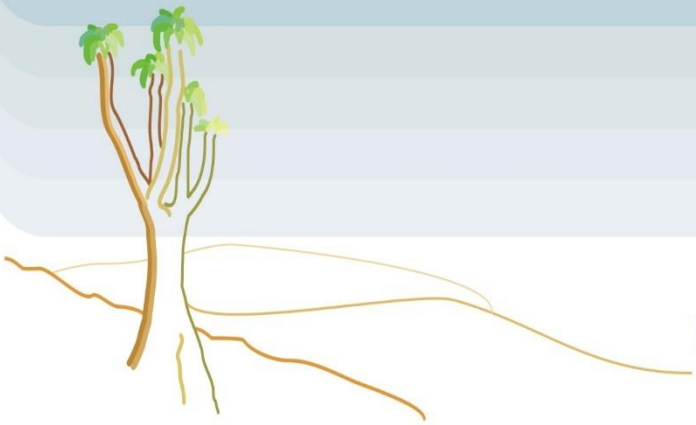

DPR
Ecologists & Environmental Services

Ecological and Wetland Assessment for proposed diamond prospecting operations around Jagersfontein, 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 four areas proposed for prospecting operations has been rated as being degraded which is mostly as a result of previous mining operations, urban development and high levels of overgrazing.

According to Mucina & Rutherford (2006) the area consists of Xhariep Karroid Grassland (Gh 3). This vegetation type is currently listed as being of Least Concern (LC) within 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. Furthermore, previous mining and overgrazing causes significant transformation of the natural vegetation type.

The proposed prospecting areas consist of four separate areas situated around and in the vicinity of the historical diamond mining areas (Map 1). A Biodiversity Management Plan dated March 2013 was previously conducted for this area and will also be utilised to provide information on these prospecting areas. A small but prominent stream drains the area and will be affected by several of the prospecting areas. The extent of the four separate prospecting areas are approximately 40, 35, 2 and 70 hectares.

All of the prospecting areas still contain at least a portion of relative natural vegetation though it is clear that historical delving activities has caused some alteration of the ecosystem. In addition, all of these areas, except the easternmost prospecting area, also contain large portions which are heavily modified by previous mining activities including haul roads, berms, artificial impoundments and large amounts of sediment deposits (Map 1). The easternmost prospecting area, although not affected by previous mining activities, is also heavily degraded but mostly due to the proximity of urban areas and affected by amongst others rubbish dumping, polluted storm water runoff and heavy overgrazing by domestic stock (Map 1).

No rare or endangered species were encountered in the area and due to the degraded condition of the habitat it is considered unlikely that any such species would occur here. The region is also not known to contain a high amount of such species. Only two protected species were encountered. These are *Olea europaea* subsp. *africana* and *Haemanthus humilis*. *Olea europaea* subsp. *africana,* occurs but is also a consequence of historical delving boulder piles which promote the establishment of trees. The species is widespread and common and not of high conservation value. However, it is still recommended that where prospecting operations will affect them the necessary permits be obtained to remove them. *Haemanthus humilis* is also considered uncommon and therefore of significant conservation value. It is confined to the low dolerite ridge along the western border of the northern prospecting area and should be easily avoided by prospecting operations. Where specimens will be affected by prospecting the necessary permits should be obtained to transplant them to an adjacent area where they will remain unaffected. Should the above recommended mitigation be adhered to the impact on protected species should remain low.

The proposed prospecting areas will affect a small but prominent stream system (Map 1). The western and northern prospecting areas will both affect two small drainage lines which form tributaries of the downstream main stream system. The eastern prospecting areas will then affect the main stream channel.

Soil samples indicate that the upper reaches of the tributaries formed in the northern and western prospecting areas are devoid of wetland conditions but that this gradually increases and the lower portions within these areas contain clear wetland conditions (Map 1, Appendix C). The formation of wetland conditions are also increased by artificial impoundments and other obstructions such as haul roads and these retain water for longer periods and in so doing causing wetland conditions to form. The main stream located on the eastern prospecting area is located downstream of the above drainage lines and consequently contain much more prominent soil wetness indicators. Furthermore, the increased runoff generated by the surrounding urban area also increases the moisture of the stream. The soil samples in the upstream drainage lines are indicative of wetland conditions only on a seasonal basis. The larger stream system in the eastern prospecting area contain wetland condition on a perennial basis.

From the study of current impacts it is clear that the affected watercourses are already heavily degraded and modified. An Index of Habitat Integrity (IHI) was conducted for the stream system and affected drainage lines within the proposed prospecting areas. The results of the IHI indicated that the stream system has an Instream IHI of category D: Largely Modified and Riparian IHI of category D: Largely Modified (Appendix D). This is considered relatively accurate and may even be somewhat overestimated. Historical mining as well as the current urban surroundings cause high impacts on the stream system. Despite this the system still provides vital services including water transportation, flood dissipation, wetland and riparian habitat and support of ecological processes. The system should still be regarded as sensitive with a high conservation value and mining should endeavour to keep impacts on it to a minimum. Furthermore, even though the drainage lines have mostly been cut off from the downstream system it still feeds into the groundwater and will influence it in terms of groundwater recharge and any pollutants associated with prospecting activities.

The EI&S of the floodplains associated with the stream system and drainage lines has been rated as being Low/Marginal: Floodplains that are not ecologically important and sensitive at any scale. The biodiversity of these floodplains is ubiquitous and not sensitive to flow and habitat modifications. They play an insignificant role in moderating the quantity and quality of water of major rivers.

A Risk Assessment for the proposed prospecting area has been undertaken according to the Department of Water & Sanitation's requirements for risk assessment and the provisional Risk Assessment Matrix for Section 21(c) & (i) water use (Appendix E). Prospecting operations in the main channel of both the stream system and drainage lines is likely to cause permanent modification but only at a local level. Prospecting may involve significant impacts associated with, amongst others, bulk sampling which will still pose a moderate risk and which is likely to cause some modification to these systems. However, prospecting is still confined to smaller areas and is not as extensive as full-scale mining which will decrease the extent of impacts considerably and therefore the risk is anticipated to remain moderate. Furthermore, these systems are already largely modified and therefore the risk will not be as high as when pristine systems are involved. It is still important that a comprehensive rehabilitation and monitoring regime be implemented to ensure that the functioning of these system area re-instated. Conducting prospecting operations in close proximity to watercourses is not anticipated to have a significant risk. This is due to the small extent of prospecting and the already highly modified nature of the affected watercourses. Construction of roads and other infrastructure such as pipelines and canals through watercourses is anticipated to only have a low risk but will still have impacts on these although at a local scale. Mining operations within 100 meters or within the floodplain of watercourses and within 500 meters of wetland areas will require authorisation from DWS.

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Ecological and Wetland Assessment

1. Introduction

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 biological diversity ranks as one the ten highest 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.

South Africa's water resources have become a major concern in recent times. As a water scarce country we need to manage our water resources sustainably in order to maintain a viable resource for the community as well as to preserve the biodiversity of the system. Thus, it should be clear that we need to protect our water resources so that we may be able to utilise this renewable resource sustainably. Areas that are regarded as crucial to maintain healthy water resources include wetlands, streams as well as the overall catchment of a river system.

The Western Free State contains isolated dolerite capped mesas, butts, hills and ridges. Due to the flat topography these are often prominent landscape features. Due to the topography, hydrology, soil properties, etc. these hills contain vegetation differing markedly from that of the surrounding plains. In this region these hills are often the only landscape features able to sustain trees. Due to the above characteristics of these hills they also sustain a faunal population distinct from that of the surrounding plains. For the above reasons these hills are often considered as sensitive areas.

It is well known that diamond prospecting operations has several detrimental impacts on the environment. These impacts are numerous but the most pronounced impacts are associated with the excavation of large amounts of earth materials, the storage and disposal thereof and the sedimentation associated with it. This usually causes degradation of waterways due to sedimentation as well as the transformation of the vegetation and ecosystem on the site.

For the above reasons it is necessary to conduct an ecological and wetland assessment of the area proposed for diamond prospecting operations.

The proposed prospecting areas consist of four separate areas situated around and in the vicinity of the historical diamond mining areas (Map 1). A Biodiversity Management Plan dated March 2013 was previously conducted for this area and will also be utilised to provide information on these prospecting areas. A small but prominent stream drains the area and will be affected by several of the prospecting areas. The extent of the four separate prospecting areas are

approximately 40, 35, 2 and 70 hectares. Due to the historical mining activities several areas have been significantly degraded although natural areas are also present. The easternmost prospecting area is situated adjacent to urban developments and consequently is highly degraded.

A site survey of the study area was conducted on 11 and 24 January 2019. The entire study area including all four prospecting areas was surveyed (Map 1). The survey was undertaken during summer and although the region is experiencing a severe drought sufficient rain had recently occurred in this area to enable accurate species identification.

For the above reasons it is necessary to conduct an ecological and wetland assessment of an area which is proposed for diamond prospecting operations.

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

1.1 Background of the historical mining area

The Jagersfontein kimberlite pipe was discovered in 1870 by J.J. de Klerk. The farm was subsequently rushed by hundreds of diggers who worked an open pit. Initial challenges included water scarcity, the arid climate, the distance to urban centres, the difficulty of securing food supplies and equipment, the primitive modes of working and insufficient capitol to work claims effectively.

By 1891 the mine was owned by the amalgamated United Diamond Mining and New Jagersfontein Companies. The mine was only acquired by De Beers Consolidated Mines in 1930.

The mine operated on and off (operations ceased during the Anglo Boer War, World War I, and World War II and during the Great Depression) for 99 years and officially closed in 1969. The mine was sold to Jagersfontein Developments (Pty) Ltd in 2010.

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 (Johnson 2005).

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 (including riparian and wetland) and watercourses and wetlands included within the study area. The importance of the ecological function and condition will also be assessed.
- To identify possible negative impacts that could be caused by the proposed prospecting operations.
- Identify and delineate watercourses including rivers, streams, pans and wetlands and ascertain condition and status therefore and recommend mitigation.
- Determine the Present Ecological State (PES) and Ecological Importance & Sensitivity (EIS) for the watercourses and wetlands in the study area.
- Conduct a risk assessment and determine the likelihood that watercourses and wetlands will be adversely affected by the development.

2.1 Vegetation

Aspects of the vegetation that will be assessed include:

- The vegetation types of the region with their relevance to the study area.
- The overall status of the vegetation including riparian vegetation in the study area.
- Species composition with the emphasis on dominant-, rare- and endangered species.
- Boundary of wetlands using obligate wetland riparian species.

The amount of disturbance present on the study area 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 encountered in the study area 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.

2.3 Watercourses and wetlands

Aspects of the watercourses and wetlands that will be assessed include:

- Identification and delineation of watercourses including rivers, streams, pans and wetlands.
- Describe condition and status of watercourses and importance relative to the larger system.
- Conduct habitat integrity assessment of perennial systems to inform the condition and status of watercourses.

2.4 Limitations

- Due to the current drought it is possible that several species, including deciduous, annual and subterranean species, were overlooked or not currently present.
- Due to time constraints only limited soil sampling could be done.
- Smaller drainage lines may have been overlooked where a distinct channel or riparian vegetation is absent.
- 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 vegetation and riparian species identification (Bromilow 1995, 2010, Coates-Palgrave 2002, Court 2010, Fish *et al* 2015, Gerber *et al* 2004, Gibbs Russel *et al* 1990, Manning 2009, Retief & Meyer 2017, Roberts & Fourie 1975, Shearing & Van Heerden 2008, Van Ginkel *et al* 2011, Van Oudtshoorn 2004, Van Wyk & Malan 1998, Venter & Joubert 1985).

Terrestrial fauna:
Field guides for species identification (Smithers 1986a).
Mammal Red Data List (Child *et al* 2016, Smithers, R.H.N. 1986b)

Wetland methodology, delineation and identification:
Department of Water Affairs and Forestry 2004, 2005, 2008, Collins 2006, Duthie 1999, Kleynhans *et al* 2008, Marnewecke & Kotze 1999, Nel *et al* 2011, SANBI 2009.

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 at 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.
The state of the habitat was also assessed.

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

All rivers, streams, pans and wetlands were identified and surveyed where it occurred in the study area.
These systems were delineated by use of topography (land form and drainage pattern) and riparian vegetation with limited soil sampling (Appendix C).
The following guidelines and frameworks were used to determine and delineate the rivers, streams, pans and wetlands in the study area:

- Department of Water Affairs and Forestry. 2005. A practical field procedure for identification and delineation of wetlands and riparian areas. Edition 1. Department of Water Affairs and Forestry, Pretoria.
- Marnewecke & Kotze 1999. Appendix W6: Guidelines for delineation of wetland boundary and wetland zones. In: MacKay (Ed.), H. Resource directed measures for protection of water resources: wetland ecosystems. Department of Water Affairs and Forestry, Pretoria.

The following guidelines and frameworks were used to determine the sensitivity or importance of these identified watercourses in the study area:

- Nel *et al.* (2011). Technical Report for the National Freshwater Ecosystem Priority Areas project. WRC Report No. K5/1801.

- Government of South Africa. 2008. National Protected Area Expansion Strategy for South Africa 2008: Priorities for expanding the protected area network for ecological sustainability and climate change adaptation. Government of South Africa, Pretoria.

- Duthie, A. 1999. Appendix W5: IER (floodplain and wetlands) determining the Ecological Importance and Sensitivity (EIS) and Ecological Management Class (EMC). In: MacKay (Ed.), H. Resource directed measures for protection of water resources: wetland ecosystems. Department of Water Affairs and Forestry, Pretoria.

These guidelines provide the characteristics which can be utilised to determine if a wetland or watercourse is present and also aids in determining the boundary of these systems.

The following were utilised to inform the condition and status of watercourses:

- Kleynhans, C.J., Louw, M.D. & Graham, M. 2008. Module G: EcoClassification and EcoStatus determination in River EcoClassification: Index of Habitat Integrity. Joint Water Research Commission and Department of Water Affairs and Forestry report. WRC Report No. TT 377-08.

A Risk Assessment will be conducted for the prospecting in or near watercourses and wetlands in accordance with the Department of Water & Sanitation's requirements for risk assessment and the provisional Risk Assessment Matrix for Section 21(c) & (i) water use.

3.3 Criteria used to assess sites

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

3.3.1 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.
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.

3.3.2 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.

3.3.3 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 discussed in section 3.3 were used to determine the biodiversity sensitivity ranking for the sites. On a scale of 0 – 30, five different classes are described to assess the biodiversity of the study area. The different classes are described in the Table 1:

Table 1: Biodiversity sensitivity ranking

BSR	BSR general floral description	Floral score equating to BSR class
Totally transformed (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.	29 – 30
Advanced Degraded (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.	26 – 28
Degraded (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.	21 – 25
Good Condition (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.	11 – 20
Sensitive/Pristine (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.	0 - 10

4. Ecological and Wetland Assessment

For the purpose of this report the ecology of the study area will first be discussed followed by a discussion of the watercourse and wetland systems.

4.1 Ecology and description of the study area

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

According to Mucina & Rutherford (2006) the area consists of Xhariep Karroid Grassland (Gh 3). This vegetation type is currently listed as being of Least Concern (LC) within 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.

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 watercourses and wetlands.

The proposed prospecting areas consist of four separate areas situated around and in the vicinity of the historical diamond mining areas (Map 1). A Biodiversity Management Plan dated March 2013 was previously conducted for this area and will also be utilised to provide information on these prospecting areas. A small but prominent stream drains the area and will be affected by several of the prospecting areas. The extent of the four separate prospecting areas are approximately 40, 35, 2 and 70 hectares. Due to the historical mining activities several areas have been significantly degraded although natural areas are also present. The easternmost prospecting area is situated adjacent to urban developments and consequently is highly degraded.

All of the prospecting areas still contain at least a portion of relative natural vegetation though it is clear that historical delving activities has caused some alteration of the ecosystem. In addition, all of these areas, except the easternmost prospecting area, also contain large portions which are heavily modified by previous mining activities including haul roads, berms, artificial impoundments and large amounts of sediment deposits (Map 1). The easternmost prospecting area, although not affected by previous mining activities, is also heavily degraded but mostly due to the proximity of urban areas and affected by amongst others rubbish dumping, polluted storm water runoff and heavy overgrazing by domestic stock (Map 1). The study area is situated in the Grassland Biome and a grass layer still dominates the largest part. A dwarf karroid shrub component is however also prominent in the grass layer and considered a natural component of this vegetation type. However, trees have become established in many areas including many exotic species, mostly as a result of disturbance which promotes tree establishment. The region is considered to have a low rainfall and forms part of an arid area.

The topography of the prospecting areas is relatively uniform but some variation does occur including a low ridge in the northern area and a small hill in the central area. The slope is mostly from north west to south east and follows the drainage pattern of the small but prominent stream in the area. Altitude gradually decreases from the western areas toward the east and varies from

1443 m in the west to 1378 m in the east. This clearly illustrates the main direction of drainage associated with the stream.

The town of Jagersfontein receives most of its rainfall from October to March. Temperatures also fluctuate accordingly with December being the hottest month at a mean temperature of 22.6˚C and July being the coldest at a mean temperature of 7.2˚C. February and March have the highest rainfall. The temperature trend follows the rainfall pattern to a large extent.

The geology of the area consists of Karoo Supergroup sediments and extensive dolerite sills. The Jagersfontein kimberlite pipe intrudes through these Karoo Supergroup sediments and dolerite intrusive sill complexes. The stratigraphy of the area shows how the local hills preserve the remnants of the dolerite sills. The outcrop of dolerites indicates the NW-SE striking structure, which appears to be a common structural trend in the region.

The soil is described as being dominated by prismacutanic and/or peducotanic horizons, with a mainly red B horizon (code Da46 and Da 104) in the central, lower part of the area and on the flatter dolerite areas. Glenrosa and/or Mispah forms with lime rare or absent occur on the higher ground in the north-eastern and western parts of the area (codes Fb191 and Fb400). On the steeper, rocky slopes of the area, soil is thin and is described as miscellaneous (code Ib348).

Mostly due to the historical land uses including mining the area contains a significant component of exotic weeds and invader species.

A detailed description of the vegetation, condition and impacts will be given separately for each prospecting area in the following sections.

4.1.1 Western prospecting area

The western prospecting area consists of a plain sloping gradually from west to east and surrounded to the north and south by historical tailing dumps (Map 1). It has an extent of approximately 30 hectares. The topography is relatively uniform without any prominent ridges or hills. A small drainage line occurs in the area also draining from west to east but will be discussed in more detail in the wetland assessment. The area contains largely natural vegetation in the western portion but which becomes gradually transformed toward the east which is heavily degraded. A few low stone walls are present as well as small boulder piles undoubtedly formed by historical delving activities. The tailings dump to the north also releases a high amount of sediment into this area and especially into the small drainage line. An artificial impoundment was also constructed in the eastern portion within the drainage line but has since been removed. A few large haul roads also cross the area and causes local transformation as well as also altering the runoff patterns. As can be deduced from the above described impacts the area is heavily degraded, especially the eastern portion.

The terrestrial vegetation is dominated by a low grass layer although it also contains a significant dwarf karroid shrub component. The grass layer is not very diverse and dominated by only a few species. These dominant species are *Eragrostis lehmanniana, Aristida congesta* and *Heteropogon contortus*. This assemblage of species are natural to the vegetation type but where they dominate as is the case here this indicates some disturbance of the natural vegetation. Other grass species which occur as scattered clumps include *Eragrostis curvula, Themeda triandra, Stipagrostis obtusa* and *Melica decumbens*. The dwarf karroid shrub component is especially prominent and although this indicates disturbance of the vegetation may also be a

consequence of the current drought, i.e. the aboveground portions of the grasses disintegrate while the karroid shrubs are more persistent and therefore more visible and prominent. Common dwarf shrubs include *Eriocephalus ericoides, E. spinescens, Rosenia humilis, Pentzia incana, Lycium cinerium, Asparagus suaveolens, Searsia ciliata, Gnidia polycephala* and *Helichrysum lucilioides*. Where boulder piles and rock walls remain these promote the establishment of trees and shrubs. These include *Searsia pyroides, Vachellia karroo, Diospyros austro-africana, Buddleja saligna, Searsia burchellii, S. pyroides* and *Olea europaea* subsp. *africana*. These can be considered a modification of the natural vegetation since, without the boulder piles they would not have succeeded in establishing here. The last named, *O europaea* subsp. *africana,* is a protected species although widespread and relatively common. They are not of old age, large size and do not form a high density of individuals and are therefore not considered to be of high conservation value. Where they will be affected by prospecting operations permits must be obtained to remove them. The establishment of trees increase considerably toward the east of the site and seem to be most likely associated with sediment deposition from the adjacent tailings dump. The trees are dominated by *Vachellia karroo* to a large extent although specimens of *Diospyros lycioides* and *Searsia pyroides* are also present. The understorey often contains the climbing shrub, *Asparagus larcinus*. The exotic shrubs, *Pyracantha angustifolia* and *Cotoneaster franchettii* has also become established as scattered clumps. Other exotic weeds are also abundant but mostly associated with degradation associated with the small drainage line and will be discussed in the wetland assessment.

In conclusion, the westernmost prospecting area consists of mostly natural vegetation in the western portion but which becomes progressively transformed toward the eastern portion. The species diversity is not significant and no rare or endangered species were observed. Owing to the degraded condition such species is considered unlikely to occur. One protected species, *Olea europaea* subsp. *africana,* occurs but is also a consequence of historical delving boulder piles which promote the establishment of trees. The species is widespread and common and not of high conservation value. However, it is still recommended that where prospecting operations will affect them the necessary permits be obtained to remove them. The area does not contain any ecological elements of high significance and due to its already degraded condition it is not anticipated that prospecting operations will have a high impact. However, the small drainage line does retain a significant conservation value but will be discussed within the wetland assessment section.

Figure 1: View of the western portion. A sparse grass layer with prominent dwarf karroid shrub component.

Figure 2: Another view of the western portion with grass and dwarf karroid shrub layer.

Figure 3: Where low stone walls (red) remain they promote the establishment of trees and shrubs.

Figure 4: In the eastern portion of the area sediment deposition by adjacent tailings dumps (white surface residue) cause the proliferation of trees.

Figure 5: A few large haul roads also cause disturbance and act as flow barriers for surface runoff.

4.1.2 Central small hill

The central prospecting area consists of a small hill with an approximate extent of 2 hectares (Map 1). The hill has moderate to steep slopes but which has also been altered to a significant degree by previous excavations. The topography is quite uneven but mostly as a result of the modification caused by previous excavations. The site does not contain any watercourses or wetlands and transformation of the surroundings is to such an extent that any natural systems would have been obliterated. Remnants of the natural vegetation is still present, being more representative of the Besemkaree Koppies Shrubland (Gh 4) of the surrounding hills, but is heavily modified. The majority of the area is transformed and dominated by pioneer species with exotic weeds and invaders common.

The vegetation of the natural vegetation type is dominated by shrubs and small trees establishing on hills and exposed dolerite. This is also present in the area although confined to remnant patches. Trees and shrubs include *Ehretia rigida, Searsia burchellii, S. ciliata, Euclea crispa* subsp. *ovata, Buddleja saligna, Diospyros lycioides* and *Olea europaea* subsp. *africana*. The last named, *O europaea* subsp. *africana,* is a protected species although widespread and relatively common. They are not of old age, large size and do not form a high density of individuals and are therefore not considered to be of high conservation value. Where they will be affected by prospecting operations permits must be obtained to remove them. A sparse grass layer is present but is evidently heavily degraded and present as scattered clumps. These grasses include *Aristida congesta, Eragrostis lehmanniana, Themeda triandra* and *Hyparrhenia hirta*. A prominent dwarf karroid shrub component includes *Chrysocoma ciliata, Pentzia incana, Felicia muricata, Melelobium candicans, Hemannia cuneifolia* and *Dimorphotheca cuneata*. Herbaceous species are also common and includes *Salvia verbenaca, Talinum caffrum, Gomphocarpus fruticosus, Cullen tomentosum* and *Arctotis arctotheca*. As mentioned exotic species are abundant and clear indicators of the transformed habitat. Invasive tree species include *Nicotiana glauca, Schinus molle, Eucalyptus camaldulensis* and *Cotoneaster franchettii*. Invasive weeds include *Argemone ochroleuca, Euphorbia inaequilatera, Bidens bipinnata, Conyza bonariensis, Alternanthera pungens* and *Datura strumarium*.

In conclusion, the central small hill prospecting area has been heavily modified by previous excavations on the site. The species diversity is very low, the habitat is heavily modified and no rare or endangered species were observed. Owing to the degraded condition such species is considered unlikely to occur. One protected species, *Olea europaea* subsp. *africana,* occurs but is also a consequence of historical delving boulder piles which promote the establishment of trees. The species is widespread and common and not of high conservation value. However, it is still recommended that where prospecting operations will affect them the necessary permits be obtained to remove them. The area does not contain any ecological elements of high significance and due to its already degraded condition it is not anticipated that prospecting operations will have a high impact.

Figure 6: View of the central prospecting area which has clearly been heavily modified.

Figure 7: Another view of the central portion with clear modification. Note excavated rubble dumps in the surroundings.

Figure 8: View of patches of remnant natural vegetation. Invasive tree species are however also prominent.

4.1.3 Northern prospecting area

The northern prospecting area is dominated by a plain with a moderate slope from west to east (Map 1). A low dolerite ridge is located along the western border of the site with a high percentage surface rock. Drainage lines occur in this area along the northern and eastern borders of the prospecting area but will be discussed in more detail in the wetland section. Two artificial impoundments or berms have also been installed in the larger of the two drainage lines and cover a large portion of the site. A large tailing dump from previous mining activities is situated to the

east of the site. The area has an approximate extent of 35 hectares. From the description of the site it should be evident that the topography is relatively uniform but contains several elements making it the most varied of the four prospecting areas. A large portion of the area still contains natural vegetation with the artificial impoundments being the largest transformation of the site. The eastern portion contains some remnants of historical delving but is still considered as natural without any significant transformation. A significant impact is a high amount of overgrazing by domestic stock which, when compared to adjacent areas, significantly decreases vegetation and increases surface erosion. The artificial impoundments, especially the larger southern impoundment, has caused transformation of a significant surface area. It also accumulates large volumes of sediment runoff from the adjacent tailings dumps which may have an unintentional advantage as it forms a sediment trap. As can be deduced from the above the area contains a large portion of natural vegetation but also with some significant impacts and some portions of transformation present.

This portion is characterised by a much higher proportion of dwarf karroid shrub with the grass layer not well represented. The plain portion is dominated by dwarf karroid shrubs and notably, *Eriocephalus ericoides,* is particularly dominant. Other dwarf shrubs include *Pentzia quinquifida, P. incana, Rosenia humilis, Amphiglossa triflora, Selago albida, Nenax microphylla, Ruschia hamata, Hertia pallens* and *Lycium horridum*. Grasses are not abundant here but may include *Aristida congesta* and *Eragrostis lehmanniana*. Where dolerite outcrops occur along the western portion of the site the vegetation structure differs significantly with a shrub component being prominent with a dwarf karroid shrub and grass understorey. Common trees and shrubs include *Searsia ciliata, S. burchellii, S. erosa, Diospyros lycioides, Gymnopsoria buxiifolia, Ehretia rigida* and *Olea europaea* subsp. *africana*. The last named, *O europaea* subsp. *africana,* is a protected species although widespread and relatively common. They are not of old age, large size and do not form a high density of individuals and are therefore not considered to be of high conservation value. Where they will be affected by prospecting operations permits must be obtained to remove them. Dwarf karroid shrubs include *Asparagus suaveolens, Wahlenbergia nodosa, Stachys lineare, Melolobium candicans* and *Felicia fillifolia*. The grass component is still quite sparse but may include *Eragrostis lehmanniana, Aristida congesta, Themeda triandra* and *Tragus koelerioides*. The micro habitats formed by boulders also promote the establishment of small succulents such as *Chasmatophyllum muscullinum,* the fern, *Cheilanthes eckloniana* and protected geophyte, *Haemanthus humilis*. The last named is a protected species which is also considered uncommon and therefore of significant conservation value. It is confined to the low dolerite ridge along the western border of the site and should be easily avoided by prospecting operations. Where specimens will be affected by prospecting the necessary permits should be obtained to transplant them to an adjacent area where they will remain unaffected. As can be deduced from the vegetation description of the remaining terrestrial component the vegetation is largely natural and does not contain any significant exotic weeds or invaders which also substantiates the largely natural condition of the vegetation.

In conclusion, the northern prospecting area contains a large portion consisting of natural vegetation with the south eastern portion having been transformed by an artificial impoundment but which will be discussed in more detail in the wetland section. Two drainage lines are also present along the northern and eastern borders and which will have a high conservation value but which will also be discussed in the wetland section of the report. The terrestrial portion of the site, although being largely natural, does not contain a high species diversity. However, two protected species do occur, *Olea europaea* subsp. *africana* and *Haemanthus humilis*. *Olea europaea* subsp. *africana,* occurs but is also a consequence of historical delving boulder piles which promote the establishment of trees. The species is widespread and common and not of

high conservation value. However, it is still recommended that where prospecting operations will affect them the necessary permits be obtained to remove them. *Haemanthus humilis* is also considered uncommon and therefore of significant conservation value. It is confined to the low dolerite ridge along the western border of the site and should be easily avoided by prospecting operations. Where specimens will be affected by prospecting the necessary permits should be obtained to transplant them to an adjacent area where they will remain unaffected. No other ecological components, except for the above mentioned drainage lines, of high conservation value occur in this area. Prospecting operations should therefore not have a high impact as long as the discussed protected species are managed appropriately as recommended.

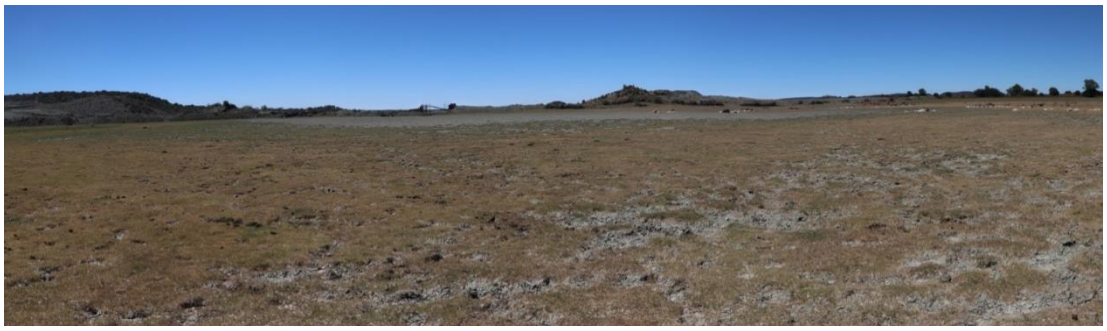

Figure 9: View of the portion of this area which has been transformed by the artificial impoundment. It resembles a pan habitat due to the low slope but is clearly transformed from the natural vegetation.

Figure 10: View of the remaining natural vegetation in this area. Note the dominance of dwarf karroid shrub in the plains habitat. The low dolerite ridge is indicated (red) and clearly causes the establishment of trees and shrubs.

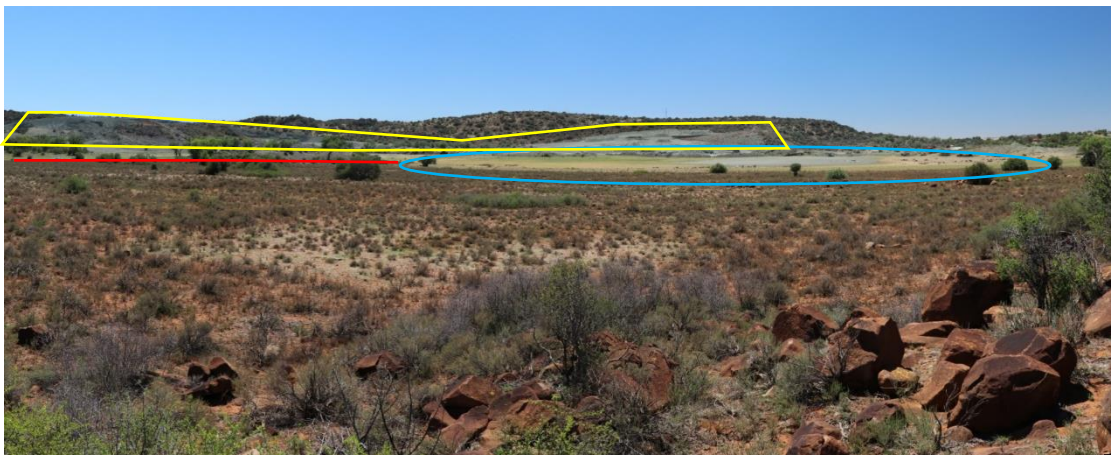

Figure 11: View of the northern prospecting area as seen from the low ridge which illustrates the dolerite boulder habitat in the foreground, the dwarf karroid shrub habitat sloping toward the drainage line (red), artificial impoundment (blue) which transforms a portion of the site and the adjacent tailings dumps (yellow).

Figure 12: Another view of the plains habitat where it is clearly dominated by a single dwarf karroid shrub, *Eriocephalus ericoides*.

4.1.4 Eastern prospecting area

The eastern prospecting area is dominated by a plain which gradually slopes toward a small but significant and perennial stream which flows through the entire site (Map 1). The stream system will be discussed in detail in the wetland section. The topography is relatively uniform, except for the stream system, without any pronounced hills or ridges. Of the four prospecting areas this is the only one which was not associated with historical mining activities but more with the urban development of the town itself. It is also the largest of the prospecting areas having an approximate extent of 70 hectares. The area still consists of natural vegetation but this has been heavily affected by the surrounding urban areas. The area is affected by a large amount of general refuse and illegal dumping. Overgrazing by domestic stock is also exceptionally high and causes degradation of the natural vegetation to a large extent. An informal brickworks also affect the eastern corner of the area. Furthermore, storm water generated by the urban areas are also highly polluted and will affect the groundwater on the site. This has a high impact on the stream system but will be discussed under the wetland section. As can be deduced from the above the current land use and surroundings are causing extensive degradation of this area.

The natural vegetation is heavily degraded and the current vegetation is dominated by a sparse grass layer with dwarf karroid shrubs prominent. The condition of the vegetation may be decreased by the current drought but the species composition will remain the same and clearly indicates high levels of disturbance. The grass layer is dominated by *Cynodon dactylon, Eragrostis lehmanniana* and *Aristida congesta*. This assemblage of species is dominated by pioneers and indicate a degraded grass layer. Other species include *Eragrostis obtusa* and *Themeda triandra*, but is represented by rare specimens which can only survive inside bushes where they escape overgrazing. The low diversity of grass species should also indicate the degraded condition. Dominant dwarf karroid shrubs include *Hertia pallens, Lycium horridum, Asparagus suaveolens, Pentzia incana, Rosenia humilis, Nenax microphylla* and *Eriocephalus ericoides*. Although these species form a natural component of the vegetation type where some of these dominate such as *L. horridum* and *H. pallens*¸ it clearly indicates overgrazing. Several herbs also become dominant and are also indicators of a disturbed vegetation layer. They include *Salvia disermas, Moraea palida, Arctotis arctotheca* and *Stachys hyssopoides*. Due to the degraded condition several exotic species have become established. These include weeds, *Argemone ochroleuca* and *Xanthium spinosum*, invasive succulent species, *Cyllindropuntia imbricata, Opuntia humifusa, Yucca aloifolia* and *Agave americana* and invasive tree species, *Prosopis glanduosa* and *Eucalyptus camaldulensis*. From the above description it should be clear that the area is heavily degraded and low in species diversity.

In conclusion, the eastern prospecting area consists of natural vegetation but which has been extensively degraded by the current high level of overgrazing by domestic stock as well as

activities associated with the surrounding urban areas. A small but prominent stream transects the area which although it is heavily degraded will still have a high conservation value but which will be discussed in detail in the wetland section of the report. Due to the degraded nature of the vegetation in this area the species diversity is low and dominated by pioneer species. No protected, rare or endangered species could be identified and owing to the degraded nature this is highly unlikely. Except for the stream system no other element of ecological importance or conservation value is present. The proposed prospecting operations is therefore not anticipated to have a high impact.

Figure 13: View of the eastern prospecting areas. Note the very low vegetation cover.

Figure 14: View of the western portion of this area. Note exotic trees is evident and again a low vegetation cover.

Figure 15: Note that general refuse is abundant in this area as a result of the adjacent urban areas.

Figure 16: This portion of the area is dominated by dwarf karroid shrubs but note still the low vegetation cover.

4.2 Overview of terrestrial fauna (actual & possible)

As a result of the proximity of mining operations, transformation of the habitat and urban development, the mammal population will be somewhat modified from the natural condition. The available habitat will not be able to sustain the same diversity and biomass of species. However, signs and tracks of mammals are still evident and the presence of watercourses will further increase the available resources for fauna.

Observed fauna or tracks and signs noted in the prospecting areas include the following:

Soil mounds formed by excavations of the Common Molerat (*Cryptomys hotentottus*) are common in most areas. This species is well-adapted to peri-urban areas and is a common generalist which is consequently not of high conservation value.

Burrows of the protected Antbear (*Orycteropus afer*) occur in the western prospecting areas but seems to be abandoned. The species is of some conservation value but should easily be able to vacate the area to surrounding natural areas should it be affected by prospecting operations.

Tracks of Porcupine *(Hystrix africaeaustralis*) occur in the northern area. This is a generalist species which should be common in the area. It is a widespread and common species which is not considered of high conservation value.

All of these prospecting areas contain small carnivorous mammals such as Yellow Mongoose (*Cinyctis penicilata*) and Ground Squirrel (*Xerus inauris*). These are also generalist species adapted to disturbed areas which is substantiated by the extensive colonies which inhabit the eastern area, one of the most disturbed of the areas. They are therefore not considered to be of significant conservation value.

It is also considered likely that several mammal species were overlooked during the survey but owing to the degraded condition of the site due to previous mining as well as the surrounding urban areas it is considered unlikely that any rare or endangered species would occur on the site.

The most significant impact on mammals anticipated on the site itself is primarily concerned with the loss and fragmentation of available habitat. Transformation of the natural vegetation on the site will result in a decrease in the population size as available habitat decreases. However, as discussed, the available habitat is already transformed and mammal population would be much diminished from the natural condition. This will significantly decrease the impact associated with

the proposed prospecting operations. Given that adequate rehabilitation is undertaken the already degraded habitat will again be available to fauna.

Prospecting operations itself may also affect the mammal population and care should therefore be taken to ensure none of the faunal species on site is harmed. The hunting, capturing or harming in any way of mammals on the site should not be allowed. Voids and excavations may also act as pitfall traps to fauna and these should continuously be monitored and any trapped fauna removed and released in adjacent natural areas.

Table 2: Red Listed mammals occurring or likely to occur in the study area (Child *et al* 2016).

Common name	Scientific name	Status
SA hedgehog	*Erinaceus frontalis*	Near Threatened
Pangolin	*Smutsia temminnki*	Vulnerable
Small spotted cat	*Felis nigripes*	Vulnerable
Brown hyena	*Parahyyaena brunnea*	Near Threatened
Leopard	*Panthera pardus*	Vulnerable

It is considered highly unlikely that any of the above species will occur on any of the proposed prospecting areas.

4.3 Wetland and Watercourses Assessment

4.3.1 Introduction

The study area consists of four separate prospecting areas but will affect a single stream system with the northern and western prospecting areas containing small drainage tributaries and the eastern area containing the main stream channel (Map 1 & 2). These separate areas will be discussed below.

The term watercourse refers to a river, stream, wetland or pan. The National Water Act (NWA, 1998) includes rivers, streams, pans and wetlands in the definition of the term watercourse. This definition follows:

Watercourse means:

- A river or spring.
- A natural channel in which water flows regularly or intermittently.
- A wetland, lake or dam into which water flows.
- Any collection of water which the Minister may, by notice in the Gazette, declare to be a watercourse, and a reference to a watercourse includes, where relevant, its bed and banks.

Riparian habitat is an accepted indicator of watercourses used to delineate the extent of wetlands, rivers, streams and pans (Department of Water Affairs and Forestry 2005).

The classification of stream orders from 1 to 3 can be illustrated by means of the Strahler 1952 classification:

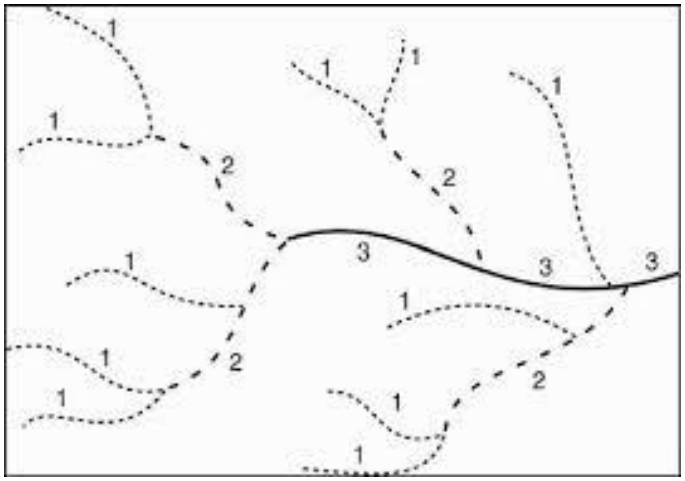

Figure 17: The classification of stream orders from 1 to 3 (Strahler 1952)

4.3.2 Wetland indicators

Obligate wetland vegetation was utilised to determine the presence and border of wetland conditions. Due to time constraints and the extent of the study area soil samples were only used to confirm the presence of wetland conditions where obligate wetland vegetation indicated wetland conditions. Soil samples were investigated for the presence of anaerobic evidence which characterises wetland soils (Appendix C).

Soil samples indicate that the upper reaches of the tributaries formed in the northern and western prospecting areas are devoid of wetland conditions but that this gradually increases and the lower portions within these areas contain clear wetland conditions (Map 1). The formation of wetland conditions are also increased by artificial impoundments and other obstructions such as haul roads and these retain water for longer periods and in so doing causing wetland conditions to form. The main stream located on the eastern prospecting area is located downstream of the above drainage lines and consequently contain much more prominent soil wetness indicators. Furthermore, the increased runoff generated by the surrounding urban area also increases the moisture of the stream. The soil samples in the upstream drainage lines are indicative of wetland conditions only on a seasonal basis. The larger stream system in the eastern prospecting area contain wetland condition on a perennial basis.

These wetland soil indicators were also confirmed in all of these areas by the presence of obligate wetland species. Obligate wetland species are confined to wetlands and cannot occur in conditions outside of these systems. As a result, where they occur, wetland conditions can be considered to occur.

4.3.3 Classification of wetland systems

The wetland conditions identified along the drainage lines and stream system can be classified into specific wetland types.

The wetland conditions associated with the western and northern drainage lines can mostly be characterised as unchanneled valley-bottom wetland systems (SANBI 2009):

“A mostly flat valley-bottom wetland area without a major channel running through it, characterised by an absence of distinct channel banks and the prevalence of diffuse flows, even

during and after high rainfall events. Water inputs are typically from an upstream channel, as the flow becomes dispersed, and from adjacent slopes (if present) or groundwater. Water generally moves through the wetland in the form of diffuse surface flow and/or interflow (with some temporary containment of water in depressional areas), but the outflow can be in the form of diffuse or concentrated surface flow. Infiltration and evaporation from unchannelled valley-bottom wetlands can be significant, particularly if there are a number of small depressions within the wetland area. Horizontal, unidirectional diffuse surface-flow tends to dominate in terms of the hydrodynamics."

This is considered an accurate description of those portions of the drainage lines where wetland conditions form. These wetland conditions are also modified to a significant degree by adjacent tailings dumps which contribute runoff from the steep slopes. Areas where a main channel becomes visible is also present and here it would be better classified as a channelled valley-bottom wetland.

The wetland conditions associated with the eastern stream system can mostly be characterised as a channel wetland system (SANBI 2009):

"An open conduit with clearly defined margins that (i) continuously or periodically contains flowing water, or (ii) forms a connecting link between two water bodies. Dominant water sources include concentrated surface flow from upstream channels and tributaries, diffuse surface flow or interflow, and/or groundwater flow. Water moves through the system as concentrated flow and usually exits as such but can exit as diffuse surface flow because of a sudden change in gradient. Unidirectional channel-contained horizontal flow characterises the hydrodynamic nature of these units. Note that, for purposes of the classification system, channels generally refer to rivers or streams (including those that have been canalised) that are subject to concentrated flow on a continuous basis or periodically during flooding, as opposed to being characterised by diffuse flow (see unchannelled valley-bottom wetland). As a result of the erosive forces associated with concentrated flow, channels characteristically have relatively obvious active channel banks. An active channel is a channel that is inundated at sufficiently regular intervals to maintain channel form and keep the channel free of established terrestrial vegetation. These channels are typically filled to capacity during bankfull discharge (i.e. during the annual flood, except for intermittent rivers that do not flood annually)."

This accurately describes the stream system but is also been modified by the storm water generated by the adjacent urban areas. Wetland conditions are most prominent along the main channel and decrease in distance from the channel.

4.3.4 Description of watercourses

The proposed prospecting areas will affect a small but prominent stream system (Map 1 & 2). The western and northern prospecting areas will both affect two small drainage lines which form tributaries of the downstream main stream system. The eastern prospecting areas will then affect the main stream channel. These different sections of the stream system will be described below.

Obligate wetland vegetation was also used to determine the presence of wetland conditions. Obligate wetland species are confined to wetlands and are only able to occur in wetlands. They are therefore reliable indicators of wetland conditions. Field observations over time as well as the following sources were used to determine FW and OW species:

- Marnewecke, G. & Kotze, D. 1999. Appendix W6: Guidelines for delineation of wetland boundary and wetland zones. In: MacKay (Ed.), H. Resource directed measures for protection of water resources: wetland ecosystems. Department of Water Affairs and Forestry, Pretoria.

- DWAF. 2008. Updated manual for the identification and delineation of wetlands and riparian areas, prepared by M.Rountree, A.L. Batchelor, J. MacKenzie and D. Hoare. Stream Flow Reduction Activities, Department of Water Affairs and Forestry, Pretoria, South Africa.

Drainage line (Western prospecting area)

A very small drainage line originates at the western border of the western prospecting area (Map 1 & 2). It flows from west to east within the site and exits at the eastern border from where it flows into a large artificial impoundment. The drainage line is very small and its main channel is quite indistinct. The flow of the drainage line has also been altered and diverted to some degree by the adjacent tailings dump which has also affected the main channel. The tailings dump contributes a higher velocity and volume of runoff and consequently a very high amount of sediment. This further affects the drainage line. The drainage line is also affected by an old artificial impoundment which has subsequently been removed, two large haul roads and also flows into a large impoundment. All of these causes significant degradation of the drainage line. The upper reach of the drainage line at its origin is not very clear although an indistinct channel is present. The vegetation in the channel is dominated by terrestrial grasses including *Sporobolus fimbriatus, Eragrostis lehmanniana* and *Cynodon dactylon*. These, especially the last named, are considered riparian grasses but indicate the absence of wetland conditions. Other dwarf karroid shrubs include *Eriocephalus ericoides* and *Chrysocoma ciliata* and the herb, *Salvia verbenaca*. None of these are considered riparian or indicative of moisture. The fern, *Ophioglossum polyphyllum*, is indicative of riparian conditions but do not indicate wetland conditions.

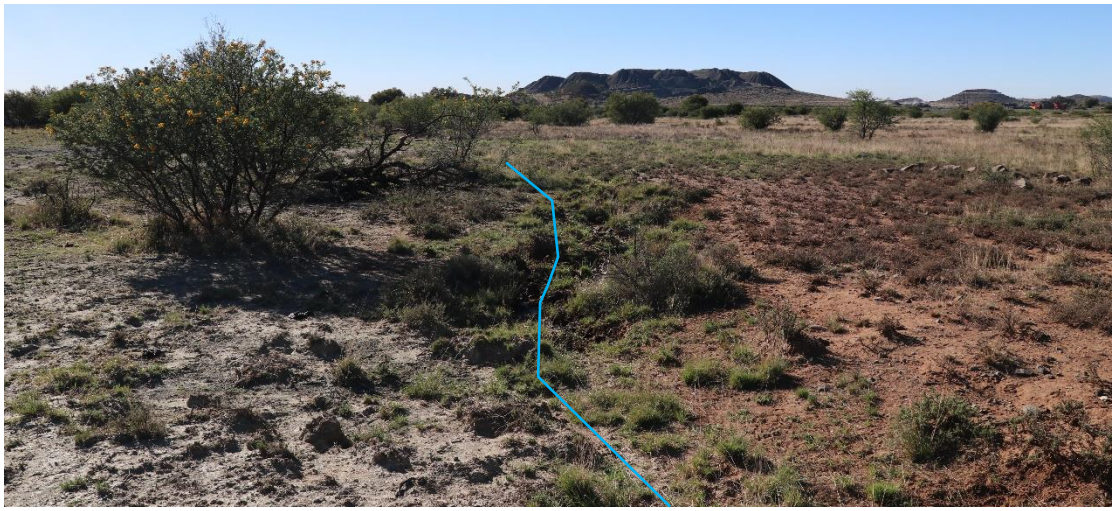

Figure 18: View of the upper reach of the small drainage line. A channel is indistinct but clearly present (blue).

Downstream of the origin and adjacent to the tailing dump the vegetation and geomorphology of the drainage line changes significantly. The establishment of trees increases here, especially *Vachellia karroo*, but also *Searsia pyroides* and *Diospyros lycioides*. The sedge, *Scirpoides dioecus*, and riparian grass, *Sporobolus ioclados*, also occur here and are clear indicators of a

watercourse. Furthermore, although not obligate wetland species they may also indicate the establishment of temporary wetland conditions. Here the main channel also becomes more prominent. The effects of the sediment deposited by the adjacent tailings dumps also becomes more prominent.

Figure 19: It is clear that the main channel becomes more prominent here.

Downstream from the above described section of the drainage line it becomes much more modified, but however, wetland conditions also become prominent. Trees are abundant and dominated by *Vachellia karroo* with other trees including *Ziziphus mucronata*. Where sediment accumulation is high this forms conditions akin to salt pans and the vegetation reflects this with salt tolerant species like *Senecio reptans* and *Chenopodium carinatum* establishing. Where surface water is present the obligate wetland grass, *Paspalum distichum*, rush, *Juncus rigidus* and sedge, *Cyperus marginatus* occurs and are clear indicators that wetland conditions are present. As mentioned, the modification of the drainage line becomes significant here and as a result a variety of exotic trees and weeds have established and include *Schinus molle, Cirsium vulgare, Datura ferox, D. stramonium, Argemone ochroleuca, Hordeum stenostachys, Xanthium spinosum* and *Nicotiana glauca*. This also indicates the modified nature of the drainage line.

Figure 20: Note high levels of sediment being deposited. This also obscures the main channel of the drainage line (blue).

Figure 21: The downstream section becomes heavily modified. Note that a large haul road (red) also causes obstruction of the flow.

Figure 22: Both wetland conditions as well as disturbance increases in the downstream section.

Drainage line (Northern prospecting area)

A small but quite distinct drainage line occurs in the northern prospecting area (Map 1 & 2). It is situated along the eastern and northern borders of the site but it is still likely to be affected by the proposed prospecting operations. The drainage line originates some distance to the north of the site and enters it along the northern border. A smaller tributary also originates on the site to the west of this point of entry and flows into the drainage line here. It is however very indistinct and small but still forms a well-defined watercourse. The main drainage line flow from the north of the site to the south. In the south western portion of the site a large artificial berm or damwall has been erected and the drainage line flows into it forming an extensive artificial impoundment which, due to the flat topography, resembles a large pan. A large tailings dump occurs to the east of the drainage line and also has a high impact on it in terms of sediment deposition. The drainage line is evidently heavily modified. It does not contain a very well defined main channel but has a drainage basin resembling an unchanneled valley-bottom wetland. Due to high levels of overgrazing the vegetation along the drainage line is not easily identified and dominated by a very short grass layer with clumps of sedges and rushes scattered about. It is also likely that the adjacent tailings dump contributes seepage to the drainage line which increases the establishment of wetland conditions and cause it to function as an unchanneled valley-bottom wetland. The grass layer is dominated by *Cynodon dactylon* and *Eragrostis lehmanniana* of which both are terrestrial species with the former being a well-known riparian species. Clumps of the sedge, *Scirpoides dioecus*, and the obligate wetland rush, *Juncus rigidus*, do indicate that

wetland conditions form in some areas of the drainage line. In the downstream section this becomes more prominent where the obligate sedge, *Fuirenia coeroelescens* and grass, *Paspalum distichum* become prominent. The drainage line then flows into the large artificial impoundment. The berm or wall of this impoundment has since been removed and it therefore no longer holds water and the interior of the dam now resembles a pan. A similar habitat has also established consisting of a silt and salt content which encourages the establishment of a pan type vegetation dominated by short grasses. The short grass, *Cynodon incompletus*, dominates the vegetation layer. Other short herbaceous species include *Senecio reptans, Helichrysum lineare, Lobelia thermalis, Phyla nodiflora* and *Arctotis arctothoides*. These are all species establishing in pan habitats and also often along the shores of artificial dams as is the case here. It is clear that this drainage line is also heavily modified form the natural condition.

Figure 23: View of the smaller drainage line along the northern boundary of the site which flows into the larger drainage line at the point of entry at the northern border of the area.

Figure 24: The drainage line does not have a distinct main channel though its flow pattern is clearly visible (blue).

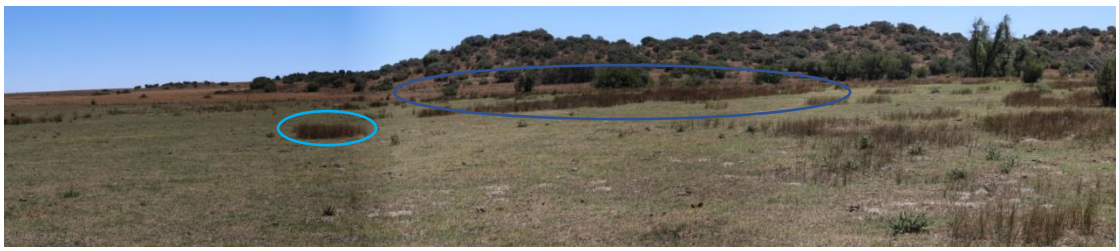

Figure 25: Although wetland conditions are not prominent areas with sedge and rush clumps (blue) must be taken as indicative of wetland conditions.

Figure 26: In the downstream section the drainage line and associated wetland conditions becomes much more prominent.

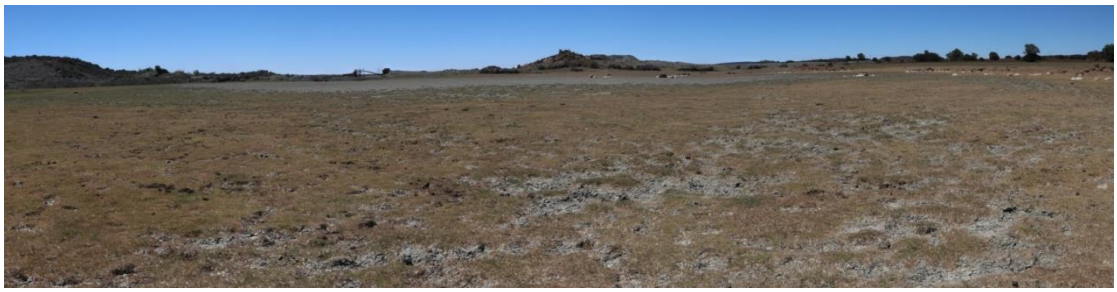

Figure 27: The artificial impoundment has formed a habitat similar to a pan system.

Stream system (Eastern prospecting area)

The eastern prospecting area contains the main stream system (Map 1 & 2). The above described drainage lines are tributaries of the stream but their confluence with the stream is disrupted by the Jagersfontein diamond pit. The stream system transects the entire area from the west to the east and exits the area along the southern border. The stream exits a large impoundment to the west of the site where it has no defined main channel but seeps from the dam as diffuse flow. It is also crossed by the R704 tarred road. From the tarred road the stream enters the prospecting area and here it is situated in close proximity to the surrounding urban areas to the north and south. The stream is heavily degraded in this section. The urban areas generate a significant amount of storm water and this diverted by channels into the stream (Map 1). This runoff is visibly highly polluted and the odour indicates a high likelihood of raw sewage pollution. The higher amount of storm water runoff also alters the flow regime of the steam significantly. Refuse dumping is abundant and will also impact significantly on the stream. Furthermore, overgrazing of the area by domestic stock is high and this will decrease the vegetation cover, increase erosion and will consequently also significantly impact on the sediment load of the stream. From the survey of the stream it is also evident that upstream tailings dumps has also contributed a high amount of sediment to the system. The stream forms a prominent watercourse with clearly defined main channel and evidently transports a significant volume of water. It is clearly heavily modified and degraded but will still provide several important functions. Due to high levels of overgrazing the vegetation along the stream is not easily identified and dominated by a very short grass layer with clumps of sedges and rushes scattered about. The banks and floodplain is dominated by a short grass layer with dwarf shrubs and herbs also abundant. Grasses include *Cynodon dactylon, Panicum coloratum, Eragrostis chloromelas* and *Setaria sphacelata*. The majority of these are riparian species often associated with watercourses. Other herbs and dwarf shrubs common in the floodplain and banks include

Berkheya onopordifolia, Lycium horridum, Arctotis artotheca, Sonchus oleraceus, Gomphocarpus fruticosus, Vahlia capensis and *Helichrysum lucilioides*. These are terrestrial species and not indicative of wetland conditions. The sedge, *Scirpoides dioecus*, is also common and is indicative of a higher moisture regime but is not listed as an obligate wetland species. The main channel is also dominated by a short grass layer, with *Cynodon dactylon* dominating, and obligate wetland sedges. These sedges include *Cyperus marginatus* and *C. longus*. The exotic grass, *Paspalum dilatatum*, is also abundant and a known riparian species along degraded watercourses. Exotic weeds are common and include *Cirsium vulgare, Opuntia humifusa, Cliclospermum leptophyllum* and *Bromus catharticus*.

Figure 28: View of the floodplain and banks of the stream. Note the high amount of refuse.

Figure 29: View of the main channel of the stream. Vegetation is dominated by a short grass layer and clumps sedges. Note the high amount of erosion taking place.

Figure 30: Close-up of the main channel illustrating a high amount of refuse, algae concentrations and an odour which indicates the presence of raw sewage.

4.3.5 Condition and importance of the affected watercourses

The determination of the condition of the watercourses and wetlands in the prospecting areas will be based on an overall determination of the Index of Habitat Integrity (IHI) (Appendix D). As the drainage lines and stream system all form part of the same system, located in close proximity to each other, are affected by the same impacts, situated in the same environmental setting and will all affect the same downstream Prosesspruit. Therefore, one IHI will be conducted for these watercourses to represent the overall condition. This is considered to give a good representation of the condition of the system within the prospecting areas as the affected drainage lines and stream system all drain into the Prosesspruit and will affect the same downstream area. The IHI will be taken as representative of the Present Ecological State (PES) of this system.

Table 3 refers to the determination and categorisation of the Present Ecological State (PES; health or integrity) of various biophysical attributes of rivers relative to the natural or close to the natural reference condition. The purpose of the EcoClassification process is to gain insights and understanding into the causes and sources of the deviation of the PES of biophysical attributes from the reference condition. This provides the information needed to derive desirable and attainable future ecological objectives for the river (Kleynhans & Louw 2007).

Table 4 refers to the Ecological Importance and Sensitivity (EIS) of wetlands. "Ecological importance" of a water resource is an expression of its importance to the maintenance of ecological diversity and functioning on local and wider scales. "Ecological sensitivity" refers to the system's ability to resist disturbance and its capability to recover from disturbance once it has occurred. The Ecological Importance and Sensitivity (EIS) provides a guideline for determination of the Ecological Management Class (EMC).

Table 3: Ecological categories for Present Ecological Status (PES).

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

Table 4: Ecological importance and sensitivity categories.

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

The drainage lines and stream system in the study area has not previously been assessed by the National Freshwater Ecosystems Priority Areas (NFEPA) (Kleynhans 2000), most likely due to their small size.

As already mentioned, the watercourse in the prospecting area has been heavily affected by previous impacts. The drainage lines had been mostly affected by historical mining activities while the stream is mostly affected by urban activities (Map 1). The natural flow pattern of the drainage lines has been modified to some degree as large tailings dumps occur in close proximity which had shifted the main channel to some degree. The most significant impact associated with these dumps are the large volume of fine sediments they deposit into the drainage lines. They contain steep slopes which generate a higher velocity runoff enabling a large volume of sediment to be mobilised and deposited into the drainage lines. This has a high impact and includes altering the riparian habitat, increases the salt concentrations, leading to blockages in the main channel and transforming the vegetation structure and composition. An impact which has a very high impact on the drainage lines are the historical diamond mining pit. This pit is situated in the natural flowpath of the drainage lines and essentially cuts them off from downstream sections. They now drain into the pit and only function in terms of groundwater recharge. This will also affect the downstream stream system as it will now be deprived of the upstream runoff from these drainage lines. Another large impact is the location of several artificial impoundments in both the drainage lines and stream system. This will have a high impact on the flow and flooding regime.

A smaller but still significant impact is several haul roads, tarred roads, dirt tracks and footpaths that cross the stream system. They will all impact in much the same way in terms of flow retardation and therefore altering the flow and flooding regime. Some larger haul roads also do not have adequate drainage systems and will also have a higher impact. The stream system in the eastern prospecting area is also affected by these upstream impacts affecting the drainage lines but the most significant impact on it is associated with the surrounding urban areas. Urban areas contain paved surfaces which prevent infiltration and in so doing significantly increases runoff. This has a high impact in terms of an increase in flow regime and alteration of the functioning of the stream from seasonal to perennial. This runoff generated by urban areas is often highly polluted, as is the case here. Thick algal mats indicate a high nutrient content and odours of the water in the stream indicate the presence of raw sewage. A high amount of refuse is also evident in the stream.

From the above described impacts it should be clear that the affected watercourses are already heavily degraded and modified. An Index of Habitat Integrity (IHI) was conducted for the stream system and affected drainage lines within the proposed prospecting areas. The results of the IHI indicated that the stream system has an Instream IHI of category D: Largely Modified and Riparian IHI of category D: Largely Modified (Appendix D). This is considered relatively accurate and may even be somewhat overestimated. Historical mining as well as the current urban surroundings cause high impacts on the stream system. Despite this the system still provides vital services including water transportation, flood dissipation, wetland and riparian habitat and support of ecological processes. The system should still be regarded as sensitive with a high conservation value and mining should endeavour to keep impacts on it to a minimum. Furthermore, even though the drainage lines have mostly been cut off from the downstream system it still feeds into the groundwater and will influence it in terms of groundwater recharge and any pollutants associated with prospecting activities.

The EI&S of the floodplains associated with the stream system and drainage lines has been rated as being Low/Marginal: Floodplains that are not ecologically important and sensitive at any scale. The biodiversity of these floodplains is ubiquitous and not sensitive to flow and habitat modifications. They play an insignificant role in moderating the quantity and quality of water of major rivers.

4.4 Risk Assessment

A Risk Assessment for the proposed prospecting area has been undertaken according to the Department of Water & Sanitation's requirements for risk assessment and the provisional Risk Assessment Matrix for Section 21(c) & (i) water use (Appendix E). Activities likely to be associated with the prospecting operations include drilling, trenching and bulk sampling in close proximity to watercourses, the possibility of these activities taking place in the watercourses as well as crossing these watercourses by infrastructure associated with the prospecting activities.

Prospecting operations in the main channel of both the stream system and drainage lines is likely to cause permanent modification but only at a local level. Prospecting may involve significant impacts associated with, amongst others, bulk sampling which will still pose a moderate risk and which is likely to cause some modification to these systems. However, prospecting is still confined to smaller areas and is not as extensive as full-scale mining which will decrease the extent of impacts considerably and therefore the risk is anticipated to remain moderate. Furthermore, these systems are already largely modified and therefore the risk will not be as high as when pristine systems are involved. It is still important that a comprehensive rehabilitation

and monitoring regime be implemented to ensure that the functioning of these system are re-instated.

Conducting prospecting operations in close proximity to watercourses is not anticipated to have a significant risk. This is due to the small extent of prospecting and the already highly modified nature of the affected watercourses.

Construction of roads and other infrastructure such as pipelines and canals through watercourses is anticipated to only have a low risk but will still have impacts on these although at a local scale.

Moderate Risks: Risk and impact on watercourses are notable and require mitigation measures on a higher level.

Low Risks: Acceptable as is or consider requirement for mitigation. Impact to watercourses and resource quality small and easily mitigated.

Mitigation as recommended should be implemented as far as possible which should considerably alleviate the risks on watercourse systems in the study area.

For the complete risk assessment please refer to Appendix E.

No.	Phases	Activity	Aspect	Impact	Risk Rating	Confidence level	Control measures
1	Mostly Operational Phase but extending long after closure	Diamond mining prospecting operations	Prospecting operations within the stream system or drainage lines in the prospecting areas.	Prospecting operations within the main channel of the stream system or drainage lines will remove riparian vegetation, transform the soil profile and in so doing will affect the hydrology, geomorphology, flow and flooding regime. Increased establishment of exotic weeds and invaders due to disturbance caused by prospecting is also probable. Although prospecting operations will have a lower risk as compared to full-scale mining the impact is still anticipated to be significant.	**M**	**4**	This impact will be mainly during the operational phase but due to its nature will extend into the closure phase and it is highly likely that the impact will have a permanent impact on the affected watercourses albeit at a local scale. Due to the nature of this activity is likely to permanently affect the watercourses at least to some extent. Should this activity take place it is recommended that a comprehensive rehabilitation plan be compiled and monitoring be constantly applied. Through a comprehensive rehabilitation program it is likely to re-establish functioning watercourses.
	Mostly Operational Phase but also extending to a degree beyond the closure phase		Prospecting operations in close proximity to the stream system or drainage lines in the prospecting areas.	Prospecting operations will require removal of the vegetation layer in the catchment of the watercourses. The extent should however remain low and consequently should also reduce the risk. This activity will most likely alter the flow- and flooding regime and sediment load to some extent. The geomorphology and basic functioning is however anticipated to remain unchanged. Increased establishment of exotic weeds is likely due to disturbance caused by mining.	**L**	4	This impact will be mainly during the operational phase but will only cease once rehabilitation has been completed and an indigenous vegetation layer has become established. This activity is anticipated to have a low risk of impact as long as the adequate mitigation and comprehensive rehabilitation is adhered to. The extent of prospecting activities is anticipated to remain low which will restrict the anticipated impacts. Measures must be implemented to minimise the amount of sediment entering the watercourses. Comprehensive rehabilitation should be applied and should aim to re-instate the natural topography and establish an indigenous vegetation layer.
	Mostly operational phase		Construction of roads and infrastructure through the stream system and drainage lines.	Construction of roads and infrastructure over watercourses and wetlands will also cause disturbance although on a local scale. These structures will act as flow barriers and will alter the hydrology of these systems. Increased erosion, sediment load and exotic weed establishment is also likely.	**L**	4	The impact will be largely confined to the operational phase as long as roads and infrastructure are removed and rehabilitated. This is likely reversible impacts and therefore has a low risk. It is still of paramount importance that adequate rehabilitation and monitoring thereof takes place. Mitigation should include the correct design of roads and structures so that they not act as flow barriers and minimise disturbance to the flow regime. Rehabilitation and monitoring should be comprehensive and should aim to remove all structures, re-instate the watercourse or wetland morphology and establish an indigenous vegetation layer. Watercourses being linear by nature is almost unavoidable

5. Biodiversity Sensitivity Rating (BSR)

Habitat diversity and species richness:
Habitat diversity is considered only moderate. As a result of four separate prospecting areas which includes plains, ridges and a small hill as well as the inclusion of watercourses this increases the habitat diversity. However, previous mining has altered the habitat significantly and this has also decreased the species diversity which is relatively low in most areas.

Presence of rare and endangered species:
No rare or endangered species were encountered in the area and due to the degraded condition of the habitat it is considered unlikely that any such species would occur here. The region is also not known to contain a high amount of such species. Only two protected species were encountered. These are *Olea europaea* subsp. *africana* and *Haemanthus humilis*. *Olea europaea* subsp. *africana,* occurs but is also a consequence of historical delving boulder piles which promote the establishment of trees. The species is widespread and common and not of high conservation value. However, it is still recommended that where prospecting operations will affect them the necessary permits be obtained to remove them. *Haemanthus humilis* is also considered uncommon and therefore of significant conservation value. It is confined to the low dolerite ridge along the western border of the northern prospecting area and should be easily avoided by prospecting operations. Where specimens will be affected by prospecting the necessary permits should be obtained to transplant them to an adjacent area where they will remain unaffected.

Ecological function:
The ecological function of the site has been altered to a significant degree. The site functions as habitat for a variety of fauna, supports a specific vegetation type and stream system and drainage lines forming part of the site also provides important functions in terms of water transportation, wetland and riparian habitats and bio-remediation. The vegetation type on the site has been transformed to a significant degree by historical mining and overgrazing by domestic stock and the resultant habitat provided to fauna is also altered and unable to sustain the natural population. The functioning of the watercourses has been shown to be largely modified but is still considered a sensitive system.

Degree of rarity/conservation value:
According to Mucina & Rutherford (2006) the area consists of Xhariep Karroid Grassland (Gh 3). This vegetation type is currently listed as being of Least Concern (LC) within 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. Furthermore, previous mining and overgrazing causes significant transformation of the natural vegetation type.

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 watercourses and wetlands.

Although degraded the affected stream system and drainage lines still play important roles in terms of water transportation, riparian and wetland habitat, bio-remediation and groundwater recharge and is therefore considered to have a high conservation value.

Percentage ground cover:
The region is in an arid area with a low annual rainfall. As a result the percentage ground cover is relatively low. However, previous mining and sustained overgrazing significantly decreases this even further.

Vegetation structure:
The vegetation structure is dominated overall by a grass layer with prominent dwarf karroid shrub layer. This is considered natural but has been altered significantly by previous mining operations which increases the tree establishment and current high levels of overgrazing which decreases the grass layer and increases the establishment of herbaceous species.

Infestation with exotic weeds and invader plants:
Several exotic weeds and invader species has established mostly due to the disturbance caused by previous mining and overgrazing by domestic stock.

Degree of grazing/browsing impact:
Several of the prospecting areas are utilised as grazing for domestic stock with some areas being subjected to communal grazing. As a result this impact is high, especially in the eastern prospecting area.

Signs of erosion:
Signs of erosion is relatively high. Adjacent tailing dumps experience high levels of erosion and contribute high sediment loads to the prospecting area, especially the affected watercourses. Due to high levels of overgrazing, trampling is also high and also leads to significant erosion. This is especially evident in the eastern prospecting area where the stream system is also affected by high levels of gulley erosion.

Terrestrial animals:
As a result of the proximity of prospecting operations, transformation of the habitat and urban development the mammal population will be somewhat modified from the natural condition. The available habitat will not be able to sustain the same diversity and biomass. However, signs and tracks of mammals are still evident and the presence of watercourses will further increase the available resources for fauna. It is also considered likely that several mammal species were overlooked during the survey but owing to the degraded condition of the site due to previous mining as well as the surrounding urban areas it is considered unlikely that any rare or endangered species would occur on the site.

Table 5: Biodiversity Sensitivity Rating for the Jagersfontein prospecting areas.

	Low (3)	Medium (2)	High (1)
Vegetation characteristics			
Habitat diversity & Species richness		2	
Presence of rare and endangered species		2	
Ecological function		2	
Uniqueness/conservation value		2	
Vegetation condition			
Percentage ground cover	3		
Vegetation structure		2	
Infestation with exotic weeds and invader plants or encroachers		2	
Degree of grazing/browsing impact	3		
Signs of erosion	3		
Terrestrial animal characteristics			
Presence of rare and endangered species	3		
Sub total	12	12	0
Total		24	

6. Biodiversity Sensitivity Rating (BSR) interpretation

Table 10: Interpretation of Biodiversity Sensitivity Rating.

Site	Score	Site Preference Rating	Value
Jagersfontein prospecting areas	24	Degraded	3

7. Anticipated impacts

The proposed prospecting operations is proposed at four separate areas around the town of Jagersfontein (Map 1). This area has already been subjected to several large impacts including previous mining, urban areas and overgrazing and this will decrease the anticipated impacts to some degree.

The main impacts will be associated with the loss of habitat and also associated impacts on the watercourses in the study area.

The prospecting operations will include activities such as drilling, trenching and bulk sampling and will necessitate clearing the vegetation layer, stripping topsoil and excavating large volumes of material to varying depths. The main impact will therefore be the loss of vegetation, vegetation type and consequently habitat. Prospecting is however much lower in extent compared to full-scale mining and the impact should therefore also be lower. The vegetation type, and therefore habitat, to be affected is currently listed as being of Least Concern and is therefore not of high conservation value (Map 2). Furthermore, previous mining activities, urban development and high levels of overgrazing has caused significant transformation of the natural habitat (Map 1). As a result the loss of this vegetation and habitat in the study area cannot be considered as high.

No rare or endangered species were encountered in the area and due to the degraded condition of the habitat it is considered unlikely that any such species would occur here. The region is also not known to contain a high amount of such species. Only two protected species were encountered. These are *Olea europaea* subsp. *africana* and *Haemanthus humilis*. *Olea europaea* subsp. *africana,* occurs but is also a consequence of historical delving boulder piles which promote the establishment of trees. The species is widespread and common and not of high conservation value. However, it is still recommended that where prospecting operations will affect them the necessary permits be obtained to remove them. *Haemanthus humilis* is also considered uncommon and therefore of significant conservation value. It is confined to the low dolerite ridge along the western border of the northern prospecting area and should be easily avoided by prospecting operations. Where specimens will be affected by prospecting the necessary permits should be obtained to transplant them to an adjacent area where they will remain unaffected. Should the above recommended mitigation be adhered to the impact on protected species should remain low.

The impacts that prospecting will have on the stream system and drainage lines will primarily affect the instream and riparian habitat due to watercourse bed degradation, increased suspended sediment and changes in the watercourse morphology and hydraulics. It is important that rehabilitation is comprehensive and successful and that the prevalent impacts as listed be managed and mitigated adequately. Historical mining as well as the current urban surroundings cause high impacts on the stream system. Despite this the system still provides vital services including water transportation, flood dissipation, wetland and riparian habitat and support of ecological processes. The system should still be regarded as sensitive with a high conservation value and mining should endeavour to keep impacts on it to a minimum. Furthermore, even though the drainage lines have mostly been cut off from the downstream system it still feeds into the groundwater and will influence it in terms of groundwater recharge and any pollutants associated with prospecting activities. Therefore impacts on these watercourses will still be significant. As a result strict mitigation measures will have to be implemented to ensure that impacts are kept to a minimum. Predicted impacts include increased sedimentation of watercourses, increased establishment of weeds and invaders and increased erosion due to

clearance of vegetation and disturbance of the soil profile. It is recommended that prospecting activities be excluded from the watercourses as described in this report as far as possible and where mining within watercourses are desired strict adherence to a comprehensive rehabilitation and monitoring plan should be adhered to. Mining operations within 100 meters or within the floodplain of watercourses and within 500 meters of wetland areas will require authorisation from DWS.

As was observed during the survey of the study area it contains several exotic weeds and invader species. As a result proposed prospecting operations will create conditions highly susceptible to the establishment of exotic weeds and invaders. Without mitigation this is anticipated to be a significant impact. Monitoring of weed establishment should form a prominent part of management of the prospecting area. 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 most significant impacts that mining operations will have on the faunal population is primarily concerned with the loss and fragmentation of available habitat. This will also place pressure on the population and will ultimately lead to a decrease in the population size, i.e. X amount of habitat is only able to sustain Y number of mammals. Therefore, transformation of habitat by prospecting will lead to a decrease in the mammal population. However, as discussed, the available habitat is already degraded with large portion being transformed and the mammal population would be much diminished from the natural condition. In addition, provided that adequate rehabilitation is undertaken the area will again be available to most generalist species as suitable habitat. Therefore, the resulting impact of clearing the vegetation for prospecting cannot be considered to have a high impact on the mammal population. In order to ensure no direct impact on the mammals on the site occur the hunting, capturing or trapping of mammals on the site should be strictly prohibited.

The impact significance has been determined and it is clear that most impacts prior to mitigation will be predominately moderate but can be decreased significantly with mitigation to low/moderate.

Please refer to Appendix F 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	4	3	3.3	3	4	3.5	11.5
Loss of protected species	4	5	3	4	4	3	3.5	14
Loss of watercourses	4	5	4	4.3	4	3	3.5	15
Infestation with weeds and invaders	4	4	3	3.6	4	3	3.5	12.6
Impact on Terrestrial fauna	3	4	3	3.3	3	3	3	10
After mitigation								
Loss of vegetation type and clearing of vegetation	3	3	3	3	3	3	3	9
Loss of protected species	1	5	3	3	1	1	1	3
Loss of watercourses	3	3	3	3	4	3	3.5	10.5
Infestation with weeds and invaders	2	2	3	2.3	3	2	2.5	5.7
Impact on Terrestrial fauna	3	4	3	3.3	3	3	3	10

8. Discussion and conclusions

The four areas proposed for prospecting operations has been rated as being degraded which is mostly as a result of previous mining operations, urban development and high levels of overgrazing.

According to Mucina & Rutherford (2006) the area consists of Xhariep Karroid Grassland (Gh 3). This vegetation type is currently listed as being of Least Concern (LC) within 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. Furthermore, previous mining and overgrazing causes significant transformation of the natural vegetation type.

The proposed prospecting areas consist of four separate areas situated around and in the vicinity of the historical diamond mining areas (Map 1). A Biodiversity Management Plan dated March 2013 was previously conducted for this area and will also be utilised to provide information on these prospecting areas. A small but prominent stream drains the area and will be affected by several of the prospecting areas. The extent of the four separate prospecting areas are approximately 40, 35, 2 and 70 hectares.

All of the prospecting areas still contain at least a portion of relative natural vegetation though it is clear that historical delving activities has caused some alteration of the ecosystem. In addition, all of these areas, except the easternmost prospecting area, also contain large portions which are heavily modified by previous mining activities including haul roads, berms, artificial impoundments and large amounts of sediment deposits (Map 1). The easternmost prospecting area, although not affected by previous mining activities, is also heavily degraded but mostly due to the proximity of urban areas and affected by amongst others rubbish dumping, polluted storm water runoff and heavy overgrazing by domestic stock (Map 1).

Western prospecting area
The westernmost prospecting area consists of mostly natural vegetation in the western portion but which becomes progressively transformed toward the eastern portion (Map 1). The species diversity is not significant and no rare or endangered species were observed. Owing to the degraded condition such species is considered unlikely to occur. One protected species, *Olea europaea* subsp. *africana,* occurs but is also a consequence of historical delving boulder piles which promote the establishment of trees. The area does not contain any ecological elements of high significance and due to its already degraded condition it is not anticipated that prospecting operations will have a high impact. However, the small drainage line does retain a significant conservation value.

Central small hill
The central small hill prospecting area has been heavily modified by previous excavations on the site (Map 1). The species diversity is very low, the habitat is heavily modified and no rare or endangered species were observed. Owing to the degraded condition such species is considered unlikely to occur. One protected species, *Olea europaea* subsp. *africana,* occurs but is also a consequence of historical delving boulder piles which promote the establishment of trees. The area does not contain any ecological elements of high significance and due to its already degraded condition it is not anticipated that prospecting operations will have a high impact.

Northern prospecting area
The northern prospecting area contains a large portion consisting of natural vegetation with the south eastern portion having been transformed by an artificial impoundment (Map 1). Two drainage lines are also present along the northern and eastern borders and which will have a high conservation value. The terrestrial portion of the site, although being largely natural, does not contain a high species diversity. However, two protected species do occur, *Olea europaea* subsp. *africana* and *Haemanthus humilis*. No other ecological components, except for the above mentioned drainage lines, of high conservation value occur in this area. Prospecting operations should therefore not have a high impact as long as the discussed protected species are managed appropriately as recommended.

Eastern prospecting area
The eastern prospecting area consists of natural vegetation but which has been extensively degraded by the current high level of overgrazing by domestic stock as well as activities associated with the surrounding urban areas (Map 1). A small but prominent stream transects the area which although it is heavily degraded will still have a high conservation value. Due to the degraded nature of the vegetation in this area the species diversity is low and dominated by pioneer species. No protected, rare or endangered species could be identified and owing to the degraded nature this is highly unlikely. Except for the stream system no other element of ecological importance or conservation value is present. The proposed prospecting operations is therefore not anticipated to have a high impact.

No rare or endangered species were encountered in the area and due to the degraded condition of the habitat it is considered unlikely that any such species would occur here. The region is also not known to contain a high amount of such species. Only two protected species were encountered. These are *Olea europaea* subsp. *africana* and *Haemanthus humilis*. *Olea europaea* subsp. *africana,* occurs but is also a consequence of historical delving boulder piles which promote the establishment of trees. The species is widespread and common and not of high conservation value. However, it is still recommended that where prospecting operations will affect them the necessary permits be obtained to remove them. *Haemanthus humilis* is also considered uncommon and therefore of significant conservation value. It is confined to the low dolerite ridge along the western border of the northern prospecting area and should be easily avoided by prospecting operations. Where specimens will be affected by prospecting the necessary permits should be obtained to transplant them to an adjacent area where they will remain unaffected. Should the above recommended mitigation be adhered to the impact on protected species should remain low.

The proposed prospecting areas will affect a small but prominent stream system (Map 1). The western and northern prospecting areas will both affect two small drainage lines which form tributaries of the downstream main stream system. The eastern prospecting areas will then affect the main stream channel.

Soil samples indicate that the upper reaches of the tributaries formed in the northern and western prospecting areas are devoid of wetland conditions but that this gradually increases and the lower portions within these areas contain clear wetland conditions (Map 1, Appendix C). The formation of wetland conditions are also increased by artificial impoundments and other obstructions such as haul roads and these retain water for longer periods and in so doing causing wetland conditions to form. The main stream located on the eastern prospecting area is located downstream of the above drainage lines and consequently contain much more prominent soil wetness indicators. Furthermore, the increased runoff generated by the surrounding urban area

also increases the moisture of the stream. The soil samples in the upstream drainage lines are indicative of wetland conditions only on a seasonal basis. The larger stream system in the eastern prospecting area contain wetland condition on a perennial basis.

The wetland conditions associated with the western and northern drainage lines can mostly be characterised as unchanneled valley-bottom wetland systems and the eastern stream system can mostly be characterised as a channel wetland system (SANBI 2009).

From the study of current impacts it is clear that the affected watercourses are already heavily degraded and modified. An Index of Habitat Integrity (IHI) was conducted for the stream system and affected drainage lines within the proposed prospecting areas. The results of the IHI indicated that the stream system has an Instream IHI of category D: Largely Modified and Riparian IHI of category D: Largely Modified (Appendix D). This is considered relatively accurate and may even be somewhat overestimated. Historical mining as well as the current urban surroundings cause high impacts on the stream system. Despite this the system still provides vital services including water transportation, flood dissipation, wetland and riparian habitat and support of ecological processes. The system should still be regarded as sensitive with a high conservation value and mining should endeavour to keep impacts on it to a minimum. Furthermore, even though the drainage lines have mostly been cut off from the downstream system it still feeds into the groundwater and will influence it in terms of groundwater recharge and any pollutants associated with prospecting activities.

The EI&S of the floodplains associated with the stream system and drainage lines has been rated as being Low/Marginal: Floodplains that are not ecologically important and sensitive at any scale. The biodiversity of these floodplains is ubiquitous and not sensitive to flow and habitat modifications. They play an insignificant role in moderating the quantity and quality of water of major rivers.

A Risk Assessment for the proposed prospecting area has been undertaken according to the Department of Water & Sanitation's requirements for risk assessment and the provisional Risk Assessment Matrix for Section 21(c) & (i) water use (Appendix E). Prospecting operations in the main channel of both the stream system and drainage lines is likely to cause permanent modification but only at a local level. Prospecting may involve significant impacts associated with, amongst others, bulk sampling which will still pose a moderate risk and which is likely to cause some modification to these systems. However, prospecting is still confined to smaller areas and is not as extensive as full-scale mining which will decrease the extent of impacts considerably and therefore the risk is anticipated to remain moderate. Furthermore, these systems are already largely modified and therefore the risk will not be as high as when pristine systems are involved. It is still important that a comprehensive rehabilitation and monitoring regime be implemented to ensure that the functioning of these system area re-instated. Conducting prospecting operations in close proximity to watercourses is not anticipated to have a significant risk. This is due to the small extent of prospecting and the already highly modified nature of the affected watercourses. Construction of roads and other infrastructure such as pipelines and canals through watercourses is anticipated to only have a low risk but will still have impacts on these although at a local scale. Mining operations within 100 meters or within the floodplain of watercourses and within 500 meters of wetland areas will require authorisation from DWS.

9. Recommendations

- Where prospecting activities occurs, it is important that comprehensive rehabilitation and monitoring of the rehabilitation takes place. It is therefore recommended that a comprehensive rehabilitation and monitoring plan be compiled and strictly adhered to.

- Only two protected species were encountered. These are *Olea europaea* subsp. *africana* and *Haemanthus humilis* which should be managed as follows:
  - *Olea europaea* subsp. *africana.* It is recommended that where prospecting operations will affect them the necessary permits be obtained to remove them.
  - *Haemanthus humilis* It is confined to the low dolerite ridge along the western border of the northern prospecting area and should be easily avoided by prospecting operations. Where specimens will be affected by prospecting the necessary permits should be obtained to transplant them to an adjacent area where they will remain unaffected.

- Prospecting operations may affect the mammal population and care should therefore be taken to ensure none of the faunal species on site is harmed. The hunting, capturing or harming in any way of mammals on the site should not be allowed.

- Voids and excavations may also act as pitfall traps to fauna and these should continuously be monitored and any trapped fauna removed and released in adjacent natural areas. This should include mammals, reptiles and amphibians.

- It is recommended that prospecting activities be excluded from the watercourses as described in this report (Map 1) as far as possible and where mining within watercourses are desired strict adherence to a comprehensive rehabilitation and monitoring plan should be adhered to.

- A natural riparian vegetation should be re-instated where this was disturbed/removed.

- When excavating in watercourses the upper 30 cm, or topsoil, should be removed together with the vegetation and stored as sods on the site. This will mostly be applicable to areas where wetland conditions are present These should then be replaced on top of the rehabilitated soil surface. Subsoil should be used as backfilling and not as top dressing. Only removed sods and topsoil should be utilised to rehabilitate the bed and bank surface. The soil surface and geomorphology should also be re-instated to its natural condition and shape.

- Watercourses and wetlands should constantly be monitored for erosion, especially where prospecting has occurred in the bed or banks. Where erosion is evident this must be remedied.

- The watercourse bed and bank geomorphology should also be re-instated as far as possible.

- Where steep banks occur and erosion is evidently problematic it is recommended that geotextiles be utilised to stabilise soils. Available options include contouring, berms, gabions and geotextile netting.

- Due to the susceptibility of disturbed areas, especially where watercourses are involved, it is recommended that weed control be judiciously and continually practised. Monitoring of weed establishment should form a prominent part of management of the prospecting areas and should be extended into the rehabilitation phase.

- The necessary authorisations must be acquired from Department of Water and Sanitation (DWS) for prospecting within watercourses and wetlands or within 100 meters or within the floodplain of watercourses and within 500 meters of wetland areas.

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Annexure A: Maps

Wetland delineation map for the proposed diamond prospecting operations around Jagersfontein, Free State Province.

Preparred for:
Jagersfontein Developments (Pty) Ltd

Legend:
- Road network
- Property boundaries
- Prospecting areas
- Watercourses
- Wetland conditions

Map Information

Spheroid: WGS 84

Quantum GIS

Scale: 1:40 000

DPR Ecologists
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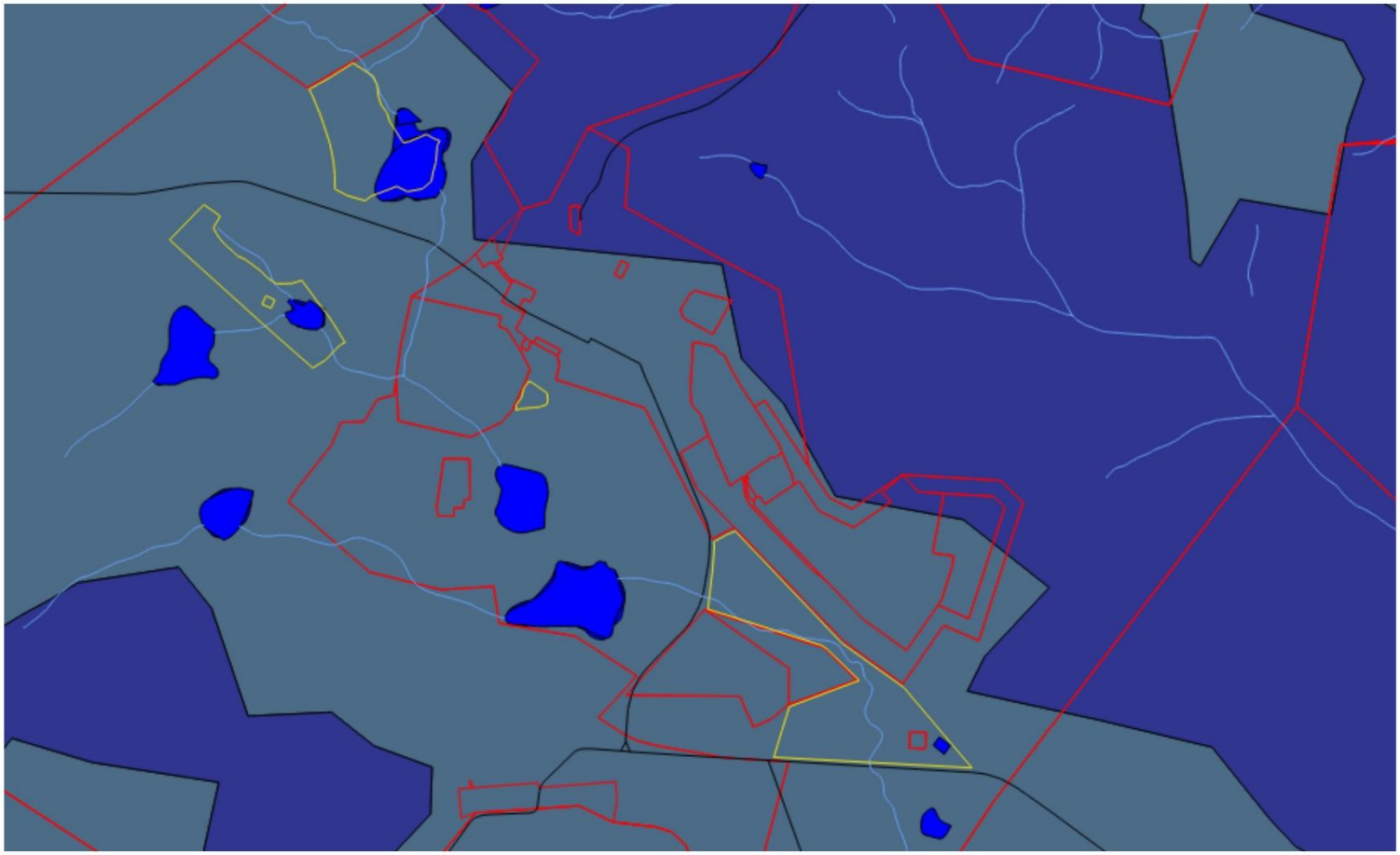
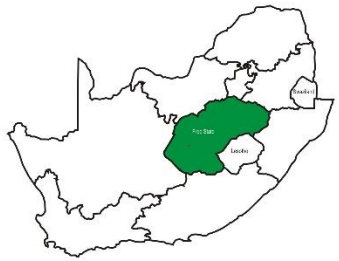
Map 1: Wetland delineation of the proposed diamond prospecting operations around Jagersfontein. Note the tailings dumps and mining activities causing extensive transformation of the area. The urban development associated with Jagersfontein is also visible. Watercourses present in the prospecting areas has been delineated and where wetland conditions has formed this is also indicated. Note that wetland conditions are not able to form in the upper reaches of the drainage lines.

General ecology map for the proposed diamond prospecting operations around Jagersfontein, Free State Province.





Preparred for:
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Legend:
- Road network
- Property boundaries
- Prospecting areas
- Watercourses
- Wetlands and impoundments
- Besemkaree Koppies Shrub
- Xhariep Karroid Grassland
- Threatened Ecosystems

Map Information

Spheroid: WGS 84

Quantum GIS

Scale: 1:40 000

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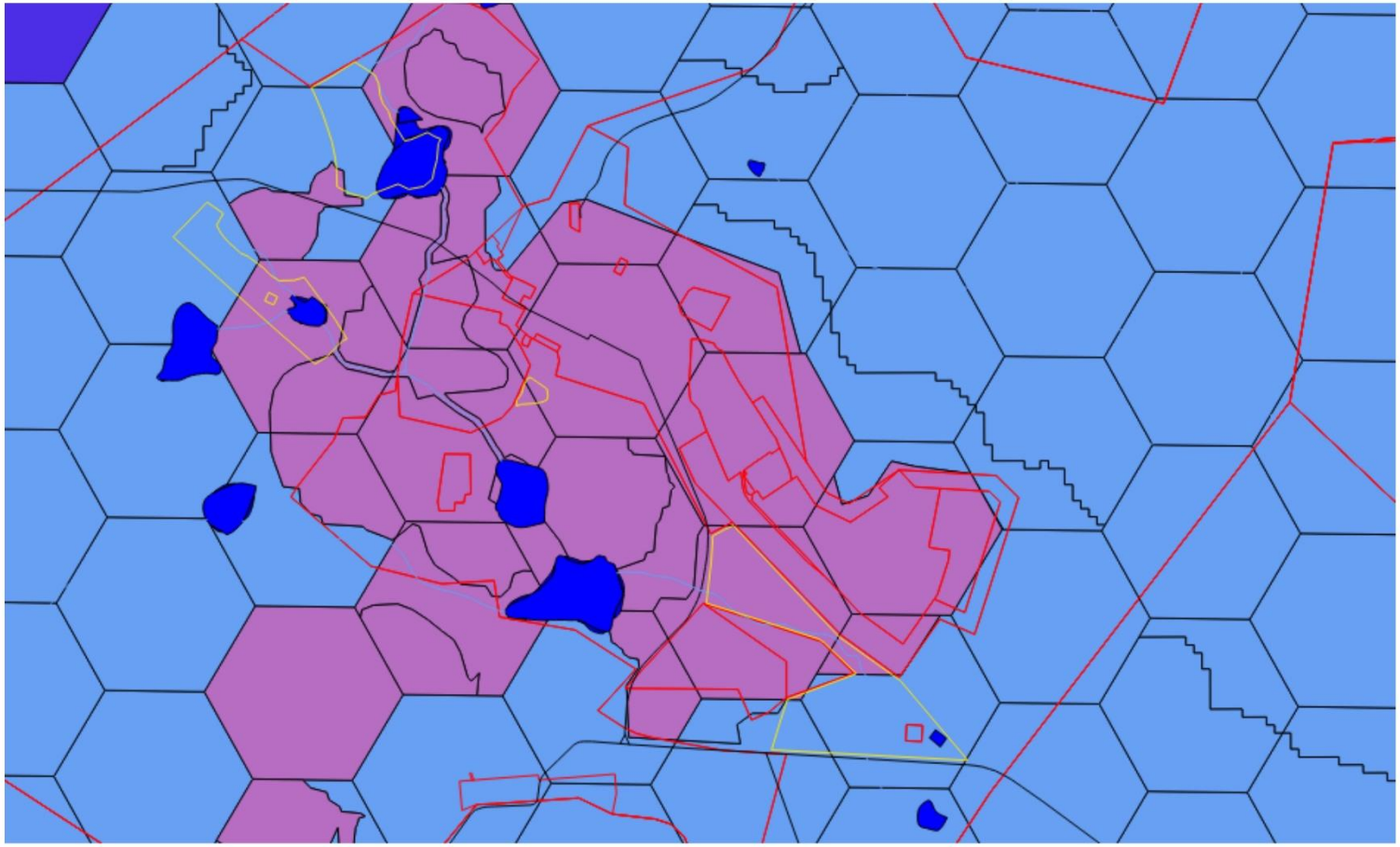
Map 2: General ecology of the proposed diamond prospecting operations around Jagersfontein. The vegetatino types in the area are not currently listed as a Threatened Ecosystem. National Ecosystems Freshwater Priority Areas (NFEPAS) indicate wetlands and watercourses in the area. Although inaccurate it does give a good indication of the presence of surface water and artificial impoundments as indicated in the western and northern prospecting areas.

Free State Biodiversity Plan map for the proposed diamond prospecting operations around Jagersfontein, Free State Province.



Preparred for:
Jagersfontein Developments (Pty) Ltd

Legend:
- Road network
- Property boundaries
- Prospecting areas
- Watercourses
- Wetlands and impoundments
- Critical Biodiversity Area 1
- Critical Biodiversity Area 2
- Ecological Support Area 1
- Ecological Support Area 2
- Degraded

Map Information

Spheroid: WGS 84

Quantum GIS

Scale: 1:40 000

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Map 3: Biodiversity plan map of the proposed diamond prospecting operations around Jagersfontein. The prospecting areas fall within Ecological Support Areas 1 (ESA 1) and 2 (ESA 2) which primarily function in support of the surrounding watercourses.

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
**Alternanthera pungens*	Herb
**Argemone ochroleuca*	Herb
**Bidens bipinnata*	Herb
**Boerhavia cordobensis*	Herb
**Bromus catharticus*	Grass
**Cirsium vulgare*	Herb
**Conyza bonariensis*	Herb
**Cotoneaster franchettii*	Shrub
**Cyclospermum leptophyllum*	Herb
**Cyllindropuntia imbricata*	Succulent
**Datura ferox*	Herb
**Datura stramonium*	Herb
**Eucalyptus camaldulensis*	Tree
**Euphorbia inaequilatera*	Herb
**Hordeum stenostahys*	Grass
**Nicotiana glauca*	Shrub
**Opuntia humifusa*	Succulent
**Paspalum dilatatum*	Grass
**Prosopis glandulosa*	Tree
**Pyracantha angustifolia*	Shrub
**Schinus molle*	Tree
**Xanthium spinosum*	Herb
**Yucca aloifolia*	Succulent
Albuca setosa	Geophyte
Amaranthus sp.	Herb
Amphiglossa triflora	Dwarf shrub
Aptosimum indivisum	Herb
Arctotis arctotoides	Herb
Aristida congesta	Grass
Asparagus larcinus	Shrub/climber
Asparagus suaveolens	Dwarf shrub
Berkheya macrocephala	Herb
Berkheya onopordifolia	Herb
Buddleja saligna	Shrub
Chaenostoma halimifolium	Herb
Chasmatophyllum muscullinum	Succulent
Cheilanthes eckloniana	Fern
Chenopodium carinatum	Herb
Chrysocoma ciliata	Dwarf shrub

Commelina sp.	Herb
Convolvulus sp.	Herb
Conyza podocephala	Herb
Cullen tomentosum	Herb
Cynodon dactylon	Grass
Cynodon incompletus	Grass
Cyperus longus	Sedge
Cyperus marginatus	Sedge
Dimorphotheca cuneata	Dwarf shrub
Dimorphotheca zeyheri	Herb
Diospyros austro-africana	Dwarf shrub
Diospyros lycioides	Shrub
Ehretia rigida	Shrub
Eragrostis chloromelas	Grass
Eragrostis lehmanniana	Grass
Eragrostis obtusa	Grass
Eriocephalus ericoides	Dwarf shrub
Eriocephalus spinescens	Dwarf shrub
Euclea crispa subsp. *ovata*	Shrub
Felicia filifolia	Dwarf shrub
Felicia muricata	Dwarf shrub
Fuirena coerulescens	Sedge
Gnidia polycephala	Dwarf shrub
Gomphocarpus fruticosus	Shrub
Gymnosporia buxiifolia	Shrub
Haemanthus humilis	Geophyte
Helichrysum lineare	Herb
Helichrysum lucilioides	Dwarf shrub
Hermannia coccocarpa	Herb
Hermannia cuneifolia	Dwarf shrub
Hertia pallens	Dwarf shrub
Heteropogon contortus	Grass
Hyparrhenia hirta	Grass
Indegofera alternans	Herb
Jamesbrittenia atropurpurea	Dwarf shrub
Juncus rigidus	Rush
Ledebouria sp.	Geophyte
Lobelia thermalis	Herb
Lycium cinerium	Dwarf shrub
Lycium horridum	Dwarf shrub
Melianthus comosus	Shrub
Melica decumbens	Grass
Melolobium candicans	Dwarf shrub
Moraea palida	Geophyte
Nenax microphylla	Dwarf shrub
Olea europaea subsp. *africana*	Tree

Ophioglossum polyphyllum	Fern
Ornithogalum sp.	Geophyte
Osteospermum scarriosum	Herb
Panicum coloratum	Grass
Paspalum distichum	Grass
Pentzia incana	Dwarf shrub
Pentzia quinquifida	Dwarf shrub
Phyla nodiflora	Herb
Polygala ephedroides	Herb
Psilocaulon sp.	Succulent
Rosenia humilis	Dwarf shrub
Ruschia hamata	Succulent
Salvia disermas	Herb
Salvia stenostachys	Herb
Salvia verbenaca	Herb
Scirpoides dioecus	Sedge
Searsia burchellii	Shrub
Searsia ciliata	Dwarf shrub
Searsia erosa	Shrub
Searsia pyroides	Shrub
Selago albida	Dwarf shrub
Senecio consanguineus	Herb
Senecio reptans	Herb
Setaria sphacelata	Grass
Solanum incanum	Herb
Sonchus oleraceus	Herb
Sporobolus fimbriatus	Grass
Sporobolus ioclados	Grass
Stachys hyssopoides	Herb
Stachys lineare	Herb
Stipagrostis obtusa	Grass
Talinum caffrum	Geophyte
Themeda triandra	Grass
Tragus koelerioides	Grass
Vachellia karroo	Tree
Vahlia capensis	Herb
Wahlenbergia nodosa	Dwarf shrub
Ziziphus mucronata	Tree

Appendix C: Soil Samples Methodology

Obligate wetland vegetation was utilised to determine the presence and border of wetlands. Soil samples were used to confirm the wetland conditions in the study area. Soil samples were investigated for the presence of anaerobic evidence which characterises wetland soils.

Within wetlands the hydrological regime differs due to the topography and landscape. For instance; a valley bottom wetland would have a main channel that is below the water table and consequently permanently saturated, i.e. permanent zone of wetness. As you move away from the main channel the wetland would become dependent on flooding in order to be saturated. As a result along this hydrological regime areas of permanent saturation, seasonal and temporary saturation would occur. At some point along this gradient the saturation of the soil would be insufficient to develop reduced soil conditions and therefore will not be considered as wetland.

Within wetland soils the pores between soil particles are filled with water instead of atmosphere. As a result available oxygen is consumed by microbes and plantroots and due to the slow rate of oxygen diffusion oxygen is depleted and biological activity continues in anaerobic conditions and this causes the soil to become reduced.

Reduction of wetland soils is a result of bacteria decomposing organic material. As bacteria in saturated soils deplete the dissolved oxygen they start to produce organic chemicals that reduce metals. In oxidised soils the metals in the soil give it a red, brown, yellow or orange colour. When these soils are saturated and metals reduced the soil attains a grey matrix characteristic of wetland soils.

Within this reduction taking place in the wetland soils there may be reduced matrix, redox depletions and redox concentrations. The reduced matrix is characterised by a low chroma and therefore a grey soil matrix. Redox depletions result in the grey bodies within the soil where metals have been stripped out. Redox concentrations result in mottles within the grey matrix with variable shape and are recognised as blotches or spots, red and yellow in colour.

Soil wetness indicator is used as the primary indicator of wetlands. The colour of various soil components are often the most diagnostic indicator of hydromorphic soils. Colours of these components are strongly influenced by the frequency and duration of soil saturation. Generally, the higher the duration and frequency of saturation in a soil profile, the more prominent grey colours become in the soil matrix.

Coloured mottles, another feature of hydromorphic soils, are usually absent in permanently saturated soils and are at their most prominent in seasonally saturated soils, becoming less abundant in temporarily saturated soils until they disappear altogether in dry soils (Collins 2005).

The following soil wetness indicators can be used to determine the permanent, seasonal and temporary wetness zones. The boundary of the wetland is defined as the outer edge of the temporary zone of wetness and is characterised by a minimal grey matrix (<10%), few high chroma mottles and short periods of saturation (less than three months per year). The seasonal zone of wetness is characterised by a grey matrix (>10%), many low chroma mottles and significant periods of wetness (at least three months per year). The permanent zone of wetness is characterised by a prominent grey matrix, few to high chroma mottles, wetness all year round and sulphuric odour (rotten egg smell). According to convention hydromorphic soil must display signs of wetness within 50 cm of the soil surface (DWAF 2005).

Table 1: Soil samples taken along a longitudinal transect of the drainage line in the western prospecting area (S 29.763235°, E 25.410497°).

	
Soil sample taken in the main channel of the drainage line where it flows into the artificial impoundment. A prominent grey matrix (>10%) is clear and mottling is present indicating a permanent zone of wetness. Wetland conditions are therefore clearly present.	Soil sample taken in the main channel of the drainage line immediately upstream of the large haul road. A grey matrix (<10%) is clear and mottling is prominent indicating a seasonal zone of wetness. Wetland conditions are therefore clearly present.
	
Soil sample taken in the main channel of the drainage line adjacent to the tailings dump. A grey matrix is largely absent although feint mottling is present and is taken as indicative of a temporary zone of wetness.	Soil sample taken in the upper reach of the drainage line. Note that a high clay content is still present although a grey matrix and mottling is absent and wetland conditions are considered absent here.

Table 2: Soil samples taken along a longitudinal transect of the drainage line in the northern prospecting area (S 29.748166°, E 25.413532°).

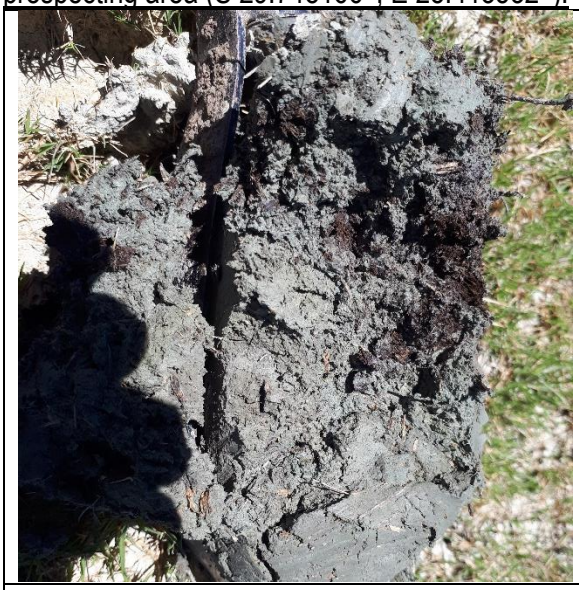	
Soil sample taken in the main channel of the drainage line where it flows into the artificial impoundment. A prominent grey matrix (>10%) is clear and mottling is present indicating a permanent zone of wetness. Wetland conditions are therefore clearly present.	Soil sample taken in the main channel of the drainage line upstream of the impoundment. A grey matrix (<10%) is clear and mottling is prominent indicating a seasonal zone of wetness. Wetland conditions are therefore clearly present.
	
Soil sample taken in the main channel of the drainage line in the upper reach. A grey matrix (<10%) is clear and mottling is prominent indicating a seasonal zone of wetness. Wetland conditions are therefore clearly present.	Soil sample taken in the northern tributary drainage line. Note that although the clay content is still significant a grey matrix and mottling is clearly absent and wetland conditions are not present.

Table 3: Soil samples taken along a longitudinal transect of the stream system in the eastern prospecting area (S 29.785965°, E 25.4444716°).

	
Soil sample taken in the main channel of the stream at the western border of the site. A prominent grey matrix (>10%) is clear and mottling is present indicating a permanent zone of wetness. Wetland conditions are therefore clearly present.	Soil sample taken in the main channel of the stream at the south eastern border of the site. A prominent grey matrix (>10%) is clear and mottling is present indicating a permanent zone of wetness. Wetland conditions are therefore clearly present.
	
Soil sample taken in the main channel of the stream in the central portion of the site. A prominent grey matrix (>10%) is clear and mottling is present indicating a permanent zone of wetness. Wetland conditions are therefore clearly present.	

Appendix D: Index of Habitat Integrity (IHI) Summary

For the complete IHI please contact the author of this report.

UPPER LATITUDE	S 29.747076
UPPER LONGITUDE	E 25.412269
UPPER ALTITUDE	1434 m
LOWER LATITUDE	S 29.785965
LOWER LONGITUDE	S 25.444716
LOWER ALTITUDE	1378 m
SURVEY SITE (if applicable)	Jagersfontein
SITE LATITUDE (if applicable)	
SITE LONGITUDE (if applicable)	
SITE ALTITUDE (if applicable)	
WMA	Upper Orange
QUATERNARY	C51H
ECOREGION 2	26_3
DATE	11/01/2018
RIVER	Unnamed Stream System
TRIBUTARY	Prosesspruit
PERENNIAL (Y/N)	**Y**
GEOMORPH ZONE	**FOOTHILL**
WIDTH (m)	**>0-2**

METRIC GROUP	RATING	CONFIDENCE
HYDROLOGY MODIFICATION	2.7	2.0
PHYSICO-CHEMICAL MODIFICATION	2.5	3.0
BED MODIFICATION	2.8	4.0
BANK MODIFICATION	3.0	3.0
CONNECTIVITTY MODIFICATION	3.0	4.0
INSTREAM IHI%	45.1	
CATEGORY	D	
CONFIDENCE	3.2	

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

METRIC GROUP	RATING	CONFIDENCE
HYDROLOGY	2.79	3.00
BANK STRUCTURE MODIFICATION	2.90	4.00
CONNECTIVITY MODIFICATION	2.50	4.00
RIPARIAN HABITAT INTEGRITY (%)	44.50	
CATEGORY	D	
CONFIDENCE	3.67	

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

	MRU
INSTREAM IHI	
Base Flows	1.5
Zero Flows	-3.0
Floods	3.5
HYDROLOGY RATING	**2.7**
pH	1.5
Salts	3.0
Nutrients	3.0
Water Temperature	2.0
Water clarity	3.0
Oxygen	2.0
Toxics	2.5
PC RATING	**2.5**
Sediment	3.0
Benthic Growth	2.5
BED RATING	**2.8**
Marginal	3.0
Non-marginal	3.0
BANK RATING	**3.0**
Longitudinal Connectivity	3.0
Lateral Connectivity	2.5
CONNECTIVITY RATING	**3.0**
INSTREAM IHI %	**45.1**
INSTREAM IHI EC	**D**
INSTREAM CONFIDENCE	**3.2**

	MRU
RIPARIAN IHI	
Base Flows	2.0
Zero Flows	-3.0
Moderate Floods	3.0
Large Floods	3.5
HYDROLOGY RATING	**2.8**
Substrate Exposure (marginal)	2.0
Substrate Exposure (non-marginal)	2.0
Invasive Alien Vegetation (marginal)	2.0
Invasive Alien Vegetation (non-marginal)	2.0
Erosion (marginal)	3.0
Erosion (non-marginal)	2.0
Physico-Chemical (marginal)	2.5
Physico-Chemical (non-marginal)	2.5
Marginal	3.0
Non-marginal	2.5
BANK STRUCTURE RATING	**2.9**
Longitudinal Connectivity	2.5
Lateral Connectivity	2.5
CONNECTIVITY RATING	**2.5**
RIPARIAN IHI %	**44.5**
RIPARIAN IHI EC	**D**
RIPARIAN CONFIDENCE	**3.7**

Appendix E: Risk Assessment Matrix

RISK MATRIX (Based on DWS 2015 publication: Section 21 c and I water use Risk Assessment Protocol)

Risk to be scored for construction and operational phases of the project. MUST BE COMPLETED BY SACNASP REGISTERED PROFESSIONAL MEMBER REGISTERED IN AN APPROPRIATE FIELD OF EXPERTISE

					Severity															
No.	Phases	Activity	Aspect	Impact	Flow Regime	Physico & Chemical (Water Quality)	Habitat (Geomorph+Vegetation)	Biota	Severity	Spatial scale	Duration	Consequence	Frequency of activity	Frequency of impact	Legal Issues	Detection	Likelihood	Significance	Risk Rating	Confidence level	Control Measures
1	Mostly Operational Phase but extending long after closure	Diamond mining prospecting operations	Prospecting operations within the stream system or drainage lines in the prospecting areas.	Prospecting operations within the main channel of the stream system or drainage lines will remove riparian vegetation, transform the soil profile and in so doing will affect the hydrology, geomorphology, flow and flooding regime. Increased establishment of exotic weeds and invaders due to disturbance caused by prospecting is also probable. Although prospecting operations will have a lower risk as compared to full-scale mining the impact is still anticipated to be significant.	3	4	3	3	3.25	3	4	10.25	4	4	5	2	15	153.75	M	4	This impact will be mainly during the operational phase but due to its nature will extend into the closure phase and it is highly likely that the impact will have a permanent impact on the affected watercourses albeit at a local scale. Due to the nature of this activity is likely to permanently affect the watercourses at least to some extent. Should this activity take place it is recommended that a comprehensive rehabilitation plan be compiled and monitoring be constantly applied. Through a comprehensive rehabilitation program it is likely to re-establish functioning watercourses.
	Mostly Operational Phase but also extending to a degree beyond the closure phase		Prospecting operations in close proximity to the stream system or drainage lines in the prospecting areas.	Prospecting operations will require removal of the vegetation layer in the catchment of the watercourses. The extent should however remain low and consequently should also reduce the risk. This activity will most likely alter the flow- and flooding regime and sediment load to some extent. The geomorphology and basic functioning is however anticipated to remain unchanged. Increased establishment of exotic weeds is likely due to disturbance caused by mining.	1	3	1	1	1.5	2	2	5.5	2	2	5	1	10	55	L	4	This impact will be mainly during the operational phase but will only cease once rehabilitation has been completed and an indigenous vegetation layer has become established. This activity is anticipated to have a low risk of impact as long as the adequate mitigation and comprehensive rehabilitation is adhered to. The extent of prospecting activities is anticipated to remain low which will restrict the anticipated impacts. Measures must be implemented to minimise the amount of sediment entering the watercourses. Comprehensive rehabilitation should be applied and should aim to re-instate the natural topography and establish an indigenous vegetation layer.

	Mostly Operational Phase		Construction of roads and infrastructure through the stream system and drainage lines.	Construction of roads and infrastructure over watercourses and wetlands will also cause disturbance although on a local scale. These structures will act as flow barriers and will alter the hydrology of these systems. Increased erosion, sediment load and exotic weed establishment is also likely.	2	2	3	2	**2.25**	1	2	5.25	2	2	5	1	**10**	**52.5**	**L**	4	The impact will be largely confined to the operational phase as long as roads and infrastructure are removed and rehabilitated. This is likely reversible impacts and therefore has a low risk. It is still of paramount importance that adequate rehabilitation and monitoring thereof takes place. Mitigation should include the correct design of roads and structures so that they not act as flow barriers and minimise disturbance to the flow regime. Rehabilitation and monitoring should be comprehensive and should aim to remove all structures, re-instate the watercourse or wetland morphology and establish an indigenous vegetation layer. Watercourses being linear by nature is almost unavoidable.

Appendix F: 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/even 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.