REPORT

EXXARO BELFAST COAL MINE PROJECT

Aquatic Baseline and Impact Assessment for the Proposed Belfast Coal Mine Project

Submitted to:
Koos Smit
Senior Environmental Specialist: Ecologist
Exxaro Services
Pretoria
South Africa
Tel: +27 (12) 307 3234
Email: koos.smit@exxaro.com

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Golder Associates

Executive Summary

Exxaro Coal (Pty) Ltd (Exxaro), owned by Exxaro Resources Ltd, operates a coal mining complex in the province of Mpumalanga This complex is referred to as the North Block Complex (NBC). As part of the NBC, Exxaro is in the process of re-looking and re-designing the proposed open pit footprint layout, the position of the washing plant and associated infrastructure, as well as the design and proposed discard dump footprint area for the proposed Belfast Coal Mine Project in order to avoid sensitive wetland areas. A water treatment plant will further be constructed and a maximum of 4ML of water per day will be discharge into the surrounding wetland and aquatic ecosystem..

Golder Associates Africa (Pty) Ltd was contracted by Exxaro Resources Ltd to conduct a specialist aquatic and impact assessment for the proposed Northern Block Complex (NBC) Belfast Coal Mine Project.

The objective of the survey was to determine whether the proposed discharge of 4ML of treated water from the WWTP would have an impact on the ecological integrity of the Klein Komati River?

From the comparison of the December 2009 and November 2013 surveys on the Klein Komati River, the following conclusions were reached based on the above question:

- All *in situ* water quality parameters were shown to fall within guideline values, except for the DO concentration for November 2013 at both sites. These low DO values were the only parameter of concern that may have a limiting effect on the aquatic biota;
- The IHAS results collected during the December 2009 and November 2013 survey, showed the habitat availability for aquatic macroinvertebrates in the Klein Komati River to range from poor to adequate, depending on the biotopes present;
- The SASS5 results showed little variation between the two surveys, with the biotic integrity remaining in a Class B, and being largely natural with minimal modification;
- The ichthyofaunal sampling revealed 2 species, namely *Barbus anoplus* (Chubbyhead Barb) and *Chiloglanis pretoriae* (Shortspine Suckermouth / Rock Catlet) with *B. anoplus* (Chubbyhead Barb) occurring in high abundance during November 2013, while *B. anoplus* (Chubbyhead Barb) and *Pseudocrenilabrus philander* (Southern Mouthbrooder) were found in low abundance in December 2009. *C. pretoriae* (Shortspine Suckermouth / Rock Catlet) *is* a rheophilic species is an indicator of good water quality and habitat integrity. This species was recorded at site KK3 during the November 2013 survey;
- The following impacts identified as a result of the proposed project on the aquatic ecosystem include:
  - Degradation of biotic integrity due to modification of water quality;
  - Degradation of biotic integrity due to increased sedimentation;
  - Change to natural flow regime;
  - Alteration to habitat availability; and
  - Loss of species diversity and abundance due to decreased water quality and habitats.
- None of the identified impacts were rated as significant should the mitigation and management measures be implemented. The recommendations provided will prevent potential reduction to the ecological integrity of aquatic ecosystem in the project area; and
- Discharge points have been recommended for the proposed project:

- One discharge point is recommended along the Klein Komati River, whereby the flow rate is at its highest along this river reach. Should this point be approved, it is further advised to construct a stilling basin at the discharge point. This structure will control the velocity of the effluent being discharged into the Klein Komati and thus avoid altering the flow regime and consequently the habitat availability within the river system. The stilling basin will be designed in such a way as to:
  - Dissipate the energy contained in the rushing effluent in the concrete stilling basin, a phenomenon known as hydraulic jump, prior to flowing into the Klein Komati River;
  - Minimise localised erosion; and
  - Provide flood protection.
- Multiple discharge points should be considered in the different wetland sections, as compared to a single discharge point. This to regain wet area / additional wetland conditions at the different wetland sections and thus increases overall wetland areas.

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1.0 INTRODUCTION

Exxaro Coal Mpumalanga (Pty) Ltd (referred to as Exxaro) is a subsidiary of Exxaro Coal (Pty) Ltd and is owned by Exxaro Resources Limited. Exxaro operates a coal mining complex in the province of Mpumalanga which is situated between the towns of Carolina and Belfast.

The coal mining complex is referred to as the North Block Complex (NBC). As part of the NBC, Exxaro is in the process of constructing a waste water treatment plant (WWTP) which will aid in the treatment of water. The coal mine then proposes to discharge a maximum of 4ML of treated water into the surrounding wetland and aquatic ecosystem, particularly the Klein Komati River.

Golder Associates Africa (Pty) Ltd was contracted by Exxaro to conduct an aquatic baseline and impact assessment for the proposed NBC Belfast Coal Mine Project.

The aquatic ecosystems assessment needs to be updated to incorporate the potential impacts of the proposed release of a maximum of 4 ML of water per day into the receiving environment. However, all flow velocity and aquatic ecosystem impacts were assessed using the worst case discharge scenario of 4ML/day.

A previous study was conducted in December 2009. This information has been incorporated into the interpretation of results.

1.1 Objectives

The objective of the survey was to determine whether the maximum proposed discharge of 4ML of treated water from the proposed Belfast Coal Mine's waste water treatment plant (WWTP) would impact the ecological integrity of the Klein Komati River?

This question will be addressed through the:

- Characterisation of the biotic integrity of aquatic ecosystems associated with the proposed Belfast Coal Mine extensions and pipeline as per the scope of work;
- Evaluation of the extent of site-related effects, in terms of selected ecological indicators, as per the scope of work;
- Consideration of the potential impacts to the Klein Komati River, as a result of proposed construction activities;
- Identification of trends in aquatic ecosystem health in the project area; and
- Identification of potential problem areas and recommend suitable mitigation measures.

2.0 AQUATIC BIOMONITORING APPROACH

In order to adequately describe the associated aquatic environments it is recommended that at least two, or preferably three, indicators be selected to represent each of the stressor, habitat and response components involved in the aquatic environment. Broad methodologies to characterise these components are described below (Figure 1). These proposed methodologies are generally applied and accepted (DWAF and USEPA).

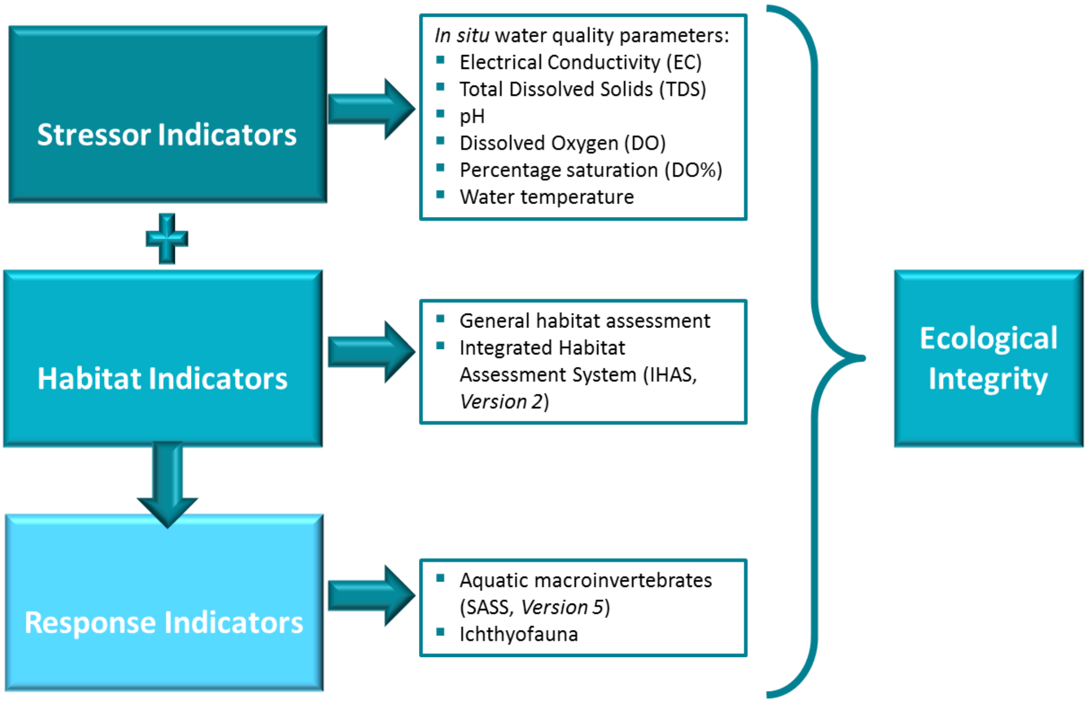

Figure 1: Aquatic biomonitoring approach

3.0 STUDY AREA

The project area is located in the magisterial district of Belfast in Mpumalanga covering an area in extent of approximately 5819.18 hectares (ha). The study area covers the farms Leeuwbank 427 JS, Zoekop 426 JS and Blyvooruitzigh 383 JT and falls within the Inkomati (WMA5) and the Olifants Water Management Area (WMA4). Three quaternary catchments drain this area, namely Leeubankspruit (X11C), Klein-Komatirivier (X11D), and the Steelpoortrivier (B41A). The Klein-Komati River and Leeubankspruit are tributaries of the larger Komati River. The Study Area receives a summer rainfall, occurring between October and April.

The sampling sites were selected to represent areas up- and downstream on the Klein Komati River. Co-ordinates of the sampling sites were determined using a Garmin GPS60CSx and are listed in Table 1. A map of the study area showing the location of the aquatic biomonitoring sites are presented in Figure 2. Photographs of sampling sites are presented in APPENDIX A.

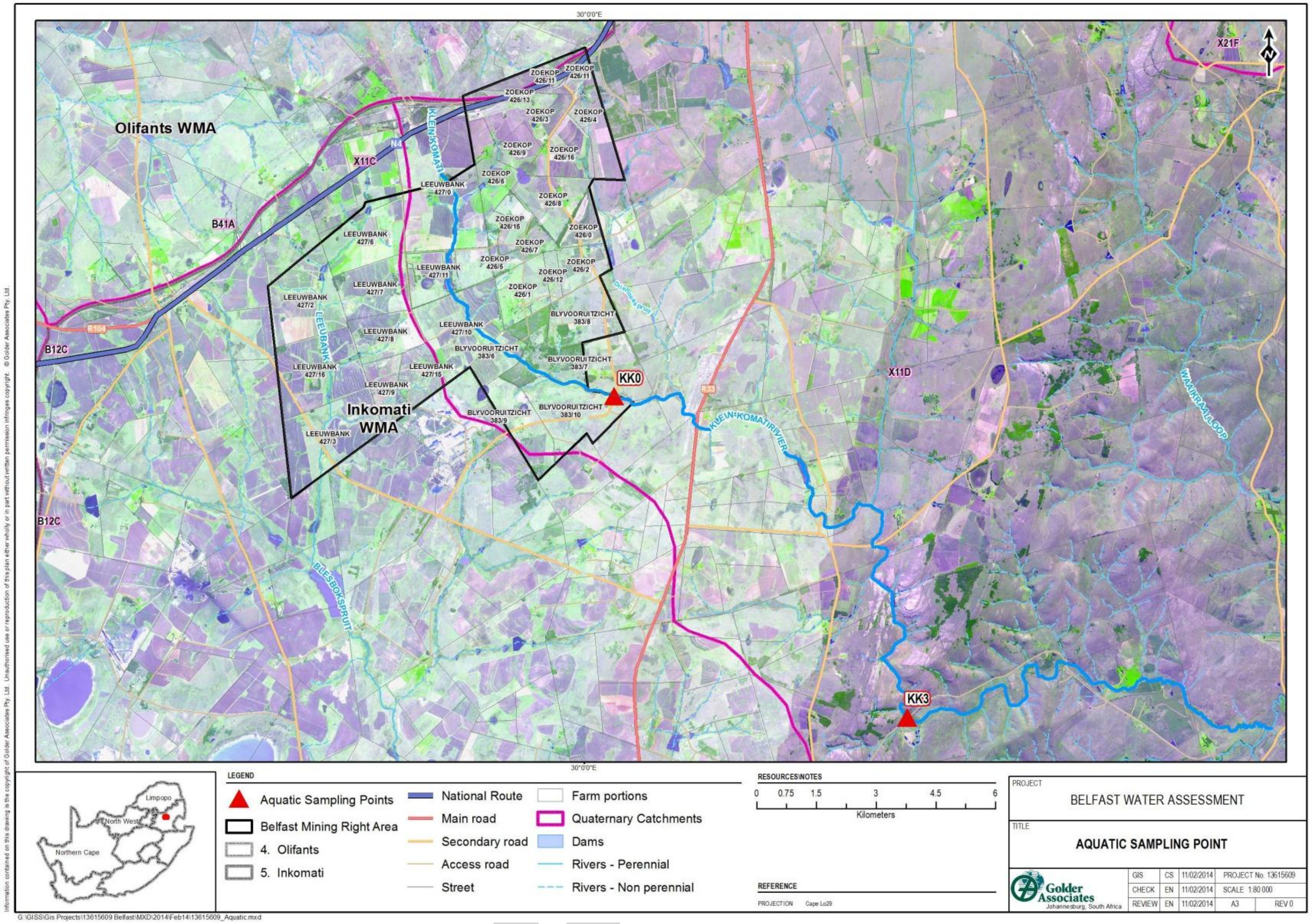

Figure 2: Map illustrating the aquatic monitoring sites associated with the proposed Belfast Coal Mine's Mining Rights Area

Table 1: Site details

Site	Description	GPS coordinates	
KK0	Situated on the Klein Komati at the southern boundary of the proposed Belfast Coal Mine's Mining Area.	25°49'40.91"S	30° 0'23.53"E
KK3	Situated on the Klein Komati, downstream of site KK0.	25°54'1.45"S	30° 4'50.29"E

4.0 METHODOLOGY

4.1 Water Quality

4.1.1 *In situ* water quality

During the field survey, the following variables were determined on site using lightweight, compact field instruments:

- pH (Eutech pHTester2);
- Electrical Conductivity (EC) (Eutech ECTester11 Dual Range);
- Dissolved oxygen (DO) (Eutech CyberScan DO300); and
- Temperature (Eutech CyberScan DO300).

Water quality has a direct influence on aquatic life forms. Although these measurements only provide a "snapshot" at the time of the survey, they can provide valuable insight into the characteristics and interpretation of a specific sample site. Results collected over time, show seasonal and flow related trends. It should be noted that this does not constitute the general water quality state and does not include chemical water quality analysis, metal or organic contaminants, nutrient analysis or pesticide analysis.

4.2 Aquatic Macroinvertebrates

The monitoring of benthic macroinvertebrates forms an integral part of the monitoring of the health of an aquatic ecosystem. Aquatic macroinvertebrates are used as they are relatively sedentary and enable the detection of localized disturbances, are relatively long lived (±1 year) allowing for the integration of pollution effects over time, and field sampling is relatively easy and since the communities are heterogeneous and several phyla are usually represented, response to environmental impacts is normally detectable in terms of the community as a whole (Hellawell, 1977).

In order to standardize the sampling effort the sampling protocol of the South African Scoring System (SASS, *version 5*) (Dickens & Graham, 2002) was used. This method relies on churning up the substrate with your feet and sweeping a finely meshed SASS net (pore size of 1000 micron), mounted on a 300 mm square frame, over the churned up area. In the Stones-In-Current (SIC) habitat (rapids, riffles, runs, etc.) the net is rested on the substrate and the area immediately upstream of the net disturbed by kicking the stones over and against each other to dislodge benthic invertebrates. The net is also swept under the edge of marginal and aquatic vegetation (VEG) for a distance of 1 - 2 m. Kick samples are collected from areas with gravel, sand and mud (GSM) substrates. Identification of the organisms is made to family level (Thirion *et. al*., 1995; Davies & Day, 1998; Dickens & Graham, 2002; Gerber & Gabriel, 2002).

The endpoint of any biological or ecosystem assessment is a value expressed either in the form of measurements (data collected) or in a more meaningful format by summarising these measurements into one or several index values (Cyrus *et. al*., 2000) The endpoints used for this study were the total SASS5 score and average score per taxa (ASPT). All sites were scored according to these indices, based on aquatic macroinvertebrate diversity. As this study's purpose is to characterise the current situation, the current survey results will be compared to those of previous surveys.

4.2.1 Biotic Integrity based on SASS5 results

The SASS5 Data Interpretation Guidelines (Dallas, 2007) were used to evaluate the SASS5 results.

Table 2: Ecological category for interpreting SASSS5 data for the Lower Highveld zone based on SASS5 and ASPT scores

Class	Description	SASS Score	ASPT
A	Excellent – Unimpaired; community structures and functions comparable to the best situation to be expected. Optimum community structure for stream size and habitat quality.	> 124	> 5.6
B	Very Good – Minimally impaired; Largely natural with few modifications. A small change in community structure may have taken place but ecosystem functions are essentially unchanged	82-124	4.8-5.6
C	Good – Moderately impaired; community structure and function less than the reference condition. Community composition lower than expected due to loss of some sensitive forms. Basic ecosystem functions are still predominantly unchanged.	65-81	4.6-4.8
D	Fair- Largely impaired; fewer families present than expected, due to loss of most intolerant forms. Basic ecosystem functions have changed.	51-64	4.2-4.6
E/F	Poor – Seriously impaired; few aquatic families present, due to loss of most intolerant forms. An extensive loss of basic ecosystem functions has occurred.	< 51	< 4.2

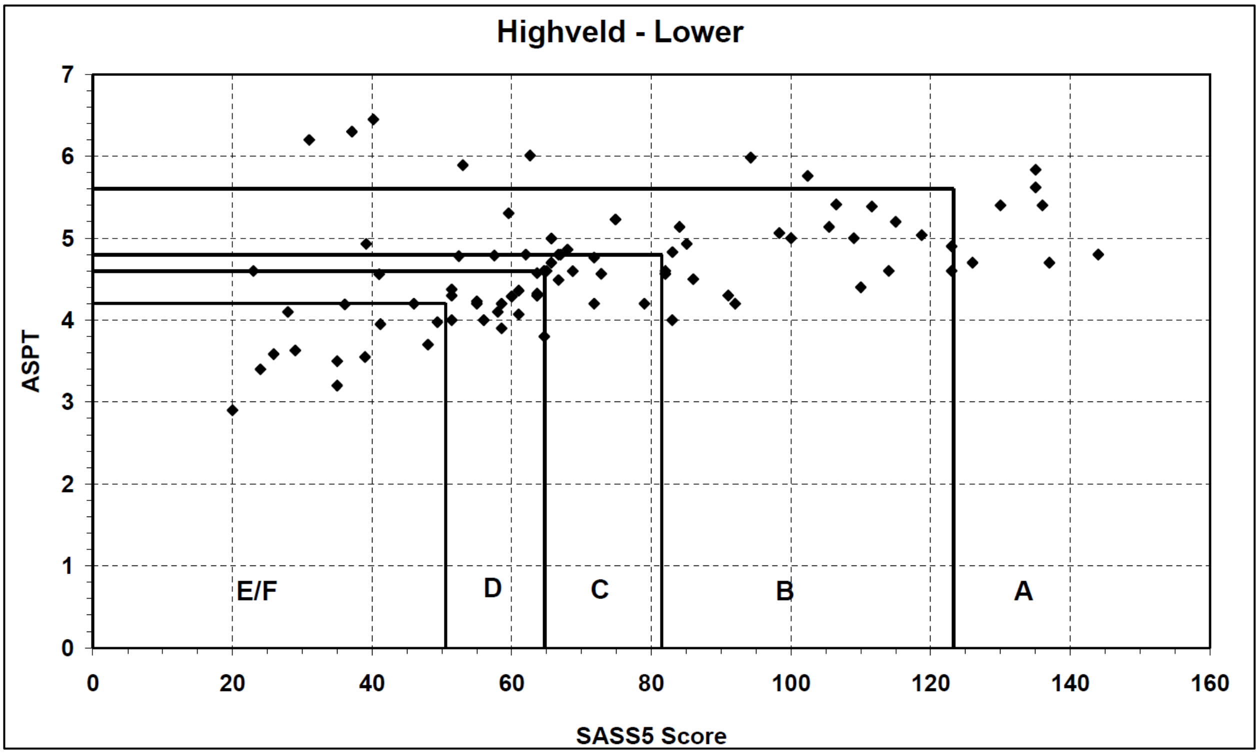

Figure 3: Biological Bands for the Highveld – Lower zone, calculated using percentiles

4.3 Ichthyofauna

Ichthyofaunal samples were collected by means of electrofishing. Electrofishing is the use of electricity to catch fish. The electricity is generated by a system whereby a high voltage potential is applied between two electrodes placed in the water (USGS, 2004). The responses of fish to electricity are determined largely by the type of electrical current and its wave form. These responses include avoidance, electrotaxis (forced swimming), electrotetanus (muscle contraction), electronarcosis (muscle relaxation or stunning) and death (USGS, 2004). Electrofishing was conducted with a Smith-Root LR-24 portable electrofishing device (DC 12V pulsating). Electrofishing is regarded as the most effective single method for sampling fish communities in wadeable streams (Plafkin, *et. al.*, 1989). The time spent electrofishing was influenced by the different flow classes and cover elements at the various sites. Thus more homogeneous sites were sampled for less time than heterogeneous habitats, and were applicable alternative netting methods were applied.

During electrofishing variables such as conductivity (Pusey*, et. al.,* 1998; Hill & Willis, 1994), stream width (Kennedy & Strange, 1981), fish size (Zalewski, 1985; Bohlin & Sundstrom, 1977), temperature (Regis, *et. al.*, 1981), and operator experience (Hardin & Connor 1992) have been shown to affect the capture efficiency in fish. The conductivity of the water affects the efficiency of sampling in two ways. Firstly under low conductivity (>100 µs/cm), the effective area of the electrical field is limited by the increased resistance of the water and the corresponding decrease in electrical current (Nelson & Little, 1987). As a result the electrical field is confined to the area immediately surrounding the electrode. Secondly water with a high conductivity has less resistance than that of the fish, and as a result the current tends to 'flow' around or have little to no effect on the fish (Reynolds, 1983). The Smith-Root LR24 is rated for a conductivity range of 10 – 1500 µs/cm (www.smith-root.com).

Fish were identified in the field, photographed and released at the point of capture. Fish species were identified using the guide Freshwater Fishes of Southern Africa (Skelton, 2001). Voucher specimens were preserved in the field (10% neutrally buffered formaldehyde solution) and transported back for submission to the South African Institute of Aquatic Biodiversity (SAIAB) for species level identification and cataloguing.

4.3.1 Expected Fish Assemblage

An expected fish species list for the sample area was compiled based on previous studies / historical data (Golder Report: 11929-8280-1) coupled with the following sources: (Skelton, 2001; Kleynhans, *et. al.,* 2007). Based on this assessment 13 fish species are expected to occur in the sample area, of which four are exotic fish species. A list of the expected fish species is provided in Table 3.

Table 3: Expected ichthyofaunal composition within the proposed Belfast Coal Mine Project Area and current IUCN status

Scientific Name	Common Name	IUCN Status
Amphilius natalensis	Natal Mountain Catfish	LC(1)
Amphilius uranoscopus	Stargazer (Mountain Catfish)	LC
Barbus anoplus	Chubbyhead Barb	LC
Cyprinus carpio	Carp	Exotic
Clarias gariepinus	Sharptooth Catfish	Unlisted
Chiloglanis pretoriae	Shortspine Suckermouth (Rock Catlet)	LC
Labeobarbus polylepis	Smallscale Yellowfish	LC
Labeobarbus marequensis	Largescale Yellowfish	LC
Micropterus salmoides	Largemouth Bass	Exotic
Oncorhynchus mykiss	Rainbow Trout	Exotic
Pseudocrenilabrus philander	Southern Mouthbrooder	Unlisted
Salmo trutta	Brown Trout	Exotic
Tilapia sparrmanii	Banded Tilapia	LC

(1) LC – Least Concern, Red - Exotic

4.3.2 Presence of Red Data Book Species

Of the twelve fish species expected to occur in the sample area:

- Two species are currently unlisted on the IUCN's Red List of Threatened Species (2013.2) (IUCN, 2013) (Table 3);

- Seven species are currently listed as Least Concern (LC). Species in this category are widespread and abundant (Table 3); and
- Four expected fish species are listed as exotic in South African waters (Table 3).

4.3.3 Fish Assemblage Integrity Index (FAII)

The Fish Assemblage Integrity Index (FAII) was applied to sites associated with the proposed Belfast Coal Mine Project. The FAII index uses the diversity and composition of fish populations, their relative tolerance / intolerance to disturbance, frequency of occurrence and health, to assess biotic integrity. This index measures the current integrity of the fish community relative to what is derived to have been present under natural / unimpaired conditions. The integrity of the fish assemblages is considered to provide a perspective on the broad biological integrity status of a river / stream.

Procedures used in the application of the FAII are described below:

Intolerance ratings

Intolerance refers to the degree to which an indigenous species is unable to withstand changes in the environmental conditions at which it occurs (Kleynhans, 1999). Four components were considered in estimating the intolerance of fish species, i.e. habitat preferences and specialization (HS), food preferences and specialisation (TS), requirement for flowing water during different life stages (FW) and association with habitats with unmodified water quality (WQ). Each of these aspects was scored for a species according to low requirements / specialization (rating = 1), moderate requirement/specialization (rating = 3) and high requirement/specialization (rating = 5). The total intolerance (IT) of fish species is estimated as follows:

$$IT = (HS + TS + FW + WQ)/4$$

Table 4: Species intolerance ratings

Score	Class
1 - 1.9	Tolerant
>2 - 2.9	Moderately Tolerant
>3 - 3.9	Moderately Intolerant
>4 - 5.0	Intolerant

Fish Health Assessment

The assessment is conducted in such a way as to derive numeric values, which reflect the status of fish health. The percentage of fish with externally evident disease or other anomalies was used in the scoring of this metric (Kleynhans, 1999; Kilian *et. al.*, 1997). The following procedures were followed to score the health of individual species at site:

- Frequency of affected fish >5%. Score = 1;
- Frequency of affected fish 2 – 5%. Score = 3; and
- Frequency of affected fish < 2%. Score = 5.

This approach is based in the principle that even under unimpaired conditions a small percentage of individuals can be expected to exhibit some anomalies (Kleynhans, 1999).

Calculation of FAII Score:

The FAII consists of the calculation of an expected value, which serves as the baseline or reference, the calculation of an observed value and the comparison of the expected and observed scores that provide a relative FAII score. The expected FAII rating for a fish habitat segment is calculated as follows (Kleynhans, 1999):

$$\text{FAII value (Exp)} = \Sigma IT \times ((F + H)/2)$$

Where:

- Exp = expected for a fish segment;
- IT = Intolerance rating for individual species expected to be present in a fish habitat segment and in habitats that were sampled;
- F = Expected frequency of occurrence rating for individual species expected to be present in a fish habitat segment and at sites that were sampled; and
- H = Expected health rating for a species expected to be present.

The observed observation is calculated on a similar basis, but is based on information collected during the survey:

$$\text{FAII value (Obs)} = \Sigma IT \times ((F + H)/2)$$

Where:

- Obs: = observed for a fish habitat segment

The relative FAII score is calculated by:

$$\text{Relative FAII score} = \text{FAII value (Obs)}/\text{FAII value (Exp)} \times 100$$

Interpretation of the FAII score

Interpretation of the relative FAII values is based on the habitat integrity classes of Kleynhans (1996) (Table 5).

Table 5: FAII Assessment Classes (Kleynhans, 1996; 1999)

Class	Description of generally expected conditions for integrity classes	FAII score (% of total)
A	Unmodified, or approximate natural conditions closely.	90 - 100
B	Largely natural with few modifications. A change in community characteristics may have taken place but species richness and presence of intolerant species indicate little modification	80 - 89
C	Moderately modified. A lower than expected species richness and presence of most intolerant species. Some impairment of health may be evident at the lower limit of this class	60 - 79
D	Largely modified. Clearly lower than expected species richness and presence of most intolerant species. Some impairment of health may be evident at the lower limit of this class	40 - 59
E	Seriously modified. A strikingly lower than expected species richness and general absence of intolerant and moderately intolerant species. Impairment of health may become evident.	20 - 39
F	Critically modified. Extremely lowered species richness and an absence of intolerant and moderately intolerant species. Only tolerant species may be present with a complete loss of species at the lower limit of the class. Impairment of health generally very	0 - 19

Class	Description of generally expected conditions for integrity classes	FAII score (% of total)
	evident.	

4.3.4 Fish Health

The fish health assessment was confined to external examination of the skin, fins, eyes, gills, opercula (the hard, bony flap covering the gill slits) and the presence of ectoparasites. This approach ensured the minimization of stress due to handling and allowed the fish to be released unharmed. This approach is based on the principle that even under unimpaired conditions, a small percentage of individuals can be expected to exhibit some anomalies (Kleynhans, 1999).

4.4 Habitat Characterisation

Habitat availability and diversity are major attributes for the biota found in a specific ecosystem, and thus knowledge of the quality of habitats is important in an overall assessment of ecosystem health. Habitat assessment can be defined as the evaluation of the structure of the surrounding physical habitat that influences the quality of the water resource and the condition of the resident aquatic community (Barbour *et. al*., 1996). Both the quality and quantity of available habitat affect the structure and composition of resident biological communities (USEPA, 1998). Habitat quality and availability plays a critical role in the occurrence of aquatic biota. For this reason habitat evaluation is conducted simultaneously with biological evaluations in order to facilitate the interpretation of results.

Assessment of physical habitat quality is an integral component of the final evaluation of any impairment. The assessment performed includes a general description of the site, GPS coordinates; photographs for future identification of changes, and documentation of habitat conditions and watershed features. These parameters are pertinent to the characterization of an aquatic system and provide valuable insight into the system’s ability to support a healthy aquatic community.

4.4.1 Invertebrate Habitat Assessment System (IHAS, Version 2)

The quality of the instream and riparian habitat influences the structure and function of the aquatic community in a stream; therefore assessment of the habitat is critical to any assessment of ecological integrity. The Invertebrate Habitat Assessment System (IHAS, version 2) was applied at each of the sampling sites in order to assess the availability of habitat biotopes for aquatic macro-invertebrates. The IHAS was developed specifically for use with the SASS5 index in South Africa (McMillan, 1998). The index considers sampling habitat and stream characteristics. The sampling habitat is broken down into three sub-sections namely stones-in-current (SIC), vegetation (VEG), and Gravel, Sand & Mud (GSM) and other habitat / general. All of these add up to a possible 100 points (or percentage). It is presently thought that a total IHAS score of over 65% represents good habitat conditions, a score over 55% indicates adequate / fair habitat conditions while below 55% is poor (Table 6).

Table 6: Invertebrate Habitat Assessment System (Version 2)

IHAS Score	Description
> 65%	Good
55 - 65%	Adequate / Fair
< 55%	Poor

4.5 Impact Assessment

4.5.1 Assessment of Potential Impacts

The impact assessment is conducted by determining how the proposed activity (discharge of 4ML of treated water from the proposed Belfast Coal Mine WWTP into the aquatic environment) will affect the state of the environment previously described. Specific requirements are:

- Undertake a comparative assessment to identify and quantify the environmental aspects of the various activities associated with the proposed project;
- Assess the impacts that may accrue and the significance of those impacts using the methodology as described below; and
- Identify and assess cumulative impacts utilising the same rating system.

4.5.2 Development of Mitigation Measures

A common approach to describing mitigation measures for critical impacts is to specify a range of targets with a predetermined acceptable range and an associated monitoring and evaluation plan. To ensure successful implementation, mitigation measures should be unambiguous statements of actions and requirements that are practical to execute. The following summarize the different approaches that may be used in prescribing and designing mitigation measures:

- Avoidance: e.g. mitigation by not carrying out the proposed action on the specific site, but rather on a more suitable site;
- Minimization: mitigation by scaling down the magnitude of a development, reorienting the layout of the project or employing technology to limit the undesirable environmental impact;
- Rectification: mitigation through the restoration of environments affected by the action;
- Reduction: mitigation by taking maintenance steps during the course of the action; and
- Compensation: mitigation through the creation, enhancement or acquisition of similar environments to those affected by the action.

4.5.3 Environmental Impact Significance Assessment

The impacts of the proposed development were assessed in terms of impact significance and recommended mitigation measures.

The determination of significant impacts relates to the degree of change in the environmental resource measured against some standard or threshold (DEAT, 2002). This requires a definition of the magnitude, prevalence, duration, frequency and likelihood of potential change (DEAT, 2002). The following criteria have been proposed by the Department of Environmental Affairs and Tourism for the description of the magnitude and significance of impacts (DEAT, 2002).

The consequence of impacts can be derived by considering the following criteria:

- Extent or spatial scale of the impact;
- Intensity or severity of the impact;
- Duration of the impact;
- Potential for Mitigation;
- Acceptability;
- Degree of certainty / Probability;

- Status of the impact; and
- Legal Requirements.

Describing the potential impact in terms of the above criteria provides a consistent and systematic basis for the comparison and application of judgments (DEAT, 2002).

The significance of the impact is calculated as:

Significance of Impact = Consequence (magnitude + duration + spatial scale) x Probability

Magnitude relates to how severe the impact is. Duration relates to how long the impact may be prevalent for and the spatial scale relates to the physical area that would be affected by the impact. Having ranked the severity, duration and spatial scale using the criteria outlined in Table 7, the overall consequence of impact can be determined by adding the individual scores assigned in the severity, duration and spatial scale. Overall probability of the impacts must then be determined. Probability refers to how likely it is that the impact may occur.

Table 7: Consequence and probability ranking

Magnitude/Severity	Duration	Spatial Scale	Probability
10 - Very high / don't know	5 - Permanent	5 - International	5 – Definite / don't know
8 - High	4 - Long-term (impact ceases after operational life)	4 – National (RSA)	4 - Highly probable
6 - Moderate	3 - Medium-term (5-15 years)	3 – Regional (Mpumalanga)	3 - Medium probability
4 - Low	2 - Short-term (0-5 years)	2 – Local (Study Area)	2 - Low probability
2 - Minor	1 - Immediate	1- Site only (Klein Komati)	1 - Improbable
0 - None	0 - None	0 - None	0 - None

The maximum value, which can be obtained, is 100 significance points (SP). Environmental effects are rated as either of High, Moderate, Low or No Impact significance on the following basis:

- SP > 75 Indicates high environmental significance
- SP 30 – 75 Indicates moderate environmental significance
- SP < 30 Indicates low environmental significance
- SP = 0 Indicates no environmental significance

The descriptors for the ratings are provided in (Table 8) (DEAT, 2002).

Table 8: Categories for the rating of impact magnitude and significance

Category	Description
High	Impact must have an influence on the decision process to develop
Moderate	Impact could influence the decision to develop in the area unless it is effectively mitigated.
Low	Impact doesn't have a direct influence on the decision to develop in the area.

5.0 RESULTS & DISCUSSION

5.1 *In Situ* Water Quality Results

The *in situ* water quality results are presented in Table 9. These results are important in assisting with the interpretation of biological results because of the direct influence water quality has on aquatic life forms. Site KK0 was previously sampled under the site name KS21.

Table 9: *In situ* water quality recorded for the Belfast survey

Site	pH		DO* (mg/ℓ)		EC** (µS/cm)		TDS*** (mg/ℓ)		Temp (°C)	
	6.5 – 9.0		>5.0		<1540		<1000		5 – 30	
	Dec 09	Nov 13	Dec 09	Nov 13	Dec 09	Nov 13	Dec 09	Nov 13	Dec 09	Nov 13
KK0 (KS21)	8.0	8.1	5.8	2.2	110	150	71.5	97.5	19.7	20.3
KK3	-	8.7	-	4.3	-	130	-	84.5	-	19.0

Variables of concern are highlighted in red, *Dissolved Oxygen; ** Electrical Conductivity; *** Total Dissolved Salts; - No data available

5.1.1 pH

The pH of natural waters is determined by both geological and atmospheric influences, as well as by biological activities. Most fresh waters are usually relatively well buffered with a pH range from 6 to 8 (Davies & Day, 1998), and most are slightly alkaline due to the presence of bicarbonates of the alkali and alkaline earth metals (DWAF, 1996). The pH target for fish health is presented as ranging between 6.5 and 9.0, as most species will tolerate and reproduce successfully within this pH range (Alabaster & Lloyd, 1982). According to the South African Water Quality Guidelines for Aquatic Ecosystems the pH values should not be allowed to vary from the range of the background pH values for a specific site and time of day, by > 0.5 of a pH unit, or by > 5 %, and should be assessed by whichever estimate is the more conservative (DWAF, 1996).

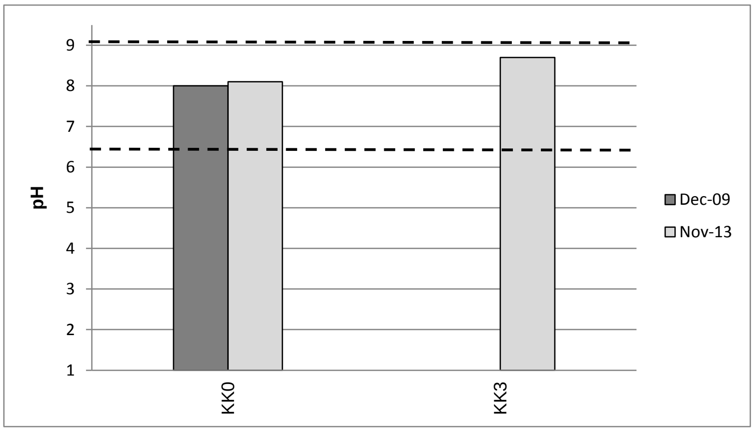

Figure 4: pH values associated with the Belfast sites (dashed lines indicate the upper and lower guideline values)

The pH levels within the Klein Komati River increased in a downstream direction but were within the guideline values (DWAF, 1996) at sites KK0 and KK3 (Figure 4 and Table 9). Consequently, pH was not a limiting factor to the aquatic ecosystem.

5.1.2 Electrical Conductivity (EC)/ Total Dissolved Solids (TDS)

Electrical conductivity (EC) is a measure of the ability of water to conduct an electrical current (DWAF, 1996). This ability is a result of the presence of ions in water such as carbonate, bicarbonate, chloride, sulphate, nitrate, sodium, potassium, calcium and magnesium, all of which carry an electrical charge (DWAF, 1996). Many organic compounds dissolved in water do not dissociate into ions (ionise), and consequently they do not affect the EC (DWAF, 1996). Electrical conductivity (EC) is a rapid and useful surrogate measure of the Total Dissolved Solids (TDS) concentration of waters with a low organic content (DWAF, 1996). For the purpose of interpretation of the biological results collected during the survey, the TDS concentrations were calculated by means of the EC using the following generic constant (DWAF, 1996):

TDS (mg/ℓ) = EC (^{m}S/m at 25 °C) x 6.5

If more accurate estimates of the TDS concentration from EC measurements are required then the conversion factor should be experimentally determined for each specific site and for specific runoff events (DWAF, 1996). According to Davies & Day (1998), freshwater organisms usually occur at TDS values less than 3000 mg/ℓ. Most of the macro-invertebrate taxa that occur in streams and rivers are sensitive to salinity, with toxic effects likely to occur in sensitive species at TDS concentrations > 1000mg/ℓ (DWAF, 1996). According to the South African Water Quality Guidelines for Aquatic Ecosystems, the TDS concentrations should not be changed by > 15 % from the normal cycles of the water body under unimpacted conditions at any time of the year (DWAF, 1996).

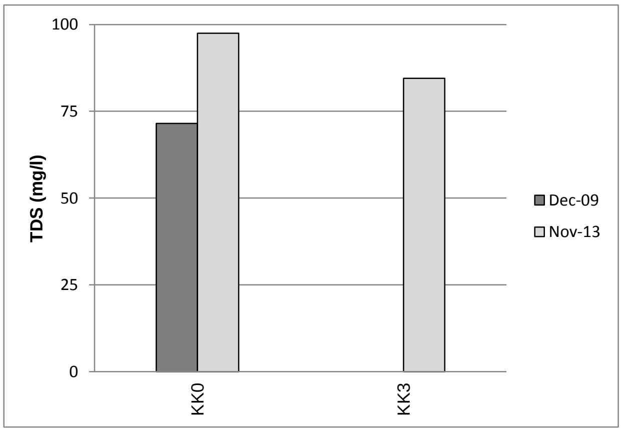

Figure 5: TDS concentrations recorded for the proposed Belfast Coal Mine Project

The TDS concentrations were low within the project area during the November 2013 survey (Figure 5 and Table 9). The TDS concentrations decreased in the Klein Komati River in a downstream direction (Figure 5).

5.1.3 Dissolved Oxygen (DO)

The maintenance of adequate Dissolved Oxygen (DO) is critical for the survival and functioning of aquatic biota as it is required for respiration by all aerobic organisms. Therefore, DO concentration provides a useful measure of the health of an ecosystem (DWAF, 1996). The median guideline for DO for the protection of aquatic biota is > 5 mg/ℓ (Kempster *et. al*., 1980). The amount of oxygen that can be dissolved in water is influenced by the temperature, as the temperature of the water increases, so the concentration of dissolved oxygen decreases (Davies & Day, 1998).

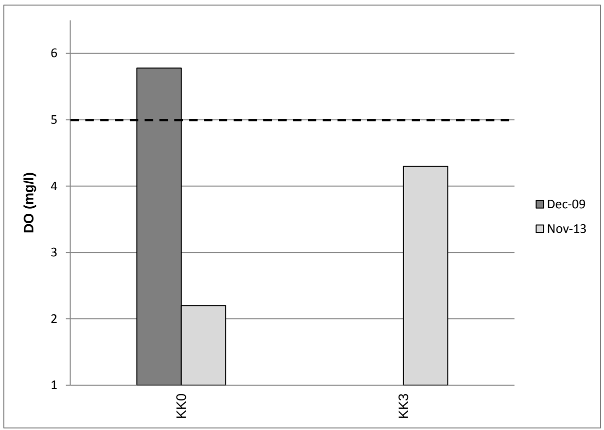

Figure 6: DO concentrations recorded for the proposed BelfastCoal Mine Project (dashed lines indicate guideline values)

The DO concentrations recorded along the Klein Komati River during the November 2013 survey were measured below the guideline concentration of 5mg/ℓ (Figure 6 and Table 9). The lowest value was recorded at site KK0 which was indicative of poor aeration of the water column which could be a result of the lack of riffle type habitat. The DO at site KK0 in December 2009 fell within guideline values with no limiting effects (Table 9). This change in DO values may be due to a difference in rainfall and associated surface runoff at the time of each survey.

5.1.4 Water Temperature

Water temperature plays an important role in aquatic ecosystems by affecting the rates of chemical reactions and therefore also the metabolic rates of organisms (Davies and Day, 1998). Temperature affects the rate of development, reproductive periods and emergence time of organisms (Davies and Day, 1998). Temperature varies with season and the life cycles of many aquatic macro-invertebrates are cued to temperature (Davies and Day, 1998).

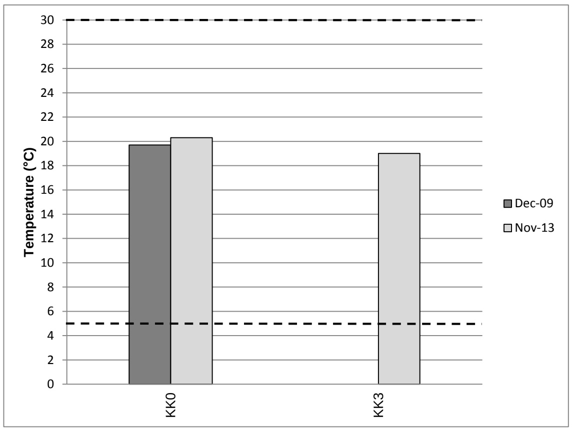

Figure 7: Water temperatures for the proposed Belfast Coal Mine Project (dashed lines indicate upper and lower guideline values)

The water temperatures measured during the field survey were considered to be normal for these systems at that time of the year and would not have a limiting effect on aquatic biota (Figure 7 and Table 9).

5.2 Habitat Assessment

5.2.1 Resource Utilization and Site Specific Impacts

Whilst on site, surrounding impacts and utilisation of resources were noted. As the study area falls within an economic hub for agricultural and mining activities, there are a range of anthropogenic impacts on the Klein Komati River and its adjoining tributaries. Impacts noted along the rivers are associated with agricultural and mining activities.

Due to the agricultural activity within and surrounding the project area, roaming cattle are a concern as overgrazing and trampling is evident. The overgrazing of the ground cover results in higher runoff velocities that mobilize particulates and result in erosion. In addition the desiccation of the wetland areas and bank erosion is of concern.

Upstream at site KK0, water lilies, *Nymphaea spp.* were observed.

Figure 8: Nymphaea spp. (water lily) at site KK0

5.2.2 General Habitat Characterization

In addition to taking note of site specific impacts, habitat characteristics were documented, as species composition is largely driven by the habitat and thus influences the biological results collected.

The substrate of a river is defined by the organic and inorganic materials making up the river bed. The inorganics include a range of sizes, from fine silts / sands, through gravels and pebbles to boulders and bedrocks. The organic materials are dominated by leaf litter, aquatic plants and wooded debris. The velocity of the water, determined by gradient erodes and deposits the different materials to form a heterogenic substrate or habitat.

Substrate heterogeneity is an important factor in determining both abundance and diversity of biota, with more stable substrate showing higher diversity and abundances (CBD, 2012). As particle size increase, so does physical complexity, so clay or sandy substrates would be considered poor due to their instability, whereas cobbles and rocks would be more stable. A mixed substrate would obviously be the best with a variety of habitats and microflow patterns available for different biota.

Table 10 provides a summary of the habitats types present at each site that would contribute to the findings in the subsequent sections. It must be noted that habitat types vary seasonally and thus this table illustrates those observed during this survey (wet season).

Table 10: Habitat descriptions

Characteristics	KK0	KK3
Width (m)	3-5	3-5
Depth (m)	1	1
Flow characteristics	None	Moderate
Gravel, Sand and Mud (GSM)	√	√
Vegetation	√	√
Stones	x	√
Riparian vegetation	Shrubs, grasses and *Salix spp.* (I[1] + E[2])	Shrubs and grasses (I)
Algae present	√	√

The width and depths are approximations
[1] *Indigenous vegetation;* [2] *Exotic vegetation*

5.2.3 Integrated Habitat Assessment System

The IHAS was developed by McMillan (1998) for use in conjunction with aquatic macro-invertebrate indices namely the SASS5 protocol. The November 2013 IHAS results are provided in Table 11. The table indicates the scores calculated in obtaining the final IHAS score as well as a bar graph of the normalised percentage contribution per biotope. This allows one to breakdown the IHAS score into what biotopes were the most and least prominent as well as look between sites at what contribution the biotopes added to the final score.

Based on the IHAS results, vegetation (VEG) and gravel, sand and mud (GSM) were the main biotopes present within the system. Stream bed composition is one of the most important physical factors controlling the structure of a freshwater invertebrate community (Mackay and Eastburn, 1990). Physical stream condition and other habitats / general biotopes are also important factors to consider.

Habitat availability at the upstream site was **Poor** compared to **adequate** habitat availability downstream at site KK3 (Table 11). The adequate habitat availability at the downstream site was largely attributed to the Stones-In-Current (SIC) habitats, compared to the upstream site, which was pooled and lacked SIC. Furthermore, there was more flow observed at the downstream site (KK3).

Table 11: IHAS scores calculated during the December 2009 and November 2013 survey

Site	December 2009		November 2013	
	IHAS Score	Description	IHAS Score	Description
KK0 (KS21)	44	Poor	50	Poor
KK3	-	-	60	Adequate

- No data available

5.3 Aquatic Macroinvertebrates

A summary of the SASS5 results recorded during the November 2013 survey is presented in Table 12.

During the survey, a total of 37 taxa were sampled (21 and 31 at site KK0 and KK3 respectively) (APPENDIX B). The increasing trend in both the SASS5 and ASPT scores in a downstream direction is largely attributed to enhance flow conditions and the presence of SIC habitat. Typically, the more sensitive taxa (ie. Mayflies) are adapted to flowing waters and SIC habitats.

The ASPT scores provide an indication of the average tolerance / intolerance of the aquatic macro-invertebrate community at each site. Furthermore, it is often used to compare sites which may have different physical attributes, such as habitat and flow. In this case, the ASPT scores indicated that the aquatic macro-invertebrate communities along the Klein Komati were primarily composed of tolerant (1 – 5) to moderately tolerant (6 - 10) taxa (Dickens & Graham, 2002) (Table 12).

Table 12: SASS5 results obtained from the December 2009 and November 2013 surveys

Site	December 2009			November 2013		
	SASS5	No. of Taxa	ASPT*	SASS5	No. of Taxa	ASPT*
KK0 (KS21)	90	17	5.3	87	21	4.1
KK3	-	-	-	189	31	6.1

**ASPT – Average score per taxon*; - No data available

5.3.1 Biotic Integrity based on SASS5 results

An evaluation of the SASS5 and ASPT scores obtained during the November 2013 survey showed that site KK3 had a higher SASS5 and ASPT score with a higher diversity of taxa when compared to site KK0 (Table 12). The lower ASPT score recorded at site KK0 may be attributed to the very low DO value recorded during the November 2013 survey (Table 9). Site KK0 scored a Class B for both the December 2009 and November 2013 surveys showing little modification in overall SASS5 score (Table 12 and Table 13). Site KK3 scored a Class A showing an excellent biotic integrity (Table 13).

Table 13: Biotic integrity based on SASS5 results

Site	December 2009		November 2013	
	PES* Class	Description	PES* Class	Description
KK0 (KS21)	B	Very Good	B	Very Good
KK3	-	-	A	Excellent

* PES (Present Ecological Status); - No data available

5.4 Ichthyofauna

A total of two fish species were recorded out of the 13 fish species expected in the project area during the November 2013 survey (Table 14). *Barbus anoplus* (Chubbyhead Barb) was the most abundant species being recorded at both sites sampled (Table 14 and Figure 9). In addition, the sensitive and rheophilic fish species, *Chiloglanis pretoriae* (Shortspine Suckermouth / Rock Catlet) was also sampled but only at the downstream site (KK3) (Table 14 and Figure 10). This species is considered to be a useful indicator species in studies on river conservation (Skelton, 2001). The presence of the *C. pretoriae* (Shortspine Suckermouth / Rock Catlet) in the Klein Komati River is of significance as it is an indicator of good water quality and habitat integrity (Skelton, 2001). However, should any instream disturbance occur, namely elevated turbidity levels, this species is unlikely to persevere as its habitat will be directly impacted upon by sedimentation. Furthermore, *Pseudocrenilabrus philander* (Southern Mouthbrooder) was previously recorded in low abundance at site KK0 during the December 2009 survey but was not recorded during the November 2013 survey (Table 14).

Table 14: Fish species recorded during the December 2009 and November 2013 surveys

Species	Common name	IUCN Status	Intolerance Rating	December 2009		November 2013	
				KK0 (KS21)	KK3	KK0 (KS21)	KK3
Barbus anoplus	Chubbyhead Barb	Least Concern	2.6	2	-	68	22
Chiloglanis pretoriae	Shortspine Suckermouth (Rock Catlet)	Least Concern	4.6	0	-	0	43
Pseudocrenilabrus philander	Southern Mouthbrooder	Unlisted	1.3	2	-	0	0
Number of individuals				**4**	**-**	**68**	**65**
Number of species				**2**	**-**	**1**	**2**

- No data available

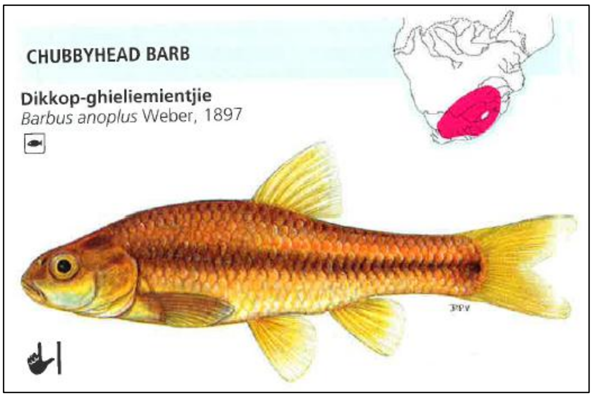

Figure 9: Barbus anoplus (reproduced from Skelton, 2001)

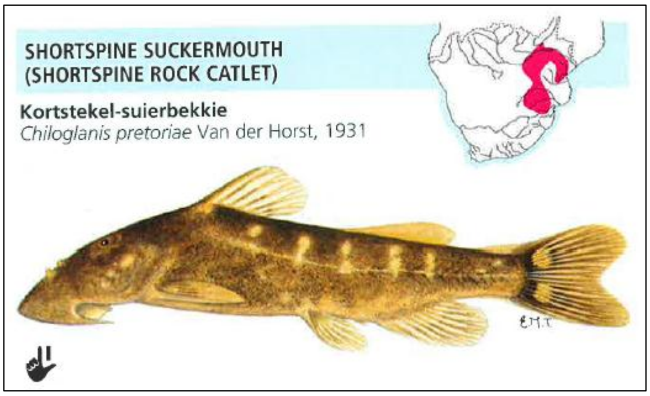

Figure 10: Chiloglanis pretoriae (reproduced from Skelton, 2001)

5.4.1 Intolerance Ratings

Barbus anoplus is considered to be moderately tolerant to a wide variety of habitats, modified flow conditions and water quality impairment. *Chiloglanis pretoriae* is considered intolerant of habitat and flow modification and water quality impairment (Table 14). As mentioned above, the presence of *C. pretoriae* in the Klein Komati River at site KK3 shows that this section of river is in a good state with minimal disturbance.

5.4.2 Fish Assemblage Integrity Index (FAII)

The interpretation of the FAII scores follows a descriptive procedure into which the FAII score is allocated into a particular class (Table 15). The PES classes for each of the sites are presented in Table 15.

Table 15: Present Ecological State (PES) Classes recorded during the November 2013 survey

Site	Relative FAII Score	Class Rating	Description
KK0	16	F	Critically Modified
KK3	30	E	Seriously Modified

Based on the FAII results biotic integrity throughout the project area ranged from *Seriously* to *Critically Modified* (PES Class E to F) (Table 15). Site KK0 was critically modified with only one recorded fish species. This may be attributed to the low DO recorded at this site but also due to the site being located high up in the catchment area where there is limited riffles and habitat availability. The biotic integrity at site KK3 was *seriously modified* despite recording *C. Pretoria*, a good indicator species. However, the low biotic integrity recorded is primarily due to low fish diversity, in comparison to the number of fish species essentially expected in the project area (Table 3 and Table 15)

5.5 Summary of aquatic assessment results

A summary of the habitat and biological indices per site is displayed in Figure 11. The habitat and biological indices are rated as per the indices described in this report. The water quality was based on a professional opinion where the four *in situ* parameters (pH, DO, EC/TDS and Temperature) were evaluated according to whether they met the South African water quality guideline values or not. Additional visual observations in terms of algal blooms, flow or observed pollutant sources were also included to give an overall professional and specialist opinion on the baseline state of the *in situ* water quality. The ratings were made according to Table 16.

Table 16: *In situ* water quality baseline state interpretation classes

Interpretation of *in situ* water quality parameters	
Class	**Class description**
Natural	As close to natural conditions as possible
Good	Above or within guideline values/ranges - optimal
Fair	Close to or at the limit of guideline values/ranges, but sub-optimal
Poor	Below or exceeding guideline values or ranges – non optimal

A summary of the *in situ* water quality baseline state of the aquatic ecosystems is shown in Table 17.

Table 17: Summarized *in situ* water quality baseline state of the in-stream sites, based on individual *in situ* water quality parameters as well as additional water quality impacts observed at the sites in November 2013

Site	***In situ* parameter baseline state**				**Additional Impacts**	***General site baseline state for *in situ* water quality**
	pH	**DO**	**TDS**	**Temp.**		
KK0	Good	Poor	Natural	Natural	Fair	Fair
KK3	Fair	Poor	Natural	Natural	Fair	Fair

DO: Dissolved Oxygen; DO%: Saturation Percentage; TDS: Total dissolved solids; Temp.: Temperature

*Should there be more than one poor variable, this will equate to the general site baseline state for *in situ* water quality being poor.

Refer to Figure 11 which illustrates a summary of the *in situ* water quality and biotic integrity in the project area. The downstream site KK3 on the Klein Komati River indicates fair *in situ* water quality, adequate habitat availability, an excellent aquatic macro-invertebrate community (Class A) and a low fish diversity (Class E – seriously modified). This low fish score may not be a true reflection of the actual fish community present at this site, due to the abundance of different habitats that usually supports a large diversity of fish species. Site KK0, the upstream site situated just downstream of the mining rights area, experienced fair *in situ* water quality and a very good aquatic macro-invertebrate community while the habitat availability and fish community (Class F – critically modified) was poor. These lower scores found at site KK0 demonstrates that there may be cumulative impacts within the study area contributing to the poor health and integrity of the Klein Komati River.

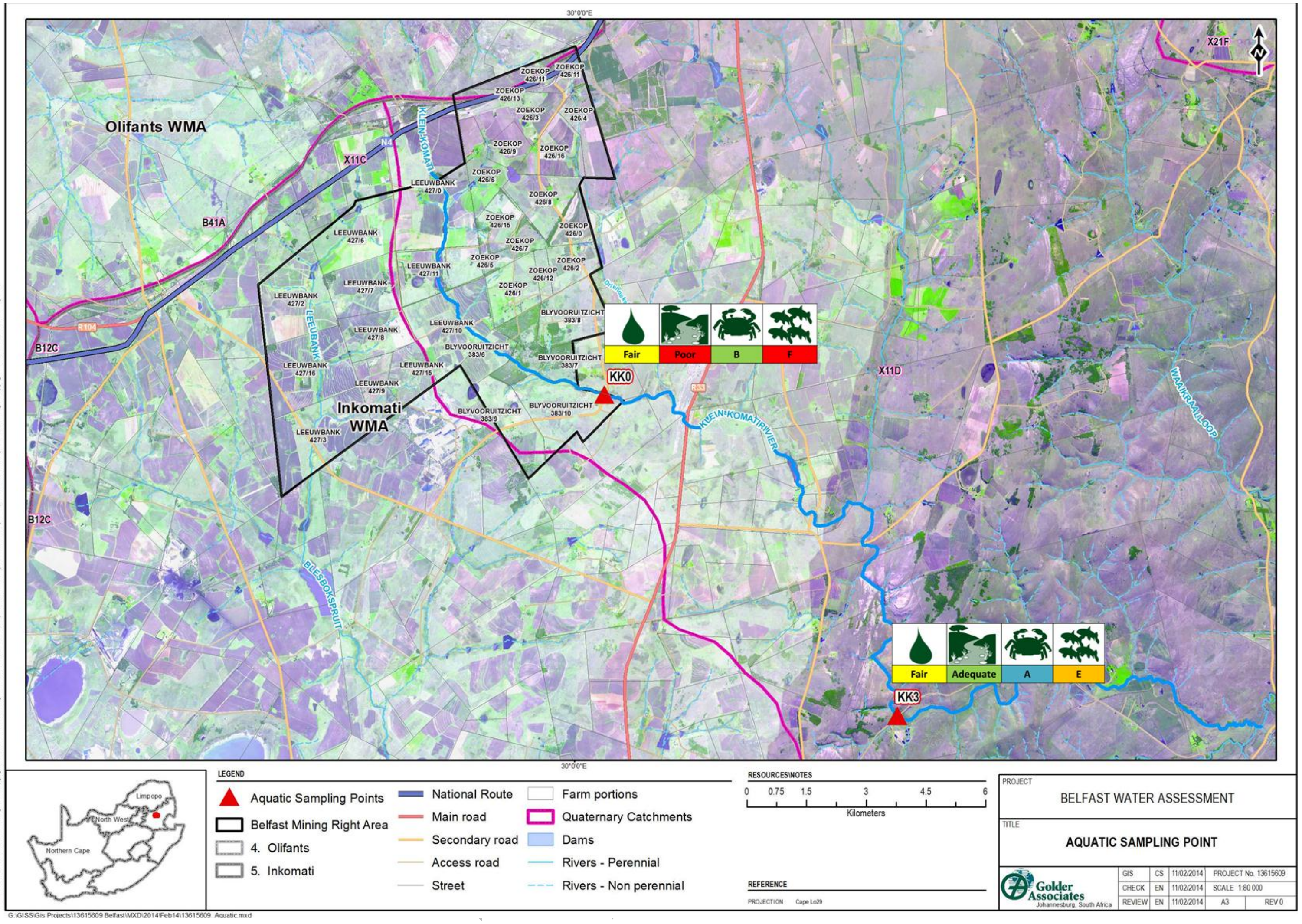

Figure 11: Summary of the habitat and biological indices per site

6.0 IMPACT RISK ASSESSMENT

Below are the identified potential Impacts associated with the discharge of a maximum of 4 Ml of treated water per day from the proposed Belfast Coal Mine's WWTP into the downstream wetlands and Klein Komati River.

6.1 Impact 1: Degradation of biotic integrity due to modification of water quality

Changes to the water quality could result in changes to the ecosystem structure and function and could result in a loss of biodiversity (Davies & Day, 1998).

However, the proposed Belfast Coal Mine Complex primary aim is to ensure that the quality of the proposed treated water to be discharged into the aquatic environment, is within the South African Fresh Water Quality Guidelines for Aquatic Ecosystems (DWAF, 1996; Volume 7). Consequently, this will ensure that the quality of the treated water to be discharged will be equivalent to the baseline water quality pre-development.

The impacts on water quality may occur due to the interaction of onsite activities with the wetlands, the upper catchments, headwaters and tributaries of the Leeuwbankspruit and the Klein Komati Rivers. These effects may be transferred downstream outside of the project area.

As the primary aim of the mine is to ensure that the quality of the water to be discharged into the aquatic environment be retained within the South African Fresh Water Quality Guidelines for Aquatic Ecosystems (DWAF, 1996; Volume 7), the impact will be insignificant. The magnitude of the impact will be low based on a medium-term duration, on a local scale with a medium probability (Table 18).

6.2 Impact 2: Degradation of biotic integrity due to increased sedimentation

The habitat availability and the quality thereof, are major determinants of the aquatic community structure. Changes in the biological community in a river may be linked to changes in water quality, habitat or both.

As a maximum of 4ML of treated water is proposed to be discharged into the Klein Komati River system on a daily basis, although it is a diminutive volume (equivalent to 0.046 m^3/s (Golder report number: 13615609 - 12625 – 2)), it may still lead to some sediment loading in the water column resulting in increased turbidity. This suspended matter, which may include clay, silt, dissolved organic and inorganic matter, plankton and other microscopic organisms, causes the water to appear turbid (Davies and Day, 1998). Suspended matter can result in harmful impacts to aquatic biota and their habitats. These impacts include *inter alia* as per Larkin *et. al.,* 1998:

- Clogging and abrasion of the gills of fish and invertebrates. The clogging of gills impedes oxygen exchange;
- Behavioral changes such as limited movement and migration;
- Decreased resistance to disease;
- Habitat smothering and destruction for bottom dwelling aquatic macroinvertebrates which fish rely on for food;
- The turbidity interferes with the feeding habits of fish species who rely visually on finding their food source;
- Poor egg development;
- Potential increase in EC and TDS;

- Fluctuation changes in the pH values; and
- Fluctuations in the surface water quality monitoring parameters.

These impacts may lead to a reduction in biotic diversity and result in a system dominated by tolerant species (Davies and Day, 1998).

This impact will be low due to the insignificant volume of discharge into the river. Following mitigation measures, the magnitude of the impact was rated as low based on a medium-term duration, on a local scale with a medium probability.

6.3 Impact 3: Change to natural flow regime

The alteration of flow regimes is often claimed to be the most serious and continuing threat to ecological sustainability of rivers and their associated floodplain wetlands (Bunn and Arthington, 2002). Flow modifications within a river may have several effects on the aquatic biota found within these systems. Firstly, flow is a major determinant of physical habitat, which in turn is a major determinant of biotic community structure. Secondly, aquatic species have evolved life history strategies primarily in direct response to the natural flow regimes; thirdly, the invasion and success of exotic species in rivers is facilitated by the alteration of flow regimes (Poff and Ward, 1990; Bunn and Arthington, 2002).

Confirmed by the surface water report (Golder report number: 13615609 - 12625 – 2) the peak flow for the Klein Komati catchment for the 1 in 50 year flood event is 102.84 m^3/s and for the 1 in 100 year the peak flow event is 120.82 m^3/s. Therefore, the flow velocity will only increase by an additional 0.046 m^3/s per day. This may consequently result in a slight increase in water levels and flow dynamics. However, this increase is not significant and thus should not alter the ichthyofauna and aquatic macro-invertebrate communities, if anything, it may benefit the fish species *C. pretoriae* which tolerate medium to fast flow velocities. Conversely, the increased water velocity may result in localized erosion and scouring of the aquatic ecosystems if not designed adequately or the discharge point incorrectly located along the river reach.

The proposed discharge of a maximum volume of 4ML of treated water into the Klein Komati River may result in a slight increase in the flow dynamics in the river, on a localised scale with a medium probability, despite mitigation measures being implemented. Discharge points have been recommended for the proposed project, which includes one along the Klein Komati River and within the wetland system located within the project area.

6.4 Impact 4: Alteration to habitat availability

As a maximum of 4ML is proposed to be discharged into the Klein Komati River from the WWTW from the proposed Belfast Coal Mine, which may either result in a loss of in-stream habitats by covering some of the exposed riffle and rocky areas. Alternatively, it may be a benefit primarily to the ichthyofauna community, particularly *Chiloglanis pretoriae,* which a good indicator species of good water quality which favours faster velocity flowing waters.

The discharge of 4ML of treated water per day into the river system may slightly alter the flow dynamics however, an additional 0.046 m^3/s is minimal and thus habitat alteration will be limited. The impact will be low, following the implementation of the mitigation and management measure (Table 18).

6.5 Impact 5: Loss of species diversity and abundance due to decreased water quality and habitats

As the proposed Belfast Coal Mine aims to ensure the quality of the treated water to be discharged into the Klein Komati River is within the South African guidelines for aquatic ecosystems (DWAF, 1996), there could still be a potential impacts on the aquatic macroinvertebrate and ichthyofaunal community and habitat availability from this activities. Loss or reduction of habitats may occur. Certain habitats that are colonised by certain aquatic macroinvetbrates or utilised for refuges for some fish species may get sediment deposited over them (stones, gravel, aquatic macrophytes and marginal vegetation), or riffle areas covered as a result of the additional influx of treated water. However, alternatively, the additional discharge may create better habitats for some ichthyofauna species, namely *C. pretoriae,* which favours faster velocity flowing waters.

An additional 0.046 m^3/s will not transform the river reach but rather result in a slight increase in flow velocity (Table 18). Therefore, this impact will be moderate following the implementation of mitigation measures.

6.6 Cumulative Impacts in the Study Area

An assessment of the cumulative impacts was conducted. The primary activities within the study area encompass other existing mining activities of other companies namely, Anglo American, as well as the proposed Belfast Coal Mine and the proposed adjacent Eerstelingsfontein mine. Agricultural activates further make up the catchment activities within the study area. All of these activities *are currently* placing stress on the aquatic environment. Consequently, the cumulative impact from existing agriculture impacts, surrounding mining activities, including the proposed discharge activity of a maximum volume of 4ML into the aquatic ecosystem, may lead to:

- Increased erosion, flooding, sedimentation and bank instability;
- Fluctuations in *in situ* water quality parameters;
- Fluctuations in surface water monitoring parameters; and
- Habitat availability alteration.

Therefore, the additional discharge activity within the project and largely catchment area, may contribute to the already existing cumulative impacts on this river system, despite the impacts from this project being insignificant (Table 18).

Table 18: Impacts for the operational phase in the project area

Discussion	Rating before Mitigation (RBM) Rating After Mitigation (RAM	Significance Score					
		Magnitude	Duration	Spatial Scale	Probability	Total	Significance
Degradation of aquatic ecosystems due to decreased water quality impacts							
Subsequent to the discharge of approximately 4ML of treated water per day into the Klein Komati River, fluctuations in the *in situ* water quality parameters most likely will occur. This may potentially have impacts on the aquatic ecosystem biotic communities and vegetation. Further impacts that may arise as a result of the discharge may include fluctuations in some water quality parameters.	RBM	10	5	3	3	**54**	**Moderate**
	RAM	4	3	2	3	**27**	**Low**
Degradation of aquatic ecosystems due to increased sedimentation							
The discharge of 4ML of treated water per day into the Klein Komati River may result in some sediment loading in the water column causing an increase in turbidity, which may be harmful to the aquatic biota within the river system.	RBM	8	4	3	4	**60**	**Moderate**
	RAM	4	3	2	3	**27**	**Low**
Change to natural flow regime							

Discussion		Significance Score					
	Rating before Mitigation (RBM) Rating After Mitigation (RAM	Magnitude	Duration	Spatial Scale	Probability	Total	Significance
As 4ML of effluent is proposed to be discharged into the Klein Komati on a daily basis, the flow velocity will only increase by an additional 0. 046 m^3/s per day. This may consequently result in a slight increase in water levels and flow dynamics thus altering both the ichthyofauna and aquatic macroinvertebrate communities along the river reach. The increased water levels and flows may result in localized erosion and scouring of the aquatic ecosystems if not designed adequately or the discharge point incorrectly located along the river reach.	RBM	6	5	2	4	**52**	**Moderate**
	RAM	4	4	1	3	**27**	**Low**
Alteration to habitat availability							
The discharge of 4ML of treated water per day into the river system may slightly alter the flow dynamics. However, an additional 0.046 m^3/s is minimal.	RBM	8	4	2	4	**56**	**Moderate**
	RAM	4	3	1	2	**16**	**Low**
Ultimately loss of biota and biodiversity due to decreased water quality and habitats							
The proposed discharge of treated water into the river system, although kept within the guideline values for aquatic ecosystems, may	RBM	8	4	3	4	**60**	**Moderate**

Discussion	Rating before Mitigation (RBM) Rating After Mitigation (RAM	Significance Score					
		Magnitude	Duration	Spatial Scale	Probability	Total	Significance
still have a potential impact on the aquatic macroinvertebrates, ichthyofaunal community and habitat availability	RAM	4	3	2	3	**27**	**Low**
Cumulative Impact							
The study area encompasses the existing mining footprint of the proposed Belfast Coal Mine, as well as adjacent coal mines, as well as extensive agricultural activities. All of these activities are currently placing stress on the aquatic environment	RBM	8	5	4	4	**68**	**Moderate**
	RAM	6	3	2	3	**33**	**Low**

7.0 MITIGATION AND MANAGEMENT MEASURES

It is imperative that the appropriate mitigation measures, concerning the aquatic environment, be implemented. The subsequent section provides the recommended discharge points along the Klein Komati River and within the wetland system.

Table 19 further provides mitigation and management measures for the major impacts as a result of the proposed discharge of treated water into the aquatic environment. In addition to the mitigation and management measures, performance criteria and monitoring / measuring tools have been included.

7.1 Recommended Discharge Points

Discharge points have been recommended for the proposed release of a maximum volume of 4ML of treated water into the aquatic environment in the project area.

7.1.1 Klein Komati River

One of the discharge points recommended is positioned on the Klein Komati River at a point located upstream from monitoring site KK0. The co-ordinates of this proposed discharge point are 25°49'15.95"S, 29°59'7.57"E (Figure 13).

This section of the river reach is characterised by rocky, riffle and a deep water area, which consist of water flowing over coarse material and creating a turbulent surface. Furthermore, this point was recommended as it has the highest flow velocity rates compared to the rest of the river reach at 3.6m/s (Golder report number: 13615609 - 12625 – 2). Therefore, this section of the Klein Komati River is tolerant of such flow velocities and will further aid in dissipating the energy and avoid localised erosion.

As rivers are channelized, diverted, straightened and corseted in levees, with little or no thought for river dynamics and biodiversity preservation, it is recommended that a stilling basin be constructed at this discharge point (Figure 12) (Golder report number: 13615609 - 12625 – 2). This structure will control the velocity of the effluent being discharged into the Klein Komati River and thus avoid altering the flow regime of the river system. The stilling basin will be designed in such a way as to:

- Dissipate the energy contained in the rushing effluent in the concrete stilling basin, a phenomenon known as hydraulic jump, prior to flowing into the Klein Komati River;
- Minimise localised erosion; and
- Provide flood protection.

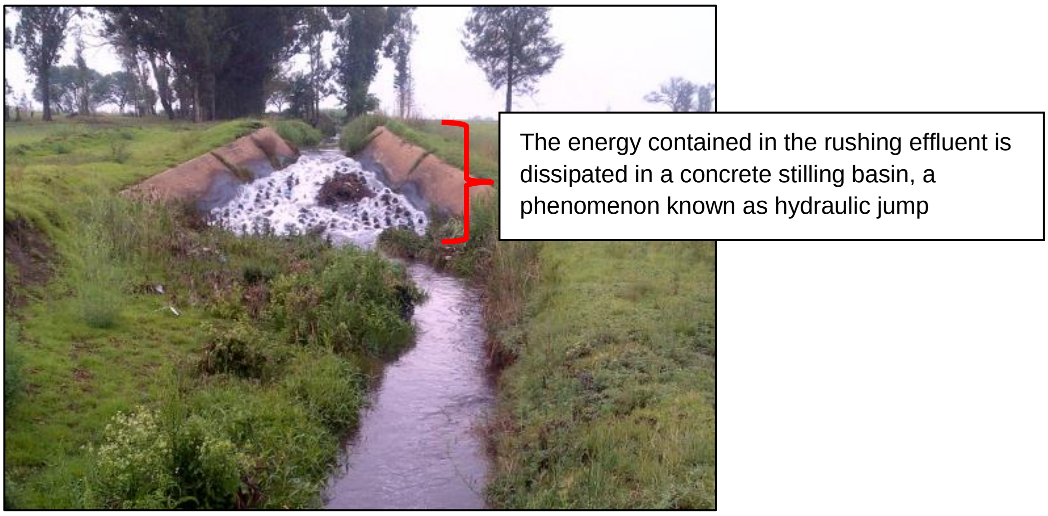

Figure 12: Illustration of a stilling basin

7.1.2 Wetland Systems

It is recommended that multiple discharge points be considered in the different wetland sections, rather than a single discharge point. This to regain wet area / additional wetland conditions at the different wetland sections and thus increases overall wetland areas.

Refer to Figure 13 which illustrates the two discharge points within the wetland system. The co-ordinates are as follows in accordance to Figure 13:

- Wetland 1: 25°47'58.23"S, 29°57'55.11"E; and
- Wetland 2: 25°48'42.30"S, 29°58'15.17"E.

These points were recommended to increase the wetland area and improve functionality. It is further suggested that the existing attenuation facilities are used, namely the existing dams within the valley bottom system, associated with the Klein Komati River, as entrance points. This is due to these dams providing additional attenuation capacity and reducing both hydrological and geomorphological impacts on the remaining wetland system (i.e. erosion and flow confinements). As part of the offset strategy development for the proposed Belfast Coal Mine Project by Wetland Consulting Services, it was recommended that within these dams, the spillways should be redesigned and / or removed to allow for hydrological connectivity to downstream areas (WCS report/reference no. 01011/2013). However, with an additional 4ML of treated water being discharged, it is further suggested that, in addition to using these dams as recommended, they are further redesigned within multi spillways across dam walls. This will further ensure even distribution of water downstream across the entire wetland areas.

In addition and similar to the above, it is recommended that rock packed stilling basins, with energy dissipaters, be constructed below the spillways. These will subsequently enhance diffuse flow and reduce erosion downstream. They will further encourage even distribution of water and increase the gains in terms of downstream wetland areas referred to Figure 14 indicating anticipated flow patterns after full implementation. Please refer to the WCS report/reference no. 01011/2013 for further mitigation and management measures from a wetland perspective.

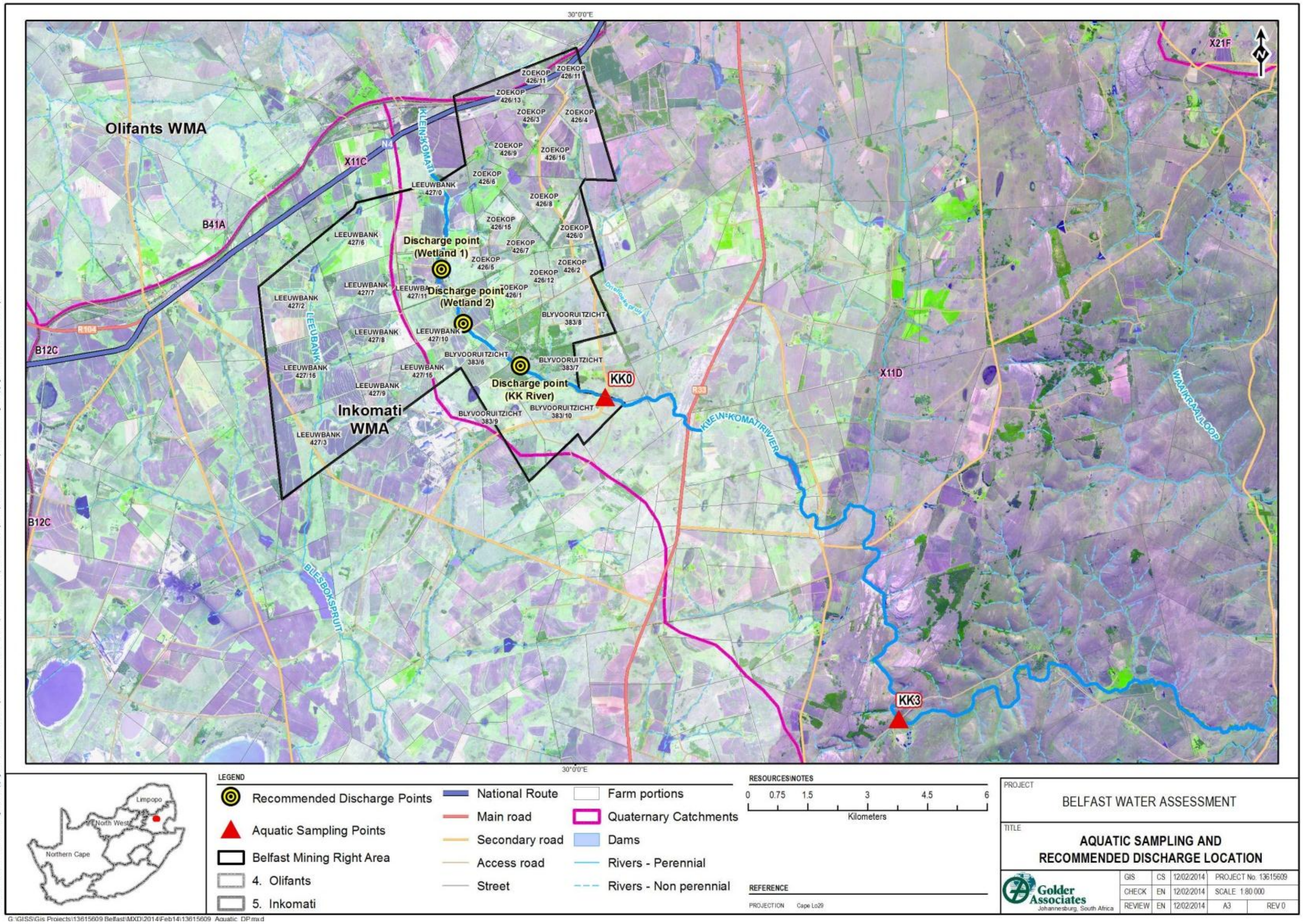

Figure 13: Recommended discharge point along the Klein Komati River and wetland systems

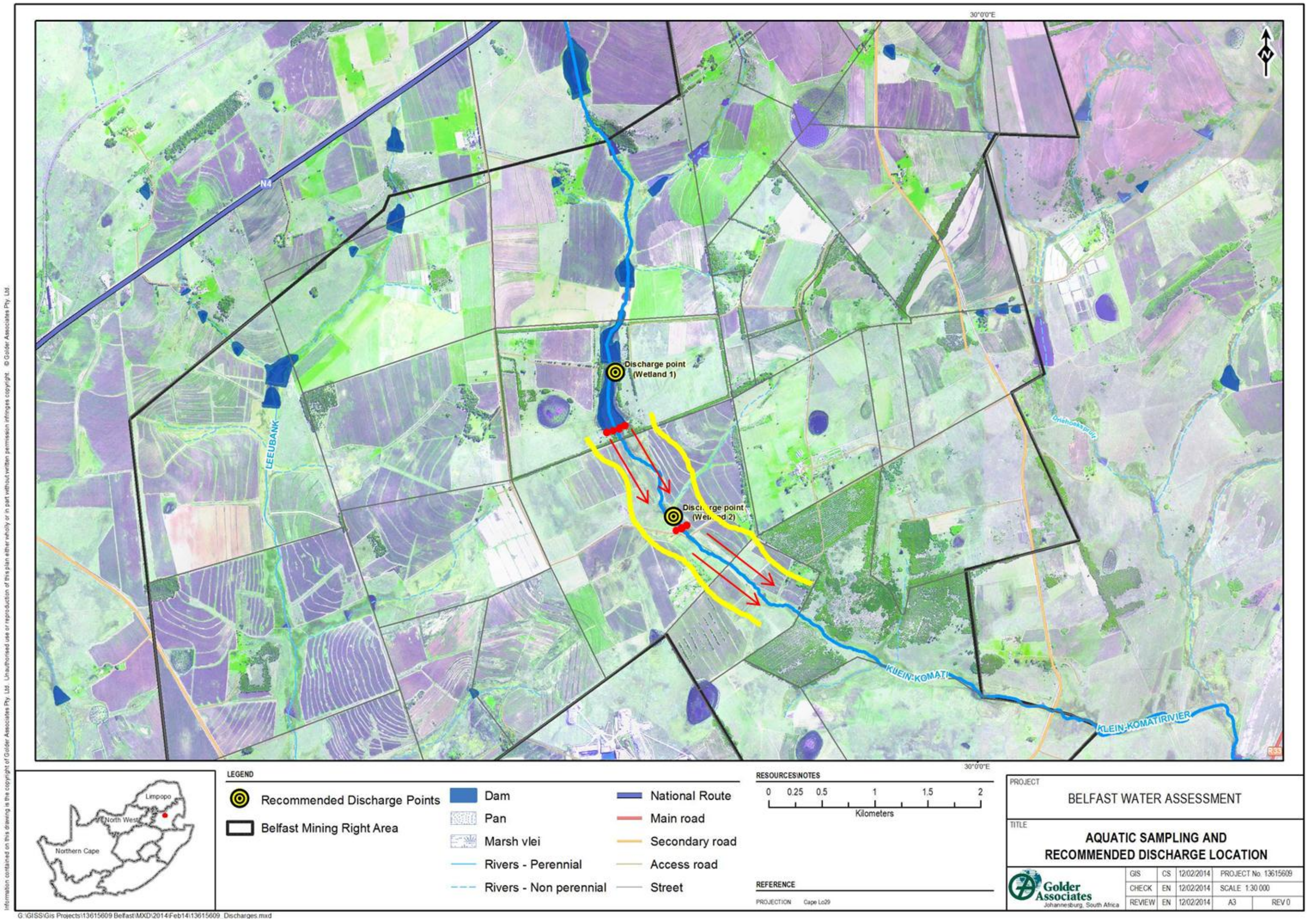

Figure 14: Anticipated flow patterns in the wetland system

Table 19: Recommended mitigation and management measures

Recommended Mitigation and Management Measures		**Responsibility**
Objective	**Implement mitigation and management measures with the aim to prevent potential reduction to the ecological integrity of aquatic ecosystem in the project area**	
Mitigation measure(s):	■ **None:** ■ Impacts to the water quality will be greatest, with further knock-on impacts on the aquatic habitats and aquatic biota. This will be the case should the quality of the treated discharged water not be within the South African Fresh Water Quality Guidelines for Aquatic Ecosystems (DWAF, 1996; Volume 7). ■ **Avoidance:** ■ All vital in-stream habitats must be identified and subsequently protected from any negative impacts as a result of the discharge of treated water of 4Ml/day. ■ **Minimization:** ■ Three discharge points have been recommended for the proposed project. Refer to Section 7.1 above: ■ One point located along the Klein Komati River where the flow velocity is at its highest; and ■ Multiple discharge points have been recommended within the different wetland sections, as compared to a single discharge point. This to regain wet area/ additional wetland conditions at the different wetland sections and thus increase overall wetland areas" ■ **Rectification:** ■ Rehabilitate any bank disturbances / erosion; ■ Large-scale impacts to specific breeding habitats must be rectified by rehabilitation of the altered of lost habitat in critical areas of the aquatic ecosystems; and ■ New habitat equilibrium will result due to shifts in habitat availability however, large-scale impacts to specific habitats must be rectified by rehabilitation of the altered or lost habitat in critical areas of the aquatic ecosystems. ■ **Reduction:** ■ Large-scale impacts to specific habitats (especially breeding, spawning and critical life-stage habitats) must be rectified by rehabilitation of the altered or lost habitat in critical areas of the aquatic ecosystems. ■ **Compensation:** N/A	■ Exxaro Belfast Coal Mine Environmental Manager
Performance Criteria and Monitoring/Measurements		

Recommended Mitigation and Management Measures		Responsibility
Objective	**Implement mitigation and management measures with the aim to prevent potential reduction to the ecological integrity of aquatic ecosystem in the project area**	
Performance criteria	■ Conformance with the South African Fresh Water Quality Guidelines for Aquatic Ecosystems (DWAF, 1996; Volume 7); and ■ Analyse the water quality against baseline data from previous surveys. This will ensure that the proposed Belfast Coal Mine is achieving their goal of retaining the water quality of the Klein Komati as per the pre-development stage.	

Monitoring/ Measurement	■ A biomonitoing plan should be implemented during both the wet and dry seasons for the proposed discharge project and must include the following:
	    ■ Monitor the *in situ* water quality;
	    ■ Monitor the habitat availability and species (fish and aquatic macroinvertebrates) communities and composition of the riparian, marginal vegetation and aquatic macrophytes within the project area;
	    ■ Habitat availability of the fish within the project area; and
	    ■ Flow regime and habitat availability of fish species within the project area.
	  ■ Water quality from the proposed 4.0 ML discharge from the mine into the Klein Komati River should be routinely monitored on a monthly basis; and
	  ■ This monitoring plan must aim to identify any improvements or degradations within the aquatic system and must be reported seasonally.
		■ Exxaro Belfast Coal Mine Environmental Manager
		■ Independent Aquatic Ecologist

8.0 CONCLUSION

From the comparison of the December 2009 and November 2013 surveys on the Klein Komati River the following can be said:

- All *in situ* water quality parameters were shown to fall within guideline values, except for the DO concentration for November 2013 at both sites. These low DO values were the only parameter of concern that may have a limiting effect on the aquatic biota;
- The IHAS results collected during the December 2009 and November 2013 survey, showed the habitat availability for aquatic macroinvertebrates in the Klein Komati River to range from poor to adequate, depending on the biotopes present;
- The SASS5 results showed little variation between the two surveys, with the biotic integrity remaining in a Class B, and being largely natural with minimal modification;
- The ichthyofaunal sampling revealed 2 species, namely *Barbus anoplus* (Chubbyhead Barb) and *Chiloglanis pretoriae* (Shortspine Suckermouth / Rock Catlet) with *B. anoplus* (Chubbyhead Barb) occurring in high abundance during November 2013, while *B. anoplus* (Chubbyhead Barb) and *Pseudocrenilabrus philander* (Southern Mouthbrooder) were found in low abundance in December 2009. *C. pretoriae* (Shortspine Suckermouth / Rock Catlet) *is* a rheophilic species is an indicator of good water quality and habitat integrity. This species was recorded at site KK3 during the November 2013 survey;
- The following impacts identified as a result of the proposed project on the aquatic ecosystem include:
  - Degradation of biotic integrity due to modification of water quality;
  - Degradation of biotic integrity due to increased sedimentation;
  - Change to natural flow regime;
  - Alteration to habitat availability; and
  - Loss of species diversity and abundance due to decreased water quality and habitats.
- None of the identified impacts were rated as significant should the mitigation and management measures be implemented. The recommendations provided will prevent potential reduction to the ecological integrity of aquatic ecosystem in the project area; and
- Discharge points have been recommended for the proposed project:
  - One discharge point is recommended along the Klein Komati River, whereby the flow rate is at its highest along this river reach. Should this point be approved, it is further advised to construct a stilling basin at the discharge point. This structure will control the velocity of the effluent being discharged into the Klein Komati and thus avoid altering the flow regime and consequently the habitat availability within the river system. The stilling basin will be designed in such a way as to:
    - Dissipate the energy contained in the rushing effluent in the concrete stilling basin, a phenomenon known as hydraulic jump, prior to flowing into the Klein Komati River;
    - Minimise localised erosion; and
    - Provide flood protection.
  - Multiple discharge points should be considered in the different wetland sections, as compared to a single discharge point. This to regain wet area / additional wetland conditions at the different wetland sections and thus increases overall wetland areas.

9.0 REFERENCES

ALABASTER, JS. & LLOYD, R. 1982. Water Quality Criteria for Freshwater Fish. Cambridge University Press.

BARBOUR, MT., GERRITSEN, J. & WHITE, JS. 1996. Development of a stream condition index (SCI) for Florida. *Prepared for Florida Department of Environmental Protection: Tallahassee, Florida.*

BOHLIN, T. & SUNDSTROM, B. 1977. *Influence of unequal catchability on population estimates using the Lincoln index and the removal method applied to electro-fishing*. Oikos 28:123–129.

BUNN, SE. and ARTHINGTON, AH. 2002. Basic Principles and Ecological Consequences of Altered Flow Regimes for Aquatic Biodiversity. *Environmental Management*. Vol. 30 (4) pp. 492–507

Conservation of Biological diversity (CBD), 2012. http://www.cbd.int/

CYRUS, DP., WEPENER, V., MACKAY, CF., CILLIERS, PM., WEERTS, SP. & VILJOEN, A. 2000. The effects of Intrabasin Transfer on the Hydrochemistry, Benthic Invertebrates and Ichthyofauna on the Mhlathuze Estuary and Lake Nsezi. *Water Research Commission Report No. 722*, (1): 99. 253.

DALLAS, HF. 2007. River Health Programme: South African Scoring System (SASS) Data Interpretation Guidelines. Report produced for the Department of Water Affairs and Forestry (Resource Quality Services) and the Institute of Natural Resources

DAVIES, B. & DAY, J. 1998*. Vanishing Water*. Cape Town: UCT Press.

DEPARTMENT OF ENVIONMENTAL AFFAIRS AND TOURISM, 2002. Department of Environmental Affairs and Tourism: Specialist Studies, Information Series 4. Pretoria

DEPARTMENT OF WATER AFFAIRS AND FORESTRY. 1996. South African Water Quality Guidelines. Volume 7: Aquatic Ecosystems.

DICKENS, C. & GRAHAM, M. 2002. South African Scoring System (SASS) Version 5. Rapid Assessment Method for Rivers. Umgeni Water.

GERBER, A. & GABRIEL, MJM. 2002. Aquatic Invertebrates of South African Rivers Field Guide. Institute for Water Quality Studies. Department of Water Affairs and Forestry. 150pp.

GOLDER REPORT NUMBER: 11929-8280-1: A terrestrial, wetland and aquatic assessment towards a feasibility study for NBC Belfast. Desktop Study.

GOLDER REPORT NUMBER: 13615609 - 12625 – 2. Surface Water Impact Assessment Report for Belfast Colliery.

HARDIN, S. & CONNOR, LL. 1992. Variability of electrofishing crew efficiency, and sampling requirements for estimating reliable catch rates. *N. Am. J. Fish. Manage.* 12:612–617.

HELLAWEL, JM. 1977. Biological Surveillance and Water Quality Monitoring. In: JS Alabaster (Ed). Biological monitoring of inland fisheries. *Applied Science*, London. Pp 69-88.

HILL, TD. & WILLIS, DW. (1994). Influence of Water Conductivity on Pulsed AC and Pulsed DC Electrofishing Catch Rates for Largemouth Bass. *North American Journal of Fisheries Management.* 14: 202-207.

IUCN (International Union for Conservation of Nature and Natural Resources). 2013.2. Red List of Threatened Species. www.iucnredlist.org

KEMPSTER, PL., HATTINGH, WAJ. & VAN VLIET, HR. 1980. Summarised water quality criteria. *Department of Water Affairs, Forestry and Environmental Conservation*, Pretoria. Technical Report No Tr 108. 45pp.

KENNEDY, GJA. & STRANGE, CD. 1981. Efficiency of electric fishing for salmonids in relation to river width. *Fish. Manage*. 12:55–60.

KILIAN, V., KLEYNHANS, CJ., DU PLESSIS, BJ. & HOFFMAN, AC. 1997. Developing of a Biomonitoring Procedure for Rapid Evaluation of Fish Health Condition, Institute for Water Quality Studies, Department of Water Affairs and Forestry.

KLEYNHANS, CJ. 1996. A qualitative procedure for the assessment of the habitat integrity status of the Luvuvhu River (Limpopo System, South Africa) Journal of Aquatic Ecosystem Health 5:41-54.

KLEYNHANS, CJ. 1999. The development of a fish index to assess the biological integrity of South African rivers. Water SA 25(3):265-278.

KLEYNHANS, CJ, MACKENZIE J & LOUW MD. 2007. Module F: Riparian Vegetation Response Assessment Index in River EcoClassification: Manual for EcoStatus Determination (version 2). *Joint Water Research Commission and Department of Water Affairs and Forestry report*. WRC Report.

LARKIN, GA., SLANEY, PA., WARBURTON, P. and WILSON, AS. 1998. Suspended Sediment and Fish Habitat Sedimentation in Central Interior Watersheds of British Columbia. Watershed Restoration Management Report No. 7.

MACKAY, N. and EASTBURN, D. 1990. The Murry. Imprint Limited, Brisban, Australiaa. 363pp. From Gerber, A. & Gabriel, M.J.M. 2002. *Aquatic Invertebrates of South African Rivers Field Guide. Institute for Water Quality Studies*. Department of Water Affairs and Forestry. 150pp.

MCMILLAN, PH. 1998. An Integrated Habitat Assessment System (IHASv2), for the Rapid Biological Assessment of Rivers and Streams. A CSIR research project, number ENV-P-I 98132 for the Water Resources Management Program, CSIR. Ii+44pp.

NELSON, KL. & LITTLE, AE. 1987. Increasing the effectiveness of electrofishing boats in low conductivity waters. *Proceedings of the annual conference southeastern association of fish and wildlife agencies*. 41:230-236.

PLAFKIN, JL., BARBOUR MT., PORTER, KD., GROSS, SK. & HUGHES, RM. 1989. Rapid Bio-assessment protocols for use in streams and rivers: benthic macroinvertebrates and fish. *U.S. Environmental Protection Agency.*

POFF, NL. and WARD, JV. 1990. Physical habitat template of lotic systems: Recovery in the context of historical patterns of spatiotemporal heterogeneity.

PUSEY, BJ., KENNARD, MJ., ARTHUR, JM. & ARTHINGTON, AH. (1998). Quantitative sampling of stream fish assemblages: Single- vs. multiple-pass electrofishing. *Australian Journal of Ecology*. 23(4): 365-374.

REGIS, J., PATTEE, E. & LEBRETON, JD. 1981. A new method for evaluating the efficiency of electric fishing. *Arch. Hydrobiol.* 93:68–82.

REYNOLDS, JB. 1983. Electrofishing. Pages 147-163. *In Nielsen, LA and Johnson, DL. Fisheries Techniques. American fisheries society, Bethesda, Maryland.*

SKELTON, PH. 2001. *A complete guide to the freshwater fishes of southern Africa*. Struik Publishers, South Africa.

THIRION, CA., MOCKE, A. & WOEST, R. 1995. Biological monitoring of streams and rivers using SASS4. A Users Manual. Internal Report No. N 000/00REQ/1195. Institute for Water Quality Studies. Department of Water Affairs and Forestry. 46.

UNITED STATES ENVIRONMETAL PROTECTION AGENCY (USEPA). 1998. Rapid Bioassessment Protocols for Use in Streams and Rivers. *US Environmental Protection Agency, Office of Water. Washington, DC.*

USGS (UNITED STATES GEOLOGICAL SURVEY). 2004. Methods for Sampling Fish Communities as part of the National Water-Quality Assessment Program. http://water.usgs.gov/nawqa/protocols/OFR-93-104/fishp1.html

Wetland Consulting Services (WCS). Wetland Mitigation Strategy for Belfast Opencast Coal Mine, Mpumalanga Province. Report / reference no. 01011/2013.

ZALEWSKI, M. 1985. The estimate of fish density and biomass in rivers on the basis of relationships between specimen size and efficiency of electrofishing. *Fish. Res*. 3:147-155.

GOLDER ASSOCIATES AFRICA (PTY) LTD.

Dale Kindler Field Technician	Warren Aken Senior Aquatic Ecologist

DK/WA/dk

Reg. No. 2002/007104/07

Directors: SAP Brown, L Greyling, RGM Heath

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APPENDIX A

Site photographs

KK0
(Upstream, taken in November 2013 by P.Kimberg)

KK0
(Downstream, taken in November 2013 by P.Kimberg)

KK3
(Upstream, taken in November 2013 by P.Kimberg)

KK3
(Downstream, taken in November 2013 by P.Kimberg)

APPENDIX B

Aquatic macroinvertebrate site data

Aquatic macroinvertebrate site data

Aquatic macroinvertebrate taxa	QV	Nov-2013							
		KK0				KK3			
		S	VEG	GSM	TOTAL	S	VEG	GSM	TOTAL
Turbellaria (Flatworms)	3					A		A	**A**
ANNELIDA									
Oligochaeta (Earthworms)	1		A		**A**				
Hirudinea (Leeches)	3								
CRUSTACEA									
Potamonautidae* (Crabs)	3		A	A	**A**	A		A	**A**
Hydracarina (Mites)	8		1		**1**				
EPHEMEROPTERA (Mayflies)									
Baetidae 1sp	4			A					
Baetidae 2sp	6		B		**B**		B	B	
Baetidae >2sp	12					B			**C**
Caenidae (Squaregills/Cainfles)	6		A		**A**	B		B	**C**
Heptageniidae (Flatheaded mayflies)	13					B			**B**
Leptophlebiidae (Prongills)	9					B		A	**B**
Tricorythidae (Stout Crawlers)	9					C			**C**
ODONATA (Dragonflies & Damselflies)									
Chlorocyphidae (Jewels)	10					1			**1**
Coenagrionidae (Sprites and blues)	4		A	A	**B**	A	A	A	**B**
Lestidae (Emerald Damselflies/Spreadwings)	8			1	**1**				
Aeshnidae (Hawkers & Emperors)	8		1		**1**	A	A		**A**
Gomphidae (Clubtails)	6			1	**1**			A	**A**
Libellulidae (Darters/Skimmers)	4			OBS	**1**			A	**A**
HEMIPTERA (Bugs)									
Belostomatidae* (Giant water bugs)	3			OBS	**1**		1		**1**
Corixidae* (Water boatmen)	3		B	C	**C**	A	B		**B**
Gerridae* (Pond skaters/Water striders)	5			OBS	**1**		1		**1**
Naucoridae* (Creeping water bugs)	7						A		**A**
Notonectidae* (Backswimmers)	3		B	C	**C**				
Pleidae* (Pygmy backswimmers)	4		A	A	**A**		B		**B**
Veliidae/M...veliidae* (Ripple bugs)	5						A		**A**
TRICHOPTERA (Caddisflies)									
Hydropsychidae 1 sp	4							A	
Hydropsychidae >2 sp	6					B			**B**
Leptoceridae	6							A	**A**
COLEOPTERA (Beetles)									
Dytiscidae/Noteridae* (Diving beetles)	5		B	1	**B**		1	A	**A**
Elmidae/Dryopidae* (Riffle beetles)	8						OBS		**1**
Gyrinidae* (Whirligig beetles)	5		B		**B**		OBS		**1**
Hydraenidae* (Minute moss beetles)	8						1		**1**

Aquatic macroinvertebrate taxa	QV	Nov-2013							
		KK0				KK3			
		S	VEG	GSM	TOTAL	S	VEG	GSM	TOTAL
Hydrophilidae* (Water scavenger beetles)	5						A		**A**
Psephenidae (Water Pennies)	10					1			**1**
DIPTERA (Flies)									
Ceratopogonidae (Biting midges)	5		A	1	**A**	A		B	**B**
Chironomidae (Midges)	2		A	A	**B**		A	A	**B**
Culicidae* (Mosquitoes)	1			1	**1**				
Tipulidae (Crane flies)	5					1			**1**
GASTROPODA (Snails)									
Lymnaeidae* (Pond snails)	3		A		**A**				
Planorbinae* (Orb snails)	3							A	**A**
SASS Score		0	66	60	**87**	112	78	67	**189**
No. of Taxa		0	15	15	**21**	15	15	15	**31**
ASPT		0	4.40	4	**4.14**	0	5.20	4.67	**6.10**

QV: Quality Value; SIC: Stones in Current; VEG: Vegetation; GSM: Gravel, Sand & Mud; 1: one individual; A: 1-10 individuals; B: 11-100 individuals; C: 100-1000 individuals; D: >1000 individuals; and ASPT: Average Score per Taxa

APPENDIX C

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solutions@golder.com
www.golder.com

Golder Associates Africa (Pty) Ltd.
PO Box 6001
Halfway House, 1685
Building 1 Maxwell Office Park
Magwa Crescent Waterfall City
cnr. Allandale Road & Maxwell Drive
Midrand
South Africa
T: [+27] (11) 254 4800

Golder Associates