Biological Monitoring Conducted

in a tributary of the

Woestalleen Spruit

for

Eco Elementum (Pty) Ltd

on

the farm

Roodepoort 151 IS (Portion 17)

September 2013

Title:

Biological monitoring to determine the baseline class for the unnamed tributary of the Woestalleen Spruit.

Client:

Eco Elementum (Pty) Ltd

Contact Number: 0826909105

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Report No:

Report No: 201310/Kebra/dry

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EXECUTIVE SUMMARY

M^2 Environmental Connections CC was appointed by Eco Elementum (Pty) Ltd to conduct aquatic bio-monitoring of the aquatic ecosystems associated with the proposed mining activities related to the farm Roodepoort 151 IS Portion 17. The area is situated outside the town of Pullenshope in the Mpumalanga Province.

The study would include surface water monitoring, IHAS and SASS5. The purpose for this is to setup baseline data for the area, as well as assist in the WULA process. The IHAS was low, with one indicating potential for sensitive species. This was however false and sensitive species was found in the areas with the lower IHAS scores. The ASPT of the sites indicated a Class B/C watercourse which is in accordance with the reference for the catchment. The impact on the water quality is indicative of biological pollution which stems from the Pullenshope town.

The recommendation is that the bio-monitoring continue in the wet season and the RQO’s be set in accordance with the PES.

Document Limitations

The document is limited by the time and budgetary constraints. Further limitation was the availability of the biotopes needed to sustain sensitive species.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

GLOSSARY OF TERMS

ASPT	Average Score per Taxa
COD	Chemical Oxygen Demand
DO	Dissolved Oxygen
DWA	Department Water Affairs
EIS	Ecological Integrity and Sensitivity
IHAS	Integrated Habitat Assessment System
KFBM	Kebrafield Biological Monitoring
MAR	Mean Annual Runoff
NFEPA	National Freshwater Ecosystem Priority Area
PES	Present Ecological Status
REC	Recommended Ecological Class
RQO	Resource Quality Objectives
SANAS	South African National Accreditation System
SASS5	South African Scoring System version 5
SANBI	South African National Biodiversity Institution
WULA	Water Use License Authorisation
WULAR	Water Use License Application Report
WMA	Water Management Area

1 Introduction and Terms of Reference

1.1 Introduction to Bio-monitoring

Eco Status can be defined as "The totality of the features and characteristics of the river and its riparian areas that bear upon its ability to support an appropriate natural flora and fauna and its capacity to provide a variety of goods and services" (KLEYNHANS, CJ and Louw, MD, 2007). Rivers and their tributaries are the "vascular system" of the planet, performing much the same function as the vascular or circulatory systems found in humans, animals and plants, just on a larger scale. Rivers and tributaries' main constituent is water, which is increasingly being considered as the most precious natural resource on earth.

Just as much as rivers are the starting point, it is also the endpoint for most of our anthropogenic activities, resulting in industrial and urban pollution entering this life transporting system. The amount of water used exceeds that which is put back into circulation, and the water that is reentering the circulation, is polluted and depleted of any life supporting capacity. This ultimately decreases the life giving capacity of each river or tributary downstream from the point of impact, resulting in much the same effect as a clogged artery, vein or lymph vessel within the human body. The problem is not necessarily the pollution itself, but rather the rate at which pollution is taking place. The river systems are subsequently overloaded and not capable of filtering and remediating the cumulating effect of pollution. This leads to an increase in river systems that fail and may ultimately lead to the complete failure of the entire system.

It is for this reason that it is essential to ensure that some level of ecological integrity be maintained in all aquatic ecosystems. Factors affecting the magnitude that anthropogenic activities will have on aquatic ecosystems are the:

- Extent of the activities in the area,
- The types of processes,
- The duration over which the activities occur and
- The rehabilitation measures that have taken place in the past and those currently taking place.

Any area where water is going to be abstracted or discharged with different physical or chemical properties or where the physical aquatic environment will be modified runs the risk of having environmental degradation taking place in a cumulative manner. This environmental degradation can be caused both during the development of any new facility as well as during the operational phase of an activity. Discharging of water into an aquatic system can have various effects on the system, particularly if the physical or chemical properties of the discharges differ from that of the system. While discharges can influence the quantity and quality of the water, it can also impact on the ecological integrity of the system. Biological communities integrate different stressors over time and can therefore be used to monitor the cumulative effects of impacts over the long-term. Therefore, the overall impact of discharges on the system under investigation should be monitored by means of a suite of indicators at various trophic levels. Such environmental risk has legal implications due to various articles of environmental law.

South Africa's National Water Act (Act No 36 of 1998) stipulates that the country's water resources (including the ecological integrity of a resource) be managed. The act focuses on protecting the needs of the environment, the basic needs of the countries present and the future population (The Reserve). The act defines water as a renewable natural resource. This definition means that the water resource and not just the water itself is the resource and must be treated as an integrated component. The ecological integrity (Ecosystem Health) of a resource is therefore considered an essential part of the resource, which must be managed. Included in the definition of this resource is:
"The physical and structural aquatic habitats (both in stream and riparian), the water, the biota and the physical, chemical and ecological; processes that link habitat and biota." (Jooste et al 2000).

A healthy ecosystem is further refined and will potentially consist of the following attributes:

- Homeostasis (tendency of biological systems to maintain a state of equilibrium)
- Disease absence
- Biodiversity
- Resilience or stability
- Growth vigour
- Balance between the components in the system

Management strategies of water resources should be built upon the knowledge and expertise of various disciplines, with the biologist playing an important and sometimes leading role. It is for this reason that bio-monitoring is extremely important in order to give indications of harmful impacts to the ecosystem.

1.2 Background and Reason for Bio-monitoring

M[2] Environmental Connections CC (hereafter referred to as Menco) was contracted by Eco Elementum (Pty) Ltd, to conduct aquatic bio-monitoring of the aquatic ecosystems associated with the proposed mining activity on the farm Roodepoort 151 IS Portion 17 (refer **Figure 1-1**).

The bio-monitoring was conducted in accordance with the SASS5 protocol and is in support of the WULAR due to be submitted by end October 2013.

This report presents the results obtained during the September 2013 survey and portrays the spatial variability between the various monitoring sites with regards to:

- Water quality results
- Habitat availability and suitability for aquatic macro invertebrates during dry periods

1.3 Document Limitations

The SASS5 bio-monitoring protocol relies greatly on the availability of suitable biotopes (habitat) needed for the establishment of viable aquatic macro invertebrate populations. The sites chosen do not necessarily provide all the necessary biotopes, but health and safety, accessibility and time constraints do not always permit optimum site selection. However, sites are chosen as optimally possible within all the constraints and limitations to portray the best possible habitat and macro invertebrate communities.

This study was conducted during the dry season as this project had a very limit timeframe. This is however just in support of the WULAR and its main purpose is to set the PES and EIS to assist with the finalization of the RQO's for this project.

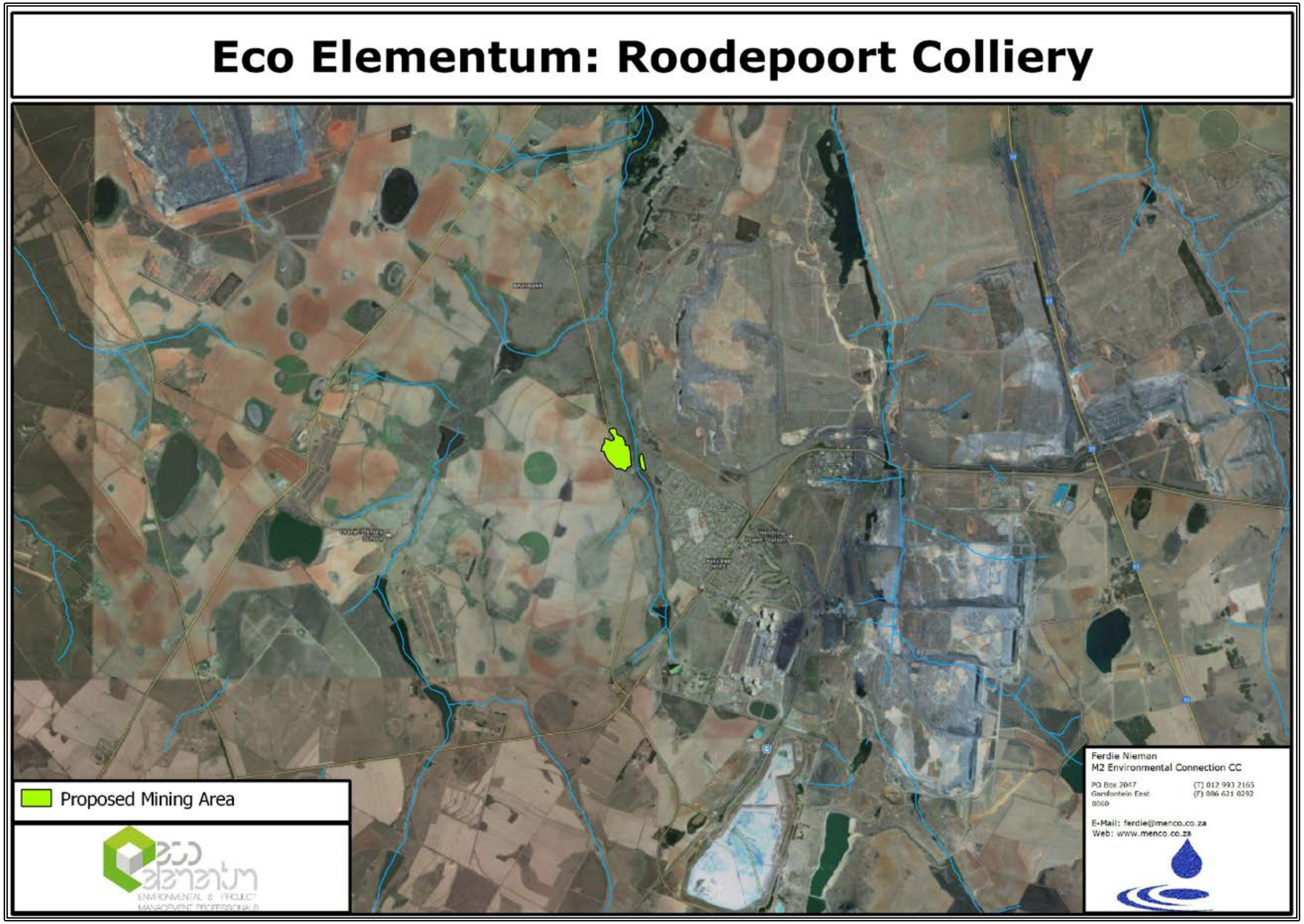

Figure 1-1: Geographical location

2 Regional and Catchment Description

Kebrafield Roodepoort Colliery is proposed to be situated within the Upper Olifants sub-Water Management Area (WMA) of the Olifants WMA (refer **Table 2-1** and **Figure 2-1**). The quaternary drainage region applicable to the activities associated with the mine is the B12B quaternary drainage region.

Reference data for the applicable quaternary catchments and associated rivers were obtained from the RWQO 4.1 (DWAF, 2006) and the National Freshwater Ecosystem Priority Areas Atlas (NEL, J.L. et al., 2011) (refer **Table 2-2** and **Figure 2-2**). The results obtained for all the bio-monitoring sites were evaluated according to the reference scores applicable to the Highveld Ecoregion (**Table 2-1**).

Table 2-1: Water Management Areas applicable to the study site

Water Management Area	Sub-water Management Area	Quaternary Drainage Region	Level 1 Ecoregion	Level 2 Ecoregion	Level 1 Ecoregion simplified longitudinal zone
Olifants	Upper Olifants	B12B	Highveld (11)	11.05	Highveld

Table 2-2: Reference and background data applicable to the rivers and quaternaries associated with the water user

Reference/Source	Licensee Results
Water User	Kebrafield Mine
River	Woestalleen Spruit
Quaternary	B12B
DWA RQO EISC	Low/Marginal
DWA RQO PESC	Class D
Rec. Ecological Category	Class C
SANBI 1999 PES	Class D (Largely Modified)
SANBI NFEPA Status	Low Priority

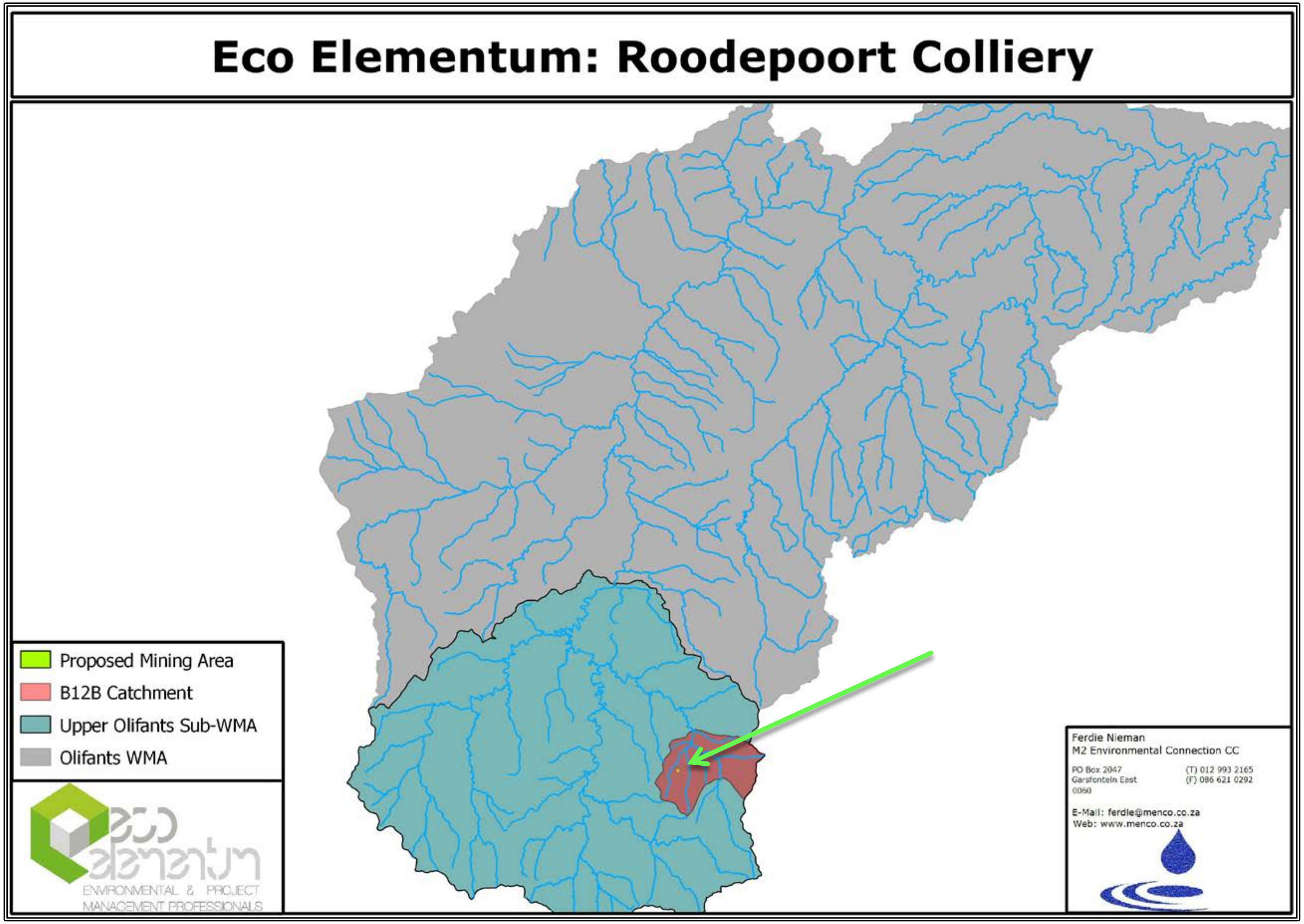

Figure 2-1: Water Management Areas applicable to the study area

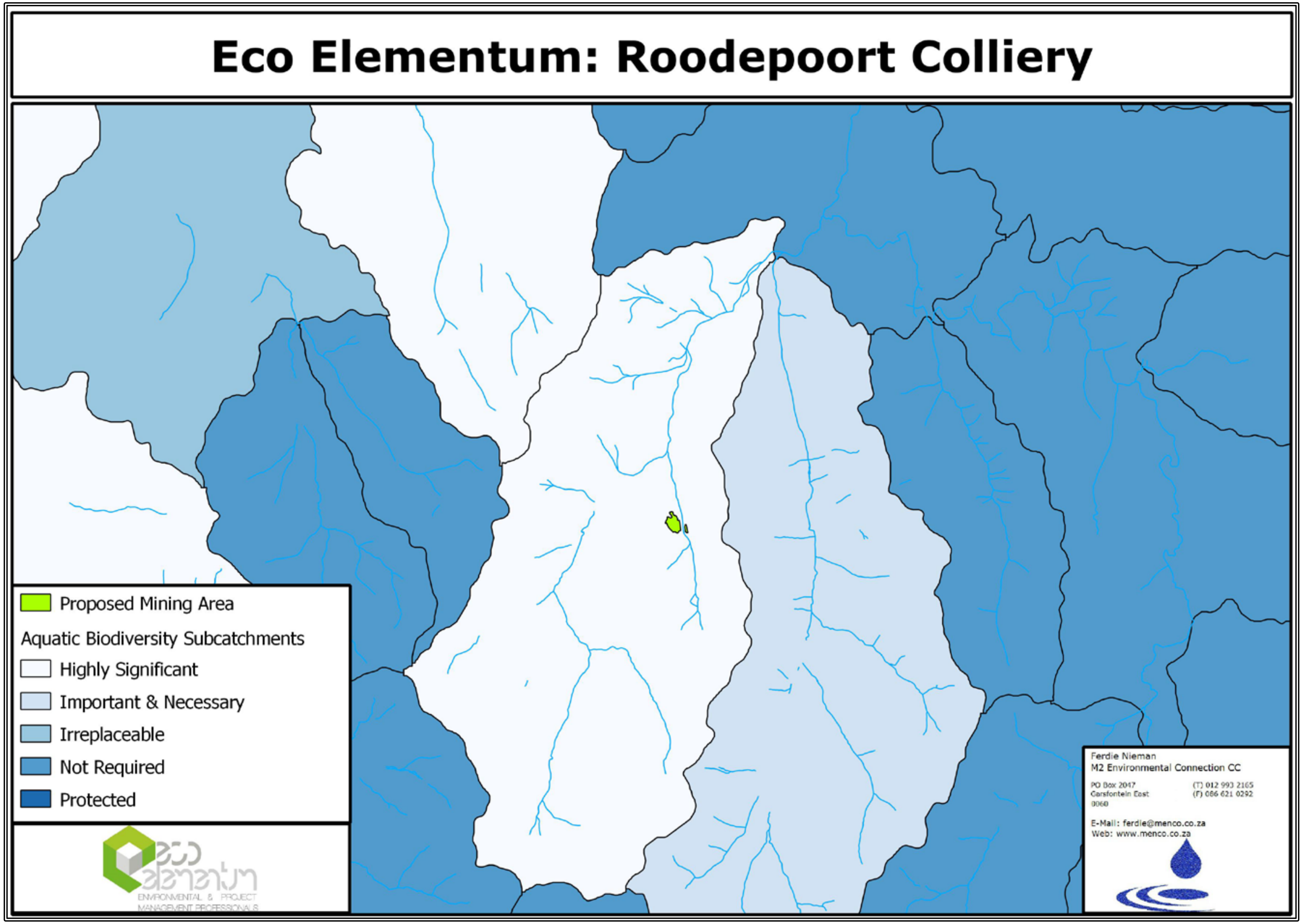

Figure 2-2: Sub-quaternary Freshwater Ecosystem Priority Areas (FEPA's)

3 Identification of Monitoring Points

The identified monitoring points are indicated in Figure 3-1, and described in Table 3-1. More detailed descriptions are provided in **Section 6**. Monitoring points were selected to obtain baseline data representative of upstream and downstream conditions in relation to the proposed activity.

3.1 Methodology to the sites chosen

In the case where new bio-monitoring sites were allocated or added to the existing monitoring program the methodology below was applied.

1. The sites were chosen in relation to the:
   - existing infrastructure and activities of the area (as understood by the aquatic ecologists)
   - which is representative of the potential impacts related to the licensee and
   - to minimize the inclusion of impacts related to water users and uses not associated with the licensee

2. How readily a site could be accessed by vehicle to allow for the transportation of equipment

3. Specific sites were selected where
   - there were good habitat conditions
   - with as good level of biotope diversity as possible
   - that is able to support as diverse aquatic community as possible
   - in conjunction with the current surface water monitoring plan in order to relate the water quality variables with the biological communities to expand the depth of interpretation of potential environmental impacts
   - the monitoring points were selected by considering the baseline monitoring survey that was done to delineate the sensitive environments (wetlands and FEPA's)

4. It was clearly communicated
   - that the outcomes should reflect the potential impacts of the licensee and not arbitrary unrelated data

5. With regards to new monitoring sites

- Sites were allocated in the tributary of the Woestalleen Spruit for the sole purpose of upstream, downstream and parallel to the proposed activity to serve as baseline data and support the WULA (refer **Table 3-1**).

Table 3-1: Kebrafield bio-monitoring locations August 2013

Monitoring site	Description	Latitude	Longitude
KFBM2	Situated in the Tributary of the Woestalleen Spruit ***upstream*** of any possible impact by the proposed activity	26° 0'26.41"S	29°34'56.71"E
KFBM3	Situated in the Tributary of the Woestalleen Spruit ***parallel*** of any possible impact by the proposed activity	26° 0'15.39"S	29°34'56.17"E
KFBM4	Situated in the Tributary of the Woestalleen Spruit ***downstream*** of any possible impact by the proposed activity	25°59'59.33"S	29°34'52.49"E

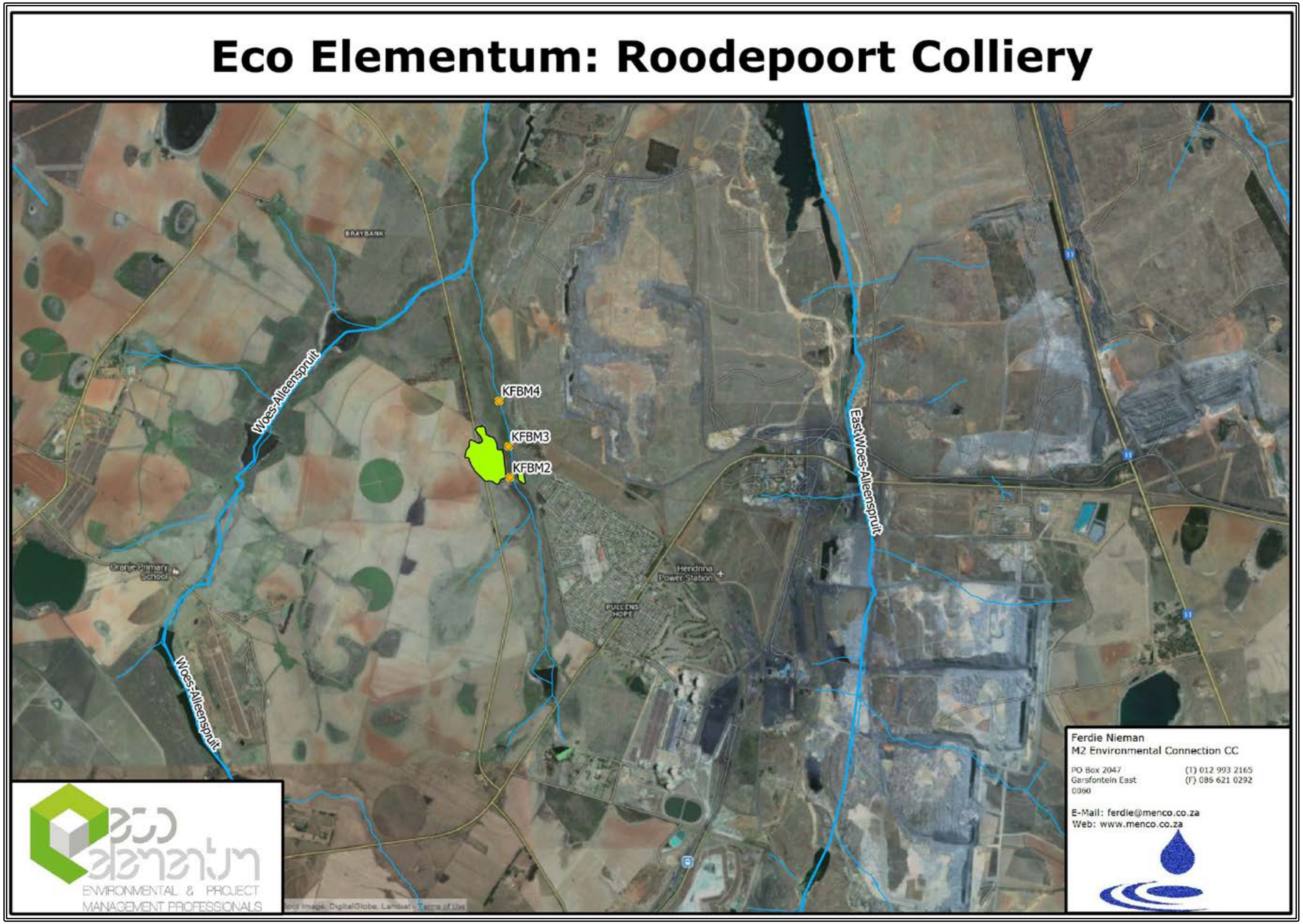

Figure 3-1: Bio-monitoring sites

4 Materials and Methods

4.1 Water quality

All water samples collected were analyzed by SANAS accredited testing laboratories. All water quality and sediment samples were analyzed by Waterlab. The quality certificate for the laboratory is attached in Appendix A.

4.2 Habitat assessments

An evaluation of habitat quality and availability to biota is critical to any assessment of ecological integrity and was conducted at each site at the time of biological sampling. On site habitat assessments were conducted using the habitat evaluation indices of McMillan (IHAS, 1998).

Habitat assessments are critical due to the fact that changes in habitat can be responsible for changes in SASS5 scores. The use of a SASS orientated habitat assessment index, namely the Invertebrate Habitat Assessment System (IHAS), is therefore important to determine the relative "health" or "availability" of sufficient habitat for the establishment or maintenance of viable biological communities.

The IHAS index was specifically designed to assess habitat and also to form a significant part of the final biological assessment of rivers. The system was developed in a way that allows different operators to obtain the same or very similar scores to ensure for replication. The version used during this assessment was version 2.0e of the IHAS system. The system is considered to be an improvement on the (HAM), (HAI) and (HQI) indices by McMillan (1998), because it allows for less subjectivity according to the assessor's interpretation. According to the River Health Program (www.csir.co.za/rhp), this system can be used with confidence throughout South Africa.

The habitat scoring system is based on a scoring system out of 100. It is described in terms of percentages. The assessment is divided into two sections. The first makes up 55 points of the scoring system and is directly related to the SASS5 sampling habitat. The second section consisting of 45 points is based on physical features such as stream make up, average width, and depth. Other features such as colour, human disturbances and riparian vegetation are also investigated (McMillan, 1998).

For each parameter, there are up to six possible answers that can be obtained. Each of these answers has a score with a value between zero and five (0–5). Generally a higher value would indicate a better habitat condition.

4.3 Aquatic invertebrate assessment: SASS, Version 5

Benthic macro-invertebrate communities of the selected sites were investigated according to the South African Scoring System, version 5 (SASS5). This method is based on the British Biological Monitoring Working Party (BMWP) method and has been adapted for South African conditions by Dr. F. M. Chutter. The SASS method is a rapid, simple and cost effective method that has progressed through four different upgrades/versions. The current upgrade is Version 5, which is specifically designed to comply with international accreditation protocols.

Interpretation of the results of biological monitoring depends, to a certain extent, on interpretation of site-specific conditions (THIRION, C.A et al., 1995). In the context of this investigation it would imply not to use SASS scores in isolation, but rather in comparison with relevant habitat scores.

4.3.1 Sample collection

An invertebrate net (30 x 30cm square with 0.5 mm mesh netting) was used for the collection of the organisms. Various different biotopes should be sampled, and each of the biotopes should be sampled with different methods. The biotypes sampled at the monitoring points were Vegetation (VG) Biotopes, Stone and Rock (S) Biotopes and Gravel, Sand and Mud (GSM) Biotopes.

Stone (S) Biotopes:

Stones in current (SIC) or any solid object**:** Movable stones of at least cobble size (≥3 cm diameter) to approximately 25 cm in diameter, within the fast and slow flowing sections of the river.

Kick sampling is used to collect organisms in this biotope. This is done by putting the net on the bottom of the river, just downstream of the stones to be kicked, in a position where the current will carry the dislodged organisms into the net. The stones are then kicked over and against each other to dislodge the invertebrates (kick sampling) for ± 2 minutes.

Stones out of current (SOOC), bedrock or any solid object out of the current: Movable stones of at least cobble size (2 cm diameter) to approximately 25 cm in diameter that are out of current where fine sediments are able to settle on their surfaces. The stones are then kicked over and against each other to dislodge the invertebrates (kick sampling) for ± 1min.
Both SIC and SOOC samples are combined into a single Stones sample

Vegetation (VG) Biotopes:

Marginal vegetation (MV): This is the overhanging grasses, bushes, twigs and reeds growing on the edge of the stream, often emergent, both in current (MvegIC) and out of current (MvegOOC). Sampling is conducted by holding the net perpendicular to the vegetation (below the surface) and sweeping back and forth through the vegetation (± 2 m of vegetation). This sampling is spread over a stretch of the river. Dominant plant species may be recorded.

Submerged vegetation (AQV): This vegetation is totally submerged and includes filamentous algae and the roots of floating aquatics such as water hyacinth. This is sampled by pushing the net (under the water) against and through the vegetation in an area of approximately one square meter.

Gravel, Sand and Mud (GSM) Biotopes:

Sand: This includes sandbanks within the river, small patches of sand in hollows at the side of the river or sand between the stones at the side of the river. These biotopes were sampled by stirring the substrate by shuffling or scraping of the feet.

Gravel: Gravel typically consists of smaller stones (2-3 mm up to 3 cm). Sampling was similar to that of sand.

Mud: It consists of very fine particles, usually as dark-coloured sediment. Mud usually settles to the bottom in still or slow flowing areas of the river. Sampling was similar to that of sand. All three biotopes are sampled for a collective total of 1min and then combined into a single GSM (Gravel, Sand and Mud) sample.

Hand picking and visual observation:

Before, during and after sampling the site, approximately 1 minute of “hand-picking” for specimens that may have been missed by the sampling procedures is carried out. Visual observation is also carried out during sampling.

4.3.2 Sample preparation

The organisms sampled in each biotope group were identified and their relative abundance noted on the SASS5 datasheet. The scoring system consists of a checklist on which the different invertebrate family has a value between 1 and 15 varying from the least intolerant to the most intolerant. The families collected at the site were identified and checked off against the list. Values according to the checklist were allocated to the families, which allow for the summation of each sample to provide a sample score. The number of families was summed as the number of taxa present. Subsequently the number of taxa to provide the Average Score Per Taxon commonly referred to as ASPT divided the sample score.

5 Reference Scores

5.1 Water Quality

Reference scores applicable to water quality related to the activities and rivers outlined in this document were obtained from the following sources:

- South African Water Quality Guidelines (Volume 8): Field Guide
- Approved Reserve for B12B as per reference 26/8/3/3/264_1/7 dated 8 December 2007

The RQO's is depicted in **Table 5-1** and **Table 5-2**. In terms of **Table 5-2** in is evident that the water qualities fall within the Basic Human Need Reserve. This is acceptable for the catchment as there are multiple mining and industrial activities found within this catchment.

Table 5-1: Catchment Characteristics

Water Resource	WMA	Catchment	PES	EIS	REC	MAR ($10^6 m^3$)	% MAR
Woestalleen Spruit	4	B12E	D	Largely Modified	C	73.7	27.01

Table 5-2: Reserves as set out for B12E Catchment

Parameter	Ecological Reserve	Basic Human Needs Reserve	Water Quality Reserve
TDS *(mg/l)*	<372	<1000	<373
Sodium *(mg/l)*	<179	<200	<179
Magnesium *(mg/l)*	<18	<100	<18
Potassium *(mg/l)*	<52	<50	<50
Calcium *(mg/l)*	<25	<150	<25
Chloride *(mg/l)*	<62	<200	<62
Sulphate *(mg/l)*	<70	<400	<70
Phosphate *(mg/l)*	<0.01	n/a	0.01
pH	6.5-8.5	5-9.5	6.5-8.5
DO	>94%	n/a	>94%
Ammonia *(mg-N/l as NH_3)*	<0.034	n/a	<0.034

5.2 SASS5

Reference scores are important to be able to determine the present health class in terms of Dickens & Graham (2001). Modeled reference conditions by the DWA were used for comparison between the present SASS5 and ASPT scores and the benchmark conditions for the Highveld Eco region, (**Table 5-3**). Reserve values for the B12B quaternary catchment were also used to determine the significance of any impacts by comparing the PES with the Recommended Ecological status of the quaternary catchments on a broad scale.

There are various factors that determine the health of the biological communities in a river system. These factors include regional characteristics such as climate, rainfall, topography, geology, geomorphology, soil and natural vegetation types. An alluvial system, for instance, will provide fewer habitats than a system where the geomorphology consists of boulders/cobbles. Similarly, a non-perennial system will be a far less hospitable environment than a perennial system. As such, there are no definitive rules when setting a background value for biological indices. Therefore, a background/reference site is important when doing Bio-monitoring in a particular river system.

Typical scores that could be expected in the Highveld Ecoregion are presented in **Table 5-3**. While this method is not the most accurate means of estimating IHAS, SASS5 as well as ASPT scores, it allows for the identification of a possible reference, or background score to compare current values to.

Table 5-3: Reference scores applicable to the study area

Class	Level 1 Eco Region	Highveld	
	Description	**SASS Score%**	**ASPT**
A	Excellent- Unimpaired. High diversity of taxa with numerous sensitive taxa. Optimum community structure.	>123	>5.6
B	Very Good- Slightly impaired. High diversity of taxa, but with fewer sensitive taxa. Largely natural with minor modifications. A small change in community structure may have taken place but ecosystem functions are essentially unchanged.	83-123	4.8-5.5
C	Good- Moderately impaired. Moderate diversity of taxa. Community composition lower than expected due to loss of some sensitive forms. Basic ecosystem functions predominantly unchanged.	65-82	4.6-4.7
D	Fair- Largely impaired. Mostly tolerant taxa present. Basic ecosystem functions have changed.	51-64	4.2-4.5
E	Poor-Severely impaired. Only tolerant taxa	<51	<4.2

Class	Level 1 Eco Region	Highveld	
	Description	SASS Score %	ASPT
	present. An extensive loss of basic ecosystem functions has occurred.		
F	Very poor- Critically impaired. Very few tolerant taxa present.	0-19	

(DALLAS, H.F., 2007)

5.3 IHAS Scores

The habitat assessment (IHAS) assesses the potential that the biotopes have to provide adequate habitat for colonization by various macro-invertebrates. According to McMillan (1998) the following parameters give a good indication to the habitat quality:

- <55%: habitat diversity and structure is inadequate for supporting a diverse aquatic macro-invertebrate community.
- 55%-65%: habitat diversity and structure is adequate for supporting a diverse aquatic macro-invertebrate community.
- >65%: habitat diversity and structure is highly suited for supporting a diverse aquatic macro-invertebrate community.

6 Findings and Results

The findings are based on the SASS5 bio-monitoring as conducted the 10th of September 2013 in the tributary of the Woestalleen Spruit. There is no reference for a previous dry season monitoring done in this stream and these results will be used to set the baseline and act as the pre-mining conditions. Therefore, it can only be measured on merit of the Departmental reference of the catchment, and the associated water qualities.

Table 6-1: Target water Quality range for B12B Catchment

Chemical Parameter	Target Water Quality Ranges		
	Class 0	Class I	Class II
pH	5 – 9.5	4.5 – 10	4 – 10.5
Electrical Conductivity	< 70	70 - 150	150 – 370
Calcium as Ca	< 80	80 - 150	150 – 300
Magnesium as Mg	< 70	70 - 100	100 – 200
Sodium as Na	< 100	100 - 200	200 – 400
Chloride as Cl	< 100	100 - 200	200 – 600
Sulphate as SO_4	< 200	200 - 400	400 – 600
Nitrate as NO_x-N	< 6	6 - 10	10 – 20

6.1 Woestalleen Spruit

The Woestalleen Spruit and its tributaries is impacted by the riparian agriculture and the industrial related activities found in the area. This is evident in the baseline water quality results as conducted on the 10th of September 2013. These results can be seen in **Table 6-2**. The in-situ data is depicted in **Table 6-3**. The monitoring points were subject to the availability of the habitat able to support sensitive species. These sites had low IHAS scores and this is reflective of the current impacts associated with the watercourse. In terms of **Table 6-1** the water analysed is found to be within the Class 0 TWQR.

Table 6-2: Water quality data applicable to Kebrafield Mine - September 2013

Analyses in mg/ℓ	Sample Identification: Pullenshope		
	KFBM3	KFBM2	KFBM4
pH – Value at 25°C	7.5	8.8	7.2
Electrical Conductivity in mS/m at 25°C	77.2	78.8	57.7
Total Dissolved Solids at 180°C	518	528	374
Suspended Solids at 105°C	17.2	3.6	324
Turbidity in N.T.U	8.6	1.5	354
Total Hardness as $CaCO_3$	274	260	169
Chloride as Cl	34	40	34
Sulphate as SO_4	200	224	115
Nitrate as N	<0.2	<0.2	<0.2
Nitrite as N	<0.1	<0.1	<0.1
Total Phosphate as P	<0.2	0.2	2.7

Analyses in mg/ℓ	**Sample Identification: Pullenshope**		
	KFBM3	**KFBM2**	**KFBM4**
Ortho Phosphate as P	<0.2	<0.2	<0.2
Chemical Oxygen Demand as O_2 (Total)	40	36	123
Dissolved Oxygen as O_2	5.2	7.3	2.9
Sodium as Na	50	47	47
Potassium as K	12.4	13.3	9.8
Calcium as Ca	49	48	28
Magnesium as Mg	37	34	24
Aluminum as Al	<0.100	<0.100	0.228
Aluminum as Al (Dissolved)	<0.100	<0.100	<0.100
Iron as Fe	0.924	0.102	76
Iron as Fe (Dissolved)	<0.025	<0.025	0.257
Manganese as Mn	0.044	0.025	3.07
Manganese as Mn (Dissolved)	<0.025	<0.025	0.751
Zinc as Zn	<0.025	<0.025	<0.025
Zinc as Zn (Dissolved)	<0.025	<0.025	<0.025

Table 6-3: Site specific *in-situ* data for sites in a Tributary of the Woestalleen Spruit

Site	Date	pH	EC (*mS/m*)	DO (*mg/l*)	SASS5	ASPT	Health Class	IHAS
KFBM2	Sept'13	8.8	78.6	10.52	42	5.3	Class B	61
KFBM3	Sept'13	7.2	76.5	6.49	37	4.6	Class C	39
KFBM4	Sept'13	6.3	56.2	3.82	60	5	Class B	39

KFBM 2	*KFBM3*
	
KFBM4	

Figure 6-1: Site photographs for bio-monitoring sites in the Tributary of the Woestalleen Spruit

6.2 ASPT Score Comparisons

It has been found that significant differences between SASS Scores and taxa numbers are obtained between different SASS operators. On the other hand it was found that ASPT scores are more consistent measures for indicating river health during temporal assessments in a given reach of a river (DICKENS, C.W.S. and Graham, P.M., 2002).

6.3 Sensitive families

Of the families identified during the August 2013 assessment, two is considered to be sensitive to pollution (SASS5 scores >7). The sensitive family is (**Figure 6-2**):

KFBM2:

- *None*

KFBM3:

- *Hydracarina* (Mites)
- *Hydraenidae* (Minute moss beetles)

KFBM4:

- *Helodidae* (Marsh beetles)
- *Hydraenidae* (Minute moss beetles)

Hydracarina (Mites)	***Hydraenidae* (Minute moss beetles)**
	
Helodidae (Marsh beetles)	
	

Figure 6-2: Sensitive Species Found During Bio-Monitoring

7 Specific Aquatic Water Quality Constituents

The water qualities are indicative that there are form of pollution entering the system in the area between KFBM3 and KFBM4. The increase in the phosphates is indicative of the biological pollution taking place at point KFBM4. The higher levels in Turbidity, Suspended Solids, and COD's are supportive to this form of pollution. The decrease in DO is another indicator of biological pollution that is clearly taking place. Upon the site visit it was noticed that there were a sewerage leakage in the town of Pullenshope and it is therefore assumed that this is the cause of this pollution as the stormwater drains into the tributary.

Further, the elevated Iron and Aluminum is indicative of the diffuse impacts caused by the mining activities in the area.

8 Discussion

From the above mentioned it is evident that there are already impacts associated with anthropogenic and urban development, sewerage, power generation (Eskom Hendrina Power Station) and mining (Optimum Colliery). This should be taken into close consideration when the RQO's are set as this is the baseline for the area. The Roodepoort Colliery has no activities on the property as yet.

Even though the in stream habitat was found to be insufficient to support sensitive biota, there were still some sensitive species identified. These species included the likes of *Helodidae* (Marsh beetles); *Hydraenidae* (Minute moss beetles) and *Hydracarina* (Mites). It was found at KFBM2 that the IHAS showed the necessary habitat, yet there were no sensitive species found. The ASPT was however evident of a Class B. The main reason found that there were no sensitive species is the fact that this is however the overflow of the dam situated in the stream. This is also the closest point to the dam of all the points monitored and the assumption is that the sensitive species has not yet established at this point.

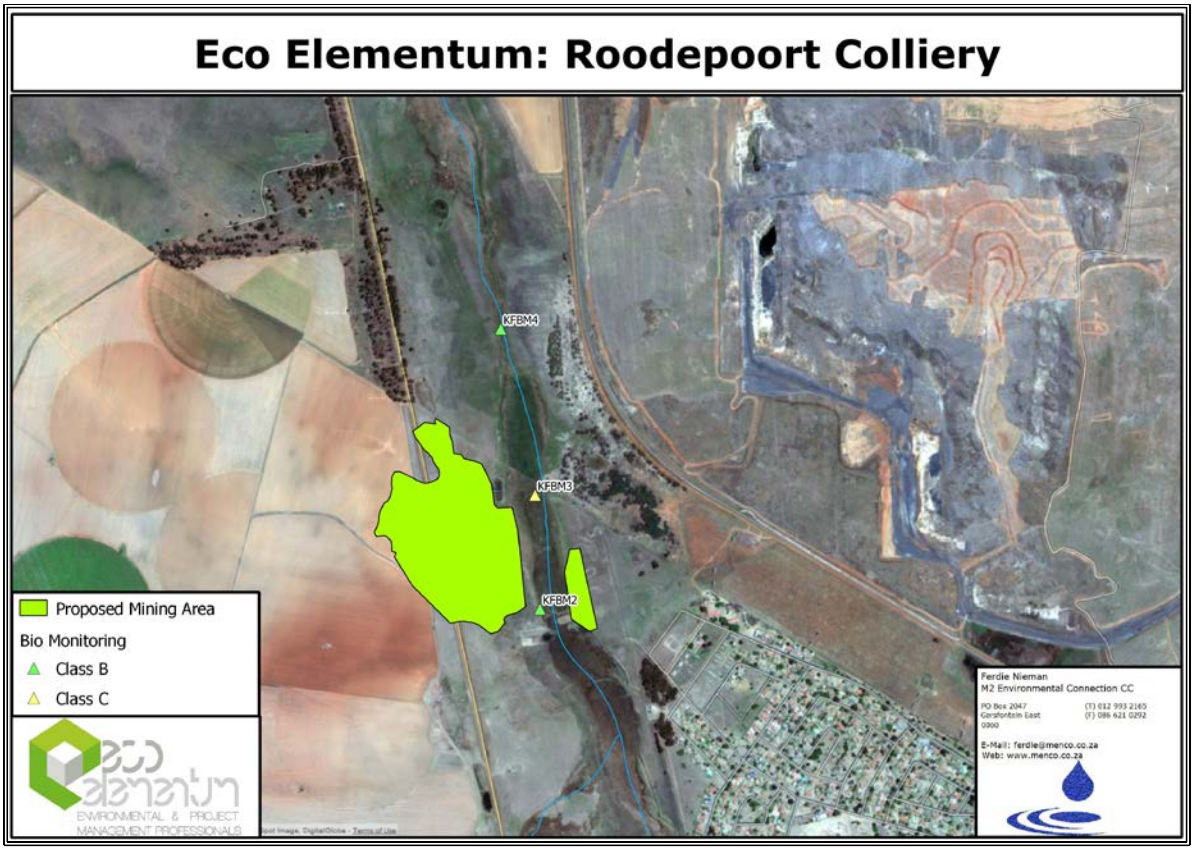

Figure 8-1: SASS 5 Classifications

The asp for the sites respectively was found as 4.6 and 5.3. That indicates a resource class of B/C. The background for the catchment is class D/C. It is however clear that this catchment is severely impacted by the activities found within, but this stream is in a very good condition in relation to the rest of the catchment.

9 Recommendations

Based on the study conducted during the dry season, the following recommendations could be made:

- The water qualities must be taken into account when the RQO's are set in the WULAR.
- Mining should not be restricted in the sub-catchment as the area is not protected in terms of NFEPA and/or SANBI criteria as well as the C-Plan for Province.
- Bio-monitoring should be conducted during the wet-season to establish the database and create the comparable data.

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Appendix A
Laboratory Quality Certificate and Results

Appendix B
IHAS Score Sheets

Appendix C
SASS5 Score Sheets