RIVER HEALTH PROGRAMME

A BIOMONITORING SURVEY OF THE LEPHALALA RIVER CATCHMENT. LIMPOPO PROVINCE.

FIELD SURVEY OF 2005.

PART 1. FISH, INVERTEBRATES AND ECO-STATUS.

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EXECUTIVE SUMMARY.

The Lephalala River Catchment was surveyed by a multi disciplinary team of scientists from Biodiversity and Resource Use Management between February and May 2005. The team was ably assisted by colleagues from the Waterberg District.

The survey was conducted using standardized River Health Programme monitoring protocols with the objective of providing an assessment of the Eco-Status of the river. Six ecological components were assessed using the following monitoring protocols.

Geomorphology.		Desktop study only.
Fish	(FRAI)	Fish Response Assessment Index.
Invertebrates	(SASS5)	South African Scoring System (version 5), interpreted through the Macro Invertebrate Response Assessment Index (MIRAI)
Riparian Vegetation	(RVI)	Riparian Vegetation Index.
Instream habitat	(HQI)	Habitat Quality Index.
Invertebrate habitat.	(IHAS)	Invertebrate Habitat Assessment System.

The data gathered during this survey, together with this ecological report provide a scientifically credible assessment of the State of the Environment (SOE) of the Lephalala Catchment. All monitoring protocols are recognized as National Indicators for the purposes of SOE reporting on aquatic ecosystems. In addition, the report will provide a valuable baseline for water resource managers in determining the Ecological Reserve of the Catchment and water licensing in terms of the National Water Act (1998).

Results indicate, that although the catchment was reeling from the effects of drought, at the time of the survey, it still has a **high** Ecological Importance and Sensitivity (EIS), largely due to the fact that a substantial portion of the catchment falls on private nature reserves or game farms. Management should take note of those issues raised in **Table A,** and take the recommended actions to help conserve this catchment.

The results of this survey have led to an assessment of the Eco Status of the catchment (Tables 13 - 16), which at this time places the entire catchment in a “fair” Ecological Category.

Table A. Management recommendations.

ISSUE	ACTION	RESPONSIBILITY
The upper catchment grasslands and source wetlands for the Lephalala, on the farm Weltevreden 172 KR, are very important but are degraded and under threat of subdivision.	This is a prime area for identification as a priority in the conservation planning process. The lands should be protected and rehabilitated. Negotiation with the land owner should be implemented without delay.	• Management to request Wetland Scientist, to address the issue with the landowner**.** • Declare as an area of natural importance. • Info to be fed into conservation planning data base – when in place. • No subdivisions should

		be allowed.
A scientifically motivated reserve determination has not been addressed for this catchment.	A Comprehensive Reserve should be undertaken as a high priority.	Management to inform DWAF, national and regional, that a Comprehensive Reserve should be addressed as soon as possible.
There are many farm dams in the upper catchment which are affecting river flows.	A moratorium on the development of new dams, should be implemented.	Management to inform EIA section and DWAF that no new dams should be considered until a Comprehensive Reserve has been completed.
Due to the high Ecological Importance and Sensitivity (EIS) of the catchment, monitoring of the river should be conducted regularly on a 3 yearly basis.	Monitoring should be coordinated accordingly.	Specialist scientist to liaise with monitoring personnel, district personnel and DWAF accordingly.
Report should be distributed to relevant role players.	Distribute to management, municipalities and DWAF.	Specialist Scientist.
A glossy SORR should be considered.	Investigate possibilities with DWAF, RHP and CSIR.	Specialist Scientist.

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1. Introduction.

The Lephalala River Catchment was surveyed by a multi disciplinary team of scientists from Biodiversity and Resource Use Management between February and May 2005. The team was ably assisted by colleagues from the Waterberg District.

The survey was conducted using standardized River Health Programme monitoring protocols with the objective of providing an assessment of the Present Ecological State (PES) of the river. Six ecological components were assessed using the following monitoring protocols.

Geomorphology.		
Fish	(FRAI)	Fish Response Assessment Index.
Invertebrates	(SASS5)	South African Scoring System (version 5).
Riparian Vegetation	(RVI)	Riparian Vegetation Index.
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The data gathered during this survey, together with this ecological report provide a scientifically credible assessment of the State of the Environment (SOE) of the Lephalala Catchment. All monitoring protocols are recognized as National Indicators for the purposes of SOE reporting on aquatic ecosystems. In addition, the report will provide a valuable baseline for water resource managers in determining the Ecological Reserve of the Catchment and water licensing in terms of the National Water Act (1998).

This is the first time that a multi disciplinary survey of the Lephalala Catchment has been undertaken by this Department, although there are substantial fish monitoring records from both the Transvaal Provincial Administration (TPA) and from Water Affairs. (DWAF) Very limited invertebrate surveys have also been conducted by DWAF. The most recent of these surveys which generated data for this catchment was made in 1997 by DWAF accompanied by this author (M.K. Angliss) in 1997. A review of the status of the Lephalala Catchment is therefore long overdue.

21 sites were addressed during this survey, ranging from Waterberg mountain catchment streams to the Limpopo Plain.

2. The study area.

The Lephalala River flows in a northerly direction across the western half of Limpopo Province.

The Lephalala River rises in the upper Waterberg Mountains in a distinct mountain catchment area dominated by grasslands and extensive wetlands. (Altitude 1642m) Strong springs which are considered the source of the river are found on the farm Weltevreden 172 KR, while a number of small tributaries such as the Rietbokvleispruit arise in Macouwpan 165KR.

The Lephalala River grows in stature as it drops through a steep gorge before merging with the Melkrivier on the southern boundary of the Lephalala Wilderness Area. The river continues to flow through a gorge in the Wilderness Area, where it is joined by the Blocklandspruit and the Daggakraal. Below the Waterberg Range, the river continues in a

northerly direction across the Limpopo Plain, before joining the Limpopo River on the Botswana border on the farm Melbourne 34LQ (Altitude 800m)

The river lies entirely within the Limpopo Water Management Area and occupies secondary sub catchment A50 with a gross area of 6725 km^2 and a Gross Mean Annual Runoff (MAR) of 149.4 (10^6m^3) (Midgely *et. al*. 1994)

There are no major towns or dams in the study area. The Waterberg Biosphere occupies a substantial portion of the catchment and is considered to have a high conservation status due to a diverse fauna and flora and a large number of endemic and red data species. Agriculture (both formal and informal) and game farming are the dominant industries of the catchment.

2.1 Ecoregions.

The Lephalala River flows through two distinct Level 1 and Level 2 ecoregions as described by Kleynhans et al. 2005. See Figure 1. The following tables provide the attributes of these ecoregions.

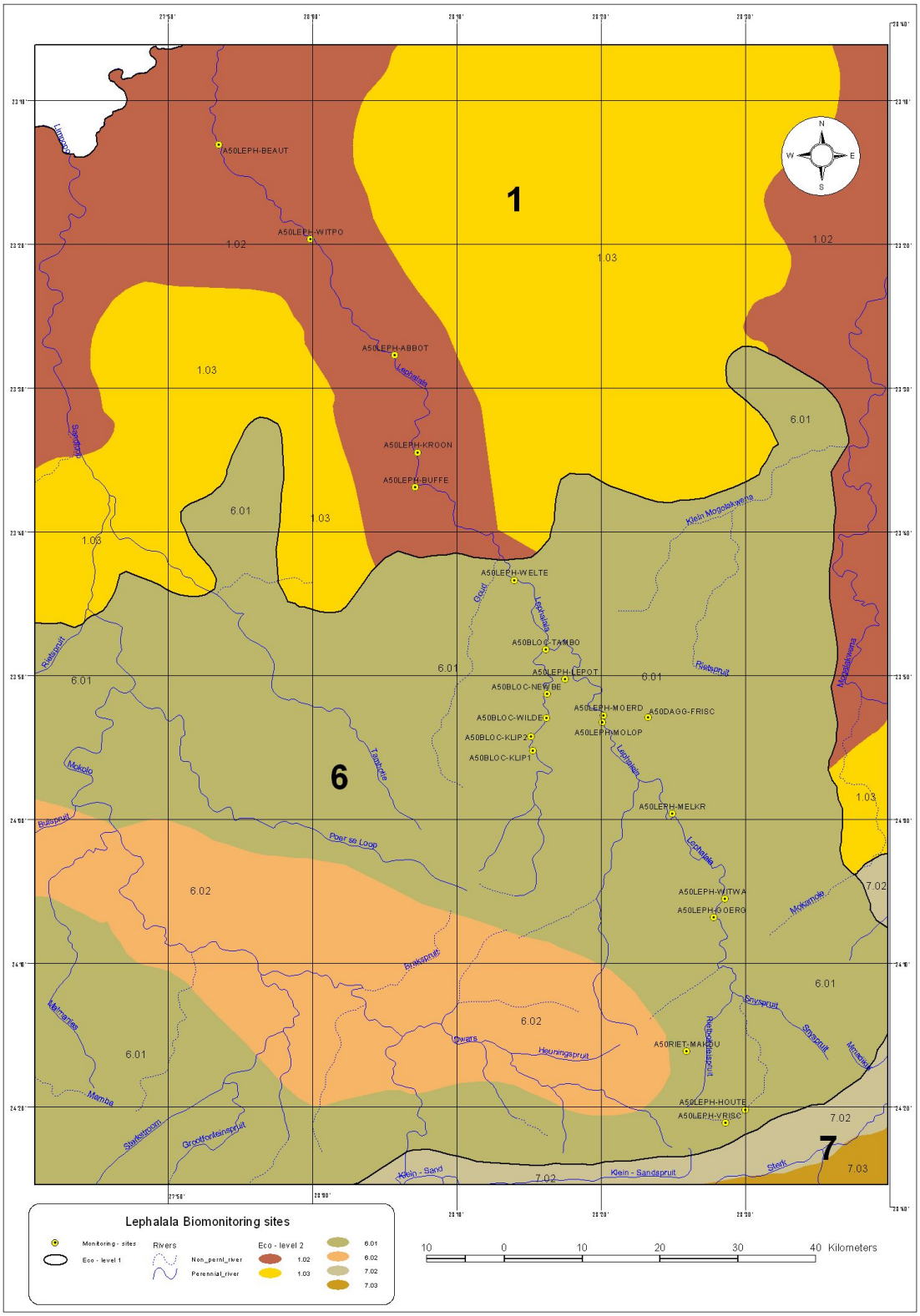
Table 1. Ecoregion attributes (level 2) for Waterberg 6.01 From Kleynhans et. al. (2005).

Main Attributes	**Waterberg 6.01**
Terrain Morphology: Broad division	***Table-lands; moderate and high relief***
Terrain Morphology (Primary)	**Table-lands (mountain and hill plateau)**
Vegetation types (dominant types in bold)	**Waterberg Moist Mountain Bushveld;** Mixed Bushveld; Mopane Bushveld
Altitude (m a.m.s.l.)	900 to 1700
MAP (mm)	300 to 700
Coefficient of variation (% of annual precipitation)	25 to 34
Rainfall concentration index	60 to >65
Rainfall seasonality	Early to mid summer
Mean annual temp (°C)	14 to 22
Mean daily max temp (°C) February	24 to 32
Mean daily max temp (°C) July	16 to 22
Mean daily min temp (°C) February	12 to 19
Mean daily min temp (°C) July	0 to 5
Median annual simulated runoff (mm) for quaternary catchment	<5 (limited); 10 to 100

Table 2. Ecoregion attributes (level 2) for Limpopo Plain 1.02. From Kleynhans et. al. (2005).

Main Attributes	**Limpopo Plain 1.02**
Terrain Morphology: Broad division	**Plains; low relief**; Plains; moderate relief; Lowlands, Hills and Mountains; moderate and high relief; Closed Hills, Mountains; moderate and high relief.
Terrain Morphology	Plains; **Slightly undulating plains;** Slight irregular plains; extremely irregular plains (almost hilly) (limited); Moderately undulating plains; Lowlands with parallel hills; Lowlands with mountains; High mountains
Vegetation types (dominant types in bold) (Primary)	***Sweet Bushveld***
Altitude (m a.m.s.l.)	500 to 1300
MAP (mm)	300 to 500
Coefficient of variation (% of annual precipitation)	25 to 39
Rainfall concentration index	60 to >65
Rainfall seasonality	Early to mid summer
Mean annual temp (°C)	18 to 22
Mean daily max temp (°C) February	24 to 32
Mean daily max temp (°C) July	18 to 24
Mean daily min temp (°C) February	16 to 19
Mean daily min temp (°C) July	2 to 7
Median annual simulated runoff (mm) for quaternary catchment	<5 to 40; (40 to 60; 80 to 100 limited)

Figure 1. **Study area map of the Lephalala Catchment showing survey sites and ecoregions. (Adapted from Kleynhans et al. 2005)**



2.2 The sites surveyed.

Table 3. Survey sites, RHP site codes and coordinates.

Site number	RHP Site Code	Site name	River	Stream	Deg. S	Deg. E	Altitude	1:50,000 Map
1	A50LEPH-VRISC	Rion Lerm canal	Lephalala	Lephalala	-24.3523	28.4775	1642	2428AD
2	A50LEPH-HOUTB	Rion Lerm bridge	Lephalala	Lephalala	-24.3369	28.5000	1600	2428AD
3	A50RIET-MAKOU	Makouwpan	Lephalala	Rietbokvleispruit	-24.2693	28.4324	1500	2428AD
4	A50LEPH-GOERG	Witwater	Lephalala	Lephalala	-24.1143	28.4638	1256	2428AB
5	A50LEPH-WITWA	Witwater camp	Lephalala	Lephalala	-24.0927	28.4767	1250	2428AB
6	A50LEPH-MELKR	Melkrivier Resort	Lephalala	Lephalala	-23.9941	28.4156	1170	2328CD
7	A50LEPH-MOLOP	Molope	Lephalala	Lephalala	-23.8882	28.3350	1105	2328CD
8	A50DAGG-FRISC	Daggakraal Boundary	Lephalala	Daggakraal	-23.8825	28.3879	1100	2328CD
9	A50LEPH-MOERD	School Bridge	Lephalala	Lephalala	-23.8801	28.3365	1073	2328CD
10	A50LEPH-LEPOT	Lepotedi	Lephalala	Lephalala	-23.8378	28.2917	950	2328CD
11	A50BLOC-KLIP1	Kliphoek 1	Lephalala	Blocklandspruit	-23.9207	28.2550	1057	2328CD
12	A50BLOC-KLIP2	Kliphoek 2	Lephalala	Blocklandspruit	-23.9043	28.2524	1053	2328CD
13	A50BLOC-WILDE	Top dam	Lephalala	Blocklandspruit	-23.8830	28.2701	1045	2328CD
14	A50BLOC-NEWBE	Bridge	Lephalala	Blocklandspruit	-23.8550	28.2710	1035	2328CD
15	A50BLOC-TAMBO	Tamboti	Lephalala	Blocklandspruit	-23.8038	28.2694	931	2328CD
16	A50LEPH-WELTE	Crede Deo	Lephalala	Lephalala	-23.7232	28.2333	876	2328CA
17	A50LEPH-BUFFE	Tafelkop-safarilands	Lephalala	Lephalala	-23.6155	28.1190	835	2328CA
18	A50LEPH-KROON	Marken Bridge	Lephalala	Lephalala	-23.5752	28.1215	830	2328CA
19	A50LEPH-ABBOT	Abbotspoort	Lephalala	Lephalala	-23.4624	28.0956	840	2328AC
20	A50LEPH-WITPO	Witpoort	Lephalala	Lephalala	-23.3280	27.9978	810	2327BD
21	A50LEPH-BEAUT	Beauty Bridge	Lephalala	Lephalala	-23.2181	27.8918	800	2327BB

2.3 Geomorphology of the Lephalala Catchment.

Geomorphology is one of several components used to assess the overall condition of a site. Commonly applied components include invertebrates, fish, riparian vegetation, habitat integrity, water quality, hydrology and geomorphology. Invertebrates, fish and vegetation together give a good picture of the ecological integrity of a site and reflect the condition of the bio-physical habitat, which are described by the remaining components, habitat integrity, water quality, hydrology and geomorphology. Changes to the stream biota must therefore be assessed against a background of possible changes to channel morphology and channel condition. (Rowntree and Ziervogel; 1999)

Rowntree and Wadeson (1999) developed a template which allows one to describe the longitudinal zone through the evaluation of valley form, gradient and characteristic channel features. Table 4.

This classification system may provide a more detailed evaluation of the river than can be obtained from examining eco-region level 2 maps. There should however be considerable correlation between the two.

Table 4. Geomorphological zonation of river channels (after Rowntree and Wadeson, 1999).

Longitudinal Zone	**Macro-reach characteristics**			**Characteristic channel features**
	Valley form	Gradient class	Zone class	
A. Zonation associated with a "normal" profile.				
Source zone	V10	not specified	S	Low gradient, upland plateau or upland basin able to store water. Spongy or peaty hydromorphic soils.
Mountain headwater stream	V1, V3	>0.1	A	A very steep gradient stream dominated by vertical flow over bedrock with waterfalls and plunge pools. Normally first or second order. Reach types include bedrock fall and cascades.
Mountain stream	V1, V3	0.04 - 0.99	B	Steep gradient stream dominated by bedrock and boulders, locally cobble or coarse gravel in pools. Reach types include cascades, bedrock fall, step-pool. Approximate equal distribution of "vertical" and "horizontal" flow components.
Transitional	V2, V3, V4, V6	0.02 - 0.039	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	V4, V6	0.005 - 0.019	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	V8, V10	0.001 - 0.005	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	V4, V8,	0.0001 - 0.001	F	Low gradient alluvial fine bed channel, typically regime reach type. May be confined, but fully developed

	V10			meandering pattern within a distinct flood plain develops in unconfined reaches where there is an increased silt content in bed or banks.
B. Additional zones associated with a rejuvenated profile.				
Rejuvenated bedrock fall/ cascades	V1, V4	>0.02	A/B/Cr	Moderate to steep gradient, confined channel (gorge) resulting from uplift in the middle to lower reaches of the long profile, limited lateral development of alluvial features, reach types include bedrock fall, cascades and pool rapid.
Rejuvenated foothills	V2, V3, V4, V6	0.001 - 0.02	D/Er	Steepened section within middle reaches of the river caused by uplift, often within or downstream of a gorge. Characteristics similar to foothills (gravel/cobble-bed rivers with pool-riffle / pool-rapid morphology) but of a higher order. A compound channel is often present with an active channel contained within a macro-channel activated only during infrequent flood events. A limited flood plain may be present between the active and macro-channel
Upland flood plain	V8, V10	<0.005	Fr	An upland low gradient channel, often associated with uplift plateau areas as occur beneath the eastern escarpment.

Table 5. Eco-regions and geomorphological zonation of the 2005 Lephalala Catchment survey sites. (after Rowntree and Wadeson, 1999).

Site number	RHP Site Code	Ecoregion	Altitude	Longitudinal Zonation	Zone Class
1	A50LEPH-VRISC	6.01	1642	Source Zone	A
2	A50LEPH-HOUTB	6.01	1600	Source Zone	A
3	A50RIET-MAKOU	6.01	1500	Source Zone	A
4	A50LEPH-GOERG	6.01	1256	Upper Foothill	D
5	A50LEPH-WITWA	6.01	1250	Upper Foothill	D
6	A50LEPH-MELKR	6.01	1170	Upper Foothill	D
7	A50LEPH-MOLOP	6.01	1105	Upper Foothill	D
8	A50DAGG-FRISC	6.01	1100	Lower Foothill	E
9	A50LEPH-MOERD	6.01	1073	Upper Foothill	D
10	A50LEPH-LEPOT	6.01	950	Upper Foothill	D
11	A50BLOC-KLIP1	6.01	1057	Lower Foothill	E
12	A50BLOC-KLIP2	6.01	1053	Lower Foothill	E
13	A50BLOC-WILDE	6.01	1045	Lower Foothill	E
14	A50BLOC-NEWBE	6.01	1035	Lower Foothill	E
15	A50BLOC-TAMBO	6.01	931	Lower Foothill	E
16	A50LEPH-WELTE	6.01	876	Lower Foothill	E
17	A50LEPH-BUFFE	1.02	835	Lower Foothill	E
18	A50LEPH-KROON	1.02	830	Lower Foothill	E
19	A50LEPH-ABBOT	1.02	840	Lower Foothill	E
20	A50LEPH-WITPO	1.02	810	Lower Foothill	E
21	A50LEPH-BEAUT	1.02	800	Lower Foothill	E

2.4 Reporting units.

Although the Level 2 ecoregions provide a good basis on which to delineate the reporting units of this report, at level 2 delineation, they lack sufficient detail with which to address this report. Table 6 provides details of the reporting units with reasoning that have been selected for this report.

Table 6. Selection of reporting units and motivations.

Reporting unit	Ecoregion	Motivation
Lephalala upper tributaries.	6.01	The upper catchment area (source zone) is dominated by grasslands and small well vegetated streams. Expected fish populations are different to the "Lephalala Waterberg" unit. Historically perennial.
Lephalala Waterberg	6.01	See above. This Upper foothill zone is dominated by steep pool and boulder rapid sequence. Riparian vegetation consists of a diverse variety of large trees and bushes. Historically perennial, but stopped flowing in 2004.
Lephalala.	1.02	Coinciding with ecoregion boundaries, this lower foothill zone is defined by a low gradient alluvial channel of pool and riffle sequences. Fish populations differ to upstream sites. Historically perennial in all but the driest of years.
Blocklandspruit	6.01	A stream of smaller order than the Lephalala with a lower foothill zone channel dominated by bedrock rapids and sandy pools. The seasonality of the stream is less well defined but it is strongly suspected that this was historically a perennial stream. Expected fish populations are different to the "Lephalala Waterberg" unit.
Daggakraal	6.01	A small, low gradient, seasonal tributary dominated by a wide wetland type floodplain and dense in-channel vegetation. Pools and shallow sandy runs dominate. Fish populations are typical for this habitat.

3. *In Situ* water quality.

Water quality was assessed at each site using hand held meters. Results are presented in table 7. At all sites the water was clear and had a low conductivity, indicating a low salt content. This is indicative of near natural water quality, due to the absence of industry and formal agriculture in the catchment. The low conductivity caused the electro-shocking apparatus to be inefficient.

Table 7. *In situ* water quality results for each site of the 2005 survey.

RHP CODE	Date	pH	Cond Ms/m	Temp oC	Flow	Clarity
A50LEPH-VRISC	24.02.05	6	2	24.5	Moderate	Clear
A50LEPH-HOUTB	25.02.05	6.0	2.0	24.0	Moderate	Clear
A50RIET-MAKOU	13.05.05	6.5	0.5	20.0	Moderate	Clear
A50LEPH-GOERG	05.05.05	6.9	3.0	17.0	Strong	Clear
A50LEPH-WITWA	05.05.05	7.0	2.0	19.0	Strong	Clear
A50LEPH-MELKR	18.03.05	7.8	3.0	24.0	Strong	Clear
A50LEPH-MOLOP	15.03.05	7.6	3.0	26.0	Moderate	Clear
A50DAGG-FRISC	15.03.05	7.4	4.0	26.0	Moderate	Grey

A50LEPH-MOERD	14.03.05	8.0	3.0	26.0	Moderate	Clear
A50LEPH-LEPOT	17.03.05	8.3	3.0	28.0	Strong	Clear
A50BLOC-KLIP1	16.03.05	8.1	3.0	29.0	Moderate	Clear
A50BLOC-KLIP2	16.03.05	8.1	3.0	29.0	Moderate	Clear
A50BLOC-WILDE	16.03.05	7.6	4.0	28.0	Moderate	Clear
A50BLOC-NEWBE	16.03.05	8.4	4.0	21.0	Moderate	Clear
A50BLOC-TAMBO	17.03.05	8.1	4.0	26.0	Moderate	Clear
A50LEPH-WELTE	12.05.05	8.2	5.0	22.0	Moderate	Clear
A50LEPH-BUFFE	12.05.05	8.4	5.0	22.0	Moderate	Clear
A50LEPH-KROON	11.05.05	8.4	5.0	24.0	Low	Clear
A50LEPH-ABBOT	13.05.05	8.4	5.0	24.0	Low	Grey
A50LEPH-WITPO	12.05.05	9.7	5.0	15.0	Moderate	Opaque
A50LEPH-BEAUT	12.05.05	8.0	5.0	22.0	Moderate	Clear

4. Fish.

4.1 Historical fish distribution.

The expected species list of fish for the Lephalala Catchment (Table 8) was developed by taking historical data for the river into consideration and by applying expert knowledge of fish distributions and habitat preferences from neighboring catchments. Historical fish distribution records are on the Limpopo Province Fish Distribution Data Base (updated January 2007) and extend as far back as 1968. The most recent survey was conducted in 1997 by DWAF scientists accompanied by the author. (MK Angliss) Data generated in the 1997 survey was used to test the earliest version of the Fish Assemblage Integrity Index (FAII) for river eco classification. However, no reports were produced at this early stage in the development process.

No comprehensive Ecological Reserve study has ever been conducted on the Lephalala River and this report will therefore provide the fist assessment on the status of fauna and flora of the wider river catchment.

36 Indigenous species of fish are expected to occur in the catchment. Four species of exotic fish are thought to occur, although none were recorded during this survey.

Table 8. Scientific, English and abbreviated names for 36 indigenous fish expected to occur within the Lephalala Catchment. (Names from Skelton, 2001 and 2002)

SCIENTIFIC NAME	ENGLISH COMMON NAME	ABBREV
APLOCHEILICHTHYS JOHNSTONI (GÜNTHER, 1893)	JOHNSTON'S TOPMINNOW	AJOH
ANGUILLA BENGALENSIS LABIATA (PETERS, 1852)	AFRICAN MOTTLED EEL	ALAB
ANGUILLA MOSSAMBICA (PETERS 1852)	LONGFIN EEL	AMOS
BARBUS AFROHAMILTONI (CRASS, 1960)	HAMILTON'S BARB	BFRI
BARBUS ANNECTENS (GILCHRIST & THOMPSON, 1917)	BROADSTRIPED BARB	BANN
BARBUS BIFRENATUS (FOWLER, 1935)	HYPHEN BARB	BBIF
BARBUS BREVIPINNIS (JUBB, 1966)	SHORTFIN BARB	BBRI
BARBUS EUTAENIA (BOULENGER, 1904)	ORANGEFIN BARB	BEUT
BRYCINUS IMBERI (PETERS, 1852)	IMBERI	BIMB
LABEOBARBUS MAREQUENSIS (SMITH, 1841)	LARGESCALE YELLOWFISH	BMAR
BARBUS NEEFI (GREENWOOD, 1962)	SIDESPOT BARB	BNEE
BARBUS PALUDINOSUS (PETERS, 1852)	STRAIGHTFIN BARB	BPAU
BARBUS RADIATUS (PETERS, 1853)	BEIRA BARB	BRAD
BARBUS TRIMACULATUS (PETERS, 1852)	THREESPOT BARB	BTRI
BARBUS VIVIPARUS (WEBER, 1897)	BOWSTRIPE BARB	BVIV
CHETIA FLAVIVENTRIS (TREWAVAS, 1961)	CANARY KURPER	CFLA
CLARIAS GARIEPINUS (BURCHELL, 1822)	SHARPTOOTH CATFISH	CGAR
CHILOGLANIS PARATUS (CRASS, 1960)	SAWFIN SUCKERMOUTH (OR ROCK CATLET)	CPAR
CHILOGLANIS PRETORIAE (VAN DER HORST, 1931)	SHORTSPINE SUCKERMOUTH (ROCK CATLET)	CPRE
CLARIAS THEODORAE (WEBER, 1897)	SNAKE CATFISH	CTHE
LABEO CONGORO (PETERS, 1852)	PURPLE LABEO	LCON
LABEO CYLINDRICUS (PETERS, 1852)	REDEYE LABEO	LCYL
LABEO MOLYBDINUS (DU PLESSIS 1963)	LEADEN LABEO	LMOL
LABEO ROSAE (STEINDACHNER, 1894) (*LABEO ALTEVILIS*)	REDNOSE LABEO	LROS
LABEO RUDDI (BOULENGER, 1907)	SILVER LABEO	LRUD
MICRALESTES ACUTIDENS (PETERS, 1852)	SILVER ROBBER	MACU
MESOBOLA BREVIANALIS (BOULENGER, 1908)	RIVER SARDINE	MBRE
MARCUSENIUS MACROLEPIDOTUS (PETERS, 1852)	BULLDOG	MMAC
OREOCHROMIS MOSSAMBICUS (PETERS, 1852)	MOZAMBIQUE TILAPIA	OMOS
OPSARIDIUM PERINGUEYI (GILCHRIST & THOMPSON, 1913)	SOUTHERN BARRED MINNOW	OPER
PETROCEPHALUS CATOSTOMA (GÜNTHER, 1866)	CHURCHILL	PCAT
PSEUDOCRENILABRUS PHILANDER (WEBER, 1897)	SOUTHERN MOUTHBROODER	PPHI
SCHILBE INTERMEDIUS (RÜPPELL, 1832)	SILVER CATFISH	SINT
SYNODONTIS ZAMBEZENSIS (PETERS, 1852)	BROWN SQUEAKER	SZAM
TILAPIA RENDALLI (BOULENGER, 1896)	REDBREAST TILAPIA	TREN
TILAPIA SPARRMANII (SMITH, 1840)	BANDED TILAPIA	TSPA

Table 9. Scientific, English and abbreviated names for 4 exotic fish expected to occur within the Lephalala Catchment. (Names from Skelton, 2001 and 2002)

SCIENTIFIC NAME	ENGLISH COMMON NAME	ABBREV
CYPRINUS CARPIO (LINNAEUS, 1758)	CARP	CCAR
MICROPTERUS DOLOMIEU (LACEPÈDE, 1802)	SMALLMOUTH BASS	MDOL
MICROPTERUS SALMOIDES (LACEPÈDE, 1802)	LARGEMOUTH BASS	MSAL
OREOCHROMIS NILOTICUS (LINNAEUS, 1758)	NILE TILAPIA	ONIL

4.2 Fish survey methods.

Fish were gathered using the following techniques.

- Electro - shocking apparatus: a two to three man operation, whereby fish are stunned using AC electric current. The stunned fish are collected in hand held scoop nets positioned down stream. The method is suited to shallow (< 1m depth) swift flowing water over assorted substrates. Also useful around snags, undercut banks and in heavily vegetated but shallow pools.

- Seine net: a net measuring 15m length by 3.5m deep, with 12mm knotless nylon netting. The net is pulled through the water by 2 - 4 people, and fish are collected in a central bag. Suitable for deep pools that are clear of snags.

- Small seine net: a small piece of seine netting attached to two wooden poles. This two man net measures 2m by 1.5m deep, and again has 10 mm mesh. The net is useful for sampling in small pools, but is particularly designed for use under and amongst overhanging and marginal vegetation.

- Cast or throw net: a circular nylon net, 1.6m radius, with 12mm mesh size. Cast nets can be used by an individual in any habitat, that is clear of snags and obstructions.

Most fish caught were identified at site and returned to the river alive. A small number of fish from a few sites were kept for a reference collection. The collection will in due course be lodged with the South African Institute for Aquatic Biodiversity. (SAIAB)

When possible, individual fish were examined for parasite loads.

The habitat at the site was categorized, and where possible individual habitats sampled. The effort used to catch fish in each habitat at each site was recorded. However, in the upper catchment, the narrow channel of the river often resulted in efforts being combined for multiple habitats.

Fish habitat is categorized into four velocity depth classes, and allocated a subjective score based upon their abundance using a five-point scale. (Kleynhans 1997)

Fast Deep (F/D); Fast Shallow (F/S); Slow Deep (S/D); Slow Shallow (S/S)
(0=Absent; 1=Rare; 2=Sparse; 3=Moderate; 4=Extensive)

The same scale is utilized to assess the availability of cover types for each velocity depth class. Four cover types are assessed.

(Overhanging vegetation; Undercut bank and root wads; Substrate; Aquatic macrophytes).

Slow Deep Water = > 0.5 meters. Fast water = > 0.3 m/sec.
Fast Deep Water = > 0.3 meters.

Each site was subjected to exhaustive searches using the most appropriate collecting techniques, given the prevailing flow conditions. At all sites, multiple habitats were sampled. At all sites, habitats of similar velocity depth classes and cover types were sampled at different localities.

4.3 Application of the Fish Response Assessment Index (FRAI)

The FRAI is an index which has recently been developed by Dr. Kleynhans of the Institute for Water Quality Studies (IWQS) of DWAF for Ecostatus determination (Kleynhans, 2007).

The index assesses the status of fish populations which are present under existing conditions in relation to those which could be expected under natural conditions. The index follows a dedicated spreadsheet format and rule based model.

The methodology has now provided a logical and standardized approach for the interpretation of system health based on fish assemblages. The FRAI has subsequently been adopted for both State of Environment Reporting (SOER) biomonitoring assessments for river health as well as for the reserve determination process.

The index assesses fish assemblages in terms of the following criteria.

- Flow-depth class metrics.
- Flow modification metrics.
- Cover metrics.
- Health/condition metrics.
- Introduced species metrics.

At each stage in the procedure, motivations for the scores are appended to the spreadsheets by way of comment boxes. Assessments of the fish populations against each of the above are calculated and then, based on expert judgment and prevailing conditions, are weighted and ranked prior to the calculation of an overall index score. The index score is interpreted as a percentage of natural, to provide an interpretation of the Ecological Category (EC).

Descriptive templates for the PES remain unchanged from the earlier FAII interpretation and for completeness are attached as tables 7 and 8.

Detailed FRAI results are contained in APPENDIX B. (Electronic format)

Table 10. FRAI assessment classes. (Adapted from Kleynhans; 1997)

Class	Description of Generally Expected Conditions	FRAI Score (Percent of total)
A	Unmodified, or approximates natural conditions closely.	90 - 100
B	Largely natural with few modifications. A change in community characteristics may have taken place but species richness and presence of intolerant species indicate little modification.	80 - 89
C	Moderately modified. A lower than expected species richness and presence of most intolerant species. Some impairment of health may be evident at the lower end of this scale.	60 - 79
D	Largely modified. A clearly lower than expected species richness and absence or much lowered presence of intolerant and moderately intolerant species. Impairment of health may become more evident at the lower end of this class.	40 - 59
E	Seriously modified. A strikingly lower than expected species richness and general absence of intolerant and moderately intolerant species. Impairment of health may become very evident.	20 - 39
F	Critically modified. An extremely lowered species richness and an absence of intolerant and moderately intolerant species. Only tolerant species may be present with a complete loss of species at the lower end of the class. Impairment of health generally very evident.	0 - 19

Table 11. A descriptive template for the Ecological Management Classes (EMC) of river systems. (From Kleynhans; 1997)

CLASS: MANAGEMENT CLASSES:	MANAGEMENT CLASSES: DESCRIPTION OF PERCEIVED CONDITIONS WITHIN DESIRED RANGE
A: UNMODIFIED OR LARGELY NATURAL.	The natural abiotic template should not be modified. The characteristics of the resource should be determined by unmodified natural disturbance regimes. There should be no human induced risks to the abiotic and biotic maintenance of the resource. The supply capacity of the resource will not be used.
B: LARGELY NATURAL WITH FEW MODIFICATIONS	Only a small risk of modifying the natural abiotic template and exceeding the resource base should be allowed. Although the risk to the well being and survival of especially intolerant biota (depending on the nature of the disturbance) at a very limited number of localities may be slightly higher than expected under natural conditions, the resilience and adaptability of the biota must not be compromised. The impact of acute disturbances must be totally mitigated by the presence of sufficient refuge areas.

C: MODERATELY MODIFIED	A moderate risk of modifying the abiotic template and exceeding the resource base may be allowed. Risks to the well-being and survival of intolerant biota (depending on the nature of the disturbance) may generally be increased with some reduction of resilience and adaptability at a small number of localities. However, the impact of local and acute disturbances must at least partly be mitigated by the presence of sufficient refuge areas.
D: LARGELY MODIFIED	A large risk of modifying the abiotic template and exceeding the resource base may be allowed. Risks to the well-being and survival of intolerant biota (depending on the nature of the disturbance) may be allowed to generally increase substantially with resulting low abundances and frequency of occurrence, and a reduction of resilience and adaptability at a large number of localities. However, the associated increase in abundance of tolerant species must not be allowed to assume pest proportions. The impact of local and acute disturbances must at least to some extent be mitigated by refuge areas.
OUTSIDE DESIRED RANGE	
E: SERIOUSLY MODIFIED	The losses of natural habitats and basic ecosystem functions are extensive.
F: CRITICALLY MODIFIED	Modifications have reached a critical level and the system has been modified completely, with an almost complete loss of natural habitats

4.4 Fish survey results.

Detailed fish survey results, habitat assessments, sampling effort and the calculation of FRAI are attached as APPENDIX B. Summarized results are presented here.

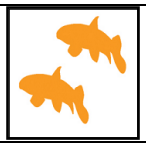
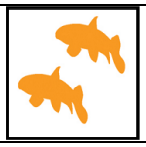
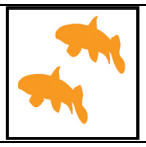
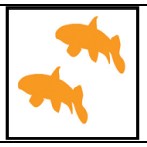
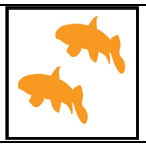
Table 12. Species expected and recorded (in yellow) in each reporting unit.

LEPHALALA RIVER			TRIBUTARIES	
Upper tribs 6.01	**Waterberg 6.01**	**Limpopo Plain 1.02**	**Blocklandspruit 6.01**	**Daggakraal 6.01**
BBIF	AJOH	AJOH	AJOH	AJOH
BBRE	ALAB	ALAB	AMOS	BBIF
BEUT	AMOS	AMOS	BBIF	BBRE
BPAU	BBIF	BAFR	BBRE	BPAU
CGAR	BBRE	BANN	BEUT	BTRI
CTHE	BEUT	BBIF	BMAR	CFLA
TSPA	BMAR	BIMB	BNEE	CGAR
5 / 7 spp	BNEE	BMAR	BPAU	MMAC
	BPAU	BPAU	BTRI	OMOS
	BTRI	BRAD	BUNI	PPHI
	BUNI	BTRI	BVIV	TREN
	BVIV	BUNI	CFLA	TSPA
	CFLA	BVIV	CGAR	**7 / 13 spp**
	CGAR	CFLA	CPRE	

CPAR	CGAR	LCYL
CPRE	CPAR	LMOL
LCYL	LCON	LROS
LMOL	LCYL	MACU
LROS	LMOL	MBRE
MACU	LROS	MMAC
MBRE	LRUD	OMOS
MMAC	MACU	OPER
OMOS	MBRE	PPHI
OPER	MMAC	PWES
PPHI	OMOS	SINT
PWES	PPHI	TREN
SINT	SINT	TSPA
SZAM	SZAM	**20 / 27 spp**
TREN	TREN	
TSPA	TSPA	
16 / 30 spp	**17 / 30 spp**	

Table 13. Summarized results for each reporting unit. (REF APPENDIX B)

NATURAL	**A**
GOOD	**B/C**
FAIR	**C/D**
POOR	**E/F**

	LEPHALALA RIVER			TRIBUTARIES	
	Upper 6.01	**Waterberg 6.01**	**Limpopo 1.02**	**Blockland 6.01**	**Daggakraal 6.01**
FRAI (%)	**53.31**	**53.31**	**53.58**	**60.23**	**54.83**
EC: FRAI	**D**	**D**	**D**	**C/D**	**D**
					

4.5 Discussion.

Upper tributaries. (3 Sites)

The upper tributaries lie entirely on private farmlands, which are dominated by expansive grasslands. At one source of the river, on Weltevreden 172 KR, the grasslands and wetlands are heavily overgrazed and are heavily infested by Bankrupt Bush (*Stoebe vulgaris*). There are even suggestions that these important catchment areas are about to be subdivided into plots. There are also large stands of wattle along the watercourse, together with a substantial number of dams and pumps. Most of these upper catchment dams have been stocked with Black Bass (*Micropterus salmoides*) for angling purposes.

At site 1, the stream flow from the wetland area has been diverted into a channel and although this has apparently been the case for many years and reasonable habitats have developed, they must be regarded as artificial.

Nevertheless, fish were abundant on all upper catchment sites, with the red data *Barbus brevipinnus* and *Barbus bifrenatus* dominating the catch. No *Clarias theodorae* were recorded, causing concern that this nationally threatened species may now have disappeared from this catchment. The absence of the sensitive *Barbus eutaenia* is also worrying. Further work is needed to confirm this situation.

The absence of these two sensitive species, together with impacted habitats and the presence of bass cause the FRAI assessment to fall in an Ecological Category of D

The Lephalala Waterberg report unit. (7 Sites)

River habitat is dominated by steep, "pool – rapid" sequences with the river substrate consisting mostly of bedrock and large boulders. The river flows almost entirely through game farms, including the Lephalala Wilderness Area and Biosphere.

Many local landowners indicated that during 2004, the strongly perennial Lephalala River stopped flowing for the first time in living memory. Drought combined with upper catchment degradation and the large number of recently built farm dams in the upper reaches of the river, were blamed for this scenario.

Furthermore, this reporting unit is largely isolated from the Limpopo River due to a large number of farm dams in the lower Limpopo Plain reporting unit. Clearly, fragmentation of the system due to dams is a problem and for this report unit, deep pools and small tributaries acted as important refuges during the drought. Recruitment and disbursement since the drought has been limited.

Only 16 of the expected 30 fish species were recorded, and of these, many were recorded in low numbers. Low numbers of fish is a clear indication of near total system crash. Nevertheless, it is recognized that large deep pools were not surveyed due to the presence of crocodiles and many pool dwelling species were probably missed.

This is the only reach where a single specimen of the red data *Opsaridium peringueyi* had been recorded in the catchment and given the above flow scenario it is doubtful that the fish is still present.

No truly migratory species (eels) were recorded.

Low conductivity combined with fast deep water and difficult sampling habitat may have contributed to an artificially low assessment for this reporting unit.

The Limpopo Plain report unit. (5 Sites)

Dominated by low gradient sand and gravel runs with reed fringed pools and bedrock outcrops. The river passes through rural settlements and informal agricultural areas before joining the Limpopo River. There are many farm dams and pumps. Although historically perennial, this lower reach is now seasonal in all but the wettest of years.

Dams and deep pools provide refuge for hardy pool dwelling species. None are equipped with fishways and the river has become both fragmented and isolated from the broader Limpopo Catchment as a result of this. No truly flow dependent species are expected in this unit, although many fish in the assemblage require flowing water for breeding purposes.

Only 17 out of an expected 30 fish species were recorded. No migratory eels were recorded. Only shallow runs, riffles and pools were surveyed. Deep water pools and dams were not surveyed and once again some fish species may have been missed because of this. Nevertheless, fragmentation of the system remains a problem and an EC of D is realistic.

The Blocklandspruit tributary. (5 sites)

All 5 survey sites fell entirely within the Lephalala Wilderness Area and the stream habitat appears largely natural. Habitat is dominated by bedrock and sandy pools with reed fringed, cobble and gravel riffles. Marginal habitats are excellent. There are however a number of small dams and one large dam in the river which are reported to house both bass and carp. It is thought that this stream is perennial in all but the driest of years. Once again the stream stopped flowing in 2004. The dams and deep pools clearly provided refuge for many species during the drought and it is likely that this river provides refuge for fishes when the Lephalala River runs dry.

A respectable 20 out of an expected 27 species were recorded. Barbs were abundant and the flow dependent *Chiloglanis pretoriae* was recorded. However, neither of the other highly sensitive flow dependent species, *Barbus eutaenia* nor *Opsaridium peringueyi* were recorded. This study unit was concluded to be in a marginally better EC than the remainder of the catchment, largely because most fish were recorded in high abundance.

The Daggakraal tributary. (1 site only)

This stream was initially investigated due to its impressive "floodplain – wetland habitat". Very low flow was encountered and a number of shallow pools were observed to have fish a considerable distance away from the Lephalala main stem. One survey was conducted, which provided an indication as to the refuge value of this stream.

7 out of a potential 13 fish species were recorded. All are typically indicative of this wetland type of habitat and show that fish will move into habitats as they become available.

5. The invertebrate survey.

5.1 Invertebrate survey methods.

The survey for invertebrates was based upon methods developed for Biomonitoring, utilizing the SASS5 protocols (Dickens and Graham 2001). (South African Scoring System version 5)

During this survey, the biomonitoring protocols were followed correctly, to obtain valid SASS5 scores. All available habitats were sampled. (Taking cognizance of available habitat both up and down stream a distance of 100 meters)

The SASS5 protocol requires that invertebrate abundances be recorded for each habitat type to family level only. Each family recorded has a predetermined sensitivity rating (score). All scores for the sites are totaled to yield the SASS5 score. The average score of all of the taxon recorded (ASPT) provides an indication on the number of sensitive, high scoring species represented in the total score.

SASS5 scores must thus be rated in terms of the Average Score Per Taxon (ASPT) and available habitat. In this regard, the Habitat Quality Index (HQI) was applied. The Invertebrate Habitat Assessment System (IHAS) score sheet was also utilized and total scores obtained.

Abundances were also recorded and are presented in the tables attached in Appendix D. Invertebrates were recorded to family level only and returned to the river alive.

The method of collecting macro invertebrates utilizes a fine mesh net (1mm nylon) measuring 30 cm x 30 cm. Bottom substrates are disturbed through kicking (kick sampling) and invertebrates collected downstream. Vegetation is sampled by sweeping the net to and fro. Sampling times are indicated on the score sheet.

5.2 Interpreting SASS5 results using MIRAI.

SASS5 results were analyzed, by using the recently developed "Macro Invertebrate Response Assessment Index" (MIRAI). MIRAI methodologies were described by Ms. C.Thirion of DWAF, in Kleynhans et al 2005. Results are then interpreted in terms of the generic frameworks as described in tables 9 and 10.

The following text is adapted from the above manual.

" The determination of aquatic invertebrate EC is essentially based on:

- An interpretation of the environmental requirements, preferences and intolerances of Invertebrate taxa constituting the natural assemblage in a particular river delineation, and
- Their responses to changes in habitat conditions as brought about by changes in driver components.

MIRAI is used to determine the Invertebrate EC. It is done by integrating the ecological requirements of the invertebrate taxa in a community or assemblage and their response to modified habitat conditions.

Although MIRAI can be determined using information collected during a standard SASS survey (Dickens and Graham 2001), it can also be determined using more detailed information. The aim of the MIRAI, is to provide a habitat based cause and effect foundation to interpret the deviation of the benthic invertebrate community (assemblage) from the reference condition. This does not preclude the calculation of SASS scores if required. However, the recent tendency is to use the MIRAI even for RHP purposes.

Information required for the application of the MIRAI

a) Establish Reference Conditions

There are two methods for determining the list of taxa expected to occur under natural (reference) conditions

- A minimally impacted site in the same level II ecoregion and geomorphological zone with similar habitat can be used as a reference site, and information from this reference site can be used to compile a reference list of taxa for the area under consideration.
- In the absence of a suitable reference site, information from similar sites in different rivers as well as any historical information available can be used do compile a derived reference list of taxa expected under reference conditions. A thorough knowledge of the area under consideration is essential in order to compile a suitable referenced list. The presence/absence of taxa within a different river the same ecoregional context can be used to derive reference presence in the river delineation being considered.

b) Site selection

One of the most important factors in selecting a sampling site is the aim of the study. A site selected for the River Health Programme (RHP) aimed at determining the state of a river may differ from a site selected for a reserve study. Whatever the main aim of the study, the site should at least have suitable habitat for the benthic macro-invertebrates. The site should be either representative of the river delineation or should represent a critical section of the river (i.e a section of the river that will stop flowing before the rest of the river). Reserve sites are usually compromise sites between the different disciplines involved. A site that is suitable for invertebrates may be too complex to model accurately, while a site preferred by the hydraulician, may not provide suitable habitat for the biota.

An "ideal" macro-invertebrate site would be a site at which all or most of the invertebrate biotopes are present. This means that the site would have Stones-in–current, Stones-out-of-current, Vegetation-in-current, Vegetation-out-of-current, Sand, Gravel and mud. In addition to a variety of biotopes, the biotopes will also be of good quality and quantity. As an absolute minimum the site should have at least either a stony biotope or a vegetation biotope, in current.

When dealing with strictly alluvial rivers that are characterized by a sandy bottom, it is important that there is enough vegetation present to provide adequate habitat for the invertebrates. Moving sand (in current) is such an inhospitable habitat for invertebrates that it often is nearly devoid of life.

c) Data collection

Before the site visit and actual sampling it is important to collect all available invertebrate data for the river. This will include a literature survey as well as a search on the rivers database and contacting specialists that have worked in the area previously. This background information will assist in setting the reference condition and if there were recent information available will help to have greater confidence in the present state of the invertebrate community.

d) Habitat assessment

The main aim of a habitat assessment is to evaluate the template on which the invertebrates exist. An organism can only occur at a site if suitable habitat exists, it is therefore essential to

assess not only the habitat quality and quantity, but also the diversity of available biotopes.
“

The index assesses invertebrate assemblages in terms of the following criteria.

- Flow modification metrics.
- Habitat / Cover metrics.
- Water quality metrics.
- Connectivity and seasonality.

.

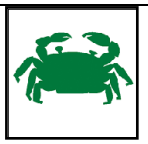
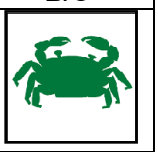
Assessments of the invertebrate populations against each of the above metrics are calculated and then, based on expert judgment and prevailing conditions, are weighted and ranked prior to the calculation of an overall index score. The index score is interpreted as a percentage of natural, to provide an interpretation of the Ecological Category (EC).

5.3 MIRAI results.

Detailed SASS5 and MIRAI results are attached as APPENDIX C.

Table 14. Summarized results for each reporting unit. (REF APPENDIX C)

NATURAL	A
GOOD	B/C
FAIR	C/D
POOR	E/F

	LEPHALALA RIVER			TRIBUTARIES	
	Upper 6.01	Waterberg 6.01	Limpopo 1.02	Blockland 6.01	Daggakraal 6.01
MIRAI (%)	71.84	80.00	80.00	74.02	79.19
EC: MIRAI	C	B	B	C	B/C
					

5.4 Invertebrate discussion.

The Lephalala Catchment has a “Good” Ecological Category, based on the invertebrate communities. The assessment falls short of the “Excellent Class” due to the prevailing flow modifications and system connectivity. These in turn have resulted in low abundances and frequency of occurrences of many invertebrate families.

Upper tributaries. (3 Sites)

18 out of a reference of 27 families were recorded. In the upper catchment, SASS5 scores are low (46 – 63) and ASPT’S of 4.85 – 5.73. This reflects the limited habitat available in these upper catchment streams.

The Lephalala Waterberg report unit. (7 Sites)

39 out of a reference of 47 families were recorded. It is suspected that a number of factors may have contributed to artificially low SASS5 scores across this reporting unit. The natural environment and generally good water quality are not indicated by the scores obtained. Droughts in 2004 followed by recent high flows in 2005 may have contributed to the lower than expected scores. The Waterberg unit also has difficult working conditions for SASS5 kick sampling of benthic substrates due to the presence of large boulders and bedrock. Nevertheless, two sites had SASS5 scores greater than 130, with ASPT'S ranging between 4.94 and 7.08.

The Limpopo Plain report unit. (5 Sites)

40 out of a reference of 46 families were recorded. The Limpopo Plain unit yielded SASS5 scores of up to 153 with fairly consistent ASPT's ranging from 4.94 to 5.62. The higher scores reflect generally easier working conditions, together with a higher diversity of easy sampling habitats.

The Blocklandspruit tributary. (4/5 sites surveyed)

26 out of a reference of 34 families were recorded. SASS5 scores varied considerably, depending on available habitats at each site. (47 – 104) with ASPT's 4.27 – 6.57. Good marginal vegetation was largely offset by poor benthic substrates of bedrock and sand.

The Daggakraal tributary. (1 site only)

Only 10 out of a reference of 17 families were recorded, giving a SASS5 score of 40 and an ASPT of 4.0. The small scale and habitat of the wetland pools account for this low score, but in terms of the reference condition, this river is still in a good class.

6. The Eco Status and Ecological Importance and Sensitivity (EIS) of the Lephalala Catchment.

The Eco Status of a catchment is determined by assessing all of the abiotic and biotic metrics (on a scale of 0 – 5) and applying a weighting to each, in order to provide an overall assessment of the condition of the catchment.

The EIS is an indication of the level of protection that a river should receive. High meaning it should be protected to a natural or good state and low, meaning it has less conservation value or is already impacted and that the resource may be further utilized.

The Eco Status and the EIS of each reporting unit are assessed in detail in APPENDIX D by following a rule based model as described by Kleynhans *et al* (2005)

Summarized results are presented in table 14 and 15.

Table 15. Summarized Eco Status, showing scores and weightings for each metric of each report unit, from a rule based model developed by Kleynhans *et al* (2005)
Score: 0 = No impact, 5 = High impact

Report unit	Bed modification		Flow modification		Introduced instream biota		Inundation		Riparian/Bank condition		Water quality modification		**DESKTOP HABITAT INTEGRITY**	Desktop Invertebrate Rating		Desktop Fish rating		**INSTREAM EC%**	**INSTREAM EC**	Desktop Vegetation Rating		**ECOSTATUS %**	**ECOSTATUS EC**	CONFIDENCE
Lephalala upper tributaries.	1	85	3	50	3	50	1	85	3	50	1	85	67.5	2	70	3	50	62.5	C	3	50	58.3	**C/D**	4.0
Lephalala Waterberg.	1	85	3	50	1	85	2	70	2	70	1	85	74.17	2	70	3	50	64.7	C	2	70	66.5	**C**	4.0
Lephalala Limpopo Plain.	2	70	3	50	0	95	2	70	4	30	1	85	66.67	2	70	3	50	62.2	C	4	30	51.5	**D**	4.0
Blocklandspruit.	1	85	2	70	0	95	1	85	2	70	0	95	83.33	2	70	3	50	67.8	C	2	70	68.5	**C**	4.0
Daggakraal.	1	85	1	85	0	95	0	95	1	85	0	95	90	2	70	3	50	70.0	C	1	85	75.0	**C**	4.0

Table 16. EIS assessments for each report unit. From a rule based model developed by Kleynhans *et al* (2005) Score: 0 = No importance, 5 = Very high importance.

Rivers (Report unit).	Description	2005 Score	2005 Conf	2005 EIS SCORE (MEDIAN)	EIS	Comments
Lephalala upper tributaries (6.01)	Diversity of habitat types	3	4			Wetlands and mountain streams.
	Importance of conservation & natural areas	3	4			Important mountain catchment and wetlands. Private reserves & source to wilderness rivers.
	Intolerant (flow & flow related water quality)	3	4			Bbre, Beut, Cthe, mayflies and caddisflies.
	Migration route/corridor	3	4			Important bird area.
	Rare & endangered	2	4			Bbre, Cthe, cranes, cycads.
	Refugia	2	4			Numerous streams providing refuge to all.
	Sensitivity to water quality changes	3	4			All fish and inverts require good quality.
	Sensitivty to flow changes	3	4			Bbre, Beut, Cthe, mayflies and caddisflies.
	Species/Taxon Richness	2	4			5/7 fish recorded, 18/27 inverts recorded.
	Unique (endemic, isolated, etc.)	2	4	3.0	**HIGH**	Cthe
Lephalala Waterberg (6.01)	Diversity of habitat types	4	4			Pools, rapids, riffles, gorge
	Importance of conservation & natural areas	3	4			Lephalala Wilderness Area and Biosphere
	Intolerant (flow & flow related water quality)	3	4			Cpre, Beut, Oper
	Migration route/corridor	3	4			Lowveld to mountain. Eels.
	Rare & endangered	3	4			Oper, Bbre, Crocodiles
	Refugia	3	4			For streams and lowveld
	Sensitivity to water quality changes	3	4			Cpre, Beut, Oper, Mayflies, Caddisflies, Stoneflies
	Sensitivty to flow changes	3	4			Cpre, Beut, Oper, Mayflies, Caddisflies, Stoneflies
	Species/Taxon Richness	4	4			16/30 fish and 39/47 inverts
	Unique (endemic, isolated, etc.)	1	4	3.0	**HIGH**	Cthe (possible)

Lephalala Limpopo Plain (1.02)	Diversity of habitat types	2	4			Pool, gravel riffle, sandy runs.
	Importance of conservation & natural areas	1	4			Private game farms
	Intolerant (flow & flow related water quality)	1	4			Cpar
	Migration route/corridor	3	4			Links Limpopo to Waterberg.
	Rare & endangered	1	4			Crocodiles.
	Refugia	2	4			Refuge for Limpopo.
	Sensitivity to water quality changes	1	4			Temperature in pools.
	Sensitivty to flow changes	3	4			Labeo spp., Cpar and Lmar.
	Species/Taxon Richness	4	4			17/30 fish recorded. 40/46 inverts recorded
	Unique (endemic, isolated, etc.)	1	4	1.5	**MODERATE**	Hippo?
Blocklandspruit (6.01)	Diversity of habitat types	3	4			Bedrock and sand, pools, rapids and riffles
	Importance of conservation & natural areas	3	4			Entirely in Lephalala Wilderness Area
	Intolerant (flow & flow related water quality)	3	4			Oper, Bbre, Beut, Cpre.
	Migration route/corridor	2	3			Eels.
	Rare & endangered	3	3			Bbre, Oper.
	Refugia	3	4			For Lephalala
	Sensitivity to water quality changes	3	3			Oper, Bbre, Beut, Cpre.
	Sensitivty to flow changes	3	3			Oper, Bbre, Beut, Cpre.
	Species/Taxon Richness	3	4			20/27 fish recorded. 26/34 inverts recorded
	Unique (endemic, isolated, etc.)	1	3	3	**HIGH**	Mayflies?
Daggakraal (6.01)	Diversity of habitat types	2	4			Wetland pools, sandy runs.
	Importance of conservation & natural areas	3	4			Entirely in Lephalala Wilderness Area.
	Intolerant (flow & flow related water quality)	0	3			
	Migration route/corridor	1	3			Fish take up available habitat.
	Rare & endangered	0	1			
	Refugia	1	2	1	**LOW/MARGINAL**	For Lephalala?

	Sensitivity to water quality changes	1	3			Wetland habitat.
	Sensitivty to flow changes	2	3			Wetland habitat.
	Species/Taxon Richness	3	3			7/13 fish recorded. 10/17 inverts recorded
	Unique (endemic, isolated, etc.)	1	1			Possible birds, reptiles etc.

7. Management recommendations.

Table 17. Management recommendations.

ISSUE	ACTION	RESPONSIBILITY
The upper catchment grasslands and source wetlands for the Lephalala, on the farm Weltevreden 172 KR, are very important but are degraded and under threat of subdivision.	This is a prime area for identification as a priority in the conservation planning process. The lands should be protected and rehabilitated. Negotiation with the land owner should be implemented without delay.	• Management to request Wetland Scientist, to address the issue with the landowner. • Declare as an area of natural importance. • Info to be fed into conservation planning data base – when in place. • No subdivisions should be allowed.
A scientifically motivated reserve determination has not been addressed for this catchment.	A Comprehensive Reserve should be undertaken as a high priority.	Management to inform DWAF, national and regional, that a Comprehensive Reserve should be addressed as soon as possible.
There are many farm dams in the upper catchment which are affecting river flows.	A moratorium on the development of new dams, should be implemented.	Management to inform EIA section and DWAF that no new dams should be considered until a Comprehensive Reserve has been completed.
Due to the high Ecological Importance and Sensitivity (EIS) of the catchment, monitoring of the river should be conducted regularly on a 3 yearly basis.	Monitoring should be coordinated accordingly.	Specialist scientist to liaise with monitoring personnel, district personnel and DWAF accordingly.
Report should be distributed to relevant role players.	Distribute to management, municipalities and DWAF.	Specialist Scientist.
A glossy SORR should be considered.	Investigate possibilities with DWAF, RHP and CSIR.	Specialist Scientist.

8. Conclusions.

Although the catchment was reeling from the effects of drought, at the time of the survey, it still has a high Ecological Importance and Sensitivity (EIS), largely due to the fact that a substantial portion of the catchment falls on private nature reserves or game farms. Management should take note of those issues raised in table 16 and take the recommended actions to help conserve this catchment.

The results of this survey have led to an assessment of the Eco Status of the catchment (Table 14), which at this time places the entire catchment in a "fair" Ecological Category.

9. References.

DC Midgley, WV Pitman and BJ Middleton. 1994. Surface Water Resources of South Africa. Book of Maps. WRC Report no. 298/1.2/94

DC Midgley, WV Pitman and BJ Middleton. 1994. Surface Water Resources of South Africa. Volume 1. APPENDICES. WRC Report no. 298/1.1/94

Kleynhans, C. J. 1997. An exploratory investigation of the instream biological integrity of the Crocodile River, Mpumalanga, as based on the assessment of fish communities. Institute for Water Quality Studies, Department of Water Affairs and Forestry, Pretoria, South Africa.

Kleynhans, CJ, Louw, MD, Thirion, C, Rossouw, NJ, and Rowntree, K (2005). River Eco Classification: Manual for Eco Status determination (Version1). Joint Water Research Commission and Department of Water Affairs and Forestry report. WRC Report No. KV 168/05

Kleynhans CJ. , 2007. Module D: Fish Response Assessment Index in River eco Classification: Manual for Eco Status Determination (version 2)

Limpopo Province Fish Distribution Data Base (updated January 2007)

National Water Act (1998).

Rowntree, K. M. and Wadeson, R. 1999. An index of stream geomorphology for the assessment of river health. Field manual for channel classification and condition assessment.

Rowntree, K. M. And Ziervogel, G. 1999. Development of an index of stream geomorphology for the assessment of river health. NAEBP Report Series No 7. Institute for Water Quality Studies, Department of Water Affairs and Forestry, Pretoria, South Africa.

Skelton, P.H. 2001. *A Complete Guide to the Freshwater Fishes of Southern Africa*. (2nd Edition). Southern Book Publishers, Halfway House.

Skelton, P. H., 2002. Change to the scientific and common names of southern African freshwater fishes. *African Journal of Aquatic Science 2002, 27: 171 – 174.*