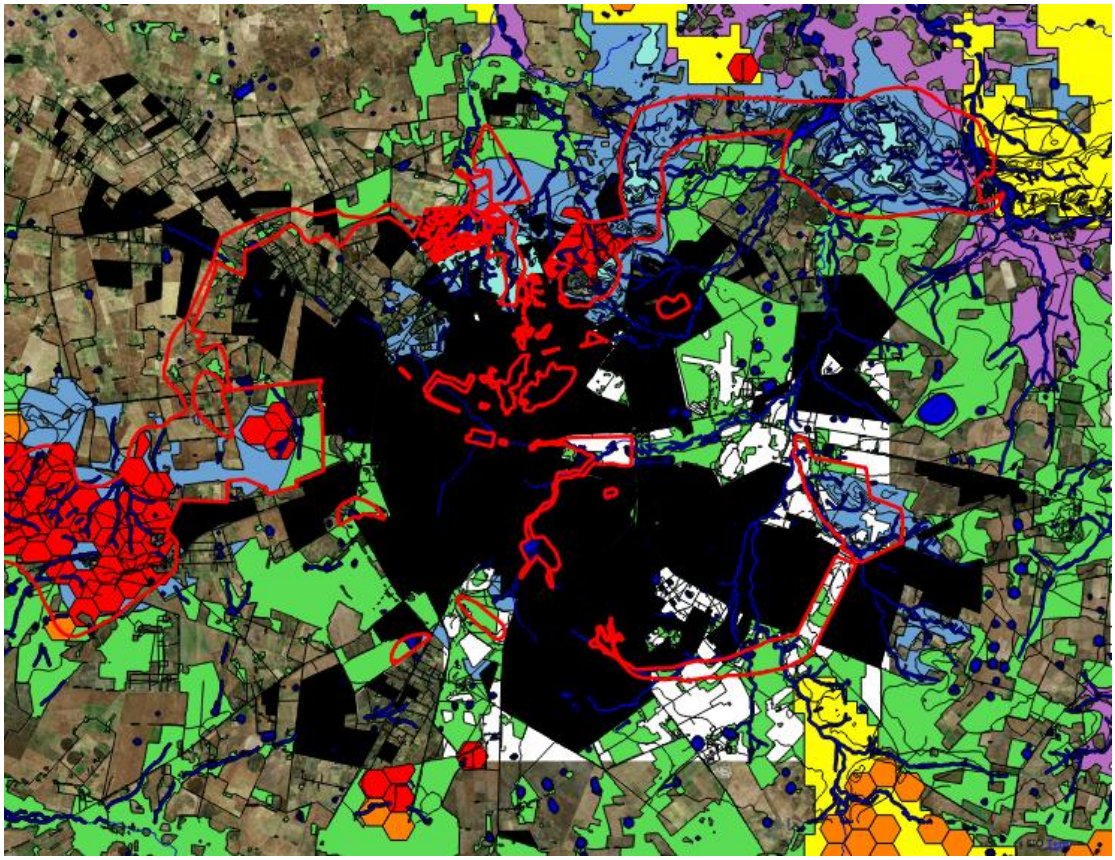
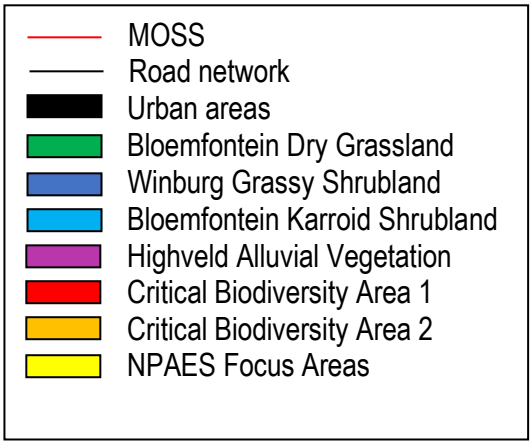


Figure 22: View of the NPAES Focus Areas within the MOSS near the Bloemfontein urban area. Note an extensive Focus Area to the south east and north east.

Legend:



4.1.1.4 Bloemfontein urban area – Conclusions (Appendix A: Map 1)

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.

4.1.2 Botshabelo urban area (Appendix A: Map 3 - 4)

Botshabelo is 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 was also confirmed during the field surveys and although these impacts were present in most areas they were most severe in and around urban areas and decreases in areas further away from the urban centres.

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. These impacts were found to be most severe in and around the urban centres and decreasing in magnitude in areas located further away from the urban centres.

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. 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.

4.1.2.1 Botshabelo Vegetation Units (Appendix A: Maps 3 – 4)

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.

The on-site and desktop surveys indicated that the MOSS comprises almost exclusively of hills, ridges and mountainous areas with almost all consisting of Basotho Montane Shrubland. Small portions on top of the Thaba Nchu Mountain and portions of the hills to the north of Thaba Nchu consist respectively of Eastern Free State Clay Grassland and Winburg Grassy Shrubland. These will however be included under the discussion of the Basotho Montane Shrubland since the species composition does not differ markedly from it and access could not be provided to areas of these vegetation types located on private property. Only small portions of the plains are situated within the MOSS to the West of Botshabelo and to the east of the Thaba Nchu Mountain. Where access could be obtained to these areas they also exhibited high levels of overgrazing by domestic livestock.

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.

Small portion of plains grassland - Central Free State Grassland (Gh 6)

As previously indicated, the MOSS for Botshabelo and Thaba Nchu has almost exclusively been delineated around the surrounding hills, ridges and mountainous terrain and as a result the grassland plains is not well represented in the MOSS. A small portion of grassland plains is situated to the west of Botshabelo though here it is evidently heavily affected by overgrazing of domestic livestock. Another small portion is located to the west of the Thaba Nchu Mountain though could not be assessed. Along the foot slopes of the mountainous areas in the MOSS small portions of plains may be included but are situated within the ecotone and considered as forming part of the Basotho Montane Shrubland. 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.

The vegetation type being dominated by undulating grassland is easily identified. Though there are no clear edaphic conditions which define the vegetation type it is still clearly differentiated by topographical and vegetation structure elements. These grasslands are confined to an undulating topography and dominated exclusively by grasses with shrubs and trees being completely absent. This clearly differentiates it from the hills, ridges and mountainous areas of the MOSS.

As indicated, a grass layer dominates and includes species such as *Aristida congesta, Tragus koelerioides, Microchloa caffra, Cymbopogon pospischillii* and *Eragrostis lehmanniana*. This indicates a quite low species diversity with the majority also consisting of pioneer species. This is a consequence of high levels of overgrazing which leads to a decrease in diversity, with many grasses not being identifiable and dominated by pioneer, unpalatable species. Aerial imagery indicate that grassland to the west of the Thaba Nchu Mountain is likely to be less affected by overgrazing but was not assessed.

A prominent dwarf karroid shrub component is also prominent in many areas and include species such as *Felicia muricata* and *Rosenia humilis*. Although these species also occur under natural conditions, where they are abundant they are a clear indicator of overgrazing as is the case in grassland portions of the MOSS around Botshabelo.

Herbaceous species are also abundant and imbedded within the grass layer and these include *Dimorphotheca zeyheri, Aptosimum procumbens, Hermannia coccocarpa* and *Berkheya macrocephala*. These are mostly natural to the vegetation type but some herbaceous species which is abundant in many areas does indicate disturbance of the grass layer.

Another component is the presence of several geophytic species. This is also a natural component of the vegetation type. These species include *Massonia jasminiflora, Eriospermum porphyrium* and *Dipcadi sp.* Another abundant geophyte, *Moraea pallida*, is however a clear indicator of overgrazing. It is poisonous and unpalatable to livestock and proliferates in areas subjected to overgrazing.

A few scattered specimens of the protected succulent, *Euphorbia clavaroides* were observed and does increase the conservation value of the grassland areas.

Exotic weeds were not found to be abundant though it is likely that several annual weeds will be present during the rainy season.

From the vegetation description the vegetation unit or type which is included within the Botshabelo and Thaba Nchu MOSS it is clearly heavily affected by overgrazing of domestic livestock. Grassland portions to the west of the Thaba Nchu Mountain may be more natural but were not assessed within the study. Overall, overgrazing has caused a decrease in species diversity and dominated by pioneer species. As a result, elements of high conservation value is largely absent. Where protected species remain, they will increase the conservation value to some extent. Although the condition of portions of remaining grassland may be poor they still form part of the delineated MOSS and should therefore be regarded as retaining a significant conservation value. Grassland areas regarded as being heavily affected by overgrazing is regarded as having a moderate sensitivity while those portions regarded as being more natural are regarded as having a high level of sensitivity.

Figure 23: Panorama of remaining Central Free State Grassland within the MOSS to the east of Botshabelo. Note low percentage grass cover and visible sheet erosion.

Figure 24: Another panorama of the grassland to the east of Botshabelo. Note again a very short grass layer caused by heavy overgrazing.

Figure 25: Though access could not be provided for grassland areas to the west of the Thaba Nchu Mountain, aerial images indicate that it is likely to be less affected by overgrazing.

Hills, ridges and mountainous areas - Basotho Montane Shrubland (Gm 5)

As previously indicated, the MOSS for Botshabelo and Thaba Nchu is almost exclusively delineated around hills, ridges and mountainous terrain consisting of Basotho Montane Shrubland. Small portions on top of the Thaba Nchu Mountain and portions of the hills to the north of Thaba Nchu consist respectively of Eastern Free State Clay Grassland and Winburg Grassy Shrubland. These will however be included under the discussion of the Basotho Montane Shrubland since the species composition does not differ markedly from it and access could not be provided to areas of these vegetation types located on private property. These hills, ridges and mountainous terrain are almost all still of largely natural composition though disturbance and degradation does occur, especially in close proximity to the urban areas. Around the urban area of Botshabelo small portions has been transformed as a result of rock quarries, landfill site and water infrastructure such as reservoirs. Furthermore, overgrazing is present in almost all areas of the MOSS though most pronounced in close proximity to the urban areas and decreasing in areas further from urban areas. The majority of the mountainous terrain is situated within municipal and communal terrain and access could easily be gained. However, the Thaba Nchu

Mountain situated on private property and areas of communal farming operations were inaccessible and here the assessment of the vegetation unit will be based on available desktop information and aerial images. The survey of available areas is however considered sufficient to give a good overview of these portions 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, hills and mountains. Larger mountains and hills also contain a prominent plateau 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 *Searsia burchellii, S. pyroides, Olea europaea* subsp. *africana, Searsia ciliata, Euclea crispa* subsp. *crispa, Diospyros lycioides, D. austro-africana, Grewia occidentalis*, *Osyris lanceolata, Ehretia rigida, Rhigozum obovatum, Heteromorpha arborescens, Cussonia paniculata, Clutia pulchella, Myrsine africana, Tarchonanthus minor, Gymnosporia buxifolia, Searsia leptodictya, Gymnosporia heterophylla, Scolopia zeyheri, Rhoicissus tridentata, Asparagus larcinus, Searsia erosa* 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.

As indicated, the plateaus and north facing slopes contain a much sparser tree canopy with a prominent grass layer. These grasses are adapted to slopes and include species such as *Melinis nerviglumis, Digitaria eriantha, Themeda triandra, Heteropogon contortus, Aristida diffusa, Eragrostis lehmanniana, Aristida congesta, Tragus koelerioides, Cymbopogon pospischillii, Hyparrhenia hirta, Sporobolus africanus, Aristida junciformis, Eragrostis chloromelas, Eragrostis curvula, Eragrostis capensis, Oropetium capense, Hyparrhenia tamba, Setaria sphacelata, Triraphis andropogonoides, Eragrostis superba, Cymbopogon excavatus* and *Eystachys paspaloides*. Note again a high diversity of species. Though many of these are climax grasses, it was notable that pioneer species dominated in many areas and can be attributed to overgrazing by domestic livestock. Such species included *Aristida congesta, A. junciformis, Cymbopogon pospischillii* and *Eragrostis lehmanniana*. This indicates a largely natural vegetation type but which is being subjected to significant levels of disturbance.

A dwarf shrub component is also quite prominent, especially within the grass layer on plateaus and north facing slopes. These form part of the natural vegetation structure and include *Melolobium candicans, Asparagus suaveolens, Jamesbrittenia atropurpurea, Hermannia cuneifolia, Felicia fillifolia, Artimisia afra, Whlenbergia nodosa, Nolletia ciliaris, Euryops empetrifolius* and *Nenax microphylla*. The pioneer shrubs, *Hertia pallens, Lycium horridum, Felicia muricata* and *Chrysocoma ciliata* are abundant in areas where overgrazing has occurred.

Herbaceous species are also abundant in the vegetation type and distributed all over. These include *Aptosimum procumbens, Chascanum pinnatifidum, Gazania krebsiana, Hermannia depressa, Lotononis listii, Dicoma macrocephala, Gerbera piloselloides, Rhynchosia sp.,*

Berkheya sp., Helicrhysum nudifolium, Berkheya onopordifolia, Berkheya setifera, Pavonia burcehllii, Jamesbrittenia albiflora, Senecio sp., Lobelia erinus, Hilliardiella sp., Salvia stenophylla, Dicoma anomala, Thesium costatum, Helichrysum rugulosum and *Wahlenbergia androsaceae*. A few herbaceous species are also indicative of overgrazing and include *Solanum tomentosum, Acrotome inflata* and *Solanum incanum*.

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,* smaller shrubs such as *Lantana rugosa* and *Asparagus denudatus,* herbaceous species such as *Cineraria lyrata* and *Crassula lanceolata* and climbers such as *Clematis brachiata*.

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, Stapelia grandiflora* var. *grandiflora, Kalanchoe thyrsiiflora, Crassula nudicaulis*, *Cotyledon orbiculata* var. *oblonga, Crassula dependens, Ruschia hamata, Euphorbia pulvinata, Delosperma sp., Chasmatophyllum muscullinum, Crassula capitella, Anacampseros rufescens* and *Aloe broomii*. A note should be made on the large colonies of *Aloe broomii* which are abundant on the highest plateaus and slopes of the larger hills and mountains. These are uncommon and forming rather dense colonies they are of significant conservation significance. Furthermore, one rare occurrence of a small population of hybrids were noted. To the west of Thaba Nchu a small colony occurs where hybrids between *Aloe broomii* and *A. grandidetata* was noted. Such hybrids are a very rare occurrence and are consequently of high conservation value. In addition, a large colony of *Euphorbia pulvinata* was observed to the east of Botshabelo. This is quite a rare species, especially in the Free State and therefore has a quite high conservation value. It is also likely that a survey during the rainy season will reveal numerous other species of significance.

Geophytic species are quite common and include *Albuca setosa, Ledebouria luteola, Gladiolus permeabilis, Gladiolus sp., Pelargonium aridum, Xysmalobium sp., Hypoxis argentea, Pelargonium sidoides* and *Androcymbium longipes*. Several of these are also listed as protected species. It is also likely that a survey during the rainy season will reveal numerous other species of significance. Another geophyte which is abundant but also an indicator of overgrazing is *Moraea pallida*. It is poisonous and unpalatable to livestock and proliferates in areas subjected to overgrazing.

Most probably as a result of overgrazing and other disturbances, exotic weeds and especially invasive succulents have become established in many areas. Exotic weeds include *Schkuhria pinata, Bidens bipinnata, Argemone ochroleuca* and *Tagetes minuta*. Succulent invasive species included *Cylindropuntia imbricata* and *Opuntia ficus-indica.*

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 *Searsia 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 and Thaba Nchu MOSS area.

From the available data and field surveys it seems that the majority of this vegetation type is still largely intact. However, small areas of transformation such as a rock quarry, landfill site and water infrastructure do occur but does not affect large portions of the MOSS. However, overgrazing by domestic stock is present in the entire MOSS. This impact is highest in close proximity to urban areas where it causes significant modification of the species composition and vegetation structure. The impact decreases in distance from urban areas though does cause a low amount of disturbance in all areas. 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 small portions affected by rock quarries, landfill site and water reservoirs 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 26: Panorama of one of small hills around Botshabelo. Here overgrazing is very high and the grass layer very short.

Figure 27: Panorama of the hills and ridges in the MOSS. A dense woodland is prominent on many of the hills.

Figure 28: Another view of the hills around Botshabelo. Note again a dense woodland layer, especially along the southern slope.

Figure 29: View of the landfill site and water reservoir which does cause local transformation within the MOSS.

Figure 30: View of a portion of the plateau where a more prominent grass layer is evident.

Figure 31: View of a colony of the rare succulent, *Euphorbia pulvinata*, identified in the MOSS.

4.1.2.2 Botshabelo Protected Species

From the previous section, it was evident that numerous protected species are present in and around the urban area of Botshabelo. All of the vegetation units 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 4 & 5). 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. africana*	LC	Y		✔

From Table 5 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 5: Protected species observed during on-site and previous surveys of the Botshabelo urban area and the specific vegetation unit in which they occurred.

Protected Species	**Undulating Plains (Gh 6)**	**Hills, ridges and mountains (Gm 5)**
Aloe broomii		X
Aloe broomii x grandidentata		X
Aloe grandidentata		X
Anacamperos rufescens		X
Cussonia paniculata		X
Euphorbia clavaroides	X	
Euphorbia pulvinata		X
Gladiolus permeabilis		X
Gladiolus sp.		X
Olea europaea subsp. *africana*		X
Orbea lutea var. *lutea*		X
Pelargonium sidoides		X
Stapelia grandiflora var. *grandiflora*		X
Xysmalobium sp.		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 the grassland plains also contain protected species it was clear that the hills, ridges and mountainous areas contained almost all of the observed protected plants. This is also a consequence of the small portions of grassland included within the MOSS. However, the Basotho Montane Shrubland and diversity of habitats contained on the hills, ridges and mountains had been anticipated to contain a significantly higher proportion of protected as the survey has confirmed. It would therefore follow that these hills, ridges and mountains delineated within the MOSS would have a higher conservation value.

4.1.2.3 Additional sensitive areas (Appendix A: Map 4)

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 (Appendix A: Map 4)

Remnants of the natural vegetation types in the area indicates that large portions of natural vegetation still remain in and around the urban area of Botshabelo (Figure 32). 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 which consists of the hills, ridges and mountainous areas has been confirmed to contain a diversity of habitat, species and a high proportion of protected and rare species. Furthermore, as positive landscape features they also act as corridors which contributes to a significant level of sensitivity. This should be taken into considered in spatial planning especially where development occurs within the MOSS.

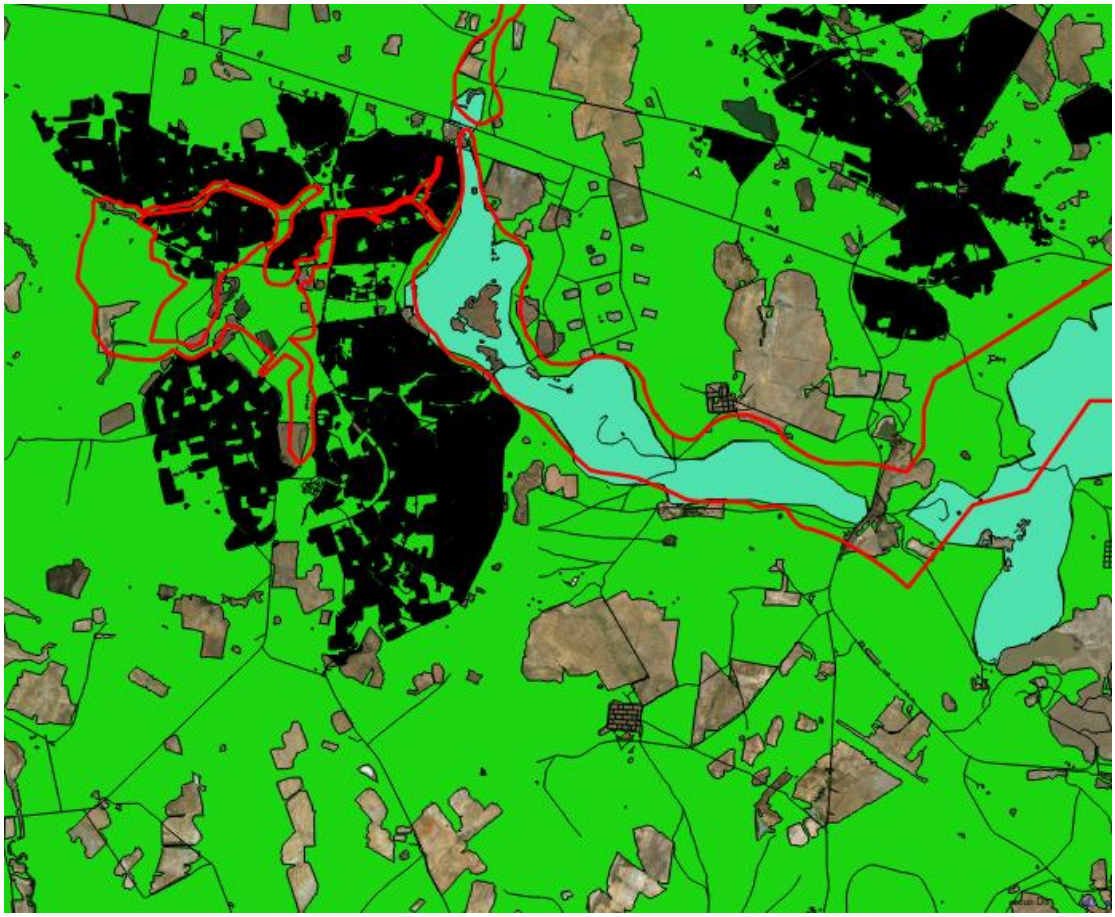
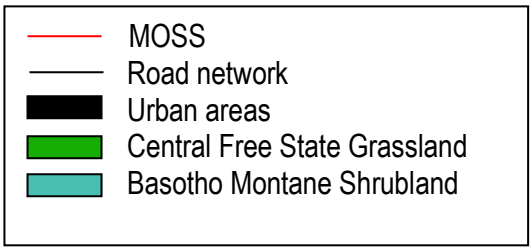


Figure 32: View of the remaining portions of the different vegetation types present in the Botshabelo urban area. Note extensive transformation has occurred although large natural areas occur around it.

Legend:



Free State Biodiversity Management Plan 2015 (Appendix A: Map 4)

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 not many CBA's in the Botshabelo MOSS. However, the Rustfontein Dam Nature Reserve borders Botshabelo to the south west and the Maria Maroka Nature Reserve occurs to the south of the Thaba Nchu Mountain, east of Botshabelo (Figure 33). Although neither these protected areas form part of the MOSS they

should still be taken into account w.r.t. urban 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.

In addition, a large CBA 1 area occurs on and around the Thaba Nchu Mountain (Figure 33) and will further increase the sensitivity of this area. Where the area is considered to have a high level of sensitivity this will increase the sensitivity to very high.

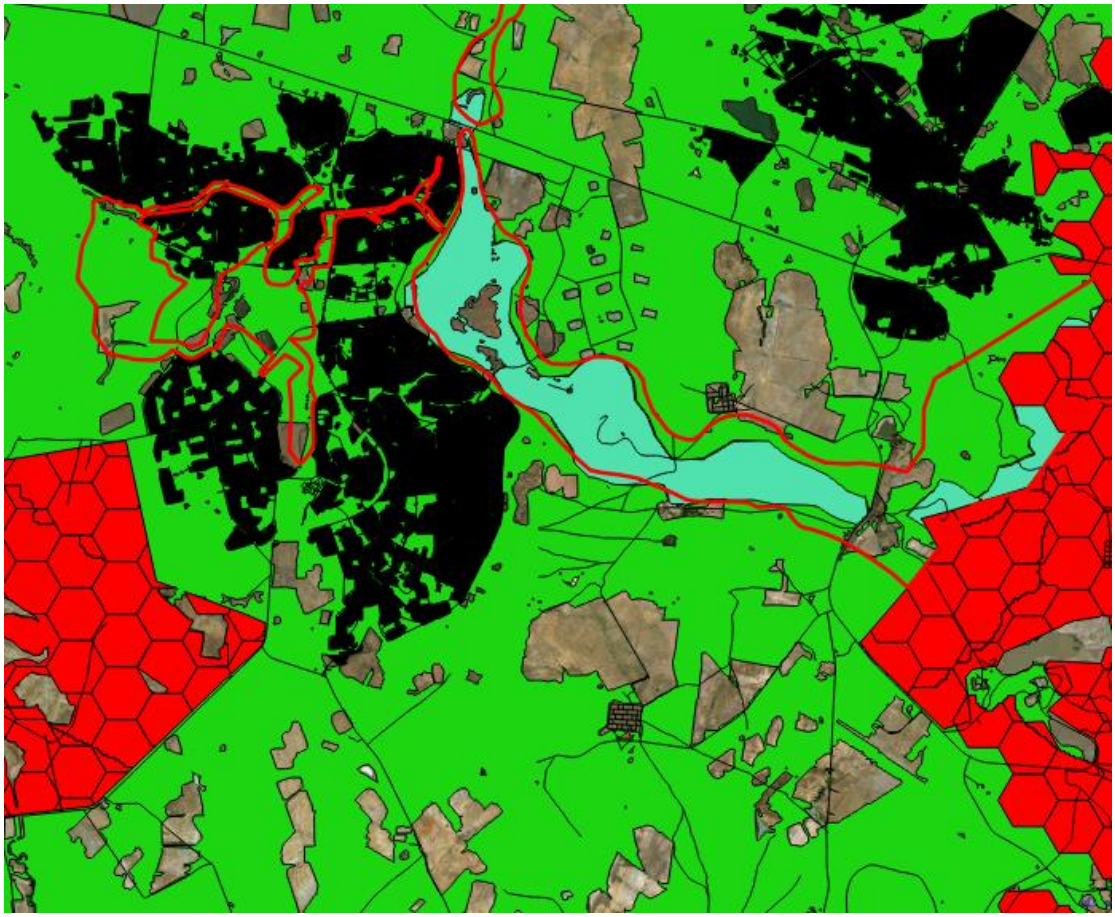
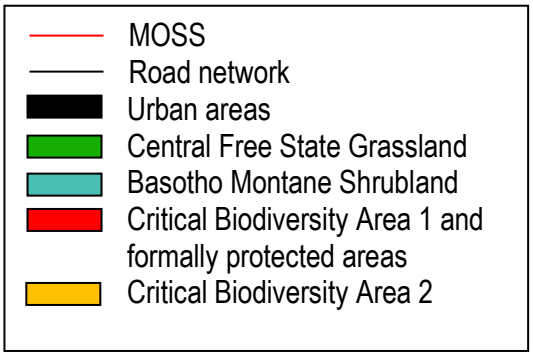


Figure 33: View of CBA 1 and 2 areas as well as protected area in the Botshabelo urban area overlain over the remaining natural vegetation portions.

Legend:



National Protected Areas Expansion Strategy (NPAES) 2010 (Appendix A: Map 4)

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 (Figure 34). 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 (Figure 34).

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.

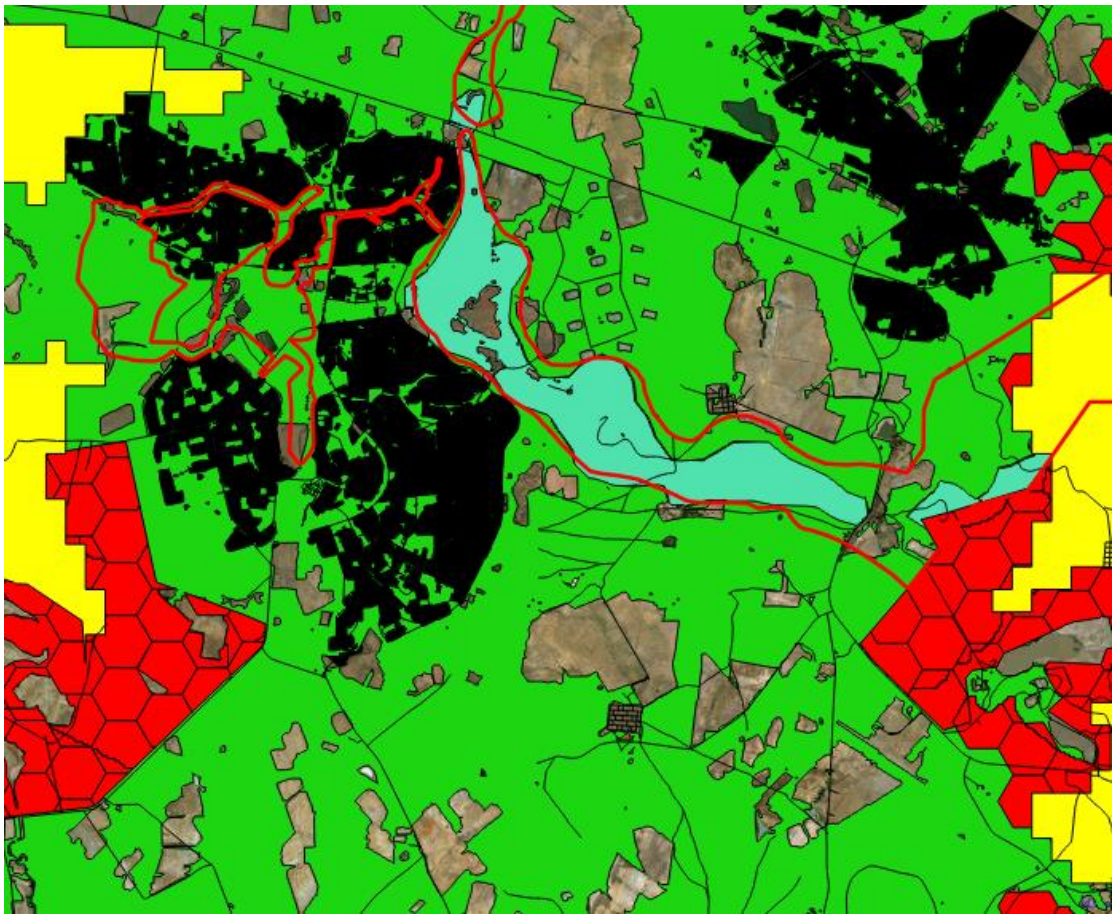
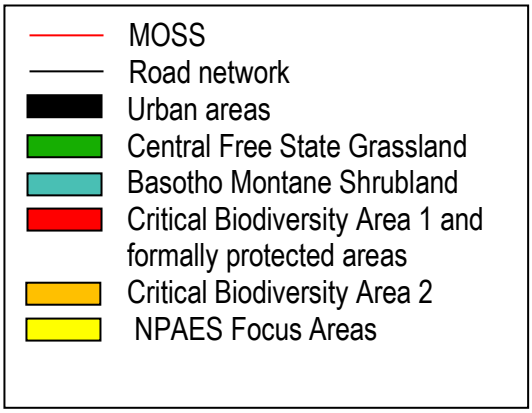


Figure 34: View of the NPAES Focus Areas near the Botshabelo urban area. Note an extensive Focus Area to the west, associated with the Rustfontein Nature Reserve as well as to the east, associated with the Thaba Nchu Mountain.

Legend:



4.1.2.4 Botshabelo urban area – Conclusions (Appendix A: Map 3)

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.

4.1.3 Thaba Nchu urban area (Appendix A: Map 5 - 6)

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 was also confirmed during the field surveys and although these impacts were present in most areas they were most severe in and around urban areas and decreases in areas further away from the urban centres.

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. It is also located on private property and access to it could not be provided.

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. These impacts were found to be most severe in and around the urban centres and decreasing in magnitude in areas located further away from the urban centres.

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 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.

4.1.3.1 Thaba Nchu Vegetation Units

The urban area of Thaba Nchu contains a relatively uniform but undulating terrain with scattered hills and ridges in the surrounding region. The MOSS around the urban area consists of a single vegetation type. The Thaba Nchu Mountain to the south east of the urban area also forms part of the MOSS though could not be accessed as it is located on private property. According to Mucina & Rutherford (2006), the urban area and immediate surroundings consist of Central Free State Grassland (Gh 6), Winburg Grassy Shrubland (Gh 7) and Basotho Montane Shrubland (Gm 5). According to the National Environmental Management: Biodiversity Act, 2004 (Act No. 10 of 2004) these are 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. The Basotho Montane Shrubland and Winburg Grassy 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.

The on-site and desktop surveys indicated that the MOSS comprises almost exclusively of hills, ridges and mountainous areas consisting of Basotho Montane Shrubland and Winburg Grassy Shrubland. Small portions on top of the Thaba Nchu Mountain consist of Eastern Free State Clay Grassland. These will however all be included under the discussion of the Basotho Montane Shrubland since the species composition does not differ markedly from it and access could not be provided to areas of these vegetation types located on private property. The MOSS around Thaba Nchu does not contain any of the plains areas and are confined to hills, ridges and mountainous areas and the Central Free State Grassland is therefore absent from the MOSS.

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.

Hills, ridges and mountainous areas - Basotho Montane Shrubland (Gm 5) & Winburg Grassy Shrubland (Gh 7)

As previously indicated, the MOSS for Botshabelo and Thaba Nchu is almost exclusively delineated around hills, ridges and mountainous terrain consisting of Basotho Montane Shrubland and Winburg Grassy Shrubland\. Small portions on top of the Thaba Nchu Mountain and portions of the hills to the north of Thaba Nchu consist respectively of Eastern Free State

Clay Grassland and Winburg Grassy Shrubland. These will however be included under the discussion of the Basotho Montane Shrubland since the species composition does not differ markedly from it and access could not be provided to areas of these vegetation types located on private property. These hills, ridges and mountainous terrain are almost all still of largely natural composition though disturbance and degradation does occur, especially in close proximity to the urban areas. Around the urban area of Botshabelo small portions has been transformed as a result of rock quarries, landfill site and water infrastructure such as reservoirs. Furthermore, overgrazing is present in almost all areas of the MOSS though most pronounced in close proximity to the urban areas and decreasing in areas further from urban areas. The majority of the mountainous terrain is situated within municipal and communal terrain and access could easily be gained. However, the Thaba Nchu Mountain situated on private property and areas of communal farming operations were inaccessible and here the assessment of the vegetation unit will be based on available desktop information and aerial images. The survey of available areas is however considered sufficient to give a good overview of these portions 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, hills and mountains. Larger mountains and hills also contain a prominent plateau 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 *Searsia burchellii, S. pyroides, Olea europaea* subsp. *africana, Searsia ciliata, Euclea crispa* subsp. *crispa, Diospyros lycioides, D. austro-africana, Grewia occidentalis*, *Osyris lanceolata, Ehretia rigida, Rhigozum obovatum, Heteromorpha arborescens, Cussonia paniculata, Clutia pulchella, Myrsine africana, Tarchonanthus minor, Gymnosporia buxifolia, Searsia leptodictya, Gymnosporia heterophylla, Scolopia zeyheri, Rhoicissus tridentata, Asparagus larcinus, Searsia erosa* 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.

As indicated, the plateaus and north facing slopes contain a much sparser tree canopy with a prominent grass layer. These grasses are adapted to slopes and include species such as *Melinis nerviglumis, Digitaria eriantha, Themeda triandra, Heteropogon contortus, Aristida diffusa, Eragrostis lehmanniana, Aristida congesta, Tragus koelerioides, Cymbopogon pospischillii, Hyparrhenia hirta, Sporobolus africanus, Aristida junciformis, Eragrostis chloromelas, Eragrostis curvula, Eragrostis capensis, Oropetium capense, Hyparrhenia tamba, Setaria sphacelata, Triraphis andropogonoides, Eragrostis superba, Cymbopogon excavatus* and *Eystachys paspaloides*. Note again a high diversity of species. Though many of these are climax grasses, it was notable that pioneer species dominated in many areas and can be attributed to overgrazing by domestic livestock. Such species included *Aristida congesta, A. junciformis, Cymbopogon pospischillii* and *Eragrostis lehmanniana*. This indicates a largely natural vegetation type but which is being subjected to significant levels of disturbance.

A dwarf shrub component is also quite prominent, especially within the grass layer on plateaus and north facing slopes. These form part of the natural vegetation structure and include *Melolobium candicans, Asparagus suaveolens, Jamesbrittenia atropurpurea, Hermannia cuneifolia, Felicia fillifolia, Artimisia afra, Whlenbergia nodosa, Nolletia ciliaris, Euryops empetrifolius* and *Nenax microphylla*. The pioneer shrubs, *Hertia pallens, Lycium horridum, Felicia muricata* and *Chrysocoma ciliata* are abundant in areas where overgrazing has occurred.

Herbaceous species are also abundant in the vegetation type and distributed all over. These include *Aptosimum procumbens, Chascanum pinnatifidum, Gazania krebsiana, Hermannia depressa, Lotononis listii, Dicoma macrocephala, Gerbera piloselloides, Rhynchosia sp., Berkheya sp., Helicrhysum nudifolium, Berkheya onopordifolia, Berkheya setifera, Pavonia burcehllii, Jamesbrittenia albiflora, Senecio sp., Lobelia erinus, Hilliardiella sp., Salvia stenophylla, Dicoma anomala, Thesium costatum, Helichrysum rugulosum* and *Wahlenbergia androsaceae*. A few herbaceous species are also indicative of overgrazing and include *Solanum tomentosum, Acrotome inflata* and *Solanum incanum*.

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,* smaller shrubs such as *Lantana rugosa* and *Asparagus denudatus,* herbaceous species such as *Cineraria lyrata* and *Crassula lanceolata* and climbers such as *Clematis brachiata*.

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, Stapelia grandiflora* var. *grandiflora, Kalanchoe thyrsiiflora, Crassula nudicaulis*, *Cotyledon orbiculata* var. *oblonga, Crassula dependens, Ruschia hamata, Euphorbia pulvinata, Delosperma sp., Chasmatophyllum muscullinum, Crassula capitella, Anacampseros rufescens* and *Aloe broomii*. A note should be made on the large colonies of *Aloe broomii* which are abundant on the highest plateaus and slopes of the larger hills and mountains. These are uncommon and forming rather dense colonies they are of significant conservation significance. Furthermore, one rare occurrence of a small population of hybrids were noted. To the west of Thaba Nchu a small colony occurs where hybrids between *Aloe broomii* and *A. grandidetata* was noted. Such hybrids are a very rare occurrence and are consequently of high conservation value. In addition, a large colony of *Euphorbia pulvinata* was observed to the east of Botshabelo. This is quite a rare species, especially in the Free State and therefore has a quite high conservation value. It is also likely that a survey during the rainy season will reveal numerous other species of significance.

Geophytic species are quite common and include *Albuca setosa, Ledebouria luteola, Gladiolus permeabilis, Gladiolus sp., Pelargonium aridum, Xysmalobium sp., Hypoxis argentea, Pelargonium sidoides* and *Androcymbium longipes*. Several of these are also listed as protected species. It is also likely that a survey during the rainy season will reveal numerous other species of significance. Another geophyte which is abundant but also an indicator of overgrazing is *Moraea pallida*. It is poisonous and unpalatable to livestock and proliferates in areas subjected to overgrazing.

Most probably as a result of overgrazing and other disturbances, exotic weeds and especially invasive succulents have become established in many areas. Exotic weeds include *Schkuhria*

pinata, Bidens bipinnata, Argemone ochroleuca and *Tagetes minuta*. Succulent invasive species included *Cylindropuntia imbricata* and *Opuntia ficus-indica.*

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 and Thaba Nchu MOSS area.

From the available data and field surveys it seems that the majority of this vegetation type is still largely intact. However, small areas of transformation such as a rock quarry, landfill site and water infrastructure do occur but does not affect large portions of the MOSS. However, overgrazing by domestic stock is present in the entire MOSS. This impact is highest in close proximity to urban areas where it causes significant modification of the species composition and vegetation structure. The impact decreases in distance from urban areas though does cause a low amount of disturbance in all areas. 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 small portions affected by rock quarries, landfill site and water reservoirs 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 35: Panorama of MOSS around Thaba Nchu which clearly consists of the surrounding hills, ridges and mountains.

Figure 36: Panorama of one of the ridge systems forming part of the MOSS. Woodland vegetation clearly dominate the ridge and the vegetation is easily distinguished from the surrounding plains.

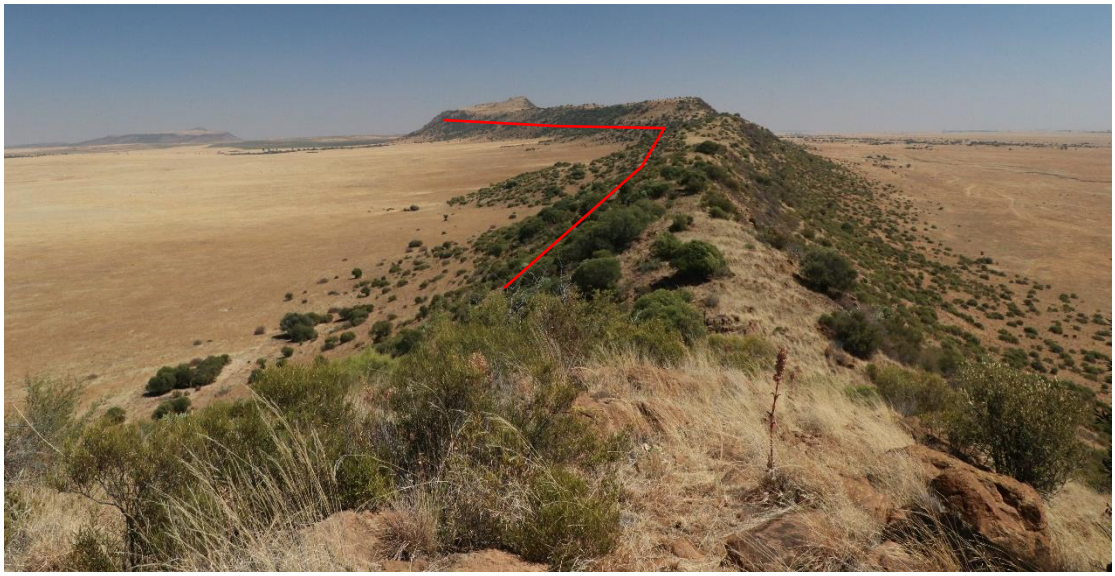


Figure 37: View of another ridge system to the north of Thaba Nchu. Note the denser tree cover along the southern slope (red).

Figure 38: Cliff habitats occur along the larger hills and mountains and contribute toward habitat diversity.

Figure 39: North facing slopes contain a much sparser tree cover with the grass layer being more dense.

Figure 40: View of a hybrid colony of Aloe, a very rare occurrence. This is a hybrid between *Aloe broomii* (left) and *Aloe grandidentata* (right).

4.1.3.2 Thaba Nchu Protected Species

From the previous section, it was evident that numerous protected species are present in and around the urban area of Botshabelo. All of the vegetation units 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 6 & 7). 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 (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. africana*	LC	Y		✔

From Table 7 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 7: Protected species observed during on-site and previous surveys of the Thaba Nchu urban area and the specific vegetation unit in which they occurred.

Protected Species	Undulating Plains (Gh 6)	Hills, ridges and mountains (Gm 5, Gh 7)
Aloe broomii		X
Aloe broomii x grandidentata		X
Aloe grandidentata		X
Anacamperos rufescens		X
Cussonia paniculata		X
Euphorbia clavaroides	X	
Euphorbia pulvinata		X
Gladiolus permeabilis		X
Gladiolus sp.		X
Olea europaea subsp. *africana*		X
Orbea lutea var. *lutea*		X
Pelargonium sidoides		X
Stapelia grandiflora var. *grandiflora*		X
Xysmalobium sp.		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 the grassland plains also contain protected species it was clear that the hills, ridges and mountainous areas contained almost all of the observed protected plants. This is also a consequence of the small portions of grassland included within the MOSS. However, the Basotho Montane Shrubland, Winbrug Grassy Shrubland and diversity of habitats contained on the hills, ridges and mountains had been anticipated to contain a significantly higher proportion of protected as the survey has confirmed. It would therefore follow that these hills, ridges and mountains delineated within the MOSS would have a higher conservation value.

4.1.2.3 Additional sensitive areas

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 (Appendix A: Map 6)

Remnants of the natural vegetation types in the area indicates that large portions of natural vegetation still remain in and around the urban area of Thaba Nchu (Figure 41). As indicated previously, all 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 and Winburg Grassy Shrubland which consists of the hills, ridges and mountainous areas has been confirmed to contain a diversity of habitat and species and a high proportion of protected and rare species. Furthermore, as positive landscape features they also act as corridors which contributes to a significant level of sensitivity. This should be taken into considered in spatial planning especially where development occurs within the MOSS.

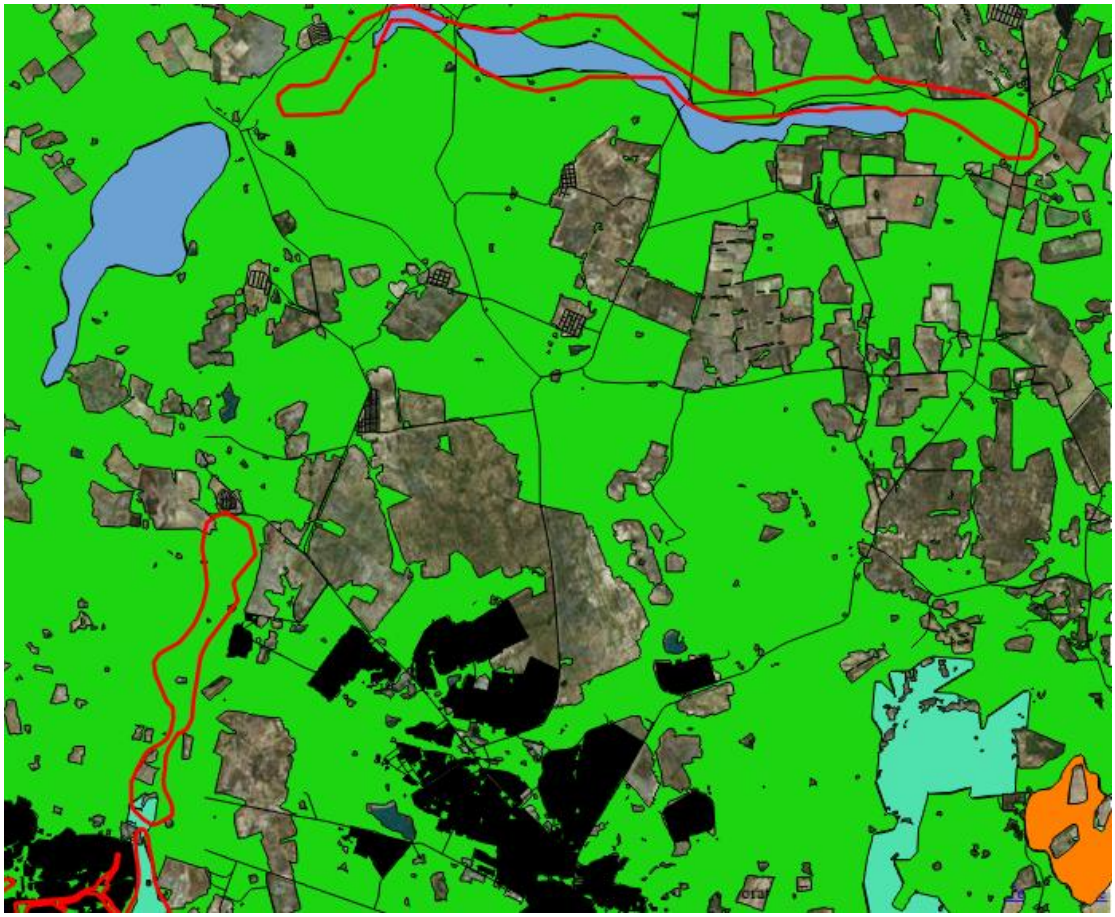
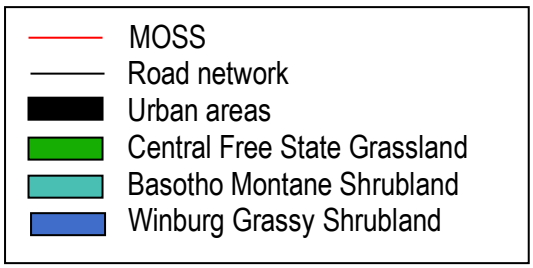


Figure 41: View of the remaining portions of the different vegetation types present in the Thaba Nchu urban area. Note extensive transformation has occurred although large natural areas occur around it.

Legend:



Free State Biodiversity Management Plan 2015 (Appendix A: Map 6)

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 not any CBA's in the Thaba Nchu MOSS (Figure 42). 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. Although these CBA areas does not form part of the MOSS they should still be taken into

account w.r.t. urban planning for Thaba Nchu. 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.

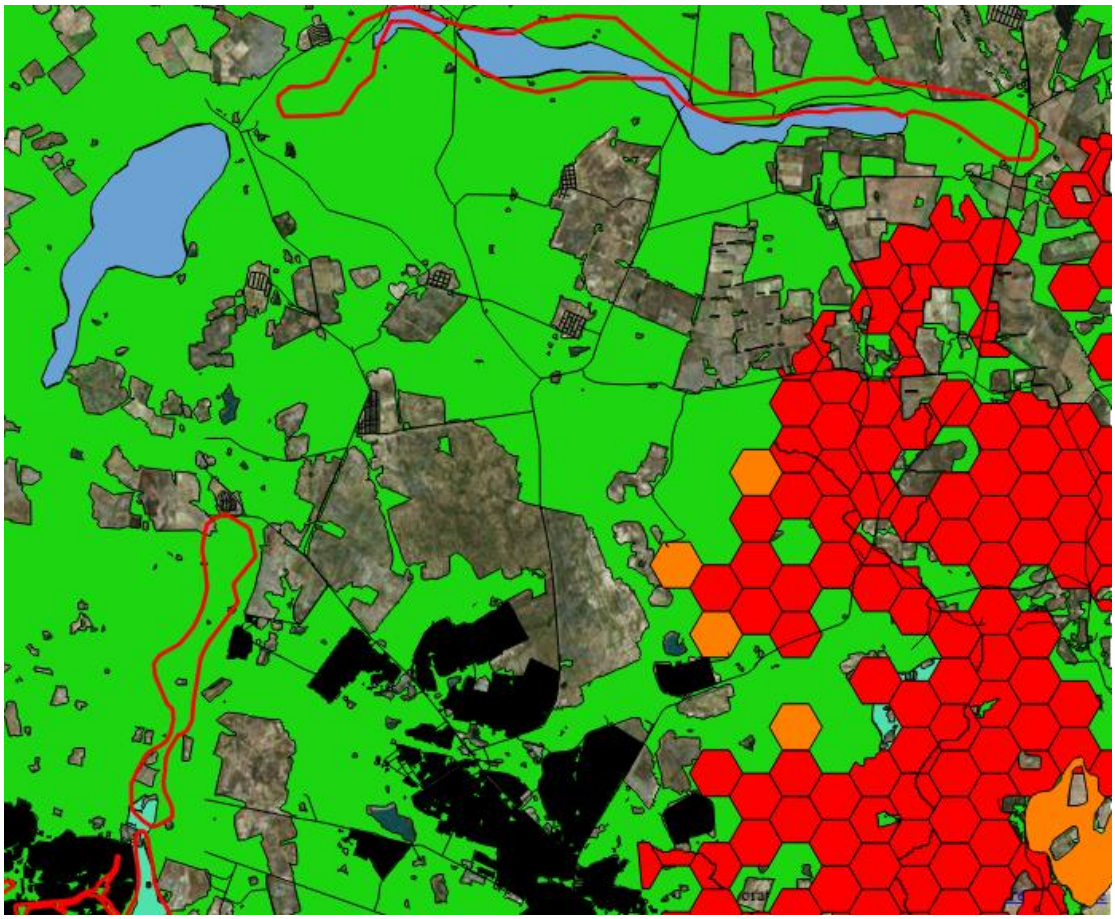
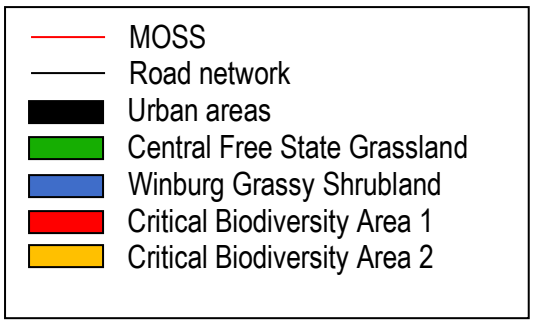


Figure 42: View of CBA 1 and 2 areas as well as protected area in the Thaba Nchu urban area overlain over the remaining natural vegetation portions.

Legend:



National Protected Areas Expansion Strategy (NPAES) 2010 (Appendix A: Map 6)

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 south of Thaba Nchu but does not fall within the MOSS surrounding the urban area (Figure 43). These areas have been indicated under the Botshabelo discussion (Figure 34). 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.

The NPAES Focus Areas to the east of Botshabelo has been discussed under that urban area (Figure 34) though its also occurs to the south of Thaba Nchu. Though not included around the Thaba Nchu MOSS spatial planning should nonetheless avoid all NPAES Focus Areas, irrespective of if they fall within the MOSS or not.

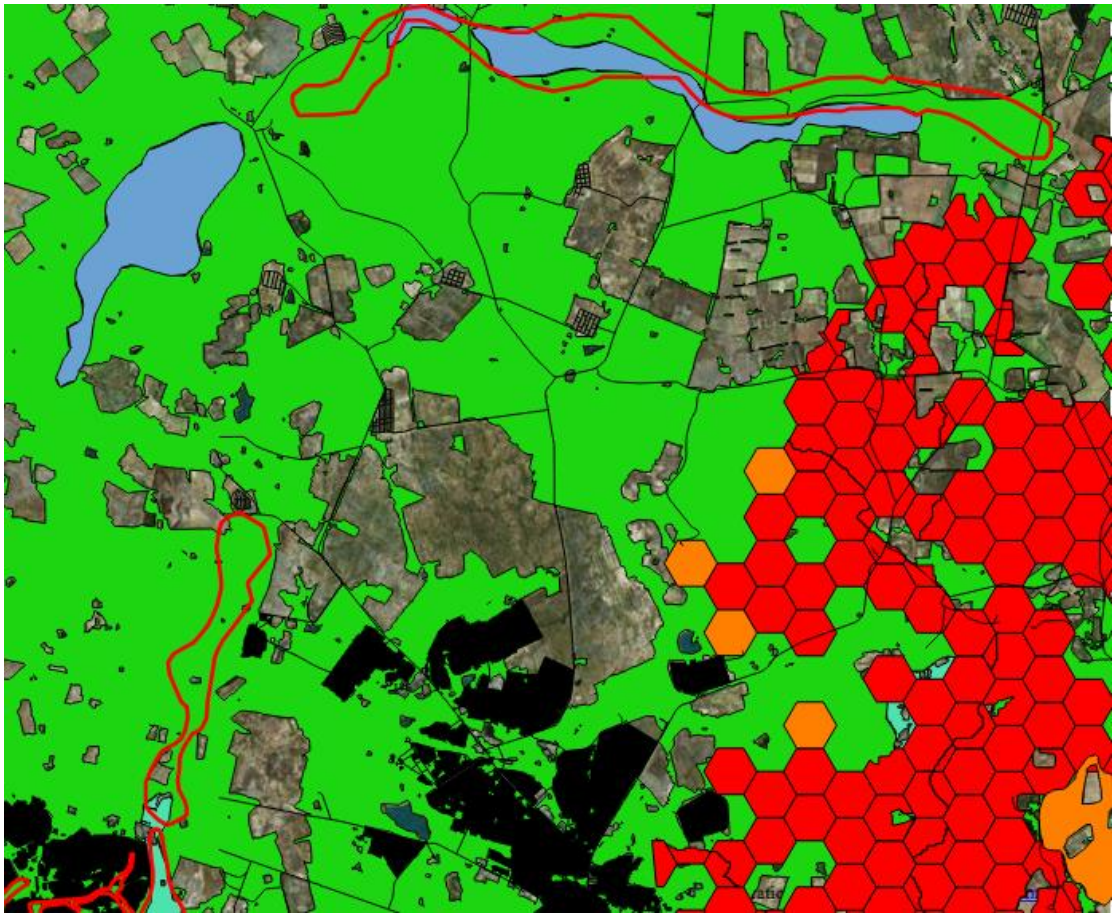


Figure 43: View of the NPAES Focus Areas near the Thaba Nchu urban area. Note no NPAES Focus Areas visible in the MOSS though does occur to the south of Thaba Nchu and east of Botshabelo.

Legend:

- MOSS
- Road network
- Urban areas
- Central Free State Grassland
- Winburg Grassy Shrubland
- Critical Biodiversity Area 1
- Critical Biodiversity Area 2
- NPAES Focus Areas

4.1.3.4 Thaba Nchu urban area – Conclusions (Appendix A: Map 5)

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 areas 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.

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.**

4.1.4 Soutpan/Ikgomotseng 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 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 does still contain significant degradation due to land-use. Overgrazing and -browsing in communal areas can cause significant degradation to the vegetation. However, this is mostly confined to the perimeter of the urban area as well as around homesteads and watering points. Overall, the degree of grazing by domestic stock is only considered as moderate. The salt mining operations has also contributed to significant impacts though these are mostly confined to the surface of the pan.

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. The majority of Soutpan is dominated by relatively flat plains though low ridges are common to the north east and north west of the town. 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 present and will have an impact on vegetation and degradation of its condition. Urban developments of Soutpan/Ikgomotseng has resulted 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 are also affected by several impacts. The salt mining operations has caused significant disturbance which has largely affected the pan system. The majority of the salt mining operations are no longer operational though the impact caused to the pan is still clearly visible. Dirt tracks and footpaths also cause some disturbance though this is limited to local areas and is not considered a high impact. Rubbish and rubble dumping is not extensive and is mostly confined to areas around the perimeter of the urban area. Communal areas are often affected by high levels of 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. However, within the remaining natural areas of Soutpan this is only regarded as moderate. Although communal grazing is practised it does not currently seem to lead to extensive loss of vegetation. Stock pens, watering points and other areas with high levels of trampling are the only areas where this impact is pronounced though these areas are not currently extensive. From the above it should be evident that the remaining natural areas around the urban area of Soutpan are still in a relatively good condition with low levels of disturbance.

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 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.

4.1.4.1 Soutpan/Ikgomotseng Vegetation Units (Appendix A: Map 7 - 8)

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.

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.

The main vegetation types correspond well with the main topographical units around Soutpan and will be utilised as baseline to describe the area around Soutpan and the relative sensitivity or conservation value of each.

Surrounding plains (Western Free State Clay Grassland)

The plains dominating the area around Soutpan are all relatively uniform in terms of soils, topography and species composition and can therefore be regarded as a single unit and discussed together. The soils in the plains are not strictly clayey but rather sandy but with a high silt content. This is no doubt linked to the flat topography and pan systems of the region. This high silt content promotes the establishment of a prominent dwarf karroid shrub component. However, a well-developed grass layer is also prominent. These plains are most prominent to the north and east of the pan.

The grass layer is well-developed although may become sparse in some areas with bare patches also present. The most dominant species include *Themeda triandra. Aristida congesta, Heteropogon contortus, Tragus koelerioides, Eragrostis obtusa, Cymbopogon pospischillii* and *Enneapogon scoparius*. This is a mixture of climax and pioneer species which indicates a still natural grass layer although overgrazing is causing some disturbance leading to the establishment of pioneer species. In addition, a few of these are also associated with karroid habitats and include *T. koelerioides* and *E. obtusa*. This is indicative of the higher silt content which promotes the presence of karroid components.

The karroid elements are well represented and rather than being indicative of disturbance this is regarded as a natural component of this vegetation type, especially where it occurs in proximity of large pans as is the case in Soutpan. This karoo component is most visible as a prominent dwarf karroid shrub component. Common dwarf shrubs include *Felicia muricata, Mestoklema arboriforme, Microloma armatum, Asparagus suaveolens, Lycium horridum, Rosenia humilis, Nolletia ciliaris, Chrysocoma ciliata, Gnidia polycephala, Helichrysum lucilioides* and *Salsola*

aphylla. This is considered a natural component of this vegetation type though the abundance of the dwarf shrubs may become quite high where overgrazing is evident.

An herbaceous component is also well represented within the grass layer though never dominates. Common herbaceous species include *Dicoma macrocephala, Aptosimum elongatum, Menodora africana, Geigeria filifolia* and *Berkheya macrocephala.*

Due to the silty nature of the soils, geophytic species are also abundant and include *Albuca unifolia, Eriospermum porphyrium, Massonia jasminiflora, Androcymbium longipes, Moraea pallida* and *Oxalis depressa*.

A note should also be made of a succulent species, *Euphorbia clavaroides*, which occurs as scattered specimens in the vegetation type. It is widespread but not common and is also a protected species which will therefore increase the conservation value of the vegetation type.

Toward the ridges in the north east small trees also become established but is not characteristic of this vegetation unit and represent an ecotone or transition between the plains and rocky ridges.

Where disturbance is high such as adjacent to the urban areas the vegetation is evidently degraded and transformed. The grass layer is absent or dominated by the pioneer *Cynodon dactylon* and exotic and invasive species are prominent, including species such as *Prosopis glandulosa, Cyllindropuntia imbricata* and *Eucalyptus camaldulensis*. These are however in the minority although it was noted that the invasive species, especially *P. glandulosa*, may invade the pan and other riparian areas where it becomes highly problematic.

From the vegetation description the vegetation unit or type is considered largely natural with a few impacts though none are considered very high. The vegetation itself is in a relatively good condition though signs of overgrazing are present. The species diversity is moderate although the variety of growth forms does increase this somewhat. Numerous geophytic species are present and one uncommon succulent species also contributes to the conservation value. Overall this vegetation unit 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.

Figure 44: Panorama of the plains in the area. A well-developed but somewhat sparse, grass layer is evident with a prominent dwarf karroid shrub component visible. The urban area of Ikgomotseng is visible in the background (red).

Figure 45: Another view of the plains around the urban area of Soutpan/Ikgomotseng.

South eastern sandy grassland (Vaal-Vet Sandy Grassland)

To the south of the urban area of Ikgomotseng the grassland transforms as a result of a change in soil characteristics. This portion lies largely outside the urban area of Soutpan and is unlikely to be affected by it but is still included here to provide a broader description of the area. Here the soils contain a much higher sand content. As a result, the grassland consists of different vegetation type, i.e. Vaal-Vet Sandy Grassland, also regarded as an endangered vegetation type. However, due to the proximity to the adjacent vegetation type, the silt component within the soil is also present and this portion rather represents an ecotone or transition between the two vegetation types.

The grass layer dominates to a large extent though sparser patches are still present. Dominant grass species include *Enneapogon scoparius, Eragrostis truncata, Aristida congesta, Chloris virgata, Fingerhuthia africana, Themeda triandra* and *Cymbopogon pospischillii*. The grass composition differs to some degree from the surrounding plains though also contains several similar species, with a few also being more characteristic of soils with a higher silt content such as *E. truncata*. This then also indicates the area to be transitional between the Western Free State Clay Grassland and Vaal-Vet Sandy Grassland. Furthermore, although several climax grass species dominate, several pioneer species are also prominent and indicate a significant level of overgrazing.

Under natural conditions, the Vaal-Vet Sandy Grassland would contain a quite low degree of dwarf shrubs, in contrast with the Western Free State Clay Grassland. However, since the portion in the study area is transitional with this vegetation type, it still contains numerous and abundant dwarf karroid shrubs. These include *Mestoklema arboriforme, Rosenia humilis, Lycium cinerium, Salsola aphylla, Chrysocoma ciliata, Melolobium candicans, Felicia muricata, Nolletia ciliaris* and *Asparagus suaveolens*. These are an indication of the transitional nature of this portion but may also be an indication of significant overgrazing. The abundance of the low shrub, *Hertia pallens,* a clear indicator of overgrazing, also confirms this.

The herbaceous component is not well represented though some of the more abundant species include *Geigeria filifolia, Menodora africana, Berkgeya onopordifolia* and *Nenax microphylla*.

Geophytic species are not well represented and some of the species observed include *Albuca unifolia, Massonia jasminiflora* and *Oxalis depressa*.

From the vegetation description the vegetation unit or type it is regarded as being largely natural. However, the species composition is not characteristic of it but rather transitional between Western Free State Clay Grassland and Vaal-Vet Sandy Grassland. The species composition also reliably indicates significant levels of overgrazing though it does not cause a large modification in the vegetation structure. The species diversity is not significant and neither does it contain any species of conservation concern. Vaal-Vet Sandy Grassland is not known for a significant species diversity or containing 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.

Figure 46: Panorama of the sandy grassland portion. A notably well-developed grass layer is present and the dwarf karroid shrub component is also much less prominent. It is therefore clearly distinguishable from the surrounding clay grasslands.

Figure 47: Another view of the sandy grassland portion. Although the grass layer is quite dense, a dwarf karroid shrub component is also evident in some areas.

Dolerite hill and ridges to the north of Soutpan (Vaalbos Rocky Shrubland)

To the north and north east of the urban area a distinctly different habitat is situated, dominated by a low dolerite hill and ridge system which is dominated by a well-developed shrub and tree layer. The grass layer is also well represented. This different habitat and vegetation structure is indicated as forming part of the Vaalbos Rocky Shrubland, a vegetation type within the Savannah Biome. However, on-site observation indicate that it does not fit well within this vegetation type but should rather be regarded as being transitional between this vegetation type and Winburg Grassy Shrubland. Vaalbos Rocky Shrubland dominates toward the west of Soutpan while Winburg Grassy Shrubland becomes dominant to the east.

The shrub/tree layer is well-developed but relatively low and imbedded within a well-developed grass layer. The most common shrubs and trees include *Olea europaea* subsp. *africana, Gymnosporia buxiifolia, Searsia ciliata, Diospyros lycioides, D. austro-africana, Ziziphus mucronata* and *Boscia albitrunca*. Of these the *O. europaea* subsp. *africana* is most abundant and large, old specimens are common. These species are all more diagnostic of the Winburg

Grassy Shrubland, although elements of Vaalbos Rocky Shrubland, such as *B. albitrunca,* are also present.

As mentioned, a well-developed grass layer is still present and includes *Heteropogon contortus, Enneapogon cenchroides, Cymbopogon pospischillii, Aristida congesta, Eragrostis lehmanniana, Digitaria eriantha, Microchloa caffra, Eragrostis nindensis, Themeda triandra* and *Eustachys paspaloides*. This is a mixture of climax and pioneer species but also a notable component of grasses only found in rocky terrain.

The rocky habitat provides for the establishment of a wide variety of different growth forms. This includes several dwarf shrubs such as *Pentzia quinquifida, Felicia muricata, Jamesbrittenia albiflora, Melolobium candicans, Asparagus suaveolens* and *Selago geniculata*. Herbaceous species are also common and include *Chascanum pinatifidum* and *Nenax microphylla*. Two terrestrial fern species are also common and are *Pellaea calomelanos* and *Cheilanthes eckloniana*.

Geophytic species are well represented in the rocky habitat and include *Haemanthus humilis, Eriospermum porphyrium, Oxalis depressa, Bonatea antennifera* and *Trachyandra asperata*. Of these, *H. humilis* and *B. antennifera* are also protected species, with the last named being a relatively rare orchid species, especially in this region. They will therefore also significantly contribute to an increased conservation value.

The rocky habitat, high runoff rate and resulting aridity also promotes the establishment of a variety of succulent species. These include *Euphorbia spartaria, Crassula capitella, Kalanchoe rotundifolia, Hereroa glenensis, Chasmatophyllum muscullinum* and *Aloe grandidentata*. A few of these are also listed protected species also contributing to an increased conservation value.

Although the vegetation is overall in a relatively good condition, the presence of scattered specimens of the exotic and invasive *Opuntia ficus-indica* does indicate some disturbance of this vegetation unit.

From the vegetation description of the vegetation unit it is considered largely natural, in a good condition with few impacts and signs of disturbance. The habitat formed by the hill and ridge is varied and subsequently a significant species diversity is present with a variety of different growth forms. As a result of this diversity of species, numerous of these are also listed as protected and a few are also considered to be relatively uncommon. This considerably increases the conservation value of the hill and ridge. As a result of the significant habitat diversity, species diversity, presence of numerous protected species and relatively good condition the hill and ridge vegetation unit is regarded to have a high level of sensitivity.

Figure 48: Panorama of the hill and ridge indicating the tree/shrub layer imbedded in a well-developed grass layer.

Figure 49: View of the ridge system, also indicating one of the exposed rock sheets which provide unique habitat to several succulent species.

Pan system and associated wetlands and watercourses

The large pan system forms a prominent and important feature of the urban area. Associated with it and feeding into the pan is also several sensitive watercourses and wetland systems. The system is highly important to the urban area of Soutpan and Ikgomotseng but since it is a wetland system will be discussed in detail under that section (Section 4.2).

4.1.4.2 Soutpan/Ikgomotseng Protected Species

From the previous section, it was evident that numerous protected species are present in and around the urban area of Soutpan and Ikgomotseng. 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 8 & 9).

Table 8: 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	Confirmed	Status	Gh9	Gh10	SVk5
Amaryllidaceae	*Ammocharis coranica*	Y	LC	✔		
Amaryllidaceae	*Brunsvigia radulosa*	N	LC	✔	✔	✔
Amaryllidaceae	*Gethyllis transkarooica*	N	LC	✔	✔	✔
Amaryllidaceae	*Haemanthus humilis subsp. humilis*	Y	LC			✔
Amaryllidaceae	*Haemanthus montanus*	N	LC	✔		
Anacampserotaceae	*Anacampseros subnuda subsp. subnuda*	N	LC			✔
Apocynaceae	*Pentarrhinum insipidum*	N	LC	✔	✔	✔
Apocynaceae	*Raphionacme hirsuta*	N	LC	✔	✔	✔
Apocynaceae	*Stapelia grandiflora var. grandiflora*	N	LC			✔
Araliaceae	*Cussonia paniculata subsp. sinuata*	N	LC			✔
Asphodelaceae	*Aloe grandidentata*	Y	LC			✔
Hyacinthaceae	*Eucomis autumnalis subsp. clavata*	Y	LC	✔	✔	
Iridaceae	*Duthieastrum linifolium*	N	LC			✔
Oleaceae	*Olea europaea* subsp. *africana*	Y	LC			✔
Orchidaceae	*Bonatea antennifera*	Y	LC			✔
Pedalicaea	*Harpagophytum procumbens*	N	LC		✔	✔

From Table 9 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 9: Protected species observed during on-site surveys of the Soutpan/Ikgomotseng urban area and the specific vegetation unit in which they occurred.

Protected Species	Dominating plains (Gh 9)	Sandy grassland (Gh 10)	NE Rocky hill (SVk 5)	Eastern Hills and ridges (Gh 9)	Pan system and wetlands
Olea europaea subsp. *africana*	X		X		
Euphorbia clavaroides	X				
Haemanthus humilis			X		
Euphorbia spartaria			X		
Aloe grandidentata			X		
Boscia albitrunca			X		
Bonatea antennifera			X		
Eucomis autumnalis subsp. *clavata*					X
Ammocahris coranica					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 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.

4.1.4.3 Additional sensitive area (Appendix A: Map 8)

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

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: Map8)

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 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 50).

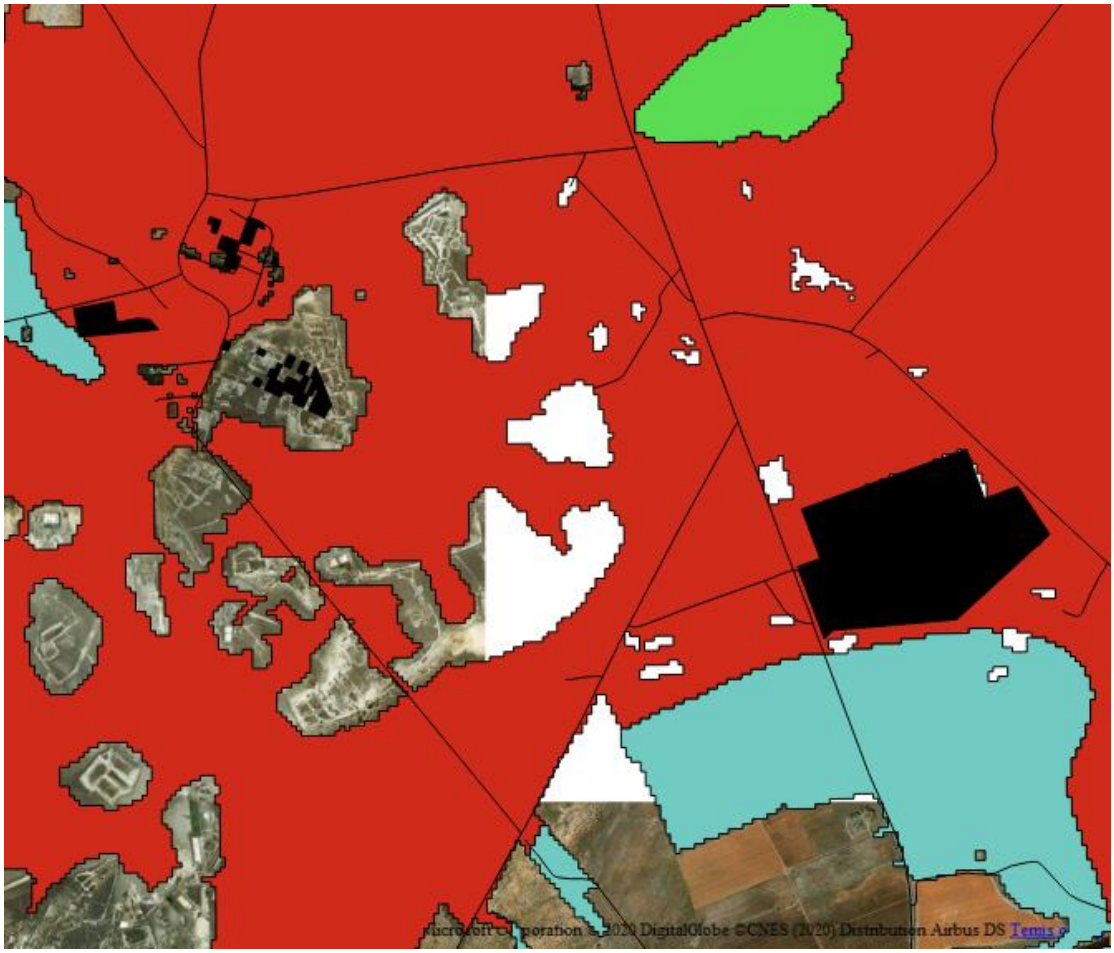


Figure 50: View of the remaining portions of the different vegetation types present in the Soutpan urban area. Note extensive natural areas and limited transformation.

Legend:

Free State Biodiversity Management Plan 2015 (Appendix A: Map 8)

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 (Figure 51). 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. Although the on-site surveys indicate that the portion to the south is situated within an ecotone or transitional area between the Vaal-Vet Sandy Grassland and the Western Free State Clay Grassland it does contain elements of this endangered vegetation type and should therefore still be regarded as at least being of high sensitivity (Appendix A: Map 8).

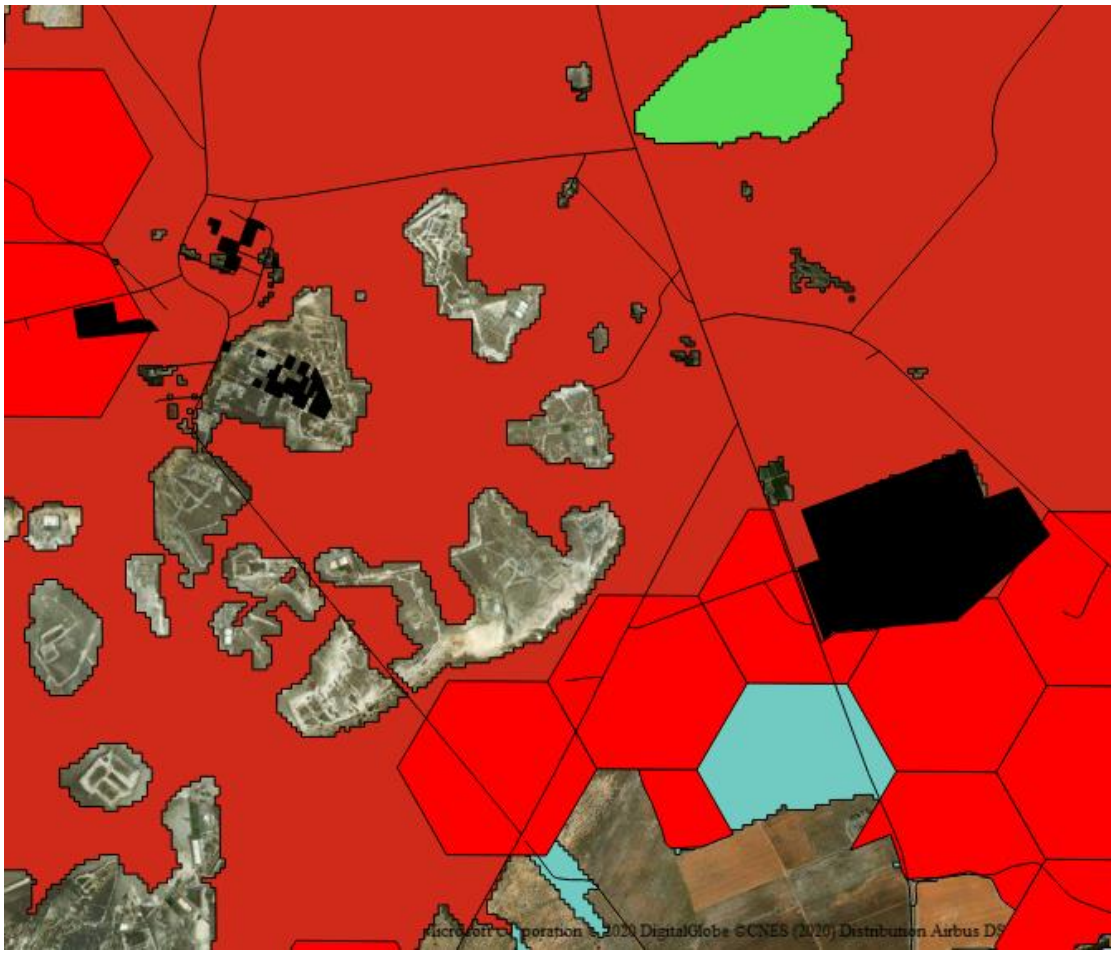
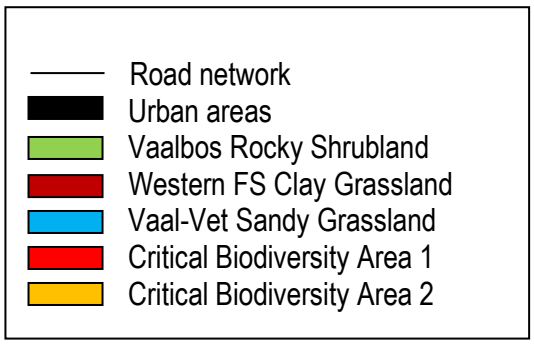


Figure 51: View of CBA 1 and 2 areas in the Soutpan/Ikgomotseng urban area overlain over the remaining natural vegetation portions.

Legend:



4.1.4.4 Soutpan/Ikgomotseng urban area – Conclusions (Appendix A: Map 7)

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).

4.1.5 Dewetsdorp urban area (Appendix A: Map 9 - 10)

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 evident that exotic trees, especially along watercourses, does 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 contains significant degradation due to land-use. Overgrazing and -browsing in communal areas has led to significant degradation of the vegetation. Other lesser impacts included small portion of old cultivated fields, disused quarries and other activities associated with the urban area, i.e. landfill site, golfcourse, WWTW, etc.

Despite the small extent of the town and surrounding municipal area, the topography is quite diverse. Undulating plains dominate the area though hills and ridges become prominent to the north, west and south of the town. These also provide significantly different habitats and the vegetation composition is also clearly different from the surrounding plains. The geology of these are dominated by sandstone although dolerite and mudstone is also present, this also contributes to habitat diversity. In addition, due to the undulating terrain, numerous watercourses are incised in the landscape and this significantly increases the habitat diversity. 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 an undulating topography of the area.

As indicated only limited transformation of the natural environment has occurred. However, several significant impacts are still 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. A few small portions within the municipal areas consists of old cultivated fields. These have caused the transformation of the natural vegetation and is a significant, though local impact, since these portions are quite small. A myriad of small dirt tracks and footpaths cause limited local disturbance. However, these clearly also cause obstructions to surface flow and coupled with high levels of overgrazing they contribute to erosion. They also clearly provide access to natural areas where illegal dumping sporadically occurs. A few smaller areas with local but complete transformation includes a few disused quarries and landfill to the west of the town. Other developments associated with the urban area and causing some transformation include the golfcourse, woodlot, WWTW and granaries, amongst others. One of the most widespread and significant impacts affecting the surrounding natural areas are overgrazing and -browsing by domestic livestock. Overgrazing and -browsing and the associated trampling cause a decrease in vegetation cover and an increase in erosion. The extent of this impact differs over the communal area and is generally higher in proximity to the urban areas. Where it is high it does lead to a loss in species diversity and modification of the vegetation structure and species composition. From the field survey it was evident that stocking levels and grazing schedule requires improved management in order to improve grazing quality and sustainability.

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). The undulating topography, coupled with climate data, indicates that wetlands and watercourses are abundant in this area.

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, 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.

4.1.5.1 Dewetsdorp Vegetation Units (Appendix A: Map 9 – 10)

Despite the relative diversity in habitat and topography the dominating grassland is relatively uniform in terms of species composition and consequently the urban area of Dewetsdorp only contain 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 was also observed during the on-site survey. 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.

The on-site survey indicated that the Central Free State Grassland dominated the plains to the east of the town with smaller portions to the west and south. Here the grass layer is dense with very few dwarf karroid shrubs and herbaceous species. The Aliwal North Dry Grassland dominates in areas where soils are shallower with sandstone outcrops also occurring. These were especially prominent along the low sandstone ridges to the west and east of the town. Coupled with this vegetation type, a prominent ridge chain to the north west and isolated hill to the west is more characteristic of Besemkaree Koppies Shrubland (Gh 4). This vegetation type

is also characterised by a more prominent shrub component and the shrub, *Searsia erosa* (Besembos), can also easily distinguish it from the surrounding vegetation types. In conclusion, the borders of vegetation types as indicated by available spatial data may not be accurate and although the on-site survey could more accurately delineate these borders, an ecotone or transition is still present.

Undulating grassland plains – south, west and north of the town (Central Free State Grassland)

The undulating plains dominating the area around Dewetsdorp are generally characterised by a uniform grass layer, with deeper soils, any surface rock or outcrops being absent and dwarf karroid shrubs and herbaceous species being largely absent. These areas can therefore be regarded as a single unit and discussed together. Due to the somewhat deeper soils these are also the only portions around the town which had previously been affected by crop cultivation. A small portion to the south of the town and somewhat larger portions to the north east had previously been affected by ploughing for crop cultivation. Consequently, the current grass layer is of secondary establishment and these areas can be regarded as being largely transformed and having a low level of sensitivity.

The vegetation type or unit is also characterised by a well-developed grass layer, being dominated by only a few species and the absence of dwarf karroid shrubs and herbaceous species also being poorly represented. It was quite prominent that two grass species dominated in almost all of the survey areas. These are *Cymbopogon pospischillii* and *Eragrostis chloromelas*. Though both are a natural component of the grassland, a dominance indicates a degraded grass layer and overgrazing by domestic stock. Under good conditions, the climax grass, *Themeda triandra*, would have been the dominant grass species. It is still abundant but does not form dominant stands. Other prominent grass species include *Aristida congesta, Digitaria eriantha, Heteropogon contortus, Setaria sphacelata* and *Sporobolus fimbriatus*.

An abundance of herbaceous species is present though they are always rare and do not form a prominent component of the grassland. These include *Berkheya onopordifolia. Gerbera pilloseloides, Hermannia depressa, Nenax microphylla, Hermannia coccocarpa, Berkheya macrocephala, Hibiscus pusillus* and *Selago densiflora*. This is considered a relatively natural component of this grassland.

Although dwarf karroid shrubs do naturally also occur in this vegetation type, where they are in abundance this is also an indication of overgrazing. Though such instances are not the norm, areas do occur around the urban area where dwarf karroid shrubs become prominent and are clear indicators of overgrazing. Dwarf karroid shrubs in the area include *Lycium horridum, Ruschia hamata, Melolobium sp., Felicia muricata* and *Pentzia incana*.

Despite the dominance of grasses, numerous geophytic species are also interspersed within this layer. These include *Moraea pallida, Pelargonium sidoides, Oxalis depressa, Brunsvigia radulosa, Massonia jasminiflora, Ammocharis coranica, Eucomis autumnalis, Bulbine frutescens* and *Colchicum cf. burkei*. Of these, several are also listed as protected species and will contribute to the conservation value of the grassland.

Scattered specimens of the protected succulent, *Euphorbia clavaroides*, also occur to the south of the town but is considered a more characteristic component of the Aliwal North Dry Grassland

of sandstone ridges and here considered as forming part of the ecotone between the vegetation types.

Exotic weeds are not abundant and indicate that though overgrazing is present, the grass layer is not extensively degraded, although the species composition is modified to some degree.

From the vegetation description the vegetation unit or type is considered largely natural although overgrazing by domestic livestock may be extensive in some areas and this does lead to some modification of the species composition. The grass layer is dominated by a few species and overall the species diversity is only considered as moderate. Coupled with this, habitat diversity is also relatively uniform and considered moderate. 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.

Figure 52: Three Panoramas of the plains in the area consisting of Central Free State Grassland. These panoramas are from top to bottom; south, west and north of the town and here a dense grass layer is evident. Although overgrazing is evident the impact is still moderate.

Figure 53: Two Panoramas of the plains in the area consisting of Central Free State Grassland. These panoramas are from top to bottom; south and north of the town and here the grass layer is much sparser and overgrazing is clearly causing a much higher impact.

Figure 54: Clear indication of the impact of overgrazing along a fenceline. Note dense grass cover on left, compared to significantly decreased cover on the right. This should clearly illustrate the impact of livestock overgrazing around Dewetsdorp.

Plains and sandstone ridges – West and north east of the town (Aliwal North Dry Grassland)

To the west and north east of the town the undulating plains increase slightly in elevation and although the dominant landscape is still plains, low sandstone outcrops and ridges become evident. Rocky terrain, hills and ridges are therefore still absent though the habitat becomes distinctly different. This has the result that the species composition and vegetation structure becomes somewhat different. It is notable that a well-developed grass layer is still dominant and that the dominant species remain largely the same but that the sub-dominant but still prominent grass species are somewhat modified. This is mostly coupled with the shallower soils over sandstone. The dwarf karroid shrub component becomes much more evident and a variety of other growth forms are also established. Due to the presence of rocky outcrops several portions has been affected by previous borrow pits and quarries which has subsequently completely transformed the vegetation type where it occurs. Associated with these old excavations are also the local landfill site which also contributes to local transformation. These areas which are

transformed will be regarded as having a low level of sensitivity. The portion of this vegetation unit or type to the north east of the town is located in close proximity to the urban area and is consequently heavily affected by overgrazing by domestic livestock. This also considerably decreases the conservation value of this portion.

As indicated, though sandstone outcrops and shallow soils occur, the vegetation type or unit is still characterised by a well-developed grass layer, being dominated by only a few species. As with the previous vegetation type, the dominance by two grass species *Cymbopogon pospischillii* and *Eragrostis chloromelas,* remain prominent. The differentiation with the previously discussed vegetation type may therefore not be immediately evident. This does however remain an indication of a degraded grass layer and overgrazing by domestic stock. Under good conditions, the climax grass, *Themeda triandra*, would have been the dominant grass species. It is still abundant but does not form dominant stands. Other prominent grass species include *Aristida congesta, Tragus koelerioides, Aristida diffusa, Eragrsotis nindensis* and *Sporobolus fimbriatus*. This does indicate some difference in species composition where grasses adapted to shallower soils become prominent while other species adapted to deeper soils and higher moisture regime such as *Digitaria eriantha, Heteropogon contortus, Setaria sphacelata* become absent.

As indicated, dwarf karroid shrubs become much more prominent and include *Felicia fillifolia, Diospyros austro-africana, Ruschia hamata, Melolobium sp., Helichrysu, dregeanum, H. zeyheri, Eriocephalus spinescens* and *Euryops empetrifolius*. The low shrub, *Searsia erosa*, is also present though considered much more characteristic of the Besemkaree Koppies Shrubland. This component also differentiates this vegetation unit from the Central Free State Grassland.

As a result of the shallower soils the moisture regime is much lower, runoff higher and this provides suitable habitat for the establishment of numerous succulent species. These include *Euphorbia clavaroides, Chasmatophyllum muscullinum, Crassula capitella, Ruschia unidens* and *Rabiea sp*. A few of these are also protected or uncommon and increases the conservation value of this vegetation unit.

Due to the shallower soils less geophytic species are present though a few of these remain protected species with significant conservation value. These include *Lapeirousia plicata* subsp. *foliosa, Eriospermum porphyrium* and *Pelargonium sidoides*.

Herbaceous species are also less abundant though a few species observed include *Hermannia depressa, Dianthus basuticus* and *Dicoma anomala*.

It was noted that along watercourses and outcrops and especially where degradation was evidently high that the invasive shrub, *Pyracantha angustifolia*, was prominent. This does also indicate that although the vegetation unit is largely natural, significant degradation may be present in some areas.

From the vegetation description the vegetation unit or type is considered largely natural although overgrazing by domestic livestock may be high in some areas and leads to significant degradation and decrease in vegetation cover. This is most notable in the north eastern portion of the vegetation unit and here it significantly decreases the conservation value where it is only regarded as having a moderate level of sensitivity. Local areas of transformation caused by old borrow pits, quarries and the landfill site are considered to be of low sensitivity. The remaining natural portion of the vegetation unit to the west of the town is considered least degraded. Here 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.

Figure 55: Panorama of the plains and sandstone ridges. A notably well-developed grass layer is present dominated by plains but with a visibly increased slope and elevation.

Figure 56: Another view of the sandstone ridges which also illustrates the increase in dwarf shrubs, slope and with sandstone outcrops becoming visible. The larger shrubs area of the invasive *Pyrancantha angustifolia*.

Figure 57: View of one of the old borrow pits which has caused transformation of the vegetation type.

Figure 58: Panorama of the vegetation unit to the east of the town. Note again the increase in dwarf shrubs and sandstone outcrop though here overgrazing is quite severe.

Figure 59: Overgrazing in the eastern portion of the vegetation unit puts pressure on many plant species.

Sandstone and dolerite ridges and hills – West and east of the town (Besemkaree Koppies Shrubland)

A very prominent ridge system lies immediately to the west of the town and a large, free-standing sandstone hill occurs to the east of the town. These are distinct and easily differentiated from the surroundings in terms of their topography. A distinctly different habitat occurs which in turn leads to a different species composition and vegetation structure. The grass layer becomes much sparser, with the dwarf shrub layer becoming dominant in some areas. The succulent component also becomes more pronounced. Along the slopes and especially along drainage lines and watercourses a tree layer is also evident. The topography and habitat is varied and consequently the diversity of growth forms are also diverse. For the most part these vegetation units are still mostly natural. However, a disused quarry in the western ridge series transforms a small portion of it. The isolated hill to the east of the town also borders on the urban area and the impacts on it are also significant and cause a decrease in its conservation value. Here livestock farming and communal grazing causes significant degradation of the vegetation.

As indicated, the grass layer becomes much sparser here and although several species also occur in the surrounding vegetation units the dominant species are different and adapted to shallow, rocky soils. These include *Eragrostis nindensis, Aristida congesta, Hyparrhenia hirta, Aristida diffusa, Tragus koelerioides, Triraphis andropogonoides* and *Heteropogon contortus*.

Other abundant grasses also include *Eragrostis chloromelas, Cymbopogon pospischillii, Themeda triandra, Digitaria eriantha*

As indicated, the dwarf shrub layer becomes more prominent and dominates the vegetation structure in many areas. Dominant species include *Felicia fillifolia, Euryops empetrifolius, Ruschia intricata, Melolobium sp.* and *Searsia erosa*. Other abundant but less dominant dwarf shrubs include *Eriocepahalus spinescens, Asparagus suaveolens* and *Diospyros austro-africana*.

The succulent component is also well represented and may form dense colonies where favourable habitat is present. Numerous of these are also protected and uncommon and significantly increase the conservation value of this vegetation unit. These include *Ruschia hamata, R. unidens, Stomatium bolusiae, Rabiea sp., Anacampseros rufescens, Crassula nudicaulis, C. capitella, Curio radicans, Crassula dependens, Hereroa glenensis, Chasmatophyllum muscullinum* and *Euphorbia clavaroides*. The abundance and diversity of succulent species is notable.

Due to the shallower soils less geophytic species are present though a few of these remain protected species with significant conservation value. These include *Lapeirousia plicata* subsp. *foliosa, Pelargonium aridum, Oxalis depressa, Colchicum cf. burkei* and *Hesperantha longituba*. The last named is also an uncommon and protected species with a significant conservation value.

Along the steeper slopes and especially south facing slopes, as well as along ravines and drainage lines on the ridges and hills a tree layer also becomes prominent. The protected tree, *Olea europaea* subsp. *africana* also occurs as scattered specimens along the slopes. Along the ravines and drainage lines other tree and shrubs also become prominent including *Grewia occidentalis, Euclea crispa* subsp. *ovata, Searsia pyroides* and *S. dentata*. Where increased shade is present the ferns, *Pellaea calomelanos* and *Cheilanthes eckloniana* is also present. Here softer leaved herbaceous species are also present and include *Helichrysum zeyheri, H. nudifolium, Helichrysum dregeanum* and *Schistostephium crataegifolium*.

From the vegetation description the vegetation unit or type is considered largely natural although overgrazing by domestic livestock does occur and causes significant degradation of especially the eastern sandstone hill. Coupled with livestock farming activities this significantly decreases the conservation value of the hill. Where it would naturally be considered to have a very high level of sensitivity this decreases it to only being regarded as having a high sensitivity level. The western ridge system is regarded to be in a much more natural condition, 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.

Figure 60: Panorama of the ridges system to the west of the town. Note a much sparser vegetation cover with a tree layer also becoming prominent along the slopes.

Figure 61: Another panorama of the ridge system to the west of the town. Note an abundant dwarf shrub component.

Figure 62: View of the prominent tree layer which occurs along one of the ravines associated with the ridge system.

Figure 63: Panorama of the isolated sandstone hill to the east of the town. The survey has indicated that it has been significantly degraded by current land use.

Stream system, Modder River and watercourses

Almost the entire urban area of Dewetsdorp is drained by a single stream system with numerous tributaries. It also originates in the immediate area and would therefore be of high conservation value. It flows into the Modder River which occurs to the north of the town and forms part of the municipal area. These systems would all be of high importance but will be discussed in detail within the wetland section (Section 4.2).

4.1.5.2 Dewetsdorp Protected Species

From the previous section, it was evident that numerous protected species are present in and around the urban area of dewetsdorp. All of the vegetation units 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 10 & 11).

Table 10: 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	✔	✔

From Table 10 it is clear that the current data for the Dewetsdorp region is severely lacking and also points to the need for on-site surveys. One of the anticipated species were observed during the survey though a high amount of additional protected species were identified. It remains also likely that the two species not observed during the survey were merely overlooked and are present in the area.

Table11: Protected species observed during on-site surveys of the Dewetsdorp urban area and the specific vegetation unit in which they occurred.

Protected Species	Undulating plains (Gh 6)	Sandstone ridges (Gh 2)	Ridge and hills system (Gh 4)	Watercourses and wetlands
Olea europaea subsp. *africana*			X	X
Euphorbia clavaroides	X	X	X	

Pelargonium sidoides	X	X		
Brunsvigia radulosa	X			
Ammocharis coranica	X			
Lapeirousia plicata subsp. *foliosa*		X	X	
Anacampseros rufescens			X	
Hesperantha longituba			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 (Table 11). It is evident that all vegetation units contain a significant portion of protected. Uncommon species but which are not protected is not included in this list but when taken into consideration it is evident that the ridges system to the west of the town contains the highest proportion of conservation significant species.

4.1.5.3 Additional sensitive areas (Appendix A: Map 10)

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 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 10)

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 (Figure 64). It is also quite clear that urban development and crop cultivation has caused the most significant transformation in this area. Smaller portion consisting of old borrow pits, quarries and the current landfill site also cause local, but not extensive, transformation of natural areas. 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 areas consisting of elevated ridge, sandstone outcrops, ridge system and hills contain a higher diversity of habitats and species, with several being protected or uncommon, forms the origin of several prominent stream and drainage systems and the varied topography also contribute to a significantly higher conservation value. Spatial planning and urban development should therefore attempt to avoid these areas.

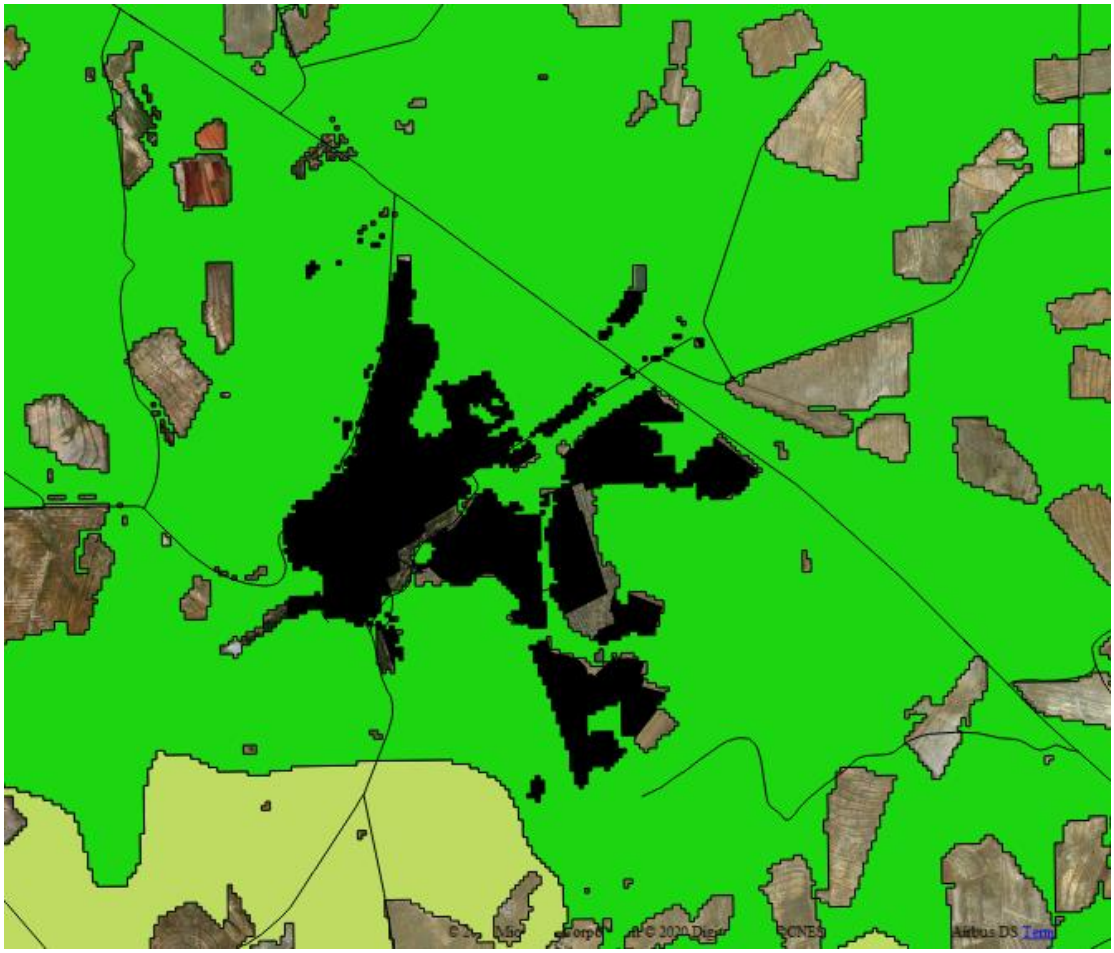
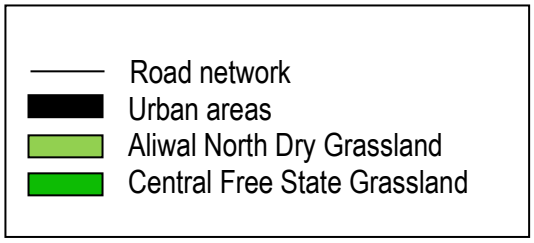


Figure 64: View of the remaining portions of the different vegetation types present in the Dewetsdorp urban area. Note extensive natural areas and limited transformation.

Legend:



Free State Biodiversity Management Plan 2015 (Appendix A: Map 10)

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 (Figure 65). The reasons for this area being considered a CBA is not clearly apparent but the on-site survey indicates that this may be coupled to the origins of stream systems in the area. Whatever the case may be, the majority of this CBA 1 area was also

determined to be largely natural and consequently FSBMP coupled with the on-site survey indicates that these areas should be afforded at least a high level of sensitivity.

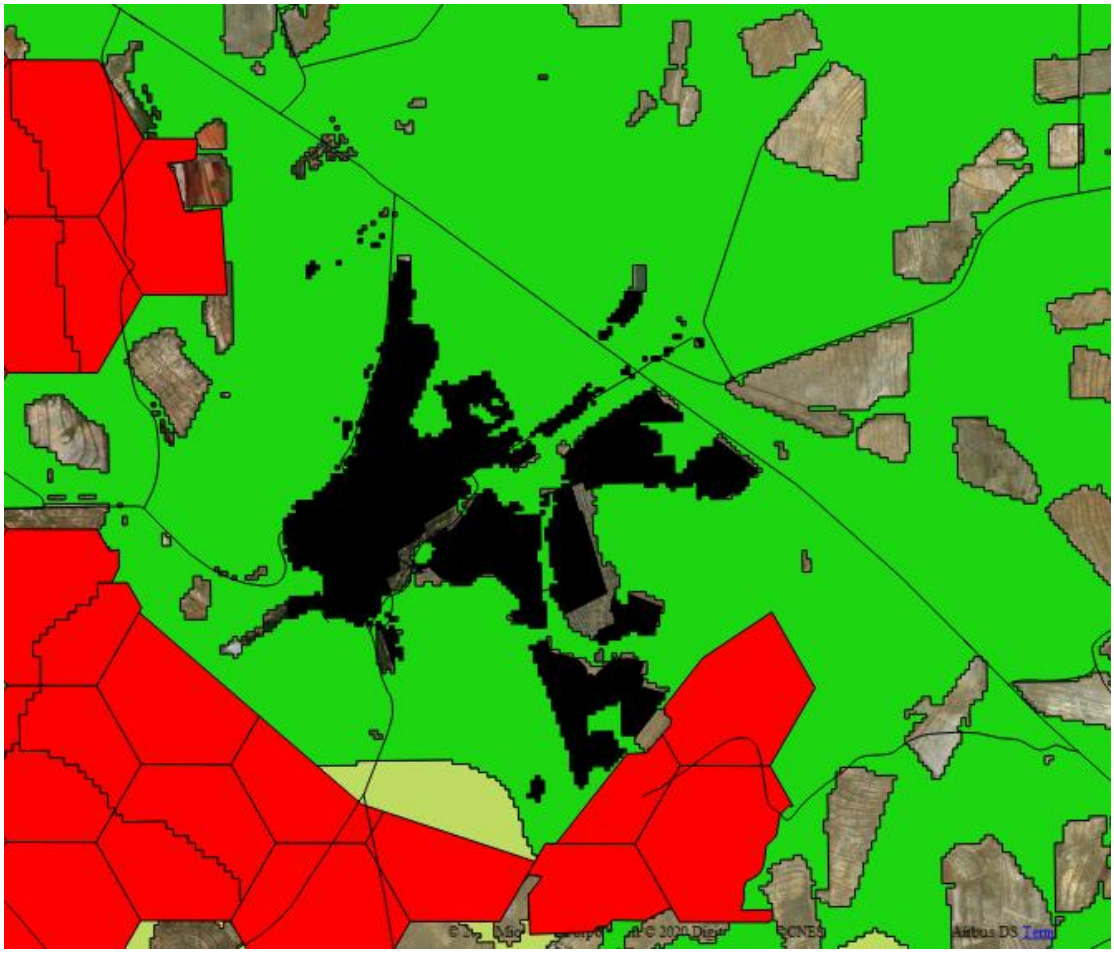
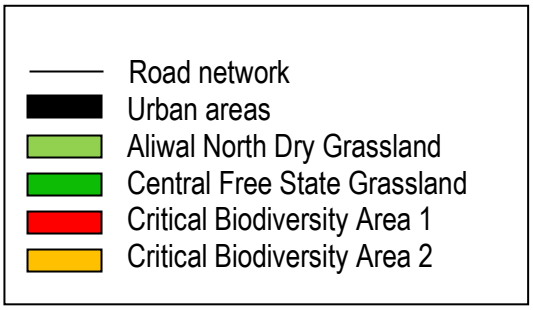


Figure 65: View of CBA 1 and 2 areas in the Dewetsdorp urban area overlain over the remaining natural vegetation portions.

Legend:



4.1.5.4 Dewetsdorp urban area – Conclusions (Appendix A: Map 9)

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.

4.1.6 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 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 mounainous terrain, large hills and ridges becoming prominent. The vegetation structure is dominated by grassland but with a shrub and tree layer becoming prominent along the mountains, hills, ridges as well as watercourses. The vegetation structure seems to be intact to a large degree though it is evident that exotic trees, especially along watercourses, does 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 contains significant degradation due to land-use. Overgrazing and -browsing in communal areas has led to significant degradation of the vegetation. Other lesser impacts included small portion of old cultivated fields, disused quarries and other activities associated with the urban area, i.e. landfill site, disused golfcourse, WWTW, etc.

Despite the relatively small extent of the town and surrounding municipal area, a varied topography is present including undulating plains, incised, large watercourses and prominent mountains, 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 mountain, 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 mountain 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. A myriad of small dirt tracks and footpaths cause limited local disturbance. However, these clearly also cause obstructions to surface flow and coupled with high levels of overgrazing they contribute to erosion. They also clearly provide access to natural areas where illegal dumping sporadically occurs. A few smaller areas with local but complete transformation includes a disused quarry and landfill to the east and west of the town. Other developments associated with the urban area and causing some transformation include the old disused golfcourse, scattered, small woodlots and windrows of exotic trees, the current and old WWTW's and cemeteries, amongst others. One of the most widespread and significant impacts affecting the surrounding natural areas are overgrazing and -browsing by domestic livestock. Overgrazing and -browsing and the associated trampling cause a decrease in

vegetation cover and an increase in erosion. The extent of this impact differs over the communal area and is generally higher in proximity to the urban areas but was also quite visible where steeper slopes occurs. Where it is high it does lead to a loss in species diversity and modification of the vegetation structure and species composition. From the field survey it was evident that stocking levels and grazing schedule requires improved management in order to improve grazing quality and sustainability.

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

4.1.6.1 Wepener Vegetation Units (Appendix A: Map 11 – 12)

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 mountains 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.

The on-site survey indicated that the Aliwal Dry Grassland dominated the plains to the south and west of the town. The grass layer is dense with few dwarf karroid shrubs and herbaceous species although these do increase where overgrazing is evident. Wherever ridges and hills become evident and especially the steep slopes of the mountainous area to the east and north of the town the Basotho Montane Shrubland is evident and is easily distinguished from the surrounding vegetation in terms of topography but also a prominent shrub layer. Due to the steep slopes here and overgrazing by domestic stock, erosion was also prominent in these areas. The Eastern Free State Clay Grassland does not cover a large portion of the study area but is confined to the plateau of the large mountain to the east and north of the town. Here the grass layer becomes more dominating although shrubs may also be present where outcrops occur. It was also prominent that numerous valley-bottom wetlands originated on the plateau and occurs imbedded within the grass layer. In conclusion, the borders of vegetation types as indicated by available spatial data are quite easily distinguished though a narrow ecotone was also evident, especially where portions of the different vegetation types are imbedded within each other, i.e. ridges in grassland, outcrops on the plateau, etc.

Undulating grassland plains – south and west of the town (Aliwal North Dry Grassland)

The undulating plains dominating the area to the south and west of the town is generally characterised by a uniform grass layer, with deeper soils but with a few outcrops of sandstone and dolerite and shallow soils. Where these form positive landscape features, i.e. ridges and hills, they are more aligned with the Basotho Montane Shrubland though where they form part of the undulating terrain they are considered a part of the vegetation type. This is also part of the characteristics of this vegetation type, a grass dominated vegetation layer but with karroid elements in some areas. The area is however quite uniform and can easily be considered and managed as a single unit. Due to the somewhat deeper soils these are also the only portions around the town which had previously been affected by crop cultivation. Small, though still significant portions to the south, west and east of the town had previously been affected by ploughing for crop cultivation. Consequently, the current grass layer is of secondary establishment and these areas can be regarded as being largely transformed and having a low level of sensitivity.

The vegetation type or unit is also characterised by a well-developed grass layer, being dominated by only a few species with a significant herbaceous component and dwarf karroid shrubs being rare but becoming prominent in overgrazed areas or where rocky outcrops are present. The grass layer is dominated by only a few species and it was also prominent that pioneer species and species indicative of overgrazing dominated though varied in dominance in accordance with the amount of overgrazing in each area. In general, *Cymbopogon pospischillii* and *Eragrostis chloromelas* was dominant in almost all sample plots though pioneer species

indicative of overgrazing, including *Aristida congesta* and *Eragrostis gummiflua*, increased in dominance where overgrazing was highest. Climax grass species such as *Themeda triandra* and *Digitaria eriantha* remained in low abundance in all sample plots. From the survey it is therefore quite clear that this vegetation type is subjected to high levels of overgrazing by domestic stock. Other grass species observed though in low numbers included *Sporobolus fimbriatus, Tragus berteronianus, Setaria sphacelata* and *Eragrostis capensis*.

An abundance of herbaceous species is present though they are all small and therefore not prominent within the tall grass layer. These include *Berkheya onopordifolia, Hermannia depressa, Haplocarpha scaposa, Dicoma anomala* and *Osteospermum scariosum*. This is considered a relatively natural component of this grassland. However, a few pioneer herbaceous species were also noted and indicate overgrazing where they occur in abundance. These include *Salvia stenophylla* and *Pseudognaphalium luteo-album*.

Dwarf karroid shrubs form a natural component of this vegetation type though where they are in abundance this is also an indication of overgrazing. They may also become more prominent in areas of rocky outcrops and shallow soils. Where overgrazing was visibly quite high the dwarf karroid shrubs, *Felicia muricata, Stoebe plumosa* and *Lycium horridum,* were quite prominent. Where shallow soils were noted the dwarf shrubs *Ruschia hamata* and *Melolobium sp.* occurred. In these rocky habitats a few small succulents also occurred which included *Euphorbia clavaroides* and *Chasmatophyllum muscullinum*

Despite the dominance of grasses, numerous geophytic species are also interspersed within this layer. These include *Moraea pallida, Oxalis depressa, Brunsvigia radulosa* and *Colchicum cf. burkei*. Of these, *M. pallida* is also an indicator of overgrazing where it is abundant. Furthermore, *B. radulosa* is a protected species with a significant conservation value.

Exotic weeds are not abundant and indicate that though overgrazing is present, the grass layer is not extensively degraded, although the species composition is modified to some degree. A few clumps and windrows of the exotic *Eucalyptus sideroxylon* tree is present but were deliberately planted.

From the vegetation description the vegetation unit or type is considered largely natural although overgrazing by domestic livestock has caused significant degradation with especially a modification in species composition being evident. The grass layer is dominated by a few species and overall the species diversity is only considered as moderate. Coupled with this, habitat diversity is also relatively uniform and considered moderate. 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.

Figure 66: Panoramas of the plains in the area consisting of Aliwal North Dry Grassland. Note a dense grass layer without any shrubs or trees and a relatively uniform topography.

Figure 67: View of a rocky outcrop within the grass layer. Note an absence of shrubs and trees, though significantly different from the surroundings it is still considered as part of the vegetation type.

Figure 68: View of a windrow of exotic *Eucalyptus sideroxylon* trees.

Figure 69: Panorama of the grassland plains. The abundance of termite mounds are prominent, a further indicator of overgrazing by domestic livestock.

Ridges, hills and slopes of mountainous areas – North and east of the town (Basotho Montane Shrubland)

To the east and north of the town lies a large mountain with highly uneven terrain, descending to foothills and ridges via a very steep slope. The scale of these slopes are large enough to be regarded as a distinct vegetation type themselves and in terms of species composition and vegetation structure is also quite distinct from the surrounding vegetation. The grass layer becomes sparser though still well-developed, although a prominent shrub and small tree layer becomes quite prominent. The density of this layer varies with aspect and a closed canopy occurs in ravines and south facing slopes where sun exposure is lowest and decreases in density on open slopes and west facing aspects. The topography and habitat is varied and consequently the diversity of growth forms are also diverse. The vegetation type or unit is still largely natural, however, has been heavily affected by overgrazing of domestic livestock. Coupled with trampling and the steep slopes of this unit, this leads to a significant decrease in vegetation cover, modification of the species composition and extensive erosion of the slopes. The vegetation type or unit would therefore be considered sensitive as a result of high species diversity but also as a result of its vulnerability to erosion.

The grass layer becomes much sparser here and although several species also occur in the surrounding vegetation units the dominant species are different and adapted to steeper slopes and rocky soils. These include *Aristida congesta, Enneapogon scoparius, Andropogon appendiculatus* and *Heteropogon contortus*. Other abundant grasses also include *Eragrostis chloromelas, Cymbopogon pospischilli* and *Themeda triandra.*

As indicated, the slopes contain a variety of other growth forms, with dwarf shrubs also being prominent. These include *Felicia fillifolia, Asparagus cooperi, Helichrysum rugulsoum, Melolobium sp., Clutia pulchella, Helichrysum splendidum. Asparagus denudatus, Nenax microphylla, Euryops annae, Hermannia cuneifolia, Pentzia quinquifida, Felicia muricata* and *Asparagus suaveolens.*

Slopes with a higher sun exposure also form suitable habitat for succulent plants. A few of these are also protected and uncommon and significantly increase the conservation value of this vegetation unit. These include *Aloe broomii, Delosperma cooperi. Crassula nudicaulis, Rabiea sp., Euphorbia clavaroides, Stapelia grandiflora, Ruschia unidens, Chasmatophyllum muscullinum* and *Hereroa glenensis*. A significant diversity of succulent species is notable.

Due to the shallower soils less geophytic species are present though a few of these remain protected species with significant conservation value. These include *Oxalis smithii, Eriospermum porphyrium, Kniphofia cf. ritualis, Colchicum cf. burkei* and *Hesperantha longituba*. The last named is also an uncommon and protected species with a significant conservation value.

Due to boulders, forming shady micro-climates, and south facing slopes where shade is abundant, a few fern species are also common in these areas. These include *Pellaea calomelanos, Cheilanthes eckloniana* and *Mohria vestita*.

Shadier south facing slopes and ravines also promote the establishment of softer leaved herbaceous species. These include *Haplocarpoha scaposa, Senecio glaberrimus, Helichrysum nudifolium* and *Glekia krebsiana*. Of these the last named is also a Drakensberg endemic and contributes to the conservation value of the area.

As indicated, a diagnostic feature of this vegetation type or unit is the presence of a prominent shrub and small tree layer. These include *Searsia lancea, S. erosa, S. divaricata, S. burcehllii, Olea europaea* subsp. *africana, Scolopia zeyheri, Osyris lanceolata, Cussonia paniculata, Maytenus heterophylla, Celtis africana* and *Euclea crispa* var. *crispa*. Note the diversity of species with a few also being considered protected species and further increasing the conservation value of the vegetation unit.

From the vegetation description the vegetation unit or type 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. Numerous drainage lines, ravines, streams and associated wetlands also occur along the slopes. As a result of the combination of the above, including high species diversity and protected species but also the vulnerability of the unit to overgrazing and erosion, it is regarded as having a high level of sensitivity.

Figure 70: Panorama of the ridges and slopes which are quite easily identified by the topography as well as the clearly visible shrub and tree layer.

Figure 71: Some of the south facing slopes contain a much denser shrub and tree layer.

Figure 72: Ravines imbedded within the plateau and slopes also contain a very dense tree canopy.

Figure 73: Another view of one of the mid-slopes where a very dense shrub cover is clearly present.

Figure 74: West facing slopes contain a much less dense shrub cover.

Figure 75: Slopes in the western portions and in closer proximity to urban areas contain a much higher degree of overgrazing and trampling and erosion is quite evident here.

Figure 76: Areas in close proximity to the urban area is also heavily affected by tree cutting for use as firewood.

Grassland plateau with rocky outcrops – north and east of the town (Eastern Free State Clay Grassland)

As previously indicated, a large mountain and uneven terrain occurs to the north and east of the town with slopes dominated by a grass- and shrub layer. The plateau of this mountain has a high

elevation, is subjected to different climatic conditions, i.e. lower minimum temperatures, higher velocity winds and increased rainfall. As a consequence, the vegetation here is also significantly different from those previously discussed. A well-developed and dense grass layer dominates although other growth forms may also become prominent, especially where rocky outcrops occur. Furthermore, due to high rainfall on the plateau and the undulating topography numerous wetlands and watercourses originate on the plateau and drain via ravines and waterfalls down the mountain cliffs to the areas down below. These will however de discussed in greater detail under the wetland section (Section 4.2). The plateau is also being heavily affected by overgrazing by domestic livestock and has a significant impact on the species composition, trampling, erosion and also has an especially detrimental impact on wetland systems. It was also notable that due to the time of year as well as overgrazing that a high amount of grasses and herbaceous species could not be identified and it is therefore highly likely that the species diversity as well as protected plants would be much higher.

As indicated, the plateau vegetation is dominated by a dense grass layer. Several grass species dominate and vary with soil depth and slope. Due to the time of year it is also likely that numerous other grass species could not be identified at this time and the diversity and species composition may differ somewhat in the rainy season. However, sufficient grass identification could still be done to give a general idea of the condition and composition of the grass layer on the plateau. Dominating grass species included *Heteropogon contortus, Eragrostis capensis, Helictotrichon turgidulum, Hyparrhenia hirta, Eragrosts curvula, Eragrostis chloromelas, Eragrostis obutsa, Aristida congesta* and *Tragus berteronianus*. This species composition indicates a natural grass layer with a few climax and sub-climax grasses, but decreased by a significant amount of pioneer species. This is clearly indicative of overgrazing where climax grass species are decreased and trampling cause an increase of pioneer grass species.

Dwarf shrubs are also abundant, and although a natural component here, an abundance is also indicative of overgrazing. Where rocky outcrops and shallow soils are present this also provides suitable habitat for dwarf shrubs. These include *Euryops annae, Hermannia cuneifolia, Melolobium candicans, Artemisia afra, Felicia fillifolia, Felicia muricata, Ruschia hamata, Pentzia quinquifida, Nolletia ciliaris, Pentzia incana, Rosenia sp.* and *Stoebe plumosa*.

A prominent herbaceous component is also imbedded within the grass layer and contain species such as *Helichrysum nudifolium, Gerbera sp., Berkheya raphontica, Scabiosa columbaria* and *Dicoma anomala*.

Geophytic species was rare within the grass layer, but is considered also a consequence of the time of year when they will not be visible and it is highly likely that a significant diversity of such species will be present as indicated by available literature. Those species observed included *Brunsvigia radulosa* and *Pelargonium sp.*

Along the plateau edge where cliffs are prominent and also where small rocky outcrops and boulders are present larger shrubs are also abundant. These include *Searsia burchellii, Diospyros austro-africana, Myrsine africana, Euclea coriacea, Rhamnus prinoides, Cussonia paniculata, Olea europaea* subsps. *africana, Clutia pulchella, Asparagus cooperi, Scolopia zeyheri, Searsia erosa* and *Euclea crispa* subsp. *ovata*. A few of these are also listed as protected species.

Cliffs and boulders also provide suitable shade and moisture for several other growth forms such as ferns. These included *Mohria sp.* and *Cheilanthes sp.* Other herbaceous species adapted to

this micro habitat include *Delosperma cooperi, Selago sp., Glekia krebsiana, Senecio glaberrimus, Cineraria sp., Clematis brachiata, Cotyledon orbiculata* var. *oblonga, Hesperantha longituba* and *Gladiolus sp.* Again, a few of these are also listed as protected and increases the conservation value of the vegetation type.

Along the plateau edge shallow soils and rock sheets are common and this provides a suitable arid habitat for several succulent species. These also include local endemics such as *Ruschia putterillii* and also a very large population of the protected *Aloe broomii*. Other common species include *Crassula nudicaulis, Crassula dependens, Kalanchoe thyrsiiflora, Euphorbia clavaroides, Rabiea sp.* and *Chasmatophyllum muscullinum*.

Although exotic weeds are not dominant anywhere they are abundant where overgrazing and trampling causes significant disturbance. Here weeds such as *Schkuhria pinata* and *Tagetes minuta* are common. The invasive succulent *Agave americana* was also noted to form dense clumps along the summit.

From the vegetation description the vegetation unit or type 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.

Figure 77: Panorama of the plateau with an undulating topography. Note low hills and outcrops are present and though a dense grass layer dominates, scattered trees are also present.

Figure 78: Panorama of the plateau which also clearly illustrates the dense grass layer.

Figure 79: View of one of the plateau with exposed rock sheets in the foreground.

Figure 80: A dense population of the protected *Aloe broomii* occurs on the plateau.

Figure 81: The edge of the plateau contains dense shrubs and a variety of other growth forms.

Caledon River, Sandspruit, wetlands and watercourses

The Caledon River, a large and important lowland river flows past the town to the west and the Sandspruit, a seasonal but still large watercourse, flows through the urban centre of the town. Due to the uneven terrain and higher rainfall, watercourses and wetlands are also abundant.

These would all be considered to be highly sensitive despite the impact that the urban area might have on them. These systems would all be of high importance but will be discussed in detail within the wetland section (Section 4.2).

4.1.6.2 Wepener Protected Species

From the previous section, it was evident that numerous protected species are present in and around the urban area of Wepener. All of the vegetation units 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 12 & 13).

Table 12: 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			✔

From Tabel 13 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. Of the anticipated species (Table 12), only five were observed during the on-site survey. This may most likely be indicative of the time of year when many species will not be visible above-ground. Surveying during the rainy season is likely to yield a much higher proportion of anticipated protected species.

Table 13: Protected species observed during on-site surveys of the Wepener urban area and the specific vegetation unit in which they occurred.

Protected Species	Undulating plains (Gh 2)	Hills, ridges and slopes (Gm 3)	Mountain plateau (Gm 5)	Watercourses and wetlands
Cussonia paniculata		X	X	
Aloe broomii		X	X	
Boophone distichia		X		
Brunsvigia radulosa	X	X	X	
Euphorbia clavaroides	X	X	X	
Hesperantha longituba		X	X	
Olea europaea subsp. *africana*		X	X	
Kniphofia cf. ritualis		X		
Gladiolus sp.			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. It is evident that all vegetation units contain a significant portion of protected. Uncommon species but which are not protected is not included in this list but were taken into consideration. It is however quite evident that the mountainous terrain which incudes the ridges, hills and slopes of Basotho Montane Shrubland and the mountain plateau of Eastern Free State Clay Grassland contains a much higher proportion of protected species and also substantiates these areas being regarded as having a high sensitivity.

4.1.6.3 Additional sensitive areas (Appendix A: Map 11)

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 (Appendix A: Map 11)

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 (Figure 82). It is also quite clear that urban development and crop cultivation has caused the most significant transformation in this area. A few smaller areas with local but complete transformation includes

a disused quarry and landfill to the east and west of the town. Other developments associated with the urban area and causing some transformation include the old disused golfcourse, scattered, small woodlots and windrows of exotic trees, the current and old WWTW's and cemeteries, amongst others. 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, it was notable that the ridges, hills, slopes and mountainous areas to the north and east of the town has a significantly higher diversity of species with a significant proportion of protected species as well. Furthermore, a high amount of wetlands originate on the plateau and waterfalls, ravines and streams drain down the slopes of the mountain. These areas were also noted to be much more susceptible to erosion. As a consequence these portions are considered to have a higher conservation value. Spatial planning and urban development should therefore attempt to avoid these areas.

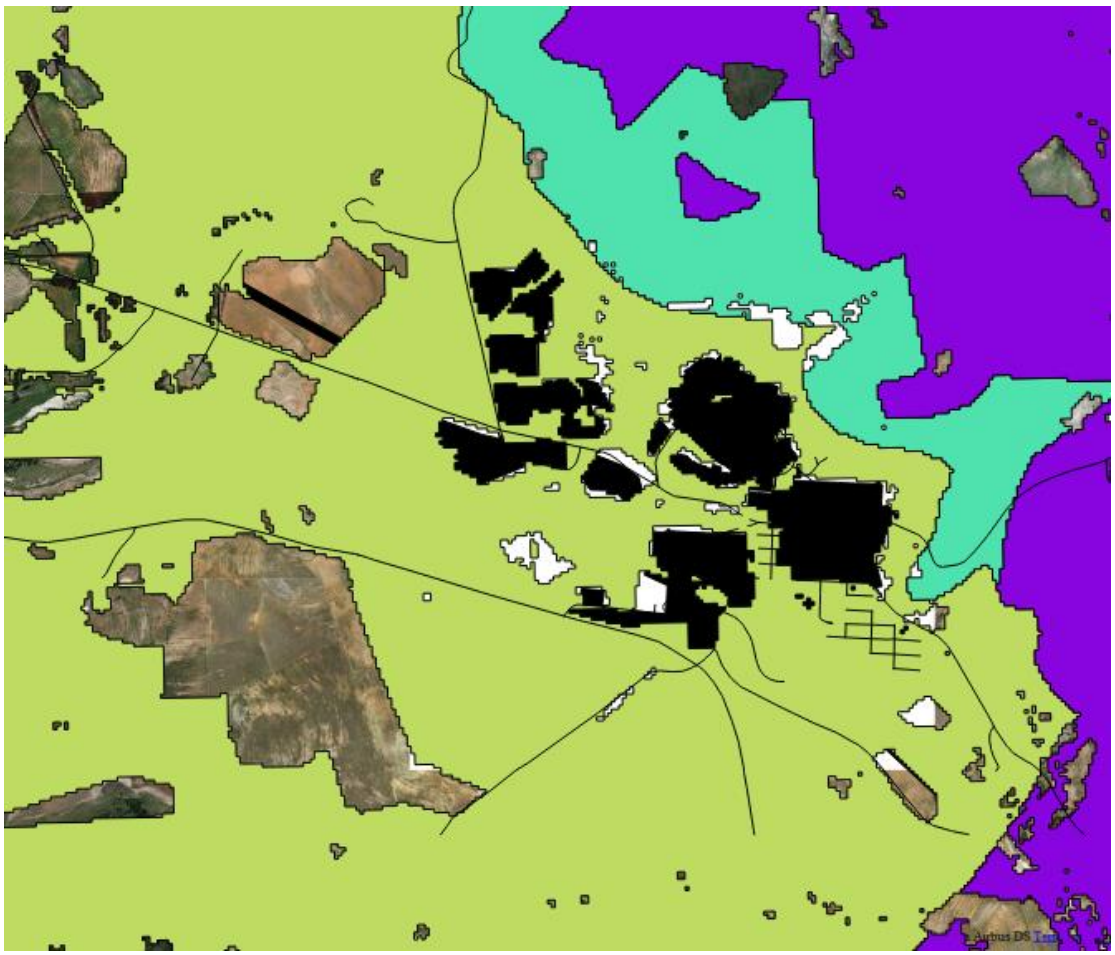
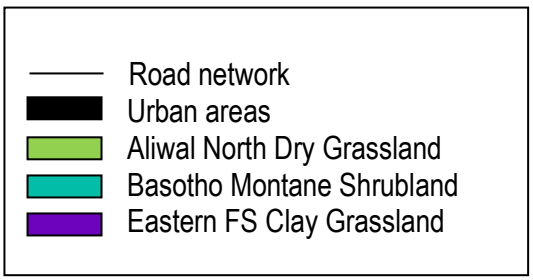


Figure 82: View of the remaining portions of the different vegetation types present in the Wepener urban area. Note extensive natural areas and limited transformation.

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 (Figure 83). 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. These CBA areas fall outside the boundary of the municipal area and 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.

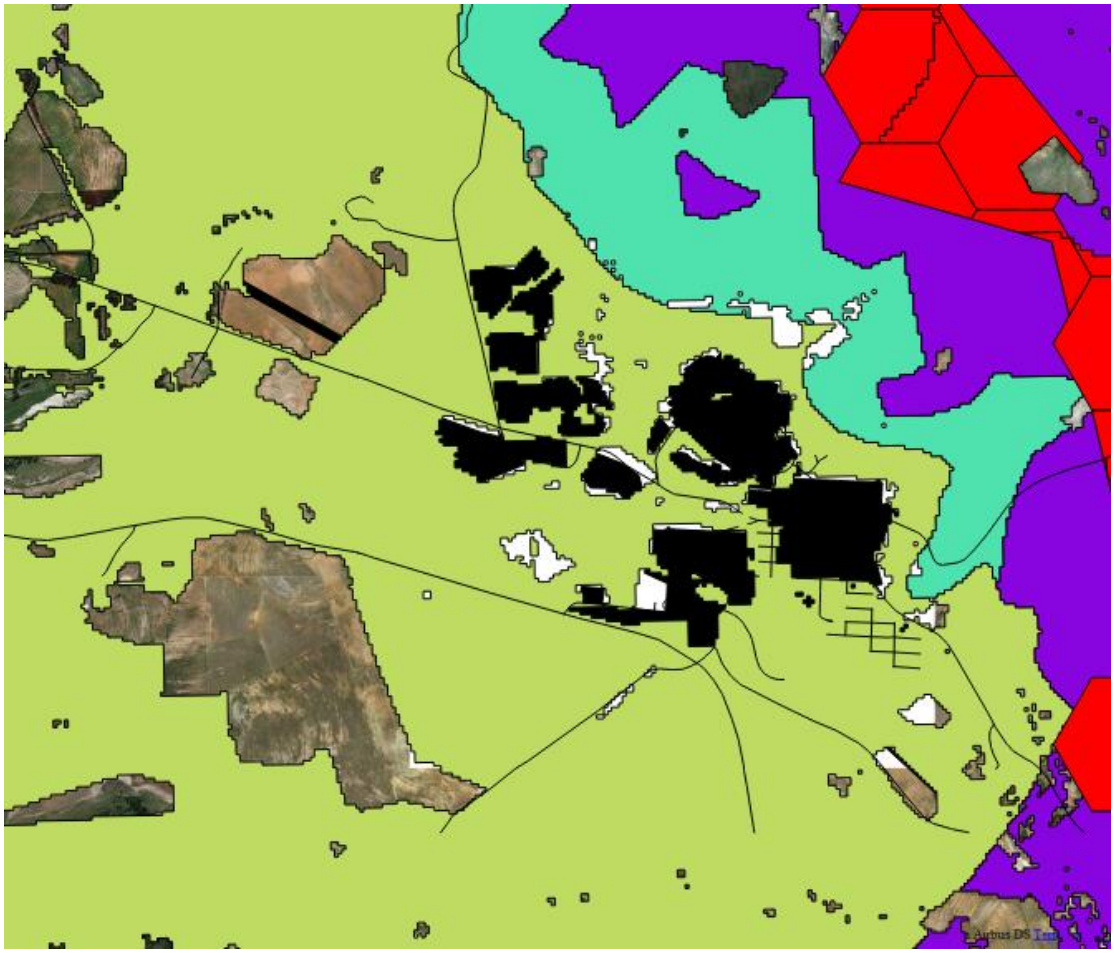
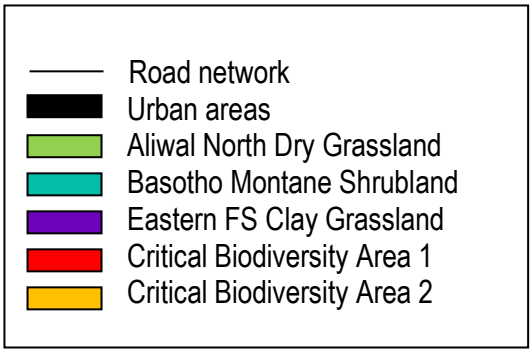


Figure 83: View of CBA 1 and 2 areas in the Wepener urban area overlain over the remaining natural vegetation portions.

Legend:



4.1.6.4 Wepener urban area – Conclusions (Appendix A: Map 11)

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.

4.1.7 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.

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 evident that exotic trees, especially along watercourses, does 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 contains significant degradation due to land-use. Overgrazing and -browsing in communal areas has led to significant degradation of the vegetation. Other lesser impacts included areas of old cultivated fields, disused quarries and other activities associated with the urban area, i.e. landfill site, graveyard, WWTW, etc.

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. A myriad of small dirt tracks and footpaths cause limited local disturbance. However, these clearly also cause obstructions to surface flow and coupled with high levels of overgrazing they contribute to erosion. They also clearly provide access to natural areas where illegal dumping sporadically occurs. A few smaller areas with local but complete transformation includes a disused quarry to the east of town and a landfill, graveyard and WWTW to the west of the town. One of the most widespread and significant impacts affecting the surrounding natural areas are overgrazing and -browsing by domestic livestock. Overgrazing and -browsing and the associated trampling cause a decrease in vegetation cover and an increase in erosion. The extent of this impact differs over the communal

area and is generally higher in proximity to the urban areas but was also quite visible where steeper slopes occurs. Where it is high it does lead to a loss in species diversity and modification of the vegetation structure and species composition. From the field survey it was evident that stocking levels and grazing schedule requires improved management in order to improve grazing quality and sustainability.

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

4.1.7.1 Vanstadensrus Vegetation Units (Appendix A: Map 13-14)

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.

The on-site survey indicated that the Aliwal Dry Grassland dominated the plains to the south of the town. The grass layer is quite sparse and with dwarf karroid shrubs also being prominent which is indicative of high levels of overgrazing. The ridge system to the north and east of the town consists of Basotho Montane Shrubland and is easily distinguished from the surrounding vegetation in terms of topography but also a prominent shrub layer. Due to the steep slopes here and overgrazing by domestic stock, erosion was also prominent in these areas. In conclusion, the borders of vegetation types as indicated by available spatial data are quite easily distinguished though a narrow ecotone was also evident, especially where portions of the

different vegetation types are imbedded within each other, i.e. ridges or outcrops within the grassland.

Undulating grassland plains – south of the town (Aliwal North Dry Grassland)

The undulating plains dominating to the south of the town is generally characterised by a uniform grass layer, with deeper soils but with a few outcrops of sandstone and dolerite and shallow soils. Where these form positive landscape features, i.e. ridges and hills, they are more aligned with the Basotho Montane Shrubland though where they form part of the undulating terrain they are considered a part of the vegetation type. This is also part of the characteristics of this vegetation type, a grass dominated vegetation layer but with karroid elements in some areas. The area is however quite uniform and can easily be considered and managed as a single unit. As this vegetation unit is situated on relatively level ground, it is most heavily affected by development. Urban development, including associated WWTW, graveyard, landfill and housing developments are amongst the impacts causing transformation. Significant portions of old cropfields north of the Witspruit stream are also associated with this vegetation unit. In these transformed areas the current grass layer is of secondary establishment and these areas can be regarded as being largely transformed and having a low level of sensitivity.

The vegetation type or unit is also characterised by a well-developed grass layer, being dominated by only a few species with a significant herbaceous component and dwarf karroid shrubs becoming prominent in overgrazed areas or where rocky outcrops are present. The grass layer is dominated by only a few species and it was also prominent that pioneer species and species indicative of overgrazing dominated in most areas consisting of this vegetation type. A comparison was also made with neighbouring grasslands to the south and this also clearly indicated high levels of disturbance and overgrazing around the town and a significant modification of the species composition and vegetation structure. Pioneer grasses dominate in general and include *Eragrostis chloromelas, Cynodon dactylon, Chloris virgata, Aristida congesta* and *Tragus koelerioides*. Climax grasses are rare and mostly absent though clumps of *Themeda triandra* were found. This species composition is modified from the natural condition and is indicative of high levels of disturbance and overgrazing. Furthermore, dwarf karroid shrubs, another indicator of overgrazing, are abundant and include *Lycium horridum, Ruschia hamata, Felicia muricata, Felicia fillifolia, Pentzia incana, Melolobium sp.* and *Chrysocoma ciliata.*

Herbaceous species are not abundant and include a few pioneer species also confirming a degraded grass layer. These include *Salvia verbenaca, Berkheya onopordifolia* and *Berkheya macrocephala*.

Several geophytic species are present and include *Massonia jasminiflora, Eriospermum porphyrium, Bulbine abyssinca* and *Moraea pallida*. The last two species are abundant, are poisonous to livestock and are also an indicator of overgrazing.

A low sandstone ridge is present to the south west of the town but is still regarded as forming part of this vegetation unit. However, due to shallow soils succulent species such as *Chasmatophyllum muscullinum* and *Euphorbia clavaroides* as well as a few low shrubs of *Diospyros austro-africana* and *Searsia erosa* are present.

From the vegetation description the vegetation unit or type is considered significantly modified from the natural condition in terms of species composition and vegetation structure. The grass layer 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.

Figure 84: Panorama of the plains south of the town consisting of Aliwal North Dry Grassland. Note the stark difference between the sparse grassland in the municipal area compared to the dense grassland of neighbouring areas.

Figure 85: Disturbance and overgrazing of the grass layer leads to significant sheet erosion.

Figure 86: Another panorama of the grassland indicating sparse grass layer and general disturbance.

Figure 87: Panorama of the grassland with the low ridge in the south west in the background. The abundance of termite mounds are prominent, a further indicator of overgrazing by domestic livestock.

Ridge system – North and east of the town (Basotho Montane Shrubland)

To the east and north of the town lies a prominent ridge system. The vegetation and topography along this ridge is quite distinct from the surrounding plains and in terms of species composition and vegetation structure is also quite distinct. The grass layer becomes sparser though still well-developed, although a prominent shrub and small tree layer becomes quite prominent. The density of this layer varies with aspect and a closed canopy occurs along the south facing slopes where sun exposure is lowest and decreases in density along the west facing slopes where a dwarf shrub component becomes more prominent. The topography and habitat is varied and consequently the diversity of growth forms are also diverse. The vegetation type or unit is still largely natural, however, has been heavily affected by overgrazing of domestic livestock. Coupled with trampling and the steep slopes of this unit, this leads to a significant decrease in vegetation cover, modification of the species composition and extensive erosion of the slopes. The vegetation type or unit would therefore be considered sensitive as a result of high species diversity but also as a result of its vulnerability to erosion.

The grass layer becomes much sparser here though several of the grass species found in the plains are also present here but with several other species also present adapted to steeper slopes and rocky soils. These include *Aristida congesta, Themeda triandra, Eragrostis chloromelas, Digitaria eriantha, Cymbopogon pospischillii, Sporobolus fimbriatus* and *Hyparrhenia*. It was also notable that areas where overgrazing was evident was dominated by the pioneer grass, *Aristida congesta*.

The slopes with a western aspect contained much less shrubs and trees, but with dwarf shrubs being quite prominent. These included *Felicia fillifolia, Amphiglossa triflora, Helichrysum rugulosum, Melolobium sp., Chrysocoma ciliata, Hermannia cuneifolia, Stoebe plumosa* and *Ruschia hamata*.

These more exposed, west facing slopes also contained several succulent species including *Rabiea sp., Chasmatophyllum muscullinum, Crassula nudicaulis* and *Euphorbia clavaroides*.

Due to boulders, forming shady micro-climates, and south facing slopes where shade is abundant, a few fern species are also common in these areas. These include *Pellaea calomelanos, Cheilanthes eckloniana* and *Cheilanthes sp*.

Shadier south facing slopes also promote the establishment of softer leaved herbaceous species. These include *Haplocarpoha scaposa, Senecio glaberrimus, Helichrysum nudifolium, Berkheya*

raphontica, Dicoma anomala, Artemisia afra, Solanum tomentosum, Crassula lanceolata and *Glekia krebsiana*. Of these the last named is also a Drakensberg endemic and contributes to the conservation value of the area.

Due to the shallower soils geophytic species are not well represented though a few of these remain and include *Oxalis smithii, Pelargonium aridum* and *Albuca sp*.

As indicated, a diagnostic feature of this vegetation type or unit is the presence of a prominent shrub and small tree layer. These include *Searsia lancea, S. erosa, Olea europaea* subsp. *africana, Scolopia zeyheri, Cussonia paniculata, Celtis africana, Myrsine africana, Tarchonanthus minor, Grewia occidentalis, Asparagus denudatus* and *Euclea crispa* var. *crispa*. Note the diversity of species with a few also being considered protected species and further increasing the conservation value of the vegetation unit.

As noted the vegetation unit is affected by overgrazing, trampling and resulting erosion. Where disturbance is high it was notable that a few invasive shrubs have become established and exotic weeds are also present. These include *Datura stramonium, Acacia dealbata* and *Pyracantha angustifolia*.

From the vegetation description the vegetation unit or type is considered largely natural although overgrazing by domestic livestock causes significant degradation and especially erosion. It is evident that 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, including significant species diversity and several protected species but also the vulnerability of the unit to overgrazing and erosion, it is regarded as having a high level of sensitivity.

Figure 88: View of a west facing slope of the ridge system. The grass layer is notably dominated by pioneer grasses here, a consequence of overgrazing.

Figure 89: Panorama of a west facing slope of the ridge system. Note a trees and shrub coponent but which is sparse.

Figure 90: South facing slopes of the ridge contains a much denser tree and shrub layer.

Tributary of the Witspruit

A tributary of the Witspruit flows from the Vanstadensrus Dam past the town to the north and is clearly also affected by it. It is a small but nonetheless important and sensitive watercourse. This system would all be of high importance but will be discussed in detail within the wetland section (Section 4.2).

4.1.7.2 Vanstadensrus Protected Species

From the previous section, it was evident that a few protected species are present in and around the urban area of Vanstadensrus. Though such species were not found to be abundant, all of the vegetation units contain a few protected species. However, some units may contain a 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 14 & 15).

Table 14: 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. africana*	LC	Y		

From Tabel 15 It is clear that the current data for the Vanstadensrus region is 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 uneven, ridge system, Basotho Montane Shrubland. Of the anticipated species (Table 14), only one were observed during the on-site survey. This may most likely be indicative of the time of year when many species will not be visible above-ground but may also be a result of overgrazing and trampling. Surveying during the rainy season is likely to yield a much higher proportion of anticipated protected species.

Table 15: Protected species observed during on-site surveys of the Vastadensrus urban area and the specific vegetation unit in which they occurred.

Protected Species	Hills, ridges and slopes (Gm 3)	Undulating plain (Gh 2)	Watercourses and wetlands
Cussonia paniculata	X		
Celtis africana	X		
Euphorbia clavaroides	X	X	
Olea europaea subsp. *africana*	X		

From the on-site observations as well as data of previous collections in the area it is clear that only a few protected species are present. Both vegetation units contained at least some protected

species though it is clear that the ridge system consisting of Basotho Montane Shrubland contains most of these and also substantiates that it be regarded as having a high sensitivity.

4.1.7.3 Additional sensitive areas (Appendix A: Map 14)

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 (Appendix A: Map 14)

Remnants of the natural vegetation types in the area indicates that the area is still largely dominated by natural vegetation (Figure 91). 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. A few smaller areas with local but complete transformation includes a disused quarry to the east of town and a landfill, graveyard and WWTW to the west of the town. 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 ridge system contained a notably higher diversity of species with a significant proportion of protected species as well. This ridge system was also noted to be much more susceptible to erosion. As a consequence it is considered to have a higher conservation value. Spatial planning and urban development should therefore attempt to avoid this ridge system.

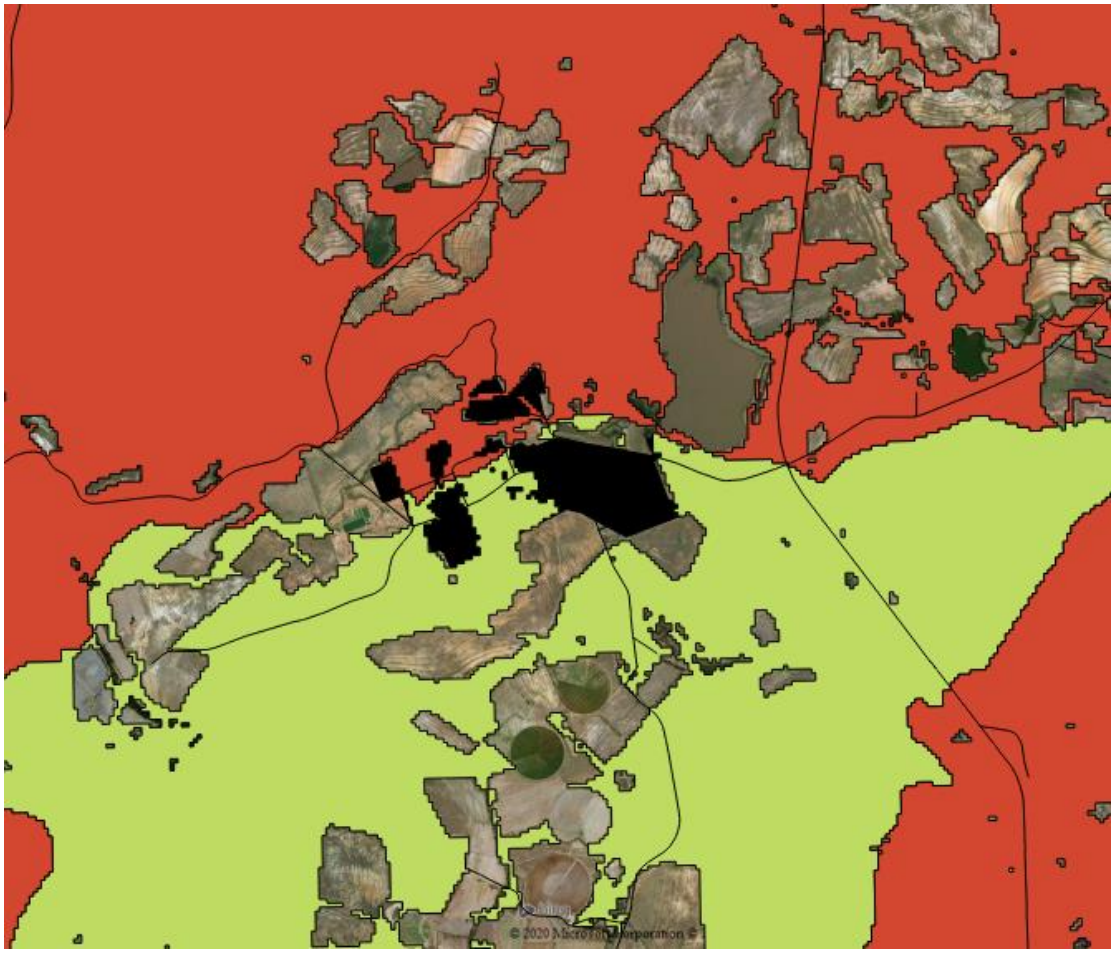
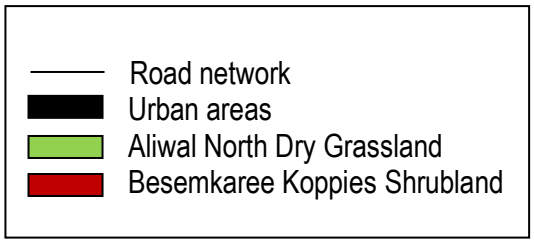


Figure 91: View of the remaining portions of the different vegetation types present in the Vanstadensrus urban area. Note extensive natural areas although agriculture has also transformed significant portion.

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 (Figure 92). However, these CBA areas are not located near the town or the surrounding municipal area and 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 Vanstadensrus.

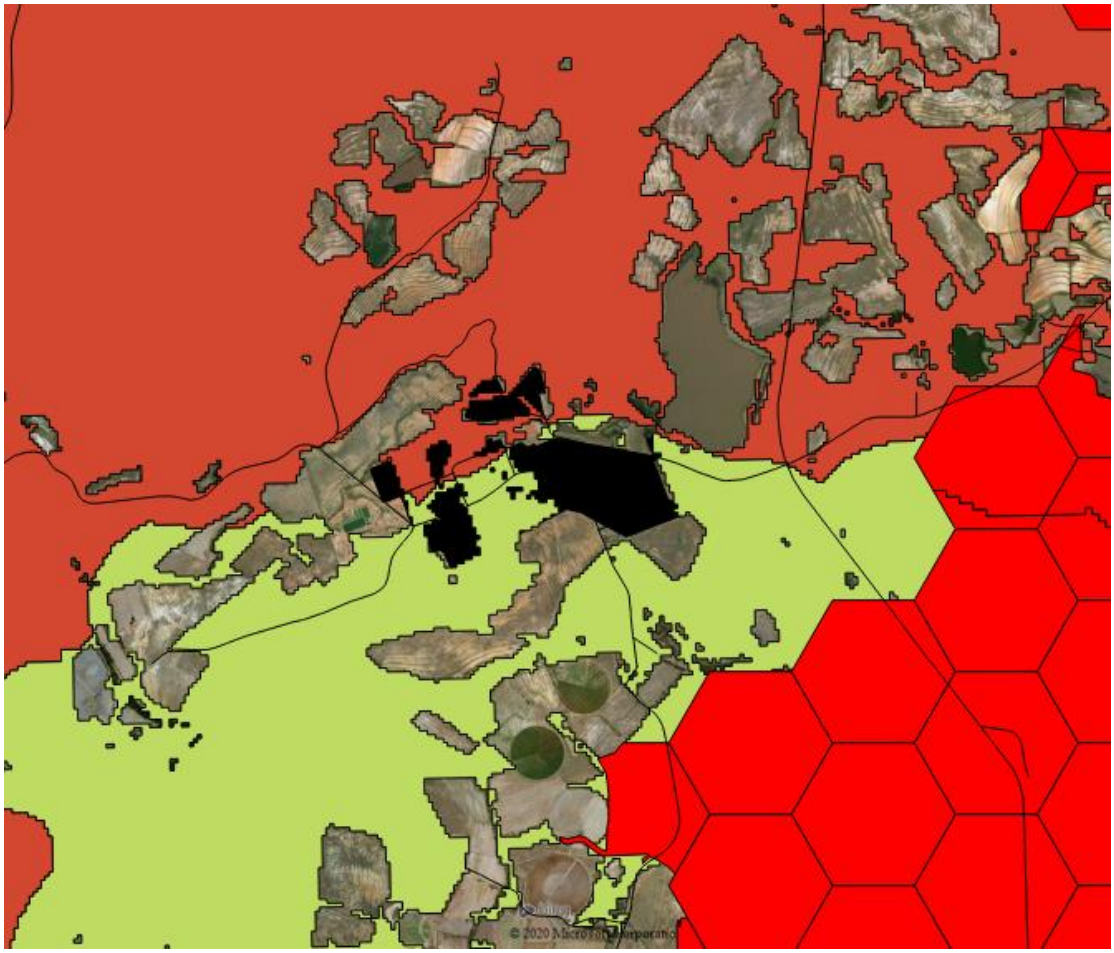
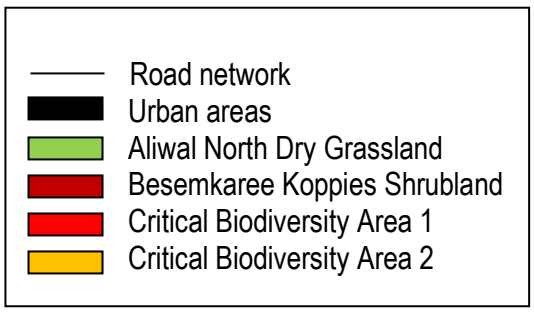


Figure 92: View of CBA 1 and 2 areas in the Vanstadensrus urban area overlain over the remaining natural vegetation portions.

Legend:



4.1.7.4 Vanstadensrus urban area – Conclusions (Appendix A: Map 13)

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.

4.2 Wetland Assessment

4.2.1 Introduction (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 1-14). Associated with these watercourses are also a wide variety of wetland systems. These will all be discussed below.

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

Watercourse means:

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

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

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

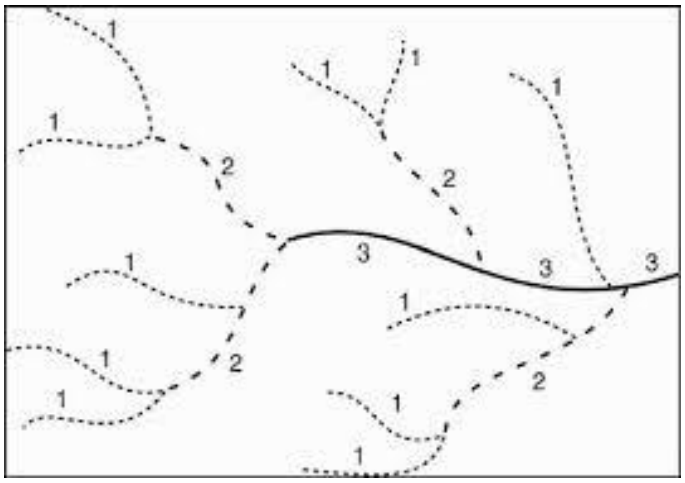


Figure 93: The classification of stream orders from 1 to 3 (Strahler 1952)

The following guidelines and frameworks were also utilised 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.

A summary of the larger watercourses in these urban areas are given below (Table 16).

Table 16: Summary of larger watercourses in the urban areas of the Mangaung Metropolitan Municipality (See also Appendix A: Map 1-14).

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	Seasonal
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.

4.2.2 Overview of watercourses

Almost all of the watercourses in the MMM is either seasonal or ephemeral in terms of flow regime. As previously indicated, the larger watercourses are either seasonal, with a few of largest watercourses being perennial. However, even these may experience short periods where a baseflow is absent or zero flow occurs. The study forms part of a semi-arid region and consequently watercourses and wetlands will also function as semi-arid systems, dominated by seasonal flow. The functioning of such seasonal and ephemeral systems are still poorly understood and this section will give an overview of the functioning of these systems.

Non-perennial rivers are systems in which surface flow stops and may disappear for some period of most years (Uys & Keeffe 1997). They can further be divided into seasonal and ephemeral systems where seasonal systems have a continuous channel flow during the rainy season and ephemeral systems have a highly variable frequency of connected channel flow, a high degree of natural disturbance and a lack of baseflow (Hughes 2008). Seasonal systems can be regarded as flowing between 20 % and 80 % of the year and ephemeral systems less than 20 % of the year (Kleynhans & Louw 1999). The largest watercourses in the MMM, the Modder- and Caledon Rivers are mostly perennial, however, even they experience short periods of zero flow. Other large watercourses such as the Bloemspruit, Renosterspruit, were naturally seasonal systems, though the urban environment now cause flow to be almost perennial. Other larger watercourses such as the Seven-Dams Stream, Klein-Modder River, Sepane River and Witspruit are all seasonal systems and the smaller watercourses are almost all ephemeral systems.

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

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

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

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

From the above it should be clear that flooding is essential to the continued and natural functioning of the watercourses in the MMM. It is also a real occurrence during the annual cycle of these watercourses and will occur annually in the seasonal and perennial systems but infrequently and perhaps only during years of high rainfall in the ephemeral systems.

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

Soil salinity is a factor that significantly affects the distribution, morphology and productivity of many riparian species. Soil enrichment by soluble salts occurs where flood waters contain a significant salt load. Soils that become enriched generally occur in the lower reaches of the river where water flow is slowed and together with infiltration and evaporation, salts are deposited (Jacobson 1997). This has also been found to be the case within the study area. The Soutpan area is perhaps one of the best examples of this. Several of the smaller watercourses contain extensive floodplains and in several cases a higher salt concentration is evident. Vegetation is also a clear indicator of higher salt concentrations and species such as *Salsola spp.* can be used as such indicators.

The above description should give a general idea of the functioning of the watercourses in the MMM and should also serve to indicate that although they may seem small and flow only occur sporadically they still have a complex functioning which provides several unique ecosystem services. They should consequently still be considered as highly sensitive systems and should therefore be included in the urban planning of the MMM.

4.2.3 Wetland indicators

Obligate wetland vegetation was utilised to determine the presence and border of wetland conditions. Due to time constraints and the large extent of the MMM and associated MOSS soil samples were only used to confirm the presence of wetland conditions where obligate wetland vegetation indicated wetland conditions (Section 4.2.6). Soil samples were investigated for the presence of anaerobic evidence which characterises wetland soils.

Soil samples indicated that most of the watercourses being situated in the MOSS contain wetland conditions. The majority of these are also ephemeral systems, i.e. having active main channel flow only every other year. It should however be kept in mind that wetland conditions occur as a result of saturated soils and not active flow or visible surface water. As a result where soils in ephemeral systems become saturated for short periods wetland conditions may occur.

Along ephemeral systems wetland conditions may also not occur along the entire length of the stream. This is also relevant where roads or infrastructure cross these watercourses. Such structures often cause retardation of flow and as a result may cause soil saturation for longer periods and so increase wetland conditions.

The majority of stream systems have a distinctive main channel and especially so where wetland conditions occur. As a result the topography also substantiate the occurrence of wetland conditions in these watercourses.

Obligate wetland species clearly indicate the presence of wetland conditions in these watercourses. These species are listed for each specific watercourse (Section 4.2.6). Obligate wetland species are confined to wetlands and cannot occur in conditions outside of these systems. As a result, where they occur, wetland conditions can be considered to occur.

4.2.4 Classification of wetland systems

Due to the large amount of watercourses and wetlands being situated within the MOSS it is difficult to place them within one type of wetland. Instead, the different wetland systems identified will be listed below.

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. Watercourses within the MOSS containing such wetland condition include the Renoster- and Bloemspruit Rivers (Bloemfontein), Seven Dams Stream (Bloemfontein),

Klein-Modder River (Botshabelo), Sepane River (Thaba Nchu), Modder River (Dewetsdorp), Caledon River (Wepener), Sandspruit (Wepener), Witspruit (Vanstadensrus).

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. Watercourses within the MOSS containing such wetland condition include the Renoster- and Bloemspruit Rivers (Bloemfontein), Seven Dams Stream (Bloemfontein), Klein-Modder River (Botshabelo), Sepane River (Thaba Nchu), Modder River (Dewetsdorp), Caledon River (Wepener), Sandspruit (Wepener).

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. There is also a likelihood that unchanneled valley bottom wetlands may occur which are very similar to channelled valley bottom systems. Unchanneled valley bottom wetlands were noted to be quite common on the mountain plateau to the east and north of the town of Wepener with a few also occurring in the mountainous terrain around Botshabelo and Thaba Nchu.

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 is the largest such system occurring within the MOSS.

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. Though such wetland areas were not prominent it is considered quite likely that they will occur along the mountain slopes to the east and north of Wepener. A few distinctive hillslope seepage wetlands were also identified in the mountainous terrain around Botshabelo and Thaba Nchu.

4.2.5 Condition and importance of the affected watercourses

Due to the high amount of watercourses and wetlands being situated in the MOSS a determination of the Index of Habitat Integrity (IHI) will only be conducted for the larger watercourses being crossed by the pipeline. These will be the Modder River, Caledon River, Bloemspruit, Renosterspruit, Seven-Dams Stream, Klein-Modder River, Sepane River, Sandspruit and Witspruit. This is considered adequate to give an adequate representation of the

overall condition of the watercourses and wetlands situated within the MOSS. The IHI will be taken as representative of the Present Ecological State (PES) of these systems.

Table 17 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 18 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 17: Ecological categories for Present Ecological Status (PES).

Ecological 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 18: Ecological importance and sensitivity categories.

Ecological Importance and Sensitivity Category (EIS)	Range of Median	Recommended Ecological Management Class
Very High Floodplains that are considered ecologically important and sensitive on a national or even international level. The biodiversity of these floodplains is usually very sensitive to flow and habitat modifications. They play a major role in moderating the quantity and quality of water of major rivers.	>3 and <=4	A
High Floodplains that are considered to be ecologically important and sensitive. The biodiversity of these floodplains may be	>2 and <=3	B

sensitive to flow and habitat modifications. They play a role in moderating the quantity and quality of water of major rivers.		
Moderate Floodplains that are considered to be ecologically important and sensitive on a provincial or local scale. The biodiversity of these floodplains is not usually sensitive to flow and habitat modifications. They play a small role in moderating the quantity and quality of water of major rivers.	>1 and <=2	C
Low/marginal Floodplains that are not ecologically important and sensitive at any scale. The biodiversity of these floodplains is ubiquitous and not sensitive to flow and habitat modifications. They play an insignificant role in moderating the quantity and quality of water of major rivers.	>0 and <=1	D

Desktop assessments of the subject watercourses was previously conducted (Kleynhans 2000) (Table 19). This was also utilised to inform the condition of the watercourses within the MOSS although it should be kept in mind that these desktop assessment may be inaccurate in some areas.

Table 19: 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
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

Irrespective of the condition of the watercourses being situated in the MOSS all should be considered as sensitive and providing essential services in terms of water transportation and ecological functioning. A short description of these larger watercourses within the MOSS will be given below.

Bloemfontein Bloemspruit/Rensoterspruit (Appendix A: Map 1-2): 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.

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 the worst instances the basic ecosystem functions have been destroyed and the changes are irreversible. 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. These watercourses are both affected by the same impacts and the Bloemspruit forms a direct tributary of the Renosterspruit within the MOSS.

Both of these watercourses were naturally seasonal streams but due to the serious modification they are now perennial and seriously degraded. An Index of Habitat Integrity (IHI) was conducted for the Renosterspruit and Bloemspruit. The results of this IHI also indicated that in the sections of these watercourses within the MOSS have an Instream IHI of category F: Critically/Extremely modified and a Riparian IHI of category F: Critically/Extremely modified. A summary of these results are included in Appendix C.

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

Bloemfontein 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. The stream originates to the south and has part of its origin in urban developments. 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. 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. 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.

The Seven Dams Stream is considered to have a PES of Category C: Moderately Modified. Loss and change of natural habitat and biota have occurred, but the basic ecosystem functions are still predominately unchanged. The stream has therefore clearly already been modified by urban development as well as numerous dams in its main channel. Despite this it must still be regarded as being highly sensitive as it still provides numerous vital services including water transportation, flood attenuation and bioremediation of pollutants. In addition, the stream is listed as a National Freshwater Ecosystems Priority Area (NFEPA): Upstream System. This significantly increases its conservation value and level of sensitivity.

The stream has its origin within the northern suburbs of Bloemfontein which will consequently cause significant modification in terms of increased storm water runoff. Numerous dams in the stream will also modify the flow and flooding regime of the stream. An Index of Habitat Integrity (IHI) was conducted for the Seven Dams Stream. The results of this IHI also indicated that in the sections of these watercourses within the MOSS have an Instream IHI of category C: Moderaly modified and a Riparian IHI of category C/D: Moderately/Largely modified. A summary of these results are included in Appendix C.

The EI&S of this watercourses has been rated as being High: Floodplains that are considered to be ecologically important and sensitive. The biodiversity of these floodplains may be sensitive to flow and habitat modifications. They play a role in moderating the quantity and quality of water of major rivers.

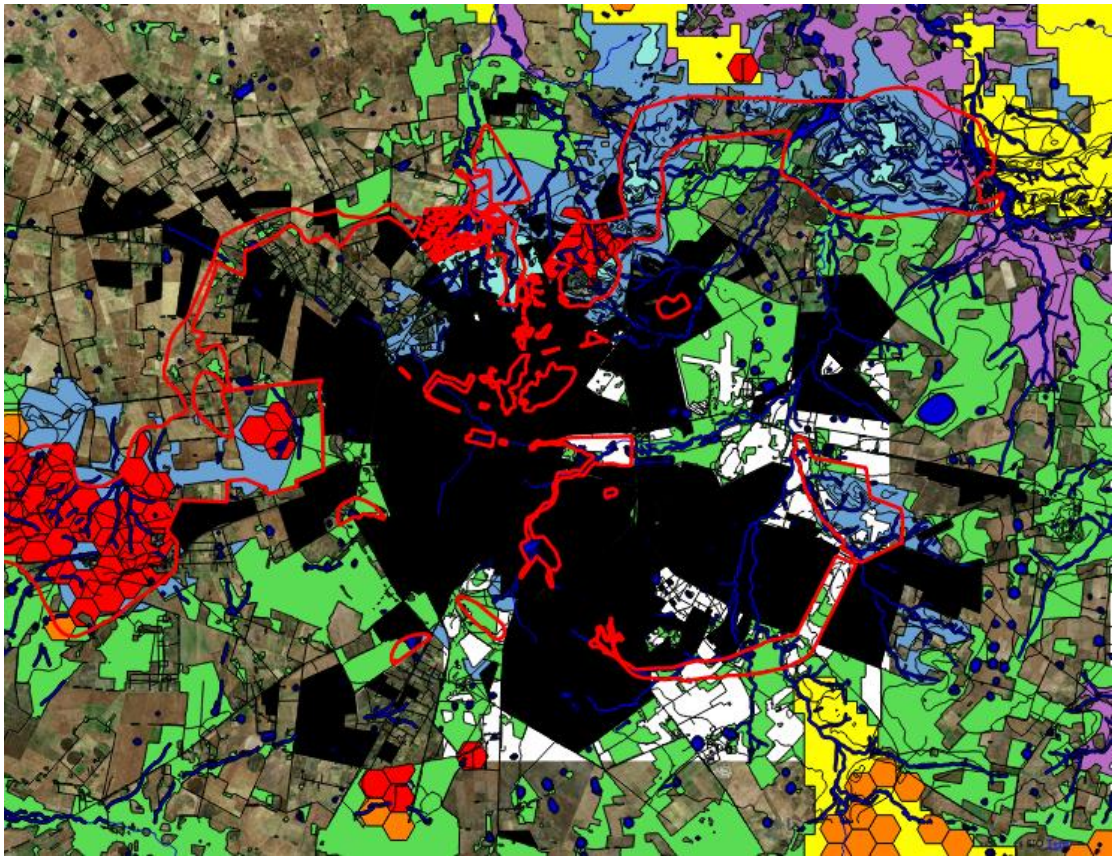
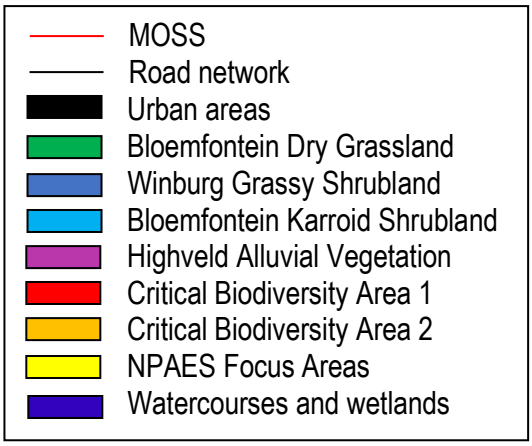


Figure 94: View of the watercourses and wetlands in the Bloemfontein urban area. Note a few larger watercourses in the urban area itself with a multitude of smaller streams and drainage lines in the northern hill terrain.

Legend:



Botshabelo Klein-Modder River (Appendix A: Map 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 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).

According to Kleynans (2000) a desktop assessment of the Klein-Modder River and tributaries within the Botshabelo MOSS is considered to have a PES of Category D: Largely Modified. On site observations indicate that this is somewhat overestimated and may be more accurate for upstream areas where impacts are less or downstream where impacts caused by Botshabelo is more dissipated. This study has however 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.

The Klein-Modder River, associated wetland areas and tributaries which is situated within the MOSS has been severely degraded by amongst others the drastic increase in inflow, high levels of pollutions and obstructions to flow. An Index of Habitat Integrity (IHI) was conducted and indicated that the watercourses have an Instream and Riparian IHI of Category E: Seriously Modified. A summary of these results are included in Appendix C.

The EI&S of the Klein-Modder River and associated tributaries has been rated as being Moderate: Floodplains that are considered to be ecologically important and sensitive on a provincial or local scale. The biodiversity of these floodplains is not usually sensitive to flow and habitat modifications. They play a small role in moderating the quantity and quality of water of major rivers.

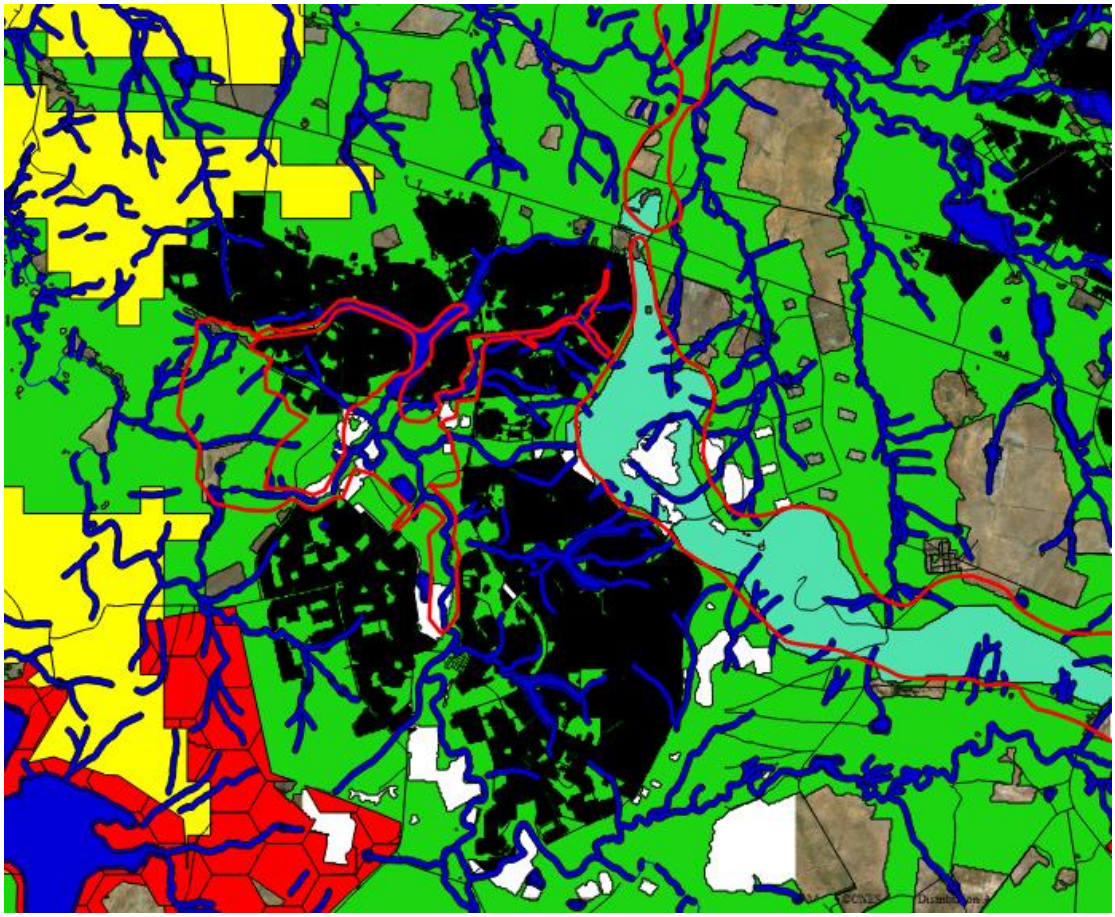
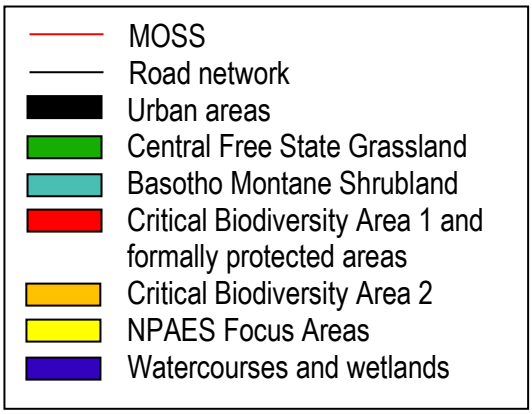


Figure 95: View of the watercourses and wetlands in the Botshabelo urban area. Note quite a high number of watercourses and wetlands, mostly a function of the uneven terrain and higher rainfall. Note also the Rustfontein Dam to the south west.

Legend:



Thaba Nchu Sepane River (Appendix A: Map 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. 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.

According to Kleynans (2000) a desktop assessment of the Sepane River and tributaries situated within the MOSS is considered to have a PES of Category D: Largely Modified. On site observations indicate that this is relatively accurate as this study has also 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.

The Sepane River and associated tributaries situated within the MOSS has been severely degraded by amongst others the drastic increase in inflow, high levels of pollution and obstructions to flow. An Index of Habitat Integrity (IHI) was conducted and indicated that the watercourses have an Instream and Riparian IHI of Category D: Largely Modified. A summary of these results are included in Appendix C.

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

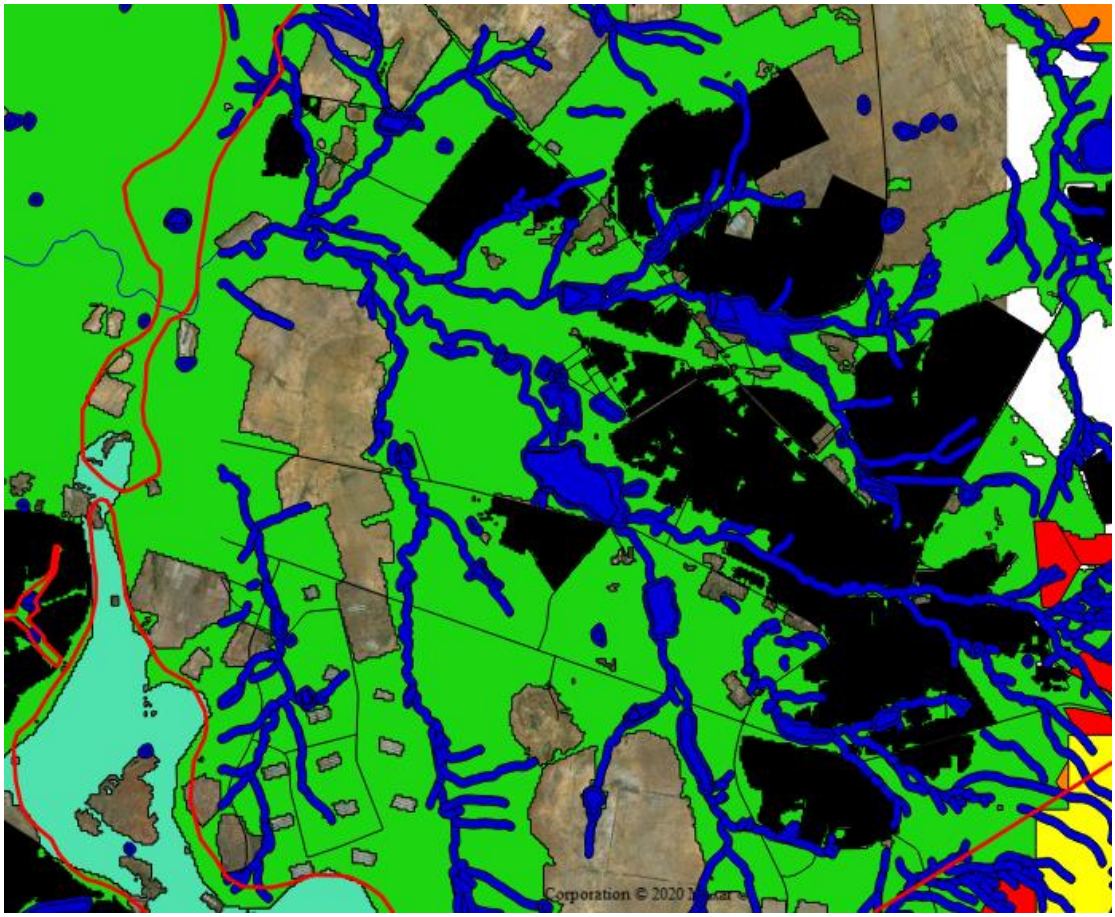
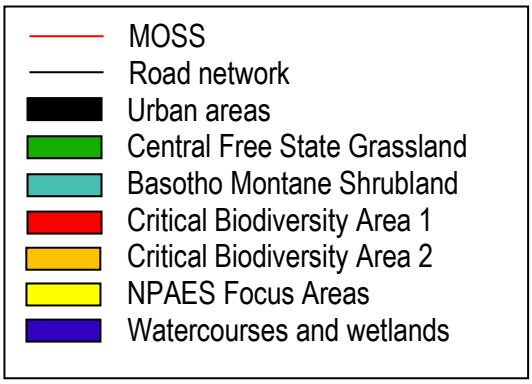


Figure 96: View of the watercourses and wetlands in the Thaba Nchu urban area. Note quite a high number of watercourses and wetlands. Note also the Sepane River flowing directly through the urban area.

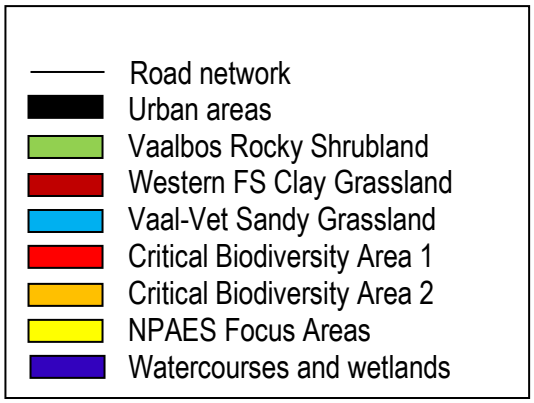
Legend:



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. Where the pan itself is dominated by halophytes adapted to high salt concentrations, where mining has disturbed the soils surface as well as abandoned evaporations ponds, this causes the establishment of grasses and wetland plants not naturally occurring in the pan. 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. Livestock grazing is one of the main landuses in the area. It does however not have a high impact on the streams and will result in low impacts as a result of overgrazing, trampling, consequent erosion and an increase in sediment load within the streams. Several significant earthen impoundments and road crossings occur in these stream systems. This will have a significant impact in terms of the flow and flooding regime. These structures all retard flow and floods and influence the nutrient and organic material transportation. They will therefore have a significant impact on the functioning of the stream systems. The WWTW of Soutpan/Ikgomotseng makes use of several oxidation ponds and the resultant effluent which discharges into one of the stream and then into the pan. This has clearly caused significant impacts in terms of increased flow volumes which alter the flow regime of the stream and higher nutrient loads which also causes significant modification of the vegetation composition. It should be clear that 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.

Figure 97: 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:



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. This modification is caused by the Novo Transfer Scheme. The water demands of the MMM required augmentation of its water supply which was in part undertaken by constructing a pipeline from the Knellpoort Dam to the headwater of the Modder River where it discharges into the river and is allowed to flow downstream and into the Rustfontein Dam. This entails an inter-catchment transfer, i.e. the Novo Transfer Scheme. This release of large volumes of water into a naturally seasonal watercourse alters the flow regime from seasonal to perennial and also has a large impact on the fish and invertebrate population of the river. This has also been confirmed by Slabbert (2007). The modification of the flow regime is also likely to modifiy the geomorphology of the river and increase erosion of the banks and consequent sedimentation. Being situated near the headwaters of the river, other impacts on it is limited. Limited dryland crop cultivation will cause low impacts in terms of fertiliser and herbicide runoff and increased sedimentation. 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.

According to Kleynans (2000) a desktop assessment of the Modder River and tributaries within the Dewetsdorp MOSS is considered to have a PES of Category C: Moderately Modified. On site observations indicate that this is somewhat overestimated and may not have taken into account the large-scale modification to the flow regime of the river. This study has determined that the Modder River and associated tributary has a PES of Category D: Largely Modified(Appendix D). 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.

The Modder River, associated wetland areas and tributaries which is situated within the MOSS has been heavily modified, largely as a result of the Novo Transfer Scheme. An Index of Habitat Integrity (IHI) was conducted and indicated that the watercourses have an Instream and Riparian IHI of Category D: Largely Modified. This also indicates that the most prominent modifications are concerned with the hydrology and bank structure modification of the river and is in agreement with the expected impacts of the Novo Transfer Scheme. A summary of these results are included in Appendix C.

The EI&S of the Modder River and associated tributaries has been rated as being Moderate: Floodplains that are considered to be ecologically important and sensitive on a provincial or local scale. The biodiversity of these floodplains is not usually sensitive to flow and habitat modifications. They play a small role in moderating the quantity and quality of water of major rivers.

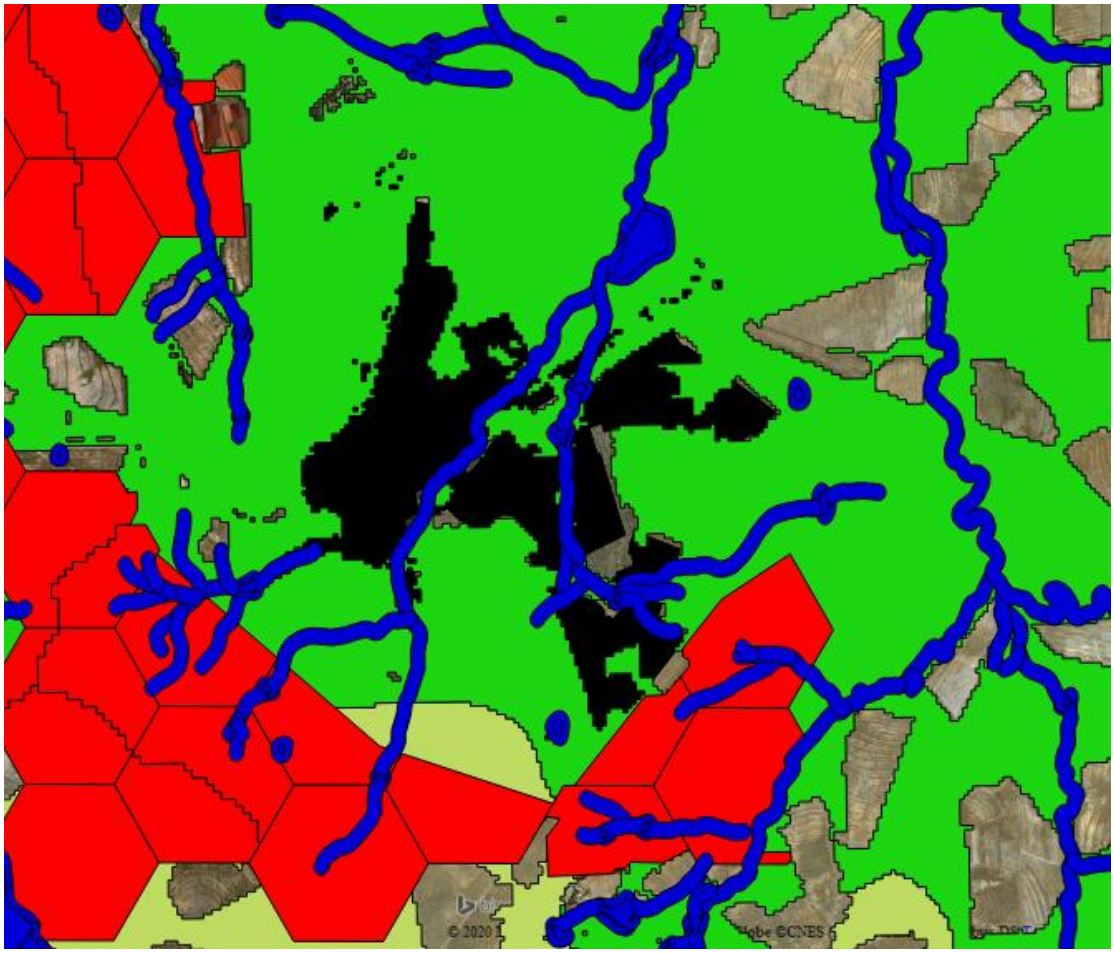
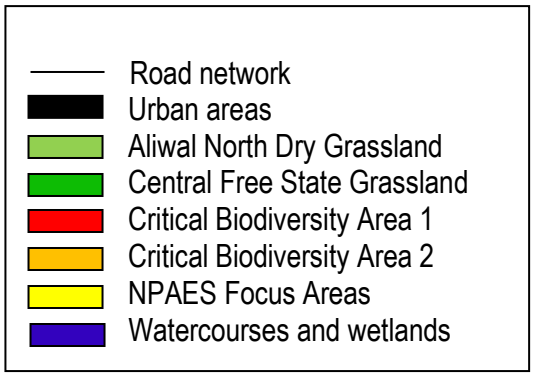


Figure 98: View of the watercourses and wetlands in the Dewetsdorp urban area. Note the Modder River to the east of the town and the large stream system originating around the town and flowing though it.

Legend:



Wepener Caledon River (Appendix A: Map 11-12): 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.

According to Kleynhans (2000) a desktop assessment of the Caledon River in the Wepener MOSS is considered to have a PES of Category C: Moderately Modified. On-site observation indicate that this is relatively accurate indicating that the Instream component is also Moderately Modified. However, the Riparian component, at least in this section, is considered Largely Modified due to the significant transformation of the natural vegetation. The system should still be regarded as sensitive with a high conservation value.

The Caledon River is considered a fourth order system. The quaternary catchment of the area is D23F. There are several large impacts on this system as discussed above. An Index of Habitat Integrity (IHI) was conducted for the Caledon River (Appendix C). The results of the IHI indicated that the study area has an Instream IHI of Category C: Moderately Modified and Riparian IHI of Category D: Largely Modified.

The EI&S of the Caledon River has been rated as being Moderate: Floodplains that are considered to be ecologically important and sensitive on a provincial or local scale. The biodiversity of these floodplains are not usually sensitive to flow and habitat modifications. They play a small role in moderating the quantity and quality of water of major rivers.

Wepener Sandspruit (Appendix A: Map 11-12): The hydrology of the river is impacted on by a few impacts. No significant impoundments occur in the river although a few off-channel catchment dams occur. These have a slight impact on the amount of runoff entering the river. The impact on the hydrology of the river is therefore considered largely natural.

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 cultivation of crops removes the natural vegetation and disturbs the

soil surface. In so doing the runoff velocity is increased as there is no longer a vegetation layer to retard flow. This in turn causes higher amounts of sediment to be mobilised and washed into the river. 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.

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.

A few bridges as well as low water crossings in the town and upstream occurs within the river and these also contribute some impacts to the watercourse. This includes increased sediment load, scour of the river bed and reduction of flow.

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. The Caledon River is naturally of high turbidity and carries a concerning high sediment load. The slopes and erodibility of soils in the area increase sediment deposition. Severe soil erosion in the area is also 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).

The Sandspruit is considered a second order system. The quaternary catchment of the areas is D23G. The watercourse is affected by several impacts as discussed above. Notable impacts are mostly concerned with increased sediment loads due to overgrazing and trampling by domestic stock, dryland crop cultivation and rural and urban development. An Index of Habitat Integrity (IHI) was conducted for the Sandspruit (Appendix C). The results of the IHI indicated that the study area has an Instream IHI of Category C/D and Riparian IHI of Category C.

The EI&S of the Sandspruit has been rated as being Moderate: Floodplains that are considered to be ecologically important and sensitive on a provincial or local scale. The biodiversity of these floodplains are not usually sensitive to flow and habitat modifications. They play a small role in moderating the quantity and quality of water of major rivers.

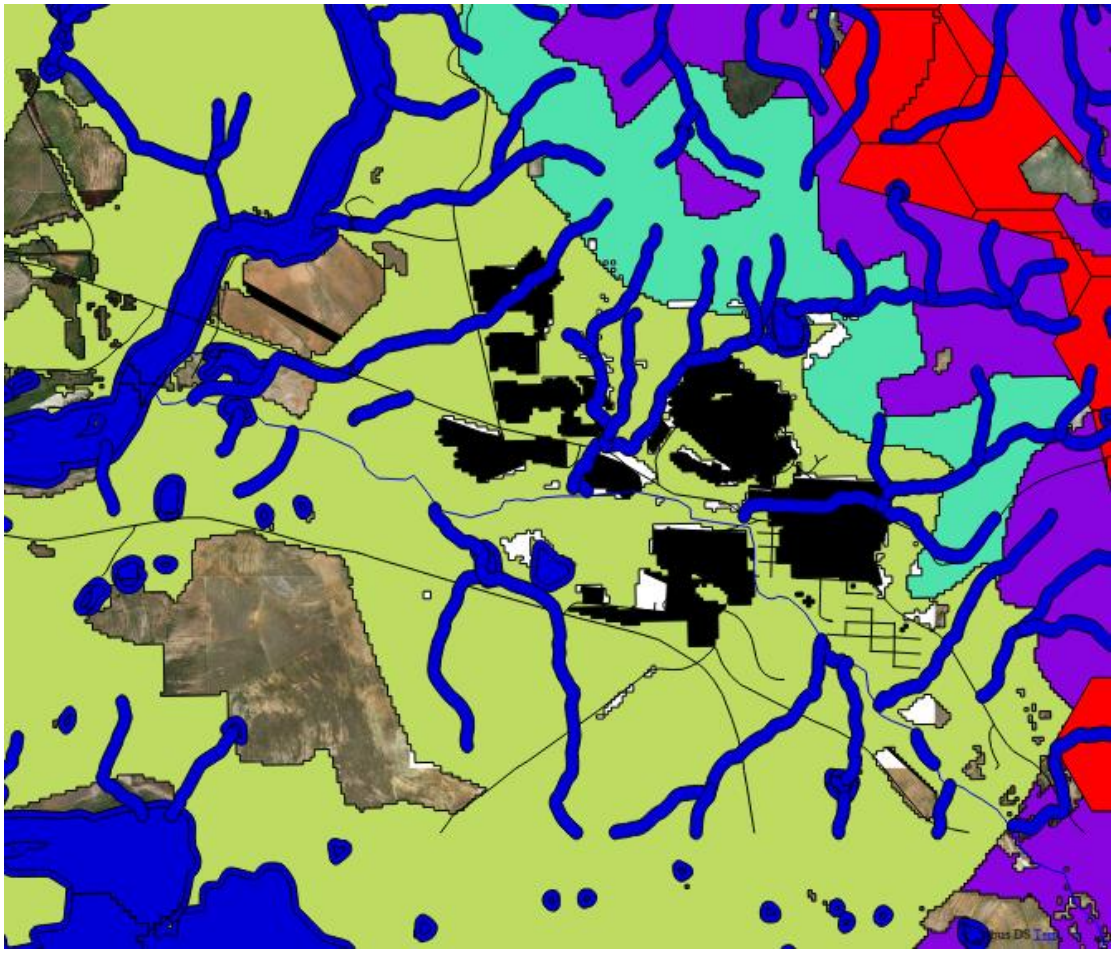
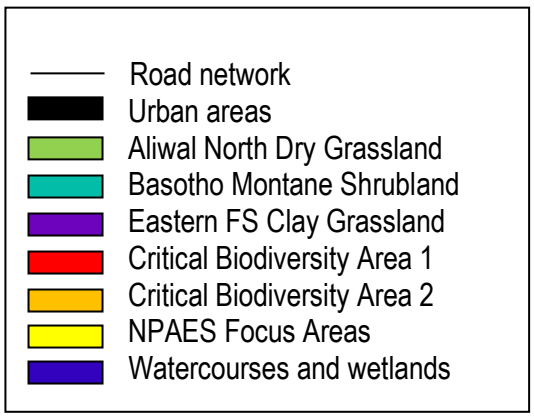


Figure 99: View of the watercourses and wetlands in the Wepener urban area. Note a relatively high number of watercourses, especially those originating in the mountainous terrain to the east and north. Note also the substantial wetland conditions associated with the Caledon- and Sand Rivers to the west of the urban area. The Sandspruit flows through the town and confluences with the Caledon River to the west.

Legend:



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. These dams act as flood regulators, whereby moderate and large flooding events are contained and prevented from flooding the downstream reaches. The impact this has on the riparian community, the aquatic fauna, sediment load and connectivity of the stream is high. In addition, the dams contain a large volume of water on a perennial basis and this will result in a slow release of water year-round. 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.

A significant portion of the catchment has been utilised for dryland crop cultivation. This will contribute significant amounts of sediment to the system. The cultivation of crops removes the natural vegetation and disturbs the soil surface. In so doing the runoff velocity is increased as there is no longer a vegetation layer to retard flow. This in turn causes higher amounts of sediment to be mobilised and washed into the stream. 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.

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.

The Witspruit and its origin is located near the Lesotho border and consequently a significant portion of the catchment of the stream is situated in rural village and urban areas especially the upper reaches of the stream. The urban area of Sephapos Gate is situated in the upper catchment of the stream and will undoubtedly also contribute significant impacts on the stream in the form of increased storm water runoff, increased sediment and refuse and pollutants associated with urban areas. The town of Vanstadensrus itself is also likely contributing toward these urban impacts as well though due to the small size of the urban area these are anticipated to still be quite low.

A few bridges as well as low water crossings in the town and upstream occurs within the stream and these also contribute some impacts to the watercourse. This includes increased sediment load, scour of the stream bed and reduction of flow.

According to Kleynhans (2000) a desktop assessment of the Witpsruit and tributary in the Vanstadesntus MOSS is considered to have a PES of Category D: Largely Modified. On-site observation indicate that this is relatively accurate indicating that the Instream component is also Moderately to Largely Modified and the Riparian component Largely Modified. Despite this, the system should still be regarded as sensitive with a high conservation value.

The Witspruit is considered a second order system while the tributary flowing through the town is a first order system. The quaternary catchment of the area is D24C. The watercourse is affected by several impacts as discussed above. Notable impacts are mostly concerned with increased sediment loads due to overgrazing and trampling by domestic stock, dryland crop cultivation and rural and urban development. An Index of Habitat Integrity (IHI) was conducted for the Witspruit (Appendix C). The results of the IHI indicated that the study area has an Instream

IHI of Category C/D and Riparian IHI of Category D. This is mostly attributed to the modification in the flow and flooding regime, which in turn modified the bank and bed structure.

The EI&S of the Witspruit has been rated as being Moderate: Floodplains that are considered to be ecologically important and sensitive on a provincial or local scale. The biodiversity of these floodplains are not usually sensitive to flow and habitat modifications. They play a small role in moderating the quantity and quality of water of major rivers.

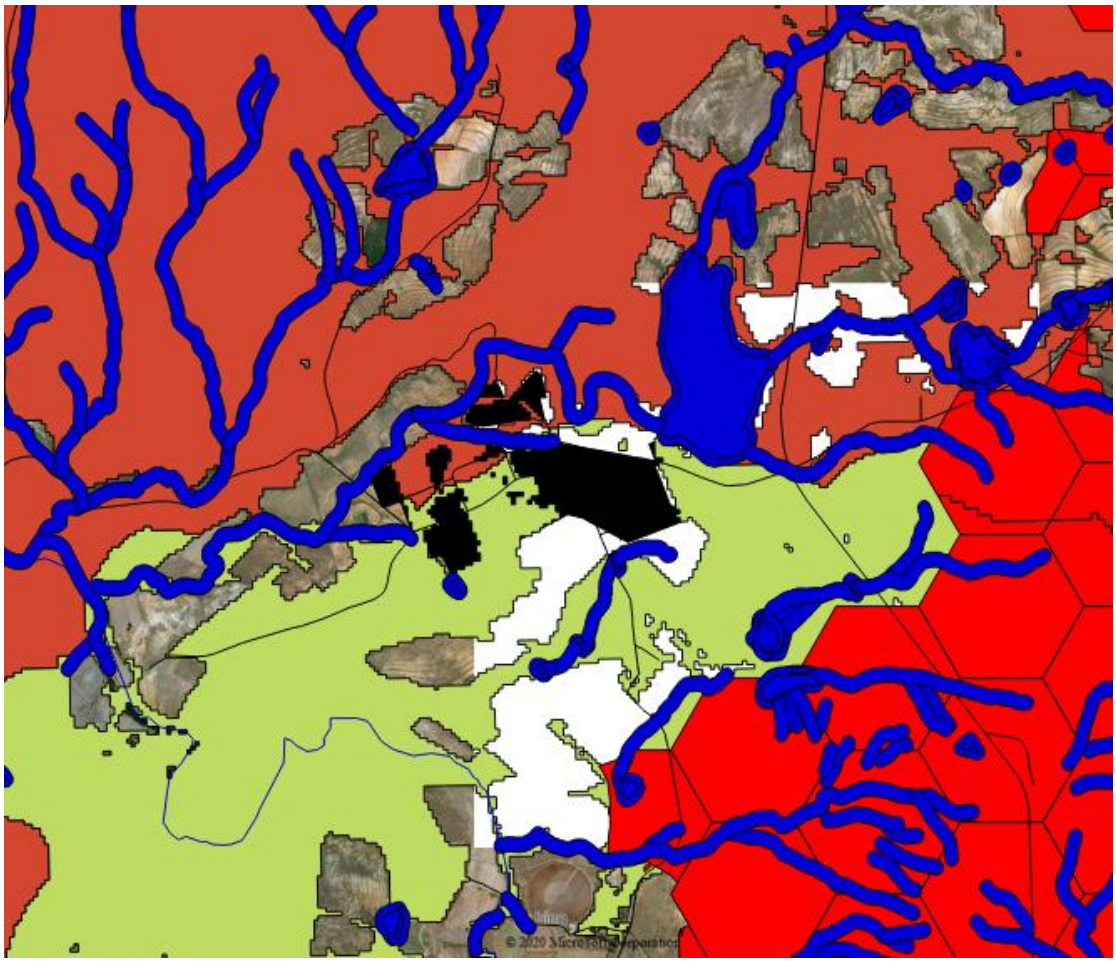
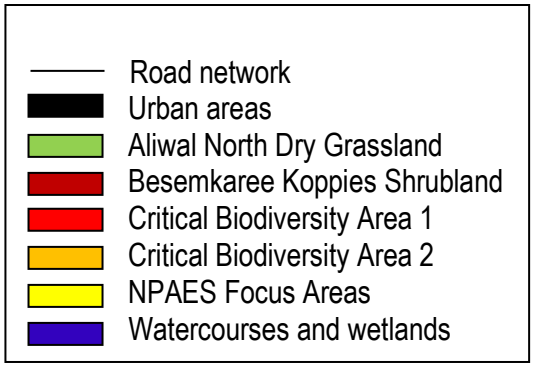


Figure 100: View of the watercourses and wetlands in the Vanstadensrus urban area. Note a relatively high number of watercourses, especially those originating in the surrounding uneven terrain.

Legend:



4.2.6 Overview of individual watercourses and wetlands

The following description will provide a short description of each watercourse surveyed within the MOSS (Table 20) (Map 1 - 14). Where FW or OW is indicated it refers to Facultative or Obligate Wetland species. A facultative wetland species is often associated with wetlands but is also able to occur in non-wetland areas. Obligate wetland species are confined to wetlands and are only able to occur in wetlands. They are therefore reliable indicators of wetland conditions. Field observations over time as well as the following sources were used to determine FW and OW species:

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

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

A comprehensive species list is provided in Appendix B.

Table 20: Description of individual watercourses and wetlands surveyed within the MOSS (FW – Facultative wetland species, OW – Obligate wetland species, * - Exotic species).

Urban area: Bloemfontein		
Watercourse name: #1 Fonteinspruit	**Coordinates of survey:** S 29.165873°, E 26.220471° S 29.168996°, E 26.233353° S 29.143563°, E 26.228248° S 29.131661°, E 26.236600°	**Flow regime:** Perennial stream system
Description of watercourse: The upper reach of the Fonteinspruit is situated adjacent to the M10 road, Robert Burns Street and Mijba Streets. It is situated in a small tributary of the Fonteinspruit upstream of the Bloudam and flowing from south to north. It originates to the south in the urban are of Mangaung and is situated in the Hamilton industrial area. The watercourse originates to the south but has been severely degraded here. The origin has been canalised and storm water conduits from the industrial area feeds into it. This increases inflow drastically and alters the flow and flooding regime to a large extent. Water quality also indicates high levels of pollution at this point. A well-defined channel is present but has been enlarged by the increase in flow and erosion is consequently also problematic. This is not large stream and flow only occurs in the summer months and when rainfall events occur. The soil samples do however indicate that soils in the main channel remain saturated throughout the year and is considered part of the permanent zone of wetness. A well-defined main channel is present although it is evident that it has been modified and portions are artificial, i.e. manmade embankments, channel straitening. Due to the increased flow obligate wetland vegetation is common along the main channel and decreases in distance from it. Soils also confirm wetland conditions although the border is difficult to determine due to the modified nature of the stream. Exotic vegetation is common and the adjacent areas consists of planted grass. Vegetation diversity is low and uniform and consists of a few dominant species.		

Lower down within the urban areas of Bothabela and Batho the stream flows from south west to north east and is situated downstream of the Bloudam. This also alters the flow and flood regime to a large extent. Channel straitening is evident and transformation of the floodplain for the installation of services has degraded the watercourse. This also complicates the delineation of the watercourse since riparian vegetation has been removed and the soil profile disturbed. Rubbish dumping and dumping of construction waste in the stream is prominent. Increase storm water inflow also alters the flow and flooding regime to a large extent. A well-defined main channel is present but has however been modified due to channel straitening. Obligate wetland vegetation is common along the main channel and stops abruptly where the artificial embankment is located due to the channel straitening and construction adjacent to the stream. Soil confirms the presence of wetland conditions in the main channel but due to the construction along the stream the border thereof is not identifiable. Exotic vegetation is abundant and riparian vegetation has been cleared from large areas in the upper zone.

Dominant plant species:
Paspalum distchum (OW), *Cyerus eragrostis* (OW), *Cyperus longus* (OW), *Ranunculus multifidus* (OW), **Pennisetum clandestinum, *Xanthium spinosum, *Plantago lanceolata, Themeda triandra, Panicum coloratum* (FW), **Sesbania punicea, *Sphaeralcea bonariensis, Enneapogon cenchroides, Hyparrheia hirta, Aristida congesta, *Bidens bipinata, Cymbopogon pospischillii, *Tagetes minuta, Vachellia karroo, Arctotis arctotoides, Typha capensis* (OW), *Paspalum distichum* (OW), *Searsia pendulina* (Planted), **Xanthium strumarium, *Verbena bonariensis, *Tagetes minuta, Cynodon dactylon, Melolobium candicans, *Datura ferox, *Argemone ochroleuca, *Conyza bonariensis, Berula eracta, *Trifolium repens, Persicaria sp., *Polygonum aviculare, *Salix matsudana, *Rumex crispus, Cyperus eragrostis* (OW), **Alternanthera pungens.*

Protected plant species:
None observed

Wetland type:
Channel and floodplain wetland.

Soil sample:

Rubbish dumping (blue) and erosion (red) is prominent.

Extensive foaming indicating pollutants, Blueish water coloration also indicative of pollutants.

Portions of the main channel has clearly been modified and channel straitening is evident.

View of the Fonteinspruit. Note extensive rubbish dumping and transformation of the streambanks on both sides.

Fonteinspruit at Dr Belcher Road. Disturbance of the stream is prominent.

Rubbish dumping and high levels of pollution are present in the stream.

Urban area: Bloemfontein

Watercourse name:	**Coordinates of survey:**	**Flow regime:**
#2 Bloudam (Fonteinspruit)	S 29.153397°, E 26.227019°	Artificial Dam

Description of watercourse:

The Bloudam is a large artificial dam in the Fonteinspruit. It is surrounded by urban areas including the industrial are of Hamilton and residential areas of Phahameng and Bochabela. It is situated within the Fonteinspruit and is also affected by the impacts affecting the stream. The dam wall is situated to the north and drains in this direction into the Fonteinspruit. The dam itself is an artificial waterbody and therefore a degraded system itself. It also has a large impact

on the Fonteinspruit in that it alters the flow and flood regime further. It is also fed by a large volume of storm water from the adjacent urban areas. An artificial wetland has developed along the dam wall and is indicated by several obligate wetland species. The dam drains by means of an overflow in the eastern end of the dam wall where artificial wetland conditions have also developed. From here it drains into the Fonteinspruit. Soils also confirm wetland conditions although being artificial the wetland border is largely confined to the dam wall and overflow. Exotic vegetation is common and the adjacent areas consists of planted grass. Vegetation diversity is low and uniform and consists of a few dominant species.

Dominant plant species:
Lycium horridum, Chloris virgata, Phragmites australis (OW), *Vachellia karroo, *Sphaeralcea bonariensis, *Verbena bonariensis, Cyperus eragrostis* (OW), *Typha capensis* (OW), *Gomphocarpus fruticosus, Cynodon dactylon, *Tegetes minuta, Searsia lancea, *Plantago lanceolata, Lobelia thermalis, Berkheya sp., Setaria sphacelata* (FW), **Rumex crispus, Leptochloa fusca* (OW)

Protected plant species:
None observed

Wetland type:
Channel and floodplain wetland.

Soil sample:

The Bloudam (yellow), dam wall (blue) and overflow channel (red) is indicated.

Wetland conditions has clearly developed along the dam wall.

View of the dam, resultant wetland conditions and the overflow channel (red).

Urban area: Bloemfontein

Watercourse name:	**Coordinates of survey:**	**Flow regime:**
#3 Tributary of Renosterspruit	S 29.186039°, E 26.245389°	Seasonal stream

Description of watercourse:

The stream is situated within the urban areas of Rocklands, Turflaagte and Freedom Square. The stream is situated in the upper reaches of a tributary of the Renosterspruit flowing from north west to south east. The stream originates immediately to the north but has been severely degraded. The origin has been canalised and has been diverted underground for a short distance and large portions has been canalised, channel straitened and consisting of storm water ditches. Storm water from the surrounding urban area also feeds into it. This increases inflow drastically and alters the flow and flooding regime to a large extent. A well-defined channel is present but the stream morphology is notably degraded and transformed mostly as a result of the urban surroundings and dumping of construction waste. The main channel has also been enlarged by the increase in flow and erosion is consequently also problematic. Due to the increased flow obligate wetland vegetation is common along the main channel and decreases in distance from it. Soils also confirm wetland conditions and indicate the border of wetlands conditions as the lower zone. Exotic vegetation dominates in many areas.

Dominant plant species:

Juncus rigidus (OW), *Leptochloa fusca* (OW), **Cirsium vulgare, Cynodon dactylon, *Xanthium spinosum, *Tegetes minuta, Gomphocarpus fruticosus, Themeda triandra, *Sphaeralcea bonariensis, *Alternanthera pungens, *Argemone ochroleuca, *Datura ferox, Chloris virgata,*

Paspalum distichum (OW), *Persicaria sp., Typha capensis* (OW), **Pennisetum clandestinum, *Verbena tenuisecta, *Plantago lanceolata, *Prosopis glandulosa*

Protected plant species:
None observed

Wetland type:
Channel and floodplain wetland.

Soil sample:

Note close proximity of urban area. The upper and lower zones are also notably degraded.

Note visible discoloration and opacity of water indicting pollutants.

A clear main channel is present and wetland conditions evident. Note also rubbish dumping instream.

Urban area: Bloemfontein

Watercourse name:	**Coordinates of survey:**	**Flow regime:**
#4 Bloemspruit and Renosterspruit Rivers	S 29.121366°, E 26.266586° S 29.097327°, E 26.331622° S 28.971299°, E 26.378213°	Perennial Rivers

Description of watercourse:

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.

A well defined main channel is present along both rivers with a quite extensive floodplain also being evident. Obligate wetland plants are abundant along the main channel and areas of

seasonal inundation within the floodplain also contain abundant obligate wetland plants. This clearly confirms the presence of wetland conditions and confirms both rivers being a channel as well as a floodplain wetland systems. Soils indicate a prominent grey matrix and mottling indicative of wetland conditions. Exotic weeds and invaders dominate in many areas along the Bloemspruit and Rensoterspruit.

Despite the dominance of exotic plants along these watercourses, protected and rare species are still present, especially within the alluvial floodplain. Numerous geophytic species are associated with the floodplain of the Bloemspruit and Renosterspruit and include *Ammocharis coranica, Eucomis autumnalis, Crinum bulbispermum, Hypoxis argentea, Chlorophytum sp., Ledebouria sp., Haemanthus montanus, Bulbine fruticosa, B. narcissifolia, Drimia elata, Brunsvigia radulosa, Colchicum longipes* and *Colchicum sp.*

Dominant plant species:
Ammocharis coranica, Eucomis autumnalis, Crinum bulbispermum, Hypoxis argentea, Chlorophytum sp., Ledebouria sp., Haemanthus montanus, Bulbine fruticosa, B. narcissifolia, Drimia elata, Brunsvigia radulosa, Colchicum longipes, Colchicum sp., Phragmites australis (OW), **Pennisetum clandestinum, *Nicotiana glauca, Senecio consanguineus, Vachellia karroo, Searsia lancea, *Melia azedarach, *Salix babylonica, *Fraxinus americana, Asparagus larcinus, *Argemone ochroleuca, *Arundo donax, *Sphaeralcea bonariensis, *Bidens pilosa, *Agave sisalana, *A. americana, *Solanum eleagnifolium, *Plantago lanceolata, *Tagetes minuta, *Cirsium vulgare, *Datura ferox, *Verbena bonariensis, Felicia muricata, Commelina africana, Psilocaulon granulicaule, Ruschia unidens, Chasmatophyllum mustellinum, Scabiosa columbaria, Gazania krebsiana, Salsola rabieana, Lycium horridum, Nolletia ciliaris,*
*Eragrostis lehmanniana, Cynodon dactylon, Sporobolus fimbriatus, Digitiaria eriantha, Setaria verticillata, Themeda triandra, Chloris virgata, Moraea pallida, *Bidens bipinnata, *Rumex cripsus, *Schkuhria pinnata, *Xanthium strumarium, *Chenopodium carinatum, *Medicago lacinata, *Phyla nodiflora, *Conyza bonariensis, *Amaranthus hybridus, *Pericaria lapathifolia, Typha capensis* (OW), *Eleusine coranica, Brachiaria eruciformis, Diospyros lycioides*, **Robinia pseudoacacia, *Salix babylonica, *Populus x canescens*, *Cyperus longus* (OW), *Leptochloa fusca* (OW).

Protected plant species:
Crinum bulbispermum, Ammocharis coranica, Haemanthus montanus, Brunsvigia radulosa, Eucomis autumnalis.

Wetland type:
Channel and floodplain wetland.

Soil sample:

View of the Bloemspruit, the vegetation along the bank of the river consists almost exclusively of exotic weeds.

Another view of the Bloemspruit. Note again dominance of exotic weeds on the bank. Note also erosion along the bank of the river.

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.

Large portions of the floodplain of the Bloemspruit has been degraded due to dumping of construction rubble and littering.

View of the Renosterspruit. Note that riparian vegetation consists almost exclusively of exotic vegetation.

Another view of the Renosterspruit.

Urban area: Bloemfontein

Watercourse name:	**Coordinates of survey:**	**Flow regime:**
#5 Seven Dams Stream	S 29.051704°, E 26.206860° S 29.040073°, E 26.202994°	Seasonal Stream

Description of watercourse:

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. The stream originates to the south and has part of its origin in urban developments. 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. 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. 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.

A well-defined main channel is present along almost the entire section of the stream although the numerous impoundments in it do obscure the channel in some areas. An extensive floodplain is present and becomes especially prominent in the downstream sections. Here flooding occurs frequently. Obligate wetland plants are abundant along the main channel and areas of seasonal inundation within the floodplain also contain abundant obligate wetland plants. This clearly confirms the presence of wetland conditions and confirms the stream being a channel as well as a floodplain wetland system. Soils indicate a prominent grey matrix and mottling indicative of wetland conditions. Exotic weeds and invasive trees may become abundant in some areas though overall they do not dominate.

Dominant plant species:
Carex glomerabilis (OW), *Cyperus marginatus* (OW), *Lemna gibba, Berula erecta, Ranunculus multifidus, Typha capensis* (OW), *Phragmites australis* (OW), *Pentameris basutorum, Paspalum distichum* (OW), *Arctotis arctotheca, Moraea simulans, Jamesbrittenia aurantiaca, Sebaea pentandra, Pseudognaphalium luteo-album, Sporobolus fimbriatus, Tulbaghia sp., *Dichondra repens, *Phyla nodiflora, *Azolla filiculoides, *Persicaria lapathifolia, *Hordeum stenostachys, *Veronica anagalis-aquatica, Searsia lancea, Diospyros lycioides, Vachellia karroo, Celtis africana, Searsia pyroides, *Schinus molle, *Punica granatum, *Alianthus altissima, *Rosa rubiginosa, *Tamarix ramosissima, *Urtica urens, *Papaver aculeatum, *Sphaeralcea bonariensis, *Cestrum laevigatum, Cirsium vulgare.*

Protected plant species:
None observed.

Wetland type:
Channel and floodplain wetland.

Soil sample:

View of the stream in the upper reaches. A narrow channel but with extensive floodplain is present here.

View of one of the stream tributaries prior to its confluence. Note riparian thicket along the banks and floodplain and clear main channel with definite wetland conditions.

View of the stream in a downstream section, note that it increases significantly in width due to flow modification.

Another view of the stream, note again prominent wetland conditions.

View of the stream at its northernmost section within the MOSS. Note that wetland conditions are still present.

Urban area: Bloemfontein

Watercourse name:	**Coordinates of survey:**	**Flow regime:**
#6 Rooidam	S 29.189899°, E 26.175362°	Artificial Dam

Description of watercourse:

The Rooidam is a large artificial dam which is fed by enriched storm water runoff from the urban areas areas to the north of it. The suburbs of Lourierpark and Fauna occur to the north while the Ferreira Small Holdings border it to the south. The dam is not situated within any watercourse and neither does it drain into any watercourse. It contains an overflow which drains into an underground tunnel which drains toward the south. This can therefore be in its entirety be regarded as an artificial system. However, it is clear that extensive wetland conditions has established in and around it and therefore provides artificial wetland conditions which still has some function as wetland habitat. Being fed by storm water from urban areas the water quality is visibly enriched. Furthermore, a severe infestation of exotic Water Hyacinth (*Eichornia crassipes*) covers almost the entire dam surface.

Dominant plant species:

**Eichornia crassipes, Diplachne dusca* (OW), **Salix babylonica, Vachellia karroo, Phragites australis* (OW).

Protected plant species:
None observed

Wetland type:
Artificial wetland.

View of the dam surface illustrating infestation by exotic *Eichornia crassipes.*

Another view of the *Eichornia crassipes* infestation on the dam completely covering it.

View of the overflow channel of the dam.

Urban area: Bloemfontein

Watercourse name:	**Coordinates of survey:**	**Flow regime:**
#7 Mooiwater Conservancy	S 29.189899°, E 26.175362°	Artificial Dam

Description of watercourse:
The Mooiwater Conservancy is situated to the west of Bloemfontein within the Mooiwater Small Holdings. Similar to the Rooidam storm water dam the Mooiwater wetland area is also a containment dam for storm water being canalised from the Langenhoven park and surrounding urban areas. It is therefore fed by enriched storm water. The impoundment is almost certainly of artificial origin and most probably the remnants of a historical borrow pit. However, it is clear

that extensive wetland conditions has established in and around it and therefore provides artificial wetland conditions which still has some function as wetland habitat. Being fed by storm water from urban areas the water quality is visibly enriched. Furthermore, it is dominated by exotic weeds which also further substantiates the artificial nature of the impoundment.

Dominant plant species:
*Vachellia karroo, *Eucalyptus camaldulensis, Searsia lancea, *Argemone ochroleuca, Gleditsia triacanthos, Cyperus congestus* (OW), **Cirsium vulgare, *Datura strumarium, *Bromus catharticus, *Sphaeralcea bonariensis, *Conyza bonariensis, *Verbena bonariensis, Cynodon dactylon*

Protected plant species:
None observed

Wetland type:
Artificial wetland.

View of the Mooiwater storm water impoundment.

View of the storm water inflow cannal.

Urban area: Botshabelo

Watercourse name:	**Coordinates of survey:**	**Flow regime:**
#1 Klein-Modder River	S 29.254800°, E 26.700392° S 29.242314°, E 26.696123° S 29.243168°, E 26.671173°	Perennial River

Several other bridge structures containing infrastructure, i.e. pipelines, cross the river in the urban area. The river is surrounded by residential areas on both sides although grazing areas buffer the river from these areas (approximately 200 and 500 meters). This also decreases the impact on the river although runoff from the residential areas evidently causes eutrophication

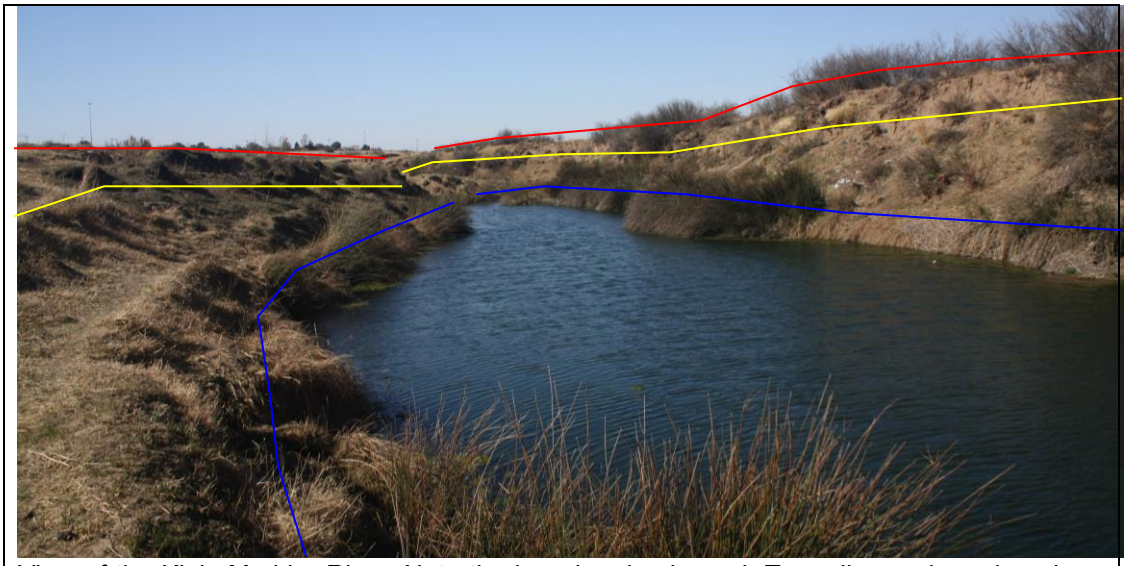
of the river as indicated by dense algal mats. The effluent from the residential areas will also significantly alter the flow and flooding regime of the river. Oxidation ponds associated with the Botshabelo WWTW is located along this section of the river and is also likely to impact on the river to some extent. Trampling and overgrazing evidently causes increased sedimentation and erosion of the river banks in this area. Some mechanical modification of the banks is present in the form of excavations and construction rubble. Rubbish dumping is common but not extensive. From observations it is clear that this portion of the river is degraded and modified although still natural to some extent. A well-defined channel is present but is evident that it is being enlarged by a combination of erosion and increased flow. Obligate wetland vegetation is common along the main channel and decreases in distance from it. Soils also confirm wetland conditions and indicate the border of wetland conditions as the bottom portion of the lower zone. Exotic vegetation is common and may dominate portions of the site.

Dominant plant species:
**Tagetes minuta, *Pennisetum clandestinum, *Salix fragilis, Pseudoschoneus inanus* (OW), **Oenothera rosea, *Argemone ochroleuca, Pseudognaphalium luteo-album, *Xanthium strumarium, Atriplex semibaccata, Phragmites australis* (OW), **Bidens bipinnata, *Sesbania punicea, Cynodon dactylon, Arctotis arctotoides, Gomphocarpus fruticosus, Hyparrhenia hirta, Asparagus larcinus, Eragrostis curvula, E. lehmanniana, Lycium horridum, Aristida congesta, Diospyros lycioides, Vachellia karroo, Sporobolus africanus, Nenax microphylla, Berula erecta, Cyperus marginatus* (OW), *Leptochloa fusca* (OW), *Artemisia afra.*

Protected plant species:
None observed

Wetland type:
Channel and floodplain wetland.

Soil sample:

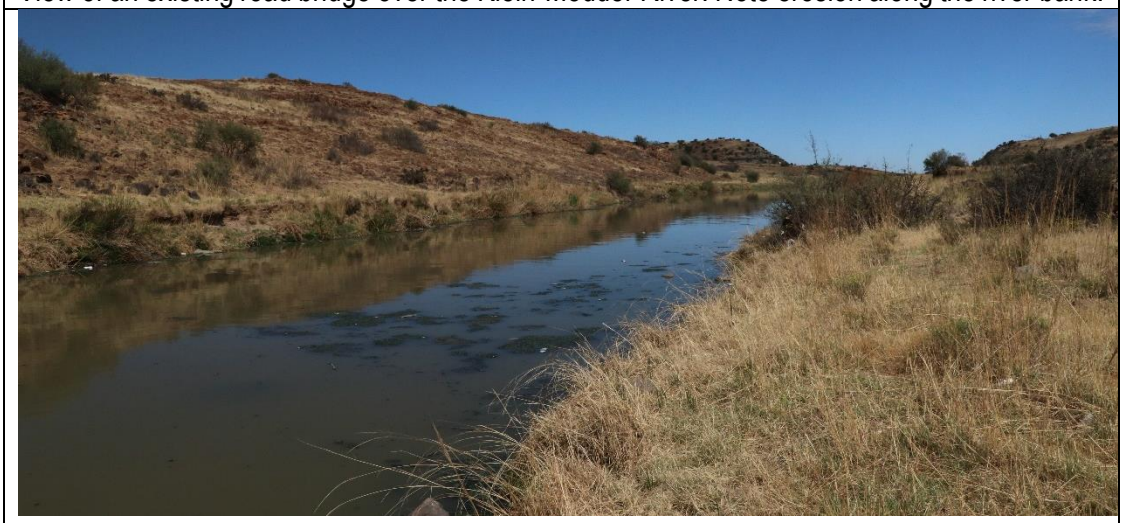


View of the Klein-Modder River. Note the broad main channel. Trampling and erosion along the banks are evident. The marginal (blue), lower (yellow) and upper (red) zones are indicated.

View of the main channel of the Klein-Modder River. Note high amount of algal growth in the river indicative of high nutrient levels.

View of the existing structures over the river. Refuse in the river is also present (red) though not extensive.

View of an existing road bridge over the Klein-Modder River. Note erosion along the river bank.



View of the river immediately downstream of the urban area.

Rubbish dumping taking place along the riverbanks.

Urban area: Botshabelo

Watercourse name:	**Coordinates of survey:**	**Flow regime:**
#2 Floodplain wetland	S 29.257076°, E 26.696511°	Seasonal wetland

The wetland area is bordered to the west by a residential area but is currently mostly utilised for grazing. It has an approximate diameter of 200 meters. The wetland are does not contain a defined in- or outflow but groundwater movement is considered most likely in the direction of the Klein-Modder River. A drainage canal has been excavated through it and this causes modification of the wetland area in terms of dewatering. Trampling and overgrazing is high and will contribute to erosion and compaction of the wetland soils. From observations it is clear that this area has been modified significantly from the natural condition. The wetland area is not well defined and difficult to discern. It is also only seasonal but will contain some waterlogged soils during the rainy season. As a result obligate wetland species are largely absent but still present in the central portion. Soils also indicate a temporary zone of wetness for the majority of the wetland area and a seasonal zone of wetness only in the central portion. Exotic vegetation is present but do not dominate.

Dominant plant species:
Leptochloa fusca (OW), *Moraea pallida, Cynodon dactylon, Berkheya onopordifolia, Themeda triandra, *Cirsium vulgare*

Protected plant species:
None observed

Wetland type:
Channel and floodplain wetland.

Soil sample:

View of the central portion of the wetland area. Lower lying portions (red) contain wetland conditions on a seasonal basis. Note also grazing by domestic stock and the short grass layer.

View of the wetland area (red). The Klein-Modder River is indicated in the background (blue).

View of the wetland area with a portion of the drainage canal visible in the foreground. Wetland conditions are also present here. Note also the adjacent residential area.

Urban area: Botshabelo

Watercourse name:	**Coordinates of survey:**	**Flow regime:**
#3 Tributary of the Klein-Modder River	S 29.234561°, E 26.704630°	Seasonal stream.

The stream is crossed by several roads where the culverts over the stream are also being blocked largely by refuse and sediment and further alters the flow and flooding regime of the stream. The residential area has a highly detrimental impact on the stream. Crossing of the road has also altered the morphology of the stream. The quality of effluent from the urban area as well as the significant increase in storm water has altered the flow and flooding regime of the stream. Trampling and overgrazing evidently causes increased sedimentation and erosion of the stream banks in this area. Rubbish dumping is extensive and causes a high impact on the stream. Furthermore, the dumping of used diapers is worrying and will significantly decrease water quality including an increase in faecal coliform and *E. coli* contamination. Modification of the morphology of the stream is evident and it is considered largely transformed. A well-defined main channel is still present. Obligate wetland vegetation is absent and vegetation dominated by the exotic grass, *Pennisetum clandestinum.* Soils do however reliably indicate the presence of wetland conditions along the main channel. Wetland conditions are restricted to the main channel. Exotic vegetation is common and dominate along the main channel.

Dominant plant species:
**Trifolium repens, Juncus rigidus* (OW), *Leptochloa fusca* (OW), **Pennisetum clandestinum, Cynodon dactylon, *Plantago lanceolata, Arctotis arctotoides, Hyparrhenia hirta, Moraea pallida, *Alternanthera pungens, Nenax microphylla.*

Protected plant species:
None observed

Wetland type:
Channel and floodplain wetland.

Soil sample:

View of the stream. Note the exceptionally high amount of rubbish in the stream of which a high proportion consists of used diapers.

Another view of the stream. Note again the high amount of rubbish.

Urban area: Botshabelo

Watercourse name:	**Coordinates of survey:**	**Flow regime:**
#4 Tributary of the Klein-Modder River	S 29.228645°, E 26.698179°	Seasonal stream.

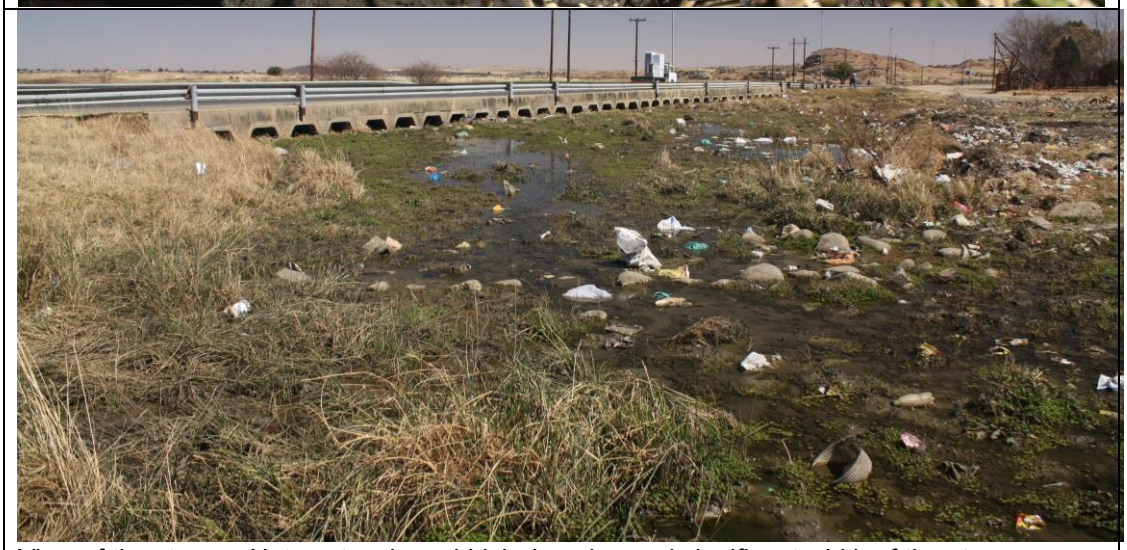
This is a significant tributary of the Klein-Modder River. The same urban area as #3 also affects this watercourse and consequently it is severely degraded. It confluences with the Klein-Modder River approximately 800 meters downstream of the point of survey. The stream is also crossed by a road here and the culvert crossings will undoubtedly also impact on the flow and flood regime of the stream. The same impacts affecting #3 also affect this watercourse and include poor water quality, rubbish dumping, altered flow and flood regime and modification of the stream morphology. A well-defined main channel is present and it is evident that large water volumes is discharged by the stream after rainfall events. Obligate wetland vegetation is present along the main channel and decreases in distance from it. Soil are also indicative of wetland conditions. Exotic vegetation is common but do not dominate.

Dominant plant species:
Marsilea burchellii (OW), **Trifolium repens, Cyperus fastigiatus* (OW), *Cyperus longus* (OW), *Leptochloa fusca* (OW), **Plantago lanceolata, Setaria sphacelata* (FW), *Themeda triandra, Aristida congesta, Eragrostis lehmanniana, Lycium horridum.*

Protected plant species:
None observed

Wetland type:
Channel and floodplain wetland.

Soil sample:



View of the stream. Note extensive rubbish dumping and significant width of the stream.

View upstream of the steam. Note proximity of the urban development.

Urban area: Botshabelo

Watercourse name:	**Coordinates of survey:**	**Flow regime:**
#5 Tributary of the Klein-Modder River	S 29.228221°, E 26.689673°	Seasonal stream.

This is a significant tributary of the Klein-Modder River draining from north to south and into the river. It originates some distance to the north but still within the urban area. Consequently

it is severely degraded and transformed. The residential area has a highly detrimental impact on the stream. Crossing of the road has also altered the morphology of the stream. The quality of effluent from the urban area as well as the significant increase in storm water has altered the flow and flooding regime of the stream. Trampling and overgrazing evidently causes increased sedimentation and erosion of the stream banks in this area. Rubbish dumping is extensive and causes a high impact on the stream. Furthermore, the dumping of used diapers is worrying and will significantly decrease water quality including an increase in faecal coliform and *E. coli* contamination. Modification of the morphology of the stream is evident and it is considered largely transformed. A well-defined main channel is present but is clearly modified. Obligate wetland vegetation is common along the main channel but confined to it. Soils also indicate wetland conditions but indicate the boundary to be within the lower zone. Exotic vegetation is common and dominate in areas.

Dominant plant species:
Typha capensis (OW), **Nasturtium oficinale, *Trifolium repens, *Plantago lanceolatum, Moraea pallida, Berkheya onopordifolia, *Cirsium vulgare, Arctotis arctotoides, Themeda triandra, Eragrostis lehmanniana, Rosenia humilis.*

Protected plant species:
None observed

Wetland type:
Channel and floodplain wetland.

Soil sample:

View of the stream.

Another view of the stream. Note the significant width of the stream.

Urban area: Botshabelo

Watercourse name:	**Coordinates of survey:**	**Flow regime:**
#6 Tributary of the Klein-Modder River	S 29.227261°, E 26.681431°	Seasonal stream.

This is a small stream and a tributary of the Klein-Modder River. It also flows into the #5 stream and therefore similarly affected. It flows from west to east and into stream #5. It is affected by much the same impacts including the urban development, increased storm water runoff, poor water quality, rubbish dumping and modification of the flow and flood regime and stream morphology. In addition, extensive brick making operations take place in the main channel of the stream and this leads to large-scale modification of the stream. A well-defined main channel is still present. Obligate wetland vegetation is absent and vegetation dominated by the exotic grass, *Pennisetum clandestinum.* Soils do however reliably indicate the presence of wetland conditions along the main channel. Wetland conditions are restricted to the main channel. Exotic vegetation is common and dominate along the main channel.

Dominant plant species:
**Pennisetum clandestinum, Gomphocarpus fruticosus, Atriplex semibaccata, Lycium horridum, *Malva parviflora.*

Protected plant species:
None observed

Wetland type:
Channel and floodplain wetland.

Soil sample:

View of the stream. Note the clear modification and extensive rubbish dumping.

View downstream. Note transformation of the surrounding area.

Urban area: Botshabelo

Watercourse name:	**Coordinates of survey:**	**Flow regime:**
#7 Hillslope seep	S 29.242961°, E 26.739387°	Hillslope seep and resulting stream

Description of watercourse:

A relatively large wetland area but which has been severely degraded by quarrying activities. The wetland is situated on the plateau of the large hill to the east of the urban area and originates as a seepage area on the plateau. The plateau is flat to undulating and water does not drain quickly from it. Instead groundwater and surface runoff drain from the surrounding slopes and accumulate on the relatively flat plateau where this wetland system is then formed.

This description indicates that this wetland area forms a seepage wetland giving rise to a stream system draining down the slope. The resulting stream drains toward the north and eventually flows into the Sepane River. It is also likely that similar and smaller systems will occur along the hill range though have not been included in this assessment. In general these systems would most likely be affected by overgrazing and trampling of domestic stock as was also observed at the site. However, this particular wetland has also been severely affected by extensive quarrying activities which has also encroached into the wetland and has caused the loss of a significant portion of it. Obligate wetland grasses dominate the wetland system. This confirms the presence of wetland conditions along the wetland system. The soils sample taken contain clear mottling and a prominent grey matrix and also confirm wetland conditions and the system must without a doubt be regarded as a wetland system.

The wetland system and resulting stream forms part of an extensive network of similar smaller streams on the mountain and hill plateaus and slopes and is taken as representative of several similar systems adjacent to it on the plateau.

Dominant plant species:
Diplachne fusca (OW), *Berkheya onopordifolia, Lobelia thermalis, *Pseudognaphalium luteo-album, Moraea pallida, Cynodon dactylon, Lotononis listii, Nenax microphylla*.

Protected plant species:
None observed

Wetland type:
Seepage wetland draining into a channelled stream system.

Soil sample:

View of the seepage wetland. Note severe trampling in the wetland with the quarry visible in the background.

View of the quarry area which also encroaches into the wetland and cause severe degradation of it.

Urban area: Botshabelo

Watercourse name:	**Coordinates of survey:**	**Flow regime:**
#8 Hillslope seep	S 29.259196°, E 26.766828°	Hillslope seep and resulting stream

Description of watercourse:

A relatively large wetland area with an approximate extent of 10 hectares. It is very similar to #7 seepage wetland but has however not been as heavily affected and is consequently in much more natural condition. The wetland is situated further to the east and not near the urban area and consequently impacts on it is also lower. It is situated on the plateau of one of the mountains and originates as a seepage area on the plateau. The plateau is flat to undulating and water does not drain quickly from it. Instead groundwater and surface runoff drain from the surrounding slopes and accumulate on the relatively flat plateau where this wetland system is then formed. This description indicates that this wetland area forms a seepage wetland giving rise to a stream system draining down the slope. The resulting stream drains toward the north and eventually flows into the Sepane River. It is also likely that similar and smaller systems will occur along the hill range though have not been included in this assessment. This specific wetland is affected by a small road along its perimeter, livestock grazing and trampling and a

small artificial impoundment though in general it is still largely natural. These are considered the prevalent impacts which would affect similar wetlands in the surrounding areas.
Obligate wetland grasses dominate the wetland system. This confirms the presence of wetland conditions along the wetland system. The soils sample taken contain clear mottling and a grey matrix and also confirm at least seasonal wetland conditions and the system must without a doubt be regarded as a wetland system.

The wetland system and resulting stream forms part of an extensive network of similar smaller streams on the mountain and hill plateaus and slopes and is taken as representative of several similar systems adjacent to it on the plateau.

Dominant plant species:
Diplachne fusca (OW), **Pseudognaphalium luteo-album, Barleria macrostegia, Aptosimum procumbens, Themeda triandra, Cyperus marginatus* (OW), *Cyperus sp., Paspalum distichum* (OW).

Protected plant species:
None observed

Wetland type:
Seepage wetland draining into a channelled stream system.

Soil sample:

View of the seepage wetland. The border of the wetland is indicated. Note also the small impoundment in it.

Urban area: Thaba Nchu

Watercourse name:	**Coordinates of survey:**	**Flow regime:**
#1 Sepane River	S 29.218738°, E 26.843256° S 29.215414°, E 26.838574°	Perennial River

	S 29.213487°, E 26.835572° S 29.182031°, E 26.744282°	

Only a small portion of the Sepane River is included within the MOSS. Although it flows through the urban area of Thaba Nchu it is there not regarded as part of the MOSS but will nonetheless form part of the discussion in order to provide an estimation of its condition. The floodplain of the river is utilised as communal grazing and is therefore affected by significant trampling and overgrazing which in turn causes increased sedimentation and erosion of the river banks in this area. Increased storm water runoff from the surrounding urban area also significantly increases erosion of the stream banks. The effluent from the residential areas will also significantly alter the flow and flooding regime of the river. Rubbish dumping is extensive and also highly problematic. Furthermore, the dumping of used diapers is worrying and will significantly decrease water quality including an increase in faecal coliform and *E. coli* contamination. From observations it is clear that where the river passes through the urban area it is highly degraded and modified to a large degree.

Downstream of the urban area where the river passes through the MOSS it has recovered significantly though it is evident that upstream urban impacts still has a large impact on it. The vegetation here is also much more representative of the natural condition with riparian thicket also still prominent.

A well-defined channel is present but is evident that it is being enlarged by a combination of erosion and increased flow. Obligate wetland vegetation is common along the main channel and decreases in distance from it. A few areas of obligate wetland grasses in the floodplain does occur and indicate some wetland conditions in the floodplain. Soil samples also confirm the presence of wetland conditions. Exotic vegetation is common and dominate within the urban area and are less abundant in the MOSS portion of the river.

Dominant plant species:
Urban section of river: **Pennisetum clandestinum, Pseudoschoenus inanus* (OW), *Salix fragilis, Cynodon dactylon, *Bidens bipinnata, *Sesbania punicea, Hyparrhenia hirta, Diospyros austro-africana, *Argemone ochroleuca, Sporobolus africanus, Eragrostis lehmanniana, Lycium horridum, Aristida congesta, Vachellia karroo, Nenax microphylla, *Flaveria bidentis, Paspalum dilatatum, *Persicaria lapathifolia* (OW), **Xanthium spinosum, *Ipomoea purpurea, *Cirsiujm vulgare, *Tagetes minuta, Panicum coloratum* (FW), **Datura stramonium, *Plantago lanceolata, *Agave americana, Enneapogon cenchroides, *Schkuhria pinata, *Verbena tenuisecta, Medicago lacineata, Chloris virgata, Cyperus eragrostis* (OW), *Cyperus marginatus* (OW), *Typha capensis* (OW), **Cyllindropuntia imbricata, *Malva parviflora, Leptochloa fusca* (OW), **Verbena officinalis, *Gleditsia triacanthos, *Sphaeralcea bonariensis, Themeda triandra.*

MOSS section of river: *Searsia lancea, Celtis africana, Cotula sp., Paspalum distichum* (OW), **Argemone ochroleuca, *Gleditsia triacanthos, Cyperus marginatus* (OW), *Asparagus larcinus, Searsia pyroides, Lycium horridum, Gymnosporia buxiifolia, Lotononis listii, Olea europaea* subsp. *africana, Clematis brachiata*.

Protected plant species:
Olea europaea subsp. *africana*

Wetland type:
Channel and floodplain wetland.

Soil sample:

Upstream view of the Sepane River. Note extensive erosion being caused by an increased storm water runoff.

View of the Sepane River within the urban area. Severe modification of the stream is clearly evident. Note the concrete structure in the streambed and rubbish dumping on the banks.

Another view of the Sepane River where it occurs within the urban area.

View of the Sepane River where it passes through the moss to the west of the urban area. Here it is evidently in a much better condition.

Urban area: Soutpan/Ikgomotseng

Watercourse name:	**Coordinates of survey:**	**Flow regime:**
#1 Unnamed	S 28.738346°, E 26.101783° S 28.737921°, E 26.113942°	Ephemeral stream system

Description of watercourse:

The area of Soutpan does not contain large watercourses, though this is one of the largest. It flows from east to west, is situated to the south of Ikgomotseng and drains into the large pan system. It originates in or near the immediate area. It is considered to still be natural to a large degree though it is also affected by several impacts, most of which are still small. A few small earthen berms or impoundments will affect its flow and flooding regime, likewise the crossing by the R700 tarred road and gravel roads will also affect the flow and flooding regime and concentrated livestock pens and the proximity of the urban area will also affect it. It is quite a

large system but the main channel may not always be distinct. However, a large floodplain is quite prominent. Obligate wetland plants are abundant along the main channel, although the floodplain is dominated by several riparian and terrestrial species, many adapted to higher salt concentrations. The confirms the presence of wetland conditions along the main channel while being absent from the floodplain. Soils indicate a prominent grey matrix and mottling indicative of wetland conditions. Exotic weeds are present but not abundant, however, the invasive *Prosopis glandulosa*, is present and may become abundant in some areas.

Dominant plant species:
Sebaea compacta, Androcymbium longipes, Helichrysum lucilioides, Ruschia hamata, Diplachne fusca (OW), *Eragrostis truncata, Eucomis autmunalis, Moraea pallida, Pentzia incana, Asparagus larcinus, Cynodon dactylon, Cyperus marginatus* (OW), *Themeda triandra, Asparagus larcinus, Sporobolus ludwigii, Nananthus broomii, Salsola humifusa, *Schkuhria pinata, *Bidens bipinnata, Prosopis glandulosa, Suaeda fruticosa, Eragrostis lehmanniana, *Verbena bonariensis, Berkheya macrocephala, Salsola aphylla, Sporobolus ioclados, *Opuntia engelmannii, Lycium cinerium*.

Protected plant species:
Eucomis autumnalis subsp. clavata

Wetland type:
Channel and floodplain wetland.

Soil sample:

A defined main channel is absent in some areas, though an extensive floodplain is evident.

Infestation of *Prosopis glandulosa* is clearly evident downstream of the R700 road (red).

Urban area: Soutpan/Ikgomotseng

Watercourse name:	**Coordinates of survey:**	**Flow regime:**
#2 Unnamed	S 28.729743°, E 26.096408°	Ephemeral stream

Description of watercourse:

A relatively small stream system but which has been significantly modified and enlarged due to the discharge from the Waste Water Treatment Works (WWTW). It flows from east to west, is situated just north of Ikgomotseng and drains into the large pan system. It also originates close by to the north east of the immediate area. It is still natural to some degree though has been heavily modified by the discharge of the WWTW into it. This clearly leads to a higher moisture regime, which enlarges and increases wetland conditions and also causes enrichment of flow with nutrients. This will then also have an effect on the pan into which it flows. In addition to this large impact it is also affected by the crossing by the R700 tarred road and gravel roads which will also affect the flow and flooding regime and a moderate level of livestock overgrazing. It is naturally a small system though discharge from the WWTW considerably increases the extent of wetland conditions. A main channel is present but not always distinct. Obligate wetland plants dominate the main channel. The confirms the presence of wetland conditions along the main channel while being absent from the floodplain. Soils indicate a prominent grey matrix and mottling indicative of wetland conditions. Exotic weeds are present but not abundant and indicate that although the stream is modified, it is still stable and functioning.

Dominant plant species:

Alternanthera sessiliflora (OW), *Cyperus marginatus* (OW), **Cirsium vulgare, Cynodon dactylon, Juncus rigidus* (OW), *Moraea pallida, Eragrostis lehmanniana, Melolobium candicans, Helichrysum lucilioides, Pentzia incana, Lycium cinerium, Osteospermum spinescens, Sebaea compacta, Asparagus larcinus*.

Protected plant species:

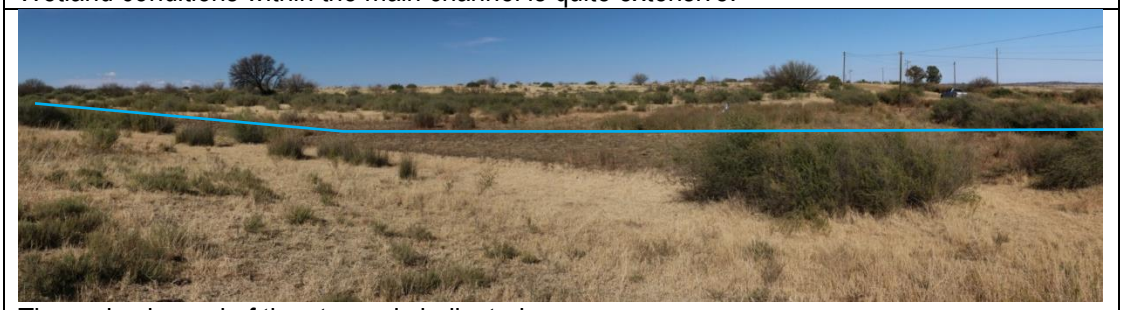
None observed

Wetland type:

Channel and floodplain wetland.

Soil sample:

Wetland conditions within the main channel is quite extensive.



The main channel of the stream is indicated.

View of the stream as it enters the pan system.

Urban area: Soutpan/Ikgomotseng

Watercourse name:	**Coordinates of survey:**	**Flow regime:**
#3 Unnamed	S 28.711641°, E 26.086495°	Ephemeral drainage line

Description of watercourse:

A very small drainage line with quite indistinct main channel. It flows from north to south and drains into the large pan system. It originates on the slopes of the hill and ridges to the north east of the urban area. The drainage line is largely natural though a significant artificial impoundment upstream will cause significant modification of its flow and flooding regime. Likewise the crossing of a large gravel road will also affect the flow and flooding regime. As indicated a main channel is not well-defined though riparian trees and the upstream impoundment clearly confirms its presence and significant runoff volumes. Due to its small size

obligate wetland plants are completely absent and riparian species also not well represented. Soils are also devoid of a grey matrix or mottling and clearly does not contain wetland conditions. Exotic species were not observed.

Dominant plant species:
Searsia lancea, Diospyros lycioides, Rosenia humilis, Aristida congesta, Vachellia karroo, FIngerhuthia africana, Berkheya macrocephala, Asparagus suaveolens, Enneapogon cenchroides, Asparagus larcinus, Ziziphus mucronata, Olea europaea subsp. *africana, Erragrostis obtusa, Diospyros austro-africana, Heteropogon contortus, Themeda triandra, Indigofera nigromontana*.

Protected plant species:
Olea europaea subsp. *africana*

Wetland type:
No wetland conditions present, ephemeral drainage line.

Soil sample:

As indicated, the drainage line is small and indistinct.

Another view of the indistinct drainage line.

Urban area: Soutpan/Ikgomotseng		
Watercourse name: #4 Unnamed	**Coordinates of survey:** S 28.713519°, E 26.073835°	**Flow regime:** Ephemeral stream

Description of watercourse:
A large and extensive wetland area functioning as a stream system. It flows from north to south and drains into the large pan system. It originates a short distance to the north of Soutpan and seems to be largely unmodified. Only a few small impacts on it could be identified. A small earthen berm upstream causes limited impoundment of flow and the crossing by a large gravel road will undoubtedly also contribute to flow and flooding modification. It is quite a large system but the main channel may not always be distinct. However, it remains quite broad and dominated by obligate wetland plants. The confirms the presence of wetland conditions along the main channel while being absent from the floodplain. Soils indicate a prominent grey matrix and mottling indicative of wetland conditions. Exotic weeds are present but not abundant.

Dominant plant species:
Diplachne fusca (OW), *Cyperus marginatus* (OW), *Lobelia thermalis, Cynodon dactylon, Marsilea sp., *Tagetes minuta, Sporobolus ioclados, *Verbena bonariensis, *Plantago lanceolata*.

Protected plant species:
None observed

Wetland type:
Channel and floodplain wetland.

Soil sample:

View of the stream system. Note the prominent wetland conditions but that a defined main channel is not clear everywhere.

Urban area: Soutpan/Ikgomotseng		
Watercourse name:	**Coordinates of survey:**	**Flow regime:**

#5 Soutpan	S 28.733453°, E 26.090723° S 28.725227°, E 26.090056° S 28.730055°, E 26.061098°	Large depression wetland

Description of watercourse:
The urban area of Soutpan is dominated by a large pan or depression which covers a large surface area. It is an endorheic system, meaning there is no defined outflow from it. The pan is fed by all of the previously described watercourses around Soutpan. These originate relatively close by and drain into it from all directions. It should therefore also be considered as the main water resource of the area. This would increase its sensitivity significantly. The pan seems to still be natural though impacts of the historical salt mining has clearly led to significant degradation of it. Is salt mine diggings the species composition becomes noticeably different from the surrounding more natural areas. The scars of salt mining are also clearly visible on aerial images. As noted, it is an extensive system and its border is well-defined and easy to delineate. The pan is dominated not by wetland or riparian plants but rather halophytes or plants adapted to very high salt concentrations. These are adapted to the high salt concentrations in the pan are a natural and relatively unique species composition for these pans. Where previous salt mining has caused disturbance, surface water is able to remain and here obligate wetland plants become established, but is considered a modification of the natural condition. Although the plant composition in the pan does not strictly confirm the presence the soils and topography confirm that the pan should be regarded as a depression wetland. Soils indicate a prominent grey matrix with clear mottling. The pan itself is largely free of exotic species though the invasive *Prosopis glandulosa* has formed dense infestations to the south of the urban area.

Dominant plant species:
*Salsola aphylla, Malephora smithii, Sporobolus ioclados, Atriplex lindleyi, Senecio consanguineus, Helichrysum lucilioides, Microloma armatum, Nolletia ciliaris, Felicia muricata, Pentzia incana, *Prosopis glandulosa, Chrysocoma cilliata, Mestoklema arboriforme. Suaeda fruticosa, Alternantghera sessiliflora* (OW), *Chloris virgata, Cyperus difformis* (OW), *Juncus rigidus* (OW).

Protected plant species:
None observed

Wetland type:
Depression wetland.

Soil sample:

A panorama of the salt pan (blue) indicating its large extent with the urban area of Soutpan also indicated (red).

View from inside the pan. Note the high salt concentrations and highly adapted plant life.

Historical salt mining (red) has caused visible modification of the natural vegetation composition.

Urban area: Dewetsdorp

Watercourse name:	**Coordinates of survey:**	**Flow regime:**
#1 Unnamed	S 29.590822°, E 26.651247° S 29.588639°, E 26.658587° S 29.583245°, E 26.669035° S 29.563487°, E 26.683215°	Seasonal stream system

Description of watercourse:

A large and significant stream system originates immediately to the west and within the municipal area of Dewetsdorp. This stream system drains almost the entire urban area and almost all watercourses and drainage lines drain into it. As a result, all the impacts that the urban area has, will affect it and it in turn will affect the downstream watercourses. The stream drains into the Modder River not far downstream of it. The stream system flows from south west to north east , originates in the sandstone ridges to the north, west and south of the town and then flows through the centre of the town. The stream is still largely natural in terms of its functioning although the town causes several significant impacts on it which does cause

significant degradation of the stream. Overgrazing and trampling of the headwaters will lead to a high sediment load in the stream. The urban itself also has significant impacts in terms of channel straightening, road crossings, rubbish duping, poor water quality and polluted runoff. In combination these result in significant degradation of the stream. In addition, the WWTW of Dewetsdorp discharges into the stream, downstream of the urban area. This will undoubtedly also result in a significant in crease in nutrient load and an increase in flow volumes which will affect the flow regime of the stream. It is quite a large stream with a clear main channel and a significant floodplain. Obligate wetland plants are abundant along the main channel, although the floodplain is dominated by several riparian and terrestrial species. The confirms the presence of wetland conditions along the main channel while being absent from the floodplain. Soils indicate a prominent grey matrix and mottling indicative of wetland conditions. Exotic species, especially invasive tree species are abundant along the stream, especially within the urban area and downstream and are also indicative of degradation of the stream.

Dominant plant species:

Diplachne fusca (OW), *Aristida congesta, Digitaria eriantha, Panicum coloratum* (FW), **Cotoneaster franchettii, Searsia pyroides, *Eucalyptus camaldulensis, Asparagus cooperi, Artemisia afra, Buddleja saligna, *Acacia dealbata, *Cestrum laevigatum, Brachiaria eruciformis, Searsia lancea, *Fraxinus americana, Cynodon dactylon, *Verbena bonariensis, *Tagetes minuta, Vachellia karroo, Diospyros lycioides, *Echinopsis schickendantzii, *Cyllindropuntia imbricata, Berula erecta, Berkheya onopordifolia, *Oxalis corniculata, *Sesbania punicea, Cymbopogon pospischillii.*

Protected plant species:

None observed

Wetland type:

Channel wetland.

Soil sample:

Panorama of the stream system (blue) where it originates to the west of the town.

View of the stream (blue) where it flows through the town. Here it is visibly degraded, note also extensive exotic trees.

View the stream downstream of the town. Note increased flow as a result of the discharge of the WWTW and also exotic trees lining the banks.

Urban area: Dewetsdorp

Watercourse name:	**Coordinates of survey:**	**Flow regime:**
#2 Unnamed	S 29.555467°, E 26.660365°	Seasonal valley-bottom wetland

Description of watercourse:

A relatively small system forming a tributary of the #1 stream system downstream of the town. The system originates to the north west of the town but still within the municipal area. It flows from west to east and follows a linear flow pattern. The system forms a small stream in its lower

reaches. However, where it originates it is situated in a shallow valley between the sandstone ridge system to the south and hill to the north. Here it is also largely without a defined channel. Consequently, here it forms an unchanneled valley-bottom wetland rather than a stream. However, as indicated, a channel does become visible in the lower reach and consequently this system can be regarded as mixture of an unchanneled valley-bottom wetland and a channel wetland. The system is still natural to a large extent. However, two artificial impoundments and a road crossing does cause significant modification of it. Due to the small size of the system such impacts will have a higher impact on it. These will largely alter the flow regime of the system. Overgrazing and trampling of the headwaters will also lead to a high sediment load in the system. Obligate wetland grasses dominate the main channel of the system. The confirms the presence of wetland conditions along the wetland system. Due to hard soils a soil sample was not taken, though the abundance of wetland grasses is ample to establish the presence of wetland conditions. No exotic species were noted indicating the system to still be largely natural.

Dominant plant species:
Diplachne fusca (OW), *Cymbopogon pospischillii, Pennisetum spacelatum* (OW), *Haplocarpa scaposa, Cyperus marginatus* (OW), *Berkheya onopordifolia, Salvia stenophylla, Ruschia hamata, Moraea pallida, Lycium horridum.*

Protected plant species:
None observed

Wetland type:
Unchanneled valley-bottom wetland transition to a channel wetland system.

Soil sample:
No soil sample taken.

View of the upper reaches of the wetland system (blue). Note that a defined channel is largely absent here though the border of the wetland system is still clear.

Urban area: Dewetsdorp

Watercourse name:	**Coordinates of survey:**	**Flow regime:**
#3 Modder River	S 29.580525°, E 26.704935°	Seasonal modified to perennial

Description of watercourse: 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. This modification is caused by the Novo Transfer Scheme. The water demands of the MMM required augmentation of its water supply which was in part undertaken by constructing a pipeline from the Knellpoort Dam to the headwater of the Modder River where it discharges

into the river and is allowed to flow downstream and into the Rustfontein Dam. This entails an inter-catchment transfer, i.e. the Novo Transfer Scheme. This release of large volumes of water into a naturally seasonal watercourse alters the flow regime from seasonal to perennial and also has a large impact on the fish and invertebrate population of the river. This has also been confirmed by Slabbert (2007). The modification of the flow regime is also likely to modifiy the geomorphology of the river and increase erosion of the banks and consequent sedimentation. Being situated near the headwaters of the river, other impacts on it is limited. Limited dryland crop cultivation will cause low impacts in terms of fertiliser and herbicide runoff and increased sedimentation. 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 well defined main channel is present with a quite extensive floodplain also being evident. Obligate wetland plants are abundant along the main channel and areas of seasonal inundation within the floodplain also contain abundant obligate wetland grasses. This clearly confirms the presence of wetland conditions and confirms the river being a channel as well as a floodplain wetland system. Soils indicate a prominent grey matrix and mottling indicative of wetland conditions. Only a few exotic species occur which indicate that overgrazing has a limited impact on the riparian vegetation although this is not indicative of the well known modified nature of the riparian component.

Dominant plant species:
Diplachne fusca (OW), **Conyza bonariensis, Phragmites australis* (OW), *Agrostis lachnantha* (OW), *Artemisia afra, *Salix babylonica, *Plantago lanceolata, Berkheya onopordifolia, Arctotis arctotheca, Cyperus marginatus* (OW), *Cymbopogon pospischillii, Cynodon dactylon, Pennisetum spacelatum* (OW), *Hemarthria altissima, Ruschia hamata, Lycium horridum, Salvia verbenaca, Convolvulus sp., Gazania krebsiana, Chasmatophyllum muscullinum, Chloris virgata, Felicia muricata, Chenopodium album, Osteospermum aghillana, Nananthus broomii*.

Protected plant species:
None observed

Wetland type:
Channel and floodplain wetland system.

Soil sample:

View of the main channel of the river which is clearly defined with a strong, perennial flow.

View fo the floodplain of the river where obligate wetland grasses indicate that wetland conditions occur, at least on a seasonal basis.

Urban area: Wepener

Watercourse name:	**Coordinates of survey:**	**Flow regime:**
#1 Unnamed	S 29.734319°, E 27.007866°	Seasonal valley-bottom wetland

Description of watercourse:

A relatively small system forming a tributary of the #3 Sandspruit system to the north. The wetland originates a short distance to the south of the town but still within the municipal grazing areas. It flows from south to north and follows a linear flow pattern. It may form a distinct channel in some areas, however, naturally and large portions of the system which is situated in a shallow valley within the undulating terrain is largely without a channel. Consequently, here it forms an unchanneled valley-bottom wetland rather than a stream. However, as indicated, a channel is present in some sections and consequently this system can be regarded as mixture of an unchanneled valley-bottom wetland and a channel wetland. This condition is however also considered to be modified to a significant degree. It was noted that the origin of the system and surrounding catchment is affected by high levels of overgrazing by domestic stock which leads to high levels of trampling within the system and an increased sediment load. This all leads to a decrease in vegetation cover within the system and increased erosion. It was therefore notable that erosion of the wetland system, including head cutting was a pronounced impact. Together with these impacts the runoff velocity increases and with erosion results in

channel formation within the wetland. It should therefore be clear that the wetland system has become significantly modified from the natural condition. Obligate wetland grasses dominate the main channel of the system. This confirms the presence of wetland conditions along the wetland system. Terrestrial species are also abundant and indicate the small nature of the system and also the seasonal wetland conditions. The soils sample taken contain clear mottling and a grey matrix and also confirm at least seasonal wetland conditions and the system must without a doubt be regarded as a wetland system. No exotic species were noted though it was clear that erosion has caused significant modification of it.

Dominant plant species:
Diplachne fusca (OW), *Cymbopogon pospischillii, Berkheya macrocephala, Salvia verbenaca, Lycium horridum, Themeda ttriandra, Cynodon dactylon.*

Protected plant species:
None observed

Wetland type:
Unchanneled valley-bottom wetland with erosion into a channel wetland system.

Soil sample:

Panorama of the wetland system as it flows from south to north.

Note severe head cutting and erosion within the wetland system.

Urban area: Wepener

Watercourse name:	**Coordinates of survey:**	**Flow regime:**

#2 Unnamed	S 29.738905°, E 27.017476°	Seasonal valley-bottom wetland

Description of watercourse:
A relatively small system forming a tributary of the #3 Sandspruit system to the north, it is also very similar to #1 wetland system. The wetland originates a short distance to the south of the town but still within the municipal grazing areas. It flows from south to north and follows a linear flow pattern. It may form a distinct channel in some areas, however, naturally and large portions of the system which is situated in a shallow valley within the undulating terrain is largely without a channel. Consequently, here it forms an unchanneled valley-bottom wetland rather than a stream. However, as indicated, a channel is present in some sections and consequently this system can be regarded as mixture of an unchanneled valley-bottom wetland and a channel wetland. This condition is however also considered to be modified to a significant degree. It was noted that the origin of the system and surrounding catchment is affected by high levels of overgrazing by domestic stock which leads to high levels of trampling within the system and an increased sediment load. This all leads to a decrease in vegetation cover within the system and increased erosion. It was therefore notable that erosion of the wetland system, including head cutting was a pronounced impact. Together with these impacts the runoff velocity increases and with erosion results in channel formation within the wetland. It should therefore be clear that the wetland system has become significantly modified from the natural condition. Obligate wetland grasses dominate the main channel of the system. This confirms the presence of wetland conditions along the wetland system. Terrestrial species are also abundant and indicate the small nature of the system and also the seasonal wetland conditions. The soils sample taken contain clear mottling and a grey matrix and also confirm at least seasonal wetland conditions and the system must without a doubt be regarded as a wetland system. No exotic species were noted though it was clear that erosion has caused significant modification of it.

The wetland system #1 and #2 is taken as representative of two identical wetland system adjacent to them.

Dominant plant species:
Diplachne fusca (OW), *Cymbopogon pospischillii, Berkheya onopordifolia, Cyperus marginatus* (OW), *Persicaria sp., Moraea pallida, Nenax microphylla, Lycium horridum.*

Protected plant species:
None observed

Wetland type:
Unchanneled valley-bottom wetland with erosion into a channel wetland system.

Soil sample:

View of the wetland system where a channel is largely absent. However, note significant erosion and which is clearly leading to channel formation.

Another view of the wetland system where a channel is absent. However, note extensive head cutting in the foreground.

Urban area: Wepener		
Watercourse name:	**Coordinates of survey:**	**Flow regime:**

#3 Unnamed	S 29.704529°, E 27.044678° S 29.708828°, E 27.048182°	Valley bottom wetland and resulting stream

Description of watercourse:
An extensive wetland system which occurs on the plateau of the large mountain to the north and east of the town. This wetland system originates on the plateau. The plateau receives a significantly higher rainfall than lower lying areas. It is also flat to undulating and water does not drain quickly from it. Instead groundwater and surface runoff drain from the surrounding slopes and accumulate on the relatively flat plateau where this extensive wetland system is then formed. This description therefore indicate that these wetland areas form broad valley-bottom wetlands without channels. These wetland areas slowly seep toward the cliff edge and as water flow nears the cliff, channels become visible. These channels or streams drain over the cliff edge via small waterfalls or ravines. They all form tributaries of the Sandspruit. These wetlands and their resultant streams are also heavily affected by overgrazing and trampling by domestic stock. This is especially evident as the wetland transitions into a stream system. Here trampling leads to erosion which promotes head cutting and erodes into the wetland areas. The impact and modification this has on the wetland system is high and lead to extensive degradation of the wetland areas. Obligate wetland grasses dominate the wetland system. Where the wetland drains in to the stream system and at the cliff edge, shrubs and other terrestrial growth forms become more prominent on the banks though obligate wetland grasses still dominated the main channel. This confirms the presence of wetland conditions along the wetland system. The soils sample taken contain clear mottling and a grey matrix and also confirm at least seasonal wetland conditions and the system must without a doubt be regarded as a wetland system. Exotic shrubs were noted along the banks of the stream and is indicative of disturbance.

The wetland system and resulting stream forms part of an extensive network on the mountain plateau and slopes and is taken as representative of several similar systems adjacent to it on the plateau.

Dominant plant species:
Valley-bottom wetland portion: *Diplachne fusca* (OW), *Eragrostis sp., Ranunculus multifidus.*

Stream channel portion: *Rhamnus prinoides, *Rosa eglanteria, Searsia lancea, Buddleja salviifolia, Maytenus heterophylla, Searsia divaricata, Tarchonanthus minor, Crassula lanceolata, Asplenium aethiopicum, Pennisetum spahecelatum* (OW), *Agrostis lachnantha* (OW).

Protected plant species:
None observed

Wetland type:
Unchanneled valley-bottom wetland draining into a channelled stream system or ravine.

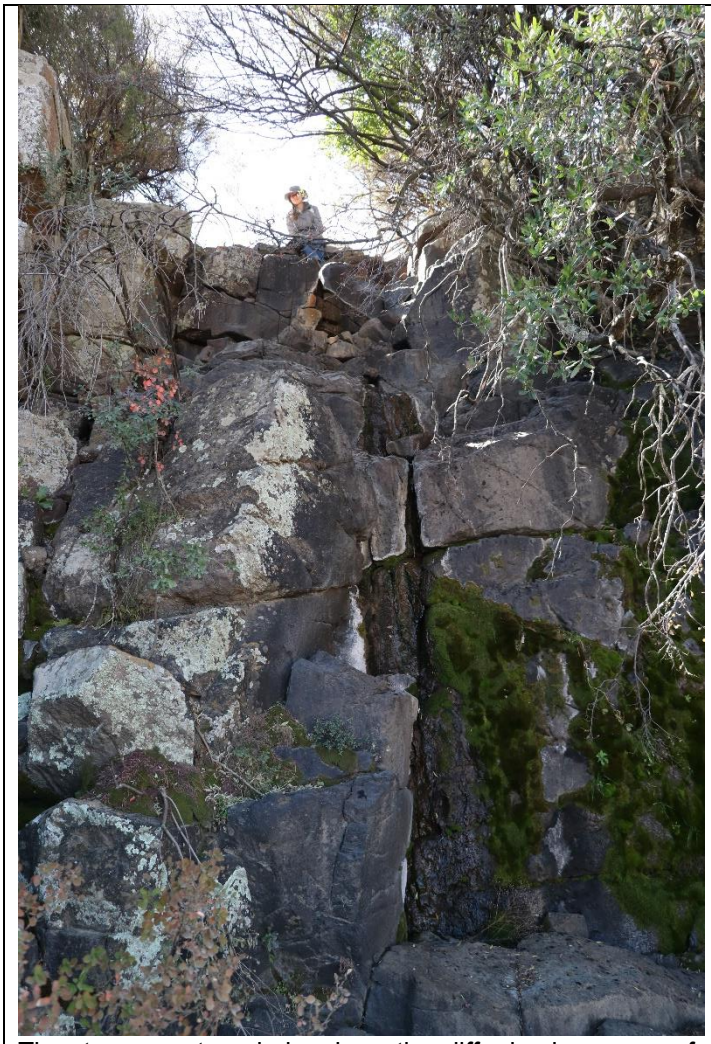
Soil sample:

Panorama of the valley-bottom wetland. It is notably flat with surroundings slopes visible.

Where the wetland drains into a channel, erosion is extensive and highly problematic.

Head cutting is quite proinent along the edge of the wetland.

High levels of trampling within the stream cause extensive erosion.



The stream system drains down the cliff edge by means of a small waterfall (not flowing at the time of the survey due to the current season).

Urban area: Wepener

Watercourse name:	**Coordinates of survey:**	**Flow regime:**
#5 Sandspruit	S 29.748487°, E 27.052997° S 29.727015°, E 27.032043° S 29.718780°, E 26.984965°	Seasonal river system

Description of watercourse: 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 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 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. 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. The Caledon River is naturally of high turbidity and carries a concerning high sediment load. The slopes and erodibility of soils in the area increase sediment deposition. Severe soil erosion in the area is also 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).

A well-defined main channel is present with a quite extensive floodplain also being evident. Large volumes of sand are being deposited along the river during large floods and this cause obstructions to flow and leads to the formation of extensive floodplain wetlands along the river. Due to seasonal flooding as well as constant sand deposition the main channel and banks of the river contain only sparse vegetation with trees common in the floodplain. The sparse vegetation that is present do however consists largely of obligate wetland species confirming the presence of wetland conditions. Due to the sandy soils they do not exhibit clear soil wetness indicators though the presence of obligate wetland plants are sufficient to indicate the presence of wetland conditions. Those portions within the floodplain forming clear wetland areas do however contain an abundance of obligate wetland plants as well as wetland soils. The presence of an abundance of exotic trees in the floodplain are also an indication of a degraded riparian component.

Dominant plant species:
Diplachne fusca (OW), *Cynodon dactylon, *Verbena bonariensis, Agrostis lachnantha* (OW), *Salix mucronata, *Nicotiana glauca, *Xanthium spinosum, Chloris virgata, Moraea pallida, Lycium horridum, Aristida congesta, *Populus x canescens, Paspalum distichum* (OW), *Gleditsia triacanthos, Gomphostigma virgatum* (OW), *Searsia pyroides, *Bidens bipinnata, Eragrostis lehmanniana, *Schoenoplectus tabernaemontani, *Pyracantha angustifolia, *Eucalyptus camaldulensis.*

Floodplain wetlands: *Diplachne fusca* (OW), *Eleocharis sp.* (OW).

Protected plant species:
None observed

Wetland type:
Channel and floodplain wetland.

Soil sample:

Sandspruit channel

Floodplain wetland

View of the main channel of the Sandspruit. Note a large and wide channel containing no active flow during winter, with banks largely devoid of vegetation. Note also exotic trees in the background.

View of the Sandspruit in the urban area.

View of the Sandspruit prior to its confluence with the Caledon River.

View of one of the large floodplain wetlands along the Sandspruit.

Urban area: Wepener

Watercourse name:	**Coordinates of survey:**	**Flow regime:**
#6 Caledon River	S 29.715632°, E 26.984420° S 29.722251°, E 26.977745°	Perennial river system

Description of watercourse: Soil samples taken along the bank of the river are largely devoid of any characteristics indicating wetland conditions. This may be attributed to the sandy nature of the soil, the constant movement of moisture/water and aerating of the soils during flooding. However, a narrow strip along the marginal zone and lower portion of the lower zone of the river bank does contain wetland characteristics and this is also substantiated by obligate wetland species. Observed obligate wetland species include *Persicaria lapathifolia, Cyperus difformis, C. marginatus, Paspalum distichum, Agrostis lachnantha* and *Phragmites australis.*

The hydrology of the river is impacted on by several factors. 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. 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.

The riparian thicket and river banks here is dominated by exotic and invasive weed and tree species. This heavy infestation is considered an indication of the degraded and transformed nature of the vegetation brought about by a long history of human activities in this area.

Dominant plant species:
**Salix fragilis, *Salix babylonica, *Populus deltoides, *Robinia pseudoacacia, *Nicotiana glauca, *Acacia dealbata, *Pyracantha angustifolia, *Tamarix chinensis, *Populus simonii, *Populus x canescens, Cynodon dactylon, Eragrostis lehmanniana, Chloris virgata, Aristida congesta, Pogonarthria squarrosa, Sporobolus fimbriatus, Artemisia afra, Searsia pyroides, Asparagus larcinus, Diospyros lycioides, *Cichorum intybus, *Richardia brasiliensis, *Papaver aculeatum, *Bidens bipinnata, *Datura stramonium, *Xanthium strumarium, *Conyza albida, *Tagetes minuta, *Datura stramonium, *Bidens pillosa, *Bidens formosa, *Argemone ochroleuca, Echinochloa colona, Setaria pallide-fusca, Persicaria lapathifolia, Rumex lanceolatus, Phragmites australis* (OW), *Juncus effusus* (OW), *Cyperus fastigiatus* (OW), *Cyperus congestus* (OW), *Paspalum distichum* (OW), *Panicum coloratum* (FW), *Phragmites australis* (OW), *Polygonum aviculare, Tagetes minuta, Agrostis lachnantha* (OW), *Gomphostigma virgatum* (OW), *Cyperus difformis* (OW), *C. marginatus* (OW).

Protected plant species:
None observed

Wetland type:
Channel and floodplain wetland.

Soil sample:

Panorama of the floodplain of the Caledon River at the site. Note a short grass layer dominated by pioneer species and a significant infestation by a variety of exotic tree species.

View of the river, note the extensive sand deposits. The marginal (blue) and lower (yellow) zones are indicated here.

View of the bank of the river with the narrow marginal (blue), lower (yellow) and upper (red) zones indicated. Note the marginal and lower zones dominated by low grass and herbaceous species with trees present in the upper zone.

Urban area: Vanstadensrus

Watercourse name:	**Coordinates of survey:**	**Flow regime:**
#1 Unnamed	S 29.992174°, E 27.000629°	Valley-bottom wetland system

Description of watercourse:

A relatively small system forming a tributary of the #3 Witspruit tributary system to the north. The wetland originates a short distance to the south of the town within the adjacent grasslands. It flows from south to north and follows a linear flow pattern. It may form a distinct channel in

some areas, however, naturally and large portions of the system which is situated in a shallow valley within the undulating terrain is largely without a channel. Consequently, here it forms an unchanneled valley-bottom wetland rather than a stream. However, as indicated, a channel is present in some sections and consequently this system can be regarded as mixture of an unchanneled valley-bottom wetland and a channel wetland. This condition is however also considered to be modified to a significant degree. It was noted that surrounding catchment is affected by high levels of overgrazing by domestic stock which leads to high levels of trampling within the system and an increased sediment load. This all leads to a decrease in vegetation cover within the system and increased erosion. It was therefore notable that erosion of the catchment was high and consequent sediment load in the wetland also high. Together with these impacts the runoff velocity increases and with erosion results in channel formation within the wetland. It should therefore be clear that the wetland system has become significantly modified from the natural condition. Obligate wetland grasses dominate the main channel of the system. This confirms the presence of wetland conditions along the wetland system. Terrestrial species are also abundant and indicate the small nature of the system and also the seasonal wetland conditions. The soils sample taken contain clear mottling and a grey matrix and also confirm at least seasonal wetland conditions and the system must without a doubt be regarded as a wetland system. Exotic weeds are present though not abundant and are also an indication of disturbance.

Dominant plant species:
Diplachne fusca (OW), *Juncus rigidus* (OW), *Cyperus marginatus* (OW), *Lycium horridum, Cynodon dactylon, Pseudognaphalium luteo-album, Chloris virgata, Eragrostis lehmanniana, Moraea pallida, Salsola sp., *Xanthium spinosum*.

Protected plant species:
None observed

Wetland type:
Unchanneled valley-bottom wetland with erosion into a channel wetland system.

Soil sample:

View of the wetland system. Wetland grasses are clearly present, note also the absence of a clear channel here and urban refuse is also visible in the wetland.

Another view of the wetland, here with a prominent pool in the main channel. Note again urban refuse as well as high sediment load (brown water colouration).

Urban area: Vanstadensrus

Watercourse name:	**Coordinates of survey:**	**Flow regime:**
#2 Witspruit tirbutary	S 29.983179°, E 27.018317° S 29.983110°, E 27.001200° S 29.988240°, E 26.995013°	Perennial stream system

Description of watercourse: 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. These dams act as flood regulators, whereby moderate and large flooding events are contained and prevented from flooding the

downstream reaches. The impact this has on the riparian community, the aquatic fauna, sediment load and connectivity of the stream is high. In addition, the dams contain a large volume of water on a perennial basis and this will result in a slow release of water year-round. 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.

A significant portion of the catchment has been utilised for dryland crop cultivation. This will contribute significant amounts of sediment to the system. 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.

A well-defined main channel is present with the floodplain being narrow and not extensive since the stream is situated in the foothills and therefore drains with higher velocity. As indicated, the upstream dams will also significantly modify flooding of the floodplain. Obligate wetland vegetation dominate the main channel and banks confirming the presence of wetland conditions. Aquatic herbaceous species were also quite abundant. Soils also exhibit a clear grey matrix and mottling further confirming wetland conditions. Trees are also abundant within the floodplain and in some area invasive tree species were also prominent being an indication of a degraded riparian component.

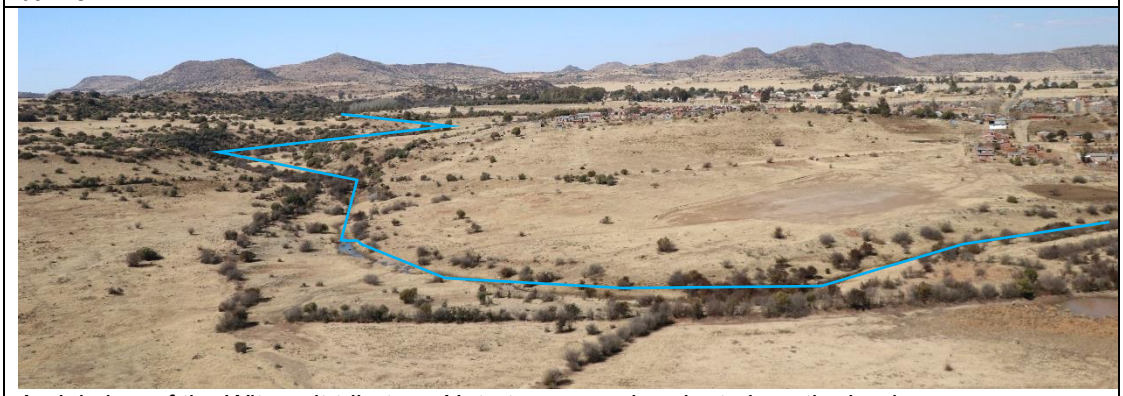
Dominant plant species:
Diplachne fusca (OW), *Cynodon dactylon, Juncus rigidus* (OW), *Ludwigia sp., Berkheya onopordifolia, Salvia verbenaca, Moraea pallida, Limosella grandiflora, Marsilea sp., *Schkuhria pinata, *Pyracantha angustifolia, Pseudognaphalium luteo-album, Cyperus longus* (OW), **Rosa eglanteria, Eragrostis biflora, Gomphostigma virgatum, Vachellia karroo, *Azolla filiculoides, *Populus x canescens, Crassula natans, Maytenus undata*, **Gledeitsia tracanthos*.

Protected plant species:
None observed

Wetland type:
Channel and floodplain wetland.

Soil sample:

View of the main channel of the Witspruit tributary. Note abundant wetland rushes along the banks.



Aerial view of the Witspruit tributary. Note trees are abundant along the banks.

View of the stream, downstream of the Vanstadensrus Dam. Note extensive trampling and erosion along the right bank.

View of the Vanstadensrus Dam to the east of the town.

View of the spillway from the dam and into the Witspruit tributary.

4.3 Overview of terrestrial fauna

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. In addition, it is notable that in communal grazing areas, herdsmen make use of a large number of herding dogs and these will also have a significant impact on the local mammal population. 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. However, given the large extent of the study area, it will likely still contain a varied faunal population with relatively high diversity. The study area also has a very large extent and consequently will be able to sustain population dynamics at a much larger scale, i.e. localised migration, varied genetic pool, unique habitats for reclusive and rare species. Furthermore, it should be kept in mind that watercourses sustain a higher biomass than surrounding terrestrial habitats and therefore often provide food and water for animals normally not frequenting these habitats. In addition, watercourses often sustain a unique aquatic faunal community only adapted to these habitats and not able to survive in other terrestrial environments. This is more pronounced in perennial systems which have a baseflow throughout the year. In contrast, ephemeral and seasonal systems only have active flow for short periods during the rainy season and as a result the aquatic fauna is adapted to a period of dormancy.

Table 21: 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 22: Mammal species observed in urban areas.

Species	**Bloemfontein**	**Botshabelo**	**Thaba Nchu**	**Soutpan**	**Dewetsdorp**	**Wepener**	**Vanstadensrus**
Cryptomys hottentotus (Common Molerat)	X	X	X	X	X	X	X
Pedetes capensis (Springhare)	X			X			
Atilax paludinosus (Water Mongoose)				X			
Cynictis penicillata (Yellow Mongoose)	X	X	X	X	X	X	X
Orycteropus afer (Aardvark)	X			X	X		
Pelea capreolus (Vaal Rhebok)				X			
Xerus inauris (Groundsquirrel)	X	X	X	X	X	X	X
Rabdomys pumilio (Striped Mouse)				X			
Hystrix africaeaustralis (Porcupine)	X	X	X		X		
Lepus capensis (Cape Hare)	X					X	
Lepus saxatilis (Scrub Hare)	X						X
Procavia capensis (Rock Hyrax)	X						X
Sylvicapra grimmea (Common Duiker)	X						
Raphicerus campestris (Steenbok)	X	X	X				
Pronolagus rupestris (Smith's Red Rock Rabbits)	X						
Suricata suricatta (Suricates)	X		X				
Chlorocebus pygerythrus (Vervet Monkeys)	X						

Table 23: 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 hottentotus*	Common Molerat
	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 pulverulentus	Cape Gray 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

A brief overview of each urban area will be provided which should give a general indication of the condition and importance of these areas. For the Bloemfontein, Botshabelo and Thaba Nchu areas this will be restricted to the delineated MOSS while for the Soutpan, Dewetsdorp, Wepener and Vanstadensrus areas this will be restricted to the municipal communal areas around the towns.

5.1 Overall condition of the study area

5.1.1 Bloemfontein

Habitat diversity and species richness: The MOSS consists largely of a series of hills and ridges around the city although some plains, watercourses and wetlands are also included. The diversity of habitats included within the MOSS is substantial and as a consequence the species diversity is also regarded as high.

Presence of rare and endangered species: From the limited surveys conducted as well as previous and desktop data it is quite clear that the Bloemfontein MOSS contains a large amount of protected species with many also regarded as being rare or uncommon. No Red Listed species could be identified though the likelihood remain and despite this is still regarded as a high value.

Ecological function: The ecological functioning of the Bloemfontein MOSS has been modified to some degree. Large portions of the MOSS has already been transformed by agricultural and urban development and these portions decrease the functioning of the MOSS. The aim of the MOSS is to preserve sensitive habitats and vegetation types, watercourses and wetlands and provide a functioning ecological system within an urban setting and therefore the ecological functioning of the MOSS must be regarded as high.

Degree of rarity/conservation value: Overall the MOSS should be regarded as having a high conservation value. Though some portions have been transformed, even they should be regarded as having at least a moderate conservation value since they still provide a function within the MOSS. Some areas such as CBA areas and watercourses and wetlands are regarded as having a very high conservation value.

Percentage ground cover: Overall the percentage ground cover is moderate. Although the majority of the MOSS is still largely natural and in good condition, significant portions has been transformed by agricultural and urban development which decreases the natural percentage ground cover.

Vegetation structure: Overall, the vegetation structure of the MOSS is natural to a large degree though modification as a result of infestation by exotic species, especially trees does cause some modification of the vegetation structure. This was especially evident along watercourses.

Infestation with exotic weeds and invader plants: In general, the infestation of exotic species is relatively low. However, invasive trees are abundant along larger watercourses such as the Bloemspruit and Renosterspruit. Invasive succulent species were also notable where disturbance in the hills and ridges were present.

Degree of grazing/browsing impact: The MOSS falls largely within private property but with municipal areas also covering a significant portion. However, communal grazing was not notably high. A few areas being utilised as grazing and browsing for introduced game did indicate high levels of overstocking and overall this impact is considered as moderate.

Signs of erosion: Since overgrazing is only occurring at moderate levels and as indicated, the majority of the MOSS is still natural, overall the amount of erosion is only regarded as moderate.

Terrestrial animals: The Bloemfontein MOSS is quite extensive and contains substantial natural areas. Consequently a varied and diverse mammal population is likely to occur. However, due to the urban setting and impacts associated with it, the likelihood of rare or endangered mammals occurring is relatively low. Overall, the mammal population is considered to be moderate in terms of diversity but low in terms of the likelihood of rare or endangered species occurring.

Table 24: Biodiversity Sensitivity Rating for the Bloemfontein 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		2	
Signs of erosion		2	
Terrestrial animal characteristics			
Presence of rare and endangered species		2	
Sub total	3	10	4
Total		17	

5.1.2 Botshabelo

Habitat diversity and species richness: The MOSS consists almost exclusively of hills, ridges and mountainous terrain with only small portions of plains being represented. Numerous wetlands and watercourses have their origins in these mountainous areas which does contribute toward habitat diversity. The mountainous terrain contain a highly variable topography which significantly contributes toward habitat diversity and the survey also indicated a relatively high species diversity.

Presence of rare and endangered species: From the limited surveys conducted as well as previous and desktop data it is quite clear that the Botshabelo MOSS contains quite a high number of protected species with several also regarded as being rare or uncommon. No Red Listed species could be identified though the likelihood remain and despite this is still regarded as a high value.

Ecological function: The ecological functioning of the Botshabelo MOSS is still largely intact though some impacts do cause some modification. The majority of the MOSS is intact though overgrazing by domestic livestock was noted to be very high close to urban areas and still significant in areas further away. This leads to a decrease in species diversity and a modification of the species composition and vegetation structure. However, as vegetation is still largely intact and contain sensitive habitats and vegetation types, watercourses and wetlands and provide a functioning ecological system within an urban setting the functioning of the MOSS must be regarded as high.

Degree of rarity/conservation value: Overall the MOSS should be regarded as having a high conservation value. It remains largely intact and contains unique habitats centred around mountainous areas with a large amount of watercourses and wetlands.

Percentage ground cover: Overall the percentage ground cover is quite low. It was notable that overgrazing by domestic livestock significantly decreases the vegetation cover.

Vegetation structure: Overall, the vegetation structure of the MOSS is natural to a large degree though modification as a result of overgrazing leads to an increase in shrubby species which leads to some modification.

Infestation with exotic weeds and invader plants: In general, the infestation of exotic species is relatively low. However, invasive weeds and succulent plants are prominent in areas of high overgrazing and general disturbance such as along watercourses. Overall this is considered as moderate.

Degree of grazing/browsing impact: The MOSS falls largely within communal areas which is utilised for grazing by domestic livestock. These is not currently any grazing regime being followed and together with high stocking levels this leads to a high amount of overgrazing.

Signs of erosion: Since overgrazing is quite high and coupled with the uneven terrain this leads to quite high levels of erosion, both sheet and gulley erosion was evident in many areas.

Terrestrial animals: The Botshabelo MOSS is quite extensive and contains substantial natural areas. Consequently a varied and diverse mammal population is likely to occur. However, due to the urban setting and impacts associated with it, the likelihood of rare or endangered mammals occurring is relatively low. Furthermore, extensive overgrazing and the use of herding dogs will also have a significant impact on the mammal population. Overall, the mammal population is considered to be moderate in terms of diversity but low in terms of the likelihood of rare or endangered species occurring.

Table 25: Biodiversity Sensitivity Rating for the Botshabelo 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	3		
Vegetation structure		2	
Infestation with exotic weeds and invader plants or encroachers		2	
Degree of grazing/browsing impact	3		
Signs of erosion	3		
Terrestrial animal characteristics			
Presence of rare and endangered species		2	
Sub total	9	6	4
Total		19	

5.1.3 Thaba Nchu

Habitat diversity and species richness: The MOSS consists exclusively of hills, ridges and mountainous terrain with plains being almost completely absent. Numerous wetlands and watercourses have their origins in these mountainous areas which does contribute toward habitat diversity. The mountainous terrain contain a highly variable topography which significantly contributes toward habitat diversity and the survey also indicated a relatively high species diversity.

Presence of rare and endangered species: From the limited surveys conducted as well as previous and desktop data it is quite clear that the Thaba Nchu MOSS contains quite a high number of protected species with several also regarded as being rare or uncommon. No Red Listed species could be identified though the likelihood remain and despite this is still regarded as a high value.

Ecological function: The ecological functioning of the Thaba Nchu MOSS is still largely intact though some impacts do cause some modification. The majority of the MOSS is intact though overgrazing by domestic livestock was noted to be very high close to urban areas and still significant in areas further away. This leads to a decrease in species diversity and a modification of the species composition and vegetation structure. However, as vegetation is still largely intact and contain sensitive habitats and vegetation types, watercourses and wetlands and provide a functioning ecological system within an urban setting the functioning of the MOSS must be regarded as high.

Degree of rarity/conservation value: Overall the MOSS should be regarded as having a high conservation value. It remains largely intact and contains unique habitats centred around mountainous areas with a large amount of watercourses and wetlands.

Percentage ground cover: Overall the percentage ground cover is quite low. It was notable that overgrazing by domestic livestock significantly decreases the vegetation cover.

Vegetation structure: Overall, the vegetation structure of the MOSS is natural to a large degree though modification as a result of overgrazing leads to an increase in shrubby species which leads to some modification.

Infestation with exotic weeds and invader plants: In general, the infestation of exotic species is relatively low. However, invasive weeds and succulent plants are prominent in areas of high

overgrazing and general disturbance such as along watercourses. Overall this is considered as moderate.

Degree of grazing/browsing impact: The MOSS falls largely within communal areas which is utilised for grazing by domestic livestock. These is not currently any grazing regime being followed and together with high stocking levels this leads to a high amount of overgrazing.

Signs of erosion: Since overgrazing is quite high and coupled with the uneven terrain this leads to quite high levels of erosion, both sheet and gulley erosion was evident in many areas.

Terrestrial animals: The Botshabelo MOSS is quite extensive and contains substantial natural areas. Consequently a varied and diverse mammal population is likely to occur. However, due to the urban setting and impacts associated with it, the likelihood of rare or endangered mammals occurring is relatively low. Furthermore, extensive overgrazing and the use of herding dogs will also have a significant impact on the mammal population. Overall, the mammal population is considered to be moderate in terms of diversity but low in terms of the likelihood of rare or endangered species occurring.

Table 26: Biodiversity Sensitivity Rating for the Thaba Nchu 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	3		
Vegetation structure		2	
Infestation with exotic weeds and invader plants or encroachers		2	
Degree of grazing/browsing impact	3		
Signs of erosion	3		
Terrestrial animal characteristics			
Presence of rare and endangered species		2	
Sub total	9	6	4
Total		19	

5.1.4. Soutpan/Ikgomotseng

Habitat diversity and species richness: Soutpan contains a significant diversity of habitat which includes plains with clay and sandy soils, ridges and hills, watercourses and wetlands and a large pan system. As a result species diversity is also significant, though due to the extent of the area and general low diversity in this region the overall species diversity remains moderate.

Presence of rare and endangered species: Survey of the Soutpan area indicated at least a moderate amount of protected species occurring here with a few also being considered as uncommon, including *Nananthus broomii, Euphorbia clavaroides* and *Bonatea antennifera*.

Ecological function: The ecological functioning of the natural areas around Soutpan/Ikgomotseng, though degraded to some extent is still largely intact. Some of the vegetation units such as the pan system, associated wetlands and the hills and ridges perform important ecological functions and in general this should therefore be regarded as high.

Degree of rarity/conservation value: Several elements and vegetation units around Soutpan contain a high or very high level of sensitivity and these would therefore have a high conservation value. These area include portions of remaining Vaal-Vet Sandy Grassland, hills and ridges, the pan system and all associated watercourses and wetlands.

Percentage ground cover: Overall the percentage ground cover is moderate. This is considered largely natural as the clay grasslands, pan system and hills and ridges naturally only has a moderate percentage vegetation cover. However, impacts such as overgrazing and salt mining would at least result in a moderate modification of the natural vegetation cover.

Vegetation structure: Overall, the vegetation structure of natural areas seem to still be intact and incudes a well-developed grass layer, woodland shrub and tree areas, a prominent dwarf karroid shrub component and halophytic riparian vegetation. However, salt mining and especially the infestation by exotic *Prosopis glandulosa* causes at least a moderate modification of the natural vegetation structure.

Infestation with exotic weeds and invader plants: In general, the infestation of exotic species is relatively low. However, areas where the invasive *Prosopis glandulosa* (Mesquite tree) forms at least moderate infestations is a concern and has the potential to become a severe infestation if measures to eradicate it is not implemented. For this reason it has been rated as low.

Degree of grazing/browsing impact: The area contains large area utilised as communal grazing and normally such areas are subjected to high levels of overgrazing. However, the survey has indicated that although significant overgrazing is present this should only be regarded as having a moderate impact.

Signs of erosion: Impacts contributing to erosion remains relatively low and as long as overgrazing and trampling by livestock remains moderate the level of erosion should also remain moderate.

Terrestrial animals:
The area of Soutpan /Ikgomotseng contains extensive natural areas with the level of modification remaining largely moderate as indicated. Consequently a varied and diverse mammal population is also present. Overall, the mammal population is considered to be moderate in terms of diversity and likelihood of rare or endangered species occurring.

Table 27: Biodiversity Sensitivity Rating for the Soutpan/Ikgomotseng urban area.

	Low (3)	Medium (2)	High (1)
Vegetation characteristics			
Habitat diversity & Species richness		2	
Presence of rare and endangered species		2	
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		2	
Signs of erosion		2	
Terrestrial animal characteristics			
Presence of rare and endangered species		2	
Sub total	3	14	2
Total		19	

5.1.5. Dewetsdorp

Habitat diversity and species richness: Dewetsdorp contains a varied diversity of habitats which includes grassland, undulating plains, sandstone outcrops, ravines, ridges and hills, watercourses and wetlands. The habitat diversity is therefore regarded as high. However, the region is not known for a high species diversity and the survey also confirm a significant but moderate species diversity.

Presence of rare and endangered species: Survey of the Dewetsdorp indicated the presence of numerous protected species though overall is still regarded as a moderate value.

Ecological function: The ecological functioning of the natural areas around Dewetsdorp remains largely intact, however the town itself does cause significant degradation, of especially the stream system flowing through it and quite heavy overgrazing also degrades the conditions of the natural areas to a significant extent. Some of the vegetation units such as the sandstone ridge system, outcrops and the stream system and associated wetland systems originating in these areas have a very high conservation value and their ecological functioning should therefore be regarded as high.

Degree of rarity/conservation value: Several elements and vegetation units around Dewetsdorp contain a high or very high level of sensitivity and these would therefore have a high conservation value. These areas include the portions of sandstone ridges, outcrops and hills and all of the watercourses and associated wetland conditions.

Percentage ground cover: Overall the percentage ground cover is moderate. This is however considered to be modified from the natural condition. The area normally contains a dense grass layer though it was noted that many areas affected by high levels of overgrazing had a significantly decreased grass cover.

Vegetation structure: Overall, the vegetation structure of natural areas seem to still be intact and is dominated by a well-developed grass layer with shrubs and trees becoming prominent along slopes and ravines and a dwarf karroid shrub component being dominant on shallow soils. However, invasive tree species is prominent along several watercourses where they alter the vegetation structure significantly.

Infestation with exotic weeds and invader plants: In general, the infestation of exotic species is relatively low. However, invasive trees are abundant along several watercourses and forms at least a moderate infestation here.

Degree of grazing/browsing impact: The area contains large area utilised as communal grazing and it was notable that overgrazing by livestock is quite high in several areas, causing visible degradation of the natural vegetation. Improved management of communal grazing should be considered in order to improve the grazing quality.

Signs of erosion: Overgrazing and trampling is quite high in many areas and coupled with gentle to moderate slopes in the majority of the study area, this leads to prominent erosion in many areas. Both sheet and gulley erosion was notable and head cutting was noted to occur in the headwaters of watercourses.

Terrestrial animals:
The area of Dewetsdorp contains extensive natural areas with the level of modification remaining largely moderate as indicated. Consequently a varied and diverse mammal population is likely to occur. However, herdsmen make use of a large number of herding dogs and these are anticipated to have a significant impact on mammals. Overall, the mammal population is considered to be moderate in terms of diversity but low in terms of the likelihood of rare or endangered species occurring.

Table 28: Biodiversity Sensitivity Rating for the Dewetsdorp urban area.

	Low (3)	Medium (2)	High (1)
Vegetation characteristics			
Habitat diversity & Species richness		2	
Presence of rare and endangered species		2	
Ecological function			1
Uniqueness/conservation value			1
Vegetation condition			
Percentage ground cover	3		
Vegetation structure		2	
Infestation with exotic weeds and invader plants or encroachers		2	
Degree of grazing/browsing impact	3		
Signs of erosion	3		
Terrestrial animal characteristics			
Presence of rare and endangered species		2	
Sub total	9	10	2
Total		21	

5.1.6. Wepener

Habitat diversity and species richness: Wepener contains a varied diversity of habitats which includes undulating grassland plains, ridges, hills and rocky outcrops, mountainous terrain and the varied habitat associated with this, numerous watercourses and sensitive wetlands. The habitat diversity is therefore regarded as high. In addition, the mountainous terrain and vegetation

types associated with it is known for elevated species diversity. This was also confirmed by the survey.

Presence of rare and endangered species: Survey of the Wepener indicated the presence of numerous protected species though they are mostly widespread and Red Listed species absent. Consequently this is still regarded as only a moderate value.

Ecological function: The ecological functioning of the natural areas around Wepener remains largely intact, however the town itself does cause significant degradation, of especially the Sandspruit flowing through it and quite heavy overgrazing and resulting erosion also degrades the conditions of the natural areas to a significant extent. Some of the vegetation units such as the Basotho Montane Shrubland and Eastern Free State Clay Grassland and the numerous watercourses and sensitive wetland systems originating in these areas have a very high conservation value and their ecological functioning should therefore be regarded as high.

Degree of rarity/conservation value: Several elements and vegetation units around Wepener contain a high or high level of sensitivity and these would therefore have a high conservation value. These areas include the hills, ridges, mountainous terrain and plateaus and all of the watercourses and associated wetland conditions.

Percentage ground cover: Overall the percentage ground cover is moderate. This is however considered to be modified from the natural condition. The area normally contains a dense grass layer though it was noted that many areas affected by high levels of overgrazing had a significantly decreased grass cover with extensive erosion also present.

Vegetation structure: Overall, the vegetation structure of natural areas seem to still be intact and is dominated by a well-developed grass layer with shrubs and trees becoming prominent along mountainous terrain and ravines. However, invasive tree species is prominent along several watercourses where they alter the vegetation structure significantly.

Infestation with exotic weeds and invader plants: In general, the infestation of exotic species is relatively low. However, invasive trees are abundant along the Sandspruit and Caledon Rivers and form heavy infestations here and is quite problematic also causing significant modification of these watercourses.

Degree of grazing/browsing impact: The area contains large area utilised as communal grazing and it was notable that overgrazing by livestock is quite high in most areas, causing visible degradation of the natural vegetation and contributing to extensive erosion, especially along watercourses and steep slopes. Improved management of communal grazing should be considered in order to improve the grazing quality.

Signs of erosion: Overgrazing and trampling is quite high in most areas and coupled with steep slopes in mountainous terrain and the functioning of watercourses and wetlands, this leads to prominent erosion. Both sheet and gulley erosion was notable and head cutting was common along watercourses and wetlands.

Terrestrial animals:
The area of Wepener contains extensive natural areas with the level of modification remaining largely moderate as indicated. Consequently a varied and diverse mammal population is likely to occur. However, herdsmen make use of a large number of herding dogs and these are

anticipated to have a significant impact on mammals. Overall, the mammal population is considered to be moderate in terms of diversity but low in terms of the likelihood of rare or endangered species occurring.

Table 29: Biodiversity Sensitivity Rating for the Wepener urban area.

	Low (3)	Medium (2)	High (1)
Vegetation characteristics			
Habitat diversity & Species richness			1
Presence of rare and endangered species		2	
Ecological function			1
Uniqueness/conservation value			1
Vegetation condition			
Percentage ground cover	3		
Vegetation structure		2	
Infestation with exotic weeds and invader plants or encroachers	3		
Degree of grazing/browsing impact	3		
Signs of erosion	3		
Terrestrial animal characteristics			
Presence of rare and endangered species		2	
Sub total	12	6	3
Total		21	

5.1.7 Vanstadensrus

Habitat diversity and species richness: Due to the small size of the town and surroundings it contains a lower diversity of habitats. However, this still includes undulating grassland plains, a ridge system and a variety of habitats associated with these as well as several watercourses and wetlands. The habitat diversity is therefore regarded as moderate. As a result, species diversity for the town overall is also regarded as moderate.

Presence of rare and endangered species: Survey of the Vanstadensrus indicated the presence of several protected species though they are mostly widespread and Red Listed species absent. Consequently this is still regarded as only a moderate value.

Ecological function: The ecological functioning of the natural areas around Vanstadensrus remains largely intact, however the town itself does cause significant degradation with overgrazing by domestic livestock also resulting in a decrease in vegetation cover and increased erosion. The ridge system consisting of Basotho Montane Shrubland as well as the Witspruit tributary and associated wetlands has a high conservation value and their ecological functioning should therefore be regarded as high.

Degree of rarity/conservation value: A few elements and vegetation units around Vanstadensrus contain a high or very high level of sensitivity and these would therefore have a high conservation value. These areas include the ridge system, Witspruit tributary and associated wetlands.

Percentage ground cover: Overall the percentage ground cover is moderate. This is however considered to be modified from the natural condition. The area normally contains a dense grass layer though it was noted that many areas affected by high levels of overgrazing had a significantly decreased grass cover with extensive erosion also present.

Vegetation structure: Overall, the vegetation structure of natural areas seem to still be intact and is dominated by a well-developed grass layer with shrubs and trees becoming prominent along the ridge system and banks of the Witspruit. However, invasive tree species is prominent along the stream where they alter the vegetation structure significantly. An increase in dwarf karroid shrubs were also notable in areas of overgrazing.

Infestation with exotic weeds and invader plants: In general, the infestation of exotic species is relatively low. However, invasive trees are abundant along the Witspruit tributary and is quite problematic also causing significant modification of the stream.

Degree of grazing/browsing impact: The surroundings of Vanstadensrus are utilised as communal grazing and it was notable that overgrazing by livestock is quite high in most areas, causing visible degradation of the natural vegetation and contributing to extensive erosion, especially along watercourses and steep slopes. Improved management of communal grazing should be considered in order to improve the grazing quality.

Signs of erosion: Overgrazing and trampling is quite high in most areas and coupled with steep slopes along the ridge and the functioning of watercourses and wetlands, this leads to prominent erosion. Both sheet and gulley erosion was notable.

Terrestrial animals:
The area of Vanstadensrus contains significant natural areas with the level of modification remaining largely moderate as indicated. Consequently a varied and diverse mammal population is likely to occur. However, herdsmen make use of a large number of herding dogs and these are anticipated to have a significant impact on mammals. Overall, the mammal population is considered to be moderate in terms of diversity but low in terms of the likelihood of rare or endangered species occurring.

Table 30: Biodiversity Sensitivity Rating for the Vanstadensrus urban area.

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

Presence of rare and endangered species		2	
Sub total	12	8	2
Total		21	

5.2. Biodiversity sensitivity rating (BSR) interpretation

Table 31: Interpretation of Biodiversity Sensitivity Rating.

Site	Score	Site Preference Rating	Value
Bloemfontein urban area	17	Good condition	2
Botshabelo urban area	19	Good condition	2
Thaba Nchu urban area	19	Good condition	2
Soutpan/Ikgomotseng urban area	19	Good condition	2
Dewetsdorp urban area	21	Degraded	3
Wepener urban area	21	Degraded	3
Vanstadesnrus	22	Degraded	3

6. Summary and conclusions

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.

6.1 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.

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.

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 area 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.

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