APPENDIX 1

HABITAT INTEGRITY INDEX
Fouche, P and Moolman J

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

AN ASSESSMENT OF THE HABITAT INTEGRITY OF THE GROOT LETABA RIVER AND MAJOR TRIBUTARIES BASED UPON AERIAL SURVEYS UNDERTAKEN IN JANUARY 2001 AND JANUARY 2003

1. INTRODUCTION

Engelbrecht and Kleynhans undertook an assessment of the conservation status of the Groot Letaba River during 1994. The assessment was undertaken as a component of the Letaba River Instream Flow Requirement (IFR) Study. Methodologies utilised within this 1994 conservation status report, were developed by Kleynhans (1995) during his assessment of the habitat integrity status of the Luvuvhu River. The 1995 report on the Luvuvhu River was the first time that the methodologies had been described as the Index of Habitat Integrity (IHI).

The 1994 assessment of conservation status fell within a critical drought period, which extended from 1991 to 1996.

Angliss (2002), assessed the IHI for the Groot Letaba River, falling between Tzaneen Dam and the Kruger National Park boundary, based on helicopter video footage taken in January 2001. This aerial footage was taken approximately 1 year after the major 2000 floods and was taken at a time when base flows were still good. Numerous tributaries to the Letaba River were also filmed during January 2001 by Angliss, but IHI reports were not completed until this time.

In January 2003, The Dept. of Water Affairs and Forestry (DWAF) undertook an aerial survey of the Groot Letaba River for the purposes of assessing alien plant infestation. The survey extended between a point approximately 15km upstream of Tzaneen Dam to Black Heron Dam in the Kruger National Park.

In 2003, DWAF commissioned a Comprehensive Reserve Determination Study of the Letaba River Catchment. The study called for the assessment of the IHI of the main stem of the Groot Letaba and Letaba River and its major tributaries, using all recently acquired data.

This report has been compiled, taking cognisance of the above aerial video material, historical reports and new information generated by the Letaba Reserve specialist study team. Due to a lack of aerial footage of the Letaba River within the Kruger National Park, a brief assessment of recent orthophotos was also undertaken.

2. THE STUDY AREA

The study area encompasses the whole of the Letaba Catchment comprised of Secondary Catchment B8, with Tertiary Sub Catchments B81, B82 and B83. The catchment area drains in an easterly direction, extending from the Drakensberg Escarpment to the junction of the Olifants River near the Mozambique border in the Kruger National Park.

3. METHODOLOGY

3.1 APPROACH

The following approach was used.

- All available literature was reviewed.
- Where aerial video footage was on hand, the most recent material was used to assess the river following the methodology described by Kleynhans (1995). This methodology is described later in this report.
    - The catchment was broken into appropriate resource units.
    - Through the application of Arc View, the catchment was mapped and the river buffered to a distance of 1km to show dominant land cover along both banks. Where such land use impacts upon the riverine ecosystem, the level of impact was described. This process permits some quantification of an otherwise subjective approach.
    - Expert judgment was applied.
    - Subjective assessments of river condition were obtained from local river experts.
    - Both qualitative and quantitative data are captured in spread sheet format for graphical presentation.
    - For the Letaba River inside the KNP, orthophoto's were used in lieu of aerial video. (Sets dating from November 1996 and September 2000)
- Where video footage or other data was unavailable, the situation is summarized in a descriptive manner based upon local knowledge and expert judgment.

3.2 DELINEATION OF THE CATCHMENT INTO RESOURCE UNITS

Note.

Each of the aerial surveys undertaken to date have relied upon the approach as described by Kleynhans, whereby the river was broken into 5km segments for interpretive purposes. However, the respective surveys were not exactly the same and where they do overlap, segment numbers do not necessarily coincide. Furthermore, the GIS approach used in this study described new 5km segments as determined by the GIS office. (J. Moolman of DWAF) Where possible, the new numbering has been adopted.

For the purposes of this study, each 5km segment was assessed, but results are summarized into larger resource units.

From the video footage and through the review of available literature, the catchment was broken into reaches of homogenous character. These are described later. However, due to the complexity of the system, it was noted that these regions approximate to ecoregions (level 2), which were identified through the application of GIS. In some cases, the ecoregions were subdivided. The subdivisions were justified, based on expert knowledge of natural breaks (waterfalls and tributaries), fish populations, and through clear changes in riparian vegetation condition. See Table 2.

The Level 2 ecoregions are closely linked to the geomorphology of the catchment, but include both biotic and abiotic factors. The geomorphology of the catchment in turn provides the template for the fauna and flora of the catchment.

The Reserve Study only addresses 7 IFR sites in total. See Table 1. These do not represent the full catchment. However, insufficient financial resources were available in this study to address a Comprehensive Reserve in all resource units of the upper catchment and lesser tributaries of the catchment. Nevertheless, these resource units have a distinct influence on the downstream resource units and it is therefore important that the IHI of each, be addressed as far as possible, in order that the influences on the downstream environment be recognized. Table 2 provides a preliminary assessment of the resource units addressed in this report.

Table 1. IFR site numbers, site names and rivers in which they occur

IFR site no.	Site name	River name
1	Appel	Groot Letaba
2	Letsitele Tank	Letsiteli
3	Die Eiland	Groot Letaba
4	Letaba Ranch	Groot Letaba
5	Klein Letaba	Klein Letaba
6	Lonely Bull	Groot Letaba
7	Below Letaba bridge	Groot Letaba

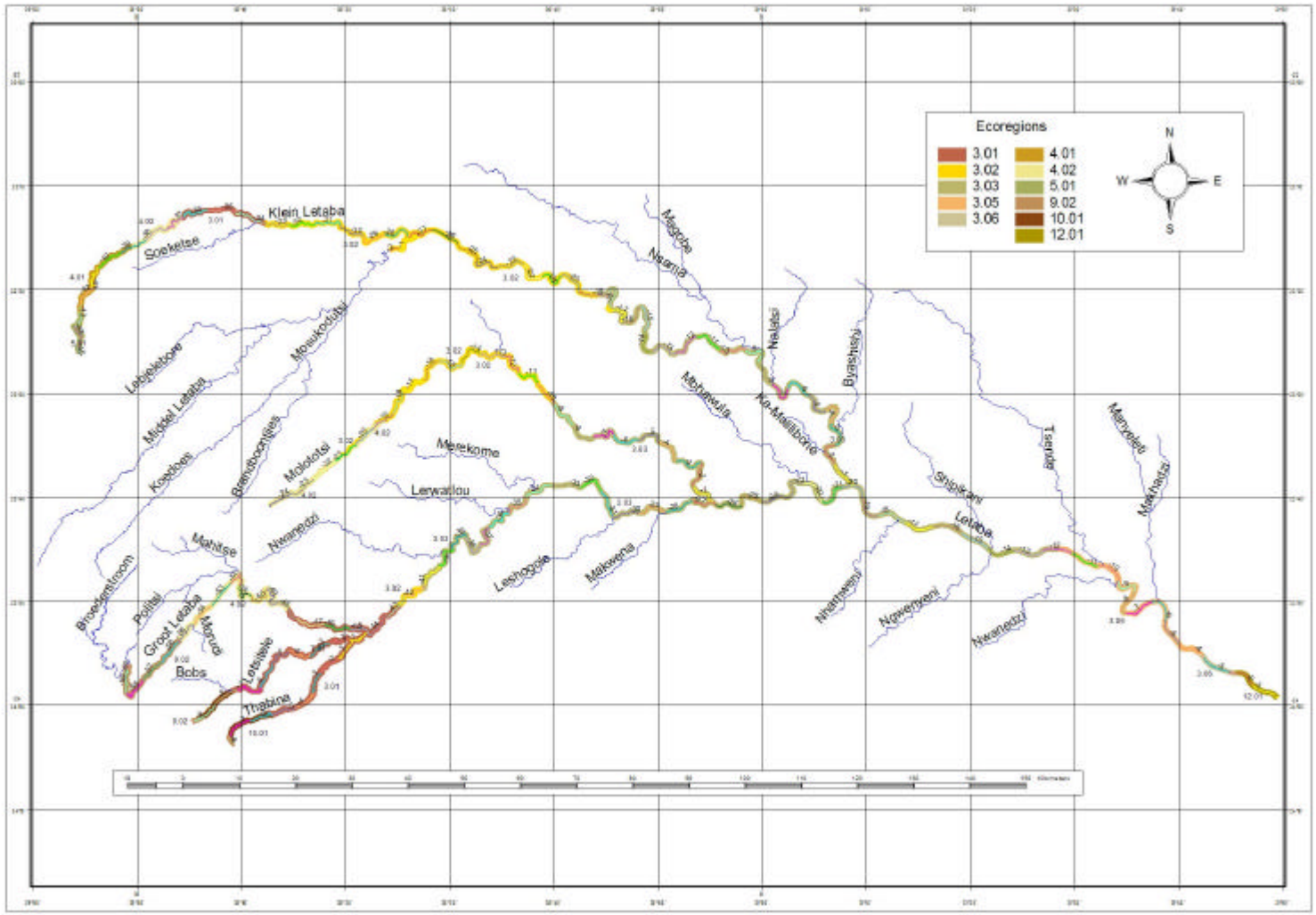


Figure 1. Study area Map, showing river segments and level 2 ecoregions

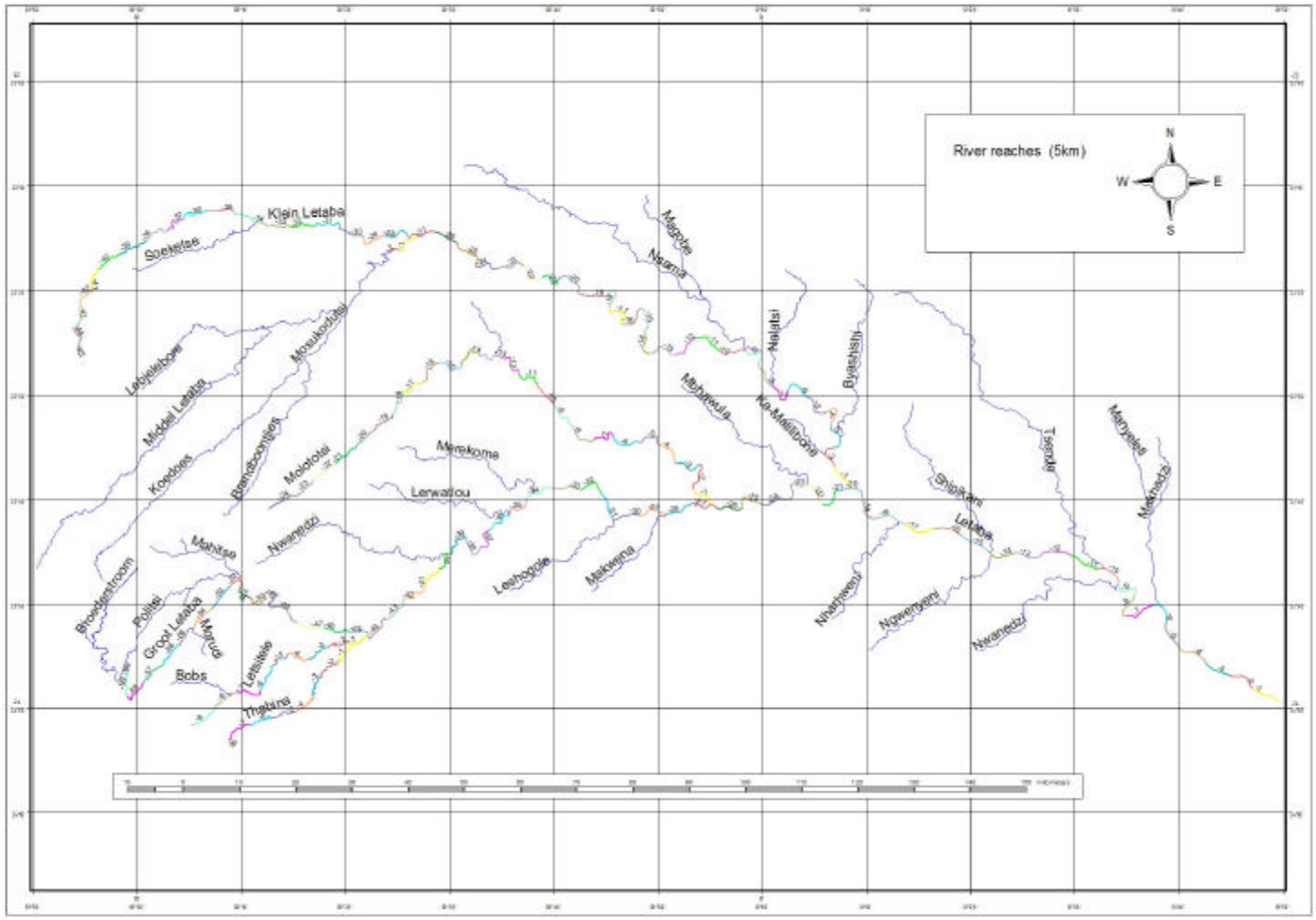


Figure 2. River Segments

Table 2. Resource units addressed in this study, ecoregions and site numbers and a summary of why the unit was sected.

River name	Resource unit code	Description	Ecoregion	Segments (inclusive)	IFR site no.	Latest Aerial survey date	Comment
Groot Letaba River	GL1	Source - Ebenezer dam	9.02	60 to 59		N/A	Largely based on ecoregions, tributary influences on hydrology, geomorphology and recognised fish communities. Letaba Dam to KNP Resource units as used in the 1996 and 2001 surveys remain largely unchanged. (Only the area between the Nondweni Dam and the Slab Weir has been changed.
	GL2	Ebenezer Dam - LetabaDrift.	9.02	58 to 56		N/A	
	GL3	Letaba Drift - Tzaneen Dam	4.02	55 to 52	1	2003	
	GL4	Tzaneen Dam - Letsitele River	4.02 & 3.01	51 to 45		2003	
	GL5	Letsitele River - Nwanedzi River	3.01 & 3.02	44 to 40		2003	
	GL6	Nwanedzi River - Prieska Dam	3.03	39 to 32	3	2003	
	GL7	Prieska Dam - Molototsi Confluence	3.03	31 to 27		2003	
	GL8	Molototsi - Slab Weir.	3.03	26 to 24		2003	
	GL9	Slab - Klein Letaba / KNP Fence.	3.03	23 to 20	4	2003	
Letaba River	KNP1	KNP Fence - Engelhardt	3.03	19 to 7	6 & 7	N/A	2003 flight to Black Heron only. Based on ecoregions, orthophoto's and fish segments. Expert opinion Dr. Deacon.
	KNP2	Engelhardt - Gorge	3.05	6 to 4.		N/A	
	KNP3	Gorge - Confluence	3.06 & 12.01	3 to 1		N/A	
Letsitele River	LET1	Source - Craighead Estates	9.02	9 to 8		N/A	Ecoregions and a known waterfall above Craighead.
	LET 2	Craighead Est. - GL Confluence	3.01	7 to 1	2	2001	
Thabina River	THA1	Above Thabina Dam	10.01	8		N/A	Based on changing character of the river, fish communities and perceived importance of the wetland area.
	THA2	Thabina Dam - Wetland	3.01	7 to 6		2001	
	THA3	Wetland	3.01	5 to 4		2001	
	THA4	Wetland - Confluence	3.01	3 to 1		2001	
Molototsi River	MOL1	Source - Modjadji Dam	4.02	24 to 23		2001	Ecoregions and the placement of Modjadji Dam and its influence on hydrology.
	MOL2	Modjadji Dam - GL Letaba	3.02 & 3.03	22 to 1.		2001	
Klein Letaba River	KL1	Na Chavane - Mid Leataba Confluence	3.02	35 to 27		2001	Largely based on fish segments and vegetation condition.
	KL2	Mid Letaba - Nkomo Village	3.02 & 3.03	26 to 16	5	2001	
	KL3	Nkomo Village - Letaba Confluence	3.03	15 to 1		2001	
Middel Letaba	ML1	Above Middel Letaba Dam (wall)	4.02	Not numbered		N/A	Limited data and importance of dam summarized
	ML2	Dam wall - Klein Letaba Confluence	3.02	3 to 1		2001	
Nsama River	NS1	Source - Klein Letaba Confluence	3.02 & 3.03	Not numbered		N/A	Eco Region: Limited data. Summary assessment

3.3 REVIEW OF DATA, VIDEO FOOTAGE AND SCORING OF HABITAT INTEGRITY

Methodologies as described by Engelbrecht and Kleynhans (1994) and Kleynhans (1995) were closely followed. The instream and riparian components of the river were rated using largely qualitative procedures. Each 5 km segment of the video footage was viewed, and commentary listened to. The general status of the river along each 5km segment was noted, impacts noted and riparian cover status and instream habitat availability assessed. For the purposes of this report, the results are further summarized and are presented in tabular and graphical format per resource unit.

The following text and tables (3 -9) providing the methodology of the index are adapted from Kleynhans (1995)

The criteria indicative of habitat integrity are selected on the basis that anthropogenic modification of their characteristics can generally be regarded as the primary cause of degradation of the habitat integrity of the river. The severity of certain modifications will, therefore, have a detrimental impact on the habitat integrity of a river. This method is primarily habitat oriented with emphasis on a qualitative interpretation of the habitat quality, size, diversity, variability and predictability as influenced by various anthropogenic modifications.

The assessment of the severity of impact of modifications was based on six descriptive classes (Table 6). A five point rating system was utilized to facilitate scoring flexibility within a class. Scoring was guided by a description of the severity of the impact of the modification for each score.

Weights for each score were derived through expert judgement (Table 7). Based on the weights of the criteria, the impact of a criterion was estimated as follows.

Rating for the criterion / maximum value (25) x the weight (expressed as a percentage)

The estimated impacts of all criteria are summed, expressed as a percentage and subtracted from 100 to arrive at a provisional assessment of habitat integrity for the instream and riparian components respectively.

However, in cases where riparian zone criteria and the water abstraction, flow, bed and channel modification , water quality and inundation criteria of the instream component exceeded ratings of large, serious or critical, an additional weighting was applied. This is intended to accommodate the possible cumulative (and integrated) negative effects of such impacts (Table 8). These negative weights were added for the instream and riparian facets respectively and the total additional negative weight subtracted from the provisionally determined integrity to arrive at a final habitat integrity estimate. The eventual total scores for the riparian zone and instream components were then used to place the habitat integrity of both in a specific descriptive class (Table 9).

Table 3. Criteria used in the assessment of habitat integrity

CRITERION	RELEVANCE
Water abstraction	Direct impact on habitat type, abundance and size. Also implicated in flow, bed, channel and water quality characteristics. Riparian vegetation may be influenced by a decrease in the supply of water.
Flow modification	Consequence of abstraction or regulation by impoundments. Changes in temporal and spatial characteristics of flow can have an impact on habitat attributes, such as an increase in duration of low flow season, resulting in low availability of certain habitat types or low availability of water at the start of the breeding, flowering or growing season.
Bed modification	Regarded as the result of increased input of sediment from the catchment or a decrease in the ability of the river to transport sediment (Gordon et al., 1992). Indirect indications of sediment are stream bank and catchment erosion. Purposeful alteration of the stream bed, e.g. the removal of rapids for navigation (Hilden and Rapport, 1993) is also included.
Channel modification	May be the result of a change in flow which may alter channel characteristics causing a change in marginal, instream and riparian habitat. Purposeful channel modification to improve drainage is also included.
Water quality modification	Originates from point and diffuse sources. Measured directly or agricultural activities, human settlements and industrial activities may indicate the likelihood of modification. Aggravated by a decrease in the volume of water during low or no flow conditions.
Inundation	Destruction of rapid, riffle and riparian zone habitat. Obstructs the movement of aquatic fauna and influences water quality and the movement of sediments.
Exotic macrophytes	Alteration of habitat by obstruction of flow and may influence water quality. Dependent upon the species involved and scale of infestation.
Exotic aquatic fauna	The disturbance of the stream bottom during feeding may influence the water quality and increase turbidity. Dependent upon the species involved and their abundance.
Solid waste disposal	A direct anthropogenic impact which may alter habitat structurally. Also a general indication of the misuse and mismanagement of the river.
Indigenous vegetation removal	Impairment of the buffer the vegetation forms to the movement of sediment and other catchment runoff products into the river. (Gordon et al., 1992) Refers to physical removal for farming, firewood and overgrazing.
Exotic vegetation encroachment	Excludes natural vegetation due to vigorous growth, causing bank instability and decreasing the buffering function of the riparian zone. Allochtonous organic matter input will also be changed. Riparian zone habitat diversity is also reduced.
Bank erosion	Decrease in bank stability will cause sedimentation and possible collapse of the river bank resulting in a loss or modification of both instream and riparian habitats. Increased erosion can be the result of natural vegetation removal, overgrazing or exotic vegetation encroachment

Table 4. General detail on river characteristics recorded for each 5km segment

CHARACTERISTIC	DESCRIPTION
Surface water and flow.	Recorded as dry, surface water but no flow, moderate flow, strong flow.
Water habitat types.	Rapids, riffles, runs, pools, weirs and impoundments. Recorded as none, few, moderate, common or exclusive.
Weirs, impoundments and pumps.	numbers per segment.
Roads, bridges, solid waste disposal, bed and channel modification, stream bank erosion, removal of natural vegetation, encroachment by exotic riparian vegetation, cultivated lands and plantations on stream banks, presence of exotic aquatic macrophytes.	Impact groupings: none, small, moderate, large, serious or critical.

Table 5. Scores for descriptive classes

SCORES:	
0	No impact
1 to 5	Small impact
6 to 10	Moderate impact
11 to 15	Large impact
16 to 20	Serious impact
21 to 25	Critical impact

Table 6. Descriptive classes for the assessment of modifications to habitat integrity

IMPACT CLASS	DESCRIPTION	SCORE
None	No discernible impact, or the modification is located in such a way that it has no impact on habitat quality, diversity, size and variability	0
Small	The modification is limited to very few localities and the impact on habitat quality, diversity, size and variability are also very small.	1 to 5
Moderate	The modifications are present at a small number of localities and the impact on habitat quality, diversity, size and variability are also limited.	6 to 10
Large	The modification is generally present with a clearly detrimental impact on habitat quality, diversity, size and variability. Large areas are however, not influenced.	11 to 15
Serious	The modification is frequently present and the habitat quality, diversity, size and variability in almost the whole of the defined area are affected. Only small areas are not influence.	16 to 20
Critical	The modification is present overall with a high intensity. The habitat quality, diversity, size and variability in almost the whole of the defined section are influenced detrimentally.	21 to 25

Table 7. Criteria and weights used for the assessment of instream and riparian zone habitat integrity

INSTREAM CRITERIA	WEIGHT	RIPARIAN ZONE CRITERIA	WEIGHT
Water abstraction	14	Indigenous vegetation removal	13
Flow modification	13	Exotic vegetation encroachment	12
Bed modification	13	Bank erosion	14
Channel modification	13	Channel modification	12
Water quality	14	Water abstraction	13
Inundation	10	Inundation	11
Exotic macrophytes	9	Flow modification	12
Exotic fauna	8	Water quality	13
Solid waste disposal	6		
Total	100		100

Table 8. Rules for applying additional ratings to criteria for the purposes of addressing cumulative and integrated negative effects

IMPACT	RULE
Impact = Large	For each criterion with such a rating, lower the integrity status by 33% of the weight.
Impact = Serious	For each criterion with such a rating, lower the integrity status by 67% of the weight.
Impact = Critical	For each criterion with such a rating, lower the integrity status by 100% of the weight.

Table 9. Habitat integrity assessment classes

CLASS	DESCRIPTION	SCORE (PERCENT OF TOTAL)
1	Unmodified, natural.	100
2	Largely natural with few modifications. A small change in natural habitats and biota may have taken place but the ecosystem functions are essentially unchanged.	80 to 99
3	Moderately modified. A loss and change of natural habitat and biota have occurred but the basic ecosystem functions are still predominantly unchanged.	60 to 79
4	Largely modified. A large loss of natural habitat, biota and basic ecosystem functions has occurred.	40 to 59
5	Seriously modified. The losses of natural habitat, biota and basic ecosystem functions are extensive.	20 to 39
6	Critically modified. Modifications have reached a critical level and the lotic system has been modified completely with an almost complete loss of natural habitat and biota. In the worst instances the basic ecosystem functions have been destroyed and the changes are irreversible.	0 to 19

3.4 GIS LAND COVERAGE

Using Arcview (version 3.1) the Groot Letaba River was buffered to a distance of 500 metres on each bank, and overlayed with land coverage. The buffered area of each land cover type per level 2 ecoregion was then calculated. Results for each ecoregion are tabulated in **Appendix A.**

This information was then reviewed subjectively to obtain a better understanding of impacts occurring along the rivers length. The final subjective assessment of each segment and river zone was conducted with this background knowledge in hand.

Issues which can be considered important for each land cover type identified, include the following:

Nature reserves

The Thabina Reserve, Lekgalameetse Reserve, Fanie Botha Nature Reserve, Merensky Reserve and Letaba Ranch all fall within the study area. The Kruger National Park occupies the lower third of the catchment.

- Protection of veld and riparian zone.
- Reduced erosion.
- Reduced exotic vegetation.
- Limited water abstraction.
- Reduced numbers of bridges and roads.
- Few point source pollution returns.

Cultivated: permanent - commercial dryland and
Commercial: temporary -commercial dryland.
Dominated by banana, mango and avocado crops and small-holdings.

- Some protection of riparian zone.
- Possibility of erosion (Sheet and donga).
- Disturbed areas prone to invasive vegetation.
- Limited water abstraction.
- Reduced numbers of bridges and roads.
- Few point source pollution returns.
- Low risk of pollution from agricultural chemicals (diffuse pollution).

Cultivated: permanent - commercial irrigated.
Dominated by large irrigated citrus and mango estates.

- Limited access provides substantial protection of riparian zone.
- Limited erosion due to grass cover within plantations.
- Where disturbed areas occur they are prone to invasive vegetation.
- Large volumes of water abstraction. Many pumps, weirs and off channel storage dams occur.
- Few point source pollution returns.
- High risk of pollution from agricultural chemicals (diffuse pollution).

- Risk of exotic fish species entering the system from off channel dams.
- Presence of dams and weirs influencing river channel and bed.
- Presence of dams and weirs increase risk of exotic macrophytes.

Cultivated: temporary - commercial irrigated.
Market gardens and small holdings.

- Limited protection of riparian zone.
- Where disturbed areas occur they are prone to invasive vegetation.
- Moderate volumes of water abstraction. Seasonal.
- Few point source pollution returns.
- Moderate risk of pollution from agricultural chemicals (diffuse pollution).

Cultivated: temporary - semi commercial / subsistence dryland.
Largely occurring in former homeland areas and on small holdings.

- Little protection of riparian zone.
- Frequently overgrazed with poor veld condition.
- Possibility of erosion (Sheet and donga).
- High risk of disturbed areas prone to invasive vegetation.
- Limited water abstraction.
- Reduced numbers of bridges and roads.
- Few point source pollution returns.
- Low risk of pollution from agricultural chemicals (diffuse pollution).

Degraded: thicket and bushland etc.
Largely occurring in former homeland areas and on small holdings.

- Little protection of riparian zone.
- Extensive removal of indigenous vegetation.
- Frequently overgrazed with poor veld condition.
- High risk of erosion (Sheet and donga).
- High risk of disturbed areas prone to invasive vegetation.
- Limited water abstraction.
- Many tracks leading to the river.
- Few point source pollution returns.
- Low risk of pollution from agricultural chemicals (diffuse pollution).
- Solid waste more prolific.

Thicket and bushland (etc)
Limited areas occur on undeveloped small holdings and game farms, largely reflecting the natural environment where there is limited canopy cover.

- High protection of riparian zone.
- Limited water abstraction.
- Few point source pollution returns.
- Low risk of pollution from agricultural chemicals (diffuse pollution).
- Moderate risk of erosion.

Forest plantations

Large areas occur in the upper Groot Letaba Catchment and additional areas in the upper Letsitele and Klein Letaba catchments. Forestry management practices are designed to minimize impacts within the riparian zone, but these practices have only been implemented in recent years and success is limited.

- Erosion from steep slopes, roads, bridges.
- Limited abstraction.
- Forestry as a stream flow reduction activity.
- Limited waste.
- Exotic vegetation encroachment.

Forest and woodland
Limited areas occur on undeveloped small holdings and game farms, largely reflecting the natural environment where there is high canopy cover from larger trees such as marula.

- High protection of riparian zone.
- Limited water abstraction.
- Few point source pollution returns.
- Low risk of pollution from agricultural chemicals. (diffuse pollution)
- Moderate risk of erosion.

Urban: built up commercial and Urban: built up residential.
Towns of Tzaneen, Nkowankowa and Letsitele.

- Limited erosion due to urban development.
- Many roads and bridges.
- Where disturbed areas occur they are prone to invasive vegetation.
- Domestic vegetation includes invasive plants types.
- Large volumes of water abstraction. Many pumps, dams and weirs.
- High incidence of point source pollution returns.
- Presence of dams, weirs, roads and bridges influencing river channel and bed.
- Presence of dams and weirs increase risk of exotic macrophytes.

4. RESULTS

4.1 DESCRIPTION OF EACH RESOURCE UNIT AND IMPACTS OBSERVED

GL1. No aerial footage

Above Ebenezer Dam the source waters of the Groot Letaba, including the Broederstroom River are considered as highly impacted streams. The streams pass through the Magoebaskloof forest area and past the village of Haenertsburg prior to entering the dam. There are also a limited number of banana and citrus plantations. Exotic vegetation has a serious impact and there are numerous small in and off channel storage and trout dams and forest bridges. Informal settlements are scattered throughout the area. Despite intensive management in the forest area, erosion from plantations and forest tracks remains a problem.

Although the instream habitat diversity is moderate, the 2001 biomonitoring survey indicated that this area is almost devoid of indigenous fish and has a poor invertebrate assemblage. Sedimentation has significantly reduced the benthic habitat for both fish and invertebrates. The streams are heavily infested by alien fish, predominantly bass and trout.

Water quality is considered good in this area, although Electrical Conductivity (EC) and turbidity reflect local impacts.

Note: The Politsi, Magoebaskloof and Ramadiepa Rivers have not been assessed independently, although impacts are very similar to that of the Broederstroom and upper Groot Letaba River. DWAF (1996) gave the MAR of this additional catchment above Tzaneen Dam to be 98 million cubic meters compared to the developed MAR of 79 million cubic meters.

GL2. No aerial footage

Between Ebenezer Dam and Letaba Drift, the Groot Letaba River cascades over bedrock and boulders with a number of waterfalls. There are many small tributaries joining the river from the adjacent mountain slopes. The river continues to pass through the forestry area, but there are areas of spectacular indigenous forest. Exotic vegetation is less noticeable than in GL1. There are also fewer bridges but there are a number of off channel storage dams in tributaries. The combined impact of Ebenezer Dam and the numerous smaller dams and forestry has a serious impact on the flow regime

Instream habitat is predominantly bedrock and typical flow dependent fish species occur in this unit. Specialist mayflies have been collected in cascades and waterfalls in surveys undertaken by Albany Museum in 2003. Alien fish species do occur in the quieter reaches of the river and are regularly stocked for angling purposes.

Water quality problems include the unseasonal release of cool water from Ebenezer Dam. Water quality is however considered to be good throughout most of the year.

GL3. Flown in 2003. (Includes IFR 1)

The Resource Unit between Letaba Drift and Tzaneen Dam (inflow) continues to cascade through the forestry area where it is fed by a myriad of small mountain streams. In the lower end of the unit, it also supports citrus, mango and tea estates. 6 weirs were identified, feeding canals to nearby fruit plantations. There are numerous bridges, riverside tracks, pump houses, sawmills, sawdust dumps, powerlines and even a limited amount of sand mining at the inflow to Tzaneen Dam, where large volumes of sediment have been deposited.

The riparian zone in this unit is narrow and dominated by trees associated with bedrock such as Mingerhout *Breonadia salicina*. Other large specimens of indigenous riparian trees occur but these do not form a large canopy structure as is evident in the alluvial sections. Common species here include *Acacia sieberiana Bridelia micrantha* and *Syzigium cordatum.* Alien plant invasion is evident all along this unit with dominant species including pines *Pinus* sp., Bluegums *Eucalyptus* sp. as well as Giant reed *Arunda donax*, *Lantana camara*, Bugweed *Solanum mauritianum* and seringa trees *Melia azederach*.

There is a considerable amount of vegetation debris in the river, stemming from both floods and activities of the Working for Water Campaign. Nevertheless, exotic vegetation is considered a serious impact which could readily be identified by the air survey team. Species

include Lantana, Eucalyptus, Giant Reed, Jacaranda, Mauritius Thorn, Acacia spp., Bugweed and others.

The weirs and canals frequently divert large volumes of flow from the river channel, leaving downstream sections with very little water. DWAF (1996) gave the MAR of the upper Groot L:etaba Catchment above Tzaneen Dam to be 62 million cubic meters compared to the developed MAR of 33 million cubic meters.

The aquatic habitat is very diverse and supports a large number of indigenous fish, although there are few recent records of migratory fish. The instream habitat supports a very healthy invertebrate population.

Fish PES 2004. 60% Class C.

Water quality problems are usually limited to elevated conductivity and turbidity, stemming form eroding slopes.

GL4. Flown in 2003

This unit extends from Tzaneen Dam, past Tzaneen Town, through Nkowankowa and on to the Junction of the Letsitele River. There are urban impacts, including solid waste and point source run off, sewage works, water treatment works, roads, tracks, pumps and bridges. Agricultural impacts include 16 weirs (in various states of repair) and numerous pumps and off channel storage dams.

The surrounding area is dominated by extensive citrus and banana plantations, which closely border the riparian zone. (Letaba Estates and others) The riparian zone is impacted along this unit but sections remain intact due to the protection afforded by private lands. Although present, exotic vegetation within the riparian zone is not as problematic as in both the upper and downstream units. Exotic species identified by the air survey team again included *Lantana camara*, Eucalyptus sp., Giant Reed *Arunda donax*, Jacaranda *Jacaranda mimosifolia*, Mauritius Thorn, Acacia sp., Bugweed *Solanum mauritianum*, Paraffin Bush, Bamboo, Sisal, and others.

The Letsitele River joins the Groot Letaba River at the downstream end of this reach. Due to the absence of any major tributaries upstream, the only water passing along this reach is direct runoff and that which passes Tzaneen Dam. When combined with the managed flow regime from Tzaneen Dam, the large number of weirs with associated water abstraction points, pose a major impact to the flow regime of the river and have significantly impacted on the instream habitat. There is however limited evidence of bank erosion in this unit.

Instream habitat is diverse, where it occurs away from dam and weir backwaters. The fish community is still considered to be in a moderately impacted class, while invertebrates are in a slightly better condition. There are no confirmed records of alien fish species in this unit, although bass are thought to occur in low numbers.

Limited flood debris was observed from the air.

The alien invasive aquatic macrophyte, water hyacinth *Eichornia crassipes* was present throughout this unit in 2003 but was almost absent in 2001. In pools and in dam backwaters the hyacinth created thick mats and in one instance the mat was estimated by the helicopter

observers as being in excess of 3 km in length. Both biological and chemical control of hyacinth was in progress in 2003.

Water quality in this unit is rated as moderate, due to the influence that Tzaneen Dam has on regulating water temperature.

The effect of fertilizers and pesticides increases along the rivers length. O'Keefe hypothesised that the Groot Letaba River has a low invertebrate diversity in comparison to other lowveld rivers, probably attributable to the effects of pesticides. Vlok and Engelbrecht (2000) recorded a general increase in pH, conductivity and turbidity as one moves down the catchment. Despite the effects of agricultural products, water quality is generally considered to be reasonable.

The proliferation of Hyacinth is most probably indicative of eutrophic conditions, which may arise from sewage outflows in this resource unit. The Hyacinth in turn may well be influencing the oxygen availability.

While undetermined, the impacts of water quality upon riparian vegetation are considered to be small along the rivers length.

GL5 Flown in 2003

This zone extends from the Letsitele River to the Nwanedzi River confluence and includes influences from Letsitele Town and the Letsitele and Thabina Rivers, which enter the Groot Letaba at Junction Weir. The area is a commercial agriculture citrus belt and impacts are largely agricultural. There are many pumps and off channel storage dams, some of which occur some distance from the main river, together with 4 instream weirs. Water abstraction is therefore considered a serious impact.

The riparian zone is in a variable condition and where it is relatively intact, this is again due the to protection afforded by private land owners. However, there are numerous tracks along the outer edge of the riparian zone, and at least 2 low level bridges across the river. Numerous pump houses were observed and citrus pack houses are built adjacent to the riparian zone. There is considerable evidence of bank erosion, particularly on bends in the river. Flood damage increases, probably due to the influences of both the Letsitele and numerous small tributaries. In places, the riparian vegetation has been completely denuded.

Exotic vegetation again becomes a serious problem in this zone, although there are few woody invaders. Dominant exotics include *Lantana camara*, Paraffin Bush, Castor oil, Cocklebur and Giant Reed *Arunda donax*. The Flame thorn *Acacia ataxacantha* is also considered a serious invader in this area.

The instream habitat also varies in condition as one moves down this unit. All habitat types are present, but there is considerable sedimentation in pools and weirs.

The fish population is moderately modified and is considered fragmented due to the number of weirs. There are however some recent records of at least 1 migratory fish occurring in this unit (*Anguilla mossambica*) and flow dependent species remain abundant, despite periods of very low flow. No alien fish have been recorded.

Water hyacinth *Eichornia crassipes* was observed from the air and dense mats were noted in pools and weirs and along river margins. The weed was also seen drifting in mats in faster flowing areas.

Biocides are frequently used in this area and are considered to pose an impact on the water quality and are suspected of impacting on aquatic invertebrate populations.

GL6 Flown in 2003. (Includes IFR 3)
This zone extends from the Nwanedzi confluence to Prieska Weir. The zone is again dominated by citrus plantations, but also includes the Merensky Reserve on the East Bank.

The Nwanedzi River is seasonal and also passes through commercial citrus country. The 1994 IFR study evaluated the possibility of a new dam at the confluence of the Nwanedzi and Groot Letaba rivers. The Nwanedzi River has a catchment area of 410 km^2 and a virgin MAR of 26 million cubic meters with a developed Mar of 15 million cubic meters. (DWAF 1996) Flow from the Nwanedzi River is therefore considered to be seriously modified.

5 Weirs (including Prieska) were observed from the video in this unit and there are a very large number of off channel storage dams. There is a treatment plant at Deeside and there is a sewage treatment plant at die Eiland. Maturation ponds at de Eiland were observed to be heavily infested with duckweed during 2004 and there have been periodic instances where these ponds spill into the Groot Letaba River, just upstream of Prieska Weir. (Angliss pers. com.) There is considerable bank erosion, particularly on the river bends and there is extensive siltation in pools and in weir backwaters.

Although the riparian zone is relatively intact, there are areas where the zone has been denuded of vegetation. Merensky Reserve provides an area of very good vegetation. Infestation with exotic plants is high, but largely limited to Castor oil, *Lantana camara* and Cocklebur but Flame thorns are also invading. Several agricultural pack houses have been built adjacent to the riparian zone. There are also a number of riverside tracks and at least 1 bridge.

Near Merensky Reserve, the river becomes a wide anastamosing channel with very diverse instream habitats. There remains a considerable amount of sediment in pools and weirs. Nevertheless, habitat is excellent and this is reflected by a reasonable fish population. No alien fish have been recorded in this unit. Fish PES 2004. 65% Class C.

There is a limited amount of Water hyacinth *Eichornia crassipes* in this unit, although not as much as was observed upstream.

Water quality continues to be impacted from agricultural biocides, although the situation probably begins to improve as one heads downstream from this unit. Commercial citrus estates become less extensive beyond Merensky Reserve. Point source pollution from die Eiland sewage works also occurs and this is considered a source of nutrient enrichment.

GL7 Flown in 2003
Extending from Prieska Weir to the Molototsi Confluence, this unit contains both citrus plantations and tribal areas with extensive agricultural lands. The area was formerly Gazankulu. The resource unit includes Nondweni Dam and road bridge.

Riparian vegetation decreases in status along this zone. Castor oil, Lantana and Cocklebur are the dominant exotic plants. There is some serious bank, sheet and donga erosion occurring in lower segments. Large numbers of cattle tracks lead to the river and in places rural agricultural plots extend into the river.

Except for Nondweni, there are no other weirs, but there are a number of pumps and off channel storage dams. Water abstraction at Nondweni is a significant impact. No environmental assessment was undertaken for Nondweni Dam.

The river continues to be anastamosing until Nondweni and there are areas of excellent instream habitat. However between the inflow to Nondweni Dam and the Molototsi River, the benthic substrates have been completely inundated with sediment.

There is only one fish monitoring point in this unit, occurring below Prieska Weir. Flow dependent species are abundant here, but in recent surveys there has been a decline in the frequency that migratory fish have been caught. Nondweni Dam may be acting as a significant barrier to all species. Fragmentation of the system is thought to have caused the loss of several migratory lowveldt species.

Water Hyacinth were observed in very low numbers by the helicopter team, but could not be discerned from the video.

Rural settlements are thought to contribute sewage effluent to the system thus increasing eutrophication. Solid waste occurs at washing sites in bedrock areas.

GL8 Flown in 2003

This zone extends from the Molototsi to the Slab Weir. This resource unit is dominated by 2 weirs and rural settlements. (the Slab Weir and one additional weir upstream) The riparian zone throughout these segments is mostly in a poor condition, with extensive erosion. Along sections of the river, riparian vegetation is largely absent and where it occurs the structure is poor. Along this entire stretch of river there is also a distinct lack of large indigenous riparian trees and/or riparian canopy structure. These segments are again tribal areas of the former Gazankulu. Agricultural lands extend into the riparian zone in places. The Molototsi River also feeds sediment into the river causing a reduction in substrate habitat. Large sand bars are common.

Water quality impacts are limited to rural settlement run off.

GL9 Flown in 2003. (Includes IFR 4)

Extending from the Slab Weir to the Klein Letaba confluence at the western Kruger National Park fence. The status of the system improves from the previous section, because the river passes through Letaba Ranch throughout this unit. Only one small gauging weir occurs in Letaba Ranch and water abstraction is limited to that used for domestic purposes by tourism camps in the reserve.

Flow regulation in the upper catchment is considered a serious threat to the lower river. Many periods of almost zero surface flow have been recorded over the last decade. DWAF (1996) gave the virgin MAR of this portion of the catchment to be 402 million cubic meters compared to the developed MAR of only 206 million cubic meters.

The very wide channel of the river shows extensive flood damage and many of the larger trees, which were present pre 2000 floods, were removed by the floods. Many of the flood terraces were also removed or scoured together with the riparian vegetation that colonized the terraces. Where terraces remain, the riparian forest structure has been severely impacted with only remnant populations of pre-flood species occurring. Establishing seedlings and coppices from some of the broken tree stumps left behind following the floods of 2000 suggest that the riparian zone is re-establishing and recovering in certain areas respectively. Many of the banks too have been scoured and there is erosion on river bends.

The post flood situation in Letaba Ranch and downstream into the KNP is thought to reflect a long term cycle and the situation may be considered a natural impact. Nevertheless, there are areas of good vegetation along the macro channel banks.

Exotic plants such as Castor oil and Cocklebur occur on disturbed sandy banks, but there are few woody invaders. Encroachment from Mopani has been observed and this could be a reflection of flow regulation. Tall and even stunted Mopane thickets are often associated with higher soil moisture areas such as along the upper banks of arid zone rivers where there is some bank storage. Many of the rivers and drainage lines within the Mopane veld therefore commonly have Mopane trees in the riparian zone – even dominating in places

The river resumes its anastamosing character and instream habitat is generally good. Sedimentation of pools and backwaters can be clearly seen from the air and large sand bars are common.

Downstream dams of the KNP are thought to obstruct the migration of lowveld fish species such as the Tigerfish and Purple Labeo. However eels do still manage to reach this section of the river. Truly flow dependent species are scarce and the community is dominated by semi rheophilic and pool dwelling species. Fish PES 2004. 62% Class .C

Recent SASS surveys indicate that invertebrate communities are in a good condition. This in turn reflects the improved water quality of this unit.

KNP1 (Aerial footage of 2003 extends to Black Heron Dam. The remainder of the segment is assessed by orthophotos) (Includes IFR 6 and 7)

This large resource unit extends along the Letaba River from the Klein Letaba confluence to Engelhardt Dam within the KNP. The unit includes Black Heron Dam, Mingerhout Dam and Engelhardt Dam basin. A small causeway exists just below the Klein Letaba confluence. Letaba Rest Camp and road crossings provide the only local anthropogenic impacts in the resource unit.

Upstream flow regulation is a very serious problem and the river stops flowing frequently. Very low flows were witnessed in the KNP by the study team at both IFR sites during 2003. The reduction in flow in the river is negatively influencing the aesthetic appeal of the river and this affects the tourist trade.

In this section of the river, again many of the flood terraces were removed or scoured during the 2000 floods. Where terraces remain, the riparian forest structure has been severely impacted with only remnant populations of pre-flood species occurring. Virtually no tall canopy forest occurs and large riparian trees and tree thickets are restricted to isolated pockets that were protected from the flood scour. Again, establishing seedlings and coppices

from some of the broken tree stumps left behind following the floods of 2000 suggest that the riparian zone is re-establishing and recovering in certain areas respectively. Flow modification in these lower reaches of the river is however is likely to influence the extent and rate of the recovery of the riparian zone. Exotic vegetation does occur but is not considered a serious problem at this time. Castor Oil, Cocklebur and *Sesbania punicea* occur in low volumes.

Sediment entering the park from both the Klein Letaba and the Groot Letaba is influencing the aquatic habitat. Below Mingerhout Dam, the river becomes a wide but single, sandy channel. In low flows there is a reduction in marginal habitat and this is negatively influencing the barb community. Abundance of fishes and fish health are impacted upon in critical low flows and this situation is being witnessed frequently. Nevertheless, the fish community is still considered to be largely natural with all expected species present. The existing dams have fish ladders, which are known to assist in the migration of some species.

KNP2 (Asessed by orthophotos)
Extending from Engelhardt Dam to the top of the gorge, this unit again becomes an anastamosing channel with bedrock influences. Marginal vegetation is more abundant. There is evidence of flood damage to the riparian zone throughout.

There are few local impacts and the biggest threat is that of flow regulation and the associated threats to fauna and flora.

KNP3 (Asessed by orthophotos)
Extending from the top of the rhyolite gorge to the Olifants River, this unit extends through a wilderness area of the park, which has outstanding aesthetic appeal. The unit is dominated by bedrock and has little marginal vegetation. The instream habitat is good, due to the gradient of the gorge and scouring. Sediment is accumulating below the gorge in the Olifants River.

The reduction in flow, due to upstream influences, continues to impact on the local fauna and on the aesthetic appeal of the area. Again there is evidence of flood damage to the riparian zone throughout and it is really only the extent that varies.

The crocodile population at the bottom of the gorge, is threatened by the frequent cessation of flows of both the Letaba and Olifants rivers.

LET1 No aerial footage
The upper catchment of the Letsitele River extending from the source in the Wolkberg mountain area of the Drakensberg, past state forests and waterfalls to Craighead Agricultural Estates. The area is largely natural. No data is available.

LET2 Flown in 2001. (Includes IFR 2)
The Letsitele River, extending from Craighead Agricultural Estates to the Groot Letaba River at Letsitele Town. The resource unit passes through commercial citrus, mango, avocado, paw paw and banana orchards, rural settlements and communal lands before reaching Letsitele town. 10 weirs of assorted sizes were observed and there are numerous pumps and off channel storage dams in the upper portion of the unit. Water abstraction is considered a large to serious impact for the whole of the Letsitele River Catchment (including the Thabina River). The catchment has an area of 410 km^2 and has a virgin MAR of 86 million cubic

meters compared to the developed MAR of only 60 million cubic meters DWAF (1996). Since 1996, the population in this area has grown considerably!

There are several road bridges and 1 rail bridge.

Riparian vegetation cover is very variable in condition and is considered to be in a moderate condition for the whole unit. Some areas are denuded of vegetation and have extensive erosion, while others have much better vegetation.

Exotic vegetation is present along the full length of the river and includes Lantana, Eucalyptus, Giant Reed, Jacaranda, Mauritius Thorn, Acacia spp., Bugweed, and Paraffin Bush. There is a sewage works below Mohlaba's location, sand mining near Khujwana and several fords across the river.

The instream habitat is moderate, with typical pool riffle sequences. However, pools and weir backwaters are heavily silted. Several species of flow dependent fish occur in this unit and the IFR specialist study places the fish community in a moderately modified condition. Fish PES 2004. 62% Class C.

Water quality impacts include solid waste disposal, salination and release of biocides, together with rural settlement run off.

THA1 No aerial footage
The upper Thabina River, from source to the Thabina Dam is a mountain stream extending from the Wolkberg region of the Drakensberg Mountains. It feeds into the Thabina Dam in the Provincial Thabina Nature Reserve. In the reserve there is critical infestation with Paraffin Bush and other alien plant invaders. No hydrological data is available.

THA2 Flown in 2001
Extending from Thabina Dam to a large wetland area in the foothills of the Drakensberg above Lenyenye.

The river is fed by a number of seasonal tributaries below the dam wall, but since the raising of the dam wall in 2001(?) there have been few managed releases from the dam itself. Only seepage flow and spilling flood waters, pass the dam wall. Water abstraction is considered a very serious impact at this time.

Below the dam, water is abstracted for domestic use. There are several small road bridge crossings but no further dams in this unit. Rural settlements occur along the river.

Immediately below the dam, there is a small protected area where the riparian vegetation is exceptional. However, below this, there has been extensive vegetation removal and there is massive erosion. (donga, sheet and bank) Agricultural plots extend right into the river channel. Cattle tracks to the water are common.

The aquatic habitat was good during the 2001 video with cobble beds and substantial marginal habitat occurring. The 2001 State of River Report placed the aquatic fauna in a fair condition and several flow dependant species were recorded here. In 2003, none of the 3 biomonitoring sites in the Thabina River could be monitored due to dry conditions. Very few

small pools persisted in the river and where they did occur they were being heavily utilized as laundry areas. (Angliss pers.com.)

Water quality impacts are likely to be related to elevated temperature and low oxygen levels due to flow regulation.

THA3 Flown in 2001
An extensive wetland area extending across the foothills of the river to the Lydenburg Road. In 2001, this area was perceived to be an extensive and very important wetland area which contributed towards the biodiversity of the catchment while performing all normal wetland functions. The wetland was dominated by reeds and bulrushes and contained numerous deep pools with water lilies. In 2003, the wetland was barely discernible from other cattle grazing areas. The drought period combined with flow regulation most probably contributed towards this decline.

The wetland has not been studied. Nevertheless, its importance as a wetland cannot be ignored.

THA4 Flown in 2001
Extending from the wetland to the Letsitele River, this unit contains 4 weirs and numerous pumps and road crossings. There are villages and agricultural plots immediately adjacent to the river. Eroded banks and dongas are contributing sediment to the river and pool habitats are clearly silted up. Many trees were noted lying in the river.

There are however some very good areas of riparian vegetation where very large trees persist. In the lower portion of the unit, it is not possible to discern the true nature of the bush from the air. It is unclear whether the riparian zone is truly riparian or is in fact non riparian bush. Further investigation is required.

Exotic vegetation could not be distinguished from the video, but is expected to reflect those species which proliferate in the upper catchment.

The instream habitat is diverse, with many cobble riffles, pools, undercut banks, roots and marginal vegetation. The fish community is expected to be similar to that of the lower Letsitele.

Water quality is expected to reflect impacts from rural communities and rural agricultural practices.

MOL1 No aerial footage
The upper catchment of the Molototsi River extending from its source, near Duiwelskloof to Modjadji Dam. The area is predominantly ex Gazankulu homeland and is comprised of rural settlements and agriculture.
No data is available. The placement of Modjadji Dam and water abstraction are thought to pose a serious impact on the functioning of the downstream Molototsi River.

The alien fish *Micropterus salmoides* is abundant in the Modjadji Dam.

MOL2 Flown in 2001

The Molototsi River, extending from Modjadji Dam to the Groot Letaba Confluence, passes through the former homeland of Gazankulu for approximately 85 km. This deeply incised river has areas of extensive erosion. While some rural agriculture exists along the river, the region is predominantly used for rural cattle farming. Below Dzumeri, the river passes through relatively undisturbed mopani bushveld. Cattle tracks to the river have contributed to serious donga erosion. Bank erosion is highly evident on the rivers bends. There is only one disused weir below Dzumeri and water abstraction by local people is through sand points dug manually into the sandy river channel. Several roads and bridges traverse the river.

During 2001, the Molototsi was dry for most of its length, with only a few pools occurring by bedrock outcrops. In 2003, the river was completely dry and could not be surveyed. (Angliss pers. com.) The catchment has an area of 957 km^2 and has a virgin MAR of 28 million cubic meters compared to the developed MAR of only 25 million cubic meters in 1996. (DWAF, 1996). This was prior to the construction of Modjadji Dam! No environmental assessment was undertaken for Modjadji Dam.

Riparian vegetation condition is highly variable. The impact of flow regulation by the Modjadji Dam on the riparian bush has not been studied. Limited Exotic vegetation has been recorded in this section of the river. Castor oil, Lantana, Bugweed and Cocklebur are the dominant exotics.

The seasonal nature of this sandy river does not lend itself to biomonitoring. Nevertheless, hardy pool dwelling species do persist in the larger permanent pools scattered along the river at bedrock intrusions. Several tributaries enter the Molototsi and at the junction to these rivers, there is often a deep pool which acts as a refuge for fish.

KL1 Flown in 2001

The Klein Letaba River between Na Chivane and the Middle Letaba River confluence again passes through the old homeland are of Gazankulu. This upper catchment has an area of approximately 1085 km^2. During the aerial survey of 2001, the river was flowing weakly.

The area is again dominated by cattle farming, although there are a number of settlements and low cost housing projects close to the river. There is extensive overgrazing and erosion. A small sewage treatment plant discharges into the river at Majosi. Many tracks occur along the river and 9 bridges and crossings were observed from the air. 2 areas of sand mining were also noted.

Extensive subsistence cultivation and vegetable gardening occurs right up to the edge of the macro-channel and within the remnants of the riparian zone throughout this unit. Most riparian shrub and smaller tree species have been removed while some large fruit bearing trees such as figs *Ficus syccamorus* and Jackal Berry *Diospyros mespilliformis* remain. There is also evidence of overgrazing on the terraces and on the macro-channel banks and livestock paths and erosion are common throughout. Alien vegetation is dominated by Castor oil, *Sesbania punicea*, Bugweed *Solanum mauritianum* and Cocklebur.

The instream habitat is limited to meandering sandy runs and gravel riffles and occasional pools near bedrock outcrops. Marginal vegetation occurs where the river flow approaches the banks and in this habitat a moderate fish and invertebrate community was recorded in the 2000 biomonitoring survey.

KL2 Flown in 2001. (Includes IFR 5)
This resource unit extends from the Middel Letaba Confluence past Giyani town and on to Nkomo Village. While still in an ex homeland area, this resource unit also encompasses a large area of commercial agriculture which is irrigated from the Middle Letaba Irrigation Scheme. The scheme grows banana's paw paw, avacado's and mango's while also providing for some market garden crops. Immediately below Giyani is an old sisal project and a dairy farm.

Sand mining is carried out extensively in this area. Gold mining is conducted a short distance from the river.

Only two disused weirs exist. Both were irreparably damaged in the 2000 floods. However, the impact that Middel Letaba Dam has on the catchment is thought to be severe. The dam does not cater for any releases of flow for the environment, although seepage flow may help maintain some permanent pools. See ML2.

Although some magnificent areas of bush still exist, the riparian cover is variable and is considered moderate to high for the resource unit. Well developed terraces with established riparian tree populations and good canopy and population structure occur along sections of the river throughout this unit. The unit also has a high diversity of indigenous riparian trees and large specimens of many of the riparian flow indicator species also occur throughout. Exotic vegetation is dominated by Castor Oil, Mauritius Thorn, *Sesbania punicea*, and Cocklebur. Flame thorn is also problematic.

The aquatic habitat is dominated by sandy runs, gravel riffles and occasional pools occurring near bedrock outcrops. In 2004, the specialist study team reported that the fish community was in a moderate condition, but that there were no fully flow dependent species present.
Fish PES 2004. 71% Class C.

Return flows from Giyani Sewage Works are considered a major water quality problem, but the only other real impacts are those stemming from agricultural biocides and from rural run off.

KL3 Flown in 2001
Extending from Nkomo to the Letaba River Confluence, this resource unit encompasses a large area of relatively unspoiled bushveld and approximately 25 km of the river borders the KNP. There are no major impacts and only a few tracks, fences, disused lands and cattle were observed on the video. Some 4 x 4 tracks were observed in the extensive sandy environment of the river. The impact of upstream abstraction has not been fully recognized. The Klein Letaba Catchment as a whole (including the Middel Letaba Catchment and Nsama Catchment) has an area of 5385 km^2 and has a virgin MAR of 129 million cubic meters compared to the developed MAR of 67 million cubic meters. (DWAF, 1996).

An important geothermal wetland borders the river at Baleni. This natural Heritage Site discharges into the Klein Letaba and is responsible for maintaining some surface water in this zone. The spring is situated on a geological intrusion, which causes a naturally high salt load in the water at this point. (Angliss 1999)

The riparian vegetation is in a very good condition and there are few exotic plants. The riparian vegetation has a well developed species and canopy structure throughout apart from along a few sections where the riparian zone narrows or the vegetation is naturally sparse as a result of flow or substrate influence. Only the occasional Castor oil and Cocklebur have been noted on flood damaged terraces.

Large permanent pools marginal vegetation and undercut banks provide for most lowveld pool dwelling fish species. The migration passage from the Letaba River is open.

ML1 No aerial footage

The Middel Letaba upstream of the Middel Letaba Dam is dominated by two distinct areas. Commercial agriculture, where tomato's are the target crop and rural homeland areas. The area has numerous instream and off channel storage dams occurring in all major tributaries to the Middel Letaba Dam.

Water quality is expected to be moderately impacted by agricultural products.

The Middel Letaba Catchment has an area of 1085 km^2 and the dam has a capacity of 184 million cubic meters. In 2000, it was reported that there was inadequate water in the Middel Letaba Catchment to meet the current demand.

Note: In May 2000 a reconnaissance study to augment water resources in this region was implemented by DWAF. It was recommended that a comprehensive reserve study be done before any augmentation scheme could be investigated further.

In 2000, the firm yield of the dam was calculated by Prof. Hughes as 13.4 million cubic meters/annum, taking cognisance of upper cachment developments and assuming a class D ecological reserve in the upper catchment. If the Dam itself was capable of releasing a Class D ecological Reserve, the yield would drop further to 10.4 million cubic meters/annum.

ML2 Flown in 2001

The short section of the Middel Letaba River between the dam wall and the Klein Letaba passes through an area of relatively undisturbed bush. A new gauging weir was erected in 2002. The dam does not have a facility to release water for environmetal flows and the dam has largely been responsible for isolating the Middel Letaba Catchment from The Klein Letaba Catchment. However, in 2000 the dam spilled for the very first time since its construction in 1984. It spilled again in 2001. The 2000 floods peaked at just over 2000 cubic meters per second and scoured a distance of approximately 1 km below the dam wall. The abnormally high flood was exaggerated by the failure of a number of dams in the upper catchment tomato growing area. (5 dams collapsed) The water purification works below the dam wall periodically discharges flow into the river, but there is also some seepage from the dam wall. Consequently there are always deep pools and some small volume of surface flow along this reach.

Riparian vegetation in this area is good below the scour zone and there are few aliens.

The deep pools below the dam wall hold a significant population of fish species. At least 2 species occur in these pools which are thought to be absent in the dam itself. (*Synodontis zambezensis* and *Schilbe intermedius*) At least two alien fish species occur in the dam and in the pools below the dam wall. (*Cyprinus carpio* and *Micropterus salmoides*)

Water quality could be an issue, because the treatment works has been known to spill purified water into the river! (Angliss pers. com.) The impact of this is unknown.

NS1 No aerial footage

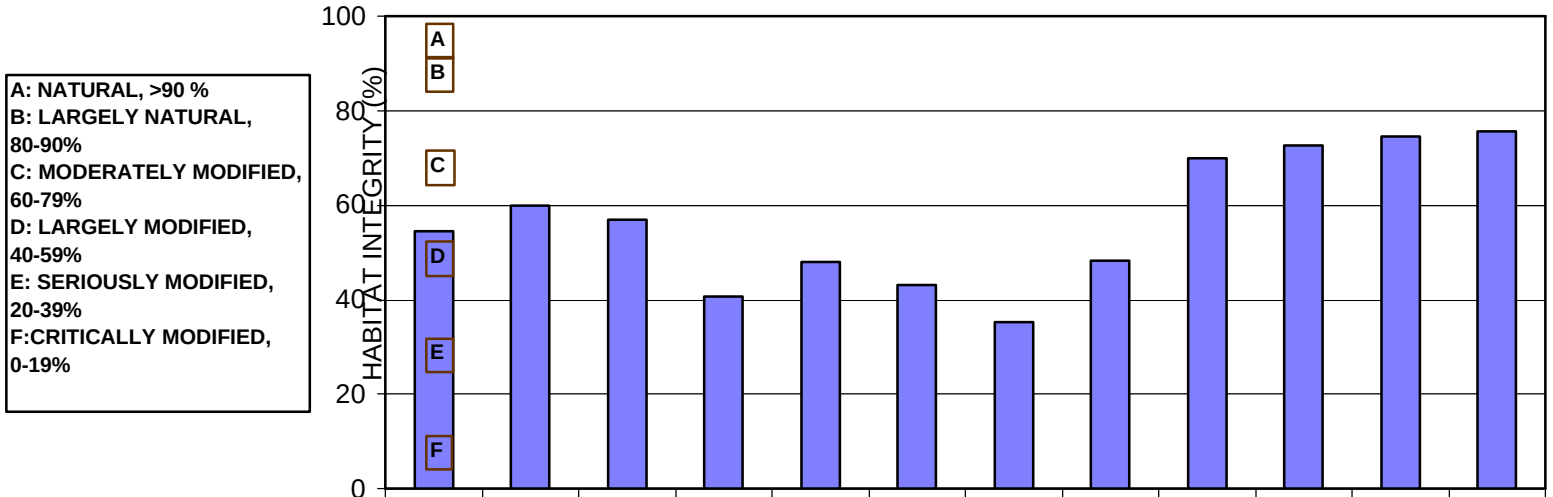
The Nsama River extends across the Lowveld just north of Giyani and meets the Klein Letaba just upstream of the KNP fence line. The river is distinctly seasonal but holds a sizeable dam The Nsami Dam. This dam is linked to the Middel Letaba Irrigation Scheme and Giyani Water Works by the 76km long irrigation canal extending from the Middel Letaba Dam and is in fact regulated as a balancing dam for this system. The Nsami Dam once again has no release capabilities and spills infrequently. This function makes this dam a valuable addition to the water distribution network, but it is important that the water transfer be recognized.

The Nsama River passes through ex Gazankulu areas which are largely used for subsistence farming. Some irrigated bananas occur downstream from Nsami Dam. The riparian vegetation is predominantly in a good condition and the infestation by exotic plants is low.

The lower river supports a large number of deep permanent pools and it is thought that these may act as an important refuge for fish to re colonize the lower Klein Letaba River. The alien fish *Cyprinus carpio* has been recorded well below the Nsami Dam.

4.2 GRAPHICAL PRESENTATION OF RESULTS

FIG A1: INSTREAM HABITAT INTEGRITY OF THE GROOT LETABA AND LETABA RIVER.

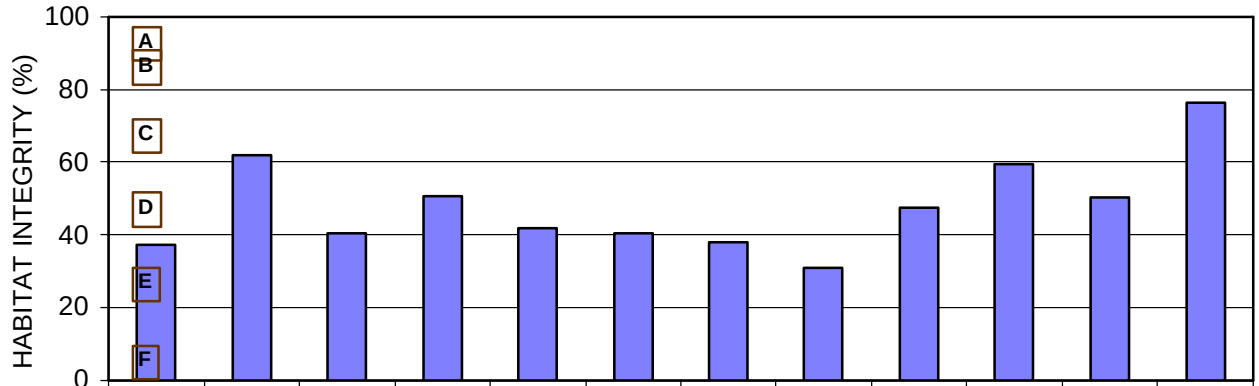


	GL1	GL2	GL3	GL4	GL5	GL6	GL7	GL8	GL9	KNP1	KNP2	KNP3
INSTREAM HABITAT INTEGRITY (%)	55	60	57	41	48	43	35	48	70	73	75	76
WATER ABSTRACTION (IMPACT 1 - 25)	10	8	10	15	15	16	18	12	5	3	0	0
FLOW MODIFICATION ((IMPACT 1 - 25)	12	19	15	18	15	15	16	15	17	17	18	18
BED MODIFICATION (IMPACT 1 - 25)	15	6	12	15	15	13	16	15	5	5	5	5
CHANNEL MODIFICATION (IMPACT 1 - 25)	8	6	7	4	4	4	8	5	5	5	5	5
WATER QUALITY (IMPACT 1 - 25)	8	10	10	10	10	12	12	12	10	8	6	4
INUNDATION (IMPACT 1 - 25)	8	10	12	15	14	15	15	15	1	0	0	0
EXOTIC MACROPHYTES (IMPACT 1 - 25)	0	0	0	20	13	10	3	1	1	0	0	0
EXOTIC FAUNA (IMPACT 1 - 25)	25	10	3	3	0	0	0	0	0	0	0	0
RUBBISH DUMPING (IMPACT 1 - 25)	5	3	5	5	3	2	5	3	0	0	0	0

SECTOR NO (---> FLOW DIRECTION)

FIG :A2 RIPARIAN ZONE HABITAT INTEGRITY OF THE GROOT LETABA AND LETABA RIVER.

A: NATURAL, >90 %
B: LARGELY NATURAL, 80-90%
C: MODERATELY MODIFIED, 60-79%
D: LARGELY MODIFIED, 40-59%
E: SERIOUSLY MODIFIED, 20-39%
F:CRITICALLY MODIFIED, 0-19%

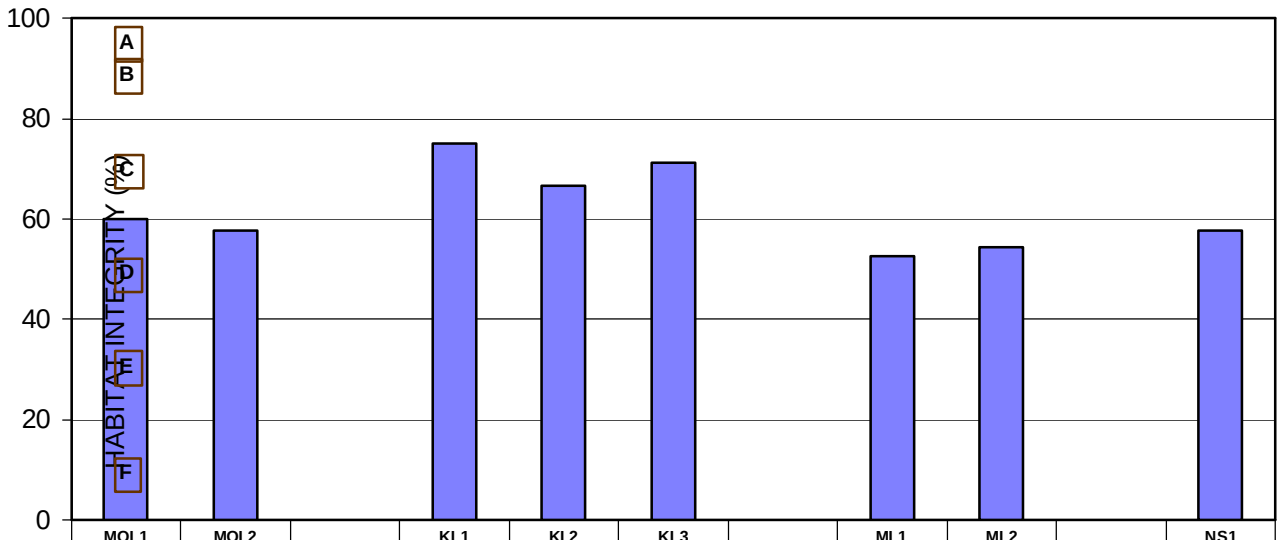


	GL1	GL2	GL3	GL4	GL5	GL6	GL7	GL8	GL9	KNP1	KNP2	KNP3
RIPARIAN ZONE HABITAT INTEGRITY	37	62	40	51	42	40	38	31	48	59	50	76
VEGETATION REMOVAL (IMPACT 1 - 25)	12	8	8	7	10	13	15	16	12	3	3	3
EXOTIC VEGETATION (IMPACT 1 - 25)	18	15	22	10	15	10	15	13	6	3	3	3
BANK EROSION (IMPACT 1 - 25)	13	5	5	7	12	10	15	15	12	12	8	2
CHANNEL MODIFICATION (IMPACT 1 - 25)	8	5	8	6	5	10	5	5	5	3	12	0
WATER ABSTRACTION (IMPACT 1 - 25)	5	5	8	5	5	8	5	5	5	5	5	5
INUNDATION (IMPACT 1 - 25)	10	5	13	10	5	12	10	5	5	5	12	5
FLOW MODIFICATION (IMPACT 1 - 25)	6	10	10	15	10	12	10	12	12	13	13	11
WATER QUALITY (IMPACT 1 - 25)	6	8	8	12	12	10	5	3	3	3	3	3

SECTOR (-> FLOW DIRECTION)

FIG : A3, INSTREAM HABITAT INTEGRITY FOR THE MOLOTOTSI, KLEIN LETABA, MIDDEL LETABA AND NSAMA RIVERS

A: NATURAL, >90 %
B: LARGELY NATURAL, 80-90%
C: MODERATELY MODIFIED, 60-79%
D: LARGELY MODIFIED, 40-59%
E: SERIOUSLY MODIFIED, 20-39%
F:CRITICALLY MODIFIED, 0-19%

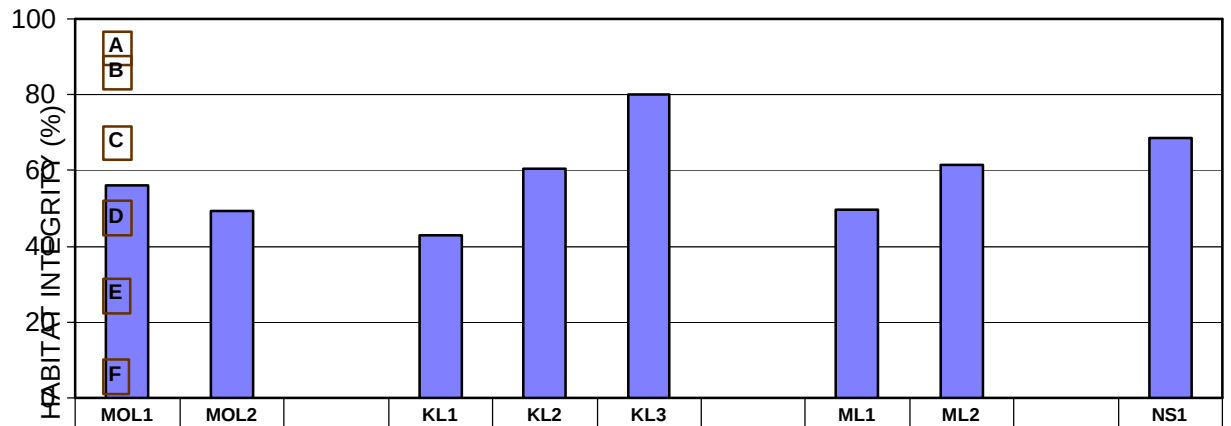


	MOL1	MOL2		KL1	KL2	KL3		ML1	ML2		NS1
INSTREAM HABITAT INTEGRITY (%)	60	58		75	67	71		53	55		58
WATER ABSTRACTION (IMPACT 1 - 25)	14	12		5	5	5		15	15		15
FLOW MODIFICATION ((IMPACT 1 - 25)	15	18		5	18	18		15	20		15
BED MODIFICATION (IMPACT 1 - 25)	10	12		12	5	5		5	8		8
CHANNEL MODIFICATION (IMPACT 1 - 25)	5	5		5	5	5		5	5		8
WATER QUALITY (IMPACT 1 - 25)	4	5		8	10	5		8	8		5
INUNDATION (IMPACT 1 - 25)	10	3		5	5	3		18	5		12
EXOTIC MACROPHYTES (IMPACT 1 - 25)	0	0		0	0	0		0	0		0
EXOTIC FAUNA (IMPACT 1 - 25)	10	0		0	0	0		8	12		5
RUBBISH DUMPING (IMPACT 1 - 25)	5	3		5	8	1		7	3		3

SECTOR NO (---> FLOW DIRECTION)

FIG :A4, RIPARIAN ZONE HABITAT INTEGRITY FOR THE MOLOTOTSI, KLEIN LETABA, MIDDEL LETABA AND NSAMA RIVERS

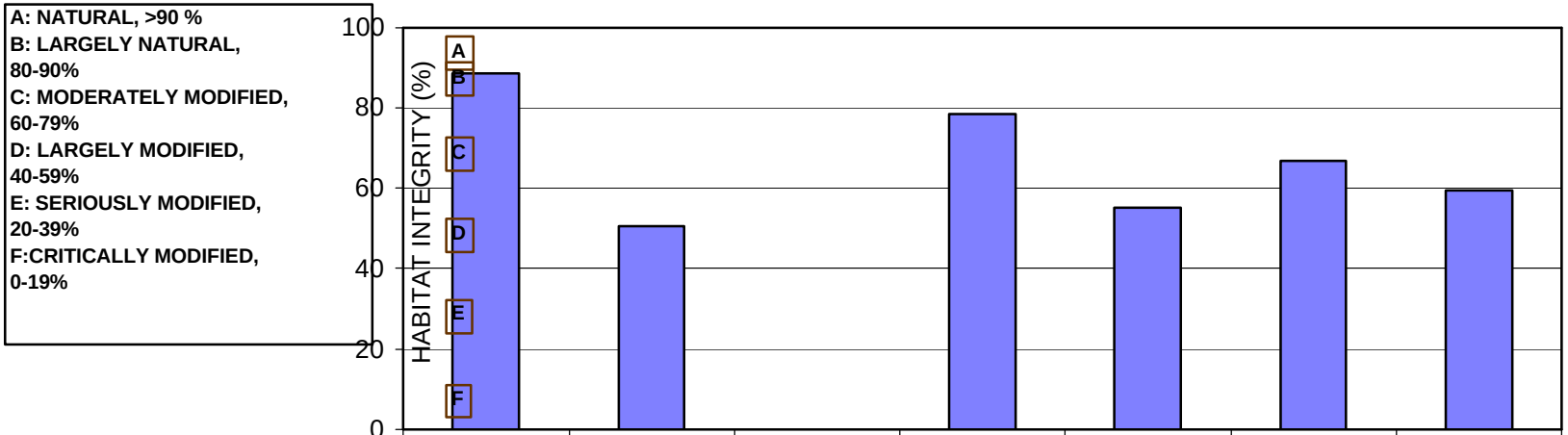
A: NATURAL, >90 %
B: LARGELY NATURAL, 80-90%
C: MODERATELY MODIFIED, 60-79%
D: LARGELY MODIFIED, 40-59%
E: SERIOUSLY MODIFIED, 20-39%
F:CRITICALLY MODIFIED, 0-19%



	MOL1	MOL2		KL1	KL2	KL3		ML1	ML2		NS1
RIPARIAN ZONE HABITAT INTEGRITY	56	49		43	61	80		50	61		69
VEGETATION REMOVAL (IMPACT 1 - 25)	15	12		18	10	5		15	5		10
EXOTIC VEGETATION (IMPACT 1 - 25)	12	10		8	10	5		8	8		8
BANK EROSION (IMPACT 1 - 25)	5	15		16	12	10		10	10		10
CHANNEL MODIFICATION (IMPACT 1 - 25)	5	8		4	8	3		10	10		10
WATER ABSTRACTION (IMPACT 1 - 25)	5	5		4	4	2		8	4		5
INUNDATION (IMPACT 1 - 25)	5	5		3	3	2		5	5		10
FLOW MODIFICATION (IMPACT 1 - 25)	5	10		5	10	10		12	15		5
WATER QUALITY (IMPACT 1 - 25)	5	5		5	5	2		5	5		5

SECTOR (-> FLOW DIRECTION)

FIG : A5, INSTREAM HABITAT INTEGRITY FOR THE LETSITELE AND THABINA RIVERS

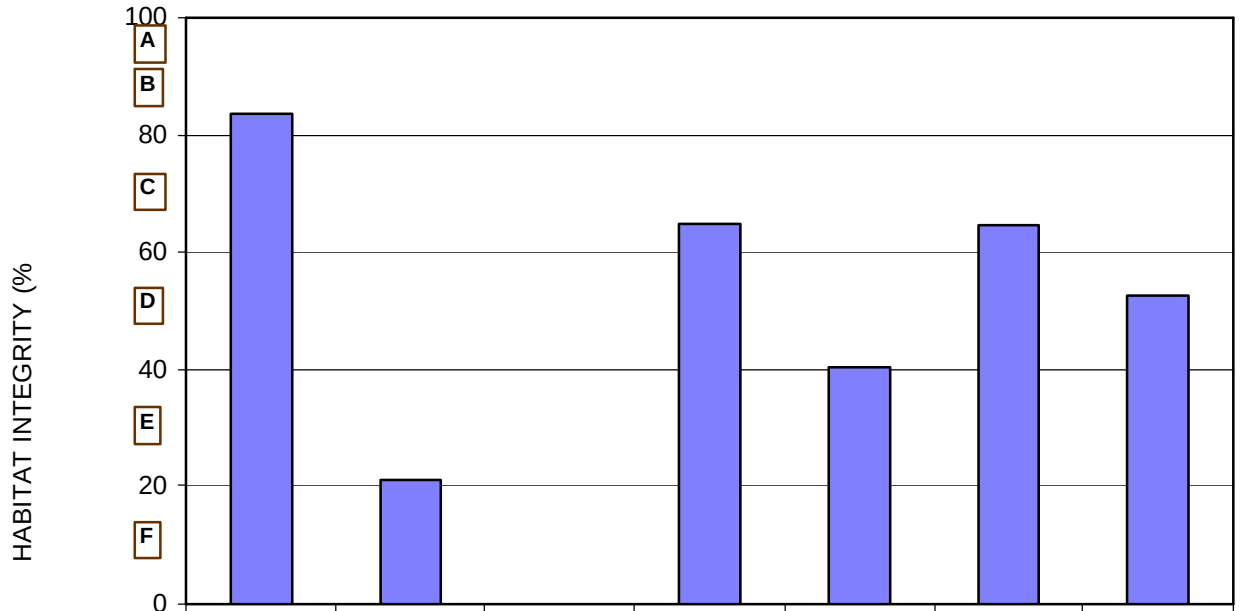


	LET 1	LET2		THA1	THA2	THA3	THA4
INSTREAM HABITAT INTEGRITY (%)	89	50		78	55	67	59
WATER ABSTRACTION (IMPACT 1 - 25)	3	15		3	20	15	12
FLOW MODIFICATION ((IMPACT 1 - 25)	5	15		7	20	15	15
BED MODIFICATION (IMPACT 1 - 25)	5	10		7	5	5	12
CHANNEL MODIFICATION (IMPACT 1 - 25)	5	8		5	5	5	5
WATER QUALITY (IMPACT 1 - 25)	0	12		3	5	5	5
INUNDATION (IMPACT 1 - 25)	5	12		15	5	3	8
EXOTIC MACROPHYTES (IMPACT 1 - 25)	0	0		0	0	0	0
EXOTIC FAUNA (IMPACT 1 - 25)	0	3		0	0	0	0
RUBBISH DUMPING (IMPACT 1 - 25)	0	5		0	5	5	10

SECTOR NO (---> FLOW DIRECTION)

FIG :A6, RIPARIAN ZONE HABITAT INTEGRITY FOR THE LETSITELE AND THABINA RIVERS.

A: NATURAL, >90 %
B: LARGELY NATURAL, 80-90%
C: MODERATELY MODIFIED, 60-79%
D: LARGELY MODIFIED, 40-59%
E: SERIOUSLY MODIFIED, 20-39%
F:CRITICALLY MODIFIED, 0-19%



	LET 1	LET2		THA1	THA2	THA3	THA4
RIPARIAN ZONE HABITAT INTEGRITY	84	21		65	40	65	53
VEGETATION REMOVAL (IMPACT 1 - 25)	5	15		5	15	5	10
EXOTIC VEGETATION (IMPACT 1 - 25)	10	15		20	12	10	11
BANK EROSION (IMPACT 1 - 25)	3	15		3	15	5	14
CHANNEL MODIFICATION (IMPACT 1 - 25)	3	5		3	5	5	5
WATER ABSTRACTION (IMPACT 1 - 25)	3	5		3	10	5	10
INUNDATION (IMPACT 1 - 25)	3	10		3	3	5	8
FLOW MODIFICATION (IMPACT 1 - 25)	3	15		3	10	15	3
WATER QUALITY (IMPACT 1 - 25)	3	15		3	5	5	3

SECTOR (-> FLOW DIRECTION)

5. REFERENCES

Angliss, M. K. 1999. Application to declare "Soutini – Baleni (Northern Province) as a Natural Heritage Site. Site 306: April 1999. Report to the South African Natural Heritage Programme.

Angliss, M. K. 2002. A revised assessment of the habitat integrity of the Groot Letaba River from Tzaneen Dam to the Kruger National Park boundary, based upon an aerial survey undertaken in January 2001. Internal Report, Limpopo Environmental Affairs.

Fouche, P.S.O. Letaba Catchment Reserve Determination Study. Inception Report. Fish. June 2003.

Fouche, P.S.O 2003. Letaba Comprehensive Reserve Study. Report on the assessment of fish populations in the Letaba River Catchment.

Gordon, N. D., T. A. Mcmahon and B. L. Finlayson, 1992. *Stream hydrology: An introduction for ecologists.* John Wiley and Sons, Chichester, New York, Brisbane, Toronto, Singapore, 529pp.

Hilden, M. and D. Rapport, 1993. Four centuries of cumulative impacts on a Finnish river and its estuary: an ecosystem health approach. J. Aquat. Ecosyst. Health 2: 261-275.

Kleynhans, C. J. 1996. A qualitative procedure for the assessment of the habitat integrity status of the Luvuvhun River (Limpopo system, South Africa) *Journal of Aquatic Ecosystem Health 5:41-54 1996.* Institute for Water Quality Studies. Department of Water Affairs and Forestry, Private Bag X313, Pretoria 0001, South Africa.

Engelbrecht, J. S. and C. J. Kleynhans, 1994. An assessment of the conservation status of the Groot Letaba River and selected tributaries. Transvaal Chief Direcorate of Nature Conservation. In the Letaba River Water Resource Development Study; Instream Flow Requirement Work Session. *Die Eiland* 6 - 9 June 1994.

Letaba River IFR. Letaba River Refinement Work Session. 30 – 31 October 1996. Department of Water Affairs and Forestry.

Letaba River Water Resources Development Study. Instream Flow Requirements Work Session. Die Eiland. 6 – 9 June 1994. Department of Water Affairs and Forestry.

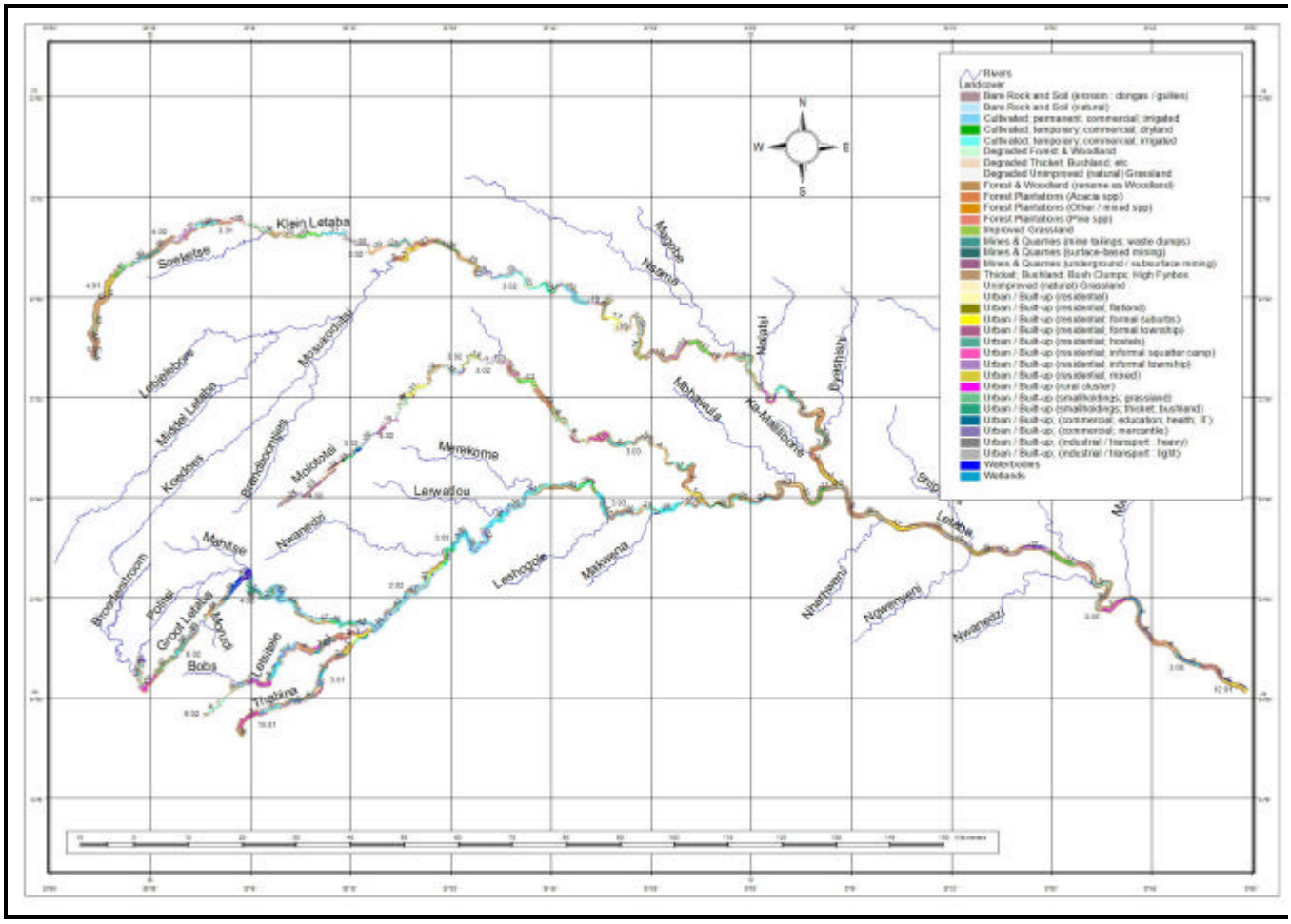
State of Rivers Report (2001) Letaba and Luvuvhu river systems. WRC report no: TT 165/01. Water Research Commission, Pretoria. ISBN No. 186845 825 3

Vlok, W. and J. S. Engelbrecht, 2000. Some aspects of the ecology of the Groot Letaba River in the Northern Province, South Africa.

6. ACKNOWLEDGEMENTS

Mick Angliss. Limpopo Environmental Affairs. For permitting some plagiarism of his 2002 report and for his local expertise.
Dr. A. R. Deacon. Kruger National Park. For his expert knowledge of the Kruger National Park.
P.J.Fouche Limpopo Environmental Affairs. For assistance with GIS files.

APPENDIX AA
Land cover areas for each level 2 Ecoregion



	Letaba	
LEVEL	DESCRIPTION	HA
3.01	Cultivated; permanent; commercial; irrigated	892.842
3.01	Cultivated; temporary; commercial; irrigated	228.591
3.01	Cultivated; temporary; subsistence; irrigated	188.716
3.01	Forest Plantations (Eucalyptus spp)	0.579
3.01	Improved Grassland	23.819
3.01	Thicket; Bushland; Bush Clumps; High Fynbos	972.504
3.01	Urban / Built-up (residential)	26.547
3.01	Urban / Built-up (residential; formal township)	17.856
3.01	Urban / Built-up (residential; informal township)	11.415
3.01	Urban / Built-up (smallholdings; woodland)	6.7
3.01	Urban / Built-up; (industrial / transport : heavy)	4.384
3.01	Waterbodies	52.933
3.01	Wetlands	36.491
3.01 Total		**2463.377**
3.02	Cultivated; permanent; commercial; irrigated	380.407
3.02	Cultivated; temporary; commercial; irrigated	23.162
3.02	Thicket; Bushland; Bush Clumps; High Fynbos	145.137
3.02	Urban / Built-up (residential)	4.223
3.02	Urban / Built-up (smallholdings; woodland)	0.66
3.02	Waterbodies	7.614
3.02	Wetlands	56.566
3.02 Total		**617.769**
3.03	Bare Rock and Soil (natural)	375.038
3.03	Cultivated; permanent; commercial; irrigated	1,414.76
3.03	Cultivated; temporary; commercial; irrigated	2,401.18
3.03	Cultivated; temporary; subsistence; dryland	895.251
3.03	Cultivated; temporary; subsistence; irrigated	16.215
3.03	Degraded Forest & Woodland	340.003
3.03	Degraded Thicket; Bushland; etc	326.397
3.03	Forest & Woodland (rename as Woodland)	4,776.43
3.03	Thicket; Bushland; Bush Clumps; High Fynbos	2,659.38
3.03	Urban / Built-up (residential)	2.978
3.03	Urban / Built-up (residential; formal township)	78.212
3.03	Waterbodies	1,424.09
3.03	Wetlands	15.733
3.03 Total		**14725.676**
3.05	Bare Rock and Soil (erosion : sheet)	2.402
3.05	Bare Rock and Soil (natural)	547.636
3.05	Forest & Woodland (rename as Woodland)	1,687.57
3.05	Thicket; Bushland; Bush Clumps; High Fynbos	1,176.94
3.05	Waterbodies	730.299
3.05 Total		**4144.843**
3.06	Bare Rock and Soil (natural)	86.549
3.06	Forest & Woodland (rename as Woodland)	351.501

	Letaba	
3.06	Thicket; Bushland; Bush Clumps; High Fynbos	80.14
3.06	Waterbodies	**196.233**
3.06 Total		714.423
4.02	Cultivated; permanent; commercial; irrigated	910.773
4.02	Cultivated; temporary; commercial; irrigated	780.546
4.02	Degraded Thicket; Bushland; etc	2.068
4.02	Forest Plantations (Eucalyptus spp)	362.307
4.02	Forest Plantations (clearfelled)	28.778
4.02	Mines & Quarries (mine tailings; waste dumps)	6.292
4.02	Thicket; Bushland; Bush Clumps; High Fynbos	581.067
4.02	Urban / Built-up (residential)	5.789
4.02	Urban / Built-up (residential; formal township)	22.348
4.02	Urban / Built-up (residential; mixed)	18.621
4.02	Urban / Built-up (smallholdings; woodland)	23.986
4.02	Urban / Built-up; (commercial; mercantile)	38.794
4.02	Urban / Built-up; (industrial / transport : light)	60.145
4.02	Waterbodies	583.516
4.02 Total		**3425.03**
9.02	Cultivated; permanent; commercial; irrigated	91.115
9.02	Cultivated; temporary; commercial; irrigated	36.74
9.02	Forest (indigenous)	49.981
9.02	Forest Plantations (Eucalyptus spp)	344.407
9.02	Forest Plantations (Pine spp)	163.56
9.02	Forest Plantations (clearfelled)	26.525
9.02	Thicket; Bushland; Bush Clumps; High Fynbos	1,259.51
9.02	Unimproved (natural) Grassland	14.715
9.02	Urban / Built-up (smallholdings; woodland)	3.888
9.02	Urban / Built-up; (industrial / transport : light)	10.497
9.02	Waterbodies	46.375
9.02 Total		**2047.31**
10.01	Thicket; Bushland; Bush Clumps; High Fynbos	0.003
10.01 Total		**0.003**
12.01	Bare Rock and Soil (natural)	77.612
12.01	Forest & Woodland (rename as Woodland)	497.213
12.01	Thicket; Bushland; Bush Clumps; High Fynbos	90.211
12.01	Waterbodies	207.742
12.01 Total		**872.778**
Grand Total		**29011.209**

	Letsitele	
LEVEL	DESCRIPTION	HA
3.01	Cultivated; permanent; commercial; irrigated	442.545
3.01	Cultivated; temporary; commercial; irrigated	99.256
3.01	Cultivated; temporary; subsistence; dryland	50.113
3.01	Cultivated; temporary; subsistence; irrigated	60.132
3.01	Degraded Thicket; Bushland; etc	214.3
3.01	Forest (indigenous)	2.883
3.01	Forest Plantations (Eucalyptus spp)	5.452
3.01	Thicket; Bushland; Bush Clumps; High Fynbos	1,815.64
3.01	Urban / Built-up (residential; formal township)	189.822
3.01	Urban / Built-up (residential; informal township)	208.883
3.01	Urban / Built-up (rural cluster)	62.101
3.01	Urban / Built-up (smallholdings; woodland)	2.396
3.01	Waterbodies	25.28
3.01	Wetlands	118.147
3.01 Total		**3296.952**
9.02	Forest (indigenous)	116.525
9.02	Forest Plantations (Eucalyptus spp)	3.565
9.02	Thicket; Bushland; Bush Clumps; High Fynbos	61.267
9.02 Total		**181.357**
10.01	Cultivated; permanent; commercial; irrigated	52.096
10.01	Cultivated; temporary; commercial; irrigated	8.858
10.01	Forest (indigenous)	195.098
10.01	Forest Plantations (Eucalyptus spp)	44.454
10.01	Forest Plantations (clearfelled)	286.707
10.01	Thicket; Bushland; Bush Clumps; High Fynbos	138.943
10.01	Unimproved (natural) Grassland	14.213
10.01	Urban / Built-up (smallholdings; woodland)	1.075
10.01 Total		**741.444**
Grand Total		**4219.753**

	Thabina	
LEVEL	DESCRIPTION	HA
3.01	Cultivated; temporary; commercial; irrigated	52.344
3.01	Cultivated; temporary; subsistence; dryland	111.943
3.01	Cultivated; temporary; subsistence; irrigated	239.857
3.01	Degraded Thicket; Bushland; etc	211.819
3.01	Thicket; Bushland; Bush Clumps; High Fynbos	962.772
3.01	Urban / Built-up (residential; formal suburbs)	3.634
3.01	Urban / Built-up (residential; formal township)	125.524
3.01	Urban / Built-up (residential; informal squatter camp)	21.007
3.01	Urban / Built-up (residential; informal township)	85.198
3.01	Urban / Built-up (rural cluster)	3.387

	Thabina	
3.01	Wetlands	497.131
3.01 Total		**2314.616**
9.02	Forest (indigenous)	7.676
9.02	Thicket; Bushland; Bush Clumps; High Fynbos	145.214
9.02 Total		**152.89**
10.01	Degraded Thicket; Bushland; etc	249.671
10.01	Forest (indigenous)	16.359
10.01	Thicket; Bushland; Bush Clumps; High Fynbos	545.337
10.01	Unimproved (natural) Grassland	1.487
10.01	Urban / Built-up (residential; informal township)	35.45
10.01	Urban / Built-up (rural cluster)	15.528
10.01	Waterbodies	28.742
10.01 Total		**892.574**
Grand Total		**3360.08**

	Klein Letaba	
LEVEL	DESCRIPTION	HA
3.01	Bare Rock and Soil (natural)	164.757
3.01	Cultivated; temporary; subsistence; dryland	522.467
3.01	Degraded Thicket; Bushland; etc	201.889
3.01	Forest Plantations (Eucalyptus spp)	30.501
3.01	Thicket; Bushland; Bush Clumps; High Fynbos	501.577
3.01	Urban / Built-up (residential; formal township)	132.25
3.01	Waterbodies	16.301
3.01 Total		**1569.742**
3.02	Bare Rock and Soil (natural)	861.822
3.02	Cultivated; permanent; commercial; irrigated	209.684
3.02	Cultivated; temporary; commercial; irrigated	670.829
3.02	Cultivated; temporary; subsistence; dryland	2,319.51
3.02	Degraded Forest & Woodland	141.611
3.02	Degraded Thicket; Bushland; etc	1,127.37
3.02	Forest & Woodland (rename as Woodland)	285.941
3.02	Forest Plantations (Eucalyptus spp)	1.245
3.02	Thicket; Bushland; Bush Clumps; High Fynbos	1,217.58
3.02	Urban / Built-up (residential)	38.789
3.02	Urban / Built-up (residential; formal township)	164.813
3.02	Waterbodies	244.921
3.02 Total		**7284.122**
3.03	Bare Rock and Soil (natural)	1,074.69
3.03	Cultivated; temporary; subsistence; dryland	1,475.00
3.03	Degraded Forest & Woodland	1,398.18
3.03	Degraded Thicket; Bushland; etc	78.502

	Klein Letaba	
3.03	Forest & Woodland (rename as Woodland)	3,174.07
3.03	Thicket; Bushland; Bush Clumps; High Fynbos	1,545.57
3.03	Urban / Built-up (residential; formal township)	18.683
3.03	Urban / Built-up (rural cluster)	0.996
3.03	Waterbodies	264.353
3.03 Total		**9030.042**
4.01	Cultivated; temporary; subsistence; dryland	328.366
4.01	Degraded Thicket; Bushland; etc	12.624
4.01	Forest & Woodland (rename as Woodland)	39.549
4.01	Thicket; Bushland; Bush Clumps; High Fynbos	1,312.69
4.01	Urban / Built-up (residential; informal township)	89.125
4.01	Waterbodies	5.317
4.01 Total		**1787.673**
4.02	Bare Rock and Soil (natural)	24.957
4.02	Cultivated; temporary; subsistence; dryland	248.99
4.02	Degraded Thicket; Bushland; etc	10.643
4.02	Forest & Woodland (rename as Woodland)	145.842
4.02	Forest Plantations (Eucalyptus spp)	43.871
4.02	Forest Plantations (Pine spp)	0.25
4.02	Thicket; Bushland; Bush Clumps; High Fynbos	679.282
4.02	Urban / Built-up (residential; formal township)	1.993
4.02	Urban / Built-up (residential; informal township)	32.087
4.02	Waterbodies	6.067
4.02 Total		**1193.982**
5.01	Cultivated; temporary; commercial; dryland	0.249
5.01	Degraded Thicket; Bushland; etc	13.774
5.01	Forest & Woodland (rename as Woodland)	1.661
5.01	Thicket; Bushland; Bush Clumps; High Fynbos	823.178
5.01 Total		**838.862**
Grand Total		**21704.423**

	Middel Letaba	
LEVEL	DESCRIPTION	HA
3.02	Bare Rock and Soil (natural)	18.359
3.02	Cultivated; temporary; subsistence; dryland	7.972
3.02	Degraded Thicket; Bushland; etc	260.289
3.02	Forest & Woodland (rename as Woodland)	132.174
3.02	Thicket; Bushland; Bush Clumps; High Fynbos	213.18
3.02	Waterbodies	24.427
3.02 Total		**656.401**
Grand Total		**656.401**

	Molototsi	
LEVEL	DESCRIPTION	HA
3.02	Bare Rock and Soil (natural)	67.28
3.02	Cultivated; permanent; commercial; dryland	14.511
3.02	Cultivated; temporary; commercial; dryland	14.356
3.02	Cultivated; temporary; subsistence; dryland	2,193.08
3.02	Degraded Forest & Woodland	750.417
3.02	Degraded Thicket; Bushland; etc	236.015
3.02	Forest & Woodland (rename as Woodland)	786.397
3.02	Thicket; Bushland; Bush Clumps; High Fynbos	494.676
3.02	Urban / Built-up (residential; formal township)	218.581
3.02	Waterbodies	64.733
3.02 Total		**4840.043**
3.03	Bare Rock and Soil (natural)	457.355
3.03	Cultivated; permanent; commercial; irrigated	0.747
3.03	Cultivated; temporary; commercial; irrigated	13.339
3.03	Cultivated; temporary; subsistence; dryland	916.152
3.03	Degraded Forest & Woodland	678.086
3.03	Degraded Thicket; Bushland; etc	155.616
3.03	Forest & Woodland (rename as Woodland)	1,422.05
3.03	Thicket; Bushland; Bush Clumps; High Fynbos	721.044
3.03	Urban / Built-up (residential; formal township)	155.43
3.03	Waterbodies	22.297
3.03 Total		**4542.111**
4.02	Cultivated; temporary; subsistence; dryland	980.63
4.02	Degraded Forest & Woodland	6.882
4.02	Degraded Thicket; Bushland; etc	281.476
4.02	Forest & Woodland (rename as Woodland)	0.409
4.02	Forest Plantations (Eucalyptus spp)	219.346
4.02	Thicket; Bushland; Bush Clumps; High Fynbos	224.328
4.02	Urban / Built-up (residential; formal township)	577.521
4.02	Waterbodies	50.636
4.02 Total		**2341.228**
Grand Total		**11723.382**