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A biodiversity and wetland assessment of the proposed development on Portion 18 of the Farm Roodepan 70, Kimberley, Northern Cape

March 2018

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DECLARATION OF INDEPENDENCE

We,
George Johannes Bredenkamp (SACNASP # 400086/83)
Lukas Niemand (SACNASP # 400095/06),
Catharina Elizabeth (Ina) Venter (SACNASP 400048/08)
Jacobus Casparus Petrus van Wyk (SACNASP # 400062/09)
declare that we:

- hold higher degrees in the biological sciences, which allowed registration by S.A. Council for National Scientific Professions (SACNASP) as Professional Ecologist or Zoologists that sanction us to function independently as specialist scientific consultants;
- declare that as per prerequisites of the Natural Scientific Professions Act No. 27 of 2003 this project was our own work from inception and reflects exclusively our observations and unbiased scientific interpretations, and executed to the best of our abilities;
- abide by the Code of Ethics of the SACNASP;
- are committed to biodiversity conservation but concomitantly recognize the need for economic development. Whereas we appreciate opportunities to learn through constructive criticism and debate, we reserve the right to form and hold our own opinions within the constraints of our training, experience and results and therefore will not submit willingly to the interests of other parties or change our statements to appease or unduly benefit them;
- are subcontracted as specialist consultants for the project "A biodiversity and wetland assessment of the proposed development on Portion 18 of the Farm Roodepan 70, Kimberley, Northern Cape " as described in this report;
- have no financial interest in the proposed development other than remuneration for the work performed;
- do not have, and will not have in the future any vested or conflicting interests in the proposed development;
- undertake to disclose to the consultant and its client(s) as well as to the competent authority any material information that may have the potential to influence any decisions by the competent authority, as required in terms of the Environmental Impact Assessment Regulations 2006;
- reserve the right to only transfer our intellectual property contained in this report to the client(s), (party or company that commissioned the work) on full payment of the contract fee. Upon transfer of the intellectual property, we recognise that written consent from the client will be required for any of us to release of any part of this report to third parties.
- In addition, remuneration for services provided by us is not subjected to or based on approval of the proposed project by the relevant authorities responsible for authorising this proposed project.

J.C.P. van Wyk

C.E. Venter

G.J. Bredenkamp

L.J. Niemand

DISCLAIMER:

Even though every care is taken to ensure the accuracy of this report, environmental assessment studies are limited in scope, time and budget. Discussions and proposed mitigations are to some extent made on reasonable and informed assumptions built on *bone fide* information sources, as well as deductive reasoning. Deriving a 100% factual report based on field collecting and observations can only be done over several years and seasons to account for fluctuating environmental conditions and migrations. Since environmental impact studies deal with dynamic natural systems additional information may come to light at a later stage. The vegetation and fauna team can thus not accept responsibility for conclusions and mitigation measures made in good faith based on own databases or on the information provided at the time of the directive. Although the authors exercised due care and diligence in rendering services and preparing documents, they accept no liability, and the client, by receiving this document, indemnifies the authors against all actions, claims, demands, losses, liabilities, costs, damages and expenses arising from or in connection with services rendered, directly or indirectly by the authors and by the use of this document. This report should therefore be viewed and acted upon with these limitations in mind.

ABSTRACT

Vegetation and Flora

It is planned to develop a residential area situated on Portion 18 of the Farm Roodepan 70, Kimberley, Northern Cape. The terrestrial vegetation and flora was investigated. Six mapping units (with an additional two wetland mapping units) were identified. From a vegetation and flora point of view, and also a conservation point of view, the terrestrial vegetation of the area is already highly disturbed, degraded and transformed. No red data plant species occurs within the site but three provincially protected plant species (*Aloe grandidentata, Ammocharis coranica* and *Orbea lutea*) do occur on the site. All these species can easily be transplanted and relocated. Care should be taken with the rescue operation of *Ammocharis coranica*, as these plants have huge bulbs.

The ecological sensitivity of the terrestrial vegetation and ecosystems is regarded to be Low to Medium-Low. The significance of the impacts of the proposed development varies from Minor to Moderate, but is mostly Low.

No development will be supported within the wetland and its buffer zone, as this is controlled by law (National Water Act 1998, National Environmental Management Act, 1998) (See Chapter 5).

It is concluded that the planned development can be supported on most of the terrestrial ecosystems, excluding wetland buffer areas and excluding the buffer zone for lesser flamingo.

Wetlands

Several wetland areas are located on the site and include the following units:

- Wetlands
    - Pan
    - Channelled Valley Bottom (CVB) Wetland
    - Unchannelled Valley Bottom (UCVB) Wetland
    - Seep
- Artificial wetlands
    - Excavations
    - Artificial seeps
- Drainage lines

The status (PES) of the wetlands varies from natural (pan) to largely modified (UCVB), with the seeps being moderately modified and the channelled valley bottom (CVB) wetland being largely natural. The PES assessment is not applicable to the artificial wetland units on site, since the PES assessment determines the alteration from the natural condition. The PES assessment is also not applicable to the drainage line units remaining on site. The remaining

drainage lines are considered to be in PES class C, moderately modified.

The EIS of the wetlands varies from very high (pan) to low (seeps). A buffer area of 50m is recommended around the wetland areas on site.

The medium and high sensitivity wetland areas, with their buffer zones is recommended to be excluded from the development. If the wetlands and their buffer zones area excluded from the development and the mitigation measures are implemented, the impact from the development can be limited.

Mammals

Three of the major habitat types are present on the site, i.e. terrestrial, arboreal and wetlands. The conservation status of these three habitats is regarded as "transformed" Species richness has been dramatically reduced by urban encroachment, isolation and habitat neglect or destruction. No more than 15 species remained, and it is predicted that over time these will also perish as result of some or other catastrophic or inbreeding.

No rare or endangered mammal species now reside on the study site.

It is suggested that the planned development be supported.

Birds

From a general avifaunal point of view, most of the terrestrial habitat types are transformed or sem-transformed (secondary) containing unspecialised and generalist bird species with widespread distribution ranges. From a specific avifaunal point of view, and from a conservation perspective, the study site also included certain aquatic and wetland habitat with *high ecological sensitivities*. These habitat types were located adjacent to the Kamfers Dam, with part of the Dam's shoreline corresponding to the study site. The Kamfers Dam is an Important Bird Area (SA032), and along with the valley-bottom wetlands on the study site, it provided habitat for a *high number of waterbirds* including five *threatened and near threatened bird species of regular occurrence*. More importantly, the study site was located next to one of the largest permanent Lesser Flamingo populations in South Africa, and one of only four Lesser Flamingo breeding sites in Africa.

Six discrete bird associations were identified with those pertaining to the shoreline of Kamfers Dam and the valley-bottom wetland being the most important. A total of 248 bird species were expected to occur with 117 species confirmed during the survey (based on 19 point counts), including three species that were not previously recorded from the area (c. Red-footed Falcon *Falco vespertinus*, Sedge Warbler *Acrocephalus schoenobaenus* and Marsh Warbler *A. palustris*). Four Red Data bird species were confirmed during the survey (e.g. globally near threatened Lesser Flamingo *Phoeniconaias minor*, regionally near threatened Greater Flamingo *Phoenicopterus roseus*, globally critically endangered White-backed Vulture *Gyps africanus* and globally near threatened Red-footed Kestrel *Falco vespertinus*). Four additional Red Data species have a high probability of occurrence (along the valley-bottom wetland and Kamfers Dam) and include the globally vulnerable Maccoa Duck (*Oxyura maccoa*), globally near threatened Curlew Sandpiper (*Calidris ferruginea*) and the globally near threatened Chestnut-banded Plover (*Charadrius pallidus*). The regionally

endangered African Marsh Harrier (*Circus ranivorus*) could occur on occasion along the valley-bottom wetland.

The proposed residential development adjacent to Kamfers Dam was regarded as a potential threat to the long-term persistence of Lesser Flamingos in the area (*sensu* Anderson, 2015a) and will entail careful planning and engineering. In the absence of environmentally accepted planning and construction activities, any development alongside the Kamfers Dam may be disastrous for the local avifauna and the respective bird habitat types in the area.

A 500 buffer zone was proposed to mitigate against the displacement of waterbird species, and no development will be supported within this buffer zone.

Herpetofauna
In terms of the National Water Act, all wetlands in and around the study area must be considered as ecologically sensitive. The wetlands are sensitive.

It is concluded that some herpetofauna species, all widely distributed generalists, do occur or may occur on the study site. There is however no reason to conserve the site habitats for the sake of any herpetofauna species.

From a herpetofauna perspective there is no objection against the development.

Conclusion
The sensitive areas on site is mainly located in the south-eastern portion of the site and is associated with the wetland units, and bird habitat associated with the wetlands. The sensitive bird habitat includes the pan and the reed dominated vegetation where the CVB enters the pan wetland unit. The wetland units and all associated buffer are considered to be of high conservation importance and must be excluded from the development. The buffer zones include the wetland buffers and bird buffer zones.

1 BACKGROUND INFORMATION

It is planned to develop a residential area situated on Portion 70 of the Farm Roodepan 70, Kimberley, Northern Cape. The site is located North of Kimberley, more specifically between Galeshewe to the south and Roodepan suburb to the northwest of the site. To the east of the site is a more open (informal) township. Most of the area northeast of the site is farmland with game. Of great importance is that the south-eastern corner of the site is adjacent to the Kamfer Dam which is known as a breeding site for lesser flamingo. A railway line runs along the entire north-eastern boundary of the site.

The planned development requires an Environmental Impact Assessment. Envirobalance Solutions requested a biodiversity and wetland assessment as part of the Environmental Impact Assessment process.

Eco-Agent CC was appointed by Alleyroads Construction (Pty) Ltd, through Envirobalance as Environmental Practitioner, to assess the vegetation and flora and undertake a mammal, bird, reptile and amphibian study as well as a wetland assessment. This investigation is in accordance with the EIA Regulations No. R982-985, Department of Environmental Affairs and Tourism, 4 December 2014 emanating from Chapter 5 of the National Environmental Management Act, 1998 (Act No. 107 of 1998), as well as the National Water Act 1998 (Act 36 of 1998) and additions, and other relevant legislation.

The assignment is interpreted as follows: Compile a study of the vegetation, flora and vertebrate fauna and wetlands of the site, with emphasis on Red Data plant and vertebrate species that occur or may occur on the site. In order to compile this, the following had to be done:

1.1 Initial preparations

- Obtain all relevant maps and information on the natural environment of the concerned area.
- This includes information on Red Data plant and vertebrate species that may occur in the area.

1.2 Vegetation and habitat survey

- List the plant species (trees, shrubs, grasses and herbaceous species) present for plant community and ecosystem delimitation.
- Identify potential red data plant species, alien plant species, and medicinal plants.
- Examine the diversity and structure of the plants (trees, shrubs, grasses and herbaceous species) present, to delimit those plant communities and ecosystems relevant to vertebrate fauna distributions and abundance.

1.3 Plant community delimitation and description

- Process data (vegetation and habitat classification) to determine vegetation types (= plant communities) on an ecological basis.
- Describe the habitat and vegetation.
- Determine the sensitivity of the site for biodiversity and presence of rare or protected plant species.

- Prepare a vegetation map of the area.
- Prepare a sensitivity map of the plant communities present, if relevant.

1.4 Faunal assessment

- Compile lists of mammals, birds and herpetofauna that can be expected in the area.
- Obtain lists of the Red Data vertebrates that can be expected in the area.
- Assess the quantitative and qualitative condition of suitable habitat for the Red Listed vertebrates that may occur in the area.
- Assess the possibility of Red Listed fauna being present on the study site.
- Compile a list of occurrences.
- Special reference has to be made to the presence of flamingos on the site and the possible impacts of the prosed development on the flamingos.

1.5 Wetland assessment

- Conform the presence / absence of wetlands on the site
- Do a wetland delineation and classification
- Do a Present Ecological State (PES) and Ecological Importance assessment
- Compile a Risk Matrix table

1.6 General

- Identify and describe particular ecologically sensitive areas.
- Identify transformed areas in need of special treatment or management, e.g. bush encroachment, erosion, water pollution, degraded areas, reclamation areas.
- Make recommendations on aspects that should be monitored during development.

1.7 Impact Assessment

- Compile prescribed impact assessment tables and associated descriptions of impacts on vegetation, flora, fauna and wetlands and suggest possible mitigation measures.

This report combines a site visit by the EcoAgent team 16-19 February 2018 to assess the vegetation, flora, wetlands and vertebrate fauna and possible impacts of the development on the biodiversity, and if needed, to suggest possible mitigation options.

This report focuses on vegetation and sensitive habitats and wetlands as well as the reigning status of vertebrates and threatened plants those occur or are likely to occur on the proposed development site, and whose conservation status should be considered in the decision-making process. Special attention was paid to the presence of flamingos and also the qualitative and quantitative habitat conditions for any Red Data plant and vertebrate species deemed present on the site. An objective of the investigation was to gauge which species still persist on the site and to compile a list of mammal, bird and herpetofauna species that may occur in the ecosystems found within the study area.

2 RATIONALE AND SCOPE

It is widely recognised that to conserve natural resources it is of the utmost importance to maintain ecological processes and life support systems for plants, animals and humans. To ensure that sustainable development takes place, it is therefore important that possible impacts on the environment are considered before relevant authorities approve any development. This led to legislation protecting the natural environment. In 1992, the Convention of Biological Diversity, a landmark convention, was signed by more than 90 % of all members of the United Nations. In South Africa, the Environmental Conservation Act (Act 73 of 1989), the National Environmental Management Act, 1998 (NEMA) (Act 107 of 1998) and the National Environmental Management Biodiversity Act, 2004 (Act 10 0f 2004) ensure the protection of ecological processes, natural systems and natural beauty, as well as the preservation of biotic diversity within the natural environment. They also ensure the protection of the environment against disturbance, deterioration, defacement or destruction as a result of man-made structures, installations, processes, products or activities. In support of these Acts, a draft list of Threatened Ecosystems was published (Government Gazette 2009), as part of the National Environmental Management Biodiversity Act, 2004 (Act 10 of 2004), and these Threatened Ecosystems are described by SANBI & DEAT (2009) and a list of Threatened or Protected Species (TOPS) regulations is also available (NEMBA Notice 388 of 2013). International and national Red Data lists have also been produced for various plant and animal taxa.

All components of the ecosystems (physical environment, vegetation, animals) at a site are interrelated and interdependent. A holistic approach is therefore imperative to include effectively the development, utilisation and, where necessary, conservation of the given natural resources into an integrated development plan, which will address all the needs of the modern human population (Bredenkamp & Brown 2001).

It is therefore necessary to make a thorough inventory of the plant communities, flora and vertebrate fauna on the site, in order to evaluate the biodiversity and possible presence of species of conservation concern, red listed species and protected species. This inventory should then serve as a scientific and ecological basis for the planning exercises and the subsequent development.

2.1 Definitions and Legal Framework

In a South African legal context, the term watercourse is often used rather than the terms wetland or river. The National Water Act (NWA) (1998) includes wetlands and rivers into the definition of the term watercourse.

Watercourse means:

- A river or spring;
- A natural channel in which water flows regularly or intermittently;
- A wetland, lake or dam into which, or from which water flows, and
- 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 the accepted indicator used to delineate the extent of a river's footprint (DWAF, 2005). The National Water Act, 1998 (Act No. 36 of 1998), defines a riparian habitat as follows: "Riparian habitat includes the physical structure and associated vegetation of the areas associated with a watercourse, which are commonly characterised by alluvial soils, and which are inundated or flooded to an extent and with a frequency sufficient to support vegetation of species with a composition and physical structure distinct from those of adjacent land areas.".

In contrast, the National Water Act, 1998 (Act 36 of 1998) defines a wetland as "land which is transitional between terrestrial and aquatic systems where the water table is usually at or near the surface, or the land is periodically covered with shallow water, and which land in normal circumstances supports or would support vegetation typically adapted to life in saturated soil."(see also Ollis *et al*. 2013)

Generally 32 m is regarded as standard for a buffer zone (Ezemvelo IEM, 2011; Biodiversity Act, 2004 (Act 10 of 2004), and Regulation 598, Government Gazette 37885, August 2014).

Authoritative legislation that lists impacts and activities on biodiversity and wetlands and riparian areas that requires authorisation includes (Armstrong, 2009):

- National Environmental Management Act, 1998 (Act No. 107 of 1998);
- National Environmental Management: Biodiversity Act, 2004 (Act 10 of 2004).
- The older Environment Conservation Act, 1989 (Act 73 of 1989);
- Conservation of Agriculture Resources Act, 1983 (Act 43 of 1983);
- National Water Act, 1998 (Act 36 of 1998);
- National Forests Act, 1998 (Act 84 of 1998);
- National Environmental Management: Protected Areas Act 2003 (Act 57 Of 2003) (as Amendment Act 31 of 2004 and Amendment Act 15 of 2009)
- Government Notice Regulation 1182 and 1183 of 5 September 1997, as amended (ECA);
- Government Notice Regulation 385, 386 and 387 of 21 April 2006 (NEMA);
- Government Notice Regulation 392, 393, 394 and 396 of 4 May 2007 (NEMA);
- Government Notice Regulation 398 of 24 March 2004 (NEMA); and
- Government Notice Regulation 544, 545 and 546 of 18 June 2010 (NEMA)
- Government Notice Regulation 982, 983, 984 and 985 of 4 December 2014 (NEMA).
- Government Notice 599 of 1 August 2014 (NEMBA)

In summary:

- Vegetation, Flora and ecosystems are protected by National Environmental Management Act, 1998 (Act No. 107 of 1998) and the National Environmental Management: Biodiversity Act, 2004 (Act 10 of 2004).
- Wetlands and other watercourses are protected water resources in the National Water Act (NWA), Act 36 of 1998.
- Development or transformation of a watercourse is regarded as a water use, which can only be allowed through an approved Water Use License, irrespective of the condition of the affected watercourse.

- The NWA defines water use in a watercourse specifically related to wetlands and riparian areas as broad impacts that include the following:
    - impeding or diverting the flow of water in a watercourse (Section 21 c); and
    - altering the bed, banks, course or characteristics of a watercourse (Section 21 i);
- A recent DWA stipulation published in Government Gazette No 32805 on 18 December 2009 also require that a Water Use License should be applied for when any wetlands are present within a 500 m radius of water use activities as defined by section 21 (c) and section 21 (i) of the NWA. A Risk Matrix should by compiled for any development within 500 m of a wetland
- Risk assessment for developments that are located within 500 m of the edge of a wetland, in accordance with DWA Notice 509 of 2016 - general authorisation in terms of section 39 of the National Water Act, 1998 (act no. 36 of 1998) for water uses as defined in section 21(c) or section 21(i)]
- Wetlands are also protected in other environmental legislation, such as the National Environmental Management Act (NEMA), Act 107 of 1998. The act lists several activities that require authorisation before they can be implemented.
- NEMA lists various activities that require authorisation, when the activity is located within 32 m or less from the edge of a wetland or other watercourse.

The Scope and objectives of this study is therefore:

- To identify and map the vegetation units as ecosystems that occur on the site,
- To assess the ecological sensitivity of these ecosystems and comment on ecologically sensitive areas, in term of their biodiversity and where needed ecosystem function,
- To assess qualitatively and quantitatively the significance of the fauna habitat components and current general conservation status of the site,
- To comment on connectivity with natural vegetation and habitats on adjacent sites,
- To assess wetlands present on the site,
- To recommend suitable buffer zones, if relevant,
- To provide a list of plant and vertebrate fauna species that do or might occur on site and that may be affected by the development, and to identify species of conservation concern,
- To highlight potential impacts of the proposed development on vegetation, fauna and flora and wetlands of the study site, and
- To provide management recommendations that might mitigate negative and enhance positive impacts, should the proposed development be approved.

3 STUDY SITE

3.1 Location and the receiving environment

It is planned to develop a residential area situated on Portion 70 of the Farm Roodepan 70, Kimberley, Northern Cape (Figure 3.1). The site is located north of Kimberley, more specifically between Galeshewe to the south and Roodepan suburb to the northwest of the site. To the east of the site is a more open township (Figure 3.2 & Figure 3.3). Most of the area northeast of the site is farmland with game. Of great importance is that the south-eastern corner of the site is adjacent to the Kamfers Dam which is known as a breeding site for lesser flamingo. A railway line runs along the entire north-eastern boundary of the site.

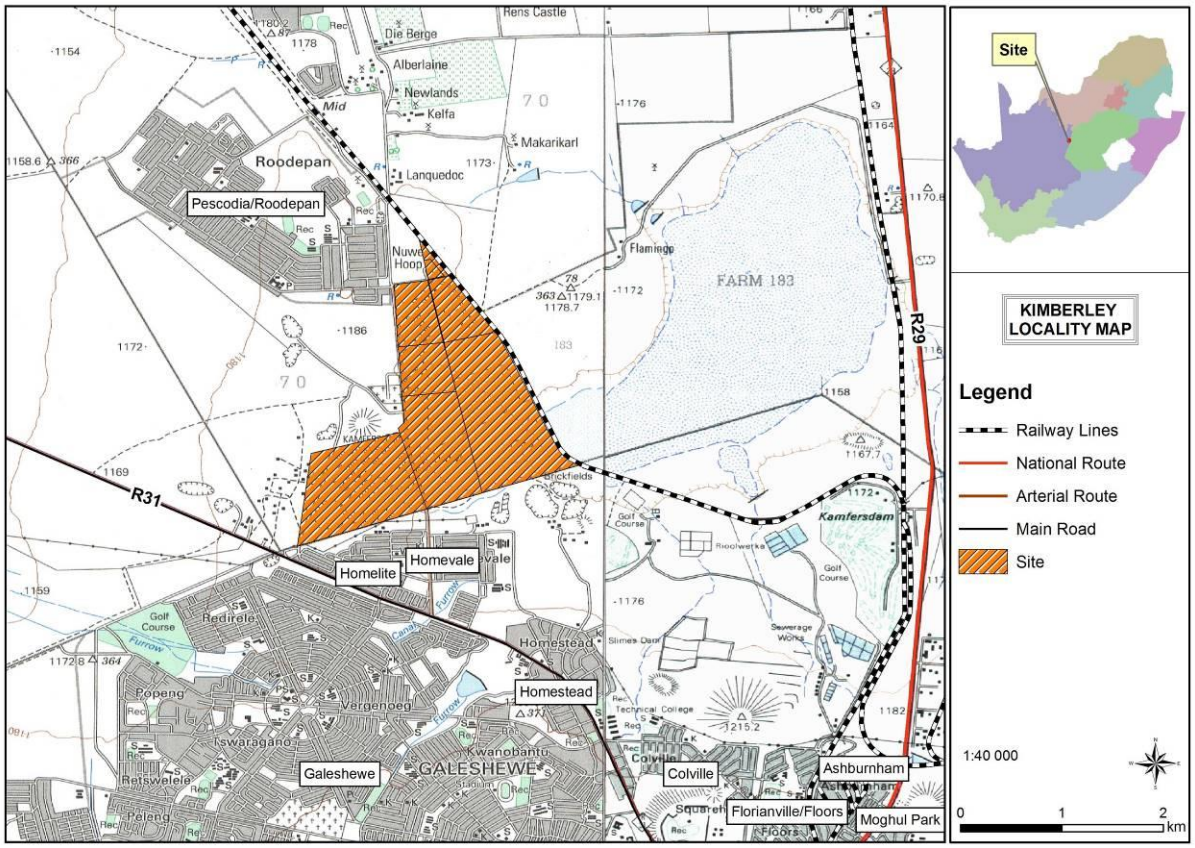

Figure 3.1: The locality of the site.

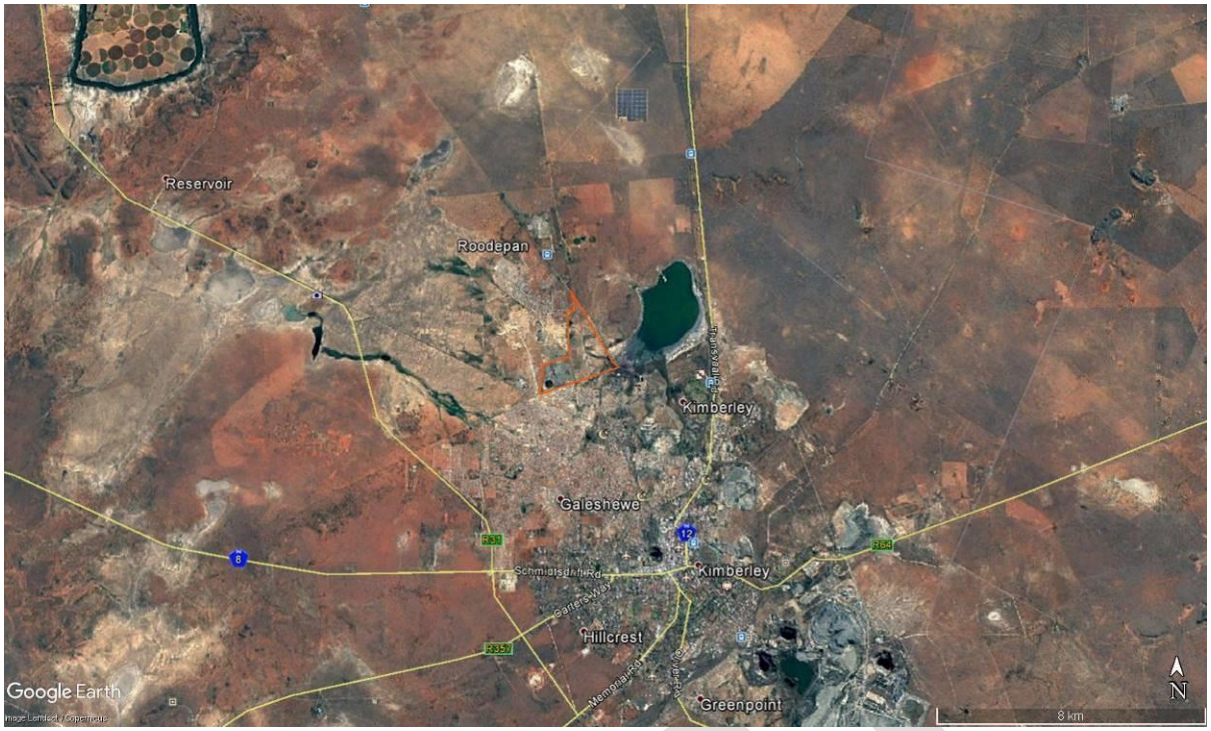

Figure 3.2: The locality of the study site in relation to surrounding developed areas and roads.

Figure 3.3: Google Earth Image of the site indicating the disturbed nature of the site.

3.2 Geology and Soil

The geology in the general area is fine grained sediments of the Karoo Supergroup. Sandy to loamy soils often of the Hutton soil form is prominent on the higher-lying areas, while

greyish more clayey soils occur in the lower-lying areas of drainage lines with wetland conditions.

3.3 Regional Climate

Summer and autumn rainfall and very dry winters are typical of the area with a mean annual precipitation of about 450 mm. Extreme variation exists between winter minimum (mean monthly minimum in July -4.1°C) and summer maximum (mean monthly maximum in January 37.5°C) temperatures. The winters are dry and cold and frost is frequent in winter.

3.4 Topography and Drainage

The site is located in the flat to slightly undulating plain, but the slope on the site is generally south-eastwards from about 1175 to 1159 masl close to the Kamfers Dam. Several drainage line, mostly highly disturbed, drain from the higher lying areas towards the Kamfers Dam (Figure 3.4). Some of these drainage lines are not natural but were man-induced in historical times (see Chapter 5 on Wetlands).

Figure 3.4: The general hydrology of the site and surrounding areas (Map provided by Envirobalance Solutions).

3.5 Land-use

The current land-use on the site is limited grazing by communal livestock from surrounding townships, though the site is basically located within Kimberley Town and this area has been utilised for diamond mining for about 150 years. Remains of mining activities are evident on the site. Signs of old agricultural fields are also present, now covered by secondary vegetation (Figure 3.3).

3.6 Vegetation Types

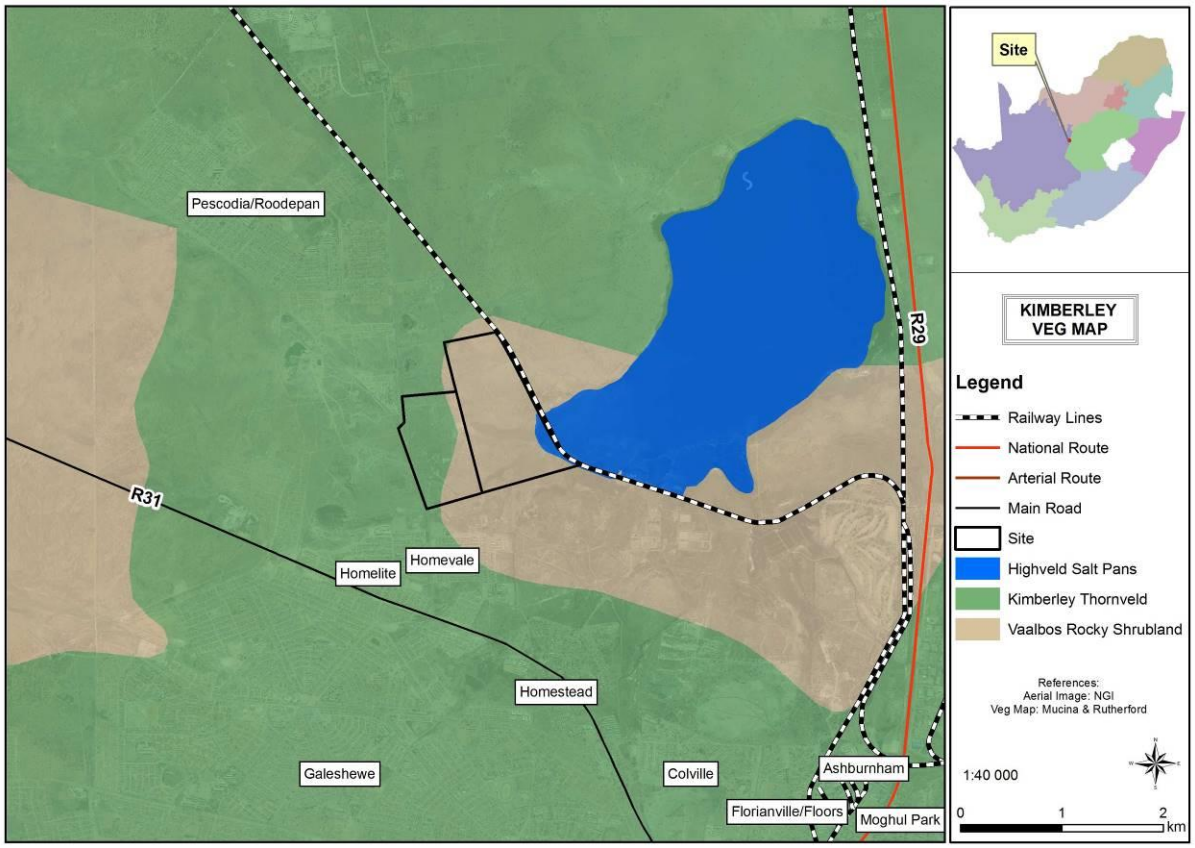

Figure 3.5: The Vegetation Map (Mucina and Rutherford 2006).

Although the Vegetation Map (Mucina and Rutherford 2006) indicates that Vaalbos Rocky Shrubland (SVk 5) occupies most of the site, it was found during the site visit that the entire site falls within Kimberley Thornveld (SVk 4) (Figure 3.5). As the site was utilized over a long period, the vegetation is mostly transformed, degraded and secondary. A small part of the Kamfers Dam occurs in the south-eastern corner of the site, though it is separated from the Dam by a railway line. This area is nevertheless still wetland and connected to the pan by culverts under the railway line. The Kamfers Dam is considered to be a pan classified as Highveld Salt Pans (AZi 10, Mucina and Rutherford 2006).

4 VEGETATION AND FLORA

4.1 METHODS

4.1.1 Initial preparations:

For background information, the relevant maps, aerial photographs and other information on the natural environment of the concerned area were obtained.

4.1.2 Site visit: vegetation and flora

Disturbed and transformed vegetation and wetland occur on the site. At several sites within each plant community / habitat type, a description of the dominant and characteristic species found was made. These descriptions were based on total floristic composition, following established vegetation survey techniques (Mueller-Dombois & Ellenberg 1974; Westhoff & Van der Maarel 1978). Data recorded resulted in a list of the plant species present on the site, including trees, shrubs, grasses and forbs. A species list was therefore derived for the site. These vegetation survey methods have been used as the basis of a national vegetation survey of South Africa (Mucina *et al*. 2000) and are considered to be an efficient method of describing vegetation and capturing species information. Additional notes were made of any other features that might have an ecological influence.

The identified systems are not only described in terms of their plant species composition, but also evaluated in terms of the potential habitat for Red Data plant species.

Threatened ecosystems are identified using Mucina & Rutherford (2006) and SANBI & DEAT 2009).

Critically Endangered, Endangered, Vulnerable and Protected Species (NEMBA species, TOPS species) are evaluated against the list published in Department of Environmental Affairs and Tourism Notice No. 2007 (National Environmental Management: Biodiversity Act, 2004 (Act 10 of 2004)).

Protected trees are identified in accordance with the list of nationally protected trees published in Government Notice No. 29062 3 (2006) (National Forests Act, 1998 (Act No. 84 0f 1998), as Amended (Department of Water Affairs Notice No 897, 2006).

Lists of Red Data plant species for the area were obtained from the SANBI data bases, with updated threatened status, (Raimondo *et al* 2009) for the map grid 2527DB. These lists were then evaluated in terms of habitat available on the site.

Alien invasive species, according to the Conservation of Agricultural Resources Act (Act No.43 of 1983) as listed in Henderson (2001) and Government Notice 599 (2014), and other weeds Bromilov (2010) are indicated.

Medicinal plants are indicated according to Van Wyk, Van Oudthoorn & Gericke (1997).

4.1.3 Conservation Value

The Critical Biodiversity Areas (CBA) map of the Kimberley area (Figure 4.1) indicates that the Kamfer's Dam area (pan) is a Critical Biodiversity Area (One). This is not surprising as this is the habitat of thousands of lesser flamingo and great numbers of other water birds. The northern part of the site is regarded as a Critical Biodiversity Area (Two), while the southern part is Ecological Support Area (Figure 4.1). Though, the field survey indicated that the pan and some of the wetlands have conservation value, though all the terrestrial vegetation on the site is highly disturbed, degraded and transformed secondary vegetation with minimal conservation value.

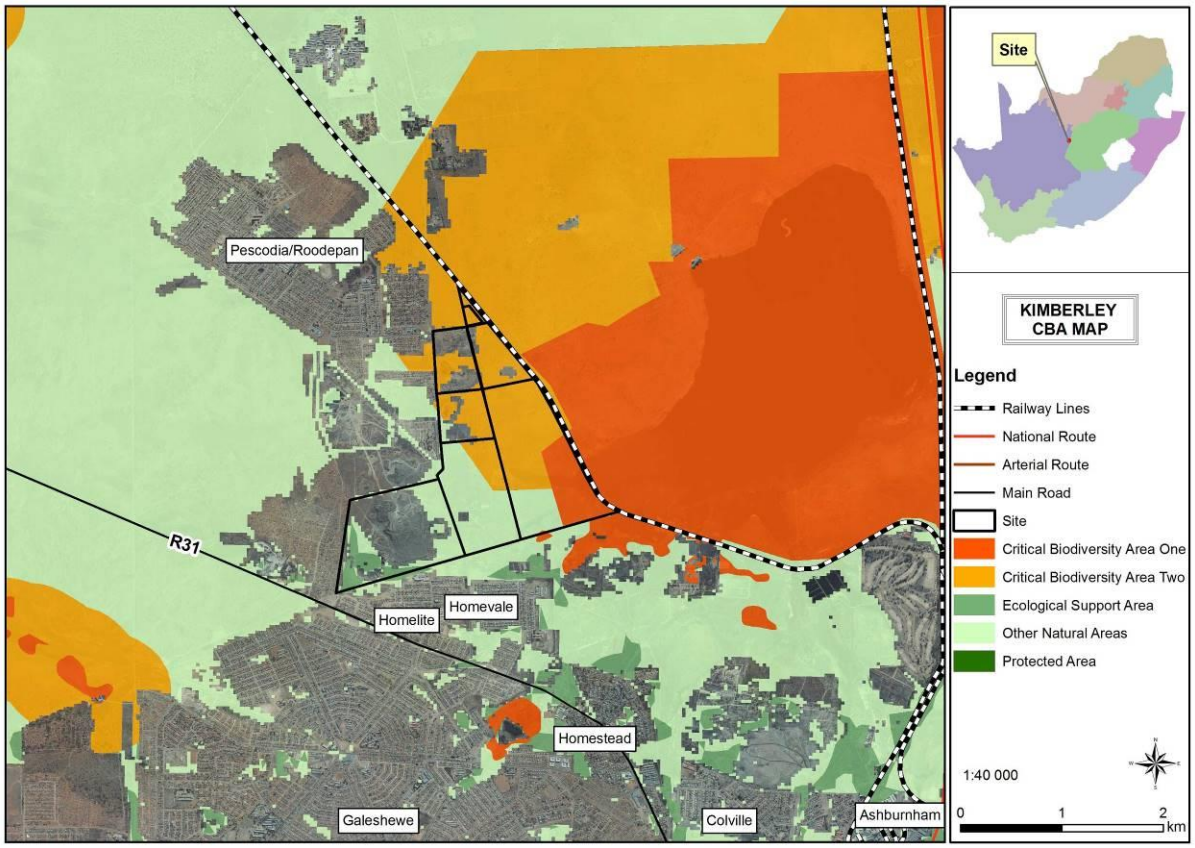

Figure 4.1: The Critical Biodiversity Areas of the site and surrounding areas.

The following **conservation value** categories were used for the vegetation on the site:
High: Ecologically sensitive and valuable land with high species richness and/or sensitive ecosystems or red data species that should be conserved and no developed allowed.
Medium-high: Land where sections are disturbed but which is in general ecologically sensitive to development/disturbances.
Medium: Land on which low impact development with limited impact on the vegetation / ecosystem could be considered for development. It is recommended that certain portions of the natural vegetation be maintained as open space.
Medium-low: Land of which small sections could be considered to conserve but where the area in general has little conservation value.
Low: Land that has little conservation value and that could be considered for developed with little to no impact on the vegetation.

4.1.4 Ecological Sensitivity

It has been clearly demonstrated that vegetation not only forms the basis of the trophic pyramid in an ecosystem, but also plays a crucial role in providing the physical habitat within which organisms complete their life cycles (Kent & Coker 1992). Therefore, the vegetation of an area will largely determine the ecological sensitivity thereof.

The vegetation sensitivity assessment aims to identify whether the vegetation within the study area is of conservation concern and thus sensitive to development:

In order to determine the sensitivity of the vegetation (ecosystem) on the site, weighting scores are calculated per plant community. The following six criteria are used and each allocated a value of 0-3.

- Conservation status of a regional vegetation unit;
- Listed ecosystem (e.g. wetlands, hills and ridges etc)
- Legislative protection (e.g. threatened ecosystems, SANBI & DEAT 2009)
- Plant species of conservation concern (e.g. red listed, nationally or provincially protected plant species, habitat or potential habitat to plants species of conservation concern, protected plants or protected trees);
- Situated within ecologically functionally important features (e.g. wetlands or riparian areas; important habitat for rare fauna species)
- Conservation importance (e.g. untransformed and un-fragmented natural vegetation, high plant species richness, important habitat for rare fauna species).

Sensitivity is calculated as the sum the values of the criteria. The vegetation with the lowest score represents the vegetation that has the least / limited sensitivity). A maximum score of 18 can be obtained, a score of 15-18 indicated high sensitivity. The sensitivity scores are as follows (Table 4.1):

Table 4.1: Sensitivity Weighting scores for vegetation.

Scoring	15-18	12-14	9-11	6-8	0-5
Sensitivity	High	Medium-High	Medium	Medium-Low	Low

Development on vegetation that has High sensitivity will normally not be supported, except that specific circumstances may still lead to support of the proposed development.

Portions of vegetation with Medium-High or Medium sensitivity should be conserved**.**

Development may be supported on vegetation considered to have Medium-Low or Low sensitivity.

4.1.5 Plant Species Status

Plant species recorded in each plant community with an indication of the status of the species by using the following symbols:

A = Alien woody species; D = Dominant; d = subdominant; G = Garden or Garden Escape; M = Medicinal plant species; P = Protected trees species; p = provincially protected species; RD = Red data listed plant; W = weed.

4.1.6 Species Richness

Species Richness is interpreted as follows: Number of indigenous species recorded in the sample plots representing the plant community. Alien woody species and weeds are not included (Table 4.2).

Table 4.2: Categories of plant species richness.

No of species	Category
1-24	Low
25-39	Medium
40-59	High
60+	Very High

4.1.7 Impact Assessment Methods

The methods and format of the impact tables used in this chapter are in accordance to the requirements of the 2014 Regulations.

- The **nature**, which shall include a description of what causes the effect, what will be affected and how it will be affected.
- The **probability (P)** *of occurrence*, which shall describe the likelihood of the impact actually occurring. Probability will be estimated on a scale of 1–5, where 1 is very improbable (probably will not happen), 2 is improbable (some possibility, but low likelihood), 3 is probable (distinct possibility), 4 is highly probable (most likely) and 5 is definite (impact will occur regardless of any prevention measures).
- The **duration (D)**, wherein it will be indicated whether:
  - the lifetime of the impact will be of a very short duration (0–1 years) – assigned a score of 1;
  - the lifetime of the impact will be of a short duration (2-5 years) - assigned a score of 2;
  - medium-term (5–15 years) – assigned a score of 3;
  - long term (> 15 years) - assigned a score of 4; or
  - permanent - assigned a score of 5;
- The **extent (E)**, wherein it will be indicated whether the impact will be local (limited to the immediate area or site of development) or regional, and a value between 1 and 5 will be assigned as appropriate (with 1 being low and 5 being high):
- The **magnitude (M)**, quantified on a scale from 0-10, where 0 is small and will have no effect on the environment, 2 is minor and will not result in an impact on processes, 4 is low and will cause a slight impact on processes, 6 is moderate and will result in processes continuing but in a modified way, 8 is high (processes are altered to the extent that they temporarily cease), and 10 is very high and results in complete destruction of patterns and permanent cessation of processes.
- the **significance (S)**, which shall be determined through a synthesis of the characteristics described above. The significance rating is calculated by the following formula:

  S (significance) = (D + E + M) x (P)
- the **status**, which will be described as either positive, negative or neutral.
- the degree to which the impact can be reversed.

» the degree to which the impact may cause irreplaceable loss of resources.
» the *degree* to which the impact can be *mitigated*.

The numerical value of the calculation is assigned to a significance category.

Table 4.3: Significance ranking of impacts

SIGNIFICANCE	**Very High**	**High**	**Moderate**	**Low**	**Minor**
	80-100	**60-79**	**40-59**	**20-39**	**1-19**

Impacts should be identified for the construction and operational phases of the proposed development. Proposed mitigation measures should be practical and feasible such that they can be realistically implemented by the applicant.

4.2 RESULTS

4.2.1 Vegetation (map units) Classification

All vegetation units on the site are disturbed, degraded and transformed. Since the diamond rush about 150 years ago, up to the present the Kimberley area has been impacted by people. Currently almost the entire eastern part of the site, east of Midlands road, is highly transformed, and old mine dump and a huge mining pit. Ruins of previous infrastructure are still present, although some infrastructure has been removed and parts have been rehabilitated. Furthermore, except for the eastern boundary, the site is totally surrounded by residential area, Eskom substation and sewerage works.

Table 4.4: List of mapping units with ecological sensitivity:

	Vegetation mapping unit	**Sensitivity analysis result**
1	Disturbed *Vachellia tortilis* Thornveld	Medium-Low
2	Highly Transformed Area	Low
3	Disturbed Open Shrubveld	Low
4	Old Field Secondary Grassland	Low
5	Degraded *Prosopis* Area	Low
6	Mine Dump	Low
7	Wetlands (see Chapter 5)	Medium-High or High
8	Quarries and Mining Pits (see Chapter 5)	Low

A vegetation map indicating the distribution of the mapping units is presented in Figure 4.2, while the ecoogical sensitivity is given in Figure 4.3

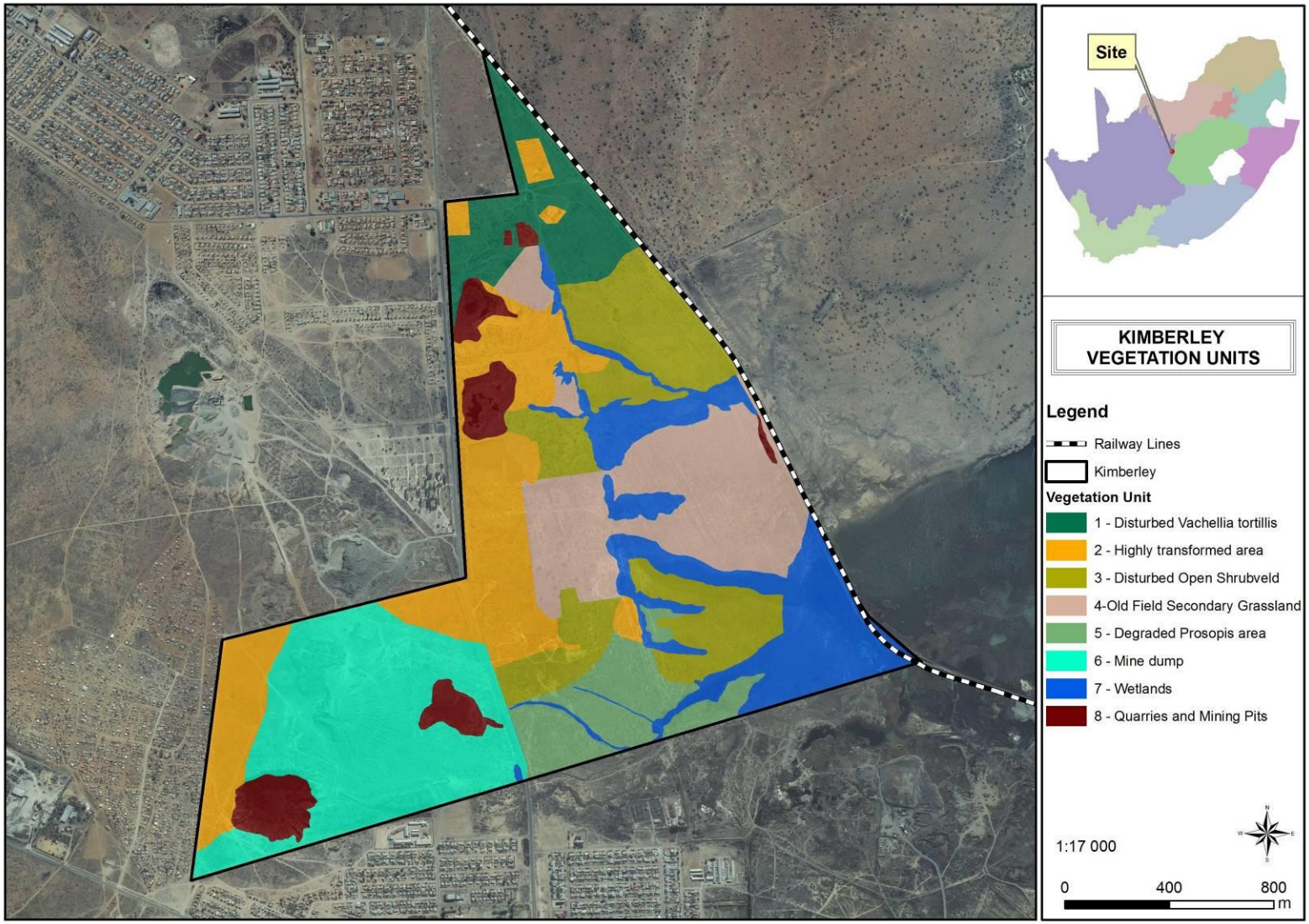

Figure 4.2: A vegetation map of the site.

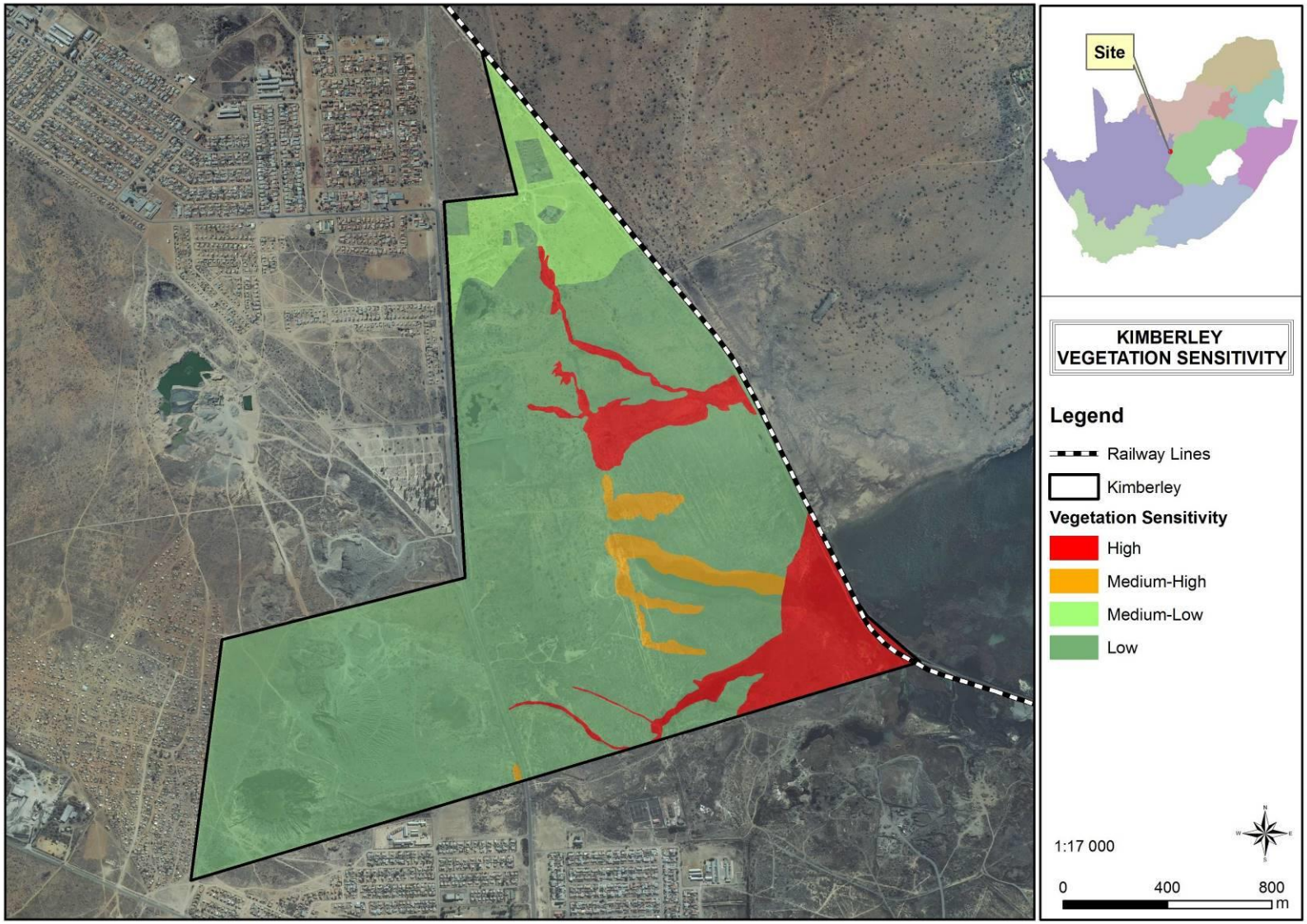

Figure 4.3: Ecological sensitivity of the site in accordance to the result of the sensitivity analysis.

4.2.2 Description of the vegetation of the mapping units

4.2.2.1 Disturbed Vachellia tortilis *Thornveld*

This vegetation is a disturbed relict of the Kimberley Thornveld, or even secondary vegetation that developed on degraded sites. This plant community occurs as isolated patches in the northern and south-eastern parts of the study site (Figure 4.2). Due to decades of intensive disturbance by the mining and related activity, the vegetation became degraded. This is clearly illustrated in Figure 3.3.

The woody layer is 2-3 m tall and covers 20-35%. The dominant tree is *Vachellia tortilis*, though the alien *Prosopis glandulosa* is often also present. The grass cover is about 30-50% with *Eragrostis lehmanniana* the most prominent grass species. Some forbs occur in the area, several being weed species.

Figure 4.4: A collage of photographs illustrating the Disturbed *Vachellia tortilis* Thornveld.

The following plant species were recorded in this plant community:

Trees and shrubs, dwarf shrubs

Lycium cinereum		*Trichodiadema pomeridianum*	
Lycium pilifolium		*Vachellia karroo*	M
Pentzia globosa		*Vachellia tortilis*	D
Prosopis glandulosa	A	*Ziziphus mucronata*	M
Searsia lancea		*Zygophyllum* sp	
Senegalia hebeclada			

Grasses and sedges

Aristida canescens		*Eragrostis obtusa*	
Aristida congesta		*Eragrostis superba*	
Cenchrus ciliaris		*Eragrostis trichophora*	
Chloris virgata		*Fingerhuthia africana*	
Cynodon dactylon		*Heteropogon contortus*	
Eragrostis lehmanniana	D	*Panicum coloratum*	

Forbs

Aloe grandidentata	p	*Hibiscus trionum*	
Ammocharis coranica	p	*Jamesbrittenia aurantiaca*	
Anthericum sp		*Nidorella anomala*	
Barleria macrostegia		*Orbea lutea*	p
Berkheya sp		*Solanum panduriforme*	W
Bulbine frutescens	M	*Tagetes minuta*	W
Cleome angustifolia		*Tribulus terrestris*	
Felicia muricata			

Table 4.5: Number of species recorded:

	Indigenous	**Aliens / Weeds**	**Total**	**Red Data**	**Protected**	**Medicinal**
Trees and shrubs	10	1	11	0	0	2
Grasses	12	0	12	0	0	0
Forbs	13	2	15	0	3	0
Total	34	3	37	0	3	2

The species richness is medium and three provincially protected plant species were found.

Table 4.6: Summary of ecological features of the Disturbed *Vachellia tortilis* Thornveld

Disturbed *Vachellia tortilis* Thornveld summary			
Status	Disturbed and often degraded		
Soil	Red loam	**Rockiness**	0%
Conservation value:	Low	**Ecological sensitivity**	Medium-Low
Species richness:	Medium	**Need for rehabilitation**	Medium
Dominant spp.	*Vachellia tortilis, Eragrostis lehmanniana*		

Discussion

The vegetation of this site has medium-low conservation value and is suitable for development. Part of this plant community will however be protected in the 50 m buffer zone surrounding the wetlands (plant communities 3 & 4 discussed below).

Development in this plant community can be supported.

4.2.2.2 Highly Transformed Areas

This mapping unit occurs scattered over the entire site (Figure 4.2). This area was totally transformed by the previous mining operations, buildings (rubble from ruins of previous infrastructure and current buildings,), current football field and other degraded areas surrounding old quarries or mining pits and old roads. The soil is extremely disturbed.

The woody layer is 1-3 m tall and covers 1-20%. The soil is bare over extensive areas, with patchy vegetation and scattered shrubs and trees. The dominant shrub/tree is *Vachellia tortilis*, though the alien *Prosopis glandulosa* is often dominant. The herbaceous vegetation scanty with the grass cover varying from about 5% to 30%, with *Eragrostis lehmanniana, Eragrostis obtusa* and *Chloris virgata* often prominent. Some forbs occur in the area, several being weed species.

Figure 4.5: Scenes within the Highly Transformed Area.

The following plant species were recorded in this plant community:

Trees and shrubs, dwarf shrubs

Lycium cinereum		*Vachellia karroo*	M
Pentzia globosa		*Vachellia tortilis*	D
Prosopis glandulosa	AD		

Grasses and sedges

Aristida canescens		*Eragrostis lehmanniana*	D
Aristida congesta		*Eragrostis obtusa*	
Cenchrus ciliaris		*Fingerhuthia africana*	
Chloris virgata			

Forbs

Aloe grandidentata	p	*Nidorella anomala*	
Berkheya sp		*Orbea lutea*	p
Cleome angustifolia		*Solanum panduriforme*	W
Felicia muricata		*Tagetes minuta*	W
Hibiscus trionum		*Tribulus terrestris*	

Table 4.7: Number of species recorded:

	Indigenous	Aliens / Weeds	Total	Red Data	Protected	Medicinal
Trees and shrubs	4	1	5	0	0	1
Grasses	7	0	7	0	0	0
Forbs	8	2	10	0	2	0
Total	19	3	22	0	2	1

The species richness is Low.

Table 4.8: Summary of ecological features of the Highly Transformed Areas

Highly Transformed Areas summary			
Status	Transformed, degraded		
Soil	Highly disturbed	**Rockiness**	0%
Conservation value:	Low	**Ecological sensitivity**	Low
Species richness:	Low	**Need for rehabilitation**	High
Dominant spp.	*Vachellia tortilis, Eragrostis lehmanniana*		

Discussion

These areas are highly disturbed and totally degraded. The species richness is Low, with two provincially protected plant species present but no red data listed plant species were recorded. The vegetation was transformed, it became established on former developed or degraded areas and is therefore secondary. The ecological sensitivity is considered to be Low.

Development in this plant community can be supported.

4.2.2.3 Disturbed Open Shrubveld

This vegetation is found in the northern part of the study site (Figure 4.2). The area was also quite disturbed in the past, and bare patches, similar to the Highly Transformed Areas (4.2.2.2 above) occur scattered throughout this area. The plant species composition is also very similar to that of the Highly Transformed Areas, but the Disturbed Open Shrubveld is in a somewhat better condition (Figure 4.6). The bare patches are locally dominated by

Prosopis glandulosa though particularly better grass cover of typical *Vachellia tortilis* Thornveld is also present (Figure 4.6).

Figure 4.6: Disturbed Open Shrubveld.

The following plant species were recorded in this plant community:

Trees and shrubs, dwarf shrubs

Lycium cinereum		*Trichodiadema pomeridianum*	
Pentzia globosa		*Vachellia tortilis*	d
Prosopis glandulosa	A	*Zygophyllum* sp	

Grasses and sedges

Aristida canescens		*Eragrostis superba*	
Aristida congesta		*Eragrostis trichophora*	
Cenchrus ciliaris		*Fingerhuthia africana*	
Chloris virgata		*Heteropogon contortus*	
Eragrostis lehmanniana	D	*Panicum coloratum*	
Eragrostis obtusa			

Forbs

Aloe grandidentata	p	*Nidorella anomala*	
Ammocharis coranica	p	*Solanum panduriforme*	W
Bulbine frutescens	M	*Tagetes minuta*	W
Felicia muricata		*Tribulus terrestris*	
Hibiscus trionum			

Table 4.9: Number of species recorded:

	Indigenous	Aliens / Weeds	Total	Red Data	Protected	Medicinal
Trees and shrubs	5	1	6	0	0	0
Grasses	11	0	11	0	0	0
Forbs	7	2	9	0	2	1
Total	23	3	26	0	2	1

The species richness is low and two provincially protected plant species were found.

Table 4.10: Summary of ecological features of the Disturbed Open Shrubveld

Disturbed Open Grassveld summary			
Status	Disturbed and often degraded		
Soil	Brown loam	**Rockiness**	0%
Conservation value:	Low	**Ecological sensitivity**	Low
Species richness:	Medium	**Need for rehabilitation**	Medium
Dominant spp.	*Vachellia tortilis, Eragrostis lehmanniana*		

Discussion

The vegetation of this site has medium-low conservation value and is suitable for development. Part of this plant community will however be protected in the 50 m buffer zone surrounding the wetlands (see Figure 5.10)

Development in this plant community can be supported.

4.2.2.4 Old Field Secondary Grassland

Secondary grassland that became established on previously cultivated fields is found in the central part of the study site (Figure 3.3, Figure 3.4 and Figure 4.2). The ploughing destroyed the original vegetation, the secondary grassland vegetation subsequently developed on the area when cultivation was abandoned. The grass cover is 40-50%, dominated by *Eragrostis lehmanniana.* Trees are rare but *Vachellia karroo* shrubs cover <2% and dwarf shrubs 10% of the surface area (Figure 4.7).

Figure 4.7: Old Field Secondary Grassland.

The following plant species were recorded in this plant community:

Trees and shrubs, dwarf shrubs

Lycium cinereum *Pentzia globosa*

Salsola kali *Zygophyllum* sp
Vachellia karroo d

Grasses and sedges

Aristida congesta *Eragrostis obtusa*
Cenchrus ciliaris *Eragrostis trichophora*
Chloris virgata *Fingerhuthia africana*
Eragrostis lehmanniana D

Forbs

Aloe grandidentata p *Hibiscus trionum*
Anthericum sp *Nidorella anomala*
Berkheya sp *Solanum panduriforme* W
Felicia muricata *Tribulus terrestris*

Table 4.11: Number of species recorded:

	Indigenous	Aliens / Weeds	Total	Red Data	Protected	Medicinal
Trees and shrubs	5	0	5	0	0	1
Grasses	7	0	7	0	0	0
Forbs	7	1	8	0	1	0
Total	19	1	20	0	1	1

The species richness is low and one provincially protected plant species were found.

Table 4.12: Summary of ecological features of the Old Field Secondary Grassland

Old Field Secondary Grassland summary			
Status	Transformed		
Soil	Brown loam	**Rockiness**	0%
Conservation value:	Low	**Ecological sensitivity**	Low
Species richness:	Medium	**Need for rehabilitation**	Medium
Dominant spp.	*Eragrostis lehmanniana*		

Discussion

The vegetation of this site has low conservation value and is suitable for development. Part of this plant community will however be protected in the 50 m buffer zone surrounding the wetlands (see Figure 5.10)

Development in this plant community can be supported.

4.2.2.5 Degraded Prosopis *Area*

The areas with prominent *Prosopis glandulosa,* an alien invader plant species, occur on bare and somewhat sodic soils mainly along drainage lines and flooded areas (see also Chapter 5 on Wetlands) situated in the south-eastern part of the site (Figure 4.2). *Prosopis glandulosa* invaded and became established in these bare floodplain areas (Figure 4.8). Very few other plant species occur in these area, and those that are present often indicate sodic conditions. The area is prone to erosion. Other bare patches that occur scattered over the study site are often also dominated by *Prosopis glandulosa*, particularly in the Disturbed Open Shrubveld (4.2.2.3 above).

Figure 4.8: The bare Degraded *Prosopis* Area.

The following plant species were recorded in this plant community:

Trees and shrubs, dwarf shrubs

Atriplex suberecta		*Vachellia karroo*	M
Lycium cinereum		*Vachellia tortilis*	
Pentzia globosa		*Zygophyllum* sp	
Prosopis glandulosa	AD		

Grasses and sedges

Aristida congesta	*Panicum coloratum*
Cenchrus ciliaris	*Sporobolus ioclados*
Chloris virgata	*Tragus racemosus*
Fingerhuthia africana	

Forbs

Aloe grandidentata	p
Atriplex vestita	
Felicia muricata	
Salsola glabrescens	
Solanum panduriforme	W
Tribulus terrestris	

Table 4.13: Number of species recorded:

	Indigenous	Aliens / Weeds	Total	Red Data	Protected	Medicinal
Trees and shrubs	6	1	7	0	0	1
Grasses	7	0	7	0	0	0
Forbs	5	1	6	0	1	1
Total	18	2	20	0	2	1

The species richness is low and one provincially protected plant species was found.

Table 4.14: Summary of ecological features of the Degraded *Prosopis* Area.

Degraded *Prosopis* Area summary			
Status	Degraded, often bare		
Soil	Brown clay loam, sodic	**Rockiness**	0%
Conservation value:	Low	**Ecological sensitivity**	Low, though prone to erosion
Species richness:	Low	**Need for rehabilitation**	Medium
Dominant spp.	*Vachellia tortilis, Eragrostis lehmanniana*		

Discussion

The vegetation of this site has medium-low conservation value and is suitable for development. Part of this plant community will however be protected in the 50 m buffer zone surrounding the wetlands (see Figure 5.10)

Development in this plant community can be supported.

4.2.2.6 Mine Dump

The mine dump is located on the south-western part of the site, west of Midlands Rd (Figure 3.3, Figure 3.4 and Figure 4.2). The dump is bare, with scanty vegetation limited to the eastern side of the dump, around an excavation, currently filled with water (see Chapter 5, wetlands).

The plant species are limited to a few trees and shrubs of *Vachellia tortilis* and the alien *Prosopis glandulosa.* Scanty grass includes *Eragrostis lehmanniana* and *Chloris virgata.*

The area has no conservation value and from a biodiversity perspective has low sensitivity.

From a biodiversity perspective, the development can be supported in this area.

Figure 4.9: The mine dump.

4.2.2.7 Wetlands

The wetlands are described and discussed in Chapter 5.

4.2.2.8 Quarries and Mining pits

The quarries and mining pits currently contains water and are discussed under Wetland in Chapter 5.

4.3 PLANTS OF CONSERVATION CONCERN

Plants of conservation concern are those plants that are important for South Africa's conservation decision making processes. These plants are nationally protected by the National Environmental Management: Biodiversity Act (Raimondo *et al*, 2009).

Threatened species are those that are facing high risk of extinction, indicated by the categories Critically Endangered (CE), Endangered (EN) and Vulnerable (VU). Species of Conservation Concern include the Threatened Species, but additionally have the categories Near Threatened (NT), Data Deficient (DD), (DDT = lack of taxonomic data), Critically Rare (CR), Rare (R) and Declining (D). This is in accordance with the new Red List for South African Plants (Raimondo *et al*. 2009).

Table 4.15: The following red data plant species have previously been collected from Grid 2824DA (Precis 2018).

Family	Species	Status
Amaryllidaceae	*Crinum bulbispermum* (Burm.f.) Milne-Redh. & Schweick.	Declining
Fabaceae	*Acacia erioloba* E.Mey.	Declining
Hyacinthaceae	*Drimia sanguinea* (Schinz) Jessop	NT
Oxalidaceae	*Oxalis setosa* E.Mey. ex Sond.	DDT

No red data listed plant species occur on the site. Although the plant species listed in Table 4.15 may occur in the vicinity, they were not found on the study site, probably due to the long-term disturbance, degradation and transformation caused by long term human occupation and the mining operations.

4.3.1 Provincially Protected Plants

Three provincially protected plant species do occur on the site, namely large populations of the geophyte *Ammocharis coranica* and the succulent *Aloe grandidentata.* A few individuals of the succulent *Orbea lutea* were observed*.* All three these plant species can easily be transplanted and relocated.

Figure 4.10: Protected plant species: *Aloe grandidentata, Orbea lutea* and *Ammocharis coranica* on the site.

4.3.2 Nationally Protected Plants

No protected trees or TOPS /NEMBA plant species occur on the site.

4.4 ALIEN INVASIVE PLANT SPECIES

Declared weeds and invader plant species have the tendency to dominate or replace the canopy or herbaceous layer of natural ecosystems, thereby transforming the structure, composition and function of natural ecosystems. Therefore, it is important that these plants controlled and eradicated by means of an eradication and monitoring program. Some invader plants may also degrade ecosystems through superior competitive capabilities to exclude native plant species (Henderson, 2001).

The amended Regulations (Regulation 15) of the Conservation of Agricultural Resources Act, 1983 (Act No. 43 of 1983) (CARA) identifies three categories of problem plants:
Category 1 (Declared weeds): plants may not occur on any land other than a biological control reserve and must be controlled or eradicated. Therefore, no person shall establish plant, maintain, propagate or sell/import any category 1 plant species;
Category 2 (Declared invaders): plants are plants with commercial application and may only be cultivated in demarcated areas (such as biological control reserves) otherwise they must be controlled; and
Category 3 (Declared invaders): plants are ornamentally used and may no longer be planted, except those species already in existence at the time of the commencement of the

regulations (30 March 2001), unless they occur within 30 m of a 1:50 year flood line and must be prevented from spreading.

In addition, a second draft of the Alien and Invasive Species Regulations, as well as a new draft list of categories of invasive species in terms of the National Environmental Management: Biodiversity Act (Act 10 of 2004) was published in the Government Gazette No. 32090, in April 2009 and revised in Government Gazette No 37886 in August 2014. Any species designated under section 70 cannot be propagated, grown, bought or sold by the industry without a permit. Whereas CARA previously classified problem plants into two groups - declared weeds and plant invaders - the amended regulations make provision for four groups: declared weeds (Category 1 plants), plant invaders (Category 2 and Category 3 plants) and indicators of bush encroachment. The first three groups consist of undesirable alien plants and are covered by Regulation 15. Bush encroachers, which are indigenous plants that require sound management practices to prevent them from becoming problematic, are covered separately by Regulation 16.

Below is a brief explanation of the three categories in terms of the National Environmental Management: Biodiversity Act (Act 10 of 2004) (NEMBA):

Category 1a: Invasive species requiring compulsory control. Remove and destroy. Any specimens of Category 1a listed species need, by law, to be eradicated from the environment. No permits will be issued.
Category 1b: Invasive species requiring compulsory control as part of an invasive species control program. Remove and destroy. These plants are deemed to have such a high invasive potential that infestations can qualify to be placed under a government sponsored invasive species management program. No permits will be issued.
Category 2: Invasive species regulated by area. A demarcation permit is required to import, possess, grow, breed, move, sell, buy or accept as a gift any plants listed as Category 2 plants. No permits will be issued for Category 2 plants to exist in riparian zones.
Category 3: Invasive species regulated by activity. An individual plant permit is required to undertake any of the following restricted activities (import, possess, grow, breed, move, sell, buy or accept as a gift) involving a Category 3 species. No permits will be issued for Category 3 plants to exist in riparian zones.

In terms of the amendments to the regulations under the Conservation of Agriculture Resources Act, 1983 (Act No. 43 of 1983) and Regulation 598, Government Gazette 37885, August 2014) (Alien and Invasive Species Regulations), landowners are legally responsible for the control of alien species on their properties.

Declared invasive plants (Henderson 2001) that should be removed and controlled (Conservation of Agricultural Resources Act (Act 43 of 1983) and Government Notice 599 No 37886 (2014) include:

Cirsium vulage	Category 1b
Prosopis glandulosa	Category 3 (in Northern Cape)

4.5 VEGETATION IMPORTANCE AND SENSITIVITY

The result of the sensitivity analysis is given in Table 4.2.

In spite of being located Critical Biodiversity Area (Two) (Figure 4.1) the assessment indicated that due to decades of intensive disturbance by the mining operation and related activity, the vegetation became degraded, even locally transformed (e.g. old fields, mining, trampling, alien tree species). This is clearly illustrated in Figure 3.3 and Figure 3.4. Furthermore, the site is surrounded to the north, east and south by residential area, mining and other developments (Eskom, Sewerage, Railway line), isolating the site from natural vegetation that is still in a fair condition, thereby closing natural corridors. The sensitivity in terms of biodiversity is therefore downgraded to Medium-Low and Low.

Ecological sensitivity of wetlands is excluded here and is discussed in Chapter 5.

Table 4.16: Scoring of terrestrial vegetation that occurs within the study area.

Vegetation	Conservation Status of regional Vegetation unit	Listed Ecosystem	Legislated Protection	Species of conservation concern	Ecological Function	Conservation Importance	Total Score out of max of 18
1. Disturbed *Vachellia tortilis* Thornveld	**1**	**0**	**1**	**2**	**2**	**1**	**7** **Medium Low**
2. Highly Transformed Area	**0**	**0**	**0**	**1**	**1**	**0**	**2** **Low**
3. Disturbed Open Shrubveld	**1**	**0**	**0**	**2**	**2**	**1**	**6** **Medium-Low**
4. Old Field Secondary Grassland	**0**	**0**	**0**	**1**	**1**	**0**	**2** **Low**
5. Degraded *Prosopis* Area	**0**	**1**	**1**	**1**	**1**	**1**	**5** **Low**
6. Mine Dump	**0**	**0**	**0**	**0**	**0**	**0**	**0** **Low**

Except for the Disturbed *Vachellia tortilis* Thornveld, which has Medium-Low ecological sensitivity, all the other terrestrial ecosystems recognised on the site have a Low ecological sensitivity (Table 4.16).

It must be emphasized that the wetlands, which have legislative protection (National Water Act 1998, National Environmental Management Act, 1998), are mostly regarded to have High ecological sensitivity. This is discussed in Chapter 5.

Furthermore, the presence of the large flock of breeding lesser flamingo on the Kamfers Dam will influence the ecological sensitivity in the region of the Dam (see Chapter 7 on Avifauna).

4.6 IMPACT ASSESSMENT: VEGETATION AND FLORA

Based on the degree of ecological sensitivity of the identified terrestrial plant communities (ecosystems), the impacts on terrestrial vegetation are grouped into three categories namely:

1. Disturbed *Vachellia tortilis* Thornveld and Disturbed Open Shrubveld
2. Old Field Secondary Grassland
3. Highly Transformed Area and Gegraded *Prosopis* Area

The Mine Dump has no vegetation and is not discussed further.

It should also be noted that the proposed residential development should be located outside the 32 m buffer of the wetlands, in which case parts of some of the terrestrial units may be excluded from the proposed development and will not be affected. The following impacts represent a worst-case scenario for the particular plant communities.

4.6.1 Impact on Disturbed *Vachellia tortilis* Thornveld and Disturbed Open Shrubveld

The ecological sensitivity of these two plant communities (Plant Communities 4.2.2.1 and 4.2.2.3) is considered to be **Medium-Low**. This is mainly due to the disturbed nature of these plant communities, but they still have relatively high species richness and do contain provincially protected plant species.

The **significance of the impact** of the proposed development on this plant community, with mitigation, is therefore considered to be **Moderate** during construction and without mitigation may be **High** during operational phases. From vegetation and flora point of view, the proposed development on this area can however be supported (Table 4.17).

Table 4.17: Impact on Disturbed *Vachellia tortilis* Thornveld and Disturbed Open Shrubveld - loss of indigenous vegetation due to clearing for construction of the residential town.

Nature: The footprint for the proposed development will be totally cleared of vegetation. This will result in the loss of some indigenous species, disturbance of plant populations and the fragmentation of the plant community. The removal of vegetation will also expose soil increasing the risk of erosion.

	Without mitigation		**With mitigation**	
CONSTRUCTION PHASE				
Probability	Definite	5	Definite	5
Duration	2-5 years	2	2-5 years	2
Extent	Limited to Site	1	Limited to Site	1
Magnitude	Major	7	Moderate	5
Significance	**Moderate**	**50**	**Moderate**	**40**
Status (positive or negative)	Negative		Negative	
OPERATIONAL PHASE				
Probability	Definite	5	Definite	5
Duration	Permanent	5	Permanent	5
Extent	Limited to Site	1	Limited to Site	1
Magnitude	Major	7	Moderate	5
Significance	**High**	**65**	**Moderate**	**55**
Status (positive or negative)	Negative		Negative	
Reversibility	Low		Medium	
Irreplaceable loss of resources?	Moderate		Moderate	
Can impacts be mitigated?	Yes			

Mitigation:

- The clearing of vegetation must be kept to a minimum and remain within the stands earmarked for development – leave some open space area (e.g. parks) with natural vegetation in tact
- Leave all trees wherever possible
- The buffer zone for the wetland is in this grassland – this area must remain with natural grassland
- Construction must be completed as quickly as possible
- Disturbed open areas must be rehabilitated immediately after construction has been completed in that area by planting appropriate indigenous tree and grass species
- During the construction phase workers must be limited to areas under construction and access to the planned open areas must be strictly controlled
- Rehabilitated areas must be monitored to ensure the establishment of re-vegetated areas.
- Plant only indigenous trees – no alien species

Cumulative impacts: Expected to reduce the grassland environment in the area.

Residual Risks: Little anticipated provided that the mitigation measures are implemented correctly.

4.6.2 Impact on Transformed and Disturbed Grassland

The ecological sensitivity of this grassland community (plant communities 4.2.2.4) is considered to be **Low.** The impacts of the development during construction are **Low** but **Moderate** during operational phase (Table 4.18). This is due to the secondary condition of this grassland, due to previous agricultural activities. From vegetation and flora point of view, the proposed development on this area can however be supported.

Table 4.18: Impact on Old Field Secondary Grassland - Loss of indigenous vegetation due to clearing for construction of the residential town.

Nature: The footprint for the proposed development will be cleared of grassland vegetation. This will result in the loss of some indigenous species, disturbance of plant populations and the fragmentation of the plant community. The removal of vegetation will also expose soil increasing the risk of erosion.

	Without mitigation		**With mitigation**	
CONSTRUCTION PHASE				
Probability	Definite	5	Definite	5
Duration	2-5 years	2	2-5 years	2
Extent	Limited to Site	1	Limited to Site	1
Magnitude	Major	4	Moderate	3
Significance	**Low**	**35**	**Low**	**30**
Status (positive or negative)	Negative		Negative	
OPERATIONAL PHASE				
Probability	Definite	5	Definite	5
Duration	Permanent	5	Permanent	5
Extent	Limited to Site	1	Limited to Site	1
Magnitude	Major	4	Moderate	3
Significance	**Moderate**	**50**	**Moderate**	**45**
Status (positive or negative)	Negative		Negative	
Reversibility	Low		Medium	
Irreplaceable loss of resources?	Moderate		Moderate	
Can impacts be mitigated?	Yes			

Mitigation:

- The clearing of vegetation must be kept to a minimum and remain within the stands earmarked for development – leave some open space area (e.g. parks) with natural vegetation in tact
- The buffer zone for the wetland is in this grassland – this area must remain with natural grassland
- Construction must be completed as quickly as possible
- Disturbed open areas must be rehabilitated immediately after construction has been completed in that area by planting appropriate indigenous tree and grass species
- During the construction phase workers must be limited to areas under construction and access to the planned open areas must be strictly controlled
- Rehabilitated areas must be monitored to ensure the establishment of re-vegetated areas
- Plant only indigenous trees – no alien species.

Cumulative impacts: Expected to reduce the grassland environment in the area, though secondary grassland not as important as primary vegetation.

Residual Risks: Little anticipated provided that the mitigation measures are implemented correctly.

4.6.3 Impact on Highly Transformed Areas and Degraded *Prosopis*.

The ecological sensitivity of these two community (plant communities 4.2.2.2 and 4.2.2.5) is considered to be **Low.** The impacts of the development during construction are **Low** but **Moderate** during operational phase (Table 4.19). This is due to the secondary condition of this grassland, due to previous agricultural activities. From vegetation and flora point of view, the proposed development on this area can however be supported.

Table 4.19: Impact on Highly Transformed Areas and Degraded *Prosopis* Areas - Loss of transformed vegetation due to clearing for construction of the residential town.

Nature: The footprint area or the proposed town development will be cleared of vegetation. The vegetation of these areas is however transformed as a result of previous mining activities. The development will result in the loss or disturbance of a few indigenous plant species. The removal of alien trees is a positive impact. The removal of vegetation will also expose soil (which is already severely disturbed) increasing the risk of erosion. Especially the *Prosopis* Area is prone to erosion.				
	Without mitigation		**With mitigation**	
CONSTRUCTION PHASE				
Probability	Definite	5	Definite	5
Duration	2-5 years	2	2-5 years	2
Extent	Limited to Site	1	Limited to Site	1
Magnitude	Major	3	Major	2
Significance	**Low**	**30**	**Low**	**25**
Status (positive or negative)	Negative, removal of alien trees is positive		Negative, removal of alien trees is positive	
OPERATIONAL PHASE				
Probability	Definite	5	Highly probable	5
Duration	Permanent	5	Permanent	5
Extent	Limited to Site	1	Limited to Site	1
Magnitude	Major	3	Major	2
Significance	**Moderate**	**45**	**Moderate**	**40**
Status (positive or negative)	Negative		Negative	
Reversibility	Low		Low	
Irreplaceable loss of resources?	High		High	
Can impacts be mitigated?	Yes			

Mitigation: • This area is totally transformed due to previous mining activities – though the clearing of vegetation must be kept to a minimum and remain within the footprint earmarked for development • Do not remove indigenous trees wherever possible, though *Prosopis* should be removed • Some areas are prone to erosion – avoid any activity that may cause or enhance erosion • Construction must be completed as quickly as possible • Disturbed open areas must be rehabilitated immediately after construction has been completed by planting appropriate indigenous tree and grass species; • Plant only indigenous trees – no alien species
Cumulative impacts: Expected to reduce the natural environment in the area.
Residual Risks: Little anticipated provided that the mitigation measures are implemented correctly.

4.6.4 Impact due to increase in alien plant species

All cleared areas within the development sites may be prone to increase of alien trees and weed species.

Table 4.20: Increase of alien invasive plant species on cleared sites.

Nature: Alien invasive plant species and weeds may encroach into any disturbed areas particularly areas cleared for the proposed development.				
	Without mitigation		**With mitigation**	
CONSTRUCTION PHASE				
Probability	Definite	4	Probable	2
Duration	Medium-term	3	Medium-term	1
Extent	Limited to site	1	Limited to Site	1
Magnitude	Moderate	5	Low	2
Significance	**Low**	**36**	**Minor**	**8**
Status (positive or negative)	Negative		Positive	
OPERATIONAL PHASE				
Probability	Improbable	2	Very Improbable	1
Duration	Permanent	5	Permanent	5
Extent	Limited to site	1	Limited to Site	1
Magnitude	Low	2	Low	1
Significance	**Minor**	**16**	**Minor**	**7**
Status (positive or negative)	Negative		Positive	
Reversibility	Moderate		High	
Irreplaceable loss of resources?	Moderate		Moderate	
Can impacts be mitigated?	Yes			

Mitigation: • An alien invasive management programme must be incorporated into the Environmental Management Programme; • Ongoing alien plant control must be undertaken; • Areas which have been disturbed will be quickly colonised by invasive alien species. An ongoing management plan **must** be implemented for the clearing/eradication of alien species. • Monitor all sites disturbed by construction activities for colonisation by exotics or invasive plants and control these as they emerge. • Avoid planting of exotic plant species, use indigenous species.
Cumulative impacts: Moderate, should mitigation measure not be implemented. Alien invader plant species pose an ecological threat as they alter habitat structure; lower biodiversity, change ecosystem services and processes e.g. change nutrient cycling and productivity, and modify food webs.
Residual Risks: None anticipated provided that the mitigation measures are implemented correctly, and rehabilitation of the site is undertaken.

4.7 CONCLUSION: TERRESTRIAL VEGETATION AND FLORA

From a vegetation and flora point of view, and also a conservation point of view, the terrestrial vegetation of the area is already highly disturbed, degraded and transformed. No red data plant species occurs within the site but three provincially protected plant species (*Aloe grandidentata, Ammocharis coranica* and *Orbea lutea*) do occur on the site. All these species can easily be transplanted and relocated. Care should be taken with the rescue operation of *Ammocharis coranica*, as these plants have huge bulbs.

The ecological sensitivity of the terrestrial vegetation and ecosystems is regarded to be Low to Medium-Low. The significance of the impacts of the proposed development varies from Minor to Moderate but is mostly Low.

No development will be supported within the wetland and its 32 m buffer zone, as this is controlled by law (National Water Act 1998, National Environmental Management Act, 1998) (See Chapter 5).

It is concluded that the planned development can be supported on most of the terrestrial ecosystems, excluding wetland buffer areas and excluding the buffer zone for lesser flamingo.

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5 WETLANDS

5.1 METHODS

5.1.1 Wetland Delineation

Aerial photographs of the site were investigated prior to the site visit. All the wetland areas on site and within 500m of the site were delineated based on the aerial photographs.

The wetlands on site were delineated according to the Department of Water Affairs (DWA) wetland delineation guideline (DWAF 2005). Several wetland indicators are used to delineate the wetland area. The wetland indicators used are the:

- Vegetation indicator;
- Terrain unit indicator;
- Soil wetness indicator.

5.1.2 Present Ecological State

The Present Ecological State (PES) of the wetlands were be calculated using the WET-Health assessment (Macfarlane *et al* 2009). This assessment evaluates the change from natural to the hydrology, geomorphology and vegetation of the wetland and gives a score for each of these assessments. From this, a PES class is assigned. A summary of the PES classes is attached in Table 5.1. A combined score of the three can be calculated for the wetland, although this is not recommended. For the purposes of this study, the level 1 assessment were used.

Table 5.1: PES categories (from Macfarlane et al 2009).

Description	Combined impact score	PES Category
Unmodified, natural.	0-0.9	A
Largely natural with few modifications. A slight change in ecosystem processes is discernible and a small loss of natural habitats and biota may have taken place.	1-1.9	B
Moderately modified. A moderate change in ecosystem processes and loss of natural habitats has taken place but the natural habitat remains predominantly intact	2-3.9	C
Largely modified. A large change in ecosystem processes and loss of natural habitat and biota and has occurred.	4-5.9	D
The change in ecosystem processes and loss of natural habitat and biota is great but some remaining natural habitat features are still recognizable.	6-7.9	E
Modifications have reached a critical level and the ecosystem processes have been modified completely with an almost complete loss of natural habitat and biota.	8 - 10	F

5.1.3 Ecological Importance and Sensitivity

A draft Ecological Importance and Sensitivity (EIS) tool has been developed for wetlands by Rountree *et al.* The EIS assessment tool gives a score between 0 and 4, with 0 a very low score and 4 very high. In general, most wetlands have a score between 1 and 2.5. Very disturbed wetlands have a low score. Wetlands with a score higher than 2.5 has some very special and distinctive features and are normally unique wetlands.

Table 5.2: Classification of the EIS categories based on score.

Ecological Importance and Sensitivity categories	EIS score
Very high: Wetlands that are considered ecologically important and sensitive on a national or even international level. The biodiversity of these systems 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**
High: Wetlands that are considered to be ecologically important and sensitive. The biodiversity of these systems 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**
Moderate: Wetlands that are considered to be ecologically important and sensitive on a provincial or local scale. The biodiversity of these systems 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**
Low/marginal: Wetlands that is not ecologically important and sensitive at any scale. The biodiversity of these systems 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**

5.1.4 Buffer zone

The buffer zone tool developed by Macfarlane *et al* (2014) was used to determine the buffer zones required around the wetland units on site. The buffer zone takes several characteristics of the wetland into account, as well as whether the aim is to maintain or improve the PES of the wetland or if it may be allowed to degrade.

5.1.5 Risk Assessment

A Risk Assessment was conducted for the wetland units on site only. The Risk Assessment took the consequence and likelihood of the impact into consideration to determine the risk. The risk assessment took place according to the DWS protocol (2014). The risk assessment is completed as per Notice of 509 of 2016 under the Department of Water and Sanitation with regards to General Authorisations for Section 21 (c) and (i) water uses. Scores were allocated as follows:

Consequence:

Consequence = Severity + Spatial scale + duration

Severity:

- Insignificant / non-harmful: 1
- Small / potentially harmful: 2
- Significant / slightly harmful: 3
- Great / harmful: 4
- Disastrous / extremely harmful and/or wetland involved: 5

Spatial scale:

- Area specific: 1
- Whole site: 2
- Regional / neighbouring areas: 3
- National: 4
- Global: 5

Duration:

- One day a month, PES, EIS and REC not impacted: 1
- One month to a year, PES, EIS and REC impacted but no change in status: 2
- One to 10 years, PES, EIS and REC impacted to a lower status but can be improved over this period through mitigation: 3
- Life of the activity, PES, EIS and REC permanently lowered: 4
- More than life of the organisation / facility, PES and EIS scores a E or F: 5

Likelihood:

Likelihood = Frequency of the activity + Frequency of impact + Legal issues + Detection

Frequency of the incident / impact:

- Almost never / almost impossible / >20%: 1
- Very seldom / highly unlikely / >40%: 2
- Infrequent / unlikely / seldom / >60%: 3
- Often / regularly / likely / possible / >80%: 4
- Daily / highly likely / definitely / >100%: 5

Legal issues:

- No legislation: 1
- Fully covered by legislation: 2

Detection:

- Immediately: 1
- Without much effort: 2
- Need some effort: 3
- Remote and difficult to observe: 4
- Covered: 5

Frequency of the activity:

- Annually or less: 1
- 6 Monthly: 2
- Monthly: 3
- Weekly: 4
- Daily: 5

RISK:

The significance of each potential impact was calculated as follows: Risk = Consequence x Likelihood. The significance rating classes should influence the development project as described below (**Table** 5.3).

Table 5.3: Significance rating categories showing values for Low, Medium and High significance

Significance	Rating
Low Environmental Significance	0 - 55
Medium Environmental Significance	56 – 169
High Environmental Significance	170 -300

5.2 RESULTS

5.2.1 Delineation and Classification

Wetland located on the site and adjacent to the site were included in the assessment, but the delineation focused on the wetland units located on site, while the off-site wetland units were mainly delineated on the aerial photographs of the site.

5.2.1.1 Wetland units

The watercourses identified on site include the following units:

- Wetlands
    - Pan
    - Channelled Valley Bottom (CVB) Wetland
    - Unchannelled Valley Bottom (UCVB) Wetland
    - Seep
- Artificial wetlands
    - Excavations
    - Artificial seeps
- Drainage lines

5.2.1.1.1 Pan

The pan is mainly located to the east of the site, with a small portion located in the south-eastern corner of the site and is indicated on the topographical map of the site (Table 5.1a & b). The pan has been modified and now have an outflow, where it likely had none in the past. The pan received polluted water or cleaned water from the waste water treatment

works located to the south of the site. The railway line also passes through the pan at the south-eastern corner of the site and to the south of the site. The disturbances are therefore mainly confined to the southern and western portions to the site, with a large natural area present to the north of the pan.

The pan generally has a poor vegetation cover, with the dense vegetation patches confined to the edges of the pan. The portions of the pan located on site generally have a higher vegetation cover than the average cover in the pan unit.

5.2.1.1.2 Channelled Valley Bottom Wetland

The channelled valley bottom (CVB) wetland unit is located to the south of the site, with the wetland unit entering the south-eastern portion of the site (Table 5.1d). The unit is indicated on the topographical map for the site as a drainage line. The upper portion of the wetland unit, to the west of Midlands Road, has been destroyed by the sedimentation from the mine dump. The downstream portion of the site has high densities of *Prosopis* species, with patches of *Phragmites australis, Typha capensis* and a few sedge species. The vegetation is dominated by *Phragmites australis* where the wetland unit enters the pan.

5.2.1.1.3 Unchannelled Valley Bottom Wetland

The unchanneled valley bottom (UCVB) wetland unit is located adjacent to the CVB wetland unit, to the north of the CVB (Table 5.1c). The wetland unit is mostly located downstream of the powerline crossing the site and the wetland unit is fairly small for the wetland type. Two drainage lines enters the upper portion of the UCVB wetland unit.

5.2.1.1.4 Seep

The seep wetland is located in the northern portion of the site, with the majority of the seep is located to the east of the powerline (Table 5.1e). The wetness of the wetland unit has been increased by the leaking pipeline located adjacent to the powerline. The upper portion of the wetland unit has been changed significantly by the various activities on site, including several excavations. One of the excavations are located on the upper edge of the seep, with some of the excavated soil dumped on the upper portion of the seep. The eastern portion of the seep is dominated by grass and sedge species, but the portion of the seep located at the powerline and pipeline is dominated by *Typha capensis* and *Cyperus eragrostis.* This dominance of *Typha capensis* is likely the result the increase wetness of from the pipeline, with a possible increase from stormwater as well.

5.2.1.1.5 Drainage lines

Two drainage lines enter the upper portion of the UCVB wetland unit. The drainage lines are present between Midlands Road and the powerline. The drainage lines have a poor vegetation cover, with a few individuals of *Prosopis* species present in the drainage line (Table 5.1f). Drainage lines were present to the west of Midlands Road in the past and are visible on aerial photographs from 1968, but the drainage lines have since been filled with sedimentation from the eroding mine dumps on site.

5.2.1.1.6 Excavations

Several excavations are present on the site and water are accumulating in the bottom of the excavations. Although wetland conditions are present in the excavations, these conditions are artificial (Table 5.1g & h). The vegetation is mainly dominate by *Phragmites australis* and *Typha capensis*.

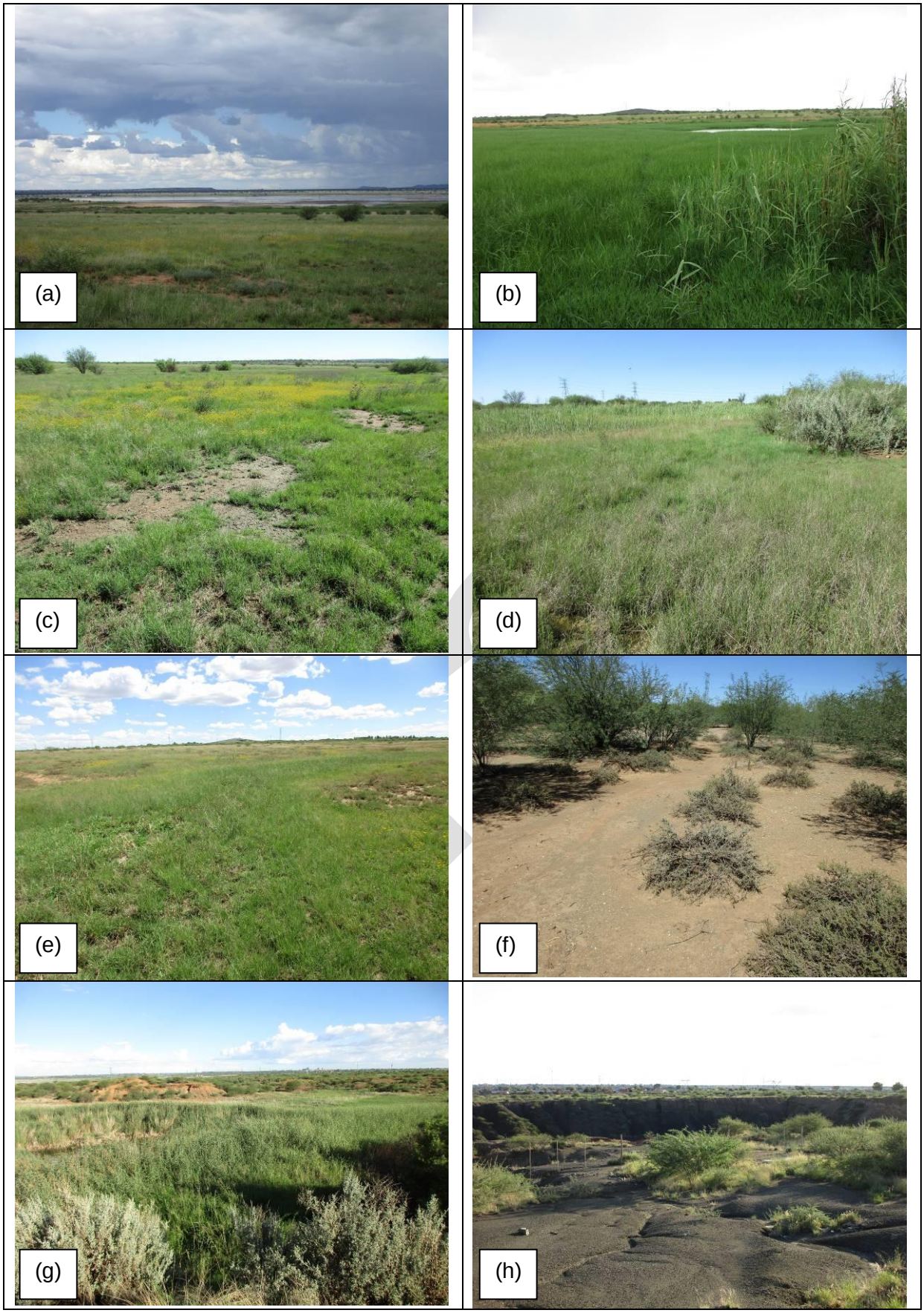

Figure 5.1: Images of the pan (a & b), UCVB (c), CVB (d), seep (e), drainage line (f) and excavations (g & h).

5.2.1.1.7 Artificial Seeps

Artificial seeps are present between the seep wetland unit and the UCVB wetland unit. It is unclear what the source of the water in the artificial seep wetland unit is, but it appears to be leaking water from the pipeline under the powerline or from stormwater runoff collecting against the small soil berm located on the pipeline. The source of the water therefore appears to be mostly artificial. The vegetation in this unit closely resembles the vegetation in the seep wetland, with the main difference being in the topography of these units.

5.2.1.2 Delineation

5.2.1.2.1 Vegetation

The vegetation on site fairly typical of wetland conditions (Table 5.4). Most of the areas dominated by *Typha capensis, Phragmites australis, Cyperus eragrostis* and *Cyperus congestus* appears to be artificial wetland area or appear to receive additional water from artificial sources. The dominance of *Phragmites australis* in the CVB wetland unit and the pan unit appears to be natural and a portion of the pan is also dominated by *Fuirena* species. The dominant species in most of the wetland unit is grass species and no trees are present apart from *Prosopis* species and *Tamarix* species on the outer edges of some of the wetland units. The encroachment of *Prosopis* species into the CVB and into the drainage lines are more severe.

Table 5.4: Species observed in the watercourses on site.

Species	Wetlands				Drainage line	Artificial wetland		
	Pan	CVB	UCVB	Seep		Artificial seep	Excavation bottom	Excavation sides
Ammocharis coranica				x				
Atriplex sp	x	x	x					x
Bulbine aethiopica						x		
Cenchrus ciliaris				x		x		
Chenopodium alba	x							
Chlorophytum sp			x	x				
Cirsium vulgare				x		x		
Conyza canadense						x		
Corchorus asplenifolius			x	x		x		
Cotula anthemoides				x				
Cynodon dactylon	x					x		
Cyperus congestus						x		
Cyperus eragrostis		x		x		x		
Cyperus sp						x		
Dipcadi viride			x			x		
Eleocharis dredgeana				x				
Epilobium hirsutum						x		
Eragrostis obtusa						x		
Eragrostis plana				x				

Species	Wetlands				Drainage line	Artificial wetland		
	Pan	CVB	UCVB	Seep		Artificial seep	Excavation bottom	Excavation sides
Eragrostis racemosa				x				
Eragrostis superba	x							
Eragrostis trichophora						x		
Felicia muricata						x		
Flaveria bidentis	x			x		x		
Fuirena pubescens	x			x		x		
Helichrysum sp						x		
Hemarthria altissima						x		
Hibiscus trionum			x	x				
Ipomoea purpurea							x	
Isolepis						x		
Jamesbrittenia sp						x		
Juncus dredgeana						x		
Juncus exertus				x		x		
Nerine sp			x		x			
Nidorella anomala	x		x	x		x		
Panicum coloratum	x	x	x	x		x		
Phragmites australis	x	x		x			x	
Plantago lanceolata				x				
Pollichia campestris	x							
Prosopis sp	x	x	x	x	x	x	x	x
Radyera urens		x						
Rumex lanceolata				x				
Salsola sp		x			x			
Salvia runcinata			x	x				
Schinus molle								x
Schoenoplectus mariculata						x		
Schoenoplectus sp						x		
Scilla				x		x		
Searcia lancea								x
Senecio sp						x		
Seriphium plumosum	x							
Setaria sphacelata				x				
Solanum panduriforme						x		
Tagetus minuta							x	
Tamarix sp	x		x					x
Taraxacum sp						x		
Typha capensis	x			x		x		
Urochloa sp				x		x		

Species	Wetlands				Drainage line	Artificial wetland		
	Pan	CVB	UCVB	Seep		Artificial seep	Excavation bottom	Excavation sides
Vachellia karroo								x
Vachellia tortillis				x	x			x
Verbena bonariense						x		
Verbena occidentalis				x		x		
Vernonia anagallis-aquatica						x		
Xanthium strumarium				x				x
Ziziphus mucronata					x			

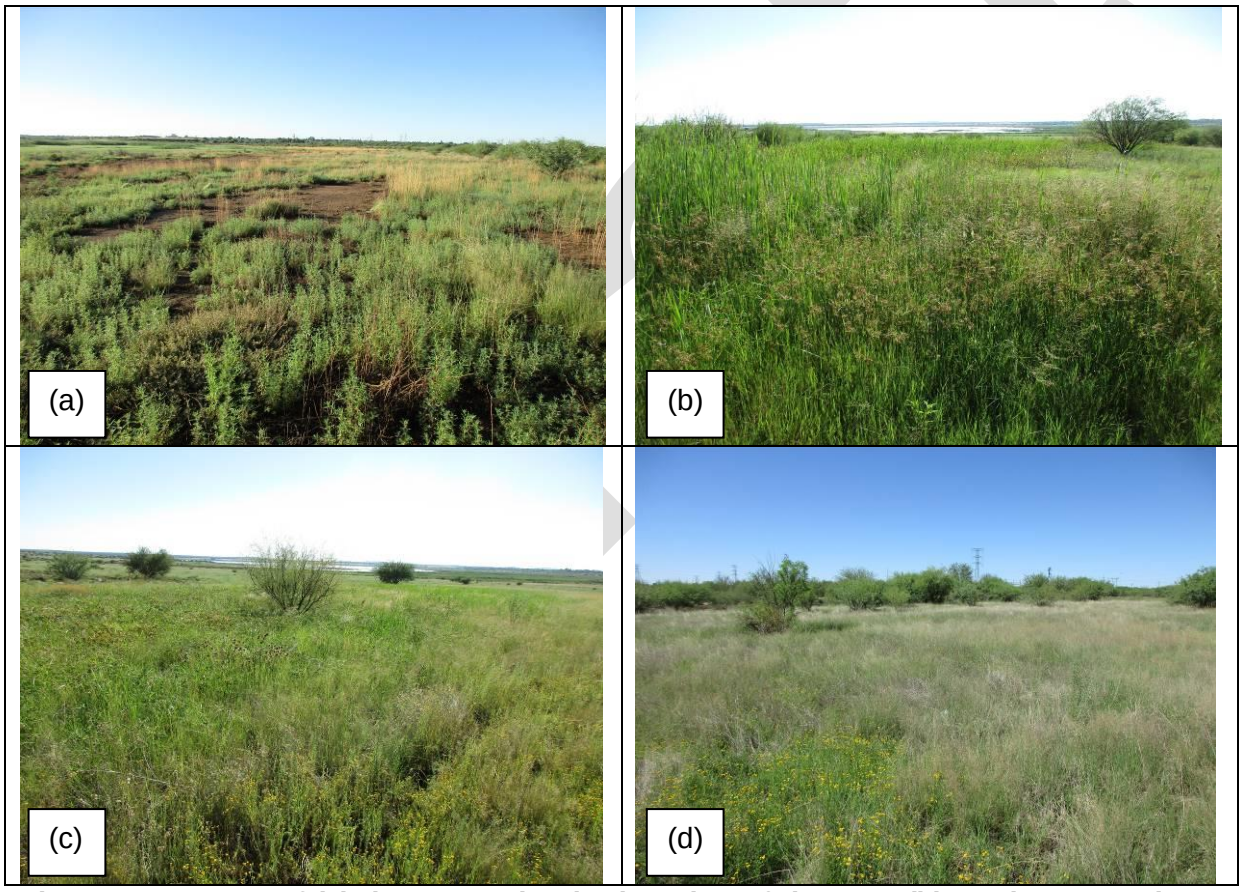

Figure 5.2: Image of (a) the vegetation in the edge of the pan, (b) *Typha capensis* on the upper edge of the artificial seepage, (c) *Typha capensis* and sedges where the seep receive additional water and (d) grass and *Nidorella anomala* dominated vegetation in the wetland.

5.2.1.2.2 Soil

The soil in the permanent wetness zone of the pan is a grey clay soil with red mottling, while the soil in the seasonal and temporary zones of the pan and in the other wetland units are a more yellow-grey clay soil with red mottling (Figure 5.3). The soil in the wetland units are typical of wetland units in the area.

The soil in the artificial seep unit is similar to the soils in the seep unit, but with fewer mottles. The soil in the excavations are very rocky, mostly due to the excavation activities and is therefore not used as an indicator of wetland conditions. Since the excavations are clearly artificial, the systems are clearly not natural, and the soil is not considered to be a useful indicator.

The drainage lines do not have wetland soil present but are still considered to be significant from a watercourse point of view.

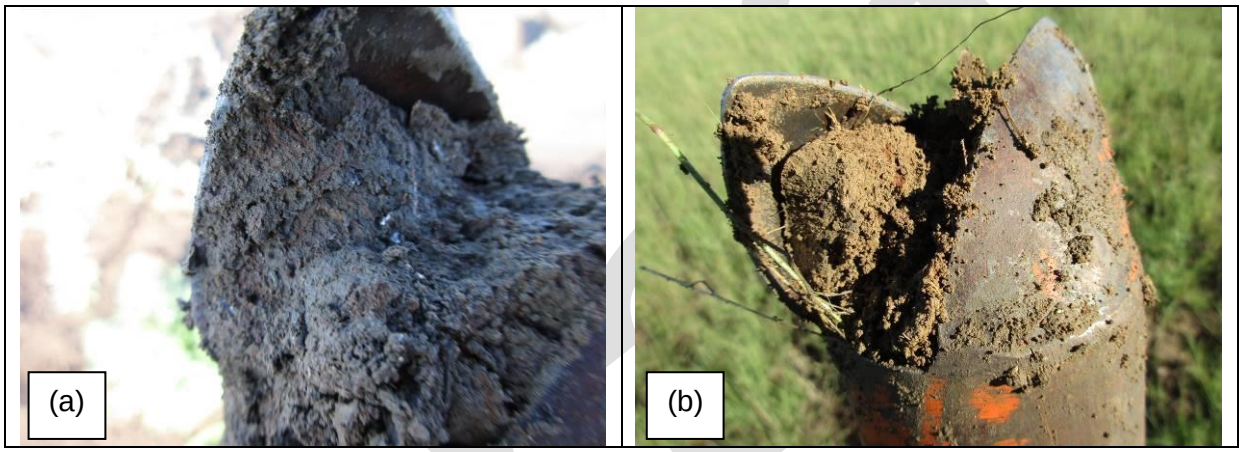

Figure 5.3: Images of (a) the grey clay with red mottles on the edge of the pan and (b) brown clay with red mottles in the seep wetland unit.

5.2.1.2.3 Topography

The natural watercourses on site are located in depressed areas on site, where wetland units are expected to be present and the pan is located on the lowest depression, also typical of wetland units in the area. The excavations with wetland vegetation is clearly manmade with steeps slopes and artificial topography. The wetland conditions in this area is therefore clearly artificial. The artificial seeps do not have any correlation with the topography, which is one of the indications that these seeps are artificial (Figure 5.4).

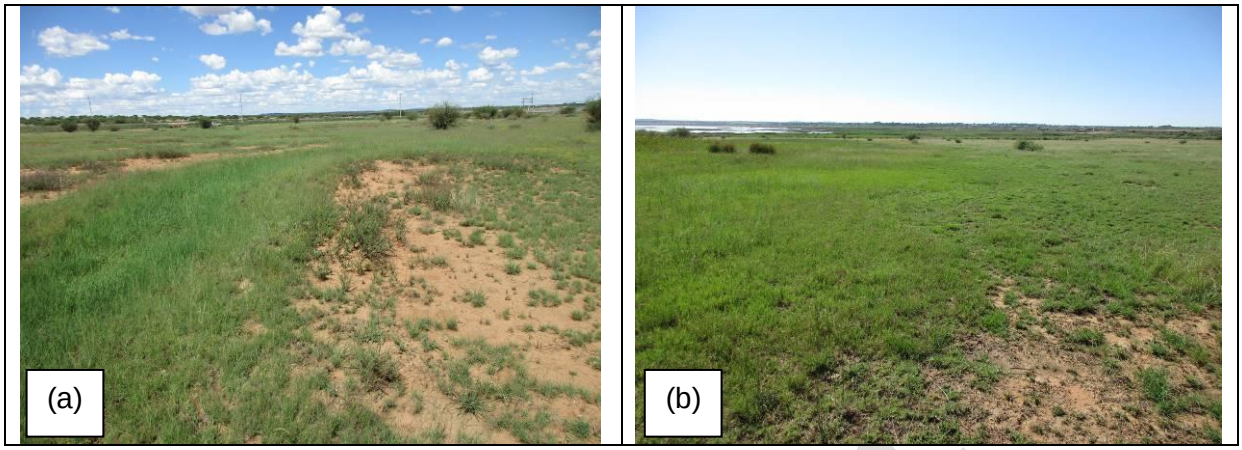

Figure 5.4: Image of the (a) typical topography of a wetland, present in the seep unit and (b) non-typical topography of the artificial seep units.

5.2.1.3 Delineation on historical aerial photographs

Due to the high level of disturbance on site historical aerial photographs of the site were investigated to determine the possible previous extent of the wetlands on site. Aerial photographs from 1968 could be obtained and the wetland areas delineated on the aerial photographs are included in Figure 5.7. This is the likely extent of the wetlands in 1968, but the extent could not be verified. Some mistakes may therefore be present. It is however clear that several wetland units extended into the western portion of the site in the past but has since been lost due to high sedimentation rates from erosion of the mine dump on the western portion of the site. The wetland units on the western portion of the site were destroyed, with a small remnant remaining to the south of the site. In addition, an artificial wet area remains next to the road where water dams up against the road and two excavations with water is present on the western portion of the site.

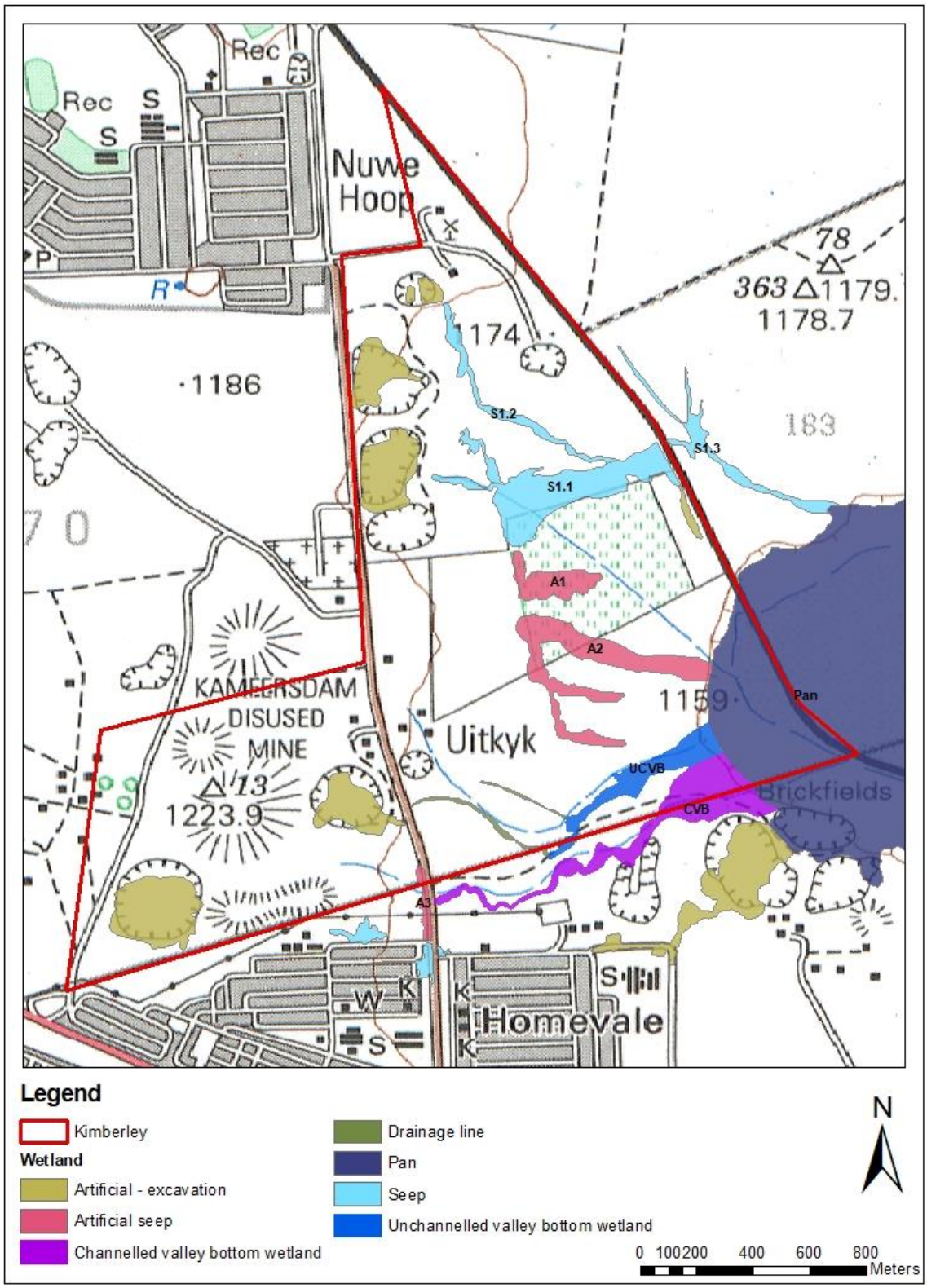

Figure 5.5: Wetland units on site as indicated on a 1:50 000 topographical map.

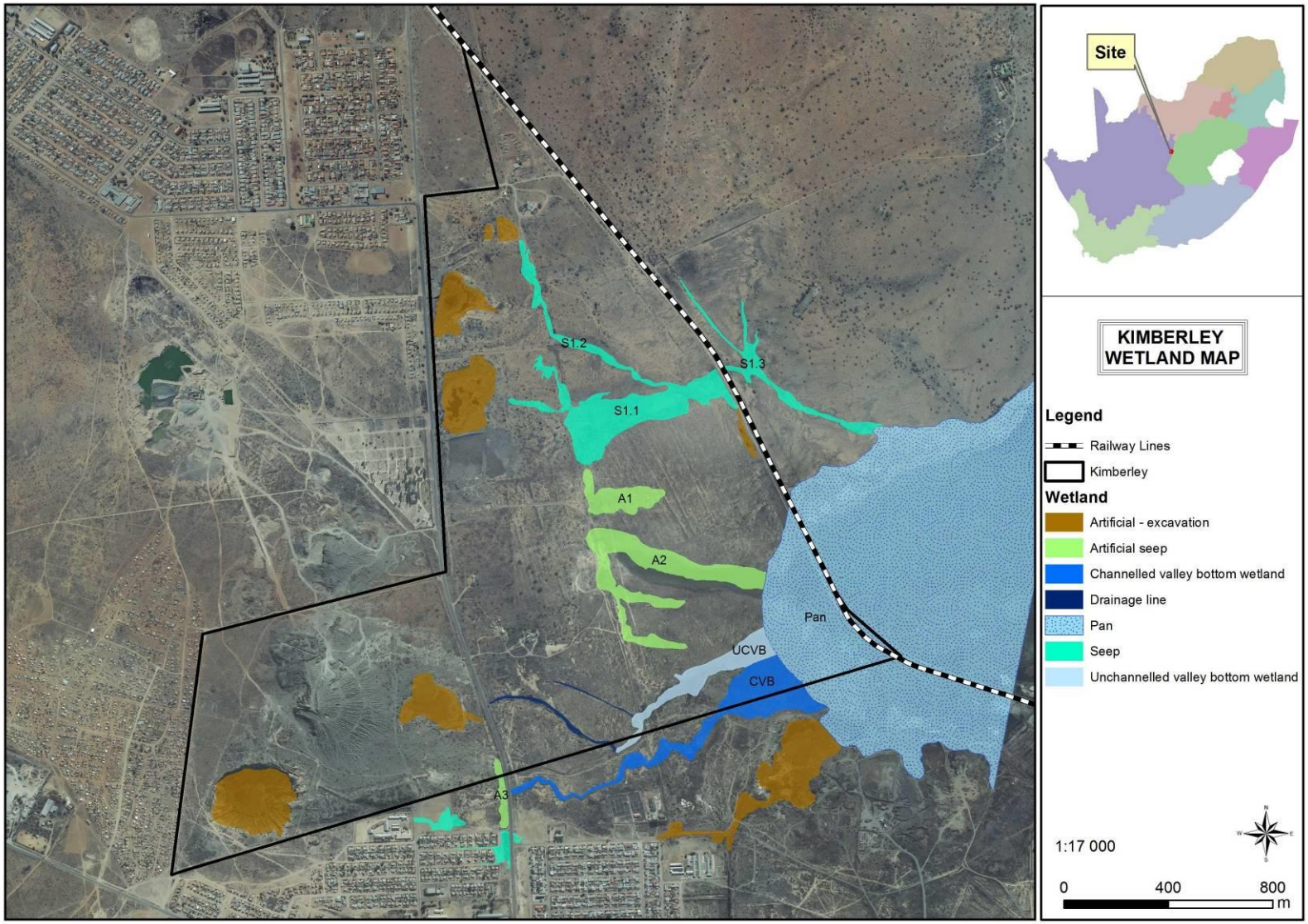

Figure 5.6: Wetland unit on site, indicated on the aerial photographs for the site.

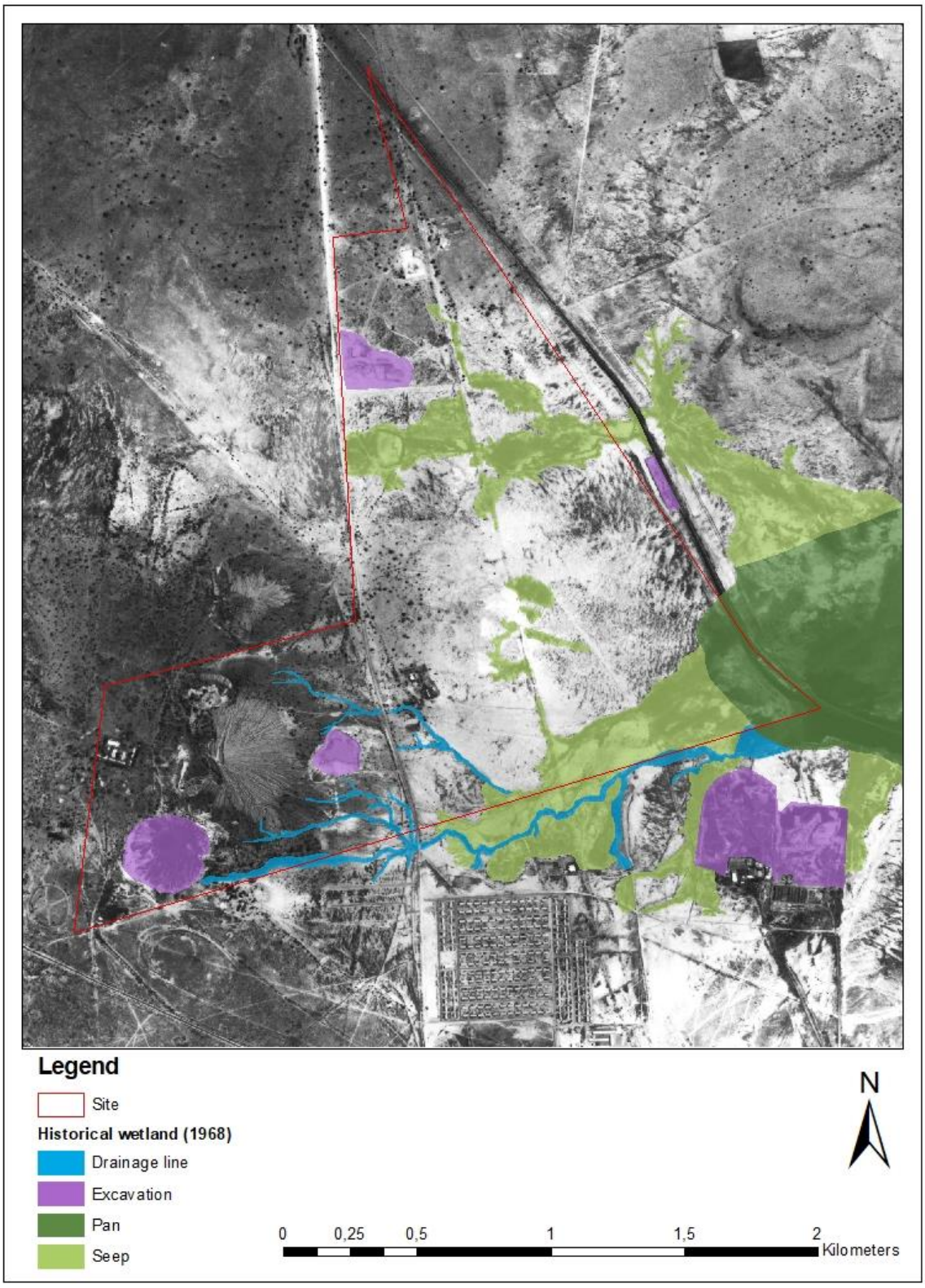

Figure 5.7: Historical wetland units delineated on an aerial photograph from 1968.

5.2.2 Present Ecological State

The Present Ecological State (PES) of the wetland units varies between Largely Natural (PES class A) and Seriously Modified (PES class D) (Table 5.5). Several impacts are present on site, including a road (Midlands Road) crossing a portion of the site in a north-south direction, as well as a railway line on the eastern boundary of the site (Figure 5.8a & b). The railway line transects the pan and the seep unit. The railway line is located on an embankment, with culvers passing under the railway line for the flow of water. The road is located on a much smaller embankment, with several culverts passing under the road, including at the CVB and at both of the excavations located in the north-western corner of the site.

A powerline and pipeline pass through the site in a north-south direction. The pipeline is leaking and contributing to the wetness of the seep wetland unit on site and is the likely cause of the artificial seep on site (Figure 5.8d, e & f). One of the excavations on the north-western corner of the site is located on the upper edge of the seep wetland and has resulted in a loss of some of the wetland area.

A large eroding mine dump is located on the south-western portion of the site (Figure 5.8c). The severe erosion of the mine dump has filled all the natural watercourse units in in the portion of the site located to the west of Midlands Road. The watercourses in this area has therefore been completely transformed.

Table 5.5: PES scores of the wetland units on site.

Wetland unit	Hydrology		Geomorphology		Vegetation		Combined	
	Score	Class	Score	Class	Score	Class	Score	Class
Pan	1.0	B	0.3	A	0.6	A	0.7	A
CVB	3.0	C	0.1	A	0.4	A	1.4	B
UCVB	7.5	E	1.2	B	2.6	C	4.2	D
Seep	3.3	C	0.2	A	1.9	B	2.0	C

The PES assessment is not applicable to the artificial wetland units on site, since the PES assessment determines the alteration from the natural condition. The PES assessment is also not applicable to the drainage line units remaining on site. The remaining drainage lines are considered to be in PES class C, moderately modified.

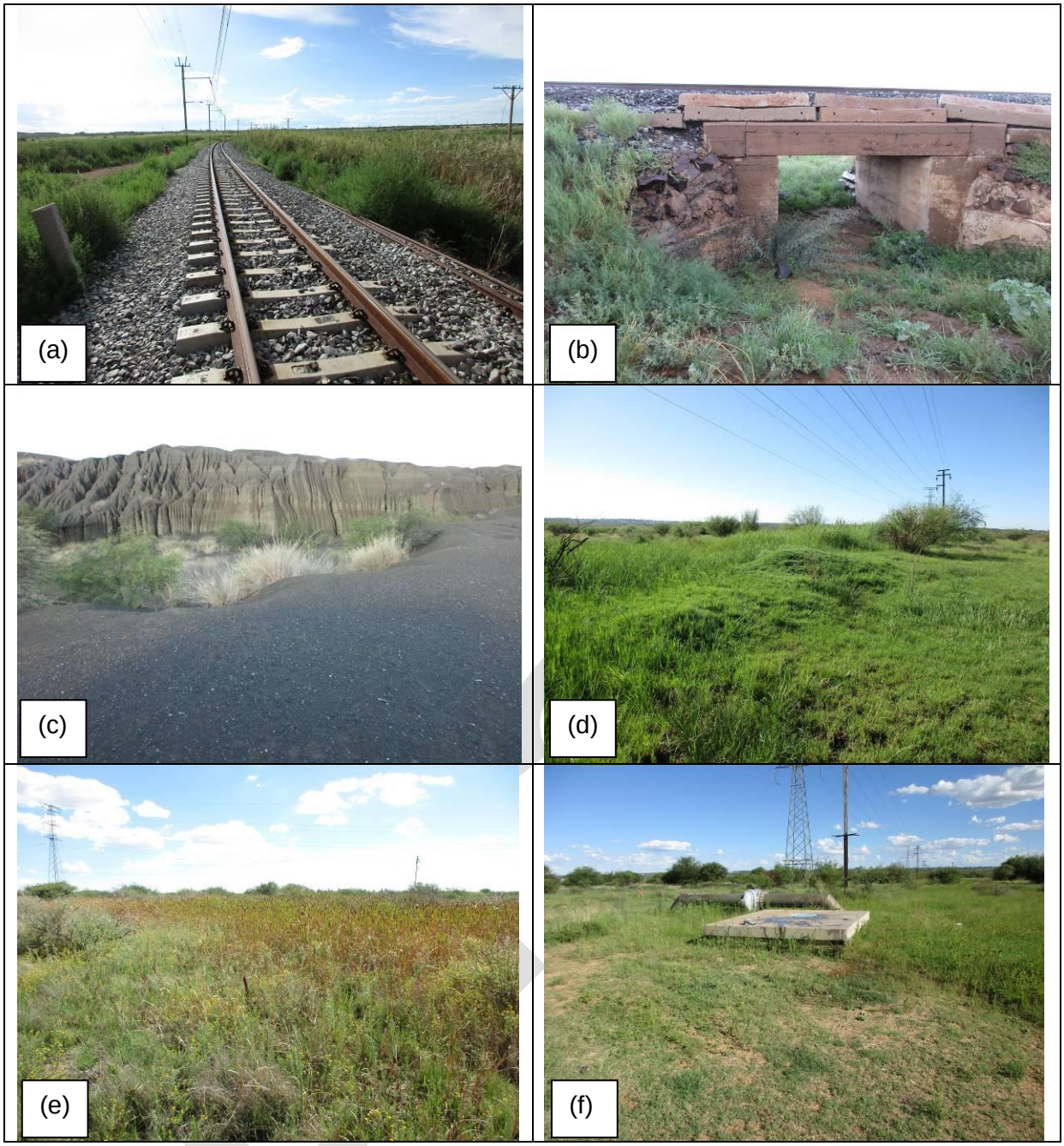

Figure 5.8: Images of (a) the railway line and (b) culverts located on the eastern border of the site, (c) the mine dump on the western portion of the site, (d, e & f) the increased wetness from the power line and pipeline passing through the site.

5.2.3 Ecological Importance and Sensitivity

The wetland unit with the highest Ecological Importance and Sensitivity (EIS) score is the pan wetland unit, followed by the UCVB wetland unit, the CVB wetland unit and with the seep wetland unit having the lowest EIS score. The pan has a very high EIS score because of the presence of both the Greater and Lesser Flamingos, Lesser Flamingo chicks and numerous bird species. The channelled and unchanneled valley bottom wetland units have a moderate EIS score, largely because of the wetland type and their sensitivity to change. The seep unit have a low EIS score. The low EIS score is largely a result of the disturbance on site and the modifications to the system.

All of the wetland units received a moderate hydro-functional importance score. The score limited for the pan and seep units due to the wetland type. The CVB and UCVB wetland units received higher scores, but the scores are limited due to the level of disturbance on site and in the catchment.

None of the wetland units are likely to have and direct human benefits. No signs of use were observed, but the pan does have potential to be used for tourism, education and research.

The EIS assessment is not applicable to the artificial wetland units on site or to the drainage line units.

Table 5.6: EIS scores of the wetland units.

Wetland unit	EIS		Hydro-functional Importance		Direct Human Benefits	
	Score	Class	Score	Class	Score	Class
Pan	3.7	Very High	1.6	Moderate	1.0	Low
CVB	1.7	Moderate	2.0	Moderate	0.3	Low
UCVB	2.0	Moderate	2.0	Moderate	0.3	Low
Seep	1.0	Low	1.3	Moderate	0.3	Low

5.2.4 Buffer zone recommendations

The buffer zone tool was used to determine the required buffer zones for all the natural wetland units on site and the required buffer zones varies between 43 and 47m, depending on the wetland unit. An overall buffer zone of 50m is therefore recommended around all the natural wetland units on site.

Two types of artificial wetland units are present on site, the artificial seeps and the excavations. No buffer zone is required around the excavations, since these units are clearly artificial. Although it appears that the artificial seep units are solely a result of the powerline and pipeline passing though the site, portions of the seep have been in place since 1968. A buffer zone of 40m is therefore recommended around these units.

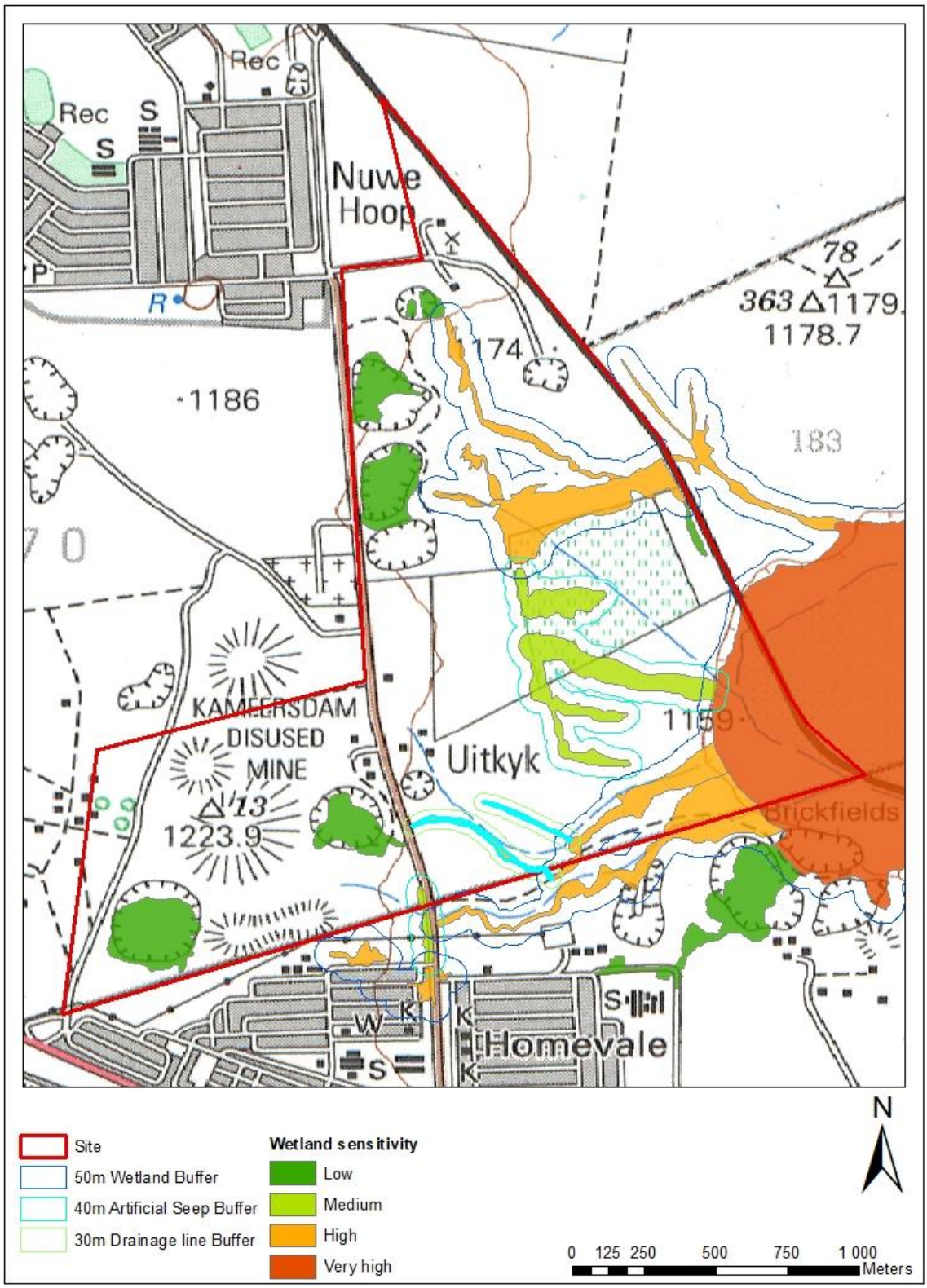

Figure 5.9: Wetland sensitivity and buffer map indicated on the 1:50 000 topographical map.

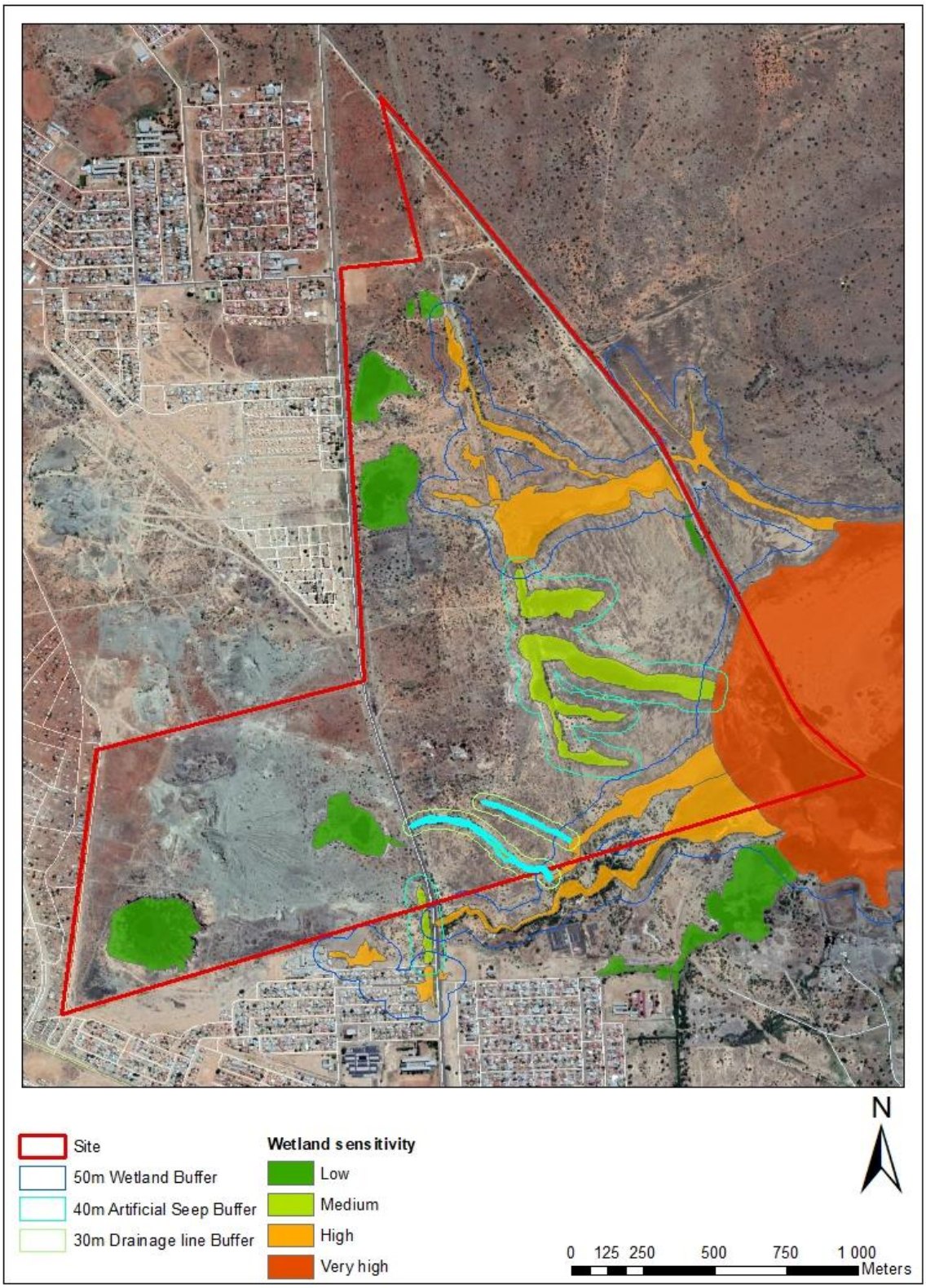

Figure 5.10: Sensitivity of the wetland units, with the buffer zones, indicated on the aerial photographs of the site.

5.3 RISK ASSESSMENT

Table 5.7: Risk assessment table for the wetland units on site.

Phase	Activity	Aspect	Impact	Severity				Severity	Spatial scale	Duration	Consequence	Frequency of activity	Frequency of impact	Legal Issues	Detection	Likelihood	Significance	Risk Rating	Confidence level	Control Measures
				Flow Regime	Physico & Chemical	Habitat	Biota													
Construction	Site clearing	Vegetation clearing	Loss of wetland habitat and functions	2	2	1	1	1.5	1	2	4.5	3	2	5	1	11	50	L	70	Refer to the mitigation measures included in this report
		Erosion		1	2	2	1	1.5	1	2	4.5	3	1	5	2	11	50	L	75	
		Sedimentation		1	2	2	2	1.8	2	2	5.8	3	1	5	2	11	63	M	70	
		Soil compaction		2	1	2	2	1.8	1	2	4.8	2	1	5	4	12	57	M	80	
		Encroachment of invasive species		1	1	2	2	1.5	1	1	3.5	3	1	5	1	10	35	L	60	
Construction	Construction camp	Littering	Pollution of the wetland units	1	2	1	1	1.3	1	1	3.3	3	3	5	1	**12**	**39**	L	55	Refer to the mitigation measures included in this report
		Biological waste		1	2	1	2	1.5	1	1	3.5	2	1	5	2	**10**	**35**	L	60	
		Spillage of hydrocarbons		1	2	2	2	1.8	1	1	3.8	1	1	5	1	**8**	**30**	L	65	
Construction	Stormwater management	Erosion	Loss of wetland habitat and functions	2	3	2	1	2	2	2	6	3	2	5	1	**11**	**66**	M	65	Refer to the mitigation measures included in this report
		Sedimentation		1	3	2	1	1.8	2	2	5.8	3	2	5	1	**11**	**63**	M	65	
		Change in hydrology of the wetland		2	2	1	1	1.5	2	2	5.5	2	2	5	1	**10**	**55**	L	60	
		Geomorphology alteration		2	2	1	1	1.5	2	2	5.5	2	2	5	1	**10**	**55**	L	60	
		Vegetation change		2	1	2	2	1.8	1	2	4.8	2	2	5	1	**10**	**48**	L	65	

Phase	Activity	Aspect	Impact	Severity				Severity	Spatial scale	Duration	Consequence	Frequency of activity	Frequency of impact	Legal Issues	Detection	Likelihood	Significance	Risk Rating	Confidence level	Control Measures
				Flow Regime	Physico & Chemical	Habitat	Biota													
Operational	Stormwater management	Erosion	Loss of wetland habitat and functions	2	3	2	1	2	2	2	6	2	2	5	1	**10**	**60**	**M**	70	Refer to the mitigation measures included in this report
		Sedimentation		1	3	2	1	1.8	2	2	5.8	2	2	5	1	**10**	**58**	**M**	70	
		Change in hydrology of the wetland		2	2	1	3	2	2	2	6	2	2	5	1	**10**	**60**	**M**	60	
		Geomorphology alteration		2	2	1	1	1.5	2	2	5.5	2	2	5	1	**10**	**55**	**L**	60	
		Vegetation change		2	1	2	2	1.8	1	2	4.8	2	2	5	1	**10**	**48**	**L**	65	
Operational	Management of open spaces	Infestation by alien and invasive species	Loss of wetland habitat and functions	2	1	2	2	1.8	1	2	4.8	2	2	5	1	**10**	**48**	**L**	55	Refer to the mitigation measures included in this report
		Alteration in species composition		2	1	2	2	1.8	1	2	4.8	1	2	5	3	**11**	**52**	**L**	60	
		Trampling and unauthorised vehicle access		2	2	2	2	2	1	1	4	1	2	5	2	**10**	**40**	**L**	60	

5.4 IMPACT AND MITIGATION

Several impacts on the wetland were considered on site. This section only focusses on the wetland specific impacts. The impacts on the vegetation and the fauna is discussed in the relevant sections of this report. The impact assessment is completed with the assumption that the recommendations included in this report will be adhered to.

5.4.1 Clearing of Vegetation and Loss of Wetland Habitat and Status

The impact is expected to be low, with a minor loss of wetland habitat and status.

Table 5.8: Impact on wetland: Loss of Wetland Habitat and Status.

Nature: The clearing of vegetation and increase in sealed surfaces in the catchment of the wetland may result in changes in the wetland habitat and status. This is mostly a result of changes in the hydrology and vegetation composition of the wetland units. The impact on the wetland can be limited by applying the mitigation measures below, as well as the mitigation measure to control the encroachment of invasive species and erosion and sedimentation.				
	Without mitigation		**With mitigation**	
CONSTRUCTION PHASE				
Probability	Probable	3	Improbable	2
Duration	Long term (>15 years)	4	Short term (2-5 years)	2
Extent	Area	2	Site	1
Magnitude	Moderate	6	Low	4
Significance	**Low**	**36**	**Minor**	**14**
Status (positive or negative)	Negative		Negative	
OPERATIONAL PHASE				
Probability	Probable	3	Improbable	2
Duration	Long term (>15 years)	4	Short term (2-5 years)	2
Extent	Area	2	Site	1
Magnitude	Moderate	6	Low	4
Significance	**Low**	**36**	**Minor**	**14**
Status (positive or negative)	Negative			
Reversibility	Can be reversed with rehabilitation		Can be reversed with rehabilitation	
Irreplaceable loss of resources?	Unlikely		Unlikely	
Can impacts be mitigated?	Yes			
Mitigation: • *The wetland and wetland buffer zone must be clearly demarcated on site and no construction activities may take place in these areas, including the temporary storage of materials, location of the construction camp and location of temporary ablution facilities.* • *No vehicle movement or clearing of vegetation may take place in these areas.*				
Cumulative impacts: *The impacts will be additional to the existing impacts on site. The impacts will therefore take place in in addition to the existing impacts on site.*				
Residual Risks: *Few residual risks are present.*				

5.4.2 Infestation by invasive plant species

Infestation by invasive plant species may potentially be have a low impact, but the impact can be mitigated. Several invasive species are already present at the site and some individuals are present in the wetland units.

Table 5.9: Impact on wetland: Infestation by invasive plant species.

Nature: Invasive plant species tend to establish in and around disturbed areas. Very few alien and invasive plant species were observed on site during the site visit and several additional species are present in the surroundings. These species may become a problem in disturbed areas in the wetlands on site.				
	Without mitigation		**With mitigation**	
CONSTRUCTION PHASE				
Probability	Probable	3	Improbable	2
Duration	Medium term (5-15 years)	3	Short term (2-5 years)	2
Extent	Area	2	Site	1
Magnitude	Moderate	6	Low	4
Significance	**Low**	**33**	**Minor**	**14**
Status (positive or negative)	Negative		Negative	
OPERATIONAL PHASE				
Probability	Probable	3	Probable	3
Duration	Medium term (5-15 years)	3	Short term (2-5 years)	2
Extent	Area	2	Site	1
Magnitude	Moderate	6	Low	4
Significance	**Low**	**33**	**Low**	**21**
Status (positive or negative)	Negative		Negative	
Reversibility	Can be controlled.		Can be controlled.	
Irreplaceable loss of resources?	No		No	
Can impacts be mitigated?	Yes			
Mitigation: • *Compile an alien and invasive species control and monitoring plan.* • *Populations of invasive species on site must be controlled.* • *The spread of invasive and weedy species from the site must be prevented.* • *Several alien and invasive species resemble indigenous species, especially as seedlings. Care must be taken not to control indigenous species during the control of invasive species.*				
Cumulative impacts: *No cumulative impacts are expected.*				
Residual Risks: Infestation of additional portions of the site will remain a risk even with control. The site already have invasive species present and species expansion remains a risk.				

5.4.3 Stormwater Management and Erosion & Sedimentation

The potential impact from poor stormwater control, erosion and sedimentation may potentially be moderate during the construction phase and high during the operation phase. The impact can however be mitigated to low.

Table 5.10: Impact on wetland: Stormwater management, erosion and sedimentation.

Nature: Additional clearing of vegetation from the site and increased runoff from unsealed surfaces on site may result in erosion on site. This may potentially cause damage to the wetland systems on site and downstream of the site. An increased sediment load in the water on site is likely to result in excess sedimentation in the pan downstream.				
	Without mitigation		**With mitigation**	
CONSTRUCTION PHASE				
Probability	Definite	5	Probable	3
Duration	Medium term (5-15 years)	3	Short term	2
Extent	Area	2	Area	2
Magnitude	Moderate	6	Moderate	6
Significance	**Moderate**	**55**	**Low**	**30**
Status (positive or negative)	Negative		Negative	
OPERATIONAL PHASE				
Probability	Definite	5	Probable	3
Duration	Long term (>15 years)	4	Short term	2
Extent	Area	2	Area	2
Magnitude	Moderate	6	Moderate	6
Significance	**High**	**60**	**Low**	**30**
Status (positive or negative)	Negative		Negative	
Reversibility	Moderate reversibility		Moderate reversibility	
Irreplaceable loss of resources?	High irreplaceability		High irreplaceability	
Can impacts be mitigated?	Yes			
Mitigation: *Construction:* • *Ensure that no sediment-laden stormwater enter the wetlands directly.* • *Stabilise and revegetate all areas bare of vegetation as soon as possible.* • *Monitor the entire site for signs of erosion throughout the construction and operational phases of the project. This may take place as part of the regular inspections for maintenance on site.* • *All erosion features must be rehabilitated as soon as possible.* • *Implement erosion control measures where necessary.* • *Implement sediment fences around erosion prone areas.* *Operation:* • *A suitable stormwater plan must be implemented for the development on site.* • *Stormwater may not enter any of the wetland units directly, stormwater must be attenuated before entering the natural system.* • *The stormwater may be used in watering of gardens or sports fields on site.* • *Energy dissipaters are recommended where the stormwater will be discharged.* • A stormwater systems where the water infiltrates into the soil profile is recommended for this project. This will allow for the slow movement of water through the soil, rather than increased runoff.				
Cumulative impacts: *Several stormwater impacts are present in the wetlands at present, impacts from the site will therefore contribute to these impacts.*				
Residual Risks: *A residual risk will remain, event with mitigation. Monitoring of the site is therefore necessary to mitigate the residual risk.*				

5.4.4 Pollution of the Water Resources and Soil Pollution

The potential impact is of moderate significance during the construction and operational phases but can be decreased to low significance with mitigation.

Table 5.11: Impact on wetland: Pollution of the Water Resources and Soil Pollution.

Nature: The most likely source of contaminants associated with the project is the possibility of sewage entering the wetland system, the spillage of petrochemicals and littering. A well-designed and maintained sewage system will negate this risk during the operational phase. During the construction phase, no sewage system will be in place and temporary ablution facilities is therefore a requirement.				
	Without mitigation		**With mitigation**	
CONSTRUCTION PHASE				
Probability	Highly probable	4	Probable	3
Duration	Short term	2	Very short term	1
Extent	Area	2	Area	2
Magnitude	High	8	Moderate	6
Significance	**Moderate**	**48**	**Low**	**27**
Status (positive or negative)	Negative		Negative	
OPERATIONAL PHASE				
Probability	Highly probable	4	Probable	3
Duration	Long term	3	Short term	2
Extent	Area	2	Area	2
Magnitude	High	8	Moderate	6
Significance	**Moderate**	**52**	**Low**	**30**
Status (positive or negative)	Negative		Negative	
Reversibility	Reversibility requires effort and cost		Reversibility requires effort and cost	
Irreplaceable loss of resources?	High irreplaceability		High irreplaceability	
Can impacts be mitigated?	Yes			
Mitigation for littering: • *Sufficient rubbish bins must be provided on site and cleared on a regular basis.* • *Rubbish must be disposed of at a registered landfill.* • *Rubbish may not be dumped on site or allowed to spread from the rubbish bins on site.* ***Mitigation for pollution by petrochemicals:*** • *Refuelling and maintenance must preferably take place off-site.* • *Should any hydro-carbon be stored on site it must be stored in a bunded area that adhere to the regulations.* • *Refuelling may only take place at a registered fuel depot or a bunded area that complies with regulations.* • *The vehicles must be inspected for oil leaks etc. regularly and any observed leaks must be repaired as soon as possible.* • *Any spillages of hydrocarbon fuels must be cleaned up immediately.* • *All regulations etc. included in the waste act must be adhered to.* ***Mitigation for temporary ablution facilities:*** • *The wetland and wetland buffer zone must be clearly demarcated on site and no construction activities may take place in these areas, including the temporary storage of materials and location of temporary ablution facilities.* • *Sufficient temporary ablution facilities must be provided for the workers during the construction phase.* • *The portable toilets must be cleaned regularly to prevent overflow and spillages.*				
Cumulative impacts: *Pollution is already entering the pan from the waste water treatment works located to the south of the site*				

and the CVB wetland unit receives sewage from a leaking sewage line to the south of the site.
Residual Risks: *Even* with mitigation, residual risks remains since the actions of individuals cannot be controlled.

5.5 CONCLUSION

Several watercourses are present on the site and must be excluded from the development. Buffer zones are required around all of the wetland units, apart from the artificial wetland units located in excavations located in several areas of the site. The medium and high sensitivity wetland areas, with their buffer zones is recommended to be excluded from the development. If the wetlands and their buffer zones area excluded from the development and the mitigation measures are implemented, the impact from the development can be limited.

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6 MAMMALS

6.1 METHODS

6.1.1 Field Surveying Mammals

The site was visited on 16-19 February 2018. During this the observed and derived presence of vertebrates associated with the recognized habitat types of the study site, were recorded. This was done with due regard to the well recorded global distributions of Southern African mammals and herpetofauna coupled to the qualitative and quantitative nature of recognized habitats.

The 500 meter wide transect along the proposed sewer line was scanned for important vertebrate habitats. During the site visit mammals were identified by visual sightings by driving and walking in transects across the site. No trapping or mist netting was conducted, as the terms of reference did not require such intensive work. In addition, mammals were also identified by means of spoor, droppings, burrows or roosting sites. Local people were interviewed to confirm occurrences or absences of mammal species.

Three criteria were used to gauge the probability of occurrences of mammals and herpetofauna species on the study site. These include known distribution ranges, habitat preferences and the qualitative and quantitative presences of suitable habitats.

6.1.2 Desktop Survey Mammals

As many mammals are either secretive, nocturnal, hibernators, migrators and/or seasonal, distributional ranges and the presence of suitable habitats were used to deduce the presence or absence of these species based on authoritative tomes, scientific literature, field guides, atlases and data bases. This can be done with a high level of confidence irrespective of season. During the field survey phase of the project, this derived list of occurrences was audited.

The probability of occurrences of vertebrate species was based on their respective geographical distributional ranges and the suitability of on-site habitats.

High probability would be applicable to a species with a distributional range overlying the study site as well as the presence of prime habitat occurring on the study site. Another consideration for inclusion in this category is the inclination of a species to be common, i.e. normally occurring at high population densities.

Medium probability pertains to a mammal species with its distributional range peripherally overlapping the study site, or required habitat on the site being sub-optimal. The size of the site as it relates to its likelihood to sustain a viable breeding population, as well as its geographical isolation is also taken into consideration. Species categorized as medium normally do not occur at high population numbers, but cannot be deemed as rare.

A low probability of occurrence will mean that the species' distributional range is peripheral to the study site and habitat is sub-optimal. Furthermore, some mammals categorized as low are generally deemed to be rare.

Based on the impressions gathered during the site visit, as well as publications, such as The Complete Book of Southern African Mammals (Mills & Hes, 1997), The Mammals of the Southern African Subregion (Skinner & Chimimba, 2005), Smithers' Mammals of Southern Africa; A Field Guide (2012) and Stuarts' Field Guide to Mammals of Southern Africa (Stuart & Stuart, 2015), a list of species which may occur on the site was compiled. The latest taxonomic nomenclature was used. The vegetation type was defined according to the standard handbook by Mucina and Rutherford (eds) (2006).

6.1.3 Specific Requirements: Mammals

During the visit the site was surveyed and assessed for the potential occurrence of Red Data species in the Northern Cape Province such as:

Grey rhebok (*Pelea capreolus*);
Cheetah (*Acinonyx jubatus*);
Black-footed cat (*Felis nigripes*);
Leopard (*Panthera pardus*);
Spotted hyaena (*Crocuta crocuta*);
Brown hyena (*Parahyaena brunnea*);
Cape clawless otter (*Aonyx capensis*);
Spotted-necked otter (*Hydrictis maculicollis*);
African striped weasel (*Poecilogale albinucha*);
Dent's horseshoe bat (*Rhinolophus denti);*
Angolan hairy bat *(Cistugo seabrai);*
Southern African hedgehog *(Atelerix frontalis);*
Riverine rabbit *(Bunolagus monticularis);*
Black Rhinoceros *(Diceros bicornis);*
White Rhinoceros (*Ceratotherium simum*);
Temminck's Ground Pangolin (*Smutsia temminckii*);
Spectacled dormouse (*Graphiurus platyops*) and
Littledale's whistling rat (Parotomys littledalei)

6.1.4 Conservation status of habitats

The conservation status of habitats within the study site can be assigned to one of five levels of sensitivity, i.e.

High: Ecologically sensitive and valuable land, with high species richness, sensitive ecosystems or Red Data species, that should be conserved and no development allowed.

Medium-high: Land where sections are disturbed but that is still ecologically sensitive to development/disturbance.

Medium: Land on which low-impact development with limited impact on the ecosystem could be considered, but where it is still recommended that certain portions of the natural habitat be maintained as open spaces.

Medium-low: Land on which small sections could be considered for conservation but where the area in general has little conservation value.

Low: Land that has little conservation value and that could be considered for developed with little to no impact on the habitats or avifauna.

Limitations
The disturbed nature of the site.

6.2 RESULTS

Rautenbach (1978 & 1982) found that mammal assemblages can at best be correlated with botanically defined biomes, such as those by Low and Rebelo (1996 & 1998), and latterly by Mucina and Rutherford (2006), as well Knobel and Bredenkamp (2006). Hence, although the former's work has been superseded by the work of the latter two, the definitions of biomes are similar and both remain valid for mammals and are therefore recognised as a reasonable determinant of mammal distribution. The vegetation types of the site were analysed according to Mucina and Rutherford (2006).

6.2.1 Mammal Habitat Assessment

The current land-use on the site is limited grazing by communal livestock from surrounding townships, though the site is basically located within Kimberley Town and this area has been utilised for diamond mining for about 150 years. Remains of mining activities are evident on the site. Signs of old agricultural fields are also present, now covered by secondary vegetation. From a mammal habitat perspective most of the study site consists of transformed terrestrial habitat. The natural habitat of the site had been used for grazing of livestock and also for cultivation of crops. Later other anthropogenic influences such as a railway line, tar and gravel roads, power lines, rubble dumping, invasive plants, winter veld fires, extensive mining exploration and other diggings (Figure 6.1), ruins, buildings, and old mining activities (Figure 6.2) had an impact on the natural vegetation and therefore mammal habitats of the site. During the site visit two snares for mammals were found as well as adults and children with catapults to shoot small mammals and birds. The study site is thus ecologically disturbed in many parts. Moribund termitaria were recorded on some parts of the study site. These structures are generally good indicators of the occurrence of small mammals. At the time of the site visit the vegetation cover was locally poor but generally fair to good and would provide adequate nourishment and cover for small terrestrial mammals.

Figure 6.1: A large hole on the south-western corner of the study site.

Figure 6.2: Old mining activities on the western part of the study site.

The terrestrial habitat is by far the most extensive. The substrate consists mostly of a red sandy soil which provides good habitat for burrowing mammals such as aardvark, a number of gerbil species, ground squirrels, suricates, aardwolves and others. The bases of low scrub offer excellent refuge for a number of small mammals such as the hare species.

The arboreal habitat is dense at some places, but generally lower than two metres (Figure 6.3). Mature trees higher than four or five metres are sparsely spaced. The scrub portion of this habitat type may be suitable for other vertebrate groups, but suboptimal for mammals.

Figure 6.3: Mesquite and Umbrella thorn trees on the study site. Note the horse also on the study site.

There are important wetland features on the study site. At the southern boundary of the study site, a stream flows (Figure 6.4) into the nearby Kamfers Dam, with its breeding population of lesser flamingos (Figure 6.5). Part of the Kamfers Dam on a neighbouring property falls in the 500 metres buffer area around the study site. Several wetland areas occur north of the stream on the southern half of the study site. A few manmade burrow pits/quarries occur on the study site. One very large, fenced-off, quarry occurs on the south-western part of the study site, however these water bodies are regarded as either non-functional or too isolated to serve as habitat for some moisture-reliant mammals, like the Cape clawless otter, spotted neck otter and marsh mongoose.

Figure 6.4: Part of the wetlands on the south-eastern section of the study site.

Figure 6.5: Flamingos in the Kamfers Dam.

No natural rupicolous habitats occur within the study site, but manmade rupicolous habitat exists in the form of ruins, building rubble and buildings. Natural rupicolous habitat (Figure 6.6) occurs on the neighbouring property, east of the site. Due to the presence of this natural rupicolous habitat, some species like eastern rock elephant shrew, rock hyrax (dassies), Smith's red rock rabbit and Namaqua rock mouse were added to the species list in Table 6.1.

Figure 6.6: Natural rupicolous habitat on a neighbouring property.

The site has no natural caves suitable for cave-dwelling bats, although some of the buildings and large quarries may act as substitute daytime roosts. It is likely that common bats commute from roosting sites elsewhere to hawk for insects over the wetlands of the study site.

6.2.2 Observed and Expected Mammal Species Richness

All charismatic mammals (like elephants, buffaloes, black and white rhinos, lions, leopards, cheetahs, spotted hyenas, eland, gemsbok and black wildebeest) have long since been extirpated for sport and later to favour livestock farming. Some mammal species like otters which are reliant on a wetland habitat have *a priori* been omitted from the list of potential occurrences in the district (Table 6.1).

Of 57 mammal species expected to occur on the study site (Table 6.1), eight were confirmed during the site visit (Table 6.2). It should be noted that potential occurrences are interpreted as being possible over a period of time as a result of environmentally induced expansions and contractions of population densities and ranges which stimulate migration. The species assemblage is typical that of a western arid region with three of the four major habitat types.

All feral mammal species expected to occur on the study site (e.g. house mice, house rats, cattle, horses, dogs and cats) were omitted from Table 6.1 since these species are normally associated with human settlements.

The conservation status of aardvark has recently been elevated to "Least Concern". This species is in fact fairly widespread and common, *albeit* with a solitary and nocturnal lifestyle. Aardvarks open termitaria with the claws on their well-developed hind feet and feed on the inhabitants by inserting their sticky tongues into tunnels used by termites. The openings are characteristic in size and form, and damage is often repaired by the termites. Several characteristic openings were recorded. It can be assumed that vagrants of this species may venture onto the site

The presence of persistent species such as porcupines, rodent moles and springhares was not confirmed, but considering the extent of the district and the connectivity towards the north-east, it can be assumed that they are at least occasional vagrants wandering onto the site. Most of the species of the resident diversity (Table 6.1) are common and widespread (viz. scrub hares, Cape hares, multimammate mice, gerbil species, small-spotted genets, South African ground squirrel, Suricate and yellow mongoose species). Many of the species listed in Table 6.1 are robust (some with strong pioneering capabilities). The reason for their survival success is predominantly seated in their remarkable reproduction potential (viz. multimammate mice species, capable of producing ca. 12 pups per litter at intervals of three weeks), and to a lesser extent their reticent and cryptic nature (scrub hares, genets and mongooses).

Chacma baboons and vervet monkeys would be inclined to forage from the relatively nearby Vaal River. In this case the inland environment is sufficiently diverse to allow forays into scrublands.

It is highly probable that duiker and steenbok still occur at least occasionally on the site since immigration from neighbouring properties is still a possibility.

Brown hyenas roam over great distances and it is very likely that individuals occasionally venture onto the site in search of sustenance. Caracal, black-backed jackals and other small carnivores like Cape foxes, a few mongoose species, African wild cat, striped polecat and small-spotted genet) are exceptionally reticent in habits, apart from having wide habitat tolerances and diets. As a result they can even persist in areas in close association with of human occupation as long as prey densities remain on sustainable levels. Although the wetlands offer some habitat it is too shallow, too polluted or too isolated for most water-dependent mammals.

The listed free-tailed bats and the Vespertilionidae bats have shown remarkable adaptability by expanding their distributional ranges and population numbers significantly by capitalising

on the roosting opportunities offered by manmade structures; in this instance in the houses in the vicinity. Vesper bats are more tolerant towards roost opportunities and it is more than likely that small colonies have found roosting opportunities in the roofs of buildings near the study site. Free-tailed bats are likewise partial to narrow-entrance roosts provided by buildings; in some instances, roost occupation could reach epidemic proportions. The study site offers no caves or suitable structures answering to the exacting roosting requirements of cave-dwelling bats (Hipposideridae, Rhinolophidae, Nycteridae), but it is likely that they have roosts elsewhere and at times commute to the site to hawk for invertebrates rising over the wetlands during summer sunsets.

The species richness is deemed poor to fair for such an area due to its disturbed nature and the encroaching urbanisation.

Table 6.1: Mammal diversity. The species observed or deduced to occupy the site. (Systematics and taxonomy as proposed by Bronner et.al [2003], Skinner and Chimimba [2005], Apps [2012] & Stuart and Stuart [2015]).

	SCIENTIFIC NAME	**ENGLISH NAME**
	CLASS: MAMMALIA	**MAMMALS**
	Order: MACROSCELIDEA	
	Family: Macroscelididae	**Elephant-shrews**
?	*Elephantulus rupestris*	Eastern rock elephant shrew (sengi)
	Order:TUBULIDENTATA	
	Family: Orycteropodidae	**Aardvark**
√	*Orycteropus afer*	Aardvark
	Order:HYRACOIDEA	
	Family: Procaviidae	**Hyraxes**
?	*Procavia capensis*	Rock hyrax (dassies)
	Order: LAGOMORPHA	
	Family: Leporidae	**Hares, rabbits and Rock rabbits**
√	*Lepus capensis*	Cape hare
√	*Lepus saxatilis*	Scrub hare
?	*Pronolagus rupestris*	Smith's red rock rabbit
	Order: RODENTIA	**RODENTS**
	Family:Bathyergidae	Molerats
√	*Cryptomys hottentotus*	African mole rat
	Family: Hystricidae	**Porcupines**
*****	*Hystrix africaeaustralis*	Cape porcupine
	Family: Pedetidae	
?	*Pedetes capensis*	Springhare
	Family: Sciuridae	**Squirrels**
√	*Xerus inaurus*	South African ground squirrel
	Family: Muridae	**Rats and Mice**
√	*Rhabdomys (complex) pumilio*	Four-striped grass mouse
*****	*Mus minutoides*	Pygmy mouse
*****	*Mastomys coucha*	Southern multimammate mouse
*****	*Aethomys namaquensis*	Namaqua rock mouse
*****	*Desmodillus auricularis*	Cape short-tailed gerbil
*****	*Gerbillurus paeba*	Hairy-footed gerbil
*****	*Gerbilliscus leucogaster*	Bushveld gerbil

	SCIENTIFIC NAME	ENGLISH NAME
*	*Gerbilliscus brantsii*	Highveld gerbil
?	*Saccostomus campestris*	Pouched mouse
*	*Malacothrix typica*	Gerbil mouse/large-eared mouse
	Order: PRIMATES	
	Family: Cercopithecidae	**Baboons and Monkeys**
?	*Papio hamadryas*	Chacma baboon
?	*Cercopithecus pygerythrus*	Vervet monkey
	Order: EULIPOTYPHLA	
	Family: Soricidae	Shrews
?	*Suncus varilla*	Lesser dwarf shrew
?	*Crocidura fuscomurina*	Tiny musk shrew
*	*Crocidura cyanea*	Reddish-grey musk shrew
?	*Crocidura hirta*	Lesser red musk shrew
	Family: Erinaceidae	Hedgehog
NT?	*Atelerix frontalis*	Southern African hedgehog
	Order: CHIROPTERA	**BATS**
	Family: Pteropodidae	
?	*Eidolon helvum*	Straw-coloured fruit bat
	Family: Molossidae	**Free-tailed bats**
√	*Tadarida aegyptiaca*	Egyptian free-tailed bat
	Family: Vesprtilionidae	**Vesper bats**
√	*Neoromicia capensis*	Cape serotine bat
	Family: Nycteridae	**Slit-faced bats**
*	*Nycteris thebaica*	Egyptian slit-faced bat
	Family: Rhinolophidae	**Horseshoe bats**
?	*Rhinolophus clivosus*	Geoffroy's horseshoe bat
?	*Rhinolophus darlingi*	Darling's horseshoe bat
NT?	*Rhinolophus denti*	Dent's horseshoe bat
	Family: Hipposideridae	**Trident bats and leaf-nosed bats**
?	*Hipposideros caffer*	Sundevall's roundleaf bat
	Order: PHOLIDOTA	**PANGOLINS**
	Family: Manidae	
V?	*Manis temminckii*	Ground pangolin
	Order: CARNIVORA	
	Family: Hyaenidae	**Hyaenas**
*	*Proteles cristatus*	Aardwolf
NT?	*Parahyaena brunnea*	Brown hyena
	Family: Felidae	**Cats**
?	*Caracal caracal*	Caracal
*	*Felis silvestris*	African wild cat
Vu*	*Felis nigripes*	Black-footed cat
	Family: Viverridae	**Civets and genets**
*	*Genetta genetta*	Small-spotted genet
	Family: Herpestidae	**Suricates and mongooses**
√	*Suricata suricatta*	Suricate or Meerkat
√	*Cynictis penicillata*	Yellow mongoose
*	*Galerella pulverulenta*	Cape grey mongoose
*	*Galerella sanguinea*	Slender mongoose
	Family: Canidae	**Foxes, wild dogs and jackals**
*	*Otocyon megalotis*	Bat-eared fox
*	*Vulpes chama*	Cape fox

	SCIENTIFIC NAME	ENGLISH NAME
*	*Canis mesomelas*	Black-backed jackal
	Family Mustelidae	**Otters, honey badger, weasel and polecat**
?	*Mellivora capensis*	Honey badger
NT?	*Poecilogale albinucha*	African striped weasel
*	*Ictonyx striatus*	Striped polecat
	Order: RUMINANTIA	
	Family: Bovidae	**Antelopes and buffalo**
?	*Tragelaphus strepsiceros*	Kudu
√	*Alcelaphus buselaphus*	Red hartebeest
√	*Sylvicapra grimmia*	Common duiker
√	*Antidorcas marsupialis*	Springbok.
√	*Raphicerus campestris*	Steenbok

√ Definitely there or have a *high* probability to occur;
***** *Medium* probability to occur based on ecological and distributional parameters;
? *Low* probability to occur based on ecological and distributional parameters.

Red Data species rankings as defined in Friedmann and Daly's S.A. Red Data Book / IUCN (World Conservation Union) (2004) are indicated in the first column: CR= Critically Endangered, En = Endangered, Vu = Vulnerable, LR/cd = Lower risk conservation dependent, LR/nt = Lower Risk near threatened, DD = Data Deficient. All other species are deemed of Least Concern.

Table 6.2: Mammal species positively confirmed from the study site, observed indicators and habitat.

SCIENTIFIC NAME	ENGLISH NAME	OBSERVATION INDICATOR	HABITAT
Orycteropus afer	Aardvark	Damage to termitaria	Terrestrial/Sand-veld
Lepus saxatilis	Scrub hare	Sight records & faecal pellets	Terrestrial /Short grass areas near scrub
Xerus inaurus	South African ground squirrel	Sight records	Terrestrial /Sandy areas
Suricata suricatta	Suricate/meerkat	Sight records	Terrestrial /Sand-veld
Cynictis penicillata	Yellow mongoose	Sight records	Terrestrial /Sand-veld
Alcelaphus buselaphus	Red hartebeest	Sight records	Terrestrial /Grassland
Sylvicapra grimmia	Common duiker	Spoor	Terrestrial /Grassland
Antidorcas marsupialis	Springbok	Sight records	Terrestrial /Mixed veld

The conservation status of aardvark has been changed to "Least Concern" from "Vulnerable" (Smithers, 1986). This species is in fact fairly widespread and common, *albeit* with a solitary and nocturnal lifestyle (Figure 6.7)

Scrub hare, South African ground squirrel, suricate, yellow mongoose and common duiker are common and wide spread in Southern Africa.

The red hartebeest (Figure 6.8) and springbok have probably been re-introduced on the neighbouring property, but both species are common and widespread on game farms and nature reserves throughout southern Africa.

Figure 6.7: Aardvark damage to a termitarium on the study site.

Figure 6.8: A few red hartebeest running along the Kamfers Dam.

6.2.3 Red Listed Mammal Species Identified:

The study site area falls outside the natural range of the Angolan hairy bat, riverine rabbit spectacled dormouse and Littledale's whistling rat, and these species should not occur on the study site.

There is no suitable habitat on the study site for the grey rhebok, Cape clawless otter and spotted-necked otter, and these species should not occur on the study site.

Cheetahs, leopards, spotted hyaena, black rhinoceros and white rhinoceros were eliminated from the study site, by hunters and farmers, more than hundred and fifty years ago.

The Southern African hedgehog (ranked as 'Near Threatened') occurs in a wide variety of habitat types, but must have vegetation. The possibility exists that some individuals occur on the study site.

There is very small chance that some individuals of the African striped weasel (ranked as 'Near Threatened'), Temminck's ground pangolin (ranked as 'Vulnerable') and black-footed cat (ranked as 'Vulnerable') may occur on the site.

Some brown hyena males (ranked as 'Near Threatened') become nomadic and can move over large distances. The possibility exists that some individuals may venture onto the study site from time to time.

Due to their ability to fly and cover large distances, the distribution information of some bat species is insufficient. This has resulted in Red Data status for some bats species as a precautionary measure. There is a small possibility that Dent's horseshoe bat (ranked as 'Near Threatened') may fly over the study site from time to time.

No other Red Data or sensitive species are deemed present on the site, either since the site is too disturbed, falls outside the distributional ranges of some species, or does not offer suitable habitat(s).

6.2.4 -By the Regulations of the Provincial Authority

The Northern Cape Nature Conservation Act, 2009 (Act No. 9 of 2009) Schedule 1: *Specially Protected Species* lists the following species that are considered present or at least vagrants to the study site: Black-footed cat, African wild cat, honey badger, striped polecat, bat-eared fox, Cape fox, brown hyena, aardwolf and hedgehog. Schedule 2: *Protected Species* lists all the other occupants of the site (Table 6.1). Schedule 4 recognises the black-backed jackal as a Damage Causing Species.

6.3 IMPACTS ON MAMMALS

The conservation rating of the site for mammals is considered to be **Low**. As the proposed project involves development of a residential area, the mammal impacts will largely be restricted to the construction phase, and mammals will be largely eliminated when people occupy their new homes. The two broad categories of impacts will be habitat loss and disturbance related to construction activities. Since the construction activities will take place over most of the site, the spatial extent of the impacts will be significant.

The impact of the envisaged development is tabulated below

Table 6.2: Direct impact on mammal communities and loss of mammal habitat.

Nature: The current habitat is mostly disturbed terrestrial habitat. The wetlands on the site are important mammal habitat and are sensitive and must be protected. The footprint for the proposed residential development will result in clearing most of the vegetation area. This will result in some loss of mammal habitat. After clearing the vegetation, construction will commence. .				
	Without mitigation		**With mitigation**	
CONSTRUCTION PHASE				
Probability	Definite	5	Definite	5
Duration	Short term 2-5years	2	Short term 2-5 years	2
Extent	Limited to Site	1	Limited to Site	1
Magnitude	Minor	1	Small	0
Significance	**Low**	**20**	**Minor**	**15**
Status (positive or negative)	Negative		Negative	
OPERATIONAL PHASE				
Probability	Definite	5	Definite	5
Duration	Permanent	5	Permanent	5

Extent	Site	1	Site	1
Magnitude	Moderate	5	Moderate	4
Significance	**Moderate**	**55**	**Moderate**	**50**
Status (positive or negative)	**Negative**		**Negative**	
Reversibility	No		No.	
Irreplaceable loss of resources?	Yes – but natural mammal habitats are already too disturbed for biodiversity or conservation.		Yes – but natural mammal habitats are already too disturbed for biodiversity or conservation.	
Can impacts be mitigated?	Yes, planting indigenous species in the gardens will improve habitats for mammals			
Mitigation: • . Plant indigenous plant species in the gardens of the new development – no alien species				
Cumulative impacts: Limited, the area is already disturbed and used as agricultural holding.				
Residual Risks**:** No.				

6.3.1 Mitigation measures

The following mitigation measures are proposed by the specialist.

- If any South African hedgehog or other mammal species are encountered or exposed during the construction phase, they should be removed and relocated to natural areas in the vicinity. The contractor must ensure that no indigenous mammal species are disturbed, trapped, hunted or killed during the construction phase. Any mammals that are inadvertently killed during earthmoving operations should be preserved as museum voucher specimens. Conservation-orientated clauses should be built into contracts for construction personnel, complete with penalty clauses for non-compliance.
- During the construction phase there will be increased surface runoff and a decreased water quality (with increased silt load and pollution). Completing construction during the winter months would mitigate the environmental impact.
- The appropriate agency should implement an ongoing monitoring and eradication program for all invasive plant species growing on the site.
- Any post-development re-vegetation or landscaping exercise should use species indigenous to South Africa. Plant species locally indigenous to the area are preferred. As far as possible, indigenous plants naturally growing along the route and that would otherwise be destroyed during construction, should be used for re-vegetation / landscaping purposes.

6.4 DISCUSSION AND CONCLUSION

Species richness: It must be emphasised that the species richness inferred (Table 8.1) is for the general area and NOT for the study site itself. The species richness for the general area is fair.

Endangered species: There is a small possibility that six Red Data mammals might occur on the site. The species are the Southern African hedgehog, the African striped weasel, Temminck's ground pangolin, black-footed cat, brown hyena and the Dent's horseshoe bat. Red Data species occurring on the site will be displaced by the development. In relative terms, however this will not worsen the conservation ranking of any species flagged herein.

Sensitive species and/or areas (Conservation ranking): From a mammal point of view there should not be any specially protected mammal species on the study site. However, the nearby Kamfers Dam, with its breeding population of lesser flamingos, is of national and international importance. The wetlands on the site are also sensitive and must be protected. The vegetation type (Kimberley Thornveld, SVk 4) is classified as Least threatened.

Habitat(s) quality and extent: The terrestrial, wetland and arboreal habitat quality is fair, but it is jeopardised by anthropogenic influences such as a railway line, tar and gravel roads, power lines, dumping, invasive plants, winter veld fires, extensive diggings, ruins, buildings, grazing by horse and cattle and old mining activities. During the site visit two snares for mammals were found as well as adults and children with catapults to shoot small mammals and birds.

Impact on species richness and conservation: The development of the study site will have a significant and probably lasting effect on species richness and conservation, because of the construction of new houses and new roads carrying more vehicles. These buildings and roads will form an even larger barrier for mammal movement and it will result in a decrease in connectivity. This development will have a large and permanent footprint. However the biggest problem is pollution of the drainage lines which will negatively affect the water quality of all wetlands, including the Kamfers Dam adjacent to the study site

Connectivity: Poor to fair. Except for the stream and a drainage line underneath the railway line, the connectivity is poor. This is due to the active railway line east of the site and the busy Midlands Road, which bisects the southern area of the study site and forms the western border of the northern part study site. Townships and a graveyard occur on the western border of the site. Another township and the Homevale waste water treatment works occur on the southern border of the study site. Real opportunities for migration exist east of the railway line from a fairly pristine property.

Management recommendation: Measures will have to be taken to stop water pollution of the nearby Kamfers Dam. The removal of invasive plants will increase the quality of habitat for mammals.

General: From a mammal point of view, no objections can be raised against the proposed development.

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7 AVIFAUNA

7.1 METHODS

The information provided in this report was principally sourced from:

- relevant literature (see section below)
- a baseline survey of the area (16 - 19 February 2018)
- personal observations from similar habitat types in close proximity to the study area, with emphasis on assessments conducted by Pachnoda Consulting (2012).

7.1.1 Literature survey and Data acquisition

A desktop and literature review of the area under investigation was commissioned to collate as much information as possible prior to the baseline survey. The literature consulted makes primarily use of small-scale datasets that were collected by citizen scientists and are located/administered at various governmental and academic institutions (e.g. Animal Demography Unit & SANBI). These include (although not limited to) the following:

- Hockey *et al*. (2005), Harrison *et al.* (1997) and Del Hoyo *et al.* (1992-2011) were consulted for general information on the life history attributes of the relevant bird species. They also provide basic distributional information at small geographic scales;
- Marnewick *et al*. (2015) was consulted for information regarding the biogeographic affinities (*sensu* Important Bird and Biodiversity Areas) of selected bird species that could be present on the study area;
- Co-ordinated waterbird count data for Kamfers Dam was obtained as per the protocol followed by Tayor *et al*. (1999) for the census period of 1995 – 2012;
- The conservation status of bird species was categorised according to the global IUCN Red List of threatened species (IUCN, 2017, v. 3) and a recent regional conservation assessment of Taylor *et al*. (2015);
- Distributional data was sourced from the South African Bird Atlas Project (SABAP1) and verified against Harrison et al. (1997) for species corresponding to the quarter-degree grid cells (QDGC) 2824DA (Barkley West). The information was then modified according to the prevalent habitat types present on the study area. The SABAP1 data provides a “snapshot” of the abundance and composition of species recorded within a quarter degree grid cell (QDGC) which was the sampling unit chosen (corresponding to an area of approximately 15 min lat and 15 min long). It should be noted that the atlas data makes use of reporting rates that were calculated from observer cards submitted by the public as well as citizen scientists. It therefore provides an indication of the thoroughness of which the QDGCs were surveyed between 1987 and 1991;

- Additional distributional data was also sourced from the SABAP2 database (http://www.sabap2.adu.org.za). The information was then modified according to the prevalent habitat types present on the study area. Since bird distributions are dynamic (based on landscape changes such as fragmentation and climate change), SABAP2 was born (and launched in 2007) from SABAP1 with the main difference being that all sampling is done at a finer scale known as pentad grids (5 min lat x 5 min long, equating to 9 pentads within a QDGC). Therefore, the data is more site-specific, recent and more comparable with observations made during the site visit (due to increased standardisation of data collection). The pentad grid relevant to the current project includes 2840_2440. In addition, the eight pentads adjacent to 2840_2440 were also scrutinized during the assessment.

- The choice of scientific nomenclature, taxonomy and common names were recommended by the International Ornithological Committee (the IOC World Bird Names, v.8.1), unless otherwise specified (see www.worldbirdnames.org as specified by Gill & Donsker, 2018). The updated nomenclatural sequence of Hackett et al. (2008) and del Hoyo et al. (2014; 2016) was adopted according to a recent upsurge of phylogenetic studies, which differs from the more traditional classification of Sibley & Ahlquist (1990). Colloquial (common) names were used according to Hockey et al. (2005) to avoid confusion;

All observations obtained during the site visit of 16 - 19 February 2018 was submitted to the South African Bird Atlas Project (SABAP2).

7.1.2 Field surveys

A site visit (during 16 - 19 February 2018) were conducted to obtain baseline information on the avifaunal composition and relative species abundance residing on the study area and immediate surroundings. An inventory of bird species along with their COMMON and SCIENTIFIC NAMES observed during the surveys is included (refer Appendix 1):

The baseline avifaunal survey was conducted by means of the following techniques:

Point Counts

Bird data was collected by means of 19 point counts (Buckland *et al.* 1993) (Figure 7.1). The data from the point counts was analysed to determine dominant and indicator (so-called discriminant species) bird species and to delineate the different assemblages present. The use of point counts is advantageous since it is the preferred method to use for cryptic or elusive species. In addition, it is the preferred method to line transect counts where access is problematic, or when the terrain appears to be complex. It is a good method to use, and very efficient for gathering a large amount of data in a short period of time (Sutherland 2006).

At each point, all the bird species seen within approximately 100 m from the centre was recorded along with their respective abundance values using a Swarovski 8.5x42 EL binoculars and a Swarovski 30-70x95 ATX spotting scope. Each point count lasted approximately 20 minutes while the area within the immediate vicinity was slowly traversed to ensure that all bird species were detected (according to Watson, 2003). To ensure the independence of observations, points were positioned at least 200 m apart. Exceptions to

the sampling protocol and timing of the counts occurred along the edge of Kamfers Dam whereby the counts were limited to water- and shorebird species and were extended until *most* of the individuals within sight were counted (ca. up to 300 m from the observer).

Data generated from the point counts was analysed according to Clarke & Warwick (1994) based on the computed percentage contribution (%) of each species, including the consistency (calculated as the similarity coefficient/standard deviation) of its contribution. Hierarchical Agglomerative Clustering (a cluster analysis based group-average linkages; Clarke & Warwick 1994) was performed on calculated Bray-Curtis coefficients derived from the data. A cluster analysis is used to assign "species associations" between samples with the aim to objectively delineate groups or assemblages. Therefore, sampling entities that group together (being more similar) are believed to have similar compositions.

The species diversity of each species association was analysed by means of rarefaction, while richness measures (such as the total number of species recorded (S) and various diversity indices) were calculated to compare the associations with each other. The advantage of rarefaction is that it adjusts the number of species expected from each sample if all were reduced to a standard size.

Random (ad hoc) surveys

To obtain an inventory of bird species present (apart from those observed during the point counts), all bird species observed/detected while moving between point counts were identified and noted. Particular attention was devoted to suitable roosting, foraging and nesting habitat for threatened or near threatened species. Besides visual observations, bird species was identified by means of their calls and other signs such as nests, discarded eggshells and feathers.

Playback/broadcasting of bird vocalisations

The probability of detecting skulking or elusive species was verified by playback of bird calls/songs wherever suitable habitat was detected (e.g. Acrocephalid warblers). Special care was taken to keep disturbance to a minimum and not to affect the bird's natural behaviour (e.g. to prevent unnecessary habituation).

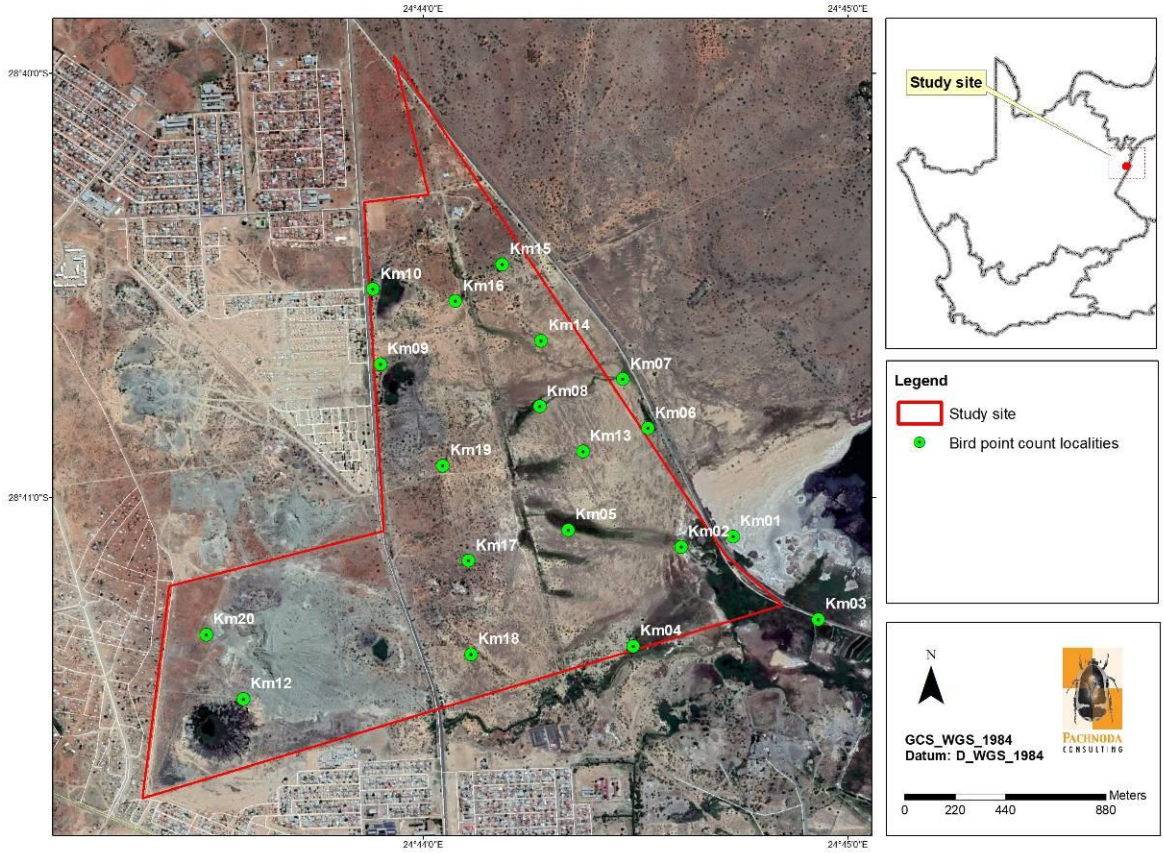

Figure 7.1: Spatial position of 19 bird point counts conducted within the study area.

7.1.3 Avifaunal sensitivity analysis

An avifaunal sensitivity analysis was performed for each habitat type on the study site based on its inherent ecosystem service (ecological function) and the preservation of bird diversity (avifaunal importance).

Ecological Function

The extent to which a habitat type is ecologically connected to the surrounding area is an important determinant of the sensitivity analysis. Habitat with a high degree of landscape connectivity or with extensive drainage systems amongst one another are perceived to be more sensitive and will be those contributing to important avifaunal flyways.

Avifaunal Importance

Avifaunal importance relates to species diversity, endemism and the presence of topographical features or primary habitat units with the intrinsic ability to sustain conservation important species.

Sensitivity Scale

High – Sensitive ecosystems with either low inherent resistance or low resilience towards disturbance factors or highly dynamic systems considered important for the maintenance of ecosystem integrity. Most of these systems represent ecosystems with high connectivity with other important ecological systems OR with high species diversity and usually provide suitable habitat for a number of threatened or rare species. These areas should be protected;

Medium – These are slightly modified systems which occur along gradients of disturbances of low-medium intensity with some degree of connectivity with other ecological systems OR ecosystems with intermediate levels of species diversity but may include potential ephemeral habitat for threatened species; and

Low – Degraded and highly disturbed/transformed systems with little ecological function and are generally very poor in species diversity (most species are usually exotic or weeds).

7.1.4 Limitations and assumptions

- It is assumed that third party information (obtained from government, academic/research institution, non-governmental organisations) is accurate and true;
- Some of the datasets are out of date and therefore extant distribution ranges may have shifted although these datasets could provide insight into historical distribution ranges of relevant species;
- The datasets are mainly small-scale and could not always consider azonal habitat types that may be present on the study area (e.g. small dams, pans and depressions). In addition, these datasets encompass surface areas larger than the study area, which could include habitat types and species that are not present on the study area. Therefore the potential to overestimate species richness is highly likely while it is also possible that certain cryptic or specialist species could have been be overlooked in the past; and
- Some of the datasets (e.g. SABAP2) managed by the Animal Demography Unit of the University of Cape Town were recently initiated and therefore incomplete.
- To obtain a comprehensive understanding of the diversity and dynamics of avifaunal community on the study area, as well as the status of endemic, rare or threatened species in the area, assessments should always consider investigations at different time scales (across seasons/years) and through replication. However, due to time constraints such long-term studies are not feasible and are mostly based on instantaneous sampling bouts. It should also be realised that bird distribution patterns fluctuate widely in response to environmental conditions (e.g. local rainfall patterns, nomadism, migration patterns, seasonality), meaning that a composition noted at a particular moment in time will differ during another time period at the same locality. This company, the consultants and/or specialist investigators do not accept any responsibility for conclusions, suggestions, limitations and recommendations made in good faith, based on the information presented to them, obtained from the surveys or requests made to them at the time of this report.

7.2 RESULTS

7.2.1 Regional Context - Regional Vegetation Types

The study site corresponds to the Savanna Biome and more particularly to the Eastern Kalahari Bushveld Bioregion as defined by Mucina & Rutherford (2006). It comprehends three ecological types known as the (1) Kimberley Thornveld, (2) Vaalbos Rocky Shrubland and (3) Highveld Salt Pans (Figure 7):

(1) *Kimberley Thornveld* – This vegetation type is confined to the western parts of the study site and is widely distributed in the Kimberley, Hartswater, Bloemhof and Hoopstad districts. It occurs on slightly irregular plains and when untransformed it conforms to a well-developed woody layer of *Vachellia erioloba*, *V. tortilis* with occasional stands of *Tarchonanthus camphorates* and *Senegalia mellifera*.

It is not threatened and mainly used for grazing purposes. However, overgrazing resulted in the proliferation of *S. mellifera*.

(2) *Vaalbos Rocky Shrubland* – This vegetation type is confined to the eastern parts of the study site on shallow calcareous soils. This vegetation type is restricted to the hills and ridges east of the Vaal-Orange confluence, in particular near the Kimberley area. It is ascribed to an evergreen shrubby vegetation dominated by *Tarchonanthus camphorates*, *Olea europaea subsp. africana*, *Euclea crispa* and *Diospyros lycioides*. When disturbed or transformed, it is often dominated by *Prosopis* and *V. tortilis*.

The Vaalbos Rocky Shrubland is not threatened.

(3) *Highveld Salt Pans* – This vegetation type is confined to depressions that are temporary filled by rain water. The central parts of these pans are often inundated for longer periods and frequently vegetated by floating macrophytes. On the study site it conforms to the Kamfers Dam.

The pan depressions are an important consideration since they provide foraging habitat and recently also breeding habitat for two near-threatened flamingo species and a diversity of waterbird species.

7.2.2 Local Context - Important Avifaunal Broad-scale Habitat Types

(1) *Disturbed* Vachellia tortilis *Thornveld* – This habitat occurs in patches on the western part of the study site and is dominated by an open microphyllous woodland supporting canopy constituents such as *Vachellia tortilis*, *V. karoo* and *Senegalia mellifera* (Figure 7.2). The basal cover is dominated by *Eragrostis lehmanniana* and includes a variety of secondary taxa within the genera *Eragrostis* and *Aristida*. Most of the taller canopy constituents have been removed which explains short woody layer of 2-3 m.

It provides habitat for a distinct “thornveld” assemblage of which some share biogeographic affinities with the Kalahari Highveld Biome. Typical “thornveld” species include Crimson-breasted Shrike (*Laniarius atrococcineus*), Kalahari Scrub-robin (Cercotrichas paena), Ashy Tit (*Melaniparus cinerascens*) and Chestnut-vented Warbler (=Tit-babbler) (*Sylvia subcoerulea*). When untransformed or primary ecological condition, this habitat supports a high bird richness and conforms to Kimberley Thornveld as evidenced along the western

section of Kamfers Dam and with good examples containing tall *V. erioloba* occurring within the nearby Dronfield Farm.

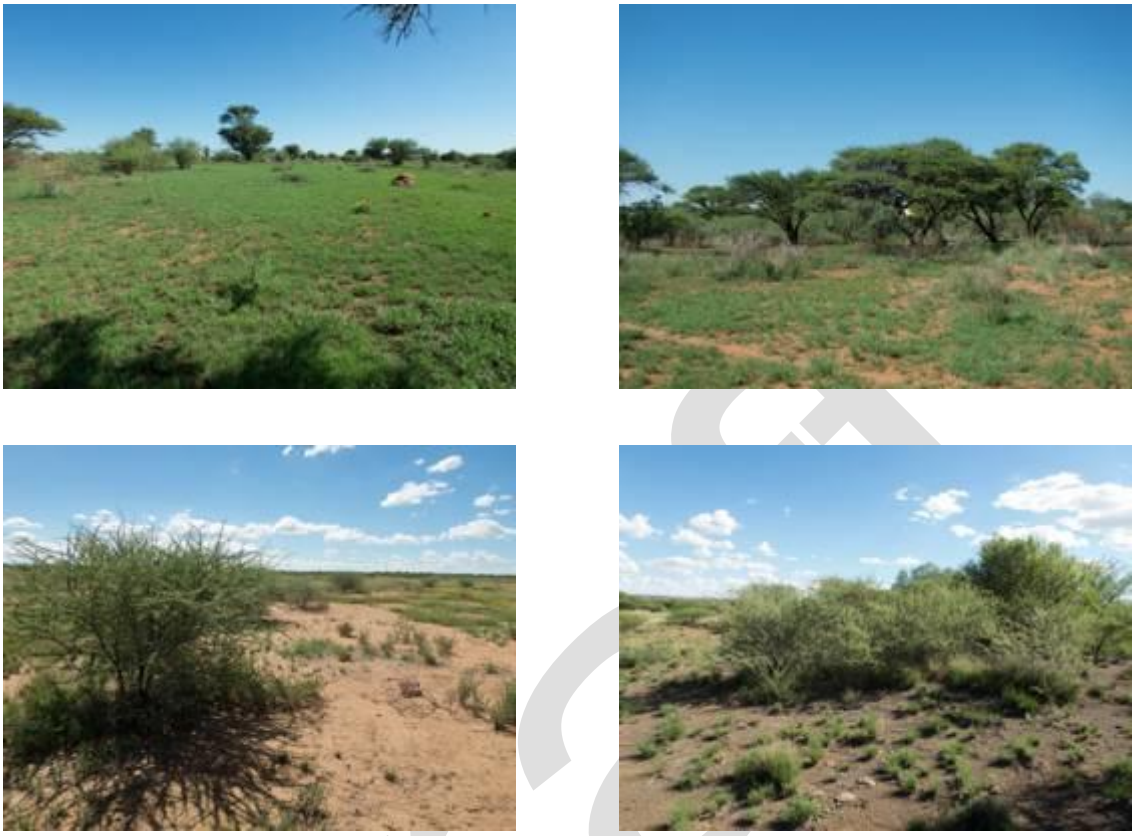

Figure 7.2: An example of disturbed *Vachellia tortilis* Thornveld on the study site.

(2) *Secondary* Vachellia and Prosopis *shrubveld* – This habitat is scattered across the study site and represented by secondary and disturbed *Vachellia tortilis* and *Prosopis glandulosa* shrubveld (Figure 7.3). It conforms to a short 1-2 m woody canopy with a graminoid layer dominated by *Eragrostis lehmanniana*. The dominant bird assemblage on this habitat is composed of unspecialised or generalist species with widespread distribution ranges. Noteworthy species include granivores such as Cape Sparrow (*Passer melanurus*), Cape Turtle Dove (*Streptopelia capicola*), Southern Masked Weaver (*Ploceus velatus*) and small insectivorous foliage gleaners of the low to mid strata (e.g. Black-chested Prinia *Prinia flavicans*).

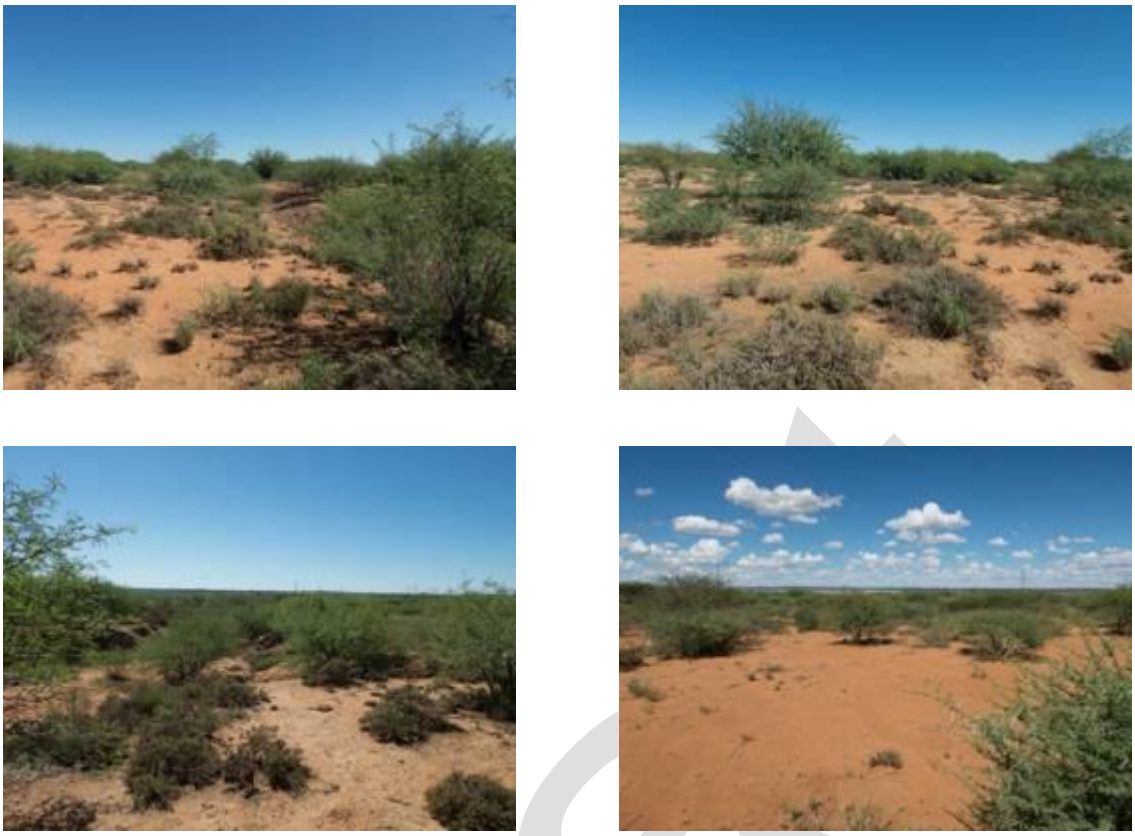

Figure 7.3: An example of secondary *Vachellia* and *Prosopis* shrubveld on the study site.

(3) *Transformed habitat, quarries and mine dumps* – These areas are represented by a number of open mine pits, quarries and a large dump on the southern section of the study site (Figure 7.4). Large parts of this habitat are devoid of vegetation or invaded by *Prosopis glandulosa* while some of the quarries tend to hold surface water when inundated. The latter areas are artificial habitat colonised by dense *Phragmites australis* reedbeds and provide roosting and breeding habitat for large numbers of Southern Red Bishop (*Euplectes orix*) and Red-billed Quelea (*Quelea quelea*). The mine dumps support few bird species although it is often utilised by Pied Starlings (*Spreo bicolor*) when foraging.

Figure 7.4: An example of transformed habitat, quarries and mine dumps on the study site.

(4) *Secondary grassland* – These areas are located on the eastern section of the study site in close proximity to the Kamfers Dam shoreline (Figure 7.5). It represents secondary savannoid grassland which were historically cleared and tilled. It is dominated by *Eragrostis lehmanniana* and *E. obtusa* and typically provides habitat for "grassland" or open woodland birds such as Zitting Cisticola (*Cisticola juncidis*), Desert Cisticola (*C. aridulus*), Northern Black Korhaan (*Afrotis afraoides*) and Spike-heeled Lark (*Chersomanes albofasciata*). The area is also frequented by aerial insectivores, notably by five swift species, three swallow/martin species and European Bee-eaters (*Merops apiaster*) in summer.

Figure 7.5: An example of secondary grassland on the study site.

(5) *Azonal habitat types* – These habitat types are represented by a number of wetland features and the Kamfers Dam shoreline. It also includes the large mining pit on the southern section of the study site (Figure 7.6).

- *Valley-bottom wetlands and seeps*: These wetland features are predominantly located on the eastern part of the study site and invariably dominated by dense stands of *Typha capensis* and *Phragmites australis*. They provide breeding habitat for granivorous species such as Southern Red Bishop (*Euplectes orix*) and Southern Masked Weaver (*Ploceus velatus*) and acrocephaline warblers such as the migratory African Reed Warbler (*Acrocephalus baeticatus*[1]) resident Lesser Swamp Warbler (*A. gracilirostris*). The moist grassland and Cyperaceae bordering the seeps provide habitat for Yellow-crowned Bishop (*Euplectes afer*) and Levaillant's Cisticola (*Cisticola tinniens*). The valley-bottom wetland on the southern part of the study site is especially important since it also provides ephemeral habitat for wading birds and waterfowl which were absent or rarely recorded from the nearby Kamfers Dam when water levels are low. These include Glossy Ibis (*Plegadis falcinellus*), Great Egret (*Ardea alba*), Intermediate Egret (*Ardea intermedia*) and Hottentot Teal (*Anas hottentota*). Reedbeds occur on the southern periphery of this wetland which is ecologically connected with an extensive reedbed on the southern parts of Kamfers Dam. The latter provides ephemeral breeding habitat for the Endangered African Marsh Harrier (Circus ranivorus), a species that is irregular in occurrence with three observations during the SABAP1 period (pre-2007; it was last recorded in 1995-1997 according to QWAC data).

- *Mining pit*: This is an artificial and fenced habitat which include a large deep pit similar in structure albeit of smaller scale to the famous Kimberley "Big Hole". It is worth mentioning as an azonal bird habitat since the steep vertical walls and rock fissures provide breeding and roosting habitat for a number of hole-nesting bird species. Noteworthy species include Speckled Pigeon (*Columba guinea*), Rock Martin (*Ptyonoprogne fuligula*), Rock Kestrel (*Falco rupicolus*), White-rumped Swift (*Apus caffer*) and the near-endemic Bradfield's Swift (*Apus bradfieldi*). The latter species has reaches its southern distributional limit at Kimberley.

- *Kamfers Dam*: Part of the study site overlaps with the southern section of Kamfers Dam, originally a natural endorheic pan and also an important bird area (SA032) which provide habitat for large numbers of resident, migratory and nomadic waterbirds. It regularly holds more than 20 000 birds at any given time, including 63 waterbird species and with up to 243 terrestrial bird species recorded (Marnewick *et al*., 2017). It is a critical important foraging habitat for Greater Flamingo (*Phoenicopterus roseus*) and Lesser Flamingo (*Phoeniconaias minor*), of which the latter has successfully bred during the 2017/2018 season (Anderson, 2018; pers.

[1] The taxonomic status of African Reed Warbler (*Acrocephalus baeticatus*) vs. the Eurasian Reed Warbler (*Acrocephalus scirpaceus*) is uncertain (Olsson *et al*., 2016) and herewith retained pending further studies on gene flow and contact zones between the two species. Some authors (Dyrcz *et al*. 2018) have subsumed *A. baeticatus* with *A. scirpaceus* (known as the Common Reed Warbler) as one polytypic species based on weak morphological, genetic and vocal differences, as well as the discovery of many North African populations which show intermediacy between the two species.

obs). Approximately 30 000 Lesser Flamingos attempted to breed during this period, with an estimated 14 000 chicks produced. The dam also holds important numbers of Grey-headed Gull (*Chroicocephalus cirrocephalus*) and occasionally also Black-necked Grebe (*Podiceps nigricollis*) and South African Shelduck (*Tadorna cana*). The highest number of waterbirds counted was during 2006 with 84 919 individuals, of which 81 664 were represented by Lesser Flamingo individuals (see references in Marnewick *et al.,* 2015).

The water levels of the dam are artificially maintained and are a critical management requirement during the supply of food for the flamingo's. The dam receives storm water and partially treated sewerage effluent from some of the neighbouring settlements and HWWTW, thereby increasing the risk of flooding and poor water quality. The sewerage effluent is important since the phosphates and nitrates increase the growth of the blue-green algae *Arthrospira fusiformis*, which is the major food item of Lesser Flamingos. However, increased and unacceptable high levels phosphates and nitrates emanating from untreated or poorly treated sewerage result in eutrophication and the growth of toxic cyanobateria. Flooding on the other hand reduce the availability of shoreline habitat, and reduces the salinity of the water in the dam, thereby stimulating the growth of green algae.

During the survey, the prominent waterbirds (according to numerical counts >20 individuals) corresponding to the study site were Lesser Flamingo (*P. minor*), Blacksmith Lapwing (Vanellus armatus), Grey-headed Gull (*C. cirrocephalus*), Little Stint (*Calidris minuta*), Common ringed Plover (*Charadrius hiaticula*), Black-winged Stilt (*Himantopus himantopus*), Greater Flamingo (*P. roseus*) and Ruff (*Philomachus pugnax*).


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Figure 7.6: An example of azonal bird habitat on the study site represented by (a-d) a valley-bottom wetland, (e-f) artificial seeps, (g-h) a mining pit and (i-j) the Kamfers Dam shoreline with (k) foraging Lesser Flamingo (*Phoeniconaias minor*), (l) part of a crèche of juvenile Lesser Flamingo and (m-n) old Lesser Flamingo nests.

7.2.3 Species Richness: Regional Perspective

According to the South African Bird Atlas Project (SABAP1 (sensu Harrison *et al*., 1997) & SABAP2), approximately 319[2] bird species have been recorded in the quarter degree square that are sympatric to the study region. This equates to approximately 33 % of the approximate 976[3] species listed for the southern African subregion[4] (and approximately 37 % of the 856[5] species recorded within South Africa[6]). However, the SABAP2 database (www.sabap2.adu.org.za) for the single pentad grid corresponding to the study site was lower (c. 190 species), which emphasises the difference in habitat quality and diveisty between the grid scales. According to personal and public observations, the average

[2] The statistic was corrected by excluding erroneous submissions pertaining to the Northern Grey-headed Sparrow (*Passer griseus*), White-browed Coucal (*Centropus superciliosus*), Cape White-eye (*Zosterops virens*), Cape Clapper Lark (*Mirafra apiata*), Agulhas Clapper Lark (*M. marjoriae*), Olive Thrush (*Turdus olivaceus*), Kimberley Pipit (*Anthus pseudosimilis*) and an unidentified species (listed as "unknown").

[3] *sensu* Southern African Bird List, version 08, updated 11 March 2018; www.zestforbirds.co.za (Hardaker, 2018).

[4] A geographical area south of the Cunene and Zambezi Rivers (includes Namibia, Botswana, Zimbabwe, southern Mozambique, South Africa, Swaziland and Lesotho).

[5] *sensu* BirdLife South Africa (2018) excluding Upcher's Warbler (*Hippolais languida*), Little Ringed Plover (*Charadrius dubius*) and White Wagtail (*Motacilla alba*) which await ratification by the BLSA Rarities Committee.

[6] With reference to South Africa (including Lesotho and Swaziland).

number of species observed per pentad within a given time period (ca. 2-4 hours) is approximately 40.8 species (range = 1-96 species). This is much lower than the regional SABAP1 statistic, and best explained by factors such as poor ecological quality of terrestrial habitat and low spatial habitat heterogeneity. On a national scale, the species richness per pentad on the study area is considered High (181+ species) (refer Figure 7.7).

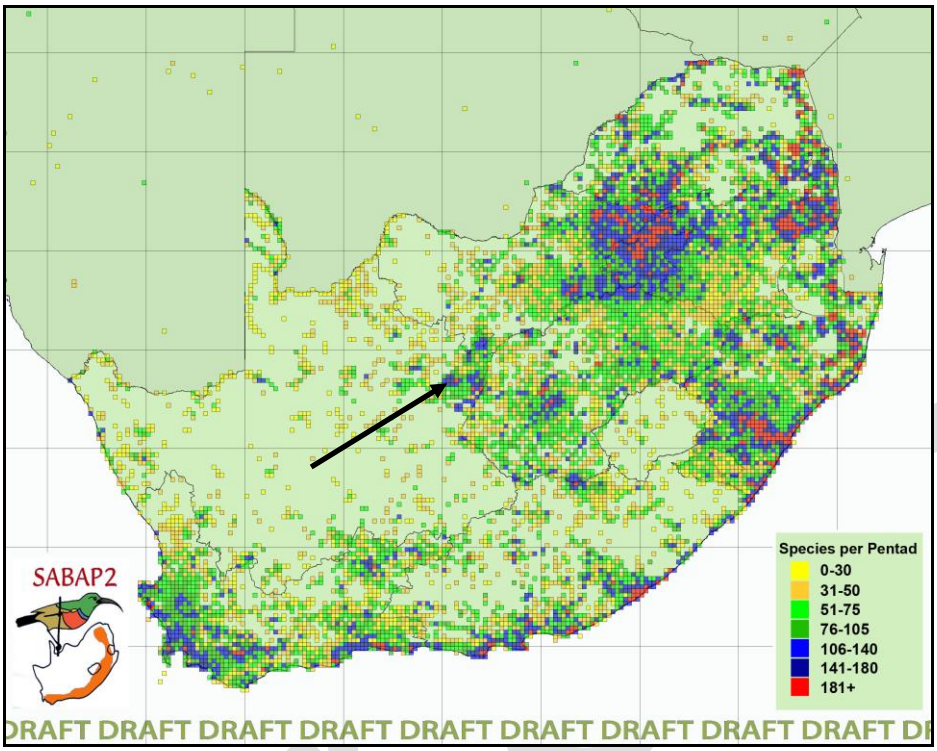


Figure 7.7: Bird species richness per pentad grid for South Africa (Map courtesy of SABAP2 and the Animal Demography Unit).

7.2.4 Species Richness: Local Perspective

The proposed study site and immediate surroundings is expected to support 248 bird species according to available habitat types present. Of these, 117 species were recorded during the survey (refer to Addendum A). The observed number of species represents 47 % of the expected number of species (refer Table 7.1). The observed species richness also equates to 14 % of the approximate 856 species listed for South Africa (including Lesotho and Swaziland).

Table 7.1: Summary table of the total number of species, Red Listed species (Taylor *et al*., 2015; IUCN 2017), endemics and biome-restricted species (Marnewick et al., 2015) expected to occur and observed within the proposed study area.

	Expected***	Observed***
Total number of species*	248 (29 %)	117 (44 %)
Number of Red Listed species (Taylor *et al*., 2015 & IUCN 2017)*	14 (9.2 %)	4 (31 %)
Number of biome-restricted species (Marnewick *et al*., 2015 –Kalahari-Highveld, Namib-Karoo and Zambezian Biome)*	5 (15 %)	3 (60 %)

	Expected***	Observed***
Number of local endemics (BirdLife SA, 2018)*	2 (5.1 %)	0
Number of local near-endemics (BirdLife SA, 2018)*	6 (30 %)	2 (33.3 %)
Number of regional endemics (Hockey *et al.*, 2005)**	17 (17 %)	8 (47 %)
Number of regional near-endemics (Hockey *et al.*, 2005)**	32 (52 %)	16 (26 %)

** only species in the geographic boundaries of South Africa (including Lesotho and Swaziland) were considered.*

*** only species in the geographic boundaries of southern Africa (including Namibia, Botswana, Zimbabwe and Mozambique south of the Zambezi River) were considered*

**** Percentage values in brackets refer to derived totals compared against the South African avifauna (Expected) and those species expected to occur on the study area (Observed)*

It is evident from Table 7.1 that the observed totals, with the exception of the Biome-restricted species, are below 50 % of the expected total. It means that the number of observed species is correlated with the ecological condition of the terrestrial habitat types on the study site. Although more species are expected per habitat unit, the observed species provides realistic evidence that the area was and is currently modified (human-induced) in some manner. In support of the aforementioned statement, it is evident that the species accumulation curve across sampled point counts has reached a saturation threshold at 18 counts (Figure 7.8). However, shorebird and waterbird richness was high, with 65 species expected to be present on Kamfers Dam and the valley-bottom wetland unit. Apart from the high number of waterbird species, the study site is poorly represented by local and regional endemic species, although containing 60 % of the Biome-restricted species that is expected to be present. The latter includes the White-bellied Sunbird (*Cynnyris talatala*), a widespread nectarivore with Zamebzian affinities, and the Kalahari Scrub-robin (*Cercotrichas paena*) and Sickle-winged Chat (*Emarginata sinuata*) which are respectively centred within the Kalahari-Highveld and Namib-Karoo Biomes. Two additional Biome-restricted species are also expected to be occasionally present, which include the Sociable Weaver (*Philetairus socius* - restricted to the Kalahari-Highveld) and the Pale-winged Starling (*Onychognathus nabouroup* - restricted to the Namib-Karoo).

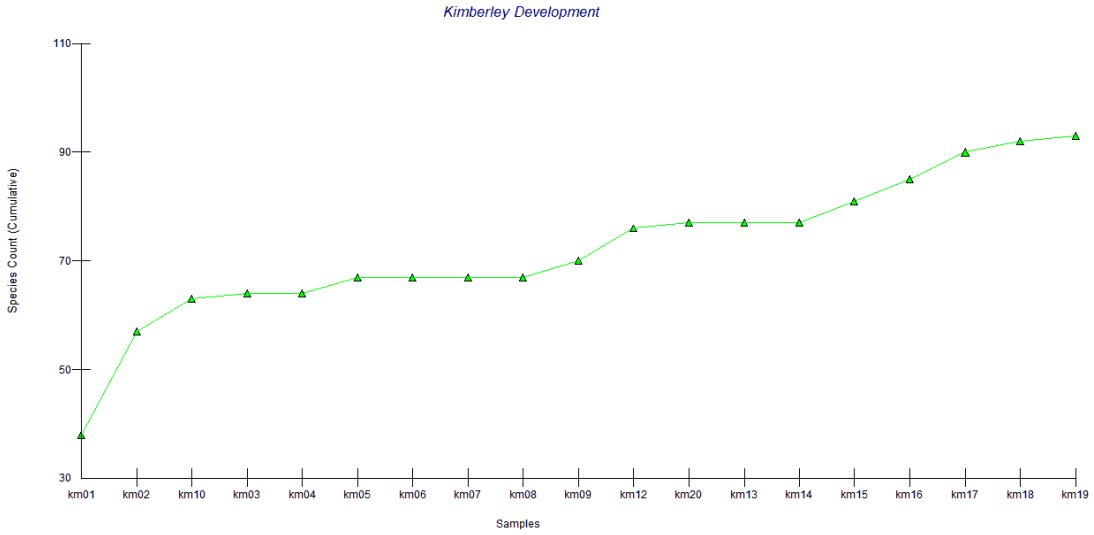


Figure 7.8: Species accumulation curve based on bird counts.

7.2.5 Dominance and Rarity (low abundance species)

Terrestrial Species

The 10 dominant (typical) species across all terrestrial habitat types on the study site are presented in Table 7.2. Only those species that cumulatively contributed to more than 90% of the overall similarity are listed. It is evident that the dominant species invariably include granivore Passerines and members of the Columbidae, as well as small cryptic insectivores of the genus *Cisticola*. Other dominant species include two widespread swift species and one carnivore, namely the Southern Fiscal (*Lanius collaris*). These species are widespread and numerically abundant on the study site, and virtually present on every habitat unit.

Low abundant species or rare species include mainly non-passerine hole-nesting species (e.g. African Hoopoe *Upupa africana* and Acacia Pied Barbet *Lybius torquatus*) and species for which the respective habitat types were either sub-optimal or they occur naturally at low abundances. These include Bokmakierie (*Telophorus zeylonus*), Black-faced Waxbill (*Estrilda erythronotos*), Black-winged Kite (*Elanus caeruleus*), Fiscal Flycatcher (*Sigelus silens*), Common Swift (*Apus apus*) and Southern Pale Chanting Goshawk (*Melierax canorus*).

Waterbirds and shorebirds

The 10 dominant water- and shorebird species in Table 7.3. The globally near threatened Lesser Flamingo *(Phoeniconaias minor*) is the most abundant waterbird with an estimated 14 000 individuals (including immature and juvenile) counted from the southern part of Kamfers Dam. Other noteworthy waterbirds with high numbers include the Grey-headed Gull (*Chroicocephalus cirrocephalus*- >300 individuals), Little Stint (*Calidris minuta* - >200 individuals), White-faced Duck (*Dendrocygna viduata*), Blacksmith Lapwing (*Vanellus armatus* - >40 individuals) and Common Ringed Plover (*Charadrius hiaticula* - >40 individuals).

Low abundant species or rare species include mainly wading birds such as Great Egret (*Ardea alba*), Little Egret (*Egretta garzetta*), Common Squacco Heron (*Ardeola ralloides*) and Intermediate Egret (*Ardea intermedia*) and waders and waterfowl such as Yellow-billed Duck (*Anas undulata*), Cape Teal (*Anas capensis*), Common Greenshank (*Tringa nebularia*) and Reed Cormorant (*Microcarbo africanus*).

Table 7.2: Dominant terrestrial bird species recorded in the study site.

Species	Average abundance	Consistency	Percentage Contribution
Cape Sparrow (*Passer melanurus*)	2.63	1.80	25.28
Southern Masked Weaver (*Ploceus velatus*)	2.69	1.21	16.02
Black-chested Prinia (*Prinia flavicans*)	1.50	0.83	11.96
Desert Cisticola (*Cisticola aridulus*)	0.75	0.59	8.62
Southern Red Bishop (*Euplectes orix*)	3.25	0.52	7.82

Species	Average abundance	Consistency	Percentage Contribution
Zitting Cisticola (*Cisticola juncidis*)	0.81	0.50	7.03
Little Swift (*Apus affinis*)	2.63	0.63	6.55
Southern Fiscal (*Lanius collaris*)	0.44	0.35	2.58
Levaillant's Cisticola (*Cisticola tinniens*)	0.63	0.29	2.39
Laughing Dove (*Spilopelia senegalensis*)	0.63	0.37	1.94
White-rumped Swift (*Apus caffer*)	0.88	0.29	1.38

Table 7.3: Dominant waterbirds and shorebirds recorded in the study site.

Species	Average abundance	Consistency	Percentage Contribution
Lesser Flamingo (*Phoeniconaias minor*)	4666.67	n/a	0
Grey-headed Gull (*Chroicocephalus cirrocephalus*)	102.33	n/a	0
Little Stint (*Calidris minuta*)	72.67	n/a	0
White-faced Duck (*Dendrocygna viduata*)	15.67	3.48	8.28
Blacksmith Lapwing (*Vanellus armatus*)	15.67	0.58	1.62
Common Ringed Plover (*Charadrius hiaticula*)	15.33	n/a	0
Ruff (*Philomachus pugnax*)	15	n/a	0
Black-winged Stilt (*Himantopus himantopus*)	13	0.58	1.62
Greater Flamingo (*Phoenicopterus roseus*)	10.33	n/a	0
Red-billed Teal (*Anas erythrorhyncha*)	5.67	0.58	2.64

7.2.6 Novelties and "out-of-range" species

Three Palearctic warbler species and one Palearctic falcon represent new distributional records for the study area. These bird species presents new records for the area since they are either out of range according to their respective known distribution ranges or they are regarded as regional rarities in the area. These species have simply not been observed in the region. However, some of these observations include overlooked species that were not previously recorded in the area during SABAP1 ("full out of range" species), which include the following:

- Sedge Warbler (*Acrocephalus schoenobaenus*) - a single adult bird was observed from *Phragmites* reedbeds along the railway line located near one of the valley - bottom seeps on the southern part of the study site.

- Red-footed Falcon (*Falco vespertinus*) - a single male observed amongst foraging Amur Falcons (*F. amurensis*) on the western part of the study site near the mining pit. This species has been observed from the QDSs that border the eastern and northern and eastern parts of the study site.

The following species represent "Regional Rarities" and were not recorded since the inception of SABAP2. They are generally uncommon or rare in the area:

- Marsh Warbler (*Acrocephalus palustris*) - a single bird in full song observed from dense Prosopis shrub bordering a seep on the southern part of the study site.

- Great Reed-warbler (*Acrocephalus arundinaceus*) - a number of individuals calling from *Phragmites* reedbeds on the south-western section of Kamfers Dam.

7.2.7 Bird Assemblages & Species Composition

A cluster analysis of the bird abundance values and composition suggests six bird associations based on vegetation structure, floristic dominance and the presence/absence of wetland features (refer Figure 7.9). It was evident that the compositions are faithful and reflects the broad-scale habitat units. However, some of that habitat units contain bird associations that are very similar to each other (high similarities), for example the secondary grasslands and artificial seeps and the disturbed *Vachellia* Thornveld and Shrubveld units. The bird compositions on these units overlap with each other. Nevertheless, some of the other units have a completely different and unique composition as is the case with the waterbird association pertaining to Kamfers Dam.

The main avifaunal associations on the study site are as follow (according to a clustering ordination):

1 *An association confined secondary grassland*: This association is widespread and prominent on secondary grassland. The bird composition is typified by Cape Sparrow (*Passer melanurus*), Zitting Cisticola (*Cisticola juncidis*), Desert Cisticola (*C. aridulus*), Black-chested Prinia (*Prinia flavicans*) and Little Swift *(Apus affinis*).

Indicator species with a high abundance in this habitat (species largely restricted to this habitat on the study area) include African Pipit (*Anthus cinnamomeus*), Northern Black Korhaan (*Afrotis afraoides*), Rufous-naped Lark (*Mirafra africana*) and Spike-heeled Lark (*Chersomanes albofasciata*).

2 *An association confined to artificial seeps*: This association is prominent on areas where artificial seeps occur. The bird composition is typified by Cape Sparrow (*Passer melanurus*), Zitting Cisticola (*Cisticola juncidis*), Levaillant's Cisticola (*C. tinniens*), Southern Red Bishop (*Euplectes orix*), Yellow-crowned Bishop (*E. afer*) and Southern Masked Weaver (*Ploceus velatus*).

This association does not appear to hold any indicator species apart from the occurrence of Yellow-crowned Bishop (*E. afer*) which was absent from the other habitat types.

3 *An association confined to secondary Thornveld and Shrubveld*: This association is widespread and essentially confined to terrestrial habitat with a prominent woody layer. Typical species include Cape Sparrow (*Passer melanurus*), Black-chested Prinia (*Prinia flavicans*), Chestnut-vented Warbler (*Sylvia subcoerulea*), Neddicky (*C. fulvicapilla*), White-browed Sparrow-weaver (*Plocepasser mahali*), Laughing Dove (*Spilopelia senegalensis*) and Southern Masked Weaver (*P. velatus*).

Indicator species with a high abundance in this habitat (species largely restricted to this habitat on the study area) include Kalahari Scrub-robin *(Cercotrichas paena*), Marico Flycatcher (*Melaenornis mariquensis*), African Red-eyed Bulbul (*Pycnonotus nigricans*), Cape Turtle Dove (*Streptopelia capicola*), Black-faced Waxbill (*Estrilda erythronotos*), Sickle-winged Chat (*Emarginata sinuata*) and Acacia Pied Barbet (*Lybius torquatus*).

4 *An association confined to transformed habitat (quarries, dumps and mining pits)*: This association is widespread and essentially confined to transformed terrestrial habitat. Typical species include Cape Sparrow (*Passer melanurus*), Southern Masked Weaver (*P. velatus*), Southern Red Bishop (*E. orix*) and Red-billed Quelea (*Quelea quelea*).

Indicator species pertaining to this habitat are rare, although certain parts such as the mining pit provides breeding and roosting habitat for Bradfield's Swift (*Apus bradfieldi*), Pied Starling (*Spreo bicolor*), Rock Martin (*Ptyonoprogne fuligula*) and Rock Kestrel (*Falco rupicolus*).

5 *An association confined to valley-bottom wetlands*: This association is confined to a large wetland system on the southern part of the study site. It shares a composition with the nearby Kamfers Dam. Typical bird species include Common Moorhen (*Gallinula chloropus*), White-faced duck (*Dendrocygna viduata*), Hottentot Teal (*Anas hottentota*), Wood Sandpiper (*Tringa glareola*), Lesser Swamp Warbler (*Acrocephalus gracilirostris*) and African Reed-warbler (*A. baeticatus*).

Indicator species pertaining to this habitat include Intermediate Egret (*Ardea intermedia*), Common Squacco Heron (*Ardeola ralloides*) and Glossy Ibis (*Plegadis falcinellus*).

6 *An association confined to Kamfers Dam (Pan system)*: This association is confined to Kamfers Dam and show high affinities to a typical pan composition of water- and shorebirds. Typical species include Lesser Flamingo (*Phoeniconaias minor*), Common Ringed Plover (*Charadrius hiaticula*), Grey-headed Gull (*Chroicocephalus cirrocephalus*), Black-winged Stilt (*Himantopus himantopus*) and Little Stint (*Calidris minuta*).

Important indicator species include Lesser Flamingo (*Phoeniconaias minor*), Greater Flamingo (*Phoenicopterus roseus*), South African Shelduck (*Tadorna cana*), Cape Teal (*Anas capensis*), Cape Shoveller (*Anas smithii*) and Pied Avocet (*Recurvirostra avosetta*).

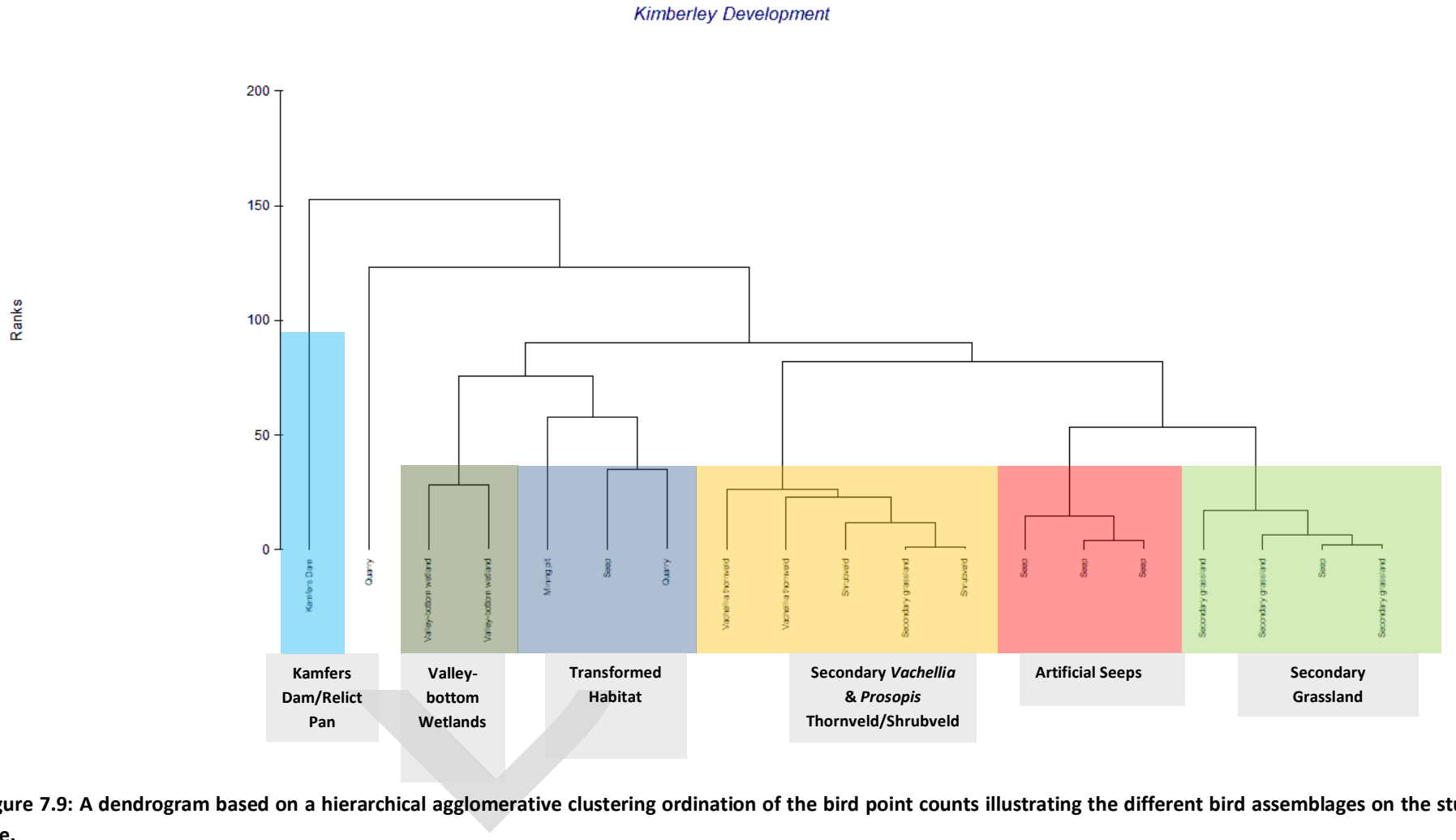


Figure 7.9: A dendrogram based on a hierarchical agglomerative clustering ordination of the bird point counts illustrating the different bird assemblages on the study site.

7.2.8 Species Diversity & Habitat Specialists

It was evident from the results that avian associations pertaining to the Kamfers Dam and valley-bottom wetlands hold the highest number of species and the highest number of individuals. Associations with intermediate bird richness values occur on the thornveld and shrubveld including transformed habitat (Table 7.4). Associations with low diversities occur on secondary grassland.

Table 7.4: Summary of the observed species richness for six prominent bird associations.

Bird Association	S	N	H'(loge)
Kamfers Dam (pan)	38	14825.00	0.33[7]
Valley-bottom wetland	40	126.50	2.98
Transformed habitat	29	45.67	2.87
Artificial seeps	19	26.20	2.51
Secondary grassland	16	12.00	2.46
Thornveld & Shrubveld	35	35.50	3.11

H' – Shannon-Weaver diversity index ($Hlog_e$)

7.2.9 Important Bird and Biodiversity Areas (IBAs)

The avifaunal importance of a particular area is often analysed based on BirdLife International's criteria to evaluate and identify Important Bird Areas (IBAs). The criteria used are outlined by the BirdLife International Secretariat (Fishpool, 1997):

- *Category A1*: the regular presence of significant numbers of globally threatened species. In general only IUCN species listed as Critically Endangered, Endangered or Vulnerable are considered. The regular presence of a Critical or Endangered species, irrespective of population size, at a site may be sufficient for a site to qualify as an IBA. For Vulnerable species, the presence of more than threshold numbers at a site is necessary to trigger selection;

- *Category A2*: the area holds a significant component of a group of species whose breeding distributions is restricted to an Endemic Bird Area (EBA) or Secondary Area. In other words, an EBA provides habitat for two or more species with restricted ranges co-occur and have global distributions of less than 50 000km^2. It is noteworthy that 70% of these species are also globally threatened. A Secondary Area (SA) holds one or more restricted-range species, but does not qualify as an EBA because less than two species are entirely confined to it. A typical SA includes a single restricted-range species which does not overlap in distribution with any other restricted-range species. For SAs, species occur where there are disjunct records of one or more restricted-range species, which are clearly geographically separate from any of the EBAs;

[7] Note: The Shannon-Wiener index is sensitive to sample size which explains the low observed index (although the association is rich in species numbers) for Kamfers Dam. The Kamfers Dam index is biased because the association was described from a single point count (n=1).

- *Category A3*: the area holds significant numbers of species whose distributions are largely confined to one biome. These species have shared distributions greater than 50 000km^2.

- *Category A4*: the area may qualify on any one or more of the four criteria listed below:

    - The area is known to hold on a regular basis more or less 1% of a biogeographic population of a congregatory waterbird species.

    - The area is known to hold on a regular basis more or less 1% of the global population of a congregatory seabird or terrestrial species.

    - The area is known or thought to hold on a regular basis more or less 20 000 waterbirds or more or less 10,000 pairs of seabirds of one or more species.

    - The area is known or thought to exceed thresholds set for migratory species at bottleneck sites.

The study site is located adjacent to the Kamfers Dam IBA (SA032; Figure 7.10), of which a section overlaps with the study site (Marnewick *et al*., 2015). It is an unprotected area of approximately 1 170 ha with the main focus on Kamfers Dam, an artificial ephemeral wetland. The dam is natural in origin as it was formally an endorheic pan, although it currently receives partially treated sewerage water while water levels are artificially and haphazardly controlled. The dam is particularly well known for its waterbirds, which holds more than 20 000 birds at a given time. However, it is particularly important for the large numbers of foraging flamingos, which include the globally near threatened Lesser Flamingo (*Phoeniconaias minor*) and regionally near threatened Greater Flamingo (*Phoenicopterus roseus*). It is also the only breeding site in South Africa for Lesser Flamingo, and one of only four regular breeding sites in sub-Saharan Africa (Lake Natron in Tanzania, Etosha Pan in Namibia and Sua Pan in Botswana). It also provides habitat for the regionally endangered African Marsh Harrier (*Circus ranivorus*) and the globally near threatened Chestnut-banded Plover (*Charadrius pallidus*). More information regarding Kamfers Dam was provided in 7.2.2. The Dam is threatened by poor water quality and potential flooding events, toxic blooms of cyanobacteria and lastly by proposed "housing estates". A summary of important IBA trigger species are provided in Table 7.5.

Table 7.5: Summary of important bird species at Kamfers Dam IBA.

Scientific Name	Common Name	Status	Approx. # of breeding pairs*	Average. total number (max)**
Globally Threatened/Near Threatened (IUCN, 2017)				
Phoeniconaias minor	Lesser Flamingo	Near Threatened	-	12 400 (27 100)
Oxyura maccoa	Maccoa Dusk	Vulnerable	-	42 (162)
Calidris ferruginea	Curlew Sandpiper	Near Threatened	-	35 (115)
Anthropoides paradiseus	Blue Crane	Vulnerable	-	OV
Gyps africanus	White-backed Vulture	Critically Endangered	-	OV
Charadrius pallidus	Chestnut-banded Plover	Near Threatened	3-4	9 (18)
Nationally Threatened/Near Threatened (Taylor *et al.* 2015)				
Phoenicopterus roseus	Greater Flamingo	Near Threatened	-	2 100 (12 400)

Circus ranivorus	African Marsh Harrier	Endangered	-	1-2 (year 1995-1997)
Mycteria ibis	Yellow-billed Stork	Near Threatened	-	4 (year 1995)
Congregator y species (1% or more of global population)				
Podiceps nigricollis	Black-necked Grebe	-	-	400 (940)
Tadorna cana	South African Shelduck	-	-	34 (128-500)
Alopochen aegyptiaca	Egyptian Goose	-	-	11 (35 - 6000)
Biome-restricted Species - abundance				
Pterocles burchellii	Burchell's Sandgrouse	Uncommon		
Cercotrichas paena	Kalahari Scrub-robin	Common		
Philetairus socius	Sociable Weaver	Uncommon		
Emarginata sinuata	Sickle-winged Chat	Uncommon (recorded during survey, 2018)		

* - numbers derived from Barnes (1998).

** - average estimates derived from QWAC data representing years 1995 - 2012 (c. 18 years)

OV - occasional visitor

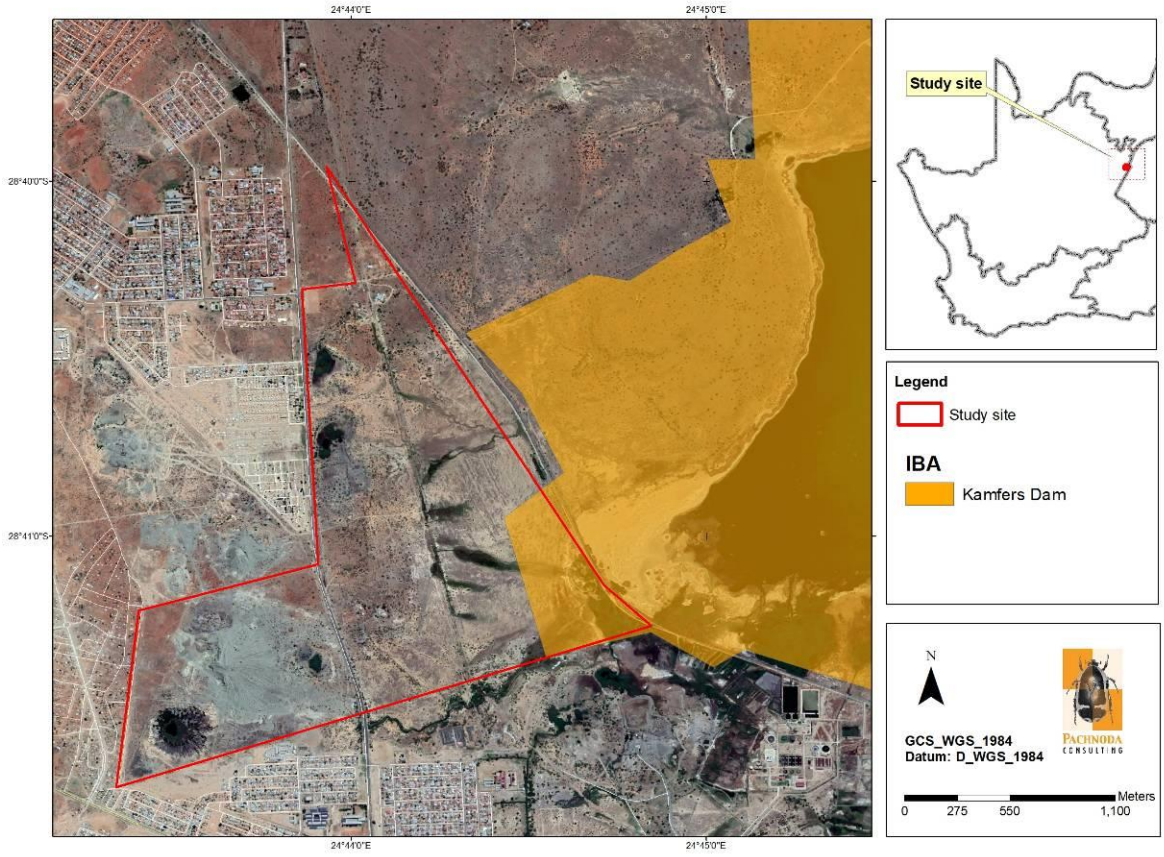


Figure 7.10: A map illustrating the spatial extent of the Kamfers Dam Important Bird and Biodiversity Area.

7.2.10 Threatened and Near Threatened Bird Species

Table 7.6 provides an overview of the threatened and near threatened bird species that could occur on the study area based on their respective distribution ranges and the presence of suitable habitat. According to Table 7.6, 14 species are known to occur in the region of which six species are expected to be regular. Of these, four species were confirmed during the site visit. Four of the 14 species are globally threatened species and five are globally near-threatened, while five are regionally threatened species and eight regionally near-threatened species. Noteworthy species confirmed from the study area include the globally near threatened Lesser Flamingo (*Phoeniconaias minor*), the regionally near threatened Greater Flamingo (*Phoenicopterus roseus*) and two overhead foraging visitors, the Critically Endangered White-backed Vulture (*Gyps africanus*) and the globally near threatened Red-footed Falcon (*Falco vespertinus*).

Five of the species listed in Table 7.6 are regular foraging visitors to the Kamfers Dam area, with one species (Lesser Flamingo) confirmed breeding on the dam (pers.obs) and another suspected to be breeding on the dam (Maccoa Duck *Oxyura maccoa*). Another three species are occasional overhead foraging visitors (White-backed Vulture, Red-footed Falcon and Lanner Falcon *Falco biarmicus*). The remaining species are regarded as uncommon or irregular residents and highly opportunistic foraging visitors to the study site. Some of these species (e.g. Secretarybird *Sagittarius serpentarius*) may be regular on suitable habitat adjacent to the study site (e.g. Dronfield), although human-induced activities and pedestrians utilising the study site will invariably deter these species from utilising the secondary grasslands habitat units.

Table 7.6: Threatened and near threatened bird species that could utilise the proposed study site based on their known (extant) and historical distribution ranges and the presence of suitable habitat. Conservation categories were used according to the IUCN (2017)* and Taylor *et al*. (2015). Species highlighted in grey were confirmed during the survey of February 2018.**

Species	Global Conservation Status*	Regional Conservation Status**	SABAP1 reporting rate	SABAP2 reporting rate	Preferred Habitat	Occurrence Status
Anthropoides paradiseus (Blue Crane)	Vulnerable	Near-threatened	9.43	5.83	Prefers open grasslands. Also forages in wetlands, pastures and agricultural land.	Potential vagrant or highly irregular foraging visitor to Kamfers Dam shoreline. Not recorded post-2007 from the study site (pentad grid scale).
Charadrius pallidus (Chestnut-banded Plover)	Near-threatened	Near-threatened	-	1.35	Large saline pans or Saltworks.	An uncommon foraging and potential breeding visitor. Abundance seldom exceeds 20 birds per annum. Not recorded post-2007 (pentad grid scale).
Calidris ferruginea (Curlew Sandpiper)	Near-threatened	-	4.66	2.69	Generally confined to muddy fringes of inland pans and large impoundments, lagoons and estuaries.	Regular summer non-breeding visitor to Kamfers Dam on exposed muddy shoreline habitat. (It was observed post-2007 from the study area (pentad grid scale).

Species	Global Conservation Status*	Regional Conservation Status**	SABAP1 reporting rate	SABAP2 reporting rate	Preferred Habitat	Occurrence Status
Ciconia abdimii (Abdim's Stork)	-	Near-threatened	1.86	1.79	Open stunted grassland, fallow land and agricultural fields.	An uncommon summer foraging visitor to areas consisting of secondary grassland or areas cleared of woodland. It was not observed post-2007 from the study area (pentad grid scale).
Circus ranivorus (African Marsh Harrier)	-	Endangered	1.55	-	Restricted to permanent wetlands with extensive reedbeds.	An uncommon foraging and potential breeding visitor. Latest observations stems from 1997. Not observed on study site post-2007 (pentad grid scale).
Falco biarmicus (Lanner Falcon)	-	Vulnerable	1.10	6.73	Varied, but prefers to breed in mountainous areas.	An occasional foraging visitor to the study site. Partial to depressions and open woodland (utilised as hunting habitat). (It was recorded during 2013 from the pentad grid corresponding to the study site).
Falco vespertinus (Red-footed Falcon)	Near-threatened	Near-threatened	1.09	-	Varied, prefers to hunt open arid grassland and savannoid woodland, often in company with Amur Falcons (*F. amurensis*).	Recorded during the 2018 site visit - one male located within a flock of Amur Falcons. This is the first observation of since 2007.
Gyps africanus (White-backed Vulture)	Critically Endangered	Critically Endangered	11.32	33.18	Breed on tall, flat-topped trees. Mainly restricted to large rural or game farming areas.	An occasional foraging visitor - frequently observed soaring overhead. Not likely to breed or roost on study site - nearest roosting and breeding sites occur on Dronfield Nature Reserve (41 % of the breeding sub-population in the Kimberley area).
Mycteria ibis (Yellow-billed Stork)	-	Endangered	1.63	1.79	Wetlands, pans and flooded grassland.	Vagrant, was last recorded during 1995 and 2012.
Oxyura maccoa (Maccoa Duck)	Vulnerable	Near-threatened	5.28	7.62	Large saline pans and shallow impoundments.	A regular foraging visitor and potential breeding species at Kamfers Dam and the valley-bottom wetland (It was recorded during 2016 from the pentad grid corresponding to the study site).
Phoeniconaias minor (Lesser Flamingo)	Near-threatened	Near-threatened	24.11	28.70	Restricted to large saline pans and other inland water bodies containing cyanobacteria.	A resident and regular foraging visitor to Kamfers Dam. Also breeding at Kamfers Dam (pers. obs.)
Phoenicopterus roseus (Greater Flamingo)	-	Near-threatened	29.77	24.22	Restricted to large saline pans and other inland water bodies.	A regular foraging visitor to Kamfers Dam.

Species	Global Conservation Status*	Regional Conservation Status**	SABAP1 reporting rate	SABAP2 reporting rate	Preferred Habitat	Occurrence Status
Rostratula benghalensis (Greater Painted-snipe)	Near-threatened	Near-threatened	0.54	0.9	Seasonal floodplains and swamps.	Rare to vagrant. Recorded during 2012.
Sagittarius serpentarius (Secretarybird)	Vulnerable	Vulnerable	8.39	16.59	Prefers open grassland or lightly wooded habitat.	Regarded as an irregular foraging visitor to the study site. However, a regular foraging visitor to open woodland bordering Kamfers Dam. It was observed from the study area during 2015, probably near Dronfield Farm (pentad grid scale).

The following species accounts refer to taxa **confirmed** and/ or with a **high probability** to be present on the study site:

*Lesser Flamingo (*Phoeniconaias minor*) - globally and regionally near threatened*

The Lesser Flamingo is globally near threatened (BirdLife International, 2016a) and regionally near threatened (Anderson, 2015a) owing to a steady decline of the global population due to soda-ash mining (Lake Natron), habitat degradation, disturbances and collisions with power lines. The birds at Kamfers Dam is the most important permanent population in South Africa, with up to 50 000 birds and represents the only breeding locality for this species in South Africa. It has bred successfully during 2007/2008 and again 2017/2018, rendering Kamfers Dam the fourth breeding locality in the world.

During the survey, an approximate 14 000 individuals (including juvenile and immature birds) were counted from the south-western section of the Dam which borders the study site (Figure 7.11). The proposed housing development is an eminent threat to the Kamfers Dam population (*sensu* Anderson, 2015a).

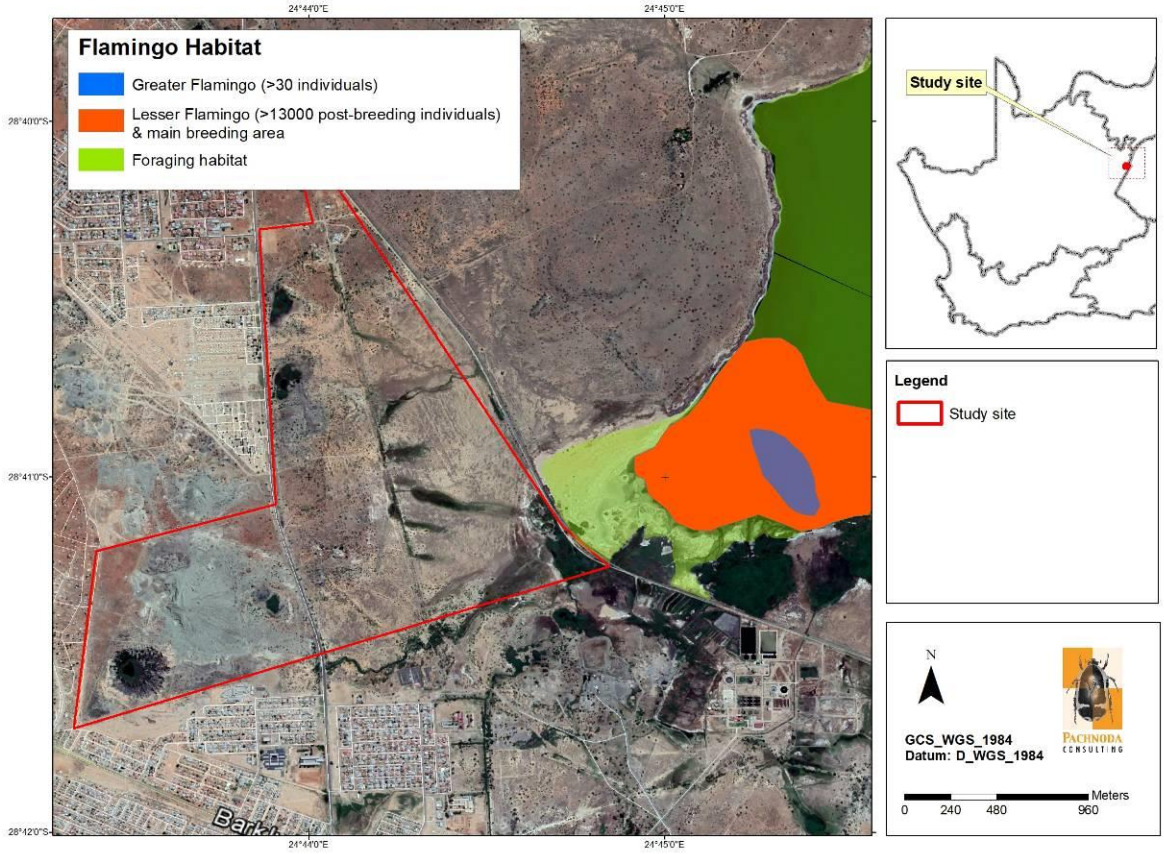


Figure 7.11: A map illustrating the occurrence of near threatened Lesser Flamingo (*Phoeniconaias minor*) and Greater Flamingo (*Phoenicopterus roseus*) near the study site.

<u>*Greater Flamingo (*Phoenicopterus roseus*) - regionally near threatened*</u>

P. roseus is listed as near threatened (*sensu* Anderson, 2015b) and has undergone declines of over 40 % during the last three generations. It is declining due to low recruitment at breeding localities as a result of salt and soda ash mining activities. It is not apparently threatened in any significant manner at non-breeding localities and may even benefit the artificial creation of large impoundments, although mortalities of dispersing birds are caused by collisions with fences and power lines. *P. roseus* is highly nomadic and thus unpredictable in their occurrence. However, it prefers to congregate on large shallow impoundments and lakes, especially alkaline pans with pH values as much as 10.5 that hold high densities of brine shrimps and diatoms (del Hoyo et. al, 1992; Simmons, 2005). The Greater Flamingo prefers to feed on *Artemia* (brine shrimps), chironomids, copepods, diatoms, the chrysalis of *Ephydra* flies and certain snails (*Cerithidea* & *Cerithium*).

Greater Flamingos is a regular and semi-permanent foraging visitor to Kamfers Dam, with numbers oscillating between 250 and up to 9 0000 individuals (QWAC data). However,

during the survey, approximately 31 mature individuals were observed on the south-western section of Kamfers Dam (Figure 7.11) amongst masses of Lesser Flamingos (*P. minor*).

*Maccoa Duck (*Oxyura maccoa*) - globally Vulnerable and regionally near threatened*

O. maccoa was recently uplisted from globally near threatened to Vulnerable owing to rapid declines in the East African population (BirdLife International, 2017a). The southern African population also experienced rapid declines owing to its small population size and ongoing declines resulting from a number of unrelated threats (Taylor, 2015). Main threats include water pollution and habitat alteration. It feeds almost exclusively on benthic invertebrates, which makes it susceptible to bio-accumulation of pollutants.

Southern Africa supports the largest population with approximately 4 500 – 5 500 individuals (in Taylor *et al*., 2015). Unfortunately, only 20 % of the South African population occurs in protected areas, making this species extremely vulnerable to further habitat alteration. They are entirely aquatic and dependant on permanent wetlands with high concentrations of benthic invertebrates (Colahan, 2005).

It was not observed on the south-western part of Kamfers Dam during the survey due to very low water levels but could be present on the northern parts of the Dam. It is known to occur on the Dam with numbers fluctuating between 1 and 170 individuals per annum (QWAC data). It was also observed (n=2) from the pentad grid corresponding to the study site during 2016 with reporting rates of 14.29 % (SABAP2). The patches of open water within the valley-bottom wetlands (when inundated) also provide suitable foraging habitat (Figure 7.12).

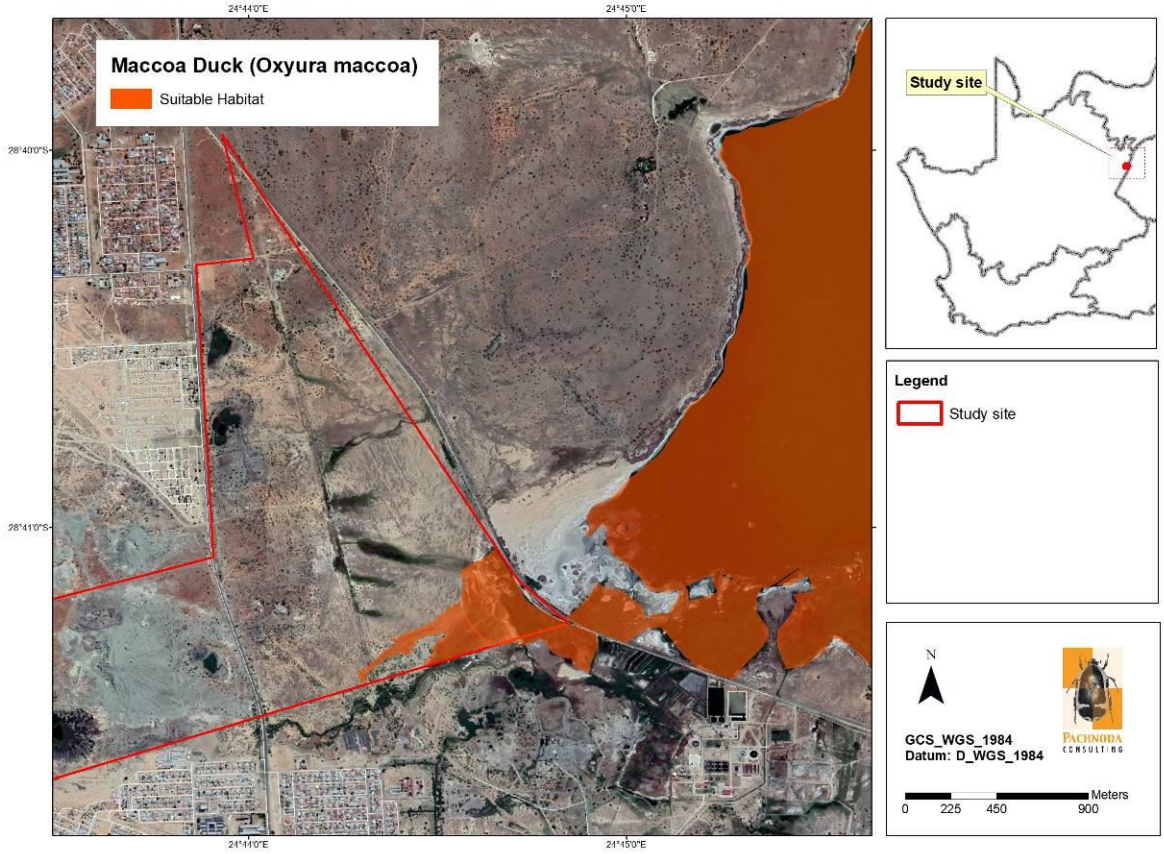


Figure 7.12: A map illustrating the occurrence of the globally vulnerable Maccoa Duck (*Oxyura maccoa*) on the study site.

*Chestnut-banded Plover (*Charadrius pallidus*) - globally and regionally near threatened*

C. pallidus is near threatened owing to its specialised habitat requirements and small area of occupancy (BirdLife International, 2016b). The national population is estimated at c. 400-600 birds with most of the birds located at coastal wetlands and commercial salt pans along the west coast. At inlands sites it is highly nomadic (Peacock, 2015) and irregular in occurrence. It is associated with hyper-saline or hyper-alkaline wetlands where it is seldom found far from the waters edge.

It was regularly observed from Kamfers Dam between 1995 - 2007 with numbers fluctuating between 1 - 18 birds per annum and occurs on the neighbouring pentad north of the study site where it was last observed during 2016 (n=3; reporting rate 1.35 % sensu SABAP2). It was not observed from the pentad grid which overlaps with the study site, although the mudflats and shoreline habitat along the south-western section of Kamfers Dam provides suitable habitat (Figure 7.13).

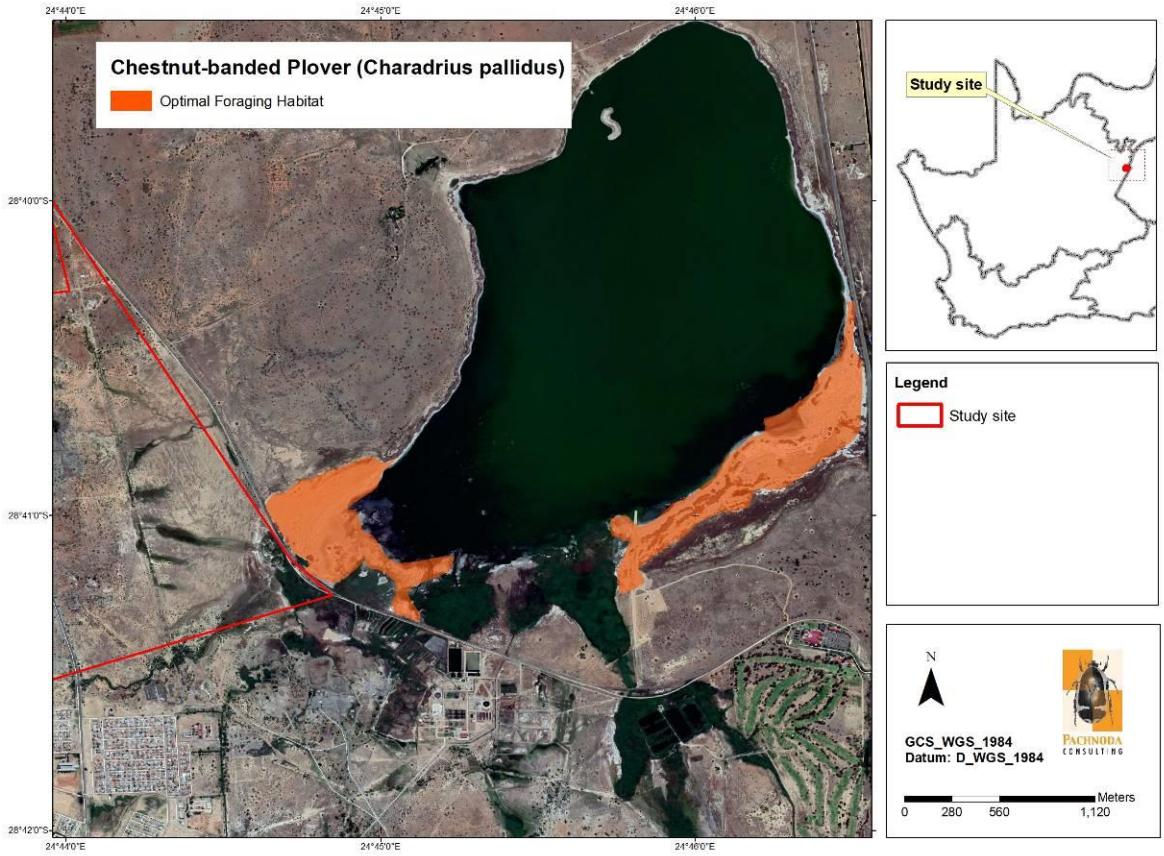
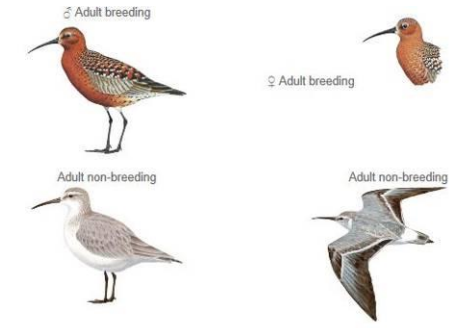


Figure 7.13: A map illustrating the occurrence of the near threatened Chestnut-banded Plover (*Charadrius pallidus*) near the study site.

<u>*Curlew Sandpiper (*Calidris ferruginea*) – globally Near threatened*</u>



The Curlew Sandpiper was recently uplisted to Near threatened since the global population declined and approached the threshold for Vulnerable (BirdLife International, 2017b). However, the population using the East Asian - Australasian Flyway is believed to be experiencing severe declines due to habitat loss in the Yellow Sea. It has also experienced short-term declines in West Africa at key staging points (stop-over points) during migration such as Banc d'Argiun (Mauritania) and Bijagos (Guinea Bissau) between 2003 and 2014. In South Africa it may be threatened by habitat and wetland degradation.

Small numbers of foraging individuals of up to 115 individuals occurs annually along the shoreline of Kamfers Dam (QWAC data). It was also recently observed from the same pentad grid corresponding to the study site (c. 2017 sensu SABAP2). The entire shoreline along the Kamfers Dam provides suitable foraging habitat.

Birds of prey - occassional foraging visitors

Three birds of prey species have been observed within the confines of the study site. These include the globally critically endangered White-backed Vulture (*Gyps africanus*), globally near threatened Red-footed Kestrel (*Falco vespertinus*) and the regionally vulnerable Lanner Falcon (*Falco biarmicus*) (Figure 7.14). However, they represent occasional overhead foraging visitors and are unlikely to utilise the study site for breeding purposes (although the mining pit could potentially provide breeding habitat for the Lanner Falcon[8]).

Soaring White-backed Vultures were observed in close proximity to the study site. Vultures are regarded as regular soaring visitors to the area as a large numbers (c. 200-300 birds) are breeding at the nearby Dronfield Farm (Marnewick *et al*., 2015). It is worth mentioning that Dronfield Farm also hold breeding pairs of Secretarybirds (*Sagittarius serpentarius*) and Martial Eagles (*Polemaetus bellicosus*) and two resident Tawny Eagles (*Aquila rapax*). The latter three species are threatened and could on occasion also be seen soaring overhead.

A single male Red-footed Falcon was observed amongst a small flock of Amur Falcons *(F. amurensis*) during the survey. This species was not previously observed on the study area (sensu SABAP2). The Red-footed Falcon was recently listed as near threatened owing to a steady decline of the global population, with the majority of the global population wintering in southern Africa. Main threats include loss of breeding habitat and hunting of individuals during migration.

Lanner Falcons could occasionally forage over the study site and the large mining pit provides potential foraging and breeding habitat. It was confirmed from the pentad grid corresponding to the study site in 2013 (n=3; reporting rate is 21.43 %; sensu SABAP2).

[8] The mining pit was fenced and could not be screened for any roosting or breeding Lanner Falcons (breeding takes normally place between May and early September).

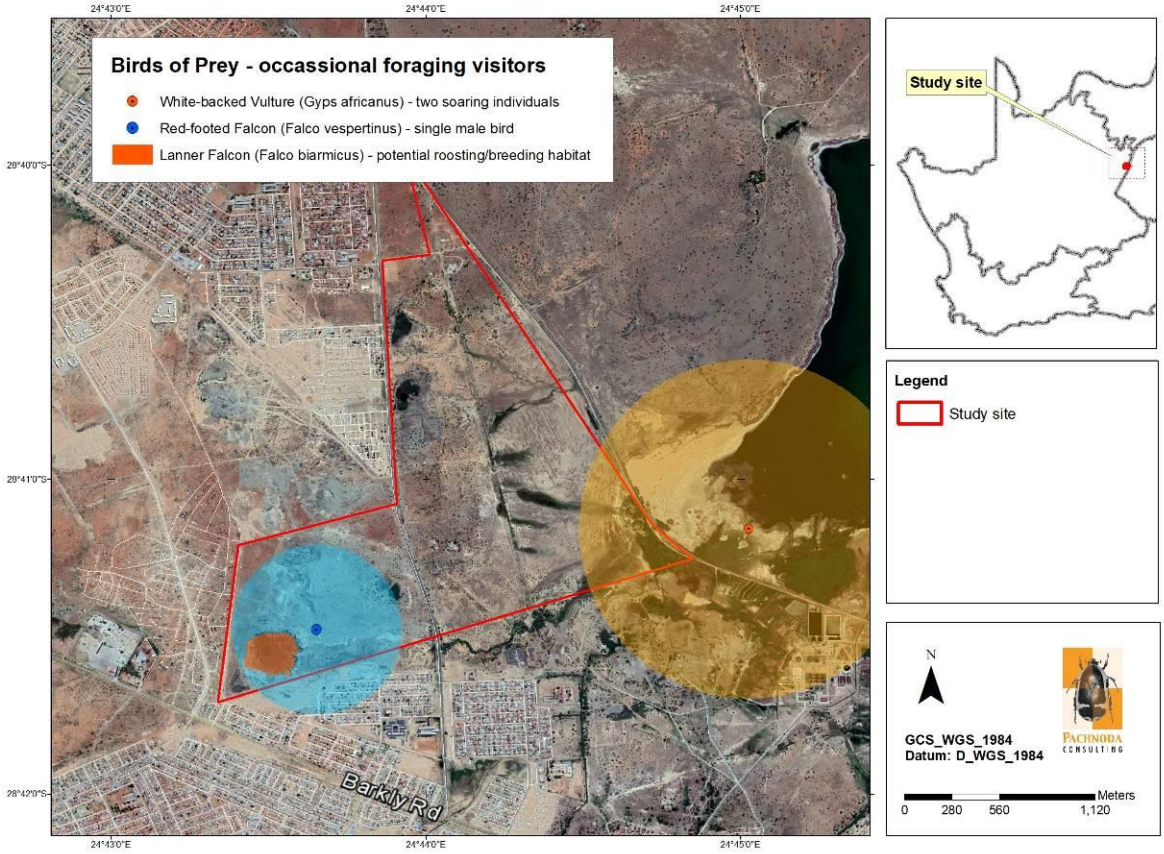


Figure 7.14: A map illustrating the occurrence of foraging/soaring threatened and near threatened birds of prey (the buffer areas are for illustrative purposes only and emphasises the proximal area where the birds were detected).

The following species **occurred historically** near the study area and suitable habitat was observed during the survey:

*African Marsh Harrier (*Circus ranivorus*) – regionally Endangered*

The African Marsh Harrier requires extensive permanent wetlands with reed beds to satisfy its breeding requirements, but will often utilise smaller wetlands during foraging bouts (Taylor *et al.,* 2015). At present, it is considerably localised and the South African population displays a highly fragmented distribution range. The breeding success of this species is highly dependent on the spatial scale of wetland systems, and is seldom successful if suitable breeding habitat is less than 100 ha in extent (Tarboton & Allen, 1984). In addition, it prefers to nest in dense reed beds placed over water. The species has experienced a significant decline in numbers during the last 24 years, with less than 2 500 mature individuals remaining in South Africa (Taylor *et a*l., 2015) due to the loss and degradation of important wetland systems.

It occurred historically at suitable habitat along Kamfers Dam with 1-2 individuals present between 1995 and 1997 (QWAC data). Potential suitable habitat was observed on the south-western part of Kamfers Dam and along the valley-bottom wetlands corresponding to dense *Phragmites* reedbeds (Figure 7.15).

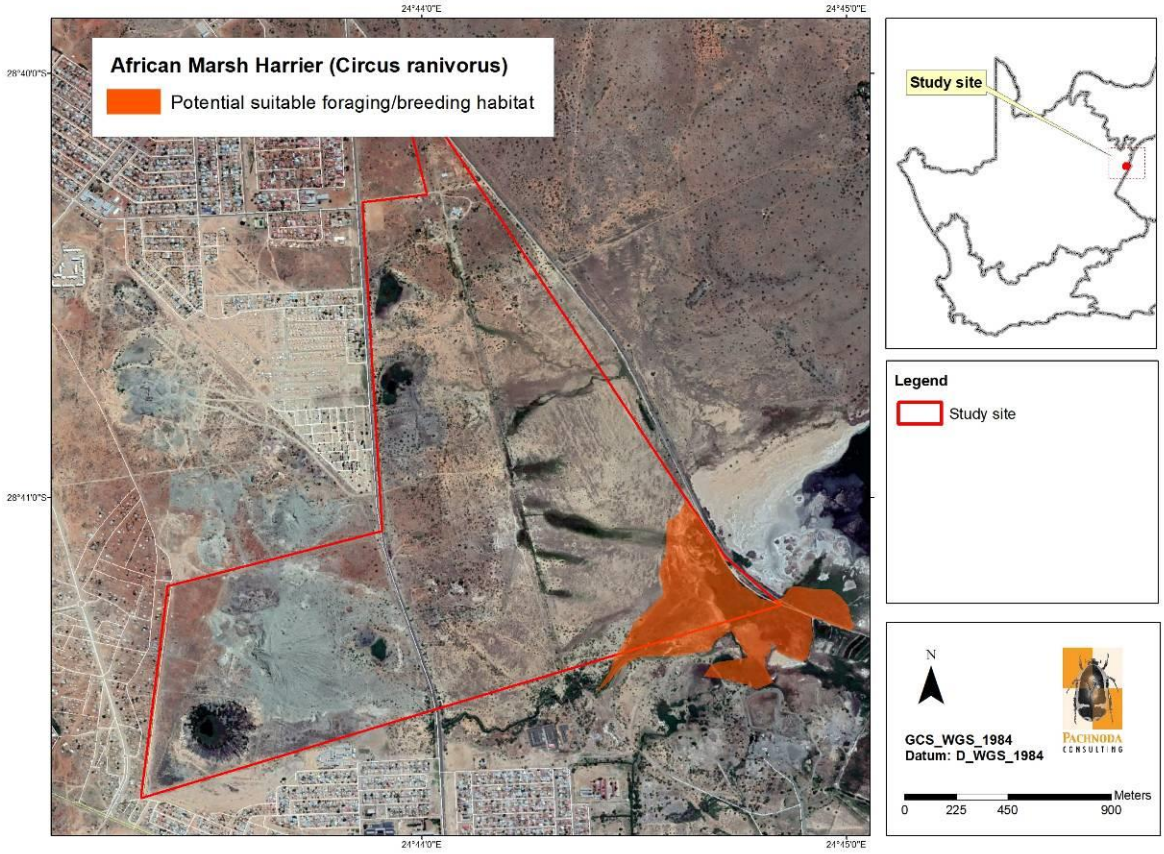


Figure 7.15: A map illustrating potential suitable habitat for the occurrence of the regionally endangered African Marsh Harrier (*Circus ranivorus*) on the study site.

7.2.11 Avifaunal Sensitivity (refer to Figure 7.16)

Areas wit High Avifauna Sensitivity

Areas with **High** sensitivities include Kamfers Dam (pan) section and all the valley-bottom wetlands:

- The Kamfers Dam and its shoreline provide ephemeral foraging habitat for a high diversity of wading bird species (including regionally and globally near threatened taxa) and waterfowl when inundated. These taxa are often absent from the surrounding dryland habitat types. They therefore contribute towards the regional avifaunal diversity.
- The Kamfers Dam shoreline and inundated zone support the only permanent population of the globally near threatened Lesser Flamingo (*Phoeniconaias minor*) in South Africa.
- The Kamfers Dam shoreline and inundated zone support the only breeding population of of Lesser Flamingo (*Phoeniconaias minor*) in South Africa, and one of four breeding populations in Africa.

- The Kamfers Dam section is regularly occupied by the globally vulnerable Maccoa Duck (*Oxyura maccoa*), regionally near threatened Greater Flamingo (*Phoenicopterus roseus*), globally near threatened Curlew Sandpiper (*Calidris ferruginea*) and the globally near threatened Chestnut-banded Plover (*Charadrius pallidus*).

- The valley-bottom wetlands support a high richness of bird species including many wading bird species with specific habitat requirements that are often absent from the nearby Kamfers Dam.

- The valley-bottom wetlands provide ephemeral foraging habitat for the regionally endangered African Marsh Harrier (*Circus ranivorus*).

- The valley-bottom wetlands are sensitive since they facilitate avian dispersal across the landscape.

Areas wit Medium-High Avifauna Sensitivity

Areas with **Medium-High** sensitivities include all wetland features and the artificial seeps:

- The wetlands provide ephemeral foraging habitat for waterbirds and waterfowl when inundated.

- The wetlands are sensitive since they facilitate avian dispersal across the landscape.

Areas wit Medium Avifauna Sensitivity

Areas with **Medium** sensitivities include the *Vachellia* Thornveld and the large mining pit on the western part of the study site:

- The *Vachellia* Thornveld holds a bird composition typical of the arid "thornveld" and contains species with high affinities to the Kalahari-Highveld and Namib-Karoo Biomes (c. Biome-restricted species).

- The *Vachellia* Thornveld holds a high richness of arboreal bird species when compared to the other species.

- The mining pit provides artificial breeding and roosting habitat for the near-endemic Bradfield's Swift (*Apus bradfieldi*) and potential breeding/roosting habitat for the regionally vulnerable Lanner Falcon (*Falco biarmicus*).

Areas wit Medium-Low Avifauna Sensitivity

Areas with **Medium-low** sensitivities include semi-transformed and secondary habitat on the northern section of the study site:

- These habitat units are widespread in the region and sustain avifaunal species with widespread distribution ranges.

- These habitat types maintain a high ecological connectivity with adjacent habitat types of similar floristic structure in the region.

Areas wit Low Avifauna Sensitivity

Areas with **Low** sensitivities include mainly secondary habitat:

- These habitat units are widespread in the region and sustain avifaunal species with widespread distribution ranges.
- These habitat types are of small surface area and often not viable to sustain large terrestrial bird species.
- These habitat types are dominated by unspecialised and generalist passerine species.

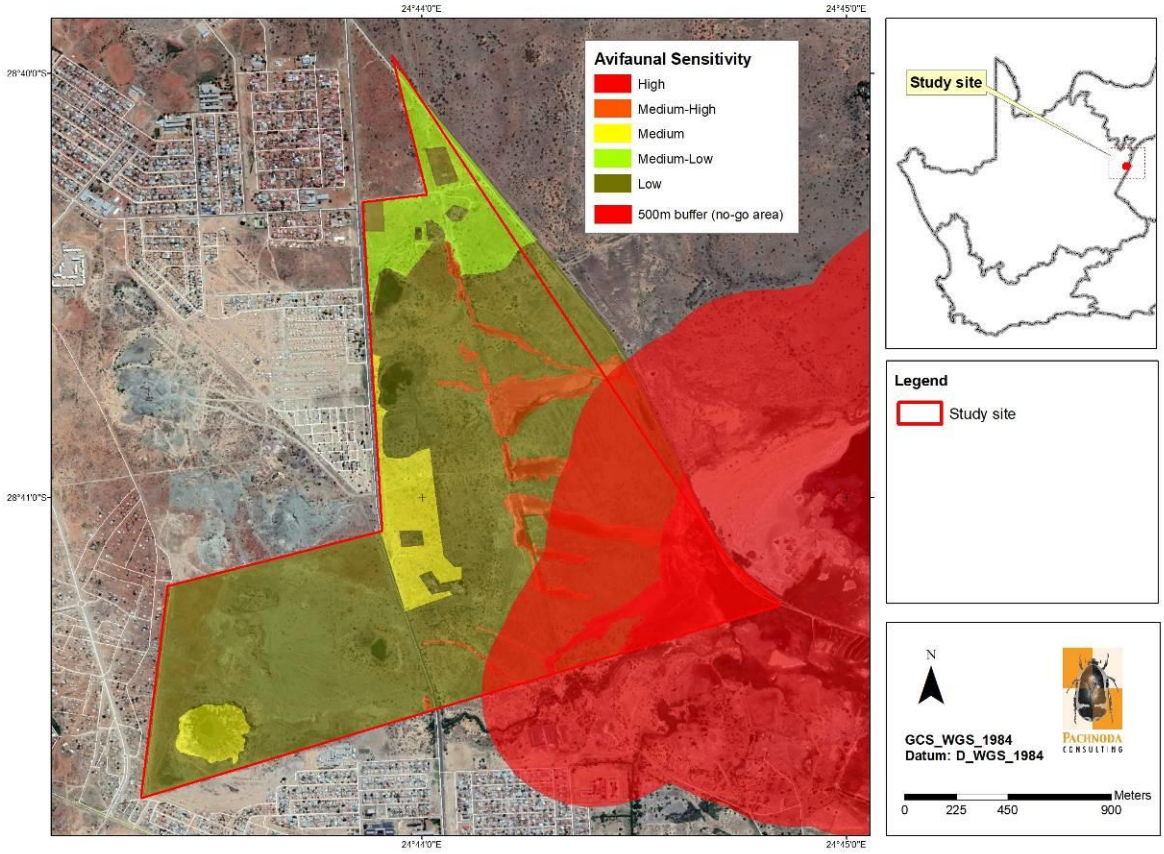


Figure 7.16: A sensitivity map of the study area based on the avifaunal habitat types and composition.

7.2.12 Buffer Zones (refer to Figure 7.16)

The Lesser Flamingo population at Kamfers Dam is a national asset and represents the only breeding population in South Africa. It is therefore critically important to conserve the population and to manage the water levels and water quality in manner which will benefit the flamingo populations. A buffer zone was applied to the Kamfers Dam shoreline to mitigate against potential disturbances or displacement imposed by the proposed development against the Lesser Flamingo population. Typical disturbances will include the construction and operational phases, as well as human pedestrian traffic in the area.

Buffer zones are intended to protect sensitive features from disturbances. The size of the buffer zone depends on the type and potential impacts of the intended activities on the sensitive features. Considering that the Northern Cape Province has no prescribed buffer zones, the new proposed buffer zone widths as prescribed by the Gauteng Department of Agriculture and Rural Development (Whittington-Jones, 2018) was consulted. The applied buffer was also modified and determined by the waterbird flight initiation distances provided by Coetzer and Bouwman (2017). According to Coetzer and Bouwman (2017) a buffer size of a least 200 m is recommended for areas with threatened or sensitive species. They also measures the flight initiation distances (the distance at which an individual bird approached by a predator or threat initiates fight) for Lesser Flamingo at Baberspan which was on average 157 m (200 m when rounded) with a maximum of 204 m. In addition, Lesser Flamingos are listed under Column A (3a) of the Agreement on the Conservation of African-Eurasian Migratory Waterbirds (AEWA, 2015), for which a buffer of at least 100 m is required to maintain water quality and some protection of wildlife (ELI, 2008). In addition, Whittington-Jones (2018) also propose a minimum buffer of 55-100 m for wetlands containing Maccoa Duck and a 500 m buffer around any wetland that is over 100 ha and may support African Marsh Harrier (according to Ruddock and Whitfield, 2007).

Based on the (1) initiation flight distances of Lesser Flamingo (c. 200 m), (2) the breeding status of Lesser Flamingos at Kamfers Dam and the (3) potential occurrence of African Marsh Harrier on the southern part of the study site, a 500 m buffer zone is proposed along the edge of Kamfers Dam. The buffer zone should be viewed as sensitive and is a ***no-go area*** *(no person or any development should be allowed within the buffer zone apart from authorized personnel such as conservation staff members) - please refer to Figure 7.16.*

7.3 IMPACTS ON AVIFAUNA

The construction and operation of the proposed residential development is expected to have negative impacts on the avifaunal assemblages of the study area and its immediate surroundings, in particular the Kamfers Dam and its population of Lesser Flamingos. Direct, indirect and cumulative adverse impacts on the bird assemblages are expected during the construction and operation of the development. *The proposed development should be regarded as a potential threat to the Kamfers Dam flamingos*. Anderson (2015a) has mentioned that "a housing estate proposal for development on a property adjacent to Kamfers Dam was a potential threat to the dam's flamingos". Therefore, the flamingos at Kamfers Dam are not only of national interest, but also of international importance (*sensu* IUCN, 2017a).

Direct impacts represent those that are a result of the proposed project and unequivocally influencing the avifauna of the region. Anticipated impacts include:

- Loss of sensitive avifaunal habitat.
- Displacement and disturbances caused to waterbirds, in particular Lesser Flamingos.
- Subsequent habitat transformation and loss in habitat quality due to inappropriate management procedures (e.g. pollution).

Indirect impacts are mostly impacts that are unseen and often only expressed during a later stage of the project:

- Subsequent habitat transformation and loss in habitat quality due to inappropriate management procedures (e.g. pollution).
- Urban sprawl based on "job-seeking" opportunities during the construction/operation leading to the localised depletion of natural resources, displacement and direct persecution of bird taxa.

Each of the aforementioned impacts are discussed in the tables that follow.

Table 7.7: Loss of avifaunal habitat and loss of sensitive habitat

Nature: Construction of residential houses is likely to take place and may potentially incur the loss of high or medium-high sensitive habitat. Part of the study site coincides with pan habitat (as part of the Kamfers Dam shoreline) and valley-bottom wetlands which provide habitat for threatened and near threatened bird species, in particular the African Marsh Harrier (*Circus ranivorus*) and Maccoa Duck (*Oxyura maccoa*). In addition, these habitat types hold high numbers of bird species, in particular waterbirds. Part of these habitat types overlap with the Kamfers Dam Important Bird and Biodiversity Area.

	Without mitigation		**With mitigation**	
CONSTRUCTION PHASE				
Probability	Definite	5	Probable	3
Duration	Permanent	5	Short duration	1
Extent	Local	2	Local	2
Magnitude	High	8	Moderate	6
Significance	**High**	**75**	**Low**	**27**
Status (positive or negative)	Negative			
Reversibility	Low		Low	
Irreplaceable loss of resources?	Yes		Yes	
Can impacts be mitigated?	Yes, to some extent			

Mitigation:

- The spatial extent of construction activities must be minimized, and as far as possible must be restricted to the historically disturbed or transformed areas on which buildings, roads etc will actually be located. Development should be focused on areas of low sensitivity.
- The boundaries of the development footprint areas are to be clearly demarcated and it must be ensured that all activities remain within the demarcated footprint area.
- Disturbance by residents of birds breeding and foraging in the area should be minimized and controlled.
- To avoid a loss of valley bottom wetland habitat, a 500 m buffer (see section 7.2.12) is proposed. This area should be regarded as sensitive and a "no-go" area for any development or residents/contractors. Access to this area should be controlled and it should preferably be fenced.
- Provide adequate briefing for site personnel and residents prior to construction.
- Any bird nests that are found during the construction period must be reported to the Environmental Control Officer (ECO).
- The mining pit should be screened for any breeding/roosting Lanner Falcons prior to construction by an ECO. This species breeds during May -early September with a peak in July. If breeding or roosting

id confirmed, then the services of an ornithologist should be acquired and an appropriate buffer zone should be allocated to the pit.
Cumulative Impacts: Expected to be minimal on habitat with low avifaunal sensitivity. The habitat of low avifaunal sensitivity is already transformed and fragmented due to historical mining, agricultural and residential activities and the site is not a unique habitat within the landscape. However, if construction overspill into or when occurring on adjacent habitat of high avifaunal sensitivity, the possibility of Red Data species becoming displaced by further habitat transformation and degradation is highly possible.
Residual Risks: Low, if mitigation measures are implemented correctly and rehabilitation of the site is undertaken.

Table 7.8 Displacement and disturbances caused to waterbirds, in particular Lesser Flamingos

Nature: Displacement of birds, in particular waterbirds during construction and operation is probably the most important negative impact relevant to this particular project. The adjacent Kamfers Dam hold one of only four breeding populations of the globally near threatened Lesser Flamingo (*Phoeniconaias minor*). In addition, it also support globally significant populations of waterbirds and at least four other globally and regionally threatened and near threatened bird species. It also holds the largest permanent population of Lesser Flamingos in South Africa.

It is possible construction and operational activities, especially noise and human-induced disturbances could displace birds from the Kamfers Dam. Therefore, flamingos could vacate the area or construction activities could result in breeding failures. Displacement and relevant impacts on the breeding success of flamingos and other waterbirds at Kamfers Dam may have disastrous consequences on waterbird recruitment and conservation which are of global importance.

	Without mitigation		**With mitigation**	
CONSTRUCTION PHASE				
Probability	Definite	5	Highly Probable	4
Duration	Permanent	5	Long-term	4
Extent	Near to region	4	Near to local	3
Magnitude	Very High	10	High	8
Significance	**Very High**	**95**	**High**	**60**
Status (positive or negative)	Negative		Negative	
OPERATIONAL PHASE				
Probability	Definite	5	Probable	3
Duration	Long-term	4	Long-term	4
Extent	Near to region	4	Local	3
Magnitude	High	8	High	8
Significance	**Very High**	**75**	**Moderate**	**45**
Status (positive or negative)	Negative		Negative	
Reversibility	Low		Low	
Irreplaceable loss of resources?	Very High		High	
Can impacts be mitigated?	Probably, although only with careful planning and execution. **Potential for displacement of birds remains high due to the precautionary principle and low confidence in mitigation measures**.			

Mitigation:

- The spatial extent of construction activities must be minimized, and as far as possible must be restricted to the historically disturbed or transformed areas on which buildings, roads etc will actually be located. Development should be focused on areas of low sensitivity.
- Construction activities should not take place when Lesser Flamingos are engaged in breeding activities.
- The boundaries of the development footprint areas are to be clearly demarcated and it must be ensured that all activities remain within the demarcated footprint area.
- Disturbance by residents of birds breeding and foraging in the area should be minimized and controlled.
- To minimize the risk of displacement, a 500 m buffer (see section 7.2.12) is proposed. This area should be regarded as sensitive and a "no-go" area for any development or residents/contractors. Access to this area should be controlled and it should preferably be fenced.
- The buffer zone is based on scientific literature and as a precautionary measure. However, the efficacy of mitigating against displacement is unknown and should be monitored (and noted). Monitoring should be continuous (daily) during construction and monthly during operation. Monitoring of displacement in birds should be conducted by the ECO (daily) with frequent monitoring (on a regular basis - e.g. weekly) by delegates of the local conservation authority. If displacement is noticed, construction activities should cease with possibility that the layout plans will require drastic amendments.
- Development should preferably make use of low-density stands (large erven and fewer stands).
- Provide adequate briefing for site personnel and residents prior to construction.
- Any bird nests that are found during the construction period must be reported to the Environmental Control Officer (ECO).
- The mining pit should be screened for any breeding/roosting Lanner Falcons prior to construction by an ECO. This species breeds during May -early September with a peak in July. If breeding or roosting id confirmed, then the services of an ornithologist should be acquired and an appropriate buffer zone should be allocated to the pit.

Cumulative impacts: If construction and operational activities overspill into adjacent habitat of high avifaunal sensitivity, the possibility of Red Data species becoming displaced by further habitat transformation and degradation is highly possible. Other possible impacts include potential flooding of Kamfers Dam by excess storm water run-off and lowering of the water quality by poor or faulty sanitary reticulation (see following impact).

Residual Risks: **It is possible that displacement is eminent even when mitigation measures are implemented**.

Table 7.9 Subsequent habitat transformation and loss in habitat quality due to inappropriate management procedures (e.g. pollution)

Nature: Poor stormwater management and faulty sewer reticulation emanating from the proposed development could affect the water levels and water quality of Kamfers Dam. Flooding events could be disastrous during breeding of Flamingos with nest or chick either drowning during these events. In addition flooding or increased storm water runn-off will lower the salinity of the Dam thereby stimulating the growth of green algae with a reduction of blue-green algae (the latter are the preferred food of Flamingos) and the subsequent displacement of flamingos from the area. In addition, increased volumes of raw and poorly treated sewerage into the dam

could stimulate the growth of toxic cyanobacteria (resulting in possible avian mortalities).

	Without mitigation		With mitigation	
CONSTRUCTION PHASE				
Probability	Probable	3	Improbable	2
Duration	Short term 2-5 years	2	Short term 2-5 years	2
Extent	Region	4	Local Area	3
Magnitude	High	8	Moderate	6
Significance	**Moderate**	**42**	**Low**	**22**
Status (positive or negative)	Negative		Negative	
OPERATIONAL PHASE				
Probability	Highly Probable	4	Probable	3
Duration	Long-term	4	Medium term	3
Extent	Region	4	Limited to Local Area	2
Magnitude	High	8	Moderate	6
Significance	**High**	**64**	**Low**	**33**
Status (positive or negative)	Negative		Negative	
Reversibility	Probable		Moderate	
Irreplaceable loss of resources?	Moderate		Moderate	
Can impacts be mitigated?	Yes, with adequate planning and engineering.			

Mitigation:

- Great care must be taken that no stormwater, pollutants, sewerage or other waste pollute the area or enter the Kamfers Dam during the construction or operational phases. Measures to rapidly deal with spills or floods must be put in place before construction commences.
- Storm water and sewer reticulation should make use of a bulk outfall system that is transported away from Kamfers Dam - the development should not make use if the storm water and sewage system at Kamfers Dam or any other system that us under-capacity.
- A management and monitoring system should be implemented to carefully monitor the water quality and water levels of the Kamfers Dam to benefit the ecological and habitat requirements of the waterbirds, in particular Lesser Flamingo.
- Construction workers must be suitably trained to deal with any spills.
- Facilities to handle pollution and waste must be provided to residents.

Cumulative impacts: As per pervious impacts.

Residual Risks: None anticipated provided that the mitigation measures are implemented correctly and rehabilitation of the site is undertaken.

Table 7.10 Urban sprawl based on "job-seeking" opportunities during the construction/operation leading to the localised depletion of natural resources, displacement and direct persecution of bird taxa.

Nature: It is possible that an influx of "job-seeking" people are expected during the construction phase. This could facilitate "urban" sprawl and informal settlements whereby natural resources will be put at risk (e.g. firewood and hunting for food). An uncontrolled influx of people could also result in the displacement of birds.				
	Without mitigation		**With mitigation**	
CONSTRUCTION PHASE				
Probability	Highly Probable	4	Probable	3
Duration	Long-term	4	Short term 2-5 years	2
Extent	Limited to local Area	2	Limited to Site	1
Magnitude	High	8	Moderate	6
Significance	**Moderate**	**56**	**Low**	**27**
Status (positive or negative)	Negative		Negative	
OPERATIONAL PHASE				
Probability	Highly Probable	4	Probable	3
Duration	Long-term	4	Short term 2-5 years	2
Extent	Limited to local Area	2	Limited to Site	1
Magnitude	High	8	Moderate	6
Significance	**Moderate**	**56**	**Low**	**27**
Status (positive or negative)	Negative		Negative	
Reversibility	High		High	
Irreplaceable loss of resources?	Moderate		Low	
Can impacts be mitigated?	Yes			
Mitigation: • Create public awareness programmes. • Implement biodiversity monitoring protocols. • Demarcate suitable areas for development (mainly on habitat with low sensitivity) • Cluster development and avoid "spread" of settlements across landscape - labour and construction camps should preferably be located near town and not on site.				
Cumulative impacts: N/a				
Residual Risks: N/a				

7.4 CONCLUSION

From a general avifaunal point of view, most of the terrestrial habitat types are transformed or sem-transformed (secondary) containing unspecialised and generalist bird species with widespread distribution ranges. From a specific avifaunal point of view, and from a conservation perspective, the study site also included certain aquatic and wetland habitat with high ecological sensitivities. These habitat types were located adjacent to the Kamfers Dam, with part of the Dam's shoreline corresponding to the study site. The Kamfers Dam is an Important Bird Area (SA032), and along with the valley-bottom wetlands on the study site, it provided habitat for a high number of waterbirds including five threatened and near threatened bird species of regular occurrence. More importantly, the study site was located next to one of the largest permanent Lesser Flamingo populations in South Africa, and one of only four Lesser Flamingo breeding sites in Africa.

The proposed residential development adjacent to Kamfers Dam was regarded as a potential threat to the long-term persistence of Lesser Flamingos in the area (*sensu* Anderson, 2015a) and will entail careful planning and engineering. In the absence of environmentally accepted planning and construction activities, any development alongside the Kamfers Dam may be disastrous for the local avifauna and the respective bird habitat types in the area. A map with areas where development appears to be feasible was proposed in Figure 7.17.

No development will be supported within the 500 buffer zone, which was proposed to mitigate against the displacement of waterbird species. It was advised that Figure 7.17 and Figure 7.16 be consulted during the planning of the proposed project.

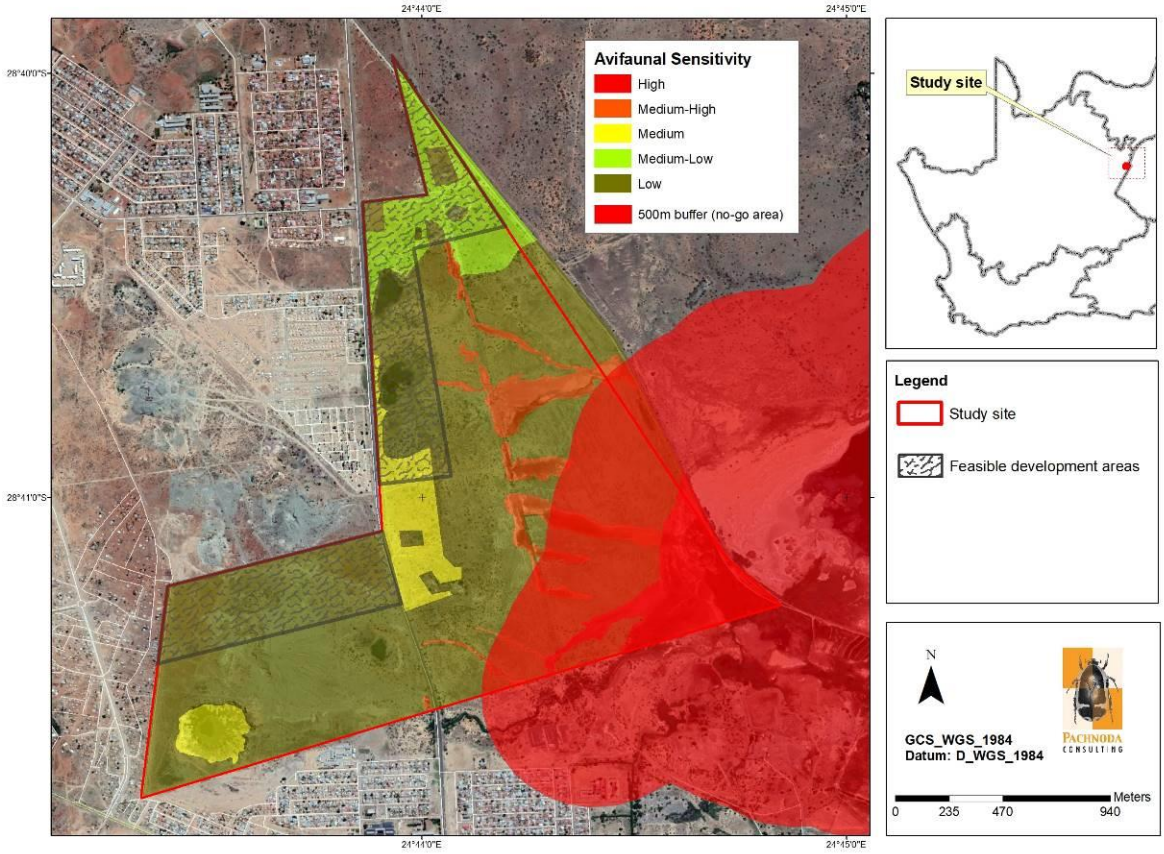


Figure 7.17: A map of the study site illustrating proposed feasible development areas (footprints).

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8 HERPETOFAUNA

8.1 METHODS

8.1.1 Field Surveying Herpetofauna

The site was visited on 16-19 February 2018. During this the observed and derived presence of vertebrates associated with the recognized habitat types of the study site, were recorded. This was done with due regard to the well recorded global distributions of Southern African herpetofauna coupled to the qualitative and quantitative nature of recognized habitats.

The 500 meter wide transect along the proposed sewer line was scanned for important herpetofauna habitats. During the site visit herpetofauna were identified by visual sightings by driving and walking in transects across the site. Amphibian diversity was also established by means of acoustic identification. No trapping or mist netting was conducted, as the terms of reference did not require such intensive work.

Three criteria were used to gauge the probability of occurrences of herpetofauna species on the study site. These include known distribution ranges, habitat preferences and the qualitative and quantitative presences of suitable habitats.

8.1.2 Desktop Survey Herpetofauna

As many reptiles and amphibians are either secretive, nocturnal, hibernators, migrators and/or seasonal, distributional ranges and the presence of suitable habitats were used to deduce the presence or absence of these species based on authoritative tomes, scientific literature, field guides, atlases and data bases. This can be done with a high level of confidence irrespective of season.

The probability of occurrences of herpetofauna species was based on their respective geographical distributional ranges and the suitability of on-site habitats.

High probability would be applicable to a species with a distributional range overlying the study site as well as the presence of prime habitat occurring on the study site. Another consideration for inclusion in this category is the inclination of a species to be common, i.e. normally occurring at high population densities.

Medium probability pertains to a mammal species with its distributional range peripherally overlapping the study site, or required habitat on the site being sub-optimal. The size of the site as it relates to its likelihood to sustain a viable breeding population, as well as its geographical isolation is also taken into consideration. Species categorized as medium normally do not occur at high population numbers, but cannot be deemed as rare.

A low probability of occurrence will mean that the species' distributional range is peripheral to the study site and habitat is sub-optimal. Furthermore, some mammals categorized as low are generally deemed to be rare.

Based on the impressions gathered during the site visit, as well as publications, such as FitzSimons' Snakes of Southern Africa (Broadley, 1990), Field Guide to Snakes and other Reptiles of Southern Africa (Branch, 1998), A Guide to the Reptiles of Southern Africa (Alexander & Marais, 2007), Atlas and Red List of the Reptiles of South Africa, Lesotho and Swaziland (Bates, Branch, Bauer, Burger, Marias, Alexander & De Villiers, 2014), Amphibians of Central and Southern Africa (Channing 2001), Atlas and Red Data Book of the Frogs of South Africa, Lesotho and Swaziland (Minter, Burger, Harrison, Braack, Bishop & Kloepfer, 2004) and Frogs of Southern Africa; A Complete Guide (Du Preez & Carruthers, 2017), a list of species which may occur on the site was compiled. The latest taxonomic nomenclature was used. The vegetation type was defined according to the standard handbook by Mucina and Rutherford (eds) (2006).

8.1.3 Specific Requirements: Herpetofauna

During the visit the site was surveyed and assessed for the potential occurrence of current Red Data species in the Northern Cape Province such as:

- Giant Bullfrogs (*Pyxicephalus adspersus*);
- Desert Rain Frog (*Breviceps macrops*);
- Namaqua Stream Frog (*Strongylopus springbokensis*);
- Karoo Caco (*Cocosternum karooicum*);
- Leatherback turtle (*Dermochelys coriacea*);
- Karoo Dwarf Tortoise (*Homopus boulengeri*);
- Speckled Dwarf Tortoise (*Homopus signatus*);
- Richtersveld Pygmy Gecko (*Goggia gemmula*);
- Good's Gecko (*Pachydactylus goodi*);
- Namib Web-Footed Gecko (*Pachydactylus rangei*);
- Rooiberg Girdled Lizard (*Cordylus imkeae*);
- Large-Scaled Girdled Lizard (*Cordylus macropholis*);
- Lomi's Blind Legless Skink (*Typhlosaurus lomiae*);
- Plain Mountain Adder (*Bitis inornata*).

8.1.4 Conservation status of herpetofauna habitats

The conservation status of habitats within the study site can be assigned to one of five levels of sensitivity, i.e.

High: Ecologically sensitive and valuable land, with high species richness, sensitive ecosystems or Red Data species, that should be conserved and no development allowed.

Medium-high: Land where sections are disturbed but that is still ecologically sensitive to development/disturbance.

Medium: Land on which low-impact development with limited impact on the ecosystem could be considered, but where it is still recommended that certain portions of the natural habitat be maintained as open spaces.

Medium-low: Land on which small sections could be considered for conservation but where the area in general has little conservation value.

Low: Land that has little conservation value and that could be considered for developed with little to no impact on the habitats or avifauna.

Limitations
The disturbed nature of the site.

8.2 RESULTS

The study site falls within the Kimberley Thornveld (SVk 4) vegetation unit as defined by Mucina and Rutherford (2006).

8.2.1 Herpetofauna Habitat Assessment

The local occurrences of reptiles and amphibians are closely dependent on broadly defined habitat types, in particular terrestrial, arboreal (tree-living), rupicolous (rock-dwelling) and wetland-associated vegetation cover. It is thus possible to deduce the presence or absence of reptile and amphibian species by evaluating the habitat types within the context of global distribution ranges.

From a herpetological habitat perspective the site and adjoining properties offer mainly terrestrial, wetland-associated vegetation cover and arboreal habitat types. There are portions of man-made rupicolous habitat on the site and east of the site on an adjacent property there is natural rupicolous habitat.

Most of the study site consists of transformed terrestrial habitat. The natural habitat was first transformed for agricultural cultivation and used for grazing of livestock. Later other anthropogenic influences include a railway line, tar and gravel roads, power lines, dumping, invasive plants, winter veld fires, extensive diggings (Figure 8.1), ruins, buildings, grazing by horse and cattle and old mining activities (Figure 8.2). The study site is thus ecologically disturbed in many parts. Moribund termitaria were recorded on some parts of the study site. These structures are generally good indicators of the occurrence of small herpetofauna. At the time of the site visit the vegetation cover was generally good, but locally poor. The good cover would provide adequate cover for small terrestrial herpetofauna.

Indigenous umbrella thorn (*Acacia [Vachellia] tortilis*) (Figure 8.3) and exotic mesquite (*Prosopis glandulosa)* occur on the study site and these trees provide arboreal habitat. Due to the presence of natural arboreal habitat, some species like flap-neck chameleon and boomslang were added to the species list in Table 8.1. Limited dead tree logs, which provide some habitat for small herpetofauna, also occur on the study site.

Figure 8.1: A large hole on the southwestern corner of the study site.

Figure 8.2:Old mining activities on the western part of the study site.

Figure 8.3: Umbrella thorn trees on the study site.

There are important wetland features present on the study site. At the southern boundary of the study site, a stream flows (Figure 8.4) into the nearby Kamfers Dam, with its breeding population of lesser flamingos (Figure 8.5). Part of the Kamfers Dam on a neighbouring property falls within the 500-metres buffer area around the study site. Several wetland areas occur north of the stream at the southern half of the study site. A few manmade burrow pits/quarries occur on the study site. One very large, fenced-off, quarry occurs on the south-western part of the study site. Some of these burrow pits are shallow and would provide good breeding habitat for many temporary water-breeding frog species (Figure 8.6).

There are no natural rupicolous habitats on the actual study site, but good manmade rupicolous habitat exists in the form of ruins, building rubble and buildings. On the neighbouring property, east of the site, there is good natural rupicolous habitat (Figure 8.7). Due to the presence of natural rupicolous habitat on the neighbouring property, some species like southern karusa lizard and rock agama were added to the species list in Table 8.1.

Figure 8.4: Part of the wetlands on the south-eastern section of the study site.

Figure 8.5: Young lesser flamingos at the edge of the Kamfers Dam.

Figure 8.6: A shallow burrow pit on the study site.

Figure 8.7: Natural rupicolous habitat on a neighbouring property.

Except for the stream and a drainage line underneath the railway line, connectivity to the site is poor. This is due to the active railway line east of the site, the busy Midlands Road which bisects the southern area of the study site and forms the western border of the northern part of the study site. Townships and a graveyard occur on the western border of the site. Another township and the Homevale waste water treatment works occur on the southern border of the study site. Real opportunities for migration exist east of the railway line to a fairly pristine property.

Sight records were also used to compile this herpetofauna report.

8.2.2 Threatened and Red listed Reptile and Amphibian Species

The study site area falls outside the natural range of the leatherback turtle, Karoo dwarf tortoise, speckled dwarf tortoise, Richtersveld pygmy gecko, Good's gecko, Namib web-footed gecko, Rooiberg girdled lizard, large-scaled girdled lizard, Lomi's blind legless skink, and the plain mountain adder, and these species should not occur on the study site.

The study site area falls outside the natural range of the Namaqua stream frog, desert rain frog and the Karoo caco, and these species should not occur on the study site either.

Giant bullfrogs occur near Kimberley (Minter *et al*, 2004). The study site contains temporary dams/burrow pits, which are potential breeding places for giant bullfrogs. Giant bullfrogs prefer warm, stagnant water, which giant bullfrog tadpoles need for rapid development (Van Wyk, Kok & Du Preez, 1992). Bullfrog breeding sites are mostly temporary, in order to avoid predation from fish. The temporary dams/burrow pits on the study site have gentle slopes, which giant bullfrogs prefer. A gentle slope allows for shallow water (less than 10cm deep), which enables the female bullfrog to stand when she lays her eggs outside the water for the male to fertilise. Many parts of the study site consist of sandy soil and are very suitable as dispersal areas, which combine feeding and aestivation. It is essential that the soil be suitable for burrowing on a daily basis during the short activity period at the beginning of the rainy season and for deeper retreats during the resting periods. There is small chance that giant bullfrog may occur on the site.

It is important to note that in the latest literature (Measey (ed.) 2011 and Carruthers & Du Preez 2011); the giant bullfrog's status has changed officially from Near Threatened (Minter *et al*, 2004) to Least Concern in South Africa. In Gauteng, South Africa, the decline in numbers has led to the species being regarded as a conservation concern (Du Preez & Carruthers, 2017).

No other reptile or amphibian species with Red Data status should occur on the study site.

8.2.3 Expected and Observed Herpetofauna Species Richness:

Of the 46 reptile species which may occur on the study site (Table 1), two were confirmed during the site visit (Table 2) and of the possible 12 amphibian species which may occur on the study site (Table 1); four were confirmed during the site visit (Table 2).

The 58 herpetofauna species are recorded as potential occupants of the study site. Most of these herpetofauna species are robust generalists with the ability to capitalise on disturbed environments. It should be noted that potential occurrence is interpreted as being possible over a period of time, as a result of expansions and contractions of population densities and ranges which stimulate migration.

The American red-eared terrapin (*Trachemys scripta elegans*) and the Brahminy blind snake (*Ramphotyphlops braminus*) are the only two feral reptile or amphibian species known to occur in South Africa (De Moor and Bruton, 1988; Picker and Griffiths, 2011), but with only a few populations, they are not expected to occur on this particular site.

The species assemblage is typical of what can be expected in extensive natural areas with sufficient habitat to sustain populations. Most of the species of the resident diversity (Table 8.1) are fairly common and widespread (viz. spotted sand lizard, brown house snake, mole snake, common egg eater, Cape cobra, Cape skink, Cape gecko, speckled skink, guttural toad, bubbling kassina, common river frog and Boettger's caco).

The species richness is poor to fair due to the disturbed nature of the study site.

Table 8.1: Reptile and Amphibian species which were decuced to occupy the site. Systematic arrangement and nomenclature according to Branch (1998), Alexander and Marais (2007), Bates, *et.al* (2014), Minter, *et.al* (2004) & Du Preez and Carruthers (2017).

	SCIENTIFIC NAME	ENGLISH NAME
	CLASS: REPTILIA	REPTILES
	Order: TESTUDINES	**TORTOISES & TERRAPINS**
	Family: Pelomedusidae	Side-necked Terrapins
?	*Pelomedusa subrufa*	Marsh Terrapin
	Family:Testudinidae	Tortoises
*	*Homopus femoralis*	Greater Dwarf Tortoise
*	*Psammobates oculifer*	Serrated Tent Tortoise
√	*Stigmochelys pardalis*	Leopard Tortoise
	Order: SQUAMATA	**SCALE-BEARING REPTILES**
	Suborder:LACERTILIA	**LIZARDS**

	SCIENTIFIC NAME	ENGLISH NAME
	Family: Gekkonidae	Geckos
?	*Chondrodactylus bibronii*	Bibron's Gecko
*	*Lygodactylus capensis capensis*	Common Dwarf Gecko
√	*Pachydactylus capensis*	Cape Gecko
√	*Pachydactylus mariquensis*	Common Banded Gecko
?	*Ptenopus garrulous*	Common Barking Gecko
	Family: Amphisbaenidae	Amphisbaenians
*	*Monopeltis capensis*	Cape Worm Lizard
	Family:Lacertidae	Old World Lizards or Lacertids
?	*Meroles squamulosus*	Savanna Lizard
?	*Nucras holubi*	Holub's Sandveld Lizard
*	*Nucras intertexta*	Spotted Sandveld Lizard
√	*Pedioplanis lineoocellata lineoocellata*	Spotted Sand Lizard
?	*Pedioplanis namaquensis*	Namaqua Sand Lizard
	Family: Cordyidae	
?	*Karusasaurus polyzonus*	Southern Karusa Lizard
	Family: Scincidae	Skinks
√	*Trachylepis capensis*	Cape Skink
√	*Trachylepys punctatissima*	Speckled Skink
?	*Trachylepis spilogaster*	Kalahari Tree Skink
?	*Trachylepis sulcata sulcata*	Western Rock Skink
?	*Trachylepis varia*	Variable Skink
*	*Trachylepis variegated*	Variegated Skink
	Family: Varanidae	Monitors
√	*Varanus albigularis*	Rock Monitor
	Family: Chamaeleonidae	Chameleons
√	*Chamaeleo dilepis*	Common Flap-Neck Chameleon
	Family: Agamidae	Agamas
√	*Agama aculeata aculeata*	Western Ground Agama

	SCIENTIFIC NAME	ENGLISH NAME
?	*Agama atra*	Southern Rock Agama
	Suborder: SERPENTES	**SNAKES**
	Family: Typhlopidae	Blind Snakes
*	*Rhinotyphlops lalandei*	Delalande's Beaked Blind Snake
	Family: Leptotyphlopidae	Thread Snakes
√	*Leptotyphlops scutifrons*	Peter's Thread Snake
	Family: Viperidae	Adders
√	*Bitis arietans*	Puff Adder
	Family: Lamprophiidae	
?	*Aparallactus capensis*	Black-headed Centipede-Eater
?	*Xenocalamus bicolor bicolor*	Bicoloured Quill-Snouted Snake
√	*Boaedon capensis*	Common House Snake
?	*Lamprophis aurora*	Aurora Snake
?	*Lycodonomorphus rufulus*	Brown Water Snake
*	*Lycophidion capense capensis*	Cape Wolf Snake
*	*Psammophis notostictus*	Karoo Sand Snake
√	*Psammophis trinasalis*	Fork-Marked Sand Snake
?	*Prosymna bivittata*	Two-striped Shovel-Snout
?	*Prosymna sundevallii*	Sundevall's Shovel-Snout
√	*Pseudaspis cana*	Mole Snake
	Family: Elapidae	Cobras, Mambas and Others
√	*Elapsoidea sundevallii*	Sundevall's Garter Snake
√	*Naja nivea*	Cape Cobra
	Family: Colubridae	
√	*Crotaphopeltis hotamboeia*	Red-Lipped Snake
√	*Dasypeltis scabra*	Rhombic Egg Eater
√	*Dispholidus typus*	Boomslang
?	*Philothammus semivariegatus*	Spotted Bush Snake

	SCIENTIFIC NAME	ENGLISH NAME
	Class: AMPHIBIA	**AMPHIBIANS**
	Order: ANURA	**FROGS**
	Family: Bufonidae	Toads
√	*Sclerophrys gutturalis*	Guttural Toad
?	*Sclerophrys capensis*	Raucous Toad
?	*Poyntonophrynus vertebralis*	Southern Pygmy Toad
?	*Amietaophrynus poweri*	Western OliveToad
	Family: Hyperoliidae	Reed frogs
√	*Kassina senegalesis*	Bubbling Kassina
	Family: Breviceptidae	Rain frogs
?	*Breviceps adspersus*	Bushveld rain Frog
	Family: Pipidae	Clawed Frogs
*	*Xenopus laevis*	Common Platanna
	Family: Pyxicephalidae	
√	*Amieta delalandii*	Common River Frog
*	*Amietia poyntoni*	Poynton's River frog
√	*Cocosternum boettgeri*	Boettger's Caco or Common Caco
?	*Amieta angolensis*	Common River Frog
√	*Tomopterna cryptotis*	Tremolo Sand Frog

√ Definitely there or have a *high* probability of occurring;
***** *Medium* probability of occurring based on ecological and distributional parameters;
? *Low* probability of occurring based on ecological and distributional parameters.

Red Data species rankings as defined in Branch, The Conservation Status of South Africa's threatened Reptiles': 89 – 103..In:- G.H.Verdoorn & J. le Roux (editors), 'The State of Southern Africa's Species (2002) and Minter, et.al, Atlas and Red Data Book of the Frogs of South Africa, Lesotho and Swaziland (2004) are indicated in the first column: CR= Critically Endangered, En = Endangered, Vu = Vulnerable, NT = Near Threatened, DD = Data Deficient. All other species are deemed of Least Concern.

Table 8.2: Reptile and Amphibian species positively confirmed on the study site, observed indicators and habitat.

SCIENTIFIC NAME	ENGLISH NAME	OBSERVATION INDICATOR	HABITAT
Pedioplanis lineoocellata lineoocellata	Spotted Sand Lizard	Sight record	Terrestrial
Trachylepys punctatissima	Speckled Skink	Sight record	Man-made rupicolous habitat
Sclerophrys gutturalis	Guttural Toad	Sight record of tadpoles at Gosner stages 24-30 (Gosner, 1960)	Aquatic habitat
Kassina senegalesis	Bubbling Kassina	Vocalisation by a few males as early as 16:15	Aquatic habitat
Amieta delalandii	Common River Frog	Sight record of one adult and tadpoles at Gosner stages 33-35 (Gosner, 1960)	Aquatic habitat
Cocosternum boettgeri	Boettger's Caco	Sight record of two adults and Vocalisation by many males throughout the day	Aquatic habitat

The spotted sand lizard, speckled skink, guttural toad, bubbling kassina, common river frog and Boettger's caco in Table 8.2 should be common within the study site and elsewhere in its range.

8.3 IMPACT ASSESSMENT

The conservation rating of the site for herpetofauna is considered to be **Low**. As the proposed project involves development of a residential area, the faunal impacts will largely be restricted to the construction phase, and fauna will be largely eliminated when people occupy their new homes. The two broad categories of impacts will be habitat loss and disturbance related to construction activities. Since the construction activities will take place over most of the site, the spatial extent of the impacts will be significant.

Table 8.3: Direct impact on mammal and herpetofauna communities and loss of faunal habitat.

Nature: The current habitat is mostly disturbed terrestrial habitat. The wetlands on the site are important herpetofauna habitat and are sensitive and must be protected. The footprint for the proposed residential development will result in clearing most of the vegetation in the area. This will result in some loss of herpetological habitat. After clearing the vegetation, construction will commence. .				
	Without mitigation		**With mitigation**	
CONSTRUCTION PHASE				
Probability	Definite	5	Definite	5
Duration	Short term 2-5years	2	Short term 2-5 years	2
Extent	Limited to Site	1	Limited to Site	1
Magnitude	Minor	1	Small	0
Significance	**Low**	**20**	**Minor**	**15**
Status (positive or negative)	Negative		Negative	
OPERATIONAL PHASE				
Probability	Definite	5	Definite	5
Duration	Permanent	5	Permanent	5
Extent	Site	1	Site	1
Magnitude	Moderate	5	Moderate	4
Significance	**Moderate**	**55**	**Moderate**	**50**
Status (positive or negative)	**Negative**		**Negative**	
Reversibility	No		No.	
Irreplaceable loss of resources?	Yes – but natural fauna habitats are to a degree already disturbed for biodiversity or conservation.		Yes – but natural fauna habitats are to a degree already disturbed for biodiversity or conservation.	
Can impacts be mitigated?	Yes, planting indigenous species in the gardens will improve habitats for fauna			
Mitigation: • . Plant indigenous plant species in the gardens of the new development – no alien species				
Cumulative impacts: Limited, the area is already disturbed and used as an large agricultural holding.				
***Residual Risks*:** No.				

8.3.1 Mitigation measures

The following mitigation measures are proposed:

- If any herpetological species are encountered or exposed during the construction phase, they should be removed and relocated to natural areas in the vicinity. The contractor must ensure that no herpetofauna species are disturbed, trapped, hunted or killed during the construction phase. Any herpetofauna that are inadvertently killed during earthmoving operations should be preserved as museum voucher specimens. Conservation-orientated clauses should be built into contracts for construction personnel, complete with penalty clauses for non-compliance.

- During the construction phase there will be increased surface runoff and a decreased water quality (with increased silt load and pollution). Completing construction during the winter months would mitigate the environmental impact.

- The appropriate agency should implement an ongoing monitoring and eradication program for all invasive plant species growing on the site.

- Any post-development re-vegetation or landscaping exercise should use species indigenous to South Africa. Plant species locally indigenous to the area are preferred. As far as possible, indigenous plants naturally growing along the route, that would otherwise be destroyed during construction, should be used for re-vegetation / landscaping purposes.

8.4 DISCUSSION AND CONCLUSION

There are important wetland features on the study site. At the southern boundary of the study site, a stream flows into the nearby Kamfers Dam, with its breeding population of lesser flamingos. The site contains three of the four herpetofauna habitats on the actual site namely terrestrial, wetlands and arboreal habitat vegetation cover. Rupicolous habitat occurs in the 500-metre buffer area.

Species richness: It must be emphasised that the species richness inferred (Table 8.1) is for the general area and NOT for the study site itself. The species richness for the general area is fair.
Endangered species: Except for the controversial red data status of giant bullfrog which might occur on the site, no other reptile or amphibian species with Red Data status should occur on the study site.
Sensitive species and/or areas (Conservation ranking): From a herpetofaunal point of view there should not be specially protected herpetofauna species on the study site. However the nearby Kamfers Dam, with its breeding population of lesser flamingos is of national and international importance. The wetlands on the site are also sensitive and must be protected. The vegetation type (Kimberley Thornveld, SVk 4) is classified as Least threatened.
Habitat(s) quality and extent: The terrestrial, wetland and arboreal habitat quality is fair, but it is jeopardised by anthropogenic influences such as a railway line, tar and gravel roads, power lines, dumping, invasive plants, winter veld fires, extensive diggings, ruins, buildings, grazing by horse and cattle and old mining activities.

Impact on species richness and conservation: The development of the study site will have a significant and probably lasting effect on species richness and conservation, because of the construction of new houses and new roads carrying more vehicles. These buildings and roads will form an even larger barrier for herpetofauna movement and it will result in a decrease in connectivity. This development will have a large and permanent footprint. However, the biggest problem is pollution of the drainage lines which will negatively affect the water quality of all wetlands, including the Kamfers Dam adjacent to the study site
Connectivity: Poor to fair. Except for the stream and a drainage line underneath the railway line, connectivity is poor. This is due to the active railway line east of the site and the busy Midlands Road which bisects the southern area of the study site and forms the western border of the northern part of the study site. Townships and a graveyard occur on the western border of the site. Another township and the Homevale waste water treatment works occur on the southern border of the study site. Real opportunities for migration exist east of the railway line from a fairly pristine property.
Management recommendation: Measures will have to be taken to stop water pollution of the nearby Kamfers Dam. The removal of invasive plants will increase the quality of habitat for herpetofauna.
General: From a herpetofaunal point of view, no objections can be raised against the proposed development.

There are important wetland features on the study site. At the southern boundary of the study site, a stream flows into the nearby Kamfers Dam. Part of the Kamfers Dam on a neighbouring property falls within the 500-metres buffer area around the study site. Several wetland areas occur north of the stream on the southern half of the study site. These wetlands, as well as their buffer zones, should be considered as ecologically sensitive.

From a herpetofaunal point of view, no objections can be raised against the proposed development.

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9 GENERAL CONCLUSIONS

9.1 VEGETATION AND FLORA

Six vegetation mapping units (with an additional two wetland mapping units) were identified. From a vegetation and flora point of view, and also a conservation point of view, the terrestrial vegetation of the area is already highly disturbed, degraded and transformed. No red data plant species occurs within the site but three provincially protected plant species (Aloe grandidentata, Ammocharis coranica and Orbea lutea) do occur on the site. All these species can easily be transplanted and relocated. Care should be taken with the rescue operation of Ammocharis coranica, as these plants have huge bulbs. The ecological sensitivity of the terrestrial vegetation and ecosystems is regarded to be Low to Medium-Low. The significance of the impacts of the proposed development varies from Minor to Moderate, but is mostly Low. It is concluded that the planned development can be supported on most of the terrestrial ecosystems, excluding wetland buffer areas and excluding the buffer zone for lesser flamingo.

9.2 WETLAND

Several watercourses are present on the site with PES classes varying from natural to largely modified and the EIS classes varying from very high from the pan to low for the seep. In addition, artificial seeps, excavations with wetland characteristics and drainage lines are present. Buffer zones are required around all of the wetland units, apart from the artificial wetland units located in excavations located in several areas of the site. The medium and high sensitivity wetland areas, with their buffer zones is recommended to be excluded from the development. If the wetlands and their buffer zones area excluded from the development and the mitigation measures are implemented, the impact from the development can be limited.

9.3 MAMMALS

From a mammal point of view there should not be any specially protected mammal species on the study site. From a mammal perspective, no objection can be raised against the development.

9.4 BIRDS

From a general avifaunal point of view, most of the terrestrial habitat types are transformed or sem-transformed (secondary) containing unspecialised and generalist bird species with widespread distribution ranges. From a specific avifaunal point of view, and from a conservation perspective, the study site also included certain aquatic and wetland habitat with high ecological sensitivities. These habitat types were located adjacent to the Kamfers Dam, with part of the Dam's shoreline corresponding to the study site. The Kamfers Dam is an Important Bird Area (SA032), and along with the valley-bottom wetlands on the study site, it provided habitat for a high number of waterbirds including five threatened and near threatened bird species of regular occurrence. More importantly, the study site was located next to one of the largest permanent Lesser Flamingo populations in South Africa, and one of only four Lesser Flamingo breeding sites in Africa.

The proposed residential development adjacent to Kamfers Dam was regarded as a potential threat to the long-term persistence of Lesser Flamingos in the area (sensu Anderson, 2015a) and will entail careful planning and engineering. In the absence of environmentally accepted planning and construction activities, any development alongside the Kamfers Dam may be disastrous for the local avifauna and the respective bird habitat types in the area. No development will be supported within the 500 buffer zone, which was proposed to mitigate against the displacement of waterbird species.

9.5 HERPETOFAUNA

From a herpetofauna perspective, no objection can be raised against the development. Measures will have to be taken to stop water pollution of the nearby Kamfers Dam. The removal of invasive plants will increase the quality of habitat for herpetofauna.

9.6 COMBINED SENSITIVITY

Each of the assessments, vegetation, mammals, wetlands, avifauna and herpetofauna resulted in a sensitivity of the identified units. The sensitivity from each assessment was combined to achieve an overall sensitivity for each of the units identified on site. The combined sensitivity is included in

Table 9.1, Figure 9.1 and **Error! Reference source not found.** below.

The sensitive areas on site are mostly the wetland areas on site and the bird habitat associated with the pan and portions of the valley bottom wetlands. The sensitive habitat is therefore associated with the portion of the site located to the east of the powerline and to the south of and including the seep located in the centre of the site. This area must therefore be excluded from the development (Figure 9.3). The units indicated as low of medium sensitivity is generally regarded as suibable for development, dependant on authorisation from the relavant authorities.

Table 9.1: Combined sensitivity assessment of identified units on site.

Unit	Sub-unit	Sensitivity					
		Vegetation	Wetland	Mammals	Birds	Herpetofauna	Combined
Disturbed *Vachellia tortillis* Thornveld		Medium-Low	Low	Low	Medium-Low	Low	Medium-Low
Highly Transformed Area	Central portion	Low	Low	Low	Medium	Low	Low
	Remainder	Low	Low	Low	Low	Low	Low
Disturbed Open Shrubveld		Low	Low	Low	Low	Low	Low
Open Field Secondary Grassland		Low	Low	Low	Low	Low	Low
Degraded *Prosopis* Area	Drainage lines	High	High	Low	Medium-High	Low	High
	Remainder	Low	Low	Low	Low	Low	Low
Mine dump		Low	Low	Low	Low	Low	Low
Wetlands	Pan	High	High	Low	High	Low	Very High
	UCVB	High	High	Low	High	Low	High
	CVB	High	High	Low	High	Low	High
	Seep	High	High	Low	Medium-High	Low	High
	Artificial Seeps	Medium-High	Medium	Low	Medium-High	Low	Medium-High
Quarries and Mining Pits	Excavation of south-western corner	Low	Low	Low	Medium	Low	Low
	Remainder	Low	Low	Low	Low	Low	Low

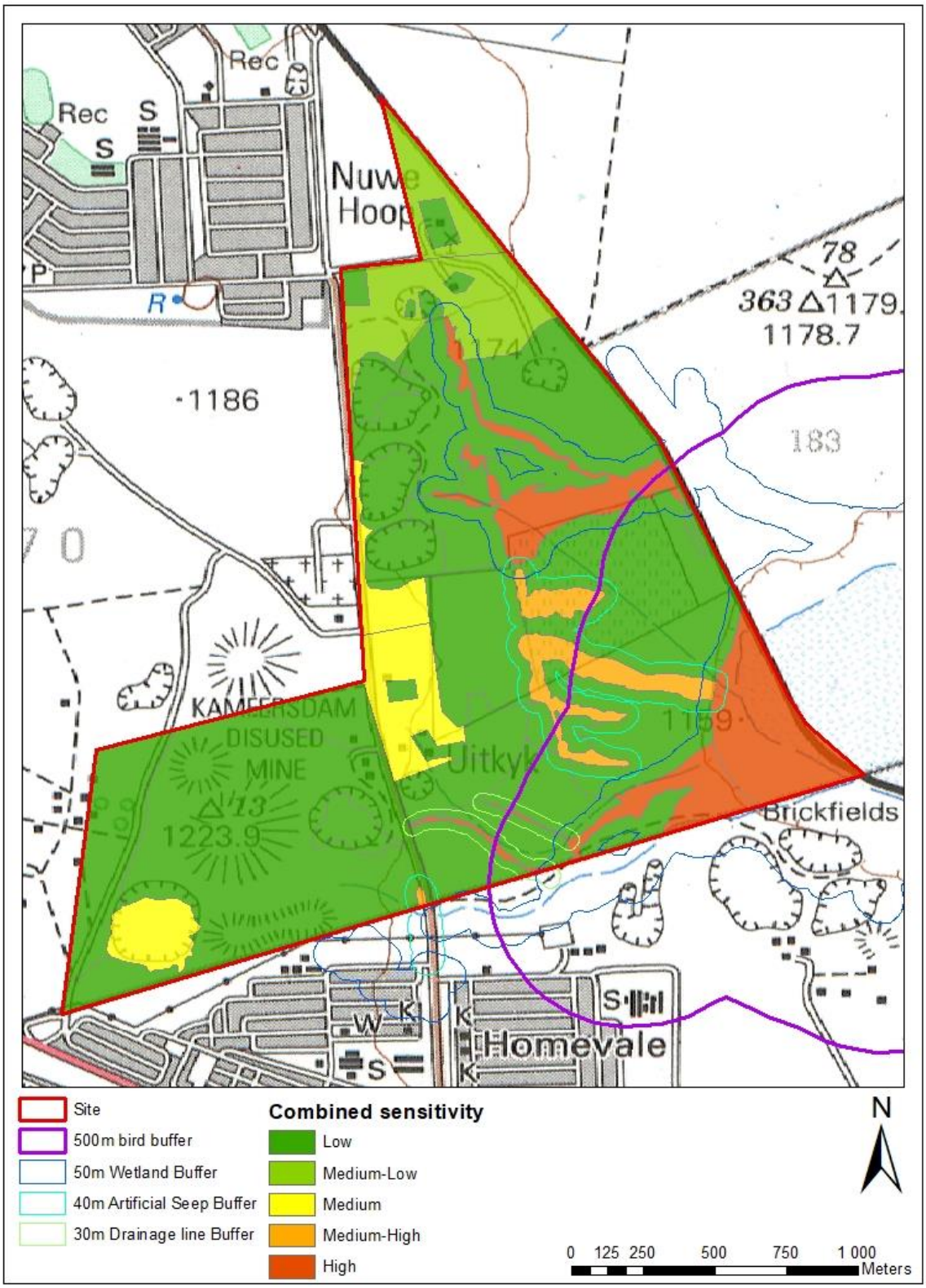

Figure 9.1: Combined sensitivity and buffer zones indicated on the topographical map of the site.

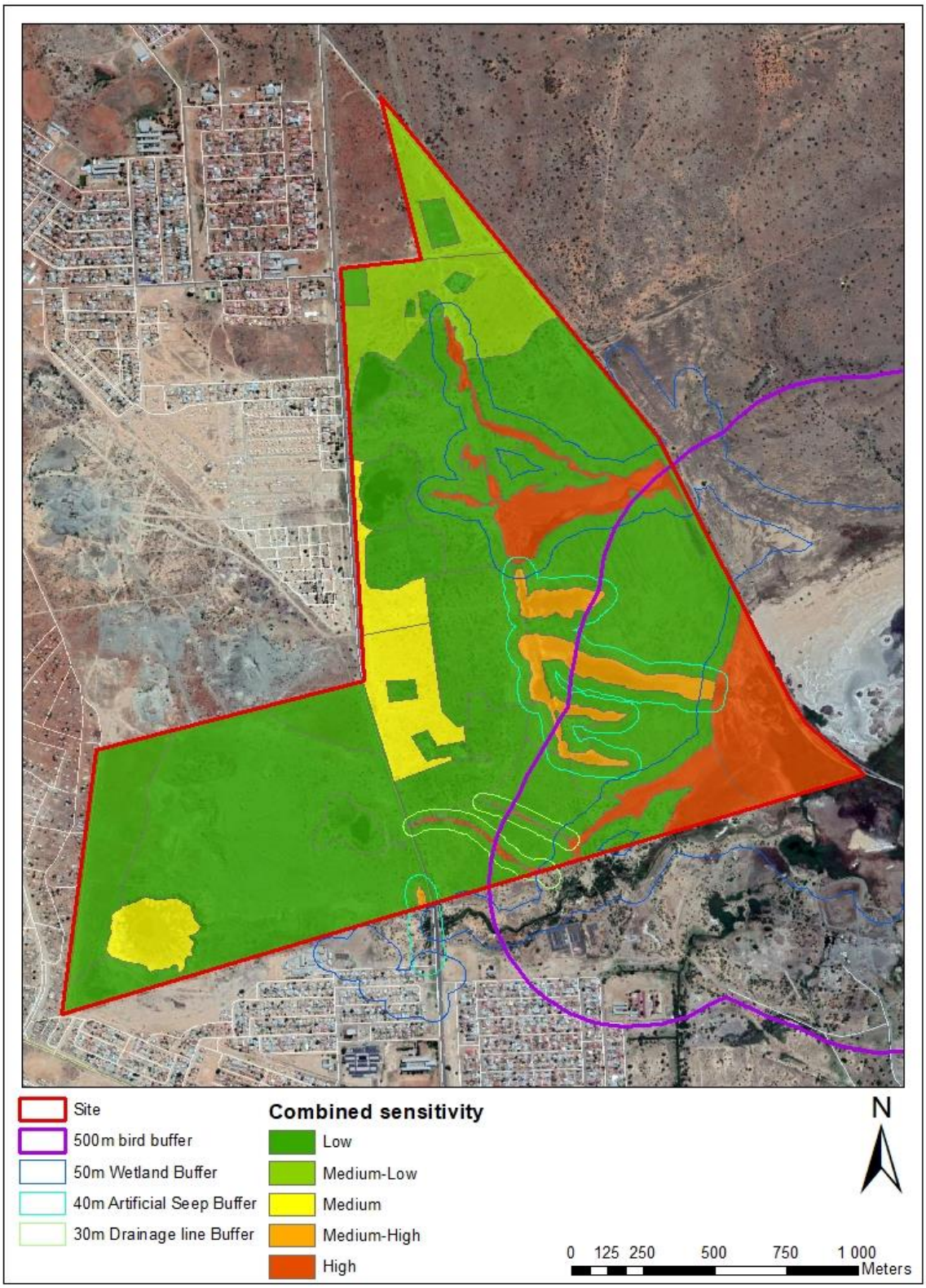

Figure 9.2: Combined sensitivity and buffer zones indicated on the aerial photographs of the site.

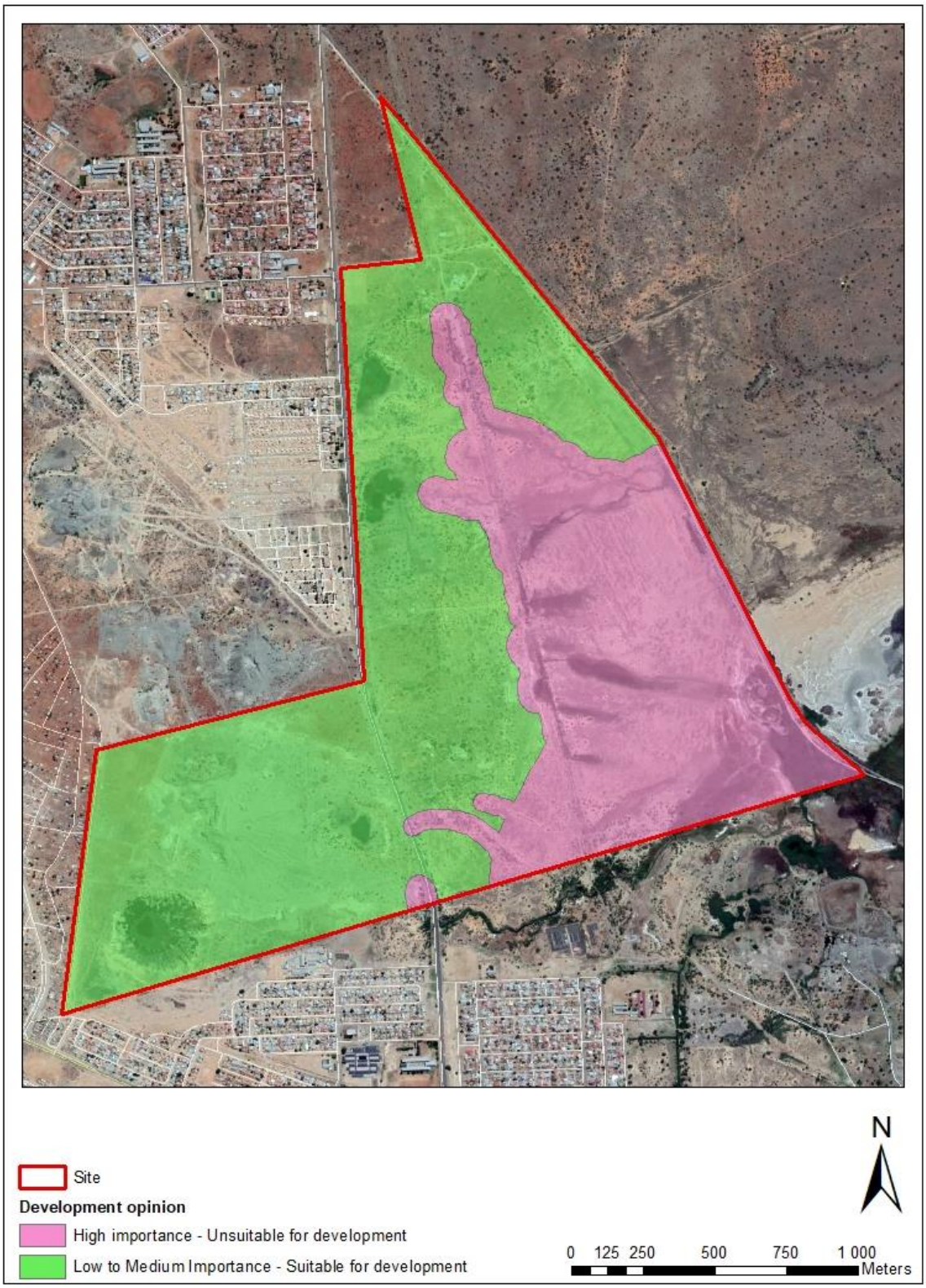

Figure 9.3: Possible suitability of the site for development.

10 LIMITATIONS, ASSUMPTIONS AND GAPS IN KNOWLEDGE

Even though every care is taken to ensure the accuracy of this report, environmental assessment studies are limited in scope, time and budget. Discussions and proposed mitigations are to some extent made on reasonable and informed assumptions built on *bone fide* information sources, as well as deductive reasoning. Deriving a 100% factual report based on field collecting and observations can only be done over several years and seasons to account for fluctuating environmental conditions and migrations. Since environmental impact studies deal with dynamic natural systems, additional information may come to light at a later stage. EcoAgent can therefore not accept responsibility for conclusions and mitigation measures made in good faith based on own databases or on the information provided at the time of the directive. This report should therefore be viewed and acted upon with these limitations in mind.

Addendum A: Avifaunal Diversity Of The Site

A shortlist of bird species expected to occur on the study area (including those observed during the surveys). # refers to IOC numbers. Scientific names were used according to Gill & Donsker (2018) and colloquial names were used according to Hockey et al. (2005). Also provided is the global and regional conservation status of each species (IUCN, 2017; Taylor et al., 2015). CR - Critically Endangered, EN - Endangered, VU - Vulnerable, NT - Near threatened).

Ref	Species name	Scientific name	SABAP2 Reporting Rate						Reporting Rate (%)	Observed	Global Conservation Status	Regional Conservation Status
			Full protocol		Adhoc protocol		Incidentals					
			Rep Rate (%)	n	Rep Rate (%)	n	Reports	Latest				
269	Avocet, Pied	*Recurvirostra avosetta*	5.83	13	2.96	5	1	1/3/2010	18.87	1		
432	Barbet, Acacia Pied	*Tricholaema leucomelas*	52.91	118	8.28	14			51.78	1		
431	Barbet, Black-collared	*Lybius torquatus*	2.69	6	1.18	2	1	6/1/2011	0.89			
439	Barbet, Crested	*Trachyphonus vaillantii*	34.08	76	14.2	24	1	10/3/2009	22.35			
674	Batis, Pririt	*Batis pririt*	41.7	93	7.69	13			12.58	1		
404	Bee-eater, European	*Merops apiaster*	46.64	104	10.06	17	3	11/15/2015	27.25	1		
411	Bee-eater, Swallow-tailed	*Merops hirundineus*	25.11	56	4.14	7	1	8/3/2008	3.56			
409	Bee-eater, White-fronted	*Merops bullockoides*	5.83	13	1.18	2			13.04			
808	Bishop, Southern Red	*Euplectes orix*	56.95	127	12.43	21	2	1/3/2011	27.25	1		
812	Bishop, Yellow-crowned	*Euplectes afer*	3.59	8	1.18	2			5.59	1		
67	Bittern, Little	*Ixobrychus minutus*	0.9	2					1.61			
722	Bokmakierie, Bokmakierie	*Telophorus zeylonus*	30.04	67	1.18	2			26.62	1		
731	Brubru, Brubru	*Nilaus afer*	41.7	93	5.33	9	1	10/3/2009	12.16			
544	Bulbul, African Red-eyed	*Pycnonotus nigricans*	73.09	163	25.44	43	6	1/7/2016	56.81	1		
872	Bunting, Cinnamon-breasted	*Emberiza tahapisi*	6.73	15	0.59	1			1.89			
874	Bunting, Golden-breasted	*Emberiza flaviventris*	11.21	25	0.59	1	1	10/15/2016	2.33			
871	Bunting, Lark-like	*Emberiza impetuani*	6.73	15	0.59	1			4.82	1		
152	Buzzard, Jackal	*Buteo rufofuscus*	0.9	2					0.62			
154	Buzzard, Common (Steppe)	*Buteo buteo vulpinus*	8.97	20	1.18	2	2	12/14/2017	9.22			
860	Canary, Black-throated	*Crithagra atrogularis*	49.78	111	15.38	26			25.79	1		

Ref	Species name	Scientific name	SABAP2 Reporting Rate						Reporting Rate (%)	Observed	Global Conservation Status	Regional Conservation Status
			Full protocol		Adhoc protocol		Incidentals					
			Rep Rate (%)	n	Rep Rate (%)	n	Reports	Latest				
865	Canary, White-throated	*Crithagra albogularis*	2.69	6	0.59	1			3.98			
866	Canary, Yellow	*Crithagra flaviventris*	68.16	152	13.02	22			33.75	1		
575	Chat, Anteating	*Myrmecocichla formicivora*	70.4	157	10.06	17	6	11/15/2015	39.62			
570	Chat, Familiar	*Oenanthe familiaris*	71.3	159	13.61	23	4	10/15/2016	48.85	1		
572	Chat, Sickle-winged	*Emarginata sinuata*	3.59	8					0.00	1		
631	Cisticola, Cloud	*Cisticola textrix*	10.31	23	0.59	1			1.79			
630	Cisticola, Desert	*Cisticola aridulus*	45.74	102	3.55	6	1	10/3/2009	8.39	1		
646	Cisticola, Levaillant's	*Cisticola tinniens*	20.18	45	2.37	4	2	10/3/2009	20.05	1		
642	Cisticola, Rattling	*Cisticola chiniana*	2.24	5					0.00	1		
629	Cisticola, Zitting	*Cisticola juncidis*	23.32	52	3.55	6			4.82	1		
504	Cliff-swallow, South African	*Petrochelidon spilodera*	32.29	72	5.92	10	1	10/2/2009	11.11			
212	Coot, Red-knobbed	*Fulica cristata*	27.35	61	3.55	6	1	10/2/2009	43.19			
50	Cormorant, Reed	*Microcarbo africanus*	15.7	35	1.18	2			24.32	1		
47	Cormorant, White-breasted	*Phalacrocorax carbo*	9.87	22	0.59	1			9.43			
4131	Coucal, Burchell's	*Centropus burchellii*							2.77			
278	Courser, Double-banded	*Rhinoptilus africanus*	25.56	57	4.14	7			9.01			
199	Crake, African	*Crecopsis egregia*	0.45	1					0.00			
203	Crake, Black	*Amaurornis flavirostra*	2.24	5	1.18	2			9.91			
216	Crane, Blue	*Anthropoides paradiseus*	5.83	13	0.59	1			9.43		VU	NT
621	Crombec, Long-billed	*Sylvietta rufescens*	21.52	48	0.59	1			3.56			
522	Crow, Pied	*Corvus albus*	59.64	133	12.43	21	5	10/10/2016	32.08	1		
344	Cuckoo, Black	*Cuculus clamosus*	3.14	7					0.00			
352	Cuckoo, Diderick	*Chrysococcyx caprius*	30.04	67	6.51	11	1	11/12/2007	16.77	1		
348	Cuckoo, Jacobin	*Clamator jacobinus*	8.52	19	1.18	2			1.10			
52	Darter, African	*Anhinga rufa*	4.04	9					13.82			
317	Dove, Laughing	*Spilopelia senegalensis*	79.82	178	40.83	69	6	1/7/2016	90.57	1		
318	Dove, Namaqua	*Oena capensis*	34.08	76	9.47	16	1	1/3/2011	42.14	1		
314	Dove, Red-eyed	*Streptopelia semitorquata*	47.53	106	12.43	21	2	1/2/2010	20.28	1		

Ref	Species name	Scientific name	SABAP2 Reporting Rate						Reporting Rate (%)	Observed	Global Conservation Status	Regional Conservation Status
			Full protocol		Adhoc protocol		Incidentals					
			Rep Rate (%)	n	Rep Rate (%)	n	Reports	Latest				
940	Dove, Rock	*Columba livia*	36.77	82	17.75	30	2	1/2/2010	29.77	1		
517	Drongo, Fork-tailed	*Dicrurus adsimilis*	52.02	116	7.1	12	3	1/2/2010	13.82			
91	Duck, Knob-billed	*Sarkidiornis melanotos*	0.45	1					1.86			
101	Duck, Fulvous	*Dendrocygna bicolor*	3.14	7					22.98			
103	Duck, Maccoa	*Oxyura maccoa*	7.62	17			1	10/2/2009	5.28		VU	NT
104	Duck, White-backed	*Thalassornis leuconotus*	1.79	4					0.68			
100	Duck, White-faced	*Dendrocygna viduata*	16.14	36	1.78	3	2	1/3/2011	27.65	1		
96	Duck, Yellow-billed	*Anas undulata*	20.63	46	4.14	7			31.57	1		
368	Eagle-owl, Spotted	*Bubo africanus*	6.73	15					3.77			
61	Egret, Western Cattle	*Bubulcus ibis*	56.05	125	18.34	31	3	1/3/2010	71.07	1		
58	Egret, Great	*Ardea alba*	3.59	8					5.99	1		
59	Egret, Little	*Egretta garzetta*	6.28	14	1.18	2			15.44	1		
60	Egret, Intermediate	*Ardea intermedia*	2.24	5					9.85	1		
600	Eremomela, Yellow-bellied	*Eremomela icteropygialis*	10.76	24	0.59	1			3.35			
119	Falcon, Amur	*Falco amurensis*	11.66	26			2	1/3/2010	1.09	1		
114	Falcon, Lanner	*Falco biarmicus*	6.73	15	0.59	1			1.10			VU
120	Falcon, Red-footed	*Falco vespertinus*							1.09	1	NT	NT
820	Finch, Red-headed	*Amadina erythrocephala*	36.77	82	2.96	5			15.72			
789	Finch, Scaly-feathered	*Sporopipes squamifrons*	47.98	107	11.83	20	1	10/2/2009	10.48			
837	Firefinch, Red-billed	*Lagonosticta senegala*	4.48	10	1.18	2	1	10/3/2009	0.00			
707	Fiscal, Common (Southern)	*Lanius collaris*	66.82	149	10.06	17	6	11/15/2015	72.12	1		
149	Fish-eagle, African	*Haliaeetus vocifer*	12.56	28	3.55	6			8.99			
86	Flamingo, Greater	*Phoenicopterus ruber*	24.22	54	10.65	18	2	4/18/2017	29.77	1		NT
87	Flamingo, Lesser	*Phoenicopterus minor*	28.7	64	17.75	30	14	4/18/2017	24.11	1	NT	NT
663	Flycatcher, Chat	*Melaenornis infuscatus*	18.83	42	2.37	4			6.71			
678	Flycatcher, Fairy	*Stenostira scita*	13.45	30					5.45			
665	Flycatcher, Fiscal	*Sigelus silens*	74.89	167	11.83	20	3	1/3/2010	54.72	1		
661	Flycatcher, Marico	*Melaenornis mariquensis*	18.39	41	0.59	1			2.90	1		

Ref	Species name	Scientific name	SABAP2 Reporting Rate						Reporting Rate (%)	Observed	Global Conservation Status	Regional Conservation Status
			Full protocol		Adhoc protocol		Incidentals					
			Rep Rate (%)	n	Rep Rate (%)	n	Reports	Latest				
654	Flycatcher, Spotted	*Muscicapa striata*	16.14	36					4.61			
179	Francolin, Orange River	*Scleroptila levaillantoides*	15.7	35	1.18	2	2	1/2/2010	3.46			
89	Goose, Egyptian	*Alopochen aegyptiacus*	32.29	72	4.73	8	1	1/3/2010	35.43	1		
88	Goose, Spur-winged	*Plectropterus gambensis*	13.45	30	4.14	7			16.77	1		
162	Goshawk, Gabar	*Melierax gabar*	17.49	39	4.14	7	2	8/3/2010	9.64			
165	Goshawk, Southern Pale Chanting	*Melierax canorus*	38.12	85	2.96	5			26.42	1		
5	Grebe, Black-necked	*Podiceps nigricollis*	9.87	22	0.59	1	2	10/2/2009	7.14			
4	Grebe, Great Crested	*Podiceps cristatus*	0.45	1					1.38			
6	Grebe, Little	*Tachybaptus ruficollis*	27.35	61	3.55	6	1	10/2/2009	26.83			
263	Greenshank, Common	*Tringa nebularia*	8.07	18	0.59	1	1	1/3/2010	6.58	1		
192	Guineafowl, Helmeted	*Numida meleagris*	39.91	89	6.51	11	2	1/2/2010	23.06			
288	Gull, Grey-headed	*Chroicocephalus cirrocephalus*	24.66	55	5.92	10	3	11/7/2015	19.92	1		
72	Hamerkop, Hamerkop	*Scopus umbretta*	4.93	11					7.13			
55	Heron, Black-headed	*Ardea melanocephala*	12.56	28	2.96	5	2	11/22/2015	36.69			
56	Heron, Goliath	*Ardea goliath*	2.69	6					7.14			
63	Heron, Green-backed	*Butorides striata*	0.9	2					2.90			
54	Heron, Grey	*Ardea cinerea*	10.76	24	2.37	4			28.51			
57	Heron, Purple	*Ardea purpurea*	4.04	9					5.99			
62	Heron, Squacco	*Ardeola ralloides*	2.69	6					9.91	1		
440	Honeyguide, Greater	*Indicator indicator*	1.35	3	0.59	1			0.93			
442	Honeyguide, Lesser	*Indicator minor*	4.04	9	0.59	1			1.24			
418	Hoopoe, African	*Upupa africana*	69.51	155	20.71	35	4	10/15/2016	65.62	1		
426	Hornbill, Southern Yellow-billed	*Tockus leucomelas*	4.93	11	0.59	1			3.80			
507	House-martin, Common	*Delichon urbicum*	0.9	2					2.33			
81	Ibis, African Sacred	*Threskiornis aethiopicus*	17.04	38	4.73	8	1	11/12/2007	41.51	1		
83	Ibis, Glossy	*Plegadis falcinellus*	20.63	46	2.96	5	2	1/3/2010	36.06	1		
84	Ibis, Hadeda	*Bostrychia hagedash*	59.64	133	17.16	29	4	9/20/2014	24.32	1		
851	Indigobird, Village	*Vidua chalybeata*	0.9	2					0.00			

Ref	Species name	Scientific name	SABAP2 Reporting Rate						Reporting Rate (%)	Observed	Global Conservation Status	Regional Conservation Status
			Full protocol		Adhoc protocol		Incidentals					
			Rep Rate (%)	n	Rep Rate (%)	n	Reports	Latest				
228	Jacana, African	*Actophilornis africanus*	3.59	8					7.45			
122	Kestrel, Greater	*Falco rupicoloides*	12.56	28					6.29			
125	Kestrel, Lesser	*Falco naumanni*	26.91	60	4.14	7	2	1/3/2010	16.56	1		
123	Kestrel, Rock	*Falco rupicolus*	7.17	16	0.59	1	1	10/15/2016	11.32	1		
402	Kingfisher, Brown-hooded	*Halcyon albiventris*	12.11	27			1	7/3/2016	2.77			
397	Kingfisher, Malachite	*Corythornis cristata*	3.59	8	0.59	1			8.53			
394	Kingfisher, Pied	*Ceryle rudis*	3.59	8					14.52			
130	Kite, Black-winged	*Elanus caeruleus*	36.77	82	8.28	14	1	4/18/2017	41.93	1		
129	Kite, Yellow-billed	*Milvus aegyptius*							1.24			
1035	Korhaan, Northern Black	*Afrotis afraoides*	66.82	149	7.69	13	3	1/2/2010	47.59	1		
224	Korhaan, Red-crested	*Lophotis ruficrista*	13.9	31	1.18	2	1	10/2/2009	0.62			
245	Lapwing, Blacksmith	*Vanellus armatus*	45.74	102	6.51	11	2	10/3/2009	59.54	1		
242	Lapwing, Crowned	*Vanellus coronatus*	74.44	166	14.2	24	1	10/3/2009	76.73	1		
1183	Lark, Eastern Clapper	*Mirafra fasciolata*	48.43	108	4.73	8	3	1/2/2010	18.03	1		
459	Lark, Fawn-coloured	*Calendulauda africanoides*	39.01	87	4.14	7			8.81			
490	Lark, Pink-billed	*Spizocorys conirostris*	12.11	27					0.89			
488	Lark, Red-capped	*Calandrella cinerea*	12.56	28					3.98			
458	Lark, Rufous-naped	*Mirafra africana*	27.8	62	5.92	10	4	1/2/2010	0.84	1		
460	Lark, Sabota	*Calendulauda sabota*	24.22	54	1.18	2	2	1/2/2010	9.01	1		
474	Lark, Spike-heeled	*Chersomanes albofasciata*	43.05	96	4.73	8			13.00	1		
703	Longclaw, Cape	*Macronyx capensis*	8.97	20	1.18	2			2.40			
167	Marsh-harrier, African	*Circus ranivorus*							1.55			EN
510	Martin, Banded	*Riparia cincta*	5.38	12					2.77			
509	Martin, Brown-throated	*Riparia paludicola*	24.22	54	4.14	7	1	11/12/2007	14.47	1		
506	Martin, Rock	*Ptyonoprogne fuligula*	48.43	108	12.43	21	1	1/3/2010	20.75	1		
508	Martin, Sand	*Riparia riparia*	2.69	6					0.00			
803	Masked-weaver, Southern	*Ploceus velatus*	78.03	174	23.08	39	4	1/3/2010	59.33	1		
210	Moorhen, Common	*Gallinula chloropus*	26.91	60	5.33	9			32.91	1		

Ref	Species name	Scientific name	SABAP2 Reporting Rate						Reporting Rate (%)	Observed	Global Conservation Status	Regional Conservation Status
			Full protocol		Adhoc protocol		Incidentals					
			Rep Rate (%)	n	Rep Rate (%)	n	Reports	Latest				
392	Mousebird, Red-faced	*Urocolius indicus*	36.32	81	10.65	18	2	10/3/2009	25.79			
391	Mousebird, White-backed	*Colius colius*	54.26	121	14.79	25	2	10/15/2016	58.49	1		
734	Myna, Common	*Acridotheres tristis*	30.94	69	20.71	35	2	1/7/2016	0.00			
637	Neddicky, Neddicky	*Cisticola fulvicapilla*	48.88	109	0.59	1			7.55	1		
69	Night-Heron, Black-crowned	*Nycticorax nycticorax*	4.93	11	1.18	2			11.29	1		
372	Nightjar, Rufous-cheeked	*Caprimulgus rufigena*	6.28	14			1	10/2/2009	1.24			
359	Owl, Western Barn	*Tyto alba*	19.73	44	4.14	7	1	10/3/2009	2.39			
361	Owl, Marsh	*Asio capensis*	0.45	1	0.59	1			2.72			
365	Owlet, Pearl-spotted	*Glaucidium perlatum*	5.38	12					0.00			
748	Oxpecker, Red-billed	*Buphagus erythrorhynchus*	0.45	1					0.00			
230	Painted-snipe, Greater	*Rostratula benghalensis*	0.9	2					0.54			NT
387	Palm-swift, African	*Cypsiurus parvus*	43.95	98	14.2	24	1	11/22/2015	2.53	1		
682	Paradise-flycatcher, African	*Terpsiphone viridis*					1	1/12/2009	0.89			
852	Paradise-whydah, Long-tailed	*Vidua paradisaea*	0.9	2					1.29			
531	Penduline-tit, Cape	*Anthoscopus minutus*	8.97	20					1.71			
311	Pigeon, Speckled	*Columba guinea*	81.61	182	28.99	49	4	11/22/2015	44.03	1		
692	Pipit, African	*Anthus cinnamomeus*	47.53	106	5.33	9			10.90	1		
695	Pipit, Buffy	*Anthus vaalensis*	16.59	37	2.37	4			2.33			
694	Pipit, Plain-backed	*Anthus leucophrys*	14.8	33	2.96	5			0.00			
236	Plover, Chestnut-banded	*Charadrius pallidus*	1.35	3	0.59	1			0.00		NT	NT
233	Plover, Common Ringed	*Charadrius hiaticula*	1.35	3	1.18	2			2.77	1		
237	Plover, Kittlitz's	*Charadrius pecuarius*	7.62	17	0.59	1			6.71	1		
238	Plover, Three-banded	*Charadrius tricollaris*	24.22	54	3.55	6			27.46	1		
102	Pochard, Southern	*Netta erythrophthalma*	12.56	28	1.78	3			12.21			
650	Prinia, Black-chested	*Prinia flavicans*	60.09	134	10.06	17			46.33	1		
189	Quail, Common	*Coturnix coturnix*	0.9	2					7.14			
190	Quail, Harlequin	*Coturnix delegorguei*	0.45	1					0.89			
844	Quailfinch, African	*Ortygospiza atricollis*	17.04	38					2.07	1		

Ref	Species name	Scientific name	SABAP2 Reporting Rate						Reporting Rate (%)	Observed	Global Conservation Status	Regional Conservation Status
			Full protocol		Adhoc protocol		Incidentals					
			Rep Rate (%)	n	Rep Rate (%)	n	Reports	Latest				
805	Quelea, Red-billed	*Quelea quelea*	31.39	70	5.92	10			7.97	1		
197	Rail, African	*Rallus caerulescens*							0.54			
606	Reed-warbler, African	*Acrocephalus baeticatus*	13.9	31	1.78	3			3.98	1		
603	Reed-warbler, Great	*Acrocephalus arundinaceus*	0.45	1					5.43	1		
581	Robin-chat, Cape	*Cossypha caffra*	41.26	92	9.47	16	2	10/5/2009	38.78	1		
561	Rock-thrush, Short-toed	*Monticola brevipes*	9.87	22	0.59	1			3.14			
412	Roller, European	*Coracias garrulus*	3.59	8	0.59	1			0.00			
413	Roller, Lilac-breasted	*Coracias caudatus*	4.04	9	0.59	1			2.17			
256	Ruff, Ruff	*Philomachus pugnax*	11.66	26	2.96	5	1	1/3/2010	13.21	1		
609	Rush-warbler, Little	*Bradypterus baboecala*	0.9	2					0.00			
307	Sandgrouse, Namaqua	*Pterocles namaqua*	9.87	22					8.18			
258	Sandpiper, Common	*Actitis hypoleucos*	2.69	6					4.15			
251	Sandpiper, Curlew	*Calidris ferruginea*	2.69	6	0.59	1			4.66		NT	
262	Sandpiper, Marsh	*Tringa stagnatilis*	5.38	12					3.23			
264	Sandpiper, Wood	*Tringa glareola*	8.07	18	2.37	4			14.29	1		
421	Scimitarbill, Common	*Rhinopomastus cyanomelas*	39.91	89	6.51	11			32.91			
586	Scrub-robin, Kalahari	*Cercotrichas paena*	60.09	134	5.92	10			21.59	1		
583	Scrub-robin, Karoo	*Cercotrichas coryphoeus*	11.21	25	0.59	1			5.03			
105	Secretarybird, Secretarybird	*Sagittarius serpentarius*	16.59	37	2.37	4			8.39		VU	VU
90	Shelduck, South African	*Tadorna cana*	25.11	56	5.33	9			19.71	1		
94	Shoveler, Cape	*Anas smithii*	20.63	46	1.18	2			24.32	1		
711	Shrike, Crimson-breasted	*Laniarius atrococcineus*	38.12	85					14.47	1		
706	Shrike, Lesser Grey	*Lanius minor*	26.01	58	3.55	6	2	1/3/2010	5.45			
708	Shrike, Red-backed	*Lanius collurio*	15.7	35	1.18	2			5.24			
146	Snake-eagle, Black-chested	*Circaetus pectoralis*	3.59	8					0.68			
250	Snipe, African	*Gallinago nigripennis*	1.79	4	1.78	3			3.92			
786	Sparrow, Cape	*Passer melanurus*	82.51	184	32.54	55	6	1/7/2016	81.34	1		
784	Sparrow, House	*Passer domesticus*	50.22	112	24.85	42	4	10/15/2016	63.94	1		

Ref	Species name	Scientific name	SABAP2 Reporting Rate						Reporting Rate (%)	Observed	Global Conservation Status	Regional Conservation Status
			Full protocol		Adhoc protocol		Incidentals					
			Rep Rate (%)	n	Rep Rate (%)	n	Reports	Latest				
4142	Sparrow, Southern Grey-headed	*Passer diffusus*	39.91	89	1.78	3	1	10/3/2009	3.46	1		
780	Sparrow-weaver, White-browed	*Plocepasser mahali*	63.23	141	10.06	17	3	11/22/2015	52.83	1		
485	Sparrowlark, Grey-backed	*Eremopterix verticalis*	7.17	16	0.59	1			2.05			
85	Spoonbill, African	*Platalea alba*	4.93	11					9.45			
185	Spurfowl, Swainson's	*Pternistis swainsonii*	17.94	40	2.37	4	1	1/2/2010	11.75	1		
737	Starling, Cape Glossy	*Lamprotornis nitens*	67.26	150	18.93	32	3	1/3/2011	49.69	1		
733	Starling, Common	*Sturnus vulgaris*	4.48	10	0.59	1			0.00			
744	Starling, Pale-winged	*Onychognathus nabouroup*	0.45	1					1.64			
746	Starling, Pied	*Spreo bicolor*	30.94	69	7.1	12	2	9/20/2014	40.25	1		
735	Starling, Wattled	*Creatophora cinerea*	26.01	58	4.14	7	1	1/3/2010	39.83			
270	Stilt, Black-winged	*Himantopus himantopus*	21.52	48	7.69	13	4	1/3/2010	35.22	1		
253	Stint, Little	*Calidris minuta*	9.87	22	2.37	4			13.21	1		
576	Stonechat, African	*Saxicola torquatus*	3.59	8	1.18	2	1	8/7/2010	3.56			
78	Stork, Abdim's	*Ciconia abdimii*	1.79	4	0.59	1			1.86			NT
80	Stork, White	*Ciconia ciconia*	2.69	6					4.35			
76	Stork, Yellow-billed	*Mycteria ibis*	1.79	4					1.63			EN
764	Sunbird, Dusky	*Cinnyris fuscus*	6.28	14	5.92	10			16.35	1		
763	Sunbird, White-bellied	*Cinnyris talatala*	22.87	51	5.33	9			0.00	1		
493	Swallow, Barn	*Hirundo rustica*	46.19	103	6.51	11	2	11/22/2015	30.82	1		
502	Swallow, Greater Striped	*Cecropis cucullata*	58.74	131	8.88	15	5	9/20/2014	22.22	1		
498	Swallow, Pearl-breasted	*Hirundo dimidiata*	4.48	10	1.18	2			0.80			
501	Swallow, Red-breasted	*Cecropis semirufa*	16.14	36	1.18	2	1	9/23/2015	7.34			
495	Swallow, White-throated	*Hirundo albigularis*	11.21	25	0.59	1	1	10/2/2009	14.88	1		
604	Swamp-warbler, Lesser	*Acrocephalus gracilirostris*	24.22	54	2.96	5			17.28	1		
208	Swamphen, African Purple	*Porphyrio madagascariensis*	4.48	10			1	10/2/2009	33.54			
380	Swift, African Black	*Apus barbatus*	3.59	8	2.37	4			4.19			
386	Swift, Alpine	*Tachymarptis melba*	28.7	64	7.1	12	3	11/22/2015	10.27	1		
381	Swift, Bradfield's	*Apus bradfieldi*	25.11	56	13.61	23	6	4/18/2017	2.19	1		

Ref	Species name	Scientific name	SABAP2 Reporting Rate						Reporting Rate (%)	Observed	Global Conservation Status	Regional Conservation Status
			Full protocol		Adhoc protocol		Incidentals					
			Rep Rate (%)	n	Rep Rate (%)	n	Reports	Latest				
378	Swift, Common	*Apus apus*	3.14	7	0.59	1			3.14	1		
385	Swift, Little	*Apus affinis*	70.4	157	25.44	43	6	10/15/2016	45.49	1		
383	Swift, White-rumped	*Apus caffer*	30.49	68	5.92	10	2	11/22/2015	9.22	1		
714	Tchagra, Brown-crowned	*Tchagra australis*	21.97	49	1.78	3			2.94			
98	Teal, Cape	*Anas capensis*	23.77	53	4.73	8	1	10/2/2009	26.27	1		
99	Teal, Hottentot	*Anas hottentota*	8.07	18	2.37	4			33.85	1		
97	Teal, Red-billed	*Anas erythrorhyncha*	19.73	44	4.73	8			19.50	1		
305	Tern, Whiskered	*Chlidonias hybrida*	3.59	8	2.37	4			3.11			
304	Tern, White-winged	*Chlidonias leucopterus*	5.83	13	0.59	1			11.75	1		
275	Thick-knee, Spotted	*Burhinus capensis*	20.63	46	3.55	6	2	1/1/2010	13.84			
557	Thrush, Groundscraper	*Turdus litsipsirupa*	2.69	6	1.78	3			1.86			
1104	Thrush, Karoo	*Turdus smithi*	37.22	83	17.75	30	2	10/15/2016	51.15	1		
514	Tit, Ashy	*Melaniparus cinerascens*	28.7	64	2.37	4			8.18	1		
658	Warbler, Chestnut-vented	*Sylvia subcoerulea*	60.54	135	4.14	7	1	10/3/2009	25.16	1		
316	Turtle-dove, Cape	*Streptopelia capicola*	72.65	162	11.83	20	2	10/3/2009	53.88	1		
107	Vulture, White-backed	*Gyps africanus*	33.18	74	8.28	14	8	12/14/2017	11.32	1	CR	CR
686	Wagtail, Cape	*Motacilla capensis*	64.57	144	18.93	32	2	4/13/2017	64.99	1		
599	Warbler, Willow	*Phylloscopus trochilus*	2.69	6					1.64			
607	Warbler, Marsh	*Acrocephalus palustris*					1	2/17/2018		1		
608	Warbler, Sedge	*Acrocephalus schoenobaenus*					1	2/17/2018		1		
841	Waxbill, Black-faced	*Estrilda erythronotos*	17.49	39					1.01	1		
843	Waxbill, Common	*Estrilda astrild*	3.14	7	1.18	2			5.30	1		
840	Waxbill, Violet-eared	*Uraeginthus granatinus*	16.59	37			1	8/3/2008	1.37			
783	Weaver, Sociable	*Philetairus socius*	13.9	31	0.59	1			10.06			
568	Wheatear, Capped	*Oenanthe pileata*	16.59	37	1.78	3			7.13			
564	Wheatear, Mountain	*Myrmecocichla monticola*	4.48	10					8.60			
1171	White-eye, Orange River	*Zosterops pallidus*	39.01	87	9.47	16			46.54	1		
846	Whydah, Pin-tailed	*Vidua macroura*	6.28	14					3.46			

Ref	Species name	Scientific name	SABAP2 Reporting Rate						Reporting Rate (%)	Observed	Global Conservation Status	Regional Conservation Status
			Full protocol		Adhoc protocol		Incidentals					
			Rep Rate (%)	n	Rep Rate (%)	n	Reports	Latest				
847	Whydah, Shaft-tailed	*Vidua regia*	4.04	9					0.93			
419	Wood-hoopoe, Green	*Phoeniculus purpureus*	2.69	6	0.59	1			0.00			
450	Woodpecker, Cardinal	*Dendropicos fuscescens*	15.25	34	1.18	2			4.15			
447	Woodpecker, Golden-tailed	*Campethera abingoni*	21.52	48	0.59	1	2	5/3/2016	2.17			

Addendum B: WetHealth Assessment Sheets

Addendum C: EIS Assessment sheets

Pan

EIS

ECOLOGICAL IMPORTANCE AND SENSITIVITY	Score (0-4)	*Confidence (1-5)*	Motivation
Biodiversity support	**3.67**	*4.67*	
Presence of Red Data species	**4.00**	*5.00*	Used by the Lesser Flamingo and Greated Flamingo
Populations of unique species	**3.00**	*4.00*	Several bird species are present.
Migration/breeding/feeding sites	**4.00**	*5.00*	The only area in South Africa where the Lesser Flamingo occasionally breed.
Landscape scale	**1.80**	*3.60*	
Protection status of the wetland	**2.00**	*4.00*	In the municipal area but protected by the province.
Protection status of the vegetation type	**1.00**	*4.00*	The site is in the Kimberley Thornveld which is not threatened.
Regional context of the ecological integrity	**3.00**	*4.00*	The wetland is Natural, which is mostly more disturbed than wetland areas in the catchment.
Size and rareity of the wetland type/s present	**1.00**	*3.00*	The site is not particularly large or rare.
Diversity of habitat types	**2.00**	*3.00*	The wetland has temporary to permanent wetness zones.
Sensitivity of the wetland	**0.67**	*3.33*	
Sensitivity to changes in floods	1.00	*3.00*	Already highly affected.
Sensitivity to changes in low flows/dry season	-	*3.00*	Already highly affected.
Sensitivity to changes in water quality	1.00	*4.00*	Unlikely to be sensitive
ECOLOGICAL IMPORTANCE & SENSITIVITY	**3.7**	*3.9*	

Hydro-functional Importance

HYDRO-FUNCTIONAL IMPORTANCE			Score (0-4)	*Confidence (1-5)*	Motivation
Regulating & supporting benefits		Flood attenuation	0	4	Unlikely to perform to a significant degree due to wetland type.
		Streamflow regulation	1	3	Higly unlikely to perform streamflow regulation function due to wetland type.
	Water Quality Enhancement	*Sediment trapping*	3	4	Likely to trap sediment mobilised in the catchment.
		Phosphate assimilation	3	4	The systems receive flow from several developments, as well as the waste water treatment works and is expected to receive some polluted water.
		Nitrate assimilation	3	4	
		Toxicant assimilation	2	4	
		Erosion control	1	3	Erosion control is expected to be limited.
		Carbon storage	0	5	No signs of carbon storage were observed, and carbon storage is unlikely due to the climate.
HYDRO-FUNCTIONAL IMPORTANCE			1.6	*4.0*	

Direct Human Benefits

DIRECT HUMAN BENEFITS		Score (0-4)	*Confidence (1-5)*	Motivation
Subsistence benefits	*Water for human use*	0	4	No signs of use were observed.
	Harvestable resources	0	5	No signs of use were observed.
	Cultivated foods	0	5	No signs of use were observed.
Cultural benefits	*Cultural heritage*	0	4	No signs of use were observed and unlikely to be used.
	Tourism and recreation	3	4	Not currently used but has potential for a birding site.
	Education and research	3	4	Not currently used but has potential for research on the Lesser Flamingo.
DIRECT HUMAN BENEFITS		1.0	*4.0*	

UCVB

EIS

ECOLOGICAL IMPORTANCE AND SENSITIVITY	Score (0-4)	*Confidence (1-5)*	Motivation
Biodiversity support	**0.67**	*3.33*	
Presence of Red Data species	**-**	*4.00*	None were observed, and none are expected.
Populations of unique species	**1.00**	*3.00*	None were observed, and none are expected.
Migration/breeding/feeding sites	**1.00**	*3.00*	None were observed, and none are expected.
Landscape scale	**1.00**	*3.60*	
Protection status of the wetland	**-**	*4.00*	The site is located in an unfenced area.
Protection status of the vegetation type	**1.00**	*4.00*	The site is in the Kimberley Thornveld which is not threatened.
Regional context of the ecological integrity	**1.00**	*4.00*	The wetland is Largely Modified, which is mostly more disturbed than wetland areas in the catchment.
Size and rareity of the wetland type/s present	**1.00**	*3.00*	The site is not particularly large or rare.
Diversity of habitat types	**2.00**	*3.00*	The wetland has temporary to permanent wetness zones.
Sensitivity of the wetland	**2.00**	*3.33*	
Sensitivity to changes in floods	2.00	*3.00*	Already highly affected.
Sensitivity to changes in low flows/dry season	3.00	*3.00*	Already highly affected.
Sensitivity to changes in water quality	1.00	*4.00*	Unlikely to be sensitive
ECOLOGICAL IMPORTANCE & SENSITIVITY	**2.0**	*3.4*	

Hydro-functional Importance

HYDRO-FUNCTIONAL IMPORTANCE			Score (0-4)	*Confidence (1-5)*	Motivation
Regulating & supporting benefits		Flood attenuation	2	*4*	The lower portion of the unit may perform function.
		Streamflow regulation	2	*3*	The lower portion of the unit may perform function.
	Water Quality Enhancement	*Sediment trapping*	3	*4*	Sediment may accumulate in portions of the wetland.
		Phosphate assimilation	3	*4*	Several developments are located next to the unit and may contribute pollutants to the system.
		Nitrate assimilation	3	*4*	
		Toxicant assimilation	2	*4*	
		Erosion control	1	*3*	Erosion control is expected to be limited.
		Carbon storage	0	*5*	No signs of carbon storage were observed, and carbon storage is unlikely due to the climate.
HYDRO-FUNCTIONAL IMPORTANCE			2.0	*4.0*	

Direct Human Benefits

DIRECT HUMAN BENEFITS		Score (0-4)	*Confidence (1-5)*	Motivation
Subsistence benefits	*Water for human use*	*0*	*4*	No signs of use were observed.
	Harvestable resources	*0*	*5*	No signs of use were observed.
	Cultivated foods	*0*	*5*	No signs of use were observed.
Cultural benefits	*Cultural heritage*	*0*	*4*	No signs of use were observed and unlikely to be used.
	Tourism and recreation	*1*	*4*	Have very limited potential for use.
	Education and research	*1*	*4*	Have very limited potential for use.
DIRECT HUMAN BENEFITS		0.3	*4.0*	

CVB

EIS

ECOLOGICAL IMPORTANCE AND SENSITIVITY	Score (0-4)	*Confidence (1-5)*	Motivation
Biodiversity support	**0.67**	*3.33*	
Presence of Red Data species	**-**	*4.00*	None were observed, and none are expected.
Populations of unique species	**1.00**	*3.00*	None were observed, and none are expected.
Migration/breeding/feeding sites	**1.00**	*3.00*	None were observed, and none are expected.
Landscape scale	**1.20**	*3.60*	
Protection status of the wetland	**-**	*4.00*	The site is located in an unfenced area.
Protection status of the vegetation type	**1.00**	*4.00*	The site is in the Kimberley Thornveld which is not threatened.
Regional context of the ecological integrity	**2.00**	*4.00*	The wetland is Largely Natural, similar to other systems in the area, but the geomorphological impact is underestimated.
Size and rareity of the wetland type/s present	**1.00**	*3.00*	The site is not particularly large or rare.
Diversity of habitat types	**2.00**	*3.00*	The wetland has temporary to permanent wetness zones.
Sensitivity of the wetland	**1.67**	*3.33*	
Sensitivity to changes in floods	2.00	*3.00*	Already highly affected.
Sensitivity to changes in low flows/dry season	2.00	*3.00*	Already highly affected.
Sensitivity to changes in water quality	1.00	*4.00*	Unlikely to be sensitive
ECOLOGICAL IMPORTANCE & SENSITIVITY	**1.7**	*3.4*	

Hydro-functional Importance

HYDRO-FUNCTIONAL IMPORTANCE			Score (0-4)	*Confidence (1-5)*	Motivation
Regulating & supporting benefits		Flood attenuation	2	*4*	The lower portion of the unit may perform function.
		Streamflow regulation	2	*3*	The lower portion of the unit may perform function.
	Water Quality Enhancement	*Sediment trapping*	3	*4*	Sediment may accumulate in portions of the wetland.
		Phosphate assimilation	3	*4*	Several developments are located next to the unit and may contribute pollutants to the system.
		Nitrate assimilation	3	*4*	
		Toxicant assimilation	2	*4*	
		Erosion control	1	*3*	Erosion control is expected to be limited.
		Carbon storage	0	*5*	No signs of carbon storage were observed, and carbon storage is unlikely due to the climate.
HYDRO-FUNCTIONAL IMPORTANCE			2.0	*4.0*	

Direct Human Benefits

DIRECT HUMAN BENEFITS		Score (0-4)	*Confidence (1-5)*	Motivation
Subsistence benefits	*Water for human use*	*0*	*4*	No signs of use were observed.
	Harvestable resources	*0*	*5*	No signs of use were observed.
	Cultivated foods	*0*	*5*	No signs of use were observed.
Cultural benefits	*Cultural heritage*	*0*	*4*	No signs of use were observed and unlikely to be used.
	Tourism and recreation	*1*	*4*	Have very limited potential for use.
	Education and research	*1*	*4*	Have very limited potential for use.
DIRECT HUMAN BENEFITS		0.3	*4.0*	

Seep

EIS

ECOLOGICAL IMPORTANCE AND SENSITIVITY	Score (0-4)	*Confidence (1-5)*	Motivation
Biodiversity support	**0.67**	*3.33*	
Presence of Red Data species	**-**	*4.00*	None were observed, and none are expected.
Populations of unique species	**1.00**	*3.00*	None were observed, and none are expected.
Migration/breeding/feeding sites	**1.00**	*3.00*	None were observed, and none are expected.
Landscape scale	**1.00**	*3.60*	
Protection status of the wetland	**-**	*4.00*	The site is located in an unfenced area.
Protection status of the vegetation type	**1.00**	*4.00*	The site is in the Kimberley Thornveld which is not threatened.
Regional context of the ecological integrity	**1.00**	*4.00*	The wetland is Moderately Modified, which is mostly more disturbed than wetland areas in the catchment.
Size and rareity of the wetland type/s present	**1.00**	*3.00*	The site is not particularly large or rare.
Diversity of habitat types	**2.00**	*3.00*	The wetland has temporary to permanent wetness zones.
Sensitivity of the wetland	**0.67**	*3.33*	
Sensitivity to changes in floods	1.00	*3.00*	Already highly affected.
Sensitivity to changes in low flows/dry season	-	*3.00*	Already highly affected.
Sensitivity to changes in water quality	1.00	*4.00*	Unlikely to be sensitive
ECOLOGICAL IMPORTANCE & SENSITIVITY	**1.0**	*3.4*	

Hydro-functional Importance

HYDRO-FUNCTIONAL IMPORTANCE			Score (0-4)	*Confidence (1-5)*	Motivation
Regulating & supporting benefits	Flood attenuation		1	*4*	Unlikely to perform to a significant degree due existing disturbance.
	Streamflow regulation		3	*3*	Likely to be performed to a greater degree due to increased flow from the leaking pipe entering the system.
	Water Quality Enhancement	*Sediment trapping*	2	*4*	Poor sources of sediment are present.
		Phosphate assimilation	1	*4*	The development to the west of the site is the only possible source of pollutants and the assimilation of pollutants are therefore unlikely.
		Nitrate assimilation	1	*4*	
		Toxicant assimilation	1	*4*	
		Erosion control	1	*3*	Erosion control is expected to be limited.
	Carbon storage		0	*5*	No signs of carbon storage were observed, and carbon storage is unlikely due to the climate.
HYDRO-FUNCTIONAL IMPORTANCE			1.3	*4.0*	

Direct Human Benefits

DIRECT HUMAN BENEFITS		Score (0-4)	*Confidence (1-5)*	Motivation
Subsistence benefits	*Water for human use*	*0*	*4*	No signs of use were observed.
	Harvestable resources	*0*	*5*	No signs of use were observed.
	Cultivated foods	*0*	*5*	No signs of use were observed.
Cultural benefits	*Cultural heritage*	*0*	*4*	No signs of use were observed and unlikely to be used.
	Tourism and recreation	*1*	*4*	Have very limited potential for use.
	Education and research	*1*	*4*	Have very limited potential for use.
DIRECT HUMAN BENEFITS		0.3	*4.0*	

Addendum D: Details of Specialist Consultants

GEORGE JOHANNES BREDENKAMP

Born: 10 February 1946 in Johannesburg, South Africa.
Citizenship: South African
Marital status: Married, 1 son, 2 daughters

Present work address
Extra-ordinary Professor
Department of Plant Science, University of Pretoria, Pretoria, 0002, South Africa
Tel:(27)(12)420-3121 Fax: (27)(12)362 5099
E-Mail: george.bredenkamp@up.ac.za

or

EcoAgent CC, or Ecotrust Environmental Services CC
PO Box 25533, Monument Park, 0105, South Africa
Tel and Fax: (27)(12) 460 2525
Cell 082 5767046
E-Mail: ecoagent@mweb.co.za or ecoagent@mile.co.za

Qualifications:

1963 Matriculation Certificate, Kemptonpark High School
1967 B.Sc. University of Pretoria, Botany and Zoology as majors,
1968 B.Sc. Hons. (cum laude) University of Pretoria, Botany.
1969 T.H.E.D. (cum laude) Pretoria Teachers Training College.
1975 M.Sc. University of Pretoria, Plant Ecology .
1982 D.Sc. (Ph.D.) University of Pretoria, Plant Ecology.

Theses: (M.Sc. and D.Sc.) on plant community ecology and wildlife management in nature reserves in South African grassland and savanna.

Professional titles:

- MSAIE&ES South African Institute of Ecologists and Environmental Scientists
  - 1989-1990 Council member
- MGSSA Grassland Society of Southern Africa
  - 1986 Elected as Sub-editor for the Journal
  - 1986-1989 Serve on the Editorial Board of the Journal
  - 1990 Organising Committee: International Conference: Meeting Rangeland challenges in Southern Africa
  - 1993 Elected as professional member
- Pr.Sci.Nat. South African Council for Natural Scientific Professions **Reg No 400086/83**
  - 1993-1997 **Chairman** of the Professional Advisory Committee: Botanical Sciences
  - 1993-1997: **Council** Member

- 1992-1994: Publicity Committee
- 1994-1997: Professional Registration Committee

Professional career:

• Teacher in Biology 1970-1973 in Transvaal Schools
• Lecturer and senior lecturer in Botany 1974-1983 at University of the North
• Associate professor in Plant Ecology 1984-1988 at Potchefstroom University for CHE
• Professor in Plant Ecology 1988-2008 at University of Pretoria.
• Founder and owner of the Professional Ecological Consultancy firms Ecotrust Environmental Services CC and Eco-Agent CC, 1988-present.

Academic career:

• Students:
- Completed post graduate students: M.Sc. 53; Ph.D. 14.
- Presently enrolled post-graduate students: M.Sc. 4; Ph.D. 1.

• Author of:
- 175 scientific papers in refereed journals
- >150 papers at national and international congresses
- >300 scientific (unpublished) reports on environment and natural resources
- 17 popular scientific papers.
- 39 contributions in books

• Editorial Committee of
- South African Journal of Botany,

Journal Grassland Society of Southern Africa,
Bulletin of the South African Institute of Ecologists.
Journal of Applied Vegetation Science.(Sweden)
- Phytocoenologia (Germany)

• FRD evaluation category: C1 (=leader in South Africa in the field of Vegetation Science/Plant Ecology)

Membership:

• International Association of Vegetation Science.
• International Society for Ecology (Intecol)
• Association for the Taxonomic study of the Flora of Tropical Africa (AETFAT).
• South African Association of Botanists (SAAB)
1988-1993 Elected to the **Council** of SAAB.
1989-1990 Elected as **Chairman** of the Northern Transvaal Branch
1990 Elected to the Executive Council as **Vice-President**
1990- Sub-editor Editorial Board of the Journal
1991-1992 Elected as **President** (2-year period)
1993 **Vice-President** and Outgoing President
• Wildlife Management Society of Southern Africa

• Suid-Afrikaanse Akademie vir Wetenskap en Kuns
(=South African Academy for Science and Art).
• Wildlife Society of Southern Africa
1975 - 1988: Member
1975 - 1983: Committee member, Pietersburg Centre
1981 - 1982: **Chairman**, Pietersburg Centre
• Dendrological Society of Southern Africa
1984 - present: Member
1984 - 1988: Committee member, Western Transvaal Branch
1986 - 1988: **Chairman**, Western Transvaal Branch
1987 - 1989: Member, Central Committee (National level)
1990 - 2000: Examination Committee
• Succulent Society of South Africa
1987 - present: Member
• Botanical Society of South Africa
2000 – present: Member
2001- 2008: Chairman, Pretoria Branch
2009-present Committee member Pretoria Branch
2002 – present: Chairman, Northern Region Conservation Committee
2002- 2007: Member of Council

Special committees:

• Member or past member of 10 special committees re ecology, botany, rangeland science in South Africa.
• Member of the International Code for Syntaxonomical Nomenclature 1993-1996.

Merit awards and research grants:

1968 Post graduate merit bursary, CSIR, Pretoria.
1977-1979 Research Grant, Committee re Research Development, Dept. of Co-operation and Development, Pretoria.
1984-1989 Research Grant, Foundation for Research Development, CSIR, Pretoria.
1986-1987 Research Grant, Dept. of Agriculture and Water Supply, Potchefstroom.
1990-1997 Research Grant, Dept. of Environmental Affairs & Tourism, Pretoria.
1991-present Research Grant, National Research Foundation , Pretoria.
Research Grant, Water Research Commission.
1999-2003 Research Grant, Water Research Commission.
2006 South African Association of Botanists Silwer Medal for outstanding contributions to South African Botany

Abroad:

1986 Travel Grant, Potchefstroom University for Christian Higher Education, Potchefstroom
Visits to Israel, Italy, Germany, United Kingdom, Portugal.
1987 Travel Grant, Potchefstroom University for Christian Higher Education, Potchefstroom.
Visits to Germany, Switzerland, Austria, The Netherlands, United Kingdom.

1990 Travel Grant, FRD.
Visit to Japan, Taiwan, Hong-Kong.
1991 Travel Grant, FRD.
Visits to Italy, Germany. Switzerland, Austria, France, The Netherlands, United Kingdom.
1993 Travel Grant, University of Pretoria.
Visits to the USA, Costa Rica, Czech Republic, Austria.
1994 Travel Grant FRD.
Visits to Switzerland, The Netherlands, Germany, Czech Republic.
1995 Travel Grant FRD, University of Pretoria
Visits to the USA
Travel Grant, University of Pretoria
Visit to the UK.
Travel Grant University of Pretoria, Visit Czech Republic, Bulgaria
Travel Grant, University of Pretoria, Visit Czech Republic, Italy, Sweden
Travel Grant, University of Pretoria, Visit Hungary, Spain, USA
Travel Grant, University of Pretoria, Visit Poland, Italy, Greece.
Travel Grant, NRF, Visit Brazil
2006 German Grant Invited lecture in Rinteln, Germany

Consultant

Founder and owner of Ecotrust Environmental Services CC and Eco-Agent CC
Since 1988 **>300** reports as consultant on environmental matters, including:
Game Farm and Nature Reserve planning,
Environmental Impact Assessments,
Environmental Management Programme Reports,
Vegetation Surveys,
Wildlife Management,
Veld Condition and Grazing Capacity Assessments,
Red data analysis (plants and animals).

JACOBUS CASPARUS PETRUS (JACO)

Identity number 680804 5041 084
Gender Male
Date of birth 4 August 1968
Nationality South African
Home languages Afrikaans, fluent in English
Postal address P.O. Box 25085, Monument Park, Pretoria, 0105.
Tel no +27 12 347 6502, Cell +27 82 410 8871
E-mail **jcpvanwyk@absamail.co.za**
Present position Co-Department Head, Environmental Education & Life Sciences, Hoërskool Waterkloof
Consultant Specialist Environmental Assessments, EIAs, writing, photo-recording
Qualifications **B.Sc**. (U.F.S.) **B.Sc. (Hon.)** (U.F.S.), **H.E.D** (U.F.S.), **M.Sc.** (U.F.S.)
Honours Foundation of Research Development bursary holder
Professional Natural Scientist (Zoology) – S.A Council for Natural Scientific Professions, Registration # 400062/09
Notable Research Contribution In-depth field study of the giant bullfrog

Formal Courses Attended Outcomes Based Education, University of the South Africa (2002)
Introductory Evolution, University of the Witwatersrand (2008)
OBE, GET & FET training, 2002-2008, Education Department

Employment history
2009 – Present Impact assessment for Vertebrate
2000 – Present Co-Department Head for Environmental Education & Life Sciences, Hoërskool Waterkloof, Pretoria.
1995 - 1999 Teaching Biology (Grades 8 – 12) and Physics / Chemistry (Grades 8 – 9) at the Wilgerivier High School, Free State. Duties included teaching, mid-level management and administration.
July 1994 – Dec 1994 Teaching Botany practical tutorials to 1st year students at the Botany & Zoology Department of the Qwa-Qwa campus of the University of Free State, plant collecting, amphibian research
1993 - 1994 Mammal Research Institute (University of Pretoria) research associate on the Prince Edward Islands: topics field biology and population dynamics of invasive alien rodents, three indigenous seals, invertebrate assemblages, censussing king penguin chicks and lesser sheathbills, and marine pollution
1991 - 1993 Laboratory demonstrator for Zoological and Entomological practical tutorials, and caring for live research material, University of the Free State
1986 - 1990 Wildlife management and eco-guiding, Mt. Everest Game Farm, Harrismith
Professional Achievement **Research:** Author and co-author of 52 scientific publications in peer-reviewed and popular subject journals, and >350 contractual EIA research reports. Extensive field work and laboratory experience in Africa
Public Recognition: Public speaking *inter alia* radio talks, TV appearances
Hobbies: Popular writing, travel, marathon running, climbing (viz Kilimanjaro), photography, biological observations, public speaking.

Catharina Elizabeth Venter

trading as Kyllinga Consulting

Date of Birth: 29 December 1979

Nationality: South African

Languages: Afrikaans, English

EDUCATIONAL QUALIFICATIONS

- M.Sc (Botany), University of Pretoria (2003)
- B.Sc Hons (Botany), University of Pretoria (2001)
- B.Sc (Environmental Sciences), University of Pretoria (2000). Majored in Geography and Botany
- Matriculated, Sasolburg High School (1997)

Additional

- Introduction to ArcGIS 1 (2006)
- Bringing your data into ArcGIS (2006)
- Introduction to ArcView 3.x (2003).

FIELDS OF EXPERTISE

- **Ecological Assessment:**
  Ecological Assessments as part of the Environmental Impact Assessment Process

- **Wetland Assessment:**
  Wetland Assessments as part of the Environmental Impact Assessment Process and Water Use Applications, as well as rehabilitation plans for wetlands, including planning or the Working for Wetlands programme. Large scale wetland assessments (catchment scale).

- **GIS:**
  Compilation of maps for submission as part of Environmental Impact Assessment Process. Creating spatial databases and large scale wetland maps (catchment scale). Projection conversions and matching/overlaying different format GIS maps.

- **Environmental Impact Assessment**
  Undertaken numerous Environmental Scoping Reports, as required by the Environment Conservation Act, 1989 (Act 73 of 1989), the National Environmental Management Act, 1998 (Act 107 of 1998), as amended and the Development Facilitation Act, 1995 (Act 67 of 1995). Project experience includes the establishment of various housing typologies, golf courses, commercial and industrial projects, infrastructure development (roads), resorts and/or game lodges as well as filling stations.

- **Public Participation:**
  Undertaken numerous public participation processes, ranging from basic to extensive, as required by relevant environmental legislation.

MEMBERSHIP IN PROFESSIONAL SOCIETIES

- Professional Natural Scientist (Pr.Sci.Nat) in the fields of Botanical and Ecological Science (Reg no. 400048/08)

- Member of the Botanical Society of South Africa

EMPLOYMENT HISTORY EXPERIENCE

Kyllinga Consulting (July 2015 - present)

Senior Ecologist responsible for wetland and ecological specialist assessments.

Spatial Ecological Consulting (February 2010 – June 2015)

Senior Ecologist responsible for wetland and ecological specialist assessments.

- Wetland Related Assessments

More than 40 wetland assessments conducted between 2010 and 2015.

- Vegetation Assessments

Approximately 16 vegetation assessments between 2010 and 2015.

- Management Plans

Completed two ecological management plans.

MSA Group Services (previously Exigent Environmental CC) (August 2004 – January 2010)

Environmental Scientist responsible for ecological and wetland assessments and the compilation of maps. Also conducted various scoping and EIA applications and EMPRs.

- Ecological Assessments

In excess of 50 ecological assessments conducted between 2004 and 2010, including managing the inclusion of the fauna specialist assessments.

- Wetland Assessments

More than 60 wetland verification projects, wetland delineations and wetland assessments, completed between 2004 and 2010.

- As well as:

Rehabilitation Projects; Fatal Flaw / Screening Assessments; National Department of Agriculture Authorisations; Mining Related Assessments; Private, Public Partnership Projects; Resource Management Plans (RMP); Environmental Management Plans; Environmental Management Programme; Environmental Exemption Processes; Basic Assessments; Environmental Impact Assessments

Part-time employment (2002-2004)

Tutor for botany practicals; Assisting Wildlife management students with Braun-Blanquette analysis; Researcher for a project on the vegetation communities and ecology of the Kruger National Park; Research assistant for the analysis of street trees in Tshwane urban forest; Various part time projects related to vegetation and wetlands

COUNTRIES OF WORK EXPERIENCE

- South Africa
- Lesotho
- Botswana
- Mozambique

PAPERS AND PUBLICATIONS

Co-author and data contributor to: SIEBEN, E. *et al*. The vegetation of inland wetlands with salt-tolerant vegetation in South Africa: description, classification and explanatory environmental factors, submitted to the South African Journal of Botany for review in Feb 2015.

Co-author and data contributor to: SIEBEN, E. *et al*. The herbaceous vegetation of subtropical freshwater wetlands in South Africa: description, classification and explanatory environmental factors, submitted to the South African Journal of Botany for review in Feb 2015.

Co-author and data contributor to: SIEBEN, E. *et al*. The vegetation of grass lawn wetlands of floodplains and pans in semi-arid regions of South Africa: description, classification and explanatory environmental factors, submitted to the South African Journal of Botany for review in Jan 2015.

Co-author of several vegetation descriptions in: MUCINA, L. & RUTHERFORD, M.C. (eds) 2006. The Vegetation of South Africa, Lesotho and Swaziland. Strelitzia 19. South African National Biodiversity Institute, Pretoria.

VENTER, C.E. & BREDENKAMP, G.J. In prep. Major plant communities on the Mfabeni swamp, St Lucia. *Bothalia.*

VENTER, C.E.; BREDENKAMP, G.J. & GRUNDLING, P-L. 2003. Plant community types, and their association with habitat factors as ecosystem driving forces, of Mfabeni swamp. Proceedings of the congress: *Environment of the St Lucia Wetland: Processes of Change*, Cape Vidal, September 4th- 7th, 2003.

VENTER, C.E.; BREDENKAMP, G.J.; GRUNDLING P-L. 2002. Vegetation change on rehabilitated peatland on Rietvlei Nature Reserve. *Kudu* 46(1):53-63.

PRESENTATIONS

Venter, C.E.; Bredenkamp, G.J. & Grundling, P-L. 2003. Plant community types, and their association with habitat factors as ecosystem driving forces, of Mfabeni Swamp. *Environment of the St Lucia Wetland: Processes of Change*, Cape Vidal, September 4th- 7th, 2003.

Poster Presentations

Venter, C.E.; Bredenkamp, G.J.; Grundling P-L. 2002. Baseline vegetation surveys of rehabilitated peatland on Rietvlei Nature Reserve. SAAB Converence. Grahamstown.

Venter, C.E.; Bredenkamp, G.J.; Grundling P-L. 2003. Vegetation change on rehabilitated peatland on Rietvlei Nature Reserve. SAAB Converence. Pretoria.

LUKAS JURIE NIEMAND

Company: Pachnoda Consulting cc (Director)
Date of Birth: 1974-03-12

Nationality: South African

Languages: English and Afrikaans

EDUCATIONAL QUALIFICATIONS

1992	Hoërskool Hartbeespoort, Hartbeespoort - Senior Certificate.
1996	University of Pretoria, Pretoria - B.Sc. (Zoology and Entomology).
1997	University of Pretoria, Pretoria - B.Sc. (Hons) (Entomology).
2001	University of Pretoria, Pretoria - M.Sc. (Restoration Ecology/Zoology).

MEMBERSHIP IN PROFESSIONAL SOCIETY

- Professional Natural Scientist (Pr. Sci. Nat.) (Reg. no. 400095/06)
- BirdLife South Africa
- Hartbeespoort Natural Heritage Society

EXPERIENCE

A. Work conducted in South Africa

1. General Ecological Assessments (Fauna, Flora and Red Data Scans, including both functional and compositional aspects):

- Belvedere Trust, Proposed retirement village on Amorosa Agricultural Holdings, Roodepoort, Gauteng (2004);
- City of Joburg Property Development Company, Proposed upgrade and development of the Orlando Dam Intersection, Soweto, Gauteng (2004);
- PDNA, Proposed NASREC development, Johannesburg, Gauteng (2004);
- 17 Shaft Conference and Education Centre, Proposed establishment of the Veteran's Heritage Education Centre, Crown Mines, Gauteng (2004);
- GAUTRANS, Proposed re-alignment of Road D781 and construction of a road bridge over the Rietvleispruit, Kempton Park, Gauteng (2004);
- Mr. N. Lang, Ecological Opinion on the proposed establishment of a township, Muldersdrift, Gauteng (2004);
- AGES, Proposed Equestrian Centre, Leeufontein 299 IR, Gauteng (2004);

- PDNA, Proposed new bridge and re-alignment of a portion of provincial road P101-2 (R51), Laversburg, Gauteng (2004);
- Blenneerville Investment (Pty) Ltd, Proposed construction of a residential and commercial development on of Paradiso Estate, Tweefontein 372 JR, Gauteng (2004);
- Les Roches (Pty) Ltd, Proposed zoning of holdings 1, 2 & 3 of Hyde Park Agricultural Holdings, Gauteng (2004);
- Transnet Limited, Terrestrial Faunal Ecological Opinion: Phase 1B expansion of the Sishen-Saldanha Iron ore export corridor, Saldanha Bay, Western Cape (2005);
- Celebration North Riding (Pty) Ltd, Proposed mixed land-use development, North Riding, Gauteng (2005);
- Wilderness Safaris, Proposed upgrade of the Manzengwenya Dive Camp, Greater St. Lucia Wetlands Park, KwaZulu-Natal (2005);
- Wilderness Safaris, Proposed upgrade of the Rocktail Bay Camp, Greater St. Lucia Wetlands Park, KwaZulu-Natal (2005);
- GAEA Projects, Corridor Assessment for the proposed Sibaya Precinct, KwaZulu-Natal (2005);
- Computer Domain Holdings (Pty) Ltd, Red Data Floral Scan on portion 3 of the farm Elandshoek, portions 12 & 27 of the farm Groot Suikerboschkop, and portions 5 & 10 of the farm Palmietfontein, Dullstroom (2005);
- Zong's Property Investments, Proposed establishment of a residential development on a portion of Pomona Estates Agricultural Holdings, Pomona, Gauteng (2005);
- GJ van Zyl Trust, Proposed development of a resort on the Farm Witpoort 216 JS, Mpumalanga (2005);
- Mr. Howard Walker, Proposed subdivision of the Farm Lunsklip 105 JT, and the Farm Morgenzon 122 JT, for the establishment of a private resort, Dullstroom, Mpumalanga (2005);
- Lavender Manor cc, Proposed establishment of a retail, commercial and Lavender Manor Township on part of farm Rietfontein 189 IQ, Muldersdrift, Gauteng (2005);
- Geo Pollution Technologies, Proposed establishment of a residential development: Noordwyk Ext 65 & 80 on Erand Agricultural Holdings, Midrand, Gauteng (2005);
- Mr. A. Le Roux, Proposed Cradle View Country Estate, Muldersdrift, Gauteng (2006);
- Viking Bay Development Company (Pty) Ltd, Proposed Viking Bay freshwater marina and hotel development, Vaal Dam, Gauteng (2006);
- Land for Africa (Pty) Ltd, Ecological Opinion for the proposed establishment of a residential township on holding 122 Erand Agricultural Holding Extension 1, Halfway House, Midrand, Gauteng (2006);
- Brickot Developments cc, Ecological opinion for the proposed Bethal Retirement Village on the remainder of portion 3 of the farm Mooifontein 108 IS, Bethal, Mpumalanga (2006);
- Brawild (Pty) Ltd, Red Data Scan for the proposed Annlin Ex 117, Pretoria, Gauteng (2006);
- Mbombela Local Municipality, Ecological Opinion for the proposed extension of the Lowveld Botanical Gardens, Nelspruit, Mpumalanga (2006);
- Natural Scientific Services cc, Botanical survey for the SASOL Mafutha coal project near Lephalale, Limpopo Province, RSA (2008);
- SRK Consulting, Ecological assessment on Vlakfontein area, NW of Ogies, Mpumalanga. Report compiled in association with EkoInfo (2009); and
- Aurecon, Desktop biodiversity assessment and wetland scan: upgrade of the River View waste water treatment works, eMalahleni, Mpumalanga province. Report compiled in association with Imperata Consulting (2009).

2. Mining and Industrial related projects (ecological):

- Lonmin Platinum (Western Platinum Limited), Ecological Assessment for the proposed MK3 Shaft Complex on the farm Wonderkop 400 JQ, Rustenburg, North West Province (2004);
- Impala Platinum Limited, Ecological Assessment for prospecting SEMPs on the farms Buffelshoek 386 KT, Kalkfontein 367 KT, Spitskop 333 KT, Steelpoortpark 366 Kt and Tweefontein 360 KT and Hackney 116 KT (all Sekhukhuneland), Mpumalanga and Limpopo Province (2004);
- Trans-Caledon Tunnel Authority (TCTA), Ecological Assessment for borrow pit SEMPs on the TCTA pipeline, Vaal Marina to Secunda (2005);
- Boynton Platinum (Pty) Ltd, Ecological Assessment for the proposed establishment of platinum mines on the farms Tuschenkomst 135 JP, Witkleifontein 136 JP and Ruighoek 169 JP, North West Province (2005);
- Impala Platinum Holdings, Ecological Assessment for prospecting SEMPs on the Impala Platinum Bafokeng Mining Complex, North West Province (2005);
- Ceramic Industries Limited, Ecological Assessment of the Rietspruit Clay Quarries, Vanderbijlpark, Gauteng (2005);
- Ekurhuleni Metropolitan Municipality, Ecological Assessment Report for the proposed GLB Landfill Site on the farm Zesfontein 27 IR, Benoni, Gauteng (peer reviewed, 2006);
- Ceramic Industries Limited, Ecological Assessment of the Leeukuil Clay Quarries, Vanderbijlpark, Gauteng (2006);
- Council for Geoscience, Habitat sensitivity assessment scoping report for Bon Accord quarry on a portion of the farm de Onderstepoort 300-JR, Tshwane, Gauteng (2007);
- Fraser Alexander, Biodiversity action plan for Lonmin Limpopo & Platinum, North West & Limpopo Province, RSA (2008-2009);
- Envirolution Consulting (Pty) Ltd., Ecological screening report and site selection process for an Eskom general landfill and hazardous waste storage facility near Lephalale, Limpopo Province, RSA (2009);
- Envirolution Consulting (Pty) Ltd., Ecological assessment for the proposed construction of an Eskom general landfill and hazardous waste storage facility at the Matimba Power Station, Limpopo Province, RSA (2009);
- Shangoni/Vergenoeg Mining Company, Ecological assessment for the proposed construction of a slurry pipeline and waste rock dump at the Vergenoeg Mine, Gauteng (2011);
- ENVASS, An ecological evaluation (vertebrate & avifaunal component) for the proposed alternative energy plant on Portion 3, 4 & 5 of the Farm Groenwater 453, Northern cape (2012); and
- ENVASS, Ecological evaluation (vertebrate & avifaunal component) for the proposed alternative energy plant on !xun & khwe, Northern cape (2012).

3. Avifaunal and Invertebrate Assessments:

- Lavender Manor cc, Red Data Bird Assessment for the proposed establishment of a retail, commercial and Lavender Manor Township on part of the farm Rietfontein 189 IQ, Muldersdrift, Gauteng (2004);
- Helga Schneider & Associates, Avifaunal & Invertebrate Red Data Assessment for the proposed rezoning & subdivision on Erf 6486 Orange Farm Ext 2, Johannesburg, Gauteng (2005);
- TOWNDEV, Avifaunal and Arachnid Assessment for the proposed subdivision of Grootfontein 349 JR, Rievlei Dam, Gauteng (2006);
- Prof. Van Rensburg, Red Data Invertebrate Scan for the proposed Rietvalleirand Extension 59, Gauteng (2006);

- Group Five Property Development, Invertebrate Assessment for the proposed Buccleuch Ex 1, Gauteng (2006);
- Zong's Property Investments, Avifaunal and *Metisella meninx* assessment for the establishment of a residential development on a portion of Pomona Estates Agricultural Holdings, Pomona, Gauteng (2006);
- Waterval Islamic Institute, Avifaunal and Invertebrate Assessment for the proposed Northern Golf Course Development, Midrand, Gauteng (2006);
- Ekurhuleni Metropolitan Municipality, Avifaunal & Invertebrate Red Data Assessment for the proposed low-cost housing development on Olifantsfontein 410 JR, Gauteng (2006);
- City of Tshwane Metropolitan Municipality, Invertebrate Red Data Scan for the proposed flood remediation and river upgrade at Soshanguve, Gauteng (2006);
- AGES, Invertebrate assessment for the proposed mining activities on the farm Thorncliffe 374 KT, Xstrata Eastern Mines, Mpumalanga (2007)
- AGES, Mammal and invertebrate assessment for the proposed Kalplats project, Stella, North West Province (2007)
- Exigent Engineering Consultants, Invertebrate assessment for the proposed Derdepoort X 11, Derdepoort, Gauteng (2007);
- Exigent Engineering Consultants, Invertebrate and Avifaunal scan for the proposed Cutty Sark hotel extension, Scottburgh, Kwazulu-Natal (2007);
- Strategic Environmental Focus, African Grass Owl assessment on the proposed Cradle View country estate on portion 60 of the farm Driefontein 179 IQ, Muldersdrift, Gauteng (2007);
- GEOLAB, Ecological assessment for the West Rand Gold Operations (WERGO) Witfontein tailings disposal facility, Mintails, Gauteng, RSA (2008);
- Coastal Environmental Services, Avifaunal Assessment for the proposed mining of heavy minerals at Port Durnford (Exxaro KZN-Sands), KwaZulu-Natal (2008);
- SRK & Natural Scientific Services cc, A feasibility study for the mining of coal north of the Limpopo Province. Avifaunal & invertebrate assessment, Rio Tinto Exploration, Limpopo Province, RSA (2009);
- Eskom/Baagi Environmental, An environmental management plan (avifaunal & faunal component) for the proposed Dinaledi - Spitskop 400 kV transmission line, North West Province (2010);
- Eskom/Baagi Environmental, An avifaunal impact report for the proposed 400 kV Ariadne-Venus transmission line between Estcourt and Pietermaritzburg, KwaZulu-Natal (2010);
- Eskom/Baagi Environmental, An avifaunal impact assessment report for a 275 kV power line between the substations of Glockner and Kookfontein, Vanderbijlpark, Gauteng (2010);
- Groundwater Consulting Services (Pty) Ltd/EkoInfo, An invertebrate and avifaunal specialist report for the proposed expansion of Exxaro's Glisa coal mine, Belfast, Mpumalanga (2010);
- Eskom/Baagi Environmental, An environmental management plan (avifauna component) for the proposed 400 kV Medupi-Massa transmission lines, Limpopo Province (2011);
- Eskom/Baagi Environmental, An avifaunal and fauna impact assessment report for the proposed 400 kV Arnott-Gumeni transmission line, Mpumalanga Province (2012);
- Eskom/Baagi Environmental, An environmental management plan (avifaunal component) for the proposed 400 kV Ngwedi transmission line and substation, North West Province (2012);
- Exxaro/EkoInfo, An avifaunal and invertebrate assessment (as part of a Biodiversity Assessment and action plan) for the Gravelotte MagVanTi Mining Area, Limpopo Province (2012);

- Groundwater Consulting Services (Pty) Ltd/EkoInfo, An invertebrate and avifaunal specialist report for the proposed Paardeplaats coal mine area, Belfast, Mpumalanga (2012);
- Groundwater Consulting Services (Pty) Ltd/EkoInfo, An invertebrate and avifaunal specialist report for the proposed Leeuwpan coal mine area, Belfast, Mpumalanga (2013);
- Eskom/Baagi Environmental, An environmental management plan (avifaunal component) for the proposed Medupi - Borutho 400 kV transmission line, Limpopo Province (2012);
- Eskom/Baagi Environmental, An environmental management plan (avifaunal component) for the proposed Gromis - Oranjemund 400 kV transmission line, Northern Cape (2013);

4. Other Assessments:

- Facilitation, project management and conduction of environmental scoping exercises, Environmental Impact Assessments, Environmental Management Plans, Feasibility Reports, for a range of projects and issues such as:
    - Housing Projects (West Rand Housing Projects) for the Gauteng Department of Housing;
    - Planning and facilitation of environmental awareness workshops (Winterveltd Workshops for the Department of Environmental Affairs and Tourism);
    - Compilation and evaluation of EIA reports and Environmental Management Plans (EMPs) for both the private and public sector (e.g. Scoping Report for the relocation of oxidation ponds for the Moqhaka Local Municipality and the installation of an underground additive tank for Sasol Oil (Pty) Ltd).
    - Urban Renewal Projects: Bekkersdal Urban Renewal Project and the Greater Evaton Urban Renewal Project for the Gauteng Department of Housing.
- Douglas Collieries (Inkwe Collieries), Biodiversity Assessment and database compilation of the Douglas Collieries (2005);
- Orion Group, Ecological Sensitivity Map for the proposed golf course and related facilities, Mont-Aux-Sources (2005);
- City of Joburg Property Development Company, Specialist *Lepidium mossii* assessment for the proposed upgrade and development of the Orlando Dam intersection, Soweto, Gauteng (2005);
- Johannesburg Roads Agency, Alien Eradication and Rehabilitation Programme for the proposed upgrade of 14th Avenue, Randburg, Gauteng (2006);
- City of Joburg Property Development Company, Ecological Management Plan for the Orlando Dam intersection, Soweto, Gauteng (2006);
- GJ van Zyl Trust, Alien Eradication Programme for the proposed development of a resort on the Farm Witpoort 216 JS, Mpumalanga (2006);
- GJ van Zyl Trust, Fire Management Plan for the proposed development of a resort on the Farm Witpoort 216 JS, Mpumalanga (2006); and
- Khutala Collieries (Inkwe Collieries), Biodiversity Assessment and database compilation (2006)

5. Linear Assessments:

- Johannesburg Roads Agency, Ecological Assessment for the Proposed upgrade of 14th Avenue, Randburg, Gauteng (2004).
- Trans-Caledon Tunnel Authority (TCTA), Proposed Vaal River Eastern Subsytem Augmentation (VRESAP) pipeline from Vaal Marina to Secunda (2005);
- PBA International (in association with Bathusi EC), Ecological Scoping Report for the proposed Eskom Delta-Epsilon 765 kV Transmission lines (2007);
- Bohlweki Environmental (in association with Bathusi EC), Ecological Scoping Report for the proposed Eskom Malelane-Boulders 132 kV Distribution line (2007);

- Bohlweki Environmental (in association with Bathusi EC), Ecological Scoping Report for the proposed Eskom Marathon-Delta 132 kV Distribution line (2007);
- Strategic Environmental Focus, Avifaunal EIA Report for the proposed Eskom Hendrina-Prairie-Marathon 400 kV Transmission line, Mpumalanga (2007);
- Natural Scientific Services cc, Botanical survey for the proposed upgrade of the Transnet railway line between Hotazel, Northern Cape and the Port of Ngqura, Eastern Cape, RSA (2008);
- Envirolution Consulting (Pty) Ltd, Ecological Report for the proposed Eskom Apollo-Lepini 400kV transmission line (2009);
- Arcus Gibb, An ecological investigation for the Tumelo 132 kV distribution line and power line near Kagiso, Gauteng (2010);
- Ekoinfo/SANRAL, Faunal investigation for the upgrade of the N3 highway (2011); and
- Aurecon (Pty) Ltd, Baseline vegetation survey for the Mokolo – Crocodile River Augmentation Project (MCWAP) pipeline from Mokolo Dam to Thabazimbi (2011).

B. Work conducted in other African countries:

- Rural Maintenance, Invertebrate study for four mini-hydroelectric generation plants, Northern Malawi, Africa (2010);
- Impacto, An avifaunal study (Phase 1) for the proposed Mpanda Nkwua Dam in the Zambezi River, Mozambique, Tete Province (2010);
- Conseil Régional des Pays de la Loire, An avifaunal investigation of the Rusizi and Ruvubu National Parks (Burundi), and the feasibility of establishing an avi-tourism network with specific emphasis on the protection of important flyways used by Palearctic birds - of - prey (2010);
- Impacto, An avifaunal study (Phase 2) for the proposed Mpanda Nkwua Dam in the Zambezi River, Mozambique, Tete Province (2011);
- Rural Maintenance, Invertebrate scan for the expansion of coal mining activities at Kayelekera, Northern Malawi, Africa (2011);
- Rural Maintenance, Invertebrate study for a mini-hydroelectric plant at the Chisanga Falls, Nyika National Park, Malawi (2011);
- Impacto/ERM/Enviro-Insight, Avifaunal investigation for the proposed Ncondezi Coal Mine, Tete Province, Mozambique (2011);
- Enviro-Insight, Avifaunal investigation for the Riversdale Coal Mine complex, Tete Province, Monzambique (2011);
- Anadarko Petroleum/ERM/Enviro-Insight, Avifaunal investigation for the proposed Anadarko Mozambique Area 1 Liquefied Natural Gas plant in northern Mozambique, Cabo Delgado Province, Mozambique (2012);
- Coffey Environments/EkoInfo, Avifaunal investigation for the mining of iron ore by Baobab Resources, Tete Province, Mozambique (a scoping-level assessment); and
- SRK/Flora, Fauna and Man Ecological Services, An avifaunal and invertebrate assessment for the establishment of a potash mine at Konkoati, Republic of the Congo (2012);
- China Union/ERM/Enviro-Insight, Avifaunal investigation for the proposed mining of iron ore in Bong County, Liberia (2012);
- SRK/Flora, Fauna and Man Ecological Services, An invertebrate assessment for the mining of iron ore by DMC Congo Mining/Exxaro at Mayoko, Republic of the Congo (2012);
- Western Cluster/ERM/Enviro-Insight, Avifaunal investigation for the proposed mining of iron ore at Bomi Hills, ,Bomi County, Liberia (2013);

- SRK/Flora, Fauna and Man Ecological Services, An invertebrate assessment for the establishment of an ecological offset for the DMC Congo Mining/Exxaro Iron Ore Mine at Mayoko, Republic of the Congo (2013);
- Western Cluster/ERM/Enviro-Insight, Avifaunal investigation for the proposed mining of iron ore at Bea Mountain, Grand Cape Mount County, Liberia (2013);
- Western Cluster/ERM/Enviro-Insight, Avifaunal investigation for the proposed mining of iron ore at Mano River, Grand Cape Mount County, Liberia (2013); and
- WSP/Flora, Fauna and Man Ecological Services, An invertebrate assessment for the establishment of a phosphate mine, Hinda Phosphate Project, Republic of the Congo (current); and
- Aureus Mine/Enviro-Insight, An avifaunal investigation for the proposed mining of gold at the New Liberty Gold Mine, Liberia (current)

C. Additional Experience:

- Monitoring and evaluation of the rehabilitation programme for the mining company Richards Bay Minerals (RBM) with special reference to vegetation, bird, small mammal and millipede assemblages.
- Other responsibilities include assessment of the ecological standard operating procedures (SOP) according to RBM's environmental management programme in compliance with ISO 14001 environmental standards accreditation process.
- Participated in the annual relief programme on the S.A Agulhas voyage to Subantarctic Marion Island (Prins Edward group). Took part in the research to estimate the population dynamics and demography of the alien house mouse (*Mus musculus*) on the island (under supervision of the University of Pretoria).
- Participated in the preparation of a conservation management plan for a game and trout farm in conjunction with Mpumalanga Parks Board (in charge of the bird section) for the farm Nu-Scotland Bavaria.
- Lead a successful professional bird tour (party of 12) to the Eastern Zimbabwean highlands and adjacent Mashonaland Plato (10 days).
- Lead a successful professional bird tour (party of 9) to the Cape Peninsula, Karoo and West Coast (10 days).
- Lead a successful professional bird tour (party of 12) to the Swaziland and Northern Zululand (10 days).
- Lead a successful professional bird tour (party of 15) to the Namibia (10 days).
- Lead a successful professional bird tour (party of 14) to the Eastern Drakensberg and Lesotho (10 days).

Employment History:

March 2007 – Current: of Director of Pachnoda Consulting cc

2004- January 2007: Strategic Environmental Focus (Pty) - Terrestrial Ecologist

2003 – 2004: Enviro-Afrik (Pty) Ltd– Environmental Consultant

2001 – 2003: University of Pretoria - Research Assistant

PUBLICATIONS:

- McEWAN, K.L., ALEXANDER, G.J., NIEMAND, L.J. & BREDIN, I.P. 2007. The effect of land transformation on diversity and abundance of reptiles. Paper presented at the 50th Anniversary Conference of the Zoological Society of Southern Africa.

- NIEMAND, L. 1997. Distribution and consumption of a rust fungus *Ravenelia macowaniana* by micro-lepidopteran larvae across an urban gradient: spatial autocorrelation and impact assessment. Hons publication, University of Pretoria, Pretoria

- NIEMAND, L. 2001. The contribution of the bird community of the regenerating coastal dunes at Richards Bay to regional diversity. MSc Thesis, University of Pretoria, Pretoria.

- VAN AARDE, R.J., WASSENAAR, T.D., NIEMAND, L., KNOWLES, T., FERREIRA, S. 2004. Coastal dune forest rehabilitation: a case study on small mammal and bird assemblages in northern KwaZulu-Natal, South Africa. In: Martínez, M.L. & Psuty, N. (Eds.) *Coastal sand dunes: Ecology and Restoration*. Springer-Verlag, Heidelberg.

- VAN AARDE, R., DELPORT, J. & NIEMAND, L. 1999. Of frogs and men. *Mechanical Technology,* June: 32-33.

- VAN AARDE, R., DELPORT, J. & NIEMAND, L. 1999. Gone Frogging. *Getaway,* January: 80-83.

PRESENTATIONS:

- Co-presenter at the Wetland Training Course (30 July – 3 August 2007) entitled: “Wetland-associated fauna”. University of Pretoria, Pretoria.
- Co-presenter and lecturer of the pre-conference training course (entitled "Can rehabilitation contribute towards biodiversity?") at the 3rd Annual LaRSSA (Land Rehabilitation Society of Southern Africa) Conference (8-11 September 2015), Glenburn Lodge, Muldersdrift, Gauteng.