1   JBS03 (OSAEH 11.13: PARYS (VAAL RIVER))

Originally it was planned to sample OSAEH 11.13 which is situated upstream of Parys in the Kromelmboogspruit which is a tributary of the Vaal River. However the site visit had to coincide with a planned PR event and an alternative site had to be selected in order to accommodate this event. A new site was selected at Parys in the Vaal River main stem.

1.1   SITE DESCRIPTION

Location:	Parys	Altitude:	1376 m
Longitude:	27.444185	Latitude:	-26.898356
EcoRegion	Highveld 11.01	Quaternary catchment	C23C
Water Management Area	Upper Vaal	Geomorphological zone:	Lower foothills

OSAEH 11.13 is situated at Parys was bedrock dominated and consisted of multiple channels. The substratum at the sampling site was slightly embedded with sediments and algae were present on some surfaces. The marginal vegetation is very well developed as a result of the available nutrients. The abundance of watercress (*Rorippa nasturtium-aquaticum*) is often an indication of excessive nutrients entering the system. The macro channel is >100 m wide at the site. The site has a diversity of instream habitats available for macroinvertebrate colonization, although filamentous algae are present on the cobbles, restricting colonization by macroinvertebrates.

Figure 1.1   Instream habitat

1.2   BIOTIC SAMPLING

1.2.1   Fish

The fish sampling was conducted at the site during October 2010. A river stretch of approximately a 100 m long, representing a variety of different depth classes, was sampled for fish along the right bank of the river. Four depth classes were sampled for 55 minutes in this stretch of river that was flowing moderately strong at the time of sampling. Sampling and data analysis was followed according to Kleynhans (2007). 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
2	3	3	3
Overhanging vegetation			
2	1	1	1
Undercut banks and root wads			
1	0	0	0
Substrate			
2	2	4	3
Aquatic macrophytes			
1	0	0	0
Water Column			
1	0	0	0

Habitats sampled and effort

SAMPLING EFFORT	SLOW DEEP	SLOW SHALLOW	FAST DEEP	FAST SHALLOW
Electro shocker (min)	10 min	20 min	20 min	15 min

1.2.2   Riparian vegetation

Two sites were surveyed on the right hand bank (RB) and on the left hand bank (LB). For the assessment description the RHB site was used because it was assumed that it represented more of the natural riparian areas within the greater area. Most of the other riparian zones are totally transformed into recreational areas (picnic sites, caravan parks, housing developments, etc.). The level 3 VEGRAI was used for the assessment.

Figure 1.2   Visual of LB of site indicating recreation grounds infringing into the riparian zone

1.3   DATA AVAILABILITY

Detailed information regarding available data is provided in Table 5.1.

Table 1.1   OSAEH 11.13: Summary of data availability

Comp	Data availability	Conf
IHI	Google Earth imagery. **Department of Water Affairs and Forestry (DWAF)** 2008b. Resource Directed Measures: Comprehensive Reserve determination study of the Integrated Vaal River System. Upper Vaal Water Management Area Technical Component: Resource Unit. Report produced by Koekemoer Aquatic Services and Water for Africa. Authored by Louw, D. Report no: RDM/WMA8 C000/01/CON/0208.	3
Riparian vegetation	Google Earth imagery. Data collected from field assessment during October 2010. <u>Literature:</u> **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) 2005. VEGMAP. Wall Map South African National Biodiversity Institute, 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.	2
Fish	One site visit and fish sampling during October 2010. South African Institute of Aquatic Biodiversity (SAIAB) data base (2006). **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.	3
Inverts	SASS5 surveys undertaken to determine the PES (Rivers Database) and October 2010.	2

1.4   REFERENCE CONDITIONS

The reference conditions for the components are summarised in Table 54.2. Additional information on fish, macroinvertebrate and riparian vegetation reference conditions are also provided.

Table 1.2   OSAEH 11.13: Reference conditions

Comp	Reference conditions	Conf
Riparian vegetation	**Marginal zone:** Grass dominated state (including sedges). Exotic species would be replaced by indigenous species, such as *Pennisetum macrourum, Persicaria senegalensis, Schoenoplectus corymbosus, Juncus effusus,* etc. No exotic trees such as *Eucalyptus* sp. and *Salix babylonica* should occur. Less water quality problems should occur. **Non-marginal zone:** Grass and shrub dominated state. More indigenous grass and cover should be present. Less exotic pioneers and terrestrial species are expected. No Picnic and recreation disturbances should be present. Without impacts the response metrics should be better on all accounts. More indigenous grass species and cover should be present, such as *Cynodon dactylon*, *Sporobolus africanus, Setaria sphacelata, Digitaria eriantha,* etc. Less terrestrial species should be present such as *Protasparagus laricinus*. Riparian vegetation species also expected under reference conditions include the following: *Setaria incrassata, Setaria sphacelata, Sporobolus africanus, Pennisetum macrourum, Digitaria eriantha, Persicaria senegalensis, Juncus effusus, Gymnosporia buxifolia, Rhus buxifolia, Cyperus esculentus, Schoenoplectus corymbosus*.	3
Fish	Reference conditions for the site were based on the National River Health Programme (NRHP) site, **C2VAAL-PARYS.** See Table 4.3 for a list of the reference fish species.	4
Inverts	Reference conditions are based on professional judgement and Rivers Database information. The reference South African Scoring System version 5 (SASS5) score is 230 and the Average Score Per Taxon (ASPT) is 6.5.	3

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 for the site were largely based on the NRHP site, **C2VAAL-PARYS** (Kleynhans *et al.,* 2007b). Although the national RHP sites refer to a specific site, it is representative of the river reach downstream of Vaal Dam down to the Bloemhof Dam.

Based on the available information and professional judgement the following alterations were made for the purpose of this site:

- *Barbus anoplus* were omitted from the expected list as this species mainly occur in smaller tributaries of the Vaal River and are unlikely to occur in the main stem.
- *Barbus paludinosus and Barbus trimaculatus* were were included in the expected list as these species were present at the site during recent site visit.

Ten indigenous fish species are expected under reference conditions and are listed in Table 5.3.

Table 1.3   OSAEH 11.13: Reference fish species

Scientific Names	Common Name	Spp abbreviation	Reference FROC	Derived FROC
Expected Reference and Habitat derived FROC of fish at OSAEH 11.13 (Values used in FRAI). Observed species (HIGHLIGHTED)			
Austroglanis sclateri	Rock catfish	ASCL	3	1
Barbus paludinosus	Straightfin barb	BPAU	3	3
Barbus trimaculatus	Threespot barb	BTRI	3	1
Clarias gariepinus	Sharptooth catfish	CGAR	4	4
Labeo capensis	Orange River labeo	LCAP	5	5
Labeo umbratus	Moggel	LUMB	3	1
Labeobarbus aeneus	Smallmouth yellowfish	BAEN	4	4
Labeobarbus kimberleyensis	Largemouth yellowfish	BKIM	3	1
Pseudocrenilabrus philander	Southern mouthbrooder	PPHI	4	4
Tilapia sparrmanii	Banded tilapia	TSPA	3	1

FROC ratings:
0 = absent   3 = present at about >25 - 50 % of sites
1 = present at very few sites (<10%)   4 = present at most sites (>50 - 75%)
2 = present at few sites (>10 - 25%)   5 = present at almost all sites (>75%)

ALIEN AND INVASIVE SPECIES

Scientific Names	Common Name	Spp abbreviation	Reference FROC	Derived FROC
Ctenopharyngodon idella	Grass Carp	CIDE		
Cyprinus carpio	Common Carp	CCAR		
Gambusia affinus	Mosquito fish	GAFF		
Micropterus salmoides	Largemouth bass	MSAL		

1.4.2   Macroinvertebrates

Macroinvertebrate taxa expected under reference conditions include:

Perlidae, Hydropsychidae (>2 spp.), Heptageniidae, Baetidae (>2 spp.), Tricorythidae, Elmidae/Dryopidae, Atyidae, Leptophlebiidae, Hydracarina, Simuliidae, Coenagrionidae, Naucoridae, Ecnomidae, Philopotamidae, Hydroptilidae, Tipulidae, Corbiculidae, Caenidae, Gerridae, Veliidae, Dytiscidae, Gyrinidae, Psephenidae, Ceratopogonidae, Porifera, Hydrophilidae, Turbellaria, Potamonautidae, Corixidae, Chironomidae, Sphaeriidae, Oligochaeta, and Hirudinea.

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: C/D EC 57.5%; RIHI: C EC, 63.6%)

The IIHI was rated a C/D (57.5%). This is mostly due to changes in water quality as a result of extensive upstream urban and mining runoff as well as some cultivation. The hydrology has also changed significantly due to upstream inundation and flow modification. The RIHI is a C (63.3%) the main impacts being bank modification in the marginal and non-marginal zones due to altered hydrological regimes, an increase in exotic vegetation, riparian irrigation, trampling, erosion and vegetation removal.

1.5.2 Diatoms (D EC)

The October 2010 sample indicated moderately polluted waters with low organic levels and elevated nutrient levels. A release was made a few days before sampling and this could have had a dilution effect of pollutants. This reach is known for deteriorated water quality at times as sewage is discharged just upstream of the site by Parys municipality. The overall EC of a C/D is based on data used for the Reserve study (DWA, 2010 a[1]), and it should be noted that salinity levels along with nutrient and organic levels do increase to critical levels in this reach at times.

1.5.3 Fish (C EC, 62.3%)

Six of the ten expected fish species were collected within this Resource Unit (RU) during the present survey suggesting that the FROC of some species has been reduced from reference conditions. Based on their absence or low abundance of smaller species such as *B. trimaculatus*, *B. paludinosus, P philander* and *T sparrmanii* the FROC at this site was rated to be reduced from reference. Although *L umbratus and L. kimberleyensis* was not collected at this site during the present survey, the sampling site did not provide suitable habitat for these species.

1.5.4 Macroinvertebrates (C EC, 77.3%)

Macroinvertebrates were sampled using the standard SASS5 method. Habitats sampled include Stones In Current (SIC), Stones Out of Current (SOOC), Marginal Vegetation In Current (MVIC), Marginal Vegetation Out of Current (MVOOC), Gravel, Sand and Mud (GSM), bedrock and boulders. For list of families present in the sample please refer to the MIRAI.

SASS results:

	SASS5 score: 166	No of Taxa: 30	ASPT: 5.5
October 2010:	SASS5 score: 126	No of Taxa: 22	ASPT: 5.7

Key taxa expected but not observed included Aeshnidae and Libellulidae. Hirudinea, Dytiscidae, Tricorythidae and Elmidae were more abundant than expected, while Heptageniidae were less abundant than expected.

1.5.5 Riparian vegetation (C EC, 71.5%)

The assessment was done using VEGRAI level 3. This site occurs within the Vredefort Dome Granite Grassland vegetation type, which has an endangered conservation status with 0% protected. Almost half of this vegetation type is already transformed by cultivation (maize fields), by urban development or by road building.

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[1] **Department of Water Affairs (DWA).** 2010a. Resource Directed Measures: Comprehensive Reserve determination study of the Integrated Vaal River System. Upper Vaal Water Management Area Technical Component: EcoClassification Report: Volume 1. Report produced by Koekemoer Aquatic Services and Rivers for Africa. Edited by Louw, D and Koekemoer, S. Report no: RDM/ WMA8 C000/01/CON/0109.

Marginal Zone:

This zone is currently in a grass and sedge dominated state. The active channel is wide with several islands. Many sedge clumps occur between rocky areas in rock cracks. Little to no bare patches arise in between. The rocky substrate is dominant. Some *Rhus pyroides, Salix babylonica* and *Eucalyptus* sp. trees are present. Impacts consist mainly of picnic related activities and the encroachment of pioneering exotic vegetation such as *Pennisetum clandestinum, Verbena bonariensis, Persicaria lapathifolia.* Other vegetation that occurs in this zone is *Phragmites australis, Veronica Anagallis-aquatic, Cyperus excalenthes, Cyperus marginata, Cyperus eragrostis, Crinum bulbispermum.* Good cover and abundance occur. Indication of enrichment of water can contribute to excessive growth of vegetation.

Non-marginal zone:

This zone is currently in a grass and shrub dominated state. Impacts consist mainly of picnic (recreation in the form of footpaths) and exotic (pioneer) species. The exotic trees occurring in this zone are *Gleditsia triacanthos, Melia azedarach, Ulmus parvifolia, Eucalyptus* sp. and *Salix babylonica*. Bank substrate consists mainly of rocks and soil. A well defined high flow channel exists in the non-marginal zone and is covered mainly with grasses and exotic (pioneer) species such as *Verbena tenuisecta, Verbena bonariensis, Pheusodognaphalia luteo-album, Melilotus indica, Tagetes minuta, Cyclospermum leptophyllum, Cirsium vulgare.* The cover is good in this zone.

1.5.1 PES causes and sources

The PES for the components as well as the reasons for the PES are summarised in Table 5.4.

Table 1.4   OSAEH 11.13: Causes and sources

	PES	Causes	Sources	F/NF
Rip veg	C	Footpaths and firewood collection.	Picnic and recreation facilities in and adjacent to study site.	NF
		Exotic invasion.	*Salix babylonica, Gleditsia triacanthos,* and *Eucalyptus* sp., and the site has non-woody weeds.	
		Water quality.	Chicken farms, non-point pollution, sewage plants, recreation facilities, etc. Housing developments on the banks of the Vaal River.	F
Fish	C	Loss of habitat diversity as a result of flow modification.	Inundation upstream and flow modification.	F
		Decreased water quality affect species with requirement for high water quality.	Increased nutrients, sediments and toxins from urban areas diamond & gold mines and agricultural areas.	NF
		Increased turbidity and disturbed bottom substrates.	Erosion and presence of bottom feeding alien (*C carpio*).	
		Presence of migration barriers reduces migration success (breeding, feeding and dispersal) of some species.	Major upstream and downstream dams as well as weirs.	
Inverts	C	Sedimentation.	Urbanization and agriculture.	NF
		Water quality and associated benthic growth.	Agriculture and urbanization.	

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 5.5.

Table 1.5   OSAEH 11.13: Trend

	PES	Trend	Trend PES	Time	Reasons	Conf
Rip veg	C	Stable			Habitat availability has defined the current condition of riparian zone integrity. The riparian vegetation has responded and it is improbable that current situation will change remarkably so as to affect the current EC.	3
Fish	C	Stable			No other new influences could be identified that would cause a direction change in the Present Ecological State of the fish assemblage.	3
Inverts	C	Stable			The macroinvertebrates have already reacted to the current conditions.	3

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 5.6. The Instream EC is a C (68.3%).

Table 1.6   OSAEH 11.13: Instream EC

INSTREAM BIOTA	Importance Score	Weight	EC %	EC
FISH				
1.What is the natural diversity of **fish** species with different flow requirements	3	100		
2.What is the natural diversity of **fish** species with a preference for different cover types	2.5	90		
3.What is the natural diversity of **fish** species with a preference for different flow depth classes	2	80		
4. What is the natural diversity of **fish** species with various tolerances to modified water quality	2	80		
FISH ECOLOGICAL CATEGORY	9.5	350	**62.3**	**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	**77.3**	**C**
INSTREAM ECOLOGICAL CATEGORY (Excl confidence)		640	**71.3**	**C**

INSTREAM ECOLOGICAL CATEGORY WITH CONFIDENCE	Confidence rating	Proportions	Modified weights
Confidence rating for **fish** information	3	0.60	37.38
Confidence rating for **macroinvertebrate** information	2	0.40	30.92
	5	1.00	68.30
INSTREAM ECOLOGICAL CATEGORY	**EC**		**C**

To determine the EcoStatus, the Vegetation Response Assessment Index (VEGRAI) EC and confidence is included in the EcoStatus assessment index (Table 5.7). The EcoStatus EC is a C.

Table 1.7   OSAEH 11.13: Instream EC

RIPARIAN VEGETATION	EC %	EC	
RIPARIAN VEGETATION ECOLOGICAL CATEGORY	71.5	C	
ECOSTATUS	Confidence rating	Proportions	Modified weights
Confidence rating for instream biological information	2.6	0.42	28.64
Confidence rating for riparian vegetation zone information	3.6	0.58	41.52
	6.2	1.00	70.16
ECOSTATUS	EC	C	

1.8   SUMMARY OF ECOCLASSIFICATION RESULTS

The EcoClassification results are summarised in Table 5.8.

Table 1.8   OSAEH 11.13: EcoClassification results

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

1.9   SUITABILITY AS FUTURE MONITORING SITE

1.9.1   Biotopes present

This site has diverse instream habitat available for SASS sampling. Good quantity of cobbles, marginal vegetation in and out of current, stones out of current and GSM biotopes are available. Algal growth is present on the cobble biotope. The site is easily accessible with wadeable areas. The fast deep habitat provides suitable habitat for larger fish species. The diversity of substratum provides good cover for all fish species. The site provides an abundance of undercut banks, marginal and overhanging vegetation as suitable habitat for small fish species. The marginal riparian zone has relatively good vegetation cover. No erosion is present in the marginal zone, although localised impacts are present along with exotic vegetation.

Component	Advantages	Disadvantages	Conf
Rip veg	Easily accessible Riparian zone (marginal and non-marginal) with relatively good vegetation cover Well defined hydro-geomorphic zones No infrastructure in riparian zone No erosion	Exotic species (pioneer species) Poor water quality Picnic and other recreation related activities Several localised impacts Housing developments adjacent to study area Terrestrialisation	3
Fish	Easily accessible with wadeable areas. Fast Deep provided suitable habitat for larger species Diversity of substratum provided good cover for all species. Abundance of undercut banks and marginal and/or overhanging vegetation provided suitable habitat for small species.	Substratum slightly imbedded with sediments Low diversity of flow velocities	4
Inverts	Good quantity of cobble biotope present Diversity of instream habitats present Good quality and quantity of marginal vegetation Diversity of velocities present	Algal growth on cobble biotope Localised impacts include a picnic site and caravan park	3

1.9.2 Site suitability

The site suitability of each site was assessed and is provided in Table 5.9. 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 11.13: Biophysical site suitability

Site	Rip veg	Fish	Inverts	Average	Median	Max	Min	Comments
OSAEH 11.13	2	3	3	2.67	3	3	2	**Moderate** suitability for biotic component monitoring, but a difficult site to assess for riparian vegetation as it is an anastomosing site with channel width over 400 m and banks have been altered. Flow is also regulated and manipulated.