THE DUEL COAL PROJECT

Plan of Study

Specialist Studies Methodology

(2015)

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1.1 ENVIRONMENTAL ASSESSMENT PRACTITIONER

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Curriculum Vitae	Refer to Appendix 2

Marietjie Eksteen is the Managing Director of the consulting firm Jacana Environmentals cc, an environmental consulting firm based in Polokwane. She is an environmental scientist with 28 years' experience, her main fields of expertise being water quality management, mine water management, environmental legal compliance and project management. Ms Eksteen is a registered Professional Environmental Scientist (Pr.Sci.Nat.) at the South African Council for Natural Scientific Professions – Registration No. 400090/02.

Since establishing Jacana Environmentals in 2006, she has been involved in a variety of mine-related environmental projects serving clients such as Coal of Africa Limited, BHP Billiton Energy Coal SA, Xstrata Coal SA and Optimum Coal. Prior to 2006 she was employed by Pulles Howard & De Lange Inc as an environmental consultant for 2 years. Before consulting, Ms Eksteen was employed by BHP Billiton as a mine environmental manager at their operations in Mpumalanga, as well as the Department of Water Affairs where she was appointed as a water quality specialist for the mining industry. Her career started off as a geophysicist at Genmin in 1990. Ms Eksteen obtained a Masters' degree in Exploration Geophysics (MSc) from the University of Pretoria in 1993. Her Curriculum Vitae is attached as Appendix 2.

1.2 SPECIALIST TEAM

The specialist team that has been appointed to assist Jacana Environmentals with the EIA is:

• Soils, land use and capability	Rossouw Associates
• Biodiversity / Aquatic systems	Scientific Aquatic Services
• Surface water	WSM Leshika Consulting (Pty) Ltd
• Groundwater	WSM Leshika Consulting (Pty) Ltd
• Air Quality	Royal Haskoning DHV
• Noise	Royal Haskoning DHV
• Blasting and Vibration	Blasting Management & Consulting
• Heritage	R&R Cultural Resources
• Palaeontology	BM Geological Services
• Visual	Scientific Aquatic Services
• Social Impact Assessment	Naledi Development Restructured (Pty) Ltd
• Macro-Economic Assessment	Mosaka Economic Consultants

Their qualification and professional registrations and affiliations are provided in Table 1.

Table 1: Qualification and professional registrations and affiliations of EIA specialists (2015)

Aspect	Firm	Specialists	Qualification	Professional registrations and affiliations
Soils, land use & land capability	Rossouw Associates	PS Rossouw	MSc Agriculture Soil Science	Pr.Sci.Nat. - SACNASP Reg No. 400194/12. Member of Soil Science Society of South Africa (SSSSA), South African Soil Surveyors Organisation (SASSO) and South African Wetland Society (SAWS).
Biodiversity impact assessment	Scientific Aquatic Services	Stephen van Staden	BSc (Hons) Zoology MSc Environmental Management	Pr.Sci.Nat. - SACNASP Reg No. 400134/05. Registered by the SA RHP as an accredited aquatic biomonitoring specialist. Member of the Gauteng Wetland Forum and South African Soil Surveyors Association (SASSO). 13 years of experience in ecology.
		Christopher Hooton	National Diploma: Nature Conservation BTech Nature Conservation	Experience in environmental enforcement with GDARD as well as customs officials. Extensive experience in large mammal and carnivore research and management across south Africa and especially the Phinda Game reserve. Ecologist with focus on zoology.
		Emile van der Westhuizen	BSc Environmental Management and Botany BSc Hons Plant Science	Cand.Sci.Nat. - SACNASP Reg No. 100008/15. Extensive experience (more than 8 years) in botanical ecological assessments throughout Southern, Central, East and West Africa. Ecologist with focus on botany.
		Natasha van de Haar	MSc Botany	Pr.Sci.Nat. - SACNASP Reg No. 400229/11. International Affiliation for Impact Assessments (IAIA). Botanical Society of SA member. Western Cape Wetlands Forum member. Ecologist with focus on botany.
		Dionne Crafford	BSc Ecology BSc (Hons) Zoology MSc Parasitology PhD Zoology	Pr.Sci.Nat. 400146/14 (Biological Science). 14 years Experience in veterinary research and aquatic parasitology. 2 years experience in aquatic ecology.

Surface water impact assessment	WSM Leshika Consulting Pty Ltd	Anna Jansen van Vuuren	M Eng (Civil Engineering)	ECSA: Professional Engineer No 770359 (registered 21 November 1977) (Registration renewed for further 5 years from Feb 2013). SAICE: Member of the SA Institution of Civil Engineers: No 010181 (registered 14 Apr 1978). Fellow of SAICE 16 Aug '02.
		Rian Coetzee	N Dip (Civil Engineering)	-
Groundwater impact assessment	WSM Leshika Consulting Pty Ltd	Carl Haupt	BSc (Hons)	Pr.Sci.Nat. SACNASP Reg No 400031/94. Member of the Groundwater Division of the Geological Society of South Africa. Member of the International Association of Hydrogeologists. Member of the borehole Water Association of SA. Member of the South African Association of Environmental and Engineering Geologists.
		Pierre Wilken	BSc (Hons)	Pr.Sci.Nat. SACNASP Reg No 400038/97. Member of the Groundwater Division of the Geological Society of South Africa. Member of the borehole Water Association of SA.
		Karim Sami	BSc Hydrology MSc Groundwater hydrology	Pr.Sci.Nat. SACNASP Reg No 400043/2001. Member of the International Association of Hydrogeologists.
Air quality and noise impact assessments	Royal Haskoning DHV	Stuart Thompson	BSc (Hons) Applied Environmental Science	Society South African Geographers. South African Geophysical Association, M07/007. National Association for Clean Air. Air Pollution Information Network - Africa, Life time Membership. Astronomical Society for SA, Committee Member, THO003.
		Lodewyk Jansen	BSc (Hons) Environmental Management	South African Society of Atmospheric Sciences. National Association for Clean Air.
		Nicole Singh	BSc Biological Sciences BSc (Hon) Environmental Sciences (underway)	-
		Raylene Watson	PhD (Toxicology)	Pr.Sci.Nat. - SACNASP Reg No. 400126/07. National Association for Clean Air. Air Pollution Information Network - Africa, Life time Membership.

Blasting and Vibration Study	Blasting Management & Consulting	Danie Zeeman	1985 - 1987 Diploma: Explosives Technology, Technikon Pretoria 1990 - 1992 BA Degree, University of Pretoria 1994 National Higher Diploma: Explosives Technology, Technikon Pretoria 2000 Advanced Certificate in Blasting, Technikon SA	International Society of Explosives Engineers.
Heritage and cultural impact assessment	R&R Cultural Resources	Frans Roodt Principal Investigator	BA Hons MA Archaeology Post Grad Dip. in Museology	Association of Southern African Professional Archaeologists (ASAPA) Member No. 120.
Palaeontological Desk-top Study	BM Geological Services	Prof Barry Millsteed	PhD (Palaeontology)	Registered with the South African Council for Natural Scientific Professions (SACNASP). Member of the Palaeontological Society of South African and the Geological Society of South Africa.
Visual Impact Assessment	Scientific Aquatic Services	Michelle Pretorius	BSc Landscape Architecture BSc Botany BSc Hons Plant Science	Pr.Sci.Nat. - SACNASP REG.NO: 400003/15. Botanical Society of South Africa (BotSoc). Member of the South African Council for the Landscape Architectural Profession (SACLAP). 8 Years experience in the fields of landscape architecture, environmental management visual impact assessments and botany.
Macro-economic impact assessment	Mosaka Economic Consultants	William Mullins	BSc – Trained as Mathematician and Statistician. 16 years' experience as macro- and micro-economist. UED – 7 years teaching at Agricultural College.	Dr. Mullins, co-CEO of Mosaka Economists is a member of The Economic Society of South Africa and a member of the Interindustry Forecasting Project at the University of Maryland (Inforum).
		Paul Grobler	B Sc (Mathematical Statistics). Electives – Economics, Financial Engineering and Actuarial Statistics.	Specialising in Cost-benefit Analyses and Macro-economic Impact Modelling.

		Tefelo Majoro	B Com (Ed) MBA	She has over ten years of combined practical work experience, of which five are within the economic consulting environment. She is an Economist with a broad project experience in evaluating the financial and economic viability of investment projects using econometric models such as Cost Benefit Analysis, Multi Criteria Decision Analysis and Social Accounting Matrix based Macro-economic Analysis.
		Daan Hamman	BA (Mil)	Data research
Social Impact Assessment	Naledi Development Restructured	Lizinda Dickson	BA (Geography) BA (Hons) Environmental Management M Inst Agrar Environment and Society	International Association for Impact Assessment.
		Carien Joubert	PhD Social and Behavioural Sciences	-
		Fransis de la Rosa	Diploma in Tourism Diploma in Environmental Management	-
		William Nkuna	Diploma in Human Resource Development and Management	-

2 SPECIALIST STUDIES METHODOLOGY

2.1 SOIL, LAND USE AND CAPABILITY

The study area was traversed and observations regarding the landscape and occurrence of soils were made continuously. Specific soil characteristics were noted and logged. Augering was done to a maximum of 1500 mm. In many cases the occurrence of rocks hampered deep augering. The soils were classified according to the South African Soil Classification System (MacVicar et al., 1994). Specific emphasis was placed on the identification of the following aspects as this assist in an assessment of the pedohydrology and agricultural potential of the area:

- Fe(II)/Fe(III) layered double hydroxides (green rusts) that is indicative of moderate conditions of reductions (Eh values of -0.5 to +0.5 V) and usually encountered in wetland soils;
- The accumulation of ferrihydrate, lepridocrosite, goethite and hematite in vesicular nodules (mottling) owing to the reduction of Fe(III) to Fe(II), under conditions of a fluctuating water table, which leads to the mobilisation of Fe;
- The occurrence of grey colours, especially where mottling is not present, as a further indication of Fe mobilisation and semi-permanent or permanent conditions of water saturation;
- The occurrence of bleached soil horizons that indicate lateral drainage of water;
- The occurrence of gleyed soil horizons that can be indicative of a permanent water table;
- The occurrence of uniform red and yellow colouration that is indicative of well drained areas;
- Signs of Mn mobilisation and/or precipitation as an indication of a fluctuating water table;
- The occurrence of smectite clays that lead to swelling and shrinking characteristics in soil and is conducive to saturated flow in the dry state but not in the wet state;
- Textural changes, and other aspects, in the soil profile that will influence saturated and unsaturated flow of water; and
- Occurrence of layers that impede water flow.

Emphasis was placed on morphological indicators of temporary or seasonal wetness within 500 mm of the soil surface.

Representative soil samples were be collected and subjected to the following chemical and physical analyses:

- pH and EC (electrical conductivity): Directly influences plant growth and crop yield;
- Exchangeable/weakly complexed fraction of major cationic plant nutrients – calcium (Ca), sodium (Na), magnesium (Mg), potassium (K);
- Plant available phosphorus (P) and nitrogen content;
- Organic carbon content; and
- Soil particle size distribution (texture including clay content).

Mitigation measures, as well as a rehabilitation plan, to be put in place during and after mining in order to minimize the impact of mining on the environment will be proposed.

The Soil, Land Use and Land Capability Impact Assessment will include an assessment of land capability and existing land use, which will inform the EIA of the potential impact on existing communal agricultural practices. The assessment will include, amongst other things, the following:

- Assess the agricultural potential and land capability of the areas earmarked for mining and related activity through a detailed soil survey;
- Assess the possible soil forms and land capability of the remainder of the 14 589 ha MRA area through predictive soil mapping;
- Determine the impact of opencast and underground mining, as well as the construction of mining related infrastructure on the soil environment; and
- Propose mitigation measures to negate the negative impact of mining on the long-term agricultural use of the area.

2.2 BIODIVERSITY

2.2.1 FAUNAL ASSESSMENT

Prior to the faunal field assessment use will be made of topographical and aerial maps to identify “areas of faunal interest” regarded as representative of the different habitat units within the MRA area. Attention will also be given to data from national and provincial databases, such as the recent South African National Biodiversity Assessment (NBA) report of 2011 (which includes the recent BGIS dataset which has been compiled by South African National Biodiversity Institute (SANBI)). Special emphasis will be placed on habitat that may support faunal species of concern that are listed in the Limpopo Environmental Management Act (Act No 7 of 2003), NBA 2011 report and IUCN.

Thus, all relevant authorities and available databases will be consulted as far as possible regarding conservational species lists, as well as all the latest available literature utilised to gain a thorough understanding of the MRA area and its surrounding habitats. This information and further literature reviews will then be used to determine the potential biodiversity lists for the proposed development site and surrounding areas. This information incorporated (amongst others) data on vegetation types, faunal habitat suitability and biodiversity potential coupled to this information.

During the detailed field assessment, focus will be placed on the occurrence of RDL and/or protected faunal species which are known to occur in the area. Furthermore, a detailed inventory of faunal species encountered through direct observation and/or field signs and other trapping techniques will be compiled.

2.2.1.1 Mammals

Small mammals are unlikely to be directly observed in the field because of their nocturnal/crepuscular and cryptic nature. A simple and effective solution to this problem is to use Sherman traps. A Sherman trap is a small aluminium box with a spring-loaded door. Once the animal is inside the trap, it steps on a small plate that causes the door to snap shut, thereby capturing the individual. Trapping will take place within relatively undisturbed small mammal habitat identified throughout the mining and infrastructure footprint area. In the event of capturing a small mammal during the night, the animal would be photographed and then set free unharmed early the following morning. Traps will be baited with a universal mixture of oats, peanut butter, fish paste and syrup.

Medium and larger faunal species will be recorded during the field assessment with the use of visual identification as well as where spoor, call, or dung samples can be positively identified. Infrared camera traps will also be set which will record any faunal species which trigger the infrared sensors. In addition, species lists provided by local conservation authorities will be used to determine the potential biodiversity lists for the MRA area.

2.2.1.2 Avifauna

Field surveys will be undertaken using a pair of binoculars and bird call identification (vocalisation) practices. The Birdlife South Africa avifaunal database for EIA reports, local conservation authority databases, along with the Southern African Bird Atlas Project 2 (www.sabap2.org) data will be used to compare with birds identified during the field survey and to provide potential biodiversity lists. Habitat evaluation for RDL species and areas of avifaunal importance will be noted and consideration will be given to impacts on avifaunal ecology with specific mention of impacts on breeding/nesting suitability, foraging suitability, migratory species and migratory corridors.

2.2.1.3 Reptiles

Reptile species encountered during the assessment will be identified. Specific attention will be paid to priority areas which may provide habitat for RDL reptile species such as rocky outcrops. Species lists provided by local conservation authorities will be used to determine the potential biodiversity lists for the MRA area and the conservation status of each species listed will be determined.

2.2.1.4 Amphibians

During the field assessment, visual identification along with other identification aids such as call identification will be used. Any habitat encountered that may provide suitable habitat for RDL amphibian species will be noted. Species lists provided by local conservation authorities will be used to determine the potential biodiversity lists for the MRA area and the conservation status of each species listed will be determined.

2.2.1.5 Invertebrates, scorpions and spiders

During the field assessment, visual identification and recording of invertebrate species will be conducted at specific priority areas, and if applicable, sweep nets will be used to capture and help identify invertebrate species. Any habitat encountered that may provide suitable habitat for RDL invertebrate species will be noted. Species lists provided by local conservation authorities will be used to determine the potential invertebrate biodiversity lists for the MRA area and the conservation status of each species listed will be determined.

2.2.1.5.1 Red Data species assessment

Given the restrictions of field assessments to identify all the faunal species that possibly occur on a particular property, the Red Data Sensitivity Index (RDSIS) has been developed to provide an indication of the potential red data faunal species that could reside in the area, while simultaneously providing a quantitative measure of the subject property's' value in terms of conserving faunal diversity. The RDSIS is based on the principles that when the knowledge of the specie's historical distribution is combined with a field assessment that identifies the degree to which the property supports a certain species habitat and food requirements, inferences can be made about the chances of that particular species residing on the property. Repeating this procedure for all the potential red data faunal species of the area and collating this information then provides a sensitivity measure of the property that has been investigated.

RDSIS Score	RDL faunal importance
0-20%	Low
21-40%	Low-Medium
41-60%	Medium
60-80%	High-Medium
81-100%	High

2.2.1.6 Sensitivity mapping

All results obtained during the literature review as well as field assessments will be used to map each habitat unit according to sensitivity. A Geographic Information System (GIS) will be used to project these features onto aerial photographs and topographic maps. The sensitivity map should guide the design and layout of the proposed mining development. The assessment will be undertaken in line with the requirements deemed necessary to address the envisaged risks associated with the proposed development.

2.2.2 FLORAL ASSESSMENT

2.2.2.1 General methodology

In order to accurately determine the desktop level Present Ecological State (PES) of the mining and infrastructure footprint area and capture comprehensive data with respect to floral taxa the following methodology was used:

- Maps, aerial photographs and digital satellite images were consulted in order to determine broad habitats, vegetation types and potentially sensitive sites.
- A literature review with respect to habitats, vegetation types and species distribution was conducted.
- Relevant data bases considered during the assessment of the MRA area included local conservation authority databases, South African National Biodiversity Institute (SANBI) Threatened Species Programme (TSP) and Pretoria Computer Information Systems (PRECIS) and the SANBI Biodiversity Geographic Information Systems (GIS) database (BGIS).

2.2.2.2 Field surveys

The overall vegetation survey will be conducted by first identifying different habitat units and then analysing the floral species composition. Vegetation analyses will be conducted within areas that are perceived to best represent the various plant communities. Species will be recorded, and a species list will be compiled for each habitat unit.

2.2.2.3 Transects

All transects will be located within what may be considered to be representative of the vegetation types associated with the MRA area. Data will be collected along at 1m intervals and the plant species or biophysical feature falling closest to the assessment point will be identified. These data points will be developed along 100m long transect lines, making for 100 data points along a single transect. Species lists will be compiled and species composition analysed along the selected transect lines, where after the data will be analysed and the percentage contribution of the various floral species for each transect line will be calculated.

If the species composition is quantitatively determined and characteristics of all components of the floral community are taken into consideration, it is possible to determine the PES of the portion of land represented by an assessment point/ transect line. This section will summarise the dominant floral species identified within each transect with their associated habitats and optimal growth conditions.

2.2.2.4 Vegetation Index Score

The Vegetation Index Score (VIS) was designed to determine the ecological state of each habitat unit defined within an assessment site. This enables an accurate and consistent description of the PES concerning the subject property in question. The information gathered during these assessments also significantly contributes to sensitivity mapping, leading to a more truthful representation of ecological value and sensitive habitats.

Each defined management unit is assessed using separate data sheets and all the information gathered then contributes to the final VIS score. The VIS is derived using the following formulas:

VIS = [(EVC) + (SI x PVC) + (RIS)]

Where:

- EVC is extent of vegetation cover;
- SI is structural intactness;
- PVC is percentage cover of indigenous species and
- RIS is recruitment of indigenous species.

The final VIS scores for each habitat unit are then categorised as follows:

Vegetation Index Score	Assessment Class	Description
25	**A**	Unmodified, natural
20 to 24	**B**	Largely natural with few modifications.
15 to 20	**C**	Moderately modified
10 to 15	**D**	Largely modified
5 to 10	**E**	The loss of natural habitat extensive
<5	**F**	Modified completely

2.2.2.5 Red Data species assessment

Prior to the field visit, a record of Red Data Listed (RDL) floral species and their habitat requirements will be acquired from the Limpopo Environmental Management Amendment Act (No. 7 of 2003), databases for the area from local conservation authorities, the National Forest Act (Act 84 of 1998) and the South African National Biodiversity Institute (SANBI) for the relevant Quarter Degree Squares (QDS). Throughout the floral assessment, special attention will be paid to the identification of any of these RDL species as well as identification of suitable habitat that could potentially sustain these species.

The Probability of Occurrence (POC) for each floral species of concern was determined using the following calculations where in the habitat requirements and habitat disturbance were considered. The accuracy of the calculation is based on the available knowledge about the species in question, with many of the species lacking in-depth habitat research. Therefore, it is important that the literature available is also considered during the calculation.

Each factor contributes an equal value to the calculation.

Literature availability						
	No Literature available					Literature available
Site score						
Score	0	1	2	3	4	5
Habitat availability						
	No Habitat available					Habitat available
Site score						
Score	0	1	2	3	4	5
Habitat disturbance						
	0	Very Low	Low	Moderately	High	Very High
Site score						
Score	5	4	3	2	1	0

[Literature availability + Habitat availability + Habitat disturbance] / 15 x 100 = POC%.

2.2.2.6 Sensitivity mapping

All sensitive features and or habitats (including localities of RDL/protected floral species, wetlands, rivers and ridges) will be mapped utilising a Geographical Positioning System (GPS) and a sensitivity map will be compiled. This sensitivity map will aim to guide the design of the proposed mining development in order to have the least ecological impact on the receiving environment.

2.3 WETLAND ASSESSMENT

2.3.1 NATIONAL WETLAND CLASSIFICATION SYSTEM

All wetland features encountered within and adjacent to the mining and infrastructure footprint area will be assessed using the Classification System for Wetlands (hereafter referred to as the 'Classification System') and other Aquatic Ecosystems in South Africa. User Manual: Inland systems (Ollis et al., 2013).

A summary of Levels 1 to 4 of the Classification System for Inland Systems are presented below.

Table 2: Classification structure for Inland Systems, up to Level 3

WETLAND / AQUATIC ECOSYSTEM CONTEXT		
LEVEL 1: SYSTEM	LEVEL 2: REGIONAL SETTING	LEVEL 3: LANDSCAPE UNIT
Inland Systems	DWA Level 1 Ecoregions OR NFEPA WetVeg Groups OR Other special framework	Valley Floor
		Slope
		Plain
		Bench (Hilltop / Saddle / Shelf)

Table 3: Hydrogeomorphic (HGM) Units for Inland Systems, showing the primary HGM Types at Level 4A and the subcategories at Level 4B to 4C

FUNCTIONAL UNIT		
LEVEL 4: HYDROGEOMORPHIC (HGM) UNIT		
HGM type	Longitudinal zonation/ Landform / Outflow drainage	Landform / Inflow drainage
A	B	C
River (Channel)	Mountain headwater stream	Active channel
		Riparian zone
	Mountain stream	Active channel
		Riparian zone
	Transitional stream	Active channel
		Riparian zone
	Upper foothill rivers	Active channel
		Riparian zone
	Lower foothill rivers	Active channel
		Riparian zone
	Lowland river	Active channel
		Riparian zone
	Rejuvenated bedrock fall	Active channel
		Riparian zone
	Rejuvenated foothill rivers	Active channel
		Riparian zone
	Upland floodplain rivers	Active channel
		Riparian zone
Channelled valley-bottom wetland	(not applicable)	(not applicable)
Unchannelled valley-bottom wetland	(not applicable)	(not applicable)
Floodplain wetland	Floodplain depression	(not applicable)
	Floodplain flat	(not applicable)

Depression	Exorheic	With channelled inflow
		Without channelled inflow
	Endorheic	With channelled inflow
		Without channelled inflow
	Dammed	With channelled inflow
		Without channelled inflow
Seep	With channelled outflow	(not applicable)
	Without channelled outflow	(not applicable)
Wetland flat	(not applicable)	(not applicable)

2.3.1.1 Inland systems

For the purposes of the Classification System, Inland Systems are defined as an aquatic ecosystem that have no existing connection to the ocean (i.e. characterised by the complete absence of marine exchange and/or tidal influence) but which are inundated or saturated with water, either permanently or periodically.

It is important to bear in mind, however, that certain Inland Systems may have had a historical connection to the ocean, which in some cases may have been relatively recent.

2.3.1.2 Level 1: Ecoregions

For Inland Systems, the regional spatial framework that has been included at Level 2 of the Classification System is that of DWA's Level 1 Ecoregions for aquatic ecosystems (Kleynhans et al., 2005). There are a total of 31 Ecoregions across South Africa, including Lesotho and Swaziland. DWA Ecoregions have most commonly been used to categorise the regional setting for national and regional water resource management applications, especially in relation to rivers.

2.3.1.3 Level 2: NFEPA Wet Veg Groups

The Vegetation Map of South Africa, Swaziland and Lesotho (Mucina & Rutherford, 2006) groups vegetation types across the country according to Biomes, which are then divided into Bioregions – composite spatial terrestrial units defined on the basis of similar biotic and physical features and processes at the regional scale (Mucina and Rutherford, 2006).

To categorise the regional setting for the wetland component of the NFEPA project, wetland vegetation groups (referred to as WetVeg Groups) were derived by further splitting Bioregions into smaller groups through expert input (Nel et al., 2011). There are currently 133 NFEPA WetVeg Groups, and it is envisaged that these groups could be used as a special framework for the classification of wetlands in national- and regional-scale conservation planning and wetland management initiatives.

2.3.1.4 Level 3: Landscape Units

At Level 3 of the Classification System for Inland Systems, a distinction is made between four Landscape Units on the basis of the landscape setting (i.e. topographical position) within which a Hydrogeomorphic (HGM) Unit is situated, as follows (Ollis et al., 2013):

- Slope: An inclined stretch of ground that is not part of a valley floor, which is typically located on the side of a mountain, hill or valley.
- Valley floor: The base of a valley, situated between two distinct valley side-slopes.
- Plain: An extensive area of low relief characterised by relatively level, gently undulating or uniformly sloping land.
- Bench (hilltop/saddle/shelf): An area of mostly level or nearly level high ground (relative to the broad surroundings), including hilltops/crests (areas at the top of a mountain or hill flanked by down-slopes in all directions), saddles (relatively high-lying areas flanked by down-slopes on two sides in one direction and up-slopes on two sides in an approximately perpendicular direction), and shelves/terraces/ledges (relatively high-lying, localised flat areas along a slope, representing a break in slope with an up-slope one side and a down-slope on the other side in the same direction).

2.3.1.5 Level 4: Hydrogeomorphic Units

Eight primary HGM Types are recognised for Inland Systems at Level 4A of the Classification System, on the basis of hydrology and geomorphology (Ollis et al., 2013), namely:

- Channel (River): A linear landform with clearly discernible bed and banks, which permanently or periodically carries a concentrated flow of water.
- Channelled valley-bottom wetland: A valley-bottom wetland with a river channel running through it.
- Unchannelled valley-bottom wetland: A valley-bottom wetland without a river channel running through it.
- Floodplain wetland: The mostly flat or gently sloping land adjacent to and formed by an alluvial river channel, under its present climate and sediment load, which is subject to periodic inundation by over-topping of the channel bank.
- Depression: A landform with closed elevation contours that increases in depth from the perimeter to a central area of greatest depth, and within which water typically accumulates.
- Wetland Flat: A level or near-level wetland area that is not fed by water from a river channel, and which is typically situated on a plain or a bench. Closed elevation contours are not evident around the edge of a wetland flat.
- Seep: A wetland area located on (gently to steeply) sloping land, which is dominated by the colluvial (i.e. gravity-driven), unidirectional movement of material down-slope. Seeps are often located on the side-slopes of a valley, but they do not, typically, extend into a valley floor.

The above terms have been used for the primary HGM Units in the Classification System to try and ensure consistency with the wetland classification terms currently in common usage in South Africa. Similar terminology (but excluding categories for “channel”, “flat” and “valleyhead seep”) is used, for example, in the tools developed as part of the Wetland Management Series including WET-Health (Macfarlane et al., 2008) and WET-EcoServices (Kotze et al., 2009).

2.3.2 RIPARIAN VEGETATION RESPONSE ASSESSMENT INDEX (VEGRAI)

Riparian vegetation is described in the NWA (Act No 36 of 1998) as follows: ‘riparian habitat’ includes the physical structure and associated vegetation of the areas associated with a watercourse which are commonly characterised by alluvial soils, and which are inundated or flooded to an extent and with a frequency sufficient to support vegetation of species with a composition and physical structure distinct from those of adjacent land areas.

VEGRAI is designed for qualitative assessment of the response of riparian vegetation to impacts in such a way that qualitative ratings translate into quantitative and defensible results (Kleynhans et al., 2007). Results are defensible because their generation can be traced through an outlined process (a suite of rules that convert assessor estimates into ratings and convert multiple ratings into an Ecological Category).

Table 4: Descriptions of the A-F ecological categories

Ecological category	Description	Score (% of total)
A	Unmodified, natural.	90-100
B	Largely natural with few modifications. A small change in natural habitat and biota may have taken place but the ecosystem functions are essentially unchanged.	80-89
C	Moderately modified. Loss and change of natural habitat have occurred, but the basic ecosystem functions are still predominately unchanged.	60-79
D	Largely modified. A large loss of natural habitat, biota and basic ecosystem functions has occurred.	40-59
E	Seriously modified. The loss of natural habitat, biota and basic ecosystem functions is extensive.	20-39
F	Critically modified. Modifications have reached a critical level and the lotic system has been modified completely with an almost complete loss of natural habitat and biota. In the worst instances the basic ecosystem functions have been destroyed and the changes are irreversible	0-19

2.3.3 WETLAND FUNCTION ASSESSMENT

“The importance of a water resource, in ecological social or economic terms, acts as a modifying or motivating determinant in the selection of the management class”. The assessment of the ecosystem services supplied by the identified wetlands was conducted according to the guidelines as described by Kotze et al (2005). An assessment was undertaken that examines and rates the following services according to their degree of importance and the degree to which the service is provided:

- Flood attenuation
- Stream flow regulation
- Sediment trapping
- Phosphate trapping
- Nitrate removal
- Toxicant removal
- Erosion control
- Carbon storage
- Maintenance of biodiversity
- Water supply for human use
- Natural resources
- Cultivated foods
- Cultural significance

- Tourism and recreation
- Education and research

The characteristics were used to quantitatively determine the value, and by extension also sensitivity, of the wetlands. Each characteristic was scored to give the likelihood that the service is being provided. The scores for each service were then averaged to give an overall score to the wetland.

Table 5: Classes for determining the likely extent to which a benefit is being supplied

Score	Rating of the likely extent to which the benefit is being supplied
<0.5	Low
0.5-1.2	Moderately low
1.3-2	Intermediate
2.1-3	Moderately high
>3	High

2.3.4 DEFINING ECOLOGICAL IMPORTANCE AND SENSITIVITY (EIS)

The method used for the EIS determination was adapted from the method as provided by DWA (1999) for floodplains. The method takes into consideration PES scores obtained for WET-Health as well as function and service provision to enable the assessor to determine the most representative EIS category for the wetland feature or group being assessed.

A series of determinants for EIS are assessed on a scale of 0 to 4, where 0 indicates no importance and 4 indicates very high importance. The median of the determinants is used to assign the EIS category.

Table 6: Wetland EIS category definitions

EIS Category	Range of Median	Recommended Ecological Management Class
Very high: Floodplains that are considered ecologically important and sensitive on a national or even international level. The biodiversity of these floodplains is usually very sensitive to flow and habitat modifications. They play a major role in moderating the quantity and quality of water of major rivers.	>3 and <=4	A
High: Floodplains that are considered to be ecologically important and sensitive. The biodiversity of these floodplains may be sensitive to flow and habitat modifications. They play a role in moderating the quantity and quality of water of major rivers.	>2 and <=3	B
Moderate: Floodplains that are considered to be ecologically important and sensitive on a provincial or local scale. The biodiversity of these floodplains is not usually sensitive to flow and habitat modifications. They play a small role in moderating the quantity and quality of water of major rivers.	>1 and <=2	C
Low/marginal: Floodplains that are not ecologically important and sensitive at any scale. The biodiversity of these floodplains is ubiquitous and not sensitive to flow and habitat modifications. They play an insignificant role in moderating the quantity and quality of water of major rivers.	>0 and <=1	D

2.3.4.1 Index of Habitat Integrity (IHI)

The WETLAND-IHI is a tool developed for use in the National Aquatic Ecosystem Health Monitoring Programme (NAEHMP), formerly known as the RHP. The WETLAND-IHI has been developed to allow the NAEHMP to include floodplain and channelled valley bottom wetland types to be assessed. The output scores from the WETLAND-IHI model are presented in A-F ecological categories and provide a score of the PES of the habitat integrity of the wetland system being examined.

Table 7: Descriptions of the A-F ecological categories (after Kleynhans, 1996, 1999)

Ecological Category	PES % Score	Description
A	90-100%	Unmodified, natural.
B	80-90%	Largely natural with few modifications. A small change in natural habitats and biota may have taken place but the ecosystem functions are essentially unchanged.
C	60-80%	Moderately modified. Loss and change of natural habitat and biota have occurred, but the basic ecosystem functions are still predominantly unchanged.
D	40-60%	Largely modified. A large loss of natural habitat, biota and basic ecosystem functions has occurred. E 20-40% Seriously modified. The loss of natural habitat, biota and basic ecosystem functions is extensive.
E	20-40%	Seriously modified. The loss of natural habitat, biota and basic ecosystem functions is extensive.
F	0-20%	Critically / Extremely modified. Modifications have reached a critical level and the system has been modified completely with an almost complete loss of natural habitat and biota. In the worst instances the basic ecosystem functions have been destroyed and the changes are irreversible.

2.3.5 RECOMMENDED ECOLOGICAL CATEGORY (REC)

“A high management class relates to the flow that will ensure a high degree of sustainability and a low risk of ecosystem failure. A low management class will ensure marginal maintenance of sustainability but carries a higher risk of ecosystem failure.”

The REC was determined based on the results obtained from the PES, reference conditions and EIS of the resource (sections above). This was followed by realistic recommendations, mitigation, and rehabilitation measures to achieve the desired REC.

A wetland may receive the same class for the PES, as the REC if the wetland is deemed to be in good condition, and therefore must stay in good condition. Otherwise, an appropriate REC should be assigned in order to prevent any further degradation as well as to enhance the PES of the wetland feature.

2.3.6 WETLAND DELINEATION

For the purposes of this investigation, a wetland habitat is defined in the NWA (Act 36 of 1998) as including the physical structure and associated vegetation of the areas associated with a watercourse which are commonly characterised by alluvial soils, and which are inundated or flooded to an extent and with a frequency sufficient to support vegetation of species with a composition and physical structure distinct from those of adjacent areas.

The wetland zone delineation of the river features took place according to the method presented in the final draft of "A practical field procedure for identification and delineation of wetlands and riparian areas" published by the DWA in February 2005. Based on these delineation principles the foundation of the method is based on the fact that wetlands and riparian zones have several distinguishing factors including the following:

- The presence of water at or near the ground surface;
- Distinctive hydromorphic soils;
- Vegetation adapted to saturated soils; and
- The presence of alluvial soils in stream systems.

By observing the evidence of these features, in the form of indicators, wetlands and riparian zones can be delineated and identified. If the use of these indicators and the interpretation of the findings are applied correctly, then the resulting delineation can be considered accurate (DWA 2005).

Riparian and wetland zones can be divided into three zones (DWA 2005). The permanent zone of wetness is nearly always saturated. The seasonal zone is saturated for a significant part of the rainy season and the temporary zone surrounds the seasonal zone and is only saturated for a short period of the year, but is saturated for a sufficient period, under normal circumstances, to allow for the formation of hydromorphic soils and the growth of wetland vegetation.

The object of this study will be to identify the outer boundary of the temporary zone and then to identify a suitable buffer zone around the wetland area.

2.4 AQUATIC ASSESSMENT

The assessment of the PES of the system, as well as possible impacts due to the proposed development, will be based on comparisons between observed conditions and the theoretical reference conditions based on desktop information reviews, and from historical data for the area.

The sections below describe the methodology which will be used to assess the aquatic ecological integrity of the various sites based on water quality, in-stream and riparian habitat condition and biological impacts and integrity.

2.4.1 VISUAL ASSESSMENT

The assessment site will be investigated in order to identify visible impacts on the site, with specific reference to impacts from surrounding activities and any effects activities occurring upstream in the catchment. Both natural constraints placed on ecosystem structure and function, as well as anthropogenic alterations to the system, will be identified by observing conditions and relating them to professional experience. Photographs of each site will be taken to provide visual indications of the conditions at the time of assessment. Factors which will be noted in the site-specific visual assessments include the following:

- Stream morphology;
- In-stream and riparian habitat diversity;
- Stream continuity;

- Erosion potential;
- Depth flow and substrate characteristics;
- Signs of physical disturbance of the area; and
- Other life forms reliant on aquatic ecosystems.

2.4.2 PHYSICO CHEMICAL WATER QUALITY DATA

On site testing of biota specific water quality variables will take place. Parameters which will be measured include pH, electrical conductivity, dissolved oxygen concentration and temperature. The results of on-site biota specific water quality analyses will be used to aid in the interpretation of the data obtained during the assessment. Results will be discussed against the guideline water quality values for aquatic ecosystems (DWA, 1996 vol. 7).

2.4.3 HABITAT SUITABILITY

The Invertebrate Habitat Assessment System (IHAS) will be applied according to the protocol of McMillan (1998). This index will be used to determine specific habitat suitability for aquatic macro-invertebrates, as well as to aid in the interpretation of the results of the South African Scoring System version 5 (SASS5) scores. Scores for the IHAS index will be interpreted according to the guidelines of McMillan (1998) as follows:

- <65%: habitat diversity and structure are inadequate for supporting a diverse aquatic macro-invertebrate community.
- 65%-75%: habitat diversity and structure are adequate for supporting a diverse aquatic macro-invertebrate community.
- >75% habitat diversity and structure are highly suited for supporting a diverse aquatic macro-invertebrate community.

2.4.4 HABITAT INTEGRITY

It is important to assess the habitat of each site, in order to aid in the interpretation of the results of the community integrity assessments by taking habitat conditions and impacts into consideration. The general habitat integrity of the site will be discussed based on the application of the Intermediate Habitat Integrity Assessment for (Kemper; 1999). The Intermediate Habitat Integrity Assessment (IHIA) protocol, as described by Kemper (1999), will be used for site specific assessments. This is a simplified procedure, which is based on the Habitat Integrity approach developed by Kleynhans (1996). The IHIA is conducted as a first level exercise, where a comprehensive exercise is not practical. The Habitat Integrity of each site will be scored according to 12 different criteria which represent the most important (and easily quantifiable) anthropogenically induced possible impacts on the system. The in-stream and riparian zones will be analysed separately, and the final assessment will be made separately for each, in accordance with Kleynhans' (1999) approach to Habitat Integrity Assessment. Data for the riparian zone are, however, primarily interpreted in terms of the potential impact on the in-stream component. The assessment of the severity of impact of modifications is based on six descriptive categories with ratings. Analysis of the data will be carried out by weighting each of the criteria according to Kemper (1999). By calculating the mean of the in-stream and riparian Habitat Integrity scores, an overall Habitat Integrity score can be obtained for each site. This method describes the Present Ecological State (PES) of both the in-stream and riparian habitats of the site. The method classifies Habitat Integrity into one of six classes, ranging from unmodified/natural (Class A), to critically modified (Class F).

Table 8: Classification of Present State Classes in terms of Habitat Integrity [Based on Kemper 1999]

Class	Description	Score (% of total)
A	Unmodified, natural.	90-100
B	Largely natural, with few modifications. A small change in natural habitats and biota may have taken place but the basic ecosystem functions are essentially unchanged.	80-90
C	Moderately modified. A loss and change of natural habitat and biota have occurred, but the basic ecosystem functions are still predominantly unchanged.	60-79
D	Largely modified. A large loss of natural habitat, biota and basic ecosystem functions has occurred.	40-59
E	Extensively modified. The loss of natural habitat, biota and basic ecosystem functions is extensive.	20-39
F	Critically modified. Modifications have reached a critical level and the lotic system has been modified completely with an almost complete loss of natural habitat and biota. In the worst instances, basic ecosystem functions have been destroyed and the changes are irreversible.	<20

2.4.5 AQUATIC MACRO-INVERTEBRATES

Aquatic Macro-invertebrates will be sampled using the qualitative kick sampling method called SASS5 (South African Scoring System version 5) (Dickens and Graham, 2001). The SASS5 method has been specifically designed to comply with international accreditation protocols. 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 assessment was undertaken according to the protocol as defined by Dickens & Graham (2001). All work will be done by an accredited SASS5 practitioner.

The SASS5 method was designed to incorporate all available biotypes at a given site and to provide an indication of the integrity of the of the aquatic macro-invertebrate community through recording the presence of various macro-invertebrate families at each site, as well as consideration of abundance of various populations, community diversity and community sensitivity. Each taxon is allocated a score according to its level of tolerance to river health degradation (Dallas, 1997).

This method relies on churning up the substrate with your feet and sweeping a finely meshed SASS net, with a pore size of 1000 micron mounted on a 300 mm square frame, over the churned-up area several times. In stony bottomed flowing water biotopes (rapids, riffles, runs, etc.) the net downstream of the assessor and the area immediately upstream of the net is 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 to cover from 1-2 meters. Identification of the organisms will be made to family level (Thirion et al., 1995; Davies & Day, 1998; Dickens & Graham, 2001; Gerber & Gabriel, 2002).

Interpretation of the results of biological monitoring depends, to a certain extent, on interpretation of site-specific conditions (Thirion et.al, 1995). In the context of this investigation it would be best not to use SASS5 scores in isolation, but rather in comparison with relevant habitat scores. The reason for this is that some sites have a less desirable habitat or fewer biotopes than others do. In other words, a low SASS5 score is not necessarily regarded as poor in conjunction with a low habitat score. Also, a high SASS5 score, in conjunction with a low habitat score, can be regarded as better than a high SASS5 score in conjunction with a high habitat score. A low SASS5 score, together with a high habitat score, would be indicative of poor conditions. The IHAS Index is valuable in helping to interpret SASS5 scores and the effects of habitat variation on aquatic macro-invertebrate community integrity.

Classification of the system will take place by comparing the present community status to reference conditions which reflect the best conditions that can be expected in rivers and streams within a specific area and reflect natural variation over time. SASS and ASPT reference conditions will be obtained from Dallas (2007). Reference conditions are stated as a SASS score of 125 and an ASPT score of 6. Sites will be classified according to the classification system for the Eastern Escarpment Mountains Ecoregion according to Dallas (2007), as well as the classification system of Dickens & Graham 2001.

The four major components of a stream system that determine productivity, with particular reference to aquatic organisms, are flow regime, physical habitat structure, water quality and energy inputs. An interplay between these factors (particularly habitat and availability of food sources) result in the discontinuous, patchy distribution pattern of aquatic macro-invertebrate populations. As such aquatic invertebrates shall respond to habitat changes (i.e. changes in driver conditions).

Table 9: Definition of Present State Classes in terms of SASS scores as presented in Dickens & Graham (2001)

Class	Description	SASS Score%	ASPT
A	Unimpaired. High diversity of taxa with numerous sensitive taxa.	90-100 80-89	Variable >90
B	Slightly impaired. High diversity of taxa, but with fewer sensitive taxa.	80-89 70-79 70-89	<75 >90 76-90
C	Moderately impaired. Moderate diversity of taxa.	60-79 50-59 50-79	<60 >75 60-75
D	Largely impaired. Mostly tolerant taxa present.	50 - 59 40-49	<60 Variable
E	Severely impaired. Only tolerant taxa present.	20-39	Variable
F	Critically impaired. Very few tolerant taxa present.	0-19	Variable

To relate drivers to such changes in habitat and aquatic invertebrate condition, two key elements are required. Firstly, habitat preferences and requirements for each taxa present should be obtained. As such reference conditions can be established against which any response to drivers can be measured. Secondly habitat features should be evaluated in terms of suitability and the requirements mentioned in the first point. As a result, expected and actual patterns can be evaluated to achieve an Ecostatus Category (EC) rating.

Based on the three key requirements, the MIRAI provides an approach to deriving and interpreting aquatic invertebrate response to driver changes.

2.4.6 FISH COMMUNITY INTEGRITY

Whereas macro-invertebrate communities are good indicators of localized conditions in a river over the short-term, fish being relatively long-lived and mobile:

- are good indicators of long-term influences;
- are good indicators of general habitat conditions;
- integrate effects of lower trophic levels; and
- are consumed by humans (Uys et al., 1996).

The FRAI (Kleynhans 2008) is based on the premise that "drivers" (environmental conditions) may cause fish stress which shall then manifest as changes in fish species assemblage. The index employs preferences and intolerances of the reference fish assemblage, as well as the response of the actual (present) fish assemblage to particular drivers to indicate a change from reference conditions. Intolerances and preferences are divided into metric groups relating to preferences and requirements of individual species. This allows cause-effect relationships to be understood, i.e. between drivers and responses of the fish assemblage to changes in drivers. These metric groups are subsequently ranked, rated and finally integrated as a fish Ecological Category (EC).

Table 10: Definition of Present State Classes in terms of FAII scores according to the protocol of Kleynhans (1999)

Class	Description	Relative FAII score (% of expected)
A	Unmodified, or approximates natural conditions closely.	90-100
B	Largely natural, with few modifications.	80-89
C	Moderately modified. A lower than expected species richness and the presence of most intolerant species.	60-79
D	Largely modified. A clearly lower than expected species richness and absence of intolerant and moderately tolerant species.	40-59
E	Seriously modified. A strikingly lower than expected species richness and a general absence of intolerant and moderately intolerant species.	20-39
F	Critically modified. Extremely lowered species richness and an absence of intolerant and moderately intolerant species.	<20

2.5 SURFACE WATER

The main objectives of the Surface Water Impact Assessment are to:

- Review surface water resources;
- Identify existing uses;
- Develop a storm water management strategy for the proposed mine in adherence to the relevant legal requirements and accepted practices; and
- Determine the impact of surface water use at the mine on the surface water sources both in terms of quality and quantity.

2.5.1 CURRENT SURFACE WATER SOURCES, USES AND THE WATER BALANCE OF THE MUTAMBA RIVER BASIN AND IMPACTS ON THE NZHELELE BASIN

Available information will be sourced from published reports and studies. Major water uses in the Mutamba River basin may include domestic, irrigation, mining and conservation water supply.

Sources of information would include reports by the Water Research Commission and the Department of Water & Sanitation on surface water resources planning and on current water quality issues, as well as studies, in the public domain, undertaken for other mining developments.

With the Nzhelele River being the receiving water body for flows in the Mutamba River, the impact study would have to extend into the Nzhelele River Basin. To be noted is the fact that the Mutamba River confluence is downstream of the Nzhelele Dam and downstream of the off-take for the irrigation canal system.

2.5.2 STORM WATER ANALYSES AND SYSTEM DESIGN

The storm water management strategy, which will conform to the requirements in the applicable legislation, may include the following:

- The first step in the surface water study is to estimate the flood peaks along affected drainage lines and determine the associated flood zone widths. For this exercise proper site survey data is required. Widely accepted standard methods, such as the Rational Method or statistical analyses of available data, will be applied to determine the flood peaks. It should be noted that large rainfall events are not only caused by cyclones (of which Demoina is the only example in the RSA), but by tropical storms, cut-off low pressure systems (Laingsburg, Port Elizabeth, East London, South East Cape coast) and large frontal systems in the interior. The hydrological analysis is based on historical rainfall records or measured flood peaks (if available) in the catchment area. A number of methods can be used to determine flood peaks, as described in the Sanral Drainage Manual (Kruger, 2006). These are generally categorized as deterministic, statistical or empirical methods:
    - Deterministic methods include those methods where the flood magnitude (the effect) is derived from an estimate of the catchment characteristics, including rainfall (the cause), for the required annual exceedance probability. Note that these methods have been calibrated according to selected regions and flood events and its application is usually limited to the size of catchment on which they can be applied. Included in this category are the Rational, Unit Hydrograph and Standard Design Flood methods.
    - Statistical methods use actual annual series flood peak data, to which a statistical Probability Distribution Function (PDF) is applied. The validity of the result depends on the record length, the quality of the data and the aptness of the applied PDF. A graphical presentation of the data and the fitted curve should be made to select the best PDF, which include the Log-normal, Log-Pearson Type 3 and General Extreme Value functions.
    - Empirical methods are calibrated equations that may be partially based on a deterministic relationship, such as the Midgley-Pitman method. Also included in this category is the Regional Maximum Flood method developed by Kovacs.
- The second action is to calculate the flood widths after the infrastructure footprints have been finalised in order to identify the relevant affected streams. The survey data will then be used to model the river flow in the universal Hec-Ras software, coupled to RiverCad drafting software, and

the flood widths for the 1:100 year (and 1:50 year where required) return period will be plotted on maps. Flood-zones will be shown on the infrastructure layout maps.

- Finally, by overlaying the proposed development on the site map which now includes the flood zones, the layout of an adequate storm water management system would be determined in collaboration with the mining engineers. Conceptual designs of mitigation measures will be indicated to ensure that the impact of the mining activity on the environment is limited to the designated dirty water areas. This will include the provision of lined pollution control dams to contain the expected 1:50-year dirty water runoffs. The dirty water is normally re-used on haul roads (dust control) and in the Process Plant. Clean water streams will be diverted by canals and berms to natural water courses and storm water control dams, where required. The reduction in mean annual runoffs of all affected tributaries of the Mutamba River will be calculated.
- The cumulative effect on the main stem flow in the Mutamba and Nzhelele Rivers will be estimated.
- To prevent excessive scour in the clean water diversion systems, which would increase the natural silt load in the receiving streams, the diversion canals should be lined where the slopes are steep and be provided with suitable energy dissipating structures to limit the flow velocity on the unlined sections. At the discharge points to natural streams, flow transition structures should be provided to release the water to the natural stream at "normal" (i.e. the natural) flow velocity. The development of wetlands may be stimulated by adapting a "conducive" design at the outlet of the canals.
- In view of the locality of the site within the zone of tropical storms and cyclones, the surface water plan will incorporate guidelines to implement preventative measures in the case of extreme flood events exceeding the 1:50 year recurrence period, e.g. additional emergency storage dams. The advantages of increasing the flood control system to cater for the 100-year flood event will be considered. Statistically, the risk of the 50-year flood occurring at least once in the design life of the mine of 30 years is 45.5 % while the risk of a 100-year event occurring once in the same period is about halved, at 26%.

2.5.3 IMPACT OF THE DEVELOPMENT ON SURFACE WATER SOURCES

Regarding surface water related activities, the following may result:

- **Direct impacts** are those impacts directly linked to the project (e.g., extraction of water, contamination of water bodies, sedimentation).
- **Indirect impacts** are those impacts resulting from the project that may occur beyond or downstream of the boundaries of the project site and/or after the project activity has ceased (e.g. migration of pollutants from waste sites, reduced flow in downstream rivers).
- **Induced impacts** are impacts that are not directly attributable to the project but are anticipated to occur because of the presence of project (e.g. impacts of associated industries and residential settlements on surface water quality and quantity with increased pressure on biodiversity).
- **Cumulative impacts** are those impacts from the project combined with the impacts from past, existing and reasonably foreseeable future projects that would affect the same biodiversity or natural resources (e.g. a number of mines in the same catchment or ecosystem type may collectively affect water quality or flow).

2.5.3.1 The Mining Site

The storm water management system as described above aim to prevent pollution of the normal surface water runoff and minimize the pollution risk for the larger storm events. The table below shows the expected major impacts on surface water runoff in the Mining Site both in terms of quantity and quality, in the absence of any control measures, as well as the reduced impact, in qualitative terms, with control measures.

ACTION	IMPACT WITH NO MITIGATION MEASURES	MINING MITIGATION MEASURES	IMPACT WITH MITIGATION MEASURES
Opencast mining	Excessive runoff into pit from upslope areas– dangerous to miners and reducing surface water runoff.	Upslope safety barrier/water diversion berm.	Pit storm water inflow reduced with less impact on surface runoff quantity.
	Water contaminated.		Water contaminated (smaller quantity) for use in pit.
	Dewatering of pit into downslope environment – scour and contamination of large area, including streamflow and groundwater.	Re-use water for dust control in pit and/or haul roads/plant area with no runoff to areas outside designated dirty water areas	Water from pit re-used in dirty water area, no outflow to streams with storms less than 1:50-year event.
Underground mining	Excess contaminated water pumped out into environment.	Contain all water in underground shafts for use as cooling water. Excess water pumped into lined pollution control pond.	Dirty water contained and re-used.
Coal wash plant	Concentrated contamination of surrounding area and drainage lines/streams due to coal particles and coal dust in contact with flowing water.	Diversion of upstream clean runoff and ring fencing plant area to contain and re-use contaminated water.	Dirty water contained and re-used, with reduction in surface water runoff, balanced by less demand for external water source.
Stockpiles (clean material)	Erosion down steep slopes.	Constructed with terraces where runoff is intercepted and discharged through chutes to lower levels; vegetation of lower slopes to proceed.	Storm water runoff from chutes through silt trap led to clean water channel system.
Discard Dumps	Contamination of surface and ground water from runoff and seepage through dump.	Constructed on impervious layer provided with sub-soil drains to collect contaminated seepage in dirty water system.	Contamination reduced and water can be re-used.
Haul Roads	Excess dust leading to air pollution and dangerous driving conditions.	Re-use dirty water from dams with dust retardant to control dust. Application rate to be controlled not to cause product runoff.	Cleaner air and safer driving conditions.
Ablution facilities	Faecal water contamination.	Provide sanitation system with DWA approved waste water treatment works	No microbiological water contamination.
Backfilling opencast pits with discards	When voids are saturated and acids have formed, acid mine drainage (AMD) will occur.	Layer deposits with suitable matter to buffer acid-formation.	When decant occurs after pit filling and AMD is detected, treatment of the outflow will be required to release water at the RWQO prescribed by DWA.

2.5.3.2 Downstream Users

The proposed mine will impact on Downstream Users both in terms of quality and quantity. The operation and maintenance of the mitigation measures described in the table above is of prime concern. The quality of water released from the MRA area by the clean storm water system should not be contaminated and excess siltation should be controlled by proper design and housekeeping.

The quantifiable impact on downstream users is the reduction in runoff. This will be quantified on a mean annual basis and shown as a percentage of the mean annual runoff in the quaternary catchment and in downstream catchments.

2.5.4 WATER QUALITY ISSUES (INCLUDING SILTATION)

A first round of river water sampling has been done. Long term data from DWA gauges will be obtained to serve as background information.

Flow in the site streams are mostly ephemeral and sampling for those would be limited to summer. During the EIA Phase of the study, another round of baseline water quality samples will be obtained in the wet period for inclusion in the water quality monitoring plan, still to be developed. During the life of the mine, the monitoring of primary pollution markers will be required on a monthly basis and results will be captured to be incorporated into a quarterly report over the lifespan of the project, which will provide a real time reflection/indication of the activities impacting on the surface water environment. It is however of importance that the monitoring points are only selected after the infrastructure layout plan is available to identify the correct and representative sampling points and determine the frequency of sampling required.

The baseline sampling, which include more constituents than the primary pollution markers, will include the following:

- Macro-elements and other indicators: pH, electrical conductivity, total dissolved solids, nitrate, fluorite, sulphate, chloride, calcium, magnesium, sodium, ammonia, Total hardness, phosphate.
- Trace metals: aluminium, chrome, iron, manganese, nickel, copper, zinc, cadmium, lead, cobalt.

Note that the list is not exhaustive since other specialists may require testing of additional elements.

The water quality results will be compared to the DWA South African Water Quality Guidelines (1996), for drinking water, agriculture (irrigation and livestock) and aquatic water use.

2.5.5 INTERACTION WITH OTHER TEAM MEMBERS

Interaction with other specialists will be established in the course of the study and are important because of:

- The interaction of groundwater and surface water, i.e. decant of groundwater into streams.
- The likelihood and details of acid mine drainage after mine closure, as identified by the geohydrologist.
- The impact of the natural erosion process of soils on water quality as determined by the soil scientist.

2.6 GROUNDWATER

Tasks to be performed for the detailed EIA phase will include:

- Confirm the location and use of all groundwater abstraction systems, i.e. boreholes, springs, caissons and well points. A borehole census will be required on certain farms where no info is available.
- Define the aquifer characteristics and develop a conceptual model of the groundwater regime.
- Set up a numerical groundwater model based on the conceptual model developed.
- Model the impact of mining on the groundwater system, determining inflows to the pits and water level variations over the life of mine.
- Determine the groundwater/surface water interaction with specific reference to the Mutamba River.
- Conduct a risk assessment of the impacts.
- Recommendations for the implementation of a monitoring system.
- Set up an environmental management plan for groundwater with recommendations for mine closure.
- Cross-referencing with other specialists to evaluate impacts in terms of community health, down-stream users, vegetation, agriculture and future projects.

2.7 AIR QUALITY

Full dispersion modeling will be carried out as part of the Impact Assessment Phase of this study. This modeling takes wind speed and direction into consideration and will then determine which areas are likely to be impacted on, as a result of mining activities.

To clearly detail the potential impacts in ambient ground level concentrations, only construction and operational emissions will be evaluated during the impact assessment phase of the EIA. The decommissioning phase of the project can only be qualitatively addressed due to its variability and unpredictable nature.

The different mitigation measures will be applied to the modelling simulations and the best possible measure will be decided on.

The proposed methodology which will be followed during the air quality impact assessment phase is provided as follows:

- An assessment of the construction and operational phases of the proposed project will be undertaken by evaluating (where possible) fugitive and point source emissions.
- Emission rates and source characteristics obtained from the client will be input into the AERMOD dispersion model to predict the off-site air quality impacts.

The model used in the estimation of impacts arising from the proposed activities has an uncertainty which is equal to 2, this it is possible for the results to be over predicting by double or under predicting by half. It is therefore recommended that monitoring to be carried out at the proposed mine during operations to confirm the modelled results and to ensure legal standards are maintained.

An assessment of compliance will be conducted using available health risk screening levels obtained for the pollutants identified. Comparison will be made to both locally and internationally available health risk levels for these pollutants.

Dispersion modelling will be undertaken using the US-EPA approved AERMOD Dispersion Model. This model is based on the Gaussian plume equation and is capable of providing ground level concentration estimates of various averaging times, for any number of meteorological and emission source configurations (point, area and volume sources for gaseous or particulate emissions).

The AERMOD View model can be used extensively to assess pollution concentrations and deposition from a wide variety of sources. AERMOD View is a true, native Microsoft Windows application and runs in Windows 2000/XP and NT4 (Service Pack 6).

Whilst it is noted that AERMOD and all dispersion models are somewhat limited, as it is not possible to recreate nature in a mathematical model. AERMOD has been accepted by the Department of Environmental Affairs (DEA) as a suitable model and is classified as a regulatory model in the United States. The limitations in terms of sources are deemed acceptable.

The AERMOD modelling capabilities are summarised as follows:

- AERMOD may be used to model primary pollutants and continuous releases of toxic hazardous waste pollutants;
- AERMOD model can handle multiple sources, including point, volume, area and open pit source types. Line sources may also be modelled as a string of volume sources or as elongated area sources;
- Source emission rates can be treated as constant or may be varied by month, season, hour of day, or other periods of variation, for a single source or for a group of sources;
- The model can account for the effects aerodynamic downwash due to nearby buildings on point source emissions;
- The model contains algorithms for modelling the effects of settling and removal (through dry deposition) of large particulates and for modelling the effects of precipitation scavenging from gases or particulates;
- Receptor locations can be specified as gridded and/or discrete receptors in a Cartesian or polar coordinate system;
- AERMOD incorporates the COMPLEX1 screen model dispersion algorithms for receptors in complex terrain;
- The model uses real-time meteorological data to account for the atmospheric conditions that affect the distribution of air pollution impact on the modelling area; and
- Output results are provided for concentration, total deposition, dry deposition, and/or wet deposition flux.

Input data to the AERMOD model includes source and receptor data, meteorological parameters, and terrain data. The meteorological data includes wind velocity and direction, ambient temperature, mixing height and stability class. Meteorological Data as mentioned within the scoping report is obtained from the South African Weather Services, the legal repository for all air quality and meteorological data in South Africa, and the terrain data is obtained from the South African Surveyor General.

The uncertainty of the AERMOD model predictions is considered to be equal to 2, thus it is possible for the results to be over predicting by double or under predicting by half, it is therefore recommended that monitoring be carried out at the proposed mining locations during operation to confirm the modelled results, to finally ensure legal standards are maintained.

All models currently available include an error factor of two. This is a standard legal caveat included in all software terms and conditions. AERMOD has been tested by the DEA and is a recommended model for use in South Africa.

The emissions inventory will need to be developed to determine the emissions generated from each source. This is likely to be undertaken using the US-EPA AP42 emission factors. These emission factors will be calculated based on standard operating conditions for various industries, and activities, and are used as an accepted alternative if no site specific or monitored data are available. The inventory will be developed based on the mine and plant operations and will require information relating to processes for mineral concentrate, tonnages processed and mining activity information.

Once these impacts have been quantified, appropriate management measures can be suggested to best mitigate the predicted impacts. These modelled results will similarly allow for the assessment of compliance to local and International Standards.

2.8 ENVIRONMENTAL NOISE

The general procedure used to determine the noise impact will be guided by the requirements of the Code of Practice SANS 10328:2008: Methods for Environmental Noise Impact Assessments. The level of investigation will be the equivalent of an EIA. A comprehensive assessment of all noise impact descriptors (standards) will be undertaken. The noise impact criteria used specifically will take into account those as specified in the South African National Standard SANS 10103:2008, The Measurement and Rating of Environmental Noise with Respect to Annoyance and Speech Communication as well as those in the National Noise Control Regulations. The investigation will include the following:

- Determination of the existing situation (prior to development).
- Identification of the noise sensitive receptors in close proximity to the mine and transport routes.
- Determination of the situation during the construction phase and the operational phase.
- Assessment of the change in noise climate and impact.
- Identification of mitigation measures.

The full impact assessment will take into account the data provided in this report. The following input data can be used in the modelling of the different scenarios.

- Scenario 01: Baseline;
- Scenario 02: Construction Phase – Earth Clearing;
- Scenario 03: Construction Phase – Construction of plant and pit establishment;
- Scenario 04: Operational Phase – Active mining (open pit);
- Scenario 05: Operational Phase – Active mining (underground);
- Scenario 05: Operational Phase – Project associated traffic and waste rock dump; and
- Scenario 06: Cumulative result

Scenarios testing the effectiveness of the proposed mitigation measure will also be included in the scenario list. This will help in selecting the best available option of mitigation.

The meteorological data to use in the CadnaA software is, for annual assessments, an average temperature of 20°C and 50% humidity, as per the integrated temperature and humidity options provided by CadnaA. As with any modelling project, it is advised to incorporate the terrain profile of the study area in the modelling software. The terrain of the region will be changed, due to the waste rock dump, and this should be included in the modelling.

All calculated model results must be compared to the project specific guidelines. The cumulative impact should also be calculated (taking into account the baseline noise level + new additional noise from this project).

Based on experience these proposed scenarios should be investigated to assess the full impact of the project:

- Baseline Noise Climate – utilising the existing noise sources' sound power levels to replicate the noise levels as measured at the different locations in the study area;
- Construction Phase – Earth clearing – the noise model replicating the typical conditions that would occur during the earth clearing and levelling stage of construction;
- Construction phase – Pit/Shaft establishment – the noise associated with the establishment and construction of mine- pits or shafts;
- Operational Phase – Cumulative plant and mining noise – the noise associated with day-to-day operation of the mine; and
- Mitigated Scenario – Construction and Operational mitigation measures to investigate.

The purpose of the environmental noise impact investigation will be to determine and quantify the noise (unwanted sound) impact on the environment and identified noise sensitive receptors surrounding the planned The Duel Coal Project and the access road to the new mine.

The results of the measurements and calculations shall be used to evaluate the noise impacts associated with The Duel Coal Project and a risk score will be awarded to the environmental impact. The rating of the environmental impact shall be used in order to recommend mitigation measures for the risk.

2.9 BLASTING AND VIBRATION STUDY

BM&C has been appointed to perform a Blast and Vibration Study for the proposed The Duel Coal Project to determine the possible effects of blasting operations in terms of Ground vibration, Air blast, Fly rock and Noxious fumes.
The project area was reviewed on scoping level phase. Some possible points of interest were identified for possible influence. One area of possible influence was identified and indicated. Various installations were identified within the 3500m from the proposed new operation. Three areas ranging from 0 to 3500 m was identified with different levels of possible influence indicated. The possible influences and level of influence will be investigated and if required mitigation measures will be recommended during the impact assessment phase.

2.9.1 SCOPE OF WORK

A detailed study will be prepared on evaluating the possible influences from blasting operations at the project. The data will be presented in a formal report and arranged according to the following sections of aspects that will be evaluated.

Consideration will be given to the following:

- Ground vibration prediction and modelling;
- Ground vibration and human perception;
- Vibration impact on water wells;
- Vibration impacts on animals, including game and birds and domestic animals (cattle, chickens, pigs, etc.);
- Vibration impact on national and provincial roads;
- Vibration impact on communication towers and equipment in the area sensitive to vibration;
- Vibration that may impact on adjacent communities;
- Damage of houses and consequent devaluation;
- Vibration impact on water boreholes;
- Air blast expected from future blasting operations;
- Fly-rock expected; and
- Noxious fumes.

Safe Blasting Procedures will be developed for the project to mitigate the potential impacts.

2.9.2 LEGISLATIVE REQUIREMENTS

The following acts contain references that will applicable to the study. Aspects on control of blast impacts, vibration and air blast are addressed in these acts:

- Explosives Act No. 26 of 1956 and its amendments GNR.1604 of 8 September 1972.
- Environment Conservation Act No. 73 of 1989.
- Mineral and Petroleum Resources Development Act No. 28 of 2002 and amendments GNR.527 of 23 April 2004.
- Mine Health and Safety Act No. 29 of 1996 and amendments GNR.93 of 15 January 1997.
- Ground vibration and air blast is also evaluated according to the USBM (United States Bureau of Mines) guidelines for safe blasting.
- Ground vibration and air blast is also evaluated according to guidelines as used by BM&C based on experienced and knowledge.

2.9.3 PLAN OF STUDY

The objective is to outline the expected environmental effects that blasting operations could have on the surrounding environment. The study will investigate the related levels and possible influences of expected ground vibration, air blast, fly rock and noxious fumes on the area of 3500m surrounding the blast areas.

The receiving environment is classed into three areas:

- 0 to 500 m which is considered the most critical. In most blasting operations this area is considered the unsafe zone and is normally cleared of all people and animals when blasting is done in a mining environment.
- Lesser sensitive is the 500 m to 1500 m reference area. 1500m is considered range by Blast Management & Consulting as range where influence may be lesser but still requires active monitoring.
- The lowest critical area is the 1500 m plus to approximately 3500 m. In this area the effects have more possibility of upsetting people than causing damage to structures.

Indicated in Figure 1 are different ranges indicated with various points of interest (POI) identified to date. These points are locations of possible receptors. At this stage this is not the final list of receptors as site visit will confirm receptors and more detail review is required of the area. This is a basic indication of possible receptors.

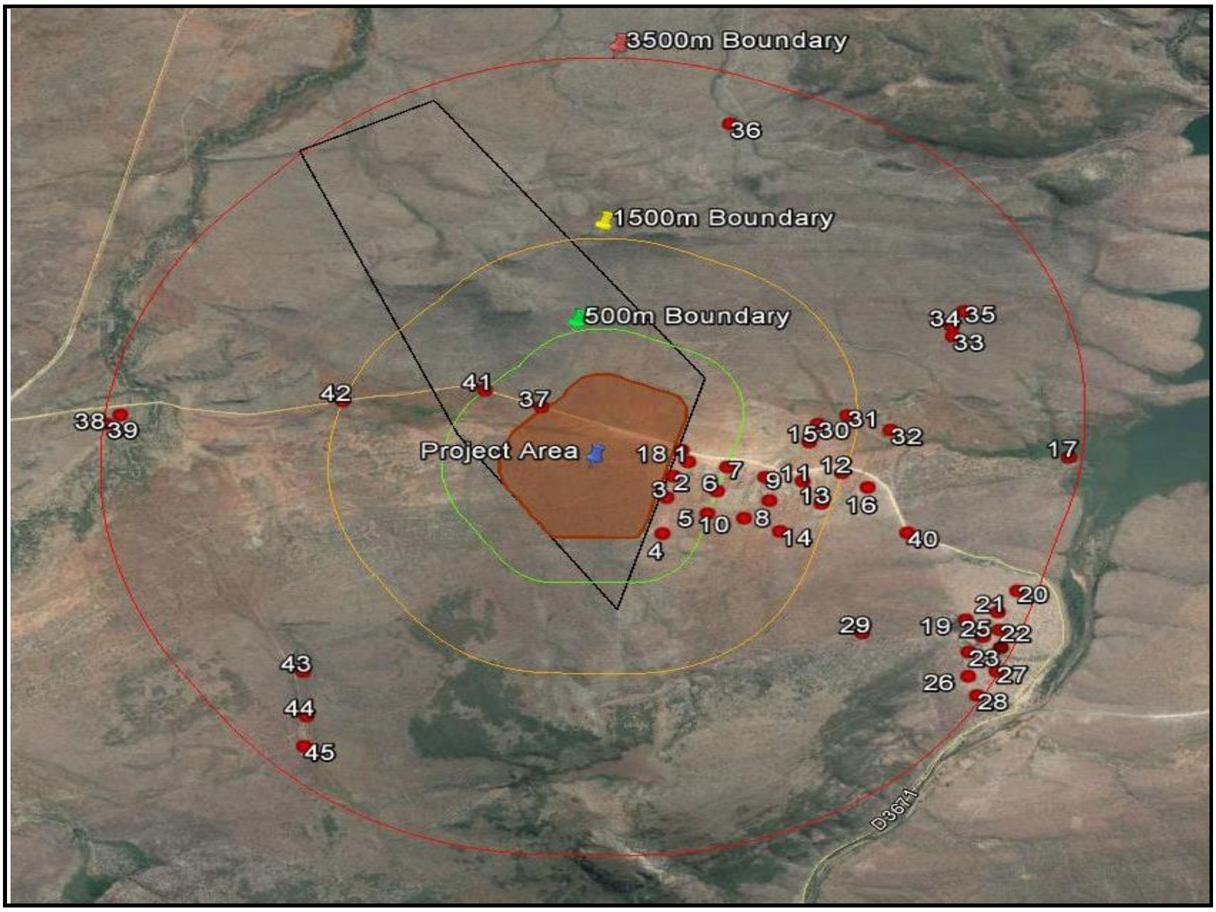

Figure 1: Study Area with POI and ranges from pit

The specific levels of influence to be considered contributing to damage of structures/installations in the area cannot be determined at this stage. The geology and expected drilling and blasting operations to be done with the possible influence with regards to the human perceptions of ground vibration and air blast will be considered. Humans are sensitive to even very low-level effects of ground vibration and air blast. In order to take this into consideration an area of 3500m is identified as area that could observe influence. This is in view that people will experience ground vibration levels as low as 0.75mm/s.

The objective is to outline the expected environmental effects that blasting operations could have on the surrounding environment. The study will investigate the related levels and possible influences of expected ground vibration, air blast, fly rock on the surrounding area.

In order to complete the impact assessment, the following will be done:

- Conduct a site visit for determining location of structures and structure profile: Determine typical structures and installations that are found in within the influence radius form the operation.
- Obtain all relevant data and information on proposed blasting methods and methodology.
- The process then consists of modelling the expected impact based on planned drilling and blasting information for the operation. Various accepted mathematical equations are applied to determine the attenuation of ground vibration, air blast and fly rock. These values are then calculated over distance from site and shown as amplitude level contours. Overlay of these contours with the location of the various receptors then give indication of the possible impact and expected result of potential impact. Evaluation of each receptor according to the predicted levels will indicate level of possible influence and required mitigation if necessary. The possible environmental or social impacts are then addressed in the detailed EIA phase investigation.
- Prepare a report that provides the discussion and outcomes of all evaluations.
- Present the outcomes to interested and affected parties if required.

2.10 HERITAGE RESOURCES

A heritage resource impact may be defined broadly as the net change, either beneficial or adverse, between the integrity of a heritage site with and without the proposed development. Beneficial impacts occur wherever a proposed development actively protects, preserves or enhances a heritage resource, by minimising natural site erosion or facilitating non-destructive public use, for example. More commonly, development impacts are of an adverse nature and can include:

- destruction or alteration of all or part of a heritage site;
- isolation of a site from its natural setting; and / or
- introduction of physical, chemical or visual elements that are out of character with the heritage resource and its setting.

A Phase 1 HIA was undertaken for this project and the report submitted to SAHRA in fulfillment of the requirements of the NHRA.

The following, flowing from the recommendations of the HIA, will be conducted during the EIA Phase:

- Although not specifically recommended, SAHRA may require mitigation for an assessment by a Stone Age specialist. No feedback was received from SAHRA in this regard.
- Plant fossils have been observed in the project area, which falls in a palaeontological very high sensitivity area. A SAHRA recognized palaeontologist must be employed to undertake at least a desktop palaeontological assessment of the project area. The terms of reference for this study were as follows:
    - Conduct a desktop assessment of the potential impact of the proposed project areas on the palaeontological heritage of each of the project areas.
    - Describe the possible impact of the proposed development on the palaeontological heritage of the site, according to a standard set of conventions.

- Quantify the possible impact of the proposed development on the palaeontological heritage of the site, according to a standard set of conventions.
- Provide an overview of the applicable legislative framework.
- Make recommendations concerning future work programs as, and if, necessary.

2.11 VISUAL IMPACT ASSESSMENT

2.11.1 KEY OBSERVATION POINTS

Conceptual visual simulations will be rendered and illustrated from key locations and will be presented as the development is envisioned in its pre-mitigated and post-mitigated state.

Key Observation Points (KOPs) will be identified based on prominent viewpoints, where uninterrupted views of the proposed development may occur and at points where positive viewshed areas intersect with potential receptors. The majority of KOPs will be selected within 10 km of the proposed project, as receptors beyond this distance are unlikely to be significantly affected.

The KOP analysis will be conducted by investigating the visual influence of proposed structures as per the available site layout. Major routes, such as the N1 and the R525, which carry increased amounts of traffic, as well as local roads, will also be considered during the assessment.

2.11.2 LINE OF SIGHT ANALYSIS

A line of sight and elevation profile analysis will be conducted through drawing of a graphic line between two points on a surface that shows where along the line the view is obstructed. Emphasis will be placed on confirming whether the proposed mining infrastructure will be visible from the villages located within 10km of the study area, protected areas (Nzhelele Nature Reserve) and from prominent roads (N1 and R525) towards the west and north of the study area.

2.11.3 IMPACT ASSESSMENT

Several potential risks to the receiving environment that may occur as a result of the proposed mining project are presented below:

- The proposed project may impact on the existing landscape and visual character of the region and Sense of Place associated with the study area and its immediate surroundings. The character of the landscape in the region of the study area is currently dominated by mountainous topography interspersed with wide valleys and characterised by low-density rural development, with the vegetation comprising closed bushveld vegetation, typical of the region. The study area itself and the larger region have not previously been exposed to mining activities and the overall character of the landscape will therefore be significantly altered by the proposed mining activities;
- The altered visual environment during the various development phases of the proposed mining project may lead to high levels of visual intrusion on the study area, with high levels of incompatibility with the surrounding land uses as well as high levels of visual contrast. This in turn will negatively impact on the existing medium to high VAC (the ability of an area to visually absorb development) of the study area;

- The proposed mining project may impact on visual exposure and visibility, which relates directly to the perception of sensitive visual receptors towards the project. Sensitive visual receptors have been determined to primarily comprise of residents living within 5km of the proposed project, local roads users, as well as potential tourists and hunters visiting the nature reserves, game farms and lodges in the region. Direct visual exposure will take place as a result of mining infrastructure being visible to residents of the various settlements in the immediate vicinity of the study area, as well as indirectly through fugitive dust generated by construction and operation related activities, such as construction vehicles driving on dirt roads, as well as blasting and earthworks activities. Temporary stockpiles and the construction of access roads will also alter the visual environment. In addition to physical mining infrastructure, impacts from clearing of vegetation, potential erosion as a result of bare soils and alteration of local topography will also create contrast in the landscape and will be highly visible to receptors; and
- Lighting associated with the proposed project may be visible during both day and night but is more likely to have an adverse visual impact during the night time. Lighting from operational activities may be visible for significant distances and indirect lighting impacts, such as sky glow (the scattering of light in the sky) may reduce the night sky quality at locations very distant from the light sources.
- Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time. Cumulative visual impacts resulting from landscape modifications as a result of the proposed project in conjunction with further planned mining activity within the region is likely to be of high significance, even more so due to the fact that no existing mining activities is currently present within the region. The cumulative impact of additional traffic on the local and regional roads will also occur and affect the sense of place of the larger region.
- It is possible that some surface infrastructure, including open pit areas may remain present post-closure and that rehabilitation and revegetation of the project footprint may not be successful. This will lead to a permanent visual impact in the area that may be significant, due to the extent and height of mining infrastructure.

The impacts will be quantified as far as possible during the EIA Phase. The following points will be considered when undertaking the assessment:

- Risks and impacts will be analysed in the context of the project's area of influence encompassing:
    - Primary project site and related facilities that the client and its contractors develop or controls;
    - Areas potentially impacted by cumulative impacts for further planned development of the project, any existing project or condition and other project-related developments; and
    - Areas potentially affected by impacts from unplanned but predictable developments caused by the project that may occur later or at a different location.
- Risks/Impacts will be assessed for all stages of the project cycle including:
    - Pre-construction;
    - Construction;
    - Operational; and
    - Closure and Rehabilitation
- Residual and post-closure impacts will also be considered;
- If applicable, transboundary or global effects will be assessed;

- Individuals or groups who may be differentially or disproportionately affected by the project because of their disadvantaged or vulnerable status will be assessed; and
- Particular attention will be paid to describing any residual impacts that will occur after rehabilitation.

2.11.4 MITIGATION MEASURES

Recommendations and management measures will be developed to address and mitigate potential impacts on the visual and aesthetic environment associated with The Duel Coal Project. These recommendations will include general management measures, which apply to the proposed development as a whole, including general housekeeping guidelines relating to the proposed project and management measures to limit visual impacts from dust, vehicle movement and lighting type and placement, as well as recommendations on infrastructure appearance and specific management measures applicable to individual infrastructure components in terms of screening potential. Mitigation measures will be developed to address issues during all project phases throughout the life of the operation from planning, through to construction and operation to after care and maintenance. Rehabilitation requirements will also be considered.

2.11.5 MONITORING

A visual monitoring programme, to ensure that mitigation measures regarding visual impacts are implemented and maintained, must be designed for implementation throughout all development phases. Aspects to be included in such a monitoring plan will be developed and outlined.

2.12 SOCIAL IMPACT ASSESSMENT

2.12.1 FIELD RESEARCH

Field research is planned for the coming months. Upon its completion the socio-economic impact assessment will be compiled.

2.12.1.1 Observations

Direct observation, such as site visits or photographic records, are descriptive records developed by participant observers. It captures free-form impressions, going beyond limitations of previously defined categories and interactions are observed in a natural setting.

2.12.1.2 Socio-economic Interviews and Surveys

The following socio-economic surveys will be conducted:

- Makushu/Mosholombe Settlement Household survey: 400 surveys
- Agricultural activities: Interviews with all existing activities within 1 km radius from project site (estimated 5)
- Mining activities: Gathering Information on planned and existing mining activities
- Regional assessment: Interviews with the municipal structures

Interviews are conversations in which questions are asked by the interviewer to obtain information from the interviewee. Benefits of interviews are that it allows for detailed, qualitative insights into interviewees' perspectives and if using a less structured approach increases chance of identifying factors not previously incorporated into assessment. The potential drawbacks includes that it must account for biases of the interviewer and interviewee and it can be time-consuming; and it may not be feasible if perspectives are needed from a large group. Seeing that the footprint of the project is medium sized it is anticipated that this approach will be effective to gain information if coupled with direct observations and collection of external data.

2.12.1.3 Information from other specialist studies and stakeholder consultation process

The review of information from other specialist studies may support the integration of direct physical impacts with the secondary socio-economic impacts that occur.

2.12.2 SOCIAL IMPACT ASSESSMENT

Social impact analysis will amongst others be done for expected changes in the social environment to:

- Demographic processes
- Socio-economic processes
- Geographic processes
- Institutional and legal processes
- Emancipatory and empowerment processes
- Socio-cultural processes
- Biophysical processes

The objectives of the mitigation measures are:

- To describe an action plan to achieve the mitigation measures identified during the impact assessment.
- To make recommendations on a monitoring programme to review the success of the mitigation measures and to provide information to the relevant decision-makers.
- The potential significance of every environmental impact identified is determined by using a ranking scale, based on the terminology from the DEA guideline document.

The report will serve to verbalise and quantify possible impacts and its significance in a coherent and descriptive manner.

2.12.3 SOCIAL MANAGEMENT PLANS

As part of the EMPr it is recommended that Social Management Plans is compiled which will serve as a mitigation policy and management plan for the impacts on the social environment including but not limited to:

- Social Impact Management Plans (including land use and influx management plan)
- Grave relocation and visitation policy (if required)
- Traffic and Safety policy

- Pre-blast and Blast Notification / Evacuation Procedures (with the focus on pre-blast surveys and evacuation)
- Other policies to be identified as part of the Social Impact Assessment

2.13 MACRO-ECONOMIC IMPACT ASSESSMENT

The focus of the economic impact analysis is macro-economic, stressing linkages between the project and the remainder of the relevant economy. Environmental externalities may affect other economic sectors and are included in the tools of the macro-economic impact assessment. Also, the local, regional and national socio-economic impact is assessed.

2.13.1 APPROACH

The approach is to establish the economic baseline of the current economic activities and weigh the change in land use of the mining proposal against the current economic baseline. This will include the possible negative impact on the current activities as well as the environment, physical and social.

In determining the economic impact of the proposed The Duel Coal Project, the economic impact on a wider scale, namely the Limpopo Province and the RSA, is considered together with the possible impact on the current economic activities in and surrounding the proposed mining area.

It is necessary to establish a baseline for the current economic activities in and adjacent to The Duel Project Area and do an estimation of the potential impact of the proposed development. Issues to be investigated and reported upon, include:

- Possible impacts on local population including the quality of life;
- Impacts on the natural environment and associated costs including the cost of possible mitigation measures;
- Potential impacts on the local municipality, the Limpopo Province and South Africa as an entity; and
- The economic sustainability of the project taking into consideration the associated economic risks.

The Macro-Economic Impact Assessment will be performed as follows:

- The possible impact on current economic activities, population and the environment, by first establishing a baseline of current activities to eventually determine possible deviations from the baseline. This will be performed in current monetary units and converted to economic parameters like Gross Domestic Product (GDP) and socio-economic parameters Employment and Payments to Households. Eventually the nature and magnitude of the possible economic impacts on the impacted agricultural sector (including game farming and the associated activities) emanating from the proposed The Duel Coal Mine Project will be determined. As such a comparison of the impacts (probably negative) that the project will have on the agricultural sector will be weighed against the positive economic development that the project will bring to the region, as is essential in projects of this nature.
- The determination of whether the project is economically viable. It is necessary to determine whether the benefits associated with the project actually outweigh the possible costs/negative impacts. This determination will include the impact on the environment as well as on the social quality of life.

- If the project is found to be economically viable, the positive macro-economic parameters must then be estimated.

2.13.2 ECONOMIC VIABILITY (MICRO ANALYSIS)

A Cost-Benefit Analysis (CBA) forms part of the macro-economic impact analysis and focuses on the positive and negative economic impacts in order to put all direct and secondary impacts of the project into perspective for effective decision-making purposes.

The theoretical foundations of a CBA are; benefits are defined as increases in human wellbeing (utility) and costs are defined as reduction in human wellbeing. For a project or policy to qualify on cost-benefit grounds, its social benefits must exceed its social costs. "Society" is simply the sum of individuals. The geographical boundary for a CBA is usually the nation but can be readily extended to wider limits.

To determine the economic viability of the proposed project an economic CBA will be done in accordance with the Water Research Commission's publication "A Manual for Cost Benefit Analysis in South Africa with specific Reference to Water Resource Development" Second Edition. In short, the CBA can be described as a system whereby the costs and benefits of a specific development project are compared to evaluate the financial and economic viability of the project. The CBA method provides a logical framework by means of which development programmes can be evaluated and serves as an aid in the decision-making process.

The CBA will accommodate all the possible negative impacts on local economic activities, impacts on the environment and, if applicable, rehabilitation.

2.13.3 MACRO-ECONOMIC IMPACT ANALYSIS

The objective of this part of the study is to determine the economic and socio-economic impacts of both the construction and operation of the coal mining processes to be conducted by Subiflex. The study reflects the total direct and indirect macro-economic impacts in quantified terms for the investment that will be generated through the inputs from all of the economic entities that are required to supply goods and services to the construction and operational segments of the project. In addition, quantification is made of the induced effects that the infrastructural investments will have on economic entities such as households, in terms of their income and expenditure activities.

According to the general economic equilibrium analysis, the impacts of the project's developments can only be evaluated meaningfully if such impacts are assessed against the background of its total effect (direct and indirect) on certain economic objectives. The updated and benchmarked 2006 Limpopo Provincial SAM tables were used as a modelling input to quantify the relevant economic impacts. Thus, both the investment and operational activities of the project were analysed in terms of its impacts.

The macro-economic impact analysis can be regarded as an extension of the more narrowly defined financial cost-benefit analysis, at the macro level and not at the project level, demonstrating the efficiency of utilising scarce capital and other economic resources. The macro-economic analysis is therefore used in conjunction with the micro project CBA to provide an indication of the project's use of scarce resources relative to the main economic objectives contained in the economic development plan.

The economic and socio-economic aggregates covered in the study are the following:

- Employment levels (jobs).
- Value added to the economy (or gross Limpopo Province product).
- Aggregate wages and salaries.
- Fiscal impacts.

Each of these measures reflects a particular dimension of improvement or impact in the economic well-being of the area's households.

There are different types of impacts that occur over time. In the initial construction phase, labour and materials will be used. After completion, on-going employment and other long-term impacts will result, as set out below.

- Total Employment Levels, reflecting the number of additional employment opportunities created by economic growth. This is the most popular measure of economic impact because it is easy to comprehend. However, employment opportunity counts do not necessarily reflect the quality/nature of the employment opportunities, nor salary levels. Therefore, levels of employment, i.e. skilled/unskilled could also be assessed where necessary.
- Value Added, which is normally equivalent to Gross Domestic Product or Gross Regional Product, and a broader measure of the full income effect.
- Aggregate Wages and Salaries in the area increase as pay levels rise and/or additional employees are hired. Either or both of these conditions can occur as a result of growth in business revenues. As long as nearly all of those affected employees live in the study area, this is a reasonable measure of the personal income benefit impact of a project.

It is also important to note that economic impacts also lead to financial impacts, which are changes in government revenues and expenditures. Economic impacts on total business sales, wealth creation or personal income, can affect municipal and other government revenues by expanding or contracting the tax base. Impacts on employment and associated population levels can affect municipal and other government expenditures by changing demand for public services.

This on-going process of macro-economic impact analysis focuses on aspects stressing linkages between the project and the surrounding economy. Environmental externalities may affect other economic sectors and are, therefore, included in the techniques of macro-economic impact assessment. This is necessary to assist in determining whether the project will enhance net societal welfare.

This necessitates the analysis of impacts on different sectors or groups that make up society. At a broad level, investigating impacts on overall economic welfare requires considering the efficiency, equity and sustainability of the project. It is important that all three of these aspects are considered in order to provide adequate information to decision makers:

- The principle of efficiency raises the issue of whether the nature and form of the project would constitute the efficient use of resources.
- The equity principle requires the consideration of whether the project results in outcomes that can be considered fair/equitable in socio-economic terms. Investigating the distribution of impacts is required to clearly indicate who is impacted upon, in what way and for what period.

- Sustainability relates to the consideration of whether the project is likely to be financially viable over the medium to long term and whether it will be economically sustainable. Risks to the long-term success of the project, including factors such as changing interest and exchange rates, therefore, become important aspects for assessment.

A partial general macro-economic equilibrium model based on the Social Accounting Matrix (SAM) of the Limpopo Province is used to determine the nature and magnitude of the macro-economic impacts that emanate from the project in terms of its impacts on larger macro-economic aggregates such as:

- Impact on Gross Domestic Product (GDP).
- Capital utilization.
- Employment impact.
- Impact on all households.
- Fiscal Impacts from tax revenues and royalties.
- Balance of Payment Impacts as a result of imports and exports.
- Infrastructure development.
- Efficiency Criteria for Capital and Labour.
- Income generation for subcontractors in Limpopo.

The economic impacts associated with the project consist of a construction and a production (operational) phase. For purposes of this assessment, both phases will be measured, and it is envisaged that the macro-economic; direct, indirect and induced emanating from the primary project as well as all the externalities will be addressed.