1 JBS23 (OSAEH 29.5: LILYDALE LODGE (RIET RIVER))

EWR 19 was assessed as part of the Lower Vaal Reserve study, and the results are provided in the summary report (Technical report 1). The results provided below are based on the assessment undertaken during October 2010 as part of this study.

1.1 SITE DESCRIPTION

Location	OSAEH 29.5	**Altitude**	1107 m
Longitude	24.075780	**Latitude**	-28.707580
EcoRegion	Southern/Central Kalahari 29.02	**Quaternary catchment**	C51L
Water Management Area	Upper Orange	**Geomorphological zone**	Lower Foothills

OSAEH 29.5 is situated in the lower reaches of the Riet River below Ritchie and lies within Mokala National Park. The catchment area is dominated by irrigated agriculture. The dominant substrate at the site is bedrock and boulder. Cobble, boulder and rocky substrate is very abundant for cover for aquatic biota. Adequate flow was present at the time of sampling. Large pools for fish refugia were present with abundant marginal vegetation consisting of sedges and reeds and GSM biotope occurs at the site. Good habitat diversity for bio-monitoring purposes is present. Riparian vegetation consists of trees, shrubs, grasses, sedges and reeds. No large dams occur upstream but small weirs are present. The surrounding land use is natural veld for the game reserve.

Figure 1.1 OSAEH 29.5: Bedrock with boulder and rock substrate and good habitat diversity

1.2 BIOTIC SAMPLING

At the time of sampling, adequate flow was present at the site. Abundant reeds, sedges, cobbles, boulders and marginal vegetation (reeds and sedges) occur at the site. Filamentous and benthic algae and the exotic macrophyte, *Azolla,* were also observed. No local erosion was present however erosion upstream and downstream of the site does occur. Moderate sedimentation was present on the substratum. No odours were detected.

1.2.1 Fish

The fish sampling was conducted at the site during October 2010. A variety of depth classes were sampled for 45 minutes. Sampling and data analysis was followed according to Kleynhans *et al*. (2008). A summary of the site conditions during sampling is provided below. Abundance of habitat was rated as:

- 0 = absent 1 = rare
- 2 = sparse 3 = moderate
- 4 = abundant 5 = very abundant

Fish velocity-depth classes and cover present at the site

SLOW DEEP	SLOW SHALLOW	FAST DEEP	FAST SHALLOW
4	4	3	2
Overhanging vegetation			
2	3	0	0
Undercut banks and root wads			
0	0	0	0
Substrate			
5	5	5	5
Aquatic macrophytes			
5	5	0	0
Water Column			
5	5	5	5

Habitats sampled and effort

SAMPLING EFFORT	SLOW DEEP	SLOW SHALLOW	FAST DEEP	FAST SHALLOW
Electro shocker (min)	15 min	15 min	10 min	5 min

1.3 DATA AVAILABILITY

Detailed information regarding available data is provided in Table 15.1.

Table 1.1 OSAEH 29.5: Summary of data availability

Comp	Data availability	Conf
IHI	Google Earth imagery. Information from Lower Vaal Reserve study.	3
Riparian vegetation	Current Google Earth imagery of the site and site context. Data collected from field assessment during October 2010. Ecological reports and specialist assessments for this study; previous Reserve determination report SANBI floristic distribution data (2009) Literature: **Kleynhans C.J, MacKenzie J., Louw M.D.** 2007a. Module F: Riparian Vegetation Response Assessment Index in River Classification: Manual for EcoStatus Determination (version 2). Joint Water Commission and Department of Water Affairs and Forestry report. WRC Report No. TT333/08. **Low B.A., Rebello A.G.** (eds) 1998. Vegetation of South Africa, Lesotho and Swaziland**.** Department of Environmental Affairs and Tourism, Pretoria. **Mucina L. & Rutherford M.C.** (eds) 2006. Vegetation of South Africa, Lesotho and Swaziland. *Strelitzia 19*. South African National Biodiversity Institute, Pretoria. **Van Wyk B. & Van Wyk P**. 2009. Field Guide to trees of Southern Africa. 12th Impression. Struik Nature Publishers, Cape Town.	4
Fish	Google Earth imagery. One site visit and fish sampling during October 2010. **Kleynhans, C.J., Louw, M.D & Moolman, J**. 2007b. Module D (Volume 2): Reference Frequency of Occurrence of Fish Species in South Africa: Manual for EcoStatus Determination (Version 2). Joint Water Research Commission and Department of Water Affairs and Forestry Report. WRC Report No. TT330/08. Water Research Commission, Pretoria, South Africa. **Rivers Data base** (2007): *Database on fish distribution in South African Rivers*. **Scott *et al.*** (2006): *Atlas of Southern African Freshwater Fishes*.	3

Inverts	Google Earth imagery. One site visit and fish sampling during October 2010.	1

1.4 REFERENCE CONDITIONS

The reference conditions for the components are summarised in Table 15.2. Additional information on fish, macroinvertebrate and riparian vegetation reference conditions are also provided.

Table 1.2 OSAEH 29.5: Reference conditions

Comp	Reference conditions	Conf
Riparian vegetation	Savanna Biome, Eastern Kalahari Bushveld Bioregion, and Kimberley Thornveld Vegetation Type (Mucina & Rutherford, 2006). **Marginal Zone:** Present state close to reference, with various vegetation components: 1) *Gomphostigma virgatum* and *Cyperus marginatus* where riffle and cobble/boulder occur (not dominant). 2) High density *P. australis*. 3) Aquatic vegetation in pools with *Ceratophyllum* and *Potemogeton* dominant. 4) *Juncus* sp and *Schoenoplectus* sp with hydrophylic grasses along boulder bars where reeds do not occur. Lower Zone: Similar to marginal zone, with more grass cover. Upper Zone including MCB: Mainly woody and grass mix, with small proportion of reeds in places.	3
Fish	Reference conditions as set for the NRHP site, C5RIETIFR01, (Kleynhans *et al.,* 2007b), which is also the OSEAH 29.5 sampling site, was used as a starting point for setting reference conditions. See Table 14.3 for a list of the reference fish species.	3
Inverts	Reference conditions are based on professional judgement and Rivers Database information. The reference SASS5 score is 200 and the ASPT is 6.5.	2

1.4.1 Fish

Reference conditions broadly refer to “expectations on the state of aquatic biological communities in the absence of human disturbance and pollution”. In the context of this report, it refers specifically to the fish species present in a particular river reach and their frequency of occurrence under reference habitat conditions. Reference conditions as set for the NRHP site, C5RIETIFR01, (Kleynhans *et al.,* 2007b), which is also the OSEAH 29.5 sampling site, was used as starting point for setting reference conditions.

Professional opinion and experience; sampling; and habitat and site observations were further used to obtain a derived FROC from the reference FROC, based on the species habitat and condition preferences and tolerances (Table 15.3).

Eight indigenous fish species are expected under reference conditions and are listed in Table 15.3. An exotic fish species *Cyprinus carpio* is also listed for this system.

Table 1.3 OSAEH 29.5: Reference fish species

Expected Reference and Habitat derived FROC of fish at OSAEH 29.5 (Values used in FRAI). Observed species (HIGHLIGHTED)				
Scientific Names	**Common Name**	**Spp abbreviation**	**Reference FROC**	**Derived FROC**
Austroglanis sclateri	Rock catfish	ASCL	3	1
Labeobarbus aeneus	Smallmouth yellowfish	BAEN	1	1
Labeobarbus kimberleyensis	Largemouth yellowfish	BKIM	1	1
Clarias gariepinus	Sharptooth catfish	CGAR	1	1
Labeo capensis	Orange River labeo	LCAP	1	1
Labeo umbratus	Moggel	LUMB	3	1

Expected Reference and Habitat derived FROC of fish at OSAEH 29.5 (Values used in FRAI). Observed species (HIGHLIGHTED)				
Scientific Names	**Common Name**	**Spp abbreviation**	**Reference FROC**	**Derived FROC**
Pseudocrenilabrus philander	Southern mouthbrooder	PPHI	1	1
Tilapia sparrmanii	Banded tilapia	TSPA	1	1
FROC ratings: 0 = absent 1 = present at very few sites (<10%) 2 = present at few sites (>10 - 25%) 3 = present at about >25 - 50 % of sites 4 = present at most sites (>50 - 75%) 5 = present at almost all sites (>75%)				
ALIEN AND INVASIVE SPECIES				
Cyprinus carpio	Common Carp	CCAR		

1.4.2 Macroinvertebrates

Macroinvertebrate taxa expected under reference conditions include:
Perlidae, Hydropsychidae (>2 spp.), Baetidae (>2 spp.), Tricorythidae, Elmidae/ Dryopidae, Leptophlebiidae, Hydracarina, Simuliidae, Coenagrionidae, Naucoridae, Corbiculidae, Caenidae, Gerridae, Veliidae, Dytiscidae/ Noteridae, Gyrinidae, Ceratopogonidae, Porifera, Hydrophilidae, Turbellaria, Potamonautidae, Corixidae, Chironomidae and Oligochaeta.

1.5 PRESENT ECOLOGICAL STATE

The component assessment models for the PES are part of the electronic information provided with this report.

1.5.1 Index of Habitat Integrity (IIHI: B/C, 80.8%; RIHI: A/B, 88.9%)

The IIHI is mostly due to elevated nutrients and benthic growth. The RIHI is an A/B with the main impacts being invasive perennial alien species, which were cleared at the site, but recruiting in large numbers again.

1.5.2 Diatoms (C EC)

The assessment is based on a sample taken during 2007 and a single sample taken during the current assessment. During 2007 the biological water quality was in a D category mainly due to very high organic loading. However, the latest sample indicates that the biological water quality was moderate to good with moderate pollution levels and the EC was a B/C. Nutrient levels are elevated at times and organic pollution levels are very low. This assessment is of low confidence as it is uncertain if elevated flows in the system might have a dilution effect at this site or if there is really an improvement in water quality. Therefore the EC was set at a C.

1.5.3 Fish (C EC, 63.8%)

All of the fish species (8 out of 8) expected under reference conditions are still expected to be present under the present conditions at this site and in the river. *L. capensis* was sampled at an increased/improved FROC from reference conditions (sampled in high densities), indicating that habitat conditions are suitable for species with a preference for a variety of flow depth classes, and species which are moderately intolerant to no flow conditions (*B. aeneus*, *L. kimberleyensis*, and *L. capensis*). The FROC of ASCL and LUMB have been reduced due to their preferred habitat loss (loss of FS and deterioration of substrate (cobbles and rock) habitat due to benthic growth. The FROC of the rest of the species is expected to remain unchanged. All flow depth classes are represented. Large pools were present and all the species will be able to utilise the pools as cover and refugia. Good spawning habitat is present for spawning during high floods, and pools with cover are present as refugia and nursery area, after floods. The presence of exotic and introduced fish species will also negatively impact on the fish species present in the system (competition, predation, habitat alteration). The FROC of *C. gariepinus* (quiet water benthic species), *P. philander* and *T. sparrmanii* is unchanged from reference as these species are moderately tolerant

to tolerant to no-flow conditions. Habitat diversity is also high in terms of their different habitat preferences (Cover – water column, bedrock, rocks and cobbles, instream veg., marginal aquatic veg. and tree overhang etc.)

The main present impacts on the fish are decreased wet season base flows and the loss of flow and especially FD and FS habitat, most probably due to water abstraction upstream, and increased dry season base flows due to Orange River water being transferred to improve water quality (loss of FS). Smaller weirs and water abstraction upstream are the main reasons for flow modification. The water quality is also negatively affected due to agriculture.

1.5.4 Macroinvertebrates (C EC, 66%)

Macroinvertebrates were sampled using the standard SASS5 method. Habitat available was Stones in current (SIC), Stones out of current (SOOC), Marginal vegetation in current (MVIC), aquatic Vegetation (AV), Marginal vegetation out of current (MVOC), Gravel sand and mud (GSM). No Aquatic vegetation (AV) was present at the site. For list of families present in the sample please refer to the MIRAI.

SASS results:

Oct 2010: SASS5 score: 104 No of Taxa: 23 ASPT: 4.5

Key taxa expected but not observed were generally those that are sensitive to water quality changes, such as Pyralidae, Perlidae, Hydropsychidae >2spp, Dixidae, Chlorocyphidae, Tricorythidae, Philopotamidae, Hydraenidae, Atyidae and Elmidae. The only key taxa observed was Baetidae (>2 spp) and were abundant.

1.5.5 Riparian vegetation (B EC, 83.7%)

The assessment was done using VEGRAI level 4.

Marginal Zone:

Various vegetation components exist:

1) *G. virgatum* and *Cyperus marginatus* where riffle and cobble/boulder occur (not dominant).
2) High density *P. australis*, often with extensive algae and *Azolla* sp.
3) Extensive aquatic vegetation in pools with *Ceratophyllum* and *Potemogeton* dominant.
4) *Juncus* sp and *Schoenoplectus* sp with hydrophylic grasses along boulder bars where reeds do not occur.

Lower Zone:

Two components:

1) High density reed beds, especially RB.
2) Sedge and grasses along boulder beds as in marginal zone.

Upper Zone:

RB: Reeds beds (*P. australis*); LB: Open boulder beds with grasses and *Acacia karoo* as dominants, *Eucalyptus camuldensis* has been removed but has a high degree of recruitment.

MCB:

RB only: Open rocky cliff with terrestrial grasses and some terrestrial *Acacia* species e.g. *A. burkei.*

1.5.6 PES causes and sources

The PES for the components as well as the reasons for the PES are summarised in Table 15.4.

Table 1.4 OSAEH 29.5: Causes and sources

	PES	Causes	Sources	F/NF
Rip veg	B	Altered species composition.	Small impact of alien vegetation (5% annuals, 5% perennial mainly *Eucalyptus camuldensis*). Elevated nutrients have resulted in higher densities of aquatic vegetation.	NF
		Increased reed.	Flow regulation and reduced flooding disturbance upstream of site, but response appears small.	F
Fish	C	Loss of mainly FD and FS habitat as a result of flow modification (especially during naturally low flow periods).	Smaller weirs and water abstraction for farming and irrigation upstream and increased dry season baseflows from Orange River transfer.	F
		Lower breeding success and recruitment for fish = lower FROC.	Lower, less and/or no natural flushes and smaller floods. Flow modification due to smaller weirs and water abstraction for farming and irrigation upstream	
		Loss of species diversity or numbers due to loss of habitat diversity due to lower flows and floods during wet seasons.	Flow modification due to smaller weirs and water abstraction for farming and irrigation upstream.	
		Loss of habitat with substrate (cobbles and rock), and water column in FD and FS due to lower than natural wet season baseflows.	Flow modification due to smaller weirs and water abstraction for farming and irrigation upstream.	
		Decreased species diversity and abundance.	Presence of exotic and introduced species.	NF
		Enrichment and impaired water quality.	Agriculture upstream.	
		Presence of weirs as migration barriers (breeding, feeding and dispersal), also causing loss of habitat of some species (inundation).	Smaller weirs in area.	
Inverts	C	Sedimentation.	Agriculture and urbanization.	F
		Poor water quality and associated benthic growth.		NF

1.6 PES TREND

An estimate was made whether the components responding to the main drivers (quality and quantity) are stable or still changing. The results are summarised in Table 15.5.

Table 1.5 OSAEH 29.5: Trend

	PES	Trend	Trend PES	Time	Reasons	Conf
Rip veg	B	Negative	B/C	>5 years	The high degree of recruitment of perennial alien species will cause the PES to deteriorate over time. This trend may also be stable if these aliens are removed once they get bigger, since other aliens have been removed from site	3
Fish	C	Stable			The site was surveyed during the dry season base flow period (low flow), and certain fish species with a moderate intolerance to no flows were sampled in high numbers. It is expected that fish will use the pools for refuge areas, and all of the expected species are still expected to be present. Spawning habitat is present, and can be utilized by fish during higher flows or floods. The PES is a C, and will remain stable under current conditions (low flow – dry season base flow). Most species sampled in high densities.	3
Inverts	C	Stable			The macroinvertebrates have already reacted to the current conditions.	1

1.7 PES ECOSTATUS

To determine the EcoStatus, the macroinvertebrates and fish results must be combined to determine an Instream EC. Results are given in Table 15.6. The Instream EC is a C (64.8%).

Table 1.6 OSAEH 29.5: Instream EC

INSTREAM BIOTA	Importance Score	Weight	EC %	EC
FISH				
1.What is the natural diversity of **fish** species with different flow requirements	4	100		
2.What is the natural diversity of **fish** species with a preference for different cover types	3	90		
3.What is the natural diversity of **fish** species with a preference for different flow depth classes	4	100		
4. What is the natural diversity of **fish** species with various tolerances to modified water quality	3	90		
FISH ECOLOGICAL CATEGORY	14	380	**63.8**	**C**
MACROINVERTEBRATES				
1. What is the natural diversity of **invertebrate** biotopes	3	100		
2. What is the natural diversity of **invertebrate** taxa with different velocity requirements	3	100		
3. What is the natural diversity of **invertebrate** taxa with different tolerances to modified water quality	2	90		
MACROINVERTEBRATE ECOLOGICAL CATEGORY	**8**	290	**66**	**C**
INSTREAM ECOLOGICAL CATEGORY (Excl confidence)		670	**64.9**	**C**
INSTREAM ECOLOGICAL CATEGORY WITH CONFIDENCE	**Confidence rating**	**Proportions**	**Modified weights**	
Confidence rating for **fish** information	3	0.60	38.28	
Confidence rating for **macroinvertebrate** information	2	0.40	26.40	
	5	1.00	64.68	
INSTREAM ECOLOGICAL CATEOGORY	**EC**		**C**	

To determine the EcoStatus, the VEGRAI EC and confidence is included in the EcoStatus assessment index (Table 15.7). The EcoStatus EC is a C.

Table 1.7 OSAEH 29.5: Instream EC

RIPARIAN VEGETATION	EC %	EC	
RIPARIAN VEGETATION ECOLOGICAL CATEGORY	**83.7**	**B**	
ECOSTATUS	**Confidence rating**	**Proportions**	**Modified weights**
Confidence rating for instream biological information	2.6	0.46	29.50
Confidence rating for riparian vegetation zone information	3.1	0.54	45.52
	5.7	1.00	75.02
ECOSTATUS	**EC**		**C**

1.8 SUMMARY OF ECOCLASSIFICATION RESULTS

The EcoClassification results are summarised in Table 15.8.

Table 1.8 OSAEH 29.5: EcoClassification results

Driver Components	PES	Trend
IHI: INSTREAM	B/C	
IHI: RIPARIAN	A/B	
DIATOMS (WQ)	C	
Response Components	**PES**	**Trend**
FISH	C	Stable
MACRO INVERTEBRATES	C	Stable
INSTREAM	C	
RIPARIAN VEGETATION	B	Negative
ECOSTATUS	C	

It is evident that there is a discernable difference in the 2007/2008 and 2010 results of the Riparian vegetation assessment. The site is now part of the Mokala National Park and together with Working for Water a lot of exotic species have been removed. This is ongoing and the vegetation has improved drastically (*Pers. comm*. H Bezuidenhout).

1.9 SUITABILITY AS FUTURE MONITORING SITE

1.9.1 Biotopes present

Good quality and quantity of cobble biotope is present for macroinvertebrate sampling. A diversity of instream habitats is present. Very good habitat diversity and cover occurs for expected fish species. Pools are abundant for water column cover and refugia for fish. This site could serve as a good fish spawning area during high floods with ample marginal vegetation and substrate present (cobbles and rocky areas). All fish flow depth classes are present and well represented. Upstream water abstraction and weirs result in flow modification which impacts negatively on the available habitat. Benthic algae are present due to nutrient enrichment. Riparian obligate species are present and dominant at the site. The site is situated within a protected area. The river is not wadeable and a boat would be needed to cross the river.

Component	Advantages	Disadvantages	Conf
Rip veg	Riparian alluvial and bedrock habitats available Riparian obligate species present (rheophytes, helophytes and bank species) and dominant at the site Site within protected area	River not wadeable, would need a boat to cross Close proximity of road on LB	5
Fish	Very good habitat diversity and cover for all expected species Marginal and instream aquatic veg., overhanging veg., water column, and substrate, abundant for fish cover Pools abundant for water column cover and refugia No NPS pollution observed Could serve as good spawning area during high floods with ample marginal veg. and substrate (cobbles and rocky areas) for spawning needs of	Up-stream water abstraction Reduced base flows Flow modification due to weirs and abstraction upstream – decrease in base flows and floods, and impact on seasonality of smaller floods Catchment scale impacts – erosion in catchment, weirs and water abstraction, upstream Benthic growth – some enrichment Deeper areas and FD are non-wadeable for	4

Component	Advantages	Disadvantages	Conf
	fish All flow depth classes present and well represented Perennial flow in this reach	sampling Some siltation, rocks were slippery.	
Inverts	Good quality and quantity of cobble biotope present Diversity of velocities present Few localised impacts Diversity of instream habitats present	Limited aquatic vegetation	2

1.9.2 Site suitability

The site suitability of each site was assessed and is provided in Table 15.9. All scores are out of 5 with 5 referring to very high suitability (see below).

Very High: 4.1 – 5 High: 3.1 – 4

Moderate: 2.1 – 3 Low: 1.1 – 2

Very Low: 0 – 1

Table 1.9 OSAEH 14.9: Biophysical site suitability

Site	Rip veg	Fish	Inverts	Average	Median	Max	Min	Comments
OSAEH 29.5	3.5	4.5	3	3.67	3.5	4.5	3	**High** suitability for biotic component monitoring. There are both flow and non-flow related impacts and alien vegetation invasion is not a main impact. There are also benefits to conservation objectives since the site falls within a protected area.