

Report on the biodiversity and ecological assessment of the proposed construction of the Reyneke Avenue dual carriageway in Bloemfontein, Free State Province.

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DECLARATION OF INDEPENDENCE

DPR Ecologists and Environmental Services is an independent company and has no financial, personal or other interest in the proposed project, apart from fair remuneration for work performed in the delivery of ecological services. There are no circumstances that compromise the objectivity of the study.

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Executive Summary

The site proposed for the road development has been rated as being acceptable for development. This is mostly as a result of the degraded condition of the site but is also subject to the implementation of adequate mitigation such as the exclusion of the wetland area from the development.

According to Mucina & Rutherford (2006) the area consists of Winburg Grassy Shrubland (Gh 7) (Map 2). This vegetation type is currently listed as being of Least Concern (LC) under the National List of Threatened Ecosystems (Notice 1477 of 2009)(National Environmental Management Biodiversity Act, 2004) (Map 2). It is not currently subjected to pronounced development pressures and has a wide area of distribution. The north eastern section is listed as an Ecological Support Area 2 whilst the south western section is listed as Degraded under the Free State Province Biodiversity Area it still functions in ecological support of watercourses.

Impacts in the area are numerous and of high magnitude, causing considerable degradation and transformation of the natural vegetation. The area has a long history of human activities. Consequently the area has been affected by numerous impacts causing a steady degradation of the natural vegetation over time. Significant rubbish dumping and dumping of building rubble has also occurred and also result in degrading the natural environment. The north eastern portion is situated between residential developments and the military compound which causes transformation of its natural functioning (Map 1). This isolates the area and alters the natural runoff patterns and coupled with the edge-effect causes significant transformation of the natural vegetation. These are the most significant impacts with numerous other smaller miscellaneous impacts also taking place. From the above it should be clear that the site is being affected by a variety of large impacts causing extensive degradation of the natural vegetation.

The Bloemspruit originates in the eastern portion of the area and flows from north east to south west (Map 1). The wetland area associated with the stream has been modified to a significant degree and is in a degraded condition. This is due to the land uses as discussed above but also due to an increase in the storm water runoff generated by the paved surfaces at its origin and crossing by dirt roads with inadequate drainage which leads to ponding. Despite this degraded condition of the Bloemspruit it still provides several important functions. These wetland areas act like a sponge whereby it is able to hold a high volume of water which is discharged slowly. This provides a bio-remediation function whereby polluted water is being held for a longer period which allows for purification and aids in flood attenuation. The downstream portions of the Bloemspruit is highly transformed with large sections having been canalised. This wetland area at its origin will therefore alleviate these impacts in the downstream section. From the above it should be clear that although the stream is considered to be degraded and modified to a significant degree it still provides several important functions and is therefore considered to be highly sensitive. These wetland areas should therefore be excluded from the proposed road layout as far as possible. These wetland areas should therefore be excluded from the proposed road layout. The proposed road will not require crossing of the wetland area but will occur in close proximity to it (Map 1). Transecting the wetland should be avoided as far as possible. Even though the wetland area will not be transected by the road it will still be necessary to apply for the relevant water uses with the Department of Water and Sanitation (DWS).

A few specimens of the protected geophyte, *Brunsvigia radulosa* were identified (Appendix C). Although widespread they are still of some conservation value and where they will be affected by the road construction it is recommended that the necessary permits be obtained to transplant them to adjacent areas where they will remain unaffected.

The impact significance has been determined and mostly as a result of the degraded condition of the area the impacts before mitigation will be mostly moderate with the exception of the loss of a portion of the wetland area which is considered a moderate-high impact. Through adequate mitigation as discussed, including the exclusion of the wetland area from the road layout, all impacts can be significantly decreased to low-moderate.

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Ecological and biodiversity assessment.

1. INTRODUCTION

1.1 Background

Natural vegetation is an important component of ecosystems. Some of the vegetation units in a region can be more sensitive than others, usually as a result of a variety of environmental factors and species composition. These units are often associated with water bodies, water transferring bodies or moisture sinks. These systems are always connected to each other through a complex pattern. Degradation of a link in this larger system, e.g. tributary, pan, wetland, usually leads to the degradation of the larger system. Therefore, degradation of such a water related system should be prevented.

Though vegetation may seem to be uniform and low in diversity it may still contain species that are rare and endangered. The occurrence of such a species may render the development unviable. Should such a species be encountered the development should be moved to another location or cease altogether.

South Africa has a large amount of endemic species and in terms of plant diversity ranks third in the world. This has the result that many of the species are rare, highly localised and consequently endangered. It is our duty to protect our diverse natural resources.

In recent times the state of South Africa's roads has become a priority. It is imperative to construct new roadways and maintain and upgrade existing roads. However, this should take into account sensitive areas. These sensitive areas such as areas where the road crosses streams, wetlands, rivers or ridges should be identified and the necessary precautions taken to mitigate the impact that road construction would have on these areas.

The proposed dual carriageway will be constructed from Lucas Steyn Road in the Heuwelsig suburb from where it will follow an existing small tar road and will connect to a proposed new development at Nelson Mandela Drive (Map 1). The approximate length of the new road to be constructed is 2.5 km. A large section, approximately 1.5 km is situated in a transformed and degraded area adjacent to an existing road and the lower section, approximately 1 km, is situated in natural vegetation, although also significantly degraded.

A site visit was conducted on 16 October 2017. The entire footprint of the proposed road was surveyed over the period of one day. The site survey was conducted during late spring and although sufficient rainfall did not yet occur at this time the vegetation present was considered sufficient to provide a good representation.

For the above reasons it is necessary to conduct a biodiversity and ecological assessment of an area proposed for development.

The report together with its recommendations and mitigation measures should be used to minimise the impact of the proposed development.

1.2 The value of biodiversity

The diversity of life forms and their interaction with each other and the environment has made Earth a uniquely habitable place for humans. Biodiversity sustains human livelihoods and life itself. Although our dependence on biodiversity has become less tangible and apparent, it remains critically important.

The balancing of atmospheric gases through photosynthesis and carbon sequestration is reliant on biodiversity, while an estimated 40% of the global economy is based on biological products and processes.

Biodiversity is the basis of innumerable environmental services that keep us and the natural environment alive. These services range from the provision of clean water and watershed services to the recycling of nutrients and pollution. These ecosystem services include:

- Soil formation and maintenance of soil fertility.
- Primary production through photosynthesis as the supportive foundation for all life.
- Provision of food, fuel and fibre.
- Provision of shelter and building materials.
- Regulation of water flows and the maintenance of water quality.
- Regulation and purification of atmospheric gases.
- Moderation of climate and weather.
- Detoxification and decomposition of wastes.
- Pollination of plants, including many crops.
- Control of pests and diseases.
- Maintenance of genetic resources.

2. SCOPE AND LIMITATIONS

- To evaluate the present state of the vegetation and ecological functioning of the area proposed for the carriageway.
- To identify possible negative impacts that could be caused by the proposed construction of a dual carriageway.

2.1 Vegetation

Aspects of the vegetation that will be assessed include:

- The vegetation types of the region with their relevance to the proposed site.
- The overall status of the vegetation on site.
- Species composition with the emphasis on dominant-, rare- and endangered species.

The amount of disturbance present on the site assessed according to:

- The amount of grazing impacts.
- Disturbance caused by human impacts.
- Other disturbances.

2.2 Fauna

Aspects of the fauna that will be assessed include:

- A basic survey of the fauna occurring in the region using visual observations of species as well as evidence of their occurrence in the region (burrows, excavations, animal tracks, etc.).
- The overall condition of the habitat.
- A list of species that may occur in the region (desktop study).

2.3 Limitations

Some geophytic or succulent species may have been overlooked due to a specific flowering time or cryptic nature. Several geophytic or annual species may not yet be present due to insufficient rains and could possibly have been overlooked.

Although a comprehensive survey of the site was done it is still likely that several species were overlooked.

Some animal species may not have been observed as a result of their nocturnal and/or shy habits.

3. METHODOLOGY

3.1 Several literature works were used for additional information.

Vegetation:

Red Data List (Raymondo et al. 2009)

Vegetation types (Mucina & Rutherford 2006)

Field guides used for species identification (Bromilow 1995, 2010, Coates-Palgrave 2002, Fish *et al* 2015, Gibbs-Russell *et al* 1990, Manning 2009, Retief & Meyer 2017, Van Oudtshoorn 2004, Van Wyk & Malan 1998, Van Wyk & Van Wyk 1997, Venter & Joubert 1985).

Terrestrial fauna: Field guides for species identification (Smithers 1986a, Child *et al* 2016).

3.2 Survey

The site was assessed by means of transects and sample plots.

Noted species include rare and dominant species.

The broad vegetation types present on the site were determined.

The state of the environment was assessed in terms of condition, grazing impacts, disturbance by humans, erosion and presence of invader and exotic species.

Animal species were also noted as well as the probability of other species occurring on or near the site according to their distribution areas and habitat requirements. The state of the habitat was also assessed.

3.3 Criteria used to assess sites

Several criteria were used to assess the site and determine the overall status of the environment.

Vegetation characteristics

Characteristics of the vegetation in its current state. The diversity of species, sensitivity of habitats and importance of the ecology as a whole.

Habitat diversity and species richness: normally a function of locality, habitat diversity and climatic conditions.

Scoring: Wide variety of species occupying a variety of niches -1, Variety of species occupying a single nich -2, Single species dominance over a large area containing a low diversity of species -3.

Presence of rare and endangered species: The actual occurrence or potential occurrence of rare or endangered species on a proposed site plays a large role on the feasibility of a development. Depending on the status and provincial conservation policy, presence of a Red Data species can potentially be a fatal flaw.

Scoring: Occurrence actual or highly likely – 1, Occurrence possible – 2, Occurrence highly unlikely – 3.

Ecological function: All plant communities play a role in the ecosystem. The ecological importance of all areas though, can vary significantly e.g. wetlands, drainage lines, ecotones, etc.

Scoring: Ecological function critical for greater system -1, Ecological function of medium importance -2, No special ecological function (system will not fail if absent) -3.

Degree of rarity/conservation value:

Scoring: Very rare and/or in pristine condition -1, Fair to good condition and/or relatively rare -2, Not rare, degraded and/or poorly conserved -3.

Vegetation condition

The sites are compared to a benchmark site in a good to excellent condition. Vegetation management practises (e.g. grazing regime, fire, management, etc.) can have a marked impact on the condition of the vegetation.

Percentage ground cover: Ground cover is under normal and natural conditions a function of climate and biophysical characteristics. Under poor grazing management, ground cover is one of the first signs of vegetation degradation.

Scoring: Good to excellent -1, Fair -2, Poor -3.

Vegetation structure: This is the ratio between tree, shrub, sub-shrubs and grass layers. The ratio could be affected by grazing and browsing by animals.

Scoring: All layers still intact and showing specimens of all age classes – 1, Sub-shrubs and/or grass layers highly grazed while tree layer still fairly intact (bush partly opened up) – 2, Mono-layered structure often dominated by a few unpalatable species (presence of barren patches notable) – 3.

Infestation with exotic weeds and invader plants or encroachers:

Scoring: No or very slight infestation levels by weeds and invaders -1, Medium infestation by one or more species -2, Several weed and invader species present and high occurrence of one or more species -3.

Degree of grazing/browsing impact:

Scoring: No or very slight notable signs of browsing and/or grazing -1, Some browse lines evident, shrubs shows signs of browsing, grass layer grazed though still intact -2, Clear browse line on trees, shrubs heavily pruned and grass layer almost absent -3.

Signs of erosion: The formation of erosion scars can often give an indication of the severity and/or duration of vegetation degradation.

Scoring: No or very little signs of soil erosion -1, Small erosion gullies present and/or evidence of slight sheet erosion -2, Gully erosion well developed (medium to large dongas) and/or sheet erosion removed the topsoil over large areas -3.

Faunal characteristics

Presence of rare and endangered species: The actual occurrence or potential occurrence of rare or endangered species on a proposed site plays a large role on the feasibility of a development. Depending on the status and provincial conservation policy, presence of a Red Data species or very unique and sensitive habitats can potentially be a fatal flaw.

Scoring: Occurrence actual or highly likely – 1, Occurrence possible – 2, Occurrence highly unlikely.

3.4 Biodiversity sensitivity rating (BSR)

The total scores for the criteria above were used to determine the biodiversity sensitivity ranking for the sites. On a scale of 0 - 30, six different classes are described to assess the suitability of the sites to be developed. The different classes are described in the table below:

BSR	BSR general floral description	Floral score equating to BSR
		class
Ideal (5)	Vegetation is totally transformed or in a highly degraded state, generally has a low level of species diversity, no species of concern and/or has a high level of invasive plants. The area has lost its inherent ecological function. The area has no conservation value and potential for successful rehabilitation is very low. The site is ideal for the proposed development.	29 – 30
Preferred (4)	Vegetation is in an advanced state of degradation, has a low level of species diversity, no species of concern and/or has a high level of invasive plants. The area's ecological function is seriously hampered, has a very low conservation value and the potential for successful rehabilitation is low. The area is preferred for the proposed development.	26 – 28
Acceptable (3)	Vegetation is notably degraded, has a medium level of species diversity although no species of concern are present. Invasive plants are present but are still controllable. The area's ecological function is still intact but may be hampered by the current levels of degradation. Successful rehabilitation of the area is possible. The conservation value is regarded as low. The area is acceptable for the proposed development.	21 – 25
Not preferred (2)	The area is in a good condition although signs of disturbance are present. Species diversity is high and species of concern may be present. The ecological function is intact and very little rehabilitation is needed. The area is of medium conservation importance. The area is not preferred for the proposed development.	11 – 20
Sensitive (1)	The vegetation is in a pristine or near pristine condition. Very little signs of disturbance other than those needed for successful management are present. The species diversity is very high with several species of concern known to be present. Ecological functioning is intact and the conservation importance is high. The area is regarded as sensitive and not suitable for the proposed development.	0 - 10

Table 1: Biodiversity sensitivity ranking

4. ECOLOGICAL OVERVIEW OF THE SITE

4.1 Overview of ecology and vegetation types

Refer to the list of species encountered on the site in Appendix B.

According to Mucina & Rutherford (2006) the area consists of Winburg Grassy Shrubland (Gh 7) (Map 2). This vegetation type is currently listed as being of Least Concern (LC) under the National List of Threatened Ecosystems (Notice 1477 of 2009)(National Environmental Management Biodiversity Act, 2004) (Map 2). It is not currently subjected to pronounced development pressures and has a wide area of distribution. The north eastern section is listed as an Ecological Support Area 2 whilst the south western section is listed as Degraded under the Free State Province Biodiversity Management Plan (2015) (Map 3). Although it does not fall within a Critical Biodiversity Area it still functions in ecological support of watercourses.

The proposed dual carriageway will be constructed from Lucas Steyn Road in the Heuwelsig suburb from where it will follow an existing small tar road and will connect to a proposed new development at Nelson Mandela Drive (Map 1). The approximate length of the new road to be constructed is 2.5 km. The north eastern section is located between the Tempe military compound to the south and several residential developments and small holdings to the north and consequently the natural habitat has been largely transformed and land use causes significant disturbance of the area. The vegetation along the proposed road is dominated by a grass layer, though it is clear that it has been significantly degraded and exotic species are prominent in many areas. Scattered trees and shrubs also occur and are mostly associated with areas of exposed dolerite or where disturbance is high. Vegetation along the wetland areas associated with the Bloemspruit is dominated by a variety of wetland species including sedges, Bulrush, and hygrophilous grasses and shrubs and trees are also common along the wetland fringes. Due to the degraded condition of the Bloemspruit exotic weeds are also common and dominate in many areas. It is clear that the vegetation along the proposed road consists mostly of natural vegetation but that it is clearly degraded with some portions being transformed to a large degree.

Impacts in the area are numerous and of high magnitude, causing considerable degradation and transformation of the natural vegetation. The area has a long history of human activities dating back to the Anglo-Boer War when it was utilised as concentration camps. Consequently the area has been affected by numerous impacts causing a steady degradation of the natural vegetation over time. A large portion of the south western part of the site is also periodically being used by the military compound for heavy vehicle training which consequently also results in degradation of the vegetation. Numerous dirt tracks and roads also criss-crosses this area. Significant rubbish dumping and dumping of building rubble has also occurred and also result in degrading the natural environment. The north eastern portion is situated between residential developments and the military compound which causes transformation of its natural functioning (Map 1). This isolates the area and alters the natural runoff patterns and coupled with the edgeeffect causes significant transformation of the natural vegetation. These are the most significant impacts with numerous other smaller miscellaneous impacts also taking place. From the above it should be clear that the site is being affected by a variety of large impacts causing extensive degradation of the natural vegetation.

The area forms part of the origin of the Bloemspruit and consequently consists of a basin sloping gradually from the north east toward the south west. The area is therefore dominated

by a sloping plain but without any prominent ridges or hills. Dolerite outcrops do occur but are low, imbedded in the landscape and are not common. The topography has been modified in several areas and include various impacts related to tracks, roads, shallow excavations, rubble dumping and infilling. This leads to a significant level of degradation and alteration of the natural environment. The elevation of the proposed road varies from 1469 m in the north east and decreases to approximately 1439 m in the south west. This clearly illustrates the gradual slope of the site and also explains the dominant runoff pattern and the origins of the Bloemspruit.

As already mentioned, the Bloemspruit originates in the eastern portion of the area and flows from north east to south west (Map 1). The origin of the stream is situated in the military compound and urban developments around the eastern portion of the proposed road and has consequently been transformed. This origin is also not well-defined and only becomes prominent along the western border of the military compound from where it forms an extensive wetland area draining toward the south west. This wetland area associated with the stream has been modified to a significant degree and is in a degraded condition. This is due to the land uses as discussed above but also due to an increase in the storm water runoff generated by the paved surfaces at its origin and crossing by dirt roads with inadequate drainage which leads to ponding. This has a significant influence on the flow and flooding regime of the stream. This also causes a significant exotic weed component within the riparian zone of the stream. Despite this degraded condition of the Bloemspruit it still provides several important functions. These wetland areas act like a sponge whereby it is able to hold a high volume of water which is discharged slowly. This provides a bio-remediation function whereby polluted water is being held for a longer period which allows for purification and aids in flood attenuation. The downstream portions of the Bloemspruit is highly transformed with large sections having been canalised. This wetland area at its origin will therefore alleviate these impacts in the downstream section. From the above it should be clear that although the stream is considered to be degraded and modified to a significant degree it still provides several important functions and is therefore considered to be highly sensitive. These wetland areas should therefore be excluded from the proposed road layout. The proposed road will not require crossing of the wetland area but will occur in close proximity to it (Map 1). Transecting the wetland should be avoided as far as possible. Even though the wetland area will not be transected by the road it will still be necessary to apply for the relevant water uses with the Department of Water and Sanitation (DWS).

The geology of the site is dominated by dolerite but which outcrops only sporadically in some areas. The dolerite covers layers of sandstone and mudstone of sedimentary origin (Adelaide Subgroup of the Beaufort Group). Soils are dominated by stony Mispah and gravel-rich Glenrosa derived from the Jurassic dolerite (Mucina & Rutherford 2006).

The area has a mean average temperature of 16.2°C, with a maximum of 30.9°C in January and temperatures below zero common in winter (-1.6°C in July). Summer rainfall occurs mostly as thunderstorms with an average annual rainfall of 548 mm.

As mentioned previously the vegetation structure is dominated by a grass layer, although it is clear that it has been significantly degraded and exotic species are prominent in many areas. Scattered trees and shrubs also occur and are mostly associated with areas of exposed dolerite or where disturbance is high. The south western and north eastern sections of the proposed road will be discussed separately.

As previously discussed the north eastern portion of the proposed road is situated between the urban area and Tempe Military Base and is consequently transformed and degraded to a large degree (Map 1). A grass layer is still dominant but is dominated in most areas by pioneer species. Grass species include Eragrostis lehmanniana. Aristida congesta. Themeda triandra. Chloris viragata, Melinis repens and Enneapogon cenchroides. Except for T. triandra which is a climax species and considered a remnant of the natural grassland, all of these are pioneer grasses which dominate in degraded areas. This should already indicate a degraded vegetation layer. Several dwarf shrubs are present and is also indicative of a modified grass laver. These include Nolletia ciliaris. Chrysocoma ciliata and Pentzia incana. These species are present in natural areas but where they increase in abundance they are normally an indicator of disturbance. Other herbaceous species common within the grass layer include Wahlenbergia androsaceae, Bulbine frutescens, Osteospermum scariosum and Nidorella resedifolia. The natural vegetation type also contains an open shrub and tree layer and is still present in this area. Tree and shrub species include Ziziphus mucronata, Diospyros lycioides, Vachellia karroo and Buddleja saligna. This is considered a natural component of the vegetation. Due to the degraded condition of the vegetation in this area exotic weeds and invaders are abundant with exotic weeds including Bidens bipinnata, Verbena tenuisecta, Tragopogon dubius, Conyza bonariensis and Sphaeralcea bonariensis. Invasive species include trees such as Eucalyptus camaldulensis, Schinus molle and Melia azedarach, shrubs such as Caesalpinia gilliesii and succulent species such as Agave americana. From the description of the vegetation in this section of the proposed road it is clearly in a degraded condition with significant transformation. The area has a low species diversity without any species of conservation significance having been observed and consequently this section has a relatively low conservation value.

The south western section of the proposed road is situated in an area with a more natural species assemblage although disturbance remains high and the vegetation is also in a degraded condition (Map 1). The vegetation is dominated by a grass layer which includes Eragrostis curvula, Hyparrhenia hirta, Enneapogon cenchroides, Cymbopogon pospischillii, Heteropogon contortus, Setaria sphacelata, Cynodon dactylon, Digitaria eriantha, Aristida congesta, Eragrostis lehmanniana and Themeda triandra. This is a mixture of pioneer and climax species which is considered indicative of a natural grass layer but with significant disturbance. Note also the much higher species diversity which also indicates that this section is somewhat more natural. Several herbaceous species are also prominent with some being considered pioneer species and indicative of disturbance within the grass layer. These herbaceous species include Nidorella resedifolia, Arctotis venusta, Senecio consanguineus, Berkheya macrocephala, Cullen tomentosum, Salvia verbenaca, Gazania krebsiana, Pseudognaphalium luteo-album, Atriplex semibaccata and Osteopsermum scariosum. These clearly indicate a higher species diversity than the previously discussed transformed section but also indicates a decrease in grass cover due to disturbance and the consequent increase in herbaceous species, especially pioneer species. A few dwarf shrubs also occur in the grass layer with a few being pioneer species but mostly representative of the natural condition. These include Asparagus suaveolens, Searsia ciliata, Hertia pallens, Pentzia incana, Lycium horridum, Felicia muricata, Ruschia hamata and Nolletia ciliaris. A few geophytic species are also scattered in the grass layer and include Hypoxis hemerocallidea, Androcymbium longipes, Albuca setosa and Brunsvigia radulosa. Of these the last named is a protected species and therefore of conservation significance (Appendix C). The species transplants easily and it is recommended that permits be obtained to transplant any specimens which will be affected by the proposed road to an adjacent area where they will remain unaffected. Trees and shrubs are largely absent from the grass layer but sporadically present, especially where dolerite outcrops occur or where significant disturbance of the soil surface has occurred. Species present include *Euclea crispa* subsp. *ovata, Diospyros austro-africana, Ziziphus mucronata* and *Vachellia karroo.* The exotic weed and invader element again indicates significant disturbance of the natural vegetation and an overall poor condition. Exotic weeds include *Verbena tenuisecta, Tagetes minuta, Bidens bipinnata, Sphaeralcea bonariensis, Schkuhria pinata, Ciclospermum leptophyllum, Oenothera rosea, Plantago lanceolata* and *Datura stramonium.* Exotic invasives includes trees such as *Eucalyptus camaldulensis, Melia azedarach* and *Gleditsia triacanthos,* shrubs such as *Cestrum laevigatum* and succulents such as *Opuntia ficus-indica* and *O. engelmannii.* The above description clearly indicates a natural vegetation layer but which has been significantly degraded. The species diversity is somewhat higher but cannot be considered as high and elements of conservation significance is largely absent. A single protected geophytic species was identified and although it is widespread is still of some conservation value but can be easily mitigated by transplanting specimens which will be affected by the development. The overall conservation value of this area is still considered as relatively low.

The wetland areas associated with the Bloemspruit contains wetland conditions on a perennial basis and riparian and obligate wetland species are common and cover a large area (Map 1). Exotic species are also common and indicative of significant disturbance. Vegetation within the wetland area is dominated by several wetland species which includes sedges such as Eleocharis dregeana, Pseudoschoenus sp. and Cyperus marginatus, Bulrush, Typha capensis, reeds, Phragmites australis and hygrophilous grasses such as Paspalum distichum. A few scattered trees occur along the fringe of the wetland area and consist mostly of Searsia lancea. As previously discussed the Bloemspruit is significantly degraded in this area and consequently numerous exotic weeds has become established and may dominate in some areas. These include Verbena bonariensis, Plantago lanceolata, Cirsium vulgare, Persicaria lapathifolia. Veronica anagalis-aquatica. Cortaderia selloana. Xanthium strumarium. Datura ferox and Lolium multiflorum. A few exotic trees have also become established consisting of Gleditsia triacanthos and Fraxinus americana. From the description of the vegetation it should be clear that an extensive wetland area is associated with the Bloemspruit but also that it is in a significantly degraded condition. As already indicated, although it is a degraded wetland system it still provides several important functions and should therefore still be regarded as highly sensitive.

In conclusion, from the description of the species composition and vegetation structure it is clear that the proposed road will be situated within natural vegetation but which has been degraded to a significant degree with several areas having been transformed. Consequently the species and habitat diversity is also relatively low. As a result the proposed road is not anticipated to have a large impact in terms of the vegetation and ecology. However, two elements are present which are considered to be of significant conservation value. Firstly, a few specimens of the protected geophyte, *Brunsvigia radulosa* were identified (Appendix C). Although widespread they are still of some conservation value and where they will be affected by the road construction it is recommended that the necessary permits be obtained to transplant them to adjacent areas where they will remain unaffected. Secondly, the road will occur in close proximity to the wetland system associated with the Bloemspruit (Map 1). It is recommended that the road avoid this wetland area and exclude it from construction. Even though the wetland area will not be transected by the road it will still be necessary to apply for the relevant water uses with the Department of Water and Sanitation (DWS).

4.2 Overview of terrestrial fauna (actual & possible)

Several mammals, or tracks and signs of mammals, were observed on the site. However, due to the degraded condition of the site as well as the urban proximity of dwellings it is considered unlikely that any species of concern will occur on the site. The mammal population on the site is also likely to be diminished from the natural condition.

Tracks and signs of small antelope, most likely Steenbok (*Raphicerus campestris*) or Common Duiker (*Sylvicapra grimmea*), occur on the site. Both of these species are widespread and relatively common and are therefore not of high conservation value.

Excavated soil mounds of the Common Molerate (*Cryptomys hottentotus*) is also common on the site. The species is well adapted to urban areas and the proposed development is not anticipated to impact significantly on this species.

The proposed development will transform the majority of the vegetation on the site thus decreasing the available habitat for fauna. The proposed development is a linear road which will require transformation of a limited area and thus decreasing the impact. The condition of the habitat is also degraded which will also further decrease the anticipated impact.

It is considered likely that the site will also contain several other mammal species but these were not observed on the site and it is considered unlikely that a rare or endangered species would occur on the site.

In order to ensure no direct impact on the mammals on the site the hunting, capturing or trapping of mammals on the site should be strictly prohibited during construction.

List of some Red Data terrestrial mammals that could occur in the region:

South African Hedgehog	Atelerix frontalis
Aardwolf	Proteles cristatus
African Wild Cat	Felis lybica
Small-Spotted Cat	Felis nigripes
Bat-Eared Fox	Otocyon megalotis
Striped Weasel	Poecilogale albinucha

It is considered unlikely that any of these species would occur on the site due to the proximity of urban developments.

5. ANTICIPATED IMPACTS

Normally one of the most prominent impacts of development is concerned with the loss of habitat and species diversity. The proposed site still consists of natural vegetation but which has clearly been degraded to a significant extent. This has consequently also significantly decreased the habitat and species diversity. The vegetation type present on the site is not considered to have a high conservation value and according to the Free State Province Biodiversity Management Plan (2015) the area is not considered a Critical Biodiversity Area (Map 2 & 3). Consequently, the loss of habitat and species diversity as a result of the proposed road cannot be considered as high. The proposed site also does not contain a high number of protected or conservation significant species. A single protected geophyte, *Brunsvigia radulosa*, does occur but as long as those specimens which will be affected by the development are transplanted to adjacent areas this impact should also remain relatively low (Appendix C).

The loss of the wetland area associated with the Bloemspruit may potentially have the highest impact. The wetland area is clearly degraded and its functioning modified to a significant degree. Despite this it still performs several important functions including bioremediation of polluted runoff and flood attenuation and alleviates the impacts on the lower sections of the Bloemspruit. It is therefore still regarded as being highly sensitive. The road layout for the preferred layout will exclude the wetland area, although occurring in close proximity. Should the layout include transecting a portion of the wetland the anticipated impact without mitigation is therefore anticipated to be relatively high. As mitigation it is recommended that the wetland area be excluded from the footprint of the proposed road. Should it become apparent that it will not be possible to avoid the wetland area additional studies should be undertaken to determine measures to minimise the resulting impact on the wetland area. This should also include measures such as rehabilitation of the upstream section in order to offset the impact of the road. Whichever alternative is undertaken it will still be necessary to apply for the relevant water uses with the Department of Water and Sanitation (DWS).

As stated previously the site contains a high amount of exotic weeds and invaders (Appendix B). The proposed construction of the road will cause local disturbance which in turn will create conditions susceptible for the establishment of further weeds and invaders. It is therefore important that the eradication of these exotics take place prior to construction and that the monitoring and eradication of exotic species be maintained throughout construction until rehabilitation of the road shoulder and reserve is completed.

Several mammals or tracks and signs of mammals were observed on the site. However, due to the degraded condition of the site as well as the urban proximity of dwellings it is considered unlikely that any species of concern will occur on the site. The mammal population on the site is also likely to be diminished from the natural condition. The proposed development will transform the majority of the vegetation on the site thus decreasing the available habitat for fauna. The proposed development is a linear road which will require transformation of a limited area and thus decreasing the impact. The condition of the habitat is also degraded which will also further decrease the anticipated impact. In order to ensure no direct impact on the mammals on the site the hunting, capturing or trapping of mammals on the site should be strictly prohibited during construction.

The impact significance has been determined and mostly as a result of the degraded condition of the area the impacts before mitigation will be mostly moderate with the exception of the loss

of a portion of the wetland area which is considered a moderate-high impact. Through adequate mitigation as discussed, including the exclusion of the wetland area from the road layout, all impacts can be significantly decreased to low-moderate.

Please refer to Appendix D for the impact methodology.

Impact	Severity	Duration	Extent	Consequence	Probability	Frequency	Likelihood	Significance
	Before Mitigation							
Loss of	3	5	2	3.3	3	2	2.5	8.2
vegetation								
type and								
clearing of								
vegetation								
Loss of	4	5	1	3.3	5	3	4	13.2
protected								
species								
Loss of	5	5	3	4.3	5	4	4.5	19.3
watercourses								
Infestation	3	4	3	3.3	4	3	3.5	11.5
with weeds								
and invaders								
Impact on	2	4	2	2.6	3	3	3	7.8
Terrestrial								
fauna					-			
				After Mitiga	tion			
Loss of	3	5	2	3.3	3	2	2.5	8.2
vegetation								
type and								
clearing of								
vegetation	-				-		-	
Loss of	2	5	1	2.6	2	2	2	5.2
protected								
species								
Loss of	5	5	3	4.3	2	2	2	8.6
watercourses								
Infestation	2	2	1	1.6	2	2	2	3.2
with weeds								
and invaders								
Impact on	2	4	2	2.6	3	3	3	7.8
Terrestrial								
tauna								

Significance of the impact:

6. SITE SPECIFIC RESULTS

Habitat diversity and species richness:

As was previously discussed, although the site mostly consists of natural vegetation it is in a significantly degraded condition with some areas having been transformed from the natural condition. As a result the habitat diversity has been significantly deceased. Under natural conditions it is also not anticipated that this area would have had a significant habitat diversity. As a consequence the species diversity is also not considered high.

Presence of rare and endangered species:

No rare or endangered species could be identified on the site and owing to the degraded condition of the site it is considered unlikely that such species would occur. However, a few specimens of the protected geophyte, *Brunsvigia radulosa* were identified (Appendix C). Although widespread they are still of some conservation value and where they will be affected by the road construction it is recommended that the necessary permits be obtained to transplant them to adjacent areas where they will remain unaffected.

Ecological function:

The site functions in terms of habitat, supports a specific vegetation type and aids in water transportation as part of the water cycle. The functioning as habitat has been impaired to a significant degree, past and present land uses has degraded the available habitat and due to the surroundings the area is isolated from other natural areas. Coupled with this is a significant modification of the natural vegetation type present in the area. As discussed under previous sections, the functioning of the Bloemspruit and wetland areas associated with it has also been modified to a significant degree. However, it still provides several important functions and its ecological functioning should therefore be considered as high.

Degree of rarity/conservation value:

According to Mucina & Rutherford (2006) the area consists of Winburg Grassy Shrubland (Gh 7) (Map 2). This vegetation type is currently listed as being of Least Concern (LC) under the National List of Threatened Ecosystems (Notice 1477 of 2009)(National Environmental Management Biodiversity Act, 2004) (Map 2). It is not currently subjected to pronounced development pressures and has a wide area of distribution. The north eastern section is listed as an Ecological Support Area 2 whilst the south western section is listed as Degraded under the Free State Province Biodiversity Area it still functions in ecological support of watercourses. The conservation value can therefore not be considered as high.

Despite being degraded the wetland areas associated with the Bloemspruit still have a high conservation value (Map 1). This area still provides several important functions and should therefore be excluded from development.

Percentage ground cover:

The percentage vegetation cover in the area has been decreased significantly but is still considered as moderate.

Vegetation structure:

The vegetation structure consists of a grass layer with scattered tree/shrub layer. This is largely natural but has been significantly altered by the presence of a range of exotic weeds and invaders.

Infestation with exotic weeds and invader plants:

Numerous exotic species occur on the site of which several are of concern (Appendix B). It is therefore important that the eradication of these exotics take place prior to construction and that the monitoring and eradication of exotic species be maintained throughout construction until rehabilitation of the road shoulder and reserve is completed.

Degree of grazing/browsing impact:

Grazing by domestic stock is considered moderate.

Signs of erosion:

Erosion is quite extensive in many areas and is a result of the disturbance of the soil surface, modification of the topography and the gradual slope toward the Bloemspruit which promotes erosion.

Terrestrial animals:

Several mammals or tracks and signs of mammals were observed on the site. However, due to the degraded condition of the site as well as the urban proximity of dwellings it is considered unlikely that any species of concern will occur on the site. The mammal population on the site is also likely to be diminished from the natural condition. It is considered likely that the site will also contain several other mammal species but these were not observed on the site and it is considered unlikely that a rare or endangered species would occur on the site.

	Low (3)	Medium (2)	High (1)
Vegetation characteristics			
Habitat diversity & Species richness	3		
Presence of rare and endangered species		2	
Ecological function			1
Uniqueness/conservation value			1
Vegetation condition			
Percentage ground cover		2	
Vegetation structure		2	
Infestation with exotic weeds and invader plants or	3		
encroachers			
Degree of grazing/browsing impact		2	
Signs of erosion	3		
Terrestrial animal characteristics			
Presence of rare and endangered species	3		
Sub total	12	8	2
Total		22	

Table 2: Biodiversity Sensitivity Rating for the proposed road development.

7. BIODIVERSITY SENSITIVITY RATING (BSR) INTERPRETATION

Table 3: Interpretation of Biodiversity Sensitivity Rating.

Site	Score	Site Preference Rating	Value
Road development	22	Acceptable	3

8. DISCUSSION AND CONCLUSION

The site proposed for the road development has been rated as being acceptable for development. This is mostly as a result of the degraded condition of the site but is also subject to the implementation of adequate mitigation such as the exclusion of the wetland area from the development.

According to Mucina & Rutherford (2006) the area consists of Winburg Grassy Shrubland (Gh 7) (Map 2). This vegetation type is currently listed as being of Least Concern (LC) under the National List of Threatened Ecosystems (Notice 1477 of 2009)(National Environmental Management Biodiversity Act, 2004) (Map 2). It is not currently subjected to pronounced development pressures and has a wide area of distribution. The north eastern section is listed as an Ecological Support Area 2 whilst the south western section is listed as Degraded under the Free State Province Biodiversity Area it still functions in ecological support of watercourses.

The proposed dual carriageway will be constructed from Lucas Steyn Road in the Heuwelsig suburb from where it will follow an existing small tar road and will connect to a proposed new development at Nelson Mandela Drive (Map 1). The approximate length of the new road to be constructed is 2.5 km. The vegetation along the proposed road is dominated by a grass layer, though it is clear that it has been significantly degraded and exotic species are prominent in many areas. Scattered trees and shrubs also occur and are mostly associated with areas of exposed dolerite or where disturbance is high.

Impacts in the area are numerous and of high magnitude, causing considerable degradation and transformation of the natural vegetation. The area has a long history of human activities. Consequently the area has been affected by numerous impacts causing a steady degradation of the natural vegetation over time. A large portion of the south western part of the site is also periodically being used by the military compound which also results in degradation of the vegetation. Numerous dirt tracks and roads also criss-crosses this area. Significant rubbish dumping and dumping of building rubble has also occurred and also result in degrading the natural environment. The north eastern portion is situated between residential developments and the military compound which causes transformation of its natural functioning (Map 1). This isolates the area and alters the natural runoff patterns and coupled with the edge-effect causes significant transformation of the natural vegetation. These are the most significant impacts with numerous other smaller miscellaneous impacts also taking place. From the above it should be clear that the site is being affected by a variety of large impacts causing extensive degradation of the natural vegetation.

The Bloemspruit originates in the eastern portion of the area and flows from north east to south west (Map 1). The wetland area associated with the stream has been modified to a significant degree and is in a degraded condition. This is due to the land uses as discussed above but also due to an increase in the storm water runoff generated by the paved surfaces at its origin and crossing by dirt roads with inadequate drainage which leads to ponding. Despite this degraded condition of the Bloemspruit it still provides several important functions. These wetland areas act like a sponge whereby it is able to hold a high volume of water which is discharged slowly. This provides a bio-remediation function whereby polluted water is being held for a longer period which allows for purification and aids in flood attenuation. The downstream portions of the Bloemspruit is highly transformed with large sections having been canalised. This wetland area at its origin will therefore alleviate these impacts in the

downstream section. From the above it should be clear that although the stream is considered to be degraded and modified to a significant degree it still provides several important functions and is therefore considered to be highly sensitive. These wetland areas should therefore be excluded from the proposed road layout as far as possible. These wetland areas should therefore be excluded from the proposed road layout. The proposed road will not require crossing of the wetland area but will occur in close proximity to it (Map 1). Transecting the wetland should be avoided as far as possible. Even though the wetland area will not be transected by the road it will still be necessary to apply for the relevant water uses with the Department of Water and Sanitation (DWS).

A few specimens of the protected geophyte, *Brunsvigia radulosa* were identified (Appendix C). Although widespread they are still of some conservation value and where they will be affected by the road construction it is recommended that the necessary permits be obtained to transplant them to adjacent areas where they will remain unaffected.

As stated previously the site contains a high amount of exotic weeds and invaders (Appendix B). The proposed construction of the road will cause local disturbance which in turn will create conditions susceptible for the establishment of further weeds and invaders. It is therefore important that the eradication of these exotics take place prior to construction and that the monitoring and eradication of exotic species be maintained throughout construction until rehabilitation of the road shoulder and reserve is completed.

The impact significance has been determined and mostly as a result of the degraded condition of the area the impacts before mitigation will be mostly moderate with the exception of the loss of a portion of the wetland area which is considered a moderate-high impact. Through adequate mitigation as discussed, including the exclusion of the wetland area from the road layout, all impacts can be significantly decreased to low-moderate.

9. RECOMMENDATIONS

- Where specimens of the protected geophyte, *Brunsvigia radulosa* will be affected by the road construction it is recommended that the necessary permits be obtained to transplant them to adjacent areas where they will remain unaffected (Appendix C).
- The process of transplanting protected species should be undertaken and overseen by a suitably qualified person. This should be undertaken during the rainy season when deciduous geophytes will be visible.
- The wetland areas associated with the Bloemspruit should be avoided and excluded from the road development (Map 1):
 - All alternatives should be considered for the layout of the road to avoid this area.
 - Should it become apparent that it will not be possible to avoid the wetland area additional studies should be undertaken to determine measures to minimise the resulting impact on the wetland area.
 - Comprehensive monitoring should be implemented to determine any changes to the condition of the wetland area.
 - Where construction takes place within the wetland area it will be susceptible to erosion. Comprehensive rehabilitation and monitoring will therefore be necessary and preventative measures should include the use of gabions or other geotextiles.
 - Even though the wetland area will not be transected by the road it will still be necessary to apply for the relevant water uses with the Department of Water and Sanitation (DWS).
 - Disturbance and sedimentation of the wetland areas should be prevented as far as possible.
 - The road design should include adequate storm water management and drainage structures which should allow for preservation of the current runoff patterns.
- The site contains a high amount of exotic weeds and invaders (Appendix B). It is therefore important that the eradication of these exotics take place prior to construction and that the monitoring and eradication of exotic species be maintained throughout construction until rehabilitation of the road shoulder and reserve is completed.
- In order to ensure no direct impact on the mammals on the site the hunting, capturing or trapping of mammals on the site should be strictly prohibited during construction.
- After construction has ceased all construction materials should be removed from the area.
- Wherever the removal of topsoil is necessary the topsoil should be stockpiled separately and protected against weed infestation and erosion.
- Topsoil should be replaced on top of the soil surface where it has been removed as soon as possible.
- Areas that have become compacted due to construction activities should be ripped.

• After cessation of activities on the site the area should be rehabilitated to acceptable standards.

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Annexure A: Maps and Site photos









Figure 1: View of the north eastern end of the proposed road. A leaking sewer pipeline occurs here and causes seepage areas (red).



Figure 2: Panorama of the north eastern portion of the site situated in an urban area. A grass layer is still present although exotic species are prominent.



Figure 3: Rubbish dumping and high levels of disturbance is common in the north eastern portion of the site.



Figure 4: Another view of the north eastern portion of the site. Note again adjacent developments. A grass layer is present although exotic trees are also common.



Figure 5: View of the origin of the Bloemspruit. Wetland conditions are clearly present here (red).



Figure 6: Panorama of the approximate road alignment (red) in the south western portion. Note the wetland areas associated with the Bloemspruit to the left (blue).



Figure 7: View of the south western portion of the road contains a grass layer with scattered trees although disturbance is significant.



Figure 8: Panorama of the south western portion of the site. Rubble dumping is also common in some areas.



Figure 9: Panorama of the wetland areas associated with the Bloemspruit in the south western portion of the site. The proposed road layout may come into close proximity of the wetland area (red).



Figure 10: Another view of the wetland area which will be situated in close proximity to the proposed road layout.



Figure 11: View of the slope of the low hill illustrating the relatively closed canopy. Note also the high percentage rocky cover.



Figure 12: Observations of fauna on the site. On the left are spoor of a small antelope (Steenbok (*Raphicerus campestris*) or Common Duiker (*Sylvicapra grimmea*)). On the right is a soil mound of the Common Molerat (*Cryptomys hottentotus*).

Appendix B: Species list

Species indicated with an * are exotic. Protected species are coloured orange and Red Listed species red.

Species	Growth form		
*Agave americana	Succulent		
*Bidens bipinnata	Herb		
*Caesalpinia gilliesii	Shrub		
*Cestrum laevigatum	Shrub		
*Ciclospermum leptophyllum	Herb		
*Cirsium vulgare	Herb		
*Conyza bonariensis	Herb		
*Cortaderia selloana	Grass		
*Datura ferox	Herb		
*Datura stramonium	Herb		
*Eucalyptus camaldulensis	Tree		
*Fraxinus americana	Tree		
*Gleditsia triacanthos	Tree		
*Lolium multiflorum	Grass		
*Melia azedarach	Tree		
*Oenothera rosea	Herb		
*Opuntia ficus-indica	Succulent		
*Opuntia engelmannii	Succulent		
*Papaver aculeatum	Herb		
*Persicaria lapathifolia	Herb		
*Plantago lanceolata	Herb		
*Rumex crispus	Herb		
*Schinus molle	Tree		
*Schkuhria pinata	Herb		
*Sphaeralcea bonariensis	Herb		
*Tagetes minuta	Herb		
*Tragopogon dubius	Herb		
*Verbena bonariensis	Herb		
*Verbena tenuisecta	Herb		
*Veronica anagalis-aquatica	Herb		
*Xanthium strumarium	Herb		
Albuca setosa	Geophyte		
Androcymbium longipes	Geophyte		
Arctotis arctotheca	Herb		
Arctotis venusta	Herb		
Aristida congesta	Grass		
Asparagus suaveolens	Dwarf shrub		
Atriplex semibaccatta	Herb		
Berkheya macrocephala	Herb		
Brunsvigia radulosa	Geophyte		
Buddleja saligna	Tree		

Bulbine frutescens	Succulent
Chloris virgata	Grass
Chrysocoma ciliata	Dwarf shrub
Cullen tomentosum	Herb
Cymbopogon pospischillii	Grass
Cynodon dactylon	Grass
Cyperus marginatus	Sedge
Cyperus sp.	Sedge
Digitaria eriantha	Grass
Diospyros austro-africana	Shrub
Diospyros lycioides	Shrub
Eleocharis dregeana	Sedge
Enneapogon cenchroides	Grass
Eragrostis curvula	Grass
Eragrostis lehmanniana	Grass
Euclea crispa subsp. ovata	Shrub
Felicia muricata	Dwarf shrub
Gazania krebsiana	Herb
Gomphocarpus fruticosus	Herb
Hertia pallens	Dwarf shrub
Heteropogon contortus	Grass
Hyparrhenia hirta	Grass
Hypoxis hemerocallidae	Geophyte
Lycium horridum	Dwarf shrub
Melinis repens	Grass
Moraea palida	Geophyte
Nenax microphylla	Dwarf shrub
Nidorella resedifolia	Herb
Nolletia ciliaris	Dwarf shrub
Osteospermum scariosum	Herb
Paspalum distichum	Grass
Pentzia incana	Dwarf shrub
Phragmites australis	Reed
Pseudognaphalium luteo-album	Herb
Pseudoschoenus sp.	Rush
Ruschia hamata	Dwarf shrub
Salvia verbenaca	Herb
Searsia ciliata	Shrub
Searsia lancea	Tree
Senecio consanguineus	Herb
Setaria sphacelata	Grass
Themeda triandra	Grass
Thesium sp.	Hemi-parasite
Typha capensis	Bulrush
Vachellia karroo	Tree
Wahlenbergia androsaceae	Herb

Ziziphus mucronata	Tree

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Appendix C: Protected species on the site

Protected species on the site may not be limited to these species but these species have identified on and around the site. Additional sources should be consulted to confirm the presence of protected species.



Brunsvigia radulosa Kandelaar Lelie/Candelabra Lily

Protected in the Free State Province

National Red List Status: Least Concern

Method: Few scattered specimens mostly in central portion of the site. Should be transplanted to adjacent area where they will remain unaffected. Transplants easily. Will not be visible during winter months.

Appendix D: Impact methodology

The environmental significance assessment methodology is based on the following determination:

Environmental Significance = Overall Consequence x Overall Likelihood

Determination of Consequence

Consequence analysis is a mixture of quantitative and qualitative information and the outcome can be positive or negative. Several factors can be used to determine consequence. For the purpose of determining the environmental significance in terms of consequence, the following factors were chosen: **Severity/Intensity, Duration and Extent/Spatial Scale.** Each factor is assigned a rating of 1 to 5, as described below and in tables 6, 7, 9 and 10.

Determination of Severity

Severity relates to the nature of the event, aspect or impact to the environment and describes how severe the aspects impact on the biophysical and socio-economic environment. Table 7 will be used to obtain an overall rating for severity, taking into consideration the various criteria.

Type of	Type of Rating				
criteria	1	2	3	4	5
Quantitative	0-20%	21-40%	41-60%	61-80%	81-100%
Qualitative	Insignificant / Non-harmful	Small / Potentially harmful	Significant / Harmful	Great / Very harmful	Disastrous Extremely harmful
Social/ Community response	Acceptable / I&AP satisfied	Slightly tolerable / Possible objections	Intolerable/ Sporadic complaints	Unacceptable / Widespread complaints	Totally unacceptable / Possible legal action
Irreversibility	Very low cost to mitigate/ High potential to mitigate impacts to level of insignificance / Easily reversible	Low cost to mitigate	Substantial cost to mitigate / Potential to mitigate impacts / Potential to reverse impact	High cost to mitigate	Prohibitive cost to mitigate / Little or no mechanism to mitigate impact Irreversible
Biophysical (Air quality, water quantity and quality, waste production, fauna and flora)	Insignificant change / deterioration or disturbance	Moderate change / deterioration or disturbance	Significant change / deterioration or disturbance	Very significant change / deterioration or disturbance	Disastrous change / deterioration or disturbance

Table 7: Rating of severity

Determination of Duration

Duration refers to the amount of time that the environment will be affected by the event, risk or impact, if no intervention e.g. remedial action takes place.

Table 8: Rating of Duration

Rating	Description
1: Low	Almost never / almost impossible
2: Low-Medium	Very seldom / highly unlikely
3: Medium	Infrequent / unlikely / seldom
4: Medium-High	Often / regularly / likely / possible
5: High	Daily / highly likely / definitely

Determination of Extent/Spatial Scale

Extent refer to the spatial influence of an impact be local (extending only as far as the activity, or will be limited to the site and its immediate surroundings), regional (will have an impact on the region), national (will have an impact on a national scale) or international (impact across international borders).

Table 9: Rating of Extent / Spatial Scale

Rating	Description
1: Low	Immediate, fully contained area
2: Low-Medium	Surrounding area
3: Medium	Within Business Unit area of responsibility
4: Medium-High	Within Mining Boundary area
5: High	Regional, National, International

Determination of Overall Consequence

Overall consequence is determined by adding the factors determined above and summarised below, and then dividing the sum by 4.

Consequence	Rating
Severity	Example 4
Duration	Example 2
Extent	Example 4
SUBTOTAL	10
TOTAL CONSEQUENCE: (Subtotal divided by 4)	3.3

Table 10: Example of calculating Overall Consequence

Likelihood

The determination of likelihood is a combination of Frequency and Probability. Each factor is assigned a rating of 1 to 5, as described below and in Table 11 and Table 12.

Determination of Frequency

Frequency refers to how often the specific activity, related to the event, aspect or impact, is undertaken.

Rating	Description
1: Low	Once a year or once/more during operation/LOM
2: Low-Medium	Once/more in 6 Months
3: Medium	Once/more a Month
4: Medium-High	Once/more a Week
5: High	Daily

Table 11: Rating of frequency

Determination of Probability

Probability refers to how often the activity/even or aspect has an impact on the environment.

Rating	Description
1: Low	Almost never / almost impossible
2: Low-Medium	Very seldom / highly unlikely
3: Medium	Infrequent / unlikely / seldom
4: Medium-High	Often / regularly / likely / possible
5: High	Daily / highly likely / definitely

Overall Likelihood

Overall likelihood is calculated by adding the factors determined above and summarised below, and then dividing the sum by 2.

Table 13: Example of calculating the overall likelihoo	bc
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Consequence	Rating
Frequency	Example 4
Probability	Example 2
SUBTOTAL	6
TOTAL LIKELIHOOD (Subtotal divided by 2)	3

Determination of Overall Environmental Significance

The multiplication of overall consequence with overall likelihood will provide the environmental significance, which is a number that will then fall into a range of LOW, LOW-MEDIUM, MEDIUM, MEDIUM, MEDIUM-HIGH or HIGH, as shown in the table below.

Table 14: Determination of overall environmental significance

Significance or Risk	Low	Low- Moderate	Moderate	Moderate- High	High
Overall Consequence X Overall Likelihood	1 - 4.9	5 - 9.9	10 - 14.9	15 – 19.9	20 - 25

Qualitative description or magnitude of Environmental Significance

This description is qualitative and is an indication of the nature or magnitude of the Environmental Significance. It also guides the prioritisations and decision making process associated with this event, aspect or impact.

Significance	Low	Low- Moderate	Moderate	Moderate- High	High
Impact Magnitude	Impact is of very low order and therefore likely to have very little real effect. Acceptable.	Impact is of low order and therefore likely to have little real effect. Acceptable.	Impact is real, and potentially substantial in relation to other impacts. Can pose a risk to the company	Impact is real and substantial in relation to other impacts. Pose a risk to the company. Unacceptable	Impact is of the highest order possible. Unacceptable. Fatal flaw.
Action Required	Maintain current management measures. Where possible improve.	Maintain current management measures. Implement monitoring and evaluate to determine potential increase in risk. Where possible improve	Implement monitoring. Investigate mitigation measures and improve management measures to reduce risk, where possible.	Improve management measures to reduce risk.	Implement significant mitigation measures or implement alternatives.

Table 15: Description of the environmental significance and the related action required.