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Ecologists & Environmental Services

Report on the ecological assessment of a proposed development on Plot 21 and 22 in the Rayton Small Holdings, 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

According to Mucina & Rutherford (2006) the area consists of Winburg Grassy Shrubland (Gh 7). 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 any pronounced development pressures and is therefore not normally of high conservation value. The on-site survey has determined that natural vegetation still dominates on the site although several areas of notable disturbance is present. The Free State Province Biodiversity Management Plan (2015) has recently been published and has identified areas which are essential to meeting conservation targets for specific vegetation types, i.e. Critical Biodiversity Areas. The site in question is however listed as being an Ecological Support Area 1 and 2 (Map 3). However, although this is not a Critical Biodiversity Area it still functions in ecological support of surrounding areas. As a result of the above the site is only considered to have a moderate conservation value.

From the survey it is clear that the site does not contain any watercourses or drainage lines (Map 1 & 2). It is also clear that no naturally occurring wetlands are present. However, alterations to the topography in the form of a berm and excavation, causes the accumulation of surface runoff which in turn causes the formation of artificial wetland conditions (Map 1). The artificial impoundments and wetland conditions formed by the artificial berm, excavation and concrete dam is clearly not considered to form part of any surface water systems and are consequently of low conservation value. As a result, should development require the removal of any of these features it will not result in any significant ecological impact. However, comments should still be obtained from the Department of Water and Sanitation (DWS) with regard to the necessity to apply for authorisation to remove these artificial impoundments.

However, the shallow excavation contains a significant juvenile population of the protected Giant Bullfrog (*Pyxicephalus adspersus*) (Map 1). Although it is a relatively widespread and common species and Red Listed as being of Least Concern (LC) it is protected and as such does retain a significant conservation value which will require adequate management and mitigation. The species is listed as Protected under the National Environmental Management: Biodiversity Act, 2004 (Act 10 Of 2004): Publication of Lists of Critically Endangered, Endangered, Vulnerable and Protected Species. As a result, should development require the removal of the shallow excavation the relevant authority should be consulted as to the need to apply for the necessary permits and any Giant Bullfrogs present on the site should be re-located to adjacent areas with suitable habitat. Should the re-location of any specimens be necessary this should be overseen by a qualified ecologist, biologist or herpetologist.

A few protected plant species were observed on the site (Appendix B). Although none of these are considered a threatened or Red Listed species they are still of significant conservation value and their loss would therefore entail a relatively high impact. However, this can be easily mitigated and the resulting impact minimised. The protected species occurring on the site are *Olea europaea* subsp. *africana*, *Brunsvigia radulosa* and *Raphionacme hirsuta*. The Wild Olive Tree (*O. europaea* subsp. *africana*) should be kept intact where possible and where development will affect them the necessary permits should be obtained to remove them. Where specimens were removed this can also be offset by using saplings in the landscaping of the development. Where *B. radulosa* and *R. hirsuta* will be affected by the development the necessary permits must be obtained to transplant them to those areas which will remain undeveloped.

Table of contents

Ecological assessment

Declaration of Independence

Executive Summary

1. Introduction	5
1.1 Background	
1.2 The value of biodiversity	
2. Scope and limitations	7
2.1 Vegetation	
2.2 Fauna	
2.3 Limitations	
3. Methodology	8
3.1 Desktop study	
3.2 Survey	
3.3 Criteria used to assess sites	
3.4 Biodiversity sensitivity rating (BSR)	
4. Ecological overview of the site	11
4.1 Overview of ecology and vegetation types	
4.2 Overview of fauna	
5. Anticipated impacts	16
6. Site specific results	19
7. Biodiversity sensitivity rating (BSR) interpretation	21
8. Discussion and conclusions	22
9. Recommendations	24
10. References	25
Annexure A: Maps and Site photos	27
Annexure B: Species list	36
Annexure C: Impact methodology	38

Ecological 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.

Development around cities and towns are necessary to accommodate an ever-growing population. Areas along the boundaries of cities and towns are usually in a degraded state due to the impact of the large population these areas house. Though this may be the case in most situations there may still be areas that consist of sensitive habitats such as water courses, wetlands or rare vegetation types that need to be conserved. These areas may also contain endangered fauna and flora.

The proposed site will include a tertiary education facility and residences and will be situated in the Rayton Small Holdings along the north western outskirts of Bloemfontein (Map 1). The site is situated adjacent to the Ilanga venue facility and is bordered to the west and south by tarred and gravel roads. Several homesteads also occur around the site. The approximate extent of the site is 8 hectares. Due to the location and surroundings the site consists of natural vegetation but with several areas of notable disturbance. The topography has also been altered in several areas.

A site visit was conducted on 13 March 2019. The entire footprint of the site was surveyed. The site survey was conducted during summer after sufficient rains and the plant identification on the site was considered optimal.

For the above reasons it is necessary to conduct an 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 development.
- To identify possible negative impacts that could be caused by the proposed development.

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.

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 niche – 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:

Table 1: Biodiversity sensitivity ranking

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

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). 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 any pronounced development pressures and is therefore not normally of high conservation value. The on-site survey has determined that natural vegetation still dominates on the site although several areas of notable disturbance is present.

The Free State Province Biodiversity Management Plan (2015) has recently been published and has identified areas which are essential to meeting conservation targets for specific vegetation types, i.e. Critical Biodiversity Areas. The site in question is however listed as being an Ecological Support Area 1 and 2 (Map 3). However, although this is not a Critical Biodiversity Area it still functions in ecological support of surrounding areas.

The proposed site will include a tertiary education facility and residences and will be situated in the Rayton Small Holdings along the north western outskirts of Bloemfontein (Map 1). The site is situated adjacent to the Ilanga venue facility and is bordered to the west and south by tarred and gravel roads. Several homesteads also occur around the site. The approximate extent of the site is 8 hectares. Due to the location and surroundings the site consists of natural vegetation but with several areas of notable disturbance. The topography has also been altered in several areas. The development will largely consist of the development of the northern and southern portions with a large central section excluded from development.

The majority of the site still consists of natural vegetation although it is clear that previous land use coupled with the surrounding small holdings has caused significant disturbance of several areas of the site (Figure 1). The northern portion of the site is affected by a few buildings, sheds, residences, roads and other impacts associated with it including rubble- and rubbish dumping. The central portion of the site also contains a small residence, numerous but scattered specimens of exotic trees and an artificial berm which also causes the accumulation of surface runoff which in turn forms an artificial wetland. Significant rubbish dumping along the berm was also evident. The southern portion also contains numerous impacts including dirt tracks, a small concrete dam and a shallow excavation which also accumulates surface runoff forming artificial wetland conditions. It should be clear that the natural vegetation is being affected by numerous significant impacts. This is also reflected in the presence of abundant exotic weeds as well as a prominent pioneer herb component in the grass layer consisting of *Nidorella resedifolia*.



Figure 1: Aerial view of the proposed site (Google Earth 2019). It is clear that the natural vegetation is affected by several impacts. The northern portion is especially disturbed. The artificial berm (yellow), concrete dam (blue) and shallow excavation (green) is also indicated.

The topography of the site consists of a gradual to moderate slope from the north to the south. The northern portion also exhibits a higher degree of surface dolerite. This is also the main direction of surface runoff, i.e. north to south, although no defined watercourses occur and the site drains by means of diffuse surface runoff without any defined drainage lines. The site has an elevation of 1460m on the north decreasing to 1450m in the south and clearly indicates the slope of the site. The artificial berm and shallow excavation on the site, coupled with the slope, accumulates surface runoff and these have formed artificial wetland conditions (Map 1 & 2).

From the survey it is clear that the site does not contain any watercourses or drainage lines. It is also clear that no naturally occurring wetlands are present. However, as previously mentioned, alterations to the topography, i.e. berm and excavation, causes the accumulation of surface runoff which in turn causes the formation of artificial wetland conditions (Map 1 & 2).

A low artificial berm has been erected centrally on the site and along the eastern border (Map 1). This berm is situated diagonally to the direction of surface runoff and therefore captures a low volume of this runoff which forms a small artificial impoundment along the berm. This causes saturated soil conditions which in turn causes the formation of a small area of artificial wetland conditions. This is confirmed by the presence of a few obligate wetland species including *Schoenoplectus sp.*, *Paspalum distichum* and *Alternanthera sessilis*. These wetland conditions are however clearly artificial and do not form part of any surface water system such as a watercourse or drainage line. It is also not fed by a defined watercourse but rather diffuse surface runoff. As a result of the above, the artificial wetland area formed by the berm is considered of low conservation value.

A small, shallow excavation occurs along the southern border of the site and due to the modified topography it also accumulates runoff forming a small artificial impoundment (Map 1). As with the berm this again causes the formation of artificial wetland conditions. This is also confirmed by the presence of several obligate wetland species which include *Schoenoplectus sp.*, *Alternanthera sessilis*, *Eleocharis sp.*, *Paspalum distichum* and *Marsilea sp.* Here the

wetland conditions are again completely artificial, are not being fed by any defined watercourse and do not form part of any surface water system. This shallow excavation forming artificial wetland conditions are therefore again not considered to have a significant conservation value. However, the artificial habitat formed does provide suitable habitat for the protected Giant Bullfrog (*Pyxicephalus adspersus*). The excavation contains a significant population of juveniles which although not a threatened species does retain a significant conservation value as a protected species. The species is listed as Protected under the National Environmental Management: Biodiversity Act, 2004 (Act 10 Of 2004): Publication of Lists of Critically Endangered, Endangered, Vulnerable and Protected Species. This species will therefore require adequate management but will be discussed under the following sections.

The small concrete dam adjacent to the shallow excavation is also completely artificial, no longer contains any water, does not form wetland conditions and is consequently not of any significant conservation value (Map 1).

From the above description of the artificial impoundments and wetland conditions formed by the artificial berm, excavation and concrete dam it is clear that they are not considered to form part of any surface water systems and are consequently of low conservation value (Map 1). As a result, should development require the removal of any of these features it will not result in any significant ecological impact. However, comments should still be obtained from the Department of Water and Sanitation (DWS) with regard to the necessity to apply for authorisation to remove these artificial impoundments. Furthermore, the shallow excavation contains a significant juvenile population of the protected Giant Bullfrog (*Pyxicephalus adspersus*). Although it is a relatively widespread and common species and Red Listed as being of Least Concern (LC) it is protected and as such does retain a significant conservation value which will require adequate management and mitigation.

The geology of the site is dominated by dolerite which outcrops sporadically over the site but especially the northern portion of the site. The dolerite covers layers of sandstone and mudstone of sedimentary origin (Adelaide Subgroup of the Beaufort Group).

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, the site is still dominated by natural vegetation but which has been affected by significant impacts and disturbances in several areas. The grass layer is dominated by *Cymbopogon pospischillii*, *Eragrostis superba*, *E. curvula*, *Aristida diffusa*, *Tragus koelerioides*, *Themeda triandra*, *Sporobolus fimbriatus*, *Triraphis andropogonoides* and *Heteropogon contortus*. This represents a natural species assemblage and indicates the grass layer on the site being largely natural. However, where disturbance is evident, several pioneer grass species dominate and include *Aristida congesta*, *Melinis repens*, *Cynodon dactylon* and *Enneapogon cenchroides*. This clearly indicates a natural grass layer but with a significant level of disturbance. A natural component of this vegetation type is the presence of a shrub/tree component, especially where rocky outcrops occur. This component is also present on the site and includes *Searsia ciliata*, *Diospyros austro-africana*, *Asparagus larcinus*, *Euclea crispa* subsp. *ovata*, *Searsia lancea*, *S. burchellii* and *Olea europaea* subsp. *africana*. The last named is also a listed protected species. The species is widespread and common and not of high conservation value. However, it is still protected and should be kept intact where possible and where development will affect them the necessary permits should be obtained to remove them.

Where specimens were removed this can also be offset by using saplings in the landscaping of the development. Dwarf karroid shrubs are abundant and are considered a natural component of this vegetation type. These species include *Nolletia ciliaris*, *Pentzia globosa*, *Ruschia hamata*, *Nenax microphylla*, *Hilliardiella oligocephala*, *Euryops multifidus*, *E. empetrifolius*, *Wahlenbergia nodosa* and *Felicia muricata*. A multitude of herbaceous species are also present but occur scattered within the grass layer (Appendix B). However, a note should be made of the abundance of *Nidorella resedifolia*. This is a pioneer herb and is indicative of disturbance where it is abundant, as is the case on the site. Geophytic species are also relatively common and include *Trachyandra saltii*, *Hypoxis rigidula*, *Drimia elata*, *Dipcadi viride*, *Dipcadi sp.*, *Brunsvigia radulosa* and *Raphionacme hirsuta*. The last two, *B. radulosa* and *R. hirsuta*, are also listed as protected species and although they are relatively widespread, are of significant conservation value. Where specimens will be affected by the development the necessary permits must be obtained to transplant them to those areas which will remain undeveloped. As already discussed the site has been affected by several significant impacts which causes degradation of the natural vegetation. As a result, numerous exotic weeds and invasive species occur on the site and these include *Echinopsis schickendantzii*, *Opuntia ficus-indica*, *O. engelmannii*, *Tagetes minuta*, *Schkuhria pinata*, *Eucalyptus camaldulensis*, *Pinus pinaster*, *Fraxinus americana*, *Verbena bonariensis*, *V. tenuisecta* and *Agave americana*. Several of these are also known to be problematic weeds and invasives.

From the description of the vegetation on the site it is clearly still natural but has been affected by several impacts which cause significant degradation of the vegetation. A few components of conservation value do however remain and are mostly associated with protected species on the site.

In conclusion, the site is considered as mostly natural but with some significant disturbance of the natural vegetation. The vegetation type on the site, Winburg Grassy Shrubland (Gh 7), is currently listed as being of Least Concern (LC) which does not contribute to the conservation value (Map 2). This is also reflected by the Free State Biodiversity Management Plan which does not consider the site to be a Critical Biodiversity Area. The site is however listed as being an Ecological Support Area 1 and 2 and although this is not a Critical Biodiversity Area it still functions in ecological support of surrounding areas (Map 3). Although the site is not considered to be of high conservation value in terms of the vegetation type a few protected species do still occur in significant numbers and are considered to be of significant conservation value (Appendix B). These are *Olea europaea* subsp. *africana*, *Brunsvigia radulosa* and *Raphionacme hirsuta*. The Wild Olive Tree (*O. europaea* subsp. *africana*) should be kept intact where possible and where development will affect them the necessary permits should be obtained to remove them. Where specimens were removed this can also be offset by using saplings in the landscaping of the development. Where *B. radulosa* and *R. hirsuta* will be affected by the development the necessary permits must be obtained to transplant them to those areas which will remain undeveloped. As discussed, the the artificial impoundments and wetland conditions formed by the artificial berm, excavation and concrete dam it is clear that they are not considered to form part of any surface water systems and are consequently of low conservation value (Map 1). As a result, should development require the removal of any of these features it will not result in any significant ecological impact. However, the shallow excavation contains a significant juvenile population of the protected Giant Bullfrog (*Pyxicephalus adspersus*) (Map 1). Although it is a relatively widespread and common species and Red Listed as being of Least Concern (LC) it is protected and as such does retain a significant conservation value which will require adequate management and mitigation. This will be discussed in the following sections.

4.2 Overview of terrestrial fauna (actual & possible)

Signs and tracks of mammals are still present on the site and despite the impacts, disturbances and proximity of dwellings a significant mammal population is still present on the site. This is also most likely due to the site still consisting of natural vegetation and being located in a peri-urban environment which still provides adequate habitat for mammals. For the same reasons it is however also considered unlikely that threatened or Red Listed species would occur here. It is also likely that some mammal species may have been overlooked during the survey.

A pair of Steenbok (*Raphicerus campestris*) were observed on the site. Although this species is widespread and common their presence does indicate that the site is still able to sustain a significant population of mammals.

As previously discussed, the artificial wetlands occurring on the site are not considered to form part of any surface water systems and are consequently of low conservation value (Map 1). As a result, should development require the removal of any of these features it will not result in any significant ecological impact. However, the shallow excavation contains a significant juvenile population of the protected Giant Bullfrog (*Pyxicephalus adspersus*). Although it is a relatively widespread and common species and Red Listed as being of Least Concern (LC) it is protected and as such does retain a significant conservation value which will require adequate management and mitigation. The species is listed as Protected under the National Environmental Management: Biodiversity Act, 2004 (Act 10 Of 2004): Publication of Lists of Critically Endangered, Endangered, Vulnerable and Protected Species. As a result, should development require the removal of the shallow excavation the relevant authority should be consulted as to the need to apply for the necessary permits and any Giant Bullfrogs present on the site should be re-located to adjacent areas with suitable habitat. Should the re-location of any specimens be necessary this should be overseen by a qualified ecologist, biologist or herpetologist.

The impact that the proposed development will have is mainly concerned with the loss of habitat which will decrease the available habitat for faunal species. The faunal population will vacate the site into adjacent natural areas which will put a strain on surrounding populations. However, a portion of the site will remain undeveloped which will create a refuge for the remaining fauna and will significantly reduce the 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 the construction phase.

List of some Red Data terrestrial mammals that could occur in the region (Child *et al* 2016):

South African Hedgehog	<i>Atelerix frontalis</i>
Striped Weasel	<i>Poecilogale albinucha</i>
Small-Spotted Cat	<i>Felis nigripes</i>

It is considered unlikely that these species would occur on the site due to the degraded condition of the site and proximity of dwellings. However, the South African Hedgehog is known to occur in per-urban areas and is still likely to occur in this area.

5. ANTICIPATED IMPACTS

Anticipated impacts that the development will have is primarily concerned with the loss of habitat and species diversity.

As previously discussed, the site still consists of natural vegetation but which has been affected by several impacts and consequently degraded to some extent. As a result of the above the species diversity is still considered moderate. The vegetation type on the site, Winburg Grassy Shrubland (Gh 7), is currently listed as being of Least Concern (LC) which does not contribute to the conservation value (Map 2). This is also reflected by the Free State Biodiversity Management Plan which does not consider the site to be a Critical Biodiversity Area. The site is however listed as being an Ecological Support Area 1 and 2 and although this is not a Critical Biodiversity Area it still functions in ecological support of surrounding areas (Map 3). As a result, the loss of the vegetation and species diversity is only considered as moderate. A few aspects of significant conservation value does occur and will be discussed under the following impacts.

A few protected plant species were observed on the site (Appendix B). Although none of these are considered a threatened or Red Listed species, they are still of significant conservation value and their loss would therefore entail a relatively high impact. However, this can be easily mitigated and the resulting impact minimised. The protected species occurring on the site are *Olea europaea* subsp. *africana*, *Brunsvigia radulosa* and *Raphionacme hirsuta*. The Wild Olive Tree (*O. europaea* subsp. *africana*) should be kept intact where possible and where development will affect them the necessary permits should be obtained to remove them. Where specimens were removed this can also be offset by using saplings in the landscaping of the development. Where *B. radulosa* and *R. hirsuta* will be affected by the development the necessary permits must be obtained to transplant them to those areas which will remain undeveloped.

As discussed, the the artificial impoundments and wetland conditions formed by the artificial berm, excavation and concrete dam it is clear that they are not considered to form part of any surface water systems and are consequently of low conservation value (Map 1). As a result, should development require the removal of any of these features it will not result in any significant ecological impact. However, the shallow excavation contains a significant juvenile population of the protected Giant Bullfrog (*Pyxicephalus adspersus*). Although it is a relatively widespread and common species and Red Listed as being of Least Concern (LC) it is protected and as such does retain a significant conservation value which will require adequate management and mitigation. This will be discussed under the impact on fauna.

As was observed the site contains numerous exotic weeds with a few being considered problematic weeds and invasives (Appendix B). The proposed development may will also increase disturbance and therefore increase the susceptibility for the establishment of weeds. Monitoring of weed establishment and eradication should form a prominent part of management of the development. Where category 1 and 2 weeds occur, they require removal by the property owner according to the Conservation of Agricultural Resources Act, No. 43 of 1983 and National Environmental Management: Biodiversity Act, No. 10 of 2004.

The impact that the proposed development will have is mainly concerned with the loss of habitat which will decrease the available habitat for faunal species. The faunal population will vacate the site into adjacent natural areas which will put a strain on surrounding populations.

However, a portion of the site will remain undeveloped which will create a refuge for the remaining fauna and will significantly reduce the 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 the construction phase.

However, a species of significant conservation value, the protected Giant Bullfrog (*Pyxicephalus adspersus*) is present as a juvenile population in the shallow excavation (Map 1). Although it is a relatively widespread and common species and Red Listed as being of Least Concern (LC) it is protected and as such does retain a significant conservation value which will require adequate management and mitigation. The species is listed as Protected under the National Environmental Management: Biodiversity Act, 2004 (Act 10 Of 2004): Publication of Lists of Critically Endangered, Endangered, Vulnerable and Protected Species. As a result, should development require the removal of the shallow excavation the relevant authority should be consulted as to the need to apply for the necessary permits and any Giant Bullfrogs present on the site should be re-located to adjacent areas with suitable habitat. Should the re-location of any specimens be necessary this should be overseen by a qualified ecologist, biologist or herpetologist. Should the above recommended mitigation be followed the resultant impact is anticipated to remain low-moderate.

The impact significance has been determined and it is clear that the impacts before mitigation will contain significant moderate-high impacts but with adequate mitigation as recommended this can all be reduced to low-moderate impacts.

Please refer to Appendix C for the impact methodology.

Significance of the impact:

Impact	Severity	Duration	Extent	Consequence	Probability	Frequency	Likelihood	Significance
Before Mitigation								
Loss of vegetation type and clearing of vegetation	3	5	2	3.3	4	4	4	13.2
Loss of protected species	5	5	2	4	5	4	4.5	18
Impact on watercourses	2	2	2	2	4	2	3	6
Infestation with weeds and invaders	3	4	2	3	4	3	3.5	10.5
Impact on Terrestrial fauna	5	5	2	4	4	4	4	16
After Mitigation								
Loss of vegetation type and clearing of vegetation	3	5	2	3.3	4	4	4	13.2
Loss of protected species	2	5	1	2.6	2	2	2	5.2
Impact on watercourses	2	2	2	2	4	2	3	6
Infestation with weeds and invaders	2	2	1	1.6	3	2	2.5	4
Impact on Terrestrial fauna	2	5	2	3	2	2	2	6

6. SITE SPECIFIC RESULTS

Habitat diversity and species richness:

The habitat diversity on the site is considered moderate but relatively uniform. This includes rocky outcrops, a gradual slope as well as a grass and shrub/tree layer. As a result the species diversity is also considered as moderate. This is however affected to some degree by impacts on the site.

Presence of rare and endangered species:

A few protected species occur in significant numbers on the site and are considered to be of significant conservation value (Appendix B). None are however threatened or considered rare but are nonetheless still of significant conservation value. These are *Olea europaea* subsp. *africana*, *Brunsvigia radulosa* and *Raphionacme hirsuta*. The Wild Olive Tree (*O. europaea* subsp. *africana*) should be kept intact where possible and where development will affect them the necessary permits should be obtained to remove them. Where specimens were removed this can also be offset by using saplings in the landscaping of the development. Where *B. radulosa* and *R. hirsuta* will be affected by the development the necessary permits must be obtained to transplant them to those areas which will remain undeveloped.

Ecological function:

The ecological function of the site is still intact but also modified to a significant degree. The site functions as habitat for fauna, sustains a specific vegetation type, i.e. Winburg Grassy Shrubland and also forms part of the catchment of surrounding watercourses and wetlands (Map 1 & 2). The natural vegetation and vegetation type is still intact though clearly degraded by a few significant impacts. Consequently, the function as habitat is also degraded to some extent and the faunal population it sustains therefore also modified. Furthermore, the function of the site is not paramount to the continued functioning of the surrounding natural areas as it is already bordered by transformed areas. In other words, development of the site should not impair the functioning of the surrounding area to a large extent. The site does not contain any natural watercourses or wetlands but still functions as part of the catchment of such surrounding systems. However, due to modification of the topography, i.e. berm and shallow excavation, these trap runoff and in so doing alter the natural runoff patterns (Map 1). From the above it is clear that the ecological functioning has been altered significantly and is consequently considered as low.

Degree of rarity/conservation value:

According to Mucina & Rutherford (2006) the area consists of Winburg Grassy Shrubland (Gh 7). 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 any pronounced development pressures and is therefore not normally of high conservation value. The on-site survey has determined that natural vegetation still dominates on the site although several areas of notable disturbance is present. The Free State Province Biodiversity Management Plan (2015) has recently been published and has identified areas which are essential to meeting conservation targets for specific vegetation types, i.e. Critical Biodiversity Areas. The site in question is however listed as being an Ecological Support Area 1 and 2 (Map 3). However, although this is not a Critical Biodiversity Area it still functions in ecological support of surrounding areas. As a result of the above the site is only considered to have a moderate conservation value.

Aspects of significant conservation value are however still present and include protected plant species, *Olea europaea* subsp. *africana*, *Brunsvigia radulosa* and *Raphionacme hirsuta* and protected fauna, Giant Bullfrog (*Pyxicephalus adspersus*).

Percentage ground cover:

The percentage vegetation cover is moderate. Areas where the vegetation has been cleared are present and decrease the natural vegetation cover.

Vegetation structure:

The vegetation structure is still natural to a large degree and consists of a grass layer with prominent shrub/tree and dwarf shrub layers. However, due to the impacts on the site including clearing of vegetation the vegetation structure has been modified to a significant degree. Furthermore, the abundance of exotic weeds and trees also contribute to the vegetation structure modification.

Infestation with exotic weeds and invader plants:

Numerous exotic weeds and invasives are present and may form dense stands in some areas. Some of these are also considered as problematic invaders.

Degree of grazing/browsing impact:

The site is not currently being utilised for grazing by domestic stock. Although pioneer species indicative of overgrazing are abundant, i.e. pioneer grasses and herbaceous *Nidorella resedifolia*, they cannot conclusively be attributed to overgrazing.

Signs of erosion:

Signs of erosion are present as small gullies as well as some sheet erosion but has not yet become extensive.

Terrestrial animals:

Signs and tracks of mammals are still present on the site and despite the impacts, disturbances and proximity of dwellings a significant mammal population is still present on the site. This is also most likely due to the site still consisting of natural vegetation and being located in a peri-urban environment which still provides adequate habitat for mammals. For the same reasons it is however also considered unlikely that threatened or Red Listed species would occur here. It is also likely that some mammal species may have been overlooked during the survey. The shallow excavation on the site contains a significant juvenile population of the protected Giant Bullfrog (*Pyxicephalus adspersus*) (Map 1). Although it is a relatively widespread and common species and Red Listed as being of Least Concern (LC) it is protected and as such does retain a significant conservation value which will require adequate management and mitigation. It is considered unlikely that any Red Listed species would occur on the site due to the degraded condition of the site and proximity of dwellings. However, the South African Hedgehog (*Atelerix frontalis*) is Red Listed as Near Threatened and is known to occur in per-urban areas and is still likely to occur in this area.

Table 2: Biodiversity Sensitivity Rating for the proposed education facility development.

	Low (3)	Medium (2)	High (1)
Vegetation characteristics			
Habitat diversity & Species richness		2	
Presence of rare and endangered species		2	
Ecological function	3		
Uniqueness/conservation value		2	
Vegetation condition			
Percentage ground cover		2	
Vegetation structure		2	
Infestation with exotic weeds and invader plants or encroachers	3		
Degree of grazing/browsing impact			1
Signs of erosion		2	
Terrestrial animal characteristics			
Presence of rare and endangered species		2	
Sub total	6	14	1
Total		21	

7. BIODIVERSITY SENSITIVITY RATING (BSR) INTERPRETATION

Table 3: Interpretation of Biodiversity Sensitivity Rating.

Site	Score	Site Preference Rating	Value
Rayton education facility	21	Acceptable	3

8. DISCUSSION AND CONCLUSION

The proposed development has been rated as being acceptable for the development but is subject to adequate mitigation of protected species occurring on the site.

The proposed site will include a tertiary education facility and residences and will be situated in the Rayton Small Holdings along the north western outskirts of Bloemfontein (Map 1). The site is situated adjacent to the Ilanga venue facility and is bordered to the west and south by tarred and gravel roads. Several homesteads also occur around the site. The approximate extent of the site is 8 hectares. Due to the location and surroundings the site consists of natural vegetation but with several areas of notable disturbance. The topography has also been altered in several areas. The development will largely consist of the development of the northern and southern portions with a large central section excluded from development.

According to Mucina & Rutherford (2006) the area consists of Winburg Grassy Shrubland (Gh 7). 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 any pronounced development pressures and is therefore not normally of high conservation value. The on-site survey has determined that natural vegetation still dominates on the site although several areas of notable disturbance is present. The Free State Province Biodiversity Management Plan (2015) has recently been published and has identified areas which are essential to meeting conservation targets for specific vegetation types, i.e. Critical Biodiversity Areas. The site in question is however listed as being an Ecological Support Area 1 and 2 (Map 3). However, although this is not a Critical Biodiversity Area it still functions in ecological support of surrounding areas. As a result of the above the site is only considered to have a moderate conservation value.

The majority of the site still consists of natural vegetation although it is clear that previous land use coupled with the surrounding small holdings has caused significant disturbance of several areas of the site (Figure 1). The northern portion of the site is affected by a few buildings, sheds, residences, roads and other impacts associated with it including rubble and rubbish dumping. The central portion of the site also contains a small residence, numerous but scattered specimens of exotic trees and an artificial berm which also causes the accumulation of surface runoff which in turn form an artificial wetland. Significant rubbish dumping along the berm was also evident. The southern portion also contains numerous impacts including dirt tracks, a small concrete dam and a shallow excavation which also accumulates surface runoff forming artificial wetland conditions.

From the survey it is clear that the site does not contain any watercourses or drainage lines (Map 1 & 2). It is also clear that no naturally occurring wetlands are present. However, alterations to the topography in the form of a berm and excavation, causes the accumulation of surface runoff which in turn causes the formation of artificial wetland conditions (Map 1). The artificial impoundments and wetland conditions formed by the artificial berm, excavation and concrete dam is clearly not considered to form part of any surface water systems and are consequently of low conservation value. As a result, should development require the removal of any of these features it will not result in any significant ecological impact. However, comments should still be obtained from the Department of Water and Sanitation (DWS) with regard to the necessity to apply for authorisation to remove these artificial impoundments.

However, the shallow excavation contains a significant juvenile population of the protected Giant Bullfrog (*Pyxicephalus adspersus*) (Map 1). Although it is a relatively widespread and common species and Red Listed as being of Least Concern (LC) it is protected and as such does retain a significant conservation value which will require adequate management and mitigation. The species is listed as Protected under the National Environmental Management: Biodiversity Act, 2004 (Act 10 Of 2004): Publication of Lists of Critically Endangered, Endangered, Vulnerable and Protected Species. As a result, should development require the removal of the shallow excavation the relevant authority should be consulted as to the need to apply for the necessary permits and any Giant Bullfrogs present on the site should be re-located to adjacent areas with suitable habitat. Should the re-location of any specimens be necessary this should be overseen by a qualified ecologist, biologist or herpetologist.

A few protected plant species were observed on the site (Appendix B). Although none of these are considered a threatened or Red Listed species they are still of significant conservation value and their loss would therefore entail a relatively high impact. However, this can be easily mitigated and the resulting impact minimised. The protected species occurring on the site are *Olea europaea* subsp. *africana*, *Brunsvigia radulosa* and *Raphionacme hirsuta*. The Wild Olive Tree (*O. europaea* subsp. *africana*) should be kept intact where possible and where development will affect them the necessary permits should be obtained to remove them. Where specimens were removed this can also be offset by using saplings in the landscaping of the development. Where *B. radulosa* and *R. hirsuta* will be affected by the development the necessary permits must be obtained to transplant them to those areas which will remain undeveloped.

As was observed the site contains numerous exotic weeds with a few being considered problematic weeds and invasives (Appendix B). The proposed development may will also increase disturbance and therefore increase the susceptibility for the establishment of weeds. Monitoring of weed establishment and eradication should form a prominent part of management of the development. Where category 1 and 2 weeds occur, they require removal by the property owner according to the Conservation of Agricultural Resources Act, No. 43 of 1983 and National Environmental Management: Biodiversity Act, No. 10 of 2004.

In conclusion, the site is considered as mostly natural but with some significant disturbance of the natural vegetation. The vegetation type on the site, Winburg Grassy Shrubland (Gh 7), is currently listed as being of Least Concern (LC) which does not contribute to the conservation value (Map 2). This is also reflected by the Free State Biodiversity Management Plan which does not consider the site to be a Critical Biodiversity Area (Map 3). Although the site is not considered to be of high conservation value in terms of the vegetation type a few protected species do still occur in significant numbers and are considered to be of significant conservation value and should be mitigated as recommended (Appendix B). As discussed, the the artificial impoundments and wetland conditions formed by the artificial berm, excavation and concrete dam it is clear that they are not considered to form part of any surface water systems and are consequently of low conservation value (Map 1). As a result, should development require the removal of any of these features it will not result in any significant ecological impact. However, the shallow excavation contains a significant juvenile population of the protected Giant Bullfrog (*Pyxicephalus adspersus*) (Map 1). Although it is a relatively widespread and common species and Red Listed as being of Least Concern (LC) it is protected and as such does retain a significant conservation value which will require adequate management and mitigation.

9. RECOMMENDATIONS

- Three protected plant species occur on the site (Appendix B):
 - The Wild Olive Tree (*Olea europaea* subsp. *africana*) should be kept intact where possible and where development will affect them the necessary permits should be obtained to remove them.
 - Where specimens were removed this can also be offset by using saplings in the landscaping of the development.
 - Where *Brunsvigia radulosa* and *Raphionacme hirsuta* will be affected by the development the necessary permits must be obtained to transplant them to those areas which will remain undeveloped.
 - The transplanting of these species should be overseen by an ecologist or botanist. Monitoring of the success of establishment should also be undertaken.
 - A walkthrough survey of the site should be conducted prior to construction. This should include identification and marking of all protected plants on the site and should be performed by an ecologist or botanist.

- The survey has determined that the artificial berm, shallow excavation and concrete dam is not considered to form part of any surface water systems and are consequently of low conservation value (Map 1). As a result, should development require the removal of any of these features it will not result in any significant ecological impact. However, comments should still be obtained from the Department of Water and Sanitation (DWS) with regard to the necessity to apply for authorisation to remove these artificial impoundments.

- The shallow excavation contains a significant juvenile population of the protected Giant Bullfrog (*Pyxicephalus adspersus*) (Map 1). Should development require the removal of the shallow excavation, the relevant authority should be consulted as to the need to apply for the necessary permits and any Giant Bullfrogs present on the site should be re-located to adjacent areas with suitable habitat. Should the re-location of any specimens be necessary this should be overseen by a qualified ecologist, biologist or herpetologist.

- The hunting, capturing or trapping of fauna, including mammals, reptiles, birds and amphibians, on the site should be strictly prohibited during construction.

- Adequate monitoring of weed establishment and their continued eradication must be maintained (Appendix B). Where category 1 and 2 weeds occur, they require removal by the property owner according to the Conservation of Agricultural Resources Act, No. 43 of 1983 and National Environmental Management: Biodiversity Act, No. 10 of 2004.

- After construction has ceased all construction waste should be removed from the area.

- Monitoring of construction including weed establishment and erosion should take place.

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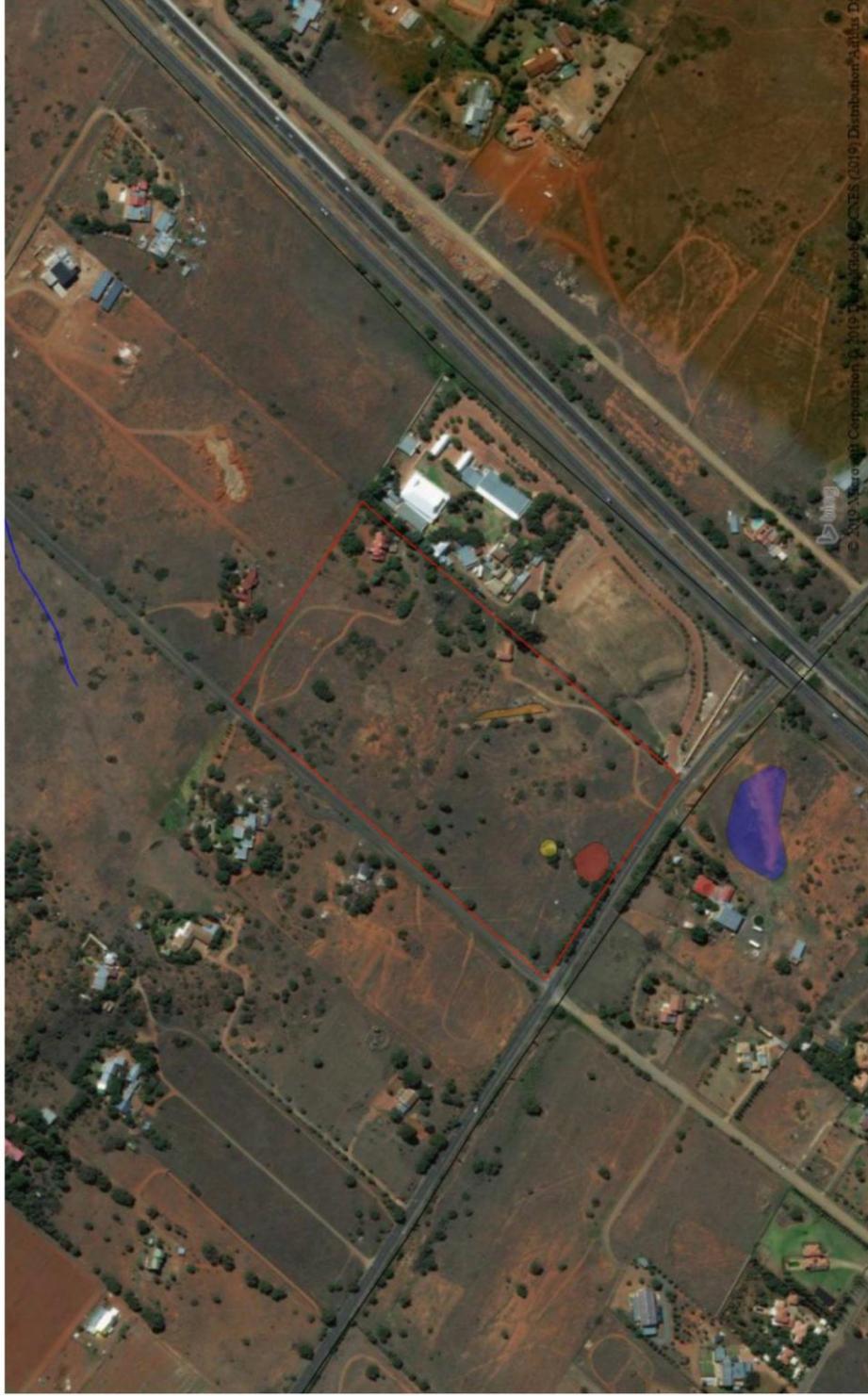
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Annexure A: Maps and Site photos

Layout map of a proposed development on Plot 21 and 22 in the Rayton Small Holdings, Bloemfontein, Free State Province.



Map 1: Layout map of the proposed development in the Rayton Small Holdings. The artificial wetland conditions formed by the artificial berm, shallow excavation as well as the concrete dam is indicated. Surrounding impoundments, wetlands and watercourses are also indicated. Disturbances on the site are also clearly visible on this aerial image.



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Legend:

-  Site location
-  Road network
-  Watercourses
-  Wetlands and impoundments
-  Artificial berm
-  Shallow excavation
-  Concrete dam

Map Information

Spheroid: WGS 84

Quantum GIS

Scale: 1:5 000

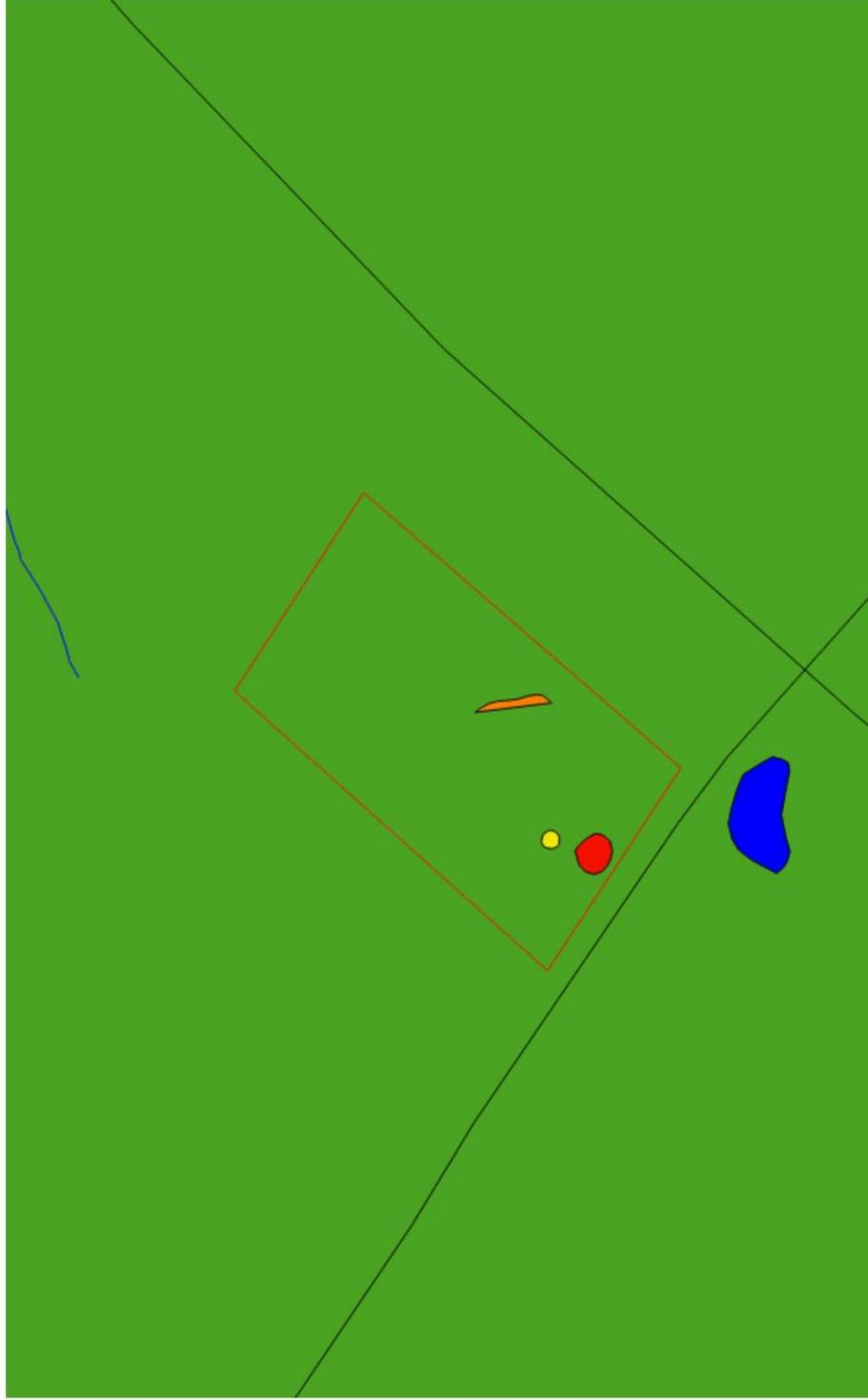
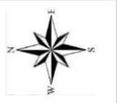
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General ecology map of a proposed development on Plot 21 and 22 in the Rayton Small Holdings, Bloemfontein, Free State Province.



Map 2: General ecology map of the proposed development in the Rayton Small Holdings. The artificial wetlands and impoundments on the site is indicated. Note also surrounding wetlands, impoundments and watercourses.



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Legend:

-  Site location
-  Road network
-  Watercourses
-  Wetlands and impoundments
-  Winburg Grassy Shrubland
-  Artificial berm
-  Shallow excavation
-  Concrete dam
-  Threatened Ecosystems

Map Information

Spheroid: WGS 84

Quantum GIS

Scale: 1:5 000

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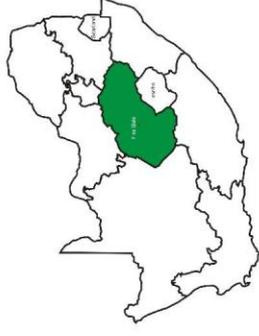
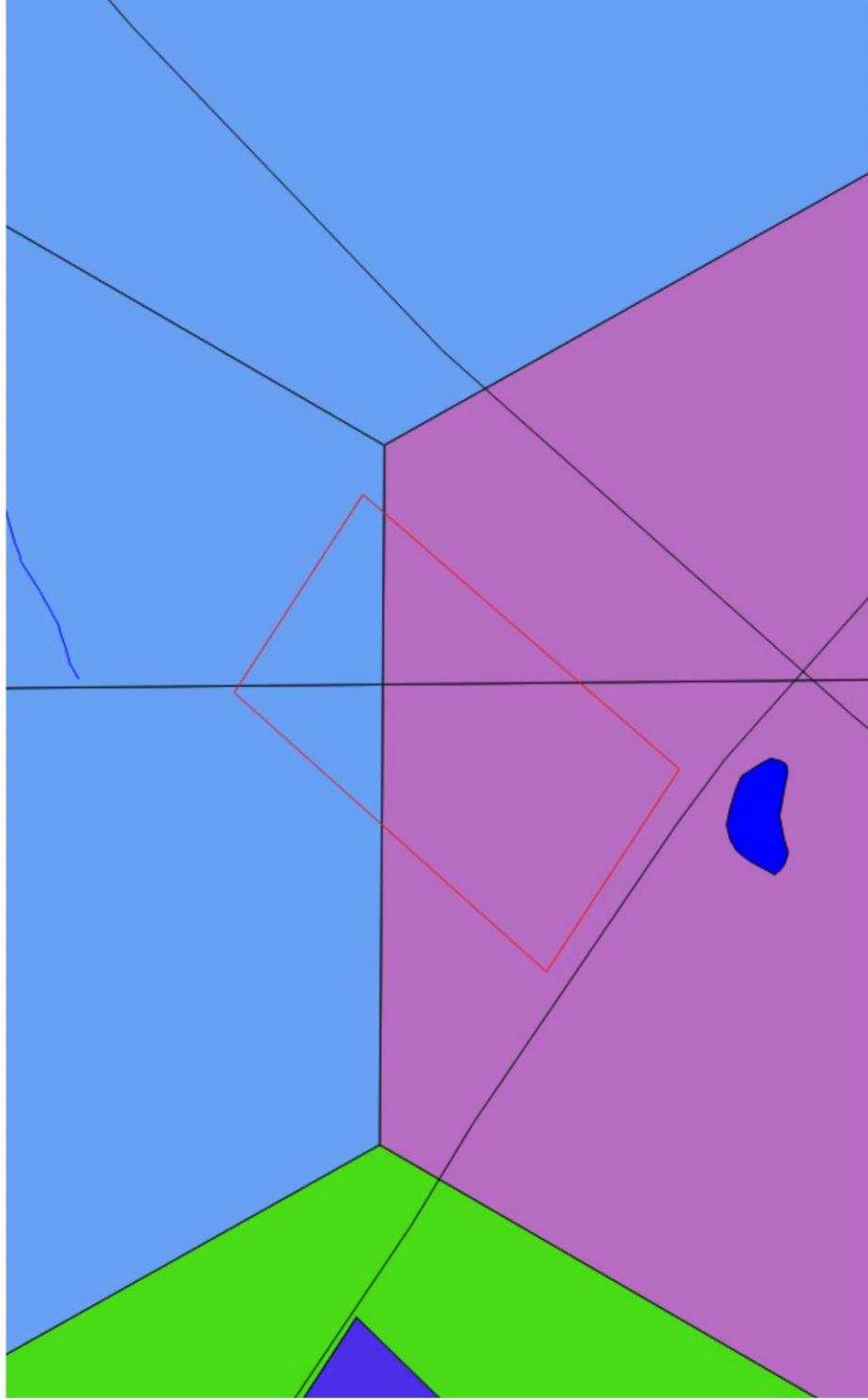
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Free State Biodiversity Plan map of a proposed development on Plot 21 and 22 in the Rayton Small Holdings, Bloemfontein, Free State Province.



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Legend:

-  Site location
-  Road network
-  Watercourses
-  Wetlands and impoundments
-  Critical Biodiversity Area 1
-  Critical Biodiversity Area 2
-  Ecological Support Area 1
-  Ecological Support Area 2
-  Degraded
-  Other

Map Information

Spheroid: WGS 84
 Quantum GIS
Scale: 1:5 000

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Map 3: Biodiversity plan map of the proposed development in the Rayton Small Holdings. The site is situated in an Ecological Support Area 1 & 2.



Figure 1: Panorama of the site. The site is clearly still dominated by natural vegetation with a grass and shrub/tree layer.



Figure 2: Significant impacts are present including rubbish dumping.



Figure 3: Dwellings and areas of transformation are also present on the site.



Figure 4: The northern portion of the site is especially affected by transformation.



Figure 5: Where disturbance has been significant, pioneer grasses dominate (*Melinis repens* – red) as well as the pioneer herb, *Nidorella resedifolia* (yellow).



Figure 6: Numerous scattered exotic trees are also common on the site (red).



Figure 7: View of the artificial wetland conditions caused by the artificial berm (red). Note also rubble dumping.



Figure 8: Exotic weeds can become abundant in many areas of the site (*Verbena tenuisecta*).



Figure 9: Natural grassland, although degraded, is still the dominant condition on the site.



Figure 10: The shallow excavation along the southern border of the site has caused the formation of artificial wetland conditions (red).



Figure 11: Close-up view of the artificial wetland conditions caused by the shallow excavation.



Figure 12: Artificial wetland conditions caused by the shallow excavation provide suitable habitat for a significant population of juvenile Giant Bullfrogs (*Pyxicephalus adspersus*).



Figure 13: Small mammals such as the Steenbok (*Raphicerus campestris*) on the site indicate that it still provides adequate habitat for fauna.



Figure 14: Protected plant species occurring on the site include; top row, *Brunsvigia radulosa* and bottom row, *Raphionacme hirsuta*.

Appendix B: Species list

Species indicated with an * are exotic.

Protected species are coloured orange and Red Listed species red.

Species	Growth form
* <i>Agave americana</i>	Succulent
* <i>Echinopsis schickendantzii</i>	Succulent
* <i>Eucalyptus camaldulensis</i>	Tree
* <i>Fraxinus americana</i>	Tree
* <i>Opuntia engelmannii</i>	Succulent
* <i>Opuntia ficus-indica</i>	Succulent
* <i>Pinus pinaster</i>	Tree
* <i>Schkuhria pinata</i>	Herb
* <i>Tagetes minuta</i>	Herb
* <i>Verbena bonariensis</i>	Herb
* <i>Verbena tenuisecta</i>	Herb
<i>Alternanthera sessilis</i>	Herb
<i>Aristida congesta</i>	Grass
<i>Aristida diffusa</i>	Grass
<i>Asparagus larcinus</i>	Shrub
<i>Barleria macrostegia</i>	Herb
<i>Berkheya macrocephala</i>	Herb
<i>Brunsvigia radulosa</i>	Geophyte
<i>Chascanum pinatifidum</i>	Herb
<i>Commelina africana</i>	Herb
<i>Crabbea acaulis</i>	Herb
<i>Crassula capitella</i>	Succulent
<i>Cymbopogon pospischillii</i>	Grass
<i>Cynodon dactylon</i>	Grass
<i>Cyperus indecoris</i>	Sedge
<i>Dicoma macrocephala</i>	Herb
<i>Digitaria eriantha</i>	Grass
<i>Diospyros austro-africana</i>	Shrub
<i>Dipcadi sp.</i>	Geophyte
<i>Dipcadi viride</i>	Geophyte
<i>Drimia elata</i>	Geophyte
<i>Eleocharis sp.</i>	Sedge
<i>Enneapogon cenchroides</i>	Grass
<i>Eragrostis curvula</i>	Grass
<i>Eragrostis obtusa</i>	Grass
<i>Eragrostis superba</i>	Grass
<i>Euclea crispa</i> subsp. <i>ovata</i>	Shrub
<i>Euryops empetrifolius</i>	Dwarf shrub
<i>Euryops multifidus</i>	Dwarf shrub
<i>Felicia muricata</i>	Dwarf shrub

<i>Gazania krebsiana</i>	Herb
<i>Geigeria filifolia</i>	Herb
<i>Heteropogon contortus</i>	Grass
<i>Hibiscus pusillus</i>	Herb
<i>Hilliardiella oligocephala</i>	Dwarf shrub
<i>Hypoxis rigidula</i>	Geophyte
<i>Ipomoea oblongata</i>	Creeper
<i>Lycium horridum</i>	Dwarf shrub
<i>Marsilea sp.</i>	Fern
<i>Melinis repens</i>	Grass
<i>Menodora africana</i>	Herb
<i>Monsonia angustifolia</i>	Herb
<i>Nenax microphylla</i>	Dwarf shrub
<i>Nidorella resedifolia</i>	Herb
<i>Nolletia ciliaris</i>	Dwarf shrub
<i>Olea europaea subsp. africana</i>	Tree
<i>Osteospermum scariosum</i>	Herb
<i>Panicum coloratum</i>	Grass
<i>Paspalum distichum</i>	Grass
<i>Pellaea calomelanos</i>	Fern
<i>Pentzia globosa</i>	Dwarf shrub
<i>Raphionacme hirsuta</i>	Geophyte
<i>Ruschia hamata</i>	Dwarf shrub
<i>Salvia stenophylla</i>	Herb
<i>Schoenoplectus sp.</i>	Sedge
<i>Searsia burchellii</i>	Shrub
<i>Searsia ciliata</i>	Shrub
<i>Searsia lancea</i>	Tree
<i>Seddera capensis</i>	Herb
<i>Selago densiflora</i>	Dwarf shrub
<i>Setaria spahcelata</i>	Grass
<i>Sporobolus fimbriatus</i>	Grass
<i>Talinum cafferum</i>	Geophyte
<i>Themeda triandra</i>	Grass
<i>Trachyandra saltii</i>	Geophyte
<i>Tragus koelerioides</i>	Grass
<i>Triraphis andropogonoides</i>	Grass
<i>Wahlenbergia nodosa</i>	Dwarf shrub
<i>Ziziphus mucronata</i>	Tree

Appendix C: 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.

Table 7: Rating of severity

Type of criteria	Rating				
	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

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.

Table 10: Example of calculating Overall Consequence

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

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.

Table 11: Rating of frequency

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

Determination of Probability

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

Table 12: Rating of probability

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 likelihood

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.

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

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.