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GROOT LETABA RIVER WATER DEVELOPMENT PROJECT (GLeWaP)

Environmental Impact Assessment

(DEAT Ref No 12/12/20/978)

ANNEXURE H2: AQUATIC ECOLOGY DESKTOP STUDY

REPORT

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Golder Associates

Executive Summary

Golder Associates Africa (Pty) Ltd. was approached by Iliso Consulting (Pty) Ltd. to conduct a desktop assessment of the aquatic habitats available to fish in the Groot Letaba River and tributaries between Junction weir and Prieska weir. This assessment was a follow on to the Environmental Impact Assessment for the proposed Groot Letaba River Water Development Project (GLeWaP), which identified the aquatic habitats associated with the proposed Nwamitwa Dam as a key area of concern. The availability of the aquatic habitats for breeding and critical life stages of the resident fish communities was uncertain. With the construction of the proposed Nwamitwa Dam, these habitats may have been lost or reduced to a point where certain fish species could no longer successfully maintain the current populations within the project area.

This document includes an assessment of historical habitat data and fish data, fly-over video footage of the rivers, spatial data of the Groot Letaba River and tributaries, stream gradients, identified migrational barriers and the potential habitat types associated with the sites. Further impacts to the fish communities and populations within the project area were also included.

The project area includes the Groot Letaba River and tributaries between Junction weir and Prieska weir. Fish movement up the tributaries from the Groot Letaba River is also restricted by man made barriers. Weirs are present in most of the tributaries and others are dry due to upstream weirs and water abstraction.

In order to assess and characterise the selected sites in terms of habitats and fish assemblages the following were included:

- Estimation of the current available river lengths;
- Calculation of stream gradients of selected relevant streams (GIS);
- Identification of associated longitudinal zones and characteristic channel features (Geomorphological Assessment);
- Identification of associated habitat types (Hydraulic Biotope Assessment);
- Estimate of potential fish breeding habitats and critical life stage habitats;
- Review of historical habitat and fish data;
- Review of flyover video footage; and
- Discussion of impacts on habitat availability to fish, fish migration, and fish species associated with the construction of the Nwamitwa Dam.

The study area included the river reaches of the Groot Letaba River and its tributaries between Junction and Prieska weirs.

It was concluded that a total of 24.76 km of the 97.43 km of river reach will be inundated by construction of Nwamitwa Dam. This constitutes a 25.41% loss of riverine habitat within the entire available reach.

It is expected that some habitats for fish breeding and life-cycle stages will be impacted upon by construction of Nwamitwa Dam. Impacts in terms of the construction and operation of Nwamitwa Dam may be mitigated by implementation of the measures detailed in the Environmental Impact Assessment (EIA) report. After the workshop held in regard to the need for a fishway within the Nwamitwa Dam, the mitigation measures now exclude the need for a fishway to be constructed in the dam wall or the need for additional studies to verify this.

Fish communities and populations upstream of the dam and within the dam will be impacted upon in terms of abundances, but it is expected that the majority of species will manage to adapt and find adequate habitats for spawning and life-cycle stages. The Nwanedzi River as well as the remaining flowing habitats in the Groot Letaba River, upstream of the inundated areas, is considered to be of high importance for the survival of most flow dependant species in the upstream section.

The habitats of the Groot Letaba River downstream of the Nwamitwa Dam should support the current diversity of fish species, provided that the mitigation measures are implemented correctly and that the Reserve requirements are maintained.

The following recommendations were made, based on the conclusions of this desktop assessment:

- Bi-annual biomonitoring of the remaining section of the Groot Letaba River, upstream of Nwamitwa Dam, the upper reaches of Nwanedzi River as well as within the dam, will indicate whether the additional 18 expected fish species still occur within the remaining river reaches and will indicate the new trends that will develop within the current fish community and populations of the individual species.

- Bi-annual biomonitoring of the Groot Letaba River downstream of Nwamitwa Dam will reveal the impacts that releases of the dam have on the receiving ecosystems. Implementation of the flow requirements can also be monitored during these bi-annual events.

- The functionality of Jasi weir should be re-evaluated and should this prove to be redundant, the removal of this weir should be investigated. This will allow for the 7 km section of river below the dam wall to be connected to the downstream sections above Prieska Weir and will improve the continuity of the entire downstream section.

- The remaining areas of flowing river habitat in the Groot Letaba River and the Nwanedzi River, should be protected from further impacts and the initiation of declaring these areas as conservation areas will ensure that no further degradation of the river habitats and fish species occur within the project area.

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1.0 INTRODUCTION

Golder Associates Africa (Pty) Ltd. was approached by Iliso Consulting (Pty) Ltd. to conduct a desktop assessment of the aquatic habitats available to fish in the Groot Letaba River and tributaries between Junction and Prieska weirs. This assessment represents a follow-on to the Environmental Impact Assessment for the proposed Groot Letaba River Water Development Project (GLeWaP) which identified the aquatic habitats associated with the proposed Nwamitwa Dam as a key area of concern.

The availability of habitats for breeding and critical life stages of fish communities was identified as a concern. With the construction of the proposed Nwamitwa Dam these habitats may be lost or reduced to a point where certain fish species can no longer successfully maintain their current populations within the project area.

This document includes an assessment of historical habitat and fish data, fly-over video footage of the rivers, spatial data of the Groot Letaba River and tributaries, stream gradients, identified migrational barriers and the potential habitat types associated with the sites. Potential impacts on fish communities and populations were also assessed.

1.1 Project objectives

The objectives of the desktop habitat assessment included the following:

- Quantification of the remaining fish habitat upstream and downstream of the proposed Nwamitwa Dam; and
- Assessment of the potential impacts of an additional migration barrier at Nwamitwa Dam on fish communities upstream and downstream of the dam.

2.0 STUDY AREA

The project area includes the Groot Letaba River between Prieska and Junction weirs, and the Nwandezi Hlangana, Mphuphule, Shilovolwe, Lerwatlou and Merekome rivers. A map indicating the project area is provided in Figure 1.

Fish migration in the Groot Letaba River is restricted by Junction and Prieska weirs, as migratory fish species cannot negotiate or overcome these two barriers. Fish migration up the tributaries of the Groot Letaba River is also restricted by man made barriers. Other impacts affecting the tributaries of the Groot Letaba River include over abstraction of water for irrigation purposes.

Global Positioning System (GPS) co-ordinates of migration barriers and tributary confluences are presented in Table 1.

Table 1: GPS co-ordinates of the weirs and tributary confluences

Site	Description	Coordinates*	
Junction weir	Upstream site on the Groot Letaba River	S 23.85986	E 30.39173
Nwanedzi confluence	Confluence of the Nwanedzi River with the Groot Letaba River	S 23.75563	E 30.48990
Hlangana confluence	Confluence of the Hlangana River with the Nwanedzi River	S 23.76581	E 30.47027
Mphuphule confluence	Confluence of the Mphuphule River with the Nwanedzi River	S 23.74722	E 30.36407
Shilovolwe confluence	Confluence of the Shilovolwe River with the Groot Letaba River	S 23.73045	E 30.51525
Lerwatlou confluence	Confluence of the Lerwatlou River with the Groot Letaba River	S 23.69200	E 30.59494
Merekome	Confluence of the Merekome River with the Groot Letaba	S 23.65927	E 30.63520

confluence	River		
Prieska weir	Downstream site on the Groot Letaba River	S 23.64613	E 30.71814

* World Geographic System (WGS) _84 datum GPS coordinate system

3.0 METHODOLOGY

In order to assess and characterise the selected sites in terms of habitats and fish assemblages the following aspects were included:

- Estimation of the current available river lengths;
- Calculation of stream gradients of selected relevant streams (GIS);
- Identification of associated longitudinal zones and characteristic channel features (Geomorphological Assessment);
- Identification of associated habitat types (Hydraulic Biotope Assessment);
- Estimate of potential fish breeding habitats and critical life stage habitats;
- Review of historical habitat and fish data;
- Review of flyover video footage; and
- Discussion of impacts on habitat availability, fish migration, and fish species associated with the construction of the Nwamitwa Dam.

3.1 Estimation of available river reaches

A combination of 1:50 000 national topographical maps and Google Earth imagery (2009) was used to calculate the existing availability of river reaches within the project area.

3.2 Calculation of stream gradients

A combination of 1:50 000 national topographical maps, the national stream gradient coverage and Google Earth imagery (2009) was used to identify the selected river reaches within the project area. Length of rivers, reach profiles and 20 m contour intervals were used to determine the stream gradients on a desktop level.

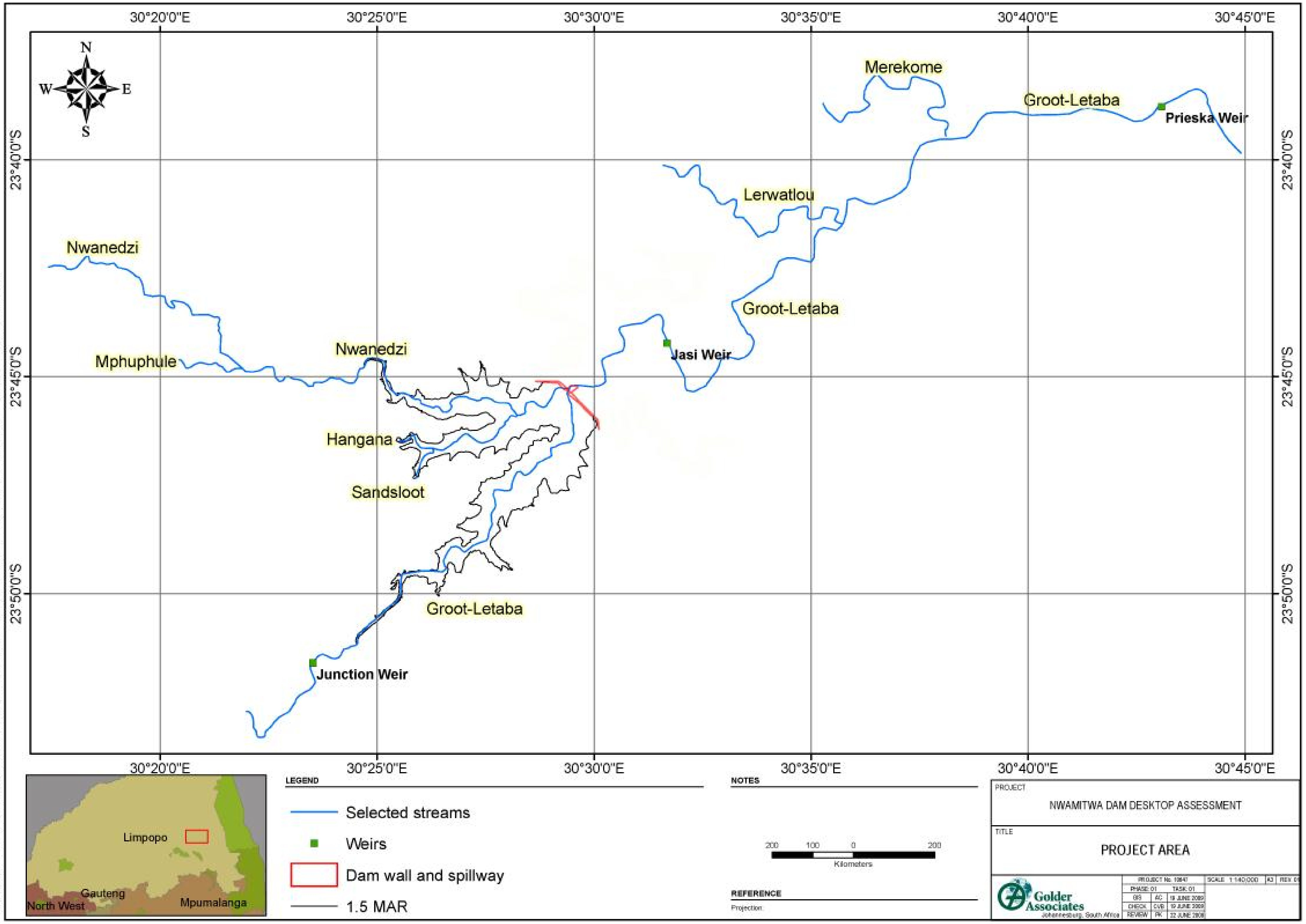

Figure 1: Map of the project area and tributaries along the Groot Letaba River The project area extends downstream from Junction Weir to upstream of Prieska Weir. The position of the proposed Nwamitwa Dam wall is indicated in red with the projected 1.5 Mean Annual Runoff (MAR) inundation area indicated in black. The lengths of the tributaries indicate remaining reaches. The ends of the tributaries represent migration barriers.

3.3 Geomorphological assessment

In order to characterize the habitat types associated with the selected sites, stream orders and gradients were assessed in terms of gradient classes and longitudinal zones according to Rowntree and Wadeson (1999). An adapted summary of the geomorphological zonation of river channels is shown in Table 2. Reach bed material or substrate was assessed in terms of the reach gradient according to those typical of three South African rivers (Rowntree *et al.*, 2000).

Table 2: Geomorphological zonation of river channels (adapted from Rowntree and Wadeson, 1999).

Longitudinal Zone	Gradient Class	Characteristic Channel Features
A. zonation of rivers associated with a 'normal' profile		
Source zone	not specified	Low gradient, upland plateau or upland basin able to store water. Spongy or peaty hydromorphic soils.
Mountain headwater stream	> 0.1	A very steep gradient dominated by vertical flow over bedrock with waterfalls and plunge pools. Normally first or second order streams. Reach types include bedrock fall and cascades.
Mountain stream	0.04 - 0.99	Steep gradient stream dominated by bedrock and boulders, locally cobble or coarse gravels in pools. Reach types include cascades, bedrock falls, step-pools. Approximate equal distribution of of vertical and horizontal flow components.
Transitional	0.02 - 0.039	Moderately steep stream dominated by bedrock or boulders. Reach types include plain-bed, pool-rapid or pool-riffle types. Confined or semi-confined valley floor with limited flood plain development.
Upper Foothills	0.005 - 0.019	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 cobbles often present.
Lower Foothills	0.001 - 0.005	Lower gradient mixed bed alluvial channel with sand and gravel dominating the bed, locally may be bedrock controlled. Reach types typically include pool-riffle or pool-rapid sequences. Sand bars common in pools. Pools of significantly greater extent than rapids or riffles. Flood plain often present.
Lowland River	0.0001 - 0.001	Low gradient alluvial fine bed channel, typically regime reach type. May be confined, but fully developed meandering pattern within a distinct flood plain develops in unconfined reaches where there is an increased silt content in bed or banks.
B. Additional zones of rivers associated with a rejuvenated profile		
Rejuvenated bedrock fall / cascade	> 0.02	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-rapids.
Rejuvenated foothills	0.001 - 0.02	Steepened section within the middle reaches of the river caused by uplift, often within or downstream of 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	< 0.005	An upland low gradient channel, often associated with uplifted plateau areas as occurs beneath the eastern escarpment.

3.4 Hydraulic biotope assessment

The characteristic channel features within each longitudinal zone were assessed in terms of hydraulic biotopes according to Rowntree and Wadeson (1999) and Wadeson and Rowntree (2005). Descriptions of these hydraulic biotopes are provided in Table 3.

Table 3: Hydraulic biotope types and descriptions (adapted from Rowntree and Wadeson, 1999 and Wadeson and Rowntree, 2005)

Hydraulic Biotopes	Definition
Eddy	An eddy is characterized by water flowing upstream against the current
Backwater	A backwater is morphologically defined as an area along-side but physically separated form the channel, but connected to it at its downstream end. Water therefore enters the feature in an upstream direction. It may occur over any substrate.
Slack Water	A slack water is an area of no perceptible flow which is hydraulically detached form the main flow but is within the main channel. It may occur at channel margins or in mid-channel areas downstream of obstructions or secondary flow cells. It may occur over any substrate.
Trickle	Very small volumes of flow trickling through cobbles or over bedrock. Trickles are characterized by barely perceptible flow.
Pool	A pool is in direct hydraulic contact with upstream and downstream water but has no perceptible flow.
Glide	A glide exhibits smooth uniform flow. A glide may occur over any substrate as long as the depth is sufficient to minimize relative roughness. Flow over a glide is uniform such that there is no significant convergence or divergence.
Run	A run can occur over any substrate apart from silt. Runs often form the transition between riffles and the downstream pool. A run may be characterized by a rippled or surging flow type. It may be useful to distinguish fast and slow runs in terms of the degree of ripple development. A fast run has clear rippling; a slow run has indistinct ripples.
Riffle	Riffles occur over potentially mobile, course alluvial substrates from gravel to cobble. A riffle may be characterized as having undular standing waves (or breaking standing waves).
Rapid	Rapids occur over a fixed substrate such as boulder or bedrock. They are characterized by having broken standing waves, chutes or limited free falling flow.
Chute	A chute is characterized by a convergence of fast flowing water (relative to surrounding flow) between obstructions in the channel. Chutes are generally short and exhibit flow acceleration.
Cascade	A cascade has free falling flow over a substrate of boulder or bedrock or over an obstruction, usually less than 1m in height, but the flow maintains contact with the substrate. Small cascades may occur in cobble where the bed has a stepped structure due to cobble accumulations.
Waterfall	A waterfall has free falling flow over a cliff, where a cliff represents a significant topographical discontinuity in the channel long profile.

3.5 Potential fish breeding and critical life stage habitats

Based on the remaining river reaches identified in section 3.1 the amount of potential breeding habitat and critical life stage habitat available to the fish species was calculated (in terms of percentage of total river habitat) based on lengths of river reaches with specific hydraulic biotopes.

3.6 Review of historical habitat and fish data

Historical habitat integrity data and fish data was assessed. Relevant information regarding the project area was highlighted and presented with reference to specific habitats and availability to fish, especially migratory species.

3.7 Review of flyover video footage

Flyover video footage collected in 1994 and 2003 (Kleynhans, 1994 and Kleynhans, 2003) was used to confirm the habitat types identified in the desktop assessment and to establish the connectivity of the reaches. Specific video footage included the Groot Letaba River from Fanie Botha Dam downstream to Prieska weir and the Nwanedzi River from the confluence with the Groot Letaba River upstream.

3.8 Discussion of impacts associated with the proposed Nwamitwa Dam on the availability of habitat to fish

The impacts of the Nwamitwa Dam on fish habitat availability, fish migration, and fish species diversity was assessed in terms of the current habitat availability compared to the potential post construction habitat availability.

4.0 RESULTS AND DISCUSSION

The results of the desktop habitat assessment are presented in this section. The river reaches of the Groot Letaba River and associated tributaries between Junction and Prieska weirs were identified and assessed in terms of in-stream aquatic habitat availability. The results only represent and include these identified reaches.

A map of the identified river reaches is provided in Figure 2.

4.1 Estimation of available river reaches

The length of river reach available for fish migration was calculated by measuring a line extending upstream along the Groot Letaba River from Prieska Weir and up along the tributaries, to the a point where no further fish migration was possible. The results are presented in Table 4. The current available river reach is divided into two parts by Jasi weir. Although some larger fish species may move over this weir during high flow events it presents a migration barrier to smaller fish species. In all cases movement up the tributaries was limited at some point by migration barriers. The longest section of continuity was in the Nwanedzi River (Table 4).

Table 4: Calculation of existing river reaches available for fish migration

River section and tributary	Available aquatic habitat (km)	Total reach available (km)
Prieska Weir to Jasi Weir		
Groot Letaba upstream of Prieska weir to Merekome confluence	9.2	
Merekome tributary	5	
Groot Letaba upstream of Merekome confluence to Lerwatlou confluence	6.6	
Lerwatlou tributary	5.4	
Groot Letaba upstream of Lerwatlou confluence to Jasi weir	14.6	**40.8**
Jasi Weir to Junction Weir		
Groot Letaba upstream of Jasi weir to Shilovolwe confluence	2.3	
Shilovolwe tributary	0	
Groot Letaba upstream of Shilovolwe confluence to Nwamitwa Dam wall site	4.7	
Groot Letaba upstream of Nwamitwa Dam wall site to Nwanedzi confluence	0.35	
Nwanedzi tributary to Hlangana confluence	3.1	
Hlangana tributary	0.9	
Nwanedzi tributary upstream of Hlangana confluence to Mphuphule confluence	15.13	
Mphuphule tributary	2.9	
Nwanedzi tributary upstream of Mphuphule confluence	8	
Groot Letaba upstream of Nwanedzi confluence to Junction weir	19.25	**56.63**
		97.43

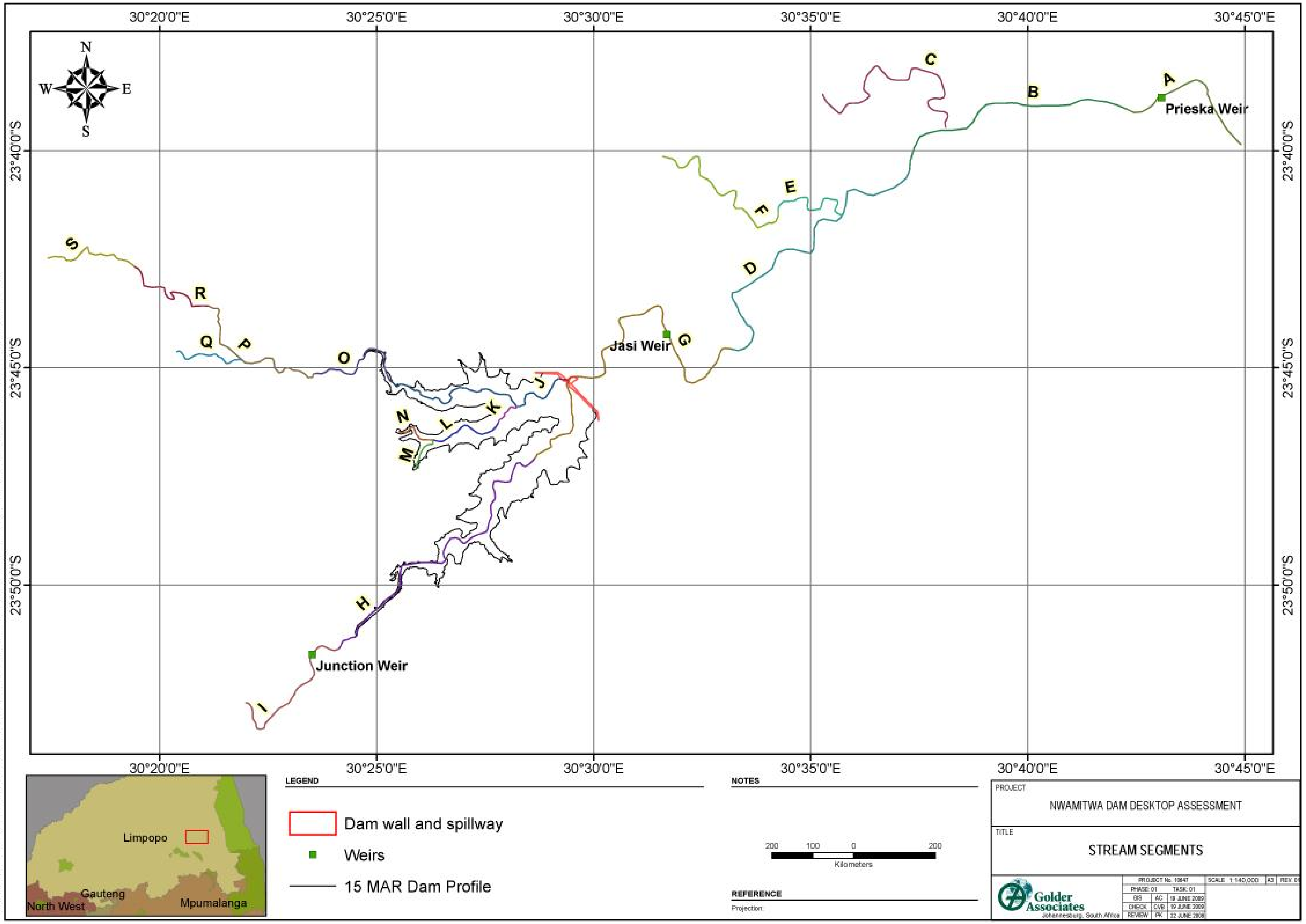

Figure 2: Identified river reaches based on gradients.

4.2 Calculation of stream gradients

The identified river reaches were given segment codes (A-S) according to lengths of reach of a particular slope or gradient. The slopes or gradients of these segments are presented in Table 5.

Table 5: Gradients of the identified river reaches

Segment Code	River Name	Length (m)	Height (m)	Slope/Gradient
A	Groot-Letaba	6567.188	410.276	0.003
B	Groot-Letaba	10299.852	430.276	0.002
C	Merekome	10494.129	447.082	0.004
D	Groot-Letaba	13697.028	450.276	0.001
E	Lerwatlou	4257.781	446.403	0.002
F	Lerwatlou	7824.622	466.403	0.003
G	Groot-Letaba	16532.457	470.276	0.001
H	Groot-Letaba	13716.152	490.276	0.001
I	Groot-Letaba	6863.683	510.276	0.003
J	Nwanedzi	9242.753	482.743	0.002
K	Hlangana	1188.763	0.000	0.003
L	Hlangana	3148.355	0.000	0.003
M	Sandsloot	1584.505	0.000	0.001
N	Hlangana	1742.110	0.000	0.003
O	Nwanedzi	4917.165	502.743	0.004
P	Nwanedzi	6846.128	522.743	0.003
Q	Mphuphule	3026.208	0.000	0.004
R	Nwanedzi	4565.518	542.743	0.004
S	Nwanedzi	4163.557	562.743	0.005

4.3 Geomorphological assessment

The gradients were used to assess the characteristic channel features associated with specific gradient classes. This was done according to the geomorphological zonation of rivers (Rowntree and Wadeson, 1999; DWAF, 1999; and Rowntree *et. al.*, 2000). The results for each identified river segment are presented in Table 6.

Table 6: Geomorphological zonation of the river segments according to slope (adapted from Rowntree and Wadeson, 1999)

Slope	Seg_Code	River Zone	Characteristic channel features
0.003	A	Lower Foothills: Gravel bed (0.001 – 0.005)	(1)
0.002	B	Lower Foothills: Gravel bed (0.001 – 0.005)	(1)
0.004	C	Lower Foothills: Gravel bed (0.001 – 0.005)	(1)
0.001	D	Lower Foothills: Gravel bed (0.001 – 0.005)	(1)
0.002	E	Lower Foothills: Gravel bed (0.001 – 0.005)	(1)
0.003	F	Lower Foothills: Gravel bed (0.001 – 0.005)	(1)

0.001	G	Lower Foothills: Gravel bed (0.001 – 0.005)	(1)
0.001	H	Lower Foothills: Gravel bed (0.001 – 0.005)	(1)
0.003	I	Lower Foothills: Gravel bed (0.001 – 0.005)	(1)
0.002	J	Lower Foothills: Gravel bed (0.001 – 0.005)	(1)
0.003	K	Lower Foothills: Gravel bed (0.001 – 0.005)	(1)
0.003	L	Lower Foothills: Gravel bed (0.001 – 0.005)	(1)
0.001	M	Lower Foothills: Gravel bed (0.001 – 0.005)	(1)
0.003	N	Lower Foothills: Gravel bed (0.001 – 0.005)	(1)
0.004	O	Lower Foothills: Gravel bed (0.001 – 0.005)	(1)
0.003	P	Lower Foothills: Gravel bed (0.001 – 0.005)	(1)
0.004	Q	Lower Foothills: Gravel bed (0.001 – 0.005)	(1)
0.004	R	Lower Foothills: Gravel bed (0.001 – 0.005)	(1)
0.005	S	Upper Foothills: Cobble bed (0.005 – 0.019)	(2)

- (1) 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.
- (2) Moderately steep, cobble-bed or mixed bedrock-cobble bed channel, with plane bed, pool -riffle, or pool-rapid reach types. Length of pools and riffles/rapids similar. Narrow flood plain of sand, gravel, or cobble often present

Based on the characteristic channel features, bed materials and reach types could be assessed. This assessment is based on three similar rivers in South Africa and is thus viewed as a general description of what may occur within the segments. The results are presented in Table 7.

Table 7: Bed materials and reach types of the river segments (bed material classes according to the Wentworth scale, adapted from Rowntree *et. al.*, 2000)

Seg_Code	Bed Material	Reach type
A	Bedrock, bedrock/cobble, cobble/sand, gravel	Pool/riffle, pool/rapid, plane bed
B	Bedrock/sand, bedrock/cobble, cobble/sand	Planar bedrock/pool, plane bed, pool/riffle
C	Bedrock, bedrock boulder, bedrock/sand	Planar bedrock, pool/riffle, pool/rapid
D	Bedrock/sand, sand, sand/gravel	Regime, anabranching pool/riffle, pool, braided regime
E	Bedrock/sand, bedrock/cobble, cobble/sand	Planar bedrock/pool, plane bed, pool/riffle
F	Bedrock, bedrock/cobble, cobble/sand, gravel	Pool/riffle, pool/rapid, plane bed
G	Bedrock/sand, sand, sand/gravel	Regime, anabranching pool/riffle, pool, braided regime
H	Bedrock/sand, sand, sand/gravel	Regime, anabranching pool/riffle, pool, braided regime
I	Bedrock, bedrock/cobble, cobble/sand, gravel	Pool/riffle, pool/rapid, plane bed
J	Bedrock/sand, bedrock/cobble, cobble/sand	Planar bedrock/pool, plane bed, pool/riffle
K	Bedrock, bedrock/cobble, cobble/sand, gravel	Pool/riffle, pool/rapid, plane bed

L	Bedrock, bedrock/cobble, cobble/sand, gravel	Pool/riffle, pool/rapid, plane bed
M	Bedrock/sand, sand, sand/gravel	Regime, anabranching pool/riffle, pool, braided regime
N	Bedrock, bedrock/cobble, cobble/sand, gravel	Pool/riffle, pool/rapid, plane bed
O	Bedrock, bedrock boulder, bedrock/sand	Planar bedrock, pool/riffle, pool/rapid
P	Bedrock, bedrock/cobble, cobble/sand, gravel	Pool/riffle, pool/rapid, plane bed
Q	Bedrock, bedrock boulder, bedrock/sand	Planar bedrock, pool/riffle, pool/rapid
R	Bedrock, bedrock boulder, bedrock/sand	Planar bedrock, pool/riffle, pool/rapid
S	Bedrock/boulder, cobble/gravel, bedrock/sand	Pool/riffle, pool/rapid

Based on the geomorphological assessment of the identified river reaches, the whole project area is in a relatively low gradient class (0.001 – 0.005). Pools are predominantly greater in length than riffles or rapids and sand bars and alluvial deposits are common. Although likely bedrock dominated, the bed material will likely be mixed alluvial cobble, gravel and sand with occasional bedrock/boulder sections. In certain sections like segments D, G, H and M (Table 7) braided or anabranching channels may be present.

4.4 Hydraulic biotope assessment

Based on the characteristic channel features, bed materials and reach types identified for each segment, the hydraulic biotopes could be estimated. This was done according to the hydraulic biotopes described in Table 3. These are general biotopes that would most likely be dominant within each river reach. The general biotopes are presented in Table 8.

Table 8: General hydraulic biotopes identified for each river reach based on gradient

Seg_Code	Hydraulic biotopes
A	Eddy, backwater, pool, glide, run, riffle
B	Eddy, backwater, slackwater, pool, glide, run, riffle, rapid
C	Eddy, backwater, pool, glide, run, riffle, rapid, chute, cascade
D	Eddy, backwater, slackwater, trickle, pool, glide, run, riffle
E	Eddy, backwater, slackwater, pool, glide, run, riffle, rapid
F	Eddy, backwater, pool, glide, run, riffle, rapid, chute
G	Eddy, backwater, slackwater, trickle, pool, glide, run, riffle
H	Eddy, backwater, slackwater, trickle, pool, glide, run, riffle
I	Eddy, backwater, pool, glide, run, riffle, rapid, chute
J	Eddy, backwater, slackwater, pool, glide, run, riffle, rapid
K	Eddy, backwater, pool, glide, run, riffle, rapid, chute
L	Eddy, backwater, pool, glide, run, riffle, rapid, chute

M	Eddy, backwater, slackwater, trickle, pool, glide, run, riffle
N	Eddy, backwater, pool, glide, run, riffle, rapid, chute
O	Eddy, backwater, pool, glide, run, riffle, rapid, chute, cascade
P	Eddy, backwater, pool, glide, run, riffle, rapid, chute
Q	Eddy, backwater, pool, glide, run, riffle, rapid, chute, cascade
R	Eddy, backwater, pool, glide, run, riffle, rapid, chute, cascade
S	Eddy, backwater, pool, run, riffle, rapid, chute, cascade

4.5 Potential fish breeding and critical life stage habitats

Based on the Aquatic component of the Environmental Impact Report (EIR) 34 fish species are expected to occur in the project area. These are presented in Table 9.

Table 9: Expected fish species list for the project area.

Species	Common Name	Habitat Preference	IUCN Status
Family Amphiliidae			
Amphilius uranoscopus	Stargazer Mountain Catfish	Clear and flowing water in rocky habitats	Unlisted
Family Anguillidae			
Anguilla mamorata	Giant Mottled Eel	Wide variety of habitats due to migration. Favours pools	Unlisted
Anguilla mossambica	Longfin Eel	Wide variety of habitats due to migration. Favours pools	Unlisted
Family Characidae			
Brycinus imberi	Imberi	Wide variety of habitats due to migration.	Unlisted
Micralestes acutidens	Silver Robber	In clear and open waters	Unlisted
Family Cichlidae			
Oreochromis mossambicus	Mozambique Tilapia	Wide range of habitats except fast flowing water	NT
Pseudocrenilabrus philander	Southern Mouthbrooder	Wide variety of habitats from flowing waters to lakes, usually favours vegetated zones.	Unlisted
Tilapia rendalli	Redbreast Tilapia	Quiet and well vegetated waters	Unlisted
Tilapia sparrmanii	Banded Tilapia	Tolerant of a wide range of habitats but prefers quiet or standing waters with	Unlisted

		submerged or emergent vegetation	
Family Clariidae			
Clarias gariepinus	Sharptooth Catfish	Occurs in a wide variety of habitats but favours floodplains, large sluggish rivers, lakes and dams	Unlisted
Family Cyprinidae			
Barbus eutaenia	Orangefin Barb	Clear, flowing and rocky rivers	Unlisted
Barbus linomaculatus	Line-spotted Barb	Wide range of habitats	Unlisted
Barbus neefi	Sidespot Barb	Wide variety of habitats	Unlisted
Barbus paludinosus	Straightfin Barb	Slow flowing and vegetated habitats	Unlisted
Barbus radiatus	Beira Barb	Marginal vegetation of streams	Unlisted
Barbus toppini	East Coast Barb	Shallow and well vegetated streams	Unlisted
Barbus trimaculatus	Threespot Barb	Wide variety of habitats	Unlisted
Barbus unitaeniatus	Longbeard Barb	Wide variety of habitats	LC
Barbus viviparus	Bowstripe Barb	Vegetated pools with submerged roots	LC
Labeo cylindricus	Redeye Labeo	Clear running water in rocky habitats	LC
Labeo molybdinus	Leaden Labeo	Deep pools and rapids	LC
Labeo rosae	Rednose Labeo	Sandy stretches of large rivers	LC
Labeo ruddi	Silver Labeo	Quiet or standing waters of large rivers	LC
Labeobarbus marequensis	Lowveld Largescale Yellowfish	Flowing water	LC
Mesobola brevianalis	River Sardine	Well aerated, open water of flowing rivers	LC
Opsaridium peringueyi	Southern Barred Minnow	Shallow, clear and flowing waters. Favours sand and gravel	LC
Family Gobiidae			
Glossogobius callidus	River Goby	Cobble pools with vegetation	LC
Glossogobius giuris	Tank Goby	Quiet sandy zones of rivers	Unlisted
Family Mochokidae			
Chiloglanis	Sawfin Suckermouth	Rocky riffles and rapids	LC

paratus			
Chiloglanis pretoriae	Shortspine Suckermouth	Rocky riffles and rapids	LC
Chiloglanis engiops	Lowveld Suckermouth	Rocky riffles and rapids	LC
Synodontis zambezensis	Brown Squeaker	Pools and slow flowing reaches	Unlisted
Family Mormyridae			
Marcusenius macrolepidotus	Bulldog	Well-vegetated and muddy bottomed rivers	Unlisted
Petrocephalus wesselsi	Southern Churchill	Quiet reaches	LC
Family Schilbeidae			
Schilbe intermedius	Silver Catfish	Slow-flowing and open water with vegetation	Unlisted

Based on an assessment of the South African Institute of Aquatic Biodiversity's (SAIAB) database it was concluded that *Glossogobius giuris*, *Opsaridium peringueyi* and *Barbus linomaculatus* would be unlikely to occur within this section of the Groot Letaba River. These three species were therefore removed from the expected species list. One additional species *Barbus annectens*, was added to the list as it has been recorded in the project area. *Chiloglanis swiestrai* has recently been renamed *Chiloglanis engiops.* Based on this 33 fish species are expected in this section of the Groot Letaba River and its tributaries. The observed species list from the Aquatic EIR is presented in Table 10.

Table 10: Observed fish species list identified in the Aquatic EIR.

Species	Common Name	IUCN Status
Family Characidae		
Micralestes acutidens	Silver Robber	Unlisted
Family Cichlidae		
Oreochromis mossambicus	Mozambique Tilapia	NT
Pseudocrenilabrus philander	Southern Mouthbrooder	Unlisted
Tilapia sparrmanii	Banded Tilapia	Unlisted
Family Clariidae		
Clarias gariepinus	Sharptooth Catfish	Unlisted
Family Cyprinidae		
Barbus toppini	East Coast Barb	Unlisted
Barbus trimaculatus	Threespot Barb	Unlisted
Barbus unitaeniatus	Longbeard Barb	LC
Barbus viviparus	Bowstripe Barb	LC
Labeo cylindricus	Redeye Labeo	LC
Labeo molybdinus	Leaden Labeo	LC
Labeo rosae	Rednose Labeo	LC

Labeobarbus marequensis	Lowveld Largescale Yellowfish	LC
Mesobola brevianalis	River Sardine	LC
Family Mochokidae		
Chiloglanis pretoriae	Shortspine Suckermouth	LC
Family Centrarchidae		
*Micropterus salmoides**	Largemouth Bass	Unlisted

* introduced exotic species

A total of 15 indigenous and one introduced fish species were recorded in the project area (Table 10). It was concluded in the Aquatic EIR that additional sampling could potentially have increased the number of observed fish species.

4.6 Review of historical habitat and fish data

The historical habitat and fish data was reviewed and relevant aspects were summarised.

4.6.1 Historical habitat data

The 2001 assessment of Intermediate Habitat Integrity (IHI) in the Letaba River (Angliss and Fouche, 2002) focused on two reaches of the Groot Letaba River relevant to the current study:

GL2 - This reach extended from Junction weir downstream. The area was situated in the citrus belt. The riparian zone was largely intact due to protection afforded by private land owners. Numerous pump houses were observed along the river. Exotic vegetation was a serious problem in this zone. A number of dead fish were observed during the aerial survey.

GL3 **-** This reach extended downstream of GL2 to the upper end of Prieska Weir. The zone was dominated by citrus plantations, but also included the Hans Merensky Nature Reserve on the East Bank. Although the riparian zone was relatively intact, infestation with exotic plants was serious.

Within these two reaches of the Groot Letaba River, the following habitat aspects were summarised:

Water abstraction

Due to the high demand for water for both irrigation and primary use this impact was rated as large for the Groot Letaba River between Tzaneen Dam and the Molototsi River confluence. Many pump houses and off channel storage dams were observed between Tzaneen and Letaba Ranch.

Flow modification

The impact was considered to be large. Seasonal variability has been affected by the placement of a number of dams and weirs in the river channel.

Bed modification

The impact was large due to the large number of weirs and dams along the rivers length. Numerous weirs were breached during the 2000 floods and were inoperative during the survey. Of those weirs which were intact, all were full and spilling, causing an estimated 30 km of river to be inundated by back waters. This represented approximately 20% of the rivers length, over which bottom habitats had been inundated with sediments.

Channel modification

This impact was rated as small along the rivers length. Islands, terraces, flood benches and flood plains remained well defined. Impacts that were observed were largely associated with physical structures such as dams, weirs and bridges.

Water quality

Water quality was rated as moderate due to the moderating influence of Tzaneen Dam on water temperature. The impacts of fertilizers and pesticides increased along the rivers length. An increase in pH, conductivity and turbidity was recorded as one moved downstream along the catchment.

Impoundments (Dams and Weirs)

The impacts of impoundments on riverine ecosystems are considered to be significant. The reduction in substrate diversity and hydraulic variability over large areas of the river had resulted in a shift in fish and invertebrate community structures in those areas. In addition, weirs acting as migrations barriers. The impacts of these weirs extend beyond the physical area of impounded water and influence the entire the study area. Weirs that are situated further downstream have a direct influence on fish migration into this upstream section of the Groot Letaba River.

Erosion

Erosion was evident throughout the alluvial reaches of the system and could be attributed primarily to flood action. Flood influences were however considered to be largely natural.

The report concluded that habitat integrity in the Groot Letaba River was predominantly moderately to largely modified. This was particularly noticeable in the instream component and was primarily due to the presence of dams and weirs in the catchment.

When compared to the 1994 survey habitat integrity in the river was at least one class higher in all segments. A number of issues were raised:

- During the 1994 survey, bed modification was considered to be a small impact along the rivers length. The 1994 survey did not recognise the loss of river habitats through the deposition of sediments in dams as a large impact. In the 2002 assessment, the loss of benthic interstitial habitats and flowing water habitats was viewed as a serious impact.
- During the 1994 survey, the impacts of dams and weirs were only attributed to those segments where the impoundments occurred. This did not recognise the impact of fragmentation of the fish communities. In the 2002 study, the impacts of weirs were considered across river zones and not just for those segments where inundation occurred.

In 2003 the IHI was undertaken on the Groot Letaba River (Fouche and Moolman, 2004). Two reaches were relevant to the current assessment:

GL5 - This reach extended from the Letsitele River to the Nwanedzi River confluence and included influences from Letsitele Town and the Letsitele and Thabina rivers, which enter the Groot Letaba at Junction weir. The area was a commercial agriculture citrus belt and impacts were largely agricultural. There were many pumps and off channel storage dams, some of which occur some distance from the main river, together with 4 instream weirs. Water abstraction was therefore considered a serious impact.

The instream habitat varied in condition along the river. All habitat types were present but there was considerable sedimentation in pools and weirs.

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

GL6 - This zone extended from the Nwanedzi River downstream confluence to Prieska Weir. The zone was dominated by citrus plantations, but also included the Hans Merensky Game Reserve on the eastern shore.

The Nwanedzi River is non-perennial and passes through commercial citrus orchards. The 1994 Instream Flow Requirements (IFR) study evaluated the possibility of a new dam at the confluence of the Nwanedzi and Groot Letaba rivers. The Nwanedzi River has a catchment area of 410 km^2 and a virgin MAR of 26 million m^3 with a developed Mar of 15 million m^3. (Flow from the Nwanedzi River was therefore considered to be seriously modified.

Based on the video five weirs (including Prieska) and a large number of off channel storage dams were observed in this reach . There was considerable bank erosion on the river bends and extensive siltation in pools and above weirs.

Near Hans Merensky Game Reserve, the river becomes a wide anastamosing channel with diverse instream habitats. There remains a considerable amount of sediment in pools and weirs. Nevertheless, fish habitat was excellent and this was reflected by the reasonable fish populations. The River Health Programme (RHP) biomonitoring survey of the Letaba River catchment (Angliss, 2004a) indicated that habitat availability had decreased due to the reduction in flow.

4.6.2 Historical fish data

The ecological requirements of fish species used as indicators in the Groot Letaba River was summarised in 2004 (Fouche, 2004).

- *Amphilius uranoscopus, Barbus eutaenia, Barbus unitaeniatus, Chiloglanis paratus, Labeo molybdinus, Micralestis acutidens, Mesobola brevianalis* and *Tilapia sparrmanii* were considered to be indicator species in the Groot Letaba River;
- *Chiloglanis pretoriae* requires the following habitats: Flow velocities of 0.8 - 1.0 m/s with rocky substrates and well oxygenated water (> 0.6 mg/l).. Breeding cues are provided by increases in water temperature and photo period.

Labeobarbus marequensis requires the following spawning habitat: Velocities > 0.7 m/s and 200 mm depth. Spawns as temperature reaches 24 °C in the early summer. Fish stress responses were summarised in 2004 (Angliss, 2004b).

- *Amphilius uranoscopus* is truly rheophilic (flow dependant) and is regarded as being highly intolerant of no flow situations and of poor water quality. This small fish prefers cobble and boulder substrates in both fast-deep and fast-shallow environments. The fish is a specialized insectivore and feeds on insects between the interstitial spaces of cobbles and boulders. Breeding occurs as rivers swell at the onset of rains. The fish is least stressed when there is abundant cool, fast flowing habitat. Deep flowing water is required to provide cover in daylight hours. As flow reduces, fast deep channels become less abundant. However, the fish are still able to survive in fast shallow, well oxygenated habitats with good benthic cover. Under such conditions, fish are able to find abundant food and the health of the individuals is likely to remain good. In readiness for the onset of rains, some gonad development will take place. As fast shallow habitats decline further, so does the quality of water. Temperatures are likely to rise. Predation becomes a problem due to reduced cover and the general health of the fish deteriorates. Parasite loads increase and the population as a whole becomes stressed. *Amphilius* can only survive such situations for short periods of time, if the water remains well aerated. If flow stops completely, the fish are unable to survive in standing water habitats.
- *Barbus eutaenia* is rheophilic species and is regarded as being highly intolerant of no flow situations and of poor water quality. This small fish has equal preference for cobble and boulder substrates and marginal vegetated areas in both fast-deep and fast-shallow environments. The fish is considered to be one of Limpopo Province’s most sensitive species. The fish is a specialized insectivore, preying on invertebrates in all cover types. Breeding occurs as rivers swell at the onset of rains. The fish is least stressed when there is abundant cool, fast flowing habitat. Deep flowing water and marginal vegetation are required to provide cover in daylight hours. As flow reduces, fast deep channels become less

abundant and the quality of marginal habitats decline. However, the fish are still able to survive in fast shallow, well oxygenated habitats with good benthic cover. Under such conditions, fish are able to find abundant food and the health of the individuals is likely to remain good. In readiness for the onset of rains, some gonad development will take place. As fast shallow habitats decline further, marginal habitats become sparse and temperatures are likely to rise. Predation becomes a problem due to reduced cover and the general health of the fish deteriorates. Parasite loads increase and the population as a whole becomes stressed. The fish can move into marginal areas of well oxygenated pools for short periods. As temperatures rise and oxygen levels drop further, the population becomes stressed. If flow stops completely, the fish are unable to survive in standing water habitats.

- *Chiloglanis pretoriae* is truly rheophilic species and is regarded as being highly intolerant of no flow conditions and impaired water quality. This small fish prefers cobble, boulder and bedrock substrates in both fast – deep and fast – shallow environments. The fish is therefore regarded as an excellent indicator for IFR purposes. *C.pretoriae* is specially adapted to feed on benthic matter adhering to rocks in fast flowing habitats. Breeding occurs as rivers swell at the onset of rains. The fish are very common in the upper and middle reaches of the Letaba Catchment, but become less abundant as one moves into the Lowveld area of Letaba Ranch and the Kruger National Park. Low flows and water temperatures are considered to be the limiting factor for this species in this Lowveld area. The fish is least stressed when there is abundant cool, fast flowing habitat over rocky substrates. As flow reduces, fast deep channels become less abundant. However, the fish are still able to survive in fast shallow, well oxygenated habitats with good benthic cover. Under such conditions, fish are able to find abundant food and the health of the individuals is likely to remain good. In readiness for the onset of rains, some gonad development will take place. As fast shallow habitats decrease further the quality of benthic habitat decreases. Temperatures are likely to rise and algal growth limits access to both the interstitial spaces and to food. Predation becomes a problem due to reduced cover and the general health of the fish deteriorates. Parasite loads increase and the population as a whole becomes stressed. *Chiloglanis pretoriae* can only survive such situations for short periods of time, if the water remains well aerated. If flow stops completely, the species is unable to survive.

- The indicator species, *Labeo molybdinus* is regarded as semi rheophic. The fish can survive considerable periods of time in well aerated pools, providing there is suitable benthic and marginal cover. The fish is equally at home in fast flowing habitats and freely moves between pools and rapids, as and when flows permit. However, the fish moves into fast flowing habitats for breeding purposes. The fish reach a considerable size (up to 400mm length) and sexual maturity is reached as the fish reaches 180 mm. In times of flood, the fish move upstream on mass. The fish are therefore considered to be most healthy when a wide range of habitats and cover types are available. The frequency of occurrence of *L.molybdinus* decreases as the quality of the cover decreases. Juvenile fish can survive with limited cover, but mature fish require deeper conditions throughout the year.

The River Health Programme (RHP) biomonitoring survey of the Letaba Catchment (Angliss, 2004b), indicated that the FAII results reflect a general decrease in the status of the river, with most segments showing FAII assessment Classes E and F (Seriously and critically modified).

- In 2000, the highly flow dependent *Amphilius uranoscopus* was present in 7 of the 10 segments where it is expected, whereas in 2003, the fish was only recorded in 2 segments.

- In 2000, the highly flow dependent *Barbus eutaenia* was abundant in 7 of the 10 segments where it is expected segments surveyed, while in 2003, the fish was only recorded in 2 segments.

- In 2000, the migratory eels Anguilla spp. were recorded in 6 of the 16 segments surveyed, while in 2003, no fish were recorded at all.

- In 2000, the "provincially scarce" *Barbus lineomaculatus* was recorded in 5 of the 15 segments surveyed, while in 2003, the fish was only recorded in one segment.

- No specimens of the red data fish *Opsaridium peringueyi* were recorded in either survey.
- Abundances of all fish species were lower in 2003 than in 1999.

The field surveys on the Letaba River, upstream of the Kruger National Park) reveal that nearly all migratory fishes were absent from the Letaba River and tributaries (including the Groot Letaba River) during the 2003 surveys. This was due to the fragmentation of the system by the numerous weirs and dams and the imposition of a regulated flow regime. Although the system was fragmented the river maintained some degree flow and most of the intolerant and flow dependant species managed to survive. However, the absence of *Chiloglanis engiops* in the lower reaches of the river was of concern and may have been linked to changes in flow patterns. *Opsaridium peringueyi* was thought to be lost due to flow regulation in the upper catchment.

In 2007, DWAF investigated the development of a sizeable new dam, the “Nwamitwa Dam” in the Groot Letaba River at the Nwanedzi confluence (Angliss, 2008). Of the expected fish species list only *Anguilla bengalensis labiata* was considered to be permanently absent, due to the fragmentation of the system by dams and weirs (Angliss, 2008). Although expected in the Letaba Catchment, due to its confirmed presence in neighbouring catchments, the first confirmed record of *Opsaridium peringueyi* in the Letaba Catchment was recorded (Angliss, 2008).

Most of the expected fish species were found in abundance. An abundance of flow dependent species such as the *Chiloglanis spp.* were noted. *Chiloglanis engiops* was feared lost from the catchment following the floods of 2000 and was the first record in the catchment since 2000. Results have shown that the Letaba River remains in a largely modified ecological category, although some individual survey sites remain in a better condition for both fish or invertebrates. The red data fish *Opsaridium peringueyi* (Southern barred minnow) was recorded for the first time in this catchment during 2007. Furthermore, *Chiloglanis engiops* (Lowveld suckermouth) was reported extinct from the catchment in 2000, but that it was found in moderate abundance at one site during the 2007 survey.

A summary of the historical fish data is presented in APPENDIX A.

4.7 Review of flyover video footage

The 1994 and 2003 flyover video footage was reviewed with the above results in mind. The purpose of the review was to determine the current state and amount of habitat available for fish migration, movement and breeding within the Groot Letaba River. A focus on river continuity and accessibility to required habitats was also included. Flyover data was only applicable for the Groot Letaba River and the Nwanedzi River as this was the only data relevant to the project area.

Junction and Prieska weirs are considered to be the largest barriers within the project area. With the exception of downstream migration over Junction and Prieska weirs the project area is isolated from the remainder of the Groot Letaba River.

Based on the flyover data the habitat between the Junction weir and the confluence with the Nwanedzi River consists predominantly of inundated pool areas with plane bed runs, corresponding to identified river sections I and H (Figure 2). An estimated 80% of this reach consists of pool habitats with runs, 15% is comprised of riffle areas through marginal vegetation and instream sand bars and 5% is comprised of bedrock rapid and riffle habitat.

Downstream of the confluence with the Nwanedzi River, the Groot Letaba River widens and habitat consists of a mixture of pool-riffle and pool-rapid habitats, corresponding to identified river section G (Figure 2). The river flows over a short weir (Jasi Weir) and then downstream towards Hans Merensky Nature Reserve, corresponding to identified river sections D and B (Figure 2). Good riffle and rapid habitat occur in these sections. As the Groot Letaba River reaches Prieska Weir, a back up of inundated water forming one large pool occurs, corresponding to identified river section A (Figure 2).

Moving upstream along the Nwanedzi River from the confluence with the Groot Letaba habitat consists of a pool formed by backwater from the Groot Letaba River, corresponding to identified river section J (Figure 2). Upstream of this the habitat consists primarily of riffle, rapid and pool sequences, corresponding to identified river section J (Figure 2). Shallow sand and gravel beds as well as small pools and riffle/rapids occur further upstream, corresponding to identified river sections O, P, R and S (Figure 2). A diverse mixture of fish habitats occurs within the Nwanedzi River although increased siltation and reduced flows were noted in some areas.

The flyover data for the Groot Letaba River and the Nwanedzi River confirmed the hydraulic biotopes identified by the assessments of the geomorphological zonations and gradients (Table 8).

4.8 Discussion of impacts associated with the proposed Nwamitwa Dam on the availability of fish habitats

The impacts of the Nwamitwa Dam on fish habitats are discussed in this section. This takes into account the availability of habitat prior to construction of the dam compared to habitat availability after construction of the dam.

4.8.1 Loss of existing river reaches

The lengths of the existing river reaches presented in Table 4 were recalculated using the 1.5 MAR projection of the area of inundation of the proposed Nwamitwa Dam. The remaining reaches are presented in Table 11. The two existing river reaches will be divided into three sections consisting of the area between Nwamitwa Dam wall and Junction weir; the area downstream of Nwamitwa Dam wall and Jasi weir and the river between Jasi and Prieska weirs.

Table 11: Estimated river reaches remaining after the construction of Nwamitwa Dam

River section	Distance of available aquatic habitat (km)	Total reach available (km)
Prieska to Jasi weir		
Groot Letaba upstream of Prieska weir to Merekome confluence	9.2	
Merekome tributary	5	
Groot Letaba upstream of Merekome confluence to Lerwatlou confluence	6.6	
Lerwatlou tributary	5.4	
Groot Letaba upstream of Lerwatlou confluence to Jasi weir	14.6	**40.8**
Jasi Weir to Nwamitwa Dam wall site		
Groot Letaba upstream of Jasi weir to Shilovolwe confluence	2.3	
Shilovolwe tributary	0	
Groot Letaba upstream of Shilovolwe confluence to Nwamitwa Dam wall site	4.7	**7**
Namitwa Dam wall site to Junction weir		
Groot Letaba upstream of Nwamitwa Dam wall site to Nwanedzi confluence	0	
Nwanedzi tributary to Hlangana confluence	0	
Hlangana tributary	0	
Nwanedzi tributary upstream of Hlangana confluence to Mphuphule confluence	8.97	
Mphuphule tributary	2.9	
Nwanedzi tributary upstream of Mphuphule confluence	8	
Groot Letaba upstream of Nwanedzi confluence to Junction weir	5	**24.87**
		72.67

Of the 97.43 km of existing river reach available to fish, 72.67 km will remain after the construction of Nwamitwa Dam. The dam will inundate 24.76 km of the existing reach length and no flow will exist within this length. Riverine habitat will be converted into dam habitat within this section.

Groot Letaba River

In the Groot Letaba River upstream of the dam wall, this accounts for a loss of an estimated 14.6 km of the original 19.6 km within reach segments G, H and I (Figure 2). Although this habitat is predominantly pool dominant, the loss of flowing water within this segment is substantial. Downstream of the proposed dam wall, the habitat in the Groot Letaba River consists primarily of a diverse mixture of pool-riffle and pool-rapid sequences. The decrease in volume of water and flow as a result of the dam is likely to affect these habitats.

Nwanedzi River

In the Nwanedzi River the length of river that will be inundated is 9.21 km of the original 26.23 km within segments J and O (Figure 2).

Hlangana River

The 0.90 km of habitat within segment K will be lost due to inundation (Figure 2). A large dam wall which currently forms a migration barrier at the upstream end of segment K will be inundated by Nwamitwa Dam allowing fish migration into segments L, M and N (Figure 2). However, upstream of where the projected inundation ends, two dam walls are present. Fish will be able to move into these areas, however, no further river lengths or habitats will be gained as a result.

4.8.2 Loss of breeding/life-cycle habitat

The potential loss of breeding habitat in the Groot Letaba River upstream of Nwamitwa Dam, is considered to be minimal as the reach is composed primarily of pool habitats. Breeding habitat for slow-flow dependant species will be altered and impacted upon temporarily; this will however recover over time as the dam begins to fill.

The Nwandezi River remains largely intact in terms of breeding habitat, with most of the breeding habitat in the form of shallow gravel and sand beds, clear riffle areas, pools and marginal vegetation with flow situated upstream of the area of inundation. Fish within Nwamitwa Dam will therefore still have access to this critical habitat. This area is considered to be important for the continued breeding potential of flow dependant species in the dam.

The Groot Letaba River downstream of the dam will be most impacted upon by the construction of Nwamitwa Dam. It is likely that the pool-riffle and pool rapid habitats will be reduced with a shift in habitats towards pools associated with decreased flows and reduced marginal vegetation inundation. The downstream tributaries of the Groot Letaba River provide little refuge or breeding habitats for fish due to the presence of instream migration barriers.

The existing 40.8 km of river reach between Jasi and Prieska weirs will remain largely unchanged although some changes are likely to occur due to the reduction in flow and volume of water. The maintenance of flow in the downstream section is therefore critical to preserving the required habitats in the section of the Groot Letaba River downstream of Nwamitwa Dam4.

The historical habitat data and previous studies have indicated that flow modification, erosion, degradation of bed material and impoundments have led to a degradation of in-stream habitats. The Groot Letaba River system is fragmented and large migratory species are no longer present. Construction of Nwamitwa Dam will further compound this impact and therefore it is critical that flows and remaining habitats are monitored and protected from further impacts.

4.8.3 Impacts on fish species

The historical fish data indicates that fish assemblages in the Groot Letaba River are stable and diverse despite the loss of some migratory species. The highest diversity and abundance of fish was recorded in the 2007 biomonitoring survey (**Error! Reference source not found.**).

It is likely that post construction fish communities will change in accordance to the changed habitats.

<u>Groot Letaba River upstream of the dam wall</u>

The dam will act as a migration barrier and will separate the upstream populations from those found downstream. It is expected that the 15 species that were sampled during the baseline assessment will still be present upstream of the dam (Table 10).

It is expected that the following species could decrease in abundance in Nwamitwa Dam:

- *Barbus toppini*;
- *Barbus unitaeniatus*;
- *Barbus viviparous*;
- *Mesobola brevianalis*;
- *Chiloglanis pretoriae*; and

- *Micralestes acutidens*.

The remaining 5 km of river reach upstream of the inundation area of Nwamitwa Dam may provide adequate habitat for populations of *M brevianalis* and *M acutidens* to persist. It is expected that the minnows *B toppini*, *B unitaeniatus* and *B viviparous* will survive in the habitats provided by the marginal vegetation of the dam, but will most likely occur in higher densities in the Nwanedzi River where access to breeding habitats and flow will be available. *Chiloglanis pretoriae* will not occur within the inundated areas of the dam and will only be found in the remaining flowing reaches of the Nwanedzi River. It is expected that this species may disappear from the river upstream of the dam but may survive downstream of the dam.

It is expected that the larger fish species such as *Oreochromis mossambicus, Clarias gariepinus, Labeo rosae,* and *Labeobarbus marequensis* will utilise the newly created habitat of the dam. During spawning periods *L rosae, Labeo cylindricus, Labeo molybdinus* and *L marequensis* will migrate upstream in search of suitable spawning and breeding habitats, which will only be found in limited locations in the upper reaches of the Nwanedzi River. These species may decrease in abundance upstream of Nwamitwa Dam. *O mossambicus* and *C. gariepinus* are expected to flourish in the impoundment. The aggressively invasive fish species *Micropterus salmoides* (Largemouth bass) was recorded in the Nwanedzi River system during the baseline assessment. This species thrives in dam habitat and will readily exploit this. The impact of this invasive species was highlighted in the EIA and could potentially prey on and decease a large number of smaller species and juveniles of large species, thus having a negative impact on the fish communities within this upstream area.

It is expected that *Pseudocrenilabrus philander* and *Tilapia sparrmanii* will be found in high abundances along the marginal habitats of the dam and within the upstream river reaches of the Nwanedzi River and the remaining river habitat upstream of the dam.

Of the remaining 18 expected fish species, biomonitoring of the section of Groot Letaba River between Nwamitwa Dam and Junction weir will show whether these species will persist within the upstream river reach and will provide insight into the new fish assemblage that will develop.

<u>Groot Letaba River downstream of the dam wall</u>

Migration routes of fish into the Groot Letaba and Nwanedzi Rivers will be cut off. The greatest impact on flow modification will be seen in the reach between Nwamitwa Dam wall and Jasi weir (approximately 7 km of river length). It is likely that only very tolerant species such as *Oreochromis mossambicus, Clarias gariepinus, Labeo cylindricus, Labeo molybdinus* and *L marequensis* will occur within this segment, but in reduced numbers. The spawning and breeding potential for these species within this segment is low. *O mossambicus* and *C gariepinus* will most likely find suitable habitat and may remain in large numbers within this section. Recruitment from the downstream segment will be possible for the *L cylindricus, L molybdinus* and *L marequensis* as these species should be able to cross Jasi weir during periods of high flow.

Downstream of Jasi weir, the habitat in the Groot Letaba River is diverse and the riparian areas are protected. The 40.8 km of river reach between Jasi and Prieska weirs should provide adequate habitat for the survival of the current fish community provided that the existing flow regime and environmental cues are maintained. The sediment trapping function of the Nwamitwa Dam will provide increased water clarity to the downstream river reaches, and provided that well oxygenated water is released, this should improve the water quality downstream of the dam.

Flow dependant fish species may survive downstream of the dam providing that their flow requirements are maintained. Future biomonitoring surveys will show whether the 18 expected species persist in the downstream river sections.

5.0 CONCLUSIONS

The following conclusions were reached based on the results of this assessment:

- A total of 24.76 km out of 97.43 km of river habitat will be inundated by construction of Nwamitwa Dam. This constitutes a 25.41% loss of riverine habitat within the currently available reach.
- Some habitats for fish breeding and life-cycle stages will be impacted upon by construction of Nwamitwa Dam.
- Impacts in terms of the construction and operation of Nwamitwa Dam may be mitigated by implementation of the measures detailed in the Environmental Impact Assessment (EIA) report.
- After the workshop held in regard to the need for a fishway within the Nwamitwa Dam, the mitigation measures now exclude the need for a fishway to be constructed in the dam wall or the need for additional studies to verify this.
- Fish communities and populations upstream of the dam and within the dam will be impacted upon in terms of abundances, but it is expected that the majority of fish species will manage to adapt and find adequate habitats for spawning and life-cycle stages.
- The Nwanedzi River as well as the remaining flowing habitats in the Groot Letaba River, upstream of the dam is considered to be of high importance for the survival of flow dependant species in the upstream section.
- The habitats of the Groot Letaba River downstream of the Nwamitwa Dam should support the current diversity of fish species, provided that the mitigation measures are implemented correctly and that the Reserve requirements are maintained.

6.0 RECOMMENDATIONS

The following recommendations are made, based on the conclusions of this desktop assessment:

- Bi-annual biomonitoring of the remaining section of the Groot Letaba River, upstream of Nwamitwa Dam, the upper reaches of Nwanedzi River as well as within the dam, will indicate whether the additional 18 expected fish species still occur within the remaining river reaches and will indicate the new trends that will develop within the current fish community and populations of the individual species.
- Bi-annual biomonitoring of the Groot Letaba River downstream of Nwamitwa Dam will reveal the impacts that releases of the dam have on the receiving ecosystems. Implementation of the flow requirements can also be monitored during these bi-annual events.
- The functionality of Jasi weir should be re-evaluated and should this prove to be redundant, the removal of this weir should be investigated. This will allow for the 7 km section of river below the dam wall to be connected to the downstream sections above Prieska Weir and will improve the continuity of the entire downstream section.
- The remaining areas of flowing river habitat in the Groot Letaba River and the Nwanedzi River, should be protected from further impacts and the initiation of declaring these areas as conservation areas will ensure that no further degradation of the river habitats and fish species occur within the project area.

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Report Signature Page

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APPENDIX A

Historical fish data for the Groot Letaba River (1991 - 2007)

RIVER NAME:	**G. Letaba**	**G. Letaba**	**G. Letaba**	**G. Letaba**	**G. Letaba**	**G. Letaba**	**G. Letaba**	**G. Letaba**	**G. Letaba**	**G. Letaba**	**G. Letaba**	**G. Letaba**	**G. Letaba**	**G. Letaba**	**G. Letaba**	**G. Letaba**	**G. Letaba**	**G. Letaba**	**G. Letaba**	**G. Letaba**	**G. Letaba**
ECO REGION:	5.05	5.05	5.02	5.02	5.02	5.02	5.02	5.02	5.02	5.05	5.05	5.02	5.02	5.02	5.02	5.02	5.02	5.02	5.02	5.05	5.05
NPDAE SITE:	114	115	116	118	119	120	121	122	124	114	115	116	117	118	119	120	121	122	124	114	114
YEAR:	1991	1991	1991	1991	1991	1991	1991	1991	1991	1991	1991	1991	1991	1991	1991	1991	1991	1991	1991	1992	1992
SURVEYOR AND DATE:	MKA 08.91	MKA 8.91	MKA 8.91	MKA 8.91	MKA 8.91	MKA 8.91	MKA 8.91	MKA 8.91	MKA 8.91	MKA 11.91	MKA 11.91	MKA 11.91	MKA 11.91	MKA 11.91	MKA 11.91	MKA 11.91	MKA 11.91	MKA 11.91	MKA 11.91	MKA 5.92	MKA 6.92
Amphilius uranoscopus																					
Anguilla mossambica		1			1													1			
Barbus annectens	15										4		11	29				8			
Barbus eutaenia	5													1						2	2
Barbus lineomaculatus	1																			1	
Barbus marequensis	53	2		2		32	15	1	5	32		20		12	32	19	27	16	11	12	72
Barbus paludinosos																					
Barbus radiatus																					
Barbus toppini	6								2			4				5			3		3
Barbus trimaculatus	1			3	1	5		13	51	1		4		1				2	11		
Barbus unitaeniatus		3		1			1		26			2				3	1				1
Barbus viviparus	12	2	1	5		3	14		4			17	2		32	34	7		42		
Brycinus imberi																					
Chiloglanis paratus						4	25	2	3					1	1	7	22		8		
Chiloglanis pretoriae		100	65	27	100	100		18	10	1	30	35		19	56	100	51	51	17		2
Chiloglanis swierstrai						1										1					
Clarias gariepinus		1	2	12		3	3				1	1	1	1	5						
Glossogobius callidus																					
Glossogobius giuris							33	6	2				5		5		2		14		
Hydrocynus vittatus																					
Labeo cylindricus	5	8	6	1	4	1	4	6	8	7	14	2	1	2		2	5	8	3		7
Labeo molybdinus	4	1	15	4	8	26	28	28	13		2	7	1	9	17	21	12	7	14	3	5
Labeo rosae		3																			
Labeo ruddi																					
Marcusenius macrolepidotus								1	1				1					1	3		
Mesobola brevianalis		6	1	1					4	5	1	10	11			3	1	9		28	2
Micralestes acutidens	25	15	1							5	30	32	3	2	1	6	1	9	7	15	6
Opsaridium peringueyi																					
Oreochromis mossambicus	1	2		39			8			1	1		1	17			2				
Petrocephalus catostoma											1		1								
Pseudocrenilabrus philander						1				1		4	2	4							9
Schilbe intermedius		1		13																	
Synodontis zambezensis																					
Tilapia rendalli									1	22					7	1	1		3		24
Tilapia sparrmanii											2										
Total number of individuals	**128**	**145**	**91**	**108**	**114**	**176**	**131**	**75**	**130**	**75**	**86**	**138**	**40**	**98**	**156**	**202**	**132**	**112**	**136**	**61**	**133**
Total number of species	**11**	**13**	**7**	**11**	**5**	**10**	**9**	**8**	**13**	**9**	**10**	**12**	**12**	**12**	**9**	**12**	**12**	**10**	**12**	**6**	**11**

RIVER NAME:	G. Letaba	G. Letaba	G. Letaba	G. Letaba	G. Letaba	G. Letaba	G. Letaba	G. Letaba	G. Letaba	G. Letaba	G. Letaba	G. Letaba	G. Letaba	G. Letaba	G. Letaba	G. Letaba	G. Letaba	G. Letaba	G. Letaba	G. Letaba	G. Letaba
ECO REGION:	5.05	5.05	5.02	5.02	5.02	5.02	5.02	5.02	5.02	5.02	5.02	5.02	5.02	5.02	5.05	5.05	5.05	5.02	5.02	5.02	5.02
NPDAE SITE:	115	115	116	116	117	118	118	119	120	121	121	122	124	124	114	114	115	116	120	118	118
YEAR:	1992	1992	1992	1992	1992	1992	1992	1992	1992	1992	1992	1992	1992	1992	1994	1995	1995	1995	1995	1996	1996
SURVEYOR AND DATE:	MKA 5.92	MKA 6.92	MKA 5.92	MKA 6.92	MKA 6.92	MKA 5.92	MKA 6.92	MKA 5.92	MKA 5.92	MKA 2.92	MKA 6.92	MKA 6.92	MKA 2.92	MKA 6.92	MKA 2.94	MKA 12.95	MKA 12.95	MKA 12.95	MKA 6.95	MKA 2.96	MKA 5.96
Amphilius uranoscopus																					
Anguilla mossambica																					
Barbus annectens																					
Barbus eutaenia															1						
Barbus lineomaculatus																					
Barbus marequensis			8	15	2			10	2	8			5	5	3	4	3				
Barbus paludinosos																					
Barbus radiatus													1								
Barbus toppini							1				2		4	5			5	25			
Barbus trimaculatus									1				10	13			6		28	31	11
Barbus unitaeniatus						1	1					1		1			1	41	10	55	
Barbus viviparus	2			1		14	11	8	5	7		2	8	1			5	10			
Brycinus imberi																					
Chiloglanis paratus	1	1				1				9		1	9								11
Chiloglanis pretoriae	100	56	51	36	51	18	15	29	100	100	3		23		17	7					1
Chiloglanis swierstrai										3											
Clarias gariepinus						4	4	1	2	1	1			1					4		1
Glossogobius callidus																					
Glossogobius giuris			1		1			2		7		1	1	2					6		
Hydrocynus vittatus																					
Labeo cylindricus	8	6	1	6	14	4	7	2		13		2	11	9	11		4				4
Labeo molybdinus	1		1	7		8	6	17	23	14		1	15	6	3		5			2	5
Labeo rosae					4															5	
Labeo ruddi					5									1						5	
Marcusenius macrolepidotus				2				1													
Mesobola brevianalis	1							1	11	4		1	2		32	1		32			
Micralestes acutidens	2		6	2				5	3	1					100	13		26			
Opsaridium peringueyi																					
Oreochromis mossambicus						2	3		2	2	14	15		13	5	1	1	70	39	13	
Petrocephalus catostoma		1																			
Pseudocrenilabrus philander			2				1		3									15	18		
Schilbe intermedius					9															3	
Synodontis zambezensis					6									1							
Tilapia rendalli								1		4					8			6	7	2	1
Tilapia sparrmanii																					
Total number of individuals	**115**	**64**	**70**	**69**	**92**	**52**	**49**	**77**	**152**	**173**	**20**	**24**	**89**	**58**	**180**	**26**	**30**	**225**	**112**	**116**	**34**
Total number of species	**7**	**4**	**7**	**7**	**8**	**8**	**9**	**11**	**10**	**13**	**4**	**8**	**11**	**12**	**9**	**5**	**8**	**8**	**7**	**8**	**7**

RIVER NAME:	G. Letaba	G. Letaba	G. Letaba	G. Letaba	G. Letaba	G. Letaba	G. Letaba	G. Letaba	G. Letaba	G. Letaba	G. Letaba	G. Letaba	G. Letaba	G. Letaba	G. Letaba	G. Letaba	G. Letaba	G. Letaba	G. Letaba	G. Letaba	G. Letaba
ECO REGION:	5.02	5.05	5.05	5.02	5.02	5.02	5.02	5.02	5.02	2.15	5.05	5.05	5.02	5.02	9.02	9.02	3.01	3.03 (a)	3.03 (a)	3.03 (a)	3.03 (b)
NPDAE SITE:	123	114	115	118	120	121	116	122	123												
YEAR:	1996	2000	2000	2000	2000	2000	2001	2001	2001	2003	2003	2003	2003	2003	2007	2007	2007	2007	2007	2007	2007
SURVEYOR AND DATE:	MKA 05.96	MKA 12.00	MKA 12.00	MKA 12.00	MKA 10.00	MKA 10.00	MKA 1.01	MKA 1.01	MKA 1.01	MKA 8.03	MKA 7.03	MKA 7.03	MKA 5.03	MKA 5.03	MKA 7.07	MKA 7.07	MKA 7.07	MKA 6.07	MKA 6.07	MKA 8.07	MKA 6.07
Amphilius uranoscopus										6					2						
Anguilla mossambica																			1		
Barbus annectens				5										12							
Barbus eutaenia											1				7	1	2				
Barbus lineomaculatus							1			1											
Barbus marequensis		28	5	18	19	21	83	28	42	32	11	1	1	50	66	46	8	38	14	7	28
Barbus paludinosos		1								15					7	23					
Barbus radiatus																					
Barbus toppini				3							11			21		11				2	1
Barbus trimaculatus	8			8	8			2	2			8	9	6						3	7
Barbus unitaeniatus	1	1	1		3		3								8						
Barbus viviparus			13	2				15				4	67	7		7				16	5
Brycinus imberi				1										1							1
Chiloglanis paratus	39			4	5	36	2	6	31				2	9		1			12	15	20
Chiloglanis pretoriae		2	34	54	2	19	100			28	13	6	28	16	15	2	9	28	2	78	
Chiloglanis swierstrai						2															
Clarias gariepinus	3				1			1	2				2	1		1		1		1	2
Glossogobius callidus				3	1		10	4	9				13								2
Glossogobius giuris																					
Hydrocynus vittatus																					
Labeo cylindricus			3	23	3	1	1	3	12	2	1		7	8	4	2	1		14	6	1
Labeo molybdinus	4	1	11	30	30	7	1			1	2	23	16	24		2	8	13	3	49	13
Labeo rosae						4															
Labeo ruddi				1																	
Marcusenius macrolepidotus			1							2		1			1	1	1		1		
Mesobola brevianalis		2	12	8	5		53	1	2		3	1	13	144	1	2	50	2		2	220
Micralestes acutidens		78	45	2		1	80	2	1	1	25	24		41		1	50		17	1	200
Opsaridium peringueyi															22						
Oreochromis mossambicus		14		5	22	1	1	7	35			12	89	114		4	10	1	21	3	9
Petrocephalus catostoma																					
Pseudocrenilabrus philander										40	2	5			4	32	15		1		1
Schilbe intermedius																					
Synodontis zambezensis					1																
Tilapia rendalli		38			6	2		1				169	3	2		5	15		3		
Tilapia sparrmanii																1	20				
Total number of individuals	**55**	**165**	**125**	**167**	**106**	**94**	**335**	**70**	**136**	**128**	**69**	**254**	**250**	**456**	**137**	**142**	**189**	**83**	**89**	**183**	**510**
Total number of species	**5**	**9**	**9**	**15**	**13**	**10**	**11**	**11**	**9**	**10**	**9**	**11**	**12**	**15**	**11**	**17**	**12**	**6**	**11**	**12**	**14**

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