BIODIVERSITY MANAGEMENT PLAN: ANGLOGOLD ASHANTI – VAAL RIVER OPERATIONS

2013 UPDATE

EXECUTIVE SUMMARY

Clean Stream Biological Services was appointed by AngloGold Ashanti to conduct a comprehensive biodiversity assessment and compile a biodiversity management plan (BMP) for the Vaal River surface rights area in 2007. This was a continuation of a desktop study conducted in 2005 to compile a draft biodiversity management plan (CSBS, 2005). The 2007 study consisted of intensive specialist assessments (soil, vegetation, terrestrial and aquatic fauna) of the study area. This biodiversity study enabled the delineation of the surface rights area into different biodiversity management units (BMU's), with distinct differences in biodiversity aspects. It furthermore describes the status of different biodiversity components (e.g. vegetation, frogs, birds, fish, threatened plants, threatened fauna, alien plants, etc.) within the study area.

The following primary conclusions were drawn from this study:

- The 2013 updated plant species list for Vaal River now includes 597 plant species and infraspecific taxa, of which 74 (15.2%) are naturalised alien species.
- Of the 516 indigenous plant taxa, seven are currently categorised as 'species of conservation concern'. The presence of one threatened and four Near Threatened plant species have been confirmed within the Vaal River study area (*Nerine gracilis, Lithops lesliei* subsp. *lesliei, Pearsonia bracteata* and *Trachyandra erythrorrhiza*). Detailed management measures have been recommended for especially the two near-threatened plant species recorded, that should be strongly considered for implementation.
- Of the 81 alien plant species thus far recorded within the study area, thirty-eight are Declared Weeds, Declared Invaders and proposed Declared Weeds or Invaders in accordance to the 'Conservation of Agricultural Resources Act' (Act 43 of the Republic of South Africa 1983), as amended in 2001. It is strongly recommended that the alien plant control programme should be implemented and maintained.
- A total of 22 monitoring sites were established during the current baseline monitoring survey. It is strongly recommended that the vegetation monitoring programme for these sites be maintained over the long term to enable the determination of deterioration or improvement in veld condition.
- A detailed riparian vegetation assessment indicated that the Schoonspruit can be classified in an ecological category D and has a low ecological importance and ecological sensitivity. The Vaal river falls in an ecological category C with a low ecological importance and a low to moderate ecological sensitivity.
- Based on distribution ranges and available habitats within the study area, it was estimated that 389 terrestrial animal species, including 12 frog species, 34 reptile species, 267 bird species and 76 mammal species could be expected to occur here.
- Seven of the 12 expected amphibian species were observed in the study area during the biodiversity surveys (2007 and 2013). The presence of one near-threatened frog species (Giant Bullfrog *Pyxicephalus adspersus)* has also been confirmed in the study area.
- Fourteen of an expected 34 reptile species were recorded in the study area during the faunal surveys conducted between 2007 and 2013.

- Hundred and sixty-two of an expected 267 bird species have been recorded in the study area between 2007 and 2013. None of these 9 threatened species were observed during the current study.
- Fifteen of the 67 expected mammal species were observed during the surveys. None of the ten red data listed animal species were observed during the current study.
- The presence of nine of an expected twelve indigenous fish species have been confirmed in the study area. The presence of two alien fish species was also confirmed.

This study indicated that in the Vaal River surface rights area, there are three BMU's with very-high biodiversity conservation value (BMU1: Vaal River ecosystem) and BMU6: Rocky grassland and sparse woodlands and BMU7: Sandy grassland). Another two BMU's have high biodiversity conservation value (BMU2: Jagspruit ecosystem and BMU5: *Acacia caffra-Euclea crispa* thicket) while three more has moderate to moderate high importance. Biodiversity management of the Vaal River surface rights area should be focussed on these BMU's (Table 15). Current activities should be managed and future mining activities planned to impact as little as possible on these BMU's. Various human activities were identified to potentially pose a risk to the biodiversity aspects of each BMU in the study area. It is strongly recommended that the management actions as stated in the report should be considered for implementation in the study area.

Economic and social development and environmental protection are the essential elements of sustainable development. The nexus between economic development and the conservation of natural resources has been a subject of continued debate. Reconciling economic and social development opportunities with the need for biodiversity conservation and environmental protection requires the development of more strategic and integrated approaches to land use planning and management in order to assist in making informed decisions.

South Africa is rightly very proud of its rich biodiversity. However, the countries biodiversity is under threat from climate change, pollution, the excessive use of resources and invasive plant and animal species. Developers are now under pressure to reduce and report on its impacts on biodiversity. Many of these developers have the opportunity to contribute to biodiversity conservation and management through gaining a better understanding of the ecosystems on their sites, and often through small changes to the way land is managed. AngloGold Ashanti's Vaal River operations is fortunate to be in control of an area that is richly endowed with exciting plant and animal species that needs protection.

Summarized biodiversity conservation value of the Biodiversity Management Units of the Vaal River operations study area.

Biodiversity Management Unit	BIODIVERSITY CONSERVATION VALUE				COMMENTS
	Botanical (vegetation)	Terrestrial fauna	Aquatic fauna	OVERALL	
BMU1: Vaal River ecosystem	High	Very High	High	**VERY-HIGH**	68 recorded plant species (23.6/100m^2) and potential presence of 288 terrestrial animal species (10 frog species, 24 reptile species, 197 bird species and 57 mammal species) 12 fish species and approximately 61 aquatic-macro-invertebrate taxa. Of these, two frogs, four reptiles, 112 bird, three mammal species were observed during the two surveys. Three plant species of conservation concern recorded within BMU1 namely *Nerine gracilis* (Vulnerable), *Trachyandra erythrorrhiza* (Near Threatened) and declining species *Crinum bulbispermum*. BMU1 meets the habitat requirements of at least 15 animal species of conservation concern (one fish, one frog, one reptile, two birds and ten mammals).
BMU2: Jagspruit/Schoonspruit ecosystem	High	High	Moderate-High	**HIGH**	36 recorded plant species (36/100m^2) and potential presence of 190 terrestrial animal species (11 frog species, 7 reptile species, 150 bird species and 22 mammal species). Of these, three frogs, two reptiles, 58 bird and one mammal species were observed during the two surveys in BMU2 on the mine. BMU2 also meets the habitat requirements of at least seven species of conservation concern (one frog, one reptile, one bird and four mammal species).
BMU3: Drainage lines	High	Moderate	Moderate-low	**MODERATE-HIGH**	19 recorded plant species (19/100m^2) and potential presence of 151 terrestrial animal species (12 frog species, 7 reptile species, 111 bird species and 21 mammal species). Of these, two frogs, 33 bird and four mammal species were observed during the two surveys in BMU3 on the mine. BMU3 furthermore meets the habitat requirements of at least seven species of conservation concern (two frogs, one reptile, two bird and two mammal species).
BMU4: *Acacia karroo* Closed Woodland	Moderate	Moderate	n/a	**MODERATE**	44 recorded plant species (29.5/100m^2) and potential presence of 199 species of terrestrial animals (26 reptile species, 134 bird species and 39 mammal species). Four reptiles, 63 bird and three mammal species were observed during the two surveys in BMU4 on the mine. This biotope also meets the habitat requirements of nine species of conservation concern (one reptile, two bird and six mammal species).
BMU5: *Acacia caffra-*	High	High	n/a	**HIGH**	72 recorded plant species (51/100m^2) and potential presence of 197

Biodiversity Management Unit	BIODIVERSITY CONSERVATION VALUE				COMMENTS
	Botanical (vegetation)	Terrestrial fauna	Aquatic fauna	OVERALL	
Euclea crispa Thickett					animal species (28 reptile species, 125 bird species and 44 mammal species). Four reptiles, 37 bird and two mammal species were observed during the two surveys. This biotope furthermore meets the habitat requirements of eight species of conservation concern (one reptile, two mammal and six bird species).
BMU6: Rocky Grassland and Sparse Woodland	Very high	Very high	n/a	**VERY HIGH**	152 recorded plant species (49.9/100m^2) and potential presence of for 232 terrestrial animal species (31 reptile species, 148 bird species and 53 mammal species). BMU6 has the largest expected number of reptiles (31 species), which utilize the crevices and cracks in the abundant rock protrusions, as well as the dense bushy clumps scattered through the biotope. Three reptiles, 78 bird and 12 mammal species were observed during the two surveys in BMU6 on the mine. *Three* Near Threatened plants (*Lithops lesliei* subsp. *Lesliei, Pearsonia bracteata and Adromischus umbraticola)* were recorded within this BMU.
BMU 7: Sandy Grassland	Very high	High	n/a	**VERY HIGH**	54 recorded plant species (39.5/100m^2) and potential presence of 148 animal species (one frog species, 19 reptile species, 91 bird species and 37 mammal species). The fact that seasonal pans might form in this biotope during high rainfall years, render it suitable habitat for the Giant bullfrog (*Pyxicephalus adspersus*). Two reptiles, 26 bird and seven mammal species were observed during the two surveys in BMU7 on the mine.
BMU8: Infrastructure	Negligible	Very low	n/a	**NEGLIGIBLE**	Highly transformed areas with negligible biodiversity conservation value. Should be managed to limit its impact on untransformed habitats.
BMU9: Cultivation	Low	Very low	n/a	**VERY LOW**	Totally transformed habitats with no potential for threatened plant or animals species.
BMU10: Secondary Grassland	Low-moderate	Moderate	n/a	**MODERATE**	27 recorded plant species (15/100m^2) and potential presence of 115 terrestrial faunal species (22 reptiles, 73 birds, 20 mammals). It includes potentially suitable habitat for at least 6 Red Data listed animal species.
BMU11: Secondary Wetlands	Low	Low-moderate	Low to negligible	**LOW-MODERATE**	14 recorded plant species (14/100m^2) and potential presence of 112 terrestrial faunal species (5 frogs, 4 reptiles, 91 birds, 12 mammals). It includes potentially suitable habitat for at least 4 Red Data listed animal species.

Biodiversity Management Unit	BIODIVERSITY CONSERVATION VALUE				
	Botanical (vegetation)	Terrestrial fauna	Aquatic fauna	OVERALL	COMMENTS
BMU12: Alien trees/plantations	Negligible	Negligible	n/a	**NEGLIGIBLE**	Completely transformed habitat with low indigenous plant species richness and potential presence of 28 terrestrial faunal species (3 reptiles, 23 birds, 2 mammals). It includes potentially suitable habitat for at least 1 Red Data listed animal species.

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1. INTRODUCTION

Clean Stream Biological Services was appointed by AngloGold Ashanti to conduct a comprehensive biodiversity assessment and compile a biodiversity management plan (BMP) for the Vaal River surface rights area in 2007. This was a continuation of a desktop study conducted in 2005 to compile a draft biodiversity management plan (CSBS, 2005). The 2007 study consisted of intensive specialist assessments (soil, vegetation, terrestrial and aquatic fauna) of the study area. This biodiversity study enabled the delineation of the surface rights area into different biodiversity management units (BMU's), with distinct differences in biodiversity aspects. It furthermore describes the status of different biodiversity components (e.g. vegetation, frogs, birds, fish, threatened plants, threatened fauna, alien plants, etc.) within the study area.

The current study (2012/3) was aimed at addressing some of the recommendations from the 2007 study, as well as incorporating additional requirements from the mine. The detailed results of the various specialist studies, conducted in 2012/3, were then used to update the 2013 biodiversity management plan (this report). The current report (2013 Biodiversity Management Plan) is to serve as a summary document providing an overview of the important biodiversity-related aspects of the mine, with reference to relevant documents where more detail can be sourced if required. The Biodiversity Management Plan furthermore goes hand in hand with an "interactive" electronic GIS-product compiled as part of the biodiversity assessments (electronically provided on DVD). One of the main uses of the GIS-product is to view spatial biodiversity information and to enable the overlay of different biodiversity aspects on aerial views of the mining area. The GIS-product can be used as an important tool in mine planning and especially in biodiversity management on the mine.

The main objective of the Biodiversity Management Plan (BMP) is to provide recommendations for biodiversity management at the mine by utilising available information gathered through various specialist studies conducted at the mine. It must therefore be emphasised that the aim of this report is not to provide or repeat all the detail regarding the different biodiversity aspects of the mine, but rather to summarise the most important aspects. The detail regarding the different biodiversity components (such as soil, vegetation, wetlands and animals) is provided in various specialist reports (provided in electronic DVD format together with the GIS product).

AngloGold Ashanti's Vaal River operational area presently contains some natural areas with moderate to very high biodiversity conservation value. In preparation of imminent changes in legislation, the mine should include relevant aspects pro-actively into a biodiversity management plan. Detailed assessments of site-specific ecosystems and the development of a management and monitoring strategy for biodiversity will enable the mine to manage its own biodiversity effectively and to facilitate the integrated management thereof on a regional and national context. In this sense, management and conservation refers to the conservation of biological diversity, rehabilitation of disturbed land to a planned post-closure use, as well as the sustainable use of its biodiversity components. This biodiversity management plan aims to provide the information required to compile a site-specific Biodiversity Action Plan for the biodiversity management of the Vaal River surface rights area.

2. BACKGROUND ON BIODIVERSITY

Biodiversity is a term used to describe all aspects of biological diversity, especially species richness, ecosystem complexity and genetic variation. "Biological diversity" or "biodiversity" means “the variability among living organisms from all sources including inter alia, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part including diversity within genes, species and between species (plant and animals), ecosystems, land-/seascapes, as well as ecological and evolutionary processes that allows these elements of biodiversity to persist over time” (COMSA, 2009; DEA *et al.,* 2013). Biodiversity loss due to worldwide over-exploitation of natural resources has become the focus of attention during recent years. The Convention on Biological Diversity (CBD) set a goal to achieve significant reduction in biodiversity loss by 2010 (Hui *et al*., 2008). A total of 143 countries including South Africa ratified the Convention on Biological Diversity at the 1992 Earth Summit in Rio de Janeiro.

South Africa ranks as the third most biologically diverse country in the world, and contains three of the world’s 34 biodiversity hotspots. As such, South Africa is of major global importance for biodiversity management and conservation (DEA *et al.,* 2013). Mining can be viewed as a sector of the South African industry that does not depend upon the direct, consumptive use of biodiversity, but may depend upon the maintenance of biodiversity, or may inadvertently have considerable negative impacts on biodiversity. Some of the potential negative impacts mentioned include habitat degradation, loss and fragmentation, the overexploitation of species, the pollution of soil, air and water, the invasion of harmful alien organisms and climatic change. A concern that arises with the use of land for mining is that the level of biodiversity in the region is normally diminished as a result. This concern can be addressed through proper planning, responsible mining with concurrent rehabilitation as well as through special measures to conserve resident species. Ecosystems support all life in a variety of ways: directly, through oxygen production by plants, recycling and redistribution of nutrients and minerals: or indirectly, through provision for waste disposal. These natural systems provide for basic human needs, such as food and water.

Legislative framework

Sustainable development is enshrined in South Africa’s Constitution and laws. Section 24 of the Constitution states that “everyone has the right (a) to an environment that is not harmful to their health or well-being; and (b) to have the environment protected, for the benefit of present and future generations, through reasonable legislative and other measures that: prevent pollution and ecological degradation; promote conservation; and secure ecologically sustainable development and use of natural resources while promoting justifiable economic and social development.”

Biodiversity in South Africa was not regulated historically by means of National Legislation. The National Environmental Management: Biodiversity Act (no. 10 of 2004) now sets out a framework for planning the conservation and sustainable use of biological diversity in South Africa. Landowners are now by law obliged to manage the biodiversity on their properties. The following two acts now specifically aim to regulate biodiversity management:

1. National Environmental Management: Biodiversity Act no. 10 of 2004

The National Environmental Management: Biodiversity Act no. 10 of 2004 sets out a framework for planning the conservation and sustainable use of biological diversity within a broader framework of planning for sustainable development. It provides for the development, monitoring and review of a national biodiversity framework, which shall be a National Biodiversity Strategy and Action Plan (NBSAP), giving effect to the objectives of the Convention on Biological Diversity (CBD). The preparation of bioregional conservation plans, that embody the ecosystem approach of conservation in the context of climatic and geographical characteristics and interaction, is provided for as well as other conservation plans addressing specific components of biodiversity requiring special conservation attention. Some of the sections relevant to the mine are as follows:

- Section 52-53: Your operation should be aware that in terms of Section 52, the Minister or the MEC of a province might, by notice in the Government Gazette, publish a list of ecosystems, which are threatened, and in need of protection. Your operation should be aware that in terms of Section 53, the Minister may, by notice in the Government Gazette, identify any process or activity in an ecosystem listed as threatened and in need of protection, as a threatening process, which requires prior authorisation from the Minister or MEC.
- Section 65-69: The Biodiversity Act defines “restricted activity” in relation to an alien species or listed invasive species as including having in possession or growing such species.
- Section 75: In terms of Section 75, your operation must control and eradicate listed invasive species by means of the prescribed methods.

2. The National Environmental Management Act (NEMA) (Act no. 107 of 1998)

The NEMA principles apply throughout South Africa to the actions of all organs of state that may significantly affect the environment, and thus to decision making on mining applications. These principles require that impacts on biodiversity and ecological integrity are avoided, and if they cannot altogether be avoided, are minimised and remedied. They also specify that the costs of remedying pollution, environmental degradation and consequent adverse health effects and of preventing, controlling or minimising further pollution, environmental damage or adverse health effects must be paid for by those responsible for harming the environment. Moreover the responsibility for the environmental health and safety consequences of a policy, programme, project, product, process, service or activity exists throughout its life cycle.

NEMA principles of particular relevance to biodiversity (DEA *et al.*, 2013) include the following:

- Section 2(4)(a)(i): the disturbance of ecosystems and loss of biological diversity are avoided, or, where they cannot be altogether avoided, are minimised and remedied.
- Section 2(4)(a)(ii): pollution and degradation of the environment are avoided, or, where they cannot be altogether avoided, are minimised and remedied.
- Section 2(4)(a)(vi): the development, use and exploitation of renewable resources and the ecosystems of which they are part do not exceed the level beyond which their integrity is jeopardised.
- Section 2(4)(a)(vii): a risk-averse and cautious approach is applied, which takes into account the limits of current knowledge about the consequences of decisions and actions.

- Section 2(4)(e): responsibility for the environmental health and safety consequences of a policy, programme, project, product, process, service or activity exists throughout its life cycle.
- Section 2(4)(o): The environment is held in public trust for the people, the beneficial use of environmental resources must serve the public interest and the environment must be protected as the people's common heritage.
- Section 2(4)(p): The costs of remedying pollution, environmental degradation and consequent adverse health effects and of preventing, controlling or minimising further pollution, environmental damage or adverse health effects must be paid for by those responsible for harming the environment.
- Section 2(4)(r): Sensitive, vulnerable, highly dynamic or stressed ecosystems, such as coastal habitats including dunes, beaches and estuaries, reefs, wetlands, and similar ecosystems require specific attention in management and planning procedures, especially where they are subject to significant human resource usage and development pressure.

3. The National Environmental Management: Protected Areas Act 57 of 2003

Some of the relevant sections in this act pertaining to mining are as follows:

- Your operation should be aware that in terms of Section 9, the following kinds of protected areas are identified in the Act: special nature reserves (including wilderness areas) and protected environments; specially protected forest areas, forest nature reserves and forest wilderness areas declared in terms of the National Forests Act 84 of 1998 and mountain catchment areas declared in terms of the Mountain Catchment Areas Act 63 of 1970.
- Section 84: Your operation may not conduct commercial prospecting or mining activities in a protected environment without the written permission of the Minister and Cabinet member responsible for minerals and energy. Your operation should be aware that the Minister may review prescribed conditions with regard to any mining activities being conducted on any of these areas prior to 1 November 2004.

Other legal obligations and acts addressing the protection of biodiversity in South Africa include (COMSA, 2009):

- The constitution of South Africa (Act No. 108 of 1996)
- National Water Act (Act No. 36 of 1998)
- Conservation of Agricultural Resources Act (Act no. 43 of 1983)
- Mineral and Petroleum Resources Development Act (MPRDA) (Act 28 of 2002).
- National Forest Act (Act 84 of 1998)
- National Environmental Management: Integrated Coastal Management Act (Act 24 of 2008).
- Convention on Biological Diversity
- Conventions on Wetlands (Ramsar Convention)
- World Heritage Convention (WHC) and World Heritage Convention Act (Act 49 of 1999)

Goods and Services of Biodiversity

Biodiversity matters to human beings in a variety of ways (Lovejoy, 1994). There are important aesthetical dimensions, but part of our existence depends on direct use of biodiversity. Some of the cultural contributions include the provision of food, water, shelter, building material, fuel, medicine, aesthetic value, spiritual value, educational purpose and recreation. It furthermore contributes to biotic and abiotic processes such as adding oxygen to air, enrichment of soils, soil formation, supporting of

nutrient cycle, provision of habitat for fauna and flora, limiting storm damage and regulation of floods and climate.

Biodiversity also serves human society as an indicator of ecological change. A few years ago, herpetologists studying amphibians, particularly frogs, began to compare incidental notes and realized that there was a major decline in populations of frogs throughout the world in patterns that are hard to understand and explain. Something is happening that appears to affect frog populations, and it would be extremely valuable to identify these vectors of change before they affect humans directly.

According to DEA *et al.,* (2013), ecosystem services can be classified into four categories:

- Provisioning services are the harvestable goods or products obtained from ecosystems such as food, timber, fibre, medicine, and fresh water.
- Cultural services are the non-material benefits such as heritage landscapes and seascapes, recreation, ecotourism, spiritual values and aesthetic enjoyment.
- Regulating services are the benefits obtained from an ecosystem's control of natural processes, such as climate, disease, erosion, water flows, and pollination, as well as protection from natural hazards.
- Supporting services are the natural processes such as nutrient cycling, soil formation and primary production that maintain the other services.

Factors reducing biodiversity

By far the biggest problem in protecting the world's biodiversity is habitat destruction. The numbers of loss can be staggering when considering the rapidly declining habitats, especially in the tropics.

Another outcome of habitat destruction is that the available habitat is broken up into pieces. A very disturbing picture appears when we begin to look at what this means for biodiversity. The fragmentation of habitats leaves remnants no longer connected to a larger wilderness and hence species are lost over time. This has serious implications for conservation and the use of landscapes. The good news is that if riparian habitats (vegetation along watercourses) are restored, the landscape has more connectivity, eliminating some of the fragmentation problems.

Stress in the biological community reduces biodiversity. Stress can be a result of a number of factors including air pollution, high loads of fertilizer, introduced species, overgrazing, over utilization, etc. Exotic fauna represent a very severe problem all over the world in this regard.

An additional and ultimate concern is global climatic change due to increasing levels of greenhouse gasses. Most of these gasses come from the burning of fossil fuels that represent carbon reservoirs that have been stored for thousands of millions of years, but which now are being oxidised and released into the atmosphere in a very short geological time. Biodiversity is dependent on an intricate web of factors that can be upset by rapid climatic change.

Beyond the immediate causes that threaten biodiversity, there are ultimate causes, such as human population growth – which adds roughly 100 million new people to the human population every year – and the massive impact of associated economic activities. In addition to these activities and the per-capita consumption in the industrial world, there is an enormous complex web of interactions. When a product is purchased, there may be a long chain between that product and some other part of this country or some other part of the world, which often goes unnoticed.

Biodiversity, Mining and Sustainable development

Although the legacy of the mining industry is not always good when it comes to social and environmental impacts, opportunities exist at every stage of the mining life cycle to reduce the impacts of mining on land use, greenhouse gas emissions, water and biodiversity, and increase the benefits to nearby communities (DEA *et al,* 2013). Biodiversity and mines need to coexist and find common ground. Biodiversity issues are very real and present a real crisis due to increased consumption and populations. It has also become evident that the biosphere cannot tolerate the current mode of economic growth. Massive change in behaviour is required in all sectors to achieve sustainable development. Mainstreaming biodiversity involves integrating the values and goals of biodiversity conservation into the economy (Cowling, 2005). The aim of mines today is to be good stewards of the environment and strive to leave the communities in which they work better than they found them (Godsell, 2005). Mines have huge conservation potential, as they own large amounts of land and only utilize a small amount for mining operations. It is therefore at the local level that we can get mining and conservation integration right (Godsell, 2005). It is important to build into the mining decision framework the understanding that not all biodiversity can be restored, and this should influence mining decision-making. An ecosystem approach should be followed for planning and conservation and it should include a holistic biodiversity and livelihoods assessment (Coombes, 2005).

Sound biodiversity management is more than an ethical and moral imperative; it also makes good business sense (COMSA, 2009). The fundamental principle that is flouted by applying conventional national income accounting to depletable resources is the separation that must be maintained between income and capital (Blignaut and Aronson, 2005). This principle tells us that if you liquidate your assets and use the proceeds for consumption, you are living beyond your means, and in doing so you are undermining your ability to create future income. Three basic rules to sustainability include: for renewable resources, the sustainable rate of use can be no greater than the rate of regeneration; for non-renewable resources, the sustainable rate of use can be no greater than the rate at which renewable resources, used sustainably, can be substituted for them; and for pollutants, the sustainable rate of emissions or effluent can be no greater than the rate at which a given pollutant can be recycled, absorbed or rendered harmless by the environment (Blignaut and Aronson, 2005).

According to COMSA (2009), two of the common reasons for mining companies to manage biodiversity impacts include legislative compliance and risk management. In addition, a greater involvement in biodiversity management adds to the improved image awarded to a company which is seen to be carrying out positive measures towards biodiversity conservation and sustainable development. Failure to adequately manage biodiversity issues can lead to:

- Prosecution and increased liabilities.
- Increased rehabilitation, remediation and closure costs.
- Local community, civil society and shareholders' objections and mobilisation.
- Restricted access to raw materials such as access to land and water resources.
- Compromised access to finance and insurance.

The consideration of biodiversity conservation and protection throughout the phases of a mining project can also reduce the social, economic and environmental risks and have the following benefits (COMSA, 2009):

- Less contentious authorisation periods, as a result of better relationships with regulatory agencies and stakeholders, and thus fewer objections and appeals.
- Reduced risks and liabilities.
- Improved local community relations and partnerships.
- Improved employee loyalty and motivation.

If we can bring about a more integrated approach to living within our ecosystems, we are much more likely to save the fundamental structure of biodiversity. Positive contributions can be made even on a small scale such as within the mine or even just in a single garden. All stakeholders, such as business, government and environmental groups need to be involved to avoid a staggering loss of biodiversity in the decades and centuries ahead. A good start in the local context of the mine is to organize the knowledge of existing biodiversity. Practicable management principles could then be incorporated into the mines' EMPR. It is just basic good biological housekeeping to try to find out what we have and where it is. In turn, biodiversity can be enjoyed and used in a variety of ways and we can learn even more about it and thus help ourselves achieve sustainable development.

Mining and biodiversity guidelines

In 2013, guidelines on mining and biodiversity was published that focuses on providing guidance to the mining sector on how to address biodiversity issues in the South African context. It aims to provide the mining sector with a practical, user-friendly manual for integrating biodiversity considerations into planning processes and managing biodiversity during the development and operational phases of a mine, from exploration through to closure. It is however emphasised that the guideline does not exempt the user from complying with the relevant pieces of legislation (DEA *et al*., 2013).

The guideline document again highlight the fact that the mining industry plays a vital role in the growth and development of South Africa and its economy and the rich endowment of mineral resources has been a key driver of social and economic development. It however also emphasises that on par with this mineral wealth are exceptional endowments of biodiversity and ecosystems. Sustaining the goods and services that flow from our ecosystems, and the benefits that these provide over the long term, will require limits in mining and other activities in certain areas (DEA *et al.*, 2013).

The Guideline (DEA *et al.,* 2013) is founded on **six principles** that should be applied when addressing biodiversity issues and impacts in a mining context:

- Apply the law (as a minimum)
- Use the best available biodiversity information
- Engage relevant stakeholders thoroughly
- Use best practice in environmental impact assessment (EIA) to identify, assess and evaluate impacts on biodiversity
- Apply the mitigation hierarchy when planning any mining-related activities and develop robust environmental management programmes (EMP)
- Ensure effective implementation of EMPs, including adaptive management.

The **principal impacts** of mining on biodiversity comprise (DEA *et al.*, 2013):

- The loss and/or degradation or conversion of land, marine and other aquatic habitats (removal of natural vegetation and destruction of habitat) and associated loss of species.

- Significant alteration of ecological processes, sometimes irreversibly (e.g. the breaching of aquitards14, changes in the water table, disruption of species movement patterns, disruption of the local hydrological cycle and permanent alteration of flow).
- Pollution (including noise and light pollution) and migration of pollutants in air, soils, surface water, groundwater or the ocean.
- Introduction of invasive alien species.
- Changes in demand for, or consumption of, natural resources (either directly or through indirect or induced changes as a consequence of mining activities).

The **mitigation** of negative impacts on biodiversity and ecosystem services is a legal requirement for authorisation purposes and must take on different forms depending on the significance of the impact and the area being affected. A mitigation hierarchy is provided that strive to first avoid disturbance of ecosystems and loss of biodiversity, and where this cannot be avoided altogether, to minimise, rehabilitate, and then finally offset any remaining significant residual negative impacts on biodiversity.

Biodiversity priority areas are areas in the landscape or seascape that are important for conserving a representative sample of ecosystems and species, for maintaining ecological processes, or for the provision of ecosystem services and include the following categories:

- Protected areas (PA's)
- World Heritage Sites and their legally proclaimed buffers
- Critically endangered and endangered ecosystems
- Critical Biodiversity Areas
- River and wetland Freshwater Ecosystem Priority Areas (FEPAs), and 1km buffer of river and wetland FEPAs
- Ramsar Sites
- Protected area buffers
- Transfrontier Conservation Areas (remaining areas outside of formally proclaimed PAs)
- High water yield areas
- Coastal Protection Zone
- Estuarine functional zones
- Ecological support areas
- Vulnerable ecosystems
- Focus areas for land-based protected area expansion and focus areas or offshore protection.

Minimizing impacts of mining is a mitigation measure that applies to the environment in general. In areas where the biodiversity to be affected is of conservation value or importance, then every effort should be made to minimize those impacts that cannot be avoided or prevented. Mining companies should strive to minimize impacts on biodiversity by (DEA *et al*., 2013):

- Minimizing land clearing by using technologies and mining practices that minimize habitat disturbance, and delineating working zones.
- Using proven pollution prevention, control and treatment measures (e.g. treatment of acid mine drainage or leachate from mine waste/dumps).
- Implementing appropriate measures to prevent or manage the introduction and spread of potential invasive species.
- Using effective erosion control measures.
- Avoiding road building wherever possible (during the early stages of the mining life cycle in particular) or existing; and if roads are to be

constructed, using existing corridors and building away from steep slopes or waterways.
- Using lighter and more energy efficient equipment to reduce impacts on biodiversity.
- Positioning drill holes and trenches away from sensitive biodiversity features where possible.
- Capping or plugging of drill holes to prevent animals becoming trapped or injured.
- Removing and rehabilitating roads and tracks that are no longer needed.
- Avoiding fouling or discharge of pollutants into aquatic/marine ecosystems.
- Avoiding the introduction of alien species.
- Using indigenous vegetation to re-vegetate land on an on-going basis as part of rehabilitation measures.

It should be noted that in some cases, where the habitat of highly threatened or local endemic species will be negatively impacted, 'search, rescue and relocation' measures are over-emphasised as a means of 'minimizing' impact. This measure is not an acceptable form of mitigation. These measures are no substitute for in situ conservation and, although they may appear to be effective in the short term, they have a net effect of shrinking the distribution of the species and increasing their vulnerability to extinction through loss of habitat. In areas where the biodiversity (or ecosystem services) to be affected are of conservation value or importance, such as in biodiversity priority areas, it is especially important that mitigation should not stop at minimizing impacts; implementing measures to remedy remaining impacts through rehabilitation/restoration and/or biodiversity offsets should become an imperative as reflected in the national environmental management principles (Section 2 of NEMA).

3. ANGLOGOLD ASHANTI VAAL RIVER OPERATIONAL AREA

The study area consists of the AngloGold Ashanti Vaal River operational area which comprises approximately 23 000 ha (Figure 1). It is situated adjacent to the town of Orkney on the boundary of the North West and Free State provinces of South Africa. Areas influenced by mining and related infrastructure, formal and informal settlements and agriculture are distributed across the entire study area. Emphasis was placed on the surface rights area (and not minerals rights area), as the mine can only effectively manage the biodiversity on the surface areas they have control over.

The study area comprises flat to gently undulating terrain. The only significant ridge is a small rocky (Black Reef rocks) ridge situated near the northern central boundary of the study area. The entire study area is situated at between 1270 m.a.s.l. and 1340 m.a.s.l. The soils of the study area are mostly sandy loam soils. The underlying geology of the central, northern and eastern parts of the study area comprises dolomite, whereas that of the remainder of the study area comprises mostly of andesite and sandstone. The Vaal River flows through the study area from east to west, and the only other river present is the weakly perennial Jagspruit, which is situated to the north of the Vaal River in the western parts of the study area, and is a tributary of the Vaal River. The climate can be characterised as warm-temperate summer-rainfall region, with overall Mean Annual Precipitation (MAP) of approximately 560mm. The summer temperatures are high, but severe and frequent frost occurs in winter.

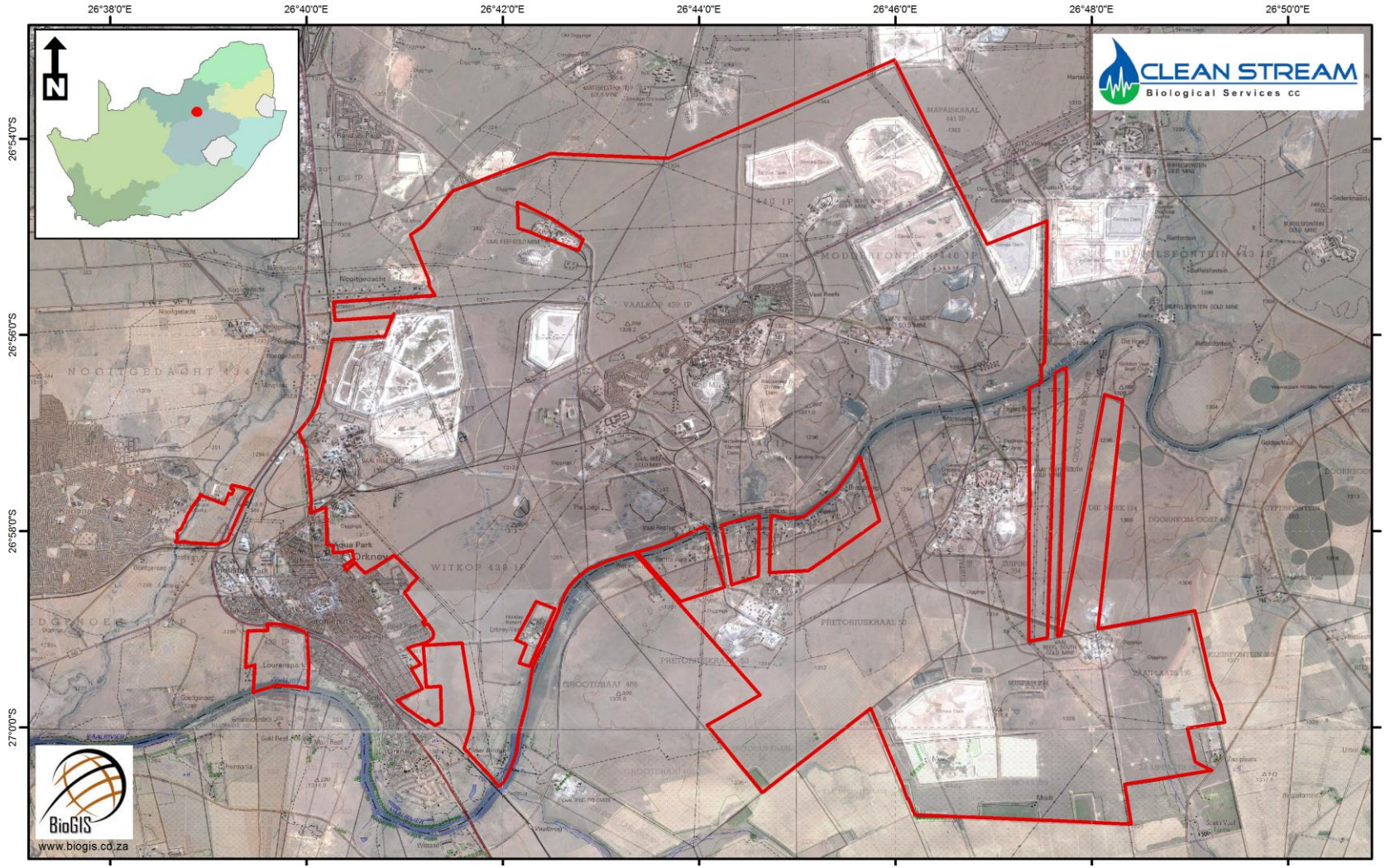


Figure 1: Locality map indicating the study area (2013) or the AngloGold Ashanti Vaal River operations.

4. BIODIVERSITY AT ANGLOGOLD ASHANTI's VAAL RIVER OPERATIONS

There are three levels at which biodiversity can be approached - namely the genetic, the species and the ecosystem levels. Genetic diversity refers to the variation of genes within species. Species diversity refers to the variety and abundance of species within a geographic area. Ecosystem diversity can refer to the variety of ecosystems within a certain political or geographical boundary (National Environmental Management Biodiversity Act, 2004). This biodiversity assessment focused on the description of ecosystem- and species-related biodiversity. It can be expected that if ecosystem diversity is managed effectively, species and genetic diversity should also be protected. Emphasis was therefore placed on the ecosystem diversity (landscape/habitat types) within the AngloGold Ashanti's Vaal River surface rights area, with reference to biota observed and expected to utilise these landscapes or habitat types. The biodiversity of the study area is presented in the following two ways:

SOIL

During the initial biodiversity assessment conducted in 2007, a soil specialist study was done to compile a soils map of the study area. No additional soil assessments were conducted as part of the 2012/3 survey. During the 2007 study, a total of 211 auger observations and 340 visual observations were made. **Twelve** broad soil patterns, based on soil properties and soil information gathered during auger observations were identified, namely **Hu1**, **Hu2**, **Hu3**, **Cv1**, **Cv2**, **Av**, **Gc**, **Gs**, **Ms1**, **Ms2**, **Oa** and **Rg** and are shown in **Figure 1**. Unit **W** consists of the Vaal River streambed and is covered with water. Units **Res** and **Min** consist of areas comprised by residential areas and mining infrastructure respectively.

The broad soil patterns are summarized in the soils legend (Table 1) in terms of the dominant soil forms and a short description of the broad soil pattern.

Soil chemical properties have little impact on biodiversity in the natural state. Limited soil samples were taken and analysed during 2007 in order to verify soil fertility. It was however observed that soil pollution, generated by leaking pipelines, tailings dams and plants often occurred (Rehab Green, 2007). Some soil samples were taken at polluted areas.

Extractable cations were analysed using the Ammonium Acetate method. Phosphorus was determined using the Bray 1 method. Soil acidity (pH) was determined in a 1:2.5 water solution. A water soluble extract was prepared to determine electrical conductivity (EC) and sulphate (SO_4). The fertility (extractable cations) of the non-polluted areas varies from low to moderate. The P status is very low except for sampling points 29 and 81 which are moderate to high. The soil acidity (pH) varies from acid to neutral. Electrical conductivity and sulphate (indicators of salt pollution) were analyzed at localities where pollution was expected. The effect of electrical conductivity on plant growth is shown in Table 3.

Table 1: **Broad Soil Pattern Legend**

Broad Soil Pattern Legend					
Map Unit	**Soil Forms**	**Broad Map Unit Description**	**Unit Count**	**Area (ha)***	**% of Total***
Hu1	Hutton, Bainsvlei, Clovelly	Moderately deep to deep, yellowish red to red, sandy loam soils, flat to gently slopes; Andesite.	1	779.3	3.26
Hu2	Hutton, Bainsvlei, Clovelly	Moderately deep, yellowish red to red, wind blown, loamy sand soils, flat to gently slopes; Mainly sandstone.	5	4402.2	18.44
Hu3	Hutton, Mispah	Shallow, red, sandy loam soils, flat to gently slopes, 1-10% exposed surface rock; Dolomite.	3	5104.1	21.38
Cv1	Clovelly, Avalon, Glencoe	Moderately deep, yellowish brown, wind blown, loamy sand soils, flat to gently slopes; Mainly sandstone.	1	158.2	0.66
Cv2	Clovelly, Glenrosa	Shallow, yellowish brown gravely soils, flat to gently slopes, 0-1% exposed surface stone; Andesite.	3	1870.8	7.84
Av	Avalon, Clovelly, Glencoe	Moderately deep, moderately drained, yellow brown, loamy sand soils, flat to gently slopes; Mainly sandstone and shale.	3	1653.4	6.93
Gc	Glencoe, Avalon, Clovelly	Moderately deep, yellow brown, loamy sand soils underlain by ferricrete, flat to gently slopes; Mainly sandstone and shale.	1	69.8	0.29
Gs	Glenrosa, Mispah, Hutton	Shallow, reddish brown stony soils, flat to gently slopes, 1-20% exposed surface stones; Chert rich dolomite.	6	2069.4	8.67
Ms1	Mispah, Glenrosa, Clovelly	Shallow, yellowish brown gravely soils, flat to gently slopes, 1-5% exposed surface stone; Andesite.	1	478.3	2.00
Ms2	Mispah, Glenrosa, Clovelly	Shallow, yellowish brown stony soils, flat to slightly steep slopes, 1-30% exposed surface stone; Black Reef.	1	130.0	0.54
Oa	Oakleaf, Tukulu, Rensburg	Deep alluvial deposits varying from yellowish brown sandy loam to brown clay loam to black clay soils along the Vaal River streambed.	6	1670.0	6.99
Rg	Rensburg, Katspruit, Tukulu, Sepane	Moderately deep, structured, dark coloured clay soils along drainage lines on flat to gently slopes.	2	547.5	2.29
W	Water	Water; Vaal River streambed.	2	321.6	1.35
Res	-	Residential areas.	5	1608.6	6.74
Min	-	Plants, shafts and mining related infrastructure	12	1853.2	7.76
Infra	-	Infrastructure	4	25.8	0.11
Dam	-	Dams	12	174.7	0.73
Tail	-	Tailings dams	5	747.6	3.13
Dist	-	Disturbed areas	5	210.0	0.88
		Total	**78**	**23874.5**	**100.0**

* Vaal River mine lease area (2007 study).

Table 2: **Soil analytical results (2007).**

Samp Point	Soil Form	Hor	Depth	Extractable Cations				P Bray 1	pH (H_2O)	EC	Satur	SO_4			
				Na	K	Ca	Mg			mS/m	%	mg/l	mmol(+)/l	mg/kg	cmol(+)/kg
				mg/kg											
17	Cv2100	A1	0-250	10	185	772	235	0.72	5.81						
20	Rg2000	A1	0-250	415	197	4769	1545	1.17	8.12	49	64.14	44.81	0.933	28.74	0.060
29	Bv2100	A1	0-250	19	313	653	146	27.35	5.74						
		B1	250-700	28	54	1005	284	9.19	6.91						
48	Hu2100	A1	0-250	23	116	312	86	3.64	5.01	21	39.35	21.8	0.454	8.58	0.018
		B1	250-700	10	93	623	136	0.17	5.46	14	46.33	44.79	0.933	20.75	0.043
53	Hu2100	A1	0-250	10	152	534	104	2.26	5.85						
		B1	250-700	11	81	655	124	0.34	6.08						
62	Gs1211	A1	0-250	16	75	260	86	2.30	5.35						
63	Hu2100	A1	0-250	7	155	532	122	0.05	5.99						
		B1	250-700	18	45	345	121	0.22	6.10						
68	Hu2100	A1	0-250	18	74	480	132	1.34	5.60						
79	Oa1110	A1	0-250	28	124	1323	428	0.30	5.97	33	50.57	44.25	0.921	22.38	0.047
		B1	250-700	62	138	2373	725	0.10	6.98						
81	Ka1000	A1	0-250	776	213	1641	1879	11.65	7.25	1049	56.22	10146.4	211.247	5704.31	11.876
		G1	250-700	979	137	1610	2261	0.09	7.57	1243	62.11	13401.6	279.020	8323.47	17.329
83	Hu2100	A1	0-250	319	150	1115	244	2.38	6.13	472	42.67	3738.7	77.839	1595.38	3.322
		B1	250-700	126	60	631	141	0.26	6.40	219	28.18	1533.91	31.936	432.19	0.900
84	Hu2100	A1	0-250	564	263	6393	573	0.34	7.79	611	43.04	5018.35	104.481	2159.70	4.496
90	Gs1211	A1	0-250	1608	138	1963	1288	0.63	6.13	2700	38.06	23919.3	497.996	9103.67	18.954
111	Hu2100	A1	0-250	14	90	524	82	0.13	5.44	67	38.25	270.39	5.629	103.42	0.215

Table 3: Influence of salt content on normal plant growth.

EC (mS/m)	Influence of salt content
0 - 200	Effect of salt quantity can be ignored
200 - 400	Salt sensitive plants can be affected negatively
400 - 800	Normal plant growth will be affected negatively
800 - 1600	Only salt tolerant species will be able to survive
> 1600	No plant species will be able to survive

The electrical conductivity (EC) values in Table 2 are colour-coded according to the effect on plant growth in Table 3. Red and purple colours indicate serious salt pollution. The very high sulphate (SO_4) concentrations in Table 2 are indicated in pink.

NB. The areas that appear to be polluted as observed during the field survey, as well as possibly polluted areas that could be identified on the aerial photos (see soil specialist report, Rehab Green (2007).

Refer to the following report for more detail regarding the soils of the study area:

- REHAB GREEN (2007). Review and Ground truthing of existing soil data of the Vaal River lease area to serve as Baseline Data for a Biodiversity Assessment. Report to Clean Stream.

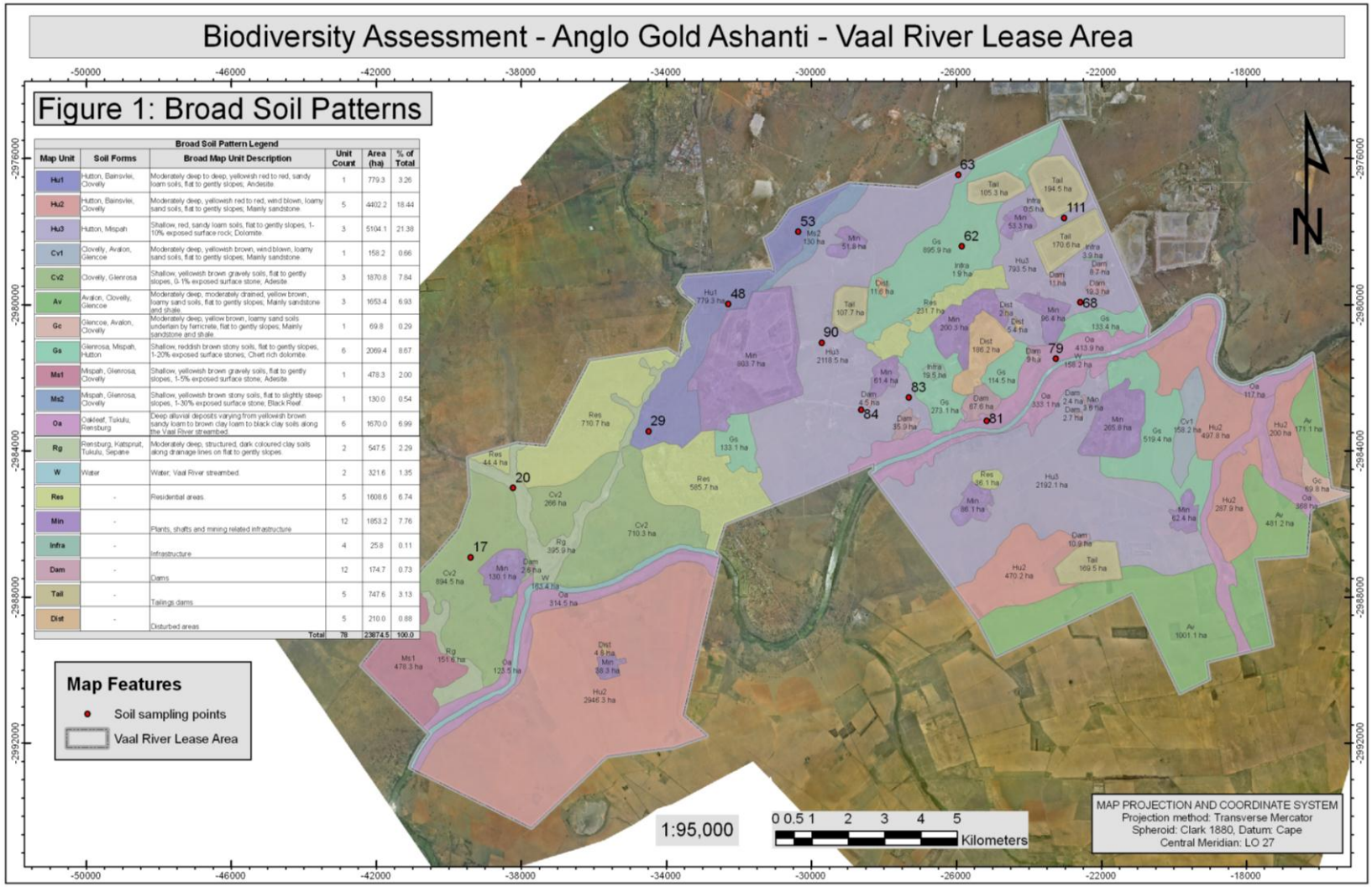


Figure 2: Map of AngloGold Ashanti's Vaal River operational area indicating broad soil units (2007).

VEGETATION

Vegetation classification and units

According to the most recent vegetation map for South Africa, Lesotho and Swaziland (Mucina *et al.*, 2005) and its descriptive companion guide (Mucina & Rutherford, 2007), the majority of the study area falls within the Vaal Reefs Dolomite Sinkhole Woodland (Gh12) vegetation type, whereas the western and southern parts of the study area fall within the Vaal-Vet Sandy Grassland (Gh 10) vegetation type. Vaal Reefs Dolomite Sinkhole Woodland is considered to be ***vulnerable*** nationally, and though the 'Conservation Target' is 24% (Mucina & Rutherford, 2006), none of this vegetation is currently conserved in statutory reserves and some 25% has already been transformed. Transformation is largely as a result of mining, cultivation, urban sprawl and road building. Vaal-Vet Sandy Grassland is considered to be ***endangered*** nationally, and though the 'Conservation Target' is 24% (Mucina & Rutherford, 2006), only 0.3% is conserved in statutory conservation areas and more than 63% has been transformed by ploughing for the cultivation of commercial crops. The remaining untransformed areas are under severe grazing pressure from cattle and sheep.

Vaal Reefs Dolomite Sinkhole Woodland is not listed in the recently published Schedule (Government Gazette of December 2011) of the Biodiversity Act (Act 10 of 2004) as a 'threatened terrestrial ecosystem'. Vaal-Vet Sandy Grassland is listed in the above-mentioned Schedule of the Biodiversity Act as a 'threatened terrestrial ecosystem', which is categorised as "Endangered".

The 'North West Province Biodiversity Conservation Assessment' (Desmet *et al*., 2009) maps almost all parts of the study area situated to the north of the Vaal River as 'Critical Biodiversity Areas' (De Castro & Brits, 2013a). Critical biodiversity areas (CBA's) are areas of the landscape that need to be maintained in a natural or near-natural state in order to ensure the continued existence and functioning of species and ecosystems and the delivery of ecosystem services. In other words, if these areas are not maintained in a natural or near-natural state then biodiversity conservation targets cannot be met. Maintaining an area in a natural state can include a variety of biodiversity-compatible land uses and resource uses (Desmet *et al*., 2009).

During the baseline floristic survey (De Castro & Brits, 2007), a total of 486 species and infraspecific taxa were recorded, of which 74 (15.2 %) were naturalised alien species. During the current revision of the 2007 species list, one plant species which proved to be an incorrect identification was removed and an additional 112 plant species recorded during the current study were added. The current plant species list for the Vaal River Mine Complex therefore contains 597 plant species and infraspecific taxa, of which 81 (13.6%) are alien taxa and **516** are **indigenous plant species** or infraspecific taxa. Of the 516 indigenous plant taxa, seven are currently categorised as 'species of conservation concern' (Raimondo *et al*., 2009 and http//:redlist.sanbi.org, downloaded July 2012), including one threatened species categorised as Vulnerable (*Nerine gracilis*) three Near Threatened species (*Lithops lesliei* subsp. *lesliei, Pearsonia bracteata* and *Trachyandra erythrorrhiza*) and three Declining species (*Boophone disticha, Crinum bulbispermum* and *Hypoxis hemerocallidea*). Of the 81 alien plant species thus far recorded within the study area, thirty-eight are Declared Weeds, Declared Invaders and proposed Declared Weeds or Invaders in accordance to the 'Conservation of Agricultural Resources Act' (Act 43 of the Republic of South Africa 1983), as amended in 2001.

The high species richness and diversity of plant communities found within the study area is attributable to the fact that the study area not only includes two vegetation types, namely Vaal Reefs Dolomite Sinkhole Woodland and Vaal-Vet Sandy Grassland, but is also situated in close proximity to another vegetation types, and is situated in an area of transition between the Savanna and Grassland Biomes (Mucina & Rutherford, 2006).

The broad-scale structural/functional vegetation and land-use units previously identified and mapped for the study area (De Castro & Brits, June 2007), are used to define Biodiversity Management Units (BMU's) for the purpose of this Biodiversity Management Plan. These units remain appropriate, but the mapping of these units has been subjected to minor revision during the current study as a result of additional fieldwork and the availability of higher resolution aerial photographs and Google Earth imagery. The 11 BMU's are listed and briefly described in Table 4, which also provides the revised surface areas of each BMU.

The main 2013 revisions include the following:

- Exclusion of areas mapped in 2007 which no longer form part of the Vaal River Mine Complex surface rights area (e.g.: areas around the Jagspruit and south western parts (to the south of the Vaal River) of the 2007 study area).
- Mapping of 6 newly acquired areas not included in the 2007 study area.
- Mapping of various ephemeral and non-perennial drainage lines and streams not mapped in 2007. These habitats have been included in BMU 3.
- No currently cultivated areas (BMU 9) are currently present in the study area, as all currently cultivated areas are situated in areas to the south of the Vaal River that no longer form part of the Vaal River Mine complex surface rights area.

Table 3: **Revised, annotated list of broad-scale vegetation units identified within the 12,734.85 ha Vaal River Mine Complex study area.**

Biodiversity Management Unit	Vegetation Types/Variations and soil types	Distribution within Mine Area	Surface area	Biodiversity Conservation Value
BMU1. Riverine Vegetation - Vaal River	**U1.a**: Instream and Marginal Vegetation (Alluvial soils) **U1.b**: Riparian Woodland on MC banks (Oa soils) **U1.c**: Closed Shrubland on Floodplain (Oa and Rg soils) **U1.d**: Seasonal Marsh Wetland (Oa soils)	Along the Vaal River	871.83 ha	High
BMU2. Riverine Vegetation - Jagspruit	Includes marginal and floodplain vegetation of the Jagspruit (Rg soils)	Along the Jagspruit	8.43 ha	High
BMU3. Drainage lines – non-perennial streams and valley bottom wetlands	Includes seasonal marsh wetlands of non-perennial or 'valley bottom wetland' (Oa soils and un-mapped hydric soils within Hu1 soil unit)	On northern boundary of Mine Area adjacent to Klerksdorp road and in south-eastern corner of Mine Area.	171.37 ha	High
BMU4. *Acacia karroo* Closed Woodland	Closed Woodland in which *A. karoo* is totally dominant and few other trees occur (Ms1, Hu1 and Hu3 soils).	Eastern parts of study area, to both north and south of Vaal River, and near northern boundary of study are to north of ridge along Klerksdorp road.	196.01 ha	Moderate
BMU5. *Acacia caffra-Euclea crispa* Thicket	Closed Woodland on rocky, north-facing slopes. Dominant trees are *A.caffra, A. karroo* and *Euclea crispa*	On ridge near northern boundary of Mine Area	50.24 ha	High

Biodiversity Management Unit	Vegetation Types/Variations and soil types	Distribution within Mine Area	Surface area	Biodiversity Conservation Value
	(Ms2 soils).	adjacent to Klerksdorp road.		
BMU6. Rocky Grassland and Sparse Woodland	**U6.a**: Grassland and Sparse Woodland on dolomites (Gs and Hu3 soils). **U6.b**: Rocky Grassland on ridge Black Reef rocks (Ms2 soils)	This unit comprises the vast majority of the Mine Area, and the distribution of the various vegetation types follows the distribution of the soils on which they occur.	5838.92 ha	Very High
BMU7. Sandy Grassland	*Themeda* Grassland (Ms1 and Cv2 soils)	This unit comprises large areas of the western and southern parts of the parts of the study area.	147.48 ha	Very High
BMU8. Infrastructure	Includes all mine infrastructure and residential areas (various soils).	Scattered throughout Mine Area.	3240.89 ha	Negligible
BMU9. Cultivation	Maize fields (Av and Hu2 soils)	Almost entirely restricted to area to south of Vaal River.	0 ha	Low
BMU10. Secondary Grassland of previously cultivated areas	Vegetation composition varies in accordance with successional stage and soil type (Av, Hu1 and Hu2 soils)	Largely restricted to Mine Area to south of Vaal River, but also some patches along northern boundary of Mine Area.	1219.45 ha	Low-Moderate
BMU11. Secondary Wetlands associated with dams and mine effluent and seepage	Large *Phragmites* reed beds surrounded by seasonally inundated or saturated soils vegetated by *Cynodon dactylon* and *Juncus* cf. *punctorius* (un-mapped hydric soils within Hu3 soil unit and Oa soils).	Williams G.R. and north of easternmost bridge over Vaal River.	917.02 ha	Low
BMU12. Plantations and areas invaded by alien tree species	Plantations of Eucalyptus and other exotic trees, as well as areas planted with trees as part of the Woodlands Project (various soils)	Widespread.	73.21 ha	Negligible
Total surface area of Vaal River Mine Complex study area			**12 734.85ha**	

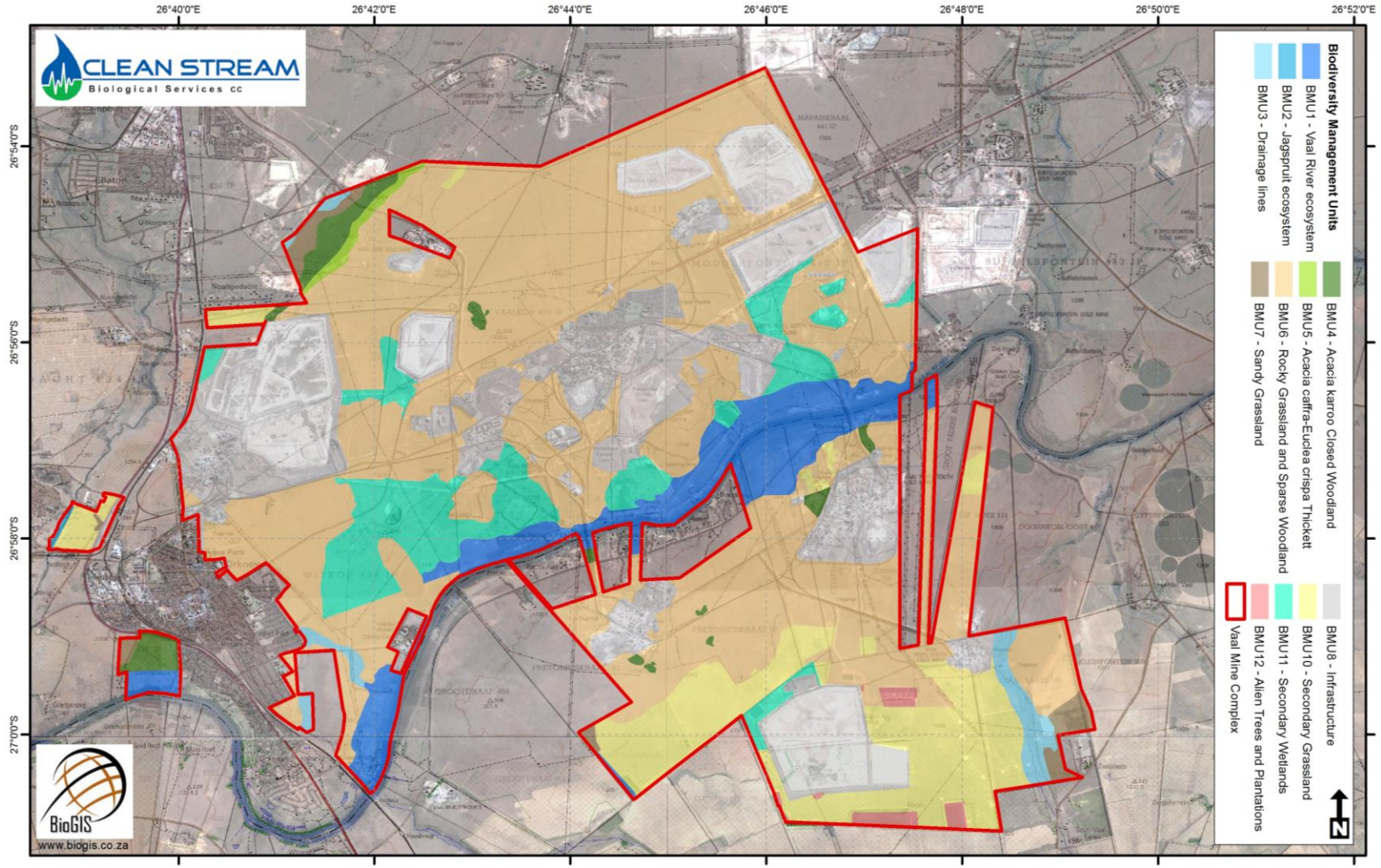


Figure 3: Map of AngloGold Ashanti's Vaal River operational area indicating vegetation units.

Plant species of conservation concern

The analysis of 'species of conservation concern' provided in the baseline vegetation survey (De Castro and Brits, 2007) is now out-dated. On the basis of the historical distribution data then available, the baseline report identified four threatened and Near Threatened species that should be searched for during future surveys conducted in December, February and May. These four species were *Brachystelma incanum* (VU), *Cleome conrathii* (NT), *Marsilea farinosa* var. *arrecta* (VU) and *Kniphofia typhoides* (NT). The current authoritative databases of 'species of conservation concern' show that that none of the four aforementioned species have historically been recorded from the grid within which the study area is situated (2626DC), or three immediately adjacent grids [(2626DD (to the east), 2726BA (to the south) and 2626CD (to the west)] which contain similar habitats. Though the current study included field surveys during November, January and May (as well as February and March), and these species were searched for in potentially suitable habitat, emphasis was placed on searching for the species historically recorded from the grids 2627AD and 2627BC. None of the four aforementioned potentially occurring threatened and Near Threatened species was recorded during the current survey.

Prior to the conduction of the field surveys, available database information pertaining to the plant 'species of conservation concern' of the region of the North West Province within which the study area is situated was obtained from the National Herbarium PRECIS database (http//:posa.sanbi.org). All 'threatened species', namely Critically Endangered, Endangered and Vulnerable species, and other '*species of conservation concern*', namely Near Threatened, Declining, Critically Rare and Rare species (Raimondo *et al*., 2009 and http://redlist.sanbi.org, downloaded August 2013) historically recorded from the quarter degree grid square within which the study area is situated (2626DC), as well as three immediately adjacent grids [(2626DD (to the east), 2726BA (to the south) and 2626CD (to the west)], were extracted from these lists and emphasis was placed on searching for these species in potentially suitable habitat within untransformed parts of the ca. 12,735 ha study area.

The Red List of South African Plants (Raimondo *et al*., 2009) provides an assessment of all South African Plant taxa. The Red List therefore contains species that are currently regarded as being threatened with extinction (Critically Endangered, Endangered and Vulnerable) or are close to being threatened with extinction (Near Threatened), as well as species that are currently not regarded as being threatened with extinction (Least Concern), in accordance with IUCN Version 3.1 criteria (IUCN, 2001). In addition to the IUCN categories, the South African Red List also includes categories for species which do not currently qualify as threatened or Near Threatened in accordance with IUCN criteria, and are thus categorised as Least Concern, but which are of some conservation concern (Raimondo *et al*., 2009). These South Africa categories are Critically Rare, Rare and Declining, and were developed specifically to highlight species that though not threatened with extinction, require some conservation effort and monitoring.

The obtained lists of historically recorded 'threatened species' and other 'species of conservation concern' included no threatened (CR, EN or VU) or Near Threatened species and only one Declining species, namely *Hypoxis hemerocaliidea,* which has been historically recorded within the grid 2626DC (study area grid). The poorly explored (in a botanical sense) nature of the study area and its surrounds is reflected by the fact that the baseline floristic survey and the current follow-up floristic surveys, revealed the

presence of subpopulations of one threatened species (*Nerine gracilis*), three Near Threatened plant species (*Lithops lesliei* subsp*. lesliei, Pearsonia bracteata* and *Trachyandra erythrorrhiza*) and three Declining plant species (*Boophone disticha, Crinum bulbispermum* and *Hypoxis hemerocallidea*) within the ca. 12,735 ha Vaal River Mine Complex study area (Figure 4). The presence of two of the four recorded threatened and Near Threatened plant species was revealed by identifying the plants from an extensive collection of photographs of flowering plants taken by Mr Gunther Wiegenhagen (AngloGold Ashanti) at Vaal River at various times of year over many years. The two recorded *Lithops* subpopulations were also only recorded as a result of anecdotal evidence gathered by Mr Wiegenhagen that indicated that the plants may be present at two localities on the mine property. *The invaluable contribution made by Mr Wiegenhagen to the current floristic follow-up survey clearly illustrates the absolute necessity of having experienced and knowledgeable naturalists who spend many hours in the field within the Biodiversity and Heritage section of the mines Environmental Management Department.*

In addition to the seven aforementioned 'species of conservation concern' that have been recorded within the study area, *Adromischus umbraticola* (NT) has also recently been recorded by Mr Wiegenhagen approximately 1km to the north of the study area within the grid 2626DC. A species which may possibly be the *Drimia sanguinea* (NT) was also recorded from photographs, but the identity of this *Drimia* could not be confirmed as it was not in flower and could not be found during the current study.

All seven of the species of conservation concern recorded within the study area, as well as *Adromischus umbraticola* and *Drimia sanguinea* are discussed in detail (locality, relevant information on flowering season, known habitat requirements, known geographical distribution, current conservation status and potential or confirmed occurrence within the current study area) in the floristic follow-up report (De Castro and Brits, 2013a). Threatened, Near Threatened and Declining species that have either been recorded or have a medium to high probability of occurring at Vaal River, in accordance to the available historical records, are also discussed.

Table 4: List of all plant 'species of conservation concern' (*sensu* Raimondo *et al*., 2009) historically recorded from the quarter degree grid square within which the study area is situated (2626DC), as well as the grids immediately to the east (2626DD), south (2726BA) and west (2626CD), as obtained from the Plants of Southern Africa website (http://posa.sanbi.org., downloaded in August 2013).

Taxon	Latest (IUCN version 3.1) Conservation Status Category*	Gauteng Nature Conservation Priority Grouping	Habitat	Flowering Time	Grid squares from which species has been recorded	Probability of occurrence within the West Wits mine complex property
AMARYLLIDACEAE						
Boophone disticha (L. f.) Herb.	Declining	N/A	Dry grassland and rocky areas. Widespread in South Africa (known from 9 provinces) and extends up the eastern half of southern Africa to Uganda.	October to January	2626DC	**Recorded**
Crinum bulbispermum (Burm.f.) Mile-Redh. & Schweik.	Declining	N/A	Along rivers and streams or in damp depressions in black clay or sandy soil. In the authors experience always occurs in areas that are seasonally or at least periodically flooded.	September to November	2626DC	**Recorded**
Nerine gracilis R.A. Dyer	Vulnerable [**VU** B1ab (ii, iii, v)]	A3	Undulating grasslands in damp, moist areas; the plants grow in full sun in damp depressions, near pans or on the edges of streams; grassland, riverbanks, vleis.	February and March	2626DC	**Recorded**
ASPHODELACEAE						
Trachyandra erythrorrhiza (Conrath) Oberm.	Near Threatened [**NT** B1ab (ii, iii, iv, v)]	A3	Marshy areas, grassland, usually in black turf marshes.	September to November	2626DC	**Recorded**
CRASSULACEAE						
Adromischus umbraticola C.A. Sm. subsp. *umbraticola*	Near Threatened **[NT** B1ab (ii, iii, v)]	A2	Rock crevices on rocky ridges, usually south-facing, or in shallow gravel on top of rocks, but often in shade of other vegetation.	September to January	2626DC	**Moderate** (recorded on an adjacent property by Gunther Wiegenhagen)
FABACEAE						
Pearsonia bracteata (Benth.) Polhill	Near Threatened [**NT** B1ab(i,ii,iii,iv,v)]	A3	Plants in Gauteng and North West occur in gently sloping Highveld grassland, while those in	December to April	2626DC	**Recorded**

Taxon	Latest (IUCN version 3.1) Conservation Status Category*	Gauteng Nature Conservation Priority Grouping	Habitat	Flowering Time	Grid squares from which species has been recorded	Probability of occurrence within the West Wits mine complex property
			the Wolkberg were collected from steep wooded slopes and cliffs in river valleys. Current authors observations at West Wits indicate that species occurs in untransformed Dolomite Grassland (BMU 6a) and quartzitic grassland (BMU6b).	according to literature, but recorded by the author flowering in late October at Vaal River in 2006.		
HYACINTHACEAE						
Drimia sanguinea (Schinz) Jessop	Near Threatened **[NT** A2d]	B	Open veld and scrubby woodland in a variety of soil types.	August to December	-	**High** (*Drimia* sp. recorded at site F30 may be this species.)
HYPOXIDACEAE						
Hypoxis hemerocallidea Fisch. & C.A. Mey.	Declining	N/A	In the authors' experience, in the Witbank region this species occurs in various types of grassland, including secondary grassland, of historically cultivated soils. Raimondo *et al.* (2009) state that this species occurs in a wide range of habitats, including sandy hills on the margins of dune forests, open, rocky grassland, dry, stony, grassy slopes, mountain slopes and plateaus. Appears to be drought and fire tolerant. Widespread in the eastern half of southern Africa, where its distribution extends from the Eastern Cape to Botswana and Mozambique. Western Cape to Malawi.	September to March	2626DC	**Recorded**
MESEMBRYANTHEMACEAE						
Lithops lesliei (N.E. Br.) N.E. Br. subsp. *lesliei*	Near Threatened [**NT** A4acd]	B	Primary habitat appears to be the arid grasslands in the interior of South Africa where it usually occurs in rocky places, growing under	March to June	2626DC	**Recorded**

Taxon	Latest (IUCN version 3.1) Conservation Status Category*	Gauteng Nature Conservation Priority Grouping	Habitat	Flowering Time	Grid squares from which species has been recorded	Probability of occurrence within the West Wits mine complex property
			the protection of surrounding forbs and grasses.			

* Status follows the latest Red Data Plant Book of South African Plants (Raimondo *et al*., 2009), and the continuously updated online Red List of SANBI (http://redlist.sanbi.org, downloaded August, 2013).

Threatened and Near Threatened species

The presence of one threatened and four Near Threatened plant species have been confirmed within the Vaal River study area (*Nerine gracilis, Lithops lesliei* subsp. *lesliei, Pearsonia bracteata* and *Trachyandra erythrorrhiza*) (refer to De Castro and Brits, 2013a for more detail).

Nerine gracilis (Plate 1) is categorised as Vulnerable [B1ab (iii)] in the latest Red List of South African plants (http://redlist.sanbi.org, accessed in August 2013) and is included in the A3 'Priority Grouping' for Gauteng plant species of conservation concern. The latest Red List states that this species is 'suspected to occur at fewer than 10 locations', only one of which is situated within the North West Province. The locality/subpopulation recorded at Vaal River during the current study is therefore one of only two subpopulations known from the North West Province. Both colonies recorded at Vaal River are situated on the Vaal River floodplain (**BMU1**) within CBMA 2. It is essential that the two localities recorded within the study area should be conserved *in situ* and protected by suitable buffer zones .

Plate 1: *Nerine gracilis*

Plate 2: Two *Lihtops lesliei* subsp*. lesliei* plants.

Plate 3: Trachyandra erythrorrhiza

Plate 4: *Adromischus umbraticola* flowering

Lithops lesliei subsp. *lesliei* (Plate 2) is categorised as **Near Threatened [B1ab (ii, iii, v)]** in the latest Red List of South African plants (Raimondo *et al*., 2009 and http://redlist.sanbi.org) and is included in the B 'Priority Grouping' for Gauteng plant species of conservation concern. *Lithops lesliei* subsp. *lesliei* is a highly inconspicuous, dwarf, succulent, 'stoneplant' which is highly sought after by succulent plant collectors and medicinal plant collectors (Raimondo *et al*., 2009 and http://redlist.sanbi.org).

According to Raimondo and co-authors (2009) this species has undergone a 15% population reduction as a result of harvesting for the medicinal plant trade and habitat destruction as a result of urban expansion and agriculture. This habitat loss is on-going and the species is known from a total of less than 50 sites or subpopulations (http:redlist.sanbi.org), some of which have recently been extirpated by urban expansion in Gauteng (personal communication with Ms Lorraine Mills). The current author has also recorded large-scale harvesting by succulent plant collectors and this is likely to also have contributed significantly to population decline. The author and Mr Gunther Wiegenhagen of AngloGold Ashanti have recorded two separate localities (each comprising a subpopulation) for this species within the Vaal River Mine Complex property, both of which are situated in **BMU6** between the waste rock dump to the south of the sports stadium and Orkney within the proposed CBMA 3. The possibility that additional subpopulations of this highly inconspicuous species, which is extremely difficult to detect when not in flower, occur within the study area can therefore not be excluded, and the personnel of the mines Biodiversity and Heritage section should conduct additional searches for this species in potentially suitable habitat between April and June.

Pearsonia bracteata is categorised as Near Threatened **[B1ab (i, ii, iii, iv, v)]** in the latest Red List of South African plants (http://redlist.sanbi.org, accessed in August 2013) and is included in the A3 'Priority Grouping' for Gauteng plant species of conservation concern. This species has lost habitat to cultivation in the past, and is threatened by on-going habitat loss and degradation due to urban development, agriculture and mining (http://redlist.sanbi.org, accessed in August 2013). The latest Red List (http://redlist.sanbi.org, accessed in August 2013) states that this species is known from only 'eight to fourteen localities', only two of which (including the locality at Vaal River recorded by the author in 2007) are situated within the North West Province. Only a few plants (some 20 cm in height) were recorded at sites M1 (eastern locality) and M2 (western locality) in 2007, and it is considered quite possible that future surveys will record this species at various other localities within the study area as large areas of potentially suitable habitat (**BMU 6a** and **BMU 6b**) are present. It is essential that the subpopulation recorded within the study area should be conserved *in situ* and protected by suitable buffer zones

Trachyandra erythrorrhiza (Plate 3) is categorised as **Near Threatened [B1ab (ii, iii, iv, v)]** in the latest Red List of South African plants (http://redlist.sanbi.org, accessed in August 2013) and is included in the A3 'Priority Grouping' for Gauteng plant species of conservation concern. The Extent of Occurrence' (EOO) for this species is 20,404 km^2 and prior to the current survey it had been recorded only from the Mpumalanga, Gauteng and Free State provinces (http://redlist.sanbi.org, accessed in August 2013). The subpopulation recorded at Vaal River (**BMU1**) during the current study is therefore the only known subpopulation of this species within the North West Province. *Trachyandra erythrorrhiza* is known from over 10 (but fewer than 20) localities and these subpopulations are not severely fragmented (http://redlist.sanbi.org, accessed in August 2013). There is on-going habitat loss due to urban and agricultural expansion and habitat transformation by alien plants (Raimondo *et al*., 2009). It is essential that the subpopulation recorded within the study area should be conserved *in situ* and protected by a suitable buffer zone.

Adromischus umbraticola (Plate 4) is categorised as Near Threatened (A4acd) in the latest Red List of South African plants (Raimondo *et al*., 2009 and http:redlist.sanbi.org)

and is included in the A2 'Priority Grouping' for Gauteng plant species of conservation concern. This species is known only from 15 localities (excluding the sub-population recorded by Mr. Gunther Wiegenhagen from a site approximately 1 km to the north of the study area), is endemic to the North West and Gauteng Provinces where it has an 'Extent Of Occurrence' of ca. 14,600 km^2, and is increasingly under threat from urbanisation. Given the fact that the only habitat occurring within the study area that is considered potentially suitable for this habitat-specific species occurs along the south-facing slopes of the 'Black Reef' ridge situated on the northern boundary of the study area (in **BMU's 5 and 6b**), and the fact that this species which is conspicuous even when not in flower has not been found despite repeated searches of suitable on the ridge by both the author and Mr Wiegenhagen in 2007 and during the current study, it is considered ***unlikely that this species occurs*** within the current Vaal River Mine Complex study area.

Drimia sanguinea is a Near Threatened (NT A2d) geophyte (Raimondo *et al*., 2009) that occurs in 'open veld and scrubby woodland in a variety of soil types' and is declining in numbers as a result of destructive harvesting for the medicinal plant trade (Raimondo *et al*., 2009). Potentially suitable habitat for this species does occur within the study area within BMU's 1, 4, 5 and 6. This species flowers from August to December, and the photographs taken by Gunther Wiegenhagen at site F30 of what may possibly be this species were taken in September 2012, before the commencement of the field surveys undertaken by the author as part of the current study. During the current study this species, which is inconspicuous when not in flower, could not be found and its identity of this *Drimia* sp. could not be confirmed. It is recommended that site F30 should be visited during September and October 2014 when the plants should be in flower, so that the plants can be found and identified. If this species is indeed *Drimia sanguinea* then a voucher specimen should be collected and sent to the National Herbarium, and appropriate *in situ* conservation measures (e.g. establishment of a buffer zone around the subpopulation) should be developed and implemented with the approval of the North West Province conservation authorities.

Declining species

Boophone disticha, *Crinum bulbispermum* and *Hypoxis hemerocallidea* are all categorised as Declining (Raimondo *et al*., 2009 and http:redlist.sanbi.org), and are therefore not 'threatened species' as defined by the IUCN, but are 'species of conservation concern' as defined by Raimondo and her co-authors (2009). Declining is a South African Red List category reserved for species which are not threatened or Near Threatened, but which are declining as a result of over-utilisation, and therefore merit some conservation effort. These species are not under any immediate threat of extinction, and has been categorised as Declining as a result of the fact that they are popular and fairly heavily utilised medicinal plants which are subjected to destructive harvesting (in all cases the underground structures are harvested), and there are concerns that long-term over utilisation of wild plants will lead to a decline in many of the sub-populations of these species.

Crinum bulbispermum was recorded at two of the surveyed sites (F17 and M13), both of which are situated within the Vaal River floodplain (**BMU1**). This species is however likely to occur at numerous localities in the riparian and floodplain habitats of the Vaal River, and possibly along the Jagspruit.

Boophone disticha is widespread within the study area and was recorded at numerous sites, but is usually represented by only one or two individuals at each site, the exception being site F12, where it is common. *Hypoxis hemerocallidea* is widespread within the study area and its immediate surrounds and has a very wide habitat tolerance, including habitats transformed by historical cultivation and even recent clearing of vegetation using bulldozers. This species is likely to occur at many more localities.

'SCARCE AND RESTRICTED' PLANT SPECIES

The term 'scarce and restricted' plant species here refers to species that are not 'species of conservation concern' (threatened, Near Threatened, Declining, Rare and Critically Rare) in accordance to the latest Red List of South African plants (Raimondo *et al*., 2009 and http:redlist.sanbi.org), but which in the opinion of the author nevertheless merit some conservation effort as they meet one or more of the following criteria:

- Species that are widespread within the South Africa or even southern Africa, but which are rare and known from only a few isolated localities in the Highveld region of the Gauteng, Mpumalanga and North West provinces, e.g. *Vigna oblongifolia* var. *parviflora*.
- Species which are largely restricted to the Highveld where they are widespread but are represented by relatively few and isolated localities, e.g. *Brachystelma nanum*.
- Species which are rare in the Highveld region where they are restricted to only a few localities in habitats which are themselves highly spatially restricted on the Highveld and are under threat from anthropogenic impacts such as transformation by alien plant species, urbanisation and reduced water qualities (e.g. indigenous Forest and Thicket patches, seasonal wetlands of first-order, non-perennial streams and ravines (or kloof's) with perennial streams).
- Species which are represented by only one or two subpopulations (or localities) on the Highveld and these subpopulations are situated on the outer edge of the known distribution range or 'extent of occurrence' of these species. Examples of such species recorded within the study area include *Nanthus* cf. *alloides* (most north-easterly known locality for this species) and *Raphionacme dyeri*.
- Species which may be widespread within the Highveld region, but for which the locality or localities within the study area represent the outer edge of the known extent of occurrence for the species, e.g.: *Eulophia inaequalis* and *Eulophia streptopetala*.

'Scarce and restricted' plant species thus far identified for the study area, many of which have an elevated likelihood of comprising unique ecotypes, include the following species: *Brachystelma nanum, Eulophia streptopetala, Eulophia inaequalis, Gladiolus ecklonii, Haemanthus montanus* (Plate 5), *Nanthus* cf. *aloides, Nerine krigei* (Plate 6), *Raphionacme dyeri, Senecio reptans* (Plate 7) and *Vigna oblongifolia* var. *parviflora.*

Plate 5: *Haemanthus montanus*

Plate 6: *Nerine krigei*

Plate 7: *Senecio reptans*

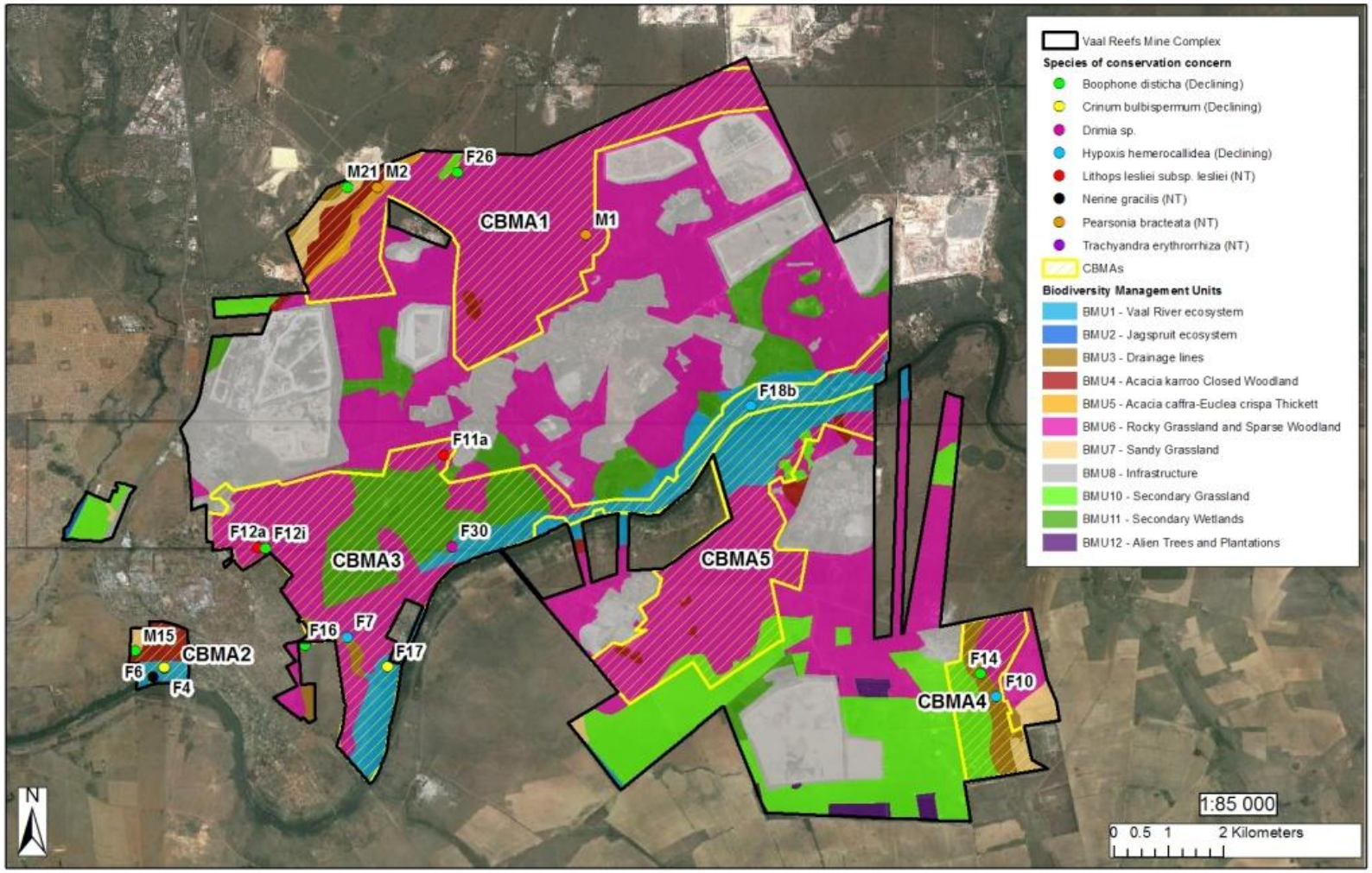


Figure 4: Map indicating the localities for the near threatened and declining plant species of Vaal River study area.

Declared Weeds and Alien Invasive plants

The current plant species list for the Vaal River Mine Complex includes 81 (13.6% of all species) alien taxa. Of the 81 alien plant species thus far recorded within the study area, thirty-eight are Declared Weeds, Declared Invaders and proposed Declared Weeds or Invaders in accordance to the 'Conservation of Agricultural Resources Act' (Act 43 of the Republic of South Africa 1983), as amended in 2001.

In terms of the amendments to Act 43, landowners are legally responsible for the control of alien plant species on their properties. The Act furthermore places each Declared Weed or Invader into one of three categories, and stipulates how each category must be controlled. The three categories are as follows (Henderson, 2001):

- **Declared Weed - Category 1:** Prohibited and must be controlled.
- **Declared Invader - Category 2** (commercially used plants): May be grown in demarcated areas provided that there is a permit and that steps are taken to prevent their spread.
- **Declared Invader - Category 3** (ornamentally used plants): May no longer be planted. Existing plants may be retained as long as all reasonable steps are taken to prevent the spreading thereof, except within the flood line of watercourses and wetlands.

The detailed alien vegetation assessment recommended as part of the current biodiversity update was omitted on instruction from management at AGA environmental management department. This was because a detailed alien plant assessment has been done in-house (by Mr. Gunther Wiegenhagen) which should be adequate for implementing an alien plant control programme.

Medicinally important plant species

A large proportion of the flora of South Africa has been identified as having some medicinal, cultural or practical use. The potential uses differ from one area to another and there is no entire knowledge on local uses of plants. Many of the 486 plant species recorded during this survey within the study area are known medicinal plants (Van Wyk *et al*., 1997 and Watt and Breyer-Brandwijk, 1962). Medicinal plants observed include *Hypoxis hemerocallidea* and *Eucomis autumnalis* subsp. *clavata*, both of which have been included in the Orange List as a result of the fact that they are popular and commercially harvested medicinal plants, and there are concerns that long-term over utilisation of wild plants will lead to a decline in many of the populations of these species. Medicinal plant use and harvesting levels vary greatly from region to region, and even between geographically proximate areas (50km's or less). In order to provide any useful management plan for medicinal plants within the study area, it will first be necessary to establish which species are utilised, where such species are harvested within the mine property, and to what extent these species are utilised. The only mitigation measure that can currently be provided is that illegal plant harvesting should be discouraged through control of access to the study area.

Baseline vegetation monitoring

A total of 22 monitoring sites were established during the current baseline monitoring survey (De Castro & Brits, 2013b). At 20 of these sites, a permanently marked 10m by 10m vegetation sampling quadrat was established and two fixed-point photographs

taken. Anthropogenic impacts identified at each were listed, which also outlines recommended management measures for the identified impacts (De Castro & Brits, 2013b).

The distribution of monitoring sites amongst the 7 untransformed Biodiversity Management Units was as follows: five in BMU 1, one in BMU 2, three in BMU 3, one in BMU 4, two in BMU 5, eight in BMU 6 and two in BMU 7. The allocation of plots was carried out in accordance with the perceived biodiversity conservation value and spatial extent of each BMU.

Though the untransformed habitats and vegetation included in all five CBMA's are regarded as important conservation areas within the study area and its surrounds, the high levels of botanical biodiversity and ecological viability of these areas can only be sustained in the long-term through the implementation of sound veld management practices such as sustainable grazing, a controlled burning programme, the systematic control of alien invasive plant species and the control of access to CBMA's in order to prevent illegal harvesting of medicinal and horticultural plants, hunting (with dogs and snares), cutting of trees for firewood, illegal human settlement and the control of alien invasive plant species.

Riparian Vegetation Assessment

On request by AngloGold Ashanti, a study was included in the 2012/3 biodiversity assessment to apply the Vegetation Response Assessment Index (VEGRAI) at the primary lotic ecosystems in the study area. Representative reaches (with emphasis on existing biomonitoring sites) were therefore selected and assessed on the Vaal River and Schoonspruit (MacKenzie, 2013).

Schoonspruit

The Schoonspruit flows through a matrix of terrestrial grassland with some tree clumps and is mainly non-woody, but overgrazing and trampling has destabilised the banks in many places and caused erosion. It is also heavily infested with Water Hyacinth (an aggressive alien invader), and this has cause serious loss of marginal and lower zone habitat and species diversity. The riparian zone is flanked by a broad (up to 450m wide) grass-dominated floodplain with scattered wetland elements and back waters dominated by sedges and hydrophilic grasses. While these are in better condition, they nevertheless are overgrazed and disturbed in many areas.

The overall eco-classification for the Schoonspruit site is a D category with a score of 47.3%. A category D is defined as an ecosystem which is largely modified such that the resource base has been decreased to a large extent, and large changes in natural habitat, biota and basic ecosystem functions have occurred. The marginal and lower zones however, were in worse categories (F and E respectively). Floodplain grassland and wetlands within floodplains were in better categories (both category C) due to more moderate disturbance and significantly less invasion by alien species.

Both the ecological importance (EI) and the ecological sensitivity (ES) of the Schoonspruit are **LOW**. The reason for a low EI score is because the site does not have a large proportion of rare, endangered, threatened or protected species, although *Crinum bulbispermum* (IUCN = Declining) occurs in or near backwaters. The low score

for ES is because the proportion of flow sensitive species that are found at the site is less than 50% of the total number of species that occur in the riparian zone, wetlands and floodplains.

Vaal River

The Vaal River, at the 3 sites assessed, flows through a matrix of terrestrial grassland with some clumps of trees in the terrestrial zone and a distinct riparian zone. The riparian zone is characterised by dense, tall woody vegetation forming a corridor along the banks, and by non-woody dominated vegetation (reeds, sedges, hydrophilic grasses) forming a narrow marginal and lower zone, with scattered islands and vegetation clumps within the channel. The riparian zone in most places is flanked by grass- and sedge-dominated floodplains with scattered wetland elements and back waters

The overall eco-classification for the Vaal River (3 integrated sites) was a C category with a score of 65.1%. The marginal zone was slightly worse (C/D) due to alien species invasion and response to eutrophication, and loss of habitat and indigenous species due to flow regulation. A category C is defined as an ecosystem that is moderately modified i.e. the resource base has been decreased to a moderate extent, a change of natural habitat and biota has occurred, but the basic ecosystem functions are still predominantly unchanged.

The Vaal sites scored LOW for ecological importance (EI) because they do not harbour a large proportion of rare, endangered, threatened or protected species, although *Acacia erioloba* (IUCN = Declining) use to be found at some of the sites and *Crinum bulbispermum* (IUCN = Declining) should occur in or near backwaters. The Vaal also scored LOW to MODERATE for ES because the proportion of flow sensitive species that are found at these sites is less than 50% of the total number of species that occur in the riparian zone, wetlands and floodplains.

The following references were mainly used and can be consulted for more detail regarding the vegetation aspects of the study area:

- DE CASTRO & BRITS (2007). Botanical Biodiversity baseline report for the AngloGold Ashanti Vaal River mines surface rights area (Orkney, North West Province). Report prepared for Clean Stream Biological Services, Pretoria, South Africa.
- DE CASTRO AND BRITS (2013a) Follow-up floristic and threatened plant survey of the 12 735 ha Vaal River complex property (Orkney, NW Province). Report to Clean Stream Biological Services and AngloGold Ashanti.
- DE CASTRO AND BRITS (2013b) Vegetation monitoring baseline survey of the 12 735 ha Vaal River complex property (Orkney, NW Province). – Fixed-point photography and vegetation sampling. Report to Clean Stream Biological Services and AngloGold Ashanti.
- MACKENZIE J (2013) Riparian vegetation baseline assessment of the Vaal River and Schoonspruit in the vicinity of Orkney, North West, South Africa. Report to Clean Stream Biological Services and AngloGold Ashanti.

FAUNA / ANIMALS

Despite the various environmental impacts that are present within the Vaal River surface rights area, the area still supports a relatively rich and diverse vertebrate fauna. Based on distribution ranges and available habitats within the study area, it was concluded that 389 terrestrial animal species (12 frog species, 34 reptile species, 267 bird and 76 mammal species) could be expected to occur here. Presence of the faunal groups obviously manifests in different ratios depending the potential habitats in the various biotopes. It should be noted that if a species was not recorded during the survey period, it does not imply that the species is not present at the site. Many species are highly secretive, nocturnal, seasonal or migratory and can therefore remain undetected during short survey periods. However, on the basis of the availability of suitable habitat, species which may occur at the site but that were not recorded during the survey are also listed and discussed, as an indication of the potential biodiversity of the Vaal River surface rights area.

Amphibians (Frogs)

Amphibians are very localized in their movement and habitat choices. Most frogs can live away from water but need water for egg laying and the larval stage, and thus will be absent if no standing water is available in the area. They only emerge after good rains when there is standing water and they are able to feed and breed. The rest of the year they shelter in damp places in order to escape the dry and/or cold climate. Their permeable skin gives them the advantage of being amphibious, but it is also this permeable skin that makes them very susceptible to air and water pollution. Frog surveys therefore give a good indication of water quality and other environmental health risks.

The Ashanti Vaal River mine lease area is situated in the Sweet Grassveld Assemblage according to the frog atlas biogeographic area. It has relatively high amphibian species richness (11-20 species per grid cell), but is low in endemics: 1-3 species per grid cell (Minter *et al.,* 2004). The most probable biotopes in which frogs are likely to be present are the natural wetlands around the Vaal River (BMU1) with 10 expected species, the Jagspruit (BMU2) with 11 expected species and ephemeral drainage lines (BMU3) with 12 expected species. Seven of the 12 expected amphibian species were observed in the study area during the survey. Only one endemic frog species, the Raucous toad (*Amietophrynus rangeri*), and one Red Data species (Minter, 2004), namely the Giant bullfrog (*Pyxicephalus adspersus*), are expected in the area. The Giant Bullfrog is classified as near-threatened and has been observed on the mine property previously.

Since frogs are susceptible to both aquatic and aerial pollution, and it is evident that they are currently being affected by some adverse influences, it is recommended to implement a faunal monitoring program to enable detection of any changes in amphibian assemblages within the study area. Future amphibian monitoring should also aim to determine if the near-threatened Giant bullfrog is present within the study area.

Reptiles

Reptiles form an important link in the food chain and their presence is a good indication of habitat integrity of an area. Thirty-four reptile species are expected to be found in AngloGold Ashanti's Vaal River mining area. Favourable reptile habitats available in the

mine lease area include woodland with trees and tree stumps, rocky areas and also wetlands. Only 14 species were observed during the survey, most probably due to their secretive ways of living, and also since a number of reptile species are nocturnal.

The most diverse area regarding the reptile species composition is the Rocky Grassland (BMU6) with 31 species, whilst the Sandy Grassland (BMU7) has only 19 species. The higher number of reptiles in BMU6 can be attributed to the presence of scattered clumps of trees and shrubs, rock protrusions and grass cover. The varied sub-habitats of the Vaal River biotope (BMU1) house a lower variety of reptiles (24 species). The woodland types, *Acacia karroo* woodland (BMU4) and *Acacia caffra* woodland (BMU5) contain similar numbers of reptiles, with 26 and 28 species respectively. Few reptiles are expected in the wetland types, with only seven species in the Jagspruit riverine areas (BMU2), and seven species in the Drainage lines biotope (BMU3).

One reptile species which is endemic to South Africa is expected to occur in the area, namely the Aurora house snake. There are no reptile species expected to occur in the area which are considered to be Red Data species.

Birds

Birds are an important component of all ecosystems, and of all the main faunal groups, birds are often the easiest to observe and count. Many studies have shown that counts of birds accurately reflect environmental changes. A decline in species richness and diversity, as determined by routine monitoring, may serve as an early warning of environmental degradation. A total of 281 bird species were surveyed in this area during the Bird Atlas project (Harrison *et al*., 1997).

With its varied composition of habitat types, the Vaal River biotope (BMU1) is by far the most diverse habitat type concerning bird assemblages, being home to 197 expected species. Another riverine biotope, the Jagspruit (BMU2), has 150 expected bird species utilizing the available habitats. The other wetland type, namely the Drainage lines (BMU3), possess lower bird diversity of 111 species. The woodland biotopes have very similar bird diversity values: *Acacia karroo* woodland (BMU4) with 134 species, *Acacia caffra* woodland (BMU5) with 125 species, and the Rocky Grassland dominated by *Acacia erioloba* (BMU6) with 148 species. The Sandy Grassland (BMU7) biotope is less diverse - providing habitat for 91 species. During the two surveys (2007 and 2013), 162 bird species were observed in all the transects surveyed.

Expected bird species in the area which are endemic to South Africa include the Cape Long-billed Lark *(Certhilauda [c.] curvirostris)* and the Pied Starling *(Spreo bicolor)*. AngloGold Ashanti's Vaal River section provides potentially suitable habitat for three Vulnerable (*African marsh harrier, White-bellied Korhaan, Black stork*) and five Near Threatened bird species (*Greater flamingo, Secretary bird, Lanner Falcon*) according to the South African Red List. The following species have IUCN threatened status: *Lesser flamingo* (IUCN; near-threatened), *Lesser Kestrel* (IUCN, Vulnerable), *European Roller* (IUCN; Near-threatened). None of these 9 threatened species were observed during the current study.

Mammals

The larger mammals are usually the first animals to disappear when man moves into an area. Conflict, persecution and fear for humans, as well as loss of natural habitats are the main reasons for the decline. Some mammal species such as rodents, small carnivores (genet, wild cat and mongoose) and some nocturnal mammals (hedgehog and porcupine) can however survive and will sometimes even thrive in the presence of human habitation. Although most of the larger mammals (9 species) that occurred here naturally have since disappeared due to persecution by humans and habitat loss, at least 67 mammal species are still expected to occur in AngloGold Ashanti's Vaal River mining area. Fifteen of the 67 expected mammal species were observed during the survey.

The diverse habitat composition of the Vaal River biotope (BMU1) provides for the highest diversity of mammals in the area, namely 57 species. The woodland types also contain relatively diverse assemblages: *Acacia karroo* woodland (BMU4) with 39 species, and *Acacia caffra* woodland (BMU5) with 44 species. The grassland-woodland combination of the Rocky Grassland biotope (BMU6) has a high diversity (only second to the Vaal River biotope) of 53 species due to the rocky protrusions and woody components within the grassland. The other grassland biotope, the Sandy Grassland (BMU7) has a mammal diversity value of 37 species.

The ten Red Data listed species which are expected to occur in the area (excluding large game exterminated by hunting and persecution) include the Threatened or Protected species (NEMBA TOPS): South African hedgehog, Cape fox, Spotted-necked otter, Cape clawless otter, Honey badger and the Water Rat. The following are considered by IUCN Red Data lists: Brown hyaena and Schreiber's long-fingered bat (IUCN; Near-threatened), Black-footed cat (IUCN; Vulnerable), and White-tailed mouse (IUCN; Endangered). None of these species were observed during the current study.

Fish

Based on available information, known distribution records and available habitats, twelve indigenous species have a high probability to occur within AngloGold Ashanti's Vaal River study area. Of these twelve species can be expected in the Vaal River (BMU1), 10 in the Jag/Schoonspruit ecosystem (BMU2) and five in the drainage lines and seasonal wetlands (BMU3). In the period between June 2006 and September 2013, nine of these expected indigenous fish species were sampled within BMU1 (*Clarias gariepinus, Barbus anoplus, Barbus paludinosus, Barbus trimaculatus, Labeobarbus aeneus, Labeo capensis, Labeo umbratus, Pseudocrenilabrus philander and Tilapia sparrmanii*). The presence of two alien species, namely Gambussia affinis and Cyprinus carpio was also confirmed, and there is a high probability that Micropterus salmoides is also present. In BMU2 eight of the above mentioned species (all except B. anoplus) was sampled over this same period in the Schoonspruit. The same alien fish species listed for BMU1 are also present in BMU2.

One of the expected indigenous species, the Vaal-Orange Largemouth Yellowfish (*Labeobarbus kimberleyensis*) is Red Data listed, being classified as *vulnerable* (Skelton, 2001). This species has not been sampled after various attempts but its presence in the Vaal River inside the study area was confirmed by the local fishing club and anglers interviewed along the river. A further five species, namely *Labeobarbus*

aeneus, Labeobarbus kimberleyensis, Labeo capensis, Labeo umbratus and *Austroglanis sclateri* are endemic to the Orange-Vaal River system. One species, namely the Threespot barb (*Barbus trimaculatus*) is also expected to be vulnerable in the Orange-Vaal system.

Invertebrates

In the Vaal River ecosystem (BMU1), a total aquatic macro-invertebrate diversity of 42 taxa was observed in the period between June 2006 and September 2013. In BMU2 (Jagspruit/Schoonspruit ecosystem), 31 aquatic macro-invertebrate taxa were sampled in this same period. The habitat diversity within wetlands is much less diverse when compared to habitats within rivers and streams, therefore the macro-invertebrate diversity inhabiting the seasonal wetlands and drainage lines (BMU3) is also expected to be lower. Various human activities in the mine lease area, as well as up- and downstream catchments, are responsible for degradation of the aquatic ecosystems integrity, and thus aquatic invertebrate biodiversity.

The distribution and physical habitat requirements indicate that there is a probability that approximately 29 Dragonflies (13 with high probability of occurrence) and 15 Damselflies (6 with high probability of occurrence) may frequent the study area (Vaal River and its perennial and non-perennial tributaries). Five adult stages of dragonflies and damselflies were observed in the study area during the current study, namely the Banded groundling (*Brachythemis leucosticta*), Blue emperor (*Anax imperator*), Swamp bluet (*Africallagma glaucum*), Common bluetail (*Ischnura senegalensis*) and Vaal sprite (*Psedagrion vaalense*).

Three butterfly species were also identified during the animal surveys conducted within the Vaal River study area*, namely Leptotes babaulti* (probably) (Babault's blue), *Tarucus sybaris* (Dotted blue) and *Lepidochrysops glauca* (Silvery blue).

Summarized status of Red Data listed and endemic faunal species

The habitats in the study area meet the requirements of a large number of Red Data listed (endangered, near-threatened and vulnerable) animal species (Table 9 & 10). These include 1 frog species (Giant bullfrog). Nine Red Data listed bird species can also be expected, namely African marsh harrier, Lesser Kestrel, White-bellied Korhaan, Black stork, Greater flamingo, Lesser flamingo, Secretary bird, Lanner Falcon and European Roller. A further ten threatened mammal species can also be expected, namely the South African hedgehog, Schreiber's long-fingered bat, Brown hyaena, Black-footed cat, Cape fox, Cape clawless otter, Spotted-necked otter, Honey badger, Water Rat and White-tailed mouse.

BMU6 (Rocky grassland and sparse woodland) and BMU7 (Sandy Grassland) both provide habitat for the highest number of Red Data listed fauna, namely 15 species. BMU1 (Vaal River ecosystem) provides habitat for the second highest number of Species of Special Concern, with a total of 14 species (1 frog, 1 reptile, 2 birds, 10 mammals) that can be expected in this biotope (Table 1). In the woodland biotopes (BMU4: A*cacia karroo* Closed Woodland and BMU5: *Acacia caffra-Euclea crispa* thicket), nine Red Data listed species are expected.

The other wetlands, which are less diverse regarding habitat aspects, can expect less Species of Special Concern than the Vaal River (BMU1), with BMU2 (Jagspruit) and BMU3 (Drainage lines) each providing habitat for seven Species of Special concern.

Table 5: Summary of expected number of Species of Special Concern per BMU.

	BMU1: Vaal River ecosystem	**BMU2:** Jagspruit ecosystem	**BMU3:** Drainage lines	**BMU4:** *Acacia karroo* Closed Woodland	**BMU5:** *Acacia caffra-Euclea crispa* Thicket	**BMU6:** Rocky grassland & Sparse woodland	**BMU7:** Sandy grassland
Frogs	1	1	2	0	0	0	1
Reptiles	1	1	1	1	1	1	1
Birds	2	1	2	2	2	6	6
Mammals	10	4	2	6	6	8	7
Total species	**14**	**7**	**7**	**9**	**9**	**15**	**15**

Table 6: Summary of all expected Species of Special Concern of the Vaal River operations study area, the most probable BMU where they may occur, their habitat preferences and Red Data status.

Species	BMU	Habitat	Status
FROGS			
Raucous toad (*Amietophrynus rangeri*)	**BMU1**. Vaal River **BMU2**. Jagspruit **BMU3**. Drainage lines	Rivers, large ponds and stream-side pools along slow-flowing streams in grassland; shallow water near banks, or among reed beds. Aquatic vegetation.	South African Endemic
Giant bullfrog (*Pyxicephalus adspersus*)	**BMU3**. Drainage lines **BMU7.** Sandy Grassland.	They inhabit open grassland areas that are based on poorly drained soils, since these promote the formation of rain-filled depressions, or pans, which are required for successful breeding.	Protected species (NEMBA)
REPTILES			
Aurora house snake *(Lamprophis aurora)*	**BMU1**. Vaal River **BMU2.** Jagspruit **BMU3.** Drainage lines **BMU4.** *Acacia karroo* Closed Woodland **BMU5**. *Acacia caffra-Euclea crispa* thicket **BMU6.** Rocky Grassland **BMU7.** Sandy Grassland	**Grasslands**, entering coastal bush and fynbos. Terrestrial. **Favours damp localities in grasslands**, moist savanna, lowland forest and fynbos.	South African Endemic
BIRDS			
Greater flamingo (*Phoenicopterus ruber*)	**BMU3.** Drainage lines.	Shallow eutrophic wetlands; breeds on pans and mudflats. Large bodies of shallow water, both inland and coastal. Saline and brackish waters preferred.	SA Red Data (Barnes 2000): Near-threatened
Lesser flamingo (*Phoeniconaias minor*)	**BMU3.** Drainage lines.	Shallow eutrophic wetlands, saltpans and sheltered coastal lagoons. Larger brackish or saline inland and coastal waters.	IUCN 2010 NT: Near-threatened; SA Red Data (Barnes 2000): Near-threatened.
Black stork (*Ciconia nigra*)	**BMU1**. Vaal River **BMU2.** Jagspruit	Shallow water: streams, rivers, floodplains, coastal estuaries, large	NEMBA (TOPS): Vulnerable species;

Species	BMU	Habitat	Status
	BMU3. Drainage lines	and small dams; pans, shallows of rivers, pools in dry riverbeds, and sometimes on marshland and flooded grassland dry land. Uncommon at seasonal pans lacking fish.	SA Red Data (Barnes 2000): Near-threatened.
Secretary bird (*Sagittarius serpentarius)*	**BMU4**. *Acacia karroo* Closed Woodland **BMU5**. *Acacia caffra-Euclea crispa* thicket **BMU6**. Rocky Grassland **BMU7**. Sandy Grassland	Open country: Savanna, open woodland, grassland and dwarf shrubland	SA Red Data (Barnes 2000): Near-threatened.
African marsh harrier	**BMU1**. Vaal River	Nests in extensive reed beds; forage over reeds, lake margins, floodplains and woodland.	NEMBA (TOPS): Protected species; SA Red Data (Barnes 2000): Vulnerable
Lanner Falcon *(Falco biarmicus)*	**BMU6**. Rocky Grassland **BMU7**. Sandy Grassland	**Open habitat**s. Cliff-nester, **also in old nests in trees.**	SA Red Data (Barnes 2000): Near-threatened
Lesser Kestrel *(Falco naumanni)*	**BMU6**. Rocky Grassland **BMU7**. Sandy Grassland	Semi-arid grassland. Avoid wooded areas; forage in agricultural fields. Grassy Karoo, Sweet and Mixed grassland, Central Kalahari vegetation types.	IUCN Vulnerable; NEMBA (TOPS): Vulnerable species; SA Red Data (Barnes 2000): Vulnerable
White-bellied Korhaan (*Eupodotis caffra*)	**BMU6**. Rocky Grassland **BMU7**. Sandy Grassland	Tall, fairly dense grassland: Open and lightly wooded areas.	SA Red Data (Barnes 2000): Vulnerable
European Roller (*Coracias garrulus*)	**BMU4**. *Acacia karroo* Closed Woodland **BMU5**. *Acacia caffra-Euclea crispa* thicket	Tall, fairly dense grassland: Open and lightly wooded areas.	IUCN 2008 NT: Near-threatened
Cape Long-billed Lark *(Certhilauda curvirostris)*	**BMU6**. Rocky Grassland **BMU7**. Sandy Grassland	Wide range of open habitats; both on hillslopes and on plains. Sparse, arid dwarf shrubland, **thinly vegetated rocky ridges and stony hills.** **Planted pastures. Grasslands** – hill slopes.	South African Endemic
Pied Starling *(Lamprotornis bicolor)*	**BMU6**. Rocky Grassland **BMU7**. Sandy Grassland	Open Karoo and **grassland habitats**. **Open fields**. Not found in wooded areas. **Areas of broken ground**.	South African Endemic
MAMMALS			
South African hedgehog (*Atelerix frontalis*)	**BMU1**. Vaal River **BMU4.** *Acacia karroo* Closed Woodland **BMU5**. *Acacia caffra-Euclea crispa* thicket **BMU6.** Rocky Grassland **BMU7.** Sandy Grassland	Temperate: Vegetable debris in shady places; dry cover. Dry habitats with ground cover for nesting.	Protected (NEMBA)
Schreiber's long-fingered bat (*Miniopterus schreibersii*)	**BMU1**. Vaal River **BMU4.** *Acacia karroo* Closed Woodland **BMU5**. *Acacia caffra-Euclea crispa* thicket **BMU6.** Rocky Grassland **BMU7.** Sandy Grassland	Cave dweller: Caves and sub-terranean habitats. Wide range of vegetational association.	IUCN (2012) Near-threatened
Brown hyaena (*Hyaena brunnea*)	**BMU1**. Vaal River **BMU4.** *Acacia karroo* Closed Woodland **BMU5**. *Acacia caffra-Euclea crispa* thicket **BMU6.** Rocky Grassland **BMU7.** Sandy Grassland	Semi-desert, open scrub and open woodland savanna. Nocturnal, holes in ground.	Near threatened (IUCN), Protected (NEMBA)
Black-footed cat (*Felis nigripes*)	**BMU1**. Vaal River **BMU4.** *Acacia karroo* Closed Woodland **BMU5**. *Acacia caffra-Euclea crispa* thicket **BMU6.** Rocky Grassland **BMU7.** Sandy Grassland	Dry **open shrub country**.	IUCN: VU Vulnerable. NEMBA: Protected species

Species	BMU	Habitat	Status
Cape fox (*Vulpes chama)*	**BMU1**. Vaal River **BMU5**. *Acacia caffra-Euclea crispa* thicket **BMU6.** Rocky Grassland **BMU7.** Sandy Grassland	Widespread. Open country, open grassland. Nocturnal & solitary. Holes in ground, in cover, underbrush.	NEMBA: Protected species
Spotted-necked otter (*Lutra maculicollis*)	**BMU1**. Vaal River **BMU2.** Jagspruit	Aquatic: Rivers, lakes, swamps and dams, extensive areas of open water.	Protected (NEMBA)
Cape clawless otter (*Aonyx capensis*)	**BMU1**. Vaal River **BMU2.** Jagspruit	Aquatic: **Rivers, lakes, swamps and dams**. Widespread. Litters born in holes in banks of rivers.	Protected (NEMBA)
Honey badger (*Mellivora capensis*)	**BMU1**. Vaal River **BMU2.** Jagspruit **BMU3.** Drainage lines **BMU4.** *Acacia karroo* Closed Woodland **BMU5**. *Acacia caffra-Euclea crispa* thicket **BMU6.** Rocky Grassland **BMU7.** Sandy Grassland	Widespread. Not in desert. Use crevices in rocky areas, will also dig refuges. Rocky koppies, scrub sandveld, open grassland, open woodland, riverine woodland and floodplain grassland.	Protected (NEMBA)
White-tailed mouse (*Mystromys albicaudatus*)	**BMU1**. Vaal River **BMU6.** Rocky Grassland **BMU7.** Sandy Grassland	Nocturnal – lives in burrows or cracks in the ground. Sandy soil with good cover.	Endangered (IUCN)
Water Rat *(Dasymys incomtus)*	**BMU1**. Vaal River **BMU2.** Jagspruit **BMU3.** Drainage lines	Streams, rivers, reed beds, swamps and is partially aquatic. Long grass close to water, between reeds and among rotting vegetation. Fringes of marshes and backwaters.	SA Red Data 2004

The following references can be consulted for more detail regarding the animals of the study area:

- CLEAN STREAM BIOLOGICAL SERVICES (CSBS) (2007). AngloGold Ashanti Vaal River Operations: Aquatic Fauna Biodiversity. Report nr. AGA/C/07.
- CLEAN STREAM BIOLOGICAL SERVICES (CSBS) (2006-2013). AngloGold Ashanti Vaal River Operations: Aquatic Biomonitoring programme reports. Various report to AGA.
- DEACON, A.R. (2007). Specialist Study: The Faunal biodiversity and associated ecological aspects of the AngloGold Ashanti Vaal River Section. Report to Clean Stream Biological Services. Pretoria, South Africa.
- DEACON, A. (2013). Biodiversity assessment for AngloGold Ashanti Vaal River: Specialist study: Monitoring local fauna, with emphasis on threatened species. Report to Clean Stream Biological Services and AngloGold Ashanti. Pretoria, South Africa.

5. BIODIVERSITY RISK ASSESSMENT (FIRST-PHASE)

A first-phase biodiversity risk assessment was performed as part of the 2012/3 biodiversity assessment for the AngloGold Ashanti's Vaal River operation (Bekker, 2013). This biodiversity risk assessment was performed to identify impacts on the various Biodiversity Management Units and is based on available information as well as a first-phase risk audit that was performed during 2013. The situation pertaining to potential risks at these expansive mining areas is complex and involves various environmental issues.

The first stage of a risk assessment is generally where a problem is acknowledged so that a preliminary hypothesis could be formulated. Many recent and historical environmental problems pertaining to the Vaal River Operations have been identified and are addressed in the mine's EMP that was approved in February 2012 (AGA Vaal River Operations EMP; August 2011). The purpose of this report is to apply a first stage of a risk assessment framework with the use of site specific findings as noted during the May 2013 site visit as well as available information so that the multidimensional facets of each risk could be better understood and acted upon. It should be emphasised that this first phase risk audit was specifically designed to support the mine's biodiversity management plan and was not based on any framework for risk assessment as applied by AngloGold Ashanti or Anglo American PLC.

The Departments of Environmental Affairs and Mineral Resources produced a Mining and Biodiversity Guideline after receiving contributions by a number of stakeholders including AngloGold Ashanti. This guideline was prepared as a tool to facilitate the sustainable development of South Africa's mineral resources and explains the value for mining companies of adopting a risk-based approach to managing biodiversity. The guideline states that it has become good business practice to incorporate appropriate scientific methodologies that encompass all levels of assessment of impacts on biodiversity. This guideline furthermore states that the early assessment of biodiversity impacts will help to:

- Reduce risk to biodiversity if appropriate mitigation action is taken.
- Avoid delay in authorisation.
- Reduce risk to the company by avoiding reputational damage and unexpected costs.
- Obtain "buy in" from local communities.
- Reduce risk to society of deteriorating ecosystem services and loss of biodiversity.

It is important to review some of the mine's EMP commitments relating to biodiversity conservation in the context of the identified risks to biodiversity. The AngloGold Ashanti Vaal River Operations EMP (approved on 14/02/2012) states that appropriate and cost effective monitoring will be required in order to allow for the early detection of threats to diversity and to determine the effectiveness of management interventions. The following commitments have also been included in the mine's approved EMP (Par. 7.2.5):

- New developments will be planned with increased sensitivity and will be prohibited in the riparian zones within a designated distance from the river banks.
- Development within the Endangered Vaal Vet Sandy Grassland, the Vulnerable Vaal Reef Dolomite Sinkhole Woodland and the Black Reef Metallophyte Woodland will be prevented or restricted.

- AGA will develop a Biodiversity Action Plan (BAP) to respond to the thresholds of probable concern with environmental quality, species and populations being used as indicators of change. Inventories of aquatic and terrestrial ecosystem taxa will be made with an assessment of genetic diversity of indicator fauna and flora. A biodiversity monitoring programme will be developed and maintained to follow population changes and indicator taxa.
- An inventory will be compiled of disturbed and contaminated areas. The BAP will include components for sensitive habitat restoration, limitations on grazing and other agricultural encroachment, fire control, alien species, natural resource harvesters as well as pesticide and fertilizer use.
- Conservation awareness campaigns will be implemented.
- Plans for soil conservation plan, invader control, stockpile management and firebreak management must be implemented to prevent land and soil degradation.
- Effective pollution control structures must be constructed along tailings pipelines only where ponding will not occur over dolomites.
- A procedure should be developed for the rehabilitation of historic spillages.
- Tested phytotechnologies must be implemented to remove harmful chemicals from contaminated soil and groundwater.
- Effective dust control technologies must be implemented.
- The main aim of biodiversity management at the Vaal River Operations is to maintain and restore the structure, function and composition of ecological processes.

Impact and Risk identification

A site audit was performed at the Vaal River Operations during May 2013. A number of observations were made, which were photographed. To facilitate the identification of current impacts and potential risks to biodiversity at the Vaal River Operations, it was attempted to link each observation to specific Biodiversity Management Units (BMU's) as identified during previous specialist studies. For a clear understanding of how the impacts and risks were identified for this assessment, the following distinction was made between the two terms:

- **Impact** refers to the effect(s) of the activity on the receiving environment. The extent and magnitude of the impact can be determined using available information such as monitoring data. Where insufficient information is available to quantify the actual effects of the activity on the receiving environment, impact prediction tools such as numeric modelling can be used. In cases where no monitoring information or impact prediction is available, the impact can be identified based on experience of a suitably qualified person.
- **Risk** usually refer to incidents that have the *potential* to occur, but have not occurred in the past, or do not occur currently or continuously. The most important factor influencing risk is the probability of occurrence, and can be affected by mitigation measures and design criteria. Risks can often only be identified by suitably qualified persons and based on comprehensive thorough experience. For existing mining areas, such as the West Wits Operations, there is little distinction between potential risk and current impact. It was therefore attempted to highlight significant risks (on biodiversity) that have the potential to occur as a result of recorded existing impacts or the combined effect of these impacts.

A table was designed to assist with the problem formulation phase of this risk assessment for each observation that poses a risk as described above. Noted impacts

were also discussed succinctly. The assessment tables include parameters as explained in the example below.

SOURCE	STRESSOR	RECEPTOR	PATHWAY	TIMEFRAME	ENDPOINTS
Where the risk originates from, i.e. discharges of water or air pollution	Specific contaminants or actions	Biodiversity, as described in BMU's or rivers, pans, etc.	Wind, run-off, inhalation, skin contact, ground water, crops, etc.	Immediate, seasonal, bio-accumulative, organism lifecycle, etc.	Toxicity, endocrine disruptors, loss of biodiversity, etc.

A number of issues, impacts or potential risks were noted during this first phase of the biodiversity risk audit. These issues or incidents of pollution were photographed and are discussed in detail in the Risk Assessment Report (Bekker, 2013) and cross referenced in this Biodiversity Management plan where applicable. The environmental management staff of AngloGold Ashanti should take note of these potential risks to biodiversity and further investigate and mitigate these risks as a matter of urgency. A summary of the identified risks are provided in Table 7 below [refer to Risk Assessment Report by Bekker (2013) for more detail].

Risk assessment is concerned with the probability, severity, frequency and timing of threats. The main identified risks to- and impacts on biodiversity have been highlighted in this first phase report but much work will be required to link site specific risks or stressors to all potential receptors. In summary, it can be concluded that the main risks to biodiversity as identified during this problem formulation stage of the audit are as follows:

- A number of slurry spills have not been attended to at the Vaal River Operations. Soil, surface and ground water pollution will be a consequence.
- A number of incidents such as sewerage pollution, hydrocarbon contamination and contaminated surfaces have been noted throughout the mine. These areas may all contribute to the surface and sub-surface pollution plumes leaving the mine property towards the Vaal River.
- It should be a major concern that large volumes of sub-surface seepage water (an estimated 5000 m^3/day) from the mine's metallurgical processes, uranium and acid plants, water conveyances, unlined dams and TSF's that potentially contain high concentrations of cyanide, salinity, acidity, trace metals and radiological contamination, reaches the Schoonspruit and Vaal River.
- A new and seemingly unlicensed emergency earthen dam has been constructed downstream from the Great Noligwa mine close to the Vaal River. This dam receives affected mine water and increased the mine's dirty water footprint in a previously unaffected area.
- Untransformed vegetation with a high biodiversity value is being destroyed and degraded (altered) as part of the Woodlands trial plantations project.
- A number of instances were noted where tailings material, building rubble, rock waste, sewerage sludge and contaminated soil have been disposed of on unlicensed waste disposal facilities. Previously unaffected habitats are being covered by these facilities with the biodiversity and soil permanently lost.

The presence of historical and existing infrastructure that has been associated with high radioactivity is a concern. Surface and ground water management around the uranium and acid plants have been found to be lacking. The mine should ideally prioritise sources of high risk in order to limit its contribution to the ground water plumes that is currently leaving its property.

Table 7: Summarised findings of biodiversity risk assessment for AngloGold Ashanti's Vaal River operations (2013).

RISK/IMPACT	SOURCE	STRESSOR	RECEPTOR	PATHWAY	TIMEFRAME	ENDPOINTS
1. Emissions from No.1 shaft acid plant.	No. 1 Shaft, Acid plant	Uranium and its decay products, radioactive isotopes, radon gas, organic radicals, hazardous waste types, acid, trace metals, $S0_3$, $S0_2$	CBMA1, BMU6, Vaal River, golf course, township.	Sub-surface seepage, spillages, windblown dust, respirable dust, inhalation, ingestion, external gamma radiation.	Long term pollution plume movement, run-off during/after rainfall events, windblown emissions, worse during adverse environmental conditions.	Tissue necrosis, changes in cell metabolism, biochemical effects, carcinogenic effects, genetic disorders, elevated tissue metal concentration.
2. Surface discharge from radiation contamination area	Radiation Yard	Uranium and its decay products, organic radicals, hazardous waste types, acid, trace metals.	Vaal River, CBMA3, BMU1, BMU6, BMU11.	Surface flow towards Eye Water Dam.	During rainfall events, during adverse water operating conditions.	Tissue necrosis, changes in cell metabolism, biochemical effects, carcinogenic effects, genetic disorders, water contamination, loss of biodiversity, toxicity.
3. Tailings spill	Tailings spills	Sediments, Acidity, Trace metals (Cu, Ni, Zn), Radiation, cyanide, Salinity.	All BMU's	Shallow seepage, surface flow, pyrite oxidation, metal accumulation, groundwater leachate, cyanide complexation and precipitation.	Medium to long term	Soil contamination, Loss of topsoil, Loss of soil structure, Loss of biodiversity, Loss of plant species, Ground water pollution. Sedimentation. Toxicity. Loss of soil micro-fauna.
4. Acid plant surface water discharge	Acid plant	Uranium and its decay products, radioactive isotopes, organic radicals, hazardous waste types, acid, trace metals.	Vaal River, CBMA3, BMU1, BMU6, BMU11.	Surface flow towards Eye Water Dam, ground aquifers.	During rainfall events, during adverse water operating conditions.	Tissue necrosis, changes in cell metabolism, biochemical effects, carcinogenic effects, genetic disorders, water contamination, loss of biodiversity, toxicity.
5. Contaminated vegetation	Radiological contamination	Radioactive isotopes.	Human users	Anthropogenic	Long-term effects	Tissue necrosis, changes in cell metabolism, biochemical

RISK/IMPACT	SOURCE	STRESSOR	RECEPTOR	PATHWAY	TIMEFRAME	ENDPOINTS
						effects, carcinogenic effects, genetic disorders.
6. Maintenance of water conveyances	Shaft 1, Acid plant, radiation contamination yard	Uranium and its decay products, organic radicals, hazardous waste types, acid, trace metals.	Ground water aquifers, Vaal River, CBMA3, BMU1, BMU6, BMU11.	Seepage, surface flow towards Eye Water Dam.	As long as surface conveyances are not maintained.	Water pollution, Tissue necrosis, changes in cell metabolism, biochemical effects, carcinogenic effects, genetic disorders, water contamination, loss of biodiversity, toxicity.
7. Process water used for dust suppression	Process water used for dust suppression	Salinity, acidity, trace metals, radiation, cyanide, sulphates, chloride.	Surface and ground water associated with all unpaved road surfaces where dust suppression is performed, i.e. all BMU's.	Road transport, surface runoff, seepage.	Operational mining phase, worse during dry season.	Loss of biodiversity, Sedimentation, water pollution, toxicity.
8. Surface seepage	TSF's Dirty water circuits & dams, contaminated soil, gypsum and jarosite crust	Radioactivity, cyanides, salinity, sulphate, chloride, acidity, hydrocarbons.	Ground water aquifers, Vaal River, Soil, CBMA3, BMU1, BMU6, BMU11.	Surface flow, ground water infiltration, Dissolution of dolomitic aquifers	Short to long term, Latent impacts over 500 years, increased flow during/after rainfall events.	Loss of biodiversity, Sedimentation, water pollution, toxicity, erosion, soil salination, bioaccumulation, radiological effects. bioaccumulation, plant cover degradation.
9. Unlicensed storage of tailings material	Tailings spills	Sediments, Acidity, cyanide, trace metals (Cu, Ni, Zn), Radiation, Salinity.	All BMU's	Shallow seepage, Surface flow, Spillage of tailings material, pyrite oxidation, metal accumulation, groundwater leachate.	Medium to long term	Soil contamination, Loss of topsoil, Loss of soil structure and soil micro-fauna, Loss of biodiversity, Loss of plant species, Ground and surface water pollution. Sedimentation.
10. Unlicensed disposal of sewage sludge	Untreated sewage sludge	Pathogenic organisms, trace metals, organic compounds, nitrogen, phosphorus.	Ground water aquifers, Vaal River, Soil, CBMA3, BMU1, BMU6, BMU11.	Airborne emissions, shallow seepage, surface flow, ground water leachate.	Medium to long term	Soil contamination, Loss of topsoil, Loss of soil structure, Loss of biodiversity, disease, toxicity, loss of plant species, ground and surface water pollution. Eutrophication.
11. Seep from East Pay	No. 1 Shaft, Acid	Radioactivity,	Ground water aquifers,	Surface flow,	Short to long	Loss of biodiversity,

RISK/IMPACT	SOURCE	STRESSOR	RECEPTOR	PATHWAY	TIMEFRAME	ENDPOINTS
Dam	Plant, East Pay Dam.	cyanides, salinity, acidity, hydrocarbons, contaminated soil, gypsum and jarosite crust.	Vaal River, Soil, CBMA3, BMU1, BMU6, BMU11.	ground water infiltration, shallow sub-surface leachate, Dissolution of dolomitic aquifers	term, Latent impacts over 500 years, increased flow during/after rainfall events.	sedimentation, water pollution, toxicity, erosion, soil salination, bioaccumulation, radiological effects, plant cover degradation, loss of soil and soil micro-fauna.
12. Trial plantations as part of the Woodlands Project	Vegetation clearance. Soil preparation. Firebreaks. Altered veld fires. Metal and NORM uptake by plantation.	Bioaccumulation, radionuclides; Deterioration and destruction of habitats; Loss of vegetation cover, loss of soil profile.	BMU11, BMU6	Direct habitat destruction, Vegetation litter, air, surface water, soil, ground water.	During plantation establishment, harvesting and use of products. Ongoing throughout trial period.	Habitat deterioration Non-implementation of better proven technologies. Erosion. Loss of natural habitat. Radionuclide accumulation effects.
13. Spill of tailings material	Tailings spills	Sediments, Acidity, cyanide, Trace metals (Cu, Ni, Zn), Radiation, Salinity.	All BMU's	Shallow seepage, Surface flow, Pyrite oxidation, Metal accumulation, Groundwater leachate. Cyanide complexation and precipitation.	Medium to long term	Soil contamination, Loss of topsoil, Loss of soil structure, Loss of biodiversity, Loss of plant species, Ground and surface water pollution. Sedimentation.
14. Waste disposal	Waste disposal	Habitat deterioration Salinity, acidity, toxicity, sediments, hydrocarbons	CBMA5 BMU6	Surface flow, ground water seepage, leachate.	Long term	Loss of biodiversity Sedimentation Water pollution Soil contamination Loss of topsoil Loss of vegetation cover.
15. Great Noligwa U Plant	Great Noligwa, U Plant	Uranium and its decay products, radioactive isotopes, radon gas, organic radicals, hazardous waste	CBMA5, BMU1, BMU4, BMU6, BMU10, Vaal River.	Sub-surface seepage, air, spillages, windblown dust, respirable dust, inhalation, ingestion,	Long term	Tissue necrosis, changes in cell metabolism, biochemical effects, carcinogenic effects, genetic disorders. Toxicity.

RISK/IMPACT	SOURCE	STRESSOR	RECEPTOR	PATHWAY	TIMEFRAME	ENDPOINTS
		types, acid, trace metals, $S0_2$, $S0_3$. Airborne dust.		external gamma radiation.		
16. Great Noligwa waste rock dump	Exposed waste rock dump	AMD; trace metals; noise; dust; fumes; radioactivity.	CBMA5 MBU6	Surface flow, ground water infiltration, airborne emissions.	Medium term and more pronounced during reworking.	Surface and ground water contamination, Loss of biodiversity, Sedimentation, toxicity, smothering of vegetation, nuisance to fauna.
17. Disposal of waste material on soil	Waste disposal	Acidity, dust, trace metals (Cu, Ni, Zn). Radiation. Salinity.	BMU6	Pyrite oxidation, Metal accumulation, groundwater leachate, surface flow.	Long term	Soil contamination; Loss of topsoil; Loss of soil structure; Loss of biodiversity; Loss of plant species; Topsoil enrichment; Ground and surface water pollution. Air pollution.
18. **:** Surface contamination	Contaminated surfaces and soils	Salinity, acidity, trace metals, cyanide, hydrocarbons, radiation.	Ground water aquifers, All BMU's, Vaal River, Schoonspruit.	Seepage to aquifers via top unsaturated soil zones. Lateral pathway of several kilometres. Perched water table.	Pollution plume movement away from sources over the long term.	Risk to aquatic biodiversity, Downstream agricultural water users, poor ground water quality, affected surface runoff.
19. Habitat deterioration	Eradication of local flora	Habitat deterioration Surface water pollution	BMU6	n/a	Medium term	Loss of topsoil Loss of biodiversity Loss of plant species of concern Erosion Visual effects
20. Use of emergency earthen dam and channel	Unlicensed earthen dam and channel	Salinity, acidity, trace metals, cyanide, radiation, sediments.	Ground water aquifers, BMU10, BMU6.	Seepage to aquifers via top unsaturated soil zones.	Pollution plume movement away from sources over the long term. More pronounced during rainfall events.	Habitat destruction, Biodiversity loss, Ground water pollution, Surface water seepage/leachate, loss of soil.

RISK/IMPACT	SOURCE	STRESSOR	RECEPTOR	PATHWAY	TIMEFRAME	ENDPOINTS
21. Vaal River riparian zone construction activities	Riparian zone construction activities, tailings material	Sediments, salinity, acidity, trace metals, cyanide, radiation, sediments.	CBMA3, BMU1, Vaal River.	Surface run-off	Medium term, during construction activities, During rainfall events.	Habitat destruction, Biodiversity loss, Sedimentation, Surface water seepage/leachate, loss of soil, loss of soil quality.
22. Surface and sub-surface seepage from East Residue Dam	Surface and sub-surface discharge.	Salinity, acidity, hydrocarbons, trace metals, radioactivity and cyanides.	BMU11, BMU6, BMU1, CBMA3.	Surface flow and sub-surface seep.	Short to long term, Latent impacts over many years, Increased flow during and after rainy season.	Loss of biodiversity, sedimentation, water pollution, toxicity, loss of agricultural income, radiological-related effects, loss of vegetation, loss of soil quality. Water loss.
23. Burst sewerage pipe at No. 2 Shaft	Surface discharge of untreated sewerage water.	Pathogenic organisms, salinity, nitrates, phosphates, COD.	CBMA3, BMU1, BMU11.	Surface flow and sub-surface seep.	Burst or leaking pipe.	Spread of diseases, loss of biodiversity, sedimentation, water pollution, toxicity, eutrophication.
24. Hydrocarbon spill	Surface discharge of hydrocarbon waste.	Hydrocarbons, trace metals, COD.	CBMA3, BMU1, BMU11.	Surface flow and sub-surface seep.	During spill.	Water pollution, toxicity, eutrophication.
25. Earthworks and vegetation destruction as part of the Woodlands Project	Vegetation clearance. Soil preparation. Firebreaks. Altered veld fires.	Bioaccumulation, radionuclides, Deterioration and destruction of habitats, increased loss of vegetation cover.	CBMA5	Direct habitat destruction, Vegetation litter, air, surface water, soil, ground water.	During plantation establishment. Ongoing and long-term effects.	Habitat deterioration, biodiversity loss, non-implementation of better proven technologies. Bioaccumulation of radionuclides, erosion.

6. BIODIVERSITY MANAGEMENT UNITS (BMU)

During the first phase biodiversity assessment study (CSBS, 2005), the Vaal River Operational Area was divided into 12 draft biodiversity management Units based on a desktop assessment. After detailed specialist assessments conducted during 2006 and 2007, these twelve drafts units have now been verified, defined and delineated within the study area. The aim of defining biodiversity management units is to identify homogenous discernible areas, each with a distinctive biodiversity composition and related aspects. The vegetation and land-sue units (De Castro & Brits, 2007) generally provide a basis for the determination of different areas with homogenous fauna characteristics (Deacon, 2007; CSBS, 2007) and are also visually identifiable within the study area. For these reasons, the vegetation units therefore formed the basis for the determination of the Biodiversity Management Units. The following biodiversity management units were defined within the Vaal River Operational Area (Figure 5):

- BMU1: Vaal River ecosystem
- BMU2: Jagspruit ecosystem
- BMU3: Drainage lines
- BMU4: *Acacia karroo* Closed Woodland
- BMU5: *Acacia caffra-Euclea crispa* Thickett
- BMU6: Rocky Grassland and Sparse Woodland
- BMU7: Sandy Grassland
- BMU8: Infrastructure
- BMU9: Cultivation
- BMU10: Secondary Grassland
- BMU11: Secondary Wetlands
- BMU12: Alien trees/plantations

Emphasis is placed on the most important areas for biodiversity conservation and management, namely the untransformed BMU's (BMU1 tot 7). The biodiversity aspects, potential impacts and management procedures are described for each of the biodiversity management units.

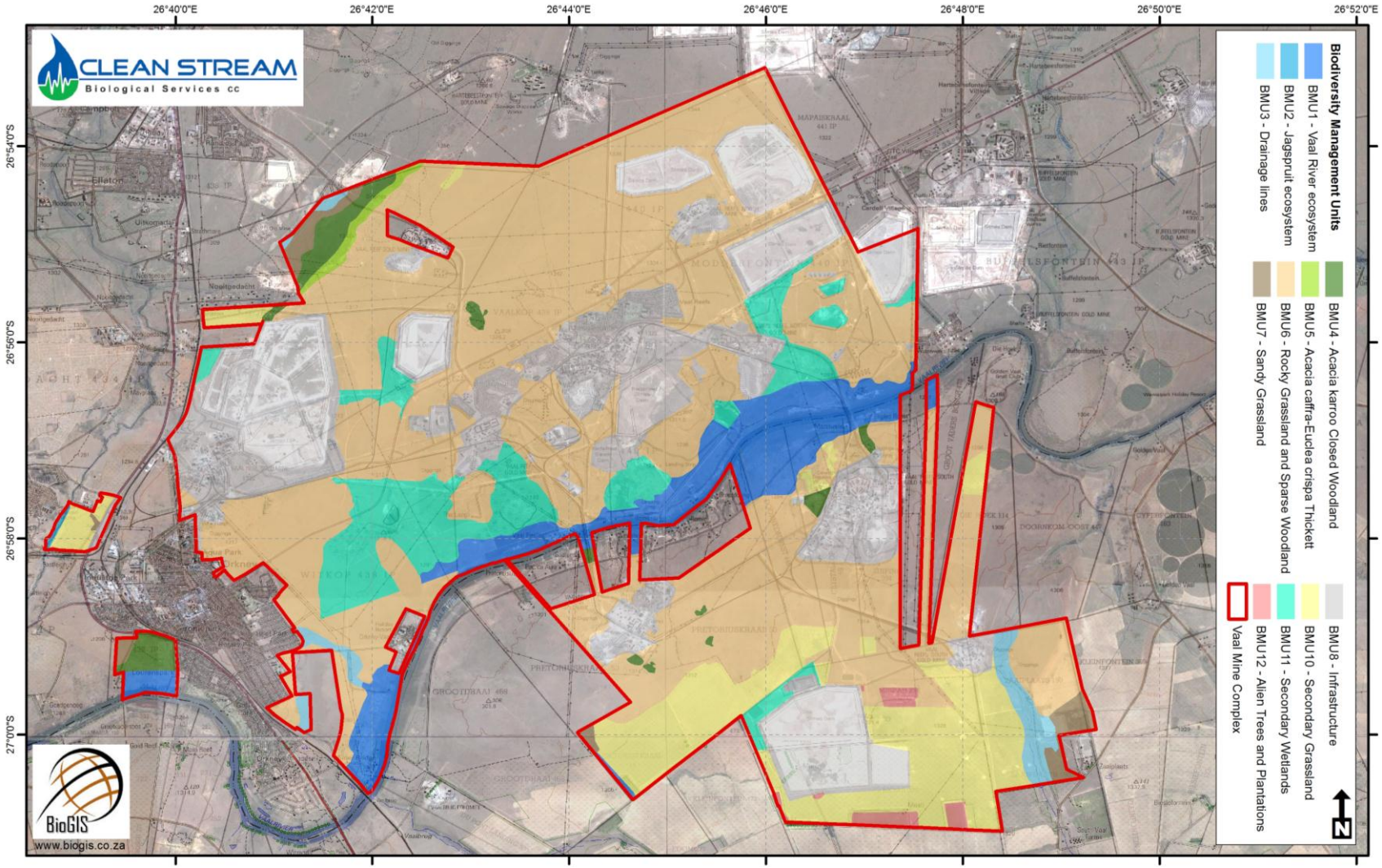


Figure 5: Map of AngloGold Ashanti's Vaal River operational area indicating Biodiversity Management Units (BMU's).

BMU1: Vaal River ecosystem

Biodiversity Management Unit 1 (Vaal River Ecosystem) comprises the Vaal River channel, macro-channel banks and floodplain, which exhibit strong lateral zonation of vegetation as a result of variations in flooding frequency, duration of flooding, speed of floodwaters and soil characteristics. Although the vegetation of these riverine habitats is still dominated by indigenous species, many aliens are present, which reflects the severe degradation upstream. Species richness varies greatly between the various habitats comprising this vegetation unit, with an average botanical species richness of 23.6 species/100m^2 and 68 plant species recorded in total, which is fairly typical for such riverine habitats along the Vaal. Plant species of conservation concern recorded within BMU1 include *Nerine gracilis* (Vulnerable), *Trachyandra erythrorrhiza* (**Near Threatened)** and declining species *Crinum bulbispermum*. The vegetation comprising this unit is floristically distinct from all other units and **four** variations have been recognised within this unit.

A detailed riparian vegetation assessment (application of VEGRAI) was done on a reach of the Vaal River as part of the 2012/3 biodiversity assessment. This study indicated that this reach falls in an ecological category C (defined as an ecosystem that is moderately modified i.e. the resource base has been decreased to a moderate extent, a change of natural habitat and biota has occurred, but the basic ecosystem functions are still predominantly unchanged). The ecological importance (in terms of riparian vegetation) was indicated to be low, while ecological sensitivity was low to moderate.

The diverse riverine environment of the Vaal River provides good shelter and habitat for a number of faunal species. The deep-water habitats of this perennial river and the associated vegetation types are unique to such a major river, utilized by a special cohort of animals. BMU1 supplied habitat for 288 terrestrial animal species (10 frog species, 24 reptile species, 197 bird species and 57 mammal species). Of these, two frogs, four reptiles, 112 bird and three mammal species were observed during the two surveys in BMU1 on the mine. A total of six bird species are specific to this particular habitat, and are not found in other local habitats. BMU1 furthermore meets the habitat requirements of at least 14 terrestrial animal species of conservation concern (one frog, one reptile, two birds and ten mammals).

The vegetation of BMU1 is considered to have a **high** value in terms of botanical biodiversity conservation. Due to the very diverse arrangement of habitat types, and the relative rarity of some of them, as well as the large number of terrestrial animal species

expected to be present (75% of all terrestrial vertebrates present), which includes 12 Red-listed species, this biotope is considered to have a **very high** value in terms of terrestrial fauna biodiversity conservation. As a result of the high fish species diversity, presence of four endemic fish species and two species with high conservation importance (Vaal-Orange Largemouth yellowfish and Threespot barb expected to be vulnerable in Orange-Vaal system), BMU1 has a **high** value in terms of aquatic fauna biodiversity conservation. The overall biodiversity conservation value of BMU1 is therefore **VERY HIGH** and it requires special attention with regards to biodiversity management.

Impacts/Risks:

The important biodiversity aspects and potential impacts/risks are summaries in Table 8.

Vegetation monitoring plots within this BMU highlighted indicated that much of the floodplain vegetation within the study area has been transformed by historical cultivation. Localised overgrazing occurs, particularly within CBMA 2 where there is no access control. Alien invasive species are present in riparian forest and woodland throughout the study area, and the most important transformers and potential transformers are **Cestrum aurantiacum, *Eucalyptus* spp*., *Morus alba, *Salix babylonica* and **Arauja sericifera*. Existing and planned plantations within the portions of BMU1 situated within CBMA 3 have or will lead to significant habitat transformation within this BMU. 'Rehabilitation' of so-called erosion dongas within CBMA 2 which are actually near pristine drainage lines which drain the Vaal River floodplain and provide habitat for a threatened species and a Near Threatened species occurred in 2012 and is considered habitat destruction.

The **biodiversity risk assessment** (Bekker, 2013) conducted as part of the biodiversity study also highlighted the following specific risks to the biodiversity of BMU1:

- Emissions from No.1 shaft acid plant, . Surface discharge from radiation contamination area**,** 3. Tailings spill, Acid plant surface water discharge, Maintenance of water conveyances , Process water used for dust suppression, Surface seepage, Unlicensed storage of tailings material, Unlicensed disposal of sewage sludge, Seep from East Pay Dam, Spill of tailings material, Great Noligwa U Plant , Surface contamination, Vaal River riparian zone construction activities, Surface and sub-surface seepage from East Residue Dam, Burst sewerage pipe at No. 2 Shaft, Hydrocarbon spill.

Table 8: Biodiversity aspects of importance and potential impacts in BMU1: Vaal River ecosystem

BIODIVERSITY ASPECTS	IDENTIFIED IMPACTS
Has moderate plant species richness (average of 23.6 species per 100m^2). Floristically distinct. Includes four major variations (or plant communities). Includes potentially suitable habitat for at least one threatened plant species.	**Impact 1:** Water abstraction.
	Impact 2: Alterations to hydrological patterns and reduction of water quality (e.g. sedimentation, increased salinity, acidity and heavy metal concentrations), through surface discharge or seepage of mine water
	Impact 4: Overgrazing and in some cases, exclusion of grazing. Also trampling of riverbanks by cattle.
	Impact 5: Altered fire regimes: increased or decrease frequency of burning and burning at wrong time, all lead to deterioration of veld condition, alterations to vegetation structure and reduced biodiversity. In the case of the mine exclusion of fire is the most frequent form of this impact.

BIODIVERSITY ASPECTS	IDENTIFIED IMPACTS
Plant species of conservation concern recorded within BMU1 include *Nerine gracilis* (Vulnerable), *Trachyandra erythrorrhiza* (**Near Threatened)** and declining species *Crinum bulbispermum*. Floristically distinct vegetation unit with **four** variations.	**Impact 6:** Invasion by alien plants. Within this unit *Eucalyptus* cf. *camaldulensis* and *Salix babylonica* pose the greatest threat. Other potentially serious invaders present include *Morus alba, Melia azedarach* and *Gleditsia triacanthos.*
	Impact 7: Harvesting of medicinal plants.
	Impact 9, 17: Construction of infrastructure in riparian zone (tourism lodges and residential estates).
	Impact 8: Harvesting of fuel wood, construction timber, sedges and thatching, though this impact is not currently evident to any significant extent.
BMU1 supplied habitat for 288 terrestrial animal species (10 frog species, 24 reptile species, 197 bird species and 57 mammal species). Of these, two frogs, four reptiles, 112 bird and three mammal species were observed during the two surveys. BMU1 meets the habitat requirements of at least 14 Species of conservation concern (one frog, one reptile, two birds and ten mammals).	**Impact 11:** Persecution (hunting with dogs, snares and trapping) of animals – especially game birds (francolin and guinea fowl) and small mammals (steenbok), snakes
	Impact 19: Collecting slow moving animals as pets or food (tortoises and hedgehogs)
	Impact 10: Human activities can disturb sensitive habitats and disturb wildlife. If repeated frequently, such disturbance can impact upon faunal reproduction and survival.
	Impact 20: Changes in lighting in an area, for example, can significantly affect some species' behavioural and biological rhythms, which are guided by natural cycles of light and dark. Nocturnal species, particularly birds, can become disoriented by night-time lighting. Increased attraction of insects to lights alter food source of insectivores.
	Impact 25: Any activity with emissions will have the potential to add to the emissions already in the air. It is the accumulative effect of these emissions that could have an adverse effect on the amphibian population.
Presence or potential presence of Red listed terrestrial animals	**Impact 11:** Giant bullfrog: Collecting for food
	Impact 11: African rock python: Persecution of snakes due to fear and misinformation
	Impact 11: Black stork: Persecution, road kills and human presence
	Impact 11: Raptors: African marsh harrier
	Impact 11: Predators: Spotted-necked otter, Honey badger, Brown hyaena – Persecution: Hunting, snaring and poisoning
	Impact 11: White-tailed mouse, South African hedgehog, Temminck's hairy bat, Geoffroy's horseshoe bat, Water Rat and Schreiber's long-fingered bat
Presence of riverine wetlands and its associated habitats	**Impact 6:** Alien invading vegetation: Spread of exotic tree species will reduce the area covered by primary grassland, deteriorate the natural environment and reduce biodiversity
	Impact 24: Increased erosion: Roads, culverts, storm water drains and cleared areas will lead to increased erosion
	Impact 22: Habitat loss due to old, redundant infrastructure and mined areas
	Impact 13: Fragmentation of habitat is a process whereby large tracts of the natural grassland are gradually developed and subdivided until only patches of original habitat remain
	Impact 17: Removal of habitat aspects such as rocks, shrubs, termite mounds and dead wood will eliminate very viable habitat for a number of animal species
	Impact 9: Removal of riverine vegetation: marginal vegetation and riparian bush, will threaten breeding habitats.
	Impact 2: Seepage from mining areas will influence seasonal marsh wetland: the composition and structure of the wetland vegetation (more nutrients and increased ground water seepage) and the quality of the water will deteriorate (dissolved nutrients)
	Impact 2: The deterioration of the water quality in the seasonal marsh wetland will influence the breeding and survival of tadpoles and thus the frog populations

BIODIVERSITY ASPECTS	IDENTIFIED IMPACTS
	Impact 2: Flushed-out pesticides, detergents and other poisonous substances will be detrimental to frogs and fish below the seepage areas
	Impact 13: Damming of the river in places creates unnatural habitats that can interfere with the natural longitudinal riparian corridors
	Impact 3: The structural habitat of aquatic systems can also be significantly degraded by modifications associated with roads and development.
Presence of at least 9 naturally occurring fish species and 42 macro-invertebrate taxa, as well as the possible occurrence of the Red Data fish species, *Labeobarbus kimberleyensis*.	**Impact 2:** Potential seepage and spills from pollution control dams, slimes dams and process plants (mine infrastructure) may result in poor water quality which could result in sub-lethal to lethal impacts on the present aquatic biota.
	Impact 15: Presence of exotic Mosquitofish. This species preys on the eggs and the young of the naturally occurring fish populations
	Impact 15: Presence of exotic Common carp. The bottom feeding habit of this species increases water turbidity and leads to the destruction of indigenous biota's feeding & breeding habitat.
	Impact 3: Deteriorating physical habitat integrity due to siltation as a result of erosion, related to livestock and other human activities responsible for removal of vegetation (clearing for pipelines, roads, etc.).
	Impact 13: Migration barriers: Take care with the construction of roads, bridges and especially dams and weirs, which may cause migration barriers to fish.
	Impact 2: Nitrification and organic enrichment due to waste water treatment works effluents, leading to increased algal growth and therefore reduce habitat quality.
Potential loss of four expected indigenous fish species from the study area and much lower than expected macro-invertebrate diversity.	**Impact 2 & 3:** Increased pressure on the aquatic ecosystem (reduced physical habitat and water quality) due to extensive human activities in the catchment.

BMU2: Jagspruit/Schoonspruit ecosystem

Biodiversity Management Unit 2 (Jagspruit/Schoonspruit System) comprises vegetation which can be divided into two main zones, namely the marginal vegetation and the marsh vegetation of the seasonally or periodically inundated black clay soils of the floodplain. The marginal vegetation is dominated by hydrophytic and hygrophytic grasses and sedges, whilst the floodplain vegetation comprises dense seasonal marsh and hygrophytic grassland, dominated by hygrophytic grasses and sedges. Many aliens are present in this biotope, which reflects the severe degradation occurring in the upstream reaches of this river. Plant species richness per $100m^2$ varies greatly between the various riverine zones or habitats comprising this vegetation unit, with an average botanical species richness of 36 species/$100m^2$ and 36 plant species recorded in total. The vegetation comprising this unit is furthermore floristically distinct from all other units, as indicated by the fact that sixteen of the species recorded in this vegetation unit were not recorded any of the other vegetation units.

A detailed riparian vegetation assessment (application of VEGRAI) was done on a reach of the Schoonspruit as part of the 2012/3 biodiversity assessment. This study indicated that this reach falls in an ecological category D (defined as an ecosystem which is largely modified such that the resource base has been decreased to a large extent, and large changes in natural habitat, biota and basic ecosystem functions have occurred). The ecological importance and ecological sensitivity (in terms of riparian vegetation) was indicated to be low.

This riverine habitat has a combination of instream biotopes, riparian patches and marginal habitats, providing a diverse habitat combination for a variety of animal species. However, much of the riparian vegetation has already been transformed by a variety of anthropogenic impacts such as canalisation, altered hydrological patterns, reduced water quality and invasion by alien plant species. BMU2 supplied habitat for 190 terrestrial animal species (11 frog species, 7 reptile species, 150 bird species and 22 mammal species). Of these, three frogs, two reptiles, 58 bird and one mammal species were observed during the two surveys in BMU2 on the mine. BMU2 also meets the habitat requirements of at least seven species of conservation concern (one frog, one reptile, one bird and four mammal species). Eleven species of frogs occur in this biotope, and due to the presence of permanent pools, the Common platanna (*Xenopus laevis)* is able to utilize the aquatic habitat. Although only seven reptile species frequent this biotope, the influx of more terrestrial species will take place during the wet season in

reaction to the appearance of frogs, which attracts the reptile species. A relatively high number of bird species (190) occur in this riverine biotope, possibly due to the presence of a combination of habitats, which includes the aquatic component, the marginal wetland vegetation, riparian zone and a variety of soil components (mud flats, sand bars, and river banks). Most of the mammals expected here are wetland species, attracted to the close proximity of water and the associated habitat aspects.

Nine of ten expected indigenous fish species are furthermore present in the system, of which 2 are endemic to the Orange-Vaal system. Of an expected 61 aquatic macro-invertebrate taxa only 31 were observed during the study. Based on the low diversity of observed macro-invertebrate taxa, as well as the fact that no taxa with a very low tolerance to pollution and only one with moderate tolerance to pollution currently occur, it can be deduced that the biotic integrity is reduced due to water quality deterioration.

The vegetation of BMU2 is considered to have a **high** value in terms of botanical biodiversity conservation. Due to vulnerability of these kinds of wetlands, and the number of faunal species expected to be present (47% of all vertebrates present), this biotope is considered to have a **high** value in terms of biodiversity conservation. The conservation value of BMU2, in terms of aquatic biota, can be classified as **moderate-high**. The overall biodiversity conservation value of BMU2 is **HIGH** and therefore necessitates special attention with regards to biodiversity management.

Impacts/Risks:

The important biodiversity aspects and potential impacts/risks are summaries in Table 9.

Vegetation monitoring plots was situated adjacent to the Kanana Township and there is no control of access within this BMU. The vegetation is severely degraded and impacts include overgrazing, altered fire regimes, cutting of trees and shrubs for fire wood and invasion by alien plants. Invasion of this BMU by alien invasive plant species was recorded monitoring site M8 where **Eucalyptus* spp. and **Morus alba* are common.

The **biodiversity risk assessment** (Bekker, 2013) conducted as part of the biodiversity study also highlighted the following specific risks to the biodiversity of BMU2:

- Tailings spill, Process water used for dust suppression, Unlicensed storage of tailings material.

Table 9: Biodiversity aspects of importance and potential impacts in BMU2: Jagspruit/Schoonspruit ecosystem

BIODIVERSITY ASPECTS	IDENTIFIED IMPACTS
Has very high plant species richness (average of 36.0 plant species per 100m^2). Floristically distinct. Includes high habitat and plant community variability with strong lateral zonation of vegetation. Riverine wetlands have been extensively transformed or are	**Impact 1:** Water abstraction.
	Impact 2: Reduction of water quality (e.g. sedimentation, increased salinity, acidity and heavy metal concentrations), through surface discharge or seepage of mine water and runoff and seepage of polluted water from residential areas (e.g. Kannana) and waste dumps.
	Impact 2:Overgrazing and in some cases, exclusion of grazing. Also trampling of riverbanks by cattle.

BIODIVERSITY ASPECTS	IDENTIFIED IMPACTS
under threat from various anthropogenic impacts throughout the Highveld region. Restricted to a short reach within the study area, and therefore comprises a unique and restricted habitat	**Impact 5:** Altered fire regimes: increased or decrease frequency of burning and burning at wrong time, all lead to deterioration of veld condition, alterations to vegetation structure and reduced biodiversity. In the case of this unit increased fire frequency and unseasonal fires are the most frequent form of this impact.
	Impact 6: Invasion by alien plants. Within this unit *Salix babylonica* poses the greatest threat. Other potentially serious invaders present include *Melia azedarach* and *Gleditsia triacanthos.*
	Impact 7: Harvesting of medicinal plants.
	Impact 17: Harvesting of fuel wood and construction timber.
Supply habitat for 190 terrestrial animal species (11 frog species, 7 reptile species, 150 bird species and 22 mammal species). Of these, three frogs, two reptiles, 58 bird and one mammal species were observed during the two surveys in BMU2 on the mine. BMU2 also meets the habitat requirements of at least seven species of conservation concern (one frog, one reptile, one bird and four mammal species).	**Impact 11:** Persecution (hunting with dogs, snares and trapping) of animals – especially game birds (francolin and guinea fowl) and small mammals (steenbok)
	Impact 11: Persecution of predators (mongoose, hyaena, wild cats and polecat) due to misinformation
	Impact 11: Persecution of snakes, especially the venomous species will influence the diversity of this group adversely
	Impact 19: Collecting slow moving animals as pets or food (tortoises and hedgehogs)
	Impact 10: Human activities can disturb sensitive habitats and disturb wildlife. If repeated frequently, such disturbance can impact on faunal reproduction and survival.
	Impact 20: Changes in lighting in an area, for example, can significantly affect some species' behavioural and biological rhythms, which are guided by natural cycles of light and dark. Nocturnal species, particularly birds, can become disoriented by night-time lighting.
	Impact 25: Any activity with emissions will have the potential to add to the emissions already in the air. It is the accumulative effect of these emissions that has the potential to adversely affect the amphibian population.
Presence or potential presence of Red listed animals	**Impact 11:** African rock python: Persecution of snakes due to fear and misinformation
	Impact 11: Raptors: African marsh harrier
	Impact 11: Predators: Spotted-necked otter, Honey badger. Persecution: Hunting, snaring and poisoning
	Impact 11: Water Rat
Presence of Jagspruit wetland ecosystem and its associated habitats	**Impact 6:** Alien invading vegetation: Spread of exotic tree species will reduce the area covered by primary grassland, deteriorate the natural environment and reduce biodiversity
	Impact 24: Increased erosion: Roads, culverts, storm water drains and cleared areas will lead to increased erosion
	Impact 22: Habitat loss due to old, redundant infrastructure and mined areas
	Impact 13: Fragmentation of habitat is a process whereby large tracts of the natural grassland are gradually developed and subdivided until only patches of original habitat remain
	Impact 13: Roads may be the single most destructive element of the habitat fragmentation process.
	Impact 17: Removal of habitat aspects such as rocks, shrubs, termite mounds and dead wood will eliminate very viable habitat for a number of animal species
	Impact 3: Removal of riverine vegetation: marginal vegetation and riparian bush, will pose a threat to breeding habitats.
	Impact 2: Seepage from mining areas will influence seasonal marsh wetland: the composition and structure of the wetland vegetation (more nutrients and increased ground water seepage) and the quality of the water will deteriorate (dissolved nutrients)

BIODIVERSITY ASPECTS	IDENTIFIED IMPACTS
	Impact 2: The deterioration of the water quality in the seasonal marsh wetland will influence the breeding and survival of tadpoles and thus the frog populations
	Impact 2: Flushed-out pesticides, detergents and other poisonous substances will be detrimental to frogs and fish below the seepage areas
	Impact 1: Damming of the river in places creates unnatural habitats that can interfere with the natural longitudinal riparian corridors
	Impact 3: The structural habitat of aquatic systems can also be significantly degraded by modifications associated with roads and development.
	Impact ??: The construction of buildings and roads alters drainage patterns and soil structure, while altered nutrient levels from run-off and septic tanks can also cause other long term problems.
Presence of at least 9 naturally occurring fish species and 15 macro-invertebrate taxa.	**Impact 2:** Potential seepage and spills from pollution control dams, slimes dams and process plants (mine infrastructure) may result in poor water quality which could result in sub-lethal to lethal impacts on the present aquatic biota.
	Impact 15: Presence of exotic Mosquitofish. This species preys on the eggs and the young of the naturally occurring fish populations
	Impact 15: High probability of the presence of exotic Largemouth bass. This species utilizes indigenous fish & invertebrates as food and could lead to the eradication of certain species in this system. It also competes with indigenous biota for food and habitat.
	Impact 15: Presence of exotic Common carp. The bottom-feeding habit of this species increases water turbidity and leads to the destruction of indigenous biota's feeding & breeding habitat.
	Impact 13: Deteriorating physical habitat integrity due to siltation as a result of erosion, related to farming and other human activities responsible for removal of vegetation (clearing for pipelines, roads, etc.).
	Impact 2: Nitrification and organic enrichment due to waste water treatment works effluents, and agricultural runoff, leading to increased algal growth and therefore reduce habitat quality.
Loss of one expected indigenous fish species from the study area and much lower than expected macro-invertebrate diversity.	**Impact 2 & 3:** Increased pressure on the aquatic ecosystem (reduced physical habitat and water quality) due to extensive human activities in the catchment.

BMU3: Drainage lines

Biodiversity Management Unit 3 (Drainage lines) comprises 'valley-bottom wetlands' that are either unchannelled or have poorly incised channels. Within BMU3 there is strong lateral zonation of vegetation as a result of variations in key habitat parameters such as flooding frequency and duration of flooding, speed of floodwaters, topography and soil characteristics. The dense marsh comprising this vegetation unit is dominated by helophytic and hygrophytic grasses and, to a lesser extent, sedges. The plant species richness of BMU3 was 19 species per 100m^2, which is typical of Highveld valley-bottom wetlands. The vegetation comprising this unit is furthermore floristically distinct from all other units, as indicated by the fact that fourteen of the species recorded in this vegetation unit were not recorded in any of the other vegetation units. This marsh vegetation is considered to be of elevated conservation importance for the following reasons:

- Performs an important ecological function, e.g. maintaining water purity and constant water supply and reducing soil erosion.
- Provides important breeding and feeding habitat for various animal and bird populations and contains many plant species that are restricted to this habitat.
- Drainage lines and accompanying valley-bottom wetlands are linear systems in which any disturbance will affect the quality of systems further downstream (O'Keefe, 1986).
- Valley-bottom wetlands have been extensively transformed or under threat from various anthropogenic impacts such as canalisation, altered hydrological patterns, reduced water quality and invasion by alien plant species (Henderson & Musil, 1987), and any remaining area of untransformed riparian vegetation must therefore be regarded as of elevated conservation importance
- Within the study area and its immediate surroundings, this vegetation unit represents a unique and restricted habitat type, much of which has already been transformed.

BMU3 supplied habitat for 151 terrestrial animal species (12 frog species, 7 reptile species, 111 bird species and 21 mammal species). Of these, two frogs, 33 bird and four mammal species were observed during the two surveys in BMU3 on the mine. BMU3 furthermore meets the habitat requirements of at least seven species of conservation concern (two frogs, one reptile, two bird and two mammal species).

The vegetation of this unit is therefore considered to have a **high** value in terms of botanical biodiversity conservation. Due to the number of species expected to be present (37% of all vertebrates present), which includes 3 Red-listed species, this biotope is considered to have a **moderate** value in terms of biodiversity conservation. Based on aquatic fauna, this BMU has a **moderate-low** value in terms of biodiversity

conservation. The overall biodiversity conservation value of BMU3 is **MODERATE-HIGH** and this area requires attention regarding biodiversity management within the study area.

Impacts/Risks:

The important biodiversity aspects and potential impacts/risks are summaries in Table 10.

Vegetation monitoring plots within this BMU highlighted the effects of historical overgrazing (in the form of high species richness of alien ruderal weeds) in the now defunct Mispah Game Park. Current overgrazing is evident also evident at some sites. The valley-bottom wetland directly to the north of CBMA 1 has been severely degraded by mine tailings which form a layer on the soil surface in the central parts of the wetland.

The **biodiversity risk assessment** (Bekker, 2013) conducted as part of the biodiversity study also highlighted the following specific risks to the biodiversity of BMU3:

- Tailings spill, Unlicensed storage of tailings material, Spill of tailings material, Surface contamination.

Table 10: Biodiversity aspects of importance and potential impacts in BMU3: Drainage lines

BIODIVERSITY ASPECTS	IDENTIFIED IMPACTS
Has typical plant species richness (average of 19.0 plants species per 100m^2) for wetland habitats. Floristically distinct. Includes high habitat and plant community variability with strong lateral zonation of vegetation. Includes potentially suitable habitat for at least one vulnerable and one near threatened plant species. Performs an important ecological function, Drainage lines are linear systems in which any disturbance will affect the quality of systems further downstream;	**Impact 1:** Damming and water abstraction.
	Impact 1: Alterations to hydrological patterns and reduction of water quality (e.g. sedimentation, increased salinity and increased acidity), through storm water runoff and discharge or seepage of mine water.
	Impact 1: Canalisation, as has occurred within the Mispah Game Park.
	Impact 4: Overgrazing and, in some cases, exclusion of grazing.
	Impact 5: Altered fire regimes: increased or decrease frequency of burning and burning at wrong time, all lead to deterioration of veld condition, alterations to vegetation structure and reduced biodiversity.
	Impact 6: Invasion by alien plants. Within this unit *Pennisetum clandestinum, Salix babylonica* and *Populus* X *canescens* pose the greatest threat, but are currently not a significant problem.
	Impact 23: Dust. Vegetation in close proximity to heavily utilized dirt roads and unstabilized slimes dams may be smothered by dust, which hinders photosynthesis and transpiration.
	Impact 7: Harvesting of medicinal plants
Provide habitat for 151 terrestrial animal species (12 frog species, 7 reptile species, 111 bird species and 21 mammal species). Of these, two frogs, 33 bird and four mammal species were observed during the two surveys in BMU3 on the mine. BMU3 furthermore meets the habitat requirements of at least seven species of conservation concern (two frogs, one reptile, two bird and two mammal species).	**Impact 11:** Noise, dust and movement associated with construction will drive out most of the more mobile faunal species (birds and larger mammals)
	Impact 11: Persecution (hunting with dogs, snares and trapping) of animals – especially game birds (francolin and guinea fowl) and small mammals (steenbok)
	Impact 11: Persecution of predators (mongoose, hyaena, wild cats and polecat) due to misinformation
	Impact 11: Persecution of snakes, especially the poisonous species will influence the diversity of this group adversely
	Impact 19: Collecting slow moving animals as pets or food (tortoises and hedgehogs)
	Impact 11: Human activities can disturb sensitive habitats and disturb wildlife. If repeated frequently, such disturbance can impact on faunal reproduction and survival.

BIODIVERSITY ASPECTS	IDENTIFIED IMPACTS
	Impact 20: Changes in lighting in an area, for example, can significantly affect some species' behavioural and biological rhythms, which are guided by natural cycles of light and dark. Nocturnal species, particularly birds, can become disoriented by night-time lighting.
	Impact 25: Any activity with emissions will have the potential to add to the emissions already in the air. It is the accumulative effect of these emissions that has adverse effects on the amphibian population.
Potential presence of the Red listed animals	**Impact 11:** Giant bullfrog: Collecting for food
	Impact 11: Predators: Honey badger – Persecution: Hunting, snaring and poisoning
	Impact 11: Water Rat
Presence of seasonal marsh wetlands and its associated habitats	**Impact 6:** Alien invading vegetation: Spread of exotic tree species will reduce the area covered by primary grassland, deteriorate the natural environment and reduce biodiversity
	Impact 24: Increased erosion: Roads, culverts, storm water drains and cleared areas will lead to increased erosion
	Impact 22: Habitat loss due to old, redundant infrastructure and mined areas
	Impact 13: Fragmentation of habitat is a process whereby large tracts of the natural grassland are gradually developed and subdivided until only patches of original habitat remain
	Impact 13: Roads may be the single most destructive element of the habitat fragmentation process.
	Impact 17: Removal of habitat aspects such as rocks, shrubs, termite mounds and dead wood will eliminate very viable habitat for a number of animal species
	Impact 3: Removal of riverine vegetation: marginal vegetation and riparian bush, will pose a threat to breeding habitats.
	Impact 2: Seepage from mining areas will influence seasonal marsh wetland: the composition and structure of the wetland vegetation (more nutrients and increased ground water seepage) and the quality of the water will deteriorate (dissolved nutrients)
	Impact 2: The deterioration of the water quality in the seasonal marsh wetland will influence the breeding and survival of tadpoles and thus the frog populations
	Impact 2: Flushed-out pesticides, detergents and other poisonous substances will be detrimental to frogs and fish below the seepage areas
	Impact 1: Damming of the river in places creates unnatural habitats that can interfere with the natural longitudinal riparian corridors
	Impact 3: The structural habitat of aquatic systems can also be significantly degraded by modifications associated with roads and development.
Presence of at least one naturally occurring fish species and 19 macro-invertebrate taxa.	**Impact 15:** Presence of exotic Mosquitofish. This species preys on the eggs and the young of the naturally occurring fish populations
Potential loss of three expected indigenous fish species from the wetland.	

BMU4: *Acacia karroo* Closed Woodland


Biodiversity Management Unit 4 (*Acacia karroo* Closed Woodland) comprises of various disjunct patches of *Acacia karroo* woodland that occur throughout the study area, on a variety of substrates, but mostly on deep sandy soils of the Ms1 and Hu1 soil units, in flat to gently undulating terrain. This vegetation can be termed Short Closed Woodland, which seems to have developed as a result of the exclusion of fire for the purposes of protecting grazing, as a result of soil disturbance (e.g. scouring and trampling), and in areas disturbed by excavation. BMU4 had an average botanical species richness of 29.5 species/100m^2 and 44 plant species recorded in total, The disturbed nature of much of this vegetation unit is reflected by the fact that species richness comprises largely of indigenous pioneer species, species indicative of disturbance and alien species, and contains few diagnostic species (i.e. species restricted only to this vegetation type).

The presence of trees and logs create sheltering and nesting habitats for animals, together with other habitat components such as stones, rocks and termite mounds. BMU4 supplied habitat for 199 species of terrestrial animals (26 reptile species, 134 bird species and 39 mammal species). No frog species are expected to utilize this habitat, as it is relatively dry. Due to the sufficient tree cover, grass cover and presence of some rocks, several reptile, bird and mammal species can be expected. Consequently, four reptiles, 63 bird and three mammal species were observed during the two surveys in BMU4 on the mine. This biotope also meets the habitat requirements of nine species of conservation concern (one reptile, two bird and six mammal species).

BMU4 is considered to have a **moderate** value in terms of botanical biodiversity conservation. Although it provides habitat for at least 8 Red Data listed animal species, the area is somewhat altered by human influence and it is a rather common biotope to the area, therefore this biotope is considered to have a **moderate** value in terms of biodiversity conservation. The overall biodiversity conservation value of BMU4 is therefore **MODERATE**.

Impacts/Risks:

The important biodiversity aspects and potential impacts/risks are summaries in Table 11.

Vegetation monitoring plots within this BMU indicated that it is heavily grazed in places but not overgrazed. Invasion, at low densities, by **Opuntia ficus-indica* recorded. Cutting of trees for firewood observed and this impact poses a serious threat to this BMU.

The **biodiversity risk assessment** (Bekker, 2013) conducted as part of the biodiversity study also highlighted the following specific risks to the biodiversity of BMU4:

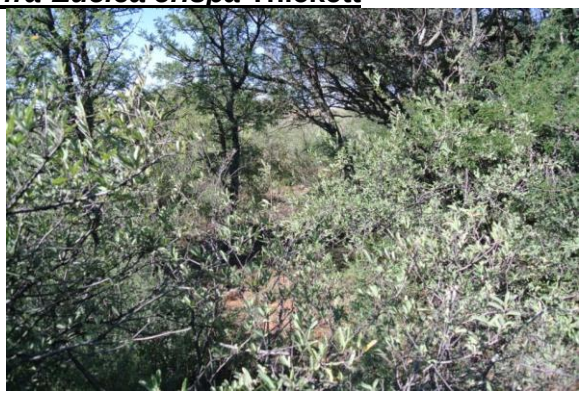
- Tailings spill, Unlicensed storage of tailings material, Spill of tailings material, Surface contamination.

Table 11: Biodiversity aspects of importance and potential impacts in BMU4: *Acacia karroo* Closed Woodland

BIODIVERSITY ASPECTS	IDENTIFIED IMPACTS
Has moderate species richness (average of 29.5 species per 100m^2 and 44 species in total). Comprises largely indigenous pioneer species. Only three of the species recorded were not recorded in any of the other vegetation units In many cases seems to have developed as a result of the exclusion of fire and the disturbance of soils.	**Impact 4:** Overgrazing and, in some cases, exclusion of grazing.
	Impact 5: Altered fire regimes: increased or decrease frequency of burning and burning at wrong time, all lead to deterioration of veld condition, alterations to vegetation structure and reduced biodiversity. In the case of the mine exclusion of fire is the most frequent form of this impact.
	Impact 6: Invasion by alien plants. Within this unit *Sphaeraclea bonariensis* and *Melia azedarach* pose the biggest threat.
	Impact 7: Harvesting of medicinal plants.
	Impact 9: Cutting of trees and shrubs (for firewood and construction). Not recorded as a serious threat currently.
BMU4 provide habitat for 199 species of terrestrial animals (26 reptile species, 134 bird species and 39 mammal species). Consequently, four reptiles, 63 bird and three mammal species were observed during the two surveys in BMU4 on the mine. This biotope also meets the habitat requirements of nine species of conservation concern (one reptile, two bird and six mammal species).	**Impact 11:** Persecution (hunting with dogs, snares and trapping) of animals – especially game birds (francolin and guinea fowl) and small mammals (steenbok)
	Impact 11: Persecution of predators (mongoose, hyaena, wild cats and polecat) due to misinformation
	Impact 11: Persecution of snakes, especially the poisonous species will influence the diversity of this group adversely
	Impact 11: Persecution of snakes, especially the poisonous species will influence the diversity of this group adversely
	Impact 19: Collecting of slow moving animals as pets or food (tortoises and hedgehogs)
	Impact 10: Human activities can disturb sensitive habitats and disturb wildlife. If repeated frequently, such disturbance can impact on faunal reproduction and survival.
	Impact 20: Changes in lighting in an area, for example, can significantly affect some species' behavioural and biological rhythms, which are guided by natural cycles of light and dark. Nocturnal species, particularly birds, can become disoriented by night-time lighting.
Potential presence of the Red data listed animals	**Impact 11:** White-bellied Korhaan: Persecution, road kills and human presence
	Impact 11: Raptors: Secretary bird: Persecution, road kills and human presence
	Impact 11: Predators: Honey badger, Brown hyaena – Persecution: Hunting, snaring and poisoning
	Impact 11: South African hedgehog, Temminck's hairy bat, Geoffroy's horseshoe bat and Schreiber's long-fingered bat: Persecution, road kills, human presence and collection as pets.
Presence of *Acacia karroo* woodland and its associated habitats	**Impact 6:** Alien invading vegetation: Spread of exotic tree species will reduce the area covered by primary grassland, deteriorate the natural environment and reduce biodiversity
	Impact 24: Increased erosion: Roads, culverts, storm water drains and cleared areas will lead to increased erosion
	Impact 22: Habitat loss due to old, redundant infrastructure and mined areas
	Impact 5: Some ecosystems, especially grasslands and heathlands, are changed significantly by inappropriate fire regimes.

BIODIVERSITY ASPECTS	IDENTIFIED IMPACTS
	Impact 13: Fragmentation of habitat is a process whereby large tracts of the natural grassland are gradually developed and subdivided until only patches of original habitat remain
	Impact 13: Roads may be the single most destructive element of the habitat fragmentation process.
	Impact 17: Removal of habitat aspects such as rocks, shrubs, termite mounds and dead wood will eliminate very viable habitat for a number of animal species
	Impact 8: Chopping down trees in the woodland (habitat for birds–nesting, perching; arboreal reptiles and mammals); for different reasons (make knobkieries, hedges, building material)
	Impact 17: Removal of rocks and stones for use in construction, quarrying or other reasons

BMU5: *Acacia caffra-Euclea crispa* Thickett

BMU5 (*Acacia caffra-Euclea crispa* Thicket) is restricted to a low ridge which is situated near the northern boundary of the study area. It can be classified as Short Thicket on shallow, yellowish brown sandy loams, and dolomitic Black Reef rock cover. This vegetation has 51.0 plants per 100m^2 (72 plant species in total), the highest average species richness of any of the vegetation units identified during this study. It is furthermore structurally and floristically distinct from all other vegetation units - twenty-two of the species recorded in this vegetation unit were not recorded within any of the other vegetation units. Furthermore, this Thicket vegetation constitutes a unique and restricted habitat, both within the study area and its immediate surroundings.

BMU5 supplied habitat for 197 animal species (28 reptile species, 125 bird species and 44 mammal species, whilst no amphibians are expected in this habitat due to the dryness of the habitat). The dense cover of the *Acacia caffra-Euclea crispa* thicket provides shelter and nesting habitat for a number of faunal species. Although very similar in faunal composition to the *Acacia karroo* Closed Woodland biotope, the *Acacia caffra-Euclea crispa* thicket has the benefit of rocky ridges that add to the habitat diversity of the biotope, creating refuge to more vertebrate species. Consequently, four reptiles, 37 bird and two mammal species were observed during the two surveys in BMU5 on the mine. This biotope furthermore meets the habitat requirements of eight species of conservation concern (one reptile, two mammal and six bird species).

The vegetation of this unit is considered to have a **high** value in terms of botanical biodiversity conservation. This biotope constitutes a unique and restricted habitat, both within the study area and its immediate surroundings, and with the number of terrestrial animal species expected to be present (50% of all vertebrates present), which includes 8 Red-listed species, this biotope is considered to have a **high** value in terms of faunal biodiversity conservation. The overall biodiversity conservation value of BMU5 is therefore **HIGH** and necessitates special attention with regards to biodiversity management.

Impacts/Risks:

The important biodiversity aspects and potential impacts/risks are summaries in Table 12.

Vegetation monitoring plots within this BMU is restricted to CBMA1, where there is no access control. This unit is heavily grazed and shows signs of overgrazing in places. Alien plants occur at low densities, and only **Opuntia ficus-indica* is currently common

and poses a risk of habitat transformation. Cutting of trees for firewood and the erection of informal structures is evident and should be controlled.

The **biodiversity risk assessment** (Bekker, 2013) conducted as part of the biodiversity study also highlighted the following specific risks to the biodiversity of BMU5:

- Tailings spill, Unlicensed storage of tailings material, Spill of tailings material, Surface contamination.

Table 12: Biodiversity aspects of importance and potential impacts in BMU5: *Acacia caffra-Euclea crispa* Thickett

BIODIVERSITY ASPECTS	IDENTIFIED IMPACTS
Has the highest average plant richness (average of 51.0 species per 100m^2 and total of 72 species) of any vegetation unit. Structurally and floristically distinct from all other units. Twenty-two of the species recorded were not recorded in any of the other vegetation units. Constitutes a unique and restricted habitat.	**Impact 4:** Overgrazing and, in some cases, exclusion of grazing.
	Impact 5: Altered fire regimes: increased or decrease frequency of burning and burning at wrong time, all lead to deterioration of veld condition, alterations to vegetation structure and reduced biodiversity.
	Impact 6: Invasion by alien plants. Within this unit *Sphaeraclea bonariensis* and *Opuntia* ficus-indica pose a serious threat, though currently only present in very small numbers.
	Impact 9: Cutting of trees and shrubs (for firewood and construction). Not recorded as a serious threat currently.
	Impact 7: Harvesting of medicinal plants.
Provide habitat for 197 animal species (28 reptile species, 125 bird species and 44 mammal species). Four reptiles, 37 bird and two mammal species were observed during the two surveys. This biotope furthermore meets the habitat requirements of eight species of conservation concern (one reptile, two mammal and six bird species).	**Impact 10:** Noise, dust and movement associated with construction will drive out most of the more mobile faunal species (birds and larger mammals)
	Impact 11: Persecution (hunting with dogs, snares and trapping) of animals – especially game birds (francolin and guinea fowl) and small mammals (steenbok)
	Impact 11: Persecution of predators (mongoose, hyaena, wild cats and polecat) due to misinformation
	Impact 11: Persecution of snakes, especially the poisonous species will influence the diversity of this group adversely
	Impact 11: Persecution of snakes, especially the poisonous species will influence the diversity of this group adversely
	Impact 19: Collecting of slow moving animals as pets or food (tortoises and hedgehogs)
	Impact 10: Human activities can disturb sensitive habitats and disturb wildlife. If repeated frequently, such disturbance can impact upon faunal reproduction and survival.
	Impact 20: Changes in lighting in an area, for example, can significantly affect some species' behavioral and biological rhythms, which are guided by natural cycles of light and dark. Nocturnal species, particularly birds, can become disoriented by night-time lighting.
Presence of the Red listed animals	**Impact 11:** White-bellied Korhaan: Persecution, road kills and human presence
	Impact 11: Raptors: Secretary bird
	Impact 11: Predators: Honey badger, Brown hyaena – Persecution: Hunting, snaring and poisoning
	Impact 11: South African hedgehog, Temminck's hairy bat, Geoffroy's horseshoe bat and Schreiber's long-fingered bat
Presence of *Acacia caffra-Euclea crispa* thicket and its associated habitats	**Impact 6:** Alien invading vegetation: Spread of exotic tree species will reduce the area covered by primary grassland, deteriorate the natural environment and reduce biodiversity
	Impact 24: Increased erosion: Roads, culverts, storm water drains and cleared areas will lead to increased erosion
	Impact 22: Habitat loss due to old, redundant infrastructure and mined areas

BIODIVERSITY ASPECTS	IDENTIFIED IMPACTS
	Impact 5: Some ecosystems, especially grasslands and heathlands, are changed significantly by inappropriate fire regimes.
	Impact 13: Fragmentation of habitat is a process whereby large tracts of the natural grassland are gradually developed and subdivided until only patches of original habitat remain. Roads may be the single most destructive element of the habitat fragmentation process.
	Impact 9: Chopping down trees in the woodland (habitat for birds–nesting, perching; arboreal reptiles and mammals); for different reasons (make knobkieries, hedges, building material).
	Impact 17: Removal of rocks and stones for use in construction, quarrying or other reasons.

BMU6: Rocky Grassland and Sparse Woodland


Biodiversity Management Unit 6 (Rocky Grassland and Sparse Woodland) comprises more than half of the surface area of the study area, and is distributed mainly over the central, northern and eastern parts of the study area, to the north of the Vaal River. The vegetation is untransformed, short, moderately dense (55% to 75% cover) grassland with numerous, small, scattered clumps of trees and shrubs, and is representative of the Vaal Reefs Dolomite Sinkhole Woodland vegetation type (Mucina & Rutherford, 2007). These grasslands or Sparse Woodlands are considered to have one of the highest biodiversity conservation values of any of the vegetation units identified in the study area, due to the very high species richness (average of 49.9 species per $100m^2$ and total of 152 species) and the fact that they represent a vegetation type (Vaal Reefs Dolomite Sinkhole Woodland) which is highly transformed, very poorly conserved and categorized as *Vulnerable* (Mucina & Rutherford, 2007) at a National level. Furthermore, the study area comprises a significant portion of the total area occupied by this vegetation type. *Lithops lesliei* subsp. *Lesliei, Pearsonia bracteata and Adromischus umbraticola* all categorised as Near Threatened were recorded within this BMU (by Mr. De Castro and Mr. Wiegenhagen).

BMU6 supplied habitat for 232 terrestrial animal species (31 reptile species, 148 bird species and 53 mammal species). BMU6 has the largest expected number of reptiles (31 species), which utilize the crevices and cracks in the abundant rock protrusions, as well as the dense bushy clumps scattered through the biotope. The sandy soils might harbour a few subterranean species, whilst the grass also adds to the habitat variety. The favourable habitat combination of grassland, sandy soils and woody bush clumps, creates habitat for some 148 bird species, of which 6 species are particular to this biotope and 6 birds are species of conservation concern. The same favorable conditions sustain a relatively high number of mammals (53 species), of which 8 are Species of Special Concern. Consequently, three reptiles, 78 bird and 12 mammal species were observed during the two surveys in BMU6 on the mine.

The vegetation of this unit is considered to have a **Very High** value in terms of botanical biodiversity conservation, primarily due to very high species richness. This diversity is reflected by the number of animal species expected to be present (57% of all vertebrates expected in the study area), which includes 12 Red Data listed species. This biotope is thus considered to have a **Very High** value in terms of faunal biodiversity conservation. The overall biodiversity conservation value of this area is therefore **VERY HIGH** and it requires special emphasis for biodiversity management.

Impacts/Risks:

The important biodiversity aspects and potential impacts/risks are summaries in Table 13.

Vegetation monitoring plots within this BMU indicated that the vegetation of this unit is mostly in good condition, the north-eastern parts of this unit within CBMA 1 have been degraded by overgrazing and altered fire regimes (unseasonal and overly frequent fires). The establishment of plantations (as part of the Woodlands Project) has transformed sections of dolomite grassland to the north of CBMA 3 and more such plantations are apparently proposed within this unit in CBMA3. Parts of this unit have been severely degraded by tailing spills (e.g. area 150m north of site M3).

The **biodiversity risk assessment** (Bekker, 2013) conducted as part of the biodiversity study also highlighted the following specific risks to the biodiversity of BMU6:

- Emissions from No.1 shaft acid plant, Surface discharge from radiation contamination area**,** Tailings spill, Acid plant surface water discharge, Maintenance of water conveyances , Surface seepage, Unlicensed storage of tailings material, Unlicensed disposal of sewage sludge, Seep from East Pay Dam, Trial plantations as part of the Woodlands project, Spill of tailings material, Waste disposal, Great Noligwa U Plant , Great Noligwa waste rock dump, Disposal of waste material on soil, Surface contamination, Habitat deterioration, Use of emergency earthen dam and channel, Surface and sub-surface seepage from East Residue Dam.

Table 13: Biodiversity aspects of importance and potential impacts in BMU6: Rocky Grassland and Sparse Woodland

BIODIVERSITY ASPECTS	IDENTIFIED IMPACTS
Has very high plant species richness (average of 49.9 species per 100m^2 and total of 152 species) and contains the highest total number of species of any of the units identified within the study area. Floristically and structurally distinct, Includes relatively high habitat and plant community variability. Comprises untransformed vegetation that is categorized as Vulnerable at national level. Furthermore, the study area comprises a significant portion of the total area occupied by this vegetation type. Three Near Threatened plant species recorded.	**Impact 4:** Overgrazing and, in some cases, exclusion of grazing.
	Impact 5: Altered fire regimes: increased or decrease frequency of burning and burning at wrong time of year, all lead to deterioration of veld condition, alterations to vegetation structure and reduced biodiversity.
	Impact 23: Dust. Vegetation in close proximity to heavily utilized dirt roads and unstabilised slimes dams may be smothered by dust, which hinders photosynthesis and transpiration.
	Impact 7: Harvesting of medicinal plants.
	Impact 8 or 9??: Cutting of trees and shrubs (for firewood and construction). Not recorded as a serious threat currently.
Provide habitat for 232 terrestrial animal species (31 reptile species, 148 bird species and 53 mammal species). BMU6 has the largest expected number of reptiles (31 species), which utilize the crevices and cracks in the abundant rock protrusions, as well as the dense bushy clumps scattered through the biotope. Three reptiles, 78 bird and 12 mammal species were observed during	**Impact 10:** Noise, dust and movement associated with construction will drive out most of the more mobile faunal species (birds and larger mammals).
	Impact 11: Persecution (hunting with dogs, snares and trapping) of animals – especially game birds (francolin and guinea fowl) and small mammals (steenbok).
	Impact 11: Persecution of predators (mongoose, hyaena, wild cats and polecat) due to misinformation.
	Impact 11: Persecution of snakes, especially the poisonous species will influence the diversity of this group adversely.

BIODIVERSITY ASPECTS	IDENTIFIED IMPACTS
the two surveys in BMU6 on the mine.	**Impact 11:** Persecution of snakes, especially the poisonous species will influence the diversity of this group adversely.
	Impact 19: Collecting of slow moving animals as pets or food (tortoises and hedgehogs).
	Impact 10: Human activities can disturb sensitive habitats and disturb wildlife. If repeated frequently, such disturbance can impact on faunal reproduction and survival.
	Impact 20: Changes in lighting in an area, for example, can significantly affect some species' behavioral and biological rhythms, which are guided by natural cycles of light and dark. Nocturnal species, particularly birds, can become disoriented by night-time lighting.
Presence of the Red listed animals	**Impact 11:** Giant bullfrog: Collecting for food
	Impact 11: African rock python: Persecution of snakes due to fear and misinformation
	Impact 11: White-bellied Korhaan: Persecution, road kills and human presence
	Impact 11: Raptors: Lanner Falcon, Lesser Kestrel and Secretary bird: Persecution, road kills and human presence
	Impact 11: Predators: Honey badger, Brown hyaena – Persecution: Hunting, snaring and poisoning
	Impact 11: South African hedgehog, Temminck's hairy bat, Geoffroy's horseshoe bat and Schreiber's long-fingered bat
Presence of woodland, grassland and its associated habitats	**Impact 6:** Alien invading vegetation: Spread of exotic tree species will reduce the area covered by primary grassland, deteriorate the natural environment and reduce biodiversity
	Impact 24: Increased erosion: Roads, culverts, storm water drains and cleared areas will lead to increased erosion
	Impact 22: Habitat loss due to old, redundant infrastructure and mined areas
	Impact 5: Some ecosystems, especially grasslands and heathlands, are changed significantly by inappropriate fire regimes.
	Impact 13: Fragmentation of habitat is a process whereby large tracts of the natural grassland are gradually developed and subdivided until only patches of original habitat remain. Roads may be the single most destructive element of the habitat fragmentation process.
	Impact 9: Chopping down trees in the woodland (habitat for birds–nesting, perching; arboreal reptiles and mammals); for other reasons (make knobkieries, hedges, building material)
	Impact 17: Removal of habitat aspects such as rocks, shrubs, termite mounds and dead wood will eliminate very viable habitat for a number of animal species
	Impact 17: Removal of rocks and stones for use in construction, quarrying or other reasons

BMU7: Sandy Grassland


Biodiversity Management Unit 7 (Sandy Grassland) comprises large areas of the western and southern parts of the study area which are generally flat to gently undulating. The vegetation is untransformed short, dense grassland representative of the Vaal-Vet Sandy Grassland vegetation type (Mucina & Rutherford, 2007). The grasslands comprising this vegetation unit are considered to have one of the highest biodiversity conservation values of any of the vegetation units identified in the study area, with a relatively high species richness (total of 54 plant species and an average of 39.5 species per $100m^2$) and the fact that they represent a vegetation type, namely Vaal-Vet Sandy Grassland, which is highly transformed, very poorly conserved and categorized as *Endangered* (Mucina & Rutherford, 2007) at a National level. Though untransformed, much of this vegetation has been somewhat degraded by impacts such as heavy grazing by cattle, altered fire regimes (either exclusion of fire or increased fire frequency and/or unseasonal burning), and various 'edge effects' emanating from surrounding transformed habitats. Sixteen of the species recorded in this vegetation unit were not recorded in any of the other vegetation units. The uncommon lily *Nerine laticoma* was recorded at only one site within this vegetation unit, and is seemingly absent form the rest of the study area.

BMU7 supplied habitat for 148 animal species (one frog species, 19 reptile species, 91 bird species and 37 mammal species). Sandy soils provide good burrowing habitat for a number of subterranean animals, whilst grass cover and associated scattered rocks also provide food and shelter. The fact that seasonal pans might form in this biotope during high rainfall years, render it suitable habitat for the Giant bullfrog (*Pyxicephalus adspersus*). Subterranean reptiles will also make use of the sandy soils to shelter and hunt, and grass snakes will shelter in grass. Although not as diverse as Rocky Grassland, Sandy Grassland provides potential habitat to 91 bird species, comprising most of the true grassland species. Consequently, two reptiles, 26 bird and seven mammal species were observed during the two surveys in BMU7 on the mine.

The vegetation of this unit is considered to have a **very high** value in terms of botanical biodiversity conservation due to its national threatened status. The diversity of fauna is not exceptionally high (40% of all vertebrates present), but it includes 9 Red Data listed species (4 birds & 5 mammals) which is an indication of the status of the biotope, and thus it is considered to have a **high** value in terms of faunal biodiversity conservation. The overall biodiversity conservation value of BMU7 is therefore **VERY HIGH** and it requires special emphasis regarding biodiversity management.

Impacts/Risks:

The important biodiversity aspects and potential impacts/risks are summaries in Table 14.

Vegetation monitoring plots within this BMU indicated that the remnant patches of this unit are mostly in good condition and though grazed show no signs of degradation associated with overgrazing or altered fire regimes. No other significant impacts were observed.

The **biodiversity risk assessment** (Bekker, 2013) conducted as part of the biodiversity study also highlighted the following specific risks to the biodiversity of BMU7:

- Tailings spill, Unlicensed storage of tailings material, Spill of tailings material, Surface contamination.

Table 14: Biodiversity aspects of importance and potential impacts in BMU7: Sandy Grassland

BIODIVERSITY ASPECTS	IDENTIFIED IMPACTS
Has high species richness (total of 54 species and average of 39.5 species per 100m^2). Floristically and structurally distinct. Vegetation is fairly uniform and untransformed - represents a vegetation type that is Endangered at national level. Includes potentially suitable habitat for at least one vulnerable and one near threatened plant.	**Impact 4:** Overgrazing and, in some cases, exclusion of grazing.
	Impact 5: Altered fire regimes: increased or decrease frequency of burning and burning at wrong time of year, all lead to deterioration of veld condition, alterations to vegetation structure and reduced biodiversity.
	Impact 7: Harvesting of medicinal plants
Provide habitat for 148 animal species (one frog species, 19 reptile species, 91 bird species and 37 mammal species). The fact that seasonal pans might form in this biotope during high rainfall years, render it suitable habitat for the Giant bullfrog (*Pyxicephalus adspersus*). Two reptiles, 26 bird and seven mammal species were observed during the two surveys in BMU7 on the mine.	**Impact 10 & 23:** Noise, dust and movement associated with construction will drive out most of the more mobile faunal species (birds and larger mammals)
	Impact 11: Persecution (hunting with dogs, snares and trapping) of animals – especially game birds (francolin and guinea fowl) and small mammals (steenbok)
	Impact 11: Persecution of predators (mongoose, hyaena, wild cats and polecat) due to misinformation
	Impact 11: Persecution of snakes, especially the poisonous species will influence the diversity of this group adversely
	Impact 11: Persecution of snakes, especially the poisonous species will influence the diversity of this group adversely.
	Impact 19: Collecting of slow moving animals as pets or food (tortoises and hedgehogs)
	Impact 10: Human activities can disturb sensitive habitats and disturb wildlife. If repeated frequently, such disturbance can impact on faunal reproduction and survival.
	Impact 20: Changes in lighting in an area, for example, can significantly affect some species' behavioural and biological rhythms, which are guided by natural cycles of light and dark. Nocturnal species, particularly birds, can become disoriented by night-time lighting.
Potential presence of the Red listed animals	**Impact 11:** White-bellied Korhaan: Persecution, road kills and human presence
	Impact 11: Raptors: Lanner Falcon, Lesser Kestrel and Secretary bird: Persecution, road kills and human presence
	Impact 11: Predators: Honey badger, Brown hyaena – Persecution: Hunting, snaring and poisoning
	Impact 11: Temminck's hairy bat, Geoffroy's horseshoe bat and White-tailed mouse: Hunting (pets), poisoning and trampling.

BIODIVERSITY ASPECTS	IDENTIFIED IMPACTS
Presence of sandy grassland and its associated habitats	**Impact 6:** Alien invading vegetation: Spread of exotic tree species will reduce the area covered by primary grassland, deteriorate the natural environment and reduce biodiversity
	Impact 24: Increased erosion: Roads, culverts, storm water drains and cleared areas will lead to increased erosion
	Impact 22: Habitat loss due to old, redundant infrastructure and mined areas
	Impact 5: Some ecosystems, especially grasslands and heathlands, are changed significantly by inappropriate fire regimes.
	Impact 13: Fragmentation of habitat is a process whereby large tracts of the natural grassland are gradually developed and subdivided until only patches of original habitat remain. Roads may be the single most destructive element of the habitat fragmentation process.
	Impact 17: Removal of habitat aspects such as rocks, shrubs, termite mounds and dead wood will eliminate very viable habitat for a number of animal species

BMU8: Infrastructure

Biodiversity Management Unit 8 (Infrastructure) comprises all linear infrastructure (railway lines and roads), mining infrastructure (including slimes dams, discard dumps, plants, offices, etc.) and residential areas. The habitats of these areas have been completely transformed and the natural vegetation cleared. The cumulative impact on the surface (soil, fauna and flora) caused by mining related infrastructure and activities comprises 4 619.9 ha (19%) within the lease area. These areas consist mostly of bare soils and subsoils, with some patches of ruderal weed and pioneer grass communities and smaller patches of ornamental alien species planted in gardens of residential and business premises. The little vegetation occurring within this unit is all secondary in nature, and has very low species richness in terms of indigenous species. Furthermore, this habitat does not provide potentially suitable habitat for any threatened plant species. Untransformed vegetation in close proximity to these areas is also often degraded as a result of various 'edge effects' emanating from these transformed habitats. This unit therefore has **negligible** value in terms of botanical biodiversity conservation.

Although buildings and other structures are completely unnatural, a number of ANIMAL species utilize these structures as surrogates for natural habitats (shelter, perching and nesting). However, this biotope is considered to have a **very low** value in terms of faunal biodiversity conservation, and therefore was not evaluated in detail (i.e. no terrestrial faunal surveys were carried out in BMU 8).

The biodiversity value of BMU8 is **NEGLIGIBLE** and biodiversity management of this unit should focus on limiting its impacts on the biodiversity of the surrounding BMU's with moderate to high biodiversity value.

The biodiversity of this biotope is unnatural as these habitats have been created by humans. Human activities impacting upon the biodiversity of this BMU are therefore of little concern, and biodiversity management of this unit should therefore be focused on limiting its impacts upon the biodiversity of the surrounding BMU's with moderate to high biodiversity value.

BMU9: Cultivation

Biodiversity Management Unit 9 (Cultivation) comprises monocultures of crop plants or ruderal and agrestral weed communities of completely transformed habitats, and has very low species richness in terms of indigenous species. According to the 2013 study, no cultivated areas (BMU 9) are currently present in the Vaal River study area, as all currently cultivated areas are situated in areas to the south of the Vaal River that no longer form part of the Vaal River Mine complex surface rights area. This section is however retained since cultivated areas surrounding the mining area may impact on and contribute to the biodiversity of the study area. This unit is regarded as having **low** value in terms of botanical biodiversity conservation.

Areas of monoculture are sometimes targeted by certain insects as a food source, which in turn creates a food source for certain larger animals. The planted crops can also provide food and shelter for certain species. This biotope is considered to have a **very low** value in terms of faunal biodiversity conservation, and was therefore not evaluated in detail (no terrestrial faunal surveys were carried out in BMU9). No Red Data animal species are expected to occur in this biotope.

The biodiversity value of this BMU is **low** and biodiversity management of this unit should be focused on limiting its impacts on the biodiversity of the surrounding untransformed BMU's with moderate to high biodiversity value.

Impacts/risks:

The maize transported from the cultivated fields often spills onto and next to the roads, due to trucks not making use of tarpaulins during transportation. The maize along the roads attracts rodents, which in turn attracts various raptors and carnivores. This significantly increases the number of road kills in the area. Management objectives for this BMU can include aspects such as:

- Reduced spilling of maize along the roads by enforcing the use of tarpaulins on trucks.
- Placing road signs in high risk areas to warn drivers and create awareness about the presence of some animal groups on the roads, especially owls at night.

BMU10: Secondary Grassland

Biodiversity Management Unit 10 (Secondary Grassland) comprises secondary vegetation of transformed habitats and has low species richness in terms of indigenous species. Average species richness is 15 species per 100m^2 with a total of 27 plant species identified. Furthermore, this habitat is unlikely to provide potentially suitable habitat for any threatened plant species. Species richness of indigenous species increases with elapsed time since ploughing, as secondary succession progresses.

Although secondary grasslands are less diverse in habitat, it does provide some shelter to a few adaptable animal species. However, the fact that rocks and other aspects of habitat were removed previously in order to prepare the area for agriculture, resulted in this biotope being a poorer biotope than the primary grasslands. BMU10 supplied habitat for 115 terrestrial animal species (22 reptile species, 73 bird species and 20 mammal species, whilst no amphibians are expected in this habitat due to the dryness of this habitat). BMU10 furthermore meets the habitat requirements of at least 6 Red Data listed animal species (3 bird and 3 mammal species). Although the habitat composition is less diverse in BMU10 than in the primary grassland due to lack of some habitat components (trees and rocks), it still supplies habitat to a number of important grassland bird and mammal species. Due to its human-induced changed status, and the lower number of species expected to be present (29% of all vertebrates present), this biotope should be rated low in biodiversity conservation terms. However, with the fact that the species expected in the biotope includes 6 Red Data listed species, this biotope is considered to have a **moderate** value in terms of biodiversity conservation.

The vegetation of this unit therefore has **low to moderate** value in terms of botanical biodiversity conservation. Due to its human-induced changed status, and the lower number of species expected to be present (29% of all vertebrates present) this biotope should be rated low in biodiversity conservation terms. However, with the fact that the species expected in the biotope includes 6 Red Data listed species, this biotope can be considered to have a **moderate** value in terms of faunal biodiversity conservation. The overall biodiversity conservation value of BMU10 is considered to be **MODERATE**.

Impacts/Risks:

The important biodiversity aspects and potential impacts/risks are summaries in Table 15.

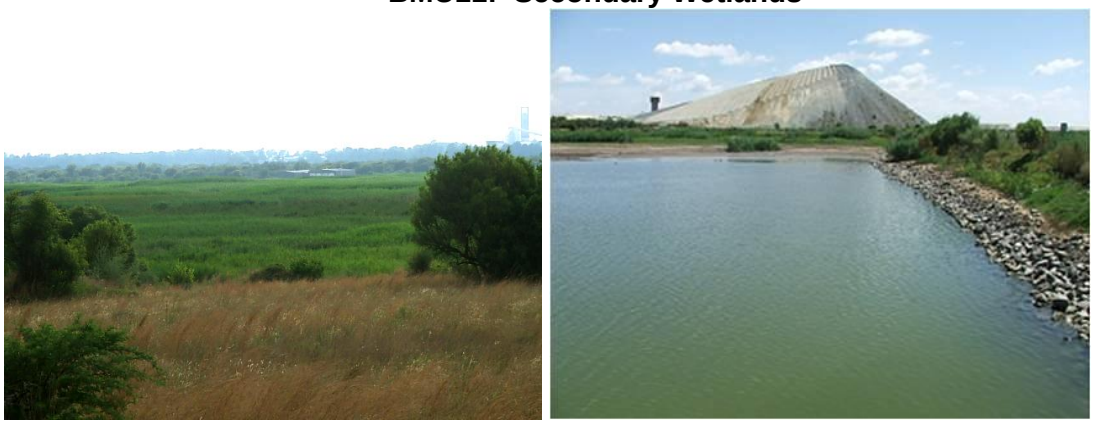
The **biodiversity risk assessment** (Bekker, 2013) conducted as part of the biodiversity study also highlighted the following specific risks to the biodiversity of BMU10:

- Tailings spill, Unlicensed storage of tailings material, Spill of tailings material, Great Noligwa U plant, Surface contamination, Use of emergency earthen dam and canal.

Table 15: Biodiversity aspects of importance and potential impacts in BMU10: Secondary Grassland

BIODIVERSITY ASPECTS	IDENTIFIED IMPACTS
Has low (total of 27 species and average of 15.0 species per 100m^2) species richness, comprising indigenous species indicative of disturbance and ruderal and agrestral weeds. Comprises secondary vegetation of habitats transformed by historical ploughing and scouring of soil and includes low habitat and plant community variability No suitable habitat for any threatened and near threatened plant species.	**Impact 4:** Overgrazing and, in some cases, exclusion of grazing.
	Impact 5: Altered fire regimes: increased or decrease frequency of burning and burning at wrong time, all lead to deterioration of veld condition, alterations to vegetation structure and reduced biodiversity. In the case of the mine exclusion of fire is the most frequent form of this impact.
	Impact 6: Invasion by alien plants. Within this unit *Sphaeraclea bonariensis* poses the biggest threat and has already invaded large patches around Site 14 in the northern parts of the study area
Presence of high faunal diversity: 22 species of reptiles; 74 species of birds; 20 species of mammals in intact habitats. Meets the habitat requirements of at least 6 Red Data listed animal species (3 bird and 3 mammal species).	**Impact 11:** Persecution (hunting with dogs, snares and trapping) of animals – especially game birds (francolin and guinea fowl) and small mammals (steenbok)
	Impact 11: Persecution of predators (mongoose, hyaena, wild cats and polecat) due to misinformation
	Impact 11: Persecution of snakes, especially the poisonous species will influence the diversity of this group adversely
	Impact 11: Persecution of snakes, especially the poisonous species will influence the diversity of this group adversely
	Impact 19: Collecting slow moving animals as pets or food (tortoises and hedgehogs)
	Impact 20: Changes in lighting in an area, for example, can significantly affect some species' behavioural and biological rhythms, which are guided by natural cycles of light and dark. Nocturnal species, particularly birds, can become disoriented by night-time lighting.
Potential presence of the Red listed animals	**Impact 11:** Raptors: Lanner Falcon, Lesser Kestrel and Secretary bird
	Impact 11: Predators: Honey badger – Persecution: Hunting, snaring and poisoning
	Impact 11: Temminck's hairy bat and Schreibers' long-fingered bat
Presence of grassland and its associated habitats	**Impact 6:** Alien invading vegetation: Spread of exotic tree species will reduce the area covered by primary grassland, deteriorate the natural environment and reduce biodiversity
	Impact 24: Increased erosion: Roads, culverts, storm water drains and cleared areas will lead to increased erosion
	Impact 22: Habitat loss due to old, redundant infrastructure and mined areas.
	Impact 5: Some ecosystems, especially grasslands and heathlands, are changed significantly by inappropriate fire regimes.
	Impact 13: Fragmentation of habitat is a process whereby large tracts of the natural grassland are gradually developed and subdivided until only patches of original habitat remain. Roads may be the single most destructive element of the habitat fragmentation process.

BMU11: Secondary Wetlands



Biodiversity Management Unit 11 (Secondary Wetlands) comprises secondary marsh vegetation and dams of habitats transformed by mine water and has low indigenous species richness. Average plant species richness is 14 species per 100m^2. Mine water has not only impacted on the hydrology of these areas, but is also likely to have lead to transformation of soil properties and impacts such as increased levels of salinity, which is evident by the presence of facultative halophytes (*Phragmites australis* and *Cynodon dactylon*), and obligate halophytes (*Juncus rigidus*). Furthermore, this habitat is unlikely to provide potentially suitable habitat for any threatened plant species. Rehabilitation of these areas is likely to be a long and costly exercise.

Near-permanent surface and subsurface flows emanating from these man-induced origins, provide lush wetland systems surrounded by reeds, sedges and bulrushes. Surface water collects along with pools and dams, and also creates viable artificial wetland systems. BMU11 supplied habitat for 112 terrestrial animal species (5 frog species, 4 reptile species, 91 bird species and 12 mammal species). Six frog species are specific to this particular habitat, and are not found in other local habitats. BMU11 furthermore meets the habitat requirements of at least 4 Red Data listed animal species (3 frog and 1 mammal species). Although the water quality in these wetlands is expected to be relatively poor, 5 frog species utilize the moist surroundings, mostly during their adult life. Few reptiles frequent this biotope; however, snake numbers may increase should frog numbers improve. Despite the fact that this biotope is fed by polluted human-induced effluent, the habitat created by the water and the wetland vegetation of reeds, bulrushes and sedges appeals to an expected 91 bird species, most of them wetland inhabitants.

The vegetation of this unit therefore has **low** value in terms of botanical biodiversity conservation. Due to the fact that this habitat is created by human influence and is rather disturbing to the area, this biotope should be considered as having a **low** value in terms of faunal biodiversity conservation. However, the number of species that is expected to be present (28% of all vertebrates present) in this altered biotope, includes 4 Red Data listed species. In addition, this artificial biotope can act as a refuge for wetland birds as wetlands are minimal in the immediate surrounding area, due to human activities. This biotope is therefore considered to have a **low-moderate** value in terms of faunal biodiversity conservation. BMU11 therefore has an overall **LOW-MODERATE** biodiversity conservation value and its management should focus on limiting its impacts on surrounding untransformed BMU's with moderate to high value.

Impacts/Risks:

The important biodiversity aspects and potential impacts/risks are summaries in Table 16.

The **biodiversity risk assessment** (Bekker, 2013) conducted as part of the biodiversity study also highlighted the following specific risks to the biodiversity of BMU11:

- Surface discharge from radiation contamination area**,** Tailings spill, Acid plant surface water discharge, Maintenance of water conveyances, Process water used for dust suppression, Surface seepage, Unlicensed storage of tailings material, Unlicensed disposal of sewage sludge, Seep from East Pay Dam, Trial plantations as part of Woodlands project, Spill of tailings material, Surface contamination, Hydrocarbon spill.

Table 16: Biodiversity aspects of importance and potential impacts in BMU11: Secondary Wetlands

BIODIVERSITY ASPECTS	IDENTIFIED IMPACTS
Has low (average of 14.0 species per $100m^2$) species richness and is dominated by hardy indigenous species Comprises secondary vegetation of habitats transformed by excavation and seepage and runoff of mine water, and includes low habitat and plant community variability. Dominated by species that are indicative of disturbance. Does not include suitable habitat for any threatened and near threatened plant species.	**Impact 1:** Continuation of altered hydrological patterns as a result of introduction of mine water through seepage and runoff.
	Impact 2: Continued deterioration of soils and vegetation as a result of continuing seepage and runoff of polluted mine water, and accompanying impacts such as increased salinity, increased acidity and bioaccumulation of heavy metals.
	Impact 4: Overgrazing and, in some cases, exclusion of grazing.
	Impact 5: Altered fire regimes: increased or decrease frequency of burning and burning at wrong time, all lead to deterioration of veld condition, alterations to vegetation structure and reduced biodiversity. In the case of the mine exclusion of fire is the most frequent form of this impact
Presence of moderate faunal diversity: 5 species of frogs; 4 species of reptiles; 91 species of birds; 12 species of mammals in intact habitats	**Impact 11:** Persecution (hunting with dogs, snares and trapping) of animals – especially game birds (francolin and guinea fowl) and small mammals (steenbok)
	Impact 11: Persecution of snakes, especially the poisonous species will influence the diversity of this group adversely
	Impact 25: Any activity with emissions will have the potential to add to the emissions already in the air. It is the accumulative effect of these emissions that has adverse effects on the amphibian population.
Presence of the Red listed animals	**Impact 11:** Greater flamingo and Lesser flamingo: Persecution, road kills and human presence
	Impact 11: Raptors: African marsh harrier
	Impact 11: Water Rat
Presence of wetlands and its associated habitats	**Impact 6:** Alien invading vegetation: Spread of exotic tree species will reduce the area covered by primary grassland, deteriorate the natural environment and reduce biodiversity
	Impact 22: Habitat loss due to old, redundant infrastructure and mined areas
	Impact 2: Seepage from mining areas will influence seasonal marsh wetland: the composition and structure of the wetland vegetation (more nutrients and increased ground water seepage) and the quality of the water will deteriorate (dissolved nutrients)
	Impact 16: Saturation of the peripheral soils along seasonal marsh wetlands by mine water seepage will make this very viable subterranean habitat unattractive to tunnelling mammals such as the mole-rats and golden moles

BMU12: Alien trees/plantations

Biodiversity Management Unit 12 (Alien Trees/Plantations) comprises habitats completely transformed through the planting and invasion of alien trees (mostly **Eucalyptus camaldulensis* and other **Eucalyptus* species). This secondary vegetation has very low species richness in terms of indigenous species. Furthermore, this habitat does not provide potentially suitable habitat for any threatened plant species.

BMU12 supplied habitat for only 28 terrestrial animal species (3 reptile species, 23 bird species and 2 mammal species whilst no amphibians are expected in this habitat due to the dryness of the habitat). One bird species is specific to this particular habitat, and is not found in other local habitats. BMU12 furthermore meets the habitat requirements of 1 Red Data listed mammal species.

This unit has **negligible** value in terms of botanical biodiversity conservation. Due to the low number of faunal species expected to be present (7% of all vertebrates present), this biotope is considered to also have a **negligible** value in terms of faunal biodiversity conservation. The overall biodiversity conservation value of BMU12 is therefore **NEGLIGIBLE**.

It is not a priority to conserve any of this biotope. However, should it be decided to remove alien trees, this should be done in phases, starting with young trees and escapees, especially along drainage lines. Older trees and plantations should be removed, but their newly acquired role in the local ecology should be kept in mind (nesting place for special birds). Dead trees and prostrate logs could be left to rot naturally, thereby slowly disappearing from the system. Local populations should be encouraged to rather use alien trees for fire and building than any of the remaining indigenous trees on the mine, thereby contributing to biodiversity management of the area.

Due to the alien nature of these plantations and invasive escapees, it is not a priority to conserve any of this biotope. The species richness is negligible and this BMU does not include any suitable habitat for any threatened and near threatened plant species. However, should it be decided to remove alien trees, this should be done in phases, starting with young trees and escapees, especially along drainage lines. Older trees and plantations could be removed, but their newly acquired role in the local ecology should be kept in mind (roosting/nesting sites for certain raptors (e.g. Amur Falcon and Black Sparrowhawk). Dead trees and prostrate logs could be left to rot naturally, thereby disappearing slowly from the system.

Trees planted at the northern foot of the Mispah slimes dam as part of the Anglo Ashanti 'Woodlands Project' include **Eucalyptus* sp., **Schinus molle, Rhus lancea, Combretum erythrophyllum* and *Celtis africana*. The two alien species are both Declared Invaders. *Rhus lancea* and *Celtis africana* both occur naturally in the Vaal Reefs area, but *Combretum erythrophyllum* is not indigenous to this area. Preference should be given to trees that are

indigenous to the Vaal Reefs trees, but care should be taken that planted trees are grown from locally obtained seed, so as to avoid genetic contamination of natural populations of these species occurring within the study area. It should be remembered that whether indigenous or alien trees are planted, these plantations must be regarded as secondary vegetation and should only be established within already transformed areas.

7. BIODIVERSITY CONSERVATION VALUE

7.1 National biodiversity value

Based on the national mining and biodiversity guideline (DEA *et al.*, 2013) biodiversity priority areas map (Figure 6), three categories of importance occurs within the West Wits study area, namely (B) Highest biodiversity importance and (D) Moderate biodiversity importance. More detail regarding the risk and implications for mining of these areas are provided in Table 17.

Table 17: Categories of biodiversity priority areas in relation to their biodiversity importance and implication for mining applicable to the AGA West Wits study area.

Category	Biodiversity priority areas	Risk for mining	Implications for mining
B. Highest biodiversity importance	• Critically endangered and endangered ecosystems • Critical Biodiversity Areas (or equivalent areas) from provincial spatial biodiversity plans • River and wetland Freshwater Ecosystem Priority Areas (FEPAs), and a 1km buffer around these FEPAs • Ramsar Sites	Highest risk for mining	Environmental screening, EIAs and their associated specialist studies should focus on confirming the presence and significance of these biodiversity features, and to provide site-specific basis on which to apply the mitigation hierarchy to inform regulatory decision-making for mining, water use licences, and environmental authorisations. If they are confirmed, the likelihood of a fatal flaw for new mining projects is very high because of the significance of the biodiversity features in these areas and the associated ecosystem services. These areas are viewed as necessary to ensure protection of biodiversity, environmental sustainability, and human well-being. An environmental impact assessment should include the strategic assessment of optimum, sustainable land use for a particular area will determine the significance of the impact on biodiversity. This assessment should fully take into account the environmental sensitivity of the area, the overall environmental and socio-economic costs and benefits of mining, as well as the potential strategic importance of the minerals to the country. Authorisations may well not be granted. If granted, the authorisation may set limits on allowed activities and impacts, and may specify biodiversity offsets that would be written into licence agreements and/or authorisations.
D. Moderate biodiversity importance	• Ecological support areas • Vulnerable ecosystems • Focus areas for protected area expansion (land-based and offshore protection)	Moderate risk for mining	These areas of moderate biodiversity value. EIAs and their associated specialist studies should focus on confirming the presence and significance of these biodiversity features, identifying features (e.g. threatened species) not included in the existing datasets, and on providing site-specific information to guide the application of the mitigation hierarchy. Authorisations may set limits and specify biodiversity offsets that would be written into licence agreements and/or authorisations.

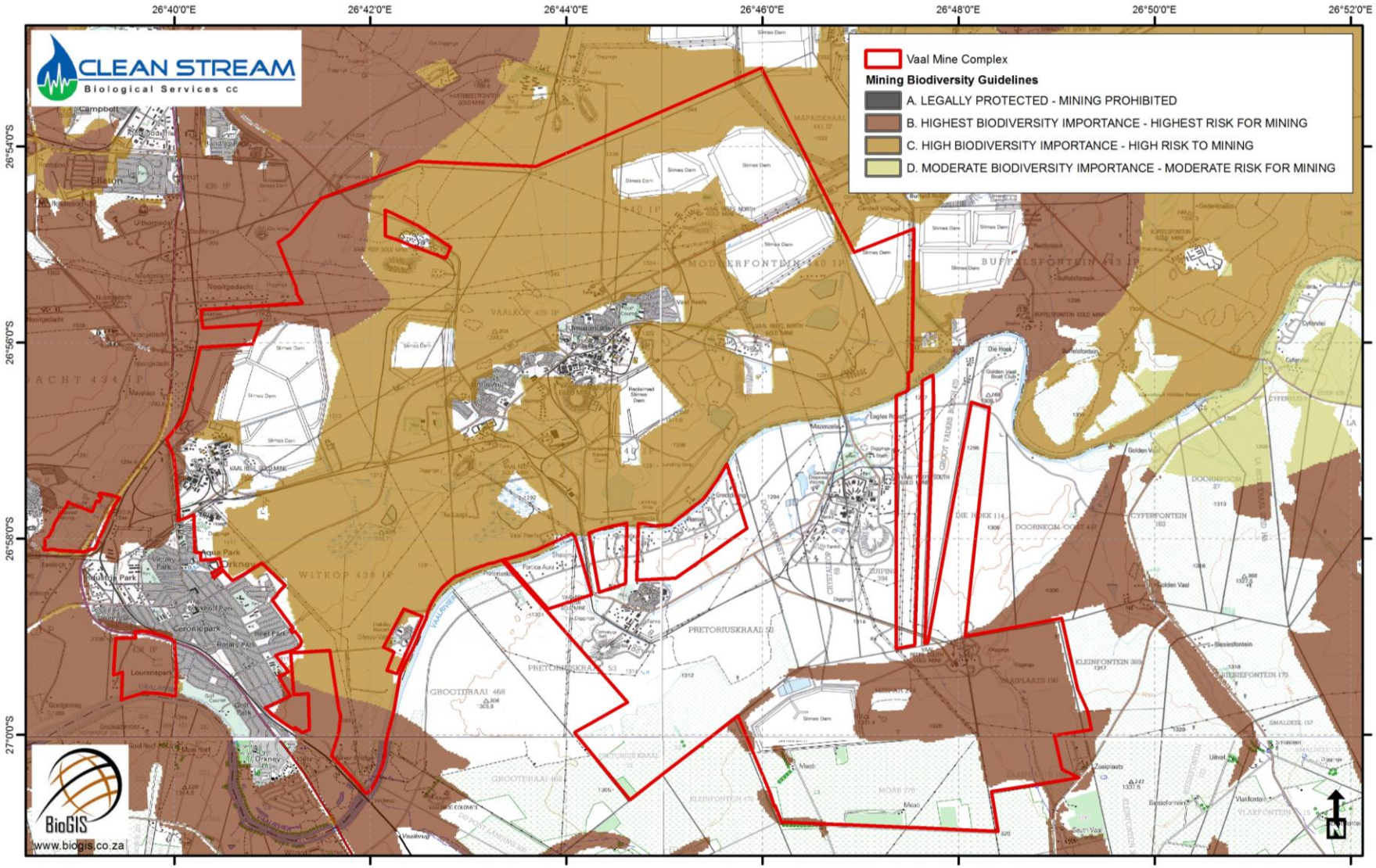


Figure 6: Map indicating biodiversity priority areas and their risk for mining (DEA *et al.*, 2013).

7.2 Site-specific conservation value

The biodiversity conservation value of each BMU in the study area was determined considering all the information collated during this study (Table 18). The following criteria were broadly taken into account in evaluating the importance of biodiversity of each BMU:

- Status of the vegetation (untransformed or transformed, primary or secondary).
- Status of the vegetation type.
- Relative indigenous fauna and flora species diversity of the BMU.
- Presence or habitat-derived probability of occurrence of Red Data or Protected fauna and flora species.
- Is the BMU a water resource (All water resources are sensitive and requires protection)?
- Presence of special habitats (such as ridge or hill).
- Presence of invasive alien species.
- Any other significant biodiversity features of the BMU that may contribute to its conservation value.

Based on the above considerations, each BMU was given a sensitivity/importance value of high, medium, low or negligible:

- The BMU's that have been critically transformed from their natural state have **negligible** value in terms of biodiversity conservation.
- The BMU's with a **low** sensitivity/importance are normally disturbed or transformed biotopes with little conservation value. The diversity of indigenous species is relatively low (compared to the natural untransformed habitats of the site) and the units are unlikely to support 'species of conservation concern'. Future developments should, where possible, be planned for these areas, rather than in the medium or high conservation areas.
- BMU's with a **moderate** sensitivity/importance are generally areas with some disturbance, but not as severe as for areas with a low sensitivity / importance. These are generally transformed habitats with good habitat potential or deteriorated untransformed habitats. The relative species richness of these units may also be lower than in those with high conservation value. No Red Data species have been identified/observed in this BMU but there is still a moderate possibility that Red Data species may utilise the BMU. Future alterations of these BMU's should be limited, but development in these areas is preferred above the areas with high conservation value.
- A BMU with **high** sensitivity/importance is generally untransformed biotopes where Red Data and protected species have been observed, or that has a strong probability to support species with high conservation value. These BMU's often consist of primary vegetation, rivers, streams and wetlands and are considered important even if they are disturbed. Mining and development should be limited and prevented as far as possible in these areas.

This study concluded that in the West Wits surface rights area, there are seven BMU's with high biodiversity conservation value, namely BMU2: *Acacia caffra* Closed Woodland, BMU3: *Protea caffra* Closed Woodland, BMU5: Plateau Grassland, BMU6: Valley Grassland, BMU 7: Shale Grassland, BMU8: Perennial streams and BMU9: Drainage lines / Seasonal streams. Another two BMU's have moderate-high biodiversity conservation value (BMU4: *Mundulea sericea* Sparse Woodland and BMU10: *Pteridium* Herbland) while two more has a moderate importance (BMU1: *Acacia karroo* Closed Woodland and BMU12: Secondary Grassland). Biodiversity management of the West Wits surface rights area should be focussed on these BMU's.

Table 18: Summarized biodiversity conservation value of the Biodiversity Management Units of the AGA Vaal River operations.

Biodiversity Management Unit	BIODIVERSITY CONSERVATION VALUE				
	Botanical (vegetation)	Terrestrial fauna	Aquatic fauna	OVERALL	COMMENTS
BMU1: Vaal River ecosystem	High	Very High	High	**VERY-HIGH**	68 recorded plant species (23.6/100m^2) and potential presence of 288 terrestrial animal species (10 frog species, 24 reptile species, 197 bird species and 57 mammal species) 12 fish species and approximately 61 aquatic-macro-invertebrate taxa. Of these, two frogs, four reptiles, 112 bird, three mammal species were observed during the two surveys. Three plant species of conservation concern recorded within BMU1 namely *Nerine gracilis* (Vulnerable), *Trachyandra erythrorrhiza* (Near Threatened) and declining species *Crinum bulbispermum*. BMU1 meets the habitat requirements of at least 15 animal species of conservation concern (one fish, one frog, one reptile, two birds and ten mammals).
BMU2: Jagspruit/Schoonspruit ecosystem	High	High	Moderate-High	**HIGH**	36 recorded plant species (36/100m^2) and potential presence of 190 terrestrial animal species (11 frog species, 7 reptile species, 150 bird species and 22 mammal species). Of these, three frogs, two reptiles, 58 bird and one mammal species were observed during the two surveys in BMU2 on the mine. BMU2 also meets the habitat requirements of at least seven species of conservation concern (one frog, one reptile, one bird and four mammal species).
BMU3: Drainage lines	High	Moderate	Moderate-low	**MODERATE-HIGH**	19 recorded plant species (19/100m^2) and potential presence of 151 terrestrial animal species (12 frog species, 7 reptile species, 111 bird species and 21 mammal species). Of these, two frogs, 33 bird and four mammal species were observed during the two surveys in BMU3 on the mine. BMU3 furthermore meets the habitat requirements of at least seven species of conservation concern (two frogs, one reptile, two bird and two mammal species).
BMU4: *Acacia karroo* Closed Woodland	Moderate	Moderate	n/a	**MODERATE**	44 recorded plant species (29.5/100m^2) and potential presence of 199 species of terrestrial animals (26 reptile species, 134 bird species and 39 mammal species). Four reptiles, 63 bird and three mammal species were observed during the two surveys in BMU4 on the mine. This biotope also meets the habitat requirements of nine species of conservation concern (one reptile, two bird and six mammal species).

Biodiversity Management Unit	BIODIVERSITY CONSERVATION VALUE				COMMENTS
	Botanical (vegetation)	Terrestrial fauna	Aquatic fauna	OVERALL	
BMU5: *Acacia caffra-Euclea crispa* Thickett	High	High	n/a	**HIGH**	72 recorded plant species (51/100m^2) and potential presence of 197 animal species (28 reptile species, 125 bird species and 44 mammal species). Four reptiles, 37 bird and two mammal species were observed during the two surveys. This biotope furthermore meets the habitat requirements of eight species of conservation concern (one reptile, two mammal and six bird species).
BMU6: Rocky Grassland and Sparse Woodland	Very high	Very high	n/a	**VERY HIGH**	152 recorded plant species (49.9/100m^2) and potential presence of for 232 terrestrial animal species (31 reptile species, 148 bird species and 53 mammal species). BMU6 has the largest expected number of reptiles (31 species), which utilize the crevices and cracks in the abundant rock protrusions, as well as the dense bushy clumps scattered through the biotope. Three reptiles, 78 bird and 12 mammal species were observed during the two surveys in BMU6 on the mine. *Three* Near Threatened plants (*Lithops lesliei* subsp. *Lesliei, Pearsonia bracteata and Adromischus umbraticola)* were recorded within this BMU.
BMU 7: Sandy Grassland	Very high	High	n/a	**VERY HIGH**	54 recorded plant species (39.5/100m^2) and potential presence of 148 animal species (one frog species, 19 reptile species, 91 bird species and 37 mammal species). The fact that seasonal pans might form in this biotope during high rainfall years, render it suitable habitat for the Giant bullfrog (*Pyxicephalus adspersus*). Two reptiles, 26 bird and seven mammal species were observed during the two surveys in BMU7 on the mine.
BMU8: Infrastructure	Negligible	Very low	n/a	**NEGLIGIBLE**	Highly transformed areas with negligible biodiversity conservation value. Should be managed to limit its impact on untransformed habitats.
BMU9: Cultivation	Low	Very low	n/a	**VERY LOW**	Totally transformed habitats with no potential for threatened plant or animals species.
BMU10: Secondary Grassland	Low-moderate	Moderate	n/a	**MODERATE**	27 recorded plant species (15/100m^2) and potential presence of 115 terrestrial faunal species (22 reptiles, 73 birds, 20 mammals). It includes potentially suitable habitat for at least 6 Red Data listed animal species.
BMU11: Secondary Wetlands	Low	Low-moderate	Low to negligible	**LOW-MODERATE**	14 recorded plant species (14/100m^2) and potential presence of 112 terrestrial faunal species (5 frogs, 4 reptiles, 91 birds, 12 mammals). It includes potentially suitable habitat for at least 4 Red Data listed animal

Biodiversity Management Unit	BIODIVERSITY CONSERVATION VALUE				
	Botanical (vegetation)	Terrestrial fauna	Aquatic fauna	OVERALL	COMMENTS
					species.
BMU12: Alien trees/plantations	Negligible	Negligible	n/a	**NEGLIGIBLE**	Completely transformed habitat with low indigenous plant species richness and potential presence of 28 terrestrial faunal species (3 reptiles, 23 birds, 2 mammals). It includes potentially suitable habitat for at least 1 Red Data listed animal species.

8. BIODIVERSITY MANAGEMENT ACTIONS

Specific impacts on biodiversity of each BMU of AngloGold Ashanti's Vaal River surface rights area have been identified and described, and specific biodiversity (See section 6). This section contains more detail on some of the most important biodiversity management activities required on the mine. The implementation of these management measures should be strongly considered.

8.1 Establishment of Core Biodiversity Management Areas (CBMA) within the study area

Based on vegetation units and animal biotopes, the study area has been classified into different 'Biodiversity Management Units' (BMU's). This approach facilitated the recommendation of area-specific management measures (Section 6 in report). Though these BMU's comprise relatively uniform ecosystems, they do not function in isolation to surrounding ecosystems, and adjacent vegetation types/biotopes usually provide important ecological services to one another. For example, cliffs provide essential breeding and roosting sites for a variety of cliff-nesting raptors, but simply protecting these cliffs will not serve to conserve the raptors, as they are dependent on adjacent habitats that serve as hunting grounds. Even transformed habitats such as secondary grassland on previously cultivated soils, or even currently cultivated maize fields, may sustain essential populations of prey species such as doves, pigeons, francolin and guinea fowl.

Furthermore, in reality there are seldom distinct boundaries between ecosystems/habitats, and vegetation types tend to grade into each other. These transition zones between vegetation types or ecosystems are also referred to as 'ecotones'. These ecotones often have high species richness, and certain species actually favour such transitional zones as habitat.

It therefore follows that conserving small areas that include only one small habitat or BMU is not a desirable approach to conserving the biodiversity of any given area (e.g. the Mine Lease Area). The most appropriate method of conserving and managing the biodiversity of the mine lease area is to select relatively large areas that contain as wide a variety of interconnected biotopes or BMU's as possible. Such areas are here referred to as 'Core Biodiversity Management Areas' (CBMA's). The identification of appropriate CBMA's will enable the mine to focus its management effort and ensure that the biodiversity of the mine lease area is sustainably conserved within ecologically viable areas. It should be noted that the general principle with regard to conservation areas is that the smaller the area, the more intensive the required management. Emphasis should therefore be placed on the selection of one or a few large CBMA's (which include various BMU's) rather than attempting to manage various small and isolated habitats.

The following approach can be followed to identify and select potential CBMA's within each mining area:

- **Step 1:** Identify the important BMU's in the study area with a high biodiversity value. These could include BMU's with high species diversity or potentially threatened, endemic, sensitive or other important species.
- **Step2:** Identify an area/s within the study area where these BMU's occur and where human activities can be minimised and controlled. As mentioned above, the bigger the CBMA, the less intensive management may be required. In some cases, some small CBMA's may have to be selected in different areas to enable the inclusion of all the required BMU's. Although biodiversity management will be required for the entire

mining area to some extent, emphasis can then be placed on the management and protection of biodiversity within these CBMA's.

Step 1: Identification of important BMU's within the study area

In the Vaal River operations study area, the following BMU's have been rated as important (moderate, high and very high biodiversity conservation value) with regard to biodiversity management:

Priority 1: Very-high biodiversity conservation value

The following BMU's have been indicated to have very high biodiversity conservation value and requires priority and special attention with regard to biodiversity management in the study area:

***BMU1: Vaal River Ecosystem*:** This biotope included 68 recorded plant species (23.6/100m^2) and potential presence of 297 terrestrial faunal species (7 amphibians, 39 reptiles, 196 birds and 55 mammals), 12 fish species and approximately 61 aquatic-macro-invertebrate taxa. It includes potentially suitable habitat for at least 1 vulnerable plant species and 14 Red Data listed animal species. The diversity of special habitat components in this specialized biotope (Instream and Marginal Vegetation; Riparian Woodland on macro-channel banks; Closed Shrubland on Floodplain; Seasonal Marsh Wetland) creates such abundant habitat that this biotope accommodates by far the largest part of the faunal component. Since there are large tracts of land managed by the mine in the lease area, this will be a perfect opportunity to conserve this biotope as it requires special conservation measures.

***BMU6: Rocky Grassland and Sparse Woodland*:** The favorable habitat combination and resultant biodiversity value renders this biotope important in terms of conservation. This biotope has a very high diversity with 152 recorded plant species (49.9/100m^2) and potential presence of 224 terrestrial faunal species (1 frog, 41 reptiles, 133 birds, 49 mammals). It includes potentially suitable habitat for at least 1 vulnerable plant species and 12 Red Data listed animal species.

***BMU 7: Sandy Grassland*:** The scarceness of this biotope and its associated Red-listed fauna species prescribe that this biotope should be conserved as such. It included 54 recorded plant species (39.5/100m^2) and potential presence of 159 terrestrial faunal species (1 frog, 25 reptiles, 98 birds, 35 mammals). It includes potentially suitable habitat for at least one vulnerable and one near threatened plant species and 9 Red Data listed animal species.

Priority 2: High biodiversity conservation value

***BMU2: Jagspruit ecosystem*:** This biotope included 36 recorded plant species (36/100m^2) and potential presence of 186 terrestrial faunal species (7 amphibians, 11 reptiles, 147 birds, 21 mammals), 10 fish species and approximately 61 aquatic-macro-invertebrate taxa. It includes potentially suitable habitat for at least 1 threatened and 1 near-threatened plant species and 5 Red Data listed animal species.

***BMU5: Acacia caffra-Euclea crispa Thickett*:** The restricted portion of this biotope in the study area is rich in biodiversity and is worthy of some sort of protection. It included 72 recorded plant species (51/100m^2) and potential presence of 197 terrestrial faunal species (34 reptiles, 121 birds, 42 mammals). It includes potentially suitable habitat for at least 8 Red Data listed animal species.

Priority 3: Moderate-high to moderate biodiversity conservation value.

BMU3: Drainage lines*:* This biotope included 19 recorded plant species (19/100m^2) and potential presence of 149 terrestrial faunal species (8 amphibians, 10 reptiles, 112 birds, 19 mammals), and 5 fish species. It includes potentially suitable habitat for at least 1 vulnerable and 1 near-threatened plant species and 3 Red Data listed animal species.

BMU4: Acacia karroo Closed Woodland: Includes 44 recorded plant species (29.5/100m^2) and potential presence of 195 terrestrial faunal species (33 reptiles, 125 birds, 37 mammals). It includes potentially suitable habitat for at least 1 near threatened plant species and 8 Red Data listed animal species.

BMU10: Secondary Grassland: Includes 27 recorded plant species (15/100m^2) and potential presence of 115 terrestrial faunal species (22 reptiles, 73 birds, 20 mammals). It includes potentially suitable habitat for at least 6 Red Data listed animal species.

Step2: Identification of an area or areas within the Vaal River Operational surface rights area to be proclaimed as CBMA's where these BMU's occur and where human activities can be minimised and controlled:

Although the current study provided the information to determine which BMU's are of importance regarding biodiversity conservation value, it is the responsibility of the managers and staff responsible for environmental management, who should make the final decision regarding the selection and implementation of CBMA's, if applicable. They have a good knowledge of the area under their control and should be aware of other factors that could influence this decision, such as the future plan of the mine. An attempt should be made to select as large areas as possible which include some or all of the above mentioned BMU's. An attempt should also be made to include corridors connecting the different BMU's and CBMA's, which would ensure that natural movement takes place between the ecosystems. Based on the experience of the specialists, the following recommendations are made regarding potential CBMA's for the Vaal River operations:

Five Core Biodiversity Management Area's (CBMA's), comprising the majority of the remaining large and more or less continuous tracts of untransformed habitats and vegetation within the 12,734.85 ha study area have been identified during the current study (Figure 7). These five CBMA's incorporate the vast majority of the surface area covered by all seven untransformed BMU's identified within the study area and the vast majority of the α-diversity (species richness) and β-diversity (rate of change in species composition across habitats or among communities) encountered within the study area. The five identified CBMA's together comprise 37.6% (or 4,792.99 ha) of the study area and include almost all 'Critical Biodiversity Areas' identified in the North West Province Biodiversity Conservation Assessment' (Desmet *et al*., 2009). Furthermore, these CBMA's contain all recorded habitat for all recorded threatened (*Nerine gracilis*) and Near Threatened (*Lithops lesliei* subsp. *lesliei, Pearsonia bracteata* and *Trachyandra erythrorrhiza*) plant species, and buffer zones around all the recorded subpopulations of these species, as well as almost all the recorded localities for the three Declining plant species recorded within the study area, namely *Boophone disticha, Crinum bulbispermum* and *Hypoxis hemerocallidea*. The proposed CBMA's also incorporate viable subpopulations of all the 'scarce and restricted' plant species recorded within the Vaal River Mine Complex study area. It is also though that the protection/conservation of these areas will allow the protection of faunal biodiversity in the study area.

The key attributes of the five selected CBMA's (Figure 7) are as follows:

- **CBMA 1:** Includes large and continuous tracts of untransformed habitats in the north-western parts of the study area. Includes large and ecologically viable tracts of five of the seven untransformed BMU's identified within the study area, namely BMU's 3, 4, 5, 6 and 7. CBMA comprises mostly of BMU 6, but also includes significant areas of BMU's 4 and 5 and smaller areas of BMU's 3 and 7. Includes all areas of BMU's 5 and 6b found within the study area. Together with CBMA's 2 and 3 is the most important area within Vaal River in terms of the conservation of biodiversity. Includes both localities of the Near Threatened plant *Pearsonia bracteata* recorded within the study area, as well as the proposed buffer zones around these localities or subpopulations. Includes sub-populations of at least one of the three Declining species recorded within the study area, namely *Boophone disticha,* and at least one other Declining species (*Hypoxis hemerocallidea)* is considered very likely to occur. Includes localities for at least 6 of the 'scarce and restricted' plant species so far identified within the study area, namely *Brachystelma nanum, Eulophia streptopetala, Eulophia inaequalis, Gladiolus ecklonii, Nanthus* cf. *aloides and Raphionacme dyeri.* CBMA 1 has a surface area of 1,535.83 ha.
- **CBMA 2:** Though the smallest of the five CBMA's, comprises ecologically viable tracts of untransformed habitats to the west of Orkney from the banks of the Vaal River inland for approximately 1 km. Comprises mostly of BMU's 1 and 2, with a smaller but near pristine area of BMU 7. Includes the least degraded (near pristine) floodplain habitat and vegetation (BMU 1) found within the study area. Also includes various ephemeral drainage lines, and most of their catchments, that flow into the Vaal River and provide habitat for two Near Threatened plant species. Together with CBMA's 1 and 3 is the most important area within Vaal River in terms of the conservation of biodiversity. Includes the only recorded localities for the only threatened plant species recorded within the study area (*Nerine gracilis*) and one of the three Near Threatened plant species recorded within the study area (*Trachyandra erythrorrhiza)*. The buffer zones for the recorded subpopulation of *Nerine gracilis* and the one recorded subpopulation of *Trachyandra erythrorrhiza* are also included in this CBMA. Includes sub-populations of at least two of the three Declining plant species recorded within the study area, namely *Boophone disticha* and *Crinum bulbispermum*. Includes localities for at least 2 of the 'scarce and restricted' thus far identified within the study area, namely *Haemanthus montanus* and *Nerine krigei*. This area should be managed as a biodiversity reserve, with the conservation of *Nerine gracilis* and *Trachyandra erythrorrhiza* as the main goal, and only conservation compatible activities should be allowed. The area is considered too small for the introduction of game animals, but light grazing by cattle should be allowed. A veld management plant (with emphasis on stocking rates and times of year when grazing should be allowed and the recommendation of a controlled burning programme) should be developed for this CBMA. CBMA 2 has a surface area of 110.23 ha.
- **CBMA 3:** This is the largest of the recommended CBMA's. Includes large and continuous tracts of untransformed habitats in the south-western parts of the study area, as well as smaller areas of historically cultivated soils along the Vaal River (BMU 1) and Secondary Wetlands (BMU 11) impacted by mine effluent and seepage. Includes large and ecologically viable tracts of four of the seven untransformed BMU's identified within the study area, namely BMU's 1, 3, 4, and 6. CBMA comprises mostly of BMU's 1 and 6, but also includes significant areas of BMU's 3 and 4. Includes the largest and most

continuous tracts of BMU 1 (floodplain vegetation of the Vaal River) found within the study area, and together with CBMA's 1 and 2 is the most important area within Vaal River in terms of the conservation of biodiversity. Includes both localities of the Near Threatened plant *Lithops lesliei* subsp. *lesliei* recorded within the study area, as well as the proposed buffer zones around these localities or subpopulations. Includes sub-populations of all three Declining species recorded within the study area, namely *Boophone disticha, Crinum bulbispermum* and *Hypoxis hemerocallidea.* Includes localities for at least 5 of the 'scarce and restricted' plant species so far identified within the study area, namely *Eulophia inaequalis, Gladiolus ecklonii, Haemanthus montanus, Nerine krigei* and *Senecio reptans.* It is strongly recommended that the portion of this CBMA situated to the south of the Orkney-Vaal River tar road should be fenced and managed as a biodiversity reserve, with *Lithops lesliei* subsp. *lesliei* and Common Reedbuck as the main conservation targets. Common Reedbuck is currently not listed as Threatened or Near Threatened, but is quite likely to be listed as Near Threatened in the Red List revision which is currently in progress, and is currently listed in the NEMBA list of Threatened and Protected species (TOPS list). The Common Reedbuck subpopulation in CBMA 3 is apparently a natural population (not introduced) according to local residents and farmers, and is one of the few remaining natural subpopulations of Common Reedbuck in the North West Province and the northern provinces of South Africa as a whole, and as such is of great conservation value. Only conservation compatible activities should be allowed within the reserve and only game species indigenous to the area should be introduced. A veld management plant (with emphasis on stocking rates and selection of appropriate game species and the recommendation of a controlled burning programme) should be developed for this CBMA. CBMA 3 has a surface area of 1,794.14 ha.

- **CBMA 4:** This CBMA is situated in the south-eastern parts of the study area, to the south of the Vaal River. Includes the largest non-perennial stream (BMU 3) occurring within the study area (BMU 3), as well as adjacent, ecologically viable tracts of untransformed vegetation (BMU's 6 and 7) and a large area of secondary grassland of historically ploughed soils (BMU 10) which has been included in the CBMA to act as a buffer for the stream and to produce a CBMA which is large enough to be ecologically viable as a whole. A low ridge with sandstone and chert geology, which comprises a unique habitat type within the study area, is also included in this CBMA. Threatened or Near Threatened species have thus far not been recorded within this CBMA, but potentially suitable habitat for the threatened *Nerine gracilis* is present. Two of the three Declining plant species thus far recorded within the study area were recorded within this CBMA, namely *Boophone disticha* and *Hypoxis hemerocallidea.* One of the 'scarce and restricted' plant species provisionally identified for the study area has been recorded within this CBMA, namely *Vigna oblongifolia* var. *parviflora* , and other such species are likely to occur. CBMA 4 has a surface area of 324.65 ha.
- **CBMA 5:** Includes large and continuous tracts of untransformed habitats to the south of the Vaal River. Comprises mostly of a large and continuous area of near pristine grassland on dolomites (BMU 6), but also includes the riparian and floodplain habitats of an over 3km long reach of the Vaal River (BMU 1) and smaller areas of *Acacia karoo* Closed Woodland (BMU 4). No threatened or Near Threatened species have thus far been recorded within this CBMA, but potentially suitable habitat for *Lithops lesliei* and *Pearsonia bracteata* is present. None of the three Declining plant species thus far recorded within the study area have yet been recorded within this CBMA, but all three are almost certainly present. None of the 'scarce and restricted' plant species provisionally identified for the study area have thus far been recorded within

this CBMA, but such species are certainly present. CBMA 5 has a surface area of 1,028.14 ha

In order to maintain and enhance current levels of botanical biodiversity found within the five proposed CBMA's, it is considered essential that the following biodiversity management measures, should be implemented for each of the CBMA's:

- Allow grazing of the CBMA's at conservative stocking rates and implement a controlled burning programme.
- Develop and implement an existing alien plant control and eradication programme for the study area, with emphasis on the five proposed CBMA's.
- Control access to the CBMA's in order to prevent illegal harvesting of medicinal and horticultural plants, the extraction of wood resources, and the hunting, persecution and disturbance of sensitive animal species.
- Conduct simple annual monitoring for the four recorded Near Threatened plant species and the three recorded Declining medicinal plant species that are considered good indicators of medicinal plant harvesting pressure at Vaal River (i.e. *Boophone disticha, Crinum bulbispermum* and *Hypoxis hemerocallidea*).
- Prevent the unauthorised and uncontrolled grazing of livestock that is currently occurring within CBMA's 1 and 2.
- Prevent the establishment of roads, pipelines and other infrastructure within CBMA's without prior approval by the Biodiversity and Heritage section of the mines Environmental Department.

The main anthropogenic impacts requiring management which were recorded at monitoring sites within each of the five CBMA's subjected to baseline monitoring, can be summarised as follows:

- **CBMA 1:** Tailings spills from the tailings dams on the north-west boundary and to the north of this CBMA have already impacted small parts of this CBMA and pose a significant threat to biodiversity in this CBMA. Though the vegetation is still largely in good condition, lack of any access control to this CBMA has allowed significant impacts such as cutting of trees and shrubs for firewood, collection of medicinal plants, hunting, altered fire regimes and overgrazing by cattle belonging to informal cattle owners. Though currently localised, invasion by alien plant, in particular **Opuntia ficus-indica* poses a significant threat to the areas of BMU4 and BMU5 situated within this CBMA.
- **CBMA 2:** Heavy overgrazing of the Vaal River floodplain vegetation (BMU 1) within this CBMA was noted in spring (November) of 2012, when heavy grazing and trampling of *Nerine gracilis* and *Trachyandra erythrorrhiza* habitat was noted. Lack of access control has also led to the creation of numerous tracks by four-wheel drive vehicles and quad bikes, and one of these tracks goes through a colony of *Nerine gracilis.* Alien invasive species are present in riparian forest and woodland throughout the study area, and the most important transformers and potential transformers within CBMA2 are **Cestrum aurantiacum, *Eucalyptus* spp*., *Morus alba, *Salix babylonica* and **Arauja sericifera*. 'Rehabilitation' of so-called erosion dongas within CBMA 2, which are actually near pristine drainage lines which drain the Vaal River floodplain and provide habitat for a threatened species and a Near Threatened species, occurred in 2012 and this is considered to be significant habitat degradation or destruction.
- **CBMA 3:** Though not recorded during the current study, tailings spills pose a significant risk to the northern parts of this CBMA. Existing plantations within the portions of BMU1 situated within CBMA 3 have led to significant habitat

destruction, and planned additional plantations will lead to further habitat destruction and degradation. Lack of access control in the past have led to the illegal removal of *Lithops lesliei* plants by plant collectors, and horticultural and medicinal plant collectors will continue to pose a significant threat to the two subpopulations of this species occurring in this CBMA if access control is not introduced. Alien invasive species are present in riparian forest and woodland throughout the study area, and the most important transformers and potential transformers within CBMA 3 are **Cestrum aurantiacum, *Eucalyptus* spp*., *Morus alba, *Salix babylonica* and **Arauja sericifera*.

- **CBMA 4:** Much of the vegetation of this CBMA was either severely degraded or transformed in the past by overgrazing by game (old Mispah Game Park) and ploughing which occurred many decades ago. The vegetation is however recovering well. Current impacts are largely the exclusion of grazing and fire, and the construction of broad (8m) firebreaks that are seemingly unplanned and cause habitat destruction as well as posing a serious erosion risk.
- **CBMA 5:** No signs of habitat and vegetation degradation as a result of overgrazing and fire damage resulting from altered fire regimes were recorded during the current study. Lack of access control poses a risk of impacts such as medicinal plant collecting and hunting occurring in future. Alien invasive species are present in riparian forest and woodland throughout the study area, and the most important transformers and potential transformers within CBMA 5 are **Cestrum aurantiacum, *Eucalyptus* spp*., *Morus alba* and **Salix babylonica.*

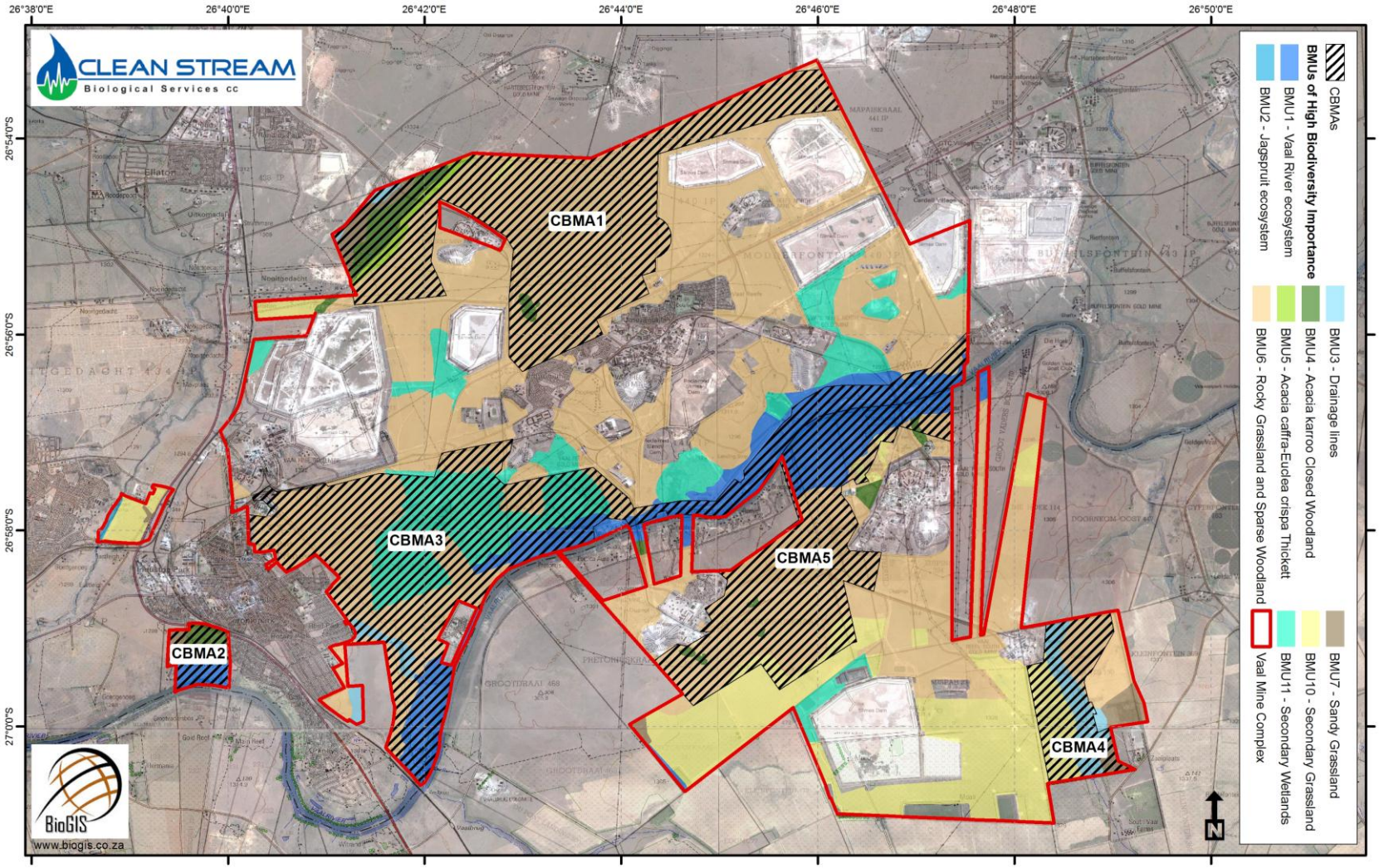


Figure 7: Recommended Core Biodiversity Management Areas (CBMA's) for the AGA Vaal River study area.

8.2 Impact/Risk-specific management actions

Various impacts on or potential risks to biodiversity have been identified in the study area and highlighted in the relevant BMU of concern. Table 19 provides detail regarding the specific action of each impact and makes recommendations on actions that could be taken to address or reduce these impacts in the study area.

Table 19: Description of impacts on biodiversity and recommended management actions to address these impacts.

IMPACT/RISK	DESCRIPTIONS	RECOMMENDED MANAGEMENT ACTIONS
Impact 1: Alteration to hydrological regime	· Damming of the river.	Comply with water use license conditions.
	· Abstraction	Remove any redundant dams from the streams. Determine and comply with ecological reserve (quality and quantity). No dams or weirs, other than those specifically designed for erosion control, may be constructed in wetlands. Unnecessary damming of the river, tributaries, wetlands and seepages should not be allowed. Refrain from building any further in-stream dams or weirs; remove redundant structures to restore the natural river continuum.
	· Draining of wetlands	It must be ensured that the natural hydrological regime of these systems is maintained. Flow modification as a result of dams and water abstraction should be minimized and managed as far as possible to ensure adequate flow in the system.
	· Alterations to surface runoff patterns.	Determine and comply with ecological reserve (quality and quantity)
Impact 2: Water quality deterioration	Alterations to water quality (eutrophication, increased salinity and increased acidity), through effluents, storm water runoff and seepage into streams. Reduced water quality related to potential seepage and spills from pollution control dams and process plants (mine infrastructure) as well as runoff from catchment. Flushed-out pesticides, detergents and other poisonous substances will be detrimental to frogs and fish below the seepage areas. Reduced water quality related to potential seepage and spills from pollution control dams, coal dumps and process plants (mine infrastructure) which could have sub-lethal to lethal impacts on the aquatic biota. Areas of poor water quality can create chemical migration barriers to fish.	Prevent surface, ground water or effluents with poor quality from entering the streams. Continue existing water quality monitoring programs and ensure compliance to water quality guidelines. Determine and comply with ecological reserve (quality and quantity)
	The deterioration of the water quality in the wetlands will influence the breeding and survival of tadpoles and thus the frog populations.	Implement site-specific aquatic biomonitoring programme to monitor any changes in the ecological integrity of the aquatic ecosystem.
	Pesticide runoff and contamination due to application along railway lines and pipelines (potentially croplands) could result in death and/or reduced fecundity of aquatic fauna.	Identify potential areas where seepage and spills can occur into the natural environment. Take necessary precautions to reduce potential spills and seepage.

IMPACT/RISK	DESCRIPTIONS	RECOMMENDED MANAGEMENT ACTIONS
		If pesticides or herbicides are used, products should be chosen responsibly to act in accordance with the sensitive environment and associated ecology. Storage, administering and disposal must be done according to the prescribed methods. Care should be taken to prevent any of the pollution from ending up in the wetlands or river. No dumping of wet or dry material and, in particular, no waste disposal of any kind may be permitted in or near a wetland. Educate farmers about the importance of invertebrate conservation and encourage use of integrated pest management (IPM) strategies with reduced reliance on pesticides.
		Conduct toxicity testing on all potential pollution sources (pollution control dams, etc) to determine their relative toxicity to the environment.
Impact 3: Deteriorating physical aquatic habitat integrity	**Increased siltation** as a result of erosion (related to overgrazing and other human activities responsible for removal of vegetation, such as agriculture, clearing for pipelines, roads, etc.).	Promote sustainable use of vegetation by local community. Livestock farmers should not exceed carrying capacity. Trampling at livestock watering areas should be minimized.
	Removal of riverine vegetation: marginal vegetation and riparian bush.. The structural habitat of aquatic systems can also be significantly degraded by modifications associated with old and new development.	Limit surface soil disturbance and manage erosion (especially dirt roads and previously disturbed areas).
	Habitat destruction in pans through mining and construction: The **construction** of buildings and roads alters drainage patterns and soil structure.	Specialist aquatic assessments should be conducted before, and monitoring conducted after disturbance of riverine habitats.
		No development or disturbance should occur within the 1:100 year flood line of any drainage line (including perennial and non-perennial streams) in accordance with the National Water Act (no. 36 of 1998).
		No development should occur within 100m of the upper margin of the seasonally flooded zone (eulittoral zone) of any pans occurring within the study area.
Impact 4: Overgrazing	**Overgrazing** due to over stocking with livestock/game	A 'veld management plan' should be implemented for all parts of the study area that are not subjected to opencast mining activities. Grazing is an essential environmental factor in maintaining veld condition and floristic diversity. Overgrazing can however be detrimental to the vegetation, and the mine should therefore establish the carrying capacity of the untransformed areas of the mine property and ensure that overgrazing is prevented.
Impact 5: Altered fire regimes	Increased or decreased frequency of burning and burning at wrong time, all lead to deterioration of veld condition, alterations to vegetation structure and reduced biodiversity. In the case of the mine, exclusion of fire is the most frequent form of this impact.	Implementation of an appropriate 'burning plan'. In order to recommend appropriate intervals between prescribed fires, various factors such as veld condition and fuel load of both fine fuels (grass) and woody fuels, have to be assessed Erect notice boards along roads: "No open fires allowed".
Impact 6: Invasion by alien plants	Results in decreased water levels and competition with indigenous species.	Implement alien plant control programme if available or conduct specialist alien plant control study.

IMPACT/RISK	DESCRIPTIONS	RECOMMENDED MANAGEMENT ACTIONS
Impact 7: Harvesting of medicinal plants.	Harvesting for use as medicinal plants.	Implement recommendations stipulated in De Castro & Brits, 2013b. Implement long-term vegetation monitoring (see De Castro & Brits, 2013b). Implement CBMA's and access control of areas where medicinal plants occur.
		Prior to the development of any area of untransformed vegetation, the area should be searched for these species. In the event of any species being recorded during these surveys, permission for their removal should be obtained from the relevant authorities, and if necessary appropriate *in situ* and / or *ex situ* conservation measures should be developed and implemented. Where feasible, viable populations of such species can also be translocated to degraded or untransformed areas within the study area which provide potentially suitable habitats, but such translocations will have to be carried out in a way that ensures no ecological degradation of the host habitat occurs, and will have to be evaluated by a botanist for each species and each potential translocation area.
Impact 8: Over utilization of vegetation	Over harvesting of sedges and reeds by local community for building/thatching, knobkieries, hedges.	Through implementation of long-term biodiversity monitoring programme, it can be established if any plants are subjected to significant levels of utilisation within the study area. Targeted conservation measures can then be developed for those species that are threatened by heavy harvesting/over-utilisation. Promote use of alien species.
Impact 9: Removal of vegetation.	Clearing of vegetation for construction (infrastructure, roads, pipelines), mining and agriculture. Also includes grading of fire breaks, grading of roads through untransformed land and uprooting of alien vegetation.	• At the planning phase, the footprint of the proposed infrastructure should be overlaid on the map showing the boundaries of the various BMU's and proposed CBMA's included in the BMP. • If the proposed footprint does not include any untransformed BMU's and is not situated within any proposed CBMA's, then all that is required is for suitably experienced staff from the mines Biodiversity and Heritage section to conduct a brief site visit to confirm the absence of untransformed habitats and vegetation within the proposed footprint, prior to internal approval of the proposed development. • If the proposed development footprint includes any untransformed BMU's and is situated within any proposed CBMA's, then this should be confirmed by the mines Biodiversity and Heritage section during a brief site visit, and an alternative site that comprises only transformed habitat and is not situated within any proposed CBMA's should be sought. If moving the proposed development site to an alternative location is not possible, then the proposed footprint should be thoroughly searched for potentially occurring plant 'species of conservation concern' and 'scarce and restricted' species prior to construction, and required environmental authorisation should be obtained. Ensure that proper Environmental Impact Assessments are conducted and that requirements of ROD and EMP are adhered to. No development should occur within the 1:100 year flood line of any drainage line (including perennial and non-perennial), stream or river, in accordance with the National Water Act (no. 36 of 1998).

IMPACT/RISK	DESCRIPTIONS	RECOMMENDED MANAGEMENT ACTIONS
		Implement erosion control measures.
		Revegetate cleared areas.
		Ensure adequate stormwater drainage.
	Chopping down trees and drying out as fire wood, collecting dead wood.	Endeavour to have electricity supplied to all the local inhabitants through the councils. Promote use of alien trees.
Impacts 10: Presence of humans	The mere presence of humans may cause a disturbance and drive away some intolerant animals (noise, movement)	Where applicable, access control should be implemented to reduce human presence in the untransformed areas of the mine.
Impact 11: Persecution/killing of animals	Hunting with dogs, snares and trapping) – especially game birds (francolin and guinea fowl) and small mammals (duiker).	Increase information campaigns and ensure that environmental officers and dedicated staff convey the message to the personnel and other inhabitants of the area.
	Killing of animals (especially owls, vultures, etc.) for "muti" trade.	Start awareness campaigns on the mine and in the community to inform the people about the roles of these species
	Persecution of predators (mongoose and wild cats) due to misinformation	
	Persecution of snakes, especially the venomous species will influence the diversity of this group adversely	
Impact 12: Trampling of fauna by vehicles	On the many roads through the area, especially slow moving animals (frogs), owls and small mammals (hares and mongoose) are blinded by lights at night. Frogs and reptiles are very susceptible during the rainy season. Off road movement of vehicles (including earth moving equipment) can also kill animals and destroy habitats.	Make people aware of the possibility of animals crossing the road, and educate not to kill indiscriminately.
		Erect road signs along roads to warn drivers about the possible impact.
		Reduce spillage of seeds (maize) on roads by use of tarpaulins (seeds attract rodents, which in turn attract owls onto the roads at night). Avoid off-road movement through untransformed habitats (high conservation value BMU's).
Impact 13: Loss of natural corridors for animal movement/fragmentation of habitats	Fencing of properties.	NB: Implement CBMA's.
		Provision for buffer zones as well as linkages to other natural areas, according to the specific requirements of the biota and the nature and layout of the system.
	Construction of dams and weirs create barriers to natural migration of aquatic biota.	Remove all redundant dams and weirs.
		Consider the inclusions of fishways in new dams and weirs.
		Allow free passage under bridge crossings (including dragline crossings).
	Fragmentation of habitat is a process whereby large tracts of the natural grassland are gradually developed and subdivided until only patches of original habitat remain.	Planning of all new developments should be done with an increased sensitivity regarding shrinking natural areas. Where fragmentation takes place, some natural habitat corridors should remain intact to facilitate faunal movement.
Impact 14: Presence of power lines and fences	Birds are especially affected through collision and electrocution on power lines.	Liaise with ESKOM regarding best environmental practice/bird-friendly powerlines.
		Ensure visibility of power lines and fences (install bird flappers where applicable).
		No fences should be constructed through or along the edges of pans, rivers and wetlands.
Impact 15: Presence of exotic/alien fauna	Presence of exotic fish species - Impacts on indigenous fish through disturbance of bottom substrates, predation and competition for food and habitat.	Prohibit stocking of exotic species and promote conservation of indigenous species and removal of alien species.
Impacts 16: Saturation of the peripheral soils	**Saturation of the peripheral soils along seasonal marsh wetlands** by mine water seepage will make this very viable subterranean habitat unattractive	Contain seepage from mining areas by the standard methods used in mining operations. Conduct regular inspection and maintenance on pipelines.

IMPACT/RISK	DESCRIPTIONS	RECOMMENDED MANAGEMENT ACTIONS
	to tunnelling mammals such as the mole-rats and golden moles. Leaks in pipelines may also result in localised saturation (and potentially pollution) of soils.	
Impact 17: Removal of habitat components such as rocks, termite mounds, dead wood.	Removal of features such rocks and stones for use in construction, quarrying or other reasons. Clearing of rocks for agriculture.	Habitat features such as termite mounds, trees, thick grassy patches, shrubs, rocks and stones should be seen as part of the natural environment, enhancing the area and should not be removed
Impact 18: Poaching of animals	Hunting with dogs or using of methods such as gill nets in dams/rivers	Access control and patrols by security. Erect information sign boards at access roads to AGA property: "No hunting allowed, no unauthorised entry, etc.". Liaise with Nature Conservation department.
Impact 19: Illegal collecting of animals.	**Collecting animals** as pets or food (terrapins and hedgehogs).	Start awareness campaigns on the mine and in the community to inform the people about the roles of these species.
Impact 20: Altered lighting	Changes in lighting in an area, for example, can significantly affect some species' behavioural and biological rhythms, which are guided by natural cycles of light and dark. Nocturnal species, particularly birds, can become disoriented by night-time lighting.	Unnecessary light sources should be reduced.
	External lighting in the vicinity of mining operations resulting in death of flying insects	Modify outdoor lighting installations to ensure lighting is not directed into natural environments and long-wavelength (yellow/orange) low pressure sodium vapour or LED lamps are used in preference to fluorescent or mercury vapour.
Impact 21: Subsidence	Potential occurrence of **Subsidence** due to underground mining**.**	Conduct regular site visit to assess occurrence of subsidences. Recontouring should be performed in correct manner (removing or topsoil first, etc) in the subsidence area to ensure normal drainage paterns (assess potential impact on natural area before recontouring). Dangerous areas should be fenced and warning signs erected. Underground fires should be controlled. Consider the increased water infiltration of subsidence areas in the goehydrological model of the mine.
Impact 22: Redundant infrastructure	Habitat loss due to old, redundant infrastructure and mined areas.	Redundant infrastructure and old mining areas could be rehabilitated with good planning, prioritization and funding, thereby increasing the environmental integrity of the mining area tremendously.
Impact 23: Soil and dust on vegetation.	Vegetation in close proximity to Waste Rock Dumps, Tailings storage facilities, tailings spillage areas and heavily utilised dirt roads may be smothered by dust that hinders photosynthesis and transpiration.	Assess possibilities to reduce soil dust pollution, especially close to wetlands/streams. Revegetate tailings storage facilities, install wind barriers (nets), use irrigation or chemical dust suppression.
Impact 24: Increased erosion	Roads, culverts, storm water drains and cleared areas will lead to increased erosion	Erosion should be prevented and controlled at all costs to prevent the wash-away of valuable top soil and sedimentation of wetlands.
Impact 25: Air pollution	Any activity with emissions has the potential to add to current emissions in the air. The accumulative effect of these emissions can potentially adversely affect especially the amphibian population.	If not in place, consider air quality monitoring programme and ensure compliance to guidelines.
		Make an effort to curb any emissions resulting from the mining activities

IMPACT/RISK	DESCRIPTIONS	RECOMMENDED MANAGEMENT ACTIONS
	Depending on the type of emissions at the site and in the region, it may impact upon plant and animal life. Dust particles may affect the health and longevity, and ultimately the breeding success of species. Certain kinds of emissions may also impact negatively upon animals, e.g. sulphur dioxide emissions cause eggshell thinning and acid rain. The impact of air quality on the fauna of the study area is unknown.	
Impact 26: Woodlands project	AngloGold Ashanti is sponsoring a phytoremediation project as undertaken by Wits University where large scale ecological engineering trials are undertaken. Various plant species are being introduced on top of the tailings dams and in seepage zones. Establishment of plantations in any area of untransformed habitat and vegetation, or even in transformed areas that are vegetated by seral plant communities dominated by indigenous pioneer plant species, amounts to habitat destruction and the erosion of the current biodiversity value of the study area. Numerous trial plantations of alien and indigenous (indigenous to South Africa but not necessarily to the study area) trees have already been established at Vaal River and it is understood that more such plantations are planned as part of the Woodlands Project. On-site observations and a brief analysis of available Google Earth imagery indicated that the trial plantations already established total many hectares. Though no documentation on the project has been provided it is understood that the intended purpose of the establishment of the plantations is for phyto-remediation of soils contaminated by polluted water and mine tailings, and though most of the plantations seen by the author have been planted directly adjacent to tailings dams, some are situated within the floodplain habitats of the Vaal River (BMU 1). It is important to note that the establishment of plantations such as those at Vaal River can cause a variety of impacts to biodiversity if not correctly located and lead to the destruction of natural vegetation classified as being of conservation importance	The establishment of plantations within the study area is very likely to require environmental authorisation in terms of the provisions of the National Environmental Management Act (Act 107 of 1998) as well as the National Water Act (Act 36 of 1998). AngloGold Ashanti should seek to ensure that both the existing and proposed plantations are not in contravention of any of the provisions of the aforementioned legislation. The establishment of plantations should only be allowed in habitats that are already completely transformed by anthropogenic impacts and where there is scientific proof that the soils are contaminated, that the proposed phyto-remediation will significantly reduce soil contamination and/or improve 'downstream' water quality, and that the proposed plantations are a more efficient and cost effective than more traditional methods such as the use of cut-off trenches. Establishment of plantations in any area of untransformed habitat and vegetation, or even in transformed areas that are vegetated by seral plant communities dominated by indigenous pioneer plant species, amounts to habitat destruction and the erosion of current biodiversity value of the study area. The Biodiversity personnel responsible for Vaal River must therefore conduct a desktop assessment (using the available map of BMU's and CBMA's) and a field survey of the proposed plantation footprint in order to ensure that no habitats, vegetation or species of biodiversity conservation value are destroyed or degraded. No alien species that are Declared Weeds or Declared Invaders listed in the CARA, or any other alien species that is considered invasive or potentially invasive within the study area should be planted. In order to avoid genetic contamination of the ecotypes of indigenous species which naturally occur within the study area, as well as the potential introduction of pathogens, it is highly recommended that only trees that are grown locally from seeds obtained within the study area or its immediate surrounds are planted.

8.3 *Species-specific* biodiversity management actions

The presence of various species with special conservation importance (red data, protected, orange-list, etc.) has been confirmed in the study area while some has a high probability of occurrence. Specific biodiversity actions are recommended for the protection of these species (Table 20).

Table 20: Species of special conservation importance, potential impacts and management recommendations

SPECIES	IMPACTS	MANAGEMENT ACTIONS
Nerine gracilis (**Vulnerable)** 	The habitat at both colonies was burnt in the winter of 2012 and the vegetation is untransformed and in good condition. The sites were heavily grazed in November, but no signs of recent grazing or trampling were present in March.	See De Castro & Brits, 2013a for detail. The Red List of South African Plants (Raimondo *et al.*, 2009) does not provide accurate guidelines for the setting of buffer zones to mitigate deleterious edge effects which may impact threatened species, and no such guidelines are available for 'species of conservation concern' in the North West Province. In the absence of guidelines for the North West Province, the Gauteng 'Red List Plant Species Guidelines' document (Pfab, 2006) are regarded as wholly appropriate and are followed in this study. The Gauteng 'Red List Plant Species Guidelines' document states that all threatened and Near Threatened species should be conserved *in situ*. These guidelines also state that the minimum buffer zone around subpopulations of A3 'Priority Grouping' species of conservation concern (e.g. *Nerine gracilis)* should be at least 400m in rural areas. The recommended preliminary minimum buffer zone for the subpopulation of *Nerine gracilis* recorded within the study area is mapped on the aerial image provided in Appendix 5. The exact width and footprint of this buffer zone can be refined on the basis of future surveys. The preliminary buffer zones provided in the current report take into account aspects such as the habitat requirements of the species, habitat characteristics and sensitivities and historical and current land-use. The buffer zone is therefore not simply circular, and the footprints of the buffer zones have been adjusted to ensure that developed industrial sites and other unsuitable transformed habitats have been excluded, connectivity between subpopulations is enhanced, the area included in the buffer zone is large enough to constitute a viable ecosystem, and as much as possible potentially suitable habitat for the species is included in the buffer zones. The recommendations for the conservation of *Nerine gracilis* at Vaal River can be summarised as follows: The personal of the mines Biodiversity and Heritage section should conduct additional searches for this species in potentially suitable habitat in early March. The recommended minimum buffer zone should be enforced by the mine and this

		buffer zone should be incorporated into CBMA 2 as recommended elsewhere in this report and shown in Appendix 5. The recommended buffer zone is regarded as minimum buffer zone, and it is strongly recommended that the entire CBMA 2 should be conserved in order to protect the catchment of the drainage depression which provides habitat for *Nerine gracilis* and *Trachyandra erythrorrhiza*. Only conservation compatible activities should be permitted within CBMA 2. Suitably experienced personnel from the Biodiversity and Heritage section of the mine should conduct simple annual monitoring at the sites listed in Table 2. Such monitoring should simply comprise of visiting each site, photographing the site, counting the number of plants and recording any observed impacts to the species and its habitat (e.g. alien plant invasion, overgrazing, trampling and medicinal plant harvesting). A permanent 100 m^2 vegetation sampling quadrat and fixed-point photography site has been established at both the eastern (site M12) and western (site M11) colonies comprising the subpopulation, and the baseline fixed point-photographs taken at these site should be repeated annually (see De Castro & Brits 2013b). Vegetation monitoring within the permanent vegetation sampling quadrats need only be repeated at three to five year intervals, or when the analysis of the fixed-point photographs or on-site observations deems this to be necessary.
Near-threatened: *Lithops lesliei* subsp. *Lesliei* 	A highly inconspicuous, dwarf, succulent, 'stoneplant' which is highly sought after by succulent plant collectors and medicinal plant collectors According to Raimondo and co-authors (2009) this species has undergone a 15% population reduction as a result of harvesting for the medicinal plant trade and habitat destruction as a result of urban expansion and agriculture. General impacts included urban expansion, harvesting by succulent plant collectors and medicinal plant trade. At West Wits, sub-population A is bisected by the western fence of the Kraalkop reserve and are situated in severely degraded habitat between a cut-off trench and berm and the fence of the Mponeng Shaft.	See De Castro & Brits, 2013a for detail. The personal of the mines Biodiversity and Heritage section should conduct additional searches for this species in potentially suitable habitat between April and June. Raimondo *et al*. (2009) recommend that the destruction of a subpopulation (i.e. limited habitat loss) of a Near Threatened species such as *Lithops lesliei* subsp. *lesliei* which is listed only under criterion B should only be considered under circumstances where certain requirements are met. In accordance with these guidelines, the *Lithops lesliei* subsp. *lesliei* subpopulations recorded within the study area should be conserved *in situ* for the following reasons: no sub-population of this species in the North West Province is currently known to occur in an area formally conserved in terms of the Protected Areas Act (Act 57 of 2003), and it occurs in only one such protected area in Gauteng, namely the Rietvlei Nature Reserve where a small subpopulation occurs; the untransformed chert grassland (BMU 6) habitat that provides the only habitat for this species within the study area, is representative of Vaal River Dolomite Sinkhole Woodland is considered to be

		Vulnerable nationally (Mucina & Rutherford, 2006); the habitat of the two recorded subpopulations, and their recommended buffer zones (see Appendix 6), is all mapped as 'Critical Biodiversity Areas' in the 'North West Province Biodiversity Conservation Assessment' (Desmet *et al*., 2009).
Pearsonia bracteata	This species has lost habitat to cultivation in the past, and is threatened by on-going habitat loss and degradation due to urban development, agriculture and mining. The habitat at both colonies was burnt in the winter of 2012 and the vegetation is untransformed and in good condition. Signs of light grazing were present at the western locality, but no signs of grazing were seen at the eastern locality.	Raimondo *et al*. (2009) recommend that the destruction of a subpopulation (i.e. limited habitat loss) of a Near Threatened species such as *Pearsonia bracteata* which is listed only under criterion B should only be considered under circumstances where certain requirements are met (see Text Box above). In accordance with these guidelines, the *Pearsonia bracteata* subpopulations recorded within the study area should be conserved *in situ* for the following reasons: The Red List of South African Plants (Raimondo *et al.*, 2009) does not provide accurate guidelines for the setting of buffer zones to mitigate deleterious edge effects which may impact threatened species, and no such guidelines are available for 'species of conservation concern' in the North West Province. In the absence of guidelines for the North West Province, the Gauteng 'Red List Plant Species Guidelines' document (Pfab, 2006) are regarded as wholly appropriate and are followed in this study. The Gauteng 'Red List Plant Species Guidelines' document states that all threatened and Near Threatened species should be conserved *in situ*. These guidelines also state that the minimum buffer zone around subpopulations of A3 'Priority Grouping' species of conservation concern (e.g. *Trachyandra erythrorrhiza)* should be at least 400m in rural areas. The recommended preliminary minimum buffer zones for the subpopulation of. The preliminary buffer zones provided in the current report take into account aspects such as the habitat requirements of the species, habitat characteristics and sensitivities and historical and current land-use. The buffer zones are therefore not simply circular, and the footprints of the buffer zones have been adjusted to ensure that developed industrial sites and other unsuitable transformed habitats have been excluded, connectivity between subpopulations is enhanced, the area included in the buffer zone is large enough to constitute a viable ecosystem, and as much as possible potentially suitable habitat for the species is included in the buffer zones. The recommendations for the conservation of *Pearsonia bracteata* at Vaal River can be summarised as follows: The recommended minimum buffer zones should be enforced by the mine and these buffer zones should be incorporated into CBMA 1 as recommended elsewhere in this report and shown in Appendix 5. The

		recommended buffer zones are regarded as minimum buffer zones, and it is recommended that the entire CBMA 1 should be conserved, as motivated elsewhere in this report. Suitably experienced personnel from the Biodiversity and Heritage section of the mine should conduct searches for Pearsonia bracteata in suitable habitat during early November in order to establish the size and extent of the colonies at sites M1 and M2, and attempt to find additional localities or subpopulations for this species. The Biodiversity and Heritage section of the mine should conduct simple annual monitoring at sites M1 and M2. Such monitoring should simply comprise of visiting each site, photographing the site, counting the number of plants and recording any observed impacts to the species and its habitat (e.g. alien plant invasion, overgrazing, trampling and medicinal plant harvesting). Permanent 100 m^2 vegetation sampling quadrats and fixed-point photography sites have been established at both sites where this species was recorded in 2007 (sites M1 and M2), and the baseline fixed point-photographs taken at these sites should be repeated annually (see De Castro & Brits 2013b). Vegetation monitoring within the permanent vegetation sampling quadrats need only be repeated at three to five year intervals, or when the analysis of the fixed-point photographs or on-site observations deems this to be necessary. It is essential that the subpopulation recorded within the study area should be conserved *in situ* and protected by a suitable buffer zone. Raimondo *et al*. (2009) recommend that the destruction of a subpopulation (i.e. limited habitat loss) of a Near Threatened species such as *Trachyandra erythrorrhiza* which is listed only under criterion B should only be considered under circumstances where certain requirements are met (see Text Box above). In accordance with these guidelines, the *Trachyandra erythrorrhiza* subpopulations recorded within the study area should be conserved *in situ* for the following reasons: the subpopulation of *Trachyandra erythrorrhiza* recorded within the study is the only subpopulation known in the North West Province, and this species is therefore not currently known to occur in an area formally conserved in terms of the Protected Areas Act (Act 57 of 2003); the untransformed vegetation of the Vaal River floodplain which constitutes the habitat for *Trachyandra erythrorrhiza* is one of the few remaining areas of near pristine floodplain habitat and vegetation left along the Vaal River in this area of the North West
Trachyandra erythrorrhiza	The *T. erythrorrhiza* habitat was burnt in the winter of 2012 and the vegetation is untransformed and in good condition. The site was very heavily grazed by cattle in November, which is the flowering time for this species, and almost all *Trachyandra* plants were heavily' and, seemingly, selectively grazed, but no signs of recent grazing or trampling were present in March when the plants were robust.	

		Province, most of which has been transformed by cultivation and the development of golf courses and residential developments, and as such has elevated conservation value; the *Trachyandra erythrorrhiza* is situated in the same floodplain habitat as the threatened (Vulnerable) species *Nerine gracilis*, both colonies of which occur within 300m of the locality for *Trachyandra erythrorrhiza;* the habitat of the recorded subpopulation, and its recommended buffer zone (see Appendix 6), is all mapped as 'Critical Biodiversity Areas' in the 'North West Province Biodiversity Conservation Assessment' (Desmet *et al*., 2009). The Red List of South African Plants (Raimondo *et al.*, 2009) does not provide accurate guidelines for the setting of buffer zones to mitigate deleterious edge effects which may impact threatened species, and no such guidelines are available for 'species of conservation concern' in the North West Province. In the absence of guidelines for the North West Province, the Gauteng 'Red List Plant Species Guidelines' document (Pfab, 2006) are regarded as wholly appropriate and are followed in this study. The Gauteng 'Red List Plant Species Guidelines' document states that all threatened and Near Threatened species should be conserved *in situ*. These guidelines also state that the minimum buffer zone around subpopulations of A3 'Priority Grouping' species of conservation concern (e.g. *Trachyandra erythrorrhiza)* should be at least 400m in rural areas. The recommended preliminary minimum buffer zones for the subpopulation of *Trachyandra erythrorrhiza* recorded within the study area is mapped on the aerial image provided in Appendix 5. The exact width and footprint of this buffer zone can be refined on the basis of future surveys. The preliminary buffer zone provided in the current report take into account aspects such as the habitat requirements of the species, habitat characteristics and sensitivities and historical and current land-use. The buffer zones are therefore not simply circular, and the footprints of the buffer zones have been adjusted to ensure that developed industrial sites and other unsuitable transformed habitats have been excluded, connectivity between subpopulations is enhanced, the area included in the buffer zone is large enough to constitute a viable ecosystem, and as much as possible potentially suitable habitat for the species is included in the buffer zones. The recommendations for the conservation of *Trachyandra erythrorrhiza* at Vaal River can be summarised as follows: The recommended minimum buffer zone should be enforced by the mine and this buffer zone should be incorporated into

		CBMA 2 as recommended elsewhere in this report and shown in Appendix 5. The recommended buffer zone is regarded as minimum buffer zone, and it is strongly recommended that the entire CBMA 2 should be conserved in order to protect the catchment of the drainage depression which provides habitat for *Trachyandra erythrorrhiza* and *Nerine gracilis*. Only conservation compatible activities should be permitted within CBMA 2. Suitably experienced personnel from the Biodiversity and Heritage section of the mine should conduct simple annual monitoring at the sites listed in Table 3. Such monitoring should simply comprise of visiting each site, photographing the site, counting the number of plants and recording any observed impacts to the species and its habitat (e.g. alien plant invasion, overgrazing, trampling and medicinal plant harvesting). A permanent 100 m^2 vegetation sampling quadrat and fixed-point photography site (M13) has been established at the recorded subpopulation comprising the subpopulation, and the baseline fixed point-photographs taken at these site should be repeated annually (see De Castro & Brits 2013b). Vegetation monitoring within the permanent vegetation sampling quadrats need only be repeated at three to five year intervals, or when the analysis of the fixed-point photographs or on-site observations deems this to be necessary.

*Drimia sanguinea (*Near Threatened) Potentially suitable habitat for this species does occur within the study area within BMU's 1, 4, 5 and 6.	n/a	It is recommended that site F30 should be visited during September and October 2014 when the plants should be in flower, so that the plants can be found and identified. If this species is indeed *Drimia sanguinea* then a voucher specimen should be collected and sent to the National Herbarium, and appropriate *in situ* conservation measures (e.g. establishment of a buffer zone around the subpopulation) should be developed and implemented with the approval of the North West Province conservation authorities.
Declining plant species: *Boophone disticha*, *Crinum bulbispermum* and *Hypoxis hemerocallidea*	popular and fairly heavily utilised medicinal plants	Development at sites where Declining plant species have been recorded should be avoided where possible. Access to sites where Declining plant species occur should be controlled. This will benefit not only Declining plant species but will facilitate biodiversity conservation at Vaal River as a whole. The three recorded Declining plant species can be used as indicators of medicinal plant harvesting pressure within the study area. These species should be subjected to simple annual monitoring by suitably experience staff from the biodiversity section of AngloGold's environmental department, with specialist input if necessary. Recommended annual monitoring consist of simply visiting the recorded localities listed in Table 4, counting the number of plants present, noting any signs of harvesting or threats to the plant habitat (e.g. overgrazing, erosion and invasion by alien plants), and photographing the site. In the event of any Declining species being recorded within an approved development site, permission for the removal of such species should be obtained from the North West Province Department of Agriculture Conservation and Environment (DACE), and the appropriate *in situ* and / or *ex situ* conservation measures should be developed and implemented with the approval of the North West Province conservation authorities. Where feasible, declining species can be translocated to degraded or untransformed parts of the study area which provide potentially suitable habitat, but such translocations will have to be carried out in a way that ensures no ecological degradation of the host habitat occurs, and will have to be evaluated by an ecologist for each species and each potential translocation area. Alternatively Declining species can be rescued and donated to appropriate conservation and research institutions such as the Walter Sisulu Botanical Garden (Roodepoort) or the National Botanical Garden (Pretoria) of SANBI.
'Scarce and restricted' plant species : *Brachystelma nanum, Eulophia streptopetala, Eulophia inaequalis, Gladiolus ecklonii, Haemanthus montanus* (Plate 5), *Nanthus* cf. *aloides, Nerine krigei* (Plate 6), *Raphionacme dyeri, Senecio*	n/a	Development at sites where 'scarce and restricted' plant species have been recorded should be avoided where possible. Access to sites where 'scarce and restricted' plant species occur should be controlled. This will benefit not only 'scarce and restricted' plant species but will facilitate

reptans (Plate 7) and *Vigna oblongifolia* var. *parviflora.*		biodiversity conservation at Vaal River as a whole. In the event of any 'scarce and restricted' species occurring within an approved development site, such species should be rescued prior to construction. Where feasible, 'scarce and restricted' can be translocated to untransformed parts of the study area which provide potentially suitable habitat, but such translocations are not recommended for 'scarce and restricted' in most cases, as these species are highly habitat specific. Where translocation is attempted, it will have to be carried out in a way that ensures no ecological degradation of the host habitat occurs, and will have to be evaluated by an ecologist for each species and each potential translocation area. The preferred mitigation measure for 'scarce and restricted' species would in most cases be to rescue and donated such species to appropriate conservation and research institutions such as the Walter Sisulu Botanical Garden (Roodepoort) or the National Botanical Garden (Pretoria) of SANBI.
The NEMBA protected **Giant Bullfrog** 	Collecting for food; Persecution, road kills and human presence. Destruction of feeding and breeding habitats by mining and agriculture. Pollutants in the system.	Protect its habitats through inclusion of optimal habitat within CBMA's. Start awareness campaigns on the mine and in the community to inform the people about the role of this species. Conduct specialist bullfrog study. Excluded sensitive areas from mining and development.
Potential presence of the Red Data listed **raptor** species: White-backed Vulture, Cape Vulture and Martial, Lanner Falcon, Lesser kestrel and Secretary bird.	Persecution, road kills and human presence; poisoning for muti.Loss of natural habitat - crop cultivation; Habitat degradation; Collision with power-lines and fences; Ploughing or covering of soil; Noise, dust and movement of construction; Domestic-dog predation; Altered fire regimes. Decline in prey species	Emphasize importance of conserving these species and their endangered status: keep the staff and surrounding community informed. Protect its habitats through inclusion of optimal habitat within CBMA's. Emphasize importance of conserving these species and their endangered status: keep the staff and surrounding community informed. Erect road signs warning motorists to take care (especially at night).
Potential presence of the Red data listed **predators** Honey badger, Brown hyaena, Serval, Cape fox and Black-footed cat –	Persecution of animals: hunting dogs and humans - hunted for their fur, and some for their meat; Used in traditional medicine and rituals; Pesticides impact on prey items; human presence affect these small mammals; poisoning - mostly on surface rights area outside the fenced mining areas. Trampling by traffic - Highway accidents cause many deaths each year. Decline in prey species	Protect its habitats through inclusion of optimal habitat within CBMA's. Inform the staff and surrounding community of importance of these predators and their function in the ecology of the area. Remove myths relating to these mammals; create awareness towards animals crossing the road.
Potential presence of the Red data listed South African hedgehog, White-tailed mouse, Schreiber's long-fingered bat, Highveld golden mole.	Persecution, road kills and human presence affect these small mammals, hunting with dogs.	Protect its habitats through inclusion of optimal habitat within CBMA's. Inform the staff and surrounding community of importance of these small mammals; discourage the presence of pets (cats and

		dogs) in the area; create awareness towards animals crossing the road.
Raptors: African marsh harrier.	Persecution and poisoning of raptors. Burning of wetland vegetation. Poisoning of prey species - Decline in prey species – vlei rat.	Protection of the wetlands, pans and drainage lines vegetation units. Livestock numbers should be controlled, to avoid excessive grazing, disturbance and trampling of nests. Inform the staff and surrounding community of importance of these raptors and their function in the ecology of the area. Remove myths relating to these birds of prey.

8.4 Implement a long-term biodiversity monitoring program

A long-term biodiversity monitoring plan covering all important aspects and components should be implemented on the mine property. This programme could aim at early detection (early warning systems) of potential negative trends in (threats to) the biodiversity of the area, as a result of mining and other human activities. This programme will also be essential to continually upgrade the available information on the biodiversity aspects of the study area.

Floral Biodiversity Monitoring Programme

The implementation of a vegetation monitoring programme is strongly recommended. This is the only quantifiable means to evaluate the impact of current and possible future management practices on the vegetation of the study area. This includes evaluating the success of rehabilitation activities. The nature of secondary succession in disturbed areas (previously mined and cultivated) should be evaluated in order to determine whether a favourable successional pathway is occurring towards indigenous vegetation cover. Emphasis should also be placed on monitoring threatened and near-threatened species and species that are subject to elevated levels of utilization (e.g. medicinal plants and species utilised for fuelwood).

Ecologists usually equate different ecosystem types with different vegetation types. Vegetation is not only the most obvious biological representation of an ecosystem, but is also largely responsible for primary production and thus forms the base of the 'trophic pyramid' (or feeding pyramid). Vegetation also acts as the physical habitat within which animals complete their life cycles. Species extinction does not usually 'occur in a vacuum', but is usually the result of habitat deterioration or loss. It therefore follows that a monitoring program that succeeds in monitoring broad-scale trends in vegetation, and provides information that can be used to select appropriate management methods on an ongoing basis will also, indirectly, serve to ensure that the populations of the various plant and animal species utilizing this vegetation as habitat remain healthy. This principle applies specifically to terrestrial habitats and not necessarily to aquatic habitats/fauna. Animal and plant species that are directly affected by human utilization (and other impacts e.g. water pollution) do however constitute an exception to this monitoring principal. In addition to vegetation monitoring, such species require monitoring that is specifically aimed at establishing trends in their populations.

Terrestrial Fauna biodiversity monitoring programme

It is recommended that a long-term faunal biodiversity programme be initiated in the mine lease area. The objectives of such a programme may include:

- Assessment of future improvement/deterioration of the faunal biodiversity of the mine lease area (thus a measure of success of environmental management)
- Increase the accuracy of present status determination (actual species present vs. expected species) of the mine lease area with every survey.
- Determination of both temporal and spatial trends in faunal biodiversity on the mine lease area.
- Assist in future management of the mine lease area by providing recommendations and guidelines regarding future activities and rehabilitation.

The following aspects regarding certain biota components should especially be considered in the faunal biodiversity monitoring programme of the mine lease area:

Frogs: Since frogs are susceptible to both aquatic and aerial pollution, and they may currently be affected by some adverse conditions, it would be wise to have a monitoring program in place within the wetlands in the mining area. The aim of the program will be to monitor the effect of the current mining activities on these amphibians and to monitor their reaction to positive and adverse conditions with change in management. Future amphibian monitoring should also aim to determine if the near-threatened Giant bullfrog is present within the study area.

Birds: Birds are an important component of many ecosystems, and of all the main wildlife groups, birds are often the easiest to observe and count, and are of social and economic importance (bird watching). It is recommended that formal bird monitoring of important BMU's should be done annually within the study area. Information gathered by local birding clubs and birding enthusiasts within the study area can also be incorporated in the annual bird surveys, to increase the confidence of known (observed) bird species compositions of the Vaal River operations surface rights areas. Bird monitoring should also aim to determine the presence of Red Data listed bird species. Information on reptiles and mammals should also be gathered as a by-product of a bird-monitoring programme.

Threatened Fauna: The large number of Red Data listed and endemic species necessitates a monitoring program to assess their numbers and status in the mining area. In the event that any threatened or near-threatened animal species are recorded within the study area in future, appropriate conservation measures should be developed in consultation with the relevant conservation authorities.

Rehabilitation - Effect of improvement on fauna: Should any of the restoration or rehabilitation actions be implemented, it will be insightful to implement an overall faunal monitoring program as a barometer for the mine management to recognize positive changes and trends in the biodiversity of the mining lease area.

Aquatic biodiversity monitoring programme

The aquatic biomonitoring programme, as initiated during June 2006, should be adapted to include protocols and sites to also address aquatic biodiversity monitoring of the mining areas. The objective of a conventional biomonitoring programme is to determine the impact of an activity on a receiving water body, where sites are

generally selected up- and downstream of potential sources of pollution. The objective of aquatic biodiversity monitoring would be focussed on assessing the biotic integrity of aquatic ecosystems within the mining area. It is envisaged that the existing biomonitoring programme could, with minor changes, be adapted to also address the objectives of aquatic biodiversity monitoring.

8.5 Integrated alien plant control program

According to the Conservation of Agricultural Resources Act (Act No. 43 of 1983), the landowner must effectively control all declared alien weeds. The mine developoped an in-house alien plant control program. This integrated control program should consider all appropriate chemical, mechanical, biological and cultural methods for the control of these species. The local community could be involved in such a program as job creation and poverty relief in the area. This would contribute to environmental education and the use of aliens/weeds above indigenous vegetation for fuel and building can be promoted. This programme could also be linked to the national "Work for Water" and "Working for Wetlands" programmes, especially for the drainage areas.

8.6 Alien fauna control programme

At least three ***alien fish species***, namely the Common carp, Mosquitofish and Largemouth bass are expected to be present within the study area. The bottom feeding habit of the Common carp increases water turbidity and leads to the destruction of indigenous biota's feeding and breeding habitat. The Largemouth bass utilizes indigenous fish and invertebrates as food and could lead to the eradication of certain species in this system. It also competes with indigenous biota for food and habitat. Mosquitofish prey on the eggs and the young of the naturally occurring fish populations. Make sure that the public, and especially anglers, are aware of potential impact of introduction of exotic species through signboards and distribution of information. No future stocking of these species should be allowed in the study area. As both Common carp and Largemouth bass have a very high social importance as anglers favour them, any attempts to remove these species from these systems will be met with opposition. Recreational and subsistence anglers should however be encouraged to remove these fish species (no catch-and-release) when caught, in an attempt to put pressure on their populations, thereby helping to control their numbers and limiting their impact on the indigenous biota. Recreational anglers should furthermore be encouraged to apply catch-and-release principles for indigenous species (especially the Red Data listed Largemouth yellowfish).

The ***Common Myna*** is listed as one of the Top 100 World's Worst Invaders by the Invasive Species Specialist Group. The species is known to impact negatively upon indigenous fauna by competing with native avifauna and small cavity nesting mammals for nest-hollows and by breaking eggs and eating nestlings. If this species is observed within the mining area (especially infrastructure) biodiversity management could include controlling their numbers by eradication, habitat modification, resource limitation and public education. Appropriate control measures for the Common Myna should be developed in consultation with the local nature conservation agency and should form part of the mine's biodiversity management plan.

8.7 Design and implement a wild fire management plan

A crucial component of the 'veld management plan' would be the recommendation of an appropriate 'burning plan'. In the Grassland Biome of Africa, fire is a natural environmental phenomenon that does not normally produce serious residual effects.

Fire is in fact a natural and beneficial disturbance of the vegetation structure (including species composition), it is essential in nutrient recycling and distribution and, at correct intervals, assists in maintaining high levels of biodiversity (Goldammer & de Ronde, 2004). Recommendation of appropriate burning intervals is an extremely complex subject that is part science and part art. Appropriate burning intervals for areas that are managed for high biodiversity, are those that mimic the 'natural' fire regimes of the area. In order to recommend appropriate intervals between prescribed fires various factors, especially veld condition and fuel load of both fine fuels (grass) and woody fuels, have to be assessed. Prescribed burning is usually recommended if a assessment of range condition indicates that the grass sward is not in a pioneer condition dominated by Increaser II grass species and the grass fuel load is $>$ 4000kg/ha. In the case of the mine property beneficial burning would normally be conducted late in the dry season in the form of a 'low intensity fire'. Precise timing of the burn must be determined on the basis of atmospheric conditions such as humidity and wind speed and direction. Fire cycles should be varied within the mine surface rights area, as uniform annual burning will be detrimental to maintenance and encouragement of high biodiversity.

8.8 Promote sustainable use of natural resources

Develop a programme to promote the sustainable utilization of natural resources to benefit the local community. The needs of the local population should be determined in order to evaluate the potential impact they may have on the natural resource base. This may take the form of a social study, which could provide an opportunity to pre-empt social impacts. It will also enable the equitable utilization of natural resources under the control of the mine, without necessarily having any negative impact on the conservation of biodiversity. The following aspects could be addressed:

Thatch: Collect from already disturbed/previously cultivated lands, limit removal from high and moderate biodiversity areas.
Wood (fire/building material)*:* Collect from already disturbed/previously cultivated lands, limit within high diversity areas. Promote use of alien species above indigenous vegetation.
Health/Spiritual/recreational requirements: Allow for sustainable collection of plants and animals with medicinal/spiritual value (create list of required species used by local community, sangomas, etc.). There is a marked absence of medicinally important species or a low frequency of occurrence of those that are present in the mine lease area, indicating that they have probably been removed. Also determine required areas for spiritual activities (water/rivers for baptism, etc.) Use high conservation areas for recreation (game walks/bird watching/fishing), and dams/rivers for angling (catch-and-release). If fish are consumed it is imperative that human health risk assessments be conducted to determine the potential risk associated with the consumption of the fish (especially from pollution control dams).
Grazing: A 'veld management plan' should be implemented for all parts of the study area that are not subjected to opencast mining activities. Grazing is an essential environmental factor in maintaining veld condition and floristic diversity. Overgrazing can however be detrimental to the vegetation, and the mine should therefore establish the carrying capacity of the untransformed areas of the mine property and ensure that overgrazing is prevented. A study to determine animal carrying capacity and sustainable utilisation levels for grazing should be undertaken. It is important to understand that production potential will differ between different habitats, and that this also depends on the condition of the vegetation. The judicious use of the vegetation for grazing and browsing will not only benefit the local communities, but will also contribute towards improvement of species composition in previously disturbed areas, and maintenance of remaining untransformed vegetation in good condition, if applied correctly.

8.9 Environmental Education Programmes

The mine should engage local assistance of appropriate local government institutions and nongovernmental organisations (NGO's) in developing and implementing an 'Environmental Education Programme' that is tailored to address environmental issues that are of relevance within the study area (mine property). Such an environmental programme should focus on the environmental education of mine staff and school children from surrounding communities that are more reliant on local natural resources such as fuel wood and medicinal plants. Environmental aspects that should form the focus of such an environmental education programme include:

- Management of waste and control of water pollution (particularly with regards to the Jagspruit and Schoonspruit).
- Utilization of alien species rather than indigenous trees as a source of fuel wood and construction timber.
- Sustainable harvesting of medicinal plants.
- Damaging effects of human induced fires, especially burning during the growing season.
- Impacts on wild animals as a result of persecution, hunting (especially with dogs and snares), over-fishing, road kills and collection of wild animals as pets.
- Responsibility to protect threatened plants and animals.

8.10 Capacity building

It is further recommended that capacity building with respect to understanding biodiversity in the study area should take place. Consultants that study the natural ecosystems learn to understand them, although it is the mine personnel that have to manage it. It is therefore recommended that mining staff should 'take ownership' of any implemented biodiversity monitoring and management program. It is also recommended that the relevant mine personnel responsible for biodiversity management, should have access to outside specialist input on an ongoing basis.

9. CONCLUSIONS & RECOMMENDATIONS

The following primary conclusions were drawn from this study:

- The 2013 updated plant species list for Vaal River now includes 597 plant species and infraspecific taxa, of which 74 (15.2%) are naturalised alien species.
- Of the 516 indigenous plant taxa, seven are currently categorised as 'species of conservation concern'. The presence of one threatened and four Near Threatened plant species have been confirmed within the Vaal River study area (*Nerine gracilis, Lithops lesliei* subsp. *lesliei, Pearsonia bracteata* and *Trachyandra erythrorrhiza*). Detailed management measures have been recommended for especially the two near-threatened plant species recorded, that should be strongly considered for implementation.
- Of the 81 alien plant species thus far recorded within the study area, thirty-eight are Declared Weeds, Declared Invaders and proposed Declared Weeds or Invaders in accordance to the 'Conservation of Agricultural Resources Act' (Act 43 of the Republic of South Africa 1983), as amended in 2001. It is strongly recommended that the alien plant control programme should be implemented and maintained.
- A total of 22 monitoring sites were established during the current baseline monitoring survey. It is strongly recommended that the vegetation monitoring

programme for these sites be maintained over the long term to enable the determination of deterioration or improvement in veld condition.

- A detailed riparian vegetation assessment indicated that the Schoonspruit can be classified in an ecological category D and has a low ecological importance and ecological sensitivity. The Vaal river falls in an ecological category C with a low ecological importance and a low to moderate ecological sensitivity.
- Based on distribution ranges and available habitats within the study area, it was estimated that 389 terrestrial animal species, including 12 frog species, 34 reptile species, 267 bird species and 76 mammal species could be expected to occur here.
- Seven of the 12 expected amphibian species were observed in the study area during the biodiversity surveys (2007 and 2013). The presence of one near-threatened frog species (Giant Bullfrog *Pyxicephalus adspersus)* has also been confirmed in the study area.
- Fourteen of an expected 34 reptile species were recorded in the study area during the faunal surveys conducted between 2007 and 2013.
- Hundred and sixty-two of an expected 267 bird species have been recorded in the study area between 2007 and 2013. None of these 9 threatened species were observed during the current study.
- Fifteen of the 67 expected mammal species were observed during the surveys. None of the ten red data listed animal species were observed during the current study.
- The presence of nine of an expected twelve indigenous fish species have been confirmed in the study area. The presence of two alien fish species was also confirmed.

This study indicated that in the Vaal River surface rights area, there are three BMU's with very-high biodiversity conservation value (BMU1: Vaal River ecosystem) and BMU6: Rocky grassland and sparse woodlands and BMU7: Sandy grassland). Another two BMU's have high biodiversity conservation value (BMU2: Jagspruit ecosystem and BMU5: *Acacia caffra-Euclea crispa* thicket) while three more has moderate to moderate high importance. Biodiversity management of the Vaal River surface rights area should be focussed on these BMU's (Table 15). Current activities should be managed and future mining activities planned to impact as little as possible on these BMU's. Various human activities were identified to potentially pose a risk to the biodiversity aspects of each BMU in the study area. It is strongly recommended that the management actions as stated in the report should be considered for implementation in the study area.

Economic and social development and environmental protection are the essential elements of sustainable development. The nexus between economic development and the conservation of natural resources has been a subject of continued debate. Reconciling economic and social development opportunities with the need for biodiversity conservation and environmental protection requires the development of more strategic and integrated approaches to land use planning and management in order to assist in making informed decisions.

South Africa is rightly very proud of its rich biodiversity. However, the countries biodiversity is under threat from climate change, pollution, the excessive use of resources and invasive plant and animal species. Developers are now under pressure to reduce and report on its impacts on biodiversity. Many of these developers have the opportunity to contribute to biodiversity conservation and management through gaining a better understanding of the ecosystems on their sites, and often through small changes to the way land is managed. AngloGold

Ashanti's Vaal River operations is fortunate to be in control of an area that is richly endowed with exciting plant and animal species that needs protection.

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