALSE	FALSE	FALSE	FALSE	5.00	FALSE	FALSE

APPENDIX G – HYDRAULIC SITE SUITABILITY

EWR 1: Upper Sabie River

- *Site suitability = 3 low-flows; 4 high-flows (scale 0-5)*
- **Positive attributes**
- Downstream bridge for the measurement of high flows when access into the river is not possible.
- **Negative attributes**
- Large nature of the bed substrate (cobbles & boulders). This makes resistance and energy slope predictions difficult for low and medium flows, compromising the accuracy of the stage-discharge relationship.
- Rapidly varies flow conditions (rapid) making it difficult to predict the energy slope in the absence of detailed topographical survey.

EWR 2: Sabie River, Aan de Vliet

Site suitability = 4 low-flows; 2 high-flows (scale 0-5)

- **Positive attributes**
- Upstream gauge (X3H023 @ Emmet) for measuring discharges.
- The data for the gauge is available at near real-time on the DWAF hydrology web site, making it useful for the follow-up collection of hydraulic data over the duration of the Reserve study.
- Reasonably uniform flow conditions at low-flows.
- **Negative attributes**
- Non-horizontal water surface across the inundated channel width at medium to high-flows due to two-dimensional flow patterns arising from bends in the river planform.
- Low confidence in the predicted velocity distribution at medium-flows and above. This will reduce the confidence in the modelled habitat-types incorporating velocity (eg. velocity-depth habitat types for fish and velocity habitat-types for invertebrates).

EWR 3: Sabie River, KNP

Site suitability = 2 low-flows; 3 high-flows (scale 0-5)

- **Positive attributes**
- Downstream gauge (X3H021) for measuring medium to high discharges, although unsteady effects will have to be considered, particularly at low-flows.
- The data for the gauge is available at near real-time on the DWAF hydrology web site, making it useful for the follow-up collection of hydraulic data over the duration of the Reserve study.
- **Negative attributes**
- Complex river morphology with multiple channels, bedrock influence and rapidly varied flow conditions at low-to medium flows.
- Difficult (dangerous) to access the river at all flows for discharge measurement and water level surveys (multiple channels with vegetation and wide river section).
- Non-horizontal water surfaces at low and medium-flows.
- Low confidence in the predicted velocity distribution at low and medium-flows and due to multiple channels. This will reduce the confidence in the modelled habitat-types

incorporating velocity (eg. velocity-depth habitat types for fish and velocity habitat-types for invertebrates).

EWR 4: Mac Mac River

Site suitability = 3 low-flows; 2 high-flows (scale 0-5)

- **Positive attributes**
- None.
- **Negative attributes**
- Location of site in bedrock morphology with rapidly varied flow conditions (rapids and cascades). Large nature of the bed substrate (cobbles, boulders & bedrock). Influence of downstream bedrock controls/bridge structure at medium-flows and above. This makes resistance and energy slope predictions difficult for all flows, compromising the accuracy of the stage-discharge relationship.
- Non-horizontal water surface across the inundated channel width at low-flows.
- Rapidly varies flow conditions making it difficult to predict the energy slope in the absence of detailed topographical survey.
- Difficult to manually determine discharge using velocity-area at medium and high-flows.
-

EWR 5: Marite River

Site suitability = 3 low-flows; 4 high-flows (scale 0-5)

- **Positive attributes**
- None.
- **Negative attributes**
- Location of site in bedrock morphology with rapidly varied flow conditions. Large nature of the bed substrate (cobbles, boulders & bedrock). Influence of vegetation on flow resistance at high flows. This makes resistance and energy slope predictions difficult for all flows, compromising the accuracy of the stage-discharge relationship.
- Multiple channels at medium/high-flows making it difficult to predict stage-discharge relationships in the absence of detailed topographical survey and two-dimensional hydraulic modelling.
- Rapidly varies flow conditions (short rapid) making it difficult to predict the energy slope in the absence of detailed topographical survey.
- Difficult to manually determine discharge using velocity-area at medium-flows and above.
- Low confidence in the predicted velocity distribution at medium-flows and above due to seasonal channel on left bank. This will reduce the confidence in the modelled habitat-types incorporating velocity (eg. velocity-depth habitat types for fish and velocity habitat-types for invertebrates).

EWR 6: Mutlumivi River

Site suitability = 2 low-flows; 3 high-flows (scale 0-5)

- **Positive attributes**
- None
- **Negative attributes**
- Location of site in bedrock morphology with rapidly varied flow conditions (rapids and cascades). Large nature of the bed substrate (cobbles, boulders & bedrock). Influence of downstream bedrock controls at low and medium-flows. This makes resistance and energy

slope predictions difficult for all flows, compromising the accuracy of the stage-discharge relationship.

- Multiple channels at medium/high-flows making it difficult to predict stage-discharge relationships in the absence of detailed topographical survey and two-dimensional hydraulic modelling.
- Non-horizontal water surface across the inundated channel width at low-flows.
- Rapidly varies flow conditions (rapid with cascades) making it difficult to predict the energy slope in the absence of detailed topographical survey.
- Low confidence in the predicted velocity distribution at medium-flows and above due to multiple bedrock channels. This will reduce the confidence in the modelled habitat-types incorporating velocity (eg. velocity-depth habitat types for fish and velocity habitat-types for invertebrates).

EWR 7: Tlulanziteka River

Site suitability = 4 low-flows; 4 high-flows (scale 0-5)

- **Positive attributes**
- Reasonably uniform flow conditions at medium flows and above.
- **Negative attributes**
- Influence of vegetation on flow resistance at high flows. This makes resistance and energy slope predictions difficult, compromising the accuracy of the stage-discharge relationship.
- Multiple channels at low-flows.
- Low confidence in the predicted velocity distribution at medium-flows and above due to extensive vegetation. This will reduce the confidence in the modelled habitat-types incorporating velocity (eg. velocity-depth habitat types for fish and velocity habitat-types for invertebrates).

EWR 8: Sand River

Site suitability = 3 low-flows; 4 high-flows (scale 0-5)

- **Positive attributes**
- Upstream low-level bridge for the measurement of medium flows when access into the river is not possible.
- Reasonably uniform flow conditions at all flows (sand bed).
- **Negative attributes**
- Influence of vegetation on flow resistance. This makes resistance and energy slope predictions difficult, compromising the accuracy of the stage-discharge relationship.
- Non-horizontal water surface across the inundated channel width at low-flows.
- Difficult to manually determine discharge using velocity-area at high flows due to extensive vegetation across the channel floor.

EWR 1: Valyspruit (Crocodile River)

Site suitability = 4 low-flows; 5 high-flows (scale 0-5)

Component	Advantages	Disadvantages
Hydraulics	Incised rectangular river section. Medium to high flows can be reasonably accurately modelled when local hydraulic controls (e.g. riffles) are drowned-out.	Non-uniform flow at low discharges. Bends in the meandering planform increase effective flow resistance at medium and high flows.

EWR 2: Goedenhoop (Crocodile River)*Site suitability = 4 low-flows; 4 high-flows (scale 0-5)*

Component	Advantages	Disadvantages
Hydraulics	Incised rectangular river section. High flows can be reasonably accurately modelled when local hydraulic controls (e.g. riffles) are drowned-out.	Non-uniform flow at low and medium discharges.

EWR 3: Poplar Creek (Crocodile River)*Site suitability = 3 low-flows; 4 high-flows (scale 0-5)*

Component	Advantages	Disadvantages
Hydraulics	Longitudinally extensive riffle. Nearby gauge for the measurement of high flows.	Large-scale bed roughness.

EWR 4: KaNyamazane (Crocodile River)*Site suitability = 3 low-flows; 3 high-flows (scale 0-5)*

Component	Advantages	Disadvantages
Hydraulics	Nearby gauge for the measurement of high flows.	Rapidly varied flow conditions. Large-scale bed roughness.

EWR 5: Malelane (Crocodile River)*Site suitability = 4 low-flows; 5 high-flows (scale 0-5)*

Component	Advantages	Disadvantages
Hydraulics	Materially uniform flow conditions over sand bed. Nearby gauge for the measurement of high flows.	Mobile bed.

EWR 6: Nkongoma (Crocodile River)*Site suitability = 2 low-flows; 4 high-flows (scale 0-5)*

Component	Advantages	Disadvantages
Hydraulics	Nearby gauge for the measurement of high flows.	Non-uniform flow. Large scale roughness due to bedrock outcrop.

EWR 7: Honeybird (Kaap River)*Site suitability = 2 low-flows; 2 high-flows (scale 0-5)*

Component	Advantages	Disadvantages
Hydraulics	None.	Rapidly varied flow conditions. Large scale roughness due to bedrock influence in this gorge.