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Ecological and Wetland Assessment for the proposed diamond prospecting operations on a portion of the Remainder of the farm Remhoogte 152 near Prieska, Northern Cape 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 proposed prospecting areas consist of two separate areas to the north and south of the current mining area which has been subjected to extensive alluvial diamond mining operations. Several studies have previously also been conducted for the existing mining area and will also be utilised to provide background information for the proposed prospecting areas. A large and prominent, though clearly ephemeral, stream system drains the northern portion while a few smaller drainage lines and the Brak River occur in or adjacent to the southern prospecting area. The combined extent of both prospecting areas are approximately 2 500 hectares although the core prospecting areas will exclude a large portion of the northern prospecting area (Map 1). The proposed prospecting areas has not yet been affected by mining operations and impacts on it are relatively low and they are therefore considered to be in a natural and pristine condition.

The southern prospecting area has an approximate extent of 800 hectares. It is bordered along the north by the existing mining area which is largely transformed, a large dirt road borders it along the western border and the Brak River forms the southern border (Map 1). Extensive natural areas occur to the east and south of this portion and extensive centre-pivot irrigation occurs to the west but does not impact on the site. This portion is dominated by a sandy soil surface with vegetation adapted to sandy soils, i.e. grasses, shrubs, herbs and geophytes.

The northern prospecting area has an approximate extent of 1 600 hectares. It is bordered along the south by the existing mining area which is largely transformed and extensive centre-pivot irrigation to the north and west (Map 1). The Orange River is also located close to the western border of the site. Extensive natural areas border the site to the north and east. The portion is dominated by soils with a high percentage rock content and consequently the vegetation is characteristic of such habitats, i.e. small trees, shrubs, grasses and most characteristically dwarf karroid shrubs.

Southern prospecting area

Undulating plains

As mentioned, the undulating plains portion covers the largest portion of the southern prospecting area with a rather uniform topography (Map 2). he area is not currently affected by any significant impact and is still in a natural condition. This increases its conservation value and although it is relatively uniform with a low species diversity it is still considered to be of moderate sensitivity (Map 3). Due to the deeper sandy soils and relatively uniform topography this portion is also considered much more easily rehabilitatable as long as adequate removal of the topsoil, protection thereof and replacement is undertaken.

Calcrete ridge associated with drainage line

Along the eastern border of the undulating plains portion a relatively large calcrete ridge is present (Map 2). The ridge contains several protected species and it is considered likely that others may also be present (Appendix C). The area is not currently affected by any significant impact and is still in a natural condition which increases its conservation value. Should prospecting activities occur in this area it will be difficult to rehabilitate and re-instate the natural vegetation due to the topography and soil/rock composition. As a result of a combination of the above this area is considered to have a high sensitivity and prospecting activities should be kept to a minimum here (Map 3).

Small but prominent ridge

Along the western border of the undulating plains portion a relatively small but prominent ridge is located (Map 2). The vegetation along the ridge is considered relatively uniform and much lower in diversity than the calcrete ridge. Should prospecting activities occur in this area it will be difficult to rehabilitate and re-instate the natural vegetation due to the topography and soil/rock composition. From the above description and conclusions this ridge is evidently of lower conservation value than the calcrete ridge and is consequently considered to only be of moderate sensitivity (Map 3).

Bottomlands associated with the Brak River

The bottomlands associated with the Brak River is situated adjacent to the river and contains a visibly high silt content in many areas (Map 2). The vegetation in this area seem to be relatively uniform with a relatively low species diversity being dominated by a few species. The area is not currently affected by any significant impact and is still in a natural condition. This increases its conservation value and although it is relatively uniform with a low species diversity it is still considered to be of moderate sensitivity (Map 3). Due to the deeper sandy soils and relatively uniform topography this portion is also considered much more easily rehabilitatable as long as adequate removal of the topsoil, protection thereof and replacement is undertaken.

Northern prospecting area

Uneven terrain dominated by hills, ridges and valleys

As mentioned, this portion of very uneven, rocky terrain which is dominated by hills, ridges, clacrete capped mesas and valleys form the largest part of the northern prospecting area (Map 2). It is evident that this portion of the prospecting area is diverse in terms of habitats and as a result also contains a relatively high species diversity. Several protected species also occur in this area with some being considered as relatively rare (Appendix C). Due to the uneven terrain, steep slopes and mobile substrate the area is highly prone to erosion. Consequently, any prospecting activities in this area will highly likely lead to high levels of erosion which will progressively worsen due to the steep slopes. Furthermore, should any prospecting activities occur in this area it will not be possible to rehabilitate and re-instate the natural vegetation due to the topography, steep slopes and soil/rock composition. As a result of a combination of the above this area is considered to have a very high sensitivity and prospecting activities should be excluded from this area as far as possible (Map 3).

Calcrete cliffs at the edge of the uneven terrain

Along the border of the uneven rocky terrain as described above a very steep calcrete cliff separates it from the surrounding plateau which forms a small part of this prospecting area (Map 2). This habitat does not contain a high diversity but does form a unique and highly unstable habitat also containing unique species localised to it. Should prospecting of the cliff habitat take place it will not be possible to rehabilitate or re-instate the habitat. Disturbance of the habitat will also undoubtedly lead to high levels of erosion which will progressively worsen due to the steep slopes. As a result of a combination of the above this area is considered to have a very high sensitivity and prospecting activities should be excluded from this area as far as possible (Map 3).

Plateau

A relatively flat to undulating plateau surrounds the uneven rocky terrain and calcrete cliffs (Map 2). The vegetation of the plateau seem to be relatively uniform and somewhat lower in species diversity compared to the uneven rocky portion. However, several protected species were observed in this area and although they are all relatively widespread, they do retain a significant conservation value (Appendix C). It is relatively uniform with a low species diversity but is still considered to be of moderate sensitivity (Map 3). Due to the even, flatter topography this portion is also considered more easily rehabilitatable with a lower likelihood of severe erosion occurring. It is however unlikely that it will be possible to re-instate the current soil surface to the natural condition due to the soil/gravel surface coverage. Comprehensive topsoil removal, topsoiling, protection and replacement may alleviate this impact.

Wetland and Watercourses Assessment

The study area consists of two separate prospecting areas (Map 1) which will affect two separate watercourse systems, the southern portion will affect the Brak River as well as a small drainage tributary and the northern portion will affect the Diepsloot and associated intricate drainage network as well as two drainage lines to the north and south of it (Map 1 & 2).

From the described impacts it should be clear that the affected watercourses are both in a very good condition and being affected by very few significant impacts. An Index of Habitat Integrity (IHI) was conducted for the Brak River as well as the Diepsloot within the proposed prospecting areas (Appendix E). The results of the IHI indicated that the Brak River has an Instream IHI of category B: Largely Natural and Riparian IHI of category C: Moderately Modified. This is mostly due to the infestation by exotic *Prosopis glandulosa* which cause moderate modification of the riparian community. The results of the IHI indicated that the Diepsloot has an Instream IHI of category B: Largely Natural and Riparian IHI of category B: Largely Natural. Although the irrigated plantation is a significant impact it only affects the lower reach of the stream whilst almost the entire stream is unaffected by any significant impacts. These watercourses will therefore provide several vital services including water transportation, flood dissipation, wetland and riparian habitat and support of ecological processes. Both watercourses should therefore be regarded as having a very high sensitivity with a high conservation value and any prospecting activities should therefore be excluded from them (Map 3). As these watercourses are also direct tributaries of the Orange River near the site they will also increase the resilience of this river and alleviate any impacts on it and this will even further increase their importance.

The EI&S of the floodplains associated with both the Brak River and Diepsloot has been rated as being 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. The Brak River was rated somewhat higher than the Diepsloot due to the its larger size and therefore higher habitat and species diversity, importance for migratory species, etc.

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 F).

Prospecting in the main channel of both the Brak River and Diepsloot will undoubtedly cause permanent modification of these systems but only at a local level. However, owing to their highly sensitive nature as described in previous sections of the study this will have unacceptably high risk to these systems and it is therefore recommended that prospecting operations avoid both the Brak River and Diepsloot as well as all drainage lines and tributaries associated with them (Map 3). The catchment of the Diepsloot consists of a highly uneven, rocky terrain which, although the soil surface is stable currently, will lead to high levels of erosion should prospecting occur and it is unlikely to be contained or rehabilitated and will lead to a high risk of modifying the stream system. It is therefore recommended that prospecting operations avoid the uneven, rocky catchment of the stream (Map 3). Conducting prospecting operations in close proximity to the Brak River is anticipated to have a moderate risk and will likely still have significant impacts though unlikely to be permanent and will mostly influence sediment load and runoff values. This is due to the more even topography which is much more likely to be successfully rehabilitated and the susceptibility to erosion also much lower. Furthermore, through adequate mitigation this can be minimised and provided adequate rehabilitation is undertaken no additional and other permanent modification to the functioning of the Brak River is anticipated. The Brak River forms the southern border of the prospecting area and is therefore unlikely to be crossed by any infrastructure. However, its associated drainage line, the Diepsloot and all other tributaries and associated drainage lines may be crossed by infrastructure such as roads and pipelines. Construction of roads and other infrastructure such as pipelines and canals through watercourses and wetland systems is anticipated to still have a moderate risk and will still have impacts on these although at a local scale. Furthermore, watercourses being linear by nature is almost unavoidable although circular wetland systems are much more easily avoided.

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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.

In order to better manage our water resources several guidelines and research sources have been developed. Amongst these are the National Freshwater Ecosystem Priority Areas for South Africa 2011 (NFEPA).

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 two separate areas to the north and south of the current mining area which has been subjected to extensive alluvial diamond mining operations. Several studies have previously also been conducted for the existing mining area and will also be utilised to provide background information for the proposed prospecting areas. A large and prominent, though clearly ephemeral, stream system drains the northern portion while a few smaller drainage lines and the Brak River occur in or adjacent to the southern prospecting area. The combined extent of both prospecting areas are approximately 2 500 hectares although the core prospecting areas will exclude a large portion of the northern prospecting area (Map 1). The proposed prospecting areas has not yet been affected by mining operations and impacts on it are relatively low and they are therefore considered to be in a natural and pristine condition.

A site survey of the study area was conducted on 18 to 20 February 2019. The entire study area including both prospecting areas were surveyed. The survey was conducted during late summer and after significant rainfall occurred in this arid region which enabled 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 proposed prospecting operations

The prospecting operations will take place as a phased approach with prospecting initiated by a non-invasive desktop study which will include a literature survey, aerial photography and satellite image interpretation and ground validation of targets in the first year. The subsequent phases will be invasive in nature and will include pitting and trenching to determine grade and quality. The most invasive process will entail bulk sampling to determine the economic viability of the potential deposit.

The total duration of the prospecting and evaluation activities is planned for five years.

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

- Although sufficient rainfall had recently occurred it is still likely that several deciduous, annual and subterranean species, were overlooked or not currently present.
- The region contains several inconspicuous and camouflaged succulent species which are difficult to observe and it is possible that some of these were overlooked.
- 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 (Adams 1976, Bromilow 1995, 2010, Coates-Palgrave 2002, Court 2010, Fish *et al* 2015, Gerber *et al* 2004, Gibbs Russel *et al* 1990, Hartmann 2001, Manning 2009, Roberts & Fourie 1975, Shearing & Van Heerden 2008, Smith *et al* 1998, Smith & Crouch 2009, Smith & Van Wyk 2003, Van Ginkel *et al* 2011, Van Oudtshoorn 2004, Van Rooyen 2001, Van Wyk & Malan 1998).

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

Previous studies of the surrounding region:
(Milne 2015, Oosthuizen *et al* 2015, Rossouw 2016, Van Schalkwyk 2011)

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 D).
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 study area consists of Northern Upper Karoo (NKu 3) and Upper Gariep Alluvial Vegetation (AZa 4). Both vegetation types are 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 4). Except for the situation in the immediate area they are not currently subjected to pronounced development pressures.

The proposed prospecting areas consist of two separate areas to the north and south of the current mining area which has been subjected to extensive alluvial diamond mining operations. Several studies have previously also been conducted for the existing mining area and will also be utilised to provide background information for the proposed prospecting areas. A large and prominent, though clearly ephemeral, stream system drains the northern portion while a few smaller drainage lines and the Brak River occur in or adjacent to the southern prospecting area. The combined extent of both prospecting areas are approximately 2 500 hectares although the core prospecting areas will exclude a large portion of the northern prospecting area (Map 1). The proposed prospecting areas has not yet been affected by mining operations and impacts on it are relatively low and they are therefore considered to be in a natural and pristine condition.

The southern prospecting area has an approximate extent of 800 hectares. It is bordered along the north by the existing mining area which is largely transformed, a large dirt road borders it along the western border and the Brak River forms the southern border (Map 1). Extensive natural areas occur to the east and south of this portion and extensive centre-pivot irrigation occurs to the west but does not impact on the site. This portion is dominated by a sandy soil surface with vegetation adapted to sandy soils, i.e. grasses, shrubs, herbs and geophytes.

The northern prospecting area has an approximate extent of 1 600 hectares. It is bordered along the south by the existing mining area which is largely transformed and extensive centre-pivot irrigation to the north and west (Map 1). The Orange River is also located close to the western border of the site. Extensive natural areas border the site to the north and east. The portion is dominated by soils with a high percentage rock content and consequently the vegetation is characteristic of such habitats, i.e. small trees, shrubs, grasses and most characteristically dwarf karroid shrubs.

The proposed prospecting areas are both almost entirely natural with few impacts.

The southern area is entirely natural with the only visible impacts being associated with stock farming and includes fencelines, a few dirt tracks, stock feeding- and watering points and a borehole with windmill and dam. A small area, approximately 0.5 hectares in extent, near the western border consist of an old borrow pit and which is consequently transformed. Another small portion, approximately 0.4 hectares in extent, along the southern border adjacent to the Brak River consists of a cleared area most probably associated with sand stockpiling and is also transformed. These above impacts are however not considered as high impacts and the area is consequently still largely natural.

The northern area is also mostly natural although a significant portion has been transformed by an irrigated pecan nut plantation with an approximate extent of 110 hectares. The majority of the area is however also associated with stock farming and much the same impacts as in the southern area are associated with it, i.e. fencelines, a few dirt tracks, stock feeding- and watering points and a borehole with windmill and dam. Except for the pecan nut plantation, the impacts in this area are also not significant and is still largely natural.

The study area is situated in the Nama Karoo Biome (Map 4) which is characterised by shallow, rocky soils and vegetation dominated by low shrubs/small trees but most prominently dwarf karroid shrubs. A grass layer is also present but not dominant. This is the dominant situation in the northern prospecting area. The southern prospecting area also has some affinity with the Savannah Biome which is situated across the Orange River to the north. This area includes deeper sandy soils and although a tree component, diagnostic of the Savannah Biome, is largely absent the area contains a much higher dominance by grasses. A much more detailed description of the vegetation will however be given in the following sections for each of the two prospecting areas.

The topography of the study area is highly variable with northern area being the most uneven, rocky terrain.

The topography of the southern prospecting area is undulating with flowing landscape mostly devoid of prominent hills or ridges (Map 1, 2 & 4). It contains a gradual but definite slope from the north to the south and is associated with the catchment of the Brak River which forms the southern border of the area. The elevation of the site decreases steadily toward the south and forms a bottomland associated with the Brak River. The elevation of this portion varies from 1022 m in the north and decreases to 942 m in the south and also clearly indicates a gradual slope over a large distance. Two prominent topographical units within this area are a calcrete outcrop along the eastern border also associated with a small drainage line and a low stony ridge along the eastern border. The Brak River is also a very important topographical feature and although situated outside the site boundary will still be included within the wetland assessment.

The topography of the northern prospecting area is very uneven and dominated by hills and ridges with calcrete cilffs and -capped mesas all linked to a complex stream system associated with a bottomland with high silt content (Map 1, 2 & 4). The stream system is the Diepsloot and drains the entire prospecting area. It flows into the Orange River adjacent to the western border of the site. Although the terrain is highly uneven the general direction of slope is from east to west and follows the drainage pattern of the Diepsloot. A flat plateau surrounds this uneven terrain or valley system associated with the Diepsloot. The elevation is highly variable but is at its maximum along the plateau or mesas at around 1040 m and decreases to 946 m where the Diepsloot exits the site along the western border.

The prospecting area is situated in a dry region with a harsh climate, consisting of cold, dry winters and hot, semi-dry summers. Due to elevation characteristics as well as hydrological zone characteristics rainfall and evaporation data from the weather station D70E001 (Boegemos) are presented here. The region experiences average midday temperatures between 19.2°C (in June) and 35.1°C in January. The coldest temperatures are recorded in July (average of 1°C) at night. The area receives 37 frost days on average per year. Prieska receives between 200 and 300 mm of rain annually, with the Boegemos station receiving a mean annual precipitation of 235.3 mm. Precipitation occurs mainly during autumn, with most rainfall received during February (41 mm) and March (40 mm). The mean annual evaporation at Boegemos is 2668.6 mm. Evaporation occurs mainly during summer, with most evaporation experienced during December (335 mm) and January (325 mm). The lowest (106 mm) evaporation is experienced in June. Form the above it should be clear that the climate in the area is severe and is situated in an arid region.

From a geological perspective the study area is located on the north-western margin of the Karoo Basin, which is filled with carboniferous glacial deposits of the Dwyka Formation. The glacial deposits have an estimated maximum thickness of 100 m. The Dwyka Formation represents the bedrock in the area and consists of tillite and diamictite. The Dwyka Formation is overlain by Quaternary deposits consisting of sand, gravel, calcrete and silcrete. Calcrete occurs as a very hard layer often exhibiting deep solution cavities or depressions which are filled with sand and gravel.

The steep slopes dominating the northern prospecting area comprises Dwyka tillite exposure. The surrounding plateau is covered by calcrete and Rooikoppie gravel. The plateau is dominated by the Coega soil form which consists of dark reddish brown, apedal, loamy sand topsoil on a hardpan carbonate horizon (calcrete). The surface and top soil have 25 to 30 % gravel and stones. The uneven hill terrain of the northern prospecting area consists of the Glenrosa soil form with the topsoil being underlain by a stony or gravelly subsoil, grading into weathered rock. The soil is dominated by a dark grey, weakly structured, sandy clay loam topsoil rich in lime. The southern prospecting area is dominated by structureless (apedal) soils, with dark brown, apedal, sandy topsoil on a dark brown, apedal, sandy loam, sub soil, underlain by a neocarbonate B horizon. The soils in this area belong mainly to the Clovelly soil form.

Most likely due to the mostly natural condition of the study area it is mostly devoid of exotic weeds and invaders. However, the adjacent mining operations indicate that the post mining environment does establish significant invasive species. The banks of the Brak River adjacent to the southern prospecting area also contain an extensive invasion by the Mesquite Tree (*Prosopis glandulosa*).

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

4.1.1 Southern prospecting area

The southern prospecting area consists of an **undulating plain** with flowing landscape mostly devoid of prominent hills or ridges (Map 1 & 2). The site does contain smaller areas which are distinct from this undulating plain and will be discussed separately from it. These areas can be summarised as follows:

- The **Brak River** forms the southern border of this area and although not forming part of the site is still likely to be affected by mining and therefore forms part of this study (Map 1 & 2). It will be discussed in detail within the wetland assessment section.

- The elevation of the site decreases steadily toward the south and forms a **bottomland** associated with the Brak River (Map 2). This bottomland does not form part of the floodplain of the river but is associated with silt deposition either from a historical floodplain or deposited from the surrounding catchment. Whichever may be the case the bottomlands contain a more nutrient rich soil with higher moisture regime which causes the vegetation composition and structure to be somewhat different warranting separate discussion.

- A prominent **calcrete ridge** occurs along the eastern border of the site and is quite distinct from the surrounding area and will be discussed separately (Map 2). The ridge is also associated with a small drainage line draining from north to south along the foot of the ridge. The drainage line will be discussed in more detail in the wetland section.

- A **small but prominent ridge** is also situated along the western border of the site (Map 2). It does contain some superficial calcrete but is rather dominated by a high degree of superficial stones. The vegetation is also distinct from the surroundings and warrants separate discussion.

Undulating plains

As mentioned, the undulating plains portion covers the largest portion of the southern prospecting area with a rather uniform topography (Map 1 & 2). Soils are dominated by deeper sandy soils which are considered one of the main ecological drivers for the vegetation composition in this area.

The vegetation structure is dominated by a sparse grass layer but with extensive patches of low shrubs dominated by *Rhigozum trichotomum*. The grass layer is dominated by *Stipagrostis uniplumis*, with patches of the climax *Centropodia glauca*, also common. *Eragrostis lehmanniana* is also present but scattered. Within this grass layer a dwarf karroid shrub component is also prominent and dominated by *Pentzia calcarea*. Other common dwarf karroid shrubs include *Aizoon schellenbergii, Salsola sp.* and *Gnidia polycephala*. The shrub, *Rhigozum trichotomum*, is often associated with overgrazing, but in this instance is considered a natural component of the sandy habitat. Due to the sandy substrate the habitat is also conducive to the establishment of geophytic species which are well adapted to the deeper sands. These species include *Dipcadi vaginatum, D. papillatum, Harpagophytum procumbens, Talinum tenuissimum, Eriospermum corymbosum, Trachyandra laxa, Babiana sp., Ledebouria sp., Asclepias meyeriana* and *Albuca cooperii*. Of the above species, *H. procumbens, Babiana sp.* and *Asclepias meyeriana*, are also listed as protected species under the Northern Cape Nature Conservation Act (NCNCA) (Appendix C). In addition, *H. procumbens*, is also listed as a medicinal plant under the Threatened Or Protected Species (TOPS) list under the National Environmental Management: Biodiversity Act, 2004. Another component associated with the sandy substrate is the establishment of an abundance of annual species which include *Limeum viscosum, Heliophylla sp.* and *Tribulus zeyheri*.

From the above description the vegetation in this area seem to be relatively uniform with a relatively low species diversity being dominated by a few species. The vegetation, especially pertaining to the dominance of grasses and the sandy soils, has some affinities with the savannah vegetation types to the north of the area. No aspects of exceptionally high conservation value were identified. However, several protected species were observed in this area and although they are all relatively widespread they do retain a significant conservation value (Appendix C). Should prospecting activities take place here it is recommended that prospecting sites be surveyed for these species and the necessary permits be obtained to transplant them to adjacent areas where they will remain intact. As geophytic species they should transplant easily, however, they are deciduous and would not be visible during the winter months or severe drought. The area is not currently affected by any significant impact and is still in a natural condition. This increases its conservation value and although it is relatively uniform with a low species diversity it is still considered to be of moderate sensitivity (Map 3). Due to the deeper sandy soils and relatively uniform topography this portion is also considered much more easily rehabilitatable as long as adequate removal of the topsoil, protection thereof and replacement is undertaken.

Figure 1: Panorama of the undulating plains portion. Note a relatively flat to gently sloping topography with a sparse but dominating grass layer. Darker patches in the background is dominated by the low shrub, *Rhigozum trichotomum*.

Figure 2: Another panorama of the undulating plains.

Figure 3: Panorama of a portion of the undulating plain where a stand of *R. trichotomum* dominates.

Calcrete ridge associated with drainage line

Along the eastern border of the undulating plains portion a relatively large calcrete ridge is present (Map 2). It is also associated with a small drainage line at the foot of the ridge draining from north to south and which flows into the Brak River to the south. This drainage line will however be discussed in the wetland assessment portion of the study. The calcrete ridge has an approximate longitudinal length of 1.2 km and width of 200 meters. The soils are overall relatively shallow and surface is dominated by gravel, stones and rocks which are dominated by calcrete in the northern portion of the ridge and gradually replaced by a variety of other rock types toward the southern end. The vegetation structure, linked to the soil and rock types, also gradually changes from the north to southern portion of the ridge.

As mentioned the vegetation differs from the northern to southern portion of the ridge. The northern, calcrete dominated portion is dominated by dwarf karroid shrubs whilst the southern portion becomes dominated by the small tree, *Senegalia melifera* subsp. *detinens* Dominant dwarf karroid shrubs which are prevalent in the northern section include *Aptosimum marlothii, Kleinia longiflora, Thesium hystrix, Rhigozum trichotomum, Ruschia intricata, Felicia muricata, Zygophyllum lichtenstienianum* and *Pteronia sp.* Although these are also present in the southern section the small tree, *S. melifera* subsp. *detinens* becomes dominant and decreases their abundance considerably. The dwarf grass, *Enneapogon desvauxii*, is also abundant as a result of shallow soils. The dwarf succulent shrub, *Monsonia salmoniflora*, is also present. This species is not protected but is considered uncommon and therefore also of significant conservation value. Three succulent species, *Euphorbia braunsii, Aloe claviflora* and *A. hereroensis*, is also present and listed as protected species under the Northern Cape Nature Conservation Act (NCNCA) (Appendix C). Although widespread, as protected species they still retain a significant conservation value.

From the above description the vegetation along the ridge is considered quite variable with a moderate species diversity and likely to yield an even higher recorded diversity following further survey. The ridge contains several protected species and it is considered that others may also be present (Appendix C). Although none are threatened or rare they are still considered to be of significant conservation value. Should prospecting activities take place here it is recommended that prospecting sites be surveyed for these species and the necessary permits be obtained to transplant them to adjacent areas where they will remain intact. As succulent species they should transplant easily. The area is not currently affected by any significant impact and is still in a natural condition which increases its conservation value. Should prospecting activities occur in this area it will be difficult to rehabilitate and re-instate the natural vegetation due to the topography and soil/rock composition. As a result of a combination of the above this area is considered to have a high sensitivity and prospecting activities should be kept to a minimum here (Map 3). This is especially relevant for the northern clacrete dominated portion where the abundance of protected species is highest.

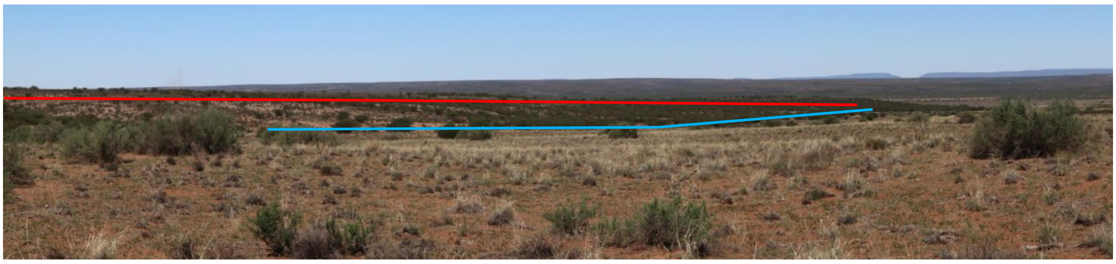

Figure 4: Panorama of the calcrete ridge (red). The drainage line at the foot of the ridge is also indicated (blue).

Figure 5: View of the calcrete ridge illustrating the high percentage surface calcrete and sparse but prominent dwarf karroid shrub dominance.

Figure 6: Panorama of the southern section of the ridge where the small tree, *S. melifera* subsp. *detinens,* becomes dominant. Note also the varied geology here.

Small but prominent ridge

Along the western border of the undulating plains portion a relatively small but prominent ridge is located (Map 2). It is situated longitudinally from east to west and is located adjacent to the bottomlands associated with the Brak River. The ridge has an approximate length of 500 meters and width of 120 meters. The soils are overall relatively shallow and surface is dominated by gravel, stones and rocks which are dominated by a variety of rock types with calcrete present but not dominating. The vegetation structure is much the same as the above described calcrete ridge with a dwarf karroid shrub and small tree layer dominating. Approximately 0.5 hectares of the eastern section of the ridge has been modified by a borrow pit but is the only significant impact on the ridge.

The tree layer of the ridge is dominated by a low sparse canopy of *Senegalia melifera* subsp. *detinens*. *Boscia albitrunca*, a protected tree under the Northern Cape Nature Conservation Act (NCNCA) and National Forest Act (NFA), is also present as a few low shrubs on the ridge (Appendix C). The species is widespread and relatively common but still of some conservation value. Dwarf karroid shrubs which are abundant on the ridge include *Kleinia longiflora, Rhigozum trichotomum, Zygophyllum lichtenstienianum, Eriocephalus ericoides, Barleria lichtensteiniana* and *Asparagus burchellii*. The geophyte, *Eriospermum porphyrium*, is also abundant on the ridge.

From the above description the vegetation along the ridge is considered relatively uniform and much lower in diversity than the calcrete ridge. Most likely a result of the smaller extent of this ridge. Coupled with the above this ridge also contains much fewer protected species, confined to one protected tree species (Appendix C). It is widespread and relatively common but still considered to be of some conservation value. It will not be possible to transplant these and should prospecting take place they should be excluded or permits obtained to remove them. There is however a likelihood that other protected species may also be present on the ridge. The ridge is still mostly intact although a borrow pit has permanently modified a small portion of it and does decrease the conservation value to a small degree. Should prospecting activities occur in this area it will be difficult to rehabilitate and re-instate the natural vegetation due to the topography and soil/rock composition. From the above description and conclusions this ridge is evidently of lower conservation value than the calcrete ridge and is consequently considered to only be of moderate sensitivity (Map 3).

Figure 7: View of the small ridge which illustrates the high percentage surface rock and vegetation structure dominated by dwarf karroid shrubs and small trees.

Figure 8: Panorama of the borrow pit which has evidently caused transformation of a portion of the ridge. Note the bottomlands portion adjacent to the ridge in the background.

Figure 9: View of a portion of the ridge where the small tree layer is more abundant. Note also the low percentage vegetation cover.

Bottomlands associated with the Brak River

The bottomlands associated with the Brak River is situated adjacent to the river and contains a visibly high silt content in many areas (Map 2). This bottomland does not form part of the floodplain of the river but is associated with silt deposition either from a historical floodplain or deposited from the surrounding catchment. Whichever may be the case the bottomlands contain a more nutrient rich soil with higher moisture regime which causes the vegetation composition and structure to be somewhat different warranting separate discussion. Furthermore, the bottomland is very similar to the undulating plains portion and also intergrades into it but can be differentiated by the lack of the shrub, *Rhigozum trichotomum*, and a higher moisture regime indicated by a few riparian species. Deep sandy soils are still one of the main ecological drivers of the vegetation structure.

The vegetation structure is also dominated by a sparse grass layer, the same as for the undulating plain section, but the shrub, *Rhigozum trichotomum*, is absent. Dwarf karroid shrubs may also be more abundant. The grass layer is dominated by *Stipagrostis uniplumis*. Dwarf karroid shrubs are dominated by *Aizoon schellenbergii, Calobota spinescens, Eriocephalus ericoides, Aptosimum spinescens, Justicia cuneata, Pentzia calcarea, Lycium cinerium, Gnidia polycephala* and *Asparagus burchellii*. Again, due to the sandy substrate the habitat is also conducive to the establishment of geophytic species which are well adapted to the deeper sands. These species include *Dipcadi vaginatum, D. papillatum, Talinum tenuissimum, Eriospermum* *corymbosum, Trachyandra laxa, Trachyandra sp., Ledebouria sp., Albuca cooperii* and *Ammocharis coranica*. Of these the last named is also listed as protected species under the Northern Cape Nature Conservation Act (NCNCA) (Appendix C). It is a widespread and relatively common species but is still of some conservation value. The annual herbaceous component is also still present and include *Limeum viscosum*. A view scattered specimens of the grass, *Stipagrostis namaquensis*, and shrub, *Salsola glabrescens*, occur and are considered riparian species and must be considered indicative of a higher moisture regime. They are also considered associated with the Brak River although is not taken as indicative of a floodplain.

From the above description the vegetation in this area seem to be relatively uniform with a relatively low species diversity being dominated by a few species. The vegetation is very similar to the undulating plains section but does contain some differences. No aspects of exceptionally high conservation value were identified. A single protected geophyte was identified and although it is relatively widespread it does retain a significant conservation value (Appendix C). Should prospecting activities take place here it is recommended that prospecting sites be surveyed for these species and the necessary permits be obtained to transplant them to adjacent areas where they will remain intact. As geophytic species they should transplant easily, however, they are deciduous and would not be visible during the winter months or severe drought. The area is not currently affected by any significant impact and is still in a natural condition. This increases its conservation value and although it is relatively uniform with a low species diversity it is still considered to be of moderate sensitivity (Map 3). Furthermore, its proximity to the Brak River, a highly sensitive area, also increases its conservation value but will be discussed in more detail in the wetland assessment section of the study. Due to the deeper sandy soils and relatively uniform topography this portion is also considered much more easily rehabilitatable as long as adequate removal of the topsoil, protection thereof and replacement is undertaken.

Figure 10: Panorama of the bottomlands (red) from the adjacent small ridge.

Figure 11: Panorama of the bottomlands which show the dominance of dwarf karroid shrubs and grasses.


Figure 12: Another panorama of the bottomlands.

4.1.2 Northern prospecting area

The northern prospecting area consists of **uneven terrain dominated by hills, ridges and valleys** (Map 2). This uneven portion is surrounded by a plateau of which only a small portion occurs in the study area and the border between these two areas are formed by a steep calcrete cliff. The uneven terrain will form the main discussion but these smaller components will also be discussed separately from it. These areas can be summarised as follows:

- The **Diepsloot** stream drains this entire prospecting area and forms a deep valley in the uneven terrain coupled with high silt content bottomland (Map 1, 2 & 4). It will be discussed in detail within the wetland assessment section.

- **Calcrete cliffs** associated with the border of the plateau around the uneven terrain (Map 2). This area consist of very steep calcrete cliffs which are almost devoid of vegetation but do form a highly unstable topographical unit distinct from the surroundings.

- The **Plateau** forms a small portion of this prospecting area in the eastern and south western corners (Map 2). It does contain differences in vegetation composition mostly attributed to the even slope.

Uneven terrain dominated by hills, ridges and valleys

As mentioned, this portion of very uneven, rocky terrain which is dominated by hills, ridges, clacrete capped mesas and valleys form the largest part of the northern prospecting area (Map 2). The highly variable topography also contributes significantly to a high diversity of habitat and species diversity. The shallow soils, steep slopes and diversity of habitat is considered the main ecological driver for the vegetation composition in this area.

Due to the slope and rocky soils the vegetation structure is dominated by dwarf karroid shrubs. A low, small tree layer becomes prominent in the lower slopes and foothills and a grass component is also present, especially in areas with a higher moisture regime, i.e. southern slopes, etc. Common dwarf karroid shrubs include *Zygophyllum lichtensteinianum, Aptosimum marlothii, A. spinescens, Rosenia humilis, Petzia incana, Pteronia sp., Eriocephalus ericoides, Aizoon schellenbergii, Lycium cinerium, Asparagus burchellii, Thesium hystrix, Salsola aphylla* and *Kleinia longiflora*. Grasses, although not dominant, are still prominent in this dwarf karroid shrub layer with the most common species including *Eragrostis nindensis, Fingerhuthia africana, Enneapogon desvauxii* and *Stipagrostis obtusa*. Lower down on the slopes and especially in valleys a small tree layer dominated by *Senegalia melifera* subsp. *detinens* become prominent with scattered specimens of the shrub, *Rhigozum obovatum*, also present. Here the protected tree species, *Boscia albitrunca*, also occurs as scattered specimens. Geophytic species are common and diverse but not abundant and include *Dipcadi pappilosum, D. crispum, Drimia intricata, Ornithoglossum vulgare, Ornithogalum juncifolium, Ledebouria sp.* and *Eriospermum porphyrium*. Other smaller herbaceous species occurring as scattered specimens include *Barleria rigida, Polygala asbestina, Felicia muricata* and *Blepharis mitrata*. South facing slopes occurring in the northern half of this prospecting area contain much the same vegetation although may be significantly denser as a result of more shade and higher moisture regime. Additional species identified on these slopes included *Justicia cuneata, Ehretia rigida* and the protected shrub, *Nymania capensis* (Appendix C). The dwarf succulent shrub, *Monsonia salmoniflora*, occurs sporadically in areas of high surface rock. This species is not protected but is considered uncommon and therefore also of significant conservation value. This habitat of the proposed prospecting area also contains several protected succulent species and include *Euphorbia braunsii, E. crassipes, Aloe claviflora* and *Larryleachia picta* (Appendix C). Of these the last named is also considered to be a relatively rare species.

From the above description it is evident that this portion of the prospecting area is diverse in terms of habitats and as a result also contains a relatively high species diversity. This will also be increased substantially should additional surveys of the area be conducted. Several protected species also occur in this area with some being considered as relatively rare (Appendix C). It is also likely that others may be present but could have been overlooked due to their subterranean or cryptic nature. Should prospecting activities take place here it is recommended that prospecting sites be surveyed for these species and the necessary permits be obtained to transplant them to adjacent areas where they will remain intact. As succulent species they should transplant easily. The area is not currently affected by any significant impact and is still in a natural condition which increases its conservation value. Due to the uneven terrain, steep slopes and mobile substrate the area is highly prone to erosion. Though it is currently relatively stable any disturbance of the soil surface is likely to lead to high levels of erosion. Consequently, any prospecting activities in this area will highly likely lead to high levels of erosion which will progressively worsen due to the steep slopes. Furthermore, should any prospecting activities occur in this area it will not be possible to rehabilitate and re-instate the natural vegetation due to the topography, steep slopes and soil/rock composition. As a result of a combination of the above this area is considered to have a very high sensitivity and prospecting activities should be excluded from this area as far as possible (Map 3).

Figure 13: Panorama of the uneven terrain. Note dwarf karroid shrub with here a prominent grass component and trees/shrubs becoming prominent in the valleys.

Figure 14: Dwarf karroid shrubs dominate in most areas. Note also the high percentage surface rock.

Figure 15: Panorama of a portion of the uneven terrain illustrating the dominant vegetation and formation of numerous valleys.

Figure 16: The geology in this area is also variable with some areas being dominated by surface calcrete.

Figure 17: The southern aspect of valleys and hills often contain a much denser vegetation cover.

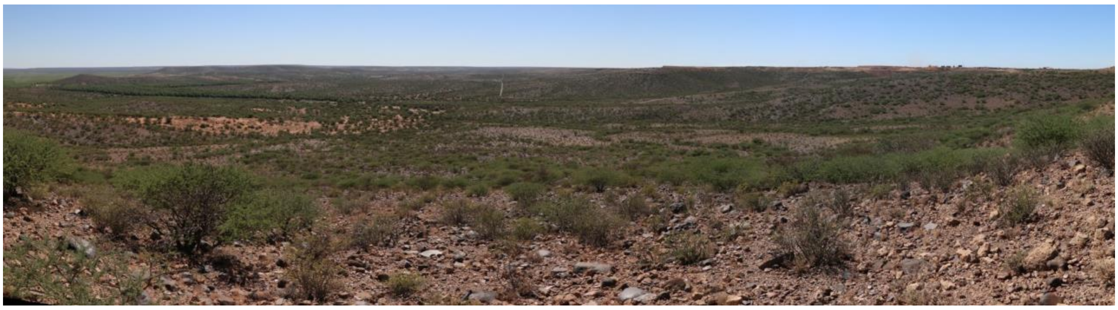

Figure 18: Panorama again illustrating the highly uneven, rocky and variable topography of this portion.

Calcrete cliffs at the edge of the uneven terrain

Along the border of the uneven rocky terrain as described above a very steep calcrete cliff separates it from the surrounding plateau which forms a small part of this prospecting area (Map 2). The vegetation is similar to the surrounding uneven terrain and plateau as it forms an ecotone between them but due to the almost bare rock the vegetation cover is very low to absent. The habitat also contains a geophytic species localised to this unique habitat. Soils are absent in many areas and plants which establish here exploit cracks and fissures. It is however a quite unstable habitat as cliff collapse does occur sporadically. The height of the cliff face varies considerably but is mostly 2 to 6 meters in height. The length of the habitat is extensive while its width is very narrow being 1 to 2 meters in general.

As mentioned the vegetation structure is somewhat similar to the surrounding habitats but due to the absence of soil in many areas and the bare rock habitat the percentage vegetation cover is very low. The vegetation structure is therefore still dominated by dwarf karroid shrubs and small trees but with a very low density. Dwarf karroid shrubs include *Zygophyllum lichtensteiniana, Pentzia incana* and *Rosenia humilis*. Small trees are still dominated by *Senegalia melifera* subsp. *detinens* although where the cliffs form sheltered pockets other trees and shrubs also occur. These include *Searsia burchellii, Grewia flava, Ziziphus mucronata* and the protected tree, *Boscia albitrunca*. Other herbaceous species able to establish in cracks include *Hermannia abrotanoides* and *Acanthopsis hoffmannsegiana*. The last named is also a Red Listed species with category Data Deficient (Appendix C). Geophytic species are also well adapted to establishment in the calcrete cracks and include *Dipcadi gracillimum, Trachyandra sp.* and *Ledebouria sp.* The last named is a definite habitat specialist which, pending identification, should be considered to be of high conservation value and provided due protection.

From the description of the vegetation it is clear that this habitat does not contain a high diversity but does form a unique and highly unstable habitat also containing unique species localised to it. One of these, *Ledebouria sp.*, is a clear habitat specialist and may be of high conservation value pending positive identification. This species should be retained intact without prospecting activities affecting it. However, the vegetation composition along the cliff cannot overall be considered to be of high conservation value. The habitat itself and the unstable nature makes this a highly sensitive area, especially to mining activities. Should prospecting of the cliff habitat take place it will not be possible to rehabilitate or re-instate the habitat. Disturbance of the habitat will also undoubtedly lead to high levels of erosion which will progressively worsen due to the steep slopes. As a result of a combination of the above this area is considered to have a very high sensitivity and prospecting activities should be excluded from this area as far as possible (Map 3).


Figure 19: View of the calcrete cliff. Note the low density vegetation cover.


Figure 20: View of the calcrete cliff. Note the cliff height varies considerably.


Figure 21: View of the calcrete cliff. It is evident that cliff collapse does occur periodically (red) and also confirms the unstable nature of this habitat.

Figure 22: *Ledebouria sp.* able to colonise cracks in the calcrete cliff is a definite habitat specialist and may prove to have a high conservation value.

Plateau

A relatively flat to undulating plateau surrounds the uneven rocky terrain and calcrete cliffs (Map 2). Only a small portion of this habitat occurs within the northern prospecting area along the eastern and south western borders. The vegetation is similar to the surrounding uneven terrain though trees may attain a larger size and the shrub, *Rhigozum trichotomum*, largely absent from the uneven terrain becomes more prominent here. The grass assemblage is also different from that of the surrounding uneven terrain. This may be due to the more even and flat topography which decreases the runoff rate, will increase infiltration and so doing will increase the moisture regime and allow species with a higher moisture dependency to establish here and trees able to grow larger. Soils are still relatively shallow with a high percentage surface rock though the sand content may be higher due to decreased erosion.

As mentioned the vegetation structure is similar to the surrounding uneven rocky terrain. However, a better developed grass layer is present dominated by *Stipagrostis uniplumis, S. obtusa, Cenchrus ciliaris* with *Enneapogon desvauxii* common where shallow soils are present. The low shrub, *Rhigozum trichotomum*, is also abundant and dominant in some areas. Large, i.e. 2 meter, specimens of the small tree, *Senegalia melifera* subsp. *detinens* is abundant as well as scattered, large specimens of the protected *Boscia albitrunca*. Dwarf karroid shrubs are also abundant in many areas and include *Zygophyllum lichtensteiniana, Pentzia incana, Eriocephalus ericoides, Felicia muricata, Kleinia longiflora* and *Aptosimum spinescens*. Noted herbaceous species included *Limeum aethiopicum* and *Chascanum pinnatifidum*. Several protected succulent species were recorded in this area and included *Aloe claviflora, Euphorbia crassipes* and *Hoodia gordonii* (Appendix C). Although they are all relatively widespread they are not overly common and are still considered to be of significant conservation value. Furthermore, *H. gordonii* is listed as being Data Deficient – Insufficient information under the National Red List and this indicates that it may be classified as Threatened and is therefore considered of high conservation value.

From the above description the vegetation of the plateau seem to be relatively uniform and somewhat lower in species diversity compared to the uneven rocky portion. No aspects of exceptionally high conservation value were identified. However, several protected species were observed in this area and although they are all relatively widespread they do retain a significant conservation value (Appendix C). Should prospecting activities take place here it is recommended that prospecting sites be surveyed for these species and the necessary permits be obtained to transplant them to adjacent areas where they will remain intact. As succulent species they should transplant easily. These portions, especially the south western corner borders on the current mining areas which do cause some disturbance of the area. Overall this area is however still largely natural. This increases its conservation value and although it is relatively uniform with a low species diversity it is still considered to be of moderate sensitivity (Map 3). Due to the even, flatter topography this portion is also considered more easily rehabilitatable with a lower likelihood of severe erosion occurring. It is however unlikely that it will be possible to re-instate the current soil surface to the natural condition due to the soil/gravel surface coverage. Comprehensive topsoil removal, topsoiling, protection and replacement may alleviate this impact.

Figure 23: View of the plateau portion. Note a flat gradient, dominated by dwarf karroid shrubs with a specimen of protected *Boscia albitrunca* in the foreground.

Figure 24: View of the plateau portion. Note the also a high percentage surface rock.

Figure 25: The plateau portion borders on the current mining operations. Note a dominance of small trees in this portion.

4.2 Overview of terrestrial fauna (actual & possible)

As the proposed prospecting areas both consist of natural vegetation in relatively good condition and being utilised almost exclusively for stock farming the study area contains a varied faunal population with relatively high density. Being situated in an arid area the carrying capacity will be somewhat lower. However, the study area also has a large extent and consequently will be able to sustain population dynamics at a larger scale, i.e. localised migration, varied genetic pool, pristine habitats for reclusive and rare species. The mammal population on the site therefore has a high conservation value.

The most significant impacts that prospecting operations will have 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. Although prospecting operations will not transform the same extent of habitat as full scale mining the impact should still be significant due to the pristine condition and diversity of the habitat. This impact could still be significantly mitigated by amongst others to limit prospecting to set areas, excluding areas of high sensitivity, limit the extent of each prospecting area and comprehensive and successful rehabilitation of mined areas.

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.

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 found in some areas, especially near calcrete gravel. 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*) are abundant, especially in the sandy southern prospecting area. 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.

- Quills of Porcupine *(Hystrix africaeaustralis*) occur in the northern prospecting 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.

- Dung of a small antelope occurs on the calcrete cliffs. This may be likely from Steenbok (*Raphicerus campestris*) or Common Duiker (*Sylvicapra grimmea*), but due to the cliff habitat the Klipspringer (*Oreotragus oreotragus*) may also be likely.

- Dung and sightings of Greater Kudu (*Tragelaphus strepsiceros*) are abundant in the study area indicating a large population of this species.

- Sightings of natural occurring populations of Springbok (*Antidorcas marsupialis*) are also abundant.

- Foraging excavations by small unidentified mammals are abundant and scat of small unidentified carnivores also indicate a large mammal population.

Of high importance will be the presence of threatened or Red Listed species. From available literature of species likely to occur in the region it is clear that numerous Red Listed species occur and is likely to occur in the study area.

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
Dent's horseshoe bat	*Rhinolopus denti*	Near Threatened
Littledai's whistling rat	*Parotomys littledalei*	Near Threatened

It is also considered highly likely that several if not all of the above species will occur within the study area.

Table 3: Likely mammal species in the region (Erasmus).

Common name	Scientific name
Reddish-grey musk shrew	*Crocidura cyaneae*
SA hedgehog	*Erinaceus frontalis*
Sclater's golden mole	*Chlorotalpa sclateri*
Round-eared elephant shrew	*Mcroscelides probiscideus*
Smith's rock elephant shrew	*Elephantulus rupestris*
Rock elephant shrew	*Elephantulus myurus*
Straw coloured fruit bat	*Eidolon helvum*
Egyptian free-tailed bat	*Taderia aegyptiaca*
Lesueur's hairy bat	*Myotis lesueuri*
Cape serotine bat	*Eptesicus capensis*
Common slit-faced bat	*Nycteris thebaica*
Geoffroy's horseshoe bat	*Rhinolopus clivosus*
Dent's horseshoe bat	*Rhinolopus denti*
Chacma baboon	*Papio ursinus*
Vervet monkey	*Cercopithecus pygerythrus*
Pangolin	*Manis temminnki*
Cape hare	*Lepus capensis*
Scrub hare	*Lepus saxatilis*
Smith's red rock rabbit	*Pronolagus rupestris*
Common molerat	*Cryptomys hottentotus*
Porcupine	*Hystrix africaeaustralis*
Springhare	*Pedetes capensis*
Spectacled mouse	*Graphiurus ocularis*
Ground squirrel	*Xerus inauris*

Brant's whistling rat	*Parotomys brantsii*
Littledai's whistling rat	*Parotomys littledalei*
Bush karroo rat	*Otomys unisulcatus*
Striped mouse	*Rhabdomys pumilio*
House mouse	*Mus musculus*
Pygmy mouse	*Mus minutoides*
Multimmmate mouse	*Praomys natalensis*
Namaqua rock mouse	*Aethomys namaquensis*
Red veld rat	*Aethomys chrysophilus*
House rat	*Rattus rattus*
Short-tailed gerbil	*Desmodilus auricularis*
Hairy-foot gerbil	*Gerbillurus paeba*
Bushveld gerbil	*Tatera leucogaster*
Highveld gerbil	*Tatera brantsii*
Pouched mouse	*Saccostomus campestris*
Large-eared mouse	*Melacothrix typica*
Aardwolf	*Proteles cristatus*
Caracal	*Felis caracal*
African wild cat	*Cape Felis sylvestris*
Small spotted cat	*Felis nigripes*
Bat-eared fox	*Otocyon megalotis*
Cape fox	*Vulpes chama*
Black-backed jackal	*Canis mesomelas*
Cape clawless otter	*Aonys capensis*
Honey badger	*Mellivora capensis*
Striped polecate	*Ictonyx striatus*
Small-spotted genet	*Genetta genetta*
Suricate	*Suricata suricatta*
Yellow mongoose	*Cynictis penicellata*
Slender mongoose	*Galerella sanguinea*
Small grey mongoose	*Galerella pulverulenta*
Water mongoose	*Atilax paludinosus*
Aardvark	*Orycteropus afer*
Rock dassie	*Procavia capensis*
Klipspringer	*Oreotragus oreotragus*
Steenbok	*Raphicerus campestris*
Kudu	*Tragelaphus strepciceros*
Blesbok	*Damaliscus dorcas phillipsi*

4.3 Wetland and Watercourses Assessment

4.3.1 Introduction

The study area consists of two separate prospecting areas (Map 1) which will affect two separate watercourse systems, the southern portion will affect the Brak River as well as a small drainage tributary and the northern portion will affect the Diepsloot and associated intricate drainage network as well as two drainage lines to the north and south of it (Map 1 & 2). These two separate watercourse systems 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:

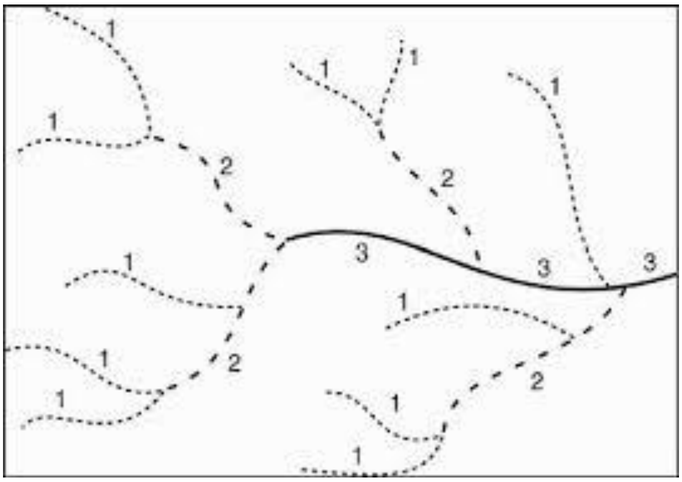

Figure 26: The classification of stream orders from 1 to 3 (Strahler 1952)

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 D).

Brak River and associated tributary

Soil samples indicate the small drainage line forming a tributary of the river is devoid of wetland conditions and is ephemeral in nature which drains by means of flash floods after sufficient rainfall has occurred (Appendix D). It flows only for very short periods which may not occur yearly but only during years of sufficient rainfall events. The Brak River is a large river draining a very large catchment. The catchment is however situated in the arid interior of the Upper Karoo which receives a relatively low rainfall and the river is not perennial but rather seasonal in terms of flow regime. However, due to the large catchment it does contain clear wetland conditions, also on a perennial basis. It should be noted that wetland conditions are not dependant on the presence of surface water but rather saturated soil conditions and therefore wetland conditions can be present without surface water flow occurring. Soil samples in the main channel of the river indicate wetland conditions on a perennial basis.

These wetland soil indicators were also confirmed along the channel of the river 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.

Diepsloot and adjacent drainage lines

Soil samples taken along the Diepsloot from its origin to where it exits the prospecting area indicate that it is devoid of wetland conditions and is ephemeral in nature (Appendix D). The lower portion of the stream does contain some wetland indicators but is likely altered due to the runoff from adjacent irrigation areas. This portion will not form part of the prospecting area and will therefore be mostly excluded from the description and determination of the condition of this watercourse. The stream system drains a relatively large area by means of an intricate network of drainage lines in the uneven rocky terrain of the northern prospecting area. Due to the steep slopes and size of the catchment the stream system drains by means of flash floods which occur after sufficient rainfall. Main channel water flow occurs for short periods and are therefore not conducive to the formation of wetland conditions.

The absence of wetland conditions are confirmed by vegetation along the main channel of the stream but clearly indicate the presence of a riparian zone and should therefore still be considered to be part of a significant watercourse.

4.3.3 Classification of wetland systems

The wetland conditions occurring along the Brak River and lower portion of the Diepsloot can be classified into a specific wetland type.

The wetland conditions occurring along the Brak River and lower portion of the Diepsloot can 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 both the Brak River and Diepsloot systems which both have very clearly defined main channels where wetland conditions are most prominent along the main channel and decrease in distance from the channel.

4.3.4 General overview of ephemeral systems in arid regions

As mentioned both the Brak River and Diepsloot are seasonal or ephemeral watercourses situated in an arid region. Seasonal, and especially ephemeral, systems are still poorly understood and their functioning is markedly different from perennial systems. This section will give an overview of the functioning of these systems in order to better understand their importance as watercourses.

Non-perennial rivers are systems in which surface flow stops and may disappear for some period of most years (Uys & Keeffe 1997). They can further be divided into seasonal and ephemeral systems where seasonal systems have a continuous channel flow during the rainy season and ephemeral systems have a highly variable frequency of connected channel flow, a high degree of natural disturbance and a lack of baseflow (Hughes 2008). Seasonal systems can be regarded as flowing between 20 % and 80 % of the year and ephemeral systems less than 20 % of the year (Kleynhans & Louw 1999). Both the Brak River and Diepsloot can be considered as ephemeral systems with the Brak River bordering on seasonal.

Precipitation in the catchments of ephemeral rivers are generally highly sporadic, localised and of short duration as is the case in the study area. This can be more pronounced during periods of drought as was recently experienced. Consequently, runoff is highly variable and peak discharges may be reached within minutes. As a result of the variable climatic conditions runoff may be generated over small areas so that tributary and even mainchannel flow occurs whilst large portions of the channel system remains dry. The downstream reduction in flow after flooding events is caused by the infiltration into channel and floodplain sediments as well as evaporative losses. This accurately describes the functioning and flow of both watercourse systems in the study area.

Floods are essential to the existence, productivity and interactions of many biotic elements in seasonal and ephemeral ecosystems. The longitudinal transfer must play a vital role where any deliverance of moisture may serve to supplement available resources. Floods transfer materials laterally and longitudinally, but more importantly, water triggers ecosystem processes. Floods activate a diverse range of terrestrial decomposer communities which otherwise are inactive during dry stages. An ephemeral system functions as a floodplain without a river where the highly variable hydrologic regime supports a terrestrial biota, dependent upon flooding (Jacobsen 1997).

Small flow events play an important role in connecting isolated pools and thus exchange of genetic material. Small flow events also recharge pools. Larger flow events influence the channel geomorphology with regard to channel size and shape and sediment dynamics (Hughes 2008). During large flood events flow occurs laterally into the floodplain and reside there, the duration of this event depends on the rainfall, but typically lasts about 4-5 days (Rassam *et al.* 2006). These floods play a critical role in regulating organic matter transport and deposition and secondary production (Kleynhans & Louw 1999).

Floods have also been shown to play an important role in structuring riparian communities. Different plant species differ in their ability to withstand or regenerate after major floods. As floods alter the species composition of a community, invariably the ecosystem functions are also altered, especially where shifts occur in plant functional types (Stromberg, Lite & Dixon 2010).

From the above it should be clear that flooding is essential to the continued and natural functioning of both the Brak River and Diepsloot. It is also a real occurrence during the annual cycle of these watercourses and will occur annually in the seasonal systems but infrequently and perhaps only during years of high rainfall in the ephemeral systems. This should therefore also be taken into consideration for the proposed prospecting operations where these watercourses may be perceived as not experiencing any flow although they may contain severe flooding events after heavy rainfall events. This may also illustrate that prospecting in or near these watercourses will contribute to high sediment load and extensive erosion.

The distribution of riparian communities in semi-arid rivers has been shown to be correlated to variation in topography. Flooding frequency and duration as well as water availability due to this variation in topography has often been cited as the reason for these distribution patterns. The catchment geology together with the hydrogeomorphic processes of a river causes a heterogeneous landscape with different morphologic units that also changes through space and time. This heterogeneous landscape is an important factor in vegetation development and gives rise to distribution of different vegetation types (Van Coller, Rogers & Heritage 1997).

Soil salinity is a factor that significantly affects the distribution, morphology and productivity of many riparian species. Soil enrichment by soluble salts occurs where flood waters contain a significant salt load. Soils that become enriched generally occur in the lower reaches of the river where water flow is slowed and together with infiltration and evaporation, salts are deposited (Jacobson 1997). This has also been found to be the case within the study area and especially the Brak River where high salt concentrations were observed. Vegetation is also a clear indicator of higher salt concentrations and species such as *Salsola spp.* can be used as such indicators. This species occurs along both affected watercourses. Furthermore, patches of *Sarcocornia sp.* occur along the Brak River. This is a confirmed halophyte and confined to salt flats.

The above description should give a good idea of the functioning of the Brak River and Diepsloot in the study area and should also serve to indicate that although they may seem small and flow only occur sporadically, they still have a complex functioning which provides several unique ecosystem services. They should consequently still be considered as highly sensitive systems which may be easily altered or affected by activities associated with the prospecting operations and should be treated as no-go areas.

4.3.5 Description of affected watercourses

The study area consists of two separate prospecting areas (Map 1) which will affect two separate watercourse systems, the southern portion will affect the Brak River as well as a small drainage tributary and the northern portion will affect the Diepsloot and associated intricate drainage network as well as two drainage lines to the north and south of it (Map 1 & 2). These two watercourses and associated tributaries 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.

Brak River and associated drainage line (Southern prospecting area)

The Brak River is a large watercourse which forms the southern border of the southern prospecting area (Map 1 & 2). It therefore does not form part of the site but there is still a high likelihood that it could be affected by prospecting operations. This river originates approximately 200 km to the south and should also illustrate the vast catchment which it drains. The catchment is also relatively unaffected by any large impacts which will also increase the condition of the river. The river flows into the Orange River approximately 6 km to the west of the site. Therefore, any impact on the river at the site is also likely to affect the Orange River. The river flows from east to west along the southern border of the site. The river is largely free of obstructions in the study area although two low water crossings at the western border of the site will affect it to some degree. The banks are also affected by a severe infestation of the exotic Mesquite Tree (*Prosopis glandulosa*). This has a significant impact on the riparian community of the river. The riparian vegetation associated with the river is clearly indicative of high salt concentrations associated with the river. The banks also exhibit salt accumulations on the soil surface. Dominant vegetation is represented by several species adapted to these high salt concentrations and include the succulent shrubs, *Suaeda fruticosa, Suaeda sp., Atriplex sp.* and *Salsola glabrescens* and the low succulent *Salicornia meyeriana*. The small tree, *Tamarix usneoides*, is also well adapted to high salt concentrations and scattered along the banks of the river. As with all watercourses the banks are affected by a flood-pulse disturbance regime and consequently contains a few pioneer species which are here represented by the succulent pioneers, *Mesembryanthemum guerichianum* and *Psilocaulon coriarium*. As already mentioned the banks are dominated by the exotic *P. glandulosa* which excludes a high percentage of indigenous vegetation.

A small drainage line also drains into the river and originates in the central portion of this prospecting area along the foot of a low calcrete ridge (Map 1 & 2). It drains from north to south along the foot of the ridge where it has a clear main channel in the deeper sands. This main channel does however become indistinct in close proximity to the Brak River in the bottomlands adjacent to it. This is caused by the decreases in slope to a relatively flat gradient in the bottomlands which causes any surface water flow to slow completely and allow it in infiltrate into the deeper sand in this area. This does however not mean that the drainage line ceases here but merely that any surface water becomes groundwater and still flows into the Brak River. The drainage line originates on the site and is located in its entirety on the site. It has an approximate length of 3 km and therefore also drains a relatively small catchment. The drainage line and its catchment is not affected by any significant impacts and should be considered as being almost pristine. As mentioned it also flows into the Brak River and any impacts on it will therefore also affect the river itself. Due to the small size of the drainage line and the low volumes of water it transports the vegetation associated with it is not comprised of riparian species but rather terrestrial. These are dominated by the small tree, *Senegalia melifera* subsp. *detinens* and to a large degree annual pioneer species adapted to the disturbance regime caused by floods in the drainage line as well as the higher moisture regime here and these include *Tribulus zeyheri, Limeum viscosum* and *Heliophylla sp.*

Figure 27: Panorama of the Brak River near the western border of the site. The two low water crossings are visible (red). Note also high level of salt residue (white colouration) and infestation by exotic Mesquite Trees along the banks.

Figure 28: View of the main channel of the river. It should be clear that main channel flow occurs at least seasonally.

Figure 29: Close-up of the banks of the river which illustrates the high salt concentrations.

Figure 30: Infestation by the exotic Mesquite Tree can become extensive, dense and highly problematic in some portions of the riverbank.

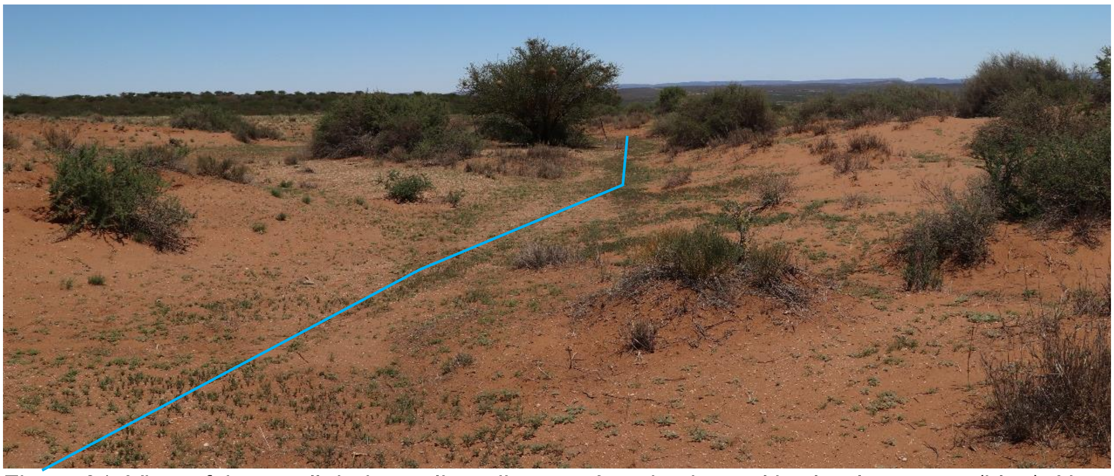

Figure 31: View of the small drainage line tributary. A main channel is clearly present (blue). Note also the prominent establishment of pioneer annuals in the main channel.

Diepsloot, associated drainage pattern and adjacent drainage lines (Northern prospecting area)

The Diepsloot is a large stream system associated with an intricate pattern of tributary drainage lines. It dominates the northern prospecting area and together with its tributaries covers almost the entire prospecting area (Map 1 & 2). Furthermore, the catchment of the stream is also almost confined to this prospecting area. It therefore also originates within this prospecting area. It is therefore highly likely that it will be affected by prospecting operations. The length of the stream is approximately 7 km but does not take into account the high number of tributaries. The catchment is not affected by any significant impacts and the condition of the stream may therefore be considered to be pristine. The lower section of the stream is located adjacent to irrigated pecan nut plantations which will have some significant impacts on the stream mostly in terms of increases runoff as well as fertiliser and pesticide pollution. The stream flows into the Orange River almost directly adjacent to the site. Therefore, any impact on the stream at the site is also likely to affect the Orange River. The main direction of flow is from east to west but due to the high number of tributaries this is just the main direction of flow with tributaries exhibiting flow in almost every other direction as well. The stream is largely free of any obstruction although a few dirt road crossings will lead to some increased erosion. Two small artificial dams are also located in the stream but has subsequently been breached and their impact on the stream will no longer be significant. The stream is also largely free of any exotic weeds or invaders with these being confined to a few exotic weeds. The vegetation associated with the stream is characteristic of riparian vegetation in this region but do not support the presence of wetland conditions. This may be due to the ephemeral nature of the stream, the deeper silty sediments which promote infiltration and decrease the likelihood of saturated soils and also the steeper gradient of the stream which causes high velocity discharge over a short time period and which also decreases the likelihood of wetland conditions forming. The stream is also associated with a substantial bottomland which is associated with silt and sediments transported from the catchment and deposited along the stream. The main channel of the stream also shows a high tendency for erosion. This is mostly due to the flash flooding regime and steep gradient of the stream. The site survey indicated that this system and catchment will be highly susceptible to erosion which should be taken into account in terms of the proposed prospecting.

Tributaries and sections of the stream in its upper reaches near its origin consist, as can be expected, of small streams with clear main channels but notably dominated by terrestrial species. A few riparian species are however already present here. The main channel indicates a significant volume of water being conveyed by these sections but due to the steep slopes here discharge occurs over a very short period. The vegetation here is dominated by the small terrestrial tree, *Senegalia melifera* subsp. *detinens*, with large specimens of the protected *Boscia albitrunca* also common. Other common terrestrial dwarf shrubs include *Cadaba aphylla, Zygophyllum lichtensteiniana, Lycium cinerium, Justicia cuneata, Polygala leptophylla, Felicia muricata, Pentzia quinquifida* and *Hermannia spinosa*. Terrestrial herbaceous species are also common and include *Hermannia abrotanoides, Dicoma capensis* and *Limeum aethiopicum*. Grasses occurring in the upper reaches include *Stipagrostis uniplumis, Fingerhuthia africana* and *Heteropogon contortus*. These are also terrestrial species except for the last named, which in the more mesic central and eastern parts of the country is strictly terrestrial, in this arid western region is considered a riparian species largely confined to watercourses. Another riparian indicator here is the shrub, *Ehretia rigida*, which is normally considered a terrestrial species, is largely confined to watercourses in this arid region.

As the stream progresses in the downstream sections the main channel becomes quite large with a wide floodplain or bottomland associated with sediment deposition. Here the dominance by riparian species become dominant and terrestrial species are rare. Riparian trees dominate along the main channel and include *Ziziphus mucronata, Grewia flava, Searsia lancea, Ehretia rigida* and *Vachellia karroo*. The riparian shrub, *Lycium arenicola*, is also abundant, especially in lower reaches. Terrestrial dwarf karroid shrubs are however still present, especially in the floodplain and include *Zygophyllum lichtensteinianum* and *Pentzia calcarea*. Due to the flooding regime which normally occurs as flash floods the main channel and floodplain contains a prominent annual pioneer component and includes annuals such as *Chenopodium album, C. carrinatum, Tribulus terestris, Solanum spuinum* and *Monechma divaricatum*. These are adapted to disturbance caused by flooding and establish annually after flooding events. As a result of this natural disturbance regime of the stream a few exotic weeds has also become established, and are especially evident at stock feeding and watering points adjacent to the stream. They include *Alternanthera pungens, Salsola kali* and *Argemone ochroleuca*. Grasses along the stream are mostly terrestrial species but which are, in this arid region, mostly confined to areas with a higher moisture regime. These include *Enneapogon cenchroides, Cenchrus ciliaris, Eragrostis echinchloidea* and *Setaria verticillata*. The exception is the strictly riparian species, *Stipagrostis namaquensis*, which becomes dominant in the lower sections of the stream. In the floodplain in the lower sections several dwarf riparian shrubs are also present which are considered good indicators of riparian vegetation and includes species such as *Salsola glabrescens* and *Zygophyllum microcarpum*.

Where the stream exits the prospecting area along the western border it has been affected to a significant degree by the adjacent irrigation developments both in terms of increased flow and fertiliser and pesticide runoff. This section will however not form part of the prospecting area and only limited surveying was done. The riparian vegetation here becomes quite dense with numerous weedy species also present. Riparian trees include *Vachellia karroo, Ziziphus mucronata, Lycium arenicola, Searsia lancea* and *S. pyroides*. The obligate wetland reed, *Phragmites australis*, is also abundant. Pioneer weedy species include *Atriplex semibaccatta, Lactuca sp., Sonchus oleraceus* and *Solanum nigrum*.

A note should be made here that two drainage lines also occur to the north and south of the Diepsloot but are included in this description due to their proximity and similarity to this stream (Map 1 & 2). Small circular depressions were also identified along the eastern border of the Diepsloot which should be assumed to be depression wetlands and should be avoided by prospecting activities (Map 1 & 2).

Figure 32: View of an upstream tributary near the origin. A main channel is prominent with terrestrial species dominating.

Figure 33: View of the upper reach of the stream. Note that the main channel is already quite large and a floodplain consisting of deposited sediment is already present. Note also the large specimen of the protected *Boscia albitrunca* (red).

Figure 34: Another view of the stream in the upper reach. The main channel already becomes quite large here.

Figure 35: View of the floodplain in the same location as Fig. 34. Note that it already becomes quite extensive here.

Figure 36: View of one of the small impoundments in the upper reach of the stream. The damwall has been breached and it is no longer functional. Note the large amount of flood debris (red) which should indicate that large water volumes are discharged during flash flooding.

Figure 37: In the central section of the stream the main channel becomes quite large and riparian species become dominant.

Figure 38: View of the stream in the downstream section. Note the large size of the main channel indicating large flooding events occurring from time to time.

Figure 39: View of the stream in the downstream section. Note again a large main channel with the establishment of riparian grasses becoming prominent here.

Figure 40: View of the Diepsloot where it exits the prospecting area. Note dense riparian vegetation and reed stands. The main channel exhibits visible residues and high algae concentrations which are most likely attributed to abundant nutrients resulting from the adjacent irrigation.

4.3.6 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 E). The drainage lines and tributaries associated with the Brak River and Diepsloot drain into these systems and will all affect the Orange River where they flow into it. Therefore, an IHI will be conducted for the Brak River and Diepsloot separately and will be taken as representative of the associated drainage lines and tributaries. These watercourses 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 section of the Orange River where they drain into it. Therefore, two IHI's will be conducted for the Brak River and Diepsloot to represent the overall condition. This is considered to give a good representation of the condition of these systems within the prospecting areas. The IHI will be taken as representative of the Present Ecological State (PES) of these systems.

Table 4 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 5 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 4: 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 5: 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

According to Kleynhans (2000) a desktop assessment of the Brak River in the study area and which will be affected by mining operations is considered to have a PES of Category B: Largely Natural. On-site observation indicate that this is relatively accurate as this study has also calculated both the Brak River and Diepsloot as having a PES of Category B: Largely Natural (Appendix E). Largely natural with few modifications. A small change in natural habitats and biota may have taken place but the ecosystem functions are essentially unchanged. These watercourses will therefore provide several vital services including water transportation, flood dissipation, wetland and riparian habitat and support of ecological processes. Both watercourses should therefore be regarded as having a very high sensitivity with a high conservation value and any prospecting activities should therefore be excluded from them (Map 3). As these watercourses are also direct tributaries of the Orange River near the site they will also increase the resilience of this river and alleviate any impacts on it and this will even further increase their importance.

As already discussed both the Brak River and Diepsloot are mostly natural and are not being affected by large impacts. A few impacts are considered significant and will be discussed below. The catchments of both watercourses are being utilised almost exclusively for stock farming. Overgrazing and trampling is not evident and the impact is therefore very low. This will therefore not contribute to significant erosion and sediment load. A network of small dirt tracks occur in the catchments of both watercourses and crossings are also present. Tarred roads also cross the

Brak River but are absent from the Diepsloot. These do contribute some impacts to the watercourses. These act as flow barriers and alter the flow regime of the watercourses, they also alter the bed and banks to a low degree and act as sediment and nutrient traps. Furthermore, dirt tracks, especially those in uneven, rocky terrain are subjected to higher levels of erosion and this was also evident in many areas. The impact is however still considered to be relatively low. Alluvial diamond mining operations occur along the periphery of the catchment of the Diepsloot and although this impact will be low as it does not currently affect the steep catchment portion it will still contribute some sediment to the system. However, it is clear from the survey that should mining of the catchment of the Diepsloot take place this will lead to severe erosion and high sediment loads entering the Orange River.

The most significant impact on the Brak River is the presence of an extensive Mesquite Tree (*Prosopis glandulosa*) infestation of the banks of the river. This will have some impacts on the hydrology of the river, i.e. will use more soil water than indigenous vegetation, but the main impact is the modification of the riparian vegetation along the banks. The functionality of the river will remain largely unchanged and it does not contain any prominent impoundments and is therefore one of the few watercourses in the country which can be considered to still have a largely natural flow and flooding regime.

The most significant impact on the Diepsloot is the presence of pecan nut plantations in the lower reach of the stream and the irrigation associated with it. The plantation involves drip irrigation. This will elevate the moisture regime which will increase groundwater flow and surface water runoff and in so doing this has altered the flow regime of the stream. This is however confined the lower reach and the majority of the stream remains unaffected by this impact. It is however still considered a significant impact. Any fertilisers and pesticides used in the plantation will also contribute polluted runoff to the stream. Survey of the stream here has indicated a high algae concentration which indicates elevated nutrient levels, i.e. fertiliser runoff, as well as a discoloured residue on the soil surface.

From the above described impacts it should be clear that the affected watercourses are both in a very good condition and being affected by very few significant impacts. An Index of Habitat Integrity (IHI) was conducted for the Brak River as well as the Diepsloot within the proposed prospecting areas (Appendix E). The results of the IHI indicated that the Brak River has an Instream IHI of category B: Largely Natural and Riparian IHI of category C: Moderately Modified. This is mostly due to the infestation by exotic *Prosopis glandulosa* which cause moderate modification of the riparian community. The results of the IHI indicated that the Diepsloot has an Instream IHI of category B: Largely Natural and Riparian IHI of category B: Largely Natural. Although the irrigated plantation is a significant impact it only affects the lower reach of the stream whilst almost the entire stream is unaffected by any significant impacts. These watercourses will therefore provide several vital services including water transportation, flood dissipation, wetland and riparian habitat and support of ecological processes. Both watercourses should therefore be regarded as having a very high sensitivity with a high conservation value and any prospecting activities should therefore be excluded from them (Map 3). As these watercourses are also direct tributaries of the Orange River near the site they will also increase the resilience of this river and alleviate any impacts on it and this will even further increase their importance.

The EI&S of the floodplains associated with both the Brak River and Diepsloot has been rated as being 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. The Brak River was rated somewhat higher than the Diepsloot due to the its larger size and therefore higher habitat and species diversity, importance for migratory species, etc.

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 F). 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 in the main channel of both the Brak River and Diepsloot will undoubtedly cause permanent modification of these systems but only at a local level. However, owing to their highly sensitive nature as described in previous sections of the study this will have unacceptably high risk to these systems and it is therefore recommended that prospecting operations avoid both the Brak River and Diepsloot as well as all drainage lines and tributaries associated with them.

The catchment of the Diepsloot consists of a highly uneven, rocky terrain which, although the soil surface is stable currently, will lead to high levels of erosion should prospecting occur and it is unlikely to be contained or rehabilitated and will lead to a high risk of modifying the stream system. It is therefore recommended that prospecting operations avoid the uneven, rocky catchment of the stream.

Conducting prospecting operations in close proximity to the Brak River is anticipated to have a moderate risk and will likely still have significant impacts though unlikely to be permanent and will mostly influence sediment load and runoff values. This is due to the more even topography which is much more likely to be successfully rehabilitated and the susceptibility to erosion also much lower. Furthermore, through adequate mitigation this can be minimised and provided adequate rehabilitation is undertaken no additional and other permanent modification to the functioning of the Brak River is anticipated.

The Brak River forms the southern border of the prospecting area and is therefore unlikely to be crossed by any infrastructure. However, its associated drainage line, the Diepsloot and all other tributaries and associated drainage lines may be crossed by infrastructure such as roads and pipelines. Construction of roads and other infrastructure such as pipelines and canals through watercourses and wetland systems is anticipated to still have a moderate risk and will still have impacts on these although at a local scale. Furthermore, watercourses being linear by nature is almost unavoidable although circular wetland systems are much more easily avoided.

Higher Risks: Watercourses impacted by the activity are such that they impose a long-term threat on a large scale and lowering of the Reserve. Licence required.

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

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 F.

No.	Phases	Activity	Aspect	Impact	Risk Rating	Confidence level	Control measures
1	Mostly Operational Phase but extending long after closure	Diamond mining prospecting operations affecting the Diepsloot.	Prospecting operations within the Diepsloot and associated drainage lines in the prospecting area.	Prospecting operations within the main channel or tributaries of the Diepsloot or associated 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 high.	H	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. Due to the nature of this activity is likely to permanently affect the Diepsloot. The stream and catchment is highly susceptible to erosion which will be impossible to rehabilitate. It is recommended that prospecting activities exclude the Diepsloot, tributaries and associated drainage lines at least during the prospecting phase and should this still be desired during the full-scale mining phase that additional studies be conducted.
	Mostly Operational Phase but extending long after closure		Prospecting operations in close proximity to the Diepsloot and associated drainage lines in the prospecting area.	Prospecting operations will require removal of the vegetation layer in the catchment of the watercourses. The extent should however remain low but due to the steep and unstable slopes the impact on the stream system is still anticipated to be high. This will also contribute high sediment load to the stream and will cause significant transformation of its morphology and functioning. Increased establishment of exotic weeds is likely due to disturbance caused by mining.	H	4	This impact will be mainly during the operational phase but due to the steep slopes in this area it is likely to have a permanent impact on the stream system since progressive erosion will continue indefinitely. Due to the nature of this activity is likely to permanently affect the Diepsloot. The stream and catchment is highly susceptible to erosion which will be impossible to rehabilitate. It is recommended that prospecting activities exclude the Diepsloot, tributaries and associated drainage lines at least during the prospecting phase and should this still be desired during the full-scale mining phase that additional studies be conducted.
	Mostly Operational Phase		Construction of roads and infrastructure through the Diepsloot and associated drainage lines in the prospecting area.	Construction of roads and infrastructure over the stream system will also cause disturbance although on a local scale. These structures will act as flow barriers and will alter the hydrology of this system. Increased erosion, sediment load and exotic weed establishment is also likely.	M	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. However, compared to dirt tracks the large haul roads required for prospecting activities will have a much higher impact and therefore still entails a moderate risk. It is 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 stream morphology and establish an indigenous vegetation layer. Watercourses being linear by nature is almost unavoidable.
2	Mostly Operational Phase but extending long after closure	Diamond mining prospecting operations affecting the Brak River.	Prospecting operations within the Brak River and associated drainage line in the prospecting area.	Prospecting operations within the main channel of the Brak River or associated drainage lines will remove riparian vegetation, transform the soil profile and	H		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

				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 high.			a local scale. Due to the nature of this activity is likely to permanently affect the Brak River at least to some extent. It is recommended that prospecting activities exclude the Brak River and associated drainage line at least during the prospecting phase and should this still be desired during the full-scale mining phase that additional studies be conducted.
	Mostly Operational Phase but also extending to a degree beyond the closure phase		Prospecting operations in close proximity to the Brak River and associated drainage line in the prospecting area.	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.	**M**		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 still have a moderate risk of impact and adequate mitigation and comprehensive rehabilitation should be 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 Brak River. 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 drainage line in the prospecting area. The Brak River forms the border of the site and it should therefore not be necessary to cross it with any infrastructure.	Construction of roads and infrastructure over the drainage line will also cause disturbance although on a local scale. These structures will act as flow barriers and will alter the hydrology of this system. Increased erosion, sediment load and exotic weed establishment is also likely.	**M**		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. However, compared to dirt tracks the large haul roads required for prospecting activities will have a much higher impact and therefore still entails a moderate risk. It is 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 drainage line 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 over the entire prospecting area is considered relatively high. Due to the large extent of the area as well as the variety of soils, geology and topography the habitat diversity is quite varied (Map 1 & 2). This is most pronounced in the northern prospecting area mostly due to the varied topography while the southern prospecting area has a lower, though still significant, habitat diversity mostly due to the uniform topography. Furthermore, watercourses, especially the intricate drainage network associated with the Diepsloot, also provide unique habitats able to sustain a higher bio-load and therefore increase habitat diversity. The site is represented by only two vegetation types. Despite this the species diversity is relatively high, most likely due to the high diversity of habitats.

Presence of rare and endangered species:

Numerous protected and Red Listed species were encountered in the study area and is likely to be increased with additional surveys (Appendix C). Although none are considered to be in imminent danger of extinction a few are considered to somewhat rare and uncommon and therefore also of high conservation value.

Observed protected species in the study area included: *Ammocharis coranica, Asclepias meyeriana, Babiana sp., Harpagophytum procumbens, Aloe claviflora, Aloe hereroensis, Euphorbia braunsii, Euphorbia crassipes, Boscia albitrunca, Nymania capensis, Larryleachia picta* and *Hoodia gordonii*. *H.gordonii* and *Acanthopsis hofmanseggiana* are also Red Listed species with category Data Defficient and *L. picta* is considered a rare species.

The majority of these species are relatively widespread and common and therefore not of exceptionally high conservation value. However, as protected species all of them still retain some conservation significance.

It is known that the rare living stone plant, *Lithops sp.*, occurs in the region and would be a species of conservation importance should it occur. Although this was a target species during the survey it could not be identified in the study area. Due to its cryptic nature there remains some likelihood that it may occur.

Ecological function:

The ecological functioning and condition of watercourses in the study area is still largely intact and natural and therefore in a good condition. They also play a vital role in the continued functioning in terms of water transport and drainage of the area (Map 1, 2 & 4). The habitat provided by the watercourses and associated habitats support a rich faunal component and is considered to perform an important ecological function in this regard. These watercourses will therefore provide several vital services including water transportation, flood dissipation, wetland and riparian habitat and support of ecological processes. Both watercourses should therefore be regarded as having a very high sensitivity with a high conservation value and any prospecting activities should therefore be excluded from them. As these watercourses are also direct tributaries of the Orange River near the site they will also increase the resilience of this river and alleviate any impacts on it and this will even further increase their importance.

The terrestrial component of the study area also performs several ecological functions. The study area functions in the support of a natural vegetation type, which in turn sustains a specific faunal community and acts as part of the catchment of surrounding watercourses. Being of natural and unmodified composition these functions are still considered to be intact.

Degree of rarity/conservation value:
According to Mucina & Rutherford (2006) the study area consists of Northern Upper Karoo (NKu 3) and Upper Gariep Alluvial Vegetation (AZa 4). Both vegetation types are 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 4). Except for the situation in the immediate area they are not currently subjected to pronounced development pressures. It is therefore not of high conservation value in terms of the vegetation type, though the almost pristine condition and high habitat diversity does increase the conservation value.

The uneven, rocky terrain in the northern prospecting area is also considered a relatively unique and rare habitat (Map 2 & 3). This habitat is confined to a narrow portion along the southern banks of the Orange River stretching as scattered sections roughly between Prieska and Douglas. Therefore, although several areas of this habitat occurs it is confined to this region and therefore considered relatively unique increasing its conservation value.

Numerous protected species were observed in the study area (Appendix C). However, though some are Red Listed and considered rare none are endangered and the majority is widespread and relatively common. The conservation value is nonetheless still considered as high.

Both the Brak River and Diepsloot stream system in the study area are in a good condition and largely natural (Appendix E). Both watercourses should therefore be regarded as having a very high sensitivity with a high conservation value and any prospecting activities should therefore be excluded from them (Map 3). As these watercourses are also direct tributaries of the Orange River near the site they will also increase the resilience of this river and alleviate any impacts on it and this will even further increase their importance. Normally all watercourses are considered as sensitive systems, consequently the affected watercourses being in a good condition should be considered even more so.

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. This is natural to the area and is considered largely unchanged by any significant anthropogenic impacts. Although grazing by domestic stock takes place it is not considered to lead to a significant change in percentage ground cover.

Vegetation structure:
The study area is situated within the Nama Karoo Biome. A well-developed dwarf karroid shrub is dominant in most areas though due to a variety of soil condition the grass component may become more dominant in some areas. The small tree, *Senegalia melifera* subsp. *detinens* may become quite dense in some areas. This species is a well-known encroacher and may indicate a low alteration in the vegetation structure.

Infestation with exotic weeds and invader plants:
The majority of the study area has almost no occurrence of any exotic species. This is mostly attributed to the almost natural condition of the vegetation. However, the Diepsloot and Brak River do contain some infestation of weeds which is mostly attributed to the flood disturbance regime which is a natural component of these systems but does make them susceptible to

infestation by exotics. The Brak River especially, does contain a moderate infestation by the exotic Mesquite Tree (*Prosopis glandulosa*).

Degree of grazing/browsing impact:
The study area is mostly being utilised as grazing by domestic stock but does not cause any significant alteration or impacts of the natural vegetation and is therefore considered relatively low.

Signs of erosion:
Mostly visible in the northern prospecting area but still present in some areas of the southern area. As a result of steep slopes, unstable soils and drainage patterns, especially the Diepsloot, the area is subjected to significant erosion. However, this erosion is considered as part of the natural ecosystem but a low amount of erosion does occur where dirt tracks cross over watercourses or occur along steep slopes. This should also indicate the high susceptibility of, especially the northern prospecting area, to severe erosion.

Terrestrial animals:
As the proposed prospecting areas both consist of natural vegetation in relatively good condition and being utilised almost exclusively for stock farming the study area contains a varied faunal population with relatively high density. Being situated in an arid area the carrying capacity will be somewhat lower. However, the study area also has a large extent and consequently will be able to sustain population dynamics at a larger scale, i.e. localised migration, varied genetic pool, pristine habitats for reclusive and rare species. From available literature of species likely to occur in the region it is clear that numerous Red Listed species occur and is likely to occur in the study area. The mammal population on the site therefore has a high conservation value.

Table 6: Biodiversity Sensitivity Rating for the Remhoogte prospecting areas.

	Low (3)	Medium (2)	High (1)
Vegetation characteristics			
Habitat diversity & Species richness			1
Presence of rare and endangered species			1
Ecological function			1
Uniqueness/conservation value			1
Vegetation condition			
Percentage ground cover			1
Vegetation structure		2	
Infestation with exotic weeds and invader plants or encroachers		2	
Degree of grazing/browsing impact			1
Signs of erosion		2	
Terrestrial animal characteristics			
Presence of rare and endangered species			1
Sub total	0	6	7
Total		13	

6. Biodiversity Sensitivity Rating (BSR) interpretation

Table 7: Interpretation of Biodiversity Sensitivity Rating.

Site	Score	Site Preference Rating	Value
Remhoogte prospecting areas	13	Good Condition	2

7. Anticipated impacts

The proposed prospecting operations for alluvial diamonds will take place in two large portions divided into a northern and southern prospecting area (Map 1). Although these prospecting operations are not as extensive as full-scale mining it still entails transformation of significant areas, especially where trenching and bulk sampling activities are undertaken. As can be expected this will still involve numerous significant impacts.

The main impacts will be associated with the loss of habitat including species of conservation value 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 will also decrease the anticipated impact. Although the vegetation types in the study area is not considered to have a high conservation value they do form part of an area which is still natural and in a good condition and represent unaltered natural vegetation (Map 1, 2 & 4). This will therefore significantly increase the impact of vegetation clearing. Furthermore, some areas contain more unique and diverse habitats such as the uneven, rocky terrain in the northern prospecting areas which will have a high conservation value (Map 3). Mining in such areas will therefore also increase the impact. These areas also include the watercourses in the study area, i.e. the Brak River, Diepsloot, associated drainage network and all other associated tributaries (Map 1, 2 & 3). These areas should be avoided as far as possible which will considerably decrease the anticipated impact (Map 3).

As previously discussed, numerous protected and Red Listed species were encountered in the study area and is likely to be increased with additional surveys (Appendix C). Mining activities will still clear vegetation and this will therefore require removal of protected species. The impact on these species will therefore still be considered to be relatively high. Most of these protected species are scattered throughout the site and not confined to specific areas. However, uneven, rocky areas such as dominates the northern prospecting area contains a somewhat higher percentage of such species. Tree and shrub species are easy to identify and include *Boscia albitrunca* (Shepherds Tree) and *Nymania capensis* (Lanternbush). They can therefore easily be avoided by mining activities or where this is not possible, permits be obtained to remove them. However, where they are removed, it is recommended that they be replaced by saplings grown in a nursery on the site from seed obtained in the study area. In contrast to these trees and shrubs the remaining protected species largely consist of succulent or geophytic species which are small and cryptic and therefore not easily identified. They are however easily transplanted and mining does not need to avoid them but they can easily be transplanted to adjacent or rehabilitated areas where they will remain unaffected. Permits should also be obtained to do this. Due to the difficulty in identifying these plants it is recommended that a walkthrough survey of each mining portion, i.e. drill sites, trenching areas, bulk sampling sites, etc., be conducted prior to mining taking place. Protected species should then be identified and marked for easy transplanting. The walkthrough survey should preferably be conducted by ecologist or botanist with adequate knowledge of the vegetation in the area. Should the above mitigation be implemented the impact on protected species can be considerably decreased.

According to research concerning small scale mining which is also comparable to prospecting operations several impacts occur and is likely to take place during these operations (Heath *et al* 2004):

- Accelerated erosion of areas adjacent to workings that have been de-vegetated leads to increased suspended sediment loads in nearby streams and rivers.
- Excavation of flood terraces and riverbanks increases the instability of these riverbanks and enhances the likelihood of increased flood scouring.
- Excavation of river sediments exposes these sediments to oxidising conditions and enhances the solubility and release of any metal ions that may previously have been previously trapped as insoluble sulphides.
- Wind-blown dusts from unprotected tailings and waste rock dumps enter aquatic environment.

The impacts that prospecting will have on watercourses 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.

Prospecting within the study area will undoubtedly lead to high impacts on the watercourses in the study area. This is especially so where prospecting occurs in the catchment of the Diepsloot, an unstable and very steep area, as well as any prospecting activities within watercourses (Map 2). 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.

Prospecting activities in close proximity to watercourses will clear vegetation, disturb the soil surface and mobilise sandy soils. This may cause high levels of sedimentation within the watercourses, especially if the catchment of the Diepsloot is affected. It is therefore recommended that measures be implemented to prevent sediment from entering the watercourses. Due to the removal of vegetation and disturbance of the soil surface the propsecting areas will be highly susceptible to the establishment of invasive weeds. It is therefore recommended that weed control be judiciously and continually practised. Monitoring of weed establishment should form a prominent part of management of the prospecting area. Prospecting within watercourses will cause disturbance of the bed and banks and will mobilise sediments from these watercourses. Due to the clearing of vegetation these sediments will be transported downstream and into the Orange River. Disturbance of the bed surface and streamflow after rain events will also lead to erosion of the streambed and banks. It is therefore recommended that these watercourses as described in this report be excluded from mining as far as possible (Map 1, 2 & 3). Prospecting activities in close proximity to watercourses should still adhere to a comprehensive rehabilitation and monitoring plan. 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 relatively few exotic species, especially the terrestrial portions which are almost devoid of exotics. 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 relatively high impact as the area is largely natural and any alteration to the vegetation structure will easily affect its integrity. It is therefore recommended that weed control be judiciously and continually practised. 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 prospecting 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 mining will lead to a decrease in the mammal population. This impact is considered to be moderate since prospecting operations will not affect as large an extent as full-scale mining would. However, significant impacts are still likely especially since the study area is still natural and would therefore contain a significant mammal population with species of conservation concern highly likely. Recommended mitigation should include amongst others limiting prospecting to set areas and not mine several areas at the same time, limit the extent of each such prospecting area and comprehensive and successful rehabilitation of mined areas. Successful rehabilitation is considered likely for the more even and flat southern prospecting area while it is unlikely that it will be possible to rehabilitate any prospecting operations in the uneven and steep northern prospecting area. Successful rehabilitation will significantly decrease the impact on mammals as this will allow a similar habitat to be made available to mammals after prospecting. 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.

The impact significance has been determined and it is clear that most impacts prior to mitigation will be moderate to high but can be decreased significantly with mitigation to low/moderate. This is however subject to the above recommended mitigation strictly being adhered to but especially the exclusion of the rocky, uneven terrain in the northern prospecting area as well as all watercourses including the Brak River, Diepsloot, associated drainage network and all other associated tributaries.

Please refer to Appendix G 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	4	5	5	4.6	5	4	4.5	20.7
Loss of protected species	4	5	5	4.6	4	4	4	18.4
Loss of watercourses	5	5	4	4.6	5	4	4.5	20.7
Infestation with weeds and invaders	4	4	4	4	4	3	3.5	14
Impact on Terrestrial fauna	4	4	4	4	4	3	3.5	14
After mitigation								
Loss of vegetation type and clearing of vegetation	3	4	4	4	4	4	4	16
Loss of protected species	2	5	3	3.3	3	3	3	9.9
Loss of watercourses	3	5	3	3.6	3	4	3.5	12.6
Infestation with weeds and invaders	2	2	3	2.3	4	2	3	7
Impact on Terrestrial fauna	3	4	3	3.3	3	3	3	9.9

8. Discussion and conclusions

The overall study area proposed for prospecting operations has been rated as being in a good condition. This is mostly due to the largely natural condition of the area with few impacts. However, this is an overall estimation with some areas being more sensitive than others.

According to Mucina & Rutherford (2006) the study area consists of Northern Upper Karoo (NKu 3) and Upper Gariep Alluvial Vegetation (AZa 4). Both vegetation types are 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 4). Except for the situation in the immediate area they are not currently subjected to pronounced development pressures. It is therefore not of high conservation value in terms of the vegetation type, though the almost pristine condition and high habitat diversity does increase the conservation value.

The proposed prospecting areas consist of two separate areas to the north and south of the current mining area which has been subjected to extensive alluvial diamond mining operations. Several studies have previously also been conducted for the existing mining area and will also be utilised to provide background information for the proposed prospecting areas. A large and prominent, though clearly ephemeral, stream system drains the northern portion while a few smaller drainage lines and the Brak River occur in or adjacent to the southern prospecting area. The combined extent of both prospecting areas are approximately 2 500 hectares although the core prospecting areas will exclude a large portion of the northern prospecting area (Map 1). The proposed prospecting areas has not yet been affected by mining operations and impacts on it are relatively low and they are therefore considered to be in a natural and pristine condition.

The southern prospecting area has an approximate extent of 800 hectares. It is bordered along the north by the existing mining area which is largely transformed, a large dirt road borders it along the western border and the Brak River forms the southern border (Map 1). Extensive natural areas occur to the east and south of this portion and extensive centre-pivot irrigation occurs to the west but does not impact on the site. This portion is dominated by a sandy soil surface with vegetation adapted to sandy soils, i.e. grasses, shrubs, herbs and geophytes.

The northern prospecting area has an approximate extent of 1 600 hectares. It is bordered along the south by the existing mining area which is largely transformed and extensive centre-pivot irrigation to the north and west (Map 1). The Orange River is also located close to the western border of the site. Extensive natural areas border the site to the north and east. The portion is dominated by soils with a high percentage rock content and consequently the vegetation is characteristic of such habitats, i.e. small trees, shrubs, grasses and most characteristically dwarf karroid shrubs.

8.1 Southern prospecting area

Undulating plains

As mentioned, the undulating plains portion covers the largest portion of the southern prospecting area with a rather uniform topography (Map 2). Soils are dominated by deeper sandy soils. The vegetation in this area seem to be relatively uniform with a relatively low species diversity being dominated by a few species. However, several protected species were observed in this area and although they are all relatively widespread they do retain a significant conservation value (Appendix C). The area is not currently affected by any significant impact and is still in a natural condition. This increases its conservation value and although it is relatively uniform with a low species diversity it is still considered to be of moderate sensitivity (Map 3). Due to the deeper sandy soils and relatively uniform topography this portion is also considered much more easily rehabilitatable as long as adequate removal of the topsoil, protection thereof and replacement is undertaken.

Calcrete ridge associated with drainage line

Along the eastern border of the undulating plains portion a relatively large calcrete ridge is present (Map 2). It is also associated with a small drainage line at the foot of the ridge draining from north to south and which flows into the Brak River to the south. The soils are overall relatively shallow. The vegetation along the ridge is considered quite variable with a moderate species diversity and likely to yield an even higher recorded diversity following further survey. The ridge contains several protected species and it is considered likely that others may also be present (Appendix C). The area is not currently affected by any significant impact and is still in a natural condition which increases its conservation value. Should prospecting activities occur in this area it will be difficult to rehabilitate and re-instate the natural vegetation due to the topography and soil/rock composition. As a result of a combination of the above this area is considered to have a high sensitivity and prospecting activities should be kept to a minimum here (Map 3).

Small but prominent ridge

Along the western border of the undulating plains portion a relatively small but prominent ridge is located (Map 2). It is situated longitudinally from east to west and is located adjacent to the bottomlands associated with the Brak River. The soils are overall relatively shallow. The vegetation along the ridge is considered relatively uniform and much lower in diversity than the calcrete ridge. Coupled with the above this ridge also contains much fewer protected species, confined to one protected tree species. There is however a likelihood that other protected species may also be present on the ridge. The ridge is still mostly intact although a borrow pit has permanently modified a small portion of it and does decrease the conservation value to a small degree. Should prospecting activities occur in this area it will be difficult to rehabilitate and re-instate the natural vegetation due to the topography and soil/rock composition. From the above description and conclusions this ridge is evidently of lower conservation value than the calcrete ridge and is consequently considered to only be of moderate sensitivity (Map 3).

Bottomlands associated with the Brak River

The bottomlands associated with the Brak River is situated adjacent to the river and contains a visibly high silt content in many areas (Map 2). The vegetation in this area seem to be relatively uniform with a relatively low species diversity being dominated by a few species. The vegetation is very similar to the undulating plains section but does contain some differences. A single protected geophyte was identified and although it is relatively widespread it does retain a significant conservation value (Appendix C). The area is not currently affected by any significant impact and is still in a natural condition. This increases its conservation value and although it is relatively uniform with a low species diversity it is still considered to be of moderate sensitivity (Map 3). Due to the deeper sandy soils and relatively uniform topography this portion is also considered much more easily rehabilitatable as long as adequate removal of the topsoil, protection thereof and replacement is undertaken.

8.2 Northern prospecting area

Uneven terrain dominated by hills, ridges and valleys

As mentioned, this portion of very uneven, rocky terrain which is dominated by hills, ridges, clacrete capped mesas and valleys form the largest part of the northern prospecting area (Map 2). It is evident that this portion of the prospecting area is diverse in terms of habitats and as a result also contains a relatively high species diversity. This will also be increased substantially should additional surveys of the area be conducted. Several protected species also occur in this area with some being considered as relatively rare (Appendix C). It is also likely that others may be present. Due to the uneven terrain, steep slopes and mobile substrate the area is highly prone to erosion. Consequently, any prospecting activities in this area will highly likely lead to high levels of erosion which will progressively worsen due to the steep slopes. Furthermore, should any prospecting activities occur in this area it will not be possible to rehabilitate and re-instate the natural vegetation due to the topography, steep slopes and soil/rock composition. As a result of a combination of the above this area is considered to have a very high sensitivity and prospecting activities should be excluded from this area as far as possible (Map 3).

Calcrete cliffs at the edge of the uneven terrain

Along the border of the uneven rocky terrain as described above a very steep calcrete cliff separates it from the surrounding plateau which forms a small part of this prospecting area (Map 2). Soils are absent in many areas. It is however a quite unstable habitat as cliff collapse does occur sporadically. This habitat does not contain a high diversity but does form a unique and highly unstable habitat also containing unique species localised to it. However, the vegetation composition along the cliff cannot overall be considered to be of high conservation. The habitat itself and the unstable nature makes this a highly sensitive area, especially to mining activities. Should prospecting of the cliff habitat take place it will not be possible to rehabilitate or re-instate the habitat. Disturbance of the habitat will also undoubtedly lead to high levels of erosion which will progressively worsen due to the steep slopes. As a result of a combination of the above this area is considered to have a very high sensitivity and prospecting activities should be excluded from this area as far as possible (Map 3).

Plateau

A relatively flat to undulating plateau surrounds the uneven rocky terrain and calcrete cliffs (Map 2). Only a small portion of this habitat occurs within the northern prospecting area along the eastern and south western borders. Soils are still relatively shallow. The vegetation of the plateau seem to be relatively uniform and somewhat lower in species diversity compared to the uneven rocky portion. However, several protected species were observed in this area and although they are all relatively widespread, they do retain a significant conservation value (Appendix C). These portions, especially the south western corner borders on the current mining areas which do cause some disturbance of the area. It is relatively uniform with a low species diversity but is still considered to be of moderate sensitivity (Map 3). Due to the even, flatter topography this portion is also considered more easily rehabilitatable with a lower likelihood of severe erosion occurring. It is however unlikely that it will be possible to re-instate the current soil surface to the natural condition due to the soil/gravel surface coverage. Comprehensive topsoil removal, topsoiling, protection and replacement may alleviate this impact.

As previously discussed, numerous protected and Red Listed species were encountered in the study area and is likely to be increased with additional surveys (Appendix C). Mining activities will still clear vegetation and this will therefore require removal of protected species. The impact on these species will therefore still be considered to be relatively high. Most of these protected species are scattered throughout the site and not confined to specific areas. However, uneven, rocky areas such as dominates the northern prospecting area contains a somewhat higher percentage of such species. Tree and shrub species are easy to identify and include *Boscia albitrunca* (Shepherds Tree) and *Nymania capensis* (Lanternbush). They can therefore easily be avoided by mining activities or where this is not possible, permits be obtained to remove them. However, where they are removed, it is recommended that they be replaced by saplings grown in a nursery on the site from seed obtained in the study area. In contrast to these trees and shrubs the remaining protected species largely consist of succulent or geophytic species which are small and cryptic and therefore not easily identified. They are however easily transplanted and mining does not need to avoid them but they can easily be transplanted to adjacent or rehabilitated areas where they will remain unaffected. Permits should also be obtained to do this. Due to the difficulty in identifying these plants it is recommended that a walkthrough survey of each mining portion, i.e. drill sites, trenching areas, bulk sampling sites, etc., be conducted prior to mining taking place. Protected species should then be identified and marked for easy transplanting. The walkthrough survey should preferably be conducted by ecologist or botanist with adequate knowledge of the vegetation in the area. Should the above mitigation be implemented the impact on protected species can be considerably decreased.

8.3 Wetland and Watercourses Assessment

The study area consists of two separate prospecting areas (Map 1) which will affect two separate watercourse systems, the southern portion will affect the Brak River as well as a small drainage tributary and the northern portion will affect the Diepsloot and associated intricate drainage network as well as two drainage lines to the north and south of it (Map 1 & 2).

Brak River and associated drainage line (Southern prospecting area)

The Brak River is a large watercourse which forms the southern border of the southern prospecting area (Map 1 & 2). It therefore does not form part of the site but there is still a high likelihood that it could be affected by prospecting operations. The catchment is also relatively unaffected by any large impacts which will also increase the condition of the river. The river flows into the Orange River approximately 6 km to the west of the site. Therefore, any impact on the river at the site is also likely to affect the Orange River. The banks are also affected by a severe infestation of the exotic Mesquite Tree (*Prosopis glandulosa*). This has a significant impact on the riparian community of the river. The riparian vegetation associated with the river is clearly indicative of high salt concentrations associated with the river. A small drainage line also drains into the river and originates in the central portion of this prospecting area along the foot of a low calcrete ridge. It drains from north to south along the foot of the ridge where it has a clear main channel in the deeper sands. This main channel does however become indistinct in close proximity to the Brak River in the bottomlands adjacent to it.

Diepsloot, associated drainage pattern and adjacent drainage lines (Northern prospecting area)

The Diepsloot is a large stream system associated with an intricate pattern of tributary drainage lines (Map 1 & 2). It dominates the northern prospecting area and together with its tributaries covers almost the entire prospecting area. The catchment is not affected by any significant impacts and the condition of the stream may therefore be considered to be pristine. The lower section of the stream is located adjacent to irrigated pecan nut plantations which will have some significant impacts on the stream mostly in terms of increased runoff as well as fertiliser and pesticide pollution. The stream flows into the Orange River almost directly adjacent to the site. Therefore, any impact on the stream at the site is also likely to affect the Orange River. The stream is also largely free of any exotic weeds or invaders with these being confined to a few exotic weeds. The vegetation associated with the stream is characteristic of riparian vegetation in this region but do not support the presence of wetland conditions. The stream is also associated with a substantial bottomland which is associated with silt and sediments transported from the catchment and deposited along the stream. The main channel of the stream also shows a high tendency for erosion. The site survey indicated that this system and catchment will be highly susceptible to erosion which should be taken into account in terms of the proposed prospecting.

A note should be made here that two drainage lines also occur to the north and south of the Diepsloot but are included in this description due to their proximity and similarity to this stream (Map 1 & 2). Small circular depressions were also identified along the eastern border of the Diepsloot which should be assumed to be depression wetlands and should be avoided by prospecting activities (Map 1 & 2).

From the described impacts it should be clear that the affected watercourses are both in a very good condition and being affected by very few significant impacts. An Index of Habitat Integrity (IHI) was conducted for the Brak River as well as the Diepsloot within the proposed prospecting areas (Appendix E). The results of the IHI indicated that the Brak River has an Instream IHI of category B: Largely Natural and Riparian IHI of category C: Moderately Modified. This is mostly due to the infestation by exotic *Prosopis glandulosa* which cause moderate modification of the riparian community. The results of the IHI indicated that the Diepsloot has an Instream IHI of category B: Largely Natural and Riparian IHI of category B: Largely Natural. Although the irrigated plantation is a significant impact it only affects the lower reach of the stream whilst almost the entire stream is unaffected by any significant impacts. These watercourses will therefore provide several vital services including water transportation, flood dissipation, wetland and riparian habitat and support of ecological processes. Both watercourses should therefore be regarded as having a very high sensitivity with a high conservation value and any prospecting activities should therefore be excluded from them (Map 3). As these watercourses are also direct tributaries of the Orange River near the site they will also increase the resilience of this river and alleviate any impacts on it and this will even further increase their importance.

The EI&S of the floodplains associated with both the Brak River and Diepsloot has been rated as being 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. The Brak River was rated somewhat higher than the Diepsloot due to the its larger size and therefore higher habitat and species diversity, importance for migratory species, etc.

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 F).

Prospecting in the main channel of both the Brak River and Diepsloot will undoubtedly cause permanent modification of these systems but only at a local level. However, owing to their highly sensitive nature as described in previous sections of the study this will have unacceptably high risk to these systems and it is therefore recommended that prospecting operations avoid both the Brak River and Diepsloot as well as all drainage lines and tributaries associated with them (Map 3).

The catchment of the Diepsloot consists of a highly uneven, rocky terrain which, although the soil surface is stable currently, will lead to high levels of erosion should prospecting occur and it is unlikely to be contained or rehabilitated and will lead to a high risk of modifying the stream system. It is therefore recommended that prospecting operations avoid the uneven, rocky catchment of the stream (Map 3).

Conducting prospecting operations in close proximity to the Brak River is anticipated to have a moderate risk and will likely still have significant impacts though unlikely to be permanent and will mostly influence sediment load and runoff values. This is due to the more even topography which is much more likely to be successfully rehabilitated and the susceptibility to erosion also much lower. Furthermore, through adequate mitigation this can be minimised and provided adequate rehabilitation is undertaken no additional and other permanent modification to the functioning of the Brak River is anticipated.

The Brak River forms the southern border of the prospecting area and is therefore unlikely to be crossed by any infrastructure. However, its associated drainage line, the Diepsloot and all other tributaries and associated drainage lines may be crossed by infrastructure such as roads and pipelines. Construction of roads and other infrastructure such as pipelines and canals through watercourses and wetland systems is anticipated to still have a moderate risk and will still have impacts on these although at a local scale. Furthermore, watercourses being linear by nature is almost unavoidable although circular wetland systems are much more easily avoided.

9. Recommendations

- Although the survey was comprehensive it is highly likely that several species, including species of conservation concern, were overlooked and should the prospecting operations determine a need to progress to a mining right further ecological and wetland studies should be undertaken.

- 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.

- As discussed in the report, the study area contains numerous protected species (Appendix C). These consist of protected trees, succulents and geophytes. The following recommendations should be followed for protected species:

    - Where protected tree/shrub species occur in mining areas they should be avoided as far as possible.
    - Where this is not possible, permits should be obtained from the relevant authority to remove them. These trees should be replaced during rehabilitation by saplings sourced from seed in the study area.
    - Saplings should be cultivated in a small nursery area established on the site. This should also be established/overseen by a suitably qualified person.
    - Saplings may require protection and watering during the initial establishment phase.
    - The success of establishment should also be continuously monitored.
    - Where protected succulent/geophytic species will be affected by mining, permits should be obtained and these transplanted to adjacent or rehabilitated areas where they will remain unaffected.
    - These species are cryptic and inconspicuous and it is recommended that a walkthrough survey be conducted prior to an area being mined, i.e. drill sites, trenching areas, bulk sampling sites, etc. This should include identification and marking of all protected plants in such an area and should be performed by an ecologist or botanist.
    - The transplanting of these species should be overseen by an ecologist, botanist or other suitably qualified person.
    - Monitoring of the success of establishment should also be undertaken.

- Several areas of high sensitivity has been identified and should be excluded from prospecting activities as far as possible (Map 3):

    - The Brak River and associated tributary.
    - The low calcrete ridge associated with above mentioned tributary.
    - The uneven, rocky terrain dominating the northern portion of the northern prospecting area.
    - The calcrete cliffs forming the border between uneven, rocky terrain and surrounding plateau.
    - The Diepsloot and its entire drainage network.
    - Tributaries and drainage lines associated and occurring to the north and south of the Diepsloot.

    - Small circular depressions to the east of the Diepsloot.

- The impact of habitat loss and fragmentation on the faunal population should be mitigated by amongst others:

    - Limiting prospecting to set areas and not mine several areas at the same time.
    - Limit the extent of each such prospecting area.
    - Comprehensive and successful rehabilitation of mined areas.
    - Exclusion of areas with high sensitivity.

- 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, 2 & 3) as far as possible.

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

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

- 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 100 meters or within the floodplain of watercourses and within 500 meters of wetland areas.

- Following completion of mining in specific areas and consequent rehabilitation it is recommended that an extended period of monitoring be initiated which should include monitoring of erosion, bank and bed stability, vegetation and weed establishment and remediating this.

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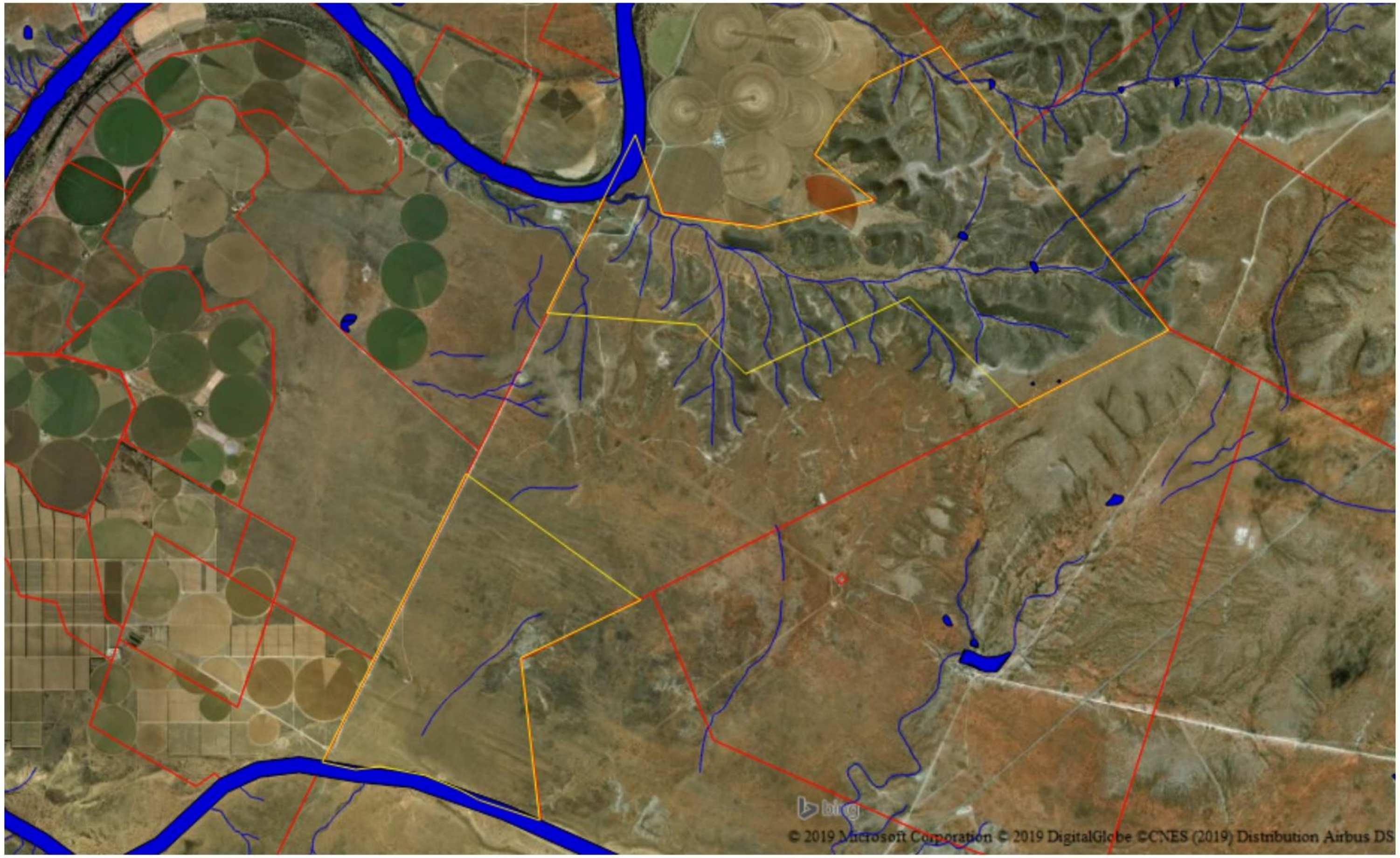
Annexure A: Maps

Locality map of the alluvial diamond prospecting operations on a portion of the Remainder of the Farm Remhoogte 152 near Prieska, Northern Cape Province.



Preparred for:
Wadala Mining and Consulting
P.O. Box 110823
Hudsonpark
8306

Legend:

- Property boundaries
- Application area
- Watercourses
- Wetlands and impoundments

Map Information

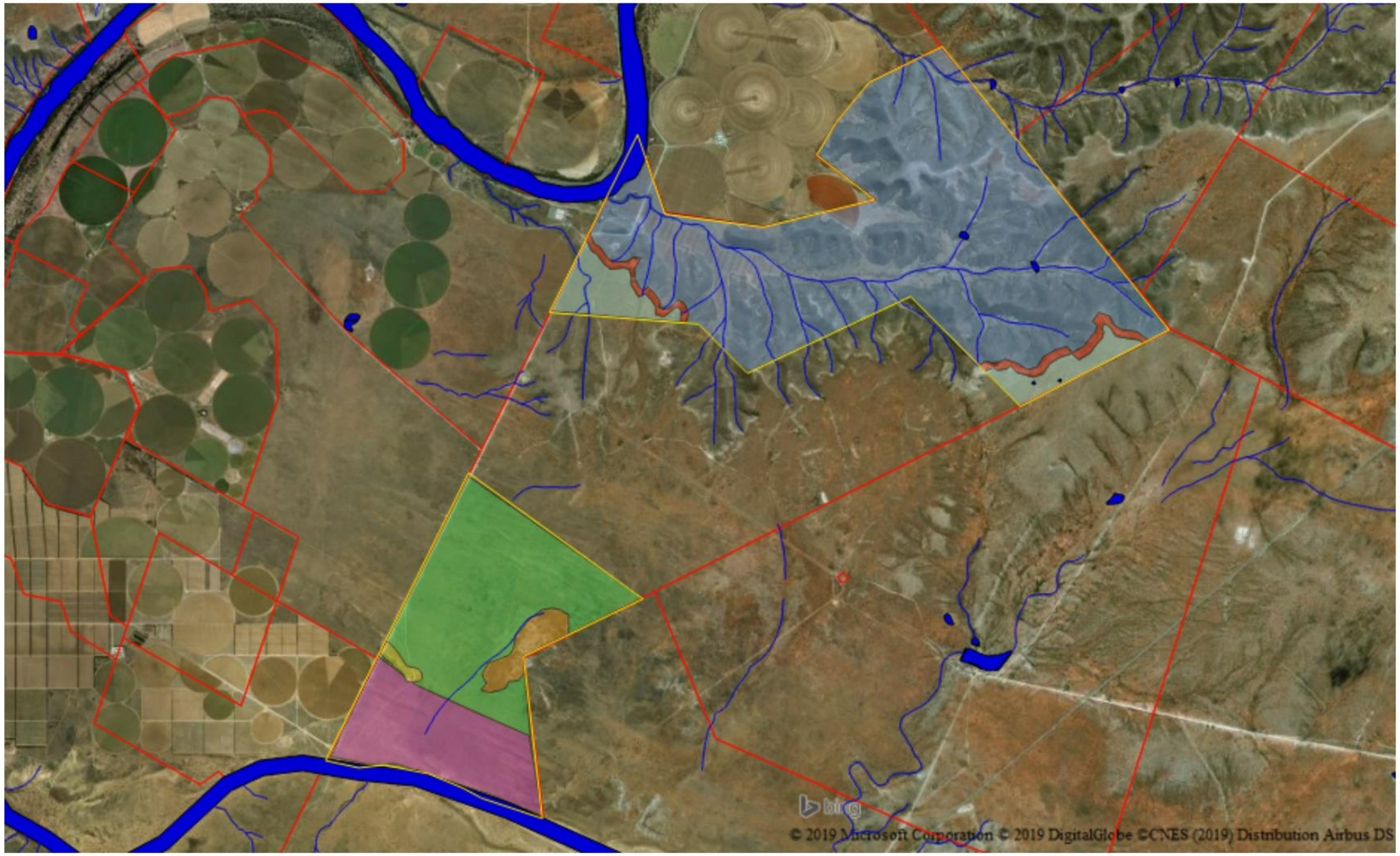
S 29.546253°
E 23.074005°

Spheroid: WGS 84
Scale: 1:85 000
Quantum GIS

DPR Ecologists
Contact Darius van Rensburg at:
darius@dprecologists.co.za
P.O. Box 12726, Brandhof, 9324
Tel: 083 410 0770

Map 1: Locality map of the proposed prospecting application area on the Farm Remhoogte 152 near Prieska. The area is clearly divided into a Northern- and Southern Prospecting areas. Watercourses are indicated including the Brak River in the southern prospecting area and Diepsloot in the northern prospecting area. Note the clear difference in topography with the northern area clearly very uneven and southern area more flat. Note also extensive irrigation to the west and natural areas to the east.

Ecological units map of the alluvial diamond prospecting operations on a portion of the Remainder of the Farm Remhoogte 152 near Prieska, Northern Cape Province.



Map 2: Ecological units map of the proposed prospecting application area on the Farm Remhoogte 152 near Prieska. The study area contains a variety of habitats but can broadly be divided into ecological units based largely on topography and soils.

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Legend:

- Property boundaries
- Application area
- Watercourses
- Wetlands and impoundments
- Uneven terrain
- Calcrete cliffs
- Plateau
- Undulating plain
- Calcrete ridge
- Bottomlands
- Small ridge

Map Information

S 29.546253º
E 23.074005º

Spheroid: WGS 84
Scale: 1:85 000
Quantum GIS

DPR Ecologists
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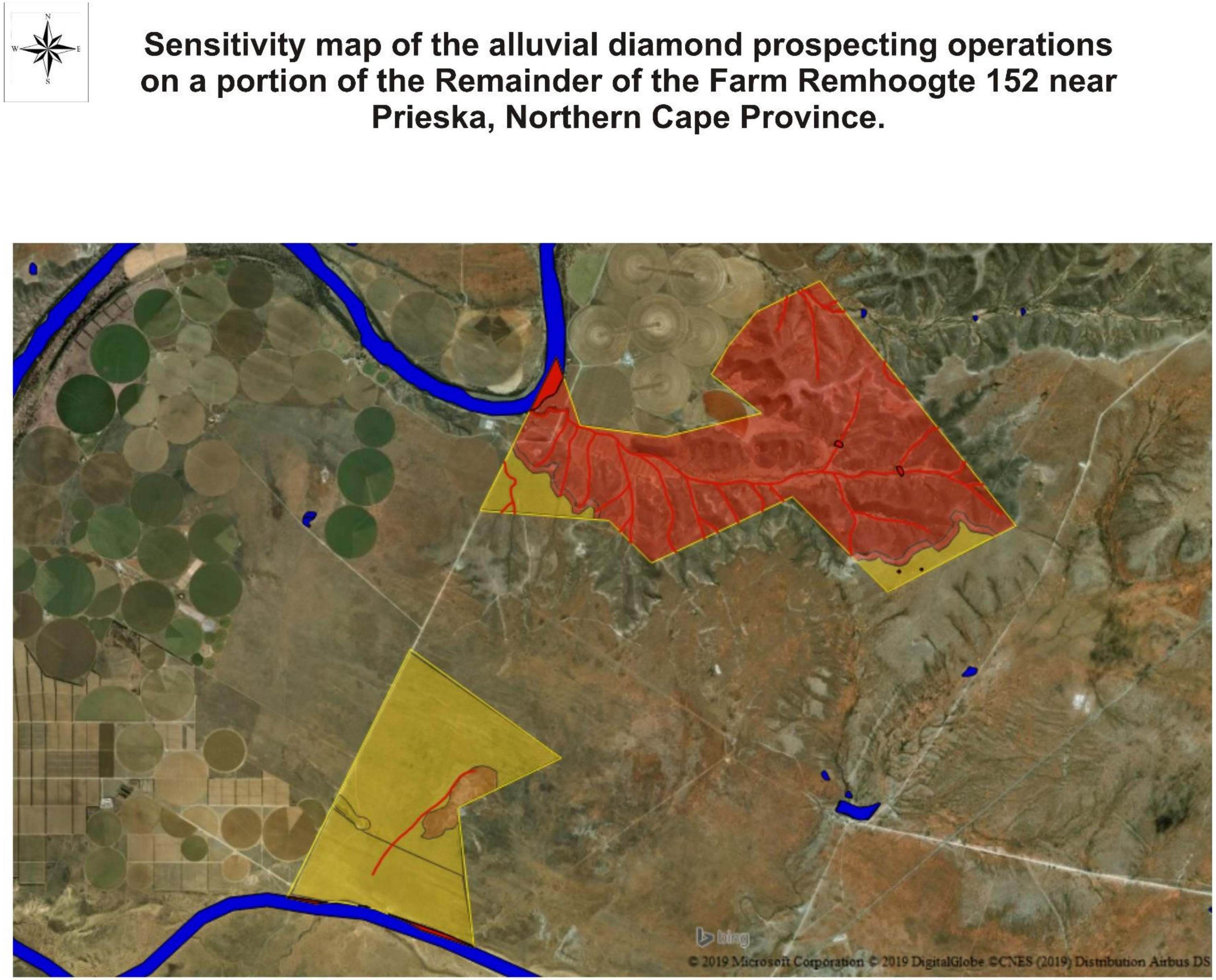
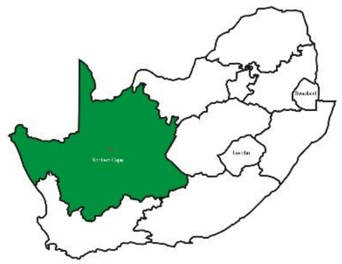
Tel: 083 410 0770

Sensitivity map of the alluvial diamond prospecting operations on a portion of the Remainder of the Farm Remhoogte 152 near Prieska, Northern Cape Province.





Preparred for:
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P.O. Box 110823
Hudsonpark
8306

Legend:

Application area

Very high sensitivity
High sensitivity
Moderate sensitivity
Low sensitivity

Map Information

S 29.546253°
E 23.074005°

Spheroid: WGS 84
Scale: 1:85 000
Quantum GIS

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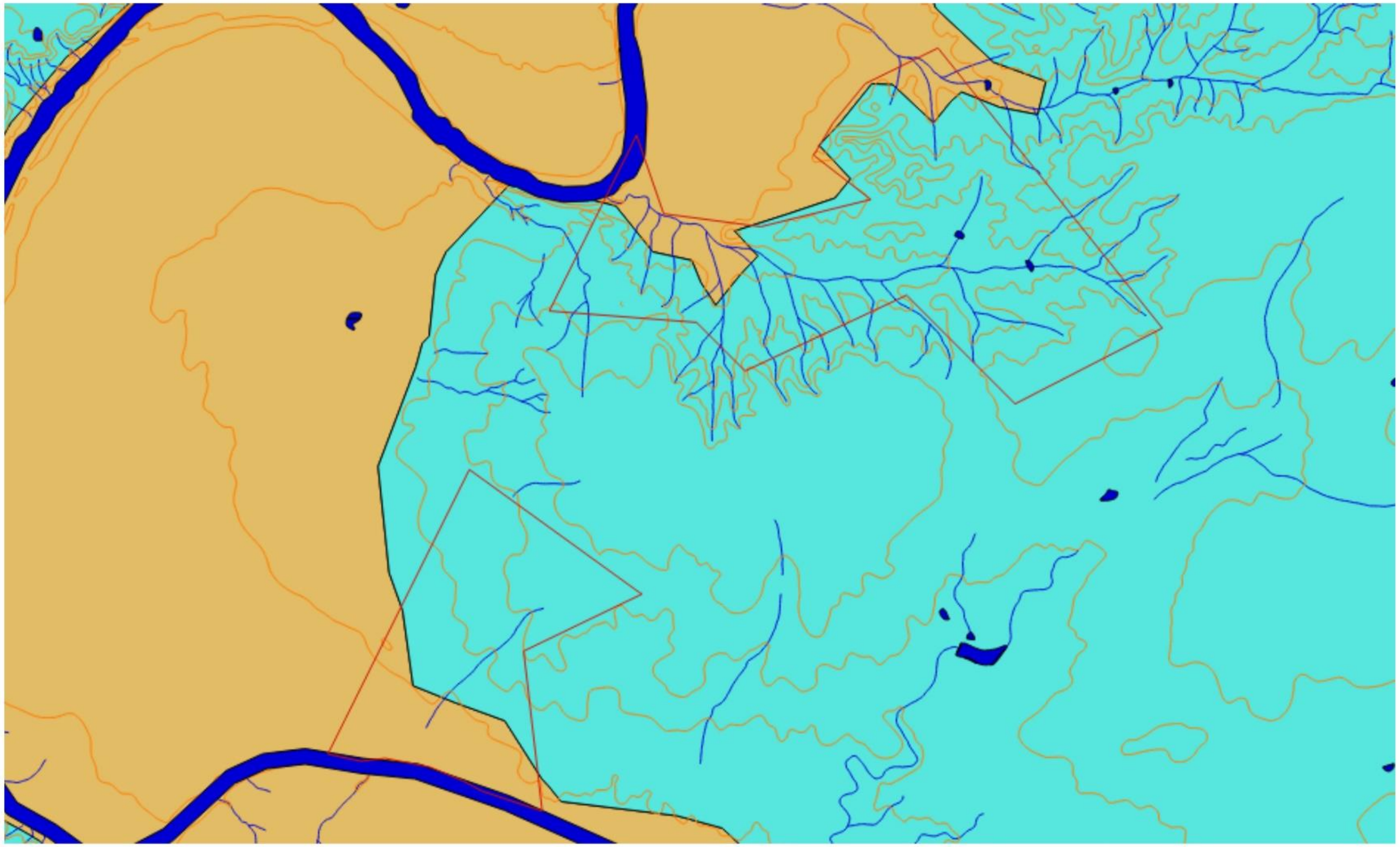
DPR Ecologists & Environmental Services

Map 3: Sensitivity map of the proposed prospecting application area on the Farm Remhoogte 152 near Prieska. All watercourses and wetland areas are considered highly sensitive. Furthermore, area with higher habitat and species diversity, protected species, steep slopes or erosion potential area also considered to be very highly sensitive. Areas of very high and high sensitivity should be excluded from prospecting activities while areas with moderate sensitivity can be subjected to prospecting although adequate mitigation will still be required.

General ecology map of the alluvial diamond prospecting operations on a portion of the Remainder of the Farm Remhoogte 152 near Prieska, Northern Cape Province.



Preparred for:
Wadala Mining and Consulting
P.O. Box 110823
Hudsonpark
8306

Legend:

- Application area
- Watercourses
- 20m Contours
- Wetlands and impoundments
- Northern Upper Karoo
- Upper Gariep Alluvial Veg

Map Information

S 29.546253º
E 23.074005º

Spheroid: WGS 84
Scale: 1:85 000
Quantum GIS

DPR Ecologists
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darius@dprecologists.co.za
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Tel: 083 410 0770

Map 4: General ecology map of the proposed prospecting application area on the Farm Remhoogte 152 near Prieska. Note that only two vegetation types are present on the site and are not considered to be Threatened Ecosystems. Contours also indicate the general topography of the site and clearly indicates the gradual slope of the southern area and steep uneven terrain of the northern area.

Appendix B: Species list

Species indicated with an * are exotic.

Protected species are coloured orange and Red Listed species red.

Species	Growth form
**Alternanthera pungens*	Herb
**Argemone ochroleuca*	Herb
**Prosopis glandulosa*	Tree
**Salsola kali*	Herb
**Solanum nigrum*	Herb
Acanthopsis hoffmansegiana	Herb
Aizoon schellenbergii	Dwarf shrub
Albuca cooperi	Geophyte
Aloe claviflora	Succulent
Aloe hereroensis	Succulent
Ammocharis coranica	Geophyte
Aptosimum marlothii	Dwarf shrub
Aptosimum spinescens	Dwarf shrub
Asclepias meyeriana	Geophyte
Asparagus burchellii	Dwarf shrub
Asparagus exuvialis	Dwarf shrub
Atriplex semibaccatta	Herb
Atriplex sp.	Herb
Babiana sp.	Geophyte
Barleria lichtensteiniana	Herb
Barleria rigida	Herb
Blepharis mitrata	Herb
Boscia albitrunca	Tree
Cadaba aphylla	Shrub
Cenchrus ciliaris	Grass
Centropodia glauca	Grass
Chascanum pinatifidum	Herb
Chenopodium album	Herb
Chenopodium carrinatum	Herb
Colobota spinescens	Dwarf shrub
Convolvulus sp.	Climber
Dicoma capensis	Herb
Dipcadi crispum	Geophyte
Dipcadi gracillimum	Geophyte
Dipcadi papillatum	Geophyte
Dipcadi vaginatum	Geophyte
Drimia intricata	Geophyte
Drimia sp.	Geophyte
Ehretia rigida	Shrub
Enneapogon cenchroides	Grass

Enneapogon desvauxii	Grass
Eragrostis echinochloidea	Grass
Eragrostis lehmanniana	Grass
Eragrostis nindensis	Grass
Eragrostis sp.	Grass
Eriocephalus ericoides	Dwarf shrub
Eriospermum corymbosum	Geophyte
Eriospermum porphyrium	Geophyte
Euphorbia braunsii	Succulent
Euphorbia crassipes	Succulent
Felicia muricata	Dwarf shrub
Fingerhuthia africana	Grass
Gnidia polycephala	Dwarf shrub
Grewia flava	Shrub
Harpagophytum procumbens	Geophyte
Heliophylla sp.	Herb
Hermannia abrotanoides	Herb
Hermannia spinosa	Herb
Heteropogon contortus	Grass
Hoodia gordonii	Succulent
Indegofera alternans	Herb
Justicia cuneata	Dwarf shrub
Kleinia longiflora	Succulent
Lactuca sp.	Herb
Larryleachia picta	Succulent
Ledebouria sp.	Geophyte
Ledebouria sp. 2	Geophyte
Limeum aethiopicum	Herb
Limeum viscosum	Herb
Lycium arenicola	Shrub
Lycium cinerium	Shrub
Mesembryanthemum guerichianum	Succulent
Monechma divaricatum	Herb
Monsonia salmoniflora	Succulent
Nymania capensis	Shrub
Ornithogalum juncifolium	Geophyte
Ornithoglossum vulgare	Geophyte
Peliostomum origanoides	Herb
Pentzia calcarea	Dwarf shrub
Pentzia incana	Dwarf shrub
Pentzia quinquifida	Dwarf shrub
Phaeoptilum spinosum	Shrub
Phragmites australis	Reed
Polygala asbestina	Herb
Polygala leptophylla	Herb
Psilocaulon coriarium	Succulent

Pteronia sp.	Dwarf shrub
Rhigozum obovatum	Shrub
Rhigozum trichotomum	Shrub
Rosenia humilis	Dwarf shrub
Ruschia intricata	Succulent
Salicornia meyeriana	Halophyte
Salsola aphylla	Dwarf shrub
Salsola glabrescens	Dwarf shrub
Salsola sp.	Dwarf shrub
Searsia burchellii	Shrub
Searsia lancea	Tree
Searsia pyroides	Shrub
Senegalia melifera subsp. *detinens*	Tree
Setaria verticillata	Grass
Solnum supinum	Herb
Sonchus oleraceus	Herb
Stipagrostis namaquensis	Grass
Stipagrostis obtusa	Grass
Stipagrostis uniplumis	Grass
Suaeda fruticosa	Dwarf shrub
Talinum tenuissimum	Geophyte
Tamarix usneoides	Tree
Thesium hystrix	Dwarf shrub
Trachyandra laxa	Geophyte
Trachyandra sp.	Geophyte
Tribulus terestris	Herb
Tribulus zeyheri	Herb
Vachellia karroo	Tree
Ziziphus mucronata	Tree
Zygophyllum microcarpum	Dwarf shrub
Zygphyllum lichtensteiniana	Dwarf shrub

Appendix C: Protected species on the site

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

Acanthopsis hoffmannseggiana
Verneukhalfmensie

Not protected

National Red List Status: **Data Deficient – Insufficient information**

Method: **Not common in the study area and confined to areas containing a high percentage surface rock. Should be transplanted to adjacent areas where they will not be affected by mining activities. Transplants easily. National Red List indicates that this species may be classified as Threatened and is therefore considered of high conservation value.**

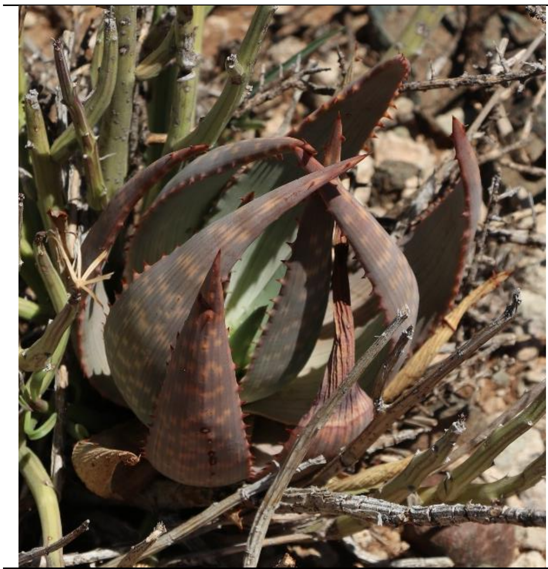
Ammocharis coranica
Seeroogblom/Ground Lily

Protected under the Northern Cape Nature Conservation Act (NCNCA)

National Red List Status: **Least Concern (LC)**

Method: **Scattered specimens present in the bottomlands in the southern prospecting area. Should be transplanted to adjacent areas where they will not be affected by mining activities. Transplants easily. Is deciduous and will not be visible in winter or drought conditions.**

	***Asclepias meyeriana*** Protected under the Northern Cape Nature Conservation Act (NCNCA) National Red List Status: **Least Concern** Method: **Scattered specimens present in undulating plains portion. Should be transplanted to adjacent areas where they will not be affected by mining activities. Transplanting success doubtful. Is deciduous and will not be visible in winter or drought conditions.**
	***Babiana sp.*** **Bobbejaantjie** Protected under the Northern Cape Nature Conservation Act (NCNCA) National Red Listed Status: **N/A** Method: **Not common in the undulating plains portion. Should be transplanted to adjacent areas where they will not be affected by mining activities. Transplants easily. Is deciduous and will not be visible in winter or drought conditions.**
	***Harpagophytum procumbens*** **Duiwelsklou/Devil's Claw** Protected under the Northern Cape Nature Conservation Act (NCNCA) and National Environmental Management: Biodiversity Act, 2004 National Red Listed Status: **Least Concern** Method: **Scattered specimens present in undulating plains portion. Should be transplanted to adjacent areas where they will not be affected by mining activities. Transplants easily. Is deciduous and will not be visible in winter or drought conditions.**

	***Aloe claviflora*** **Kraal Aalwyn/Canon Aloe** Protected under the Northern Cape Nature Conservation Act (NCNCA) National Red List Status: **Least Concern** Method: **Scattered throughout the study area especially areas with a high percentage surface calcrete. Should be transplanted to adjacent areas where they will not be affected by mining activities. Transplants easily.**
	***Aloe hereroensis*** **Sand Aalwyn/Vlakte Aalwyn** Protected under the Northern Cape Nature Conservation Act (NCNCA) National Red List Status: **Least Concern** Method: **Not common in the study area and only encountered on the clacrete ridge in the southern prospecting area. Should be transplanted to adjacent areas where they will not be affected by mining activities. Transplants easily.**
	***Euphorbia braunsii*** **Vingerpol** Protected under the Northern Cape Nature Conservation Act (NCNCA) National Red List Status: **Least Concern** Method: **Not common in the study area and confined to areas containing a high percentage surface rock, especially ridges. Should be transplanted to adjacent areas where they will not be affected by mining activities. Transplants easily.**

	***Euphorbia crassipes*** **Melkpol/Vingerpol** Protected under the Northern Cape Nature Conservation Act (NCNCA) National Red List Status: **Least Concern** Method: **Not common in the study area and confined to areas containing a high percentage surface rock, especially ridges. Should be transplanted to adjacent areas where they will not be affected by mining activities. Transplants easily.**
	***Boscia albitrunca*** **Shepherds Tree/Witgat Boom** Protected under the Northern Cape Nature Conservation Act (NCNCA) and National Forest Act (NFA) National Red List Status: **Least Concern** Method: **Scattered throughout the study area. It will not be possible to transplant this species and it should be avoided by prospecting activities. Should any specimens require removal the necessary permits will have to be obtained.**
	***Nymania capensis*** **Chinese Lanterns/Klapperbos** Protected under the Northern Cape Nature Conservation Act (NCNCA) National Red List Status: **Least Concern** Method: **Scattered in the uneven rocky portion in the northern prospecting areas. May also occur in other areas. As long as the uneven rocky terrain is excluded from prospecting they should remain unaffected.**

	***Larryleachia picta*** **Hondebal** Protected under the Northern Cape Nature Conservation Act (NCNCA) National Red Listed Status: **Least Concern** Method: **Rare in the uneven rocky portion in the northern prospecting areas. As long as the uneven rocky terrain is excluded from prospecting they should remain unaffected.**
	***Hoodia gordonii*** **Hoodia/Bitterghaap** Protected under the Northern Cape Nature Conservation Act (NCNCA) National Red List Status: **Data Deficient – Insufficient information** Method: **Not common in the study area and confined to areas containing a high percentage surface rock. Should be transplanted to adjacent areas where they will not be affected by mining activities. Transplants easily. National Red List indicates that this species may be classified as Threatened and is therefore considered of high conservation value.**

Appendix D: 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 the Brak River and associated drainage line in the southern prospecting area.

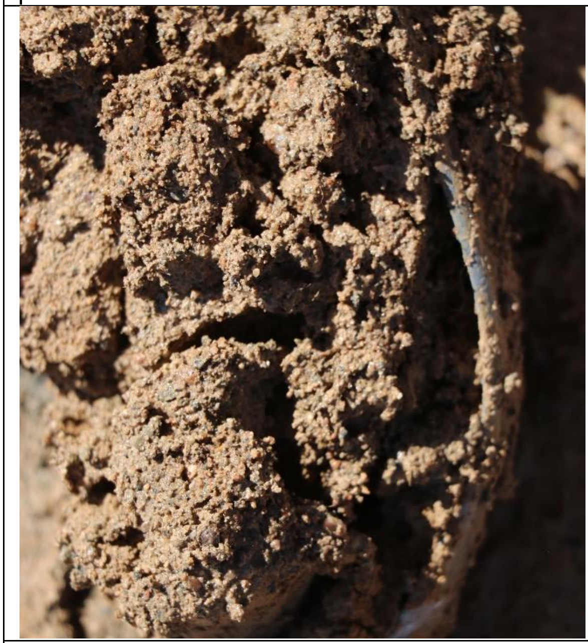
	
Soil sample taken in the main channel of the Brak River near the western border of the site. A prominent grey matrix (>10%) is clear and mottling is present indicating a permanent zone of wetness. Wetland conditions are therefore clearly present.	Soil sample taken on the banks of the Brak River near the western border of the site. 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 Brak River 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.	Soil sample taken in the main channel of the drainage line. Soils are dominated by a high sand content without any grey matrix or mottling and wetland conditions are clearly absent. The soil does exhibit a clearly higher moisture regime and indicates periodic water flow.

Table 2: Soil samples taken along the Diepsloot and associated tributaries in the northern prospecting area.

	
Soil sample taken in the upper reaches of the Diepsloot. Soils are high in silt but a grey matrix and mottling is absent indicating the absence of wetland conditions. Note also a low moisture content.	Another soil sample taken in the upper reaches of the Diepsloot. Again a high silt content is present and is being eroded from the catchment and deposited in the bottomlands associated with the stream. Wetland conditions are clearly absent.
	
Soil sample taken in the middle reaches of the Diepsloot. Note a higher moisture content here. Wetland conditions are however still clearly absent.	Soil sample taken in one of the small impoundments in a tributary. Wetland conditions are clearly absent but note the high silt content here.

	
Soil sample taken in the lower reaches of the Diepsloot. Moisture content becomes progressively higher although wetland conditions are still absent.	Soil sample taken in the lower reaches of the Diepsloot where it exits the irrigated plantations. Soil moisture is high although no clear wetland conditions are discernible.

Appendix E: Index of Habitat Integrity (IHI) Summary

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

Brak River

ASSESSMENT UNIT INFORMATION	
ASSESSMENT UNIT INFORMATION	
UPPER LATITUDE	S 29.605283
UPPER LONGITUDE	E 22.991743
UPPER ALTITUDE	948m
LOWER LATITUDE	S 29.598799
LOWER LONGITUDE	E 22.963892
LOWER ALTITUDE	941m
SURVEY SITE (if applicable)	Remhoogte Southern Prospecting
SITE LATITUDE (if applicable)	
SITE LONGITUDE (if applicable)	
SITE ALTITUDE (if applicable)	
WMA	Low er Orange
QUATERNARY	D62J
ECOREGION 2	26_1
DATE	18/02/2019
RIVER	Orange River
TRIBUTARY	Brak River
PERENNIAL (Y/N)	**N**
GEOMORPH ZONE	**LOWLAND**
WIDTH (m)	**2-15**

METRIC GROUP	RATING	CONFIDENCE
HYDROLOGY MODIFICATION	0.2	1.7
PHYSICO-CHEMICAL MODIFICATION	0.7	1.1
BED MODIFICATION	1.2	4.0
BANK MODIFICATION	1.3	3.0
CONNECTIVITTY MODIFICATION	1.5	4.0
INSTREAM IHI%	82.6	
CATEGORY	B	
CONFIDENCE	2.8	

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	0.11	3.00
BANK STRUCTURE MODIFICATION	2.20	4.00
CONNECTIVITY MODIFICATION	1.25	4.00
RIPARIAN HABITAT INTEGRITY (%)	74.17	
CATEGORY	C	
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

INSTREAM IHI	MRU
Base Flows	-0.5
Zero Flows	0.0
Floods	0.0
HYDROLOGY RATING	**0.2**
pH	0.0
Salts	1.0
Nutrients	1.5
Water Temperature	0.0
Water clarity	1.0
Oxygen	1.0
Toxics	0.5
PC RATING	**0.7**
Sediment	1.5
Benthic Growth	1.0
BED RATING	**1.2**
Marginal	1.0
Non-marginal	1.5
BANK RATING	**1.3**
Longitudinal Connectivity	1.5
Lateral Connectivity	1.5
CONNECTIVITY RATING	**1.5**
INSTREAM IHI %	**82.6**
INSTREAM IHI EC	**B**
INSTREAM CONFIDENCE	**2.8**

RIPARIAN IHI	MRU
Base Flows	-0.5
Zero Flows	0.0
Moderate Floods	0.0
Large Floods	0.0
HYDROLOGY RATING	**0.1**
Substrate Exposure (marginal)	0.0
Substrate Exposure (non-marginal)	0.0
Invasive Alien Vegetation (marginal)	0.0
Invasive Alien Vegetation (non-marginal)	3.0
Erosion (marginal)	1.0
Erosion (non-marginal)	0.0
Physico-Chemical (marginal)	1.0
Physico-Chemical (non-marginal)	1.0
Marginal	1.0
Non-marginal	3.0
BANK STRUCTURE RATING	**2.2**
Longitudinal Connectivity	1.0
Lateral Connectivity	1.5
CONNECTIVITY RATING	**1.3**
RIPARIAN IHI %	**74.2**
RIPARIAN IHI EC	**C**
RIPARIAN CONFIDENCE	**3.7**

Diepsloot

ASSESSMENT UNIT INFORMATION	
ASSESSMENT UNIT INFORMATION	
UPPER LATITUDE	S 29.546253
UPPER LONGITUDE	E 23.074005
UPPER ALTITUDE	1028m
LOWER LATITUDE	S 29.532445
LOWER LONGITUDE	E 23.005362
LOWER ALTITUDE	948m
SURVEY SITE (if applicable)	Remhoogte Northern Prospecting
SITE LATITUDE (if applicable)	
SITE LONGITUDE (if applicable)	
SITE ALTITUDE (if applicable)	
WMA	Low er Orange
QUATERNARY	D71D
ECOREGION 2	26_1
DATE	19/02/2019
RIVER	Orange River
TRIBUTARY	Diepsloot
PERENNIAL (Y/N)	**N**
GEOMORPH ZONE	**MOUNTAIN STREAM**
WIDTH (m)	**2-15**

METRIC GROUP	RATING	CONFIDENCE
HYDROLOGY MODIFICATION	0.0	1.7
PHYSICO-CHEMICAL MODIFICATION	0.8	1.1
BED MODIFICATION	1.0	4.0
BANK MODIFICATION	1.3	3.0
CONNECTIVITTY MODIFICATION	1.5	4.0
INSTREAM IHI%	84.1	
CATEGORY	B	
CONFIDENCE	2.8	

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	0.13	3.00
BANK STRUCTURE MODIFICATION	1.00	4.00
CONNECTIVITY MODIFICATION	1.00	4.00
RIPARIAN HABITAT INTEGRITY (%)	85.80	
CATEGORY	B	
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

INSTREAM IHI	MRU
Base Flows	0.0
Zero Flows	0.0
Floods	0.0
HYDROLOGY RATING	**0.0**
pH	0.0
Salts	1.5
Nutrients	1.5
Water Temperature	0.0
Water clarity	1.0
Oxygen	0.0
Toxics	1.0
PC RATING	**0.8**
Sediment	1.0
Benthic Growth	1.0
BED RATING	**1.0**
Marginal	1.5
Non-marginal	1.0
BANK RATING	**1.3**
Longitudinal Connectivity	1.5
Lateral Connectivity	1.0
CONNECTIVITY RATING	**1.5**
INSTREAM IHI %	**84.1**
INSTREAM IHI EC	**B**
INSTREAM CONFIDENCE	**2.8**

RIPARIAN IHI	MRU
Base Flows	-0.5
Zero Flows	0.0
Moderate Floods	0.0
Large Floods	0.0
HYDROLOGY RATING	**0.1**
Substrate Exposure (marginal)	0.0
Substrate Exposure (non-marginal)	0.0
Invasive Alien Vegetation (marginal)	0.0
Invasive Alien Vegetation (non-marginal)	1.0
Erosion (marginal)	1.0
Erosion (non-marginal)	1.0
Physico-Chemical (marginal)	1.0
Physico-Chemical (non-marginal)	1.0
Marginal	1.0
Non-marginal	1.0
BANK STRUCTURE RATING	**1.0**
Longitudinal Connectivity	1.0
Lateral Connectivity	1.0
CONNECTIVITY RATING	**1.0**
RIPARIAN IHI %	**85.8**
RIPARIAN IHI EC	**B**
RIPARIAN CONFIDENCE	**3.7**

Appendix F: 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 affecting the Diepsloot.	Prospecting operations within the Diepsloot and associated drainage lines in the prospecting area.	Prospecting operations within the main channel or tributaries of the Diepsloot or associated 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 high.	4	5	4	4	4.25	4	5	13.25	4	4	5	4	17	225.25	H	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. Due to the nature of this activity is likely to permanently affect the Diepsloot. The stream and catchment is highly susceptible to erosion which will be impossible to rehabilitate. It is recommended that prospecting activities exclude the Diepsloot, tributaries and associated drainage lines at least during the prospecting phase and should this still be desired during the full-scale mining phase that additional studies be
	Mostly Operational Phase but extending long after closure		Prospecting operations in close proximity to the Diepsloot and associated drainage lines in the prospecting area.	Prospecting operations will require removal of the vegetation layer in the catchment of the watercourses. The extent should however remain low but due to the steep and unstable slopes the impact on the stream system is still anticipated to be high. This will also contribute high sediment load to the stream and will cause significant transformation of its morphology and functioning. Increased establishment of exotic weeds is likely due to disturbance caused by mining.	4	4	3	3	3.5	4	4	11.5	3	4	5	4	16	184	H	4	This impact will be mainly during the operational phase but due to the steep slopes in this area it is likely to have a permanent impact on the stream system since progressive erosion will continue indefinitely. Due to the nature of this activity is likely to permanently affect the Diepsloot. The stream and catchment is highly susceptible to erosion which will be impossible to rehabilitate. It is recommended that prospecting activities exclude the Diepsloot, tributaries and associated drainage lines at least during the prospecting phase and should this still be desired during the full-scale mining phase that additional studies be conducted.

	Mostly Operational Phase		Construction of roads and infrastructure through the Diepsloot and associated drainage lines in the prospecting area.	Construction of roads and infrastructure over the stream system will also cause disturbance although on a local scale. These structures will act as flow barriers and will alter the hydrology of this system. Increased erosion, sediment load and exotic weed establishment is also likely.	3	3	3	3	**3**	2	3	8	3	3	5	2	**13**	**104**	**M**	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. However, compared to dirt tracks the large haul roads required for prospecting activities will have a much higher impact and therefore still entails a moderate risk. It is 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 stream morphology and establish an indigenous
2	Mostly Operational Phase but extending long after closure	Diamond mining prospecting operations affecting the Brak River.	Prospecting operations within the Brak River and associated drainage line in the prospecting area.	Prospecting operations within the main channel of the Brak River or associated 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 high.	**3**	**4**	**4**	**4**	**3.75**	**3**	**4**	**10.75**	**4**	**4**	**5**	**4**	**17**	**182.75**	**H**	**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 Brak River at least to some extent. It is recommended that prospecting activities exclude the Brak River and associated drainage line at least during the prospecting phase and should this still be desired during the full-scale mining phase that additional studies be conducted

	Mostly Operational Phase but also extending to a degree beyond the closure phase		Prospecting operations in close proximity to the Brak River and associated drainage line in the prospecting area.	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**	**2**	**2**	**2**	**3**	**3**	**8**	**3**	**3**	**5**	**2**	**13**	**104**	**M**	**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 still have a moderate risk of impact and adequate mitigation and comprehensive rehabilitation should be 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 Brak River. 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 drainage line in the prospecting area. The Brak River forms the border of the site and it should therefore not be necessary to cross it with any infrastructure.	Construction of roads and infrastructure over the drainage line will also cause disturbance although on a local scale. These structures will act as flow barriers and will alter the hydrology of this system. Increased erosion, sediment load and exotic weed establishment is also likely.	3	2	3	2	**2.5**	2	3	7.5	3	3	5	2	**13**	**97.5**	**M**	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. However, compared to dirt tracks the large haul roads required for prospecting activities will have a much higher impact and therefore still entails a moderate risk. It is 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 drainage line morphology and establish an

Appendix G: 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.