AQUATIC ECOLOGICAL STUDY PRIOR TO THE PROPOSED DEVELOPMENT OF THE INGULA BRIDGE

PREPARED FOR

Cymbian Enviro Social Consulting Services (Pty) Ltd

Prepared by:	Scientific Aquatic Services
Report Authors:	S. van Staden (Pr. Sci. Nat)
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Scientific Aquatic Services CC
CK Reg No 2003/078943/23
Vat Reg. No. 4020235273
347 Highland Rd
Kensington
2094
Tel: 011 616 7893
Fax: 011 615 4106
E-mail: admin@sasenvironmental.co.za

Executive Summary

Cymbian Enviro Social Consulting Services (Pty) Ltd requested that an aquatic ecological assessment of the Braamhoekspruit be undertaken prior to the proposed development of the Ingula Bridge. The purpose of the report is to provide a summary of the ecological status of the aquatic resources and to identify risks to the aquatic ecology which will be related to the proposed development.

The Braamhoekspruit forms part of the V12A quaternary catchment and is a headwater stream of the Kliprivier in the Tugela water management area. The site is represented on the 2829BC SA 1: 50 000 topographical map.

The Braamhoekspruit River originates in a remote, hilly area in the vicinity of the van Reenen mountain pass over the Drakensberg escarpment where numerous tributaries of varying size enter the stream upstream of the study area. The area is populated by rural villages and the surrounding areas are generally used for subsistence agriculture and cattle grazing. Limited impact on water quality is presently likely to occur; however, some impact due to the use of the water for domestic purposes and livestock watering is possible.

According to the ecological importance classification for the quaternary catchment the system is classified as a moderately sensitive system which in its present state can be considered to be a Class B (Largely natural) stream.

The points below summarise the findings of the assessment undertaken:

Water quality

- The general water quality in the system is very good and based on the EC value the system can be considered to be natural.
- Limited addition of salts is likely to occur upstream of the development site at the present time.
- The pH values of the sites indicate that water is fairly neutral and is unlikely to limit the aquatic community in any significant way.
- Good concentrations of dissolved oxygen were observed in the system.

Habitat suitability and integrity

- Channel modifications have been caused by erosion while small changes to water quality due to cattle watering and the surrounding rural activities are deemed likely.
- Overall instream habitat integrity can be regarded as being natural (Class A) on the Braamhoekspruit.
- Bank erosion has had a serious impact on the riparian zone of the Braamhoekspruit.
- Overall riparian habitat integrity can be regarded as being largely natural (Class B).
- The overall integrity of the system can be considered to be natural (Class A) on the Braamhoekspruit.
- Habitat structure and diversity are suitable for supporting a diverse aquatic macro-invertebrate community. In areas where no rocky habitat is present the suitability for invertebrates is reduced.
- The site provides fairly good habitat for fish with a fair diversity of depth flow and substrate types present.
- Some deeper pools are present and can provide refuge areas for several fish species.
- The lack of fast deep cover features will limit the potential aquatic community to some degree.

Aquatic macro-invertebrates

- The aquatic macro-invertebrate community has numerous sensitive taxa present; however, the diversity of the community is limited.
- Overall both sites were classified as Class D sites indicating largely impaired conditions according to Dickens & Graham while according to the Dallas (2007) classification the upstream site was classified as a Class D site while the downstream site was classified as a Class E/F site.

- Impacts on habitat and more specifically bank erosion are deemed to be a significant limiting factor in the aquatic macro-invertebrate community of the area.
- The more sensitive taxa in the area, such as *Tricorythidae; Heptageniidae; Leptophlebidae;* are sensitive both to water quality changes as well as changes in flow, turbidity and substrate conditions.

Fish community and other species reliant on aquatic environments

- No fish community was present at the time of assessment. Some impacts on the system may be occurring which may affect fish migration to the site. Seasonal absence of fish from the system is deemed a possible reason for the absence of fish in the system.

The points below serve to summarise the measures deemed necessary in order to ensure protection of the riparian and aquatic resources and to ensure environmental protection during the construction phase of the proposed development.

- It is deemed essential that flow continuity be maintained in the Braamhoekspruit River throughout the construction phase of the proposed development. This is necessary to ensure the ongoing viability of the aquatic communities downstream of the proposed crossing which is dependant on fair levels of flow in the system.
- The bridge design must ensure that the creation of turbulent flow in the system is minimised to prevent downstream erosion. No support pillars should be constructed within the active channel.
- The duration of impacts on the stream should be minimised as far as possible by ensuring that the duration of time in which flow alteration and sedimentation will take place is minimised.
- During construction erosion berms should be installed to prevent gully formation and siltation of the Braamhoekspruit River. This is necessary to ensure the ongoing viability of the aquatic communities downstream of the proposed dam wall which are dependant on cobble substrates which are free of sediment deposition.
- All areas affected by construction should be rehabilitated upon completion of the construction phase of the development. Areas should be reseeded with indigenous grasses as required.
- During the construction phase no vehicles should be allowed to indiscriminately drive through the riparian areas.
- No dumping of waste should take place within the riparian zone.
- No fires should be permitted near the bridge construction area
- If any spills occur, they should be immediately cleaned up.
- The characteristics of the stream bed are likely to be altered locally. Rough rocks easily abrade and damage fish skin, and are a common cause of skin infections among fish. It is likely that any rubble left in the stream will lead to chronic (low-level) skin infections among fish for a long period. This could be mitigated by ensuring that all rock and rubble is removed from the active stream channel once construction has been completed.
- All alien vegetation in the riparian zones of the should be removed upon completion of construction.
- Throughout the construction phase of the development biomonitoring using the same techniques as were used in this baseline report should be implemented in order to monitor the effects of the development on the Braamhoekspruit River. If the SASS and ASPT scores decrease by more than 15%, it should serve as an indication that the system is suffering harm and measures to minimise the impacts of the development on the system should be implemented.

The points below serve to summarise the measures deemed necessary in order to ensure protection of the riparian and aquatic resources and to ensure environmental protection during the operational phase of the proposed development.

- Any areas where bank failure is observed, due to the effects of bridge crossing should be immediately repaired by reducing the gradient of the banks to a 1:3 slope.
- Bank vegetation cover should be monitored to ensure that sufficient vegetation is present to bind the bankside soils and prevent further bankside erosion.

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1. Introduction and background information

Cymbian Enviro Social Consulting Services (Pty) Ltd requested that an aquatic ecological assessment of the Braamhoekspruit be undertaken prior to the proposed development of the Ingula Bridge. The purpose of the report is to provide a summary of the ecological status of the aquatic resources and to identify risks to the aquatic ecology which will be related to the proposed development.

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According to the ecological importance classification for the quaternary catchment the system is classified as a moderately sensitive system which in its present state can be considered to be a Class B (Largely natural) stream.

The following points summarise the impacts known to occur within the catchment:

- Significant impacts from stream bed modifications have been noted due to impacts from agriculture
- Flow modification has occurred in isolated areas
- Some impact in the catchment from the introduction of alien fish species namely *Cyprinus carpio* and *Micropterus salmoides* has occurred.
- Some impact from inundation is evident.
- Banks are often severely eroded.

The following points summarise the most important aspects in terms of the classification of the sensitivity of the system:

- The system is regarded as having no importance for Rare and endangered species conservation.
- The system has a low importance in terms of providing refugia for aquatic community members.

- The site can be considered to be sensitive to changes in water quality and flow.
- The site is of moderate importance in terms of species sensitivity.
- The site is of moderate importance due to the system hosting some species with limited distributions including *Labeobarbus natalensis, Labeo molybdinus* and *Labeo rubromaculatus.*

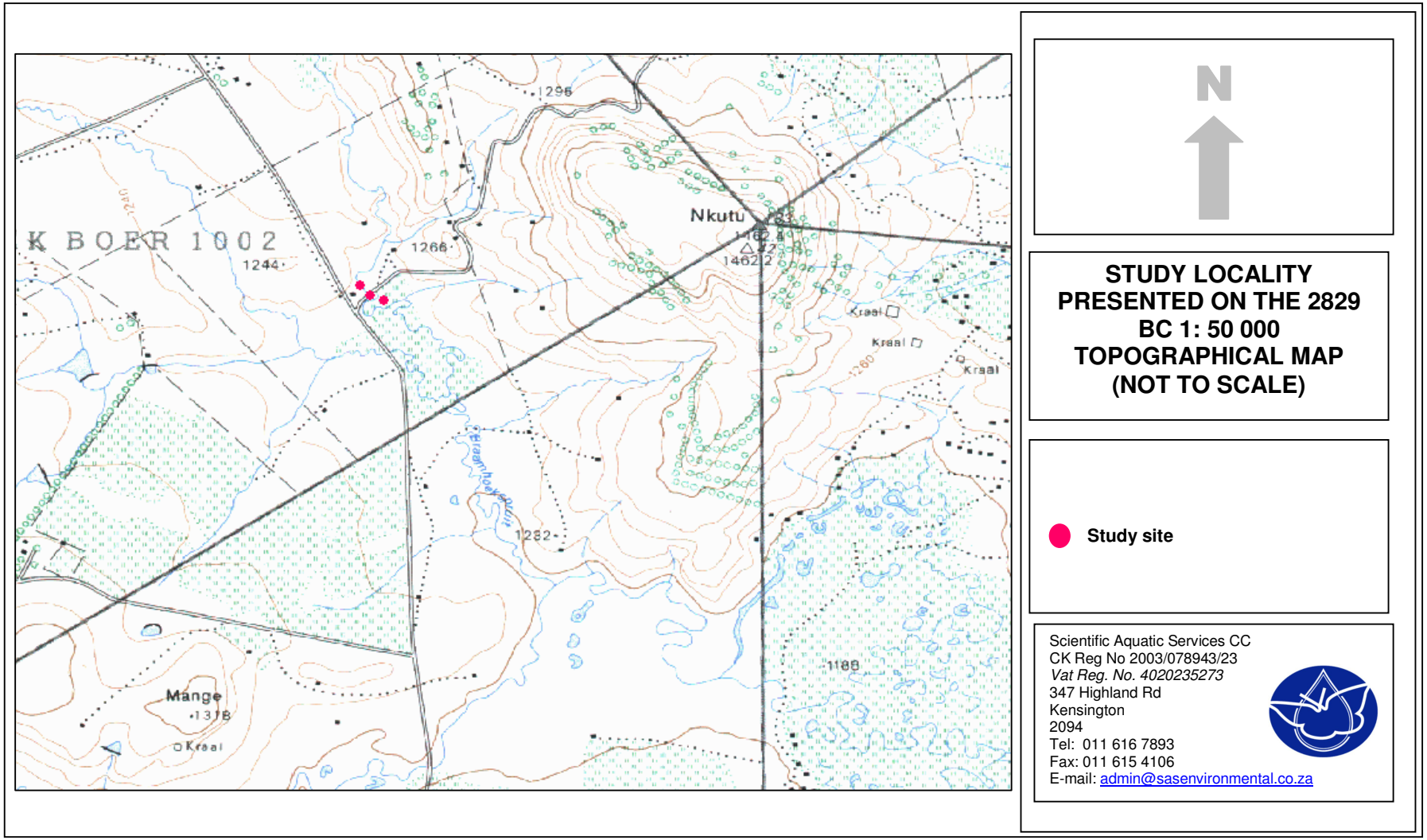


Figure 1: Study locality presented on the 2829 BC 1:50 000 topographical map

2. Methodology

A point on the Braamhoekspruit River was assessed to determine the aquatic ecological integrity of the system. The macro-invertebrate, fish and the aquatic habitat suitability for various aquatic biota was assessed at this point. The sections below will define the various methods of assessment used during the study.

2.1 Visual assessment

Each site was investigated in order to identify visible impacts on the site with specific reference to impacts from surrounding activities. Both natural constraints placed on ecosystem structure and function as well as anthropogenic alterations to the system was assessed by observing conditions and relating them to professional experience. Photographs of each site were taken to provide visual indications of the conditions at the time of assessment. Factors which were noted in the site-specific visual assessments included the following:

- Stream morphology;
- Instream and riparian habitat diversity;
- Stream continuity;
- Erosion potential;
- Depth flow and substrate characteristics;
- Signs of physical disturbance of the area;
- Other life forms reliant on aquatic ecosystems;
- Signs of impact related to water quality

2.2 Water quality

On site testing of biota specific water quality variables took place where surface water was present. Parameters measured include pH, electrical conductivity, dissolved oxygen concentration and temperature. The results of on-site biota specific water quality analyses were used to aid in the interpretation of the data obtained during the aquatic ecological assessment. Results are discussed against the guideline water quality values for aquatic

ecosystems (DWAF 1996 vol. 7) as well as the classification system modified from Palmer and Rossouw (2000) as indicated below.

Table 1: TDS and EC values linked to water quality classes for the Olifants River catchment (Modified from Palmer and Rossouw 2000)

Class	Salinity (TDS mg/l)	Electrical conductivity (mS/m)
Natural	130-195	<30
Good	195-360	30-55
Fair	360-520	55-80
Poor	>520	>80

A water sample was also taken for physico-chemical analyses. The sample was analysed for selected parameters in addition to an ICP MS scan for 66 elements. These results aid in defining the baseline conditions to which future data can be compared to.

2.3 Habitat integrity

2.3.1 General Habitat Integrity

The general habitat integrity of each site was discussed based on the application of the Intermediate Habitat Integrity assessment for use in rapid and intermediate habitat assessments (Kleynhans; 1999). It is important to assess the habitat of each site in order to aid in the interpretation of the results of the community integrity assessments by taking habitat conditions and impacts into consideration. This method describes the Present Ecological State (PES) of both the in-stream and riparian habitats at each site are included in the assessment. The method classifies habitat integrity into one of six classes, ranging from unmodified/natural (Class A), to critically modified (Class F).

Table 2: Classification of Present State Classes in terms of Habitat Integrity [Based on DWAF 1999]

Class	Description	Score (% of total)
A	Unmodified, natural.	90-100
B	Largely natural, with few modifications.	80-90
C	Moderately modified.	60-79
D	Largely modified.	40-59
E	Extensively modified.	20-39
F	Critically modified.	<20

2.3.2 Habitat for aquatic macro-invertebrates

The Invertebrate Habitat Assessment System (IHAS) was applied according to the protocol of McMillan (1998). This index was used to determine specific habitat suitability for aquatic macro-invertebrates as well as to aid in the interpretation of the results of the South African Scoring System version 5 (SASS5) scores. Scores for the IHAS index were interpreted according to the guidelines of McMillan (1998) as follows:

- <65% inadequate for supporting a diverse aquatic macro-invertebrate community
- 65%-75% adequate for supporting a diverse aquatic macro-invertebrate community
- >75% highly suited for supporting a diverse aquatic macro-invertebrate community

2.3.3 Habitat for fish

This assessment is aimed at the determination of the potential of a site to provide habitat for fish (Fish Habitat Cover Ratings) by assessing features generally referred to as cover (Brookes *et al,* 1996). Cover ratings allow the diversity and amount of cover available to fish to be assessed (Van Staden 2003).

This approach was developed to assess habitats according to different attributes that are surmised to satisfy the habitat requirements of various fish species. At each site, the following depth-flow (df) classes are identified, namely:

- Slow (<0.3m/s), shallow (<0.5m) – Shallow pools and backwaters
- Slow, deep (>0.5m) – Deep pools and backwaters
- Fast (>0.3m/s), shallow – Riffles, rapids and runs
- Fast, deep – Usually rapids and runs

For each depth-flow class, the following cover features (cf) – considered to provide fish with the necessary cover to utilise a particular flow and depth class – were investigated:

- Overhanging vegetation
- Undercut banks and root wads
- Stream substrate

- Aquatic macrophytes

The relative contribution of each of the above-mentioned cover classes as well as the amount of cover present at each of these cover features (cf) was noted using the following system:

- 0 = Absent
- 1 = Rare/very poor (<5%)
- 2 = Sparse/poor (5-25%)
- 3 = Moderate/good (25-75%)
- 4 = Extensive/excellent (>75%)

The fish habitat cover rating (HCR) was calculated as follows:

– The contribution of each depth-flow class at the site was calculated ($df/\Sigma df$)

– For each depth-flow class, the fish cover features (cf) were summed (Σcf)

$HCR = df/\Sigma df \times \Sigma cf$

The amount and diversity of cover available for the fish community at the selected sites was expressed as habitat cover ratings (HCR) for different depth-flow classes.

2.4 Aquatic macro-invertebrates

Aquatic macro-invertebrate communities of the selected sites were investigated according to the method, which is specifically designed to comply with international accreditation protocols. This method is based on the British Biological Monitoring Working Party (BMWP) method and has been adapted for South African conditions by Dr. F. M. Chutter. The assessment was undertaken according to the protocol as defined by Dickens & Graham (2001). All work was undertaken by an accredited SASS5 practitioner.

Interpretation of the results of biological monitoring depends, to a certain extent, on interpretation of site-specific conditions (Thirion *et.al*, 1995). In the context of this investigation it would be best not to use SASS5 scores in isolation, but rather in comparison with relevant habitat scores. The reason for this is that some sites have a less desirable habitat or fewer biotopes than others do. In other words, a low SASS5 score is not necessarily regarded as poor in conjunction with a low habitat score. Also, a high SASS5

score in conjunction with a low habitat score can be regarded as better than a high SASS5 score in conjunction with a high habitat score. A low SASS5 score together with a high habitat score would be indicative of poor conditions. The IHAS Index is valuable in helping to interpret SASS5 scores and the effects of habitat variation on aquatic macro-invertebrate community integrity.

The perceived reference state for the Braamhoekspruit was determined as a SASS5 score of 212 and an ASPT of 7.2 based on general conditions of streams in the north eastern uplands ecoregion. The score was, however, downgraded slightly to account for the lack of flow in the system and the local habitat conditions and the season in which the assessment took place. The SASS score was therefore adjusted to 175 and the ASPT to 6.5. Interpretation of the results in relation to the reference scores was made according to the classification of SASS5 scores presented in the SASS5 methodology published by Dickens & Graham (2001) according to this reference as well as Dallas (2007). See Figure 2.

Table 3: Definition of Present State Classes in terms of SASS scores as presented in Dickens & Graham (2001)

Class	Description	SASS Score%	ASPT
A	Unimpaired. High diversity of taxa with numerous sensitive taxa.	90-100 80-89	Variable >90
B	Slightly impaired. High diversity of taxa, but with fewer sensitive taxa.	80-89 70-79 70-89	<75 >90 76-90
C	Moderately impaired. Moderate diversity of taxa.	60-79 50-59 50-79	<60 >75 60-75
D	Largely impaired. Mostly tolerant taxa present.	50 – 59 40-49	<60 Variable
E	Severely impaired. Only tolerant taxa present.	20-39	Variable
F	Critically impaired. Very few tolerant taxa present.	0-19	Variable

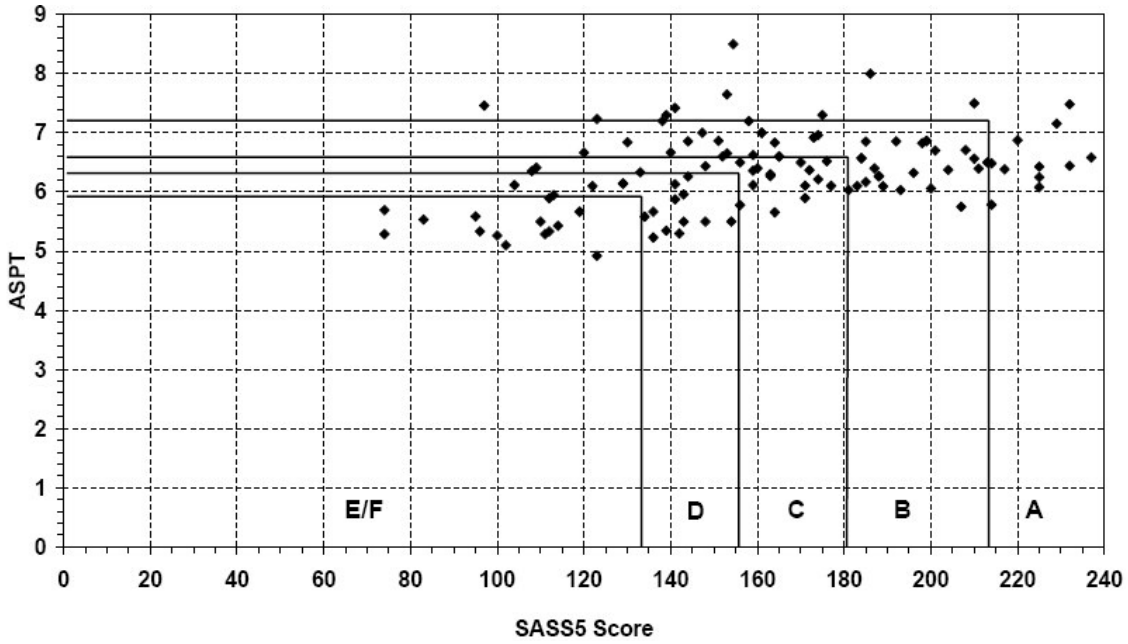


Figure 2: Biological bands for the North Eastern Uplands calculated using percentiles (Dallas; 2007)

2.5 Fish community integrity

The Fish Assemblage Integrity Index (FAII) was applied according to the protocol of Kleynhans (1999). Fish species identified were compared to those expected to be present at the site. Assessing the state of the fish community at a site can provide an indication of the long-term biological integrity of a stream segment. The expected fish species list was developed from a literature survey and included sources such as Skelton; (2001). The expected fish assemblage for each site was determined using these specific species known to occur in the area along with an assessment of availability of habitats, at each site. An expected species list was compiled for the region (Table 4). The integrity of the site was assessed according to the classification system of Kleynhans; (1999). See Table 5. Species regarded as being unlikely to occur on site or species which are only likely to occur on site in summer were omitted from the expected FAII score for the site.

Table 4: Intolerance ratings for naturally occurring indigenous fish species with natural ranges included in the study area (Kleynhans, 2003)

SPECIES NAME	COMMON NAME	INTOLERANCE RATING*	COMMENTS
Anguilla mossambica	Geelbek paling Longfin eel	1.8	Possibly occurring at the site
Anguilla bengalensis	African mottled eel	2.9	Possibly occurring at the site
Amphilius natalensis	Natal mountain catfish	4.9	Possibly occurring at the site but lack of fast water may prevent colonisation
Barbus anoplus	Chubbyhead barb	2.6	Likely to occur
Barbus pallidus	Chubbyhead barb	3.1	Likely to occur
Clarias gariepinus	Sharptooth catfish	1.2	Likely to occur
Labeobarbus natalensis	Natal yellowfish (Scaly)	2.8	Likely to occur in summer
Labeo rubromaculatus	Tugela labeo	2.7	Likely to occur in summer
Labeomolybdinus	Leaden labeo	3.2	Likely to occur
Lepomis macrochirus	Bluegill sunfish	1.9	Unlikely to occur unless introduced
Micropterus salmoides	Largemouth bass	2.2	Unlikely to occur unless introduced
Micropterus dolomieu	Smallmouth bass	2.3	Unlikely to occur unless introduced
Oreochromis mossambicus	Bloukurper Mozambique tilapia	1.3	Possibly occurring at the site
Cyprinus carpio	Carp	1.4	Possibly occurring at the site
Salmo trutta	Brown trout	3.4	Unlikely to occur
Onychorhynchus mykiss	Rainbow trout	3.4	Unlikely to occur
Tilapia Sparrmanii	Vleikurper Banded tilapia	1.3	Likely to occur

*Tolerant: 1-2 moderately tolerant :> 2-3 Moderately Intolerant: >3-4Intolerant: >4

Table 5: Definition of Present State Classes in terms of FAII scores according to the protocol of Kleynhans (1999)

Class	Description	Relative FAII score (% of expected)
A	Unmodified, or approximates natural conditions closely.	90-100
B	Largely natural, with few modifications.	80-89
C	Moderately modified. A lower than expected species richness and the presence of most intolerant species.	60-79
D	Largely modified. A clearly lower than expected species richness and absence of intolerant and moderately tolerant species	40-59
E	Seriously modified. A strikingly lower than expected species richness and a general absence of intolerant and moderately intolerant species	20-39
F	Critically modified. An extremely lowered species richness and an absence of intolerant and moderately intolerant species	<20

2.6 Assumptions and limitations

The following points serve to indicate the assumptions and limitations of this study.

- ***Reference conditions are unknown:*** The composition of aquatic biota in the study area prior to major disturbance is unknown. For this reason, reference conditions are hypothetical, and are based on professional judgement and/or inferred from limited data available.
- ***Temporal variability:*** The data presented in this report are based on a single site visit, undertaken in spring (February 2008). The effects of natural seasonal and long term variation in the ecological conditions and aquatic biota found in the streams are therefore unknown.
- ***Ecological assessment timing:*** Aquatic and terrestrial ecosystems are dynamic and complex; it is likely that aspects, some of which may be important, could have been overlooked during the winter assessment of the site. A more reliable assessment of the biota would require seasonal sampling with sampling being undertaken under both low flow and high flow conditions. Stream levels were fairly low during this field survey. The results of the study therefore represent the conditions on site under cool and relatively low flow conditions.

3. Results

3.1 Visual assessment

Figure 3: Downstream view of the IN1 site on the Braamhoekspruit showing the presence of pool habitats

Figure 4: Upstream view of the IN1 site on the Braamhoekspruit showing lack of low in the system at the time of assessment

Figure 5: Local view of the IN2 site indicating the pools habitat and slow flowing water

Figure 6: Local view of the IN2 site indicating the severe bank erosion at the site

Table 6: Visual description of the location of the upper and lower assessment sites

ASPECT	IN1	IN2
Surrounding features	The surrounding area is characterised by a remote rural environment dominated by subsistence agriculture and cattle grazing activities. There is a gauging weir immediately upstream of the site.	The surrounding area is characterised by a remote rural environment dominated by subsistence agriculture and cattle grazing activities. There is a small residential dwelling and a low water crossing immediately upstream of the site.
Significance of the points	The points serve to characterise the nature of the Braamhoekspruit upstream of the proposed bridge crossing prior to any impacts from the proposed development.	The points serve to characterise the nature of the Braamhoekspruit downstream of the proposed bridge crossing prior to any impacts from the proposed development.
Riparian zone characteristics	The riparian zone is fairly narrow due to the incised nature of the stream in some areas and the dominance of bedrock in other areas. In some areas the stream valley is steep sided leading to limited development of a riparian zone. The riparian vegetation consists of grasses such as *Imperata cylindrica, Hypparhenia hirta* and isolated stands of *Cyperus sp* and *Phragmites australis*.	The riparian zone is fairly narrow due to the incised nature of the stream along most of the areas downstream of the existing low water crossing. The riparian vegetation consists of grasses such as *Imperata cylindrica, Hypparhenia hirta* and islated stands of *Cyperus sp* and *Phragmites australis*.
Depth characteristics	The river has a good diversity of depth with deeper pools and glides and shallow riffles, rapids.	The river has a good diversity of depth with deeper pools and glides and shallow riffles, rapids.
Flow characteristics	The Braamhoekspruit has a good diversity of flow types ranging from very slow to moderately fast in a variety of depth classes. The lack of fast flowing water in this section of the stream will prevent several taxa from becoming established at this point in the system.	The Braamhoekspruit has a poor diversity of flow types below the stream crossing consisting mostly of slow flowing glides and pools. The lack of fast flowing water in this section of the stream will prevent several taxa from becoming established at this point in the system.
Water clarity	Water at this point is discoloured due to algal growth.	Water at this point is discoloured due to algal growth.
Erosion potential	The banks have a significant potential for erosion due to the presence of very steep banks in some areas. Bank failure has already occurred in some areas. Other areas are protected from erosion by the presence of bedrock.	The banks have a significant potential for erosion due to the presence of very steep banks in some areas. Bank failure has already occurred in some areas.
Stream continuity	Limited impacts on stream continuity were observed; however, the gauging weir and existing road crossing may prevent some migration of more mobile species.	No impacts on stream continuity below the bridge were observed.

3.2 Water quality

The table below records the biota specific water quality of the two riverine assessment sites.

Table 7: Biota specific water quality data along the main drainage feature

SITE	COND mS/m	pH	D. O. mg/l	TEMP °C
IN1	6.4	7.9	7.8	10.3
IN2	6.4	7.82	7.6	10.4

The general water quality in the system is very good and based on the EC value the system can be considered to be natural. Limited addition of salts is likely to occur upstream of the development site at the present time. The pH values of the sites indicate that water is fairly neutral. The neutral water conditions can be regarded as being natural, due to the local geological and biological processes and is therefore unlikely to limit the aquatic community in any significant way.

Good concentrations of dissolved oxygen were observed in the system. The dissolved oxygen content is unlikely to be a significant limiting factor in the aquatic ecological integrity of the system.

The water temperature of the site can be regarded as normal for the time of the year and for the time of day at which sampling took place and with the given depth and flow conditions.

3.3 Habitat integrity

The Index of Habitat Integrity was applied to the Braamhoekspruit segment in the vicinity of the proposed development. The assessment results are presented in Figure 7.

From the assessment of general habitat integrity it can be seen that instream impacts were limited to low level impacts on the stream with channel and water quality modification being the most significant. Channel modifications have been caused by erosion while small changes to water quality due to cattle watering and the surrounding rural activities are deemed likely. Overall instream habitat integrity can be regarded as being natural (Class A) on the Braamhoekspruit.

The riparian zone showed impacts of a similar nature to the instream environment. Bank erosion has had a serious impact on the riparian zone of the Braamhoekspruit. Overall riparian habitat integrity can be regarded as being largely natural (Class B).

The overall integrity of the system can be considered to be natural (Class A) on the Braamhoekspruit. The system can therefore be considered to be in good condition and can be considered to be fairly sensitive. As such due protection of these resources should be afforded and cognizance of the potential impacts on the system needs to be considered.

In stream Habitat Integrity

Weights	14	13	13	13	14	10	9	8	6		
REACH	Water abstraction	Flow modification	Bed modification	Channel modification	Water quality	Inundation	Exotic macrophytes	Exotic fauna	Solid waste disposal	Total Score (%)	Classification
INGULA	0	0	0	6	3	0	0	0	0	95	A Natural

None	small	Moderate	Large	Serious	Critical

Riparian Zone Habitat Integrity

Weights	13	12	14	12	13	11	12	13		
REACH	Vegetation removal	Alien encroachment	Bank erosion	Water abstraction	Flow modification	Channel modification	Water quality	Inundation	Total Score (%)	Classification
INGULA	0	0	19	0	0	4	0	0	88	B Largely natural

None	small	Moderate	Large	Serious	Critical

REACH	*INSTREAM HABITAT*	*RIPARIAN ZONE*	*IHI SCORE*	*CLASS*
INGULA	93.6	88	91	A Natural

Figure 7: Summary of the application of the IHI index to the study site

3.4 Aquatic macro-invertebrates

Tables 8, 9 and 10 provide a summary of the results obtained from the application of the SASS5 and IHAS indices to the two assessment point on the Braamhoekspruit.

Table 8: Biotope specific summary of the results obtained from the application of the SASS5 index to the assessment sites

PARAMETER	SITE	STONES	VEGETATION	GRAVEL, SAND AND MUD	TOTAL
SASS5 Score	IN1	71	25	-	75
	IN2	-	39	39	77
Number of taxa	IN1	11	4	-	12
	IN2	-	8	8	14
ASPT	IN1	6.5	6.3	-	6.3
	IN2	-	4.9	4.9	5.5

Table 9: A summary of the results obtained from the application of the SASS5 and IHAS indices to the assessment sites

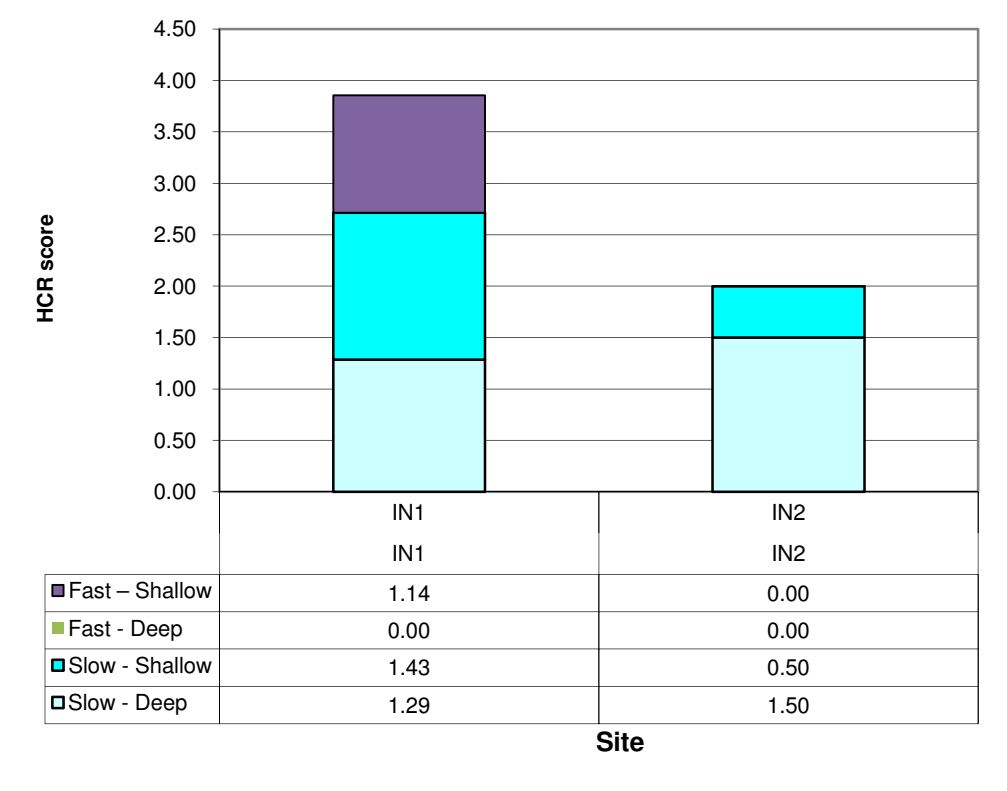
Type of Result	IN1	IN2
Biotopes sampled	Stones in and out of current, bedrock, marginal vegetation in and out of current.	Marginal vegetation in and out of current gravel, sand and mud.
Sensitive taxa present	*Tricorythidae; Heptageniidae; Leptophlebidae;*	*Dixidae*
Sensitive taxa absent	*Aeshnidae; Cordulidae; Ecnomidae; Psephenidae; Hydracarina, Perlidae; Chlorocyphidae; Philopotamidae; Elmidae; Chlorolestidae; Athericidae; Dixidae*	*Aeshnidae; Cordulidae; Hydracarina, Chlorocyphidae; Elmidae; Chlorolestidae; Athericidae*
Adjusted SASS5 score	91	111
SASS5 % of reference score	42.9%	44%
ASPT % of reference score	96.9%	84.6%
Dickens and Graham, 2001 SASS5 classification	Class D: Largely impaired	Class D: Largely impaired

Table 10: Summary of the results obtained from the application of the IHAS index to the assessment sites

ASPECT	IN1	IN2
McMillan, 1998 IHAS description	Habitat structure and diversity are suitable for supporting a diverse aquatic macro-invertebrate community.	Habitat structure and diversity is inadequate for supporting a diverse aquatic macro-invertebrate community.
Flow types	The flow at the site is diverse providing good diversity of habitats for aquatic macro-invertebrates although faster flows are lacking.	The flow at the site consists of slow flowing pools and glides which limits the habitat suitability and diversity for aquatic macro-invertebrates.
IHAS stones biotopes results	Rocky habitat is present in a diversity of depth and flow classes providing good habitat for aquatic macro-invertebrates. The lack of interstitial spaces may limit the community in this biotope to some degree. The lack of rocky habitat in fast current will prevent some taxa from colonizing the site.	No rocky habitat was present downstream of the bridge.
IHAS vegetation biotopes results	Marginal vegetation cover was fairly poorly represented due to the degree of bank incision. Vegetation cover was present both in and out of current. Marginal vegetation had little leafy structure providing poor habitat and cover for aquatic macro-invertebrates and fish. No aquatic vegetation cover was present.	Marginal vegetation cover was fairly poorly represented due to the degree of bank incision. Vegetation cover was present out of current only. Marginal vegetation had little leafy structure providing poor habitat and cover for aquatic macro-invertebrates and fish. No aquatic vegetation cover was present.
IHAS other biotopes results	No GSM biotopes were present.	Excellent sandy substrate is present providing cover for suitably adapted aquatic families.
IHAS general stream characteristics	A fairly narrow relatively clear flowing river with diverse depth, and substrate. Flow in the system is generally slow. Riparian vegetation consists of grasses with low diversity and limited degree of wetland formation.	A fairly narrow relatively clear flowing river with diverse depth. Substrate at this point is limited to gravel sand and mud. Flow in the system is generally slow. Riparian vegetation consists of grasses with low diversity and limited degree of wetland formation.
IHAS score	69	48
IHAS Adjustment score	+16	+34

3.5 Fish community and habitat for fish

The riverine assessment site was sampled for fish for a period of one hour. Figure 8 below summarises the habitat and cover availability for fish in this reach of the Braamhoekspruit River. The table below serves to summarise the findings of the application of the FAII index to the site.



	IN1	IN2
	IN1	IN2
Fast – Shallow	1.14	0.00
Fast - Deep	0.00	0.00
Slow - Shallow	1.43	0.50
Slow - Deep	1.29	1.50

Figure 8: Summary of the application of the HCR index to the study site

Table 11: A summary of the results obtained from the application of the FAII index to the assessment site

Type of Result	IN1	IN2
Habitat for fish	The site provides fairly good habitat for fish with a fair diversity of depth flow and substrate types present. Some deeper pools are present and can provide refuge areas for several fish species. Little coverage is provided by bankside overhanging vegetation and undercut root wads. The rocky habitat both in faster and slow moving water provides excellent cover for fish species. The lack of fast deep cover features will limit the potential aquatic community to some degree.	The site provides poor habitat for fish with a poor diversity of depth flow and substrate types present. Some deeper pools are present and can provide refuge areas for several fish species. Fairly good coverage is provided by bankside overhanging vegetation. There is no cover from rocky habitat or undercut root wads in this section of the system. The lack of fast water cover features will limit the potential aquatic community to some degree.
Species present and number of individuals obtained	0	0
Health and condition	Not applicable .	Not applicable .
Expected FAII score	118.5	70.5
Observed FAII score	0	0
Relative FAII score	0%	0%
FAII classification (Kleynhans, 1999)	"Class F". Critically Modified.	"Class F". Critically Modified.
Comments	No fish community was present at the time of assessment. Some impacts on the system may be occuring. Seasonal absence of fish from the system is deemed a possible reason for the absence of fish in the system.	No fish community was present at the time of assessment. Some impacts on the system may be occuring. Seasonal absence of fish from the system is deemed a possible reason for the absence of fish in the system.

3.6 Key findings

Water quality

- The general water quality in the system is very good and based on the EC value the system can be considered to be natural.

- Limited addition of salts is likely to occur upstream of the development site at the present time.
- The pH values of the sites indicate that water is fairly neutral and is unlikely to limit the aquatic community in any significant way.
- Good concentrations of dissolved oxygen were observed in the system.

Habitat suitability and integrity

- Channel modifications have been caused by erosion while small changes to water quality due to cattle watering and the surrounding rural activities are deemed likely.
- Overall instream habitat integrity can be regarded as being natural (Class A) on the Braamhoekspruit.
- Bank erosion has had a serious impact on the riparian zone of the Braamhoekspruit.
- Overall riparian habitat integrity can be regarded as being largely natural (Class B).
- The overall integrity of the system can be considered to be natural (Class A) on the Braamhoekspruit.
- The system can therefore be considered to be in good condition and can be considered to be fairly sensitive.
- As such due protection of these resources should be afforded and cognizance of the potential impacts on the system needs to be considered.

- Habitat structure and diversity are suitable for supporting a diverse aquatic macro-invertebrate community. In areas where no rocky habitat is present the suitability for invertebrates is reduced.

- The site provides fairly good habitat for fish with a fair diversity of depth flow and substrate types present.
- Some deeper pools are present and can provide refuge areas for several fish species. Little coverage is provided by bankside overhanging vegetation and undercut root wads.
- The rocky habitat both in faster and slow-moving water provides excellent cover for fish species.
- The lack of fast deep cover features will limit the potential aquatic community to some degree.

Aquatic macro-invertebrates

- The aquatic macro-invertebrate community has numerous sensitive taxa present; however, the diversity of the community is limited.
- Overall both sites were classified as Class D sites indicating largely impaired conditions according to Dickens & Graham while according to the Dallas (2007) classification the upstream site was classified as a Class D site while the downstream site was classified as a Class E/F site.
- Impacts on habitat and more specifically bank erosion are deemed to be a significant limiting factor in the aquatic macro-invertebrate community of the area.
- The more sensitive taxa in the area, such as *Tricorythidae; Heptageniidae; Leptophlebidae;* are sensitive both to water quality changes as well as changes in flow, turbidity and substrate conditions.

Fish community and other species reliant on aquatic environments

- No fish community was present at the time of assessment. Some impacts on the system may be occurring which may affect fish migration to the site. Seasonal absence of fish from the system is deemed a possible reason for the absence of fish in the system.

3.7 Design and impact minimisation

The points below serve to summarise the measures deemed necessary in order to ensure protection of the riparian and aquatic resources and to ensure environmental protection during the construction phase of the proposed development.

- It is deemed essential that flow continuity be maintained in the Braamhoekspruit River throughout the construction phase of the proposed development. This is necessary to ensure the ongoing viability of the aquatic communities downstream of the proposed crossing which is dependant on fair levels of flow in the system.
- The bridge design must ensure that the creation of turbulent flow in the system is minimised to prevent downstream erosion. No support pillars should be constructed within the active channel.
- The duration of impacts on the stream should be minimised as far as possible by ensuring that the duration of time in which flow alteration and sedimentation will take place is minimised.

- During construction erosion berms should be installed to prevent gully formation and siltation of the Braamhoekspruit River. This is necessary to ensure the ongoing viability of the aquatic communities downstream of the proposed dam wall which are dependant on cobble substrates which are free of sediment deposition.
- The following points should serve to guide the placement of erosion berms during the construction phase of the development:
    - Where the track has slope of less than 2%, berms every 50m should be installed.
    - Where the track slopes between 2% and 10%, berms every 25m should be installed.
    - Where the track slopes between 10%-15%, berms every 20m should be installed.
    - Where the track has slope greater than 15%, berms every 10m should be installed.
- All areas affected by construction should be rehabilitated upon completion of the construction phase of the development. Areas should be reseeded with indigenous grasses as required.
- During the construction phase no vehicles should be allowed to indiscriminately drive through the riparian areas.
- No dumping of waste should take place within the riparian zone.
- No fires should be permitted near the bridge construction area
- If any spills occur, they should be immediately cleaned up.
- The characteristics of the stream bed are likely to be altered locally. In particular, the rock and rubble created during the construction process is likely to have sharp edges, and not the smooth surfaces that are typically associated with river rocks and pebbles. Rough rocks easily abrade and damage fish skin, and are a common cause of skin infections among fish. It is likely that any rubble left in the stream will lead to chronic (low-level) skin infections among fish for a long period. This could be mitigated by ensuring that all rock and rubble is removed from the active stream channel once construction has been completed.
- All alien vegetation in the riparian zone should be removed upon completion of construction.
- Throughout the construction phase of the development biomonitoring using the same techniques as were used in this baseline report should be implemented in order to

monitor the effects of the development on the Braamhoekspruit River. Assessments should be undertaken on a quarterly basis. If the SASS and ASPT scores decrease by more than 15%, it should serve as an indication that the system is suffering harm and measures to minimise the impacts of the development on the system should be implemented.

The points below serve to summarise the measures deemed necessary in order to ensure protection of the riparian and aquatic resources and to ensure environmental protection during the operational phase of the proposed development.

- Any areas where bank failure is observed, due to the effects of bridge crossing should be immediately repaired by reducing the gradient of the banks to a 1:3 slope.
- Bank vegetation cover should be monitored to ensure that sufficient vegetation is present to bind the bankside soils and prevent further bankside erosion.

4. References

Bredenkamp, G. and Van Rooyen, N. (1998). 34. **Rocky Highveld Grassland – Grassland Biome**. *In:* Low, A. B. and Rebelo, A. G. (eds) (1998) Vegetation **of South Africa, Lesotho and Swaziland.** Department of Environmental Affairs & Tourism, Pretoria

Bromilow, C. (2001). **Problem plants of South Africa.** Briza Publications, Pretoria

Carruthers, V. (2001). **Frogs and frogging in southern Africa.** Struik Publishers, Cape Town

Coates-Palgrave, K. (2000). **Trees of southern Africa – second edition.** Struik Publishers, Cape Town

Chutter, F. M. (1998). **Research on the rapid biological assessment of water quality impacts in streams and rivers**. **Report to the water research commission by Environmentek,** CSIR, WRC report No 422/1/98. Pretoria: Government printer

Davis, B. and Day, J. (1998). **Vanishing waters**. University of Cape Town Press, Cape Town, South Africa

Dallas, H. F. (2007). River Health Programme: South African Scoring System (Sass) Data Interpretation Guidelines; Department of Water Affairs and Forestry

Dickens, C. & Graham, M. (2001). **South African Scoring System (SASS) version 5 Rapid bio assessment for rivers.** *May 2001*. CSIR. http.//www.csir.co.za/rhp/sass.html

Department of Water Affairs and Forestry (1996). **South African water quality guidelines vol. 7, Aquatic ecosystems**

Henderson, L. (2001). **Alien weeds and invasive plants – A complete guide to declared weeds and invaders in South Africa.** Plant Protection Research Institute, Agricultural Research Council Handbook No 12. Pretoria

Kleynhans, C.J. (2002). **Fish Intolerance ratings**. Proceedings resulting from the national fish workshop held at the WRC during 2001

Langer, R. H. M. and Hill, G. D. (1991). **Agricultural plants – second edition.** Cambridge University Press, Cambridge

McMillan, P. H. (1998). **An integrated habitat assessment system (IHAS v2) for the rapid biological assessment of rivers and streams**. A CSIR research project. Number ENV-P-I 98132 for the water resources management programme. CSIR. ii +44 pp

Mucina, L. and Rutherford, M. C. (2004). **Vegetation Map of South Africa, Lesotho and Swaziland (Beta version).** South African National Botanical Institute, Kirstenbosch Research Centre, Newlands, South Africa

Pooley, E. (1998). **A field guide to wild flowers Kwazulu-Natal and the eastern region.** Natal Flora Publications Trust

Schmidt, E., Lötter, M. and McCleland, W. (2002). **Trees and shrubs of Mpumalanga and Kruger National Park.** Jacana Publishers, Johannesburg, South Africa

Skelton P. H., (2001). **A complete guide to freshwater fishes of Southern Africa**. Southern Book Publishers (Pty) Ltd., Halfway House. 388pp

Van Oudtshoorn, F. (1999). **Guide to grasses of southern Africa.** Briza Publications, Pretoria

Van Staden, S. (2003). **A case study on the use of habitat assessments and biological indices for the management of recreational stream fisheries**. Rand Afrikaans University, M.Sc. Dissertation

Van Wyk, B. and Malan, S. (1998). **Field guide to the wild flowers of the Highveld.** Struik Publishers, Cape Town

Van Wyk, B., van Oudtshoorn, B. and Gericke, N. (1997). **Medicinal plants of South Africa.** Briza Publications, Pretoria

Van Wyk, B. van Wyk, P. and van Wyk, B. (2000). **Photographic guide to trees of southern Africa.** Briza Publications, Pretoria

Appendix 1: IHAS score sheet August 2008

INVERTEBRATE HABITAT ASSESSMENT SYSTEM (IHAS)						
River Name:						
Site Name: IN1	**Date**: 12/08/2008					
SAMPLING HABITAT	**0**	**1**	**2**	**3**	**4**	**5**
STONES IN CURRENT (SIC)	0					
Total length of white water rapids (i.e.: bubbling water) (in meters)	none	0-1	>1-2	>2-3	>3-5	>5
Total length of submerged stones in current (run) (in meters)	none	0-2	>2-5	>5-10	>10	
Number of separate SIC area's kicked (not individual stones)	0	1	2-3	4-5	6+	
Average stone size's kicked (cm's) (gravel is <2, bedrock is >20)	none	<2>20	2-10	11-20	2-20	
Amount of stone surface clear (of algae, sediment, etc) (in %)*	n/a	0-25	26-50	51-75	>75	
PROTOCOL: time spent actually kicking stones (in minutes) (gravel/bedrock = 0 min)	0	<1	>1-2	2	>2-3	>3
(* NOTE: up to 25% of stone is usually embedded in the stream bottom)						
	SIC Score (max 20):			**17**		
VEGETATION	**0**	**1**	**2**	**3**	**4**	**5**
	0					
Length of fringing vegetation sampled (river banks) (PROTOCOL - in meters)	none	0-½	>½-1	>1-2	2	>2
Amount of aquatic vegetation sampled (underwater) (in square meters)	none	0-½	>½-1	>1		
Fringing vegetation sampled in: ('still' = pool/still water only; 'run' = run only)	none		run	pool		mix
Type of vegetation (% leafy veg. As opposed to stems/shoots) (aq. Veg. Only = 49%)	none		1-25	26-50	51-75	>75
	Vegetation Score (max 15):				**9**	
OTHER HABITAT/GENERAL	**0**	**1**	**2**	**3**	**4**	**5**
	0			3		5
Stones out of current (SOOC) sampled: (PROTOCOL - in square meters)	none	0-½	>½-1	1	>1	
Sand sampled: (PROTOCOL - in minutes) ('under' = present, but only under stones)	none	under	0-½	>½-1	1	>1
Mud sampled: (PROTOCOL - in minutes) ('under' = present, but only under stones)	none	under	0-½	½	>½	
Gravel sampled: (PROTOCOL - in minutes) (if all gravel, SIC stone size = <2)**	none	0-½	½	>½**		
Bedrock sampled: ('all' = no SIC, sand, or gravel then SIC stone size = >20)**	none	some			all**	
Algae present: ('1-2m² = algal bed; 'rocks' = on rocks; 'isol' = isolated clumps)***	>2m²	rocks	1-2m²	<1m²	isol	none
Tray identification: (PROTOCOL - using time: 'coor' = correct time)		under		corr		over
(** NOTE: you must still fill in the SIC section)						
	Other Habitat Score (max 20):				**13**	
	HABITAT TOTAL (MAX 55):				**39**	
STREAM CONDITION	**0**	**1**	**2**	**3**	**4**	**5**
PHYSICAL	0	1	6	6	4	
River make up: ('pool' = pool/still/dam only; 'run' only; etc)	pool		run	rapid	2mix	3mix
Average width of stream: (in meters)		>10	>5-10	<1	1-2	>2-5
Average depth of stream: (in meters)	>1	1	>½-1	½	<½-¼	<¼
Approximate velocity of stream: ('slow' = <½m/s; 'fast' = >1m/s) (use twig to test)	still	slow	fast	med		mix
Water colour: ('disc' = discoloured with visible colour but still transparent)	silty	opaque		disc		clear
Recent disturbance due to: ('const.' = construction; 'fl/dr' = flood or drought)***	fl/dr	fire	constr	other		none
Bank/riparian vegetation is: ('grass' = includes reeds; 'shrubs' = include trees)	none		grass	shrubs	mix	
Surrounding impacts: ('erosn' = erosion/shear bank; 'farm' = farmland/settlement)***	erosn	farm	trees	other		open
Left bank cover: (rocks and vegetation) (in %)	0-50	51-80	81-95	>95		
Right bank cover: (rocks and vegetation) (in %)	0-50	50-80	81-95	>95		
(*** NOTE: if more than one option, choose the lowest)						
	STREAM CONDITIONS TOTAL (MAX 45):				**30**	
	TOTAL IHAS SCORE (%):				**69**	

INVERTEBRATE HABITAT ASSESSMENT SYSTEM (IHAS)						
River Name:						
Site Name: IN2	**Date**: 12/08/2008					
SAMPLING HABITAT	**0**	**1**	**2**	**3**	**4**	**5**
STONES IN CURRENT (SIC)	0					
Total length of white water rapids (i.e.: bubbling water) (in meters)	none	0-1	>1-2	>2-3	>3-5	>5
Total length of submerged stones in current (run) (in meters)	none	0-2	>2-5	>5-10	>10	
Number of separate SIC area's kicked (not individual stones)	0	1	2-3	4-5	6+	
Average stone size's kicked (cm's) (gravel is <2, bedrock is >20)	none	<2>20	2-10	11-20	2-20	
Amount of stone surface clear (of algae, sediment, etc) (in %)*	n/a	0-25	26-50	51-75	>75	
PROTOCOL: time spent actually kicking stones (in minutes) (gravel/bedrock = 0 min)	0	<1	>1-2	2	>2-3	>3
(* NOTE: up to 25% of stone is usually embedded in the stream bottom)						
SIC Score (max 20):	**0**					
VEGETATION	**0**	**1**	**2**	**3**	**4**	**5**
	0					
Length of fringing vegetation sampled (river banks) (PROTOCOL - in meters)	none	0-½	>½-1	>1-2	2	>2
Amount of aquatic vegetation sampled (underwater) (in square meters)	none	0-½	>½-1	>1		
Fringing vegetation sampled in: ('still' = pool/still water only; 'run' = run only)	none		run	pool		mix
Type of vegetation (% leafy veg. As opposed to stems/shoots) (aq. Veg. Only = 49%)	none		1-25	26-50	51-75	>75
Vegetation Score (max 15):	**9**					
OTHER HABITAT/GENERAL	**0**	**1**	**2**	**3**	**4**	**5**
	0			3		5
Stones out of current (SOOC) sampled: (PROTOCOL - in square meters)	none	0-½	>½-1	1	>1	
Sand sampled: (PROTOCOL - in minutes) ('under' = present, but only under stones)	none	under	0-½	>½-1	1	>1
Mud sampled: (PROTOCOL - in minutes) ('under' = present, but only under stones)	none	under	0-½	½	>½	
Gravel sampled: (PROTOCOL - in minutes) (if all gravel, SIC stone size = <2)**	none	0-½	½	>½**		
Bedrock sampled: ('all' = no SIC, sand, or gravel then SIC stone size = >20)**	none	some			all**	
Algae present: ('1-2m² = algal bed; 'rocks' = on rocks; 'isol' = isolated clumps)***	>2m²	rocks	1-2m²	<1m²	isol	none
Tray identification: (PROTOCOL - using time: 'coor' = correct time)		under		corr		over
(** NOTE: you must still fill in the SIC section)						
Other Habitat Score (max 20):	**12**					
HABITAT TOTAL (MAX 55):	**21**					
STREAM CONDITION	**0**	**1**	**2**	**3**	**4**	**5**
PHYSICAL	0	1	6	6	4	
River make up: ('pool' = pool/still/dam only; 'run' only; etc)	pool		run	rapid	2mix	3mix
Average width of stream: (in meters)		>10	>5-10	<1	1-2	>2-5
Average depth of stream: (in meters)	>1	1	>½-1	½	<½-¼	<¼
Approximate velocity of stream: ('slow' = <½m/s; 'fast' = >1m/s) (use twig to test)	still	slow	fast	med		mix
Water colour: ('disc' = discoloured with visible colour but still transparent)	silty	opaque		disc		clear
Recent disturbance due to: ('const.' = construction; 'fl/dr' = flood or drought)***	fl/dr	fire	constr	other		none
Bank/riparian vegetation is: ('grass' = includes reeds; 'shrubs' = include trees)	none		grass	shrubs	mix	
Surrounding impacts: ('erosn' = erosion/shear bank; 'farm' = farmland/settlement)***	erosn	farm	trees	other		open
Left bank cover: (rocks and vegetation) (in %)	0-50	51-80	81-95	>95		
Right bank cover: (rocks and vegetation) (in %)	0-50	50-80	81-95	>95		
(*** NOTE: if more than one option, choose the lowest)						
STREAM CONDITIONS TOTAL (MAX 45):	**27**					
TOTAL IHAS SCORE (%):	**48**					

Appendix 2: SASS5 score sheet August 2008

RIVER HEALTH PROGRAMME - SASS 5 SCORE SHEET

DATE: 12/08/2008	**TAXON**		**S**	**VG**	**GSM**	**TOT**	**TAXON**		**S**	**VG**	**GSM**	**TOT**	**TAXON**		**S**	**VG**	**GSM**	**TOT**
GRID REFERENCE:	**PORIFERA**	5					**HEMIPTERA:**						**DIPTERA:**					
S:°	**COELENTERATA**	1					Belostomatidae*	3					Athericidae	10				
E: °	**TURBELLARIA**	3	**1**			**1**	Corixidae*	3					Blepharoceridae	15				
SITE CODE: IN1	**ANNELIDA:**						Gerridae*	5					Ceratopogonidae	5	**B**	**A**		**B**
RIVER:	Oligochaeta	1					Hydrometridae*	6					Chironomidae	2	**A**			**A**
SITE DESCRIPTION:	Leeches	3					Naucoridae*	7					Culicidae*	1				
WEATHER CONDITION:	**CRUSTACEA:**						Nepidae*	3					Dixidae*	10				
TEMP: 10.3° C	Amphipoda	13					Notonectidae*	3					Empididae	6				
Ph: 7.9	Potamonautidae*	3					Pleidae*	4					Ephydridae	3				
DO: 7.8mg/l	Atyidae	8					Veliidae/M…veliidae*	5					Muscidae	1				
Cond: 6.4mS/m	Palaemonidae	10					**MEGALOPTERA:**						Psychodidae	1				
BIOTOPES SAMPLED:	**HYDRACARINA**	8					Cordalidae	8					Simuliidae	5	**B**			**B**
SIC: 2 TIME: minutes	**PLECOPTERA:**						Sialidae	6					Syrphidae*	1				
SOOC:	Notonemouridae	14					**TRICHOPTERA**						Tabanidae	5				
BEDROCK:	Perlidae	12					Dipseudopsidae	10					Tipulidae	5				
AQUATIC VEG: DOM SP:	**EPHEMEROPTERA**						Ecnomidae	8					**GASTROPODA**					
M VEG IC: 1 DOM SP:	Baetidae 1 sp	4					Hydropsychidae 1 sp	4	**A**	**A**		**A**	Ancylidae	6				
M VEG OOC: 3 DOM SP:	Baetidae 2 sp	6					Hydropsychidae 2 sp	6					Bulininae*	3				
GRAVEL: 5	Baetidae >2 sp	12	**B**	**B**		**B**	Hydropsychidae >2 sp	12					Hydrobiidae*	3				
SAND: 3	Caenidae	6	**B**			**B**	Philopotamidae	10					Lymnaeidae*	3				
MUD: 2	Ephemeridae	15					Polycentropodidae	12					Physidae*	3	**A**			**A**
HAND PICKING/VISUAL OBS: Yes	Heptageniidae	13	**A**			**A**	Psychomyiidae/Xiphocen.	8					Planorbidae*	3				
FLOW: Low	Leptophlebiidae	9	**A**			**A**	**CASED CADDIS:**						Thiaridae*	3				
TURBIDITY: Medium	Oligoneuridae	15					Barbarochthonidae SWC	13					Viviparidae* ST	5				
RIPARIAN LAND USE:	Polymitarcyidae	10					Calamoceratidae ST	11					**PELECYPODA**					
	Prosopistomatidae	15					Glossosomatidae SWC	11					Corbiculidae	5				
	Teloganodidae SWC	12					Hydroptilidae	6					Sphaeriidae	3				
	Tricorythidae	9	**1**			**1**	Hydrosalpingidae SWC	15					Unionidae	6				
	ODONATA:						Lepidostomatidae	10					**SASS SCORE:**		71	25		75
DISTURBANCE IN RIVER:	Calopterygidae ST,T	10					Leptoceridae	6					**NO OF TAXA:**		11	4		12
	Chlorocyphidae	10					Petrothrincidae SWC	11					**ASPT:**		6.5	6.3		6.3
	Chlorolestidae	8					Pisuliidae	10					**IHAS**: 69%					
	Coenagrionidae	4		**A**		**A**	Sericostomatidae SWC	13					**OTHER BIOTA**:					
	Lestidae	8					**COLEOPTERA:**											
SIGNS OF POLLUTION:	Platycnemidae	10					Dytiscidae*	5					**COMMENTS**:					
	Protoneuridae	8					Elmidae/Dryopidae*	8					* = airbreathers					
	Zygoptera juvs.	6					Gyrinidae*	5					SWC = South Western Cape					
	Aeshnidae	8					Halipidae*	5					T = Tropical					
	Corduliidae	8					Helodidae	12					ST = Sub-tropical					
OTHER OBSERVATIONS:	Gomphidae	6					Hydraenidae*	8					S = Stone & rock					
	Libellulidae	4					Hydrophilidae*	5					VG = all vegetation					
	LEPIDOPTERA:						Limnichidae	10					GSM = gravel, sand & mud					
	Pyralidae	12					Psephenidae	10					1=1, A=2-10, B=10-100, C=100-1000, D=>1000					

RIVER HEALTH PROGRAMME - SASS 5 SCORE SHEET

DATE: 12/08/2008	**TAXON**		**S**	**VG**	**GSM**	**TOT**	**TAXON**		**S**	**VG**	**GSM**	**TOT**	**TAXON**		**S**	**VG**	**GSM**	**TOT**
GRID REFERENCE:	**PORIFERA**	5					**HEMIPTERA:**						**DIPTERA:**					
S:°	**COELENTERATA**	1					Belostomatidae*	3					Athericidae	10				
E: °	**TURBELLARIA**	3					Corixidae*	3					Blepharoceridae	15				
SITE CODE: IN2	**ANNELIDA:**						Gerridae*	5					Ceratopogonidae	5		**A**		**A**
RIVER:	Oligochaeta	1					Hydrometridae*	6					Chironomidae	2			**A**	**A**
SITE DESCRIPTION:	Leeches	3					Naucoridae*	7					Culicidae*	1		**1**		**1**
WEATHER CONDITION:	**CRUSTACEA:**						Nepidae*	3					Dixidae*	10		**1**		**1**
TEMP: 10.4 ° C	Amphipoda	13					Notonectidae*	3					Empididae	6				
Ph: 7.82	Potamonautidae*	3					Pleidae*	4					Ephydridae	3				
DO: 7.6mg/l	Atyidae	8					Veliidae/M…veliidae*	5					Muscidae	1				
Cond: 6.4mS/m	Palaemonidae	10					**MEGALOPTERA:**						Psychodidae	1				
BIOTOPES SAMPLED:	**HYDRACARINA**	8					Cordalidae	8					Simuliidae	5			**A**	**A**
SIC: TIME: minutes	**PLECOPTERA:**						Sialidae	6					Syrphidae*	1				
SOOC:	Notonemouridae	14					**TRICHOPTERA**						Tabanidae	5			**1**	**1**
BEDROCK:	Perlidae	12					Dipseudopsidae	10					Tipulidae	5				
AQUATIC VEG: DOM SP:	**EPHEMEROPTERA**						Ecnomidae	8					**GASTROPODA**					
M VEG IC: 1 DOM SP:	Baetidae 1 sp	4					Hydropsychidae 1 sp	4		**A**	**A**	**A**	Ancylidae	6				
M VEG OOC: 3 DOM SP:	Baetidae 2 sp	6			**B**	**B**	Hydropsychidae 2 sp	6					Bulininae*	3				
GRAVEL: 5	Baetidae >2 sp	12		**B**		**B**	Hydropsychidae >2 sp	12					Hydrobiidae*	3				
SAND: 3	Caenidae	6			**A**	**A**	Philopotamidae	10					Lymnaeidae*	3				
MUD: 2	Ephemeridae	15					Polycentropodidae	12					Physidae*	3				
HAND PICKING/VISUAL OBS: Yes	Heptageniidae	13					Psychomyiidae/Xiphocen.	8					Planorbidae*	3				
FLOW: Low	Leptophlebiidae	9					**CASED CADDIS:**						Thiaridae*	3				
TURBIDITY: Medium	Oligoneuridae	15					Barbarochthonidae SWC	13					Viviparidae* ST	5				
RIPARIAN LAND USE:	Polymitarcyidae	10					Calamoceratidae ST	11					**PELECYPODA**					
	Prosopistomatidae	15					Glossosomatidae SWC	11					Corbiculidae	5				
	Teloganodidae SWC	12					Hydroptilidae	6					Sphaeriidae	3				
	Tricorythidae	9					Hydrosalpingidae SWC	15					Unionidae	6				
	ODONATA:						Lepidostomatidae	10					**SASS SCORE:**			42	39	77
DISTURBANCE IN RIVER:	Calopterygidae ST,T	10					Leptoceridae	6		**1**		**1**	**NO OF TAXA:**			7	8	14
	Chlorocyphidae	10					Petrothrincidae SWC	11					**ASPT:**			6	4.9	5.5
	Chlorolestidae	8					Pisuliidae	10					**IHAS**: 48%					
	Coenagrionidae	4		**A**		**A**	Sericostomatidae SWC	13					**OTHER BIOTA**:					
	Lestidae	8					**COLEOPTERA:**											
SIGNS OF POLLUTION:	Platycnemidae	10					Dytiscidae*	5					**COMMENTS**:					
	Protoneuridae	8					Elmidae/Dryopidae*	8					* = airbreathers					
	Zygoptera juvs.	6					Gyrinidae*	5			**A**	**A**	SWC = South Western Cape					
	Aeshnidae	8					Halipidae*	5					T = Tropical					
	Corduliidae	8					Helodidae	12					ST = Sub-tropical					
OTHER OBSERVATIONS:	Gomphidae	6			**A**	**A**	Hydraenidae*	8					S = Stone & rock					
	Libellulidae	4					Hydrophilidae*	5					VG = all vegetation					
	LEPIDOPTERA:						Limnichidae	10					GSM = gravel, sand & mud					
	Pyralidae	12					Psephenidae	10					1=1, A=2-10, B=10-100, C=100-1000, D=>1000					