MANGAUNG METROPOLITAN OPEN SPACE SYSTEM (MOSS)

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FINAL REPORT

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MANGAUNG

AT THE HEART OF IT ALL

SECTION A:

SITUATIONAL ANALYSIS FOR THE MANGAUNG METROPOLITAN OPEN SPACE SYSTEM

DECLARATION OF INDEPENDENCE

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

Report Version	**Final 1.1**		
Title	**Desktop Ecological and Wetland Assessment for the Mangaung Metropolitan Open Space System (MOSS) including the urban areas of Bloemfontein, Thaba Nchu, Botshabelo, Soutpan, Wepener, Dewetsdorp and Vanstadensrus, Free State Province.**		
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Executive Summary

The MOSS study area is considered to be relatively sensitive in terms of its vegetation characteristics but somewhat degraded in terms of the vegetation conditions when seen from an overall, desktop perspective. The desktop study should be utilised as a baseline to provide information on areas and aspects which should form the focus of a comprehensive, on-site survey to inform the refinement of the MOSS.

The study area consists of several separate urban areas with large extent. These are the city of Bloemfontein and surrounding towns, including Thaba Nchu, Botshabelo, Soutpan, Dewetsdorp, Wepener and Vanstadensrus (Appendix A: Map 1-7). From aerial images it is clear that these areas consist of extensive urban areas but that significant natural areas are also visible within the urban edge. The desktop study will assess all open spaces and natural areas within the urban edge of these urban areas. Furthermore, a high number of watercourses and wetlands also occur in these urban areas with some of the larger rivers including the Bloemspruit, Renosterspruit, Modder River, Klein-Modder River, Sepane River, Caledon River and Witspruit.

Bloemfontein Urban Area (Appendix A: Map 1)

From the description of the remaining natural vegetation in the Bloemfontein urban area the following elements of ecological importance should be taken into account in the MOSS:

- Bloemfontein Dry Grassland is listed as a Vulnerable (VU) vegetation type which increases its sensitivity and conservation value.
- Bloemfontein Karroid Shrubland, although not listed as a Threatened Ecosystem, has clearly been shown to contain unique habitat with a proportion of protected species and should therefore be afforded a high level of sensitivity.
- Winburg Grassy Shrubland is confined to hills and ridges, positive landscape elements forming terrestrial corridors and should therefore still be regarded as having a significant level of sensitivity.
- Highveld Alluvial Vegetation, although itself not a threatened or highly unique habitat, is however closely associated with the larger watercourse system which are highly sensitive systems and therefore increase the sensitivity of the vegetation type by default.
- Areas identified as CBA 1 and 2 areas are essential to meeting conservation targets and are also concentrated on areas with a high level of sensitivity.

Botshabelo Urban Area (Appendix A: Map 2)

From the description of the remaining natural vegetation in the Botshabelo urban area the following elements of ecological importance should be taken into account in the MOSS:

- Both vegetation types are relatively widespread and currently listed as being of Least Concern.
- Basotho Montane Shrubland contains a somewhat higher habitat and species diversity, varied topography and a somewhat higher proportion of protected species. The hills and ridges of this vegetation type may also act as natural corridors which may further increase its sensitivity. The vegetation type will therefore have a somewhat higher conservation value.

- The area does not contain any CBA areas although the Rustfontein Nature Reserve to the south west has a very high conservation value and planning should aim to retain a suitable buffer between urban development and the reserve. This buffer area should also be designated open space where no development is allowed and communal grazing is kept at a low-intensity.
- Extensive NPAES Focus Areas occur to the west of Botshabelo which aim to increase the conservation area of the Rustfontein Nature Reserve. Spatial planning should therefore aim to avoid expansion into these NPAES Focus Areas and should implemented a buffer between any future development and the proposed conservation areas.

Thaba Nchu Urban Area (Appendix A: Map 3)

- Both vegetation types are relatively widespread and currently listed as being of Least Concern.
- Basotho Montane Shrubland contains a somewhat higher habitat and species diversity and a somewhat higher proportion of protected species. In this area it is also associated with the Thaba Nchu Mountain, a highly prominent feature with significant conservation value.
- Extensive areas of CBA 1 & 2 occur to the east of Thaba Nchu and these areas will have a high conservation value and urban planning should avoid these areas and aim to retain a suitable buffer between urban development and the CBA areas. This buffer area should also be designated open space where no development is allowed and communal grazing is kept at a low-intensity.
- A large NPAES Focus Area coincides with the Thaba Nchu Mountain and also affirms the high conservation value of this area. Spatial planning should therefore aim to avoid expansion into these NPAES Focus Areas and should implemented a buffer between any future development and the proposed conservation areas.
- Future planning of Thaba Nchu should take into account the high conservation value of the Thaba Nchu Mountain and the tourism potential this may have.

Soutpan Urban Area (Appendix A: Map 4)

From the description of the remaining natural vegetation in the Soutpan/Ikgomotseng urban area the following elements of ecological importance should be taken into account in the MOSS:

- Vaal-Vet Sandy Grassland is listed as an Endangered (EN) vegetation type which increases its sensitivity and conservation value considerably.
- The Vaalbos Rocky Shrubland has a significant diversity of species and it is also prominent that numerous protected species occur within the vegetation type. Being a prominent topographical unit (hills and ridges) this will also increase its conservation value.
- Portions of CBA 1 areas are associated with remaining intact portions of Vaal-Vet Sandy Grassland (EN) which will have a high level of sensitivity. An on-site survey will enable accurate delineation of the border of these sensitive areas.
- Spatial planning should therefore aim to avoid CBA 1 areas, ridges and hills and the pan system although it is important that an on-site survey be conducted to delineate these areas more accurately and determine their respective sensitivity.

Dewetsdorp Urban Area (Appendix A: Map 5)

From the description of the remaining natural vegetation in the Dewetsdorp urban area the following elements of ecological importance should be taken into account in the MOSS:

- Although neither of the vegetation types are considered threatened a large portion to the west and south of the town is regarded as a CBA 1 area and will therefore have a high level of sensitivity.
- The reason for this CBA 1 area is not clearly apparent and comprehensive on-site surveys should be conducted.
- Whatever the case may be, for the time being these CBA areas must be regarded as highly sensitive and should be avoided by spatial planning.

Wepener Urban Area (Appendix A: Map 6)

From the description of the remaining natural vegetation in the Wepener urban area the following elements of ecological importance should be taken into account in the MOSS:

- The species and habitat diversity quite clearly increases along the prominent hills and ridges to the north and east of Wepener and these mountainous areas will contain a significantly higher conservation value.
- All three vegetation types are likely to contain numerous protected species though current data is lacking and indicate the need for further on-site assessment.
- It is also prominent that the mountainous vegetation types, Basotho Montane Shrubland and Eastern Free State Clay Grassland, contain a significantly higher proportion of protected species which will also increase their conservation value.
- The Eastern Free State Clay Grasslands are currently listed as a Vulnerable (VU) vegetation type, is under transformation pressure for crop cultivation, and therefore remaining natural portions of this vegetation type will have an increased conservation value.
- In addition, a few areas of this vegetation type to the north east of Wepener is also listed CBA 1 areas which will even further increase its conservation value.
- It is clear that several areas of conservation value occur around Wepener, especially the areas associated with the mountainous terrain to the north and east. It is unlikely that urban expansion will encroach into these areas though they should still be taken into consideration i.t.o. the spatial planning of Wepener.

Vanstadensrus Urban Area (Appendix A: Map 7)

From the description of the remaining natural vegetation in the Vanstadensrus urban area the following elements of ecological importance should be taken into account in the MOSS:

- Both vegetation types are likely to contain numerous protected species though current data is lacking and indicate the need for further on-site assessment. It is seems also evident that the hills and ridges the north and east of the town is likely to contain a higher diversity of species, habitat and protected species which increase its conservation value.
- Although neither of the vegetation types are considered threatened a large portion to the east and south of the town is regarded as a CBA 1 area and will therefore have a high level of sensitivity.

- The reason for this CBA 1 area is not clearly apparent and comprehensive on-site surveys should be conducted.
- Whatever the case may be, for the time being these CBA areas must be regarded as highly sensitive and should be avoided by spatial planning.

Wetlands and Watercourses

The study area consists of the urban areas of Bloemfontein, Botshabelo, Thaba Nchu, Soutpan, Dewetsdorp, Wepener and Vanstadensrus. From current mapping resources it is clear that these areas are drained by several large and significant watercourses. Some of these larger watercourses include the Renosterspruit, Bloemspruit, Seven-Dams Stream, Klein-Modder River, Sepane River, Modder River, Caledon River and Witspruit (Appendix A: Map 1-7). It is however not possible from a desktop assessment perspective to determine if wetland conditions are present in these and therefore, they must all be assumed to contain wetland conditions.

The wetland systems which may likely occur in the study areas and which will be associated with the watercourses may be classified into numerous different wetland types. In the absence of a site-survey these types cannot be determined with accuracy but the likely wetland systems to occur may include the following:

- The wetland condition along the main channel of larger stream and rivers may be characterised as a **channel wetland** (SANBI 2009).
- The wetland conditions adjacent to larger stream and rivers may be characterised as a **floodplain wetland** (SANBI 2009).
- Smaller streams and drainage lines in more mountainous and hill terrain are likely to be characterised as **valley bottom wetlands** with a channel (SANBI 2009).
- Several pan systems occur, especially around Bloemfontein and Soutpan, and these can be categorised as **depression wetlands** (SANBI 2009).
- Both **hillslope seeps and valley-head seeps** are likely to occur but will most likely only be found on the more prominent mountains and hills (SANBI 2009).

Table 1: Desktop summary of the Present Ecological State (PES) of larger watercourses in the urban areas of the Mangaung Metropolitan Municipality (NFEPA – National Freshwater Ecosystem Priority Areas).

Urban Area	Watercourse	PES (Kleynhans 2000)	Quarternary Cathcment	NFEPA Status
Bloemfontein	Renosterspruit	C: Moderately Modified	C52F	Not listed
Bloemfontein	Bloemspruit	C: Moderately Modified	C52F	Not listed
Bloemfontein	Seven Dams Stream	C: Moderately Modified	C52G	Upstream system
Botshabelo	Klein-Modder River	D: Largely Modified	C52B	Not listed
Thaba Nchu	Sepane River	D: Largely Modified	C52B	Not listed
Thaba Nchu	Korannaspruit	C: Moderately	C52C	Not listed

		Modified		
Dewetsdorp	Modder River	C: Moderately Modified	C52A	Not listed
Wepener	Caledon River	C: Moderately Modified	D23J	Not listed
Wepener	Sandspruit	D: Largely Modified	D23G	Not listed
Vanstadensrus	Witspruit	D: Largely Modified	D24C	FishFSA

The importance of wetlands and watercourses and the functioning and services they provide has become especially evident in recent times. It is clear that those watercourses situated in the urban areas has been heavily modified by it. The MOSS should therefore aim to incorporate several of the more sensitive and important watercourses and wetlands in order to retain their functioning as much as possible. These watercourses can in many instances also function as corridors between natural areas.

Biodiversity and Ecological Sensitivity

The following should be taken into account where the MOSS is reviewed and the level of sensitivity determined:

- Overall, the diversity of habitat and species are substantial. However, it is difficult to provide an accurate determination of this. Comprehensive on-site surveys will however provide a much better picture and indication of which specific areas will have the most significant habitat and species diversity.
- From available literature and previous studies conducted in the area it is considered a certainty that the MOSS will contain a multitude of protected species. Refinement of the MOSS and on-site surveys should confirm which areas contain most protected species and will therefore be portions of the MOSS with a higher level of sensitivity.
- The vegetation types contain different species compositions, vegetation structure, habitats and species diversity and consequently will also vary in their conservation value and consequently a representative portion of each will have to be retained within the MOSS.
- Preservation of the faunal population should be attained by the preservation of natural areas within the MOSS which will then by default preserve the faunal population.
- Corridors for the movement of fauna between natural areas should also form part of the MOSS.
- The importance of wetlands and watercourses and the functioning and services they provide has become especially evident in recent times. The MOSS should therefore aim to incorporate several of the more sensitive and important watercourses and wetlands in order to retain their functioning as much as possible.
- The preservation of natural areas through implementation of the MOSS will be irrelevant without incorporating measures to ensure that these natural areas remain largely free of exotic and invasive species.

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List of Acronyms

MOSS – Metropolitan Open Space System
MMM – Mangaung Metropolitan Municipality
NFEPA – National Freshwater Ecosystem Priority Areas
MSDF – Municipal Spatial Development Framework
PES – Present Ecological State
NBA – National Biodiversity Assessment
TOPS – Threatened Or Protected Species
DWS – Department of Water and Sanitation
WRC – Water Research Commission
EIS – Ecological Importance and Sensitivity
EMC – Ecological Management Class
SAIIAE – South African Inventory of Inland Aquatic Ecosystems
CSIR – Council for Scientific and Industrial Research
SANBI – South African National Biodiversity Institute
BSR – Biodiversity Sensitivity Rating
AMSL – Above Mean Sea Level
POSA – Plants of South Africa
LC – Least Concern
DDD - Data Deficient - Insufficient Information
NT – Near Threatened
VU – Vulnerable
EN – Endangered
NWA – National Water Act

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Desktop Ecological and Wetland Assessment

1. Introduction

Natural vegetation is an important component of ecosystems. Some of the vegetation units in a region can be more sensitive than others, usually as a result of a variety of environmental factors and species composition.

Some vegetation units perform vital functions in the larger ecosystem. These units are often associated with water bodies, water transferring bodies or moisture sinks. These systems are always connected to each other through a complex pattern. Degradation of a link in this larger system, e.g. tributary, pan, wetland, usually leads to the degradation of the larger system. Therefore, degradation of such a water related system should be prevented.

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

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

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

Development around cities and towns are necessary to accommodate an ever-growing population. However, urban expansion is well known for the transformation pressures they exert on diminishing natural areas. Areas within the urban border of cities and towns are usually in a degraded state due to the impact of the large population these areas house. Though this may be the case in most situations there may still be areas that consist of sensitive habitats such as watercourses, wetlands, areas of high diversity or rare vegetation types that need to be conserved. These areas may also contain endangered fauna and flora.

For the above reasons it is necessary to conduct an ecological and wetland assessment for the remaining open spaces within the Mangaung Metropolitan Municipality in order to aid in improved management and preservation of these areas.

The study area consists of several separate urban areas with a large extent. These are the city of Bloemfontein and surrounding towns, including Thaba Nchu, Botshabelo, Soutpan, Dewetsdorp, Wepener and Vanstadensrus. From aerial images it is clear that these areas consist of extensive urban areas but that significant natural areas are also visible within the urban edge. The desktop study will assess all open spaces and natural areas within the urban edge of these urban areas. Furthermore, a high number of watercourses and wetlands also occur in these urban areas with some of the larger rivers including the Bloemspruit, Renosterspruit, Modder River, Klein-Modder River, Sepane River, Caledon River and Witspruit.

The assessment is based on desktop information only and no on-site survey was conducted as part of this phase of the study. Information of the study area is therefore limiting and no detailed description of either vegetation or fauna can be provided. The assessment will make use of previous studies conducted in the surrounding region.

The report together with its recommendations should be utilised to inform further studies and management of open spaces.

1.1 Background

Mangaung Metropolitan Municipality comprises of different spatial land uses, one of which is the Metropolitan Open Space System (MOSS). Through the proper planning of Municipal Spatial Development Frameworks, metropolitan open spaces are meant to play a Pivotal role in maintaining sustainable development and the liveability of the area. To achieve a sustainable development between social, economic and environmental issues, the municipality uses a tool called Municipal Spatial Development Framework (MSDF) to spatially restructure the municipality and guide the location of future developments. According to Koomen *et al.* (2005), changes in the supply of land is one of the major concerns around metropolitan areas and hence, metropolitan open spaces are under threat of urbanisation making its valuation crucial for helping metropolitan planners to better asses the societal values of open spaces.

Sustainable development (in the view of Shi & Woolley, 2014) is influenced by green and open spaces in urban areas that are well planned and managed. Moreover, development of the urban green spaces at a larger scale and across multiple sites could contribute to restoration of natural processes and functions as well as creation of multifunctional landscapes and promotion of sustainable development.

1.2 The value of biodiversity

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

The balancing of atmospheric gases through photosynthesis and carbon sequestration is reliant on biodiversity, while an estimated 40% of the global economy is based on biological products and processes (Johnson 2005).

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

- Soil formation and maintenance of soil fertility.
- Primary production through photosynthesis as the supportive foundation for all life.
- Provision of food, fuel and fibre.
- Provision of shelter and building materials.
- Regulation of water flows and the maintenance of water quality.
- Regulation and purification of atmospheric gases.
- Moderation of climate and weather.
- Detoxification and decomposition of wastes.

- Pollination of plants, including many crops.
- Control of pests and diseases.
- Maintenance of genetic resources.

2. Scope and limitations

- To evaluate the present state of the vegetation and ecological functioning of the metropolitan urban areas including Bloemfontein, Botshabelo, Thaba Nchu, Soutpan, Dewetsdorp, Wepener and Vanstandesnrus. At a desktop level, accurate determination of the condition will not be possible and this will be a rough estimate, utilising current land use and previous studies in the region.
- To evaluate the present state of the wetlands and riparian vegetation included within the study area. The importance of the ecological function and condition will also be assessed. As above this will have to be based on available desktop data and will only provide rough estimates of the condition.
- Identify and delineate watercourses including rivers, streams, pans and wetlands and ascertain condition and status therefore and recommend mitigation. These will be done by aerial images and available mapping resources.
- Determine the Present Ecological State (PES) and Ecological Importance & Sensitivity (EIS) for the wetlands in the study area. Available information such as NFEPA (2011) will be used to give an estimated condition.

2.1 Vegetation (including riparian)

Aspects of the vegetation that will be assessed include:

- The vegetation types of the region with their relevance to the study area.
- The status of terrestrial and riparian vegetation cannot be determined through a desktop survey, though estimates of current impacts deduced from aerial images and current land use will be provided.
- Species composition with the emphasis on dominant-, rare- and endangered species. This will only be based on available literature and it must be assumed that they will be present in the study area.
- The boundary of wetland and watercourses cannot be determined by desktop study alone and it can only be indicated if such systems are present or not.

The amount of disturbance present on the study area assessed according to:

- The amount of grazing impacts cannot be determined but will be estimated from current land use.
- Disturbance caused by human impacts can also not be determined but will also be estimated by means of aerial images.
- Other disturbances.

2.2 Wetlands and watercourses

Aspects of the wetlands that will be assessed include:

- Identification and delineation of watercourses including rivers, streams, pans and wetlands. The wetland type and extent cannot be determined from desktop data and the likely occurrence will therefore be determined and likely types indicated.
- Describe condition and status of watercourses and importance relative to the larger system. Condition will be estimated from desktop literature.

2.3 Limitations

As this assessment will only be conducted on desktop level it contains numerous limitations:

- The assessment is based on desktop information only and no on-site survey was conducted as part of this phase of the study.
- No detailed description of the study area, including fauna or flora, can be given and will only be assessed in overview.
- Protected, rare and endangered species in the study area will only be estimated and must be regarding as occurring in the area.
- The condition of riparian and terrestrial vegetation, species composition, wetlands and watercourses and any other ecological aspect will only be estimated and assessed in overview.
- The extent of wetlands and watercourses cannot be determined and delineation is therefore not possible.
- The study will be confined to the assessment of natural open spaces within the urban edge of the towns of Bloemfontein, Thaba Nchu, Botshabelo, Soutpan, Dewetsdorp, Wepener and Vanstadensrus. Urban open spaces are man-made and will not be included in the assessment.

It should be clear that the limitations on a desktop assessment are extensive and it is highly recommended that additional, on-site ecological surveys be conducted in order to give a more accurate description of the study area.

3. Methodology

3.1 Several literature works were used for additional information.

Background information of the current MOSS will be taken from:

- Environmental Implementation and Management Plan for the Mangaung Metropolitan Municipality (2015).
- Draft Mangaung Metropolitan Municipality Spatial Development Framework (2020).
- Mangaung Metropolitan Municipality Open Space System (MOSS): Context Report (2015).
- 2015 MOSS Review: Urban Context Report.
- Mangaung Local Municipality: Urban Open Space Policy (2004).

Vegetation:

- Red Data List (Raymondo *et al.* 2009).
- Vegetation types (Mucina & Rutherford 2006).
- NBA 2018 Technical Report Volume 1: Terrestrial Realm.
- SANBI (2011): List of threatened ecosystems.
- NEM:BA: List of threatened ecosystems and Threatened Or Protected Species (TOPS).
- Free State Biodiversity Management Plan (2018).

Faunal Red List: Child *et al* 2016.

Field guides used for vegetation species identification:
(Bromilow 1995, 2010, Coates-Palgrave 2002, Court 2010, Fish *et al* 2015, Gerber *et al* 2004, Gibbs-Russell *et al* 1990, Griffiths & Picker 2015, Hartmann 2001, Manning 2009, Retief & Meyer 2017, Smith *et al* 1998, Smith & Crouch 2009, Smith & Van Wyk 2003, Van Ginkel *et al* 2011, Van Oudtshoorn 2004, Van Wyk & Malan 1998, Van Wyk & Van Wyk 1997, Venter & Joubert 1985).

Previous studies of the surrounding region:

- (Brown & Du Preez 2014, Dingaan & Du Preez 2002, Dingaan & Du Preez 2013, Dingaan & Du Preez 2017, Dingaan *et al* 2001, Malan *et al* 1998, 2001, Nthejane 2007, Potts & Tidmarch 1937).

- A collection of over 200 ecological, biodiversity and wetland studies conducted for a variety of development projects in the Mangaung Metropolitan Municipality will also be utilised (Van Rensburg 2009 – 2020) .

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

3.2 Survey

The study area was only assessed by means of a desktop review.

- The study area was surveyed by means of remote sensing in terms of aerial images obtained from Google Earth (2020).
- The broad vegetation types present in the study area were determined.
- The state of the environment was assessed in terms of condition, grazing impacts, disturbance by humans, erosion and presence of invader and exotic species but only with the aid of aerial images and comparison with studies conducted in the surrounding region.
- The state of the habitat was also assessed but again only by means of a desktop review.
- From the above it should be clear that the description of the site is limiting when only dependant on desktop information.

All rivers, streams, pans and wetlands were identified and surveyed where it occurred in the study area by means of aerial images and available mapping systems (NFEPA 2011 & SAIIAE 2018).

These wetlands and watercourses cannot be delineated by desktop assessment only and their presence will only be indicated, the DWS regulated area, i.e. 500 meters, should be taken as the affected area.

The following guidelines and frameworks were used to give background information as no site survey was performed:

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

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

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

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

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

- Van Deventer *et al*. 2018. South African National Biodiversity Assessment 2018: South African Inventory of Inland Aquatic Ecosystems (SAIIAE). Council for Scientific and Industrial Research (CSIR) and South African National Biodiversity Institute (SANBI): Pretoria, South Africa.

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

3.3 Criteria used to assess sites

Several criteria were used to assess the study area and determine the overall status of the environment. This was however applied in desktop form only and is only an estimation.

3.3.1 Vegetation characteristics

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

Habitat diversity and species richness: normally a function of locality, habitat diversity and climatic conditions.
Scoring: Wide variety of species occupying a variety of niches – 1, Variety of species occupying a single nich – 2, Single species dominance over a large area containing a low diversity of species – 3.

Presence of rare and endangered species: The likley occurrence or potential occurrence of rare or endangered species.
Scoring: Occurrence actual or highly likely – 1, Occurrence possible – 2, Occurrence highly unlikely – 3.

Ecological function: All plant communities play a role in the ecosystem. The ecological importance of all areas though, can vary significantly e.g. wetlands, drainage lines, ecotones, etc.
Scoring: Ecological function critical for greater system – 1, Ecological function of medium importance – 2, No special ecological function (system will not fail if absent) – 3.

Degree of rarity/conservation value:
Scoring: Very rare and/or in pristine condition – 1, Fair to good condition and/or relatively rare – 2, Not rare, degraded and/or poorly conserved – 3.

3.3.2 Vegetation condition

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

Percentage ground cover: Ground cover is under normal and natural conditions a function of climate and biophysical characteristics. Under poor grazing management, ground cover is one of the first signs of vegetation degradation.
Scoring: Good to excellent – 1, Fair – 2, Poor – 3.

Vegetation structure: This is the ratio between tree, shrub, sub-shrubs and grass layers. The ratio could be affected by grazing and browsing by animals.
Scoring: All layers still intact and showing specimens of all age classes – 1, Sub-shrubs and/or grass layers highly grazed while tree layer still fairly intact (bush partly opened up) – 2, Mono-

layered structure often dominated by a few unpalatable species (presence of barren patches notable) – 3.

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

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

Signs of erosion: The formation of erosion scars can often give an indication of the severity and/or duration of vegetation degradation.
Scoring: No or very little signs of soil erosion – 1, Small erosion gullies present and/or evidence of slight sheet erosion – 2, Gully erosion well developed (medium to large dongas) and/or sheet erosion removed the topsoil over large areas – 3.

3.3.3 Faunal characteristics

Presence of rare and endangered species: The actual occurrence or potential occurrence of rare or endangered species on a proposed site plays a large role on the feasibility of a development. Depending on the status and provincial conservation policy, presence of a Red Data species or very unique and sensitive habitats can potentially be a fatal flaw.
Scoring: Occurrence actual or highly likely – 1, Occurrence possible – 2, Occurrence highly unlikely.

3.4 Biodiversity sensitivity rating (BSR)

The total scores for the criteria discussed in section 3.3 were used to determine the biodiversity sensitivity ranking for the sites. On a scale of 0 – 3, five different classes are described to assess the biodiversity of the study area. The different classes are described in the Table 1:

Table 2: Biodiversity sensitivity ranking

BSR	BSR general floral description	Floral score equating to BSR class
Totally transformed (5)	Vegetation is totally transformed or in a highly degraded state, generally has a low level of species diversity, no species of concern and/or has a high level of invasive plants. The area has lost its inherent ecological function. The area has no conservation value and potential for successful rehabilitation is very low.	29 – 30
Advanced Degraded (4)	Vegetation is in an advanced state of degradation, has a low level of species diversity, no species of concern and/or has a high level of invasive plants. The area's ecological function is seriously hampered, has a very low conservation value and the potential for successful rehabilitation is low.	26 – 28
Degraded (3)	Vegetation is notably degraded, has a medium level of species diversity although no species of concern are present. Invasive plants are present but are still controllable. The area's ecological function is still intact but may be hampered by the current levels of degradation. Successful rehabilitation of the area is possible. The conservation value is regarded as low.	21 – 25
Good Condition (2)	The area is in a good condition although signs of disturbance are present. Species diversity is high and species of concern may be present. The ecological function is intact and very little rehabilitation is needed. The area is of medium conservation importance.	11 – 20
Sensitive/Pristine (1)	The vegetation is in a pristine or near pristine condition. Very little signs of disturbance other than those needed for successful management are present. The species diversity is very high with several species of concern known to be present. Ecological functioning is intact and the conservation importance is high.	0 - 10

4. Desktop Ecological and Wetland Assessment

For the purpose of this report the terrestrial and aquatic ecology will be discussed separately. A general description of the terrestrial environment for each urban area will be given separately followed by an overall discussion of wetland and aquatic systems.

4.1 Ecology, vegetation and description of the study area

4.1.1 Bloemfontein urban area (Appendix A: Map 1)

Bloemfontein is the economic hub of the municipal area and will remain the locus for future development. The city is centrally located in South Africa and is served by major roads such as the N1 which links Gauteng with the southern and western Cape, the N6 which links Bloemfontein to the Eastern Cape and the N8 which links Lesotho in the east with the Northern Cape in the west via Bloemfontein. The urban extent of the city is approximately 18 530 hectares. Larger watercourses occurring in this urban area include the Renosterspruit, Bloemspruit and Seven-Dams Stream. Owing to the high-density urban areas these are generally heavily modified.

Bloemfontein is situated within the Grassland Biome and under natural conditions would be dominated by grasses with shrubs and trees being almost completely absent. The exception to this being hills and ridges which provide suitable habitat and climate for shrubs and trees to establish. Watercourses also contain differing soils conditions, climate and moisture regime which enables the establishment of shrubs and trees. Consequently, plains should be dominated by grasses while ridges, hills and watercourses would contain a prominent grass component but also substantial shrub and tree cover. This is also the case for the remaining natural areas comprising the Mangaung MOSS. However, the urban environment also increases the establishment of trees. Under natural conditions the Grassland Biome is kept free of trees by a combination of periodic burning and high frost incidence. However, the urban environment often prevents fires in the remaining grassland areas and buildings also decrease frost incidence and this then increases the establishment of trees in the remaining natural areas. The overall vegetation structure has therefore been modified to some degree. In addition, the urban environment itself also cause large-scale transformation of the natural environment as can be expected. Even the remaining natural areas are often in a heavily degraded condition which may be attributed to land-use but is in large-part also a result of the edge-effect, especially for smaller portions of vegetation. The edge-effect is normally exacerbated by habitat fragmentation and is caused by transformed and degraded areas which also affect and degrade the adjacent natural areas along their borders. This has also been substantiated by several previous studies of the area (Dingaan *et al,* Van Rensburg).

Due to the large extent of the urban area it contains a moderate variety in terms of topography though overall it is a relatively flat area. From aerial images and contours of the study area the majority of Bloemfontein is dominated by relatively flat plains which is pronounced in the western half with an undulating topography becoming more prominent toward the eastern half. A series of dolerite hills and ridges also become prominent along the northern portions of the study area. These also provide significantly different habitats and the vegetation composition is also clearly different from the surrounding plains. As mentioned, several significant watercourses as well as smaller drainage lines and numerous wetland systems are also incised into the terrain and these also contribute to the varied topography. These areas will again represent a different topographical unit with a differing vegetation composition and habitat. The

altitude of the Bloemfontein urban area varies from 1590 m AMSL on the more prominent hills to 1330 m AMSL along the lower lying watercourses. This represents a difference of 160 m which although this indicates a significant variety in topography also indicates the absence of mountains or other similar prominent topographical elements.

As indicated, the transformation and degradation caused by the urban area of Bloemfontein is extensive and also impacts on the portions of remaining natural vegetation. As can be expected, the urban environment itself and associated amenities, recreational, infrastructure and industrial activities lead to the direct transformation of large areas. The areas of remaining natural vegetation and the main areas of focus of this study is also affected by numerous impacts associated with the urban area. Recreational activities such as hiking trails, All Terrain Vehicle (ATV) tracks and roads and other informal dirt roads all cause local transformation though the impact is still relatively low. This does however provide access to these areas and in many cases exacerbate the impact of illegal dumping which may transform significantly large areas. One of the most significant impacts on the remaining natural areas, besides urban development itself, is associated with agricultural activities. Both small- and large-scale farming operations occur around the city. Where dryland and irrigated crop cultivation occurs this leads to the direct and largely irreversible transformation of the vegetation and these areas are essentially lost. This is also substantiated by both the Free State Biodiversity Management Plan as well as other available mapping sources of the remaining Threatened Ecosystems (SANBI 2011, NBA 2018). A lesser impact, but still quite significant is overgrazing by domestic stock and introduced game. Overgrazing and -browsing and the associated trampling cause a decrease in vegetation cover and an increase in erosion. Where this is severe it may lead to a significant loss in diversity and transformation of the natural vegetation type. This has especially been observed in small holding situations, overstocking of introduced game in several estates or similar housing developments as well as around communal grazing areas (especially to the south east around the lower-income urban areas).

Bloemfontein is situated in a region experiencing moderate rainfall, with cold, dry winters and warm summers. According to the climate statistics from the South African Weather Service, the annual mean maximum and minimum temperatures are 24.6 °C and 7.6 °C, respectively. Climate for the site can be relatively accurately represented by rainfall and evaporation data from the weather station D5E003 (Maselspoort). Bloemfontein receives an average of 548 mm per year. Precipitation occurs mainly during summer, with most rainfall received during January to March. This is considered a moderate rainfall though the area is still considered to form part of a semi-arid region of South Africa. The mean annual evaporation is 1676 mm. Evaporation is highest during summer. As a result, surface runoff in the area is not significant and relatively low, occurs mostly during summer and results in an estimated mean annual runoff for the area between 10 – 20 mm according to a study by the Water Research Commission (WRC REPORT NO. TT 685/16, 2016).

The following description of the soils and geology of the Bloemfontein area was taken from Dingaan *et al* (2017). Three different land types are distinguished in the study area, namely the Ca, Dc and Ea land types. Within each of these land types, soils vary from sandy to clayey, as a result of the variation in parent material. The Ca land type, occurring as Ca8 and Ca22 subdivisions, is a mixture of duplex and plinthic soils. The Ca8 subdivision is found on the western part of the study area and consists mainly of sandy Hutton– Bainsvlei soils and more clayey Valsrivier–Swartland soils; the Ca22 subdivision occurs in the south and is mainly dominated by Valsrivier soils. The Dc land type occurs as subdivision Dc13, which is dominated by duplex soils of the Valsrivier–Swartland–Sterkspruit forms. It is only present in

small pockets in the eastern part of the study area. The Ea land type is found in the central and northern parts and occurs as subdivision Ea39, the most extensive in the study area. It consists mainly of sandy Oakleaf soils, although a mixture of the clayey Milkwood, Arcadia and Valsrivier soils are also prominent. The geologic formations of the study area belong to the Karoo Supergroup and consist of the Tierberg Formation of the Ecca Group and the Adelaide Sub-Group of the Beaufort Group, as well as dolerite intrusions of the post-Karoo age. Rcoky outcrops, including ridges and hills in the area is dominated by dolerite. It consists of a network of dolerite sills, sheets and dykes, mainly intrusive into the Karoo Supergroup (Council for Geoscience 2016).

As can be deduced from the description of the Bloemfontein urban area the impacts caused on the remaining natural areas are significant and would most likely decrease the condition of several of the areas.

4.1.1.1 Bloemfontein Vegetation Types

As a result of the variation in topography, soil, geology, etc. the urban area of Bloemfontein contains several different vegetation types. According to Mucina & Rutherford (2006), the study area includes Bloemfontein Dry Grassland (Gh 5), Winburg Grassy Shurbland (Gh 7), Bloemfontein Karroid Shrubland (Gh 8) and Highveld Alluvial Vegetation (AZa 5). According to the National Environmental Management: Biodiversity Act, 2004 (Act No. 10 of 2004) these are all currently listed as being of Least Concern (LC), except for the Bloemfontein Dry Grassland which is listed as a Vulnerable (VU) vegetation type. In addition, the Bloemfontein Karroid Shrubland has recently become increasingly under pressure from development and due to its high species diversity and high proportion of protected species it is also regarded as a sensitive vegetation type.

These vegetation types also correspond easily to the different topographical elements as previously described. The Bloemfontein Dry Grassland is confined to the plains areas and is dominated by a well-developed grass layer with shrubs and trees completely absent. The Winburg Grassy Shrubland is confined to dolerite outcrops including ridges and hills and is dominated by a well-developed though short shrub and tree layer. The Bloemfontein Karroid Shrubland is confined to a rather unique habitat confined to exposed dolerite rock sheets with a very shallow soil layer and is dominated by especially dwarf succulents and geophytic species. The Highveld Alluvial Vegetation is confined to the floodplains of the larger rivers in the Bloemfontein are, i.e. the Bloem- and Renosterspruit, and is dominated by a variety of growth forms ranging from a tree/shrub layer to geophyte rich herblands.

In the absence of a site survey a general description of the vegetation composition is given as obtained from Mucina & Rutherford (2006) and other previous vegetation studies. This is by no means a comprehensive description of the vegetation but should give a general description.

Bloemfontein Dry Grassland (Gh 5)

Important Taxa:

Graminoids: *Anthephora pubescens*, *Aristida congesta*, *A. diffusa*, *Cynodon dactylon*, *Digitaria argyrograpta*, *Elionurus muticus*, *Eragrostis chloromelas*, *E. lehmanniana*, *E. obtusa*, *E. plana*, *E. superba*, *E. trichophora*, *Heteropogon contortus*, *Panicum stapfianum*, *Setaria sphacelata*, *Themeda triandra*, *Tragus koelerioides*, *Aristida stipitata* subsp. *graciliflora*, *Chloris virgata*,

Cymbopogon pospischilii, *Pogonarthria squarrosa*, *Sporobolus fimbriatus*, *Trichoneura grandiglumis*, *Triraphis andropogonoides*.

Herbs: *Selago densiflora*, *Berkheya onopordifolia* var. *onopordifolia*, *Blepharis integrifolia* var. *clarkei*, *Chamaesyce inaequilatera*, *Commelina africana*, *Dicoma macrocephala*, *Gazania krebsiana* subsp. *krebsiana*, *Geigeria ornativa*, *Harpagophytum procumbens*, *Helichrysum caespititium*, *Heliotropium ciliatum*, *Hermannia comosa*, *H. tomentosa*, *Indigofera alternans*, *Lactuca dregeana*, *Lotononis listii*, *Monsonia burkeana*, *Nolletia ciliaris*, *Pollichia campestris*.

Geophytic Herbs: *Oxalis depressa*, *Haemanthus humilis* subsp. *humilis*.

Succulent Herb: *Tripteris aghillana* var. *integrifolia*.

Low Shrubs: *Chrysocoma ciliata*, *Felicia filifolia* subsp. *filifolia*, *Pentzia globosa*, *P. incana*, *Amphiglossa triflora*, *Anthospermum rigidum* subsp. *pumilum*, *Asparagus striatus*, *Felicia muricata*, *Gnidia polycephala*, *Helichrysum dregeanum*, *Nenax microphylla*, *Osteospermum leptolobum*, *Polygala hottentotta*, *Selago saxatilis*.

Succulent Shrub: *Hertia pallens*.

Further studies conducted by Dingaan *et al* (2013) has further divided this vegetation type into several vegetation communities based, largely on habitat factors such as soil depth and texture, rockiness of the soil surface and habitat disturbance (especially utilisation by livestock). This results in seven distinct plant communities with four sub-communities. These are (Note that several botanical name changes has since been implemented though the original naming is used in this instance to better allow for comparison with previous studies):

1. *Felicia muricata – Themeda triandra* major community
    - 1.1. *Panicum coloratum – Digitaria eriantha* community
        - 1.1.1. *Cyperus usitatus – Digitaria eriantha* sub-community
    - 1.2. *Eragrostis obtusa – Sporobolus fimbriatus* community
        - 1.2.1. *Panicum schinzii – Themeda triandra* sub-community
    - 1.3. *Eragrostis biflora – Themeda triandra* community
2. *Aristida congesta – Themeda triandra* major community
    - 2.1. *Trichoneura grandiglumis – Rhynchosia nervosa* community
        - 2.1.1. *Conyza bonariensis – Eragrostis curvula* sub-community
        - 2.1.2. *Antephora pubescens – Digitaria argyrograpta* sub-community
    - 2.2. *Eragrostis trichophora – Cyperus capensis* community
    - 2.3. *Hyparrhenia hirta – Themeda triandra* community
    - 2.4. *Melinis repens – Eragrostis lehmanniana* community.

The vegetation type is clearly dominated by grass species with *Themeda triandra* and *Eragrostis lehmanniana* being dominant. A total of 115 species was recorded by previous studies (Dingaan *et al* 2013) indicating only a moderate species diversity. A few protected species are noted, especially *Harpagotphytum procumbens*, though the vegetation type does not contain an abundance of protected species.

Winburg Grassy Shrubland (Gh 7)

Important Taxa**:**

Small Trees: *Acacia karroo*, *Celtis africana*, *Cussonia paniculata*, *Pittosporum viridiflorum*, *Rhus lancea*, *Scolopia zeyheri*, *Ziziphus mucronata*.

Tall Shrubs: *Buddleja saligna*, *Euclea crispa* subsp. *ovata*, *Gymnosporia polyacantha*, *Olea europaea* subsp. *africana*, *Rhus burchellii*, *R. erosa*, *Diospyros lycioides* subsp. *lycioides*, *Grewia occidentalis*, *Gymnosporia buxifolia*, *Tarchonanthus camphoratus*.

Low Shrubs: *Helichrysum dregeanum*, *Pentzia globosa*, *Anthospermum rigidum* subsp. *pumilum*, *Asparagus cooperi*, *A. laricinus*, *Berkheya annectens*, *Chrysocoma ciliata*, *Clutia pulchella*, *Euryops empetrifolius, Felicia filifolia* subsp. *filifolia*, *F. muricata*, *Nenax microphylla*, *Osyris lanceolata*, *Rosenia humilis*, *Selago saxatilis*, *Solanum tomentosum* var. *coccineum*.

Graminoids: *Aristida adscensionis*, *A. congesta*, *A. diffusa*, *Cymbopogon pospischilii*, *Cynodon dactylon*, *C. incompletus*, *Eragrostis chloromelas*, *E. lehmanniana*, *E. micrantha*, *E. obtusa*, *E. trichophora*, *Eustachys paspaloides, Heteropogon contortus, Panicum stapfianum, Setaria lindenbergiana, S. sphacelata, Sporobolus fimbriatus, Themeda triandra, Tragus koelerioides, Digitaria argyrograpta, Elionurus muticus, Enneapogon scoparius, Eragrostis plana, E. superba, Tragus berteronianus, T. racemosus, Triraphis andropogonoides.*

Herbs: Berkheya onopordifolia var. onopordifolia, Hermannia coccocarpa, Indigofera alternans, Mohria caffrorum, Pupalia lappacea, Salvia repens. Geophytic

Herbs: Oxalis corniculata, O. depressa.

Succulent Herb: Crassula lanceolata.

Previous studies (Dingaan *et al* 2013) has also only identified one vegetation community in this vegetation type namely the *Olea europaea–Buddleja saligna* Shrubland. This therefore also indicates a relatively uniform vegetation type confined to the dolerite hills and ridges. It also contains a moderate species diversity but with a significantly higher proportion of protected species.

Bloemfontein Karroid Shrubland (Gh 8)

Important Taxa:

Tall Shrubs: *Diospyros austro-africana*, *Euclea crispa* subsp. *ovata*, *Rhus burchellii*, *R. erosa*, *R. tridactyla*.

Low Shrubs: *Eriocephalus ericoides*, *Euryops empetrifolius*, *Anthospermum rigidum* subsp. *pumilum*, *Asparagus suaveolens*, *Felicia muricata*, *Helichrysum dregeanum*, *Heliophila suavissima*, *Jamesbrittenia pristisepala*, *Nenax microphylla*, *Pentzia globosa*, *Phyllanthus parvulus*, *Selago albida*.

Succulent Shrubs: *Chasmatophyllum musculinum*, *Euphorbia mauritanica*, *Ruschia spinosa*, *Stomatium mustellinum*, *Cotyledon orbiculata* var. *dactylopsis*, *Euphorbia rectirama*, *Kalanchoe paniculata*, *Othonna protecta*, *Pachypodium succulentum*, *Ruschia hamata*, *R. unidens*, *Sarcocaulon salmoniflorum*, *Stapelia grandiflora*.

Succulent Woody Climber: *Sarcostemma viminale*.

Graminoids: *Aristida diffusa*, *Eragrostis nindensis*, *Heteropogon contortus*, *Oropetium capense*, *Aristida adscensionis*, *A. congesta*, *Cymbopogon caesius*, *C. pospischilii*, *Cyperus rupestris* var. *rupestris*, *Digitaria eriantha*, *Enneapogon scoparius*, *Eragrostis chloromelas*, *E. obtusa*, *E. superba*, *E. trichophora*, *Eustachys paspaloides*, *Melinis repens* subsp. *repens*, *Microchloa caffra*, *Themeda triandra*, *Tragus koelerioides*, *T. racemosus*.

Herbs: *Berkheya onopordifolia* var. *onopordifolia*, *B. rigida*, *Chamaesyce inaequilatera*, *Commelina africana*, *Gazania linearis* var. *linearis*, *Geigeria aspera* var. *aspera*, *G. filifolia*, *Hermannia coccocarpa*.

Geophytic Herbs: *Cheilanthes eckloniana*, *Albuca setosa*, *Dipcadi ciliare*, *D. viride*, *Nerine laticoma*, *Pellaea calomelanos*, *Trachyandra saltii*.

Succulent Herbs: *Senecio radicans*, *Adromischus trigynus*, *Aloe grandidentata*, *Anacampseros telephiastrum*, *Avonia ustulata*, *Crassula nudicaulis*, *Duvalia corderoyi*, *Orbea cooperi*, *Orbeopsis lutea*, *Tripteris aghillana* var. *integrifolia*.

Endemic Taxon, Geophytic Herb: *Brachystelma glenense*.

Due to the rather unique nature of this vegetation type, several other studies have also been undertaken here and has indicated a further division of the vegetation type into vegetation communities and sub-communities (Dingaan & Du Preez 2002). These are largely the result of differing soil depth and topography within the vegetation type and consist of (Note that several botanical name changes has since been implemented though the original naming is used in this instance to better allow for comparison with previous studies):

1. Nerine laticoma – Aristida congesta community
2. *Eragrostis trichophora – Aristida congesta* community
3. *Heliophylla carnosa – Senecio radicans* community
    3.1. *Lessertia annularis – Ruschia spinosa* sub-community
        3.1.1. *Senecio inaquidens* variant
        3.1.2. *Senecio burchellii* variant
4. *Stomatium mustellinum – Avonia ustulata* community
    4.1. *Stomatium mustellinum – Aristida diffusa* sub-community
    4.2. *Oropetium capense – Eragrostis nindensis* sub-community

In addition, this study has also identified several additional species of conservation significance. These include:

Crassula coralina, Crassula dependens, Euphorbia catervifolia, Strumaria tenella subsp. *orientalis, Tulbaghia acutiloba.*

Other species noted from personal observations during past studies of the area (Van Rensburg 2009 – 2020) also include the following conservation significant species:

Anacampseros filamentosa, Anacampseros rufescens, Bonatea attenifera, Cussonia paniculata, Eucomis autumnalis, Gladiolus permeabilis, Haemanthus humilis, Hereroa glenensis, Rabiea albipuncta, Ruschia unidens.

From the description of the vegetation composition and communities it should be evident that this vegetation type contains a significant species diversity, higher than other surrounding vegetation types and also with a high proportion of these being protected species. In addition, the species composition is also markedly different from the surrounding grassland vegetation types, dominated by dwarf succulents, geophytes and karroid shrubs. The vegetation type would therefore seem to have a significant conservation value.

This is also substantiated by previous studies which have come to the same conclusion. According to Dingaan & Du Preez (2017). The vegetation type is being threatened by urban expansion and is a botanically diverse area being confined to the northern portions of the urban areas of Bloemfontein. Rampant development in this vegetation type will also lead to heavy disturbance, extinction of some of the rare species here, as well as unique plant communities of which the succulent dwarf shrubs are the most sensitive (Dingaan & Du Preez 2002). According to Brown & Du Preez 2014 the vegetation type must be regarded as endemic to the Free State Province and must be afforded a high conservation status and must be included as a Threatened Ecosystem.

Highveld Alluvial Vegetation (Aza 5)

Important Taxa Riparian thickets**:**

Small Trees: *Acacia karroo*, *Salix mucronata* subsp. *mucronata*, *S. mucronata* subsp. *woodii*, *Ziziphus mucronata*, *Celtis africana*, *Rhus lancea*.
Tall Shrubs: *Gymnosporia buxifolia*, *Rhus pyroides*, *Diospyros lycioides*, *Ehretia rigida*, *Grewia flava*.
Low Shrubs: *Asparagus laricinus*, *A. suaveolens*.
Woody Climber: *Clematis brachiata*.
Succulent Shrub: *Lycium hirsutum*.
Graminoids: *Setaria verticillata*, *Panicum maximum*.
Herb: *Pollichia campestris*.

Reed beds Megagraminoid: *Phragmites australis*.

Flooded grasslands & herblands Low Shrubs: *Gomphocarpus fruticosus*, *Felicia muricata*.
Succulent Shrub: *Salsola rabieana*.
Graminoids: *Agrostis lachnantha*, *Andropogon eucomus*, *Chloris virgata*, *Cynodon dactylon*, *Eragrostis plana*, *Hemarthria altissima*, *Imperata cylindrica*, *Ischaemum fasciculatum*, *Miscanthus junceus*, *Paspalum distichum*, *Andropogon appendiculatus*, *Brachiaria marlothii, Cyperus denudatus*, *C. longus*, *Echinochloa holubii*, *Eragrostis obtusa*, *E. porosa*, *Fimbristylis ferruginea, Panicum coloratum*, *Pycreus mundii*, *Sporobolus africanus*, *S. fimbriatus*, *Themeda triandra*, *Urochloa panicoides*.
Herbs: *Persicaria lapathifolia*, *Alternanthera sessilis*, *Barleria macrostegia*, *Corchorus asplenifolius*, *Equisetum ramosissimum*, *Galium capense*, *Hibiscus pusillus*, *Lobelia angolensis, Nidorella resedifolia*, *Persicaria amphibia, P. hystricula*, *Pseudognaphalium oligandrum*, *Pulicaria scabra, Rorippa fluviatilis* var. *fluviatilis*, *Senecio inornatus*, *Stachys hyssopoides*, *Vahlia capensis*.
Geophytic Herbs: *Crinum bulbispermum*, *Haplocarpha lyrata*.

Open water Aquatic Herb: *Myriophyllum spicatum*.

A comprehensive study on the different communities associated with this vegetation type has been conducted by Dingaan *et al* (2001). This has resulted in the subdivision of the vegetation type into several vegetation communities and sub-communities. A few other communities associated with other wetland systems and rivers have also been identified by this study but will be included within the wetland assessment section where it will be more relevant. Vegetation communities and sub-communities relevant to the Highveld Alluvial Vegetation consist of (Note that several botanical name changes has since been implemented though the original naming is used in this instance to better allow for comparison with previous studies):

3. Acacia karroa - Asparagus laricinus Major Community
- *3.1 Themeda triandra - Atriplex semibaccata* Community
- *3.2 Acacia karroo - Rhus pyroides* Community
- *3.3 Acacia karroa - Cynodon hirsutus* Community
  - *3.3.1 Acacia karroo - Aristida congesta* Sub-community
    - *3.3.1.1 Sporobolus limbriatus* Variant
    - *3.3.1.2 Rhus lancea* Variant
  - *3.3.2 Acacia karreo - Altemanthera pungens* Sub-community
- *3.4 Acacia karroo - Rhus lancea* Community

From the description of the vegetation composition it should be clear that the vegetation type contains a varied vegetation structure with a high amount of different growth forms. This also translates to a varied topography and habitat diversity. Though not clearly evident the vegetation type also contains a diversity of geophytic species, with several being protected and of conservation significance. Those species of importance having been observed from previous studies and personal observation and which will be of importance include:

Crinum bulbispermum, Ammocharis coranica, Massonia jasminiflora, Hypoxis argentea, Chlorophytum sp., Ledebouria sp., Haemanthus montanus, Bulbine fruticosa, B. narcissifolia, Eucomis autumnalis, Drimia elata, Brunsvigia radulosa, Colchicum longipes, Nananthus broomii.

The vegetation type will clearly also contain elements of conservation significance. In addition, it is associated with larger watercourses which are themselves also highly sensitive systems and will further increase the significance of the vegetation type.

4.1.1.2 Bloemfontein Protected Species

As previously mentioned, the vegetation types around the urban area of Bloemfontein all contain some protected and Red Listed species. These are also of significant conservation value and will therefore increase the sensitivity of open spaces where they occur. Furthermore, when utilising the Plants of South Africa (http://posa.sanbi.org) an analysis of plant species previously recorded in the region includes the following protected and Red Listed species recorded. Additional sources also include numerous studies conducted in this area.

Table 3: Protected and Red Listed species recorded for the quarter degree squares (2926AA, 2926AB & 2826CC) (http://posa.sanbi.org).

LC – **Least Concern** A species is Least Concern when it has been evaluated against the IUCN criteria and does not qualify for any of the above categories. Species classified as Least Concern are considered at low risk of extinction. Widespread and abundant species are typically classified in this category.

DDD – **Data Deficient - Insufficient Information (DDD)** A species is DDD when there is inadequate information to make an assessment of its risk of extinction, but the species is well defined. Listing of species in this category indicates that more information is required and that future research could show that a threatened classification is appropriate.
NT – **Near Threatened (NT)** A species is Near Threatened when available evidence indicates that it nearly meets any of the IUCN criteria for Vulnerable and is therefore likely to become at risk of extinction in the near future.
VU – **Vulnerable (VU)** A species is Vulnerable when the best available evidence indicates that it meets at least one of the five IUCN criteria for Vulnerable, indicating that the species is facing a high risk of extinction.
EN – **Endangered (EN)** A species is Endangered when the best available evidence indicates that it meets at least one of the five IUCN criteria for Endangered, indicating that the species is facing a very high risk of extinction.
Gh5 – **Bloemfontein Dry Grassland**
Gh7 – **Winburg Grassy Shrubland**
Gh8 – **Bloemfontein Karroid Shrubland**
Aza5 – **Highveld Alluvial Vegetation**

FAMILY	Scientific name	Status	Protected	Gh5	Gh7	Gh8	Aza5
Aizoaceae	*Nananthus vittatus*	DDT	N				✔
Amaryllidaceae	*Ammocharis coranica*	LC	Y	✔		✔	✔
Amaryllidaceae	*Brunsvigia radulosa*	LC	Y	✔	✔	✔	✔
Amaryllidaceae	*Crinum bulbispermum*	LC	Y				✔
Amaryllidaceae	*Gethyllis transkarooica*	LC	Y	✔	✔	✔	✔
Amaryllidaceae	*Haemanthus humilis subsp. humilis*	LC	Y		✔	✔	
Amaryllidaceae	*Haemanthus montanus*	LC	Y				✔
Amaryllidaceae	*Nerine laticoma*	LC	Y	✔	✔	✔	✔
Amaryllidaceae	*Strumaria tenella subsp. orientalis*	LC	Y			✔	
Anacampserotaceae	*Anacampseros filamentosa subsp. filamentosa*	LC	Y			✔	
Anacampserotaceae	*Anacampseros rufescens*	LC	Y			✔	
Anacampserotaceae	*Anacampseros ustulata*	LC	Y			✔	
Apocynaceae	*Asclepias gibba var. gibba*	LC	Y	✔	✔	✔	✔
Apocynaceae	*Asclepias meyeriana*	LC	Y	✔	✔	✔	✔
Apocynaceae	*Asclepias multicaulis*	LC	Y	✔	✔	✔	✔
Apocynaceae	*Brachystelma circinatum*	LC	Y	✔	✔	✔	✔
Apocynaceae	*Brachystelma glenense*	DDT	Y	✔	✔	✔	✔
Apocynaceae	*Cynanchum virens*	LC	Y	✔	✔	✔	✔
Apocynaceae	*Duvalia corderoyi*	LC	Y			✔	
Apocynaceae	*Pachypodium succulentum*	LC	Y			✔	
Apocynaceae	*Pentarrhinum insipidum*	LC	Y	✔	✔	✔	✔
Apocynaceae	*Raphionacme dyeri*	LC	Y	✔	✔	✔	✔
Apocynaceae	*Raphionacme hirsuta*	LC	Y	✔	✔	✔	✔
Apocynaceae	*Stapelia grandiflora var. grandiflora*	LC	Y		✔	✔	
Apocynaceae	*Stenostelma capense*	LC	Y	✔	✔	✔	✔
Apocynaceae	*Stenostelma corniculatum*	LC	Y	✔	✔	✔	✔
Araliaceae	*Cussonia paniculata subsp. sinuata*	LC	Y		✔	✔	
Asphodelaceae	*Aloe grandidentata*	LC	Y		✔	✔	
Asphodelaceae	*Aloe jeppeae*	LC	Y	✔			✔
Euphorbiaceae	*Euphorbia clavarioides*	LC	Y	✔	✔	✔	✔
Euphorbiaceae	*Euphorbia mauritanica*	LC	Y		✔	✔	
Euphorbiaceae	*Euphorbia rhombifolia*	LC	Y			✔	
Euphorbiaceae	*Euphorbia spartaria*	LC	Y			✔	
Geraniaceae	*Pelargonium sidoides*	LC	Y	✔	✔	✔	✔
Hyacinthaceae	*Eucomis autumnalis subsp. amaryllidifolia*	LC	Y	✔	✔	✔	✔
Hyacinthaceae	*Eucomis autumnalis subsp. clavata*	LC	Y	✔	✔	✔	✔
Iridaceae	*Gladiolus permeabilis subsp.*	LC	Y	✔	✔	✔	✔

	edulis						
Oleaceae	*Olea europaea subsp. cuspidata*	LC	Y		✔	✔	
Orchidaceae	*Bonatea antennifera*	LC	Y			✔	
Orchidaceae	*Eulophia hians var. nutans*	LC	Y	✔	✔	✔	✔
Orchidaceae	*Eulophia ovalis var. ovalis*	LC	Y	✔	✔	✔	✔
Orchidaceae	*Habenaria epipactidea*	LC	Y	✔	✔	✔	✔
Pedalicaea	*Harpagophytum procumbens*	LC	Y	✔			

There is a high likelihood that many of these species as listed will occur within the Bloemfontein urban area. Note that only two Red Listed species occur here and these are currently Data Deficient Taxonomically problematic. The Bloemfontein urban area therefore does not contain any plant species which is significantly endangered or rare.

A comparison between the different vegetation types and the likelihood that protected species may occur indicate that all vegetation types contain a significant proportion of protected species which will be of significant conservation significance. The Winburg Grassy Shubland contains a somewhat higher number of protected species. However, note that the Bloemfontein Karroid Shrubland contains a significantly higher amount of protected species when compared to the other vegetation types. This also indicates a significant conservation value of this vegetation type and will also contribute to a higher conservation value for it.

4.1.1.3 Additional data sets

Numerous data sets and mapping resources have been developed to aid in the identification of sensitive areas and areas with a high conservation value, notably those resources developed by the South African National Biodiversity Institute (SANBI). Several of these resources were also combined with the results and discussion of the previous sections to indicate areas within the Bloemfontein urban area which should be regarded as sensitive. From these data sets the following conclusions can be made:

National Biodiversity Assessment (NBA) 2018

Remnants of the natural vegetation types in the area indicates that the urban development of Bloemfontein has led to the loss of large portions of natural vegetation types. As indicated in previous sections, all of the vegetation types in the area contain elements of significant conservation value and therefore all portions of remaining natural vegetation will have a significant level of sensitivity. However, the Bloemfontein Dry Grassland is a Vulnerable vegetation type and will therefore have an increased sensitivity. As concluded, the Bloemfontein Karroid Shrubland contains a high species diversity, provide unique habitat of limited extent and has a high proportion of protected species and will therefore also have an increased sensitivity. The hills and ridges consisting of Winburg Grassy Shrubland also contain numerous protected species and as positive landscape features acting as corridors the vegetation type still has a significant level of sensitivity though lower than the two aforementioned vegetation types. The Highveld Alluvial Vegetation also contains a significant number of protected species and being associated with large watercourses it also still has a significant level of sensitivity.

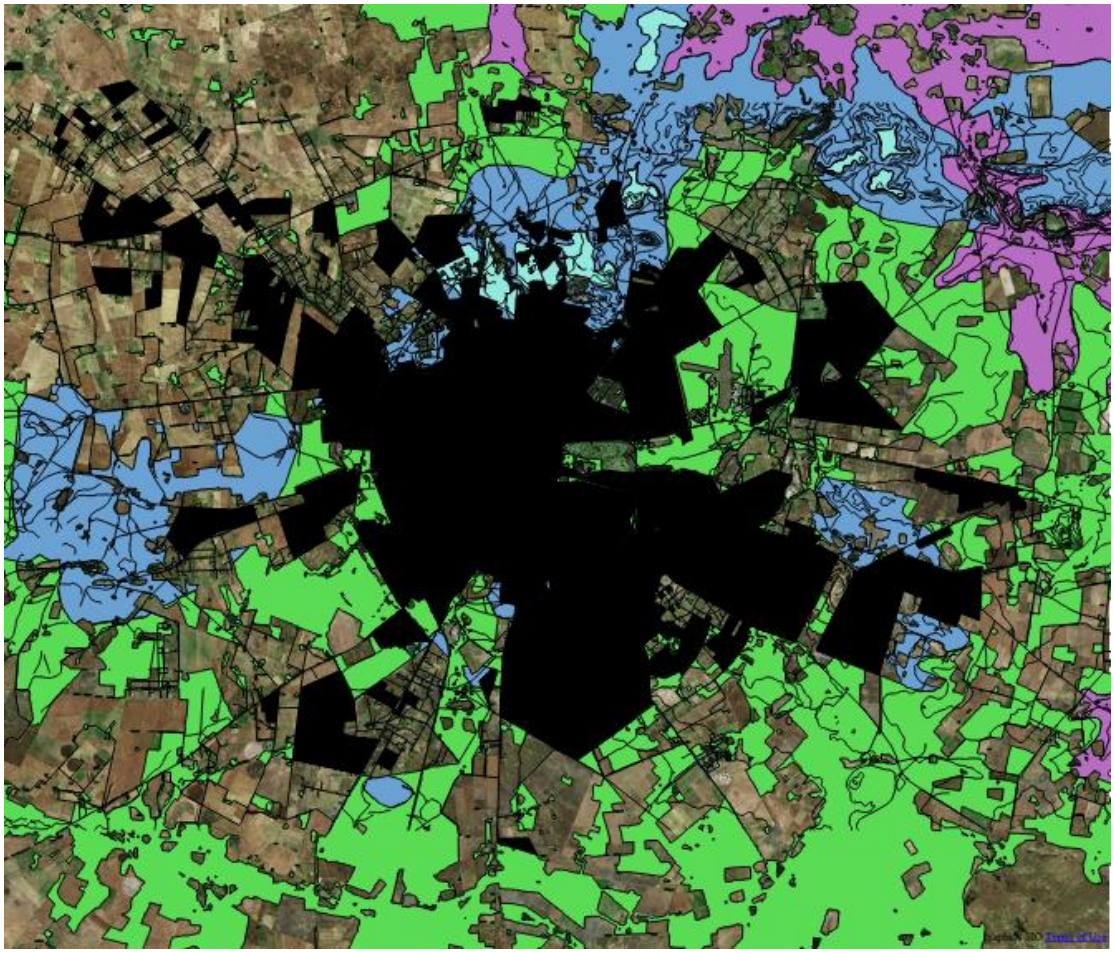
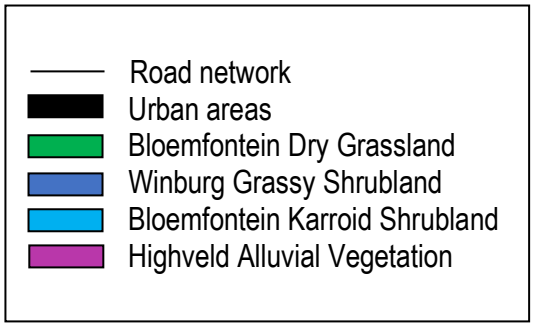


Figure 1: View of the remaining portions of the different vegetation types present in the Bloemfontein urban area. Note extensive transformation has already occurred.

Legend:



Free State Biodiversity Management Plan 2015

The Free State Province Biodiversity Management Plan (2015) has been developed and has identified areas which are essential to meeting conservation targets for specific vegetation types, i.e. Critical Biodiversity Areas (CBA), and other elements of high conservation importance.

Due to the already heavily transformed nature of the Bloemfontein urban area there are not a high amount of these CBA's left. However, the following CBA's are still present and must be regarded as having a high level of sensitivity:

- A large CBA 1 is located to the west of the Kellysview Small Holdings consisting of natural grassland, dominated by Bloemfontein Dry Grassland.
- The Brandkop Conservancy and associated hills along the western periphery of Bloemfontein.
- Smaller portions to the south of the urban area, associated with a large hill.
- Significantly large CBA 1 to the north of the city and associated with a large portion of intact Bloemfontein Karroid Shrubland.

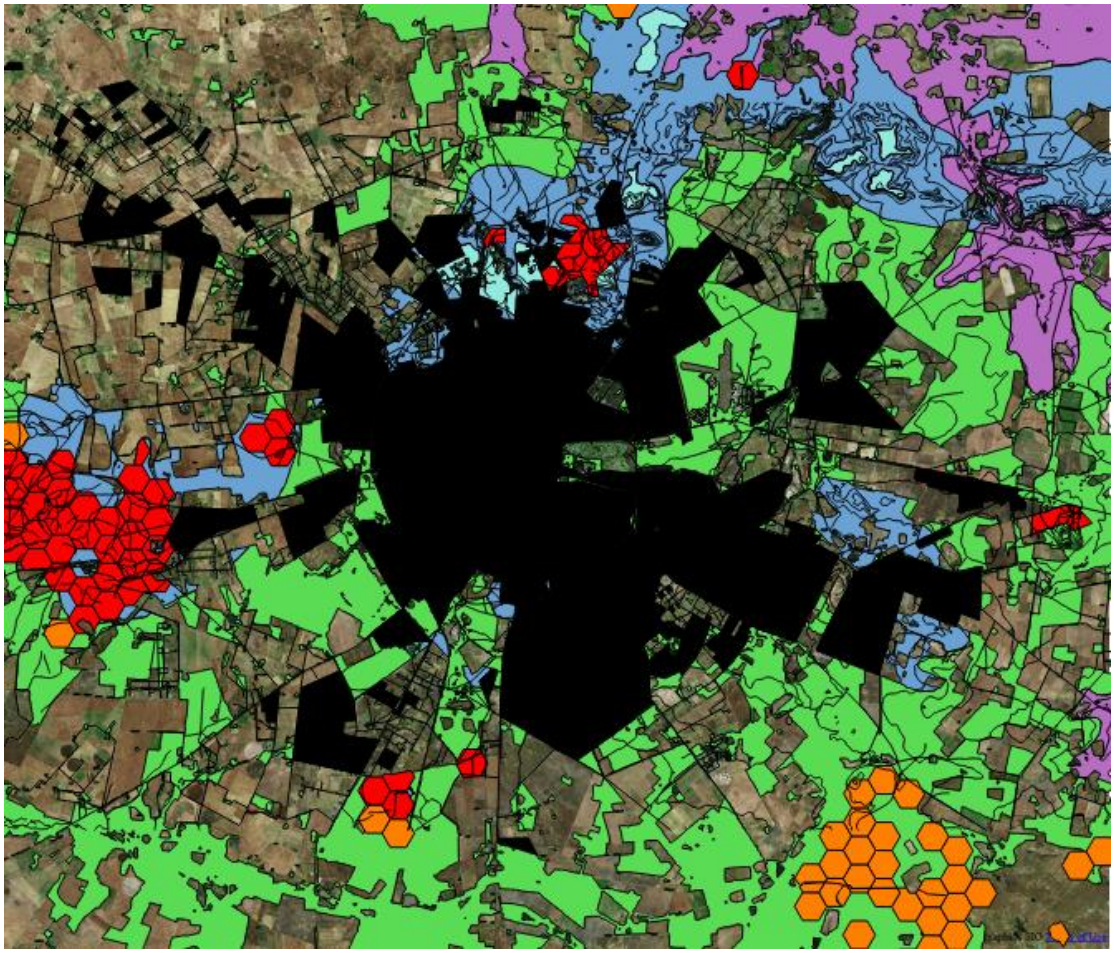
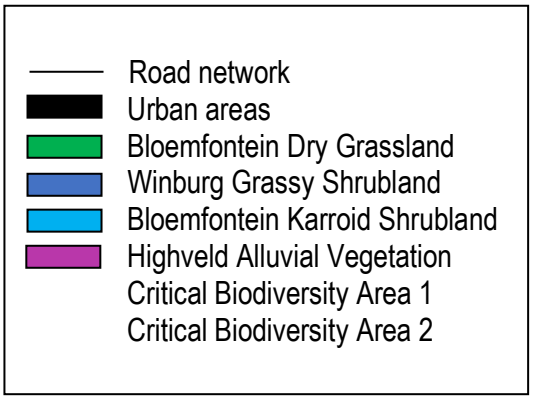


Figure 2: View of CBA 1 and 2 areas in the Bloemfontein urban area overlain over the remaining natural vegetation portions.

Legend:



National Protected Areas Expansion Strategy (NPAES) 2010

As development increases through time, the expansion of protected areas should also be increased. The NPAES has been developed to identify areas which represent areas of natural vegetation in good condition, with significant diversity and in need of increased conservation. These NPAES Focus Areas therefore represent areas with a significant sensitivity.

Due to the already transformed nature of the majority of the Bloemfontein urban area it does not contain any NPAES Focus Areas. A large portion of NPAES Focus Area occurs to the south of Bloemfontein, south of the Martindale Small Holdings but should not be affected as long as urban expansion toward it is not extensive.

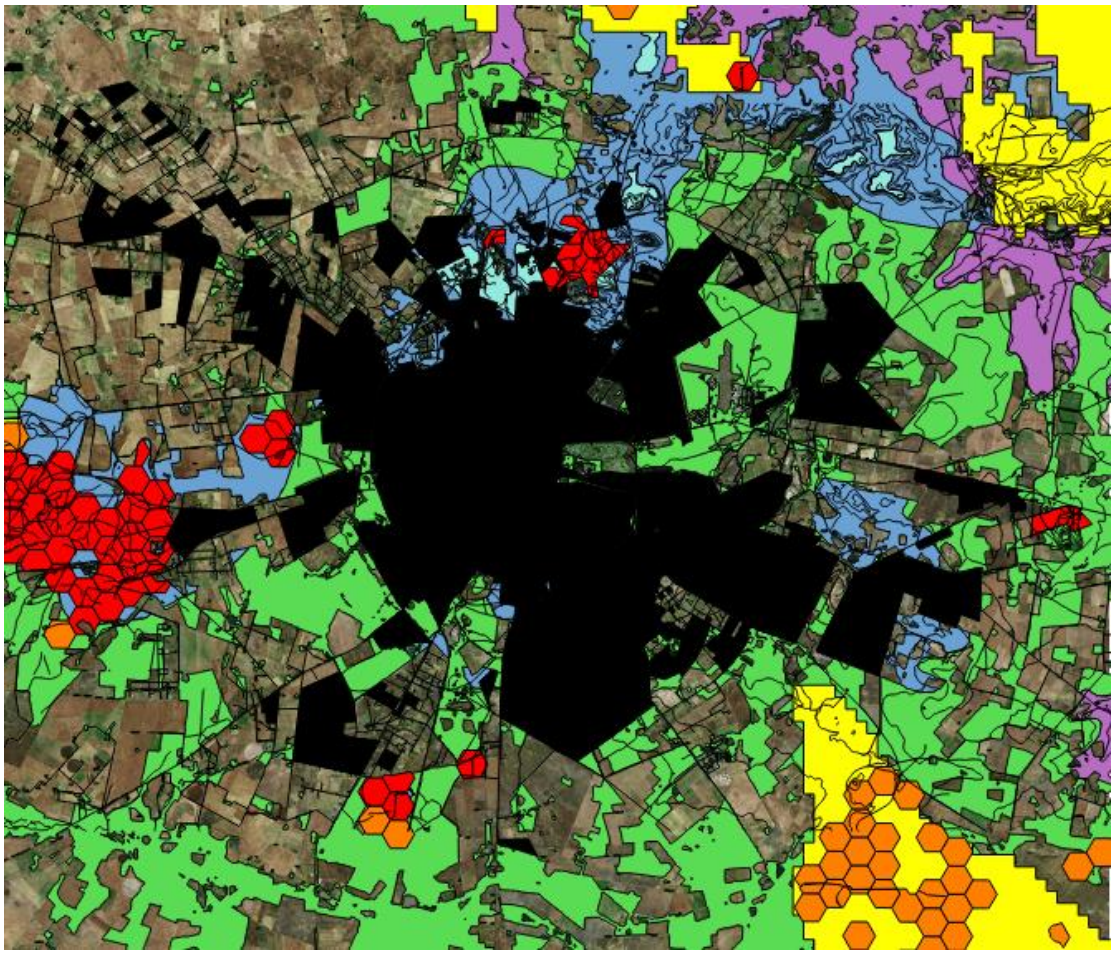
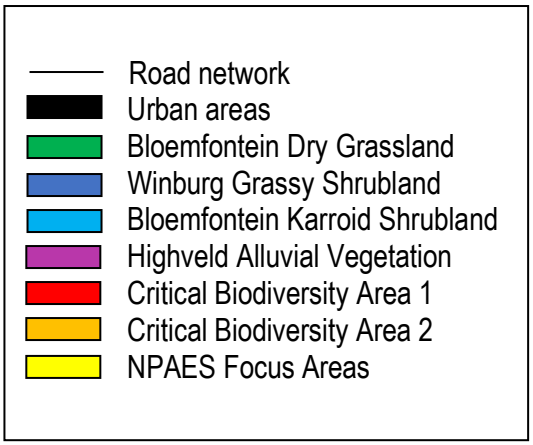


Figure 3: View of the NPAES Focus Areas near the Bloemfontein urban area. Note an extensive Focus Area to the south east.

Legend:



4.1.1.4 Bloemfontein urban area – Conclusions

From the description of the remaining natural vegetation in the Bloemfontein urban area the following elements of ecological importance should be taken into account in the MOSS:

- All four vegetation types contain elements of conservation value and consequently, where natural portions of these vegetation types remain they should be regarded as having a significant conservation value.
- All four vegetation types contain significant numbers of protected species which should also be taken into account in the sensitivity of remaining natural vegetation.
- Bloemfontein Dry Grassland is listed as a Vulnerable (VU) vegetation type which increases its sensitivity and conservation value.
- Bloemfontein Karroid Shrubland, although not listed as a Threatened Ecosystem, has clearly been shown to contain unique habitat with a high proportion of protected species and should therefore be afforded a high level of sensitivity.
- Winburg Grassy Shrubland is confined to hills and ridges, positive landscape elements forming terrestrial corridors and should therefore still be regarded as having a significant level of sensitivity.
- Highveld Alluvial Vegetation, although itself not a threatened or highly unique habitat, is however closely associated with the larger watercourse systems which are highly sensitive systems and therefore increase the sensitivity of the vegetation type by default.
- Areas identified as CBA 1 and 2 areas are essential to meeting conservation targets and are also concentrated on areas with a high level of sensitivity.

4.1.2 Botshabelo urban area (Appendix A: Map 2)

Botshabelo are located 55 km east from Bloemfontein. The urban node was spatially designed along a major access route that runs in a north/south direction through the centre of the area, giving rise to a linear urban form. The urban extent of this town is approximately 6180 hectares. Being situated more toward the eastern half of the province, large hills ridges and even mountains become prominent. A prominent feature is the Klein-Modder River flowing through the urban area. Although heavily impacted by the urban area it is still natural to a large extent as it remains largely uncanalised with limited development encroachment into the floodplain.

The area is dominated by low-income housing. Owing to high-density urban development the urban area is also generally heavily modified. The town consists of 18 residential areas comprising designated blocks with each named by a letter of the alphabet.

Botshabelo is completely situated within the Grassland Biome and under natural conditions would be dominated by grasses with shrubs and trees being almost completely absent. The exception to this being hills and ridges which provide suitable habitat and climate for shrubs and trees to establish. Watercourses also contain differing soils conditions, climate and moisture regime which enables the establishment of shrubs and trees. Consequently, plains should be dominated by grasses while ridges, hills and watercourses would contain a prominent grass component but also substantial shrub and tree cover. This is also the case for the remaining natural areas comprising the Mangaung MOSS. Furthermore, trees and shrubs in this area is often utilised as firewood and this also decreases the tree cover in the plains area as well as along watercourses. Grasses within the communal grazing area is also frequently burned during winter and this also suppresses the establishment of tree saplings. The overall vegetation structure therefore remains largely natural although firewood collection and high levels of overgrazing does cause significant modification of it. In addition, the urban environment itself also cause large-scale transformation of the natural environment as can be expected. Even the remaining natural areas are often in a heavily degraded condition which may be attributed to land-use but is in large-part also a result of the edge-effect, especially for smaller portions of vegetation. The edge-effect is normally exacerbated by habitat fragmentation and is caused by transformed and degraded areas which also affect and degrade the adjacent natural areas along their borders. This has also been substantiated by previous studies of the area (Van Rensburg 2017).

The Botshabelo urban area is extensive though much smaller than Bloemfontein, though as mentioned, the topography becomes more pronounced in this area. From aerial images and contours of the study area it is clear that the area is dominated by gentle, undulating terrain sloping gradually towards watercourses, especially the Klein-Modder River. Pronounced and quite prominent ridge systems occur along the eastern and western borders of the town. These are dominated by sandstone terraces. These also provide significantly different habitats and the vegetation composition is also clearly different from the surrounding plains. As mentioned, the Klein-Modder River as well as smaller drainage lines and numerous wetland systems are also incised into the terrain and these also contribute to the varied topography. These areas will again represent a different topographical unit with a differing vegetation composition and habitat. The altitude of the Botshabelo urban area varies from 1680 m AMSL along the eastern prominent ridge system and decreases sharply to 1350 m along the lower lying Klein-Modder River. This represents a difference of 330 m which, in relation to a much smaller study area, indicates a quite significant variety in topography and is indicative of the more mountainous terrain in this area.

As indicated, the transformation and degradation caused by the urban area of Botshabelo is extensive and also impacts on the portions of remaining natural vegetation. As can be expected, the urban environment itself and associated amenities, recreational, infrastructure and industrial activities lead to the direct transformation of large areas. The areas of remaining natural vegetation and the main areas of focus of this study is also affected by numerous impacts associated with the urban area. Everyday activities including pedestrian and livestock tracks, informal sports fields and other informal dirt roads all cause local transformation though the impact is still relatively low. This does however provide access to these areas and in many cases exacerbate the impact of illegal dumping which may transform significantly large areas.

One of the most significant impacts on the remaining natural areas, besides urban development itself, is associated with communal grazing and browsing by domestic livestock. Open spaces are utilised for communal grazing and browsing and does not follow a structured grazing schedule or stocking levels and consequently heavy and sustained overgrazing occurs. Coupled with this is also high levels of trampling. The combination of these impacts causes a significant modification of the natural grassland and the vegetation composition and structure and decreases the percentage ground cover. Trampling then disturbs the soil surface and leads to significant levels of erosion. A loss of diversity due to overgrazing is also likely to occur.

Botshabelo is located within the summer rainfall zone of South Africa which is classified as a sub-humid, warm zone with annual water deficiency. The area receives summer thunderstorms and soft rains in approximately equal quantities. The mean annual rainfall for Botshabelo is given as 533 mm. Temperatures range from an average maximum of 30˚C in January to an average minimum of 1˚C in June. Monthly pan-evaporation rates are highest in summer with 323 mm in December and lowest in winter with 85 mm in July (Pretorius 1996).

Botshabelo is situated within the Beaufort Series of the Karoo System consisting of imbedded mudstone, siltstone and occasional sandstone that have been intruded by numerous narrow dolerite dykes and sills. Soil depth vary from 0.1 m to 1.0 m consisting of a shallow upper layer of blackish or dark-brown silty-clay overlying a slightly deeper layer of blackish or dark-brown silty-clay with occasional lime or ferricrete nodules. Beneath these two layers, the clays are usually dark yellow to olive in colour, mixed with weathered siltstone fragments and some sand (Pretorius 1996).

The study area has soils with a high clay content which result in a very low permeability. The permanent water table is usually located at a depth of 20m to 35m below ground level (Pretorius 1996).

As can be deduced from the description of the Botshabelo urban area it is quite extensive, but less so than Bloemfontein, and therefore still has a variety of habitats and topographical units. However, impacts caused on the remaining natural areas are significant and would most likely decrease the condition of several of the areas.

4.1.2.1 Botshabelo Vegetation Types

As a result of the variation in topography, soil, geology, etc., but given the smaller extent of the urban area of Botshabelo it contains only two different vegetation types. According to Mucina & Rutherford (2006), the study area includes Central Free State Grassland (Gh 6) and Basotho Montane Shrubland (Gm 5). According to the National Environmental Management: Biodiversity Act, 2004 (Act No. 10 of 2004) these are both currently listed as being of Least Concern (LC). However, Basotho Montane Grassland forms part of the Eastern Mesic Grasslands which are generally recognised as containing a significant species diversity with several being protected and of conservation importance.

The vegetation types can very easily be distinguished in terms of their habitat as well as vegetation structure. Central Free State Grassland is confined to undulating plains and do not occur on hills or ridges. It is also dominated by grasses with shrubs and trees being almost completely absent. Basotho Montane Shrubland is confined to larger hills and ridges and will not occur within lower lying plains. It will also always contain a significant shrub component,

although the grass layer will still be well-developed in most cases. It should therefore be clear that these vegetation types are easily distinguishable and can be assessed separately.

In the absence of a site survey a general description of the vegetation composition is given as obtained from Mucina & Rutherford (2006) and other previous vegetation studies. This is by no means a comprehensive description of the vegetation but should give a general description.

Central Free State Grassland (Gh 6)

Important Taxa:

Graminoids: *Aristida adscensionis*, *A. congesta*, *Cynodon dactylon*, *Eragrostis chloromelas*, *E. curvula*, *E. plana*, *Panicum coloratum*, *Setaria sphacalata, Themeda triandra, Tragus koelerioides, Agrostis lachnantha, Andropogon appendiculatus, Aristida bipartita, A. canescens, Cymbopogon pospischilii, Cynodon transvaalensis, Digitaria argyrograpta, Elionurus muticus, Eragrostis lehmanniana, E. micrantha, E. obtusa, E. racemosa, E. trichophora, Heteropogon contortus, Microchloa caffra, Setaria incrassata, Sporobolus discosporus.*

Herbs: Berkheya onopordifolia var.onopordifolia, Chamaesyce inaequilatera, Conyza pinnata, Crabbea acaulis, Geigeria aspera var. aspera, Hermannia depressa, Hibiscus pusillus, Pseudognaphalium luteo-album, Salvia stenophylla, Selago densiflora, Sonchus dregeanus.

Geophytic Herbs: Oxalis depressa, Raphionacme dyeri.

Succulent Herb: Tripteris aghillana var. integrifolia.

Low Shrubs: Felicia muricata, Anthospermum rigidum subsp. pumilum, Helichrysum dregeanum, Melolobium candicans, Pentzia globosa.

The vegetation type is clearly dominated by grass species with shrubs and trees being completely absent. From desktop information a moderate species diversity is likely and a few protected species is already likely to occur. However, on-site information will provide a much more accurate situation w.r.t. species diversity and it is also highly likely that the amount of protected species will be increased substantially.

Basotho Montane Shrubland (Gm 5)

Important Taxa:

Tall Shrubs: *Buddleja salviifolia*, *Euclea crispa* subsp. *ovata*, *Olea europaea* subsp. *africana*, *Diospyros whyteana*, *Heteromorpha arborescens* var. *abyssinica*, *Leucosidea sericea*, *Rhamnus prinoides*, *Rhus dentata*, *Tarchonanthus minor*.

Low Shrubs: *Anthospermum rigidum* subsp. *pumilum*, *Euphorbia striata* var. *cuspidata*, *Felicia filifolia* subsp. *filifolia*, *F. muricata*, *Gnidia capitata*, *Myrsine africana*.

Graminoids: *Andropogon appendiculatus*, *A. schirensis*, *Aristida congesta*, *Cymbopogon pospischilii*, *Cynodon dactylon*, *Elionurus muticus*, *Eragrostis chloromelas*, *E. plana*, *E. racemosa*, *Heteropogon contortus*, *Hyparrhenia hirta*, *Microchloa caffra*, *Setaria sphacelata*,

Themeda triandra, *Tristachya leucothrix*, *Aristida diffusa*, *Brachiaria serrata*, *Digitaria tricholaenoides*, *Eragrostis capensis*, *E. curvula*, *Harpochloa falx*, *Pennisetum sphacelatum*, *Setaria nigrirostris*.

Herbs: *Ajuga ophrydis*, *Cineraria lyratiformis*, *Conyza podocephala*, *Dicoma anomala*, *Haplocarpha scaposa*, *Helichrysum caespititium*, *H. nudifolium* var. *nudifolium*, *H. rugulosum*, *Hermannia depressa*, *Hibiscus microcarpus*, *Ipomoea crassipes*, *Nolletia ciliaris*, *Pollichia campestris*, *Selago densiflora*, *Senecio erubescens* var. *crepidifolius*, *Tolpis capensis*, *Vernonia oligocephala*.

Geophytic Herb: *Hypoxis rigidula* var. *pilosissima*.

Herbaceous Climber: *Rhynchosia totta*.

Endemic Taxa Herbs: *Lessertia tenuifolia*, *Leucaena latisiliqua*.

In addition to this information, a study conducted by Du Preez & Bredenkamp (1991) also provides a basic description of the vegetation type. It is synonymous with the *Rhus erosa* vegetation community described by them. According to this study it is a shrubland community on the slope of mountains and hills and is transitional between Afro-montane forest communities and the much drier lowland areas. The typical habitat consists of relatively dry hills, ridges and slopes to the west of the Drakensberg escarpment. This also fits well with the description of this community in the Botshabelo area.

It is clear that the vegetation type contains a much more varied assemblage of different growth forms with grasses being dominant but shrubs and trees also being prominent. Due to the higher diversity of habitat and varied topography the vegetation type contains a somewhat higher species diversity. It is also highly likely that this will also include a higher proportion of protected species. On-site information will however provide a much more accurate description.

4.1.2.2 Botshabelo Protected Species

As previously mentioned, the vegetation types around the urban area of Botshabelo both contain some protected and Red Listed species. These are also of significant conservation value and will therefore increase the sensitivity of open spaces where they occur. Furthermore, when utilising the Plants of South Africa (http://posa.sanbi.org) an analysis of plant species previously recorded in the region includes the following protected and Red Listed species recorded. Additional sources also include numerous studies conducted in this area. The area has not been surveyed as thoroughly as the Bloemfontein area and available data would therefore not be as comprehensive and representative of the area.

Table 4: Protected and Red Listed species recorded for the quarter degree squares (2926BA, 2926BB, 2826BC & 2826BD) (http://posa.sanbi.org).

LC – **Least Concern** A species is Least Concern when it has been evaluated against the IUCN criteria and does not qualify for any of the above categories. Species classified as Least Concern are considered at low risk of extinction. Widespread and abundant species are typically classified in this category.

DDD – **Data Deficient - Insufficient Information (DDD)** A species is DDD when there is inadequate information to make an assessment of its risk of extinction, but the species is well defined. Listing of species in this category indicates that more information is required and that future research could show that a threatened classification is appropriate.

NT – **Near Threatened (NT)** A species is Near Threatened when available evidence indicates that it nearly meets any of the IUCN criteria for Vulnerable and is therefore likely to become at risk of extinction in the near future.

VU – **Vulnerable (VU)** A species is Vulnerable when the best available evidence indicates that it meets at least one of the five IUCN criteria for Vulnerable, indicating that the species is facing a high risk of extinction.
EN – **Endangered (EN)** A species is Endangered when the best available evidence indicates that it meets at least one of the five IUCN criteria for Endangered, indicating that the species is facing a very high risk of extinction.
Gh6 – **Central Free State Grassland**
Gm5 – **Basotho Montane Shrubland**

FAMILY	Scientific name	Status	Protected	Gh6	Gm5
Amaryllidaceae	*Ammocharis coranica*	LC	Y	✔	
Amaryllidiceae	*Boophone distichia*	LC	Y	✔	✔
Amaryllidaceae	*Brunsvigia radulosa*	LC	Y	✔	✔
Amaryllidaceae	*Crinum bulbispermum*	LC	Y	✔	
Amaryllidaceae	*Cyrtanthus contractus*	LC	Y	✔	✔
Amaryllidaceae	*Haemanthus humilis subsp. humilis*	LC	Y		✔
Anacampserotaceae	*Anacampseros rufescens*	LC	Y		✔
Apocynaceae	*Asclepias gibba var. gibba*	LC	Y	✔	✔
Apocynaceae	*Pachycarpus rigidus*	LC	Y	✔	✔
Apocynaceae	*Raphionacme dyeri*	LC	Y	✔	
Apocynaceae	*Raphionacme hirsuta*	LC	Y	✔	
Apocynaceae	*Stenostelma corniculatum*	LC	Y	✔	✔
Apocynaceae	*Asclepias multicaulis*	LC	Y	✔	✔
Araliaceae	*Cussonia paniculata subsp. sinuata*	LC	Y		✔
Asphodelaceae	*Aristaloe aristata*	LC	Y		✔
Asphodelaceae	*Kniphofia ritualis*	LC	Y	✔	
Ericaceae	*Erica maesta var. maesta*	LC	Y		✔
Euphorbiaceae	*Euphorbia clavarioides*	LC	Y	✔	✔
Euphorbiaceae	*Euphorbia rhombifolia*	LC	Y		✔
Euphorbiaceae	*Euphorbia pulvinata*	LC	Y		✔
Geraniaceae	*Pelargonium sidoides*	LC	Y	✔	✔
Hyacinthaceae	*Eucomis autumnalis subsp. amaryllidifolia*	LC	Y	✔	✔
Iridaceae	*Dierama robustum N.E.Br.*	LC	Y		✔
Iridaceae	*Gladiolus permeabilis subsp. edulis*	LC	Y	✔	✔
Oleaceae	*Olea europaea subsp. cuspidata*	LC	Y		✔

There is a high likelihood that many of these species as listed will occur within the Botshabelo urban area. Note that no Red Listed species had previously been recorded in this area, though as indicated it has not been thoroughly surveyed and there remains a likelihood that such a species will occur. It is however unlikely that any endangered or very rare species would occur.

A comparison between the different vegetation types and the likelihood that protected species may occur indicate that both vegetation types contain a significant proportion of protected species which will be of significant conservation significance. It is however evident that the mountainous terrain of Basotho Montane Shrubland may contain a somewhat higher proportion of protected species. Both vegetation types may therefore still have a significant conservation value although hills and ridges comprised of Basotho Montane Shrubland may have a somewhat higher level of sensitivity.

4.1.2.3 Additional data sets

Numerous data sets and mapping resources have been developed to aid in the identification of sensitive areas and areas with a high conservation value, notably those resources developed by the South African National Biodiversity Institute (SANBI). Several of these resources were also combined with the results and discussion of the previous sections to indicate areas within the Botshabelo urban area which should be regarded as sensitive. From these data sets the following conclusions can be made:

National Biodiversity Assessment (NBA) 2018

Remnants of the natural vegetation types in the area indicates that large portions of natural vegetation still remain in and around the urban are of Botshabelo. The condition of these areas can however not be assessed accurately at desktop level and they may be in a degraded condition. The urban area has nonetheless transformed extensive areas though there is still ample opportunity to conserve natural areas. As indicated previously, both vegetation types in the area contain elements of significant conservation value and therefore all portions of remaining natural vegetation will have a significant level of sensitivity. However, the Basotho Montane Shrubland may have a somewhat higher conservation value due to an increase in habitat and species diversity, varied topography and a somewhat higher proportion of protected species. The hills and ridges of this vegetation type may also act as natural corridors which may further increase its sensitivity.

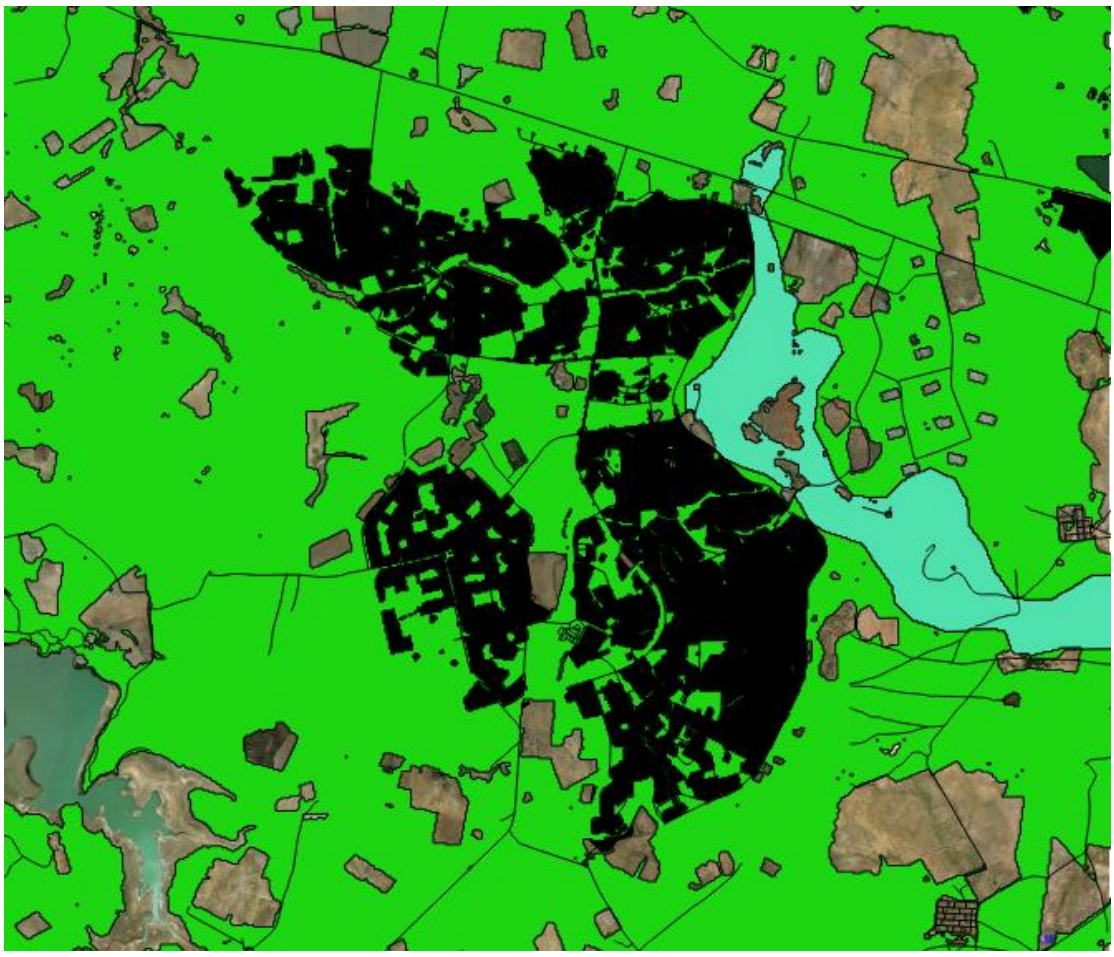
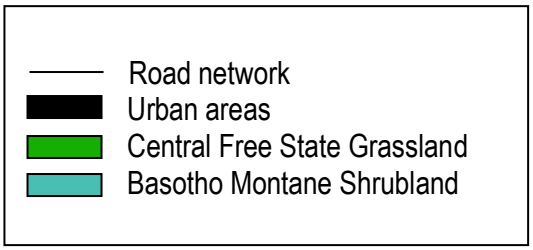


Figure 4: View of the remaining portions of the different vegetation types present in the Botshabelo urban area. Note extensive transformation has occurred although large areas natural areas occur around it.

Legend:



Free State Biodiversity Management Plan 2015

The Free State Province Biodiversity Management Plan (2015) has been developed and has identified areas which are essential to meeting conservation targets for specific vegetation types, i.e. Critical Biodiversity Areas (CBA), and other elements of high conservation importance.

Due to the already extensive transformation caused by the urban area and in combination with high levels of livestock overgrazing there are no CBA areas for Botshabelo. However, the Rustfontein Dam Nature Reserve borders Botshabelo to the south west and although it does not form part of its urban area it should still be taken into account w.r.t. open space planning for Botshabelo. Such protected areas are also susceptible to the edge effect, i.e. degradation of natural area caused by adjacent degraded areas. As a result a buffer around such protected areas should be maintained. Such buffer areas normally attempt to limit impacts to low intensity land use, normally associated with agricultural activities and low-intensity grazing. A suitable buffer between Botshabelo and the Rustfontein Nature Reserve should therefore be implemented which should be designated open space where no development is allowed and communal grazing is kept at a low-intensity.

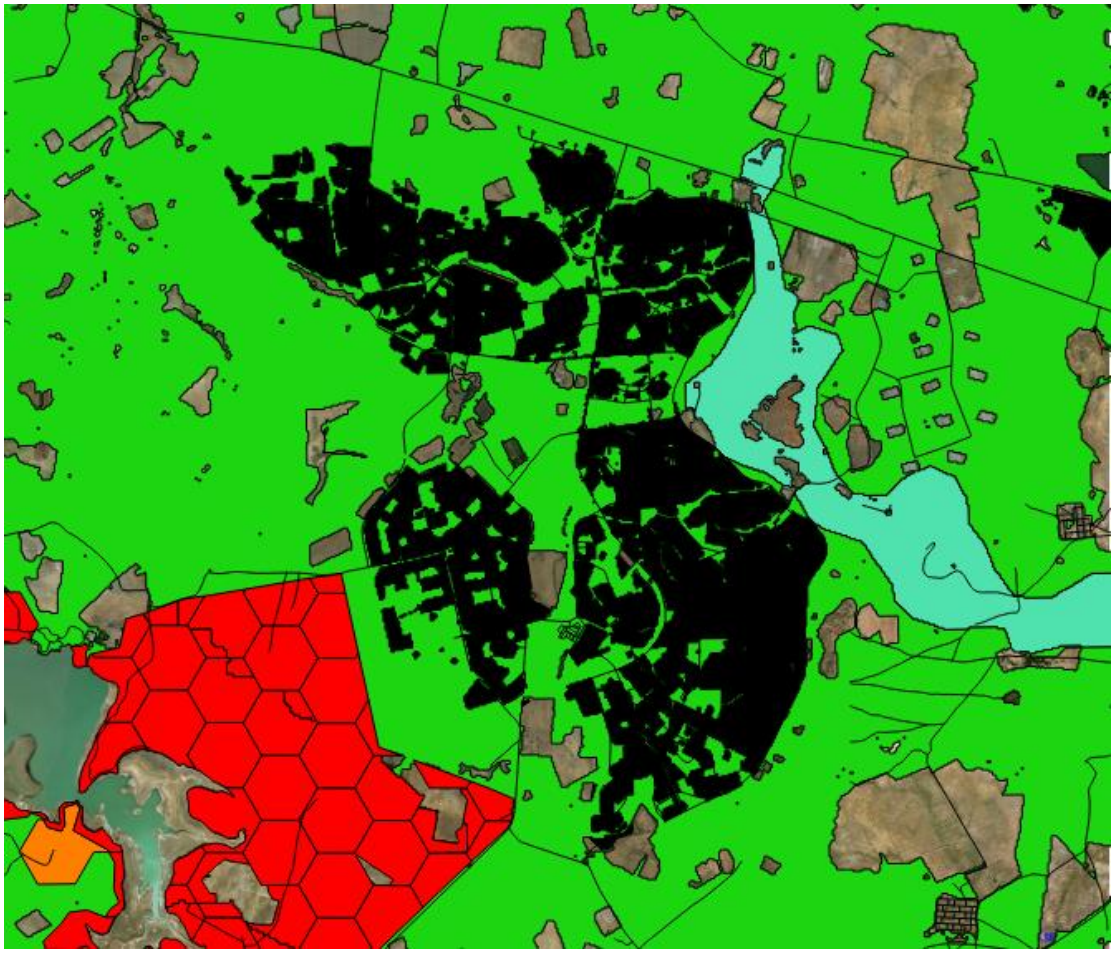


Figure 5: View of CBA 1 and 2 areas as well as protected area in the Botshabelo urban area overlain over the remaining natural vegetation portions.

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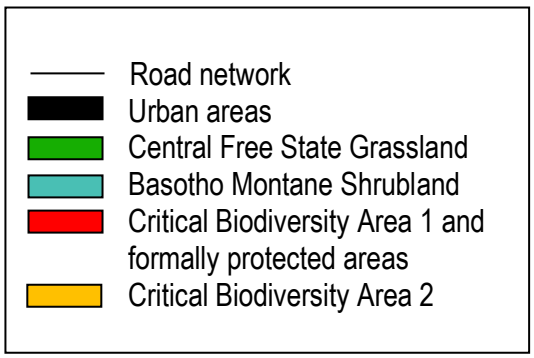


National Protected Areas Expansion Strategy (NPAES) 2010

As development increases through time, the expansion of protected areas should also be increased. The NPAES has been developed to identify areas which represent areas of natural vegetation in good condition, with significant diversity and in need of increased conservation. These NPAES Focus Areas therefore represent areas with a significant sensitivity.

Large portions of NPAES Focus Areas occur to the west of Botshabelo. These areas also aim to increase the conservation area of the Rustfontein Nature Reserve. Spatial planning should therefore aim to avoid expansion into these NPAES Focus Areas and should implemented a buffer between any future development and the proposed conservation areas.

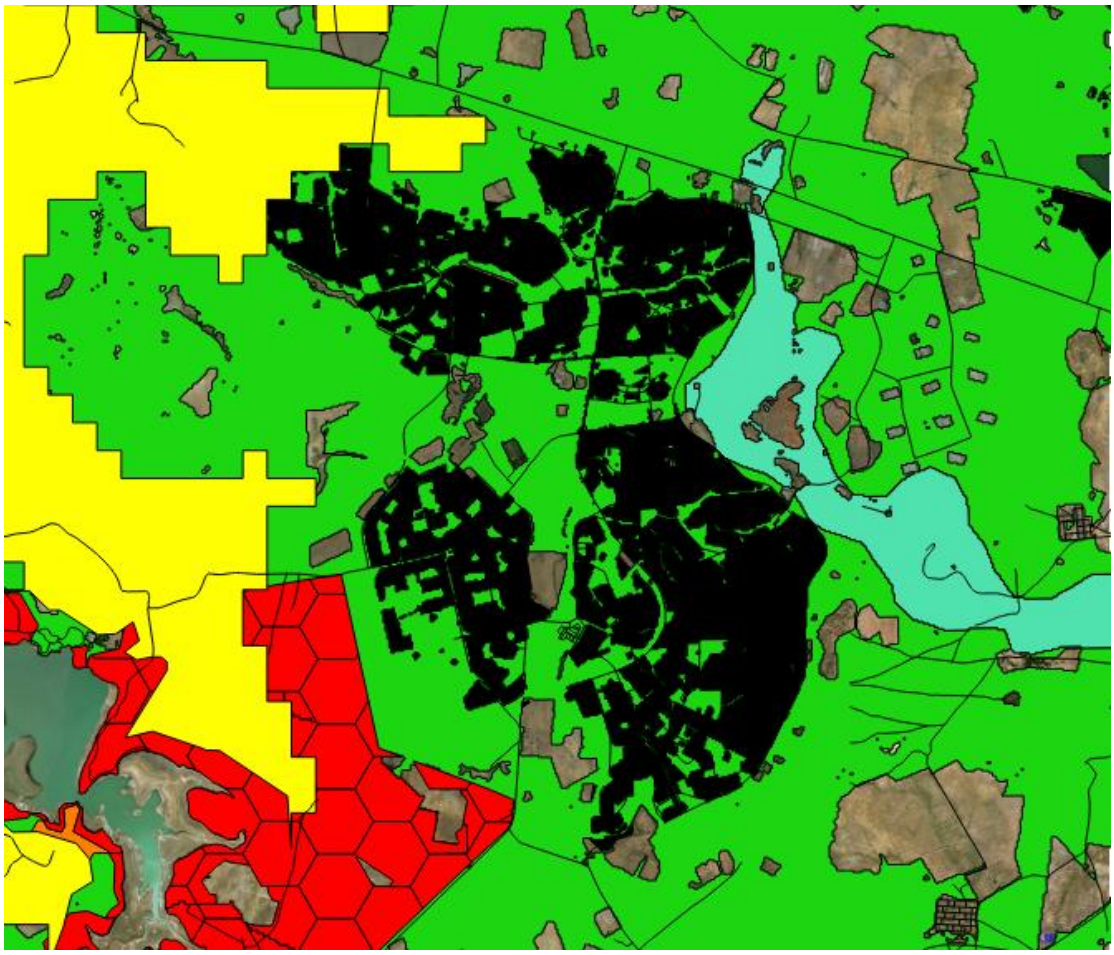
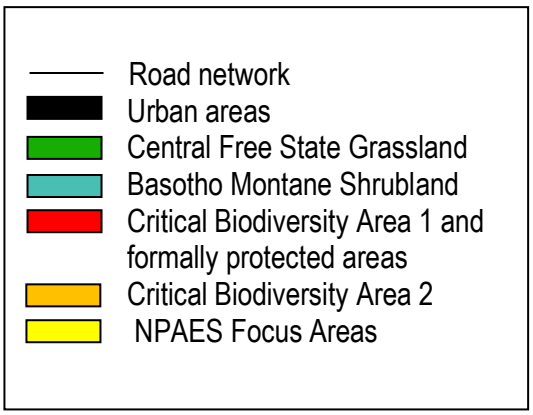


Figure 6: View of the NPAES Focus Areas near the Botshabelo urban area. Note an extensive Focus Area to the west, associated with the Rustfontein Nature Reserve.

Legend:



4.1.2.4 Botshabelo urban area – Conclusions

From the description of the remaining natural vegetation in the Botshabelo urban area the following elements of ecological importance should be taken into account in the MOSS:

- Both vegetation types contain elements of conservation value and consequently, where natural portions of these vegetation types remain they should be regarded as having a significant conservation value.
- Both vegetation types contain significant numbers of protected species which should also be taken into account in the sensitivity of remaining natural vegetation.
- Both vegetation types are relatively widespread and currently listed as being of Least Concern.
- Basotho Montane Shrubland contains a somewhat higher habitat and species diversity, varied topography and a somewhat higher proportion of protected species. The hills and ridges of this vegetation type may also act as natural corridors which may further increase its sensitivity. The vegetation type will therefore have a somewhat higher conservation value.
- The area does not contain any CBA areas although the Rustfontein Nature Reserve to the south west has a very high conservation value and planning should aim to retain a suitable buffer between urban development and the reserve. This buffer area should also be designated open space where no development is allowed and communal grazing is kept at a low-intensity.
- Extensive NPAES Focus Areas occur to the west of Botshabelo which aim to increase the conservation area of the Rustfontein Nature Reserve. Spatial planning should therefore aim to avoid expansion into these NPAES Focus Areas and should implemented a buffer between any future development and the proposed conservation areas.

4.1.3 Thaba Nchu urban area (Appendix A: Map 3)

Thaba Nchu are located 67 km east from Bloemfontein and has a more scattered development pattern with 37 villages surrounding the urban centre, some as far as 35 kilometres from the closest urban centre. 4 of these villages have recently been formalised. The area is characterised by vast stretches of communal grazing areas that surround the urban centre. Many residents still keep cattle within the urban area and this creates a problem to residents. The area has also two industrial areas. The urban extent of this town is approximately 3490 hectares. Being situated more toward the eastern half of the province, large hills ridges and even mountains become prominent. A prominent feature is the Sepane River flowing through the urban area. It flows directly through the CBD which leads to high levels of degradation and encroachment into the floodplain of the river. The area is dominated by low-income housing. Owing to high-density urban development the urban area is also generally heavily modified. Being situated almost adjacent to Botshabelo, Thaba Nchu will have much the same description and will share much of the same information and data.

Thaba Nchu is completely situated within the Grassland Biome and under natural conditions would be dominated by grasses with shrubs and trees being almost completely absent. The exception to this being hills and ridges which provide suitable habitat and climate for shrubs and trees to establish. Watercourses also contain differing soils conditions, climate and moisture regime which enables the establishment of shrubs and trees. Consequently, plains should be dominated by grasses while ridges, hills and watercourses would contain a

prominent grass component but also substantial shrub and tree cover. This is also the case for the remaining natural areas comprising the Mangaung MOSS. Furthermore, trees and shrubs in this area is often utilised as firewood and this also decreases the tree cover in the plains area as well as along watercourses. Grasses within the communal grazing area is also frequently burned during winter and this also suppresses the establishment of tree saplings. The overall vegetation structure therefore remains largely natural although firewood collection and high levels of overgrazing does cause significant modification of it. In addition, the urban environment itself also cause large-scale transformation of the natural environment as can be expected. Even the remaining natural areas are often in a heavily degraded condition which may be attributed to land-use but is in large-part also a result of the edge-effect, especially for smaller portions of vegetation. The edge-effect is normally exacerbated by habitat fragmentation and is caused by transformed and degraded areas which also affect and degrade the adjacent natural areas along their borders. This has also been substantiated by previous studies of the area (Van Rensburg 2017).

The Thaba Nchu urban area is extensive though somewhat smaller than Botshabelo and even smaller than Bloemfontein. The topography becomes quite mountainous toward the south and towards Thaba Nchu Mountain. The topography of the urban area and immediate surroundings consists of undulating plains sloping gradually towards watercourses, such as the Sepane River. The elevation increases gradually from east to west along the flow pattern of the Sepane River. The Thaba Nchu Mountain to the south of the urban area forms a very prominent topographical feature. Sandstone is also a dominant geological feature of this mountain. It provides a varied diversity of habitats and the vegetation composition is also clearly different from the surrounding plains. As mentioned, the Sepane River as well as smaller drainage lines and numerous wetland systems are also incised into the terrain and these also contribute to the varied topography. These areas will again represent a different topographical unit with a differing vegetation composition and habitat. The altitude of the Thaba Nchu urban area varies from 1620 m AMSL within the low hills in the urban area itself and decreases to 1435 m AMSL along the lower lying Sepane River. This represents a difference of 185 m which although it is substantial only indicates an undulating terrain. The Thaba Nchu Mountain has a height of about 2110 m AMSL and does indicate the mountainous terrain to the south of the urban area. The mountain does not form part of the urban area but due to its close proximity to it, will still be discussed in overview.

As indicated, the transformation and degradation caused by the urban area of Thaba Nchu is extensive and also impacts on the portions of remaining natural vegetation. As can be expected, the urban environment itself and associated amenities, recreational, infrastructure and industrial activities lead to the direct transformation of large areas. The areas of remaining natural vegetation and the main areas of focus of this study is also affected by numerous impacts associated with the urban area. Everyday activities including pedestrian and livestock tracks, informal sports fields and other informal dirt roads all cause local transformation though the impact is still relatively low. This does however provide access to these areas and in many cases exacerbate the impact of illegal dumping which may transform significantly large areas. One of the most significant impacts on the remaining natural areas, besides urban development itself, is associated with communal grazing and browsing by domestic livestock. Open spaces are utilised for communal grazing and browsing and does not follow a structured grazing schedule or stocking levels and consequently heavy and sustained overgrazing occurs. Coupled with this is also high levels of trampling. The combination of these impacts causes a significant modification of the natural grassland and the vegetation composition and structure and decreases the percentage ground cover. Trampling then disturbs the soil surface and

leads to significant levels of erosion. A loss of diversity due to overgrazing is also likely to occur.

Thaba Nchu is located within the summer rainfall zone of South Africa which is classified as a sub-humid, warm zone with annual water deficiency. The area receives summer thunderstorms and soft rains in approximately equal quantities. The mean annual rainfall for Botshabelo is given as 533 mm. Temperatures range from an average maximum of 30˚C in January to an average minimum of 1˚C in June. Monthly pan-evaporation rates are highest in summer with 323 mm in December and lowest in winter with 85 mm in July (Pretorius 1996).

Thaba Nchu is situated within the Beaufort Series of the Karoo System consisting of imbedded mudstone, siltstone and occasional sandstone that have been intruded by numerous narrow dolerite dykes and sills. Soil depth vary from 0.1 m to 1.0 m consisting of a shallow upper layer of blackish or dark-brown silty-clay overlying a slightly deeper layer of blackish or dark-brown silty-clay with occasional lime or ferricrete nodules. Beneath these two layers, the clays are usually dark yellow to olive in colour, mixed with weathered siltstone fragments and some sand. The study area has soils with a high clay content which result in a very low permeability. The permanent water table is usually located at a depth of 20m to 35m below ground level (Pretorius 1996).

As can be deduced from the description of the Thaba Nchu urban area it is still a large area though smaller than Botshabelo, even smaller than Bloemfontein, and it has a somewhat lower habitat diversity than Botshabelo. The Thaba Nchu Mountain significantly increases diversity but does not form part of the urban area itself. Impacts caused on the remaining natural areas are significant and would most likely decrease the condition of several of the areas.

4.1.3.1 Thaba Nchu Vegetation Types

The urban area of Thaba Nchu contains a relatively uniform but undulating terrain and consequently is dominated by a single vegetation type. The Thaba Nchu Mountain to the south east of the site does not form part of the urban area but does increase the surrounding habitat diversity contributing another vegetation type. According to Mucina & Rutherford (2006), the urban area and immediate surroundings consist of Central Free State Grassland (Gh 6) while the Thaba Nchu Mountain and slopes consist of Basotho Montane Shrubland (Gm 5). According to the National Environmental Management: Biodiversity Act, 2004 (Act No. 10 of 2004) these are both currently listed as being of Least Concern (LC). However, Basotho Montane Grassland forms part of the Eastern Mesic Grasslands which are generally recognised as containing a significant species diversity with several being protected and of conservation importance.

The vegetation types in the Thaba Nchu area is easily distinguished in terms of their habitat as well as vegetation structure. Central Free State Grassland is confined to undulating plains and do not occur on hills or ridges. It is also dominated by grasses with shrubs and trees being almost completely absent. This vegetation type therefore dominates Thaba Nchu while Basotho Montane Shrubland is confined to the Thaba Nchu Mountain. Basotho Montane Shrubland is confined to larger hills, mountains and ridges and will not occur within lower lying plains. It will also always contain a significant shrub component, although the grass layer will still be well-developed in most cases. It should therefore be clear that these vegetation types are easily distinguishable and can be assessed separately.

In the absence of a site survey a general description of the vegetation composition is given as obtained from Mucina & Rutherford (2006) and other previous vegetation studies. This is by no means a comprehensive description of the vegetation but should give a general description.

Central Free State Grassland (Gh 6)

Important Taxa:

Graminoids: *Aristida adscensionis*, *A. congesta*, *Cynodon dactylon*, *Eragrostis chloromelas*, *E. curvula*, *E. plana*, *Panicum coloratum*, *Setaria sphacalata, Themeda triandra, Tragus koelerioides, Agrostis lachnantha, Andropogon appendiculatus, Aristida bipartita, A. canescens, Cymbopogon pospischilii, Cynodon transvaalensis, Digitaria argyrograpta, Elionurus muticus, Eragrostis lehmanniana, E. micrantha, E. obtusa, E. racemosa, E. trichophora, Heteropogon contortus, Microchloa caffra, Setaria incrassata, Sporobolus discosporus.*

Herbs: Berkheya onopordifolia var.onopordifolia, Chamaesyce inaequilatera, Conyza pinnata, Crabbea acaulis, Geigeria aspera var. aspera, Hermannia depressa, Hibiscus pusillus, Pseudognaphalium luteo-album, Salvia stenophylla, Selago densiflora, Sonchus dregeanus.

Geophytic Herbs: Oxalis depressa, Raphionacme dyeri.

Succulent Herb: Tripteris aghillana var. integrifolia.

Low Shrubs: Felicia muricata, Anthospermum rigidum subsp. pumilum, Helichrysum dregeanum, Melolobium candicans, Pentzia globosa.

The vegetation type is clearly dominated by grass species with shrubs and trees being completely absent. From desktop information a moderate species diversity is likely and a few protected species is already likely to occur. However, on-site information will provide a much more accurate situation w.r.t. species diversity and it is also highly likely that the amount of protected species will be increased substantially. This vegetation type covers the entire urban area and surroundings of Thaba Nchu.

Basotho Montane Shrubland (Gm 5)

Important Taxa:

Tall Shrubs: *Buddleja salviifolia*, *Euclea crispa* subsp. *ovata*, *Olea europaea* subsp. *africana*, *Diospyros whyteana*, *Heteromorpha arborescens* var. *abyssinica*, *Leucosidea sericea*, *Rhamnus prinoides*, *Rhus dentata*, *Tarchonanthus minor*.

Low Shrubs: *Anthospermum rigidum* subsp. *pumilum*, *Euphorbia striata* var. *cuspidata*, *Felicia filifolia* subsp. *filifolia*, *F. muricata*, *Gnidia capitata*, *Myrsine africana*.

Graminoids: *Andropogon appendiculatus*, *A. schirensis*, *Aristida congesta*, *Cymbopogon pospischilii*, *Cynodon dactylon*, *Elionurus muticus*, *Eragrostis chloromelas*, *E. plana*, *E. racemosa*, *Heteropogon contortus*, *Hyparrhenia hirta*, *Microchloa caffra*, *Setaria sphacelata*, *Themeda triandra*, *Tristachya leucothrix*, *Aristida diffusa*, *Brachiaria serrata*, *Digitaria*

tricholaenoides, *Eragrostis capensis*, *E. curvula*, *Harpochloa falx*, *Pennisetum sphacelatum*, *Setaria nigrirostris*.

Herbs: *Ajuga ophrydis*, *Cineraria lyratiformis*, *Conyza podocephala*, *Dicoma anomala*, *Haplocarpha scaposa*, *Helichrysum caespititium*, *H. nudifolium* var. *nudifolium*, *H. rugulosum*, *Hermannia depressa*, *Hibiscus microcarpus*, *Ipomoea crassipes*, *Nolletia ciliaris*, *Pollichia campestris*, *Selago densiflora*, *Senecio erubescens* var. *crepidifolius*, *Tolpis capensis*, *Vernonia oligocephala*.

Geophytic Herb: *Hypoxis rigidula* var. *pilosissima*.

Herbaceous Climber: *Rhynchosia totta*.

Endemic Taxa Herbs: *Lessertia tenuifolia*, *Leucaena latisiliqua*.

In addition to this information, a study conducted by Du Preez & Bredenkamp (1991) also provides a basic description of the vegetation type. It is synonymous with the *Rhus erosa* vegetation community described by them. According to this study it is a shrubland community on the slope of mountains and hills and is transitional between Afro-montane forest communities and the much drier lowland areas. The typical habitat consists of relatively dry hills, ridges and slopes to the west of the Drakensberg escarpment. This also fits well with the description of this community occurring on the Thaba Nchu Mountain.

It is clear that the vegetation type contains a much more varied assemblage of different growth forms with grass being dominant but shrubs and trees also being prominent. Due to the higher diversity of habitat and varied topography the vegetation type contains a somewhat higher species diversity. It is also highly likely that this will also include a higher proportion of protected species. On-site information will however provide a much more accurate description. The Thaba Nchu Mountain does not form part of the urban area of Thaba Nchu and should therefore remain unaffected by urban expansion. However, in addition to a higher conservation value it also has a significant tourism potential and this should be taken into account in development planning of Thaba Nchu.

4.1.3.2 Thaba Nchu Protected Species

As previously mentioned, the vegetation types around the urban area of Thaba Nchu both contain some protected and Red Listed species. These are also of significant conservation value and will therefore increase the sensitivity of open spaces where they occur. Furthermore, when utilising the Plants of South Africa (http://posa.sanbi.org) an analysis of plant species previously recorded in the region includes the following protected and Red Listed species recorded. Additional sources also include numerous studies conducted in this area. The area has not been surveyed as thoroughly as the Bloemfontein area and available data would therefore not be as comprehensive and representative of the area.

Table 5: Protected and Red Listed species recorded for the quarter degree squares (2926BA, 2926BB, 2826BC & 2826BD) (http://posa.sanbi.org).

LC – **Least Concern** A species is Least Concern when it has been evaluated against the IUCN criteria and does not qualify for any of the above categories. Species classified as Least Concern are considered at low risk of extinction. Widespread and abundant species are typically classified in this category.

DDD – **Data Deficient - Insufficient Information (DDD)** A species is DDD when there is inadequate information to make an assessment of its risk of extinction, but the species is well defined. Listing of species in this category

indicates that more information is required and that future research could show that a threatened classification is appropriate.
NT – **Near Threatened (NT)** A species is Near Threatened when available evidence indicates that it nearly meets any of the IUCN criteria for Vulnerable and is therefore likely to become at risk of extinction in the near future.
VU – **Vulnerable (VU)** A species is Vulnerable when the best available evidence indicates that it meets at least one of the five IUCN criteria for Vulnerable, indicating that the species is facing a high risk of extinction.
EN – **Endangered (EN)** A species is Endangered when the best available evidence indicates that it meets at least one of the five IUCN criteria for Endangered, indicating that the species is facing a very high risk of extinction.
Gh6 – **Central Free State Grassland**
Gm5 – **Basotho Montane Shrubland**

FAMILY	Scientific name	Status	Protected	Gh6	Gm5
Amaryllidaceae	*Ammocharis coranica*	LC	Y	✔	
Amaryllidiceae	*Boophone distichia*	LC	Y	✔	✔
Amaryllidaceae	*Brunsvigia radulosa*	LC	Y	✔	✔
Amaryllidaceae	*Crinum bulbispermum*	LC	Y	✔	
Amaryllidaceae	*Cyrtanthus contractus*	LC	Y	✔	✔
Amaryllidaceae	*Haemanthus humilis subsp. humilis*	LC	Y		✔
Anacampserotaceae	*Anacampseros rufescens*	LC	Y		✔
Apocynaceae	*Asclepias gibba var. gibba*	LC	Y	✔	✔
Apocynaceae	*Pachycarpus rigidus*	LC	Y	✔	✔
Apocynaceae	*Raphionacme dyeri*	LC	Y	✔	
Apocynaceae	*Raphionacme hirsuta*	LC	Y	✔	
Apocynaceae	*Stenostelma corniculatum*	LC	Y	✔	✔
Apocynaceae	*Asclepias multicaulis*	LC	Y	✔	✔
Araliaceae	*Cussonia paniculata subsp. sinuata*	LC	Y		✔
Asphodelaceae	*Aristaloe aristata*	LC	Y		✔
Asphodelaceae	*Kniphofia ritualis*	LC	Y	✔	
Ericaceae	*Erica maesta var. maesta*	LC	Y		✔
Euphorbiaceae	*Euphorbia clavarioides*	LC	Y	✔	✔
Euphorbiaceae	*Euphorbia rhombifolia*	LC	Y		✔
Euphorbiaceae	*Euphorbia pulvinata*	LC	Y		✔
Geraniaceae	*Pelargonium sidoides*	LC	Y	✔	✔
Hyacinthaceae	*Eucomis autumnalis subsp. amaryllidifolia*	LC	Y	✔	✔
Iridaceae	*Dierama robustum N.E.Br.*	LC	Y		✔
Iridaceae	*Gladiolus permeabilis subsp. edulis*	LC	Y	✔	✔
Oleaceae	*Olea europaea subsp. cuspidata*	LC	Y		✔

There is a high likelihood that many of these species as listed will occur within the Thaba Nchu urban area. Note that no Red Listed species had previously been recorded in this area, though as indicated it has not been thoroughly surveyed and there remains a likelihood that such a species will occur. It is however unlikely that any endangered or very rare species would occur.

A comparison between the different vegetation types and the likelihood that protected species may occur indicate that both vegetation types contain a significant proportion of protected species which will be of significant conservation significance. It is however evident that the Thaba Nchu Mountain consisting of Basotho Montane Shrubland may contain a somewhat higher proportion of protected species. Both vegetation types may therefore still have a significant conservation value although the Thaba Nchu Mountain comprised of Basotho Montane Shrubland may have a somewhat higher level of sensitivity.

4.1.2.3 Additional data sets

Numerous data sets and mapping resources have been developed to aid in the identification of sensitive areas and areas with a high conservation value, notably those resources developed by the South African National Biodiversity Institute (SANBI). Several of these resources were

also combined with the results and discussion of the previous sections to indicate areas within the Thaba Nchu urban area which should be regarded as sensitive. From these data sets the following conclusions can be made:

National Biodiversity Assessment (NBA) 2018

Remnants of the natural vegetation types in the area indicates that large portions of natural vegetation still remain in and around the urban are of Thaba Nchu. The condition of these areas can however not be assessed accurately at desktop level and they may be in a degraded condition. The urban area has nonetheless transformed extensive areas though there is still ample opportunity to conserve natural areas. As indicated previously, both vegetation types in the area contain elements of significant conservation value and therefore all portions of remaining natural vegetation will have a significant level of sensitivity. However, the Basotho Montane Shrubland may have a somewhat higher conservation value due to an increase in habitat and species diversity, varied topography and a somewhat higher proportion of protected species.

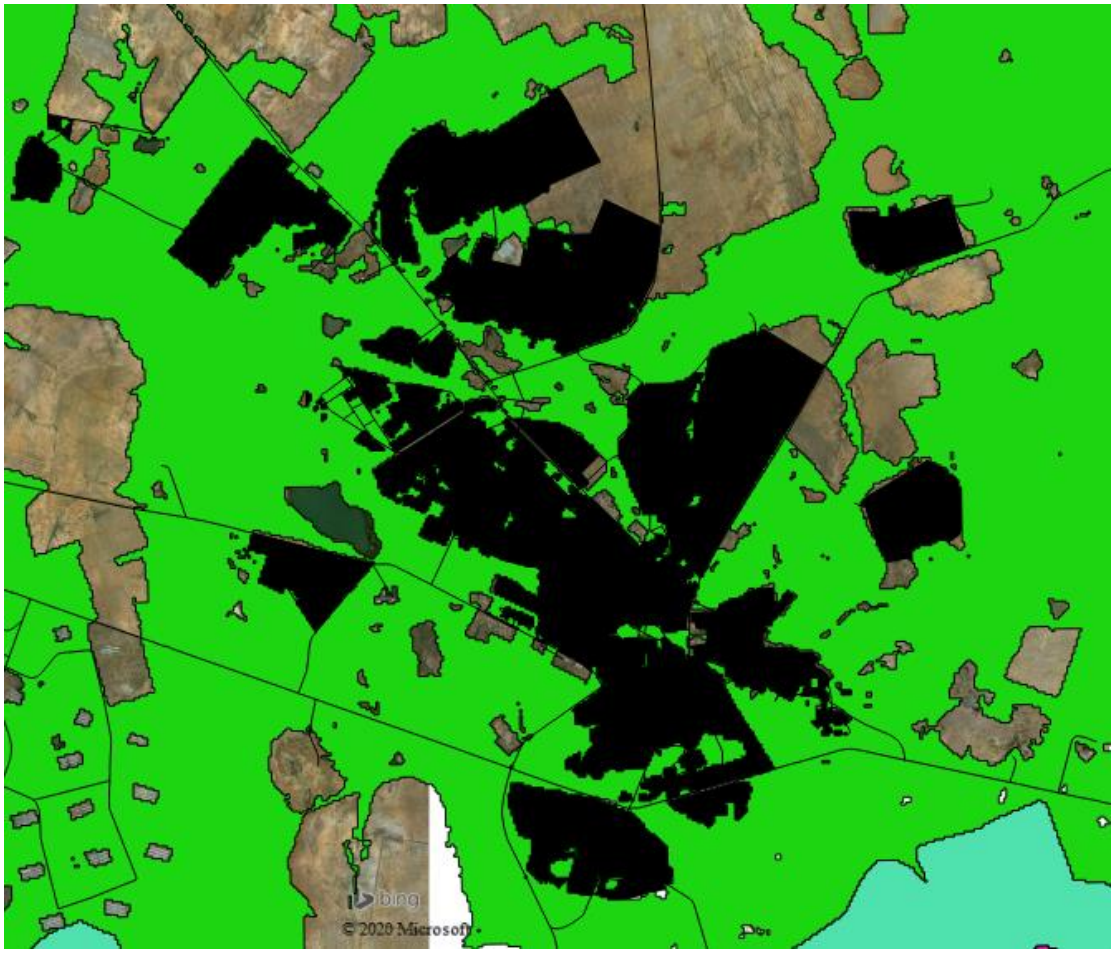
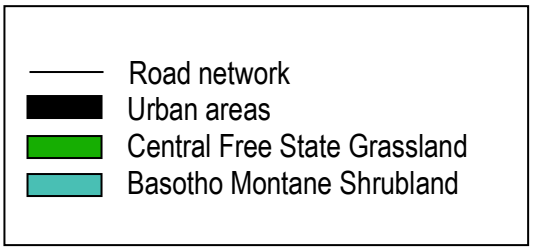


Figure 7: View of the remaining portions of the different vegetation types present in the Thaba Nchu urban area. Note extensive transformation has occurred although large areas natural areas occur around it. Note the slopes of the Thaba Nchu Mountain to the south east consisting of Basotho Montane Shrubland.

Legend:



Free State Biodiversity Management Plan 2015

The Free State Province Biodiversity Management Plan (2015) has been developed and has identified areas which are essential to meeting conservation targets for specific vegetation types, i.e. Critical Biodiversity Areas (CBA), and other elements of high conservation importance.

Extensive transformation caused by the urban area and high levels of livestock overgrazing degrade the condition of natural areas and as a result CBA's are not abundant in this area. However, extensive areas of CBA 1 & 2 occur to the east of Thaba Nchu and close proximity to urban areas. These include the Thaba Nchu Mountain as well as other natural grassland areas. The urban planning of Thaba Nchu should aim to avoid these CBA areas. Further, on-site surveys should also be conducted to determine the species and habitat diversity and identification of sensitive areas. Planning should also take into account the edge-effect, i.e. degradation of natural area caused by adjacent degraded areas. As a result a buffer around such CBA areas should be maintained. Such buffer areas normally attempt to limit impacts to low intensity land use, normally associated with agricultural activities and low-intensity grazing. A suitable buffer between urban areas and CBA's should therefore be implemented which should be designated open space where no development is allowed and communal grazing is kept at a low-intensity.

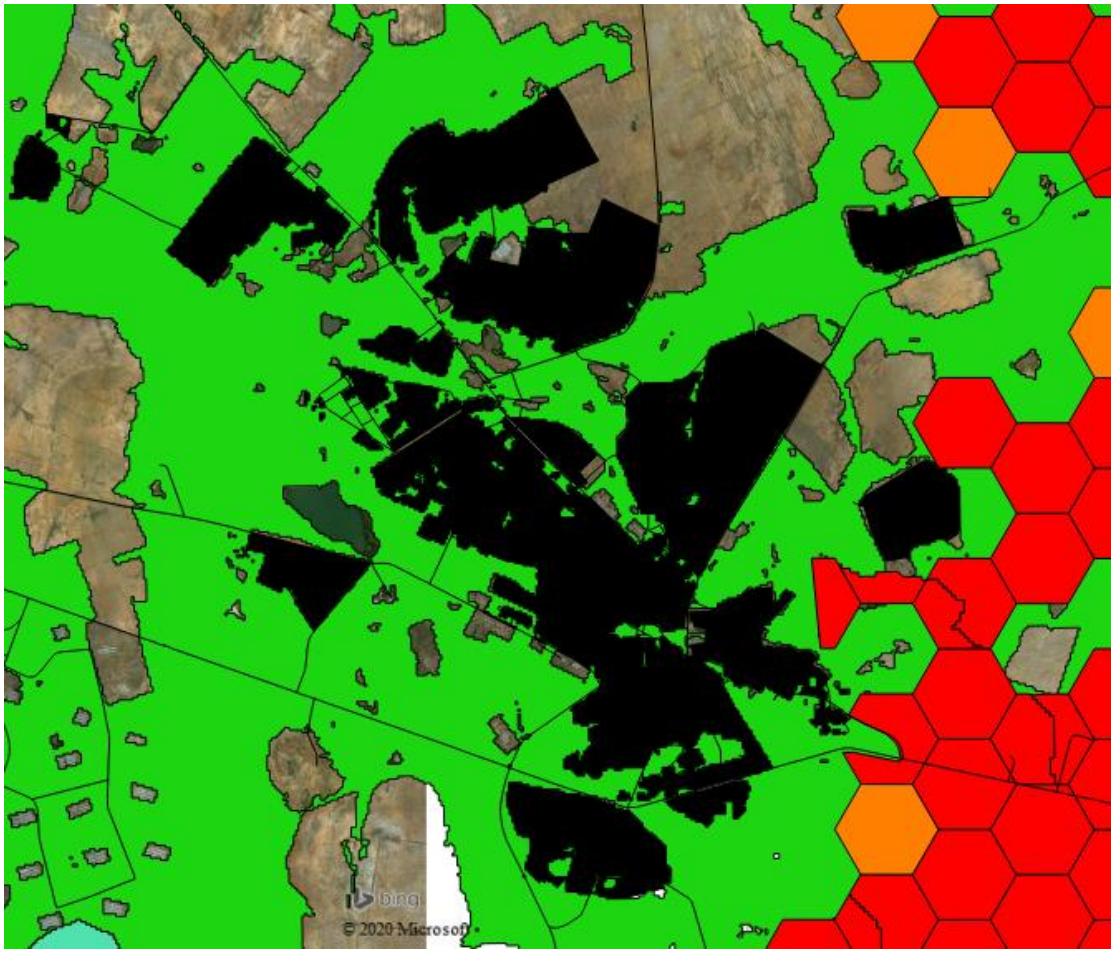
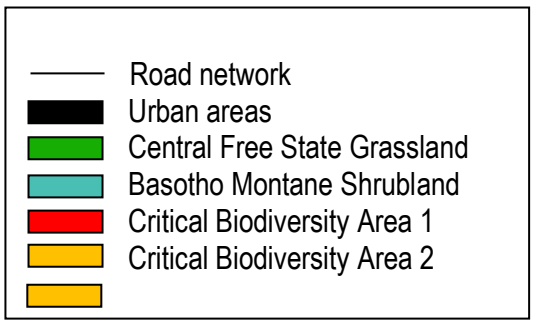


Figure 8: View of CBA 1 and 2 areas as well as protected area in the Thaba Nchu urban area overlain over the remaining natural vegetation portions.

Legend:



National Protected Areas Expansion Strategy (NPAES) 2010

As development increases through time, the expansion of protected areas should also be increased. The NPAES has been developed to identify areas which represent areas of natural vegetation in good condition, with significant diversity and in need of increased conservation. These NPAES Focus Areas therefore represent areas with a significant sensitivity.

Large portions of NPAES Focus Areas occur to the east of Thaba Nchu. These areas also coincide with the Thaba Nchu Mountain and to some extent with CBA areas and aim to

formalise the protection of the Thaba Nchu Mountain. Spatial planning should therefore aim to avoid expansion into these NPAES Focus Areas and should implemented a buffer between any future development and the proposed conservation areas.

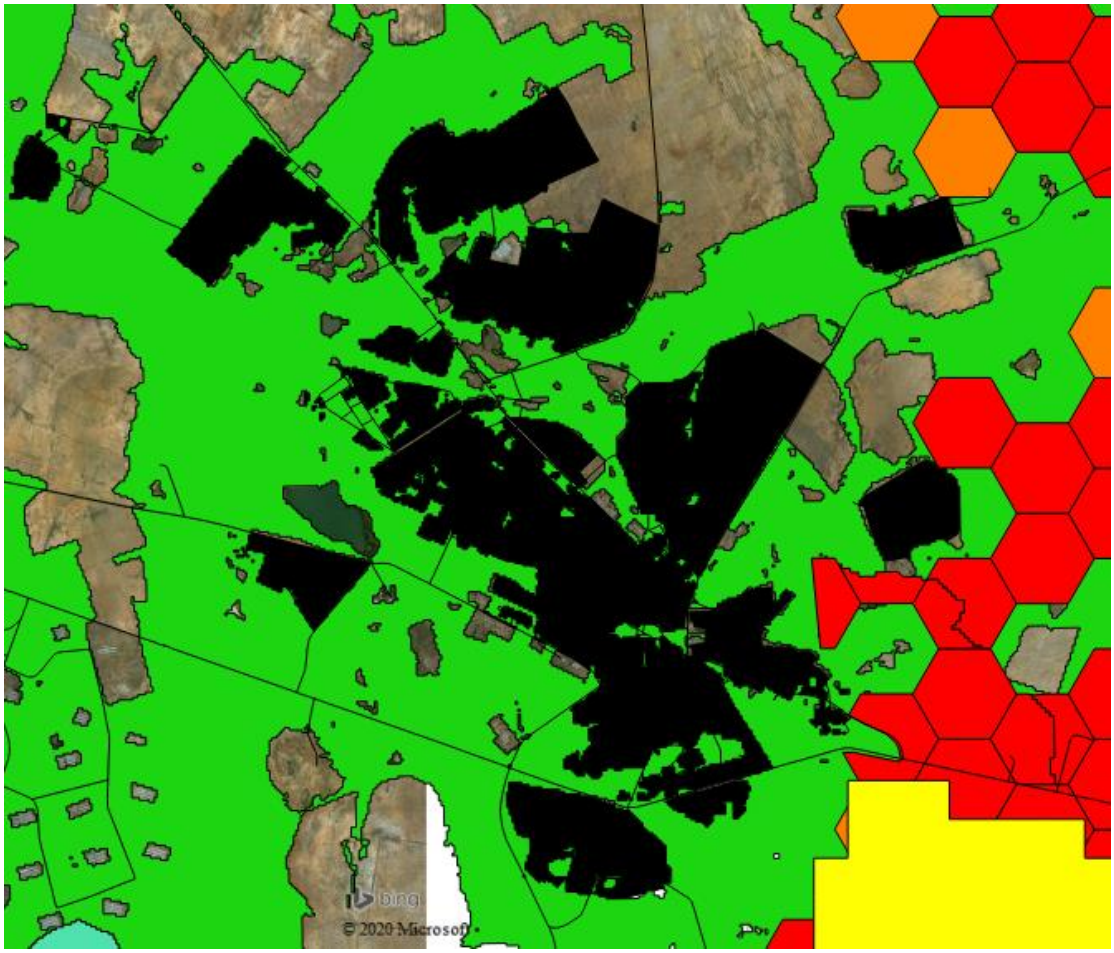
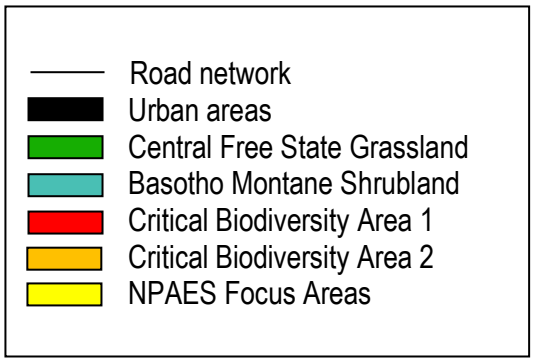


Figure 9: View of the NPAES Focus Areas near the Thaba Nchu urban area. Note the NPAES Focus Area covering the Thaba Nchu Mountain and a portion of CBA areas.

Legend:



4.1.3.4 Thaba Nchu urban area – Conclusions

From the description of the remaining natural vegetation in the Thaba Nchu urban area the following elements of ecological importance should be taken into account in the MOSS:

- Both vegetation types contain elements of conservation value and consequently, where natural portions of these vegetation types remain they should be regarded as having a significant conservation value.
- Both vegetation types contain significant numbers of protected species which should also be taken into account in the sensitivity of remaining natural vegetation.
- Both vegetation types are relatively widespread and currently listed as being of Least Concern.
- Basotho Montane Shrubland contains a somewhat higher habitat and species diversity and a somewhat higher proportion of protected species. In this area it is also associated with the Thaba Nchu Mountain, a highly prominent feature with significant conservation value.
- Extensive areas of CBA 1 & 2 occur to the east of Thaba Nchu and these areas will have a high conservation value and urban planning should avoid these areas and aim to retain a suitable buffer between urban development and the CBA areas. This buffer area should also be designated open space where no development is allowed and communal grazing is kept at a low-intensity.
- A large NPAES Focus Area coincides with the Thaba Nchu Mountain and also affirms the high conservation value of this area. Spatial planning should therefore aim to avoid expansion into these NPAES Focus Areas and should implemented a buffer between any future development and the proposed conservation areas.
- Future planning of Thaba Nchu should take into account the high conservation value of the Thaba Nchu Mountain and the tourism potential this may have.

4.1.4 Soutpan/Ikgomotseng urban area (Appendix A: Map 4)

Soutpan is a very small town that was established due to the existence of salt in the immediate surroundings of the town. The town is still producing a vast amount of salt and the current inhabitants of Soutpan are employed by the salt production industry. The town is 52 km away from the town of Bultfontein to the north and 38 km away from Bloemfontein to the south. Ikgomotseng is 5 km to the east of Soutpan and can almost be seen as a centre on its own. The urban extent of the town is approximately 80 hectares and should also clearly indicate the small extent of the town. No prominent watercourses are present although the large pan system, also a depression wetland area, is a prominent feature of the town. The town forms part of a mostly natural area although the urban areas and salt mining operations do cause some degradation of the area.

Soutpan is situated within the Grassland Biome and under natural conditions would be dominated by grasses with shrubs and trees being almost completely absent. The exception to this being hills and ridges which provide suitable habitat and climate for shrubs and trees to establish. Watercourses also contain differing soils conditions, climate and moisture regime which enables the establishment of shrubs and trees. Consequently, plains should be dominated by grasses while ridges, hills and watercourses would contain a prominent grass component but also substantial shrub and tree cover. This is also the case for the remaining natural areas comprising the Mangaung MOSS. Planted trees within the urban area of especially Soutpan does decrease the grass layer but not significantly. The overall vegetation structure is therefore still largely intact. Furthermore, as can be expected, the urban area of Soutpan has caused only limited transformation of natural areas. However, remaining natural areas may still contain significant degradation due to land-use. Overgrazing and -browsing in

communal areas may lead to significant degradation of the vegetation and activities associated with salt mining may also disturb natural areas.

Despite the small extent of the urban area it still contains a varied topography though in general it forms part of a largely flat area. From aerial images and contours of the study area the majority of Soutpan is dominated by relatively flat plains. One consequence of this flat topography is also the presence of large pan systems of depression wetlands of which one of the larger ones is present adjacent to Soutpan. Around this large pan several low hills and ridges are also present and these also provide a further topographical element. These also provide significantly different habitats and the vegetation composition is also clearly different from the surrounding plains. The altitude of the Soutpan urban area varies from 1300 m AMSL on the surrounding low hills and ridges and decreases to 1250 m AMSL within the pan system. This represents a difference of 50 m which further substantiates the relatively flat topography of the area.

As indicated only limited transformation of the natural environment has occurred. However, several significant impacts are still likely to be present and will have an impact on vegetation and degradation of its condition. Urban developments of Soutpan/Ikgomotseng will result in limited transformation of vegetation but will still be the main impact in the area. Remaining natural areas around the urban development and the main areas of focus of this study will also be affected by several impacts. The salt mining operations will also cause significant disturbance but which will largely affect the pan system or depression wetland. Dirt tracks and footpaths will cause limited local disturbance but will also provide access to these areas and in many cases exacerbate the impact of illegal dumping which may transform some areas. Another significant impact is overgrazing by domestic livestock. Overgrazing and -browsing and the associated trampling cause a decrease in vegetation cover and an increase in erosion. Where this is severe it may lead to a significant loss in diversity and transformation of the natural vegetation type. This may be especially relevant in communal areas where grazing and browsing does not follow a structured grazing schedule or stocking levels and consequently heavy and sustained overgrazing occurs.

Soutpan is situated in a region experiencing moderate rainfall, with cold, dry winters and warm summers. According to the climate statistics from the South African Weather Service, the annual mean maximum and minimum temperatures are24.6 °C and 7.6 °C, respectively. Climate for the site can be extrapolated from rainfall and evaporation data from the weather station C5E009 (Krugersdrift Dam). Soutpan receives an average of 590 mm per year. Precipitation occurs mainly during summer, with most rainfall received during January to March. This is considered a moderate rainfall though the area is still considered to form part of a semi-arid region of South Africa.

Soutpan is situated on geology associated with the Tierberg Formation. The Tierberg Formation of the Ecca Group in the vicinity of Soutpan comprises well bedded shales and thin siltstones. An unconsolidated covering of red-yellow and pale bleached aeolian sand of varying depth occurs at the surface in the vicinity of Soutpan. To the west and through to the north of Soutpan, dolerite intrusion intermixed with Ecca Group rocks are visible.

From the description of Soutpan/Ikgomotseng it is clear that the area has a small extent but nonetheless contains several topographical elements which will translate to different habitats and vegetation types. The area is dominated by natural areas though the impact in many areas may still be significant.

4.1.4.1 Soutpan/Ikgomotseng Vegetation Types

Due to the small extent of the area it does not contain a large amount of vegetation types. However, significant topographical diversity is present and as a result three distinct vegetation types are present. According to Mucina & Rutherford (2006), the study area includes Western Free State Clay Grassland (Gh 9), Vaal-Vet Sandy Grassland (Gh 10) and Vaalbos Rocky Shrubland (SVk 5). According to the National Environmental Management: Biodiversity Act, 2004 (Act No. 10 of 2004) these are all currently listed as being of Least Concern (LC), except for the Vaal-Vet Sandy Grassland which is listed as and Endangered (EN) vegetation type.

These vegetation types also correspond easily to the different topographical, geological and soil properties as previously described. The Vaalbos Rocky Shrubland is most easily distinguished as it is considered a part of the Savannah Biome and will be dominated by shrubs and trees. It will also be confined to the more prominent hills and ridges which only occurs to the north east of Soutpan. The Western Free State Clay Grassland and Vaal-Vet Sandy Grassland are both similar in terms of vegetation structure and topography but is distinguished by the soil properties in which they occur. Western Free State Clay Grassland is confined to areas dominated by clay soils while Vaal-Vet Sandy Grassland is confined to areas dominated by a shallow layer of aeolian sands.

In the absence of a site survey a general description of the vegetation composition is given as obtained from Mucina & Rutherford (2006) and other previous vegetation studies. This is by no means a comprehensive description of the vegetation but should give a general description.

Western Free State Clay Grassland (Gh 9)

Important Taxa:

Graminoids: *Aristida adscensionis*, *A. bipartita*, *Cynodon dactylon*, *Eragrostis chloromelas*, *E. lehmanniana*, *Panicum coloratum*, *Themeda triandra*, *Aristida congesta*, *Cymbopogon pospischilii*, *Digitaria eriantha*, *Eragrostis bicolor*, *E. curvula*, *E. micrantha*, *E. obtusa*, *E. plana*, *E. superba*, *E. trichophora*, *Heteropogon contortus*, *Setaria nigrirostris*, *Tragus berteronianus*, *T. koelerioides*, *T. racemosus*.

Herbs: *Berkheya onopordifolia* var. *onopordifolia*, *Chamaesyce inaequilatera*, *Gnaphalium declinatum*, *Indigofera alternans*, *Kohautia cynanchica*, *Nidorella microcephala*, *Platycarpha parvifolia*, *Salvia stenophylla*, *Selago paniculata*, *Stachys spathulata*.

Geophytic Herbs: *Bulbine narcissifolia*, *Oxalis depressa*.

Succulent Herb: *Tripteris aghillana* var. *integrifolia*.

Low Shrubs: *Lycium cinereum*, *Pentzia globosa*, *Amphiglossa triflora*, *Aptosimum elongatum*, *Berkheya annectens*, *Felicia filifolia* subsp. *filifolia*, *F. muricata*, *Gnidia polycephala*, *Helichrysum dregeanum*, *Melolobium candicans*, *Nenax microphylla*, *Rosenia humilis*, *Selago saxatilis*.

Succulent Shrub: *Hertia pallens*.

The vegetation type is clearly dominated by grass species although a prominent karroid dwarf shrub component, adapted to the higher clay content is also prominent. The vegetation type dominates in the pan fields of this region. Species diversity is evidently not significant, relatively low from available data and does not contain an abundance of protected species. There is however still a likelihood that several such species will occur.

Vaal-Vet Sandy Grassland (Gh 10)

Important Taxa:

Graminoids: *Anthephora pubescens*, *Aristida congesta*, *Chloris virgata*, *Cymbopogon caesius*, *Cynodon dactylon*, *Digitaria argyrograpta*, *Elionurus muticus*, *Eragrostis chloromelas*, *E. lehmanniana*, *E. plana*, *E. trichophora*, *Heteropogon contortus*, *Panicum gilvum*, *Setaria sphacelata*, *Themeda triandra*, *Tragus berteronianus*, *Brachiaria serrata*, *Cymbopogon pospischilii*, *Digitaria eriantha*, *Eragrostis curvula*, *E. obtusa*, *E. superba*, *Panicum coloratum*, *Pogonarthria squarrosa*, *Trichoneura grandiglumis*, *Triraphis andropogonoides*.

Herbs: *Stachys spathulata*, *Barleria macrostegia*, *Berkheya onopordifolia* var. *onopordifolia*, *Chamaesyce inaequilatera*, *Geigeria aspera* var. *aspera*, *Helichrysum caespititium*, *Hermannia depressa*, *Hibiscus pusillus*, *Monsonia burkeana*, *Rhynchosia adenodes*, *Selago densiflora*, *Vernonia oligocephala*.

Geophytic Herbs: *Bulbine narcissifolia*, *Ledebouria marginata*.

Succulent Herb: *Tripteris aghillana* var. *integrifolia*.

Low Shrubs: *Felicia muricata*, *Pentzia globosa*, *Anthospermum rigidum* subsp. *pumilum*, *Helichrysum dregeanum*, *H. paronychioides*, *Ziziphus zeyheriana*.

Endemic Taxon Herb: *Lessertia phillipsiana*.

The vegetation type is dominated by grass species with other growth forms not prominently represented. Species diversity is not significant and the presence of protected species are also not prominent. There is however still a likelihood that several such species will occur. Furthermore, the vegetation type is subject to extensive transformation for dryland crop cultivation and has consequently become under severe pressure. Any remaining natural areas of this vegetation type will therefore still have a significant conservation value.

Vaalbos Rocky Shrubland (SVk 5)

Important Taxa:

Small trees: *Boscia albitrunca, Cussonia paniculata, Searsia lancea.*

Tall shrubs: *Euclea crispa* subsp. *crispa, Olea europaea* subsp. *africana*, *Tarchonanathus camphoratus, Ziziphus mucronata, Buddleja saligna, Cadaba aphylla, Diospyros austro-africana, D. lycioides* subsp. *lycioides, Ehretia rigida* subsp. *rigida, Gymnosporia polyacantha, Rhigozum obovatum, Searsia burchellii.*

Low shubs: *Asparagus suaveolens, Hermannia comosa, Lantana rugozum, Lycium pilifolium, Pentzia globosa, Searsia ciliata.*

Succulent shrubs: *Cotyledon orbiculata* var. *orbiculata, Crassula nudicaulis, Kalanchoe paniculata, Lycium cinerium.*

Graminoids: *Aristida adscensionis, A. congesta, Digitaria eriantha* subsp. *eriantha, Elionurus muticus, Enneapogon scoparius, Eragrostis lehmanniana, E. obtusa, Eustachyus paspaloides, Fingerhuthia africana, Heteropogon contortus, Hyparrhenia hirta, Stipagrostis uniplumis, Themeda triandra*.

Herbs: *Chascanum pinnatifidum, Harpagophytum procumbens* subsp. *procumbens, Hibiscus pusillus.*

Geophytic herbs: *Albuca setosa, Cheilanthes eckloniana, Hamenathus humilis* subsp. *humilis, Pellaea calomelanos*.

Succulent herbs: *Aloe grandidentata, Stapelia grandiflora*.

From the description of the vegetation composition it should be evident that the vegetation type is dominated by trees and shrubs and a variety of different growth forms and although grasses are abundant, they do not form the dominant vegetation element. A diversity of species is indicated and it is also prominent that numerous protected species occur within the vegetation type. Being a prominent topographical unit (hills and ridges) this will also increase its conservation value.

4.1.4.2 Soutpan/Ikgomotseng Protected Species

As previously mentioned, the vegetation types around the urban area of Soutpan all contain some protected and Red Listed species. These are also of significant conservation value and will therefore increase the sensitivity of open spaces where they occur. Furthermore, when utilising the Plants of South Africa (http://posa.sanbi.org) an analysis of plant species previously recorded in the region includes the following protected and Red Listed species recorded. Additional sources also include numerous studies conducted in this area. The area has not been surveyed as thoroughly as the Bloemfontein area and available data would therefore not be as comprehensive and representative of the area.

Table 6: Protected and Red Listed species recorded for the quarter degree squares (2826CA & 2826CC) (http://posa.sanbi.org).

LC – **Least Concern** A species is Least Concern when it has been evaluated against the IUCN criteria and does not qualify for any of the above categories. Species classified as Least Concern are considered at low risk of extinction. Widespread and abundant species are typically classified in this category.
DDD – **Data Deficient - Insufficient Information (DDD)** A species is DDD when there is inadequate information to make an assessment of its risk of extinction, but the species is well defined. Listing of species in this category indicates that more information is required and that future research could show that a threatened classification is appropriate.
NT – **Near Threatened (NT)** A species is Near Threatened when available evidence indicates that it nearly meets any of the IUCN criteria for Vulnerable and is therefore likely to become at risk of extinction in the near future.
VU – **Vulnerable (VU)** A species is Vulnerable when the best available evidence indicates that it meets at least one of the five IUCN criteria for Vulnerable, indicating that the species is facing a high risk of extinction.
EN – **Endangered (EN)** A species is Endangered when the best available evidence indicates that it meets at least one of the five IUCN criteria for Endangered, indicating that the species is facing a very high risk of extinction.
Gh9 – **Western Free State Clay Grassland**

Gh10 – **Vaal-Vet Sandy Grassland**
SVk5 – **Vaalbos Rocky Shrubland**

FAMILY	Scientific name	Status	Protected	Gh9	Gh10	SVk5
Amaryllidaceae	*Ammocharis coranica*	LC	Y	✔	✔	✔
Amaryllidaceae	*Brunsvigia radulosa*	LC	Y	✔	✔	✔
Amaryllidaceae	*Gethyllis transkarooica*	LC	Y	✔	✔	✔
Amaryllidaceae	*Haemanthus humilis subsp. humilis*	LC	Y			✔
Amaryllidaceae	*Haemanthus montanus*	LC	Y	✔		
Anacampserotaceae	*Anacampseros subnuda subsp. subnuda*	LC	Y			✔
Apocynaceae	*Pentarrhinum insipidum*	LC	Y	✔	✔	✔
Apocynaceae	*Raphionacme hirsuta*	LC	Y	✔	✔	✔
Apocynaceae	*Stapelia grandiflora var. grandiflora*	LC	Y			✔
Araliaceae	*Cussonia paniculata subsp. sinuata*	LC	Y			✔
Asphodelaceae	*Aloe grandidentata*	LC	Y			✔
Hyacinthaceae	*Eucomis autumnalis subsp. clavata*	LC	Y	✔	✔	✔
Iridaceae	*Duthieastrum linifolium*	LC	Y			✔
Oleaceae	*Olea europaea subsp. cuspidata*	LC	Y			✔
Orchidaceae	*Bonatea antennifera*	LC	Y			✔
Pedalicaea	*Harpagophytum procumbens*	LC	Y		✔	✔

There is a high likelihood that many of these species as listed will occur within the Soutpan urban area. Note that no Red Listed species had previously been recorded in this area, though as indicated it has not been thoroughly surveyed and there remains a likelihood that such a species will occur. It is however unlikely that any endangered or very rare species would occur.

A comparison between the different vegetation types and the likelihood that protected species may occur indicate that all vegetation types contain a significant proportion of protected species which will be of significant conservation significance. However, note that the hills and ridges consisting of Vaalbos Rocky Shrubland will contain a significantly higher proportion of protected species which will in turn significantly increase its conservation value.

4.1.4.3 Additional data sets

Numerous data sets and mapping resources have been developed to aid in the identification of sensitive areas and areas with a high conservation value, notably those resources developed by the South African National Biodiversity Institute (SANBI). Several of these resources were also combined with the results and discussion of the previous sections to indicate areas within the Bloemfontein urban area which should be regarded as sensitive. From these data sets the following conclusions can be made:

National Biodiversity Assessment (NBA) 2018

Remnants of the natural vegetation types in the area indicates that the area is till largely dominated by natural vegetation and that transformation is not extensive. It is also quite clear that urban development and salt mining activities has caused the most significant transformation in this area. Agricultural croplands to the south also result in extensive transformation but is not relevant to the urban development of Soutpan/Ikgomotseng. As indicated in previous sections, all of the vegetation types in the area contain elements of significant conservation value and therefore all portions of remaining natural vegetation will have a significant level of sensitivity. However, the Vaal-Vet Sandy Grassland is an Endangered vegetation type and will therefore have an increased sensitivity. As concluded, the Vaalbos Rocky Shrubland contains a significant species diversity and has a high proportion of

protected species and will therefore also have an increased sensitivity. Spatial planning and urban development should therefore attempt to avoid remaining portions of Vaal-Vet Sandy Grassland immediately to the south of Ikgomotseng as well as the low hill to the north east of Soutpan which consists of Vaalbos Rocky Shrubland.

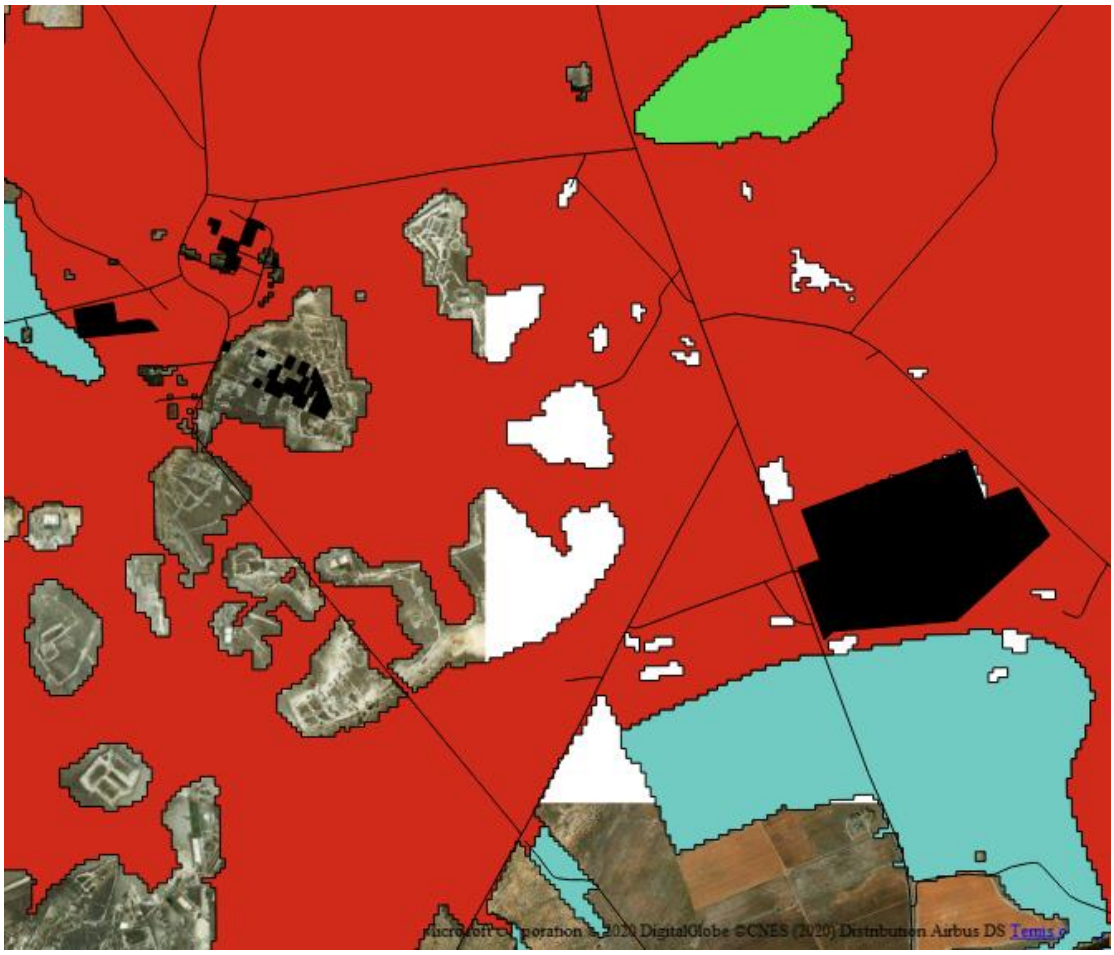


Figure 10: View of the remaining portions of the different vegetation types present in the Soutpan urban area. Note extensive natural areas and limited transformation.

Legend:

Free State Biodiversity Management Plan 2015

The Free State Province Biodiversity Management Plan (2015) has been developed and has identified areas which are essential to meeting conservation targets for specific vegetation types, i.e. Critical Biodiversity Areas (CBA), and other elements of high conservation importance.

The majority of vegetation types in this area is widespread, largely intact and therefore of lower conservation value. However, all portions of remaining intact portions of the intact Vaal-Vet Sandy Grassland are listed as CBA 1 areas. This vegetation type has heavily transformed by crop cultivation and urbanisation and as a result any remaining portions must be regarded as being irreplaceable and of high conservation value. Such remaining portions are still present along the southern border of Ikgomotseng as well as to the west of Soutpan. These areas will have a high conservation value. These CBA areas are clearly illustrated as pentagons and an on-site survey will be able to more accurately delineate the border of these CBA areas.

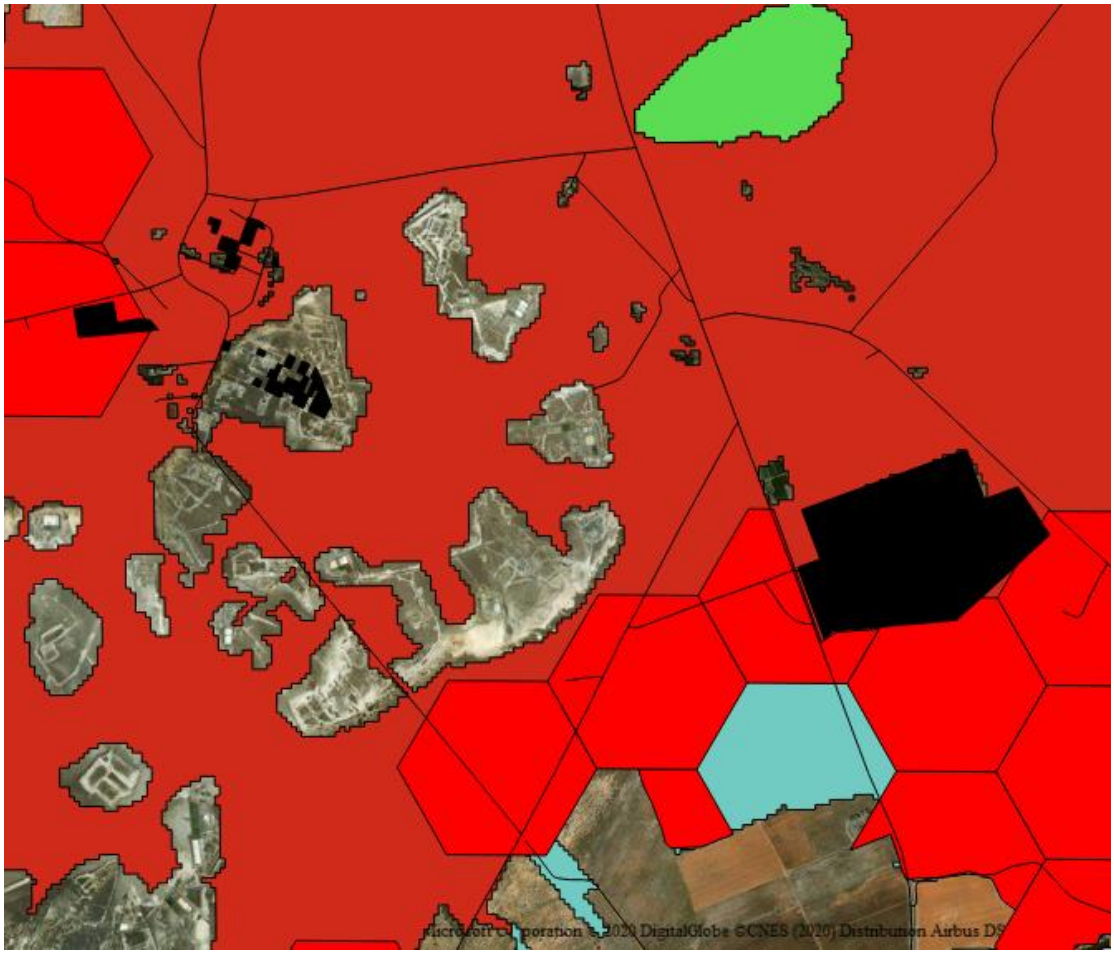


Figure 11: View of CBA 1 and 2 areas in the Soutpan/Ikgomotseng urban area overlain over the remaining natural vegetation portions.

Legend:

National Protected Areas Expansion Strategy (NPAES) 2010

As development increases through time, the expansion of protected areas should also be increased. The NPAES has been developed to identify areas which represent areas of natural vegetation in good condition, with significant diversity and in need of increased conservation. These NPAES Focus Areas therefore represent areas with a significant sensitivity.

No NPAES Focus Areas occur near the urban area. This is most likely due to the fragmented nature of the remaining natural vegetation. NPAES Focus Areas are mostly focused around more extensive natural areas which provide a feasible area for future conservation, a situation largely absent from the Soutpan/Ikgomotseng urban area.

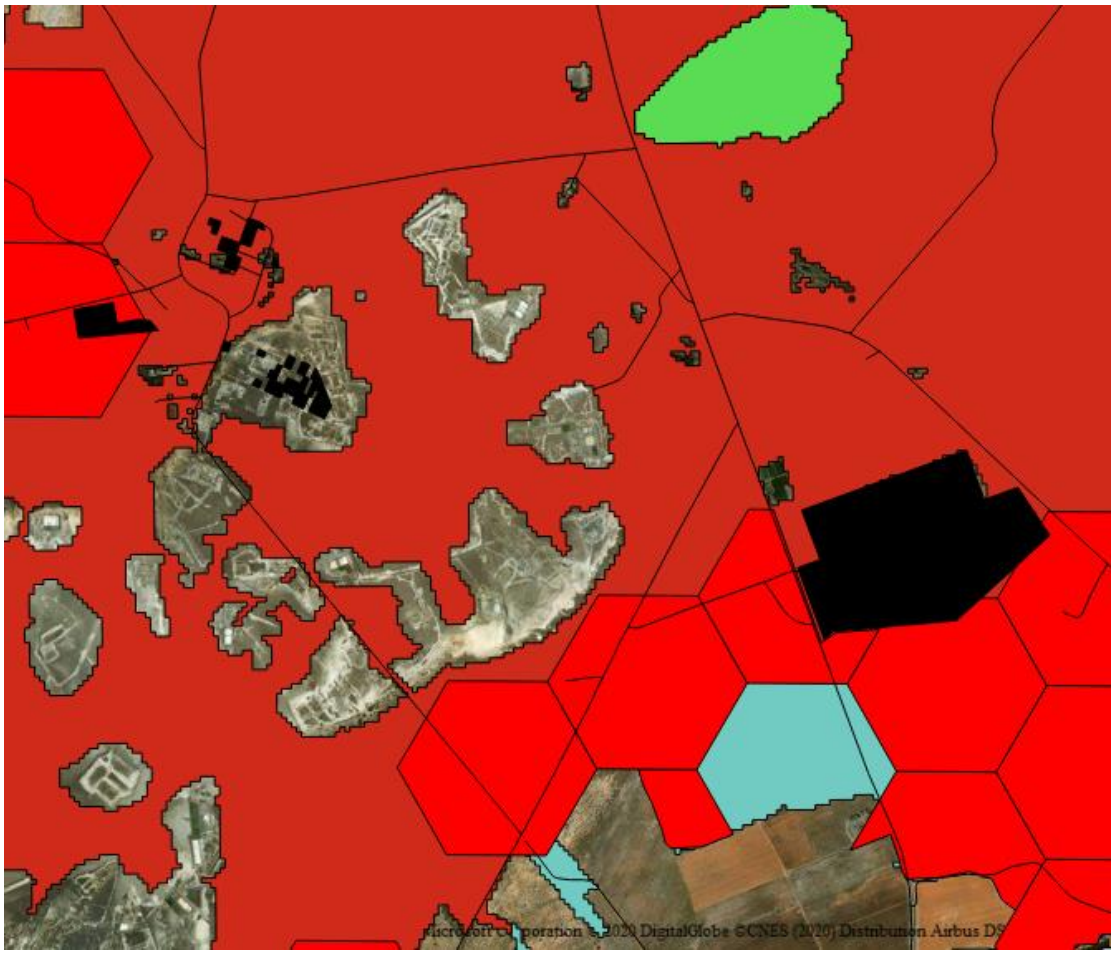
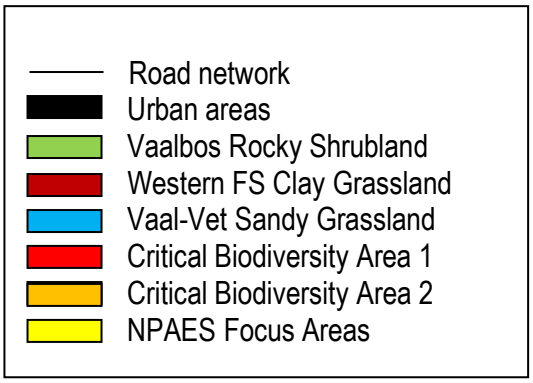


Figure 12: View of the NPAES Focus Areas near the Soutpan/Ikgomotseng urban area. Note no NPAES Focus Areas occur in this region.

Legend:



4.1.4.4 Soutpan/Ikgomotseng urban area – Conclusions

From the description of the remaining natural vegetation in the Soutpan/Ikgomotseng urban area the following elements of ecological importance should be taken into account in the MOSS:

- All three vegetation types contain elements of conservation value and consequently, where natural portions of these vegetation types remain they should be regarded as having a significant conservation value.
- All three vegetation types contain significant numbers of protected species which should also be taken into account in the sensitivity of remaining natural vegetation.
- Vaal-Vet Sandy Grassland is listed as an Endangered (EN) vegetation type which increases its sensitivity and conservation value considerably.
- The Vaalbos Rocky Shrubland has a significant diversity of species and it is also prominent that numerous protected species occur within the vegetation type. Being a prominent topographical unit (hills and ridges) this will also increase its conservation value.
- Portions of CBA 1 areas are associated with remaining intact portions of Vaal-Vet Sandy Grassland (EN) which will have a high level of sensitivity. An on-site survey will enable accurate delineation of the border of these sensitive areas.
- Spatial planning should therefore aim to avoid CBA 1 areas, ridges and hills and the pan system although it is important that an on-site survey be conducted to delineate these areas more accurately and determine their respective sensitivity.

4.1.5 Dewetsdorp urban area (Appendix A: Map 5)

Dewetsdorp is a small town located 75 km south-east of Bloemfontein on the R702. The town of Dewetsdorp is part of the Battlefields Route. The urban extent of the town is approximately 600 hectares and should also clearly indicate the small extent of the town. A few prominent watercourses have their origin near the town and the Modder River also flows past the town to the east of the urban area. The town forms part of a mostly natural area although the urban areas and surrounding agricultural operations do cause some degradation of the area.

Dewetsdorp is situated within the Grassland Biome and under natural conditions would be dominated by grasses with shrubs and trees being almost completely absent. The exception to this being hills and ridges which provide suitable habitat and climate for shrubs and trees to establish. Watercourses also contain differing soils conditions, climate and moisture regime

which enables the establishment of shrubs and trees. Consequently, plains should be dominated by grasses while ridges, hills and watercourses would contain a prominent grass component but also substantial shrub and tree cover. This is also the case for the remaining natural areas comprising the Mangaung MOSS. It is evident that the region of Dewetsdorp is dominated by extensive, undulating grass plains but that ridges, hills and especially watercourses contain a prominent shrub/tree component. The vegetation structure seems to be intact to a large degree though it is likely that exotic trees, especially along watercourses will cause some modification of the natural structure. As can be expected, the urban area of Dewetsdorp has caused only limited transformation of natural areas and natural grassland is still evident around the town. However, remaining natural areas may still contain significant degradation due to land-use. Overgrazing and -browsing in communal areas may lead to significant degradation of the vegetation and areas utilised for crop cultivation will also cause transformation of the natural vegetation.

Most likely also a result of the small extent of the town, the topography is relatively uniform and dominated by undulating plains. From aerial images and contours of the study area the majority of Dewetsdorp is dominated by undulating plains. Due to the undulating terrain, numerous watercourses are incised in the landscape and this significantly increases the habitat diversity. Rocky outcrops, including low hills and ridges are present, though not abundant, but do provide a further topographical element. These also provide significantly different habitats and the vegetation composition is also clearly different from the surrounding plains. The altitude of the Dewetsdorp urban area varies from 1610 m AMSL along the low ridges to the west of the town and decreases to 1500 m AMSL along the lower lying watercourses to the east of the town. This represents a difference of 110 m which illustrates the relatively uniform, though undulating, topography of the area.

As indicated only limited transformation of the natural environment has occurred. However, several significant impacts are still likely to be present and will have an impact on vegetation and degradation of its condition. Urban developments of Dewetsdorp will result in limited transformation of vegetation but will still be the main impact in the area. Remaining natural areas around the urban development and the main areas of focus of this study will also be affected by several impacts. Around the town several areas which had previously been subjected to crop cultivation has caused transformation of the natural grassland. This is however still not extensive but is one of the larger impacts in the surroundings. Dirt tracks and footpaths will cause limited local disturbance but will also provide access to these areas and in many cases exacerbate the impact of illegal dumping which may transform some areas. Another significant impact is overgrazing by domestic livestock. Overgrazing and -browsing and the associated trampling cause a decrease in vegetation cover and an increase in erosion. Where this is severe it may lead to a significant loss in diversity and transformation of the natural vegetation type. This may be especially relevant in communal areas where grazing and browsing does not follow a structured grazing schedule or stocking levels and consequently heavy and sustained overgrazing occurs.

Dewetsdorp is situated in a region experiencing moderate rainfall, with cold, dry winters and warm summers. The South African Weather Service does not have a weather station at the town with the nearest station being stationed at Wepener approximately 42 km to the south east. This should still give a relatively accurate approximation of the climate in Dewetsdorp. Data from the weather station D2E002 (Wepener) indicates an average precipitation of 568.9 mm per year. Precipitation occurs mainly during summer, with most rainfall received during January (92.0 mm), February (81.6 mm) and March (86.4 mm). The overall climate is

considered temperate with a moderate rainfall. As a result, surface runoff in the area is also moderate, occurs mostly during summer and results in an estimated mean annual runoff for the area between 20 – 50 mm according to a study by the Water Research Commission (WRC REPORT NO. TT 685/16, 2016).

Dewetsdorp is underlain by both the Tarkastad and Adelaide Subgroups of the Beaufort Group, in particular the Katberg Formation of the Tarkastad Subgroup and the Balfour Formation of the Adelaide Subgroup. The Katberg Formation that forms the lower contact between the Tarkastad- and Adelaide Subgroups is very prominent in the area, probably because it is more resistant to weathering than the underlying Balfour Formation. The Katberg Formation consists mainly of sandstone, it tends to form cliffs. The area north-east of Dewetsdorp is underlain by the Balfour Formation with its fine-grained, cross-bedded sandstone, coarse arkose layers and mudstones. The mudstones, that vary in colour from green to red, represent the cyclic sedimentation of channel and flood-plain deposits. There are a number of circular dolerite hills present in the area that represent ring dykes. A circular outcrop of dolerite to the west of Dewetsdorp, also resembles a ring dyke (Botha *et al* 1998).

From the description of Dewetsdorp it is clear that the area has a small extent with a relatively uniform topography dominated by undulating grassland although a few topographical elements do contribute to some habitat diversity and vegetation types. The area is dominated by natural areas though the impact in many areas may still be significant.

4.1.5.1 Dewetsdorp Vegetation Types

Due to the relatively uniform topography, although some habitat diversity is evident, and smaller extent of the urban area of Dewetsdorp it contains only two different vegetation types. According to Mucina & Rutherford (2006), the study area includes Central Free State Grassland (Gh 6) and Aliwal North Dry Grassland (Gh 2). According to the National Environmental Management: Biodiversity Act, 2004 (Act No. 10 of 2004) these are both currently listed as being of Least Concern (LC).

The distinction and border between these vegetation types may not be readily apparent and a significant ecotone is likely to be present. These two grassland types are mostly distinguished by a rainfall gradient with Central Free State Grassland occurring in areas with a moderate rainfall while Aliwal North Dry Grassland receiving a somewhat lower rainfall. The latter can also be regarded as forming the transitional zone between the proper Grassland Biome and the Nama Karoo Biome. As a result, it also contains a prominent dwarf karroid shrub component and the dominance of karroid shrubs and grasses vary between years of lower and higher rainfall.

In the absence of a site survey a general description of the vegetation composition is given as obtained from Mucina & Rutherford (2006) and other previous vegetation studies. This is by no means a comprehensive description of the vegetation but should give a general description.

Aliwal North Dry Grassland (Gh 2)

Important Taxa:

Graminoids: *Aristida adscensionis*, *A. congesta*, *Cymbopogon pospischilii*, *Cynodon incompletus*, *Elionurus muticus*, *Eragrostis chloromelas*, *E. lehmanniana*, *E. obtusa*,

Heteropogon contortus, *Microchloa caffra*, *M. kunthii*, *Setaria sphacelata*, *Themeda triandra*, *Tragus koelerioides*, *Aristida diffusa*, *Cynodon dactylon*, *Cyperus usitatus*, *Digitaria eriantha*, *Eragrostis capensis*, *E. curvula*, *E. plana*, *Helictotrichon turgidulum*, *Sporobolus fimbriatus*, *Tetrachne dregei*, *Trichoneura grandiglumis*, *Triraphis andropogonoides*.

Herbs: *Berkheya onopordifolia* var. *onopordifolia*, *Galium capense* subsp. *capense*, *Gazania krebsiana* subsp. *krebsiana*, *Helichrysum rugulosum*, *Hermannia coccocarpa*, *Indigofera alternans*, *Jamesbrittenia aurantiaca*, *Lotononis listii*, *Nolletia ciliaris*, *Pseudognaphalium luteo-album*, *Salvia stenophylla*, *Selago densiflora*, *Trichogyne verticillata*.

Geophytic Herb: *Oxalis depressa*.

Low Shrubs: *Helichrysum dregeanum*, *Pentzia globosa*, *Anthospermum rigidum* subsp. *pumilum*, *Atriplex semibaccata* var. *appendiculata*, *Berkheya annectens*, *Chrysocoma ciliata*, *Euryops annae, E. oligoglossus* subsp. *oligoglossus, Felicia muricata*, *Helichrysum niveum*, *H. rosum*, *Nenax microphylla*, *Selago saxatilis*, *Senecio burchellii*.

The vegetation type is clearly dominated by grass species with shrubs and trees being completely absent. However, note that a prominent and also dominant dwarf shrub component is also present. This is one of the main criterions to distinguish it from Central Free State Grassland. From desktop information a moderate species diversity is likely and though no protected species are apparent it is highly likely that at least a few will be present. Furthermore, on-site information will provide a much more accurate situation w.r.t. species diversity and it is also highly likely that the amount of protected species will be increased substantially.

Central Free State Grassland (Gh 6)

Important Taxa:

Graminoids: *Aristida adscensionis*, *A. congesta*, *Cynodon dactylon*, *Eragrostis chloromelas*, *E. curvula*, *E. plana*, *Panicum coloratum*, *Setaria sphacalata, Themeda triandra, Tragus koelerioides, Agrostis lachnantha, Andropogon appendiculatus, Aristida bipartita, A. canescens, Cymbopogon pospischilii, Cynodon transvaalensis, Digitaria argyrograpta, Elionurus muticus, Eragrostis lehmanniana, E. micrantha, E. obtusa, E. racemosa, E. trichophora, Heteropogon contortus, Microchloa caffra, Setaria incrassata, Sporobolus discosporus.*

Herbs: Berkheya onopordifolia var.onopordifolia, Chamaesyce inaequilatera, Conyza pinnata, Crabbea acaulis, Geigeria aspera var. aspera, Hermannia depressa, Hibiscus pusillus, Pseudognaphalium luteo-album, Salvia stenophylla, Selago densiflora, Sonchus dregeanus.

Geophytic Herbs: Oxalis depressa, Raphionacme dyeri.

Succulent Herb: Tripteris aghillana var. integrifolia.

Low Shrubs: Felicia muricata, Anthospermum rigidum subsp. pumilum, Helichrysum dregeanum, Melolobium candicans, Pentzia globosa.

The vegetation type is clearly dominated by grass species with shrubs and trees being completely absent. From desktop information a moderate species diversity is likely and a few

protected species is already likely to occur. However, on-site information will provide a much more accurate situation w.r.t. species diversity and it is also highly likely that the amount of protected species will be increased substantially.

4.1.5.2 Dewetsdorp Protected Species

As previously mentioned, the vegetation types around the urban area of Dewetsdorp both contain some protected and Red Listed species. These are also of significant conservation value and will therefore increase the sensitivity of open spaces where they occur. Furthermore, when utilising the Plants of South Africa (http://posa.sanbi.org) an analysis of plant species previously recorded in the region includes the following protected and Red Listed species recorded. Additional sources also include numerous studies conducted in this area. The area has not been surveyed as thoroughly as the Bloemfontein area and available data would therefore not be as comprehensive and representative of the area.

Table 7: Protected and Red Listed species recorded for the quarter degree squares (2926DA) (http://posa.sanbi.org).

LC – **Least Concern** A species is Least Concern when it has been evaluated against the IUCN criteria and does not qualify for any of the above categories. Species classified as Least Concern are considered at low risk of extinction. Widespread and abundant species are typically classified in this category.
DDD – **Data Deficient - Insufficient Information (DDD)** A species is DDD when there is inadequate information to make an assessment of its risk of extinction, but the species is well defined. Listing of species in this category indicates that more information is required and that future research could show that a threatened classification is appropriate.
NT – **Near Threatened (NT)** A species is Near Threatened when available evidence indicates that it nearly meets any of the IUCN criteria for Vulnerable and is therefore likely to become at risk of extinction in the near future.
VU – **Vulnerable (VU)** A species is Vulnerable when the best available evidence indicates that it meets at least one of the five IUCN criteria for Vulnerable, indicating that the species is facing a high risk of extinction.
EN – **Endangered (EN)** A species is Endangered when the best available evidence indicates that it meets at least one of the five IUCN criteria for Endangered, indicating that the species is facing a very high risk of extinction.
Gh2 – **Aliwal North Dry Grassland**
Gh6 – **Central Free State Grassland**

FAMILY	Scientific name	Status	Protected	Gh2	Gh6
Asteraceae	*Helichrysum niveum*	LC	Y	✔	
Asteraceae	*Helichrysum rosum*	LC	Y	✔	
Iridaceae	*Hesperantha longituba*	LC	Y	✔	✔

It is clear that the current data for the Dewetsdorp region is severely lacking and also points to the need for on-site surveys. It is highly likely that many other protected species will also occur in this area but has not previously been recorded. Note that no Red Listed species had previously been recorded in this area, though as indicated it has not been thoroughly surveyed and there remains a likelihood that such a species will occur.

The current data does not allow for any usable conclusions to be drawn or comparisons between vegetation types made. Comprehensive on-site surveys is essential to provide accurate data for spatial planning purposes.

4.1.5.3 Additional data sets

Numerous data sets and mapping resources have been developed to aid in the identification of sensitive areas and areas with a high conservation value, notably those resources developed by the South African National Biodiversity Institute (SANBI). Several of these resources were also combined with the results and discussion of the previous sections to indicate areas within

the Botshabelo urban area which should be regarded as sensitive. From these data sets the following conclusions can be made:

National Biodiversity Assessment (NBA) 2018

Remnants of the natural vegetation types in the area indicates that the area is still largely dominated by natural vegetation and that transformation is not extensive. It is also quite clear that urban development and crop cultivation has caused the most significant transformation in this area. As indicated in previous sections, all of the vegetation types in the area contain elements of significant conservation value and therefore all portions of remaining natural vegetation will have a significant level of sensitivity. Low hills and ridges to the west of the town is likely to contain a higher diversity of species, habitat and protected species. This will however only be confirmed by on-site surveys.

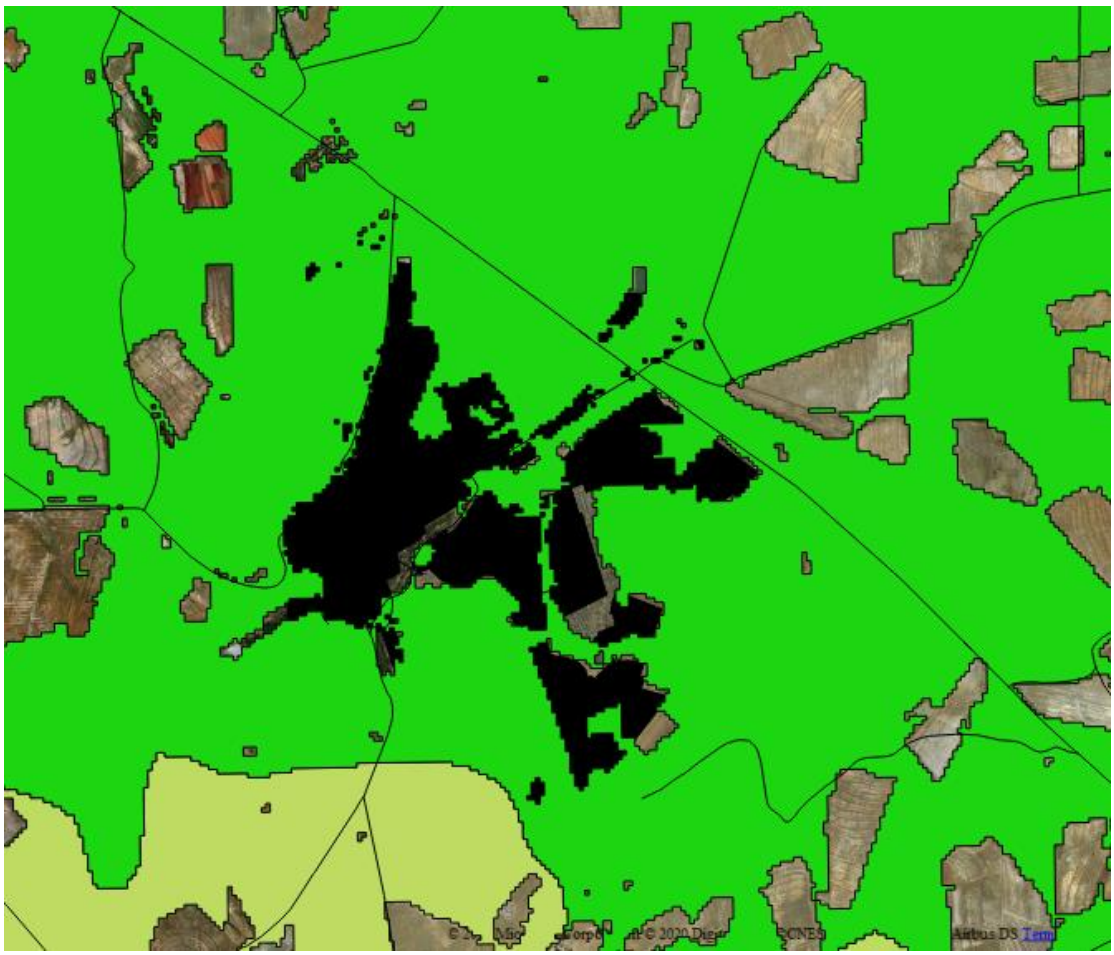
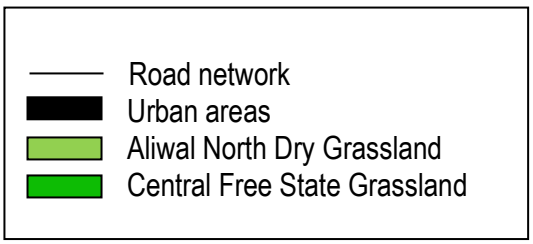


Figure 13: View of the remaining portions of the different vegetation types present in the Dewetsdorp urban area. Note extensive natural areas and limited transformation.

Legend:



Free State Biodiversity Management Plan 2015

The Free State Province Biodiversity Management Plan (2015) has been developed and has identified areas which are essential to meeting conservation targets for specific vegetation types, i.e. Critical Biodiversity Areas (CBA), and other elements of high conservation importance.

The majority of vegetation types in this area is widespread, largely intact and therefore of lower conservation value. However, an extensive area of Critical Biodiversity Area 1 (CBA 1) occurs to the west and south of the town. The reasons for this area being considered a CBA is not clearly apparent and determining the sensitivity of these areas should also form part of the on-site surveys. Whatever the case may be, for the time being these CBA areas must be regarded as highly sensitive and should be avoided by spatial planning.

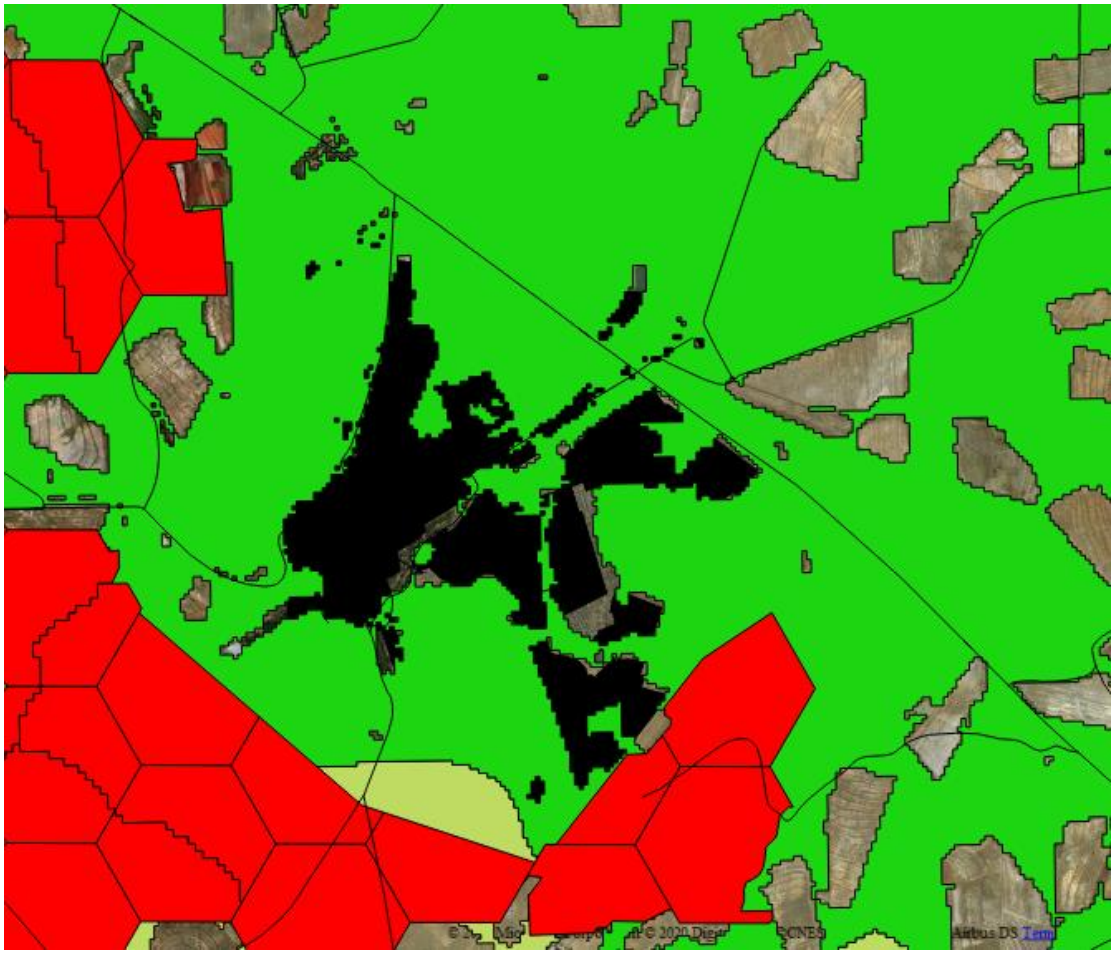
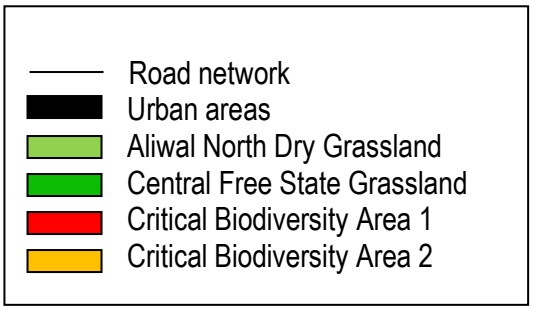


Figure 14: View of CBA 1 and 2 areas in the Dewetsdorp urban area overlain over the remaining natural vegetation portions.

Legend:



National Protected Areas Expansion Strategy (NPAES) 2010

As development increases through time, the expansion of protected areas should also be increased. The NPAES has been developed to identify areas which represent areas of natural vegetation in good condition, with significant diversity and in need of increased conservation. These NPAES Focus Areas therefore represent areas with a significant sensitivity.

No NPAES Focus Areas occur near the urban area. This is merely a reflection of the absence of areas considered as likely future protected areas and does not indicate the absence of sensitive areas of high conservation value.

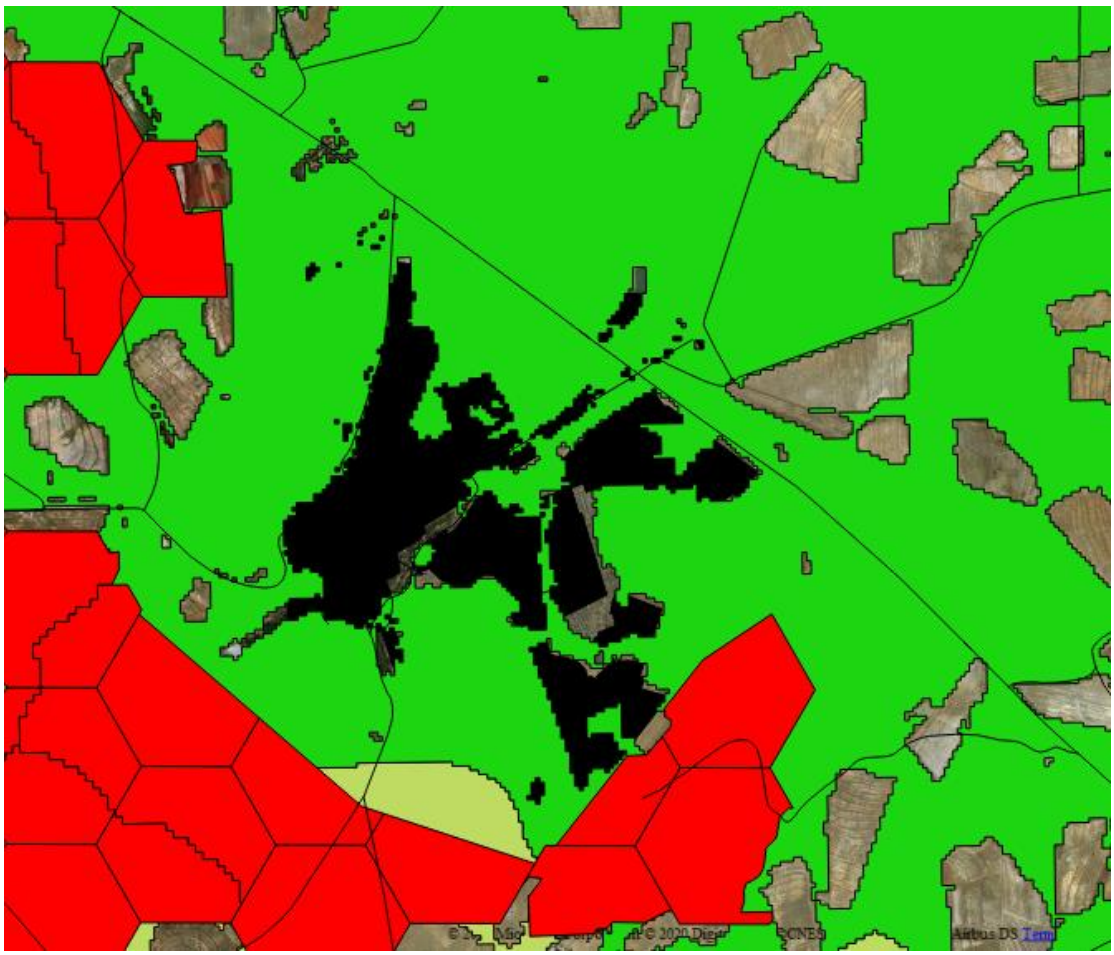
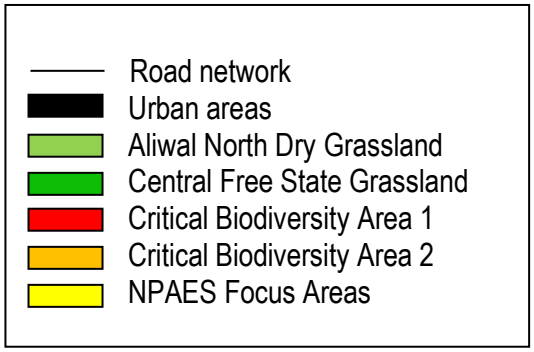


Figure 15: View of the NPAES Focus Areas near the Dewetsdorp urban area. Note no NPAES Focus Areas occur in this region.

Legend:



4.1.5.4 Dewetsdorp urban area – Conclusions

From the description of the remaining natural vegetation in the Dewetsdorp urban area the following elements of ecological importance should be taken into account in the MOSS:

- Both vegetation types contain elements of conservation value and consequently, where natural portions of these vegetation types remain they should be regarded as having a significant conservation value.
- Both vegetation types are likely to contain numerous protected species though current data is severely lacking and indicate the need for further on-site assessment.
- Although neither of the vegetation types are considered threatened a large portion to the west and south of the town is regarded as a CBA 1 area and will therefore have a high level of sensitivity.
- The reason for this CBA 1 area is not clearly apparent and comprehensive on-site surveys should be conducted.
- Whatever the case may be, for the time being these CBA areas must be regarded as highly sensitive and should be avoided by spatial planning.

4.1.6 Wepener urban area (Appendix A: Map 6)

Wepener is located 120km south east of Bloemfontein and was founded in 1867 on the banks of Jammersbergspruit, a tributary of the Caledon River. The Caledon Nature Reserve is about 15km south of Wepener on the R701. The Caledon River is situated along the western border of the town and is a large and significant watercourse. The urban extent of the town is approximately 840 hectares and should also clearly indicate the small extent of the town. The town forms part of a mostly natural area although the urban areas and surrounding agricultural operations do cause some degradation of the area.

Wepener is situated within the Grassland Biome and under natural conditions would be dominated by grasses with shrubs and trees being almost completely absent. The exception to this being hills and ridges which provide suitable habitat and climate for shrubs and trees to establish. Watercourses also contain differing soils conditions, climate and moisture regime which enables the establishment of shrubs and trees. Consequently, plains should be dominated by grasses while ridges, hills and watercourses would contain a prominent grass component but also substantial shrub and tree cover. This is also the case for the remaining natural areas comprising the Mangaung MOSS. The area of Wepener is situated toward the

east and along the foothills of the Drakensberg mountain range and consequently is dominated by an undulating terrain but with large hills and ridges becoming prominent. The vegetation structure is dominated by grassland but with a shrub and tree layer becoming prominent along the hills, ridges as well as watercourses. Therefore, the vegetation structure seems to be intact to a large degree though it is likely that exotic trees, especially along watercourses will cause some modification of the natural structure. As can be expected, the urban area of Wepener has caused only limited transformation of natural areas and natural grassland is still evident around the town. However, remaining natural areas may still contain significant degradation due to land-use. Overgrazing and -browsing in communal areas may lead to significant degradation of the vegetation and areas utilised for crop cultivation will also cause transformation of the natural vegetation.

Despite the relatively small extent of the town a varied topography is present including undulating plains, incised, large watercourses and prominent hills and ridges. From aerial images and contours of the study area this is also quite clear. Some of the larger watercourses in this area include the Caledon River flowing past the western border of the urban area and the Sandspruit, a large but seasonal stream, flowing through the town. A system of large hills and ridges occur along the northern and eastern border of the town containing sandstone plateaus. These will provide a diversity of different habitats and will undoubtedly contain a significant species diversity. The altitude of the Wepener urban area varies from 1670 m along the plateau of the adjacent ridges and decreases to 1421 m along the lower lying Caledon River. This represents a difference of 249 m which illustrates a quite varied topography of the area.

As indicated only limited transformation of the natural environment has occurred. However, several significant impacts are still likely to be present and will have an impact on vegetation and degradation of its condition. Urban developments of Wepener will result in limited transformation of vegetation but will still be the main impact in the area. Remaining natural areas around the urban development and the main areas of focus of this study will also be affected by several impacts. Around the town several areas which had previously been subjected to crop cultivation has caused transformation of the natural grassland. This is however still not extensive but is one of the larger impacts in the surroundings. Dirt tracks and footpaths will cause limited local disturbance but will also provide access to these areas and in many cases exacerbate the impact of illegal dumping which may transform some areas. Another significant impact is overgrazing by domestic livestock. Overgrazing and -browsing and the associated trampling cause a decrease in vegetation cover and an increase in erosion. Where this is severe it may lead to a significant loss in diversity and transformation of the natural vegetation type. This may be especially relevant in communal areas where grazing and browsing does not follow a structured grazing schedule or stocking levels and consequently heavy and sustained overgrazing occurs.

Wepener is situated in a region experiencing moderate rainfall, with cold, dry winters and moderate summers. Climate for the area can be relatively accurately represented by rainfall and evaporation data from the weather station D2E002 (Wepener). Wepener receives an average of 568.9 mm per year measured for the period 1956 to 1980. Precipitation occurs mainly during summer, with most rainfall received during January (92.0 mm), February (81.6 mm) and March (86.4 mm). This is considered a moderate rainfall and causes the area to form part of one of the more temperate areas of South Africa. The mean annual evaporation at Wepener is 2154.5 mm. From the above description of the climate conditions conducive to the formation of wetlands are regarded as moderate. The overall climate is considered temperate

with a moderate rainfall. As a result, surface runoff in the area is also moderate, occurs mostly during summer and results in an estimated mean annual runoff for the area between 20 – 50 mm according to a study by the Water Research Commission (WRC REPORT NO. TT 685/16, 2016). Though this is a significant amount of runoff it is still considered moderate.

Geologically the region is characterized by Molteno and Elliot Formations. Molteno Formation, the first of the Stormberg Group, lies on top of the Beaufort Group. The Elliot Formation follows conformably on the Molteno Formation (Malan *et al* 1999).

The Ca and Ib land types are the most prominent in the region. The Ib land type is associated with rocky areas in the surrounding area along ridges and hills. The Ca land type is associated with the lower lying areas and includes Hutton-. Bainsvlei-, Avalon- and Longlands soil forms. Generally the soils in the region are referred to as 'Podsolic' soils. These soils are generally deeper than 'solonetic' soils and contains a high salt content and also comprises well-developed horizons. Donga and surface erosion are a common phenomenon of these soils (Malan *et al* 1999).

From the description of Wepener it is clear that although the town has a small extent it contains a diversity of topographical elements and habitats which will also considerably increase species diversity. The area is dominated by natural areas though the impact in many areas may still be significant.

4.1.6.1 Wepener Vegetation Types

As a result of the varied topography and mountainous terrain in this area despite the small extent of the town it contains three diverse vegetation types. According to Mucina & Rutherford (2006), the study area includes Aliwal North Dry Grassland (Gh 2), Basotho Montane Shrubland (Gm 5) and Eastern Free State Clay Grassland (Gm 3). According to the National Environmental Management: Biodiversity Act, 2004 (Act No. 10 of 2004) these are all currently listed as being of Least Concern (LC), except for the Eastern Free State Clay Grassland which is listed as a Vulnerable (VU) vegetation type. In addition, the Basotho Montane Grassland forms part of the Eastern Mesic Grasslands which are generally recognised as containing a significant species diversity with several being protected and of conservation importance.

These vegetation types also correspond easily to the different topographical elements as previously described. The Aliwal North Dry Grassland is confined to the undulating plains and is dominated by a well-developed grass layer with shrubs and trees completely absent. The Basotho Montane Shrubland is confined to larger hills, mountains and ridges to the north and east of the urban area and will not occur within lower lying plains. It will also always contain a significant shrub component, although the grass layer will still be well-developed in most cases. It is also confined to the slopes and summit of the ridges and hills. The Eastern Free State Clay Grassland is confined to the plateau above the ridges and hills to the north and east of Wepener. The vegetation types are therefore easily distinguished in terms of their topographical habitat, i.e. undulating plains, hillslopes and plateaus.

In the absence of a site survey a general description of the vegetation composition is given as obtained from Mucina & Rutherford (2006) and other previous vegetation studies. This is by no means a comprehensive description of the vegetation but should give a general description.

Aliwal North Dry Grassland (Gh 2)

Important Taxa:

Graminoids: *Aristida adscensionis*, *A. congesta*, *Cymbopogon pospischilii*, *Cynodon incompletus*, *Elionurus muticus*, *Eragrostis chloromelas*, *E. lehmanniana*, *E. obtusa*, *Heteropogon contortus*, *Microchloa caffra*, *M. kunthii*, *Setaria sphacelata*, *Themeda triandra*, *Tragus koelerioides*, *Aristida diffusa*, *Cynodon dactylon*, *Cyperus usitatus*, *Digitaria eriantha*, *Eragrostis capensis*, *E. curvula*, *E. plana*, *Helictotrichon turgidulum*, *Sporobolus fimbriatus*, *Tetrachne dregei*, *Trichoneura grandiglumis*, *Triraphis andropogonoides*.

Herbs: *Berkheya onopordifolia* var. *onopordifolia*, *Galium capense* subsp. *capense*, *Gazania krebsiana* subsp. *krebsiana*, *Helichrysum rugulosum*, *Hermannia coccocarpa*, *Indigofera alternans*, *Jamesbrittenia aurantiaca*, *Lotononis listii*, *Nolletia ciliaris*, *Pseudognaphalium luteo-album*, *Salvia stenophylla*, *Selago densiflora*, *Trichogyne verticillata*.

Geophytic Herb: *Oxalis depressa*.

Low Shrubs: *Helichrysum dregeanum*, *Pentzia globosa*, *Anthospermum rigidum* subsp. *pumilum*, *Atriplex semibaccata* var. *appendiculata*, *Berkheya annectens*, *Chrysocoma ciliata*, *Euryops annae, E. oligoglossus* subsp. *oligoglossus, Felicia muricata*, *Helichrysum niveum*, *H. rosum*, *Nenax microphylla*, *Selago saxatilis*, *Senecio burchellii*.

The vegetation type is clearly dominated by grass species with shrubs and trees being completely absent. However, note that a prominent and also dominant dwarf shrub component is also present. From desktop information a moderate species diversity is likely and though no protected species are apparent it is highly likely that at least a few will be present. Furthermore, on-site information will provide a much more accurate situation w.r.t. species diversity and it is also highly likely that the amount of protected species will be increased substantially.

Basotho Montane Shrubland (Gm 5)

Important Taxa:

Tall Shrubs: *Buddleja salviifolia*, *Euclea crispa* subsp. *ovata*, *Olea europaea* subsp. *africana*, *Diospyros whyteana*, *Heteromorpha arborescens* var. *abyssinica*, *Leucosidea sericea*, *Rhamnus prinoides*, *Rhus dentata*, *Tarchonanthus minor*.

Low Shrubs: *Anthospermum rigidum* subsp. *pumilum*, *Euphorbia striata* var. *cuspidata*, *Felicia filifolia* subsp. *filifolia*, *F. muricata*, *Gnidia capitata*, *Myrsine africana*.

Graminoids: *Andropogon appendiculatus*, *A. schirensis*, *Aristida congesta*, *Cymbopogon pospischilii*, *Cynodon dactylon*, *Elionurus muticus*, *Eragrostis chloromelas*, *E. plana*, *E. racemosa*, *Heteropogon contortus*, *Hyparrhenia hirta*, *Microchloa caffra*, *Setaria sphacelata*, *Themeda triandra*, *Tristachya leucothrix*, *Aristida diffusa*, *Brachiaria serrata*, *Digitaria tricholaenoides*, *Eragrostis capensis*, *E. curvula*, *Harpochloa falx*, *Pennisetum sphacelatum*, *Setaria nigrirostris*.

Herbs: *Ajuga ophrydis*, *Cineraria lyratiformis*, *Conyza podocephala*, *Dicoma anomala*, *Haplocarpha scaposa*, *Helichrysum caespititium*, *H. nudifolium* var. *nudifolium*, *H. rugulosum*,

Hermannia depressa, *Hibiscus microcarpus*, *Ipomoea crassipes*, *Nolletia ciliaris*, *Pollichia campestris*, *Selago densiflora*, *Senecio erubescens* var. *crepidifolius*, *Tolpis capensis*, *Vernonia oligocephala*.

Geophytic Herb: *Hypoxis rigidula* var. *pilosissima*.

Herbaceous Climber: *Rhynchosia totta*.

Endemic Taxa Herbs: *Lessertia tenuifolia*, *Leucaena latisiliqua*.

In addition to this information, a study conducted by Malan *et al* (1999) also resembles to a significant degree this vegetation type and may therefore give a further indication of the vegetation composition and habitat diversity. This also confirms a strong prominence of trees and shrubs, especially along south and east facing slopes, as is the case in Wepener. This study also divides the slope vegetation into several communities and sub-communities These are (Note that several botanical name changes has since been implemented though the original naming is used in this instance to better allow for comparison with previous studies):

2 Stoebe plumosa-Leucosidea sericea Major community
- *2.1 Leucosidea sericea-Themeda triandra* Community
- *2.2 Stoebe plumosa- Elionurus muticus* Community
- *2.3 Stoebe plumosa-Peucedanum capense* Community
- *2.4 Cliffortia paucistaminea- Passerina montana* Community
- *2.5 Leucosidea sericea- Pelargonium alchemilloides* Community
- *2.6 Hyparrhenia hirta- Osyris lanceolata* Community
  - *2.6.1 Helichrysum ruglulosum-Leucosidea sericea* Sub-community
  - *2.6.2 Rhus dregeana-Leucosidea sericea* Sub-community

3 Olea europaea- Rhus burchellii Major community
- *3.1 Euclea crispa* subsp. *crispa-Rhus dentata* Community
- *3.2 Clutia pulchella -Diospyros lycioides* Community
  - *3.2.1 Jamesbrittenia atropurpurea- Rhus erosa* Sub-community
  - *3.2.2 Rhus lancea-Celtis africana* Sub-community
- *3.3 Protasparagus suaveolens-Eragrostis lehmanniana* Community
  - *3.3.1 Cymbopogon excavatus-Prtoasparagus suaveolens* Sub-community
  - *3.3.2 Eragrostis curvula- Sutera albiflora* Sub-community
  - *3.3.3 Cheilanthes eckloniana-Tragus koelerioides* Sub-community
  - *3.3.4 Olea europaea- Melianthus comosus* Sub-community
  - *3.3.5 Aloe ferox- Rhigozum obovatum* Community
  - *3.4.1 Aloe ferox- Setaria incrassata* Sub-community
  - *3.4.2 Aloe ferox-Olea europaea* Sub-community
- *3.5 Rhus ciliata- Olea europaea* Community
- *3.6 Euclea crispa* subsp. *ovata- Olea europaea* Community

From the above it is clear that the vegetation type occurring along the steep slopes of the hills to the north and east of Wepener contain a high diversity of vegetation structure, species and habitat diversity and growth form. It is also highly likely that this will also include a higher proportion of protected species. On-site information will however provide a much more accurate description. It is unlikely that these steep slopes will be affected by urban expansion but is situated in close proximity to the town and should be taken into consideration in the spatial planning of Wepener.

Eastern Free State Clay Grassland (Gm 3)

Important Taxa:

Graminoids: *Aristida junciformis* subsp. *galpinii*, *Cymbopogon pospischilii*, *Digitaria monodactyla*, *D. tricholaenoides*, *Elionurus muticus*, *Eragrostis chloromelas*, *E. curvula*, *E. plana*, *E. racemosa*, *Harpochloa falx*, *Heteropogon contortus*, *Hyparrhenia hirta*, *Microchloa caffra*, *Monocymbium ceresiiforme*, *Setaria sphacelata*, *Themeda triandra*, *Tristachya leucothrix*, *Andropogon appendiculatus*, *A. schirensis*, *Aristida congesta*, *A. diffusa*, *Brachiaria serrata*, *Cymbopogon caesius*, *Cynodon dactylon*, *Cyperus obtusiflorus* var. *flavissimus*, *C. obtusiflorus* var. *obtusiflorus*, *Diheteropogon amplectens*, *Ehrharta capensis*, *Eragrostis capensis*, *Helictotrichon natalense*, *H. turgidulum*, *Koeleria capensis*, *Panicum gilvum*, *Setaria nigrirostris*, *Trachypogon spicatus*, *Trichoneura grandiglumis*.

Herbs: *Barleria monticola*, *Berkheya onopordifolia* var. *onopordifolia*, *B. speciosa*, *Dicoma anomala*, *Helichrysum psilolepis*, *Acalypha angustata*, *A. peduncularis*, *Ajuga ophrydis*, *Anthospermum herbaceum*, *Berkheya pinnatifida*, *B. setifera*, *Crabbea acaulis*, *Cycnium racemosum*, *Dianthus basuticus*, *Haplocarpha scaposa*, *Hebenstretia dentata*, *H. dura*, *Helichrysum ammitophilum*, *H. aureonitens*, *H. caespititium*, *H. cephaloideum*, *H. herbaceum*, *H. nudifolium* var. *nudifolium*, *H. nudifolium* var. *pilosellum*, *H. oreophilum*, *H. rugulosum*, *H. spiralepis*, *Hermannia depressa*, *Hirpicium armerioides*, *Ipomoea crassipes*, *I. pellita*, *Kohautia amatymbica*, *Lactuca inermis*, *Nolletia ciliaris*, *Pelargonium luridum*, *Pentanisia prunelloides* subsp. *prunelloides*, *Selago densiflora*, *S. galpinii*, *Senecio coronatus*, *S. erubescens* var. *crepidifolius*, *S. inornatus*, *Sonchus nanus*, *Tolpis capensis*, *Trifolium burchellianum*, *Vernonia natalensis*, *V. oligocephala*.

Geophytic Herbs: *Boophone disticha*, *Crinum bulbispermum*, *Cyrtanthus stenanthus*, *Drimiopsis maculata*, *Eucomis autumnalis* subsp. *autumnalis*, *Gladiolus dalenii*, *G. papilio*, *Hypoxis rigidula* var. *pilosissima*, *Ledebouria ovatifolia*, *Watsonia lepida*, *Xysmalobium involucratum*, *X. undulatum*.

Herbaceous Climber: *Rhynchosia totta*.

Low Shrubs: *Helichrysum melanacme*, *Anthospermum rigidum* subsp. *pumilum*, *Euphorbia striata* var. *cuspidata*, *Gnidia kraussiana*, *Helichrysum dasycephalum*, *Polygala hottentotta*, *Tephrosia capensis* var. *acutifolia*.

Biogeographically Important Taxon (Low Escarpment endemic) Low Shrub: *Heteromma krookii*.

The vegetation type forms the plateau of the hills to the north and east of Wepener and constitute the foothills of the Drakensberg mountain range. It is clearly dominated by grass species with shrubs and trees being completely absent. However, note the relatively high species diversity with a diversity of growth forms and also a quite high proportion of protected species. However, on-site information will provide a much more accurate situation w.r.t. species diversity and it is also highly likely that the amount of protected species will be increased further.

4.1.6.2 Wepener Protected Species

As previously mentioned, the vegetation types around the urban area of Wepener all contain a significant proportion of protected and Red Listed species. These are also of significant conservation value and will therefore increase the sensitivity of open spaces where they occur. Furthermore, when utilising the Plants of South Africa (http://posa.sanbi.org) an analysis of plant species previously recorded in the region includes the following protected and Red Listed species recorded. Additional sources also include numerous studies conducted in this area. The area has not been surveyed as thoroughly as the Bloemfontein area and available data would therefore not be as comprehensive and representative of the area.

Table 8: Protected and Red Listed species recorded for the quarter degree squares (2926DB, 2927CA) (http://posa.sanbi.org).

LC – **Least Concern** A species is Least Concern when it has been evaluated against the IUCN criteria and does not qualify for any of the above categories. Species classified as Least Concern are considered at low risk of extinction. Widespread and abundant species are typically classified in this category.

DDD – **Data Deficient - Insufficient Information (DDD)** A species is DDD when there is inadequate information to make an assessment of its risk of extinction, but the species is well defined. Listing of species in this category indicates that more information is required and that future research could show that a threatened classification is appropriate.

NT – **Near Threatened (NT)** A species is Near Threatened when available evidence indicates that it nearly meets any of the IUCN criteria for Vulnerable and is therefore likely to become at risk of extinction in the near future.

VU – **Vulnerable (VU)** A species is Vulnerable when the best available evidence indicates that it meets at least one of the five IUCN criteria for Vulnerable, indicating that the species is facing a high risk of extinction.

EN – **Endangered (EN)** A species is Endangered when the best available evidence indicates that it meets at least one of the five IUCN criteria for Endangered, indicating that the species is facing a very high risk of extinction.

Gh2 – **Aliwal North Dry Grassland Grassland**

Gm2 – **Eastern Free State Clay Grassland**

Gm5 – **Basotho Montane Shrubland**

FAMILY	Scientific name	Status	Protected	Gh2	Gm3	Gm5
Amaryllidaceae	*Ammocharis coranica*	LC	Y	✔	✔	✔
Amaryllidaceae	*Boophone disticha*	LC	Y	✔	✔	✔
Amaryllidaceae	*Brunsvigia radulosa*	LC	Y	✔	✔	✔
Amaryllidaceae	*Crinum bulbispermum*	LC	Y	✔	✔	
Amaryllidaceae	*Cyrtanthus stenanthus*	LC	Y		✔	
Amaryllidaceae	*Gethyllis transkarooica*	LC	Y	✔	✔	
Amaryllidaceae	*Haemanthus humilis subsp. humilis*	LC	Y			✔
Apocynaceae	*Xysmalobium involucratum*	LC	Y		✔	
Apocynaceae	*Xysmalobium undulatum*	LC	Y		✔	
Asteraceae	*Helichrysum ammitophilum*	LC	Y		✔	
Asteraceae	*Helichrysum aureonitens*	LC	Y		✔	
Asteraceae	*Helichrysum cephaloideum*	LC	Y		✔	
Asteraceae	*Helichrysum dasycephalum*	LC	Y		✔	
Asteraceae	*Helichrysum herbaceum*	LC	Y		✔	
Asteraceae	*Helichrysum melanacme*	LC	Y		✔	
Asteraceae	*Helichrysum niveum*	LC	Y	✔		
Asteraceae	*Helichrysum oreophilum*	LC	Y		✔	
Asteraceae	*Helichrysum psilolepis*	LC	Y		✔	
Asteraceae	*Helichrysum rosum*	LC	Y	✔		
Asteraceae	*Helichrysum spiralepis*	LC	Y		✔	
Hyacinthaceae	*Eucomis autumnalis subsp. autumnalis*	LC	Y		✔	✔
Iridaceae	*Gladiolus dalenii*	LC	Y		✔	
Iridaceae	*Gladiolus papilio*	LC	Y		✔	
Iridaceae	*Gladiolus permeabilis subsp. edulis*	LC	Y		✔	✔
Iridaceae	Watsonia lepida	LC	Y		✔	
Oleaceae	*Olea europaea subsp. cuspidata*	LC	Y			✔

It is clear that the current data for the Wepener region is severely lacking and also points to the need for on-site surveys. Despite this under representative data, a high proportion of protected species are still evident, especially on the plateau vegetation type, Eastern Free State Clay Grassland. It is also highly likely that many other protected species will also occur in this area but has not previously been recorded. Note that no Red Listed species had previously been recorded in this area, though as indicated it has not been thoroughly surveyed and there remains a likelihood that such a species will occur.

A comparison between the different vegetation types and the likelihood that protected species may occur indicate that all vegetation types are likely to contain a significant amount of such species but that the proportion of protected species and also overall diversity increases along the mountainous terrain (Basotho Montane Shrubland) but is highest on the plateau of the Drakensberg foothills (Eastern Free State Clay Grassland). All three vegetation types may therefore still have a significant conservation value although this is likely to increase along the hills and ridges to the north and east of Wepener.

4.1.6.3 Additional data sets

Numerous data sets and mapping resources have been developed to aid in the identification of sensitive areas and areas with a high conservation value, notably those resources developed by the South African National Biodiversity Institute (SANBI). Several of these resources were also combined with the results and discussion of the previous sections to indicate areas within the Botshabelo urban area which should be regarded as sensitive. From these data sets the following conclusions can be made:

National Biodiversity Assessment (NBA) 2018

Remnants of the natural vegetation types in the area indicates that the area is still largely dominated by natural vegetation and that transformation is not extensive. It is also quite clear that urban development and crop cultivation has caused the most significant transformation in this area. As indicated in previous sections, all of the vegetation types in the area contain elements of significant conservation value and therefore all portions of remaining natural vegetation will have a significant level of sensitivity. However, the prominent hills and ridges to the north and east of Wepener clearly contains a higher species and habitat diversity and a higher proportion of protected species. On-site surveys should however provide a more accurate determination of the relative sensitivity and importance of each vegetation type.

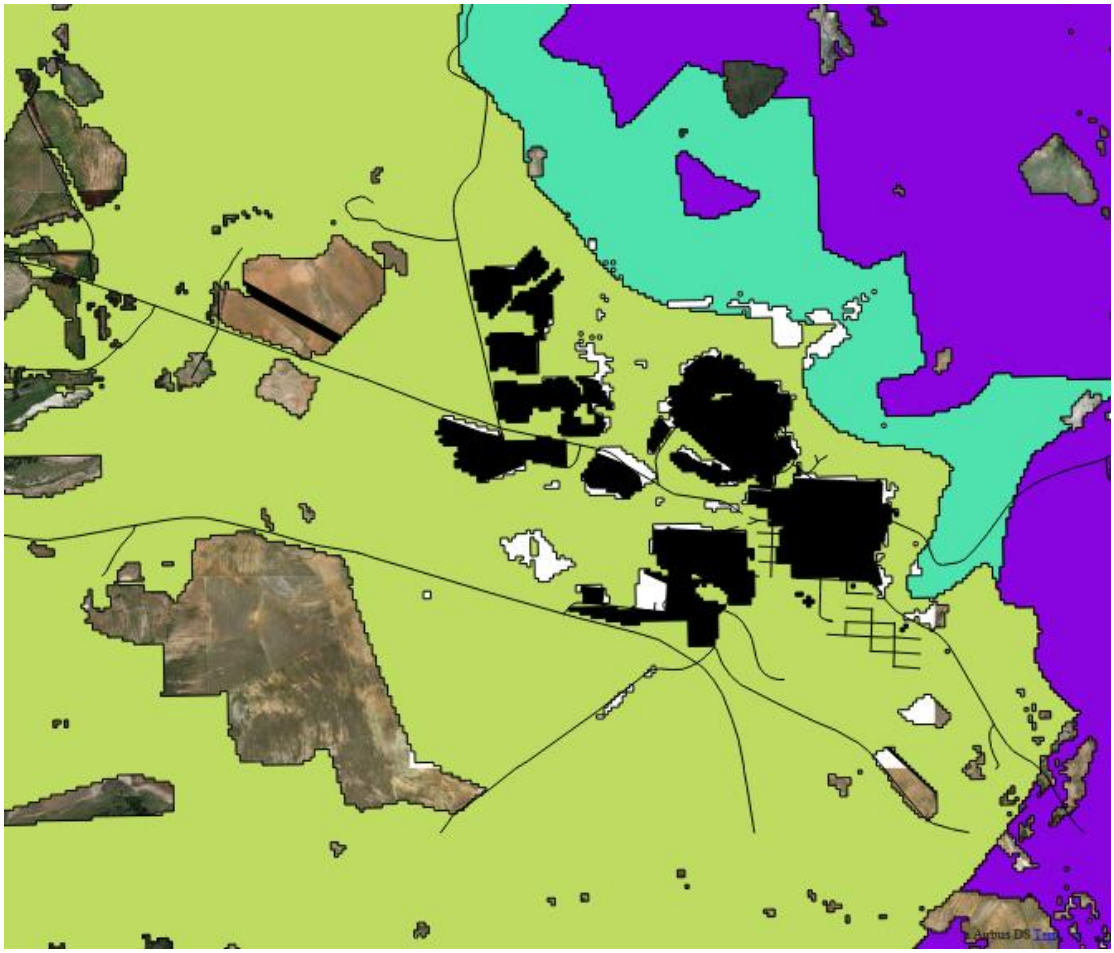
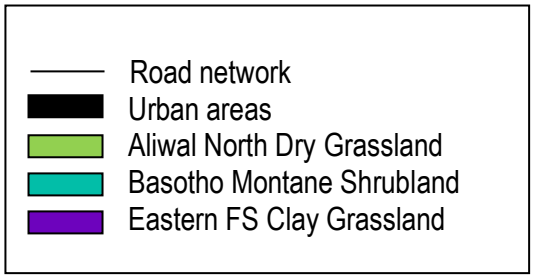


Figure 16: View of the remaining portions of the different vegetation types present in the Wepener urban area. Note extensive natural areas and limited transformation.

Legend:



Free State Biodiversity Management Plan 2015

The Free State Province Biodiversity Management Plan (2015) has been developed and has identified areas which are essential to meeting conservation targets for specific vegetation types, i.e. Critical Biodiversity Areas (CBA), and other elements of high conservation importance.

The majority of vegetation types in this area is widespread, largely intact and therefore of lower conservation value. However, several portions of the Vulnerable (VU) Eastern Free State Clay Grassland on the plateau to the east of Wepener are listed as CBA 1 areas. The vegetation

type is heavily affected by transformation for crop cultivation and also clearly has a quite high species diversity and consequently these CBA 1 areas will have a very high level of sensitivity. It is unlikely that urban expansion will encroach into these though they should still be taken into consideration i.t.o. the spatial planning of Wepener.

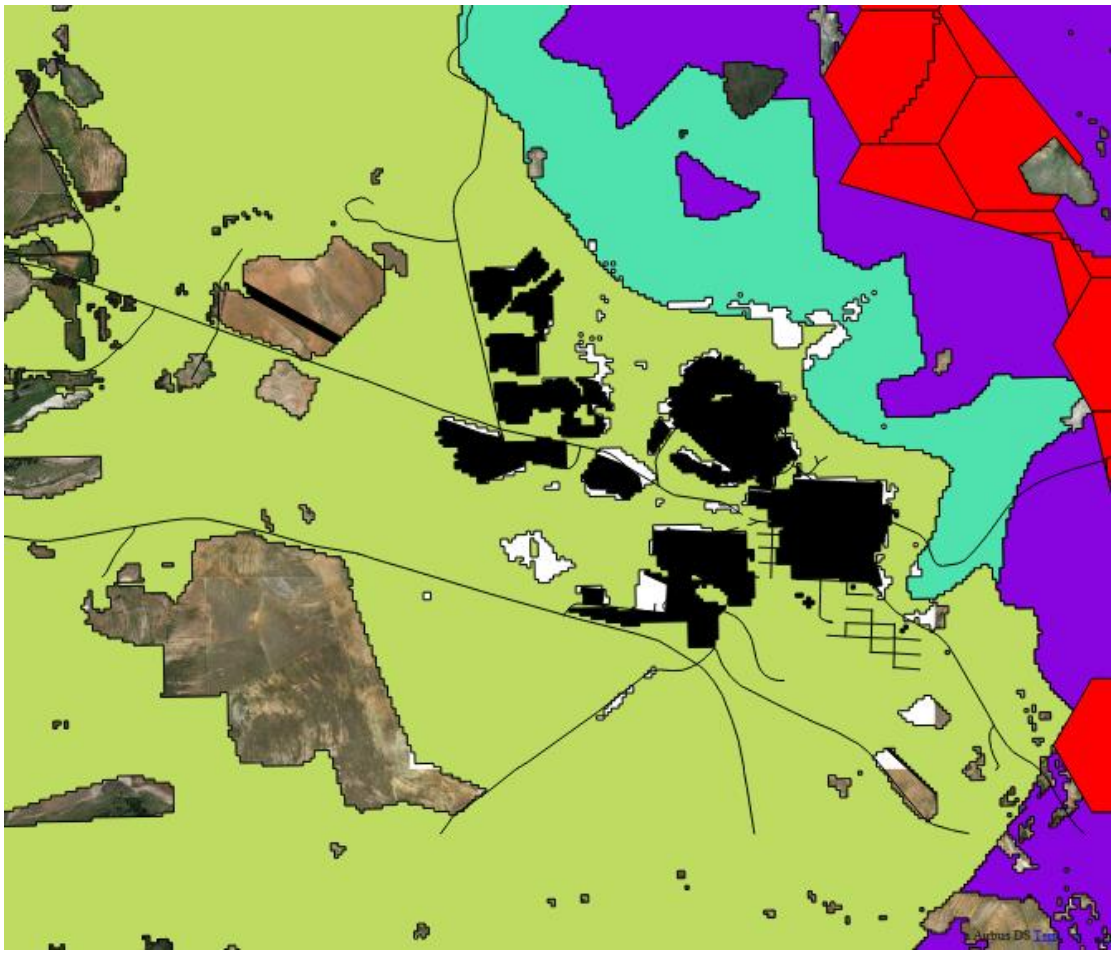
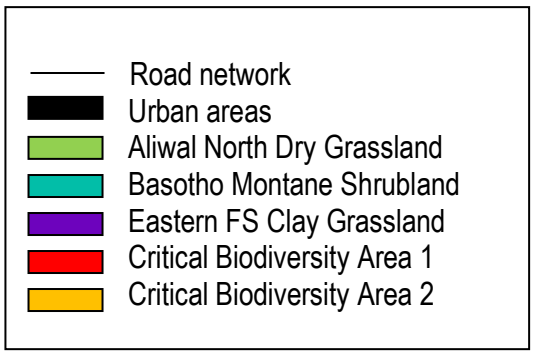


Figure 17: View of CBA 1 and 2 areas in the Wepener urban area overlain over the remaining natural vegetation portions.

Legend:



National Protected Areas Expansion Strategy (NPAES) 2010

As development increases through time, the expansion of protected areas should also be increased. The NPAES has been developed to identify areas which represent areas of natural vegetation in good condition, with significant diversity and in need of increased conservation. These NPAES Focus Areas therefore represent areas with a significant sensitivity.

No NPAES Focus Areas occur near the urban area. This is merely a reflection of the absence of areas considered as likely future protected areas and does not indicate the absence of sensitive areas of high conservation value.

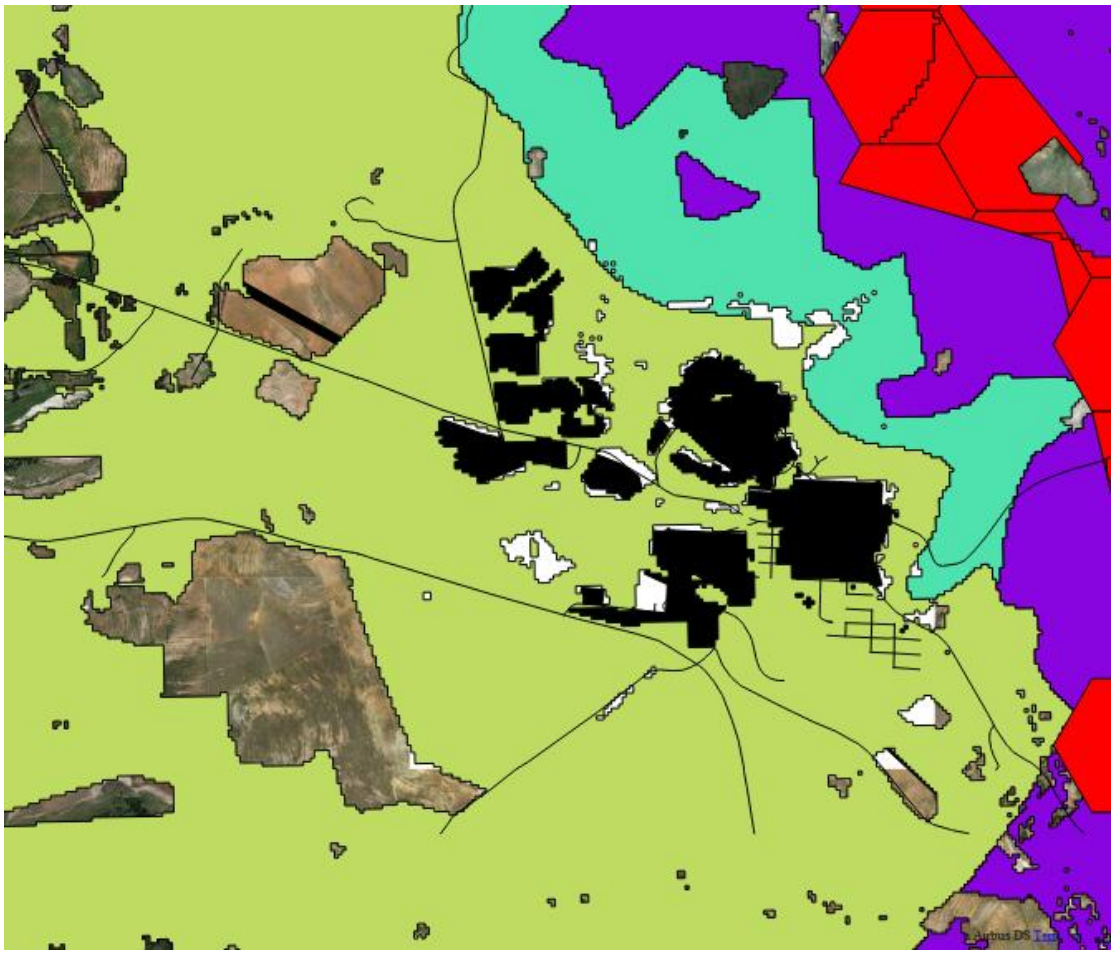
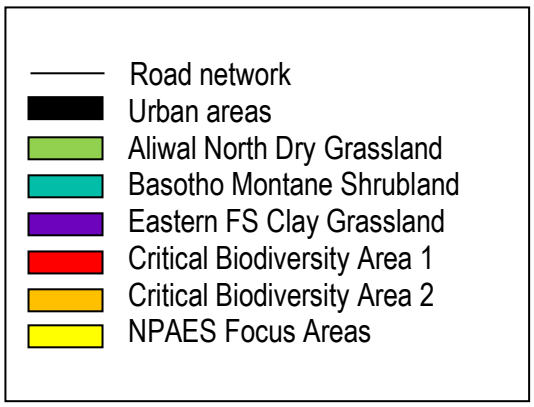


Figure 18: View of the NPAES Focus Areas near the Wepener urban area. Note no NPAES Focus Areas occur in this region.

Legend:



4.1.6.4 Wepener urban area – Conclusions

From the description of the remaining natural vegetation in the Wepener urban area the following elements of ecological importance should be taken into account in the MOSS:

- All three vegetation types contain elements of conservation value and consequently, where natural portions of these vegetation types remain they should be regarded as having a significant conservation value.
- The species and habitat diversity quite clearly increases along the prominent hills and ridges to the north and east of Wepener and these mountainous areas will contain a significantly higher conservation value.
- All three vegetation types are likely to contain numerous protected species though current data is lacking and indicate the need for further on-site assessment.
- It is also prominent that the mountainous vegetation types, Basotho Montane Shrubland and Eastern Free State Clay Grassland, contain a significantly higher proportion of protected species which will also increase their conservation value.
- The Eastern Free State Clay Grasslands are currently listed as a Vulnerable (VU) vegetation type, is under transformation pressure for crop cultivation, and therefore remaining natural portions of this vegetation type will have an increased conservation value.
- In addition, a few areas of this vegetation type to the north east of Wepener is also listed CBA 1 areas which will even further increase its conservation value.
- It is clear that several areas of conservation value occur around Wepener, especially the areas associated with the mountainous terrain to the north and east. It is unlikely that urban expansion will encroach into these areas though they should still be taken into consideration i.t.o. the spatial planning of Wepener.

4.1.7 Vanstadensrus urban area (Appendix A: Map 7)

The town of Van Stadensrus is located 160km south east of Bloemfontein and is one of the frontier towns on the border of South Africa and Lesotho. It is in close proximity to the Egmont and Van Stadensrus Dams, and is on the Anglo-Boer War Route. The urban extent of the town is approximately 190 hectares and should also clearly indicate the small extent of the town. A few small but still prominent stream system occur, including the Witspruit, and flows past the existing urban area of the town. The town forms part of a mostly natural area although the urban areas and surrounding agricultural operations do cause some degradation of the area.

Vanstadensrus is situated within the Grassland Biome and under natural conditions would be dominated by grasses with shrubs and trees being almost completely absent. The exception to this being hills and ridges which provide suitable habitat and climate for shrubs and trees to establish. Watercourses also contain differing soils conditions, climate and moisture regime which enables the establishment of shrubs and trees. Consequently, plains should be dominated by grasses while ridges, hills and watercourses would contain a prominent grass component but also substantial shrub and tree cover. This is also the case for the remaining natural areas comprising the Mangaung MOSS. It is evident that the region of Vanstadensrus is dominated by undulating grasslands, however, low ridges and hills are also abundant and these together with the numerous small watercourses in the area substantially increase the shrub/tree component. The vegetation structure seems to be intact to a large degree though it is likely that exotic trees, especially along watercourses will cause some modification of the

natural structure. As can be expected, the urban area of Vanstadensrus has caused only limited transformation of natural areas and natural grassland is still evident around the town. However, remaining natural areas may still contain significant degradation due to land-use. Overgrazing and -browsing in communal areas may lead to significant degradation of the vegetation and areas utilised for crop cultivation will also cause transformation of the natural vegetation.

Although the landscape is relatively uniform there is still a variation in the topography and includes undulating plains, low ridges and hills, rocky outcrops and numerous small watercourses. This is clearly discerned from aerial imagery. As mentioned the varied topography cause the formation of numerous small watercourses which are incised in the landscape and this significantly increases the habitat diversity. Rocky outcrops, including low hills and ridges are abundant, especially to the north of the town and also increase topographical diversity significantly. Habitats and the vegetation composition is also clearly different from the surrounding plains. The altitude of the Vanstadensrus urban area varies from 1530 m AMSL along the surrounding low hills and decreases to 1430 m along the lower lying watercourses. This represents a difference of 100 m which illustrates a relatively uniform landscape but with a varied topography.

As indicated only limited transformation of the natural environment has occurred. However, several significant impacts are still likely to be present and will have an impact on vegetation and degradation of its condition. Urban developments of Vanstadensrus will result in limited transformation of vegetation but will still be the main impact in the area. Remaining natural areas around the urban development and the main areas of focus of this study will also be affected by several impacts. Around the town several areas which had previously been subjected to crop cultivation has caused transformation of the natural grassland. These are significant though extensive natural areas still dominate the landscape. Dirt tracks and footpaths will cause limited local disturbance but will also provide access to these areas and in many cases exacerbate the impact of illegal dumping which may transform some areas. Another significant impact is overgrazing by domestic livestock. Overgrazing and -browsing and the associated trampling cause a decrease in vegetation cover and an increase in erosion. Where this is severe it may lead to a significant loss in diversity and transformation of the natural vegetation type. This may be especially relevant in communal areas where grazing and browsing does not follow a structured grazing schedule or stocking levels and consequently heavy and sustained overgrazing occurs.

Vanstadensrus is situated in a region experiencing moderate rainfall, with cold, dry winters and moderate summers. Climate for the area can be relatively accurately represented by rainfall and evaporation data from the weather station D2E002 (Wepener). The region receives an average of 568.9 mm per year measured for the period 1956 to 1980. Precipitation occurs mainly during summer, with most rainfall received during January (92.0 mm), February (81.6 mm) and March (86.4 mm). This is considered a moderate rainfall and causes the area to form part of one of the more temperate areas of South Africa.

Vanstadensrus is underlain by the Tarkastad Subgroups of the Beaufort Group consisting of red and greenish-grey mudstones and fine- to medium-grained sandstones. Rocky outcrops, low hills and ridges are characterised by the Karoo Dolerite Suite which consists of a network of dolerite sills, sheets and dykes, mainly intrusive into the Karoo Supergroup

From the description of Vanstadensrus it is clear that the area has a small extent with a relatively uniform landscape but with some variation in the topography including rocky outcrops, low hills and ridges and numerous small watercourses. This also contributes to some diversity in terms of habitat and vegetation types. The area is dominated by natural areas though the impact in many areas may still be significant.

4.1.7.1 Vastadensrus Vegetation Types

Due to the relatively uniform topography, although some habitat diversity is evident, and smaller extent of the urban area of Vanstadensrus, it contains only two different vegetation types. According to Mucina & Rutherford (2006), the study area includes Aliwal North Dry Grassland (Gh 2) and Besemkaree Koppies Shrubland (Gh 4). According to the National Environmental Management: Biodiversity Act, 2004 (Act No. 10 of 2004) these are both currently listed as being of Least Concern (LC).

The distinction and border between these vegetation types are easily discernible by means of both the topography and vegetation structure. Aliwal North Dry Grassland is confined to lower lying undulating plains and is dominated by a well-developed grass layer but with a prominent dwarf karroid shrub component. In contrast, Besemkaree Koppies Shrubland is confined to the low hills and ridges and also contains a prominent shrub/tree layer. A clear distinction is therefore evident between these vegetation types.

In the absence of a site survey a general description of the vegetation composition is given as obtained from Mucina & Rutherford (2006) and other previous vegetation studies. This is by no means a comprehensive description of the vegetation but should give a general description.

Aliwal North Dry Grassland (Gh 2)

Important Taxa:

Graminoids: *Aristida adscensionis*, *A. congesta*, *Cymbopogon pospischilii*, *Cynodon incompletus*, *Elionurus muticus*, *Eragrostis chloromelas*, *E. lehmanniana*, *E. obtusa*, *Heteropogon contortus*, *Microchloa caffra*, *M. kunthii*, *Setaria sphacelata*, *Themeda triandra*, *Tragus koelerioides*, *Aristida diffusa*, *Cynodon dactylon*, *Cyperus usitatus*, *Digitaria eriantha*, *Eragrostis capensis*, *E. curvula*, *E. plana*, *Helictotrichon turgidulum*, *Sporobolus fimbriatus*, *Tetrachne dregei*, *Trichoneura grandiglumis*, *Triraphis andropogonoides*.

Herbs: *Berkheya onopordifolia* var. *onopordifolia*, *Galium capense* subsp. *capense*, *Gazania krebsiana* subsp. *krebsiana*, *Helichrysum rugulosum*, *Hermannia coccocarpa*, *Indigofera alternans*, *Jamesbrittenia aurantiaca*, *Lotononis listii*, *Nolletia ciliaris*, *Pseudognaphalium luteo-album*, *Salvia stenophylla*, *Selago densiflora*, *Trichogyne verticillata*.

Geophytic Herb: *Oxalis depressa*.

Low Shrubs: *Helichrysum dregeanum*, *Pentzia globosa*, *Anthospermum rigidum* subsp. *pumilum*, *Atriplex semibaccata* var. *appendiculata*, *Berkheya annectens*, *Chrysocoma ciliata*, *Euryops annae, E. oligoglossus* subsp. *oligoglossus, Felicia muricata*, *Helichrysum niveum*, *H. rosum*, *Nenax microphylla*, *Selago saxatilis*, *Senecio burchellii*.

The vegetation type is clearly dominated by grass species with shrubs and trees being completely absent. However, note that a prominent and also dominant dwarf shrub component is also present. From desktop information a moderate species diversity is likely and though no protected species are apparent it is highly likely that at least a few will be present. Furthermore, on-site information will provide a much more accurate situation w.r.t. species diversity and it is also highly likely that the amount of protected species will be increased substantially.

Besemkaree Koppies Shrubland (Gh 4)

Important Taxa:

Small Trees: *Cussonia paniculata*, *Ziziphus mucronata*. Tall Shrubs: *Diospyros austro-africana*, *Euclea crispa* subsp. *ovata*, *Olea europaea* subsp. *africana*, *Rhus burchellii*, *R. ciliata*, *R. erosa*, *Buddleja saligna*, *Diospyros lycioides* subsp. *lycioides*, *Ehretia rigida*, *Grewia occidentalis*, *Gymnosporia polyacantha*, *Tarchonanthus minor*.

Low Shrubs: *Asparagus suaveolens*, *Chrysocoma ciliata*, *Amphiglossa triflora, Aptosimum elongatum, Asparagus striatus, Diospyros pallens, Eriocephalus ericoides, E. spinescens, Euryops empetrifolius, Felicia filifolia subsp. filifolia, F. muricata, Helichrysum dregeanum, H. lucilioides, Hermannia multiflora, H. vestita, Lantana rugosa, Limeum aethiopicum, Lycium cinereum, Melolobium candicans, M. microphyllum, Nenax microphylla, Pegolettia retrofracta, Pentzia globosa, Rhigozum obovatum, Selago saxatilis, Stachys linearis, S. rugosa, Sutera halimifolia, Wahlenbergia albens.*

Succulent Shrubs: Aloe broomii, Chasmatophyllum musculinum, C. verdoorniae, Cotyledon orbiculata var. dactylopsis, Pachypodium succulentum.

Graminoids: Aristida adscensionis, A. congesta, A. diffusa, Cenchrus ciliaris, Cymbopogon caesius, Cynodon incompletus, Digitaria eriantha, Eragrostis curvula, E. lehmanniana, Heteropogon contortus, Setaria lindenbergiana, Themeda triandra, Tragus koelerioides, Cymbopogon pospischilii, Enneapogon scoparius, Eragrostis chloromelas, E. obtusa, Eustachys paspaloides, Fingerhuthia africana, Hyparrhenia hirta, Sporobolus fimbriatus.

Herbs: Convolvulus sagittatus, Dianthus caespitosus subsp. caespitosus, Gazania krebsiana subsp. krebsiana, Hibiscus pusillus, Indigofera alternans, I. rhytidocarpa, Lepidium africanum subsp. africanum, Pollichia campestris.

Herbaceous Climber: Argyrolobium lanceolatum.

Geophytic Herbs: Albuca setosa, Asplenium cordatum, Cheilanthes bergiana, C. eckloniana, Freesia andersoniae, Haemanthus humilis subsp. humilis, Oxalis depressa, Pellaea calomelanos.

Succulent Herbs: Aloe grandidentata, Crassula nudicaulis, Duvalia caespitosa, Euphorbia pulvinata, Huernia piersii, Stapelia grandiflora, S. olivacea, Tridentea gemmiflora.

The vegetation type is clearly dominated by a shrub/trees layer but also with a well-developed grass layer. Note that a significant species diversity is evident consisting of a diversity of different growth forms. A significant proportion of protected species are also clearly evident. On-site information will however provide a much more accurate description. Nonetheless, from

available information it is highly likely that natural remaining portions of this vegetation type will have a significant conservation value.

4.1.7.2 Vanstadensrus Protected Species

As previously mentioned, the vegetation types around the urban area of Vanstadensrus both contain some protected and Red Listed species. These are also of significant conservation value and will therefore increase the sensitivity of open spaces where they occur. Furthermore, when utilising the Plants of South Africa (http://posa.sanbi.org) an analysis of plant species previously recorded in the region includes the following protected and Red Listed species recorded. Additional sources also include numerous studies conducted in this area. The area has not been surveyed as thoroughly as the Bloemfontein area and available data would therefore not be as comprehensive and representative of the area.

Table 9: Protected and Red Listed species recorded for the quarter degree squares (2926DD, 2927CC, 3027AA) (http://posa.sanbi.org).

LC – **Least Concern** A species is Least Concern when it has been evaluated against the IUCN criteria and does not qualify for any of the above categories. Species classified as Least Concern are considered at low risk of extinction. Widespread and abundant species are typically classified in this category.

DDD – **Data Deficient - Insufficient Information (DDD)** A species is DDD when there is inadequate information to make an assessment of its risk of extinction, but the species is well defined. Listing of species in this category indicates that more information is required and that future research could show that a threatened classification is appropriate.

NT – **Near Threatened (NT)** A species is Near Threatened when available evidence indicates that it nearly meets any of the IUCN criteria for Vulnerable and is therefore likely to become at risk of extinction in the near future.

VU – **Vulnerable (VU)** A species is Vulnerable when the best available evidence indicates that it meets at least one of the five IUCN criteria for Vulnerable, indicating that the species is facing a high risk of extinction.

EN – **Endangered (EN)** A species is Endangered when the best available evidence indicates that it meets at least one of the five IUCN criteria for Endangered, indicating that the species is facing a very high risk of extinction.

Gh2 – **Aliwal North Dry Grassland**

Gh4 – **Besemkaree Koppies Shrubland**

FAMILY	Scientific name	Status	Protected	Gh2	Gh4
Amaryllidaceae	*Haemanthus humilis subsp. humilis*	LC	Y		✔
Apocynaceae	*Brachystelma duplicatum*	LC	Y	✔	✔
Apocynaceae	*Duvalia caespitosa*	LC	Y		✔
Apocynaceae	*Huernia piersii*	LC	Y		✔
Apocynaceae	*Stapelia grandiflora*	LC	Y		✔
Apocynaceae	*Stapelia olivacea*	LC	Y		✔
Apocynaceae	*Tridentea gemmiflora*	LC	Y		✔
Asphodelaceae	*Aristaloe aristata*	LC	Y		✔
Asphodelaceae	*Aloe grandidentata*	LC	Y		✔
Asteraceae	*Helichrysum niveum*	LC	Y	✔	
Asteraceae	*Helichrysum rosum*	LC	Y	✔	
Asteraceae	*Helichrysum rutilans*	LC	Y	✔	✔
Asteraceae	*Helichrysum splendidum*	LC	Y	✔	✔
Euphorbiaceae	*Euphorbia pulvinata*	LC	Y		✔
Iridaceae	*Freesia andersoniae*	LC	Y		✔
Iridaceae	*Gladiolus ecklonii*	LC	Y	✔	✔
Oleaceae	*Olea europaea subsp. cuspidata*	LC	Y		

It is evident that the current data for Vanstadensrus is not comprehensive and will have to be supplemented by comprehensive on-site surveys to supplement the available data. Despite the under representative data it is already evident that the area contains numerous species of conservation importance of which many are considered to be relatively rare. It is highly likely

that many other protected species will also occur in this area but has not previously been recorded.

Although data is lacking it is already clear that low hills and ridges containing rocky outcrops will contain a significantly higher proportion of protected species than the lower lying undulating plains.

4.1.5.3 Additional data sets

Numerous data sets and mapping resources have been developed to aid in the identification of sensitive areas and areas with a high conservation value, notably those resources developed by the South African National Biodiversity Institute (SANBI). Several of these resources were also combined with the results and discussion of the previous sections to indicate areas within the Botshabelo urban area which should be regarded as sensitive. From these data sets the following conclusions can be made:

National Biodiversity Assessment (NBA) 2018

Remnants of the natural vegetation types in the area indicates that the area is still largely dominated by natural vegetation. However, note that agricultural cropfields has transformed significant portions of the vegetation here. Urban transformation is clearly not extensive but is still regarded as a significant impact. As indicated in previous sections, all of the vegetation types in the area contain elements of significant conservation value and therefore all portions of remaining natural vegetation will have a significant level of sensitivity. Low hills and ridges to the north and east of the town is likely to contain a higher diversity of species, habitat and protected species. This will however only be confirmed by on-site surveys.

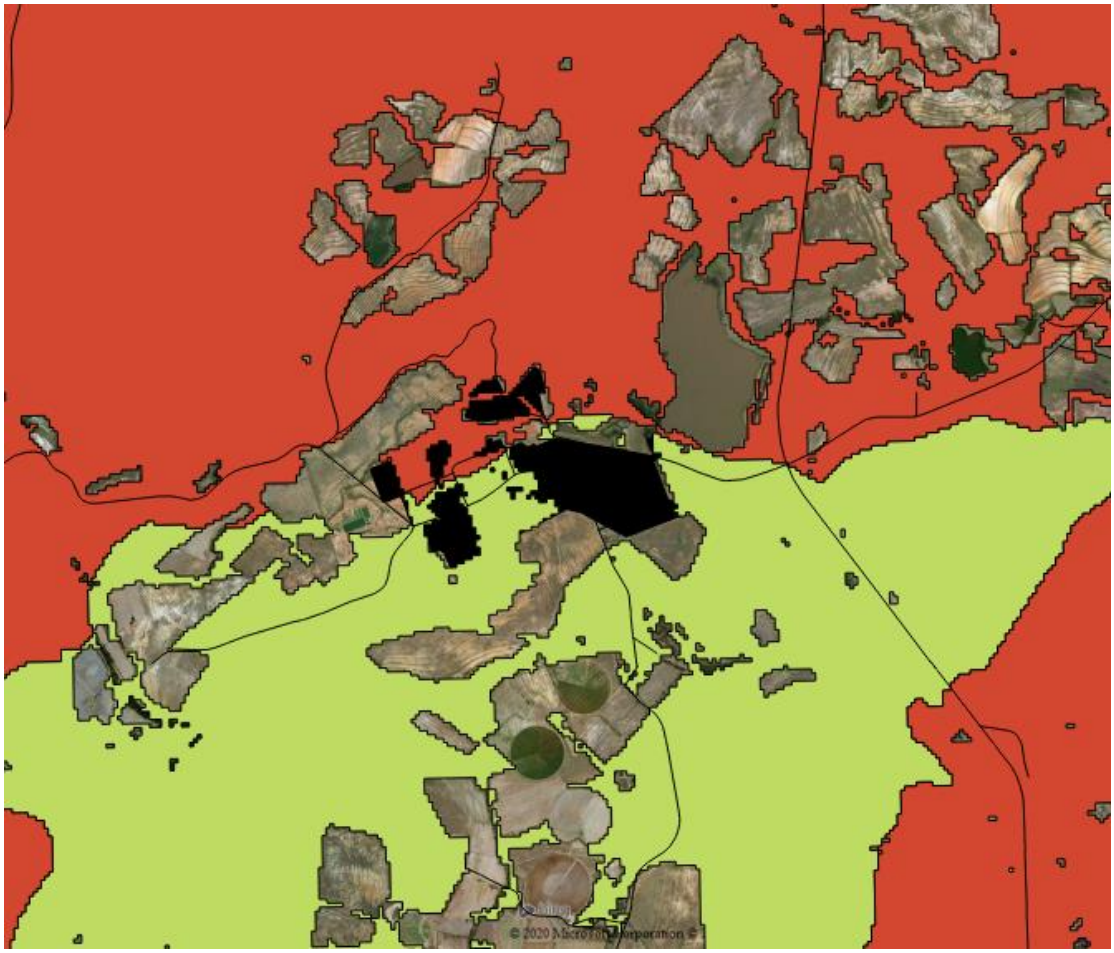
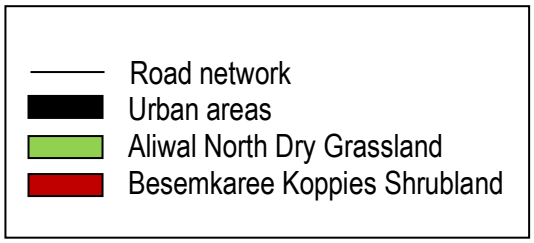


Figure 19: View of the remaining portions of the different vegetation types present in the Vanstadensrus urban area. Note extensive natural areas although agriculture has also transformed significant portion.

Legend:



Free State Biodiversity Management Plan 2015

The Free State Province Biodiversity Management Plan (2015) has been developed and has identified areas which are essential to meeting conservation targets for specific vegetation types, i.e. Critical Biodiversity Areas (CBA), and other elements of high conservation importance.

The majority of vegetation types in this area is widespread, largely intact and therefore of lower conservation value. However, an extensive area of Critical Biodiversity Area 1 (CBA 1) occurs to the east and south of the town. The reasons for this area being considered a CBA is not

clearly apparent and determining the sensitivity of these areas should also form part of the on-site surveys. Whatever the case may be, for the time being these CBA areas must be regarded as highly sensitive and should be avoided by spatial planning.

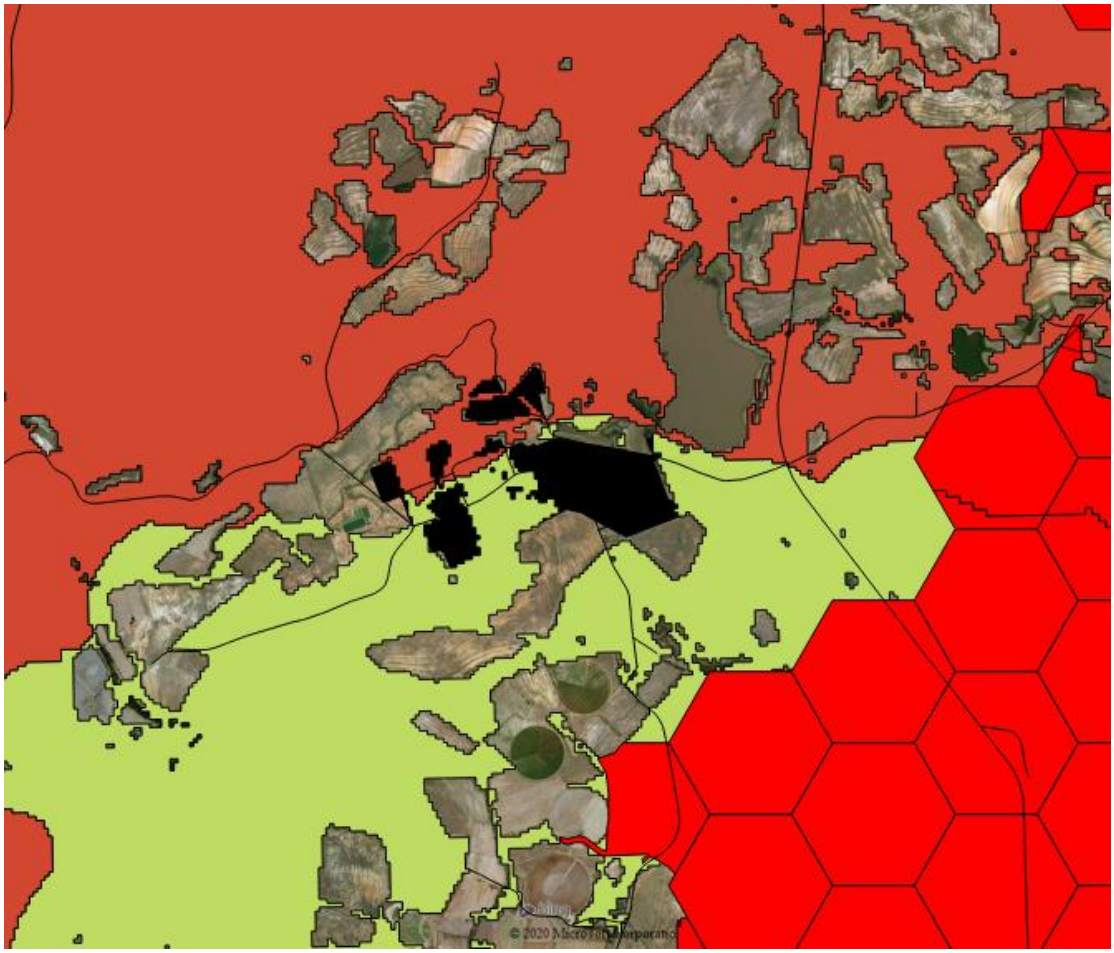
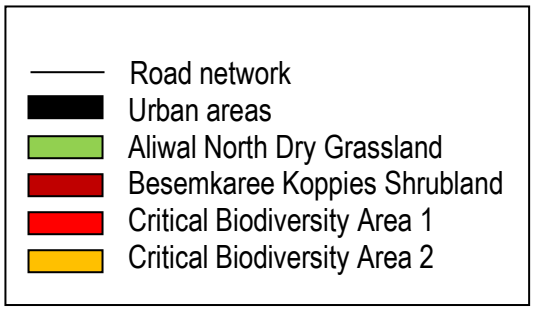


Figure 20: View of CBA 1 and 2 areas in the Vanstadensrus urban area overlain over the remaining natural vegetation portions.

Legend:



National Protected Areas Expansion Strategy (NPAES) 2010

As development increases through time, the expansion of protected areas should also be increased. The NPAES has been developed to identify areas which represent areas of natural vegetation in good condition, with significant diversity and in need of increased conservation. These NPAES Focus Areas therefore represent areas with a significant sensitivity.

No NPAES Focus Areas occur near the urban area. This is merely a reflection of the absence of areas considered as likely future protected areas and does not indicate the absence of sensitive areas of high conservation value.

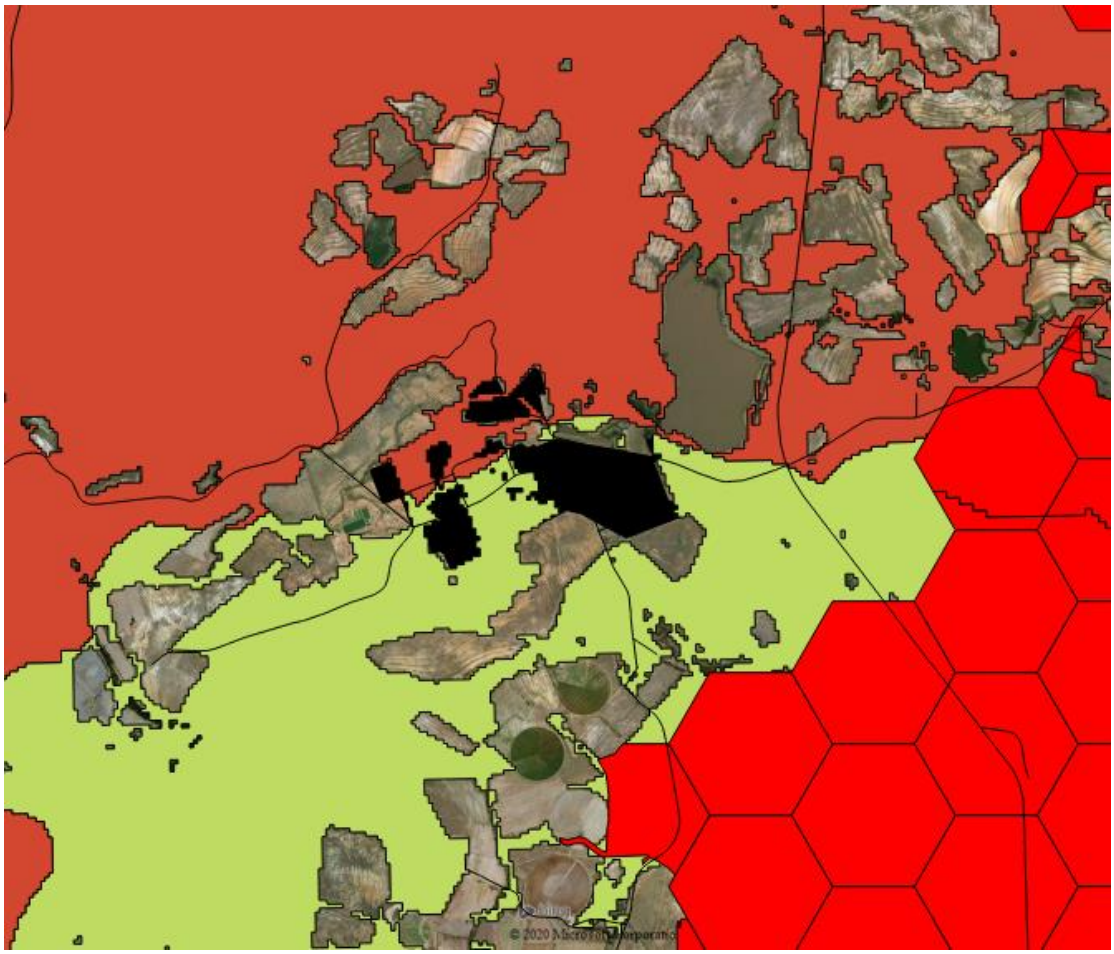
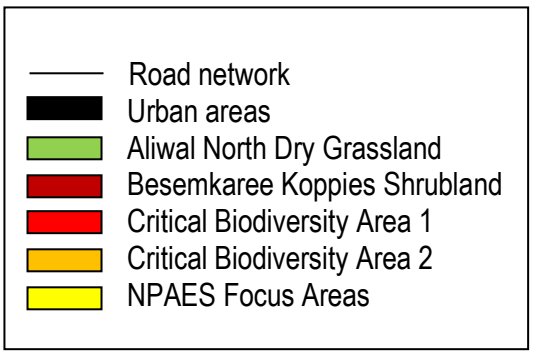


Figure 21: View of the NPAES Focus Areas near the Vanstadensrus urban area. Note no NPAES Focus Areas occur in this region.

Legend:



4.1.7.4 Vanstadensrus urban area – Conclusions

From the description of the remaining natural vegetation in the Vanstadensrus urban area the following elements of ecological importance should be taken into account in the MOSS:

- Both vegetation types contain elements of conservation value and consequently, where natural portions of these vegetation types remain they should be regarded as having a significant conservation value.
- Both vegetation types are likely to contain numerous protected species though current data is lacking and indicate the need for further on-site assessment. It is seems also evident that the hills and ridges the north and east of the town is likely to contain a higher diversity of species, habitat and protected species which increase its conservation value.
- Although neither of the vegetation types are considered threatened a large portion to the east and south of the town is regarded as a CBA 1 area and will therefore have a high level of sensitivity.
- The reason for this CBA 1 area is not clearly apparent and comprehensive on-site surveys should be conducted.
- Whatever the case may be, for the time being these CBA areas must be regarded as highly sensitive and should be avoided by spatial planning.

4.2 Wetland Assessment

4.2.1 Wetland and watercourse indicators

The study area consists of the urban areas of Bloemfontein, Botshabelo, Thaba Nchu, Soutpan, Dewetsdorp, Wepener and Vanstadensrus. From current mapping resources it is clear that these areas are drained by several large and significant watercourses. Some of these larger watercourses include the Renosterspruit, Bloemspruit, Seven-Dams Stream, Klein-Modder River, Sepane River, Modder River, Caledon River and Witspruit (Appendix A: Map 1-7). It is however not possible from a desktop assessment perspective to determine if wetland conditions are present in these and therefore, they must all be assumed to contain wetland conditions.

Available mapping resources and previous studies in the surrounding areas will be utilised to provide a basic description of the study area (Appendix A: Map 1-7).

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

Watercourse means:

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

Riparian habitat is an accepted indicator of watercourses used to delineate the extent of wetlands, rivers, streams and pans (Department of Water Affairs and Forestry 2005). In the absence of a site survey the delineation of the border of the riparian zone is however not possible and the regulated area (DWS 2016) should be used:

"regulated area of a watercourse" for section 21(c) or (i) of the Act water uses in terms of this Notice means:
(a) The outer edge of the 1 in 100 year flood line and /or delineated riparian habitat, whichever is the greatest distance, measured from the middle of the watercourse of a river, spring, natural channel, lake or dam;
(b) In the absence of a determined 1 in 100 year flood line or riparian area **the area within 100m from the edge of a watercourse** where the edge of the watercourse is the first identifiable annual bank fill flood bench (subject to compliance to section 144 of the Act); or
(c) **A 500 m radius from the delineated boundary (extent) of any wetland or pan**.

In the absence of a site survey the following guidelines and frameworks will be used to give background information in terms of delineation of the watercourses and wetlands in the study area:

- Department of Water Affairs and Forestry. 2005. A practical field procedure for identification and delineation of wetlands and riparian areas. Edition 1. Department of Water Affairs and Forestry, Pretoria.

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

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

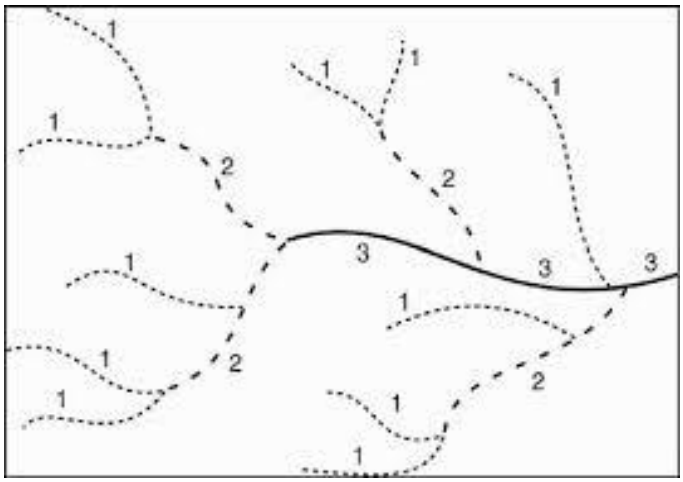


Figure 22: The classification of stream orders from 1 to 3 (Strahler 1952)

A summary of the larger watercourses in these urban areas are given below (Table 10).

Table 10: Summary of larger watercourses in the urban areas of the Mangaung Metropolitan Municipality (See also Appendix A: Map 1-7).

Urban Area	Watercourse	Order	Flow Regime
Bloemfontein	Renosterspruit	3	Perennial
Bloemfontein	Bloemspruit	3	Perennial
Bloemfontein	Seven Dams Stream	1	Seasonal
Botshabelo	Klein-Modder River	3	Seasonal
Thaba Nchu	Sepane River	1	Seasonal
Thaba Nchu	Korannaspruit	1	Perennial
Dewetsdorp	Modder River	1	Perennial
Wepener	Caledon River	4	Perennial
Wepener	Sandspruit	2	Seasonal
Vanstadensrus	Witspruit	2	Seasonal

From previous studies conducted in and around these urban areas (Dingaan *et al* 2000, Janecke *et al* 2003, Pretorius 1996, Koning & Roos 1999, Malan *et al* 1999, Van Rensburg 2009 – 2020) it is clear that numerous rivers, streams, drainage lines and pan systems occur in the area which clearly contain wetland conditions.

From these studies it is clear that the watercourses and wetlands in these urban areas are diverse in terms of their geomorphology, flow and flooding regimes and riparian vegetation composition. These studies also illustrate a few of the different vegetation communities associated with the watercourses and wetlands in the area and include:

Bloemfontein, Botshabelo, Thaba Nchu and Soutpan:

1. Salix mucronata - Cyperus marginatus Major Community
- *1.1 Salix mucronata - Conium chaerophylloides* Community
- *1.2 Salix mucronata - Alchemilla elongata* Community

2. Cyperus longus - Paspalum dilatatum Major Community
- *2.1 Cyperus longus - Rumex lanceolatus* Community
- *2.2 Eragrostis micrantha - Diplachne fusca* Community
- *2.3 Cyperus longus - Mariscus congestus* Community
  - *2.3.1 Polygonum aviculare - Alternanthera sessilis* Sub-community
  - *2.3.2 Agrostis lachnantha - Polypogon monspeliensis* Sub-community

3. Acacia karroa - Asparagus laricinus Major Community
- *3.1 Themeda triandra - Atriplex semibaccata* Community
- *3.2 Acacia karroo - Rhus pyroides* Community
- *3.3 Acacia karroo - Cynodon hirsutus* Community
  - *3.3.1 Acacia karroo - Aristida congesta* Sub-community
    - *3.3.1.1 Sporobolus limbriatus* Variant
    - *3.3.1.2 Rhus lancea* Variant
  - *3.3.2 Acacia karroo - Altemanthera pungens* Sub-community
- *3.4 Acacia karroo - Rhus lancea* Community

Pan systems, including the large salt pan in Soutpan:

1. *Cynodon transvaalensis–Gnaphalium declinatum* community
- 1.1 *Hemarthria altissima–Cyperus denudatus* subcommunity
- 1.2 *Selago dinteri–Cynodon transvaalensis* subcommunity
- 1.3 *Panicum schinzii–Cynodon transvaalensis* subcommunity
- 1.4 *Portulaca oleracea–Cynodon dactylon* subcommunity
- 1.5 *Eleusine coracana–Cynodon dactylon* subcommunity

2.*Diplachne fusca–Eragrostis bicolor* community
- 2.1 *Diplachne fusca* subcommunity
- 2.2 *Eragrostis bicolor–Diplachne fusca* subcommunity
  - 2.2.1 *Polygonum aviculare–Eragrostis bicolor* variant
  - 2.2.2 *Sporobolus ioclados–Eragrostis bicolor* variant

3. *Helictotrichon turgidulum–Phyla nodiflora* community

4.*Juncus rigidus* community
- 4.1 *Cyperus bellus–Eragrostis biflora* subcommunity
- 4.2 *Cynodon transvaalensis–Juncus rigidus* subcommunity
- 4.3 *Digitaria eriantha–Selago dinteri* subcommunity
- 4.4 *Phragmites australis–Juncus rigidus* subcommunity

5.*Sporobolus virginicus* community.

Southern Free State, including Dewetsdorp, Wepener and Vanstadensrus:

1. *Acacia karroo-Protasparagus laricinus* Major Community
- 1.1 *Acacia karroo-Salix babylonica* Community
- 1.2 *Ziziphus mucronata-Protasparagus laricinus* Community
  - 1.2.1 *Rhus pyroides-Lycium hirsutum* Sub-community
    - 1.2.1.1*Setaria verticillata -Chenopodium* album Variant
    - 1.2.1.2 *Crassula lanceolata-Acacia karroo* Variant

1.2.1.3 *Rhus pyroides-Protasparagus laricinus* Variant
1.2.2 *Heteromorpha trifoliata-Nidorella resedifolia* Sub-Community
2. *Rhus lancea-Rhus burchellii* Major Community
2.1 *Olea europaea-Rhus lancea* Community
2.2 *Rhus erosa-Rhus lancea* Community
2.2.1 *Diospyros austro-africana-Rhus lancea* Sub-community
2.2.2 *Heteropogon contortus-Rhus lancea* Sub-community
2.3 *Euclea crispa-Rhus lancea* Community

4.2.2 Classification of wetland systems

The wetland systems which may likely occur in the study areas and which will be associated with the watercourses as listed in the previous section may be classified into numerous different wetland types. In the absence of a site-survey these types cannot be determined with accuracy but the likely wetland systems to occur may include the following:

The wetland conditions along the main channel of larger stream and rivers may be characterised as a channel wetland (SANBI 2009):

Channel (river, including the banks): an open conduit with clearly defined margins that (i) continuously or periodically contains flowing water, or (ii) forms a connecting link between two water bodies. Dominant water sources include concentrated surface flow from upstream channels and tributaries, diffuse surface flow or interflow, and/or groundwater flow. Water moves through the system as concentrated flow and usually exits as such but can exit as diffuse surface flow because of a sudden change in gradient. Unidirectional channel-contained horizontal flow characterises the hydrodynamic nature of these units. Note that, for purposes of the classification system, channels generally refer to rivers or streams (including those that have been canalised) that are subject to concentrated flow on a continuous basis or periodically during flooding, as opposed to being characterised by diffuse flow (see unchanneled valley-bottom wetland). As a result of the erosive forces associated with concentrated flow, channels characteristically have relatively obvious active channel banks. At Level 4A of the classification system, the entire active channel (including wetlands occurring on the banks, i.e. in the riparian zone) is treated as a unit.

This wetland type is likely to occur along the channel of almost all the larger stream and river systems where sufficient flow and soil saturation occurs but will only occur in the lowland plains. It will most likely be absent in mountainous or hill terrain where valley bottom wetlands will be more likely to occur.

The wetland conditions adjacent to larger stream and rivers may be characterised as a floodplain wetland (SANBI 2009):

A floodplain wetland and lowland river floodplain: the mostly flat or gently sloping wetland area adjacent to and formed by a lowland floodplain river and subject to periodic inundation by overtopping of the channel bank of the river. The location of the wetland adjacent to the river in the lowland floodplain zone is the key criterion for distinguishing a floodplain wetland from a channelled valley-bottom wetland. Water and sediment input to floodplain wetland areas is mainly via overtopping of a major channel, although there could be some overland or subsurface flow from adjacent valley side-slopes (if present). Water movement through the wetland is dominantly horizontal and bidirectional, in the form of diffuse surface flow and

interflow, although there can be significant temporary containment of water in depressional areas (within which water movement is dominantly vertical and bidirectional). Water generally exits as diffuse surface flow and/or interflow, but infiltration and evaporation of water from a floodplain wetland can also be significant, particularly if there are a number of depressional areas within the wetland.

This is highly likely to occur but will likely be confined to the larger lowland river systems where flooding events are sufficient to overtop the main channel.

Smaller streams and drainage lines in more mountainous and hill terrain are likely to be characterised as valley bottom wetlands with a channel (SANBI 2009):

A mostly flat valley-bottom wetland dissected by and typically elevated above a channel (see channel). Dominant water inputs to these areas are typically from the channel, either as surface flow resulting from overtopping of the channel bank/s or as interflow, or from adjacent valley-side slopes (as overland flow or interflow). Water generally moves through the wetland as diffuse surface flow, although occasional, short-lived concentrated flows are possible during flooding events. Small depressional areas within a channelled valley-bottom wetland can result in the temporary containment and storage of water within the wetland. Water generally exits in the form of diffuse surface flow and interflow, with the infiltration and evaporation of water from these wetlands also being potentially significant (particularly from depressional areas). The hydrodynamic nature of channelled valley-bottom wetlands is characterised by bidirectional horizontal flow, with limited vertical fluctuations in depressional areas.

This may be likely to occur along smaller streams situated along more mountainous and hill terrain. It may therefore occur in all of the MOSS urban areas but will be much more prevalent in the eastern and southern urban areas (Botshabelo, Thaba Nchu, Wepener, Vanstadensrus) where mountainous and hill terrain is much more prominent. There is also a likelihood that unchanneled valley bottom wetlands may occur which are very similar to channelled valley bottom systems but is anticipated to be much fewer.

Several pan systems occur, especially around Bloemfontein and Soutpan, and these can be categorised as depression wetlands (SANBI 2009):

A depression wetland is a basin shaped area with a closed elevation contour with an increase in depth from the perimeter to the central areas that allows for the accumulation of surface water (i.e. it is inward draining). It may also receive sub-surface water. An outlet is usually absent. Dominant water sources are precipitation, ground water discharge, interflow and (diffuse or concentrated) overland flow. For ‘depressions with channelled inflow’, concentrated overland flow is typically a major source of water for the wetland, whereas this is not the case for ‘depressions without channelled inflow’. Dominant hydrodynamics are (primarily seasonal) vertical fluctuations. Depressions may be flatbottomed (in which case they are often referred to as ‘pans’) or round-bottomed (in which case they are often referred to as ‘basins’) and may have any combination of inlets and outlets or lack them completely. For ‘exorheic depressions’, water exits as concentrated surface flow while, for ‘endorheic depressions’, water exits by means of evaporation and infiltration.

These are clearly present in the MOSS urban areas and although the majority is visible around Bloemfontein and Soutpan the other urban areas are also likely to contain such systems. The

Soutpan pan system is especially large and prominent and additional on-site surveys of this system should also be conducted.

Both hillslope seeps and valley-head seeps are likely to occur but will most likely only be found on the more prominent mountains and hills (SANBI 2009):

Hillslope seep: a wetland area located on (gently to steeply) sloping land, which is dominated by the colluvial (i.e. gravity-driven), unidirectional movement of material down-slope. Water inputs are primarily from groundwater or precipitation that that enters the wetland from an up-slope direction in the form of subsurface flow. Water movement through the wetland is mainly in the form of interflow, with diffuse overland flow ('sheetwash') often being significant during and after rainfall events. Water leaves a 'hillslope seep with channelled outflow' mostly by means of concentrated surface flow, whereas water leaves a 'hillslope seep without channelled outflow' by means of a combination of diffuse surface flow, interflow, evaporation and infiltration (as distinguished at Level 4C).
Valley-head seep: gently-sloping, typically concave wetland area located on a valley floor at the head of a drainage line, with water inputs mainly from subsurface flow (although there is usually also a convergence of diffuse overland water flow in these areas during and after rainfall events). Horizontal, unidirectional (down-slope) movement of water in the form of interflow and diffuse surface flow dominates within a valleyhead seep, while water exits at the downstream end as concentrated surface flow where the valleyhead seep becomes a channel.

These wetland types are not common but is still likely to occur but will mostly be confined to the more prominent hills and mountains and where sufficient rainfall occurs. As a result, these types of wetlands will increase in abundance from the western/northern urban areas (Bloemfontein, Soutpan, Dewetsdorp) toward the more eastern/western urban areas (Thaba Nchu, Botshabelo, Wepener, Vanstadensrus).

4.2.3 Condition and importance of the affected watercourses and wetlands

Previous desktop assessment Nel *et al* (2011) and Kleynhans (2000) will be utilised to provide estimated conditions of the larger watercourses in the MOSS urban areas (Table 10). It must however be stressed that these are in themselves not very accurate and therefore should be augmented by on-site surveys.

Table 11 refers to the determination and categorisation of the Present Ecological State (PES; health or integrity) of various biophysical attributes of rivers relative to the natural or close to the natural reference condition. The purpose of the EcoClassification process is to gain insights and understanding into the causes and sources of the deviation of the PES of biophysical attributes from the reference condition. This provides the information needed to derive desirable and attainable future ecological objectives for the river (Kleynhans & Louw 2007).

Table 12 refers to the Ecological Importance and Sensitivity (EIS) of wetlands. "Ecological importance" of a water resource is an expression of its importance to the maintenance of ecological diversity and functioning on local and wider scales. "Ecological sensitivity" refers to the system's ability to resist disturbance and its capability to recover from disturbance once it has occurred. The Ecological Importance and Sensitivity (EIS) provides a guideline for determination of the Ecological Management Class (EMC).

Table 11: Ecological categories for Present Ecological Status (PES).

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

Table 12: Ecological importance and sensitivity categories.

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

Table 13: Desktop summary of the Present Ecological State (PES) of larger watercourses in the urban areas of the Mangaung Metropolitan Municipality (NFEPA – National Freshwater Ecosystem Priority Areas).

Urban Area	Watercourse	PES (Kleynhans 2000)	Quarternary Cathcment	NFEPA Status
Bloemfontein	Renosterspruit	C: Moderately Modified	C52F	Not listed
Bloemfontein	Bloemspruit	C: Moderately Modified	C52F	Not listed
Bloemfontein	Seven Dams Stream	C: Moderately Modified	C52G	Upstream system
Botshabelo	Klein-Modder River	D: Largely Modified	C52B	Not listed
Thaba Nchu	Sepane River	D: Largely Modified	C52B	Not listed
Thaba Nchu	Korannaspruit	C: Moderately Modified	C52C	Not listed
Dewetsdorp	Modder River	C: Moderately Modified	C52A	Not listed
Wepener	Caledon River	C: Moderately Modified	D23J	Not listed
Wepener	Sandspruit	D: Largely Modified	D23G	Not listed
Vanstadensrus	Witspruit	D: Largely Modified	D24C	FishFSA

The condition and functioning of several of these larger watercourses has previously been assessed and a short description of each system within the relevant urban area will be given below.

The determination of the Ecological Importance & Sensitivity (EI&S) for the larger watercourses is not possible at a desktop level as this requires the input of site-specific data.

Bloemfontein Bloemspruit/Rensoterspruit (Appendix A: Map 1): Several impacts on the Bloemspruit and Renosterspruit have caused severe modification of these watercourses. In addition, the Bloemspruit is a tributary of the Renosterspruit and confluences with it in the urban area. Consequently, what affects the Bloemspruit will also affected the Renosterspruit. These watercourses are naturally seasonal in nature flowing only during the rainy season. However, due to canalisation of portions of these watercourses, especially the Bloemspruit, as well as increased runoff from urban areas and industries and the release of treated water these systems are now both perennial in nature. This is considered a severe alteration to the flow and flood regime. It has also had a profound impact on the riparian vegetation. Both these watercourses flow through urban and industrial areas which contribute highly polluted runoff. This leads to high levels of pollution within the stream. Algal growth is abundant and also indicates high nutrient levels as a result pollution. High nutrient levels also promote dominance by exotic weeds and invaders. A large portion of the Bloemspruit has also been canalised. This has a large impact on the functioning of the stream in terms of flood dynamics and the ecosystem services rendered by an intact riparian community. The Bloemspruit flows past the Bloemfontein WWTW which does not have sufficient capacity and consequently untreated

sewage overflows into the stream further leading to high levels of pollution and degradation of the stream. The Sterkwater WWTW is situated within the Renosterspruit. This WWTW has sufficient capacity and current operation is considered adequate but will nonetheless increase nutrient levels and increase flow due to treated water discharge. High levels of rubbish dumping takes place within the catchment and in these watercourses and this further degrades them.

Bloemfontein Seven Dams Stream (Appendix A: Map 1): This is a large system supporting a varied wetland system. Under natural conditions this stream is anticipated to have had a connected main channel flow only at a seasonal basis and after heavy rainfall events. This flow regime has however been modified to a large extent by several significant artificial dams which have been constructed in the upstream reaches. These have several impacts. They reduce the likelihood of flooding which alters the flooding regime and increase the establishment of trees along the watercourse. They also retain surface runoff and provide a source of continuous water flow which cause a more perennial flow regime for the stream. Furthermore, the WWTW of the Woodland Hills development also discharge treated effluent into the stream which may further increase baseflow. The large areas of urban development which is also situated in the catchment of the stream also cause a significant increase in runoff which in turn even further increases the flow volumes of the stream. As a consequence the flow regime of the stream is considered modified to a large extent and has caused a significant increase in wetlands associated with the stream. Despite being modified the stream is still considered to be a highly sensitive system and provides several vital services. Furthermore, the stream flows into the Modder River to the north (Approximately 15 km) and therefore performs an important function in terms of purification of urban effluent from the catchment before it flows into the Modder River.

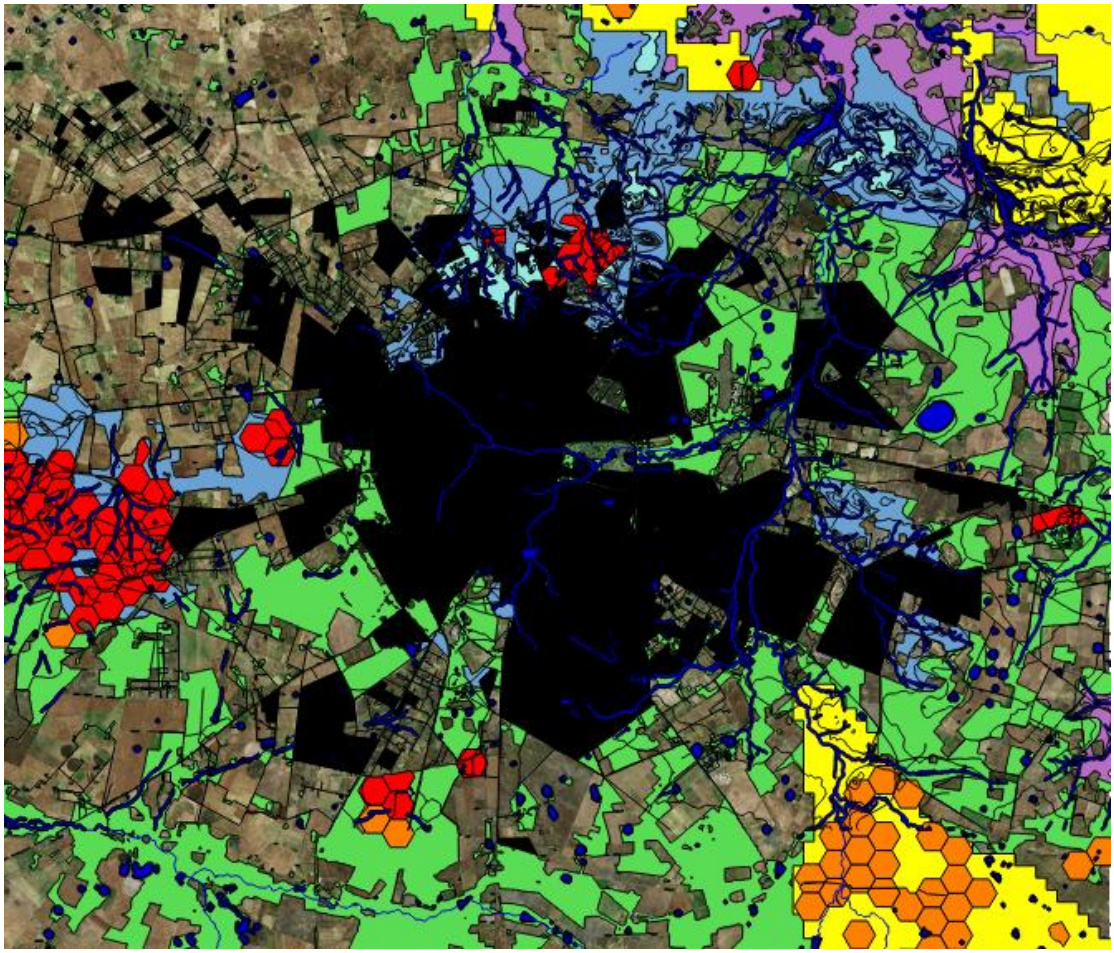
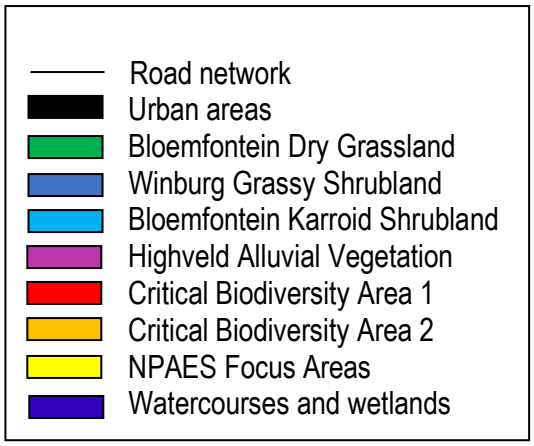


Figure 23: View of the watercourses and wetlands in the Bloemfontein urban area. Note a few larger watercourses in the urban area itself with a multitude of smaller streams and drainage lines in the northern hill terrain.

Legend:



Botshabelo Klein-Modder River (Appendix A: Map 2): The Klein -Modder River is severely degraded by several significant impacts. The Klein-Modder is naturally an ephemeral system flowing only after heavy rainfall events. However, due to increased runoff from urban areas it has now become perennial. This is considered a severe alteration to the flow and flood regime. It has also had a significant impact on the riparian vegetation and the composition and structure

thereof. It flows through the urban centre of Botshabelo which contribute highly polluted runoff. This leads to high levels of pollution within the river. Algal growth is abundant and also indicates high nutrient levels as a result of pollution. High nutrient levels also promote dominance by exotic weeds and invaders. The river itself is still largely intact in terms of morphology but several of its tributaries has been affected by channel straightening and canalisation. This will also have a large impact on the functioning of the Klein-Modder River in terms of flood dynamics and the ecosystem services rendered by an intact riparian community. High levels of rubbish dumping take place within the catchment and in the river and this further degrades the condition. Existing road crossings also cause significant impacts. These act as flow barriers retarding flow and in so doing altering the flow and flooding regime. They also contribute pollutants in the form of runoff from the road surface. It was observed that several culverts/bridge openings have become blocked by sediment and refuse which will further influence flow and flooding and often cause flooding of the surrounding urban area upstream of the blockage. Concentrated livestock farming is noted along the banks of the watercourses and this will also contribute impacts in the form of decreasing the vegetation layer, trampling will disturb the soil surface and increased runoff and sediment load will result. In addition, manure will increase the nutrient load within watercourses.

The Klein-Modder River and Modder River downstream of Botshabelo is severely degraded by the urban area in terms of water quality. Botshabelo affect water quality in terms of nutrient concentrations and algal biomass. To put this in context; the inflow of the Klein-Modder into the Modder River causes on average a 112 % increase in phosphate-phosphorus (PO4-P), 171% increase in nitrate-nitrogen (NO3-N) and a 50% increase in chlorophyll-*a* concentration (Koning & Roos 1999). It is evident that the Botshabelo urban area considerably increases effluent and so affect the flow regime of the Klein-Modder River (Grobler & Toerien 1986).

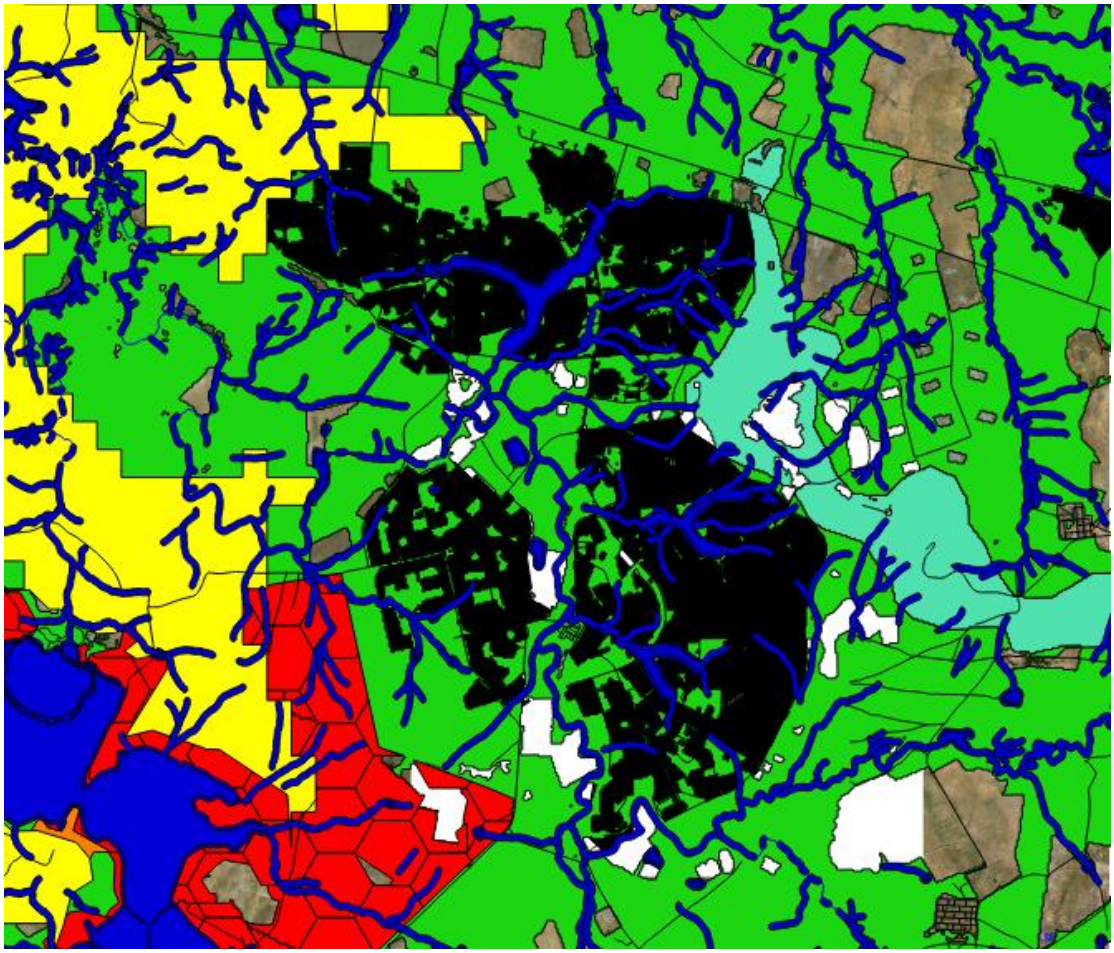
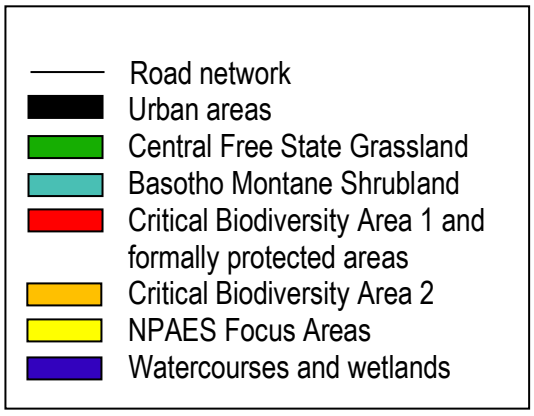


Figure 24: View of the watercourses and wetlands in the Botshabelo urban area. Note quite a high number of watercourses and wetlands, mostly a function of the uneven terrain and higher rainfall. Note also the Rustfontein Dam to the south west.

Legend:



Thaba Nchu Sepane River (Appendix A: Map 3): Several impacts on the Sepane River has caused significant modification and degradation of these watercourses. The Sepane River is naturally a seasonal system flowing only after heavy rainfall events. However, due to the significant increase in runoff from the Thaba Nchu urban area it has now become almost perennial. This is considered a severe alteration to the flow and flood regime. It has also had a

high impact on the riparian vegetation. The urban area also contributes high values of pollutants to the system. High levels of rubbish dumping takes place within the river as well as the surrounding catchment and further degrades it. Algal growth is abundant and also indicates high nutrient levels as a result of pollution. High nutrient levels also promote dominance by exotic weeds and invaders. Existing road crossings also cause significant impacts. These act as flow barriers retarding flow and in so doing altering the flow and flooding regime. They also contribute pollutants in the form of runoff from the road surface. It was observed that several culverts/bridge openings have become blocked by sediment and refuse which will further influence flow and flooding and often cause flooding of the surrounding urban area upstream of the blockage. Concentrated livestock farming was noted along the banks of the watercourses and this will also contribute impacts in the form of decreasing the vegetation layer, trampling will disturb the soil surface and increased runoff and sediment load will result. In addition, manure will increase the nutrient load within watercourses. Du Preez *et al* (2011) has also identified several impacts which are largely similar to those identified in the study area. Several impacts have been determined as small-scale fishing, trampling by humans and livestock and rubbish dumping. A major impact has been identified as the release of poorly treated sewage from the Thaba Nchu WWTW downstream of the study area.

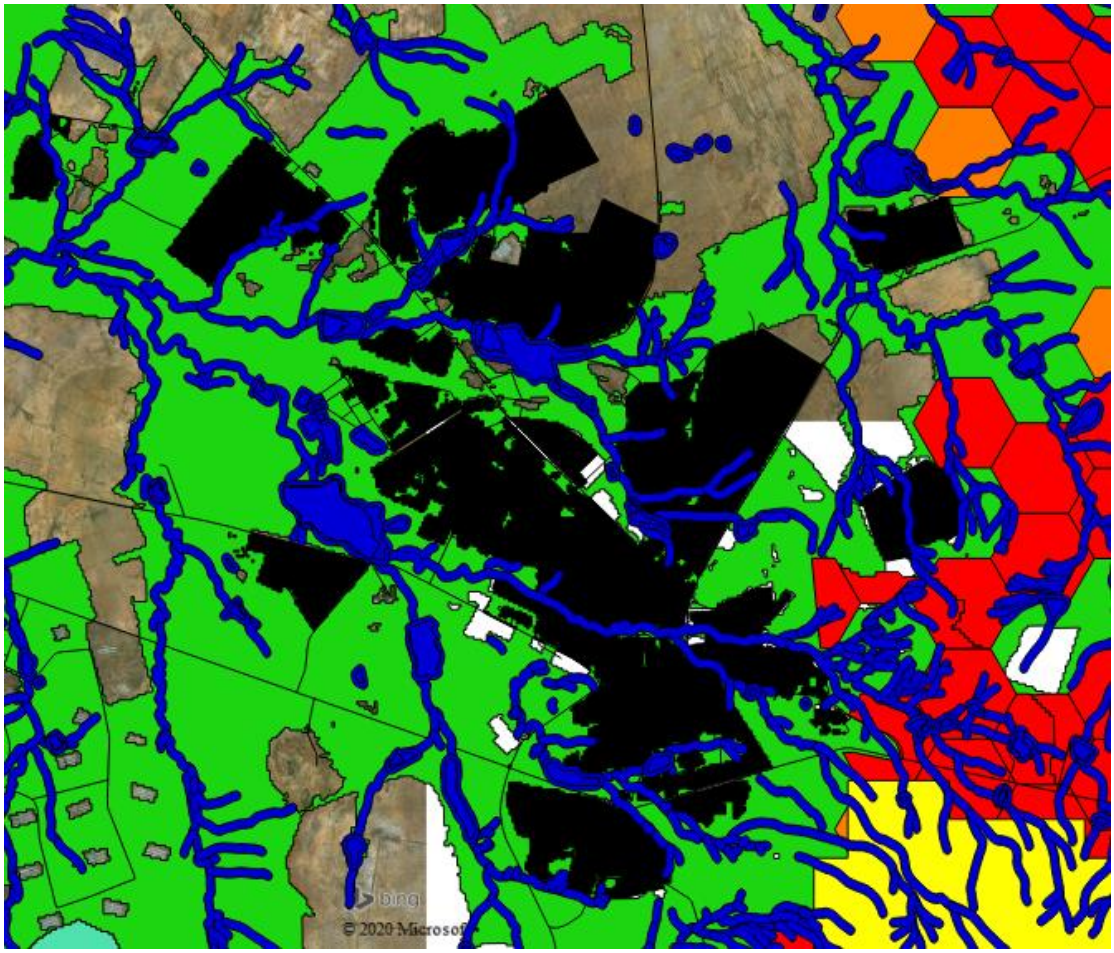


Figure 25: View of the watercourses and wetlands in the Thaba Nchu urban area. Note quite a high number of watercourses and wetlands, especially to the east and south in the more mountainous terrain. Note also the Sepane River flowing directly through the urban area.

Legend:

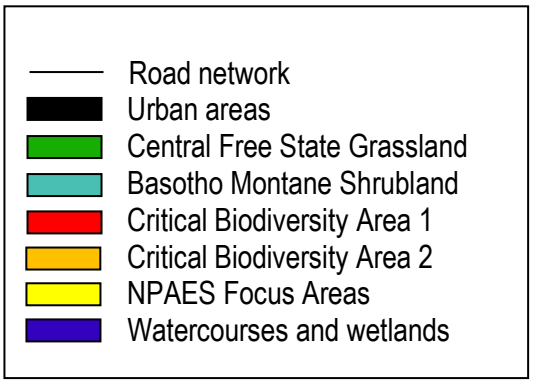
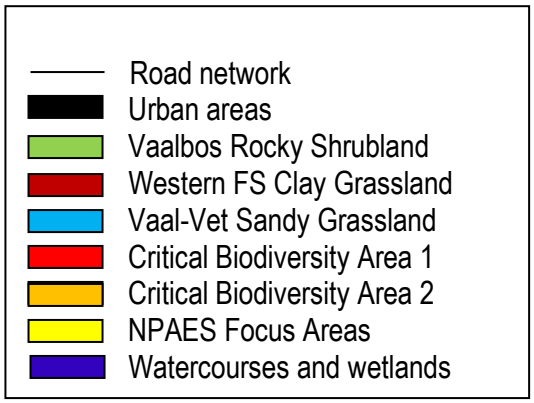


Figure 26: View of the watercourses and wetlands in the Soutpan/Ikgomotseng urban area. Note relatively few watercourses without any large river or stream. However, the saltpan wetland is extensive and a prominent feature of the area.

Legend:



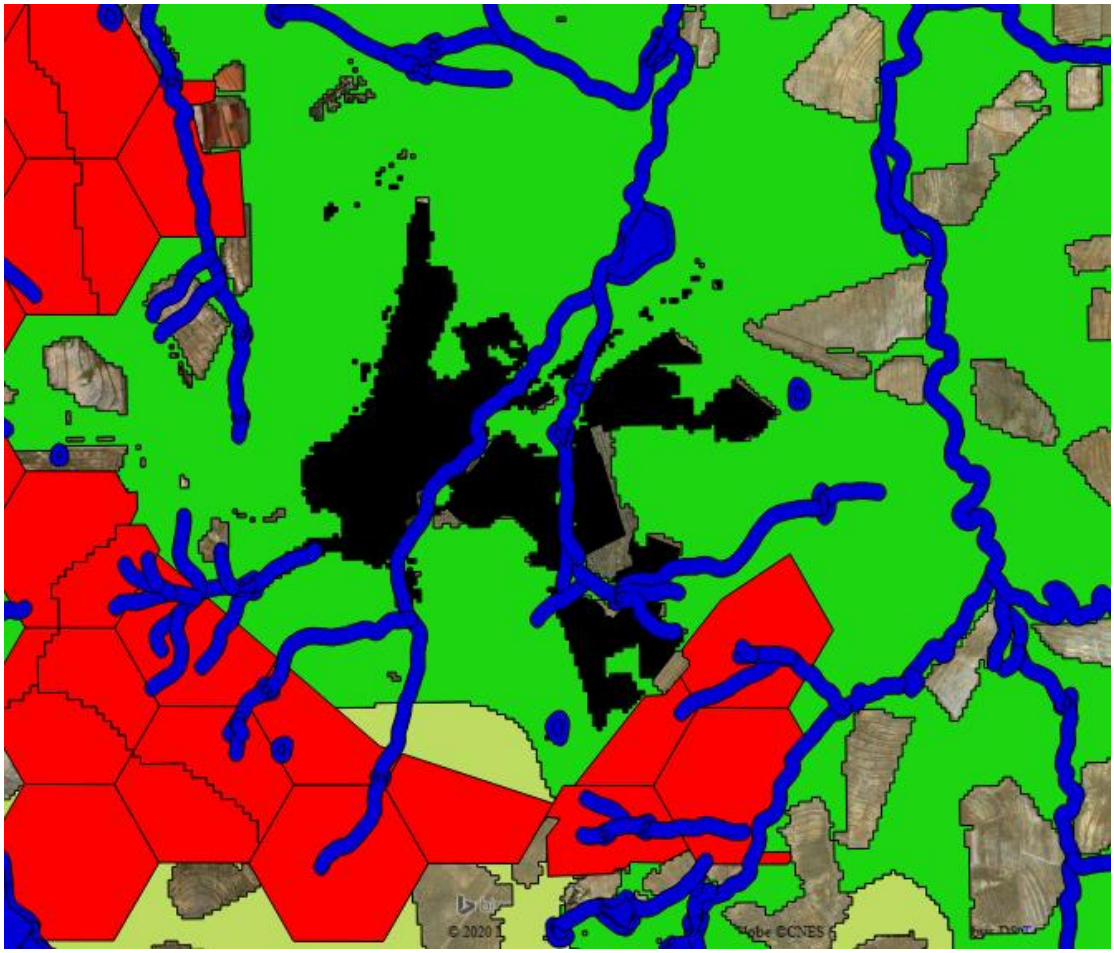
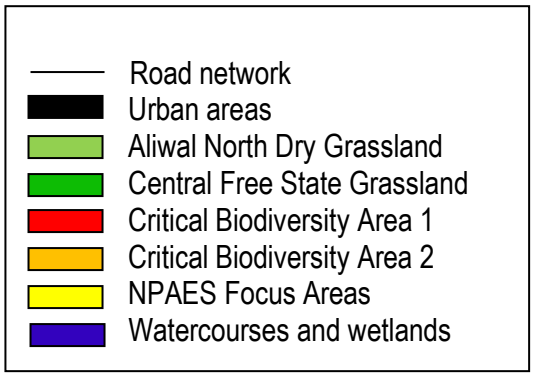


Figure 27: View of the watercourses and wetlands in the Dewetsdorp urban area. Note relatively few watercourses although several larger watercourses originate in this area and the Modder River borders the area to the east.

Legend:



Wepener Caledon River (Appendix A: Map 6): The hydrology of the river is impacted on by several factors. There are currently no large dams situated within the river, however, a large amount of smaller dirt wall dams are situated within the catchment. These decrease the runoff into the river. The extensive crop cultivation and overgrazing decrease vegetation cover and increase runoff into the river. The inter basin transfers from the Katse water scheme into the Caledon River would also lead to a change in the hydrology of the river. Although the contributing factors are numerous it is not considered that this would lead to a large change in

the hydrology of the Caledon River. Large portions of the catchment is utilised for crop production. These include dryland as well as irrigated crops. This results in increased sediment runoff. This is further exacerbated by the topography, rainfall and erodability of the soil. Coupled with the agricultural activities is an increase in nutrient load (Nitrogen and Phosphorous fertilisers) and pesticides. Extensive human settlement occurs in the catchment of the river and in close proximity to the river. These settlements include Wepener, Mabotse, Chere and Sekameng. These settlements all contribute to increased runoff, pollutants and sediment. Industrial pollutants are an emerging but serious problem and most discharges from industry flows into the Caledon River. It is known that the water in the Caledon (Mohokare) River is naturally of high turbidity and carries a concerning high sediment load. However, poor management practises result in high sediment yields. The slope as well as the erodability of the soils in the upper Caledon catchment leads to increased sediment deposition. Severe soil erosion, especially in the Caledon system, is a contributing factor. This amount of sediment that is mobilised due to poor range management is also exacerbated by many factors such as land use, topography, climate, erodability of soil, rainfall and runoff (ORASECOM 2007 & 2008). Therefore it must be clear that although the river has a naturally high sediment load the poor management of the catchment rangeland has significantly exacerbated the sediment impact on the Caledon River. The catchment and river bank itself is heavily overgrazed. Other impacts associated with human impacts and trampling by domestic stock also add to the degradation of the river banks. Overgrazing and trampling by domestic stock decrease the vegetation cover, this in turn leads to higher soil erosion, which in turn leads to a further decrease in vegetation cover. This forms a negative feedback loop. The above paragraph is considered to encapsulate the highest impacts on the river catchment and river itself.

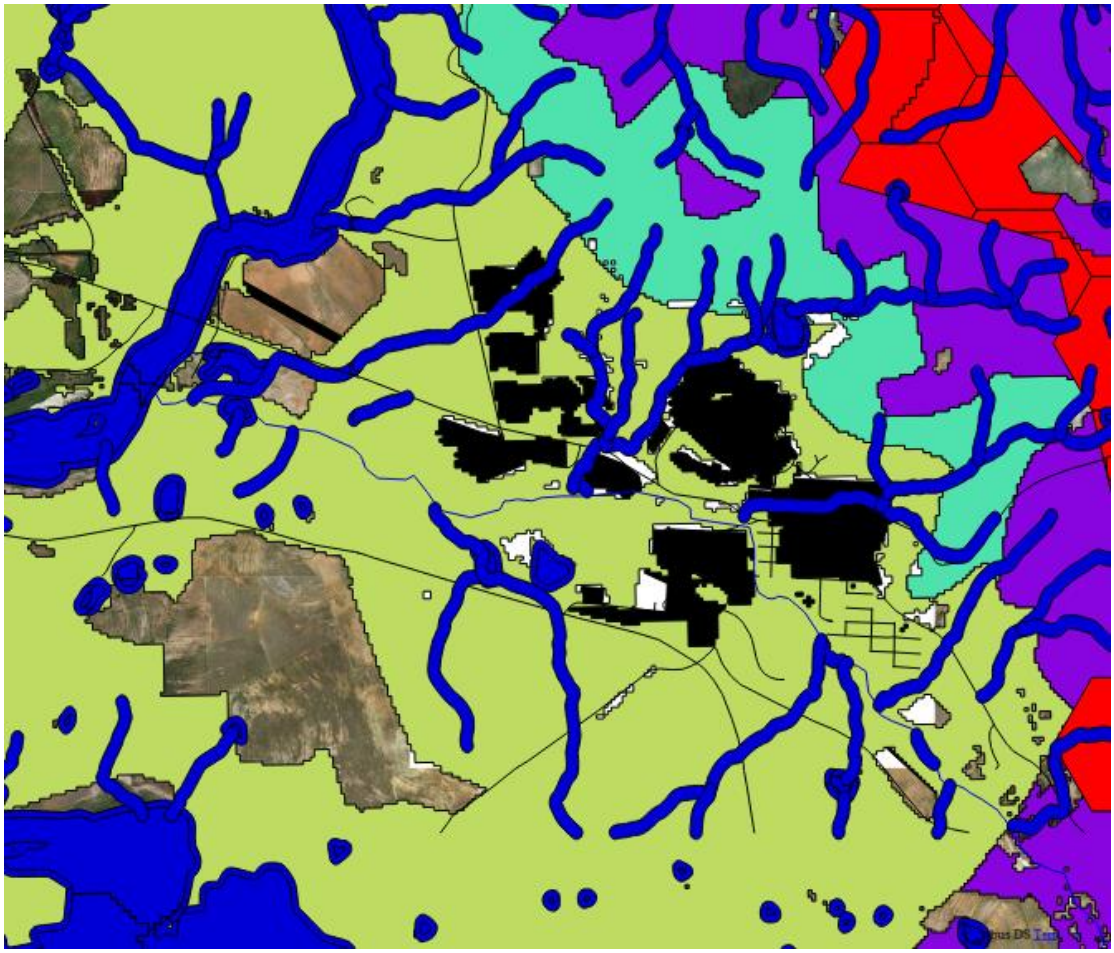
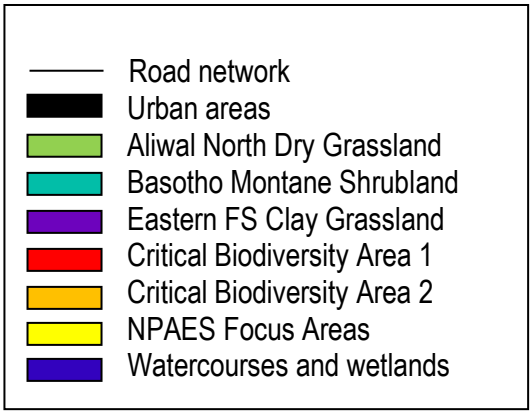


Figure 28: View of the watercourses and wetlands in the Wepener urban area. Note a relatively high number of watercourses, especially those originating in the mountainous terrain to the east and south. Note also the substantial wetland conditions likely associated with the Caledon River to the west of the urban area.

Legend:



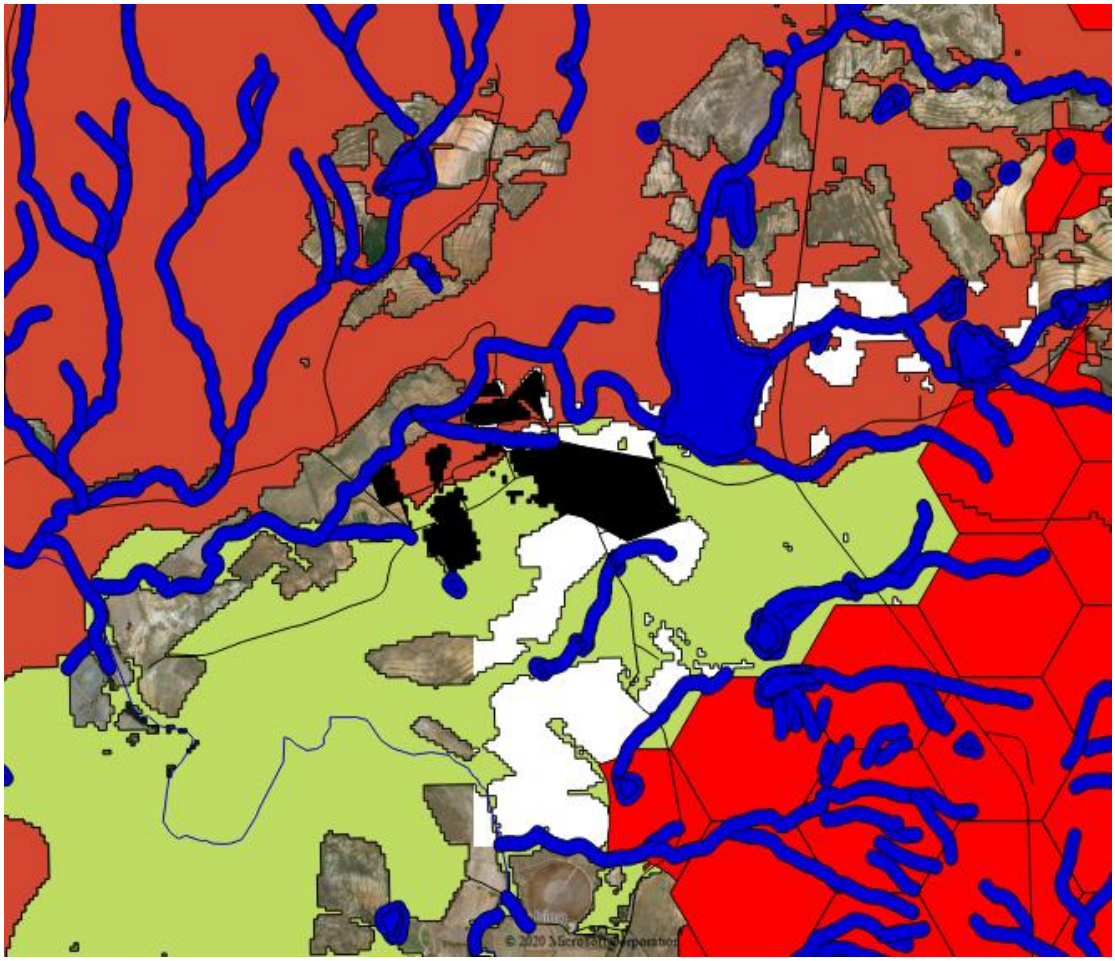
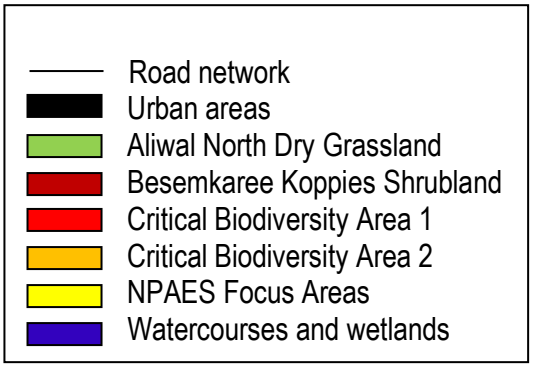


Figure 29: View of the watercourses and wetlands in the Vanstadensrus urban area. Note a relatively high number of watercourses, especially those originating in the surrounding uneven terrain.

Legend:



4.3 Overview of terrestrial fauna

From desktop assessment the actual occurrence of fauna in the MOSS cannot be determine but species likely to occur in the region can be determined. Given the urban nature of the entire study area, the fragmentation of habitat and the degradation caused to remaining natural vegetation caused by such urban areas it is anticipated to be relatively unlikely that species of conservation significance will occur. Despite this, and as a result of the large extent of these urban areas, it does however remain a low possibility that fauna of conservation importance may occur.

Table 14: Red Listed mammals likely to occur in the study area (Child *et al* 2016).

Common name	Scientific name	Status
SA hedgehog	*Erinaceus frontalis*	Near Threatened
Dent's horseshoe bat	*Rhinolopus denti*	Near Threatened
Striped Weasel	*Poecilogale albinucha*	Near Threatened
White-tailed mouse	*Mastomys albicaudatus*	Vulnerable
Small spotted cat	*Felis nigripes*	Vulnerable
Vaal Rhebok	*Pelea capreolus*	Near Threatened
Serval	*Leptailurus serval*	Near Threatened
Brown Hyena	*Hyaena brunnea*	Near Threatened
Southern African Vlei Rat	*Otomys auratus*	Near Threatened
African Clawless Otter	*Aonyx capensis*	Near Threatened

One of the main purposes of the MOSS is to retain and preserve unique habitats, areas of high diversity and similar sensitive areas which has perhaps become threatened by development. It is therefore of higher importance to focus on the preservation of the habitat of fauna instead of trying to preserve the animal itself. If habitat is adequately preserved and maintained the animals themselves will by default also be adequately preserved.

Table 15: Likely faunal species in the region.

Order	Family	Scientific name	Common name
Phylum Vertebrata; Class Amphibia			
Aneura			
	Breviceptidae	*Poyntonophrynus vertebralis*	Southern Pygmy Toad
	Bufonidae	*Amietophrynus rangeri*	Raucous Toad
		Amietophrynus gutteralis	Gutteral Toad
		Vandijkophrynus gariepensis	Karoo Toad
	Hyperoliidae	*Kassina senegalensis*	Bubbling Kassina
	Pipidae	*Xenopus laevis*	Common Platanna
	Pixycephalidae	*Cacosternum boettgeri*	Boettger's Caco
		Cape River Frog	*Amietia fuscigula*
		Common River Frog	*Amieta angolensis*
		Giant Bullfrog	*Pixycephalus adspersus*

		Tremolo Sand Frog	*Tomopterna cryptotis*
		Tandy's Sand Frog	*Tomopterna tandyi*
Phylum Vertebrata; Class Reptilia			
Testudines	Testudinidae	*Geochelone pardalis*	Leopard Tortoise
		Homopus femoralis	Greater Padloper
		Psammobates oculiferus	Kalahari Tent Tortoise
	Trionychidae	*Pelomedusa subrufa*	Marsh Terrapin
Squamata	Typhlopidae	*Rhinotyphlops lalandei*	Delalande's Blind Snake
	Leptotyphlopidae	*Leptotyphlops scutifrons*	Peter's Thread Snake
	Leptotyphlopidae	*Lycodonomorphus rufulus*	Common Brown Water Snake
	Atractaspidae	*Atractaspis bibronii*	Bibron's burrowing Asp
	Colubridae	*Lamprophis fuliginosus*	Brown House Snake
		Lamprophis aurora	Aurora House Snake
		Lycophidion capense	Cape Wolf Snake
		Pseudaspis cana	Mole Snake
		Prosymna sundevallii	Sundevall's Shovel-snout
		Psammophylax rhombeatus	Rhombic Skaapsteker
		Psammophis notostrictus	Karoo Sand Snake
		Psammophis leightonii	Cape Fork-marked Snake
		Psammophis crucifer	Cross-marked Snake
		Dasypeltis scabra	Common Egg Eater
		Crotaphopeltis hotamboeia	Red-lipped Snake
		Telescopus semiannulatus	Eastern Tiger Snake
		Dispholidus typus	Boomslang
	Elapinae	*Elapsoidea boulengeri*	Boulenger's Garter Snake
		Elapsoidea sundevallii	Sundevall's Garter Snake
		Naja nivea	Cape Cobra
		Hemachatus haemachatus	Rinkhals
	Viperidae	*Bitis arietans*	Puff Adder
	Amphisbaenidae	*Zygaspis quadrifrons*	Cape Spade-snouted Worm Lizard
	Scincidae	*Acontias gracilicauda*	Thin-tailed Legless Skink
		Mabuya capensis	Cape Skink

		Mabuya striata	Striped Skink
		Mabuya sulcata	Western Rock Skink
		Mabuya variegate	Variegated Skink
	Lacertidae	*Ichnotropis squamulosa*	Common Rough-scaled Lizard
		Nucras intertexta	Spotted Sandveld-Lizard
		Pedioplanis lineocellata	Spotted Sand lizard
		Nucras holubii	Holub's Sandveld Lizard
		Gerrhosaurus flavigularis	Yellow-throated Plated Lizard
		Cordylus polyzonus	Karoo Girdled Lizard
	Varanidae	*Varanus albigularis*	Rock Monitor
		Varanus niloticus	Water Monitor
	Agamidae	*Agama aculeate*	Ground Agama
		Agama atra	Southern Rock Agama
		Agama hispida	Southern Spiny Agama
	Chamaeleonidae	*Chamaeleo dilepis*	Flap-neck Chameleon
	Gekkonidae	*Lygodactylus capensis*	Cape Dwarf Gecko
		Pachydactylus bibronii	Bibron's Thick-toed Gecko
		Pachydactylus capensis	Cape Thick-toed Gecko
		Pachydactylus mariquensis	Marico Thick-toed Gecko
Phylum Vertebrata; Class Mammalia			
Chiroptera	Molossidae	*Tadarida aegyptiaca*	Egyptian Free-tailed Bat
	Rhinolophidae	*Rhinolophus clivosus*	Geoffroy's Horseshoe Bat
	Vespertilionidae	*Neoromicia capensis*	Cape Serotine
Insectivora	Chrysochloridae	*Chlorotalpa sclateri*	Sclater's Golden Mole
	Erinaceidae	*Atelerix frontalis*	Hedgehog
	Macroscelididae	*Elephantulus myurus*	Eastern Rock Elephant Shrew
	Soricidae	*Suncus varilla*	Lesser Dwarf Shrew
		Crocidura cyanea	Reddish-grey musk shrew
		Elephantulus myurus	Rock Elephant Shrew
		Chlorotalpa sclateri	Sclater's Golden mole
Rodentia	Bathyergidae	*Cryptomys*	Common Molerat

		hottentotus	
	Muridae	*Tatera leucogaster*	Bushveld Gerbil
		Mastomys coucha	Multimammate Mouse
		Desmodillus auricularis	Cape Short-tailed Gerbil
		Saccostomys campestris	Pouched Mouse
		Graphyurus murinus	Woodland dormouse
		Otomys angolensis	Angoni vlei rat
		Otomys iroratus	Vlei rat
		Otomys auratus	Southern African Vlei Rat
		Otomys saundersiae	Saunders' Vlei Rat
		Otomys sloggetti	Sloggett's Rat
		Rabdomys pumilio	Striped mouse
		Mus musculus	House mouse
		Mus minutoides	Pygmy mouse
		Mastomys natalensis	Multimammate mouse
		Aethomys namaquensis	Namaqua rock mouse
		Aethomys chrysophilus	Red veld rat
		Rattus rattus	House rat
		Desmodillus auricularis	Short-tailed gerbil
		Gerbillus paeba	Hairy-footed gerbil
		Gerbilliscus leucogaster	Bushveld Gerbil
		Gerbilliscus brantsii	Highveld Gerbil
		Mastomys albicaudatus	White-tailed mouse
		Malacothrix typica	Large-eared mouse
		Dendromys melanotis	Grey climbing mouse
	Sciuridae	*Xerus inauris*	Cape Ground Squirrel
	Pedetidae	*Pedetes capensis*	Spring Hare
	Hystricidae	*Hystrix africaeaustralis*	South African Porcupine
Lagomorpha	Leporidae	*Lepus saxatilis*	Scrub Hare
		Lepus capensis	Cape Hare
Carnivora	Canidae	*Canis mesomelas*	Canis mesomelas
		Otocyon megalotis	Bat-eared Fox
		Vulpes chama	Cape Fox
	Herpestidae	*Suricata suricata*	Meerkat
		Atilax paludinosus	Marsh Mongoose
		Cynictis penicillata	Yellow mongoose
		Herpestes	Cape Gray

		pulverulentus	Mongoose
		Herpestes sanguineus	Slender Mongoose
	Mustelidae	*Ictonix striatus*	Zorilla
		Poecilogale albinucha	Striped Weasel
		Aonyx capensis	African Clawless Otter
	Protelidae	*Proteles cristatus*	Aardwolf
	Viverridae	*Genetta maculata*	Common Large-spotted Genet
		Genetta genetta	Common Genet
		Genetta tigrina	Cape Genet (Cape Large-spotted Genet)
	Felidae	*Caracal caracal*	Caracal
		Felis nigripes	Black-footed Cat
		Felis sylvestris	Wild Cat
	Hyaenidae	*Hyaena brunnea*	Brown Hyena
		Leptailurus serval	Serval
Tubulidentata	Orycteropidae	*Orycteropus afer*	Aardvark
Primates	Cercopithecidae	*Chlorocebus pygerythrus*	Vervet Monkey
Hyracoidea	Procaviidae	*Procavia capensis*	Cape Rock Hyrax
Artiodactyla	Bovidae	*Tragelaphus strepsiceros*	Kudu
		Antidorcas marsupialis	Springbok
		Pelea capreolus	Vaal Rhebok
		Raphicerus campestris	Steenbok
		Redunca arundinum	Southern Reedbuck
		Redunca fulvorufula	Mountain Reedbuck
		Sylvicapra grimmia	Common Duiker

5. Biodiversity condition and sensitivity rating

From a desktop perspective it is not possible to provide area specific assessments for the MOSS urban areas. Instead, the entire MOSS, including Bloemfontein, Botshabelo, Thaba Nchu, Soutpan, Dewwetsdorp, Wepener and Vastadensrus, will be discussed in overview to give an indication of the overall condition and sensitivity which will then indicate the need for further detailed assessment.

5.1 Overall condition of the study area

Habitat diversity and species richness:
Overall, the diversity of habitat is substantial. This is mostly attributed to the extent of these urban areas. Even the smallest of these, Soutpan, contains a significant diversity of habitats such as ridges and hills, grassland plains, a variety of three vegetation types and wetland systems such as the saltpan. On a desktop level it is difficult to determine the species diversity of these urban areas though if habitat is taken as an indication then species diversity would also be anticipated as being significant. Comprehensive on-site surveys will however provide a much better picture and indication of which specific areas will have the most significant habitat and species diversity.

Presence of rare and endangered species:
From available literature and previous studies conducted in the area it is considered a certainty that the MOSS will contain a multitude of protected species. These will contribute to a significant conservation value. The majority of these seem to be relatively widespread though it is clear that many are also uncommon and rare in some instances. It is also clear that certain habitats, vegetation types and topographical units contain a significantly higher proportion of protected species than other areas, these areas will also have a higher conservation value. Although the likelihood cannot be discounted, it seems relatively unlikely that the MOSS will contain red listed plant species. Refinement of the MOSS and on-site surveys should confirm which areas contain most protected species and there will therefore be portions of the MOSS with a higher level of sensitivity.

Ecological function:
From available information and recent aerial imagery, it is clear that urban expansion has caused extensive transformation of the natural environment and ecological functions. Under natural conditions the area should function in sustaining distinct and different vegetation types, sustaining a faunal population adapted to these different habitats and functioning as part of the water cycle, i.e. watercourses and wetlands and the transport of water including the catchment.

The vegetation types contain different species compositions, vegetation structure, habitats and species diversity and consequently will also vary in their conservation value (Appendix A: Map 1-7). The MOSS should therefore take into account that the different vegetation types and habitats will require differing portions being conserved with some areas requiring a larger portion being conserved and other areas smaller portions. However, since these vegetation types and habitats are all different a representative portion of each will have to be retained within the MOSS.

The fauna occurring in the MOSS area will be significantly modified from the natural condition. Urban areas and the human activities, habitat fragmentation and overall degraded habitat significantly decrease the natural fauna population both in terms of diversity and size. Despite

this, natural areas will still be able to sustain a substantial faunal population. Preservation of these natural areas within the MOSS will therefore by default preserve the faunal population. However, fauna differ in their habitat requirements and this also substantiates the need to preserve representative samples of all the different vegetation types in the MOSS as each will support a differing faunal assemblage. Furthermore, a viable faunal population requires exchange of genetic material in order to retain diversity. This requires that corridors remain, whereby fauna can move between remaining natural areas within the urban framework. Such corridors should also form part of the MOSS.

The importance of wetlands and watercourses and the functioning and services they provide has become especially evident in recent times. It is clear that those watercourses situated in the urban areas has been heavily modified by it. The MOSS should therefore aim to incorporate several of the more sensitive and important watercourses and wetlands in order to retain their functioning as much as possible. These watercourses can in many instances also function as corridors between natural areas.

Degree of rarity/conservation value:
From the desktop overview of the MOSS it is clear that it contains a high diversity of both habitats and species with a multitude of watercourses and wetlands which will all have a high conservation value (Appendix A: Map 1-7). Although it is clear that some areas will contain a much higher diversity or be rarer and that some watercourses and wetlands will be more sensitive and important than others it is also clear that all portions of remaining natural areas may contain elements of significant conservation value. The MOSS will therefore have to incorporate a representative sample of all natural areas.

Percentage ground cover:
From a desktop perspective, it is not possible to accurately determine the modification in terms of the vegetation cover. However, from available information, aerial imagery and estimates, the decrease in the percentage vegetation cover is anticipated to be significant. Urban development, agricultural activities, especially small holdings and overgrazing in communal areas, is anticipated to significantly decrease the overall percentage vegetation cover. This modification is anticipated to be highest in the larger urban areas such as Bloemfontein and will decrease somewhat in the smaller urban areas such as Soutpan.

Vegetation structure:
Likewise, the modification of the natural vegetation structure in the MOSS based only on desktop information cannot be determined with accuracy. However, from available desktop information it seems likely that middle- and high-income urban areas will contain an increase in the tree/shrub layer due to landscaping and gardens and lower-income areas may contain a decrease in tree cover due to cutting for firewood. Overall, an increase in the herbaceous layer due to infestation by exotic weeds and invasives is also likely. The MOSS should take this into account and should also incorporate measures to eradicate invasive infestations and limit their spread into natural areas.

Infestation with exotic weeds and invader plants:
From the available desktop information, it seems highly likely that the MOSS will contain extensive infestations of exotic weeds and invasive species. The preservation of natural areas through implementation of the MOSS will be irrelevant without incorporating measures to ensure that these natural areas remain largely free of exotic and invasive species.

Degree of grazing/browsing impact:
Agricultural activities are clearly one of the main land uses around the urban areas of the MOSS. Grazing and browsing is therefore anticipated to be a quite prominent impact in the MOSS and has also been shown to significantly decrease the condition and modify natural areas. This is especially evident in areas where stocking levels of introduced game is high, in small holdings where agricultural activities are confined to a small area and in communal grazing areas which does not follow a structured grazing schedule or stocking levels and consequently heavy and sustained overgrazing occurs.

Signs of erosion:
From desktop information it is difficult to estimate the amount of erosion occurring in the MOSS. However, when taking into account the known land uses the amount of erosion is anticipated to be at least moderate. Areas which is anticipated to be most affected by erosion will occur in those portions affected by overgrazing, which will decrease the vegetation cover, increase trampling and consequently erosion of the topsoil. Higher erosion values is also likely where infrastructure cross watercourses and where these structures caused obstruction to flow they may increase erosion of the banks.

Terrestrial animals:
From desktop assessment the actual occurrence of fauna in the MOSS cannot be determine but species likely to occur in the region can be determined. Given the urban nature of the entire study area, the fragmentation of habitat and the degradation caused to remaining natural vegetation caused by such urban areas it is anticipated relatively unlikely that species of conservation significance will occur. Despite this, and as a result of the large extent of these urban areas, it does however remain a low possibility that fauna of conservation importance may occur. One of the main purposes of the MOSS is to retain and preserve unique habitats, areas of high diversity and similar sensitive areas which has perhaps become threatened by development. It is therefore of higher importance to focus on the preservation of the habitat of fauna instead of trying to preserve the animal itself. If habitat is adequately preserved and maintained the animals themselves will by default also be adequately preserved.

Table 16: Biodiversity Sensitivity Rating for the MOSS.

	Low (3)	Medium (2)	High (1)
Vegetation characteristics			
Habitat diversity & Species richness			1
Presence of rare and endangered species			1
Ecological function			1
Uniqueness/conservation value			1
Vegetation condition			
Percentage ground cover		2	
Vegetation structure		2	
Infestation with exotic weeds and invader plants or encroachers	3		
Degree of grazing/browsing impact	3		
Signs of erosion		2	
Terrestrial animal characteristics			
Presence of rare and endangered species			1
Sub total	6	6	5
Total		17	

5.2. Biodiversity sensitivity rating (BSR) interpretation

Table 17: Interpretation of Biodiversity Sensitivity Rating.

Site	Score	Site Preference Rating	Value
Mangaung Metropolitan Open Space System	17	Good condition	2

In terms of the biodiversity sensitivity for the MOSS, when considered from an overall perspective, it is clear that the vegetation characteristics contain several aspects with high sensitivity values and which therefore indicates the need for comprehensive survey thereof in order to accurately determine the site specific areas which will be most relevant to the MOSS. However, overall, the vegetation condition of the MOSS is most likely significantly degraded by the urban environment.

6. Summary and conclusions

The MOSS study area is considered to be relatively sensitive in terms of its vegetation characteristics but somewhat degraded in terms of the vegetation conditions when seen from an overall, desktop perspective. The desktop study should be utilised as a baseline to provide information on areas and aspects which should form the focus of a comprehensive, on-site survey to inform the refinement of the MOSS.

The study area consists of several separate urban areas with large extent. These are the city of Bloemfontein and surrounding towns, including Thaba Nchu, Botshabelo, Soutpan, Dewetsdorp, Wepener and Vanstadensrus (Appendix A: Map 1-7). From aerial images it is clear that these areas consist of extensive urban areas but that significant natural areas are also visible within the urban edge. The desktop study will assess all open spaces and natural areas within the urban edge of these urban areas. Furthermore, a high number of watercourses and wetlands also occur in these urban areas with some of the larger rivers including the Bloemspruit, Renosterspruit, Modder River, Klein-Modder River, Sepane River, Caledon River and Witspruit.

6.1 Terrestrial Ecology

6.1.1 Bloemfontein Urban Area (Appendix A: Map 1)

As a result of the variation in topography, soil, geology, etc. the urban area of Bloemfontein contains several different vegetation types. According to Mucina & Rutherford (2006), the study area includes Bloemfontein Dry Grassland (Gh 5), Winburg Grassy Shurbland (Gh 7), Bloemfontein Karroid Shrubland (Gh 8) and Highveld Alluvial Vegetation (AZa 5). According to the National Environmental Management: Biodiversity Act, 2004 (Act No. 10 of 2004) these are all currently listed as being of Least Concern (LC), except for the Bloemfontein Dry Grassland which is listed as a Vulnerable (VU) vegetation type. In addition, the Bloemfontein Karroid Shrubland has recently become increasingly under pressure from development and due to its high species diversity and high proportion of protected species it is also regarded as a sensitive vegetation type.

There is a high likelihood that many protected species will occur within the Bloemfontein urban area. The Bloemfontein urban area therefore does not contain any plant species which is significantly endangered or rare. A comparison between the different vegetation types and the likelihood that protected species may occur indicate that all vegetation types contain a significant proportion of protected species which will be of significant conservation significance. The Winburg Grassy Shubland contains a somewhat higher number of protected species. However, note that the Bloemfontein Karroid Shrubland contains a significantly higher amount of protected species when compared to the other vegetation types. This also indicates a significant conservation value of this vegetation type and will also contribute to a higher conservation value for it.

From the description of the remaining natural vegetation in the Bloemfontein urban area the following elements of ecological importance should be taken into account in the MOSS:

- All four vegetation types contain elements of conservation value and consequently, where natural portions of these vegetation types remain they should be regarded as having a significant conservation value.

- All four vegetation types contain significant numbers of protected species which should also be taken into account in the sensitivity of remaining natural vegetation.
- Bloemfontein Dry Grassland is listed as a Vulnerable (VU) vegetation type which increases its sensitivity and conservation value.
- Bloemfontein Karroid Shrubland, although not listed as a Threatened Ecosystem, has clearly been shown to contain unique habitat with a proportion of protected species and should therefore be afforded a high level of sensitivity.
- Winburg Grassy Shrubland is confined to hills and ridges, positive landscape elements forming terrestrial corridors and should therefore still be regarded as having a significant level of sensitivity.
- Highveld Alluvial Vegetation, although itself not a threatened or highly unique habitat, is however closely associated with the larger watercourse system which are highly sensitive systems and therefore increase the sensitivity of the vegetation type by default.
- Areas identified as CBA 1 and 2 areas are essential to meeting conservation targets and are also concentrated on areas with a high level of sensitivity.

6.1.2 Botshabelo Urban Area (Appendix A: Map 2)

As a result of the variation in topography, soil, geology, etc., but given the smaller extent of the urban area of Botshabelo it contains only two different vegetation types. According to Mucina & Rutherford (2006), the study area includes Central Free State Grassland (Gh 6) and Basotho Montane Shrubland (Gm 5). According to the National Environmental Management: Biodiversity Act, 2004 (Act No. 10 of 2004) these are both currently listed as being of Least Concern (LC). However, Basotho Montane Grassland forms part of the Eastern Mesic Grasslands which are generally recognised as containing a significant species diversity with several being protected and of conservation importance.

There is a high likelihood that many proetcted species will occur within the Botshabelo urban area. A comparison between the different vegetation types and the likelihood that protected species may occur indicate that both vegetation types contain a significant proportion of protected species which will be of significant conservation significance. It is however evident that the mountainous terrain of Basotho Montane Shrubland may contain a somewhat higher proportion of protected species. Both vegetation types may therefore still have a significant conservation value although hills and ridges comprised of Basotho Montane Shrubland may have a somewhat higher level of sensitivity.

From the description of the remaining natural vegetation in the Botshabelo urban area the following elements of ecological importance should be taken into account in the MOSS:

- Both vegetation types contain elements of conservation value and consequently, where natural portions of these vegetation types remain they should be regarded as having a significant conservation value.
- Both vegetation types contain significant numbers of protected species which should also be taken into account in the sensitivity of remaining natural vegetation.
- Both vegetation types are relatively widespread and currently listed as being of Least Concern.
- Basotho Montane Shrubland contains a somewhat higher habitat and species diversity, varied topography and a somewhat higher proportion of protected species. The hills and ridges of this vegetation type may also act as natural corridors which may further

increase its sensitivity. The vegetation type will therefore have a somewhat higher conservation value.

- The area does not contain any CBA areas although the Rustfontein Nature Reserve to the south west has a very high conservation value and planning should aim to retain a suitable buffer between urban development and the reserve. This buffer area should also be designated open space where no development is allowed and communal grazing is kept at a low-intensity.
- Extensive NPAES Focus Areas occur to the west of Botshabelo which aim to increase the conservation area of the Rustfontein Nature Reserve. Spatial planning should therefore aim to avoid expansion into these NPAES Focus Areas and should implemented a buffer between any future development and the proposed conservation areas.

6.1.3 Thaba Nchu Urban Area (Appendix A: Map 3)

The urban area of Thaba Nchu contains a relatively uniform but undulating terrain and consequently is dominated by a single vegetation type. The Thaba Nchu Mountain to the south east of the site does not form part of the urban area but does increase the surrounding habitat diversity contributing another vegetation type. According to Mucina & Rutherford (2006), the urban area and immediate surroundings consist of Central Free State Grassland (Gh 6) while the Thaba Nchu Mountain and slopes consist of Basotho Montane Shrubland (Gm 5). According to the National Environmental Management: Biodiversity Act, 2004 (Act No. 10 of 2004) these are both currently listed as being of Least Concern (LC). However, Basotho Montane Grassland forms part of the Eastern Mesic Grasslands which are generally recognised as containing a significant species diversity with several being protected and of conservation importance.

There is a high likelihood that many protected species will occur within the Thaba Nchu urban area. A comparison between the different vegetation types and the likelihood that protected species may occur indicate that both vegetation types contain a significant proportion of protected species which will be of significant conservation significance. It is however evident that the Thaba Nchu Mountain consisting of Basotho Montane Shrubland may contain a somewhat higher proportion of protected species. Both vegetation types may therefore still have a significant conservation value although the Thaba Nchu Mountain comprised of Basotho Montane Shrubland may have a somewhat higher level of sensitivity.

From the description of the remaining natural vegetation in the Thaba Nchu urban area the following elements of ecological importance should be taken into account in the MOSS:

- Both vegetation types contain elements of conservation value and consequently, where natural portions of these vegetation types remain they should be regarded as having a significant conservation value.
- Both vegetation types contain significant numbers of protected species which should also be taken into account in the sensitivity of remaining natural vegetation.
- Both vegetation types are relatively widespread and currently listed as being of Least Concern.
- Basotho Montane Shrubland contains a somewhat higher habitat and species diversity and a somewhat higher proportion of protected species. In this area it is also associated with the Thaba Nchu Mountain, a highly prominent feature with significant conservation value.

- Extensive areas of CBA 1 & 2 occur to the east of Thaba Nchu and these areas will have a high conservation value and urban planning should avoid these areas and aim to retain a suitable buffer between urban development and the CBA areas. This buffer area should also be designated open space where no development is allowed and communal grazing is kept at a low-intensity.
- A large NPAES Focus Area coincides with the Thaba Nchu Mountain and also affirms the high conservation value of this area. Spatial planning should therefore aim to avoid expansion into these NPAES Focus Areas and should implemented a buffer between any future development and the proposed conservation areas.
- Future planning of Thaba Nchu should take into account the high conservation value of the Thaba Nchu Mountain and the tourism potential this may have.

6.1.4 Soutpan Urban Area (Appendix A: Map 4)

Due to the small extent of the area it does not contain a large amount of vegetation types. However, significant topographical diversity is present and as a result three distinct vegetation types are present. According to Mucina & Rutherford (2006), the study area includes Western Free State Clay Grassland (Gh 9), Vaal-Vet Sandy Grassland (Gh 10) and Vaalbos Rocky Shrubland (SVk 5). According to the National Environmental Management: Biodiversity Act, 2004 (Act No. 10 of 2004) these are all currently listed as being of Least Concern (LC), except for the Vaal-Vet Sandy Grassland which is listed as an Endangered (EN) vegetation type.

There is a high likelihood that many protected species will occur within the Soutpan urban area. A comparison between the different vegetation types and the likelihood that protected species may occur indicate that all vegetation types contain a significant proportion of protected species which will be of significant conservation significance. However, note that the hills and ridges consisting of Vaalbos Rocky Shrubland will contain a significantly higher proportion of protected species which will in turn significantly increase its conservation value.

From the description of the remaining natural vegetation in the Soutpan/Ikgomotseng urban area the following elements of ecological importance should be taken into account in the MOSS:

- All three vegetation types contain elements of conservation value and consequently, where natural portions of these vegetation types remain they should be regarded as having a significant conservation value.
- All three vegetation types contain significant numbers of protected species which should also be taken into account in the sensitivity of remaining natural vegetation.
- Vaal-Vet Sandy Grassland is listed as an Endangered (EN) vegetation type which increases its sensitivity and conservation value considerably.
- The Vaalbos Rocky Shrubland has a significant diversity of species and it is also prominent that numerous protected species occur within the vegetation type. Being a prominent topographical unit (hills and ridges) this will also increase its conservation value.
- Portions of CBA 1 areas are associated with remaining intact portions of Vaal-Vet Sandy Grassland (EN) which will have a high level of sensitivity. An on-site survey will enable accurate delineation of the border of these sensitive areas.
- Spatial planning should therefore aim to avoid CBA 1 areas, ridges and hills and the pan system although it is important that an on-site survey be conducted to delineate these areas more accurately and determine their respective sensitivity.

6.1.5 Dewetsdorp Urban Area (Appendix A: Map 5)

Due to the relatively uniform topography, although some habitat diversity is evident, and smaller extent of the urban area of Dewetsdorp, it contains only two different vegetation types. According to Mucina & Rutherford (2006), the study area includes Central Free State Grassland (Gh 6) and Aliwal North Dry Grassland (Gh 2). According to the National Environmental Management: Biodiversity Act, 2004 (Act No. 10 of 2004) these are both currently listed as being of Least Concern (LC).

It is clear that the current data for the Dewetsdorp region is severely lacking and also points to the need for on-site surveys. It is highly likely that many other protected species will also occur in this area but has not previously been recorded. Note that no Red Listed species had previously been recorded in this area, though as indicated it has not been thoroughly surveyed and there remains a likelihood that such a species will occur. The current data does not allow for any usable conclusions to be drawn or comparisons between vegetation types. Comprehensive on-site surveys is essential to provide accurate data for spatial planning purposes.

From the description of the remaining natural vegetation in the Dewetsdorp urban area the following elements of ecological importance should be taken into account in the MOSS:

- Both vegetation types contain elements of conservation value and consequently, where natural portions of these vegetation types remain they should be regarded as having a significant conservation value.
- Both vegetation types are likely to contain numerous protected species though current data is severely lacking and indicate the need for further on-site assessment.
- Although neither of the vegetation types are considered threatened a large portion to the west and south of the town is regarded as a CBA 1 area and will therefore have a high level of sensitivity.
- The reason for this CBA 1 area is not clearly apparent and comprehensive on-site surveys should be conducted.
- Whatever the case may be, for the time being these CBA areas must be regarded as highly sensitive and should be avoided by spatial planning.

6.1.6 Wepener Urban Area (Appendix A: Map 6)

As a result of the varied topography and mountainous terrain in this area despite the small extent of the town, it contains three diverse vegetation types. According to Mucina & Rutherford (2006), the study area includes Aliwal North Dry Grassland (Gh 2), Basotho Montane Shrubland (Gm 5) and Eastern Free State Clay Grassland (Gm 3). According to the National Environmental Management: Biodiversity Act, 2004 (Act No. 10 of 2004) these are all currently listed as being of Least Concern (LC), except for the Eastern Free State Clay Grassland which is listed as a Vulnerable (VU) vegetation type. In addition, the Basotho Montane Grassland forms part of the Eastern Mesic Grasslands which are generally recognised as containing a significant species diversity with several being protected and of conservation importance.

It is clear that the current data for the Wepener region is severely lacking and also points to the need for on-site surveys. Despite this under representative data, a high proportion of protected species are still evident, especially on the plateau vegetation type, Eastern Free State Clay

Grassland. It is also highly likely that many other protected species will also occur in this area but has not previously been recorded. A comparison between the different vegetation types and the likelihood that protected species may occur indicate that all vegetation types are likely to contain a significant amount of such species but that the proportion of protected species and also overall diversity increases along the mountainous terrain (Basotho Montane Shrubland) but is highest on the plateau of the Drakensberg foothills (Eastern Free State Clay Grassland). All three vegetation types may therefore still have a significant conservation value although this is likely to increase along the hills and ridges to the north and east of Wepener.

From the description of the remaining natural vegetation in the Wepener urban area the following elements of ecological importance should be taken into account in the MOSS:

- All three vegetation types contain elements of conservation value and consequently, where natural portions of these vegetation types remain they should be regarded as having a significant conservation value.
- The species and habitat diversity quite clearly increases along the prominent hills and ridges to the north and east of Wepener and these mountainous areas will contain a significantly higher conservation value.
- All three vegetation types are likely to contain numerous protected species though current data is lacking and indicate the need for further on-site assessment.
- It is also prominent that the mountainous vegetation types, Basotho Montane Shrubland and Eastern Free State Clay Grassland, contain a significantly higher proportion of protected species which will also increase their conservation value.
- The Eastern Free State Clay Grasslands are currently listed as a Vulnerable (VU) vegetation type, is under transformation pressure for crop cultivation, and therefore remaining natural portions of this vegetation type will have an increased conservation value.
- In addition, a few areas of this vegetation type to the north east of Wepener is also listed CBA 1 areas which will even further increase its conservation value.
- It is clear that several areas of conservation value occur around Wepener, especially the areas associated with the mountainous terrain to the north and east. It is unlikely that urban expansion will encroach into these areas though they should still be taken into consideration i.t.o. the spatial planning of Wepener.

6.1.7 Vanstadensrus Urban Area (Appendix A: Map 7)

Due to the relatively uniform topography, although some habitat diversity is evident, and smaller extent of the urban area of Vanstadensrus it contains only two different vegetation types. According to Mucina & Rutherford (2006), the study area includes Aliwal North Dry Grassland (Gh 2) and Besemkaree Koppies Shrubland (Gh 4). According to the National Environmental Management: Biodiversity Act, 2004 (Act No. 10 of 2004) these are both currently listed as being of Least Concern (LC).

It is evident that the current data for Vanstadensrus is not comprehensive and will have to be supplemented by comprehensive on-site surveys to supplement the available data. Despite the under representative data it is already evident that the area contains numerous species of conservation importance of which many are considered to relatively rare. It is highly likely that many other protected species will also occur in this area but has not previously been recorded.

Although data is lacking it is already clear that low hills and ridges containing rocky outcrops will contain a significantly higher proportion of protected species than the lower lying undulating plains.

From the description of the remaining natural vegetation in the Vanstadensrus urban area the following elements of ecological importance should be taken into account in the MOSS:

- Both vegetation types contain elements of conservation value and consequently, where natural portions of these vegetation types remain they should be regarded as having a significant conservation value.
- Both vegetation types are likely to contain numerous protected species though current data is lacking and indicate the need for further on-site assessment. It is seems also evident that the hills and ridges the north and east of the town is likely to contain a higher diversity of species, habitat and protected species which increase its conservation value.
- Although neither of the vegetation types are considered threatened a large portion to the east and south of the town is regarded as a CBA 1 area and will therefore have a high level of sensitivity.
- The reason for this CBA 1 area is not clearly apparent and comprehensive on-site surveys should be conducted.
- Whatever the case may be, for the time being these CBA areas must be regarded as highly sensitive and should be avoided by spatial planning.

6.2 Wetlands and Watercourses

The study area consists of the urban areas of Bloemfontein, Botshabelo, Thaba Nchu, Soutpan, Dewetsdorp, Wepener and Vanstadensrus. From current mapping resources it is clear that these areas are drained by several large and significant watercourses. Some of these larger watercourses include the Renosterspruit, Bloemspruit, Seven-Dams Stream, Klein-Modder River, Sepane River, Modder River, Caledon River and Witspruit (Appendix A: Map 1-7). It is however not possible from a desktop assessment perspective to determine if wetland conditions are present in these and therefore, they must all be assumed to contain wetland conditions.

From previous studies conducted in and around these urban areas (Dingaan *et al* 2000, Janecke *et al* 2003, Pretorius 1996, Koning & Roos 1999, Malan *et al* 1999, Van Rensburg 2009 – 2020) it is clear that numerous rivers, streams, drainage lines and pan systems occur in the area which clearly contain wetland conditions.

From these studies it is clear that the watercourses and wetlands in these urban areas are diverse in terms of their geomorphology, flow and flooding regimes and riparian vegetation composition. These studies also illustrate a few of the different vegetation communities associated with the watercourses and wetlands in the area and include:

The wetland systems which may likely occur in the study areas and which will be associated with the watercourses may be classified into numerous different wetland types. In the absence of a site-survey these types cannot be determined with accuracy but the likely wetland systems to occur may include the following:

- The wetland condition along the main channel of larger stream and rivers may be characterised as a **channel wetland** (SANBI 2009). This wetland type is likely to occur along the channel of almost all the larger stream and river systems where sufficient flow and soil saturation occurs but will only occur in the lowland plains. It will most likely be absent in mountainous or hill terrain where valley bottom wetlands will be more likely to occur.

- The wetland conditions adjacent to larger stream and rivers may be characterised as a **floodplain wetland** (SANBI 2009). This is highly likely to occur but will likely be confined to the larger lowland river systems where flooding events are sufficient to overtop the main channel.

- Smaller streams and drainage lines in more mountainous and hill terrain are likely to be characterised as **valley bottom wetlands** with a channel (SANBI 2009). This may be likely to occur along smaller streams situated along more mountainous and hill terrain. It may therefore occur in all of the MOSS urban areas but will be much more prevalent in the eastern and southern urban areas (Botshabelo, Thaba Nchu, Wepener, Vanstadensrus) where mountainous and hill terrain is much more prominent. There is also a likelihood that unchanneled valley bottom wetlands may also occur which are very similar to channelled valley bottom systems but is anticipated to be much fewer.

- Several pan systems occur, especially around Bloemfontein and Soutpan, and these can be categorised as **depression wetlands** (SANBI 2009). These are clearly present in the MOSS urban areas and although the majority is visible around Bloemfontein and Soutpan the other urban areas are also likely to contain such systems. The Soutpan pan system is especially large and prominent and additional on-site surveys of this system should also be conducted.

- Both **hillslope seeps and valley-head seeps** are likely to occur but will most likely only be found on the more prominent mountains and hills (SANBI 2009). These wetland types are not common but is still likely to occur but will mostly be confined to the more prominent hills and mountains and where sufficient rainfall occurs. As a result, these types of wetlands will increase in abundance from the western/northern urban areas (Bloemfontein, Soutpan, Dewetsdorp) toward the more eastern/western urban areas (Thaba Nchu, Botshabelo, Wepener, Vanstadensrus).

Previous desktop assessment Nel *et al* (2011) and Kleynhans (2000) will be utilised to provide estimated conditions of the larger watercourses in the MOSS urban areas (Table 18). It must however be stressed that these are in themselves not very accurate and therefore should be augmented by on-site surveys.

Table 18: Desktop summary of the Present Ecological State (PES) of larger watercourses in the urban areas of the Mangaung Metropolitan Municipality (NFEPA – National Freshwater Ecosystem Priority Areas).

Urban Area	Watercourse	PES (Kleynhans 2000)	Quarternary Cathcment	NFEPA Status
Bloemfontein	Renosterspruit	C: Moderately Modified	C52F	Not listed

Bloemfontein	Bloemspruit	C: Moderately Modified	C52F	Not listed
Bloemfontein	Seven Dams Stream	C: Moderately Modified	C52G	Upstream system
Botshabelo	Klein-Modder River	D: Largely Modified	C52B	Not listed
Thaba Nchu	Sepane River	D: Largely Modified	C52B	Not listed
Thaba Nchu	Korannaspruit	C: Moderately Modified	C52C	Not listed
Dewetsdorp	Modder River	C: Moderately Modified	C52A	Not listed
Wepener	Caledon River	C: Moderately Modified	D23J	Not listed
Wepener	Sandspruit	D: Largely Modified	D23G	Not listed
Vanstadensrus	Witspruit	D: Largely Modified	D24C	FishFSA

The importance of wetlands and watercourses and the functioning and services they provide has become especially evident in recent times. It is clear that those watercourses situated in the urban areas has been heavily modified by it. The MOSS should therefore aim to incorporate several of the more sensitive and important watercourses and wetlands in order to retain their functioning as much as possible. These watercourses can in many instances also function as corridors between natural areas.

6.3 Biodiversity and Ecological Sensitivity

In terms of the biodiversity sensitivity for the MOSS, when considered from an overall perspective, it is clear that the vegetation characteristics contain several aspects with high sensitivity values and which therefore indicates the need for comprehensive survey thereof in order to accurately determine the site specific areas which will be most relevant to the MOSS. However, overall, the vegetation condition of the MOSS is most likely significantly degraded by the urban environment.

The following should be taken into account where the MOSS is reviewed and the level of sensitivity determined:

- Overall, the diversity of habitat and species are substantial. However, it is difficult to provide an accurate determination of this. Comprehensive on-site surveys will however provide a much better picture and indication of which specific areas will have the most significant habitat and species diversity.
- From available literature and previous studies conducted in the area it is considered a certainty that the MOSS will contain a multitude of protected species. Refinement of the MOSS and on-site surveys should confirm which areas contain most protected species and will therefore be portions of the MOSS with a higher level of sensitivity.
- The vegetation types contain different species compositions, vegetation structure, habitats and species diversity and consequently will also vary in their conservation value and consequently a representative portion of each will have to be retained within the MOSS.

- Preservation of the faunal population should be attained by the preservation of natural areas within the MOSS which will then by default preserve the faunal population.
- Corridors for the movement of fauna between natural areas should also form part of the MOSS.
- The importance of wetlands and watercourses and the functioning and services they provide has become especially evident in recent times. The MOSS should therefore aim to incorporate several of the more sensitive and important watercourses and wetlands in order to retain their functioning as much as possible.
- The preservation of natural areas through implementation of the MOSS will be irrelevant without incorporating measures to ensure that these natural areas remain largely free of exotic and invasive species.

7. References

Botha, J.F., Verwey, J.P., van der Voort, I., Vivier, J.J.P., Buys, J., Collision, W.P. and Loock, J.C. 1998. Karoo Aquifers: Their Geology, Geometry and Physical Properties. Report to the Water Research Commission by the Institute for Groundwater Studies University of the Free State. WRC Report No: 487/1/98.

Bromilow, C. 1995. Problem Plants of South Africa. Briza Publications CC, Cape Town.

Bromilow, C. 2010. Problem plants and alien weeds of South Africa. Briza Publications CC, Cape Town.

Brown, L.R. & Du Preez, P.J. 2014. Threats of mining and urbanisation on a vulnerable ecosystem in the Free State, South Africa. In: Grillo, O. (edt.) 2014. Biodiversity: The dynamic balance of the planet. InTech Open.

Child MF, Roxburgh L, Do Linh San E, Raimondo D, Davies-Mostert HT, editors. The 2016 Red List of Mammals of South Africa, Swaziland and Lesotho. South African National Biodiversity Institute and Endangered Wildlife Trust, South Africa.

Coates-Palgrave, M. 2002. Keith Coate-Palgrave Trees of Southern Africa, edn 3, imp. 4 Random House Struik (Pty.) Ltd, Cape Town.

Collins, N.B. 2005. Wetlands: The basics and some more. Free State Department of Tourism, Environmental and Economic Affairs.

Collins, N.B. 2018. Free State Province Biodiversity Plan: Technical Report v1.0. Free State Department of Economic, Small Business Development, Tourism and Environmental Affairs. Internal Report.

Conservation of Agricultural Resources Act, 1983 (ACT No. 43 OF 1983) Department of Agriculture.

Court, D. 2010. Succulent flora of Southern Africa. Struik Publishers, Cape Town.

Department of Water Affairs and Forestry. 2005. A practical field procedure for identification and delineation of wetlands and riparian areas. Edition 1. Department of Water Affairs and Forestry, Pretoria.

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

Department of Water Affairs and Forestry. 2004. Development of a framework for the assessment of wetland ecological integrity in South Africa. Phase 1: Situation Analysis. by MC Uys. Contributors G Marneweck And P Maseti. Report No. 0000/00/REQ/0904 ISBN No.: 0-621-35474-0. Resource Quality Services, Department of Water Affairs and Forestry, Pretoria, South Africa.

Department of Water Affairs and Forestry. 2005. A practical field procedure for identification and delineation of wetlands and riparian areas, Edition 1. Department of Water Affairs and Forestry, Pretoria.

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

Department of Water and Sanitation. 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). Pretoria, South Africa.

Dingaan, M.N.V. & Du Preez, P.J. 2002. The phytosociology of the succulent dwarf shrub communities that occur in the "Valley of Seven Dams" area, Bloemfontein, South Africa. *Navorsinge van die Nasionale Museum Bloemfontein*. Vol. 18, Part 3.

Dingaan, M.N.V. & Du Preez, P.J., 2013. Grassland communities of urban open spaces in Bloemfontein, Free State, South Africa. *Koedoe* 55(1).

Dingaan, M.N.V. & Du Preez, P.J., 2017, Floristic composition and species diversity of urban vegetation in Bloemfontein, Free State, South Africa, *Bothalia* 47(1).

Dingaan, M.N.V., Du Preez, P.J. & Venter, H.J.T. 2001. Riparian and wetland vegetation of natural open spaces in Bloemfontein, Free State. *Bothalia* 67: 294 - 302.

Du Preez, P.J. & Bredenkamp, G.J. 1991. Vegetation classes of the Southern and Eastern Orange Free State (Republic of South Africa) and the highlands of Lesotho. *Navorsinge van die Nasionale Museum Bloemfontein*. Vol. 7, Issue 10.

Du Preez, P.J., Koikoi, D.M.E. & Roos, J. 2011. The effects of sewage effluent on the water quality of Sepane spruit Thaba Nchu, Free State Province. Poster at the 8 th Annual Inkaba yeAfrica (IyA) Workshop, Cape Town International Conference Center, Cape Town, South Africa. 28 August – 2 September.

Fish, L., Mashau, A.C., Moeaha, M.J. & Nembudani, M.T. 2015. Identification guide to the southern African grasses. An identification manual with keys, descriptions and distributions. *Strelitzia* 36. South African National Biodiversity Institute, Pretoria.

FitzPatrick Institute of African Ornithology. 2020. mammalmap Virtual Museum. Accessed at http://vmus.adu.org.za/?vm=mammalmap on 2020-05-07

Gerber, A., Cilliers, C.J., Van Ginkel, C. & Glen, R. 2004. Easy identification of aquatic plants. Department of Water Affairs, Pretoria.

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

Germishuizen, G. & Meyer, N.L. (eds) 2003. Plants of Southern Africa: an annotated checklist. *Strelitzia* 14. National Botanical Institute, Pretoria.

Gibbs Russell, G.E., Watson, L., Koekemoer, M., Smook, L., Barker, N.P., Anderson, H.M. & Dallwitz, M.J. 1990. Grasses of Southern Africa. Memoirs of the Botanical Survey of South Africa No. 58. Botanical Research Institute, South Africa.

Google Earth V 7.3.2.5776. 2020. Bloemfontein, Thaba Nchu, Botshabelo, Soutpan, Dewetsdorp, Wepener, Vastadensrus, South Africa. S 29.116068°, E 26.216641°, S 29.232140°, E, 26.732956°, S 29.196554°, E 26.796855°, S 28.744910°, E 26.071767°, S 29.582375°, E 26.666614°, S 29.732440°, E 27.033135°, S 29.983771°, E 27.002736°. Eye alt. 3 - 20 km. Digital Globe 2020. http://www.earth.google.com (May 2020).

Griffiths, C., Day, J. & Picker, M. 2015. Freshwater Life: A field guide to the plants and animals of southern Africa. Penguin Random House South Africa (Pty) Ltd, Cape Town.

Hartmann, H.E.K. 2001. Illustrated handbook of succulent plants: Aizoaceae F-Z. Springer-Verlag, Berlin.

Johnson, S. 2005. Good practise guidance for mining and biodiversity. International Council on Mining & Minerals (ICMM). London.

Kleynhans, C.J. 2000. Desktop estimates of the ecological importance and sensitivity categories (EISC), default ecological management classes (DEMC), present ecological status categories (PESC), present attainable ecological management classes (present AEMC), and best attainable ecological management class (best AEMC) for quaternary catchments in South Africa. DWAF report, Institute for Water Quality Studies, Pretoria, South Africa.

Kleynhans, C.J. & Louw, M.D. 2007. Module A: EcoClassification and EcoStatus determination in River EcoClassification: Manual for EcoStatus Determination (version 2). Joint water Research Commission and Department of Water Affairs and Forestry report. WRC Report No. TT 329/08.

Kleynhans, C.J., Louw, M.D. & Graham, M. 2008. Module G: EcoClassification and EcoStatus determination in River EcoClassification: Index of Habitat Integrity (Section 1, Technical Manual). Joint Water Research Commission and Department of Water Affairs and Forestry Report. WRC Report No. TT 377-08.

Koomen, E., Kuhlman, T. Groen, J. & Bouwman, A. (2005). Simulating the Future of Agricultural Land Use in the Netherlands. *Tijdschrift voor Economische en Sociale Geografie*. 96. 218-224.

Malan, P.W., Venter, H.J.T. & Du Preez, P.J. 1998. Vegetation ecology of the southern Free State: Shrubland communities of the rocky outcrops. *South African Journal of Botany*. 64(1): 1 – 17.

Malan, P.W., Venter, H.J.T. & Du Preez, P.J. 1999. Vegetation ecology of the southern Free State: 1. Plant communities of the Zastron area. *South African Journal of Botany*. 65(4): 260-269.

Malan, P.W., Venter, H.J.T. & Du Preez, P.J. 2001. Vegetation ecology of the southern Free State: Vegetation of the drainage channels. *South African Journal of Botany*. 67: 58 – 64.

Manning, J. 2009. Field Guide to Wild Flowers. Struik Nature, Cape Town.

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

Mucina, L. & Rutherford, M.C. (eds.) 2006. The Vegetation of South Africa, Lesotho and Swaziland. *Strelitzia* 19.South African National Biodiversity Institute, Pretoria.

National Environmental Management: Biodiversity Act (10/2004): National list of ecosystems that are threatened and in need of protection. Government Notice 1002 of 2011, Department of Environmental Affairs.

National Water Act (Act No. 36 of 1998). Republic of South Africa.

Nel, J.L., Murray, K.M., Maherry, A.M., Petersen, C.P., Roux, D.J., Driver, A., Hill, L., Van Deventer, H., Funke, N., Swartz, E.R., Smith-Adao, L.B., Mbona, N., Downsborough, L. and Nienaber, S. (2011). Technical Report for the National Freshwater Ecosystem Priority Areas project. WRC Report No. K5/1801.

Nthejane, M. 2007. Vegetation classification of the University of the Free State Campus, Bloemfontein. Unpublished M.Sc. Thesis, University of the Free State.

http://posa.sanbi.org, South African National Biodiversity Institute (SANBI), accessed on 22/04/2020.

Potts, G. & Tidmarch, C.E. 1937. An ecological study of a piece of Karroo-like vegetation near Bloemfontein. *Journal of South Afican Botany.* 2: 51 – 92.

Raymondo, D. Van Staden, L. Foden, W. Victor, J.E. Helme, N.A. Turner, R.C. Kamundi, D.A. Manyama, P.A. (eds.) 2009. Red List of South African Plants. *Strelitzia* 25. South African National Biodiversity Institute, Pretoria.

Retief, E. & Meyer, N.L. 2017. Plants of the Free State: Inventory and identification guide. *Strelitzia* 38. South African National Biodiversity Institute, Pretoria.

SANBI. 2009. Further Development of a Proposed National Wetland Classification System for South Africa. Primary Project Report. Prepared by the Freshwater Consulting Group (FCG) for the South African National Biodiversity Institute (SANBI).

Shi, W. & Woolley, H. 2014. Managing for multifunctionality in urban open spaces: Approaches for sustainable development. *Journal of Urban Management*, Elsevier, Amsterdam, Vol. 3, Iss. 1/2, pp. 3-21.

Smith, G.F., Chesselet, P., Van Jaarsveld, E., Hartmann, H., Van Wyk, B.E., Burgoyne, P., Klak, C. & Kurzweil, H. 1998. Mesembs of the World. Briza Publications, Pretoria.

Smith, G.F. & Crouch, N.R. 2009. Guide to succulents of Southern Africa. Random House Struik (Pty) Ltd, Cape Town.

Smith, G.F. & Van Wyk, B.E. 2003. Guide to the Aloes of South Africa. Briza Publications, Pretoria.

Smithers, R.H.N. 1986a. Land Mammals of Southern Africa. Macmillan, Johannesburg.

Smithers, R.H.N. 1986b. South African Red Data Book - Terrestrial Mammals. *South African National Scientific Programmes Report No. 125.* A report for the Committee for Nature Conservation Research National Programme for Ecosystem Research.

Strahler, A.N. 1952. Hypsometric (area-altitude) analysis of erosional topology. *Geological Society of American Bulletin* 63 (11): 1117-1142.

Van Deventer, H., Smith-Adao, L., Mbona, N., Petersen, C., Skowno, A., Collins, N.B., Grenfell, M., Job, N., Lötter, M., Ollis, D., Scherman, P., Sieben, E. & Snaddon, K. 2018. South African National Biodiversity Assessment 2018: Technical Report. Volume 2a: South African Inventory of Inland Aquatic Ecosystems (SAIIAE). Version 3, final released on 3 October 2019. Council for Scientific and Industrial Research (CSIR) and South African National Biodiversity Institute (SANBI): Pretoria, South Africa. Report Number: CSIR report number CSIR/NRE/ECOS/IR/2018/0001/A.

Van Ginkel, C.E., Glen, R.P., Gordon-Grey, K.D., Cilliers, C.J., Musaya, M. & Van Deventer, P.P. 2011. Easy Identification of some South African Wetland Plants. WRC Report No. TT 479/10.

Van Oudtshoorn, F. 2004. Gids tot Grasse van Suider-Afrika. Briza Publications, Pretoria.

Van Rensburg, D.P. 2009-2020. Various ecological and wetland studies conducted in the Mangaung Metropolitan Municipality for a variety of developments. Bloemfontein.

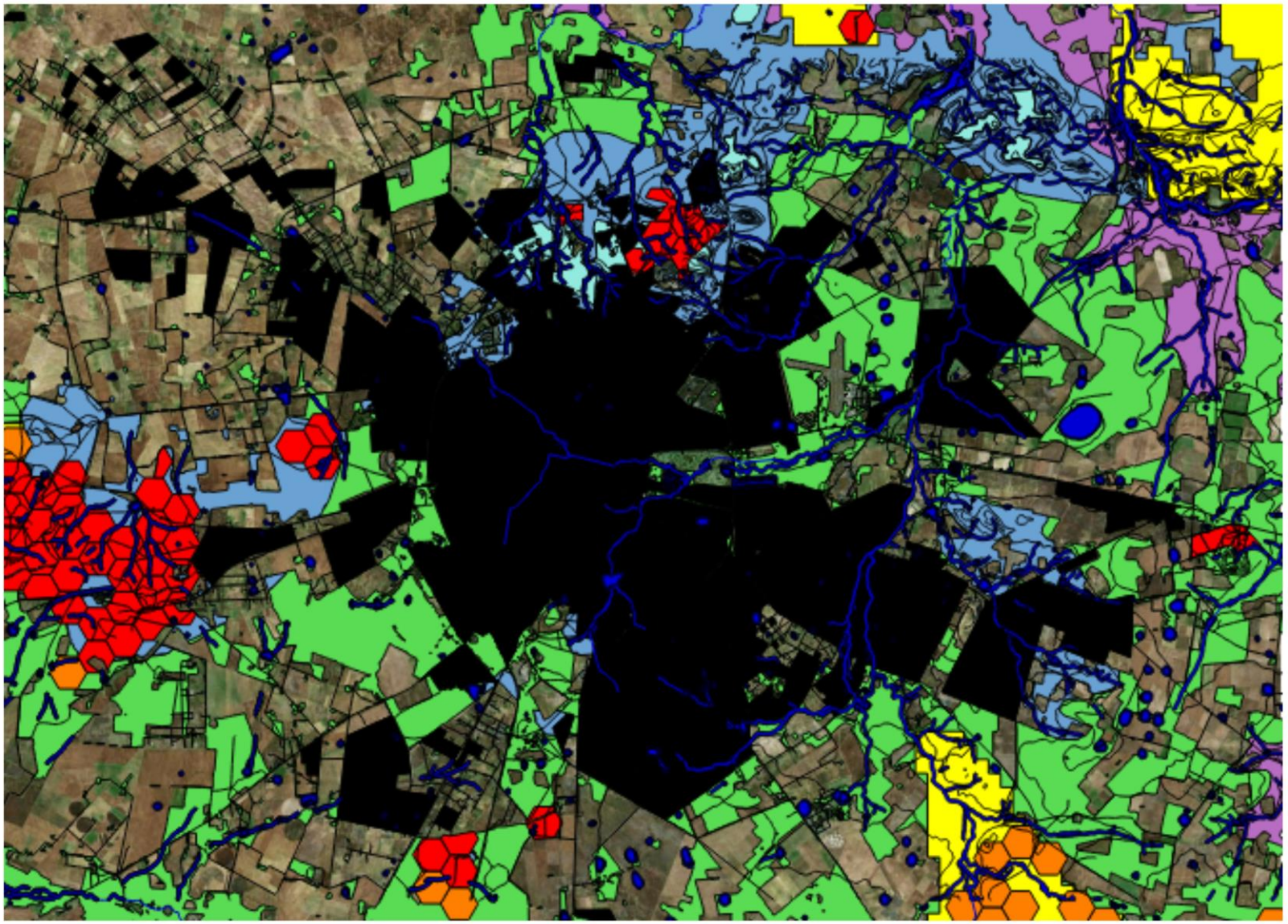
Van Wyk, B. & Malan, S. 1998. Field guide to the wild flowers of the Highveld. Struik Publishers, Cape Town.

Van Wyk, B. & Van Wyk, P. 1997. Field guide to trees of Southern Africa. Struik Publishers, Cape Town.

Venter, H.J.T. & Joubert, A.M. 1985. Climbers, trees and shrubs of the Orange Free State. P.J. de Villiers Publishers, Bloemfontein.

Annexure A: Maps

General ecology map for the Mangaung Metropolitan Open Space System (MOSS) for the urban area of Bloemfontein, Free State Province.



Preparred for:
Dipabala Engineers JV SDPI
Suite 7, Westdene Park
Bloemfontein
9301

Legend:

- Urban area
- Road network
- Watercourses
- Wetlands and impoundments
- Winburg Grassy Shrubland
- BFN Karroid Shrubland
- Highveld Alluvial Vegetation
- Bloemfontein Dry Grassland
- Critical Biodiversity Area 1
- Critical Biodiversity Area 2
- NPAES Focus Areas

Map Information

Spheroid: WGS 84

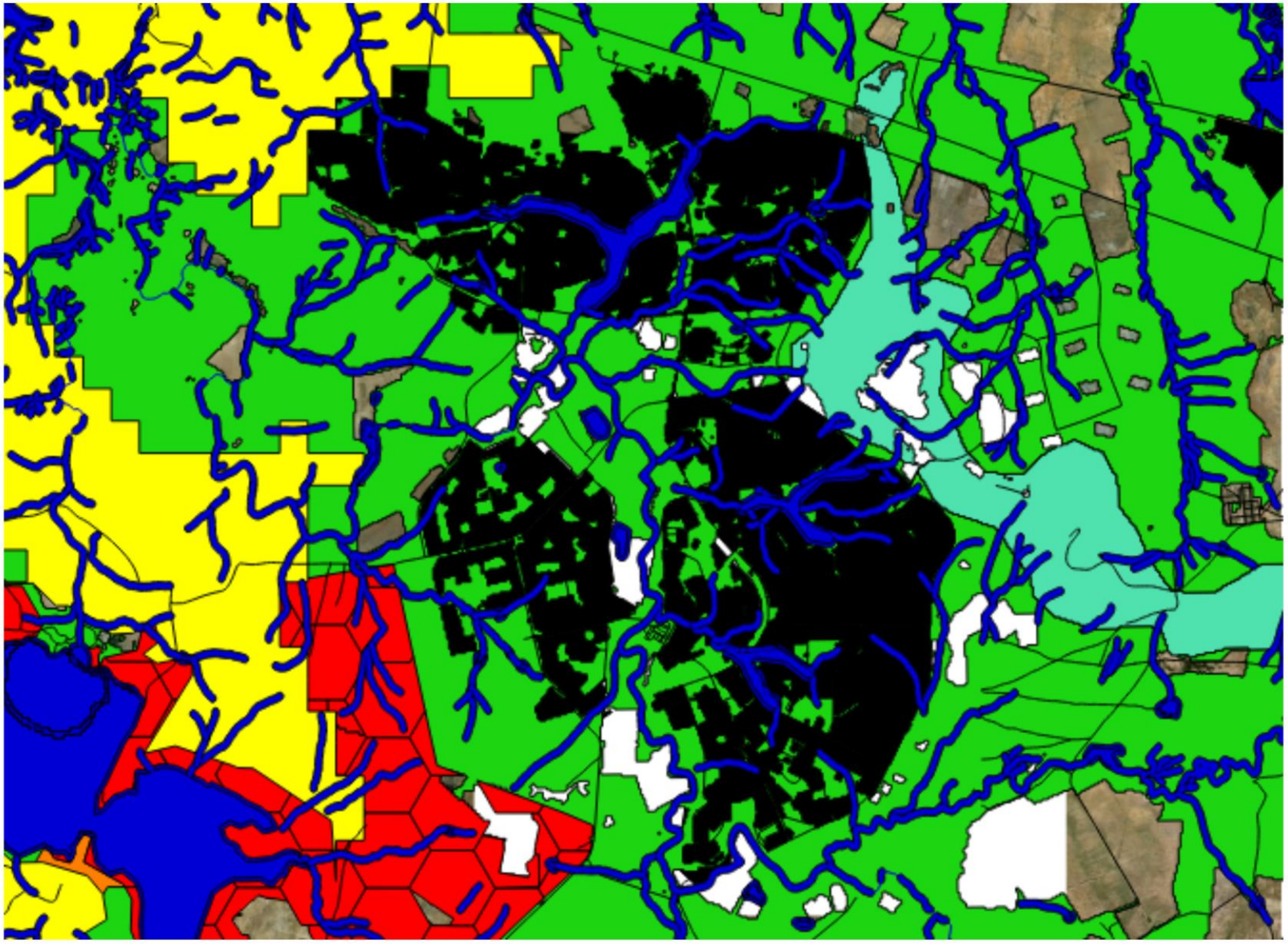
Quantum GIS

Scale: 1:220 000

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

Map 1: General ecology map of the Bloemfontein urban area. Note the extensive urban development and the large-scale transformation of natural areas. Areas of apparent conservation value include intact and CBA 1 areas to the west with smaller CBA areas also to the north, south and east. Note also a few, but large watercourses within the urban area and also a multitude of smaller streams in the northern uneven, hill terrain.

General ecology map for the Mangaung Metropolitan Open Space System (MOSS) for the urban area of Botshabelo, Free State Province.



Preparred for:
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Suite 7, Westdene Park
Bloemfontein
9301

Legend:

- Urban area
- Road network
- Watercourses
- Wetlands and impoundments
- Central Free State Grassland
- Basotho Montane Shrubland
- Critical Biodiversity Area 1
- Critical Biodiversity Area 2
- NPAES Focus Areas

Map Information

Spheroid: WGS 84

Quantum GIS

Scale: 1:120 000

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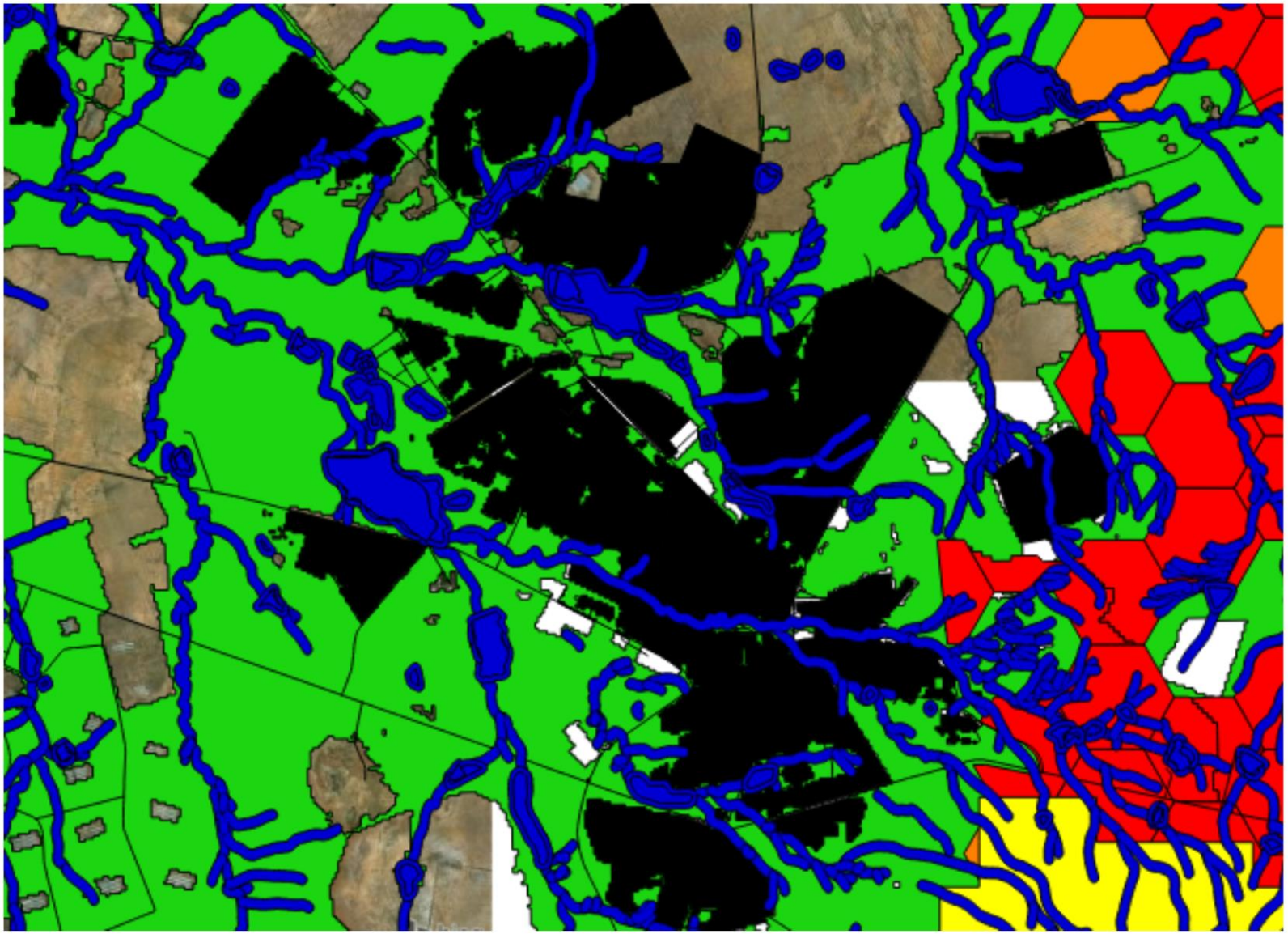
Map 2: General ecology map of the Botshabelo urban area. Note the extensive urban development although large portions of apparent natural vegetation still remain. Areas of significance may include the mountainous terrain associated with Basotho Montane Shrubland, the Rustfontein Nature Reserve and associated CBA 1 areas and NPAES Focus Areas to the west and the high number of watercourses and wetlands, including the Klein-Modder River.

General ecology map for the Mangaung Metropolitan Open Space System (MOSS) for the urban area of Thaba Nchu, Free State Province.



Preparred for:
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Bloemfontein
9301

Legend:

- Urban area
- Road network
- Watercourses
- Wetlands and impoundments
- Central Free State Grassland
- Basotho Montane Shrubland
- Critical Biodiversity Area 1
- Critical Biodiversity Area 2
- NPAES Focus Areas

Map Information

Spheroid: WGS 84

Quantum GIS

Scale: 1:85 000

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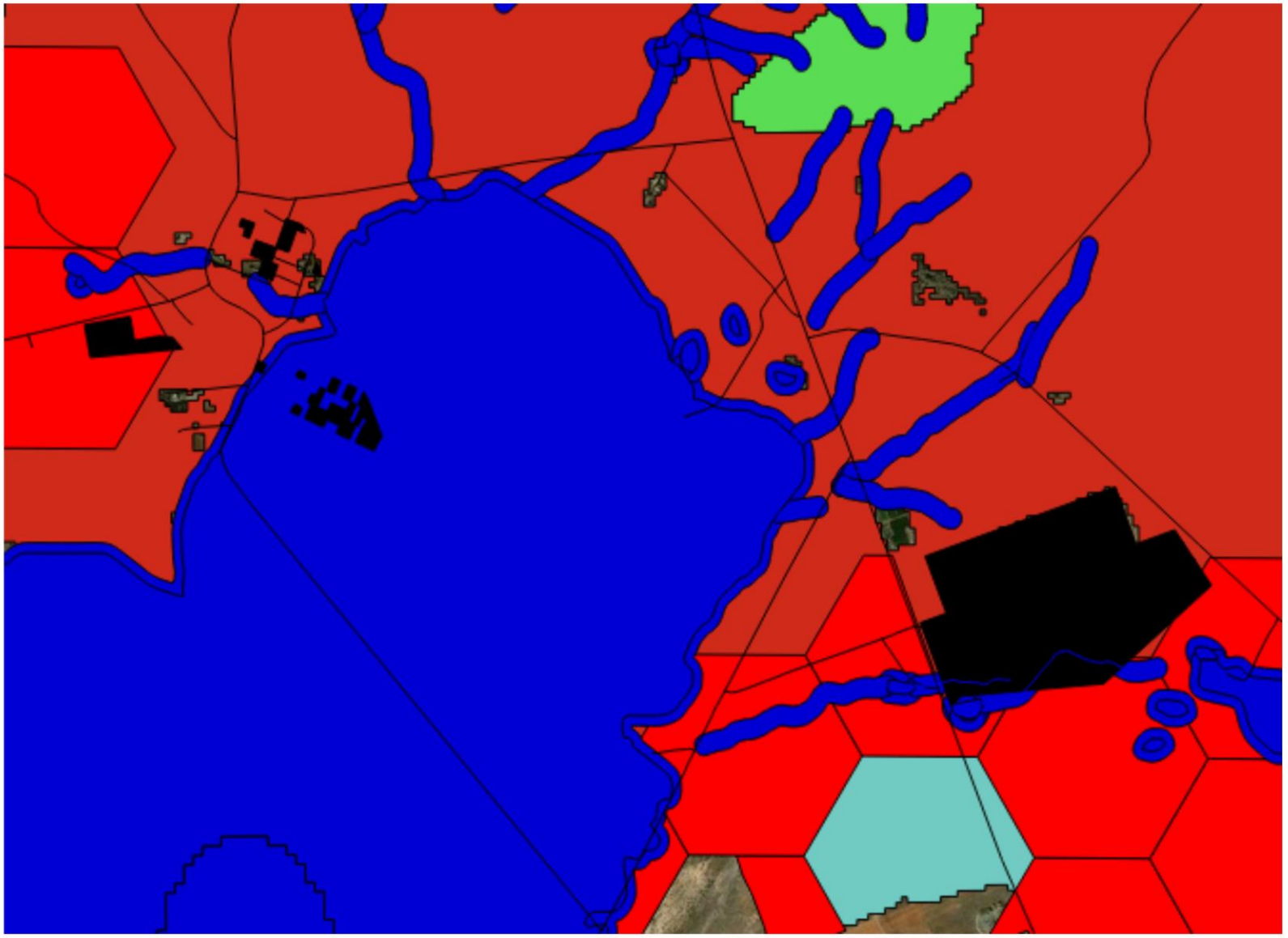
Map 3: General ecology map of the Thaba Nchu urban area. Note the extensive urban development although large portions of apparent natural vegetation still remain. Areas of significance may include the mountainous terrain associated with Thaba Nchu Mountain and also the extensive portions of CBA 1 and NPAES Focus Areas to the east of the urban area. Note also the relatively high amount of wetlands and watercourses, including the Sepane River flowing through the urban area.

General ecology map for the Mangaung Metropolitan Open Space System (MOSS) for the urban area of Soutpan/Ikgomotseng, Free State Province.



Preparred for:
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Suite 7, Westdene Park
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9301

Legend:

- Urban area
- Road network
- Watercourses
- Wetlands and impoundments
- Vaalbos Rocky Shrubland
- Sand-Vet Sandy Grassland
- Western FS Clay Grassland
- Critical Biodiversity Area 1
- Critical Biodiversity Area 2
- NPAES Focus Areas

Map Information

Spheroid: WGS 84

Quantum GIS

Scale: 1:45 000

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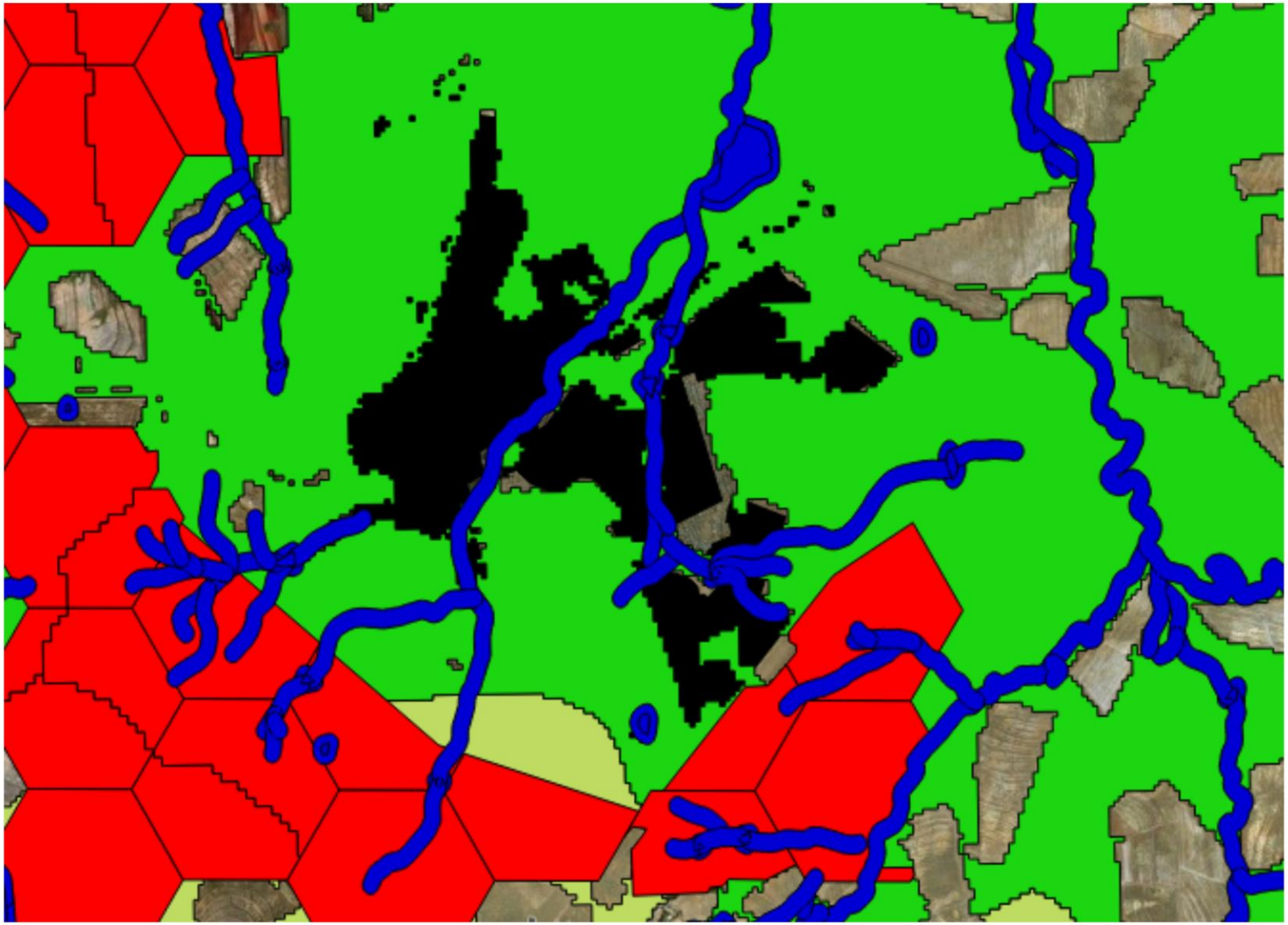
Map 4: General ecology map of the Soutpand/Ikgomotseng urban area. Note the small extent of urban areas though some transformation of natural vegetation is still evident. Areas which may have a significant conservation value include the uneven terrain consisting of Vaalbos Rocky Shrubland, CBA areas to the west and south as well as the numerous small watercourses and the large salt pan, forming a depression wetland.

General ecology map for the Mangaung Metropolitan Open Space System (MOSS) for the urban area of Dewetsdorp, Free State Province.



Preparred for:
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Suite 7, Westdene Park
Bloemfontein
9301

Legend:

- Urban area
- Road network
- Watercourses
- Wetlands and impoundments
- Central Free State Grassland
- Aliwal North Dry Grassland
- Critical Biodiversity Area 1
- Critical Biodiversity Area 2
- NPAES Focus Areas

Map Information

Spheroid: WGS 84

Quantum GIS

Scale: 1:40 000

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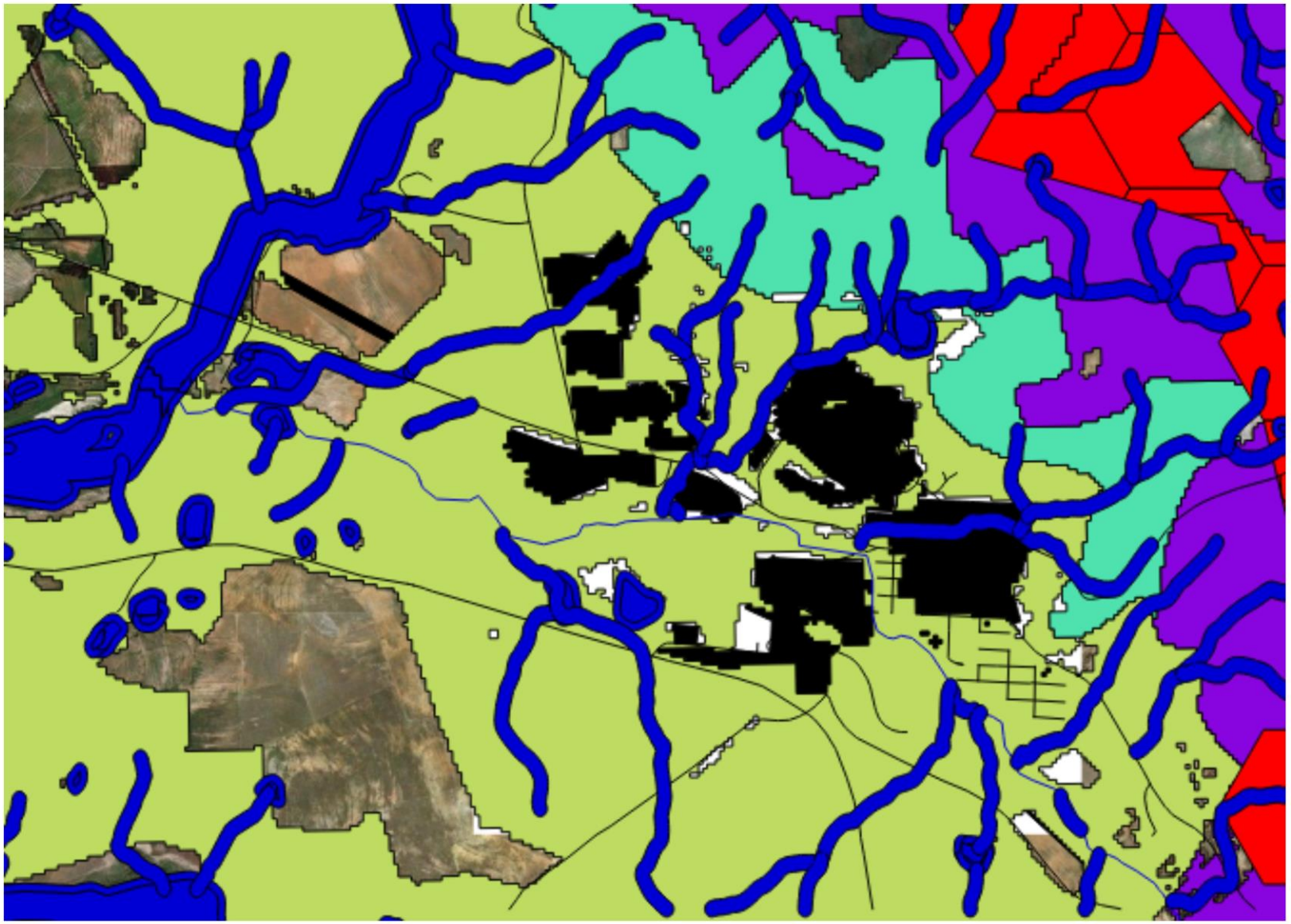
Map 5: General ecology map of the Dewetsdorp urban area. Note the small extent of urban areas though some transformation of natural vegetation is still evident. Areas which may have a significant conservation value include the uneven terrain along the western border of the urban area, extensive CBA areas to the west and south as well as numerous watercourses of which a few flow through the urban area and the Modder River flows past the eastern border of the area.

General ecology map for the Mangaung Metropolitan Open Space System (MOSS) for the urban area of Wepener, Free State Province.



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9301

Legend:

- Urban area
- Road network
- Watercourses
- Wetlands and impoundments
- Basotho Montane Shrubland
- Aliwal North Dry Grassland
- Eastern FS Clay Grassland
- Critical Biodiversity Area 1
- Critical Biodiversity Area 2
- NPAES Focus Areas

Map Information

Spheroid: WGS 84

Quantum GIS

Scale: 1:45 000

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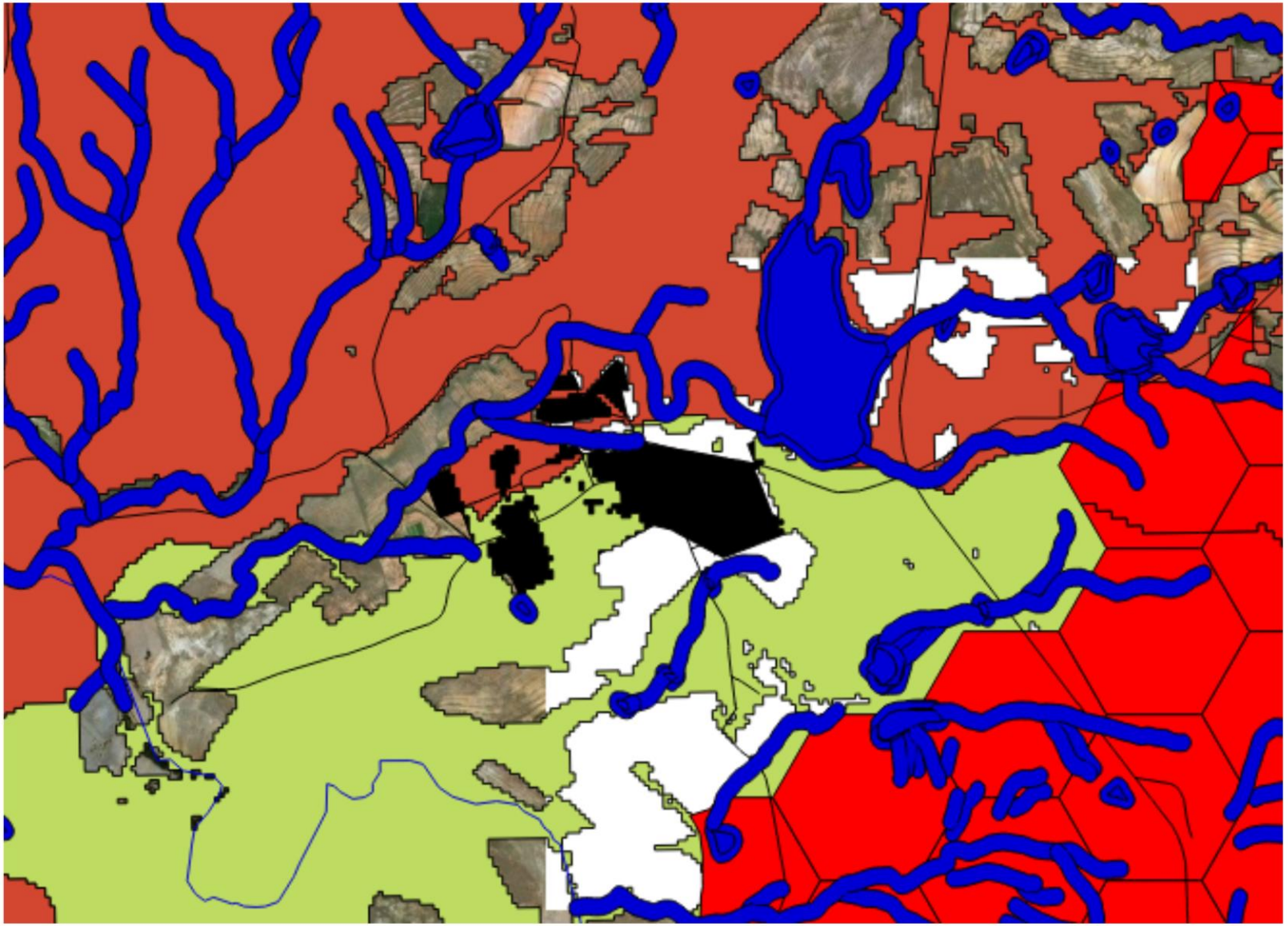
Map 6: General ecology map of the Wepener urban area. Note the small extent of urban areas though some transformation of natural vegetation is still evident. Areas which may have a significant conservation value include the mountainous terrain consisting of Basotho Montane Shrubland and Eastern Free State Clay Grassland to the north and east of the urban area and the numerous watercourses including the large Caledon River to the east.

General ecology map for the Mangaung Metropolitan Open Space System (MOSS) for the urban area of Vanstadensrus, Free State Province.



Preparred for:
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Bloemfontein
9301

Legend:

- Urban area
- Road network
- Watercourses
- Wetlands and impoundments
- Basotho Montane Shrubland
- Aliwal North Dry Grassland
- Critical Biodiversity Area 1
- Critical Biodiversity Area 2
- NPAES Focus Areas

Map Information

Spheroid: WGS 84

Quantum GIS

Scale: 1:55 000

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Map 7: General ecology map of the Vanstadensrus urban area. Note the small extent of urban areas though some transformation of natural vegetation is still evident. Areas which may have a significant conservation value include the uneven rocky terrain consisting of Besemkaree Koppies Shrubland to the north and extensive CBA areas to the south east. Note also numerous small watercourses and wetlands occurring in the area.

SECTION B:

ECOLOGICAL AND WETLAND ASSESSMENTS FOR THE MANGAUNG METROPOLITAN OPEN SPACE PLAN

DECLARATION OF INDEPENDENCE

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

Report Version	**Final 1.0**		
Title	**Ecological and Wetland Assessment for the Mangaung Metropolitan Open Space System (MOSS) including the urban areas of Bloemfontein, Thaba Nchu, Botshabelo, Soutpan, Wepener, Dewetsdorp and Vanstadensrus, Free State Province.**		
Author	**DP van Rensburg (Pr.Sci.Nat)**		**Oct'20**

Executive Summary

The study area consists of several separate urban areas with a large extent. These are the city of Bloemfontein and surrounding towns, including Thaba Nchu, Botshabelo, Soutpan, Dewetsdorp, Wepener and Vanstadensrus. From aerial images it is clear that these areas consist of extensive urban areas but that significant natural areas are also visible within the urban edge. The study will be limited to the natural areas within the MOSS located within the urban edge of these urban areas. Furthermore, a high number of watercourses and wetlands also occur in these urban areas with some of the larger rivers including the Bloemspruit, Renosterspruit, Modder River, Klein-Modder River, Sepane River, Caledon River and Witspruit.

Survey of the study area was initiated during June 2020 and each urban area surveyed consecutively. The survey was conducted by means of sampling sites which were allocated to each distinct topographical or vegetation unit in order to get a representative sample of them within the MOSS. The survey is considered to be comprehensive and should give a good description of each distinct element within the MOSS. The time of the survey is no longer considered optimal in terms of seasonality although it was still possible to identify dominant vegetation and riparian and wetland vegetation. Accurate identification of the species diversity is therefore considered a limitation of the survey. Supplemental data collection should therefore also be considered where possible. Data collected during previous studies were also utilised to augment the study.

The urban areas of Bloemfontein, Botshabelo and Thaba Nchu contain a clearly defined MOSS which is centred around hills, ridges and watercourses which will form the focus of this survey. This delineated MOSS is situated within municipal and private properties which results in several limitations. Access to private properties could not be provided and these areas could therefore only be assessed by desktop overview. Due to the lack of access the delineation of sensitive areas were assessed on a course level. Due to the coarse level of assessment, where ever development or spatial planning is proposed, detailed and comprehensive assessment will still need to be conducted. It is recommended that private landowners be consulted and that additional surveys be conducted in these areas in order to improve the accuracy of the MOSS.

The urban areas of Soutpan, Dewetsdorp, Wepener and Vanstadensrus does not contain a defined MOSS and the assessment was therefore applied to communal municipal areas surrounding these towns. Access could easily be obtained for municipal communal areas around these towns and this allowed for comprehensive survey of the remaining natural areas. In view of the lack of a defined MOSS all areas defined as having a High or Very High level of sensitivity should be taken as synonymous with a MOSS and avoided by urban planning as far as possible. Although comprehensive assessment of remaining natural areas was undertaken it is likely that inaccuracies in delineation occur and sensitive areas may have been overlooked. As a result, wherever development or spatial planning is proposed, detailed and comprehensive assessment should still be undertaken.

Bloemfontein Urban Area

Bloemfontein is the economic hub of the municipal area and will remain the locus for future development. Larger watercourses occurring in this urban area include the Renosterspruit, Bloemspruit and Seven-Dams Stream. Owing to the high-density urban areas these are generally heavily modified.

In the Bloemfontein urban area the impacts caused on the remaining natural areas are significant and decreases the condition of several of the areas. This is also applicable to the delineated MOSS of the city where large portions of relatively natural portions remain though several areas of the MOSS has also become fragmented due to agricultural and urban development.

It is evident that large portions of the MOSS, especially those areas forming ecological corridors are already transformed. In-field surveys were largely confined to areas of municipal properties, while previous field surveys and desktop information were utilised for private properties, as well as other inaccessible areas such as military bases and airports.

From the description of the remaining natural vegetation in the Bloemfontein urban area and by using available data sets the following elements of ecological importance should be taken into account in the MOSS:

- All four vegetation types contain elements of conservation value and consequently, where natural portions of these vegetation types remain they should be regarded as having a significant conservation value.
- Significant portions of the vegetation within the delineated MOSS has already been transformed, especially plains portions consisting of Bloemfontein Dry Grassland. Despite being transformed these areas still form part of the MOSS and function in terms of ecological corridors and as a result they are still considered to have a moderate level of Sensitivity.
- Access to large portions of the MOSS could not be provided and the assessment is therefore based on limited field surveys of the MOSS and surrounding areas, previous data and desktop information. Delineation of sensitive areas may therefore contain inaccurate delineation and therefore additional studies should be conducted for any site specific areas within the MOSS.
- Bloemfontein Dry Grassland is listed as a Vulnerable (VU) vegetation type which increases its sensitivity and conservation value. All remaining portions of this vegetation type should be afforded at least a High level of sensitivity and those portions having been transformed should still be regarded as having a Moderate level of sensitivity.
- Winburg Grassy Shrubland is confined to hills and ridges, positive landscape elements forming terrestrial corridors. The survey has indicated that the majority of the vegetation type within the MOSS is still intact and in relatively good condition with a high species diversity and many protected and rare or uncommon species. The combination of the above provides this vegetation type with at least a High level of sensitivity where it occurs in the MOSS and which should be regarded as Very High where this also coincides with CBA areas.
- The survey has indicated that areas of Bloemfontein Karroid Shrubland within the MOSS is still largely intact and in relatively good condition with a high species diversity and many protected and rare or uncommon species forming a quite unique habitat. The combination of the above provides this vegetation type with at least a High level of sensitivity where it occurs in the MOSS and which should be regarded as Very High where this also coincides with CBA areas.
- Furthermore, the portion of this vegetation type situated within the Valley-of-Seven-Dams area also forms the catchment of the Seven Dams Stream system which has been identified as a highly sensitive system, also being listed as a National Freshwater Ecosystem Priority Area (NFEPA): Upstream System (refer to Section 4.2.5. and 4.2.6). This will also increase the conservation value of the vegetation type in this area.

- The high level of sensitivity of the Bloemfontein Karroid Shrubland has also been confirmed by several previous studies (Dingaan & Du Preez 2017, Dingaan & Du Preez 2002, Brown & Du Preez 2014).
- The Highveld Alluvial Vegetation type is associated with the floodplains of the Bloemspruit and Renosterspruit which, although they are heavily modified, remain highly important in terms of their functions and services, and all portions of the vegetation type as well as these watercourses where they occur within the MOSS must be regarded as having a Very High level of sensitivity.
- As previously indicated the Bloemfontein MOSS contains a few areas also listed as Critical Biodiversity Areas 1 (CBA1) and where this coincides with the MOSS the level of sensitivity should be increased to Very High.
- Surveys of the MOSS seems to indicate that where the local community has been involved in the management of natural areas this improves the general condition of these areas. Further involvement of the local community in the management of the MOSS should be considered.

Bloemspruit/Rensoterspruit (Appendix A: Map 1-2): Several impacts on the Bloemspruit and Renosterspruit have caused severe modification of these watercourses. These watercourses are naturally seasonal in nature flowing only during the rainy season. However, due to canalisation of portions of these watercourses, especially the Bloemspruit, as well as increased runoff from urban areas and industries and the release of treated water these systems are now both perennial in nature. Both these watercourses flow through urban and industrial areas which contribute highly polluted runoff. This leads to high levels of pollution within the stream. High nutrient levels also promote dominance by exotic weeds and invaders. A large portion of the Bloemspruit has also been canalised. This has a large impact on the functioning of the stream in terms of flood dynamics and the ecosystem services rendered by an intact riparian community.
Both the Bloemspruit and Renosterspruit are considered to have a PES of Category F: Critically/Extremely modified. Modifications have reached a critical level and the system has been modified completely with an almost complete loss of natural habitat and biota. In spite of this seriously modified nature the rivers both still provides a vital ecosystem service as a water conduit and must therefore still be considered sensitive.

Seven Dams Stream (Appendix A: Map 1-2): This is a large system supporting a varied wetland system. Under natural conditions this stream is anticipated to have had a connected main channel flow only at a seasonal basis and after heavy rainfall events. A large portion of its catchment is certainly situated within the urban environment. There are however large portions of the stream which still flows through natural areas, notably the Seven Dams Conservancy and Free State Botanical Gardens. As a result of the urban catchment the amount of runoff is increased substantially. This alters the flow regime of the stream to a large degree, i.e. the stream would naturally only have flowed during summer after heavy rainfall but due to increased runoff the flow is now almost perennial. Furthermore, several dams occur in the stream and although they capture runoff and floods they provide a constant water flow and so also sustain a perennial flow. Despite being modified the stream is still considered to be a highly sensitive system and provides several vital services. In addition, the stream is also listed as a National Freshwater Ecosystems Priority Area (NFEPA): Upstream System and as a result this even further increases the value of this system. The stream and its catchment should therefore be regarded as having a very high level of sensitivity.

Botshabelo Urban Area (Appendix A: Map 2)

Botshabelo is located 55 km east from Bloemfontein. Being situated more toward the eastern half of the province, large hills ridges and even mountains become prominent. A prominent feature is the Klein-Modder River flowing through the urban area. Owing to high-density urban development the urban area is also generally heavily modified.

The Botshabelo urban area it is quite extensive, but less so than Bloemfontein, and therefore still has a variety of habitats and topographical units. The Botshabelo MOSS consists almost exclusively of the surrounding hills and mountains and these still consist to a large degree of natural vegetation though impacts around the urban area does cause significant degradation, decreasing in magnitude further away from the urban area.

The survey has indicated that almost the entire MOSS still consists of natural vegetation but that overgrazing and urban impacts cause substantial degradation. The level of disturbance was noted to be highest around the urban areas and decreasing substantially in the portions of the MOSS located further away from urban areas. In-field surveys were confined to areas of municipal or communal properties while previous field surveys and desktop information were utilised for private properties, as well as other inaccessible areas such as communal farming operations.

From the description of the remaining natural vegetation in the Botshabelo urban area and by using available data sets the following elements of ecological importance should be taken into account in the MOSS:

- Both vegetation types contain elements of conservation value and consequently, where natural portions of these vegetation types remain they should be regarded as having a significant conservation value.
- The Botshabelo MOSS is largely intact with only small portions having been transformed from the natural condition. Despite being transformed these areas still form part of the MOSS and function in terms of ecological corridors and as a result they are still considered to have a moderate level of Sensitivity.
- The majority of the Botshabelo MOSS is situated within municipal and communal areas and access could easily be obtained. However, access could not be provided for areas located on private property such as the Thaba Nchu Mountain and assessment is therefore based on surrounding areas. Delineation of sensitive areas may therefore contain inaccurate delineation and therefore additional studies should be conducted for any site specific areas within the MOSS.
- The portion of Central Free State Grassland to the west of Botshabelo is degraded as a result of heavy overgrazing and consequently this portion is regarded as having a moderate level of sensitivity.
- The portion of Central Free State Grassland to the east of the Thaba Nchu Mountain could not be assessed though seems to be in a good condition and is therefore assigned a default sensitivity rating of High.
- The Basotho Montane Shrubland dominated the MOSS and consists of hills, ridges and mountainous areas. The survey has indicated that the majority of the vegetation type within the MOSS is still intact and though overgrazing does cause disturbance it retains a high species diversity and many protected and rare or uncommon species. The combination of the above provides this vegetation type with at least a High level of sensitivity where it occurs in the MOSS and which should be regarded as Very High where this also coincides with CBA areas and NPAES Focus Areas.

- Both vegetation types contain numerous protected species which should also be taken into account in the sensitivity of remaining natural vegetation.
- Areas listed as CBA areas such as occurs in and around the Rustfontein Dam Nature Reserve, Maria Maroka Nature Reserve and Thaba Nchu Mountain should be regarded as having a very high level of sensitivity and remains important irrespective of occurring within the reserve or not.
- Large portions of NPAES Focus Areas occur to the west of Botshabelo. These areas also aim to increase the conservation area of the Rustfontein Nature Reserve. A large NPAES Focus Area also occur to the east of Botshabelo and coincide with the Thaba Nchu Mountain and to some extent with CBA areas and aim to formalise the protection of the Thaba Nchu Mountain. Only the NPAES Focus Area to the east occur within the MOSS. However, spatial planning should aim to avoid all NPAES Focus Areas, irrespective of if they fall within the MOSS or not.
- Survey of the MOSS indicate that overgrazing by domestic livestock is high in most areas and leads to substantial disturbance of the natural areas. Consultation with the local community should aim to improve grazing practises and alleviate the pressure on natural areas.

Klein-Modder River (Appendix A: Map 3 - 4): A significant portion of the Klein-Modder River flows through the centre of the town and is also included within the MOSS. The Klein -Modder River is severely degraded by several significant impacts. The Klein-Modder is naturally an ephemeral system flowing only after heavy rainfall events. However, due to increased runoff from urban areas it has now become perennial. This is considered a severe alteration to the flow and flood regime. It flows through the urban centre of Botshabelo which contribute highly polluted runoff. This leads to high levels of pollution within the river. High nutrient levels also promote dominance by exotic weeds and invaders. The river itself is still largely intact in terms of morphology but several of its tributaries has been affected by channel straightening and canalisation. High levels of rubbish dumping take place within the catchment and in the river and this further degrades the condition. Existing road crossings also cause significant impacts. These act as flow barriers retarding flow and in so doing altering the flow and flooding regime. Concentrated livestock farming is noted along the banks of the watercourses and this will also contribute impacts in the form of decreasing the vegetation layer, trampling will disturb the soil surface and increased runoff and sediment load will result. This study has determined that the Klein-Modder River and its associated tributaries has a PES of Category E: Seriously Modified (Appendix C). Despite this the system still provides vital services including water transportation, storm water and groundwater recharge. The entire system should therefore still be considered as sensitive and management of the MOSS should rather attempt to improve the condition however unlikely that may be.

6.3 Thaba Nchu Urban Area (Appendix A: Map 3)

Thaba Nchu are located 67 km east from Bloemfontein and has a more scattered development pattern with 37 villages surrounding the urban centre, some as far as 35 kilometres from the closest urban centre. The area is characterised by vast stretches of communal grazing areas that surround the urban centre. The area has also two industrial areas. Being situated more toward the eastern half of the province, large hills ridges and even mountains become prominent. A prominent feature is the Sepane River flowing through the urban area. It flows directly through the CBD which leads to high levels of degradation and encroachment into the floodplain of the river. Owing to high-density urban development the urban area is also generally heavily modified.

Being situated almost adjacent to Botshabelo, Thaba Nchu will have much the same description and will share much of the same information and data.

The Thaba Nchu urban area it is still a large area though smaller than Botshabelo, even smaller than Bloemfontein, and it has a somewhat lower habitat diversity than Botshabelo. The Thaba Nchu Mountain significantly increases diversity but does not form part of the urban area itself and access to it could also not be provided. The Thaba Nchu MOSS consists almost exclusively of the surrounding hills and mountains and these still consist to a large degree of natural vegetation though impacts around the urban area does cause significant degradation, decreasing in magnitude further away from the urban area.

The survey has indicated that almost the entire MOSS still consists of natural vegetation but that overgrazing and urban impacts cause substantial degradation. The level of disturbance was noted to be highest around the urban areas and decreasing substantially in the portions of the MOSS located further away from urban areas. In-field surveys were confined to areas of municipal or communal properties while previous field surveys and desktop information were utilised for private properties, as well as other inaccessible areas such as communal farming operations.

From the description of the remaining natural vegetation in the Thaba Nchu urban area and by using available data sets the following elements of ecological importance should be taken into account in the MOSS:

- Both vegetation types contain elements of conservation value and consequently, where natural portions of these vegetation types remain they should be regarded as having a significant conservation value.
- The Thaba Nchu MOSS is largely intact with almost all portions of the MOSS remaining untransformed from the natural condition. Irrespective of the condition of degraded areas they all form part of the MOSS and function in terms of ecological corridors and as a result they will retain a significant level of sensitivity.
- The majority of the Thaba Nchu MOSS is situated within municipal and communal areas and access could easily be obtained. However, access could not be provided for areas located within communal farming operations and assessment is therefore based on surrounding areas. Delineation of sensitive areas may therefore contain inaccurate delineation and therefore additional studies should be conducted for any site specific areas within the MOSS.
- The Thaba Nchu MOSS consists exclusively of hill, ridges and mountainous areas and therefore does not contain plains areas. Vegetation is therefore dominated by Basotho Montane Shrubland and Winburg Grassy Shrubland.
- These area are largely intact and though overgrazing does cause disturbance it retains a high species diversity and many protected and rare or uncommon species. The combination of the above provides this vegetation type with at least a High level of sensitivity where it occurs in the MOSS and which should be regarded as Very High where this also coincides with CBA areas and NPAES Focus Areas.
- Both vegetation types contain numerous protected species which should also be taken into account in the sensitivity of remaining natural vegetation.
- Large areas listed as CBA areas occur to the east and south of Thaba Nchu. Though these do not occur within the MOSS they should still be regarded as having a high conservation value and taken into account in spatial planning.

- Though no NPAES Focus Areas occur within the Thaba Nchu MOSS (Appendix A: Map 6) such areas do occur to the east of Botshabelo and are associated with the Thaba Nchu Mountain (Appendix A: Map 4) and are then considered to have a very high level of sensitivity.
- Survey of the MOSS indicate that overgrazing by domestic livestock is high in most areas and leads to substantial disturbance of the natural areas. Consultation with the local community should aim to improve grazing practises and alleviate the pressure on natural areas.

Sepane River (Appendix A: Map 5 - 6): A large portion of the Sepane River flows through the urban area of Thaba Nchu but is not included within the MOSS. Only a small section of the river passes through the MOSS to the west of the urban area. However, since it is one of the larger watercourses in the area it is nonetheless included in this discussion. Several impacts on the Sepane River has caused significant modification and degradation of these watercourses. The Sepane River is naturally a seasonal system flowing only after heavy rainfall events. However, due to the significant increase in runoff from the Thaba Nchu urban area it has now become almost perennial. This is considered a severe alteration to the flow and flood regime. IThe urban area also contributes high values of pollutants to the system. High levels of rubbish dumping takes place within the river as well as the surrounding catchment and further degrades it. High nutrient levels also promote dominance by exotic weeds and invaders. Concentrated livestock farming was noted along the banks of the watercourses and this will also contribute impacts in the form of decreasing the vegetation layer, trampling will disturb the soil surface and increased runoff and sediment load will result. This study has calculated the Sepane River as having a PES of Category D: Largely Modified. A large loss of natural habitat, biota and basic ecosystem function has occurred. Despite this the system still provides vital services including water transportation, storm water and groundwater recharge. The entire system should therefore still be considered as sensitive.

Soutpan Urban Area (Appendix A: Map 7-8)

Soutpan is a very small town that was established due to the existence of salt in the immediate surroundings of the town. The town is still producing a large amount of salt and the current inhabitants of Soutpan are employed by the salt production industry. The urban extent of the town is approximately 80 hectares and should also clearly indicate the small extent of the town. No prominent watercourses are present although the large pan system, also a depression wetland area, is a prominent feature of the town. The town forms part of a mostly natural area although the urban areas and salt mining operations do cause some degradation of the area.

The area has a small extent but nonetheless contains several topographical elements which will translate to different habitats and vegetation types. The area is dominated by natural areas and it is evident that although several significant impacts are present these are not extensive and consequently the remaining natural vegetation is still in a relatively good condition.

From the description of the remaining natural vegetation in the Soutpan/Ikgomotseng urban area and by using available data sets the following elements of ecological importance should be taken into account in the MOSS:

- All three vegetation types contain elements of conservation value and consequently, where natural portions of these vegetation types remain they should be regarded as having a significant conservation value.

- Overall the dominating plains consisting of the Western Free State Clay Grassland vegetation type does not contain elements of high sensitivity, a high species diversity or species of high conservation value and does not contain any unique habitats. As a result, overall, it is considered to have a moderate level of sensitivity.\
- The sandy grassland vegetation unit constituting the remaining Vaal-Vet Sandy Grassland, an Endangered (EN) vegetation type, does not contain a significant species diversity or species of high conservation value. However, the habitat and species composition is unique and it is also under severe transformation pressures for crop cultivation. This is also clear when looking to the south of the urban area. As a result, although this remaining portion of grassland does not contain a high species diversity or species of conservation importance, and is also situated within an ecotone or transition, it must still be regarded as having at least a high level of sensitivity.
- The dolerite hill and ridges to the north of Soutpan consisting of Vaalbos Rocky Shrubland has a significant habitat diversity, species diversity, presence of numerous protected species and relatively good condition and as a result the vegetation unit is regarded to have a high level of sensitivity.
- The area contains numerous protected species. Although all the vegetation units and vegetation types contain some protected species the rocky hill and ridge system to the north and east of the urban area contain a proportionally much higher number of protected species. This further warrants this area being regarded as having a high sensitivity.
- The portion indicated as a CBA 1 to the south of the urban area consists of Vaal-Vet Sandy Grassland (EN) and also substantiates this portion being regarded as having a high level of sensitivity. However, on-site observations indicates a much more accurate delineation of this area (Appendix A: Map 8).

Soutpan – Depression wetland/pan system (Appendix A: Map 7-8): The large pan system or depression wetland forms the main feature of the urban area of Soutpan/Ikgomotseng. The pan itself is being degraded by several impacts of the historical and current salt mining operations is most significant. This includes the abstraction of groundwater, excavation of evaporation ponds and removal of salt. This will most likely impact on the hydrology of the pan, impacting to some degree its functioning and has clearly also caused significant modification of the species composition. The pan is being fed by several watercourses, none of which are large but most which consist of extensive wetland conditions. Any impacts on these streams will also affect the pan and as such it should be regarded as one system and managed as such. Numerous impacts affect the large depression wetland or pan in Soutpan and this causes significant modification of it. However, thus far its functioning still seems to be intact and it still provides extensive wetland habitat. Its conservation value should therefore be regarded as having a very high sensitivity.

Dewetsdorp Urban Area (Appendix A: Map 9 - 10)

Dewetsdorp is a small town located 75 km south-east of Bloemfontein on the R702. The urban extent of the town is approximately 600 hectares and should also clearly indicate the small extent of the town. A few prominent watercourses have their origin near the town and the Modder River also flows past the town to the east of the urban area. The town forms part of a mostly natural area although the urban areas and surrounding agricultural operations do cause some degradation of the area.

The area has a small extent, however, a diverse topography and habitats, dominated by undulating grassland, significantly increases the species and habitat diversity. The area is

dominated by natural areas, however, significant impacts, including widespread overgrazing does notably degrade the condition of natural areas.

From the description of the remaining natural vegetation in the Dewetsdorp urban area and by using available data sets the following elements of ecological importance should be taken into account in the MOSS:

- All three vegetation types or units identified during the survey contain elements of conservation value and consequently, where natural portions of these vegetation types remain they should be regarded as having a significant conservation value.
- The undulating plains consisting of Central Free State Grassland is still largely natural though modified somewhat by overgrazing. The grass layer is dominated by a few species leading to a moderate species diversity. Coupled with this, habitat diversity is also relatively uniform. As a result, elements of high conservation value is largely absent. However, several geophytic species are present with a few being listed as protected species and this does contribute to the conservation value of this vegetation unit. Overall, this vegetation type or unit is considered to have a moderate level of sensitivity.
- The portions consisting of Aliwal North Dry Grassland and shallow soils with sandstone outcrops is still largely natural. However, the north eastern portion has been heavily affected by overgrazing and this has decreased its conservation value to moderate.
- Other smaller portions of total transformation, including the old borrow pits and quarries and the current landfill site must be regarded as having a low level of sensitivity.
- The portion of Aliwal North Dry Grassland to the west of the town is least degraded, contains a moderate habitat diversity, significant species diversity and the presence of several protected species are considered to lend a high level of sensitivity to the area. This area also forms the origin of a prominent stream and wetland system which also further substantiates a high level of sensitivity.
- The prominent ridge system to the west of the town consisting of Besemkaree Koppies Shrubland is considered largely natural, it contains a quite high species and habitat diversity with many being listed as protected or being uncommon. This ridges system also gives rise to several drainage lines and stream systems. As a result of the combination of the above the ridge system and watercourses associated with it is regarded as having a very high level of sensitivity.
- The prominent sandstone hill to the east of the town would normally also have been regarded as having a very high conservation value. However, it is being degraded, mostly due to overgrazing by domestic livestock, and consequently it is only regarded as having a high sensitivity level.
- The areas to the south and east of the town being listed as a Critical Biodiversity Area 1 (CBA 1) should be regarded as having a high level of sensitivity. Though the reasons for this area being considered a CBA is not clearly apparent the on-site survey indicates that this may be coupled to the origins of stream systems in the area (Appendix A: Map 10).
- The survey indicated that overgrazing by domestic livestock in the communal grazing areas area quite high in many areas, leading to degradation of the grassland. Management of municipal area should therefore also take this into consideration.

Dewetsdorp Modder River (Appendix A: Map 9-10): The Modder River is heavily degraded but mostly modified in terms of its functioning by the upstream Novo Transfer Scheme. The town of Dewetsdorp is situated quite close to the origin of the river (Approximately 5 km to the south), yet the flow at the survey site was noted to be perennial with a fast flow rate. Under natural

conditions the river at the site would at best have been seasonal and only have active flow after large rainfall events. This therefore indicates a large modification in terms of the flow and flooding regime. Concentrated livestock farming was noted along the banks of the river and this will also contribute impacts in the form of decreasing the vegetation layer, trampling will disturb the soil surface and increased runoff and sediment load will result. In addition, manure will increase the nutrient load within the river. A large stream system also originates in Dewetsdorp and forms a direct tributary of the Modder River downstream of the urban area. Any impacts on it will therefore also affect the river. Pollution within the stream was notable, especially where it flows through the urban area. A few small impoundments will have a limited impact in terms of its flow regime. The WWTW of Dewetsdorp also discharges into this stream and this is likely to also have a significant impact in terms of the nutrient load and increased flow volumes. The entire system should still be considered as sensitive and management of the MOSS should rather attempt to improve the condition however unlikely that may be.

Wepener Urban Area (Appendix A: Map 11 - 12)

Wepener is located 120km south east of Bloemfontein and was founded in 1867 on the banks of Jammersbergspruit, a tributary of the Caledon River. The Caledon River is situated along the western border of the town and is a large and significant watercourse. The urban extent of the town is approximately 840 hectares and should also clearly indicate the small extent of the town. The town forms part of a mostly natural area although the urban areas and surrounding agricultural operations do cause some degradation of the area.

Although the town has a small extent it contains a diversity of topographical elements and habitats which will also considerably increase species diversity. The area is dominated by natural areas, however, significant impacts, including widespread overgrazing does notably degrade the condition of natural areas.

From the description of the remaining natural vegetation in the Wepener urban area and by using available data sets the following elements of ecological importance should be taken into account in the MOSS:

- All three vegetation types contain elements of conservation value and consequently, where natural portions of these vegetation types remain they should be regarded as having a significant conservation value.
- Smaller portions around the town which were clearly transformed by amongst others a disused quarry and landfill to the east and west of the town, the old disused golfcourse, scattered, small woodlots and windrows of exotic trees, the current and old WWTW's and cemeteries are considered to be of low sensitivity.
- The undulating plains consisting of Aliwal North Dry Grassland is still largely natural though modified somewhat by overgrazing. The grass layer is dominated by a few species leading to a moderate species diversity. Coupled with this, habitat diversity is also relatively uniform. As a result, elements of high conservation value is largely absent. However, a few protected species are present and this does contribute to the conservation value of this vegetation unit. Overall, this vegetation type or unit is considered to have a moderate level of sensitivity.
- The ridges, hills and slopes consisting of Basotho Montane Shrubland is largely natural though it was noted that overgrazing by livestock, especially in the areas closest to urban development is quite high and does lead to significant erosion. This significantly decreases the condition of this vegetation type. However, it was also quite evident that

it contains a high diversity of species and growth forms with many being listed as protected or being uncommon. Numerous drainage lines, ravines, streams and associated wetlands also occur along the slopes. As a result of a combination of the above the vegetation type should as a whole be regarded as having a high level of sensitivity. Furthermore, it is quite evident that the vegetation type is vulnerable to overgrazing and trampling and this also further substantiates that it be regarded as having a high level of sensitivity.

- The plateau of the mountainous areas to the east and north of the town consisting of Eastern Free State Clay Grassland is considered largely natural although overgrazing by domestic livestock causes significant degradation and especially erosion. It is evident that the vegetation unit contains a high diversity of species and growth forms with many being listed as protected or being uncommon. A high amount of seepage wetlands also form on the plateau. As a result of the combination of the above, including high species diversity and protected species but also as a result of the vegetation type being listed as Vulnerable (VU), it is regarded as having a high level of sensitivity.
- Although the municipal area of Wepener does not contain any Critical Biodiversity Areas (CBA) it does border on such areas to the east, associated with Eastern Free State Clay Grassland, and although it is therefore unlikely to impact on these areas it should still be taken into considered by the urban planning of the town (Appendix A: Map 12).
- The survey indicated that overgrazing by domestic livestock in the communal grazing areas area quite high in many areas, leading to degradation of the grassland and where slopes and wetlands are affected, this also leads to high levels of erosion. Management of municipal areas should therefore also take this into consideration.

Wepener Caledon River (Appendix A: Map 11-12): The hydrology of the river is impacted on by several factors. Extensive human settlement occurs in the catchment of the river and in close proximity to the river. These settlements include Wepener, Mabotse, Chere and Sekameng. These settlements all contribute to increased runoff, pollutants and sediment. Industrial pollutants are an emerging but serious problem and most discharges from industry flows into the Caledon River. It is known that the water in the Caledon (Mohokare) River is naturally of high turbidity and carries a concerning high sediment load. However, poor management practises result in high sediment yields. The slope as well as the erodability of the soils in the upper Caledon catchment leads to increased sediment deposition. Severe soil erosion, especially in the Caledon system, is a contributing factor. This amount of sediment that is mobilised due to poor range management is also exacerbated by many factors such as land use, topography, climate, erodability of soil, rainfall and runoff (ORASECOM 2007 & 2008). Therefore it must be clear that although the river has a naturally high sediment load the poor management of the catchment rangeland has significantly exacerbated the sediment impact on the Caledon River. Despite the heavily modified system it should still be regarded as sensitive with a high conservation value.

Wepener Sandspruit (Appendix A: Map 11-12): The catchment has been utilised for extensive dryland crop cultivation. A large number of these crop fields are barren and no longer cultivated. This will contribute significant amounts of sediment to the system. The area and at the origin of the river is subjected to high levels of domestic stock grazing. The overgrazing and destruction of vegetation also decreases the vegetation cover and together with trampling also increase sediment load within the river. Wepener and the Sandspruit is located near the Lesotho border and consequently a large portion of the catchment of the river is situated in rural village and urban areas especially the upper reaches of the river. The urban area of Mefeteng is situated in the upper catchment of the river and will undoubtedly also contribute significant impacts on the

river in the form of increased storm water runoff, increased sediment and refuse and pollutants associated with urban areas. The town of Wepener itself is also visibly contributing significantly toward these urban impacts as well and algal blooms in the river are indicative of high volumes of nutrients entering the river. The Sandspruit is a tributary of the Caledon River and confluences with it immediately west of the town of Wepener. It is also considered a significant contributor of sediment to this system. Despite the heavily modified system it should still be regarded as sensitive with a high conservation value.

Vanstadensrus Urban Area (Appendix A: Map 13-14)

The town of Van Stadensrus is located 160km south east of Bloemfontein and is one of the frontier towns on the border of South Africa and Lesotho. It is in close proximity to the Egmont and Van Stadensrus Dams, and is on the Anglo-Boer War Route. The urban extent of the town is approximately 190 hectares and should also clearly indicate the small extent of the town. A few small but still prominent stream systems occur, including the Witspruit, and flows past the existing urban area of the town. The town forms part of a mostly natural area although the urban areas and surrounding agricultural operations do cause some degradation of the area.

The area has a small extent with a relatively uniform landscape but with some variation in the topography including rocky outcrops, low hills and ridges and numerous small watercourses. This also contributes to some diversity in terms of habitat and vegetation types. The area is dominated by natural areas, however, significant impacts, including widespread overgrazing does notably degrade the condition of natural areas.

From the description of the remaining natural vegetation in the Vanstadensrus urban area and by using available data sets the following elements of ecological importance should be taken into account in the MOSS:

- Both vegetation types contain elements of conservation value and consequently, where natural portions of these vegetation types remain they should be regarded as having a significant conservation value.
- Portions of the vegetation around the town has clearly been transformed by amongst others old cropfields, a disused quarry to the east of town and a landfill, graveyard and WWTW to the west of the town.
- The undulating plains consisting of Aliwal North Dry Grassland is considered significantly modified from the natural condition, is dominated by pioneer species and overall the species diversity is considered as quite low. Coupled with this, habitat diversity is also relatively uniform and considered low. The vegetation type or unit around the town is therefore considered as having a relatively low level of sensitivity.
- However, the low ridge in the south west does still contain a protected species, *Euphorbia clavaroides*, and contains a somewhat higher species diversity. It is therefore considered as having a moderate level of sensitivity.
- The ridge system consisting of Basotho Montane Shrubland is considered largely natural although overgrazing by domestic livestock causes significant degradation and especially erosion. The vegetation unit contains a significant diversity of species and growth forms with a few being listed as protected or being uncommon. As a result of the combination of the above, it is regarded as having a high level of sensitivity.
- An extensive Critical Biodiversity Area 1 (CBA 1) occurs to the east and south of the town , but is not located near the town or the surrounding municipal area and it is unlikely to be affected by it (Appendix A: Map 14).

- The survey indicated that overgrazing by domestic livestock in the communal grazing areas area quite high in many areas, leading to degradation of the grassland and where slopes and wetlands are affected, this also leads to high levels of erosion. Management of municipal areas should therefore also take this into consideration.

Vanstadensrus Witspruit (Appendix A: Map 13-14): A small but prominent stream system flows through the town of Vanstadesnrus. It is a direct tributary of the Witspruit flowing into it adjacent and to the west of the town. An overall description of the impacts on the Witspruit with a focus on the affected tributary should therefore provide an adequate description of the condition of this system located within the MOSS of Vanstadensrus. The hydrology of the stream is affected by several significant impacts. The Vanstadensrus and Egmont Dams are quite large and situated a short distance upstream. These will have a significant impact on the flow and flooding regime. Where this stream would have been strictly seasonal this now results in a low and slow baseflow which results in a modification from seasonal to perennial. The area and at the origin of the Witspruit is subjected to high levels of domestic stock grazing. The overgrazing and destruction of vegetation also decreases the vegetation cover and together with trampling also increase sediment load within the river. Despite this, the system should still be regarded as sensitive with a high conservation value.

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List of Acronyms

MOSS – Metropolitan Open Space System
MMM – Mangaung Metropolitan Municipality
NFEPA – National Freshwater Ecosystem Priority Areas
MSDF – Municipal Spatial Development Framework
PES – Present Ecological State
NBA – National Biodiversity Assessment
TOPS – Threatened Or Protected Species
FSBMP – Free State Biodiversity Management Plan
DWS – Department of Water and Sanitation
WRC – Water Research Commission
WWTW – Waste Water Treatment Works
EIS – Ecological Importance and Sensitivity
EMC – Ecological Management Class
SAIIAE – South African Inventory of Inland Aquatic Ecosystems
CSIR – Council for Scientific and Industrial Research
SANBI – South African National Biodiversity Institute
BSR – Biodiversity Sensitivity Rating
AMSL – Above Mean Sea Level
POSA – Plants of South Africa
LC – Least Concern
DDD - Data Deficient - Insufficient Information
NT – Near Threatened
VU – Vulnerable
EN – Endangered
NWA – National Water Act

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Ecological and Wetland Assessment

1. Introduction

Natural vegetation is an important component of ecosystems. Some of the vegetation units in a region can be more sensitive than others, usually as a result of a variety of environmental factors and species composition.

Some vegetation units perform vital functions in the larger ecosystem. These units are often associated with water bodies, water transferring bodies or moisture sinks. These systems are always connected to each other through a complex pattern. Degradation of a link in this larger system, e.g. tributary, pan, wetland, usually leads to the degradation of the larger system. Therefore, degradation of such a water related system should be prevented.

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

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

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

Development around cities and towns are necessary to accommodate an ever-growing population. However, urban expansion is well known for the transformation pressures they exert on diminishing natural areas. Areas within the urban border of cities and towns are usually in a degraded state due to the impact of the large population these areas house. Though this may be the case in most situations there may still be areas that consist of sensitive habitats such as watercourses, wetlands, areas of high diversity or rare vegetation types that need to be conserved. These areas may also contain endangered fauna and flora.

For the above reasons it is necessary to conduct an ecological and wetland assessment for the Metropolitan Open Space System (MOSS) within the Mangaung Metropolitan Municipality (MMM) in order to aid in improved management and preservation of these areas.

The study area consists of several separate urban areas with a large extent. These are the city of Bloemfontein and surrounding towns, including Thaba Nchu, Botshabelo, Soutpan, Dewetsdorp, Wepener and Vanstadensrus. From aerial images it is clear that these areas consist of extensive urban areas but that significant natural areas are also visible within the urban edge. The study will be limited to the natural areas within the MOSS located within the urban edge of these urban areas. Furthermore, a high number of watercourses and wetlands also occur in these urban areas with some of the larger rivers including the Bloemspruit, Renosterspruit, Modder River, Klein-Modder River, Sepane River, Caledon River and Witspruit.

Survey of the study area was initiated during June 2020 and each urban area surveyed consecutively. The survey was conducted by means of sampling sites which were allocated to each distinct topographical or vegetation unit in order to get a representative sample of them within the MOSS. The survey is considered to be comprehensive and should give a good description of each distinct element within the MOSS. The time of the survey is no longer considered optimal in terms of seasonality although it was still possible to identify dominant vegetation and riparian and wetland vegetation. Accurate identification of the species diversity is therefore considered a limitation of the survey. Supplemental data collection should therefore also be considered where possible. Data collected during previous studies were also utilised to augment the study.

The report together with its recommendations should be utilised to inform further studies and management of open spaces.

1.1 Background

Mangaung Metropolitan Municipality comprises of different spatial land uses, one of which is the Metropolitan Open Space System (MOSS). Through the proper planning of Municipal Spatial Development Frameworks, metropolitan open spaces are meant to play a Pivotal role in maintaining sustainable development and the liveability of the area. To achieve a sustainable development between social, economic and environmental issues, the municipality uses a tool called Municipal Spatial Development Framework (MSDF) to spatially restructure the municipality and guide the location of future developments. According to Koomen *et al.* (2005), changes in the supply of land is one of the major concerns around metropolitan areas and hence, metropolitan open spaces are under threat of urbanisation making its valuation crucial for helping metropolitan planners to better asses the societal values of open spaces.

Sustainable development (in the view of Shi & Woolley, 2014) is influenced by green and open spaces in urban areas that are well planned and managed. Moreover, development of the urban green spaces at a larger scale and across multiple sites could contribute to restoration of natural processes and functions as well as creation of multifunctional landscapes and promotion of sustainable development.

1.2 The value of biodiversity

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

The balancing of atmospheric gases through photosynthesis and carbon sequestration is reliant on biodiversity, while an estimated 40% of the global economy is based on biological products and processes (Johnson 2005).

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

- Soil formation and maintenance of soil fertility.
- Primary production through photosynthesis as the supportive foundation for all life.

- Provision of food, fuel and fibre.
- Provision of shelter and building materials.
- Regulation of water flows and the maintenance of water quality.
- Regulation and purification of atmospheric gases.
- Moderation of climate and weather.
- Detoxification and decomposition of wastes.
- Pollination of plants, including many crops.
- Control of pests and diseases.
- Maintenance of genetic resources.

2. Scope and limitations

- To evaluate the present state of the vegetation and ecological functioning of the metropolitan urban areas including Bloemfontein, Botshabelo, Thaba Nchu, Soutpan, Dewetsdorp, Wepener and Vanstandesnrus.
- To evaluate the present state of the wetlands and riparian vegetation included within the study area. The importance of the ecological function and condition will also be assessed.
- Identify and delineate watercourses including rivers, streams, pans and wetlands and ascertain condition and status therefore and provide recommendations.
- Determine the Present Ecological State (PES) and Ecological Importance & Sensitivity (EIS) for the wetlands in the study area. This will however only be provided for the larger systems within the study area.

2.1 Vegetation (including riparian)

Aspects of the vegetation that will be assessed include:

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

The amount of disturbance present on the study area assessed according to:

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

2.2 Fauna

Aspects of the fauna that will be assessed include:

- A basic survey of the fauna encountered in the study area using visual observations of species as well as evidence of their occurrence in the region (burrows, excavations, animal tracks, etc). This will be based on terrestrial fauna only.
- The overall condition of the habitat.
- A list of species that may occur in the region (desktop study).

2.3 Wetlands and watercourses

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

- Identification and delineation of watercourses including rivers, streams, pans and wetlands.
- Describe condition and status of watercourses and importance relative to the larger system.

2.4 Limitations

- The study will be confined to the assessment of natural open spaces within the MOSS of the towns of Bloemfontein, Thaba Nchu, Botshabelo, Soutpan, Dewetsdorp, Wepener

and Vanstadensrus. Urban open spaces are man-made and will not be included in the assessment.

- Due to the time of year very few plant species were flowering and this has made identification impossible for many of the less common species. Furthermore, several bulbs, seasonal herbs and subterranean succulents may have been overlooked as leaves and flowers may be absent due to the season.
- Surveying was conducted by means of sampling sites within each distinct natural unit as discerned from aerial images. It may therefore be possible that where smaller unique habitats occur that they may have been overlooked.
- Due to time constraints only limited soil sampling could be done.
- Due to the large extent of the study area only spot surveys of watercourses were undertaken. Furthermore, where a high amount of similar drainage lines, wetlands or watercourses occurred in close proximity only a few of them were surveyed and the data extrapolated to the adjacent areas.
- Smaller drainage lines and wetlands may have been overlooked where a distinct channel or riparian vegetation is absent.
- Some animal species may not have been observed as a result of their nocturnal and/or shy habits.
- Some fauna may not have been observed due to being in a dormant state or overwintering in egg or embryo form.
- The urban areas of Bloemfontein, Botshabelo and Thaba Nchu contain a clearly defined MOSS which is centred around hills, ridges and watercourses which will form the focus of this survey. This delineated MOSS is situated within municipal and private properties which results in several limitations:
    - Access to private properties could not be provided and these areas could therefore only be assessed by desktop overview.
    - Surveys were confined to areas of municipal properties where access to the sites could be obtained. These included municipal areas such as Valley-of-Seven-Dams, Naval Hill Nature Reserve, Brandkop Conservancy, Mooiwater Conservancy, Rooidam.
    - Due to the lack of access the delineation of sensitive areas were assessed on a course level.
    - Assessment of watercourses and wetlands were confined to larger systems situated on municipal property and where access could be obtained. These include the Seven Dams Stream, Renoster- and Bloemspruit Rivers. Smaller watercourses and wetlands situated on private property has been omitted from the assessment due to a lack of access.
    - The aim of the delineated MOSS in the urban areas of Bloemfontein, Botshabelo and Thaba Nchu are to preserve important and sensitive vegetation units and ecosystems and to provide ecological corridors between these areas. As a result, irrespective of the condition of areas within the delineated MOSS, they should still be regarded as having a significant level of sensitivity.
    - Due to the coarse level of assessment, where ever development or spatial planning is proposed, detailed and comprehensive assessment will still need to be conducted.
    - It is recommended that private landowners be consulted and that additional surveys be conducted in these areas in order to improve the accuracy of the MOSS.

- The urban areas of Soutpan, Dewetsdorp, Wepener and Vanstadensrus does not contain a defined MOSS and the assessment was therefore applied to communal municipal areas surrounding these towns:
  - Access could easily be obtained for municipal communal areas around these towns.
  - This allowed for comprehensive survey of the remaining natural areas.
  - In view of the lack of a defined MOSS all areas defined as having a High or Very High level of sensitivity should be taken as synonymous with a MOSS and avoided by urban planning as far as possible.
  - Although comprehensive assessment of remaining natural areas was undertaken it is likely that inaccuracies in delineation occur and sensitive areas may have been overlooked. As a result, wherever development or spatial planning is proposed, detailed and comprehensive assessment should still be undertaken.

3. Methodology

3.1 Several literature works were used for additional information.

Background information of the current MOSS will be taken from:

- Environmental Implementation and Management Plan for the Mangaung Metropolitan Municipality (2015).
- Draft Mangaung Metropolitan Municipality Spatial Development Framework (2020).
- Mangaung Metropolitan Municipality Open Space System (MOSS): Context Report (2015).
- 2015 MOSS Review: Urban Context Report.
- Mangaung Local Municipality: Urban Open Space Policy (2004).

Vegetation:

- Red Data List (Raymondo *et al.* 2009).
- Vegetation types (Mucina & Rutherford 2006).
- NBA 2018 Technical Report Volume 1: Terrestrial Realm.
- SANBI (2011): List of threatened ecosystems.
- NEM:BA: List of threatened ecosystems and Threatened Or Protected Species (TOPS).
- Free State Biodiversity Management Plan (2018).

Faunal Red List: Child *et al* 2016.

Field guides used for vegetation species identification:
(Bromilow 1995, 2010, Coates-Palgrave 2002, Court 2010, Fish *et al* 2015, Gerber *et al* 2004, Gibbs-Russell *et al* 1990, Griffiths & Picker 2015, Hartmann 2001, Manning 2009, Retief & Meyer 2017, Smith *et al* 1998, Smith & Crouch 2009, Smith & Van Wyk 2003, Van Ginkel *et al* 2011, Van Oudtshoorn 2004, Van Wyk & Malan 1998, Van Wyk & Van Wyk 1997, Venter & Joubert 1985).

Previous studies of the surrounding region:

- (Brown & Du Preez 2014, Dingaan & Du Preez 2002, Dingaan & Du Preez 2013, Dingaan & Du Preez 2017, Dingaan *et al* 2001, Malan *et al* 1998, 2001, Nthejane 2007, Potts & Tidmarch 1937).

- A collection of over 200 ecological, biodiversity and wetland studies conducted for a variety of development projects in the Mangaung Metropolitan Municipality will also be utilised (Van Rensburg 2009 – 2020) .

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

3.2 Survey

The outlines of the current MOSS was overlain onto available aerial images and GIS mapping resources. This allowed for the identification and delineation of distinct landscape features, wetlands watercourses, topographical units and areas of likely high sensitivity. A desktop assessment was also previously conducted for the MOSS and this also provided a valuable

baseline to identify areas in need of survey. Utilising the above information sampling sites were identified in order to give a good representation of each distinct unit.

Each sampling site was surveyed within an estimated footprint of 20 x 20 meters and the following information recorded:

- An inventory of all plant species recorded in the sampling plot.
- Noted species include rare and dominant species.
- The broad vegetation types present at the site were determined.
- The state of the environment was assessed in terms of condition, grazing impacts, disturbance by humans, erosion and presence of invader and exotic species.
- The state of the habitat was also assessed.

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

All rivers, streams, pans and wetlands were identified and surveyed where it occurred in the study area. The likely occurrence of these systems were also identified prior to fieldwork by means of aerial images and available mapping systems (NFEPA 2011 & SAIIAE 2018).

These systems were delineated by use of topography (land form and drainage pattern) and riparian vegetation with limited soil sampling (Table 6, Appendix B).
The following guidelines and frameworks were used to determine and delineate the rivers, streams, pans and wetlands in the study area:

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

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

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

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

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

- Van Deventer *et al*. 2018. South African National Biodiversity Assessment 2018: South African Inventory of Inland Aquatic Ecosystems (SAIIAE). Council for Scientific and Industrial Research (CSIR) and South African National Biodiversity Institute (SANBI): Pretoria, South Africa.

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

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

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

3.3 Criteria used to assess sites

Several criteria were used to assess the study area and determine the overall status of the environment. This was however applied in desktop form only and is only an estimation.

3.3.1 Vegetation characteristics

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

Habitat diversity and species richness: normally a function of locality, habitat diversity and climatic conditions.
Scoring: Wide variety of species occupying a variety of niches – 1, Variety of species occupying a single nich – 2, Single species dominance over a large area containing a low diversity of species – 3.

Presence of rare and endangered species: The likley occurrence or potential occurrence of rare or endangered species.
Scoring: Occurrence actual or highly likely – 1, Occurrence possible – 2, Occurrence highly unlikely – 3.

Ecological function: All plant communities play a role in the ecosystem. The ecological importance of all areas though, can vary significantly e.g. wetlands, drainage lines, ecotones, etc.
Scoring: Ecological function critical for greater system – 1, Ecological function of medium importance – 2, No special ecological function (system will not fail if absent) – 3.

Degree of rarity/conservation value:
Scoring: Very rare and/or in pristine condition – 1, Fair to good condition and/or relatively rare – 2, Not rare, degraded and/or poorly conserved – 3.

3.3.2 Vegetation condition

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

Percentage ground cover: Ground cover is under normal and natural conditions a function of climate and biophysical characteristics. Under poor grazing management, ground cover is one of the first signs of vegetation degradation.
Scoring: Good to excellent – 1, Fair – 2, Poor – 3.

Vegetation structure: This is the ratio between tree, shrub, sub-shrubs and grass layers. The ratio could be affected by grazing and browsing by animals.
Scoring: All layers still intact and showing specimens of all age classes – 1, Sub-shrubs and/or grass layers highly grazed while tree layer still fairly intact (bush partly opened up) – 2, Mono-layered structure often dominated by a few unpalatable species (presence of barren patches notable) – 3.

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

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

Signs of erosion: The formation of erosion scars can often give an indication of the severity and/or duration of vegetation degradation.
Scoring: No or very little signs of soil erosion – 1, Small erosion gullies present and/or evidence of slight sheet erosion – 2, Gully erosion well developed (medium to large dongas) and/or sheet erosion removed the topsoil over large areas – 3.

3.3.3 Faunal characteristics

Presence of rare and endangered species: The actual occurrence or potential occurrence of rare or endangered species on a proposed site plays a large role on the feasibility of a development. Depending on the status and provincial conservation policy, presence of a Red Data species or very unique and sensitive habitats can potentially be a fatal flaw.
Scoring: Occurrence actual or highly likely – 1, Occurrence possible – 2, Occurrence highly unlikely.

3.4 Biodiversity sensitivity rating (BSR)

The total scores for the criteria discussed in section 3.3 were used to determine the biodiversity sensitivity ranking for the sites. On a scale of 0 – 3, five different classes are described to assess the biodiversity of the study area. The different classes are described in the Table 1:

Table 1: Biodiversity sensitivity ranking

BSR	BSR general floral description	Floral score equating to BSR class
Totally transformed (5)	Vegetation is totally transformed or in a highly degraded state, generally has a low level of species diversity, no species of concern and/or has a high level of invasive plants. The area has lost its inherent ecological function. The area has no conservation value and potential for successful rehabilitation is very low.	29 – 30
Advanced Degraded (4)	Vegetation is in an advanced state of degradation, has a low level of species diversity, no species of concern and/or has a high level of invasive plants. The area's ecological function is seriously hampered, has a very low conservation value and the potential for successful rehabilitation is low.	26 – 28
Degraded (3)	Vegetation is notably degraded, has a medium level of species diversity although no species of concern are present. Invasive plants are present but are still controllable. The area's ecological function is still intact but may be hampered by the current levels of degradation. Successful rehabilitation of the area is possible. The conservation value is regarded as low.	21 – 25
Good Condition (2)	The area is in a good condition although signs of disturbance are present. Species diversity is high and species of concern may be present. The ecological function is intact and very little rehabilitation is needed. The area is of medium conservation importance.	11 – 20
Sensitive/Pristine (1)	The vegetation is in a pristine or near pristine condition. Very little signs of disturbance other than those needed for successful management are present. The species diversity is very high with several species of concern known to be present. Ecological functioning is intact and the conservation importance is high.	0 - 10

4. Ecological and Wetland Assessment

For the purpose of this report the terrestrial and aquatic ecology will be discussed separately. A general description of the terrestrial environment for each urban area will be given separately followed by an overall discussion of wetland and aquatic systems.

4.1 Ecology, vegetation and description of the study area

The urban areas of Bloemfontein, Botshabelo and Thaba Nchu contain a clearly defined MOSS which is centred around hills, ridges and watercourses which will form the focus of this survey. This delineated MOSS is situated within municipal and private properties which results in several limitations:

- **Access to private properties could not be provided and these areas could therefore only be assessed by desktop overview.**
- **Surveys were confined to areas of municipal properties where access to the sites could be obtained. These included municipal areas such as Valley-of-Seven-Dams, Naval Hill Nature Reserve, Brandkop Conservancy, Mooiwater Conservancy, Rooidam.**
- **Due to the lack of access the delineation of sensitive areas were assessed on a course level.**
- **Assessment of watercourses and wetlands were confined to larger systems situated on municipal property and where access could be obtained. These include the Seven Dams Stream, Renoster- and Bloemspruit Rivers. Smaller watercourses and wetlands situated on private property has been omitted from the assessment due to a lack of access.**
- **The aim of the delineated MOSS in the urban areas of Bloemfontein, Botshabelo and Thaba Nchu are to preserve important and sensitive vegetation units and ecosystems and to provide ecological corridors between these areas. As a result, irrespective of the condition of areas within the delineated MOSS, they should still be regarded as having a significant level of sensitivity.**
- **Due to the coarse level of assessment, where ever development or spatial planning is proposed, detailed and comprehensive assessment will still need to be conducted.**
- **It is recommended that private landowners be consulted and that additional surveys be conducted in these areas in order to improve the accuracy of the MOSS.**

4.1.1 Bloemfontein urban area (Appendix A: Map 1 – 2)

Bloemfontein is the economic hub of the municipal area and will remain the locus for future development. The city is centrally located in South Africa and is served by major roads such as the N1 which links Gauteng with the southern and western Cape, the N6 which links Bloemfontein to the Eastern Cape and the N8 which links Lesotho in the east with the Northern Cape in the west via Bloemfontein. The urban extent of the city is approximately 18 530 hectares. Larger watercourses occurring in this urban area include the Renosterspruit, Bloemspruit and Seven-Dams Stream. Owing to the high-density urban areas these are generally heavily modified.

Bloemfontein is situated within the Grassland Biome and under natural conditions would be dominated by grasses with shrubs and trees being almost completely absent. The exception to

this being hills and ridges which provide suitable habitat and climate for shrubs and trees to establish. Watercourses also contain differing soils conditions, climate and moisture regime which enables the establishment of shrubs and trees. Consequently, plains should be dominated by grasses while ridges, hills and watercourses would contain a prominent grass component but also substantial shrub and tree cover. This is also the case for the remaining natural areas comprising the Mangaung MOSS. However, the urban environment also increases the establishment of trees. Under natural conditions the Grassland Biome is kept free of trees by a combination of periodic burning and high frost incidence. However, the urban environment often prevents fires in the remaining grassland areas and buildings also decrease frost incidence and this then increases the establishment of trees in the remaining natural areas. The overall vegetation structure has therefore been modified to some degree. In addition, the urban environment itself also cause large-scale transformation of the natural environment as can be expected. Even the remaining natural areas are often in a heavily degraded condition which may be attributed to land-use but is in large-part also a result of the edge-effect, especially for smaller portions of vegetation. The edge-effect is normally exacerbated by habitat fragmentation and is caused by transformed and degraded areas which also affect and degrade the adjacent natural areas along their borders. This has also been substantiated by several previous studies of the area (Dingaan *et al,* Van Rensburg).

Due to the large extent of the urban area it contains a moderate variety in terms of topography though overall it is a relatively flat area. From aerial images and contours of the study area the majority of Bloemfontein is dominated by relatively flat plains which is pronounced in the western half with an undulating topography becoming more prominent toward the eastern half. A series of dolerite hills and ridges also become prominent along the northern portions of the study area. These also provide significantly different habitats and the vegetation composition is also clearly different from the surrounding plains. As mentioned, several significant watercourses as well as smaller drainage lines and numerous wetland systems are also incised into the terrain and these also contribute to the varied topography. These areas will again represent a different topographical unit with a differing vegetation composition and habitat. The altitude of the Bloemfontein urban area varies from 1590 m AMSL on the more prominent hills to 1330 m AMSL along the lower lying watercourses. This represents a difference of 160 m which although this indicates a significant variety in topography also indicates the absence of mountains or other similar prominent topographical elements.

As indicated, the transformation and degradation caused by the urban area of Bloemfontein is extensive and also impacts on the portions of remaining natural vegetation. As can be expected, the urban environment itself and associated amenities, recreational, infrastructure and industrial activities lead to the direct transformation of large areas. The areas of remaining natural vegetation and the main areas of focus of this study is also affected by numerous impacts associated with the urban area. Recreational activities such as hiking trails, All Terrain Vehicle (ATV) tracks and roads and other informal dirt roads all cause local transformation though the impact is still relatively low. This does however provide access to these areas and in many cases exacerbate the impact of illegal dumping which may transform significantly large areas. One of the most significant impacts on the remaining natural areas, besides urban development itself, is associated with agricultural activities. Both small- and large-scale farming operations occur around the city. Where dryland and irrigated crop cultivation occurs this leads to the direct and largely irreversible transformation of the vegetation and these areas are essentially lost. This is also substantiated by both the Free State Biodiversity Management Plan as well as other available mapping sources of the remaining Threatened Ecosystems (SANBI 2011, NBA 2018). A lesser impact, but still quite significant is overgrazing by domestic stock and introduced game.

Overgrazing and -browsing and the associated trampling cause a decrease in vegetation cover and an increase in erosion. Where this is severe it may lead to a significant loss in diversity and transformation of the natural vegetation type. This has especially been observed in small holding situations, overstocking of introduced game in several estates or similar housing developments as well as around communal grazing areas (especially to the south east around the lower-income urban areas).

Bloemfontein is situated in a region experiencing moderate rainfall, with cold, dry winters and warm summers. According to the climate statistics from the South African Weather Service, the annual mean maximum and minimum temperatures are 24.6 °C and 7.6 °C, respectively. Climate for the site can be relatively accurately represented by rainfall and evaporation data from the weather station D5E003 (Maselspoort). Bloemfontein receives an average of 548 mm per year. Precipitation occurs mainly during summer, with most rainfall received during January to March. This is considered a moderate rainfall though the area is still considered to form part of a semi-arid region of South Africa. The mean annual evaporation is 1676 mm. Evaporation is highest during summer. As a result, surface runoff in the area is not significant and relatively low, occurs mostly during summer and results in an estimated mean annual runoff for the area between 10 – 20 mm according to a study by the Water Research Commission (WRC REPORT NO. TT 685/16, 2016).

The following description of the soils and geology of the Bloemfontein area was taken from Dingaan *et al* (2017). Three different land types are distinguished in the study area, namely the Ca, Dc and Ea land types. Within each of these land types, soils vary from sandy to clayey, as a result of the variation in parent material. The Ca land type, occurring as Ca8 and Ca22 subdivisions, is a mixture of duplex and plinthic soils. The Ca8 subdivision is found on the western part of the study area and consists mainly of sandy Hutton– Bainsvlei soils and more clayey Valsrivier–Swartland soils; the Ca22 subdivision occurs in the south and is mainly dominated by Valsrivier soils. The Dc land type occurs as subdivision Dc13, which is dominated by duplex soils of the Valsrivier–Swartland–Sterkspruit forms. It is only present in small pockets in the eastern part of the study area. The Ea land type is found in the central and northern parts and occurs as subdivision Ea39, the most extensive in the study area. It consists mainly of sandy Oakleaf soils, although a mixture of the clayey Milkwood, Arcadia and Valsrivier soils are also prominent. The geologic formations of the study area belong to the Karoo Supergroup and consist of the Tierberg Formation of the Ecca Group and the Adelaide Sub-Group of the Beaufort Group, as well as dolerite intrusions of the post-Karoo age. Rcoky outcrops, including ridges and hills in the area is dominated by dolerite. It consists of a network of dolerite sills, sheets and dykes, mainly intrusive into the Karoo Supergroup (Council for Geoscience 2016).

As can be deduced from the description of the Bloemfontein urban area the impacts caused on the remaining natural areas are significant and decreases the condition of several of the areas. This is also applicable to the delineated MOSS of the city where large portions of relatively natural portions remain though several areas of the MOSS has also become fragmented due to agricultural and urban development.

4.1.1.1 Bloemfontein Vegetation Units (Appendix A: Map 1 – 2)

As a result of the variation in topography, soil, geology, etc. the urban area of Bloemfontein contains several different vegetation types. According to Mucina & Rutherford (2006), the study area includes Bloemfontein Dry Grassland (Gh 5), Winburg Grassy Shurbland (Gh 7), Bloemfontein Karroid Shrubland (Gh 8) and Highveld Alluvial Vegetation (AZa 5). According to

the National Environmental Management: Biodiversity Act, 2004 (Act No. 10 of 2004) these are all currently listed as being of Least Concern (LC), except for the Bloemfontein Dry Grassland which is listed as a Vulnerable (VU) vegetation type. In addition, the Bloemfontein Karroid Shrubland has recently become increasingly under pressure from development and due to its high species diversity and high proportion of protected species it is also regarded as a sensitive vegetation type.

These vegetation types also correspond easily to the different topographical elements as previously described. The Bloemfontein Dry Grassland is confined to the plains areas and is dominated by a well-developed grass layer with shrubs and trees completely absent. The Winburg Grassy Shrubland is confined to dolerite outcrops including ridges and hills and is dominated by a well-developed though short shrub and tree layer. The Bloemfontein Karroid Shrubland is confined to a rather unique habitat confined to exposed dolerite rock sheets with a very shallow soil layer and is dominated by especially dwarf succulents and geophytic species. The Highveld Alluvial Vegetation is confined to the floodplains of the larger rivers in the Bloemfontein area, i.e. the Bloem- and Renosterspruit, and is dominated by a variety of growth forms ranging from a tree/shrub layer to geophyte rich herblands.

The on-site and desktop surveys indicated that the MOSS comprises largely of hills and ridges with the majority consisting of Winburg Grassy Shrubland. These are also largely situated on private property with a large portion to the west also being occupied by a military base. Ecological corridors link these ridges and hills via plains with smaller portions of these areas consisting of Bloemfontein Dry Grassland. It is also notable from available resources that a large portion of these corridors are considered to be already transformed from the natural condition. Bloemfontein Karroid Shrubland is imbedded within the Winburg Grassy Shrubland but is mostly confined to the northern portions of the MOSS and is also quite prominent in the Valley-of-Seven-Dams and Woodland Hills areas. The Highveld Alluvial Vegetation is very poorly represented within the MOSS with only small portions being present in the extreme north east of the MOSS.

It is evident that large portions of the MOSS, especially those areas forming ecological corridors are already transformed. In-field surveys were largely confined to areas of municipal properties, while previous field surveys and desktop information were utilised for private properties, as well as other inaccessible areas such as military bases and airports.

Undulating plains - Bloemfontein Dry Grassland (Gh 5)

Available information indicate the vegetation type is dominated by grass species with *Themeda triandra* and *Eragrostis lehmanniana* being dominant. A total of 115 species was recorded by previous studies (Dingaan *et al* 2013) indicating only a moderate species diversity.

As previously indicated, the MOSS for Bloemfontein has largely been delineated around hills and ridges and as a result the grassland plains is not well represented in the MOSS. Small portions of the Bloemfontein Dry Grassland are present though the majority of the vegetation type has been transformed by agricultural and urban development. Access could not be provided to the majority of these remaining portions and the assessment of the vegetation unit will be based on available desktop information, a few sites in the surroundings and some of the remaining areas in the north of the MOSS.

The vegetation type being dominated by undulating grassland is easily identified. The soils of which this vegetation type consists is also a major ecological driver and responsible for the

species composition of this vegetation type. Soils are highly sandy and overlay a clay layer. This promotes the establishment of a variety of plants adapted to these sandy conditions. The species composition of this vegetation type is therefore also diagnostic and differentiates it from similar grassland in the surrounding region.

As indicated, a grass layer dominates and includes species such as *Themeda triandra, Eragrostis lehmanniana, E. gummiflua, Pogonarthria squarrosa, Anthephora pubescens*, *Eragrostis superba, Aristida congesta, Tragus koelerioides, Eragrostis curvula, Cynodon dactylon, Chloris virgata, Digitaria eriantha, Urochloa panicoides*, *Melinis nerviglumis, Tragus berteronianus, Eragrostis obtusa, Eleonurus muticus, Cymbopogon pospischillii, Aristida junciformis*, Triraphis andropognoides, Hyparrhenia tamba and *Eragrostis chloromelas*. It was noted that in general the majority of these are also pioneer species with climax species in the minority and is indicative of high levels of overgrazing in most remaining natural portions. This is attributed to both domestic livestock as well as introduced game. Furthermore, because remaining portions of this grassland is highly fragmented and also generally quite small in extent they are also degraded by surrounding land use and the edge effect.

In some instances, the sedge, *Scirpoides burkei*, also form clumps in the grass layer but is not regarded as indicator of wetland conditions, this was also confirmed by soil sampling. It may however indicate a shallow watertable.

A prominent dwarf karroid shrub component is also prominent in many areas and include species such as *Nolletia jeneattae, Nolletia ciliaris, Lycium horridum, Amphiglossa triflora, Helichrysum zeyheri, Plinthus sericeus, Ruschia hamata, Menodora africana, Rosenia humilis, Nenax microphylla, Felicia muricata, Gnidia polycephala, Chrysocoma ciliata, Hertia pallens* and *Pentzia incana*. This is a natural component of the vegetation type, although high abundances of dwarf karroid shrubs are indicative of disturbance. This was observed in many areas though overall are regarded as only indicative of a moderate level of disturbance.

Herbaceous species are also abundant and imbedded within the grass layer and these include *Selago densiflora, Massonia angustifolia, Berkheya onopordifolia, Commelina africana, Hibiscus pusillus, Hermannia comosa, Sesamum triphyllum, Hibiscus trionum, Helichrysum caespititum, Dimorphotheca zeyheri, Ipomoea oblongata, Ipomoea crassipes, Solanum incanum, Hermannia coccocarpa, H. depressa, Manulea plurirosulata, Vahlia capansis, Wahlenbergia denticulata, Salvia verbenaca, Gazania krebsiana*. and *Nidorella resedifolia*. These are mostly natural to the vegetation type but some herbaceous species such as *Nidorella resedifolia* and *Salvia verbenaca* which is abundant in many areas does indicate significant disturbance of the grass layer.

Another prominent component is the abundance of geophytic species. This is also a natural component of the sandy soils of this vegetation type and does indicate that remnant portions can still be regarded as largely natural. These species include *Hypoxis hemerocallidae, Hypoxis rigidula, Schizocarpus nervosus, Oxalis depressa, Chlorophytum fasciculatum, Bulbine narcissifolia, Aloe jeppeae, Dipcadi viride, Trachyandra saltii, Dipcadi ciliare, Ledebouria luteola, Eriospermum porphyrium, E. corymbosum, Raphionacme dyeri, Nerine laticoma, Albuca cooperi, Ammocharis coranica, Massonia echinata* and *Raphionacme hirsuta*. A large proportion of these are also protected species with several also being regarded as being rare and uncommon. This will significantly increase the conservation value of remaining portions of this vegetation type.

Exotic weeds and invader species were found to be common, at least in those areas which could be surveyed and confirm a moderate level of disturbance in most areas. These include *Argemone ochroleuca, Opuntia engelmannii, Tagetes minuta Bidens bipinnata, Opuntia ficus-indica, Gleditsia triacanthos, Echinopsis schickendantzii, Verbena tenuisecta, Sphaeralcea bonariensis, Schkuhria pinnata, Malva parviflora, Datura ferox* and *Cestrum laevigatum*.

As a result of the urban setting and the fragmented and small remaining portions of this grassland vegetation type, trees and shrubs are also encroaching into the grassland, especially along the borders with transformed or degraded areas. Encroaching thicket include *Ziziphus mucronata, Vachellia karroo, Asparagus larcinus, Searsia lancea, Ehretia rigida* and *Buddleja saligna*.

From the available data and field surveys it seems that the majority of this vegetation type has already been transformed. This corresponds with it also being listed as a Vulnerable (VU) vegetation types according to the National Environmental Management: Biodiversity Act, 2004 (Act No. 10 of 2004). Furthermore, those small remaining portions are, as far as could be determined, relatively degraded. However, although degraded and not in a good condition all remaining natural portions of the vegetation type should be regarded as having a high conservation value. All remaining portions of the vegetation type within the MOSS should be regarded as having at least a High level of sensitivity. Where the vegetation type has clearly been transformed it still forms part of the ecological corridors within the MOSS and should still be regarded as having at least a Moderate level of sensitivity. In addition, as previously indicated, only limited surveys of the vegetation type were able to be conducted and therefore additional studies should be conducted for any site-specific areas within the MOSS.

Figure 1: Panorama of the Bloemfontein Dry Grassland. Note relatively low percentage grass cover.

Figure 2: Panorama of the Bloemfontein Dry Grassland. Note a much denser grass layer here.

Figure 3: Another view of the Bloemfontein Dry Grassland. Again, note low vegetation cover.

Figure 4: Note a more dense grass cover with sandy soils also clearly visible.

Rocky ridges and hills - Winburg Grassy Shrubland (Gh 7)

As previously indicated, the MOSS for Bloemfontein has largely been delineated around hills and ridges and as a result this vegetation type cover, by far, the largest proportion of the MOSS. The vegetation type, consisting of ridges and hills, are unfavourable for agriculture and is mostly also avoided by urban developments and as a result the majority of this vegetation type within the MOSS is still intact. Several of the protected areas in Bloemfontein is also situated within this vegetation type and forms part of the MOSS and includes areas such as the Naval Hill Nature Reserve and Brandkop Conservancy. However, a few of the smaller portions of these hills such as occurs adjacent to the Bloemfontein South landfill site as well as a few other being affected by quarry developments have been heavily degraded. Large portions of these areas within the MOSS are also situated on private property or similar areas which are inaccessible such as a military base and fenced game areas. Access could not be provided to these areas and as a result the assessment of the vegetation unit will be based on available desktop information, a few sites in the surroundings and some of the smaller portions in the north of the MOSS.

The vegetation type is, to a large extent, dominated by woodland vegetation with a shrub and tree layer prominent on the slopes of ridges and hills. Larger hills will contain plateaus where a grass layer is more prominent with a low, sparse shrub layer also present. The density of the shrub and tree layer is also often dependant on slope aspect with south facing slopes containing a dense and closed tree canopy while north facing slopes contain a much sparser tree density. Furthermore, due to the diversity of the topography and soil depth the vegetation type also supports a variety of other growth forms.

As indicated, a shrub and tree layer is characteristic of the vegetation type and these include *Ziziphus mucronata, Searsia burchellii, S. pyroides, Olea europaea* subsp. *africana, Searsia ciliata, Euclea crispa* subsp. *ovata, Diospyros lycioides, D. austro-africana, Grewia occidentalis*, *Searsia burchellii, Osyris lanceolata, Ehretia rigida, Osyris lanceolata, Celtis africana, Rhigozum obovatum, Heteromorpha arborescens, Cussonia paniculata, Clutia pulchella* and *Buddleja*

saligna. It is clear that a diversity of shrubs and trees are present on these hills and ridges. They also differ in their distribution with some better adapted to shadier south facing slopes whilst others are confined to more arid north facing slopes. Of these species the Wild Olive (*O. europaea* subsp. *africana*) and Cabbage Tree (*Cussonia paniculata*) are also both protected species in the Free State. They therefore do have a significance to conservation. Furthermore, several exceptionally large and old specimens were noted in some areas and these further increase the conservation significance of these species.

The canopy formed by the tree and shrub layer also provide habitat for an understorey which is also adapted to a shadier habitat. Here a variety of growth forms occurs and includes the following. Shadier south facing slopes provide suitable habitat for softer leaved plants such as ferns, *Cheilanthes eckloniana, Mohria vestita* and *Pellaea calomelanos* and numerous herbaceous species such as *Lobelia erinus, Salvia vebenaca, Arctotis arctotheca, Selago densiflora, Acrotome inflata, Cleome rubella, Commelina erecta, Phyllanthus maderaspatensis, Indigofera cryptantha, Lantana rugosa, Cleome monophylla, Pupalia lappachea* and *Chascanum pinnatifidum*. Ravines along the slopes may contain even more shade loving plants such as *Pentameris basutorum, Setaria verticillata* and *Arctotis arctotoides*. Despite the shady habitat, several succulent plants are also adapted to this habitat and include *Crassula nudicaulis, Delosperma potsii, Curio radicans, Crassula capitella, C. lanceolata* and *Cotyledon orbicularis*. Geophytic species are also abundant in the understorey and include *Oxalis obliquifolia, Gladiolus permeabilis, Albuca virens, Haemanthus humilis, Bonatea antennifera, Eucomis autumnalis* and *Eriospermum porphyrium*. Several of these species are also protected.

In contrast to south facing slopes, the more arid north facing slopes, which contain a much sparser tree canopy, also contains a prominent grass layer. These grasses are adapted to slopes and include species such as *Enneapogon scoparius, Melinis nerviglumis, Digitaria eriantha, Themeda triandra, Heteropogon contortus, Melinis repens, Aristida diffusa, Eragrostis lehmanniana, Aristida congesta, Tragus koelerioides* and *Eystachys paspaloides*. This is generally an assemblage of climax grasses indicating that in general this vegetation type is still largely natural. In addition, north facing slopes also contain numerous dwarf shrubs which is part of the natural vegetation structure and include *Melolobium candicans, Asparagus suaveolens, Euryops subcarnosus, Selago albida, Pentzia quinquifida* and *Nenax microphylla*. The more arid north facing slopes also provide suitable habitat for a range of succulent species of which many are regarded as protected species and include *Orbea lutea* subsp. *lutea, Aloe grandidentata, Kleinia longiflora, Stapelia grandiflora* var. *grandiflora, Kalanchoe paniculata, Crassula nudicaulis*, *Cotyledon orbiculata, Sarcostemma veminale* and *Aloe jeappeae*.

Despite the vegetation type being largely natural, areas of disturbances are also present and impacts associated with over browsing and trampling also occur. As a result, exotic weeds and especially invasive succulents have become established in many areas. Exotic weeds include *Schkuhria pinata, Chenopodium carinatum, Bidens bipinnata, Zinnia peruviana, Argemone ochroleuca, Tagetes minuta, Conyza bonariensis* and *Verbena bonariensis*. Succulent invasive species included *Cereus jamacaru, Gleditsia triacanthos, Opuntia engelmanii, Cylindropuntia imbricata, Opuntia ficus-indica, Agave americana* and *Cereus hildmanianus*. In ravines, invasive shrubs are also common though only where significant disturbance has occurred and these include *Sphaeralcea bonariensis, Cestrum laevigatum, Cotoneaster frachettii* and *Pyracantha angustifolia*. Several of the above are considered serious invasives.

From the available data and field surveys it seems that the majority of this vegetation type is still largely intact. The level of disturbance within the vegetation varies although overall the condition

is still regarded as relatively good. From the vegetation description it is also evident that a wide variety of growth forms, with significant species diversity and a high proportion of protected and rare species are also present. The above will all contribute to an increased conservation value. All remaining portions of the vegetation type within the MOSS should be regarded as having at least a High level of sensitivity. Those few hills being affected by rubbish dumping and quarry developments will have a lower conservation value and these areas are considered to have a Moderate level of sensitivity. In addition, as previously indicated, only limited surveys of the vegetation type were able to be conducted and therefore additional studies should be conducted for any site-specific areas within the MOSS.

Figure 5: Panorama of the hills and ridges forming the Winburg Grassy Shrubland.

Figure 6: A dense woodland is prominent on many of the hills.

Figure 7: Woodland vegetation along south facing slopes can become quite dense.

Figure 8: Another view illustrating the relatively closed canopy. Note also the high percentage rocky cover.

Figure 9: A few of the hills have been degraded as seen here adjacent to the Bloemfontein South landfill site.

Figure 10: View of the Brandkop Conservancy which also illustrates the hill topography, rocky terrain and prominent woodland component.

Figure 11: Panorama of a low hill. Note the dense woodland vegetation of the southern slope compared to the northern slope.

Figure 12: In some area exceptionally large specimens of Wild Olive (*Olea europaea* subsp. *africana*) occur. These trees are protected and given their exceptional size are considered to be of conservation significance.

Exposed dolerite rock sheets - Bloemfontein Karroid Shrubland (Gh 8)

This vegetation type is situated on low ridges and hills with exposed dolerite rock sheets and is largely imbedded within the Winburg Grassy Shrubland. The vegetation type does not cover extensive areas and a few smaller portions are situated in the northern portions of the MOSS. Portions of this vegetation type remain intact though along the northern suburbs it has come under significant development pressures from urban expansion. This has also been substantiated by Dingaan & Du Preez (2017). Although significant portions, especially outside the MOSS, has already been transformed, larger portions of the vegetation type do still remain intact. A portion of this vegetation type is also associated with the Valley-of-Seven-Dams, Woodland Hills and Free State Botanical Gardens and the stream system and wetlands in this area. Large portions of this vegetation type, especially to the north east, within the MOSS are also situated on private property or similar areas which are inaccessible such as a quarry mining operation. Access could not be provided to these areas and as a result the assessment of the vegetation unit will be based on available desktop information, a few sites in the surroundings and portions associated with the Valley-of-Seven-Dams area.

The vegetation type is characterised by a quite unique vegetation composition with succulents, geophytes and dwarf karroid shrubs being prominent. Several other growth forms are also imbedded within it. This vegetation generally occur on exposed dolerite rock sheets where shallow soils and an arid micro-climate is present. The diversity of species is quite high and significantly different from other vegetation types in the region with similar vegetation types only occurring in the Karoo regions of the Cape Provinces.

A sparse grass layer with species adapted to rocky soils is characteristic of the vegetation type. Grasses are usually small and may include *Oropetium capense, Microchloa caffra, Eragrostis nindensis* and *Tragus koelerioides*. Other common grasses also include *Eragrostis lehmanniana, Themeda triandra, Aristida congesta, Tragus berteronianus, Heteropogon contortus, Melinis repens* and *Aristida diffusa*.

The dwarf karroid shrub layer is quite prominent and contains a diversity of species which includes *Searsia ciliata, Lycium horridum, Jamesbrittenia pinnatifidum, Eriocephalus ericoides, Pentzia quinquifida, Euryops empetrifolius, E. subcarnosus, Nenax microphylla, Diospyros austro-africana, Nolletia ciliaris* and *Melolobium candicans*. Larger shrubs are mostly absent although scattered specimens of species adapted to rocky environments may be present in some areas. Such shrubs include *Diospyros austro-africana, Euclea crispa* subsp. *ovata, Rhigozum obovatum, Olea europaea* subsp. *africana* and *Cussonia paniculata*.

As indicated, a diagnostic component of these shallow soils is a prominent succulent layer. Common succulent species include *Kalanchoe paniculata, Aloe grandidentata, Pachypodium succulentum, Hereroa glenensis, Ruschia intricata, Anacamperos rufescens, Cotyledon orbiculata, Curio radicans, Euphorbia rhombifolia, E. mauritanica, Curio radicans, Crassula nudicaulis, C. capitella, C. corallina, Cotyledon orbiculata, Stomatium bolusiae, Othonna protecta, Pterodiscus speciosus, Adromischus trigynus, Kalanchoe paniculata, Avonia ustulata, Ruschia unidens, Trichodiadea barbatum, Chasmatophyllum muscullinum, Sarcostemma veminale, Anancampseros filamentosa, Rabiea albipuncta, Stapelia grandiflora* var. *grandiflora, Duvalia corderoyi* and *Kleinia longiflora*. A high number of these are also listed protected species with several also considered as rare and uncommon. It is evident that succulent species make up a significant portion of the biodiversity of this habitat and significantly increases its conservation value.

In addition to succulent plants, geophytic species are also abundant and also forms a characteristic component of the vegetation type. Geophytic species observed included *Albuca setosa, Albuca cooperi, Boophone distchia, Ledebouria luteola, Strumaria tenella* subsp. *orientalis, Bulbine abyssinica, Gladiolus permeabilis, Chlorophytum fasciculatum, Brunsvigia radulosa, Tulbaghia sp., Trachyandra saltii, Nerine laticoma, Oxalis obliquifolia, Albuca setosa, Boophone distichia, Tulbaghia acutiloba, Haemanthus humilis, Eucomis autumnalis* and *Bonatea antennifera*. Note again a high diversity of species with several being listed as protected or rare and uncommon.

Herbaceous species are also common and a natural component of these exposed rock sheets and include *Geigeria filifolia, Commelina africana, Helichrysum argyrosphaerum, Chascanum pinnatifidum, Jamesbrittenia aurantiaca* and *J. stricta*.

It was noted that although remaining portions of the vegetation type was largely natural that where landowners had introduced game and the stocking levels had not been managed adequately, this has resulted in significant degradation of the vegetation layer. Here succulent species are still present, although in much lower densities than expected. It is however evident that they only remain sustained underneath thorny shrubs where they are protected from grazing and consequently their density is low.

Although largely natural, it was evident that disturbance was evident in some areas, especially where overgrazing or trampling by introduced game occurred. As a result exotic species are not abundant but several are still present, especially around areas of disturbance. These include *Opuntia lindheimeri, Chenopodium carinatum, Portulaca oleraceae, Schkuhria pinata, Cereus jamacaru, Bidens bipinnata* and *Tagetes minuta*.

From the available data and field surveys it seems that the majority of this vegetation type is still largely intact. The level of disturbance within the vegetation type varies although overall the condition is still regarded as relatively good. From the vegetation description it is also evident that the species composition is quite unique with a variety of growth forms occurring and that the species diversity is also quite high, significantly higher than other surrounding vegetation types, with a large proportion being regarded as protected species and several also rare or uncommon. In addition, the species composition is also markedly different from the surrounding grassland vegetation types, dominated by dwarf succulents, geophytes and karroid shrubs. The vegetation type would therefore seem to have a significant conservation value.

In addition, the portion of this vegetation type situated within the Valley-of-Seven-Dams area also forms the catchment of the Seven Dams Stream system which has been identified as a highly sensitive system, also being listed as a National Freshwater Ecosystem Priority Area (NFEPA): Upstream System (refer to Section 4.2.5. and 4.2.6). This will also increase the conservation value of the vegetation type in this area.

The above is also substantiated by previous studies which have come to the same conclusion. According to Dingaan & Du Preez (2017) the vegetation type is being threatened by urban expansion and is a botanically diverse area being confined to the northern portions of the urban areas of Bloemfontein. Rampant development in this vegetation type will also lead to heavy disturbance, extinction of some of the rare species here, as well as unique plant communities of which the succulent dwarf shrubs are the most sensitive (Dingaan & Du Preez 2002). According to Brown & Du Preez 2014 the vegetation type must be regarded as endemic to the Free State

Province and must be afforded a high conservation status and must be included as a Threatened Ecosystem.

All remaining portions of the vegetation type within the MOSS should be regarded as having at least a High level of sensitivity with a few portions also having a Very High level of sensitivity. In addition, as previously indicated, only limited surveys of the vegetation type were able to be conducted and therefore additional studies should be conducted for any site-specific areas within the MOSS.

Figure 13: Panorama of exposed dolerite rock sheets consisting of Bloemfontein Karroid Shrubland. Note high percentage exposed dolerite rock which sustains a high diversity of succulent and bulbous species.

Figure 14: Close-up view of the vegetation on the rock sheets, illustrating the high diversity. This small clump contains at least six visible bulbous and succulent species of which some are protected.

Figure 15: Another panorama illustrating the unique habitat.

Figure 16: Close-up view of the succulent vegetation characteristic of the Bloemfontein Karroid Shrubland. Note high amount of protected succulent species (red circles).

Figure 17: Where disturbance is evident significant infestation by exotic succulents occur (*Opuntia engelmannii* and *O. ficus-indica*).

Bloemspruit and Renosterspruit Floodplain - Highveld Alluvial Vegetation (Aza 5)

As previously indicated, the Highveld Alluvial Vegetation is very poorly represented within the MOSS with only small portions being present in the extreme north east of the MOSS. Here it is associated with the floodplains of the Bloemspruit and Renosterspruit Rivers. The MOSS has largely been delineated around hills and ridges with only a small portion incorporating these watercourses. As a result, only a small portion of this vegetation type is included within the MOSS.

Being associated with the floodplains of the Bloemspruit and Renosterspruit Rivers a description of the vegetation will be provided under the wetland section of the report (refer to Section 4.2.5 and 4.2.6).

From the available data and field surveys it seems that this vegetation type contains a varied vegetation structure with a high amount of different growth forms. This also translates to a varied topography and habitat diversity. Though not clearly evident the vegetation type also contains a diversity of geophytic species, with several being protected and of conservation significance. Those species of importance having been observed from previous studies and personal observation will also significantly contribute toward a higher conservation value. As this vegetation type is associated with the Bloemspruit and Renosterspruit which, although they are heavily modified, remain highly important in terms of their functions and services, it must be regarded as having a Very High level of sensitivity. In addition, as previously indicated, only limited surveys of the vegetation type were able to be conducted and therefore additional studies should be conducted for any site-specific areas within the MOSS.

Figure 18: Panorama of the floodplain of the Bloemspruit. Disturbance is high and the area is considered largely transformed although elements of conservation significance such as protected bulb species still remain.

Figure 19: Large portions of the floodplain of the Bloemspruit has been degraded due to dumping of construction rubble and littering.

4.1.1.2 Bloemfontein Protected Species

From the previous section, it was evident that numerous protected species are present in and around the urban area of Bloemfontein. All of the vegetation units including the wetland systems contain such protected species. However, some units may contain a much higher proportion of such species than others and this will also accordingly increase the conservation value of some units more than others. Whatever the case may be all of these protected species should be

regarded as having a significant conservation value. On-site data will also be combined with the available electronic resources (Plants of South Africa - http://posa.sanbi.org) to provide a comprehensive list of protected species which actually and probably occur in the area (Table 2 & 3).

Table 2: Protected and Red Listed species recorded for the quarter degree squares (2926AA, 2926AB & 2826CC) (http://posa.sanbi.org).

LC – **Least Concern** A species is Least Concern when it has been evaluated against the IUCN criteria and does not qualify for any of the above categories. Species classified as Least Concern are considered at low risk of extinction. Widespread and abundant species are typically classified in this category.

DDD – **Data Deficient - Insufficient Information (DDD)** A species is DDD when there is inadequate information to make an assessment of its risk of extinction, but the species is well defined. Listing of species in this category indicates that more information is required and that future research could show that a threatened classification is appropriate.

NT – **Near Threatened (NT)** A species is Near Threatened when available evidence indicates that it nearly meets any of the IUCN criteria for Vulnerable and is therefore likely to become at risk of extinction in the near future.

VU – **Vulnerable (VU)** A species is Vulnerable when the best available evidence indicates that it meets at least one of the five IUCN criteria for Vulnerable, indicating that the species is facing a high risk of extinction.

EN – **Endangered (EN)** A species is Endangered when the best available evidence indicates that it meets at least one of the five IUCN criteria for Endangered, indicating that the species is facing a very high risk of extinction.

Gh5 – **Bloemfontein Dry Grassland**

Gh7 – **Winburg Grassy Shrubland**

Gh8 – **Bloemfontein Karroid Shrubland**

Aza5 – **Highveld Alluvial Vegetation**

FAMILY	Scientific name	Status	Protected	Gh5	Gh7	Gh8	Aza5
Aizoaceae	*Nananthus vittatus*	DDT	N				✔
Amaryllidaceae	*Ammocharis coranica*	LC	Y	✔		✔	✔
Amaryllidaceae	*Brunsvigia radulosa*	LC	Y	✔	✔	✔	✔
Amaryllidaceae	*Crinum bulbispermum*	LC	Y				✔
Amaryllidaceae	*Gethyllis transkarooica*	LC	Y	✔	✔	✔	✔
Amaryllidaceae	*Haemanthus humilis subsp. humilis*	LC	Y		✔	✔	
Amaryllidaceae	*Haemanthus montanus*	LC	Y				✔
Amaryllidaceae	*Nerine laticoma*	LC	Y	✔	✔	✔	✔
Amaryllidaceae	*Strumaria tenella subsp. orientalis*	LC	Y			✔	
Anacampserotaceae	*Anacampseros filamentosa subsp. filamentosa*	LC	Y			✔	
Anacampserotaceae	*Anacampseros rufescens*	LC	Y			✔	
Anacampserotaceae	*Anacampseros ustulata*	LC	Y			✔	
Apocynaceae	*Asclepias gibba var. gibba*	LC	Y	✔	✔	✔	✔
Apocynaceae	*Asclepias meyeriana*	LC	Y	✔	✔	✔	✔
Apocynaceae	*Asclepias multicaulis*	LC	Y	✔	✔	✔	✔
Apocynaceae	*Brachystelma circinatum*	LC	Y	✔	✔	✔	✔
Apocynaceae	*Brachystelma glenense*	DDT	Y	✔	✔	✔	✔
Apocynaceae	*Cynanchum virens*	LC	Y	✔	✔	✔	✔
Apocynaceae	*Duvalia corderoyi*	LC	Y			✔	
Apocynaceae	*Pachypodium succulentum*	LC	Y			✔	
Apocynaceae	*Pentarrhinum insipidum*	LC	Y	✔	✔	✔	✔
Apocynaceae	*Raphionacme dyeri*	LC	Y	✔	✔	✔	✔
Apocynaceae	*Raphionacme hirsuta*	LC	Y	✔	✔	✔	✔
Apocynaceae	*Stapelia grandiflora var. grandiflora*	LC	Y		✔	✔	
Apocynaceae	*Stenostelma capense*	LC	Y	✔	✔	✔	✔
Apocynaceae	*Stenostelma corniculatum*	LC	Y	✔	✔	✔	✔
Araliaceae	*Cussonia paniculata subsp. sinuata*	LC	Y		✔	✔	
Asphodelaceae	*Aloe grandidentata*	LC	Y		✔	✔	

Asphodelaceae	*Aloe jeppeae*	LC	Y	✔			✔
Euphorbiaceae	*Euphorbia clavarioides*	LC	Y	✔	✔	✔	✔
Euphorbiaceae	*Euphorbia mauritanica*	LC	Y		✔	✔	
Euphorbiaceae	*Euphorbia rhombifolia*	LC	Y			✔	
Euphorbiaceae	*Euphorbia spartaria*	LC	Y			✔	
Geraniaceae	*Pelargonium sidoides*	LC	Y	✔	✔	✔	✔
Hyacinthaceae	*Eucomis autumnalis subsp. amaryllidifolia*	LC	Y	✔	✔	✔	✔
Hyacinthaceae	*Eucomis autumnalis subsp. clavata*	LC	Y	✔	✔	✔	✔
Iridaceae	*Gladiolus permeabilis subsp. edulis*	LC	Y	✔	✔	✔	✔
Oleaceae	*Olea europaea subsp. cuspidata*	LC	Y		✔	✔	
Orchidaceae	*Bonatea antennifera*	LC	Y			✔	
Orchidaceae	*Eulophia hians var. nutans*	LC	Y	✔	✔	✔	✔
Orchidaceae	*Eulophia ovalis var. ovalis*	LC	Y	✔	✔	✔	✔
Orchidaceae	*Habenaria epipactidea*	LC	Y	✔	✔	✔	✔
Pedalicaea	*Harpagophytum procumbens*	LC	Y	✔			

From Table 2 it is evident that several of the species anticipated to occur in the area were confirmed during the on-site surveys. Many of those not confirmed are still likely to occur and it is also notable that deciduous species were not observed due to the absence of above ground leaves during winter. They are therefore highly likely to still occur in the area.

Table 3: Protected species observed during on-site and previous surveys of the Bloemfontein urban area and the specific vegetation unit in which they occurred.

Protected Species	**Undulating Plains (Gh 5)**	**Rocky hills and ridges (Gh 7)**	**Exposed rock sheets (Gh 8)**	**Floodplains (Aza 5)**
Aloe grandidentata		X	X	
Aloe jeppeae	X	X		
Ammocahris coranica	X		X	X
Anacamperos rufescens			X	
Anancampseros filamentosa			X	
Bonatea antennifera		X	X	
Boophone distchia	X		X	
Brunsvigia radulosa	X		X	
Crinum bulbispermum				X
Cussonia paniculata		X	X	
Duvalia corderoyi			X	
Eucomis autumnalis subsp. *clavata*	X	X	X	X
Euphorbia mauritanica			X	
Euphorbia rhombifolia			X	
Gladiolus permeabilis		X	X	
Haemanthus humilis		X	X	
Haemanthus montanus				X
Nerine laticoma	X		X	
Olea europaea subsp. *africana*		X	X	
Othonna protecta			X	
Pachypodium succulentum			X	
Raphionacme dyeri	X			
Raphionacme hirsuta	X		X	
Sarcostemma veminale		X	X	
Stapelia grandiflora var. *grandiflora*		X	X	
Strumaria tenella subsp. *orientalis*			X	

From the on-site observations as well as data of previous collections in the area it is clear that numerous protected species are present. Although all the vegetation units and vegetation types contain some protected species it was evident that especially those associated with hills, ridges and exposed rock sheets contained the largest proportion. Note that the Bloemfontein Karroid Shrubland contains a significantly higher amount of protected species when compared to the other vegetation types. This also indicates a significant conservation value of this vegetation type and will also contribute to a higher conservation value for it.

4.1.1.3 Additional sensitive areas (Appendix A: Map 2)

Numerous data sets and mapping resources have been developed to aid in the identification of sensitive areas and areas with a high conservation value, notably those resources developed by the South African National Biodiversity Institute (SANBI). Several of these resources were also combined with the results and discussion of the previous sections to indicate areas within the Bloemfontein urban area which should be regarded as sensitive. From these data sets the following conclusions can be made:

National Biodiversity Assessment (NBA) 2018 (Appendix A: Map 2)

Remnants of the natural vegetation types in the area indicates that the urban development of Bloemfontein has led to the loss of large portions of natural vegetation types (Figure 20). As indicated in previous sections, all of the vegetation types in the area contain elements of significant conservation value and therefore all portions of remaining natural vegetation will have a significant level of sensitivity. However, the Bloemfontein Dry Grassland is a Vulnerable vegetation type and will therefore have an increased sensitivity. As concluded, the Bloemfontein Karroid Shrubland contains a high species diversity, provide unique habitat of limited extent and has a high proportion of protected species and will therefore also have an increased sensitivity. The hills and ridges consisting of Winburg Grassy Shrubland also contain numerous protected species and as positive landscape features acting as corridors the vegetation type still has a significant level of sensitivity though lower than the two aforementioned vegetation types. The Highveld Alluvial Vegetation also contains a significant number of protected species and being associated with large watercourses it also still has a significant level of sensitivity. This should be taken into considered in spatial planning especially where development occurs within the MOSS.

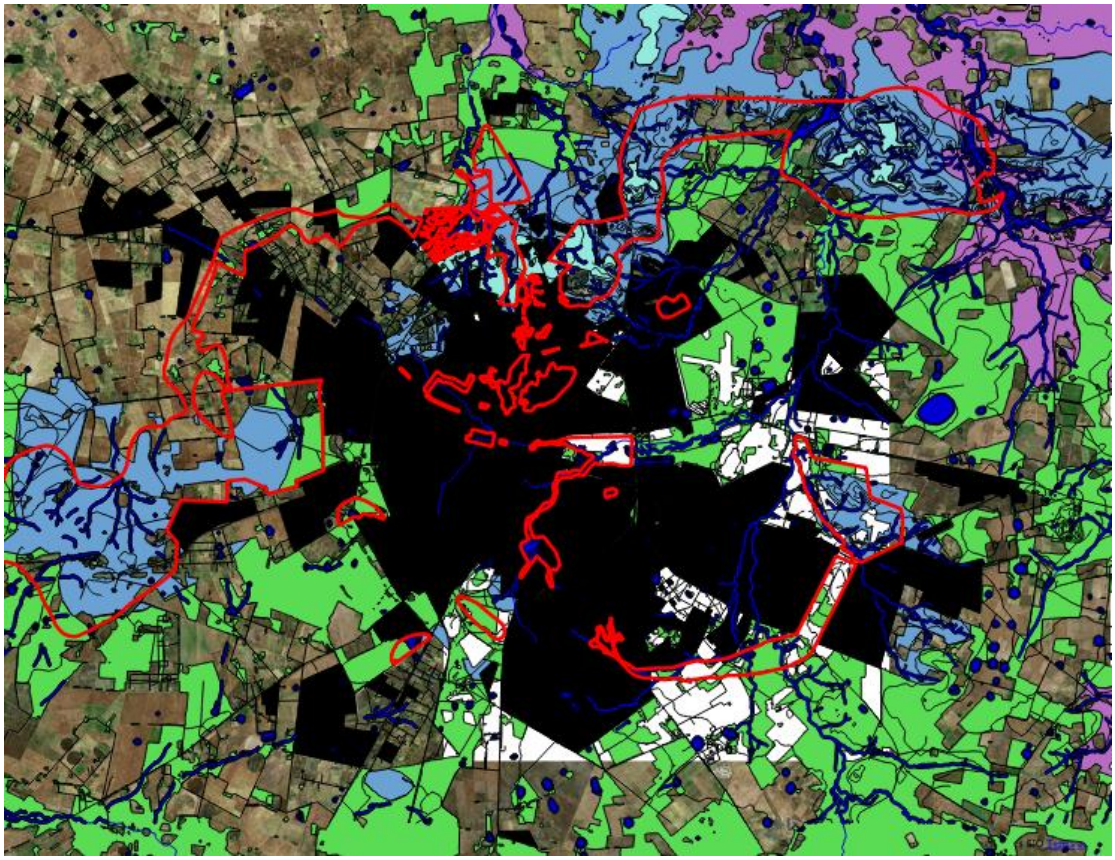
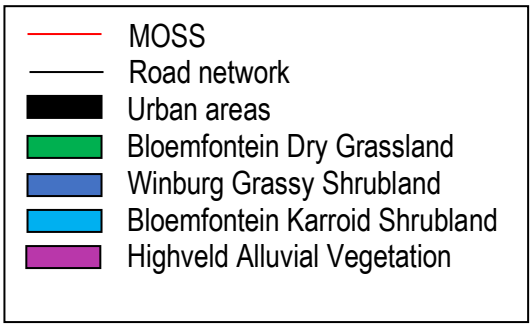


Figure 20: View of the remaining portions of the different vegetation types present in the Bloemfontein urban area in relation to the MOSS. Note extensive transformation has already occurred.

Legend:



Free State Biodiversity Management Plan 2015 (Appendix A: Map 2)

The Free State Province Biodiversity Management Plan (2015) has been developed and has identified areas which are essential to meeting conservation targets for specific vegetation types, i.e. Critical Biodiversity Areas (CBA), and other elements of high conservation importance.

Due to the already heavily transformed nature of the Bloemfontein urban area there are not a high amount of these CBA's left. However, the following CBA's are situated within the MOSS and will further increase the sensitivity where they occur within it and must be regarded as having a high level of sensitivity (Figure 21):

- A large CBA 1 is located to the west of the Kellysview Small Holdings consisting of a series of large hills, dominated by Winburg Grassy Shrubland.
- Large hill to the west of the urban area.
- Significantly large CBA 1 to the north of the city and associated with a large portion of intact Bloemfontein Karroid Shrubland.

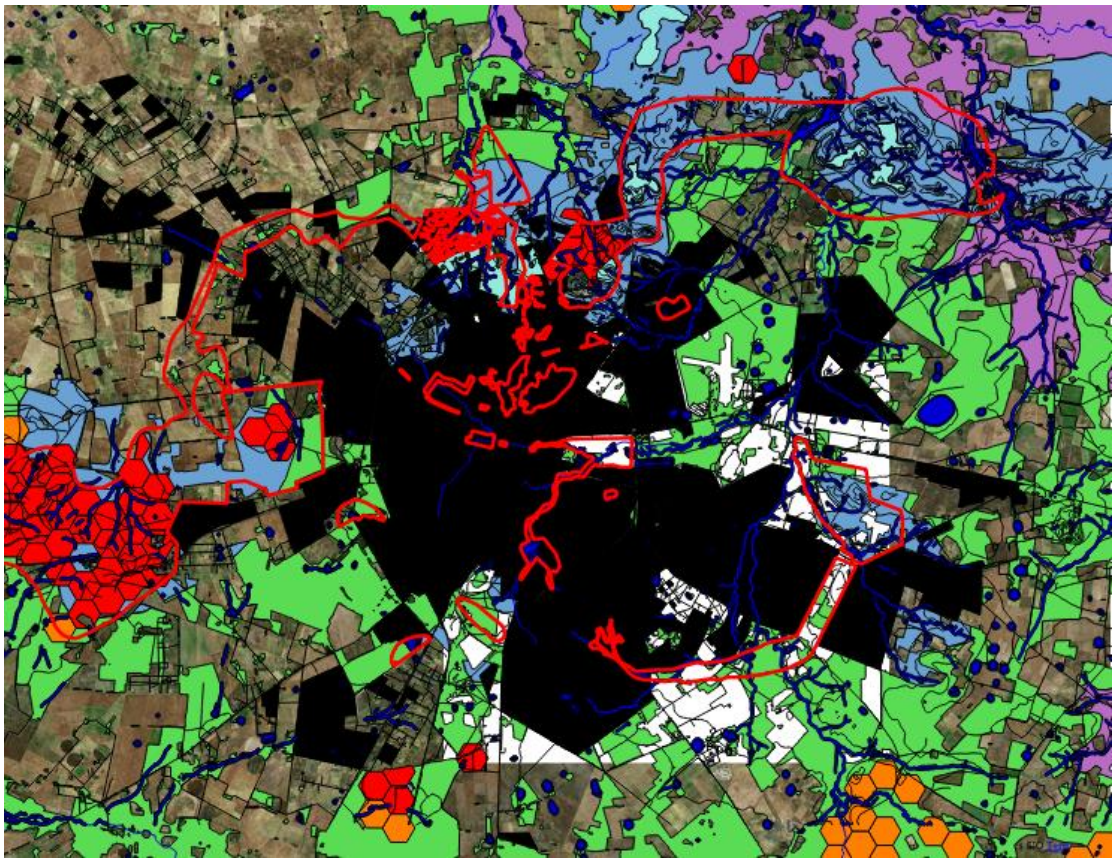
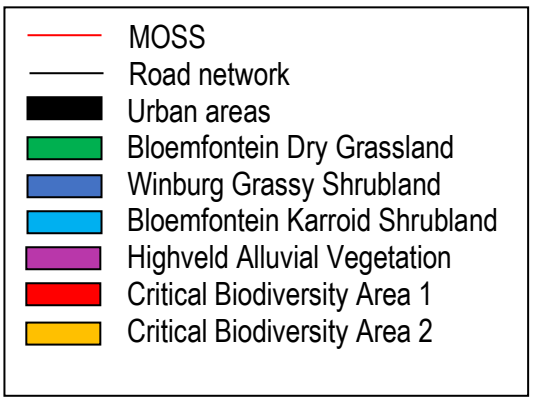


Figure 21: View of CBA 1 and 2 areas where they occur within the MOSS in the Bloemfontein urban area overlain over the remaining natural vegetation portions.

Legend:



National Protected Areas Expansion Strategy (NPAES) 2010 (Appendix A: Map 2)

As development increases through time, the expansion of protected areas should also be increased. The NPAES has been developed to identify areas which represent areas of natural vegetation in good condition, with significant diversity and in need of increased conservation. These NPAES Focus Areas therefore represent areas with a significant sensitivity.

Due to the already transformed nature of the majority of the Bloemfontein urban area it does not contain any NPAES Focus Areas. A large portion of NPAES Focus Area occurs to the south and north east of Bloemfontein, but is situated outside the MOSS and should not be affected as long as urban expansion toward it is not extensive (Figure 22).