# 5. BIOPHYSICAL DESCRIPTION OF THE PROPOSED SITE

## 5.1 Location of the site

The proposed site, Remaining Extent (also referred to as the Remainder (Urban Dynamics, 2017a)) of the farm Rockdale 442 JS, is located west of the existing Rockdale residential area and the N11 National Road (Figure 5.1). It is located north of the N4 National Road, to the south of Columbus Stainless (Pty) Ltd. and southeast of Middelburg (Figure 5.1).

Figure 5.1 indicates the location of the site in relation to the greater Middelburg area. The said site is approximately 230 ha in extent.

The centre co-ordinates of the site are:
- 25º49'19.57"S;
- 29º30'55.92"E.

The Surveyor-General 21 digit site reference number for the proposed site is:

| | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| REMAINING EXTENT | T | O | J | S | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4 | 4 | 2 | 0 | 0 | 0 | 0 | 0 |

The said site falls under the jurisdiction of the Steve Tshwete Local Municipality (MP313) and the Nkangala District Municipality.

## 5.2 Land use

### 5.2.1 Zoning of the site

The Remaining Extent of the farm Rockdale 442 JS is currently zoned 'Agricultural' (Urban Dynamics, 2017b).

### 5.2.2 Land ownership

The said site currently belongs to Rockdale Industrial (Pty) Ltd (Appendix 1). The title deed number is T00009261/2014 (Appendix 1). According to the title deed, the property is 736.9632 ha in extent.

It should be noted that in 2014 an area measuring 2.3517 ha (described as Portion 9 of the farm Rockdale 442 JS) was registered in the name of the Steve Tshwete Local Municipality for the purposes of an electrical substation.

Another piece of the property (approximately 1.46 ha in extent) is utilised for a weigh bridge (Mid-Hen overloading mass control facility; Figure 5.2).

Therefore, the remaining area of the Remaining Extent (or Remainder) of the farm Rockdale 442 JS measures 733.1515 ha (Urban Dynamics, 2017b). An area of approximately 230 ha located to the north of the N4 National Road is proposed to be developed (Urban Dynamics, 2017b).

### 5.2.3 Land use and major existing infrastructure

Figure 5.2 provides an aerial view of the proposed development site.

The following infrastructure is present on site:
- Rockdale Electrical Substation (Figure 5.2);
- Eskom powerlines (Figure 5.2):

    - adjacent to the N11 national road (Figure 5.2);
    - along the northwestern portion (Figure 5.2);
    - crossing from the east towards the Rockdale Substation (Figure 5.2);
- Mid-Hen overloading mass control facility (weighbridge; Figure 5.2);
- PIC South Africa (Alzu) AI facility and associated infrastructure (including manure dam; Figure 5.2);
- Small dam located in the south western corner of the site (Figure 5.2);
- Two abandoned borrow pits and an illegal dumping site (industrial and domestic waste) (Figure 5.2);
- An old railway line servitude (Figure 5.2);
- Water pipelines (raw and potable; Photo 5.1) extending across the property (Figure 5.2) from the RMB reservoir up to Kanhym farm situated to the south of the development (Urban Dynamics, 2017b);
- Various gravel roads extending across the site (Figure 5.2).

The above-mentioned railway line servitude dates back to 1949 (Urban Dynamics, 2017a). The railway line was never developed. However, construction did commence as an elevated embankment with culverts (Photo 5.2 and Photo 5.3) in places is present in the south western portion of the property. In addition, a deep cutting/trench (5m wide and 5-8m deep; Photo 5.4) extending over a distance of 750m is also present. This trench is filled with water.

It is known that an Initiation School is held on site at certain times of the year.


Photo 5.1: Water pipeline extending across the property

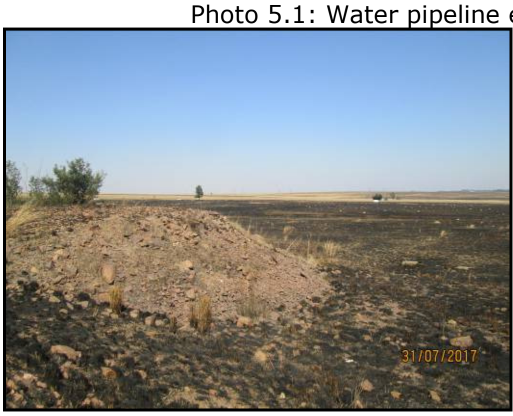

Photo 5.2: The railway embankment

Photo 5.3: Culverts under the railway embankment


Photo 5.4: The deep trench/cutting for the railway line

According to Urban Dynamics (2017b), the following servitudes or endorsements are registered against the said property and included in the layout plan:

- Right of way servitude in favour of Union Free State Coal and Gold Mine Limited for a railway track – Notarial Deed of Servitude No 479/1951-S, diagram numbers S.G. A6861/49 & S.G. A6862/49.
- Expropriation of 54.57 ha of the land by the Department of Transport in terms of Section 8(1)(b) of Act 54 of 1971 – Expropriation Notice EX638/75.
- Servitude to convey electricity over the property in favour of ESKOM – Notarial Deed K2318/85 S,
- Expropriation of 34.84 ha of the land by the Department of Transport in terms of Section 8(1)(b) of Act 54 of 1971 – Expropriation Notice EX 192/85.
- The right to take gravel, stone, sand, clay, water or any other material or substance on or in a portion of the property has been expropriated by the National Transport Commission – EX 370/85.
- The right to use a portion of the property measuring approximately 14.85 ha has been expropriated by the National Transport Commission in terms of Section 8(1)(b) of Act 54 of 1971 – Expropriation Notice EX 127/86, diagram A.
- Servitude to convey electricity over the property in favour of ESKOM – Notarial Deed K222/85 S.
- Expropriation of approximately 2,17 ha of the land by the National Transport Commission in terms of Section 8(1)(b) of Act 57 of 1971 – Expropriation Notice EX 1141/86.
- Expropriation of approximately 8,824 ha of the land by the National Transport Commission in terms of Section 8(1)(b) of Act 54 of 1971 – Expropriation Notice EX 211/87.
- Right of way servitude in favour of the Middelburg Town Council measuring 9 684m²– Notarial Deed of Servitude No K634/81.
- Property is subject to certain rights in favour of Ingwe Collieries Limited as mentioned in Notarial Deed K 3235/02 S.

It is proposed that the following two servitudes be cancelled (a formal request in this regard to be submitted to Eskom):

- Right granted in favour of Electrical Supply Commission to convey electricity over the property – Notarial Deed of Servitude No 664/1967-S, diagram A2162/1965.
- Servitude to convey electricity in favour of ESKOM – Notarial Deed K1384/1974-S, diagram A9097/1973.

The water pipelines (raw and potable) extending across the property (Photo 5.1) are not located within a registered servitude. A formal servitude needs to be registered for this purpose as part of the township establishment process (Urban Dynamics, 2017b).

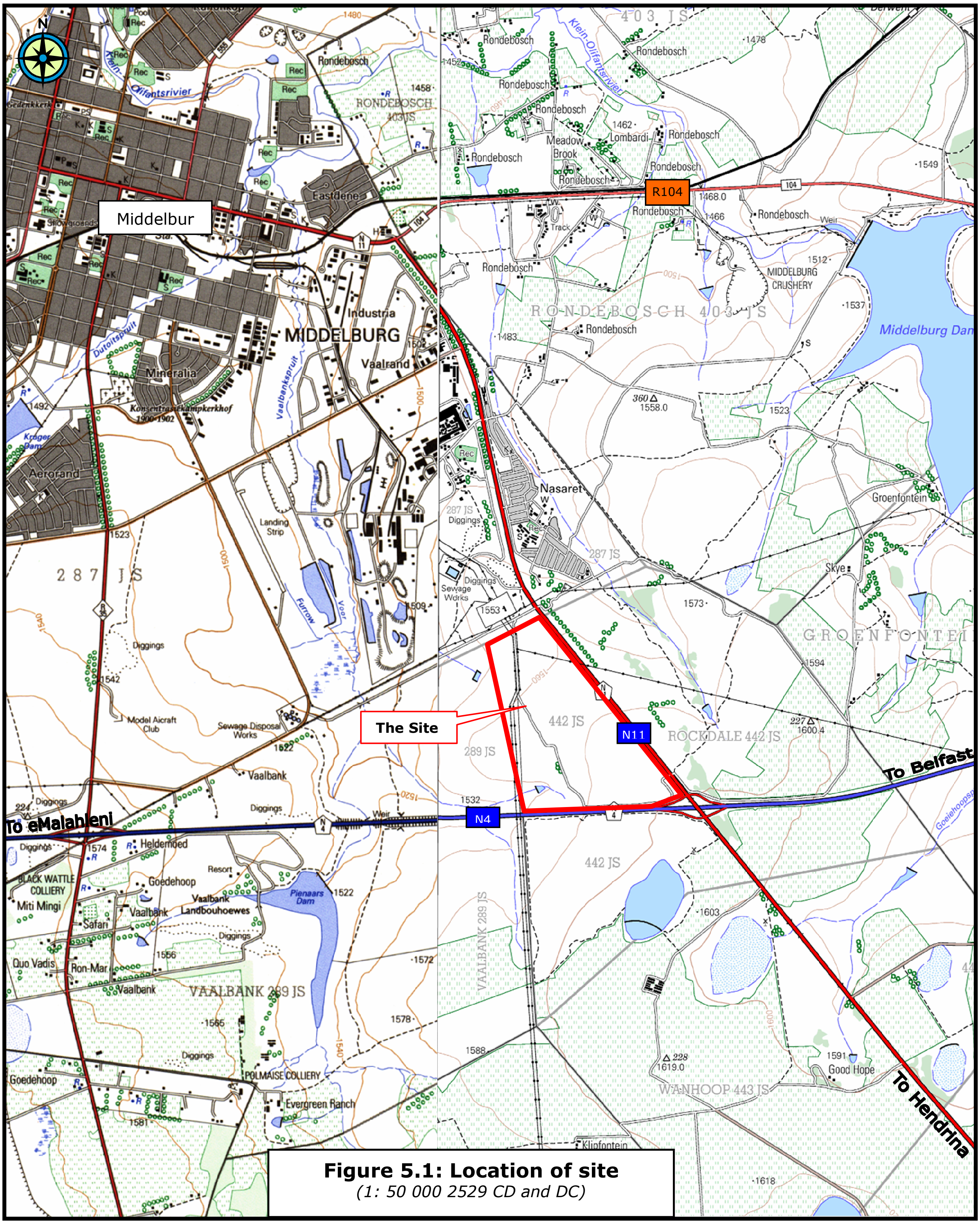


**Figure 5.1: Location of site**
*(1: 50 000 2529 CD and DC)*

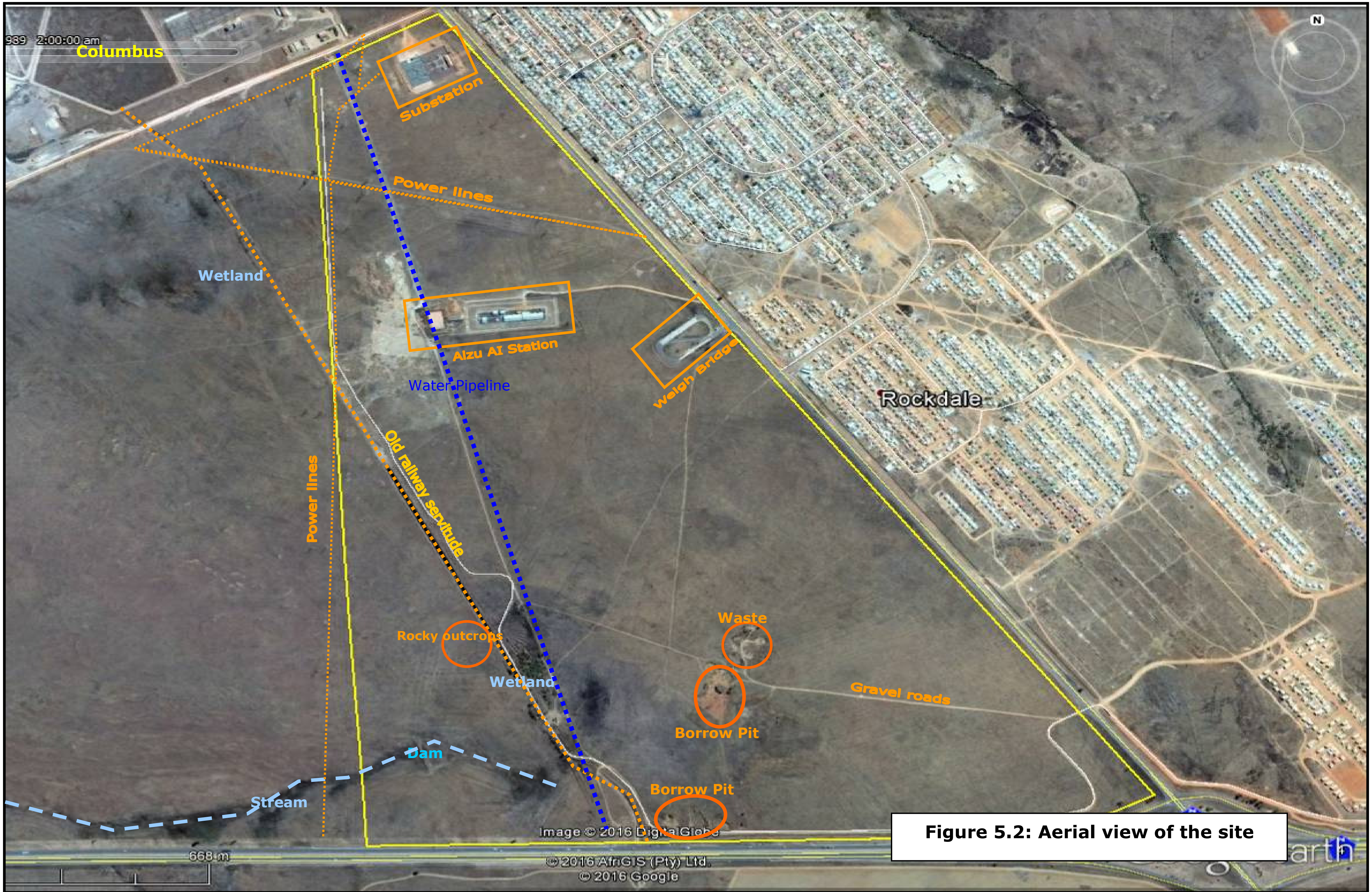


**Figure 5.2: Aerial view of the site**

#### 5.2.4 Adjacent land uses

The proposed site is located west of the existing Rockdale residential areas, Middelburg Extension 24 and the N11 National Road (Figure 5.2). It is located north of the N4 National Road (Figure 5.2) and southeast of Middelburg (Figure 5.1). No development is present to the west of the proposed development site (Figure 5.2).

The proposed development site is connected to the southern portion of the property by means of a gravel road underneath of the N4 national road as indicated in Photo 5.5.


Photo 5.5: View of road underneath the N4 national road

An industrial area (Industria) is located towards the north north-west of the site (Figure 5.3a). A gravel road is present between the proposed site and boundary fence of these industries (Columbus Stainless and Middelburg Ferrochrome; Figure 5.3a).

It should be noted that the area located directly adjacent to the site is mostly vacant as indicated in Figure 5.3a. An Eskom substation (Figure 5.3a; no 2) is located adjacent to the gravel road as well as the Nasaret Reservoir (Figure 5.3a; no 3), which provides water to the Nasaret area. Further north, the main raw water reservoir of Middelburg is present (Figure 5.3a; no 4).

Columbus Stainless was founded in 1966 and is Africa's only producer of stainless steel flat products. The facility comprises of a steel plant and furnaces (Figure 5.3b; no 6), shot blaster (Figure 5.3b; no 7), slag handling area, etc. An Ammonia installation (which is registered as a Major Hazard Installation (MHI)) is also present within the Columbus Stainless site (Figure 5.3a; no 1). This installation is located approximately 3km from the proposed Rockdale residential area.

A company (PBD-Lime - Calmasil Plant) that produces agricultural lime (consists of calcium, magnesium and silica) from slag produced by Columbus Stainless operates on a small portion of the Columbus Stainless property near the Eskom substation (Figure 5.3a and Figure 5.3b; no 5). This plant is located approximately 1km from the proposed residential development.

Middelburg Ferrochrome is located on the western boundary of Columbus Stainless (Figure 5.3a) and was established in 1964 as a Low Carbon Ferrochrome production facility. Charge chrome was first produced on this site in 1974 by Middelburg Steel and Alloys (Pty) Ltd, which was acquired by Samancor in 1991. The plant currently produces charge chrome from two

Submerged-Arc Furnaces (SAF's), two Direct-Current (DC) Furnaces, a Pelletising and Sintering plant (PSP) and a metal recovery plant.


**Figure 5.3a: An aerial view of Columbus Stainless and Middelburg Ferrochrome in relation to the said site.**


**Figure 5.3b: An aerial view of the Columbus Stainless and Middelburg Ferrochrome facilities.**

*(Legend: 1: Ammonia Installation; 2: Eskom substation; 3: Nasaret Reservoir; 4: Main water reservoir; 5: PBD-Lime: Calmasil Plant; 6: Steel Plant & Furnaces; 7: Shot blaster).*

**Protected areas**

The nearest 'Formal Protected Area' in terms of the National Environmental Management: Protected Areas Act, 2003 (Act No. 57 of 2003) is the Witbank Nature Reserve, which is situated approximately 30 km to the southwest of the study area.

However, the Vaalbank Private Nature Reserve (435.627 ha in extent and consisting of a number of properties) was proclaimed in 1961 and is located approximately 1.6km to the west of the site (Figure 5.3c). The proposed site is located outside of the 1km buffer zone as indicated in Figure 5.3c.

This 'nature reserve' is however not managed as such and currently a number of activities take place within this so-called private nature reserve. No information regarding de-proclamation of the nature reserve could be found.

In the Mpumalanga Biodiversity Sector Plan (2013), a 'Protected Area' (PA) is defined as:

*Those areas that are already proclaimed under some legislation, including stewardship sites.*

According to the MBSP Land-Use Guideline (2013), these areas are managed primarily for biodiversity conservation. The management of PAs is provided for in laws and regulations at national and provincial level and as such requires a formally approved management plan. The required management plan must identify allowable activities, uses and developments and allocate them to appropriate zones. The plan must also deal with policy and implementation issues, time-frames, staffing, performance criteria, budgets, capacity building, resource use and other social and economic opportunities, including contractual and co-management arrangements. All operational aspects of managing PAs are subject to their main purpose, that of protecting and maintaining biodiversity.

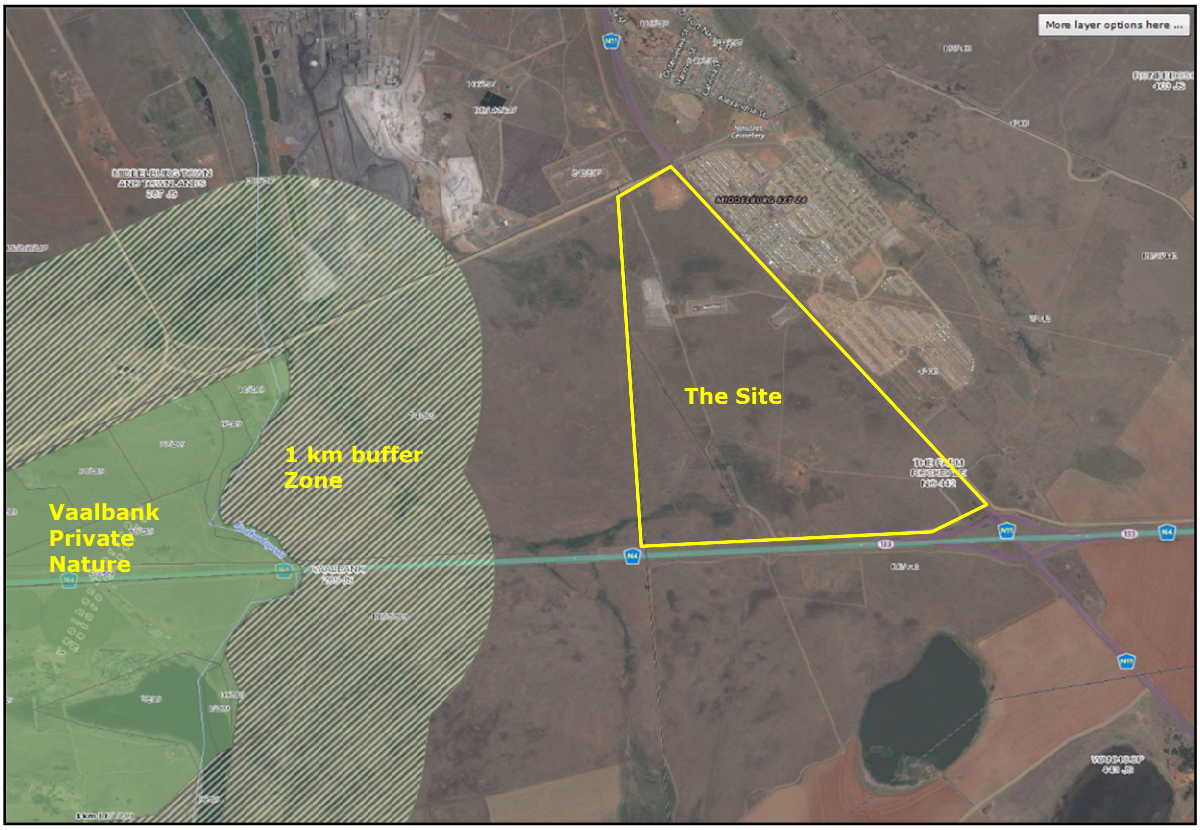


**Figure 5.3c: The proposed site in relation to the Vaalbank Private Nature Reserve**

## 5.3 Geology/geotechnical aspects

### 5.3.1 Geology of the site

According to the 1: 250 000 Geological Series (number 2528 Pretoria):

- The eastern half is underlain by the Vryheid Formation (sandstone, shale, gritstone, conglomerates and coal measures) of the Ecca Group, Karoo Sequence – grey-green (Figure 5.4);
- The western half is underlain by Selonsrivier Formation (subordinate andesite and red porphyritic rhyolite (felsite) classified as volcanic rocks) of the Rooiberg Group, Transvaal Sequence – orange (Figure 5.4). According to Engeolab (2016), a generally shallow soil profile

with outcrops and shallow sub-outcrops can be expected within this area.

The proposed development site falls within a region with a Weinert N-Value of 2.5 indicating that chemical decomposition would be the dominant mode of weathering (Cilliers and Meyer, 2017).

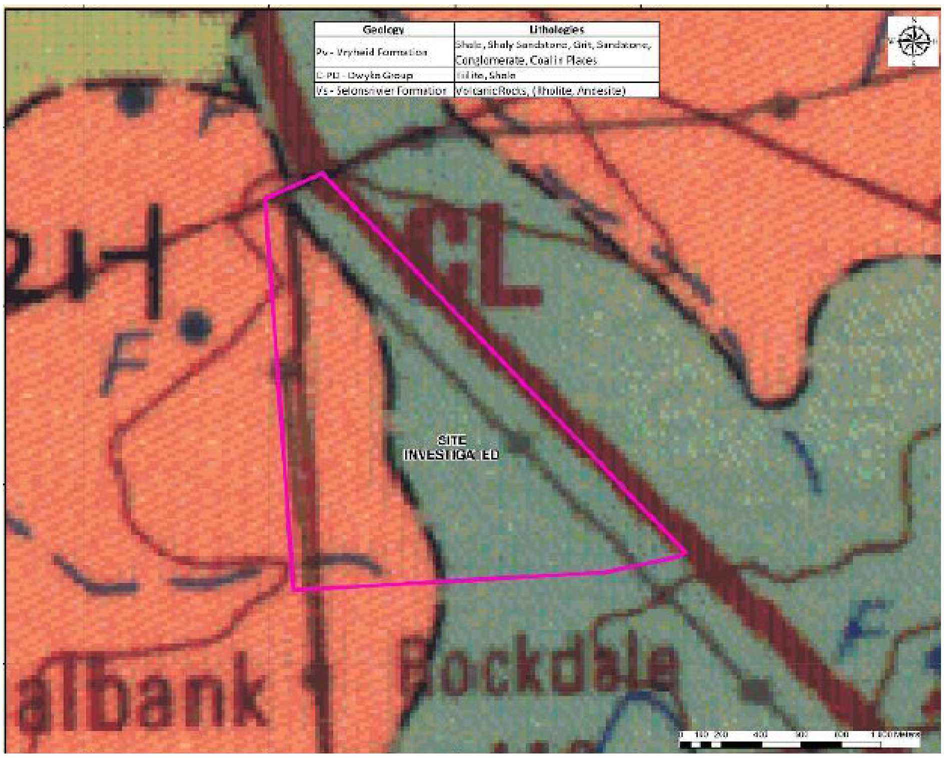


**Figure 5.4: Geology of the site (taken from Engeolab, 2016; Cilliers and Meyer, 2017).**

Engeolab (2016) indicated the following for the site:

- no mining activity (including undermining) is present on site (according to the historic data obtained from the Department of Mineral Resources (Cilliers and Meyer, 2017)) except for the two abandoned borrow pits identified (Figure 5.2);
- the area is not underlain by dolomitic or other carbonaceous rocks prone to sinkhole or doline formation (Celliers and Meyer, 2017);
- the site is located in a low seismic activity zone with any natural tremors being negligible. Any mining induced seismic activity is also expected to be insignificant.

### 5.3.2 Geotechnical investigation

A geotechnical investigation was conducted by B. Cilliers and M. Meyer of Engeolab cc in order to determine the geotechnical suitability of site for development purposes. A copy of the geotechnical report (referred to as Cilliers and Meyer, 2017) is provided in Appendix 13. This report should be consulted with regards to methodology used and the tests carried out on the samples collected.

#### 5.3.2.1 Site soils

One hundred and nineteen (119) test pits were excavated using a tractor-loader-backhoe (TLB). Based on the analysis of these test pits, the following materials were identified on site as indicated in Table 5.1:

- imported material;
- transported materials (colluvium and pebble marker);
- pedogenic material;
- sandstone residuum and bedrock;
- rhyolite residuum and bedrock.

**Table 5.1: Average soil and bedrock profile (taken from Cilliers and Meyer, 2017)**

| SOIL/BEDROCK PROFILE | ORIGIN | AVERAGE THICKNESS RANGE (m) | AVERAGE DEPTH RANGE (m) | ENGINEERING CHARACTERISTICS |
|---|---|---|---|---|
| Imported material | Various origins | Surface to 0.6 | Surface to 0.6 | Medium compressible, soft excavatable, not recommended as founding medium without some remedial measures. |
| Colluvium | Transported material | Surface to 0.1 to 1.9 | Surface to 0.1 to 1.9 | High to Medium compressible, soft excavatable, poor founding medium. |
| Pebble marker | Transported material | 0.2 – 0.6 | 0.1 – 0.9 | Medium compressible, soft excavatable, poor to fair founding medium. |
| Pedogenic material | Pedogenesis | 0.1 – 0.6 | 0.1 – 0.9 | Soft excavation class, susceptible to shallow perched water table, good founding medium |
| Pedogenic material (hardpan) | Pedogenesis | >0.1 – 0.4 | >0.4 – 1.1 | Intermediate excavation class, susceptible to shallow perched water table, good founding medium |
| Residuum Sandstone | In situ decomposed | 0.1 – 1.9 | 0.2 – 2.6 | Medium to low compressible, soft excavatable, good founding medium. |
| Sandstone of the Vryheid Formation | Weathered Sandstone | N/A | >surface – 2.1 | Intermediate to hard excavatable, generally very good founding medium. |
| Residual Rhyolite | In situ decomposed | 0.3 – 1.4 | 0.1 – 1.9 | Medium to low compressible, soft excavatable, good founding medium. |
| Rhyolite of the Selonsrivier Formation | Weathered Rhylite | N/A | >surface – 2.4 | Intermediate to hard excavatable, generally very good founding medium. |

**Imported material**

Cilliers and Meyer (2017) noted some imported material on the northern side of the substation and on the western side of the PIC South Africa (Alzu) facility (Figure 5.2). This material consisted of dark greyish brown, medium dense to dense, fine to medium sandy silty clay with scattered fine to coarse gravel and cobbles. The average depth of this material ranged from surface to 0.6m below surface (Table 5.1).

**Transported materials (colluvium and pebble marker)**

The average soil profile in this area consists of a thin topsoil, extending to depths ranging between 0.10m and 1.90m below surface (Table 5.1). These transported soils consist of loose to medium dense, intact, fissured and slight 'pinhole structures' within some profiles, silty clayey sand with traces of fine gravels and nodules with grass roots in the upper portion of the profile (Cilliers and Meyer, 2017).

According to Cilliers and Meyer (2017), these transported soils become thicker (thicknesses of up to 1.9m recorded) to the southeast (i.e. adjacent to the N11 and N4 interchange). These soils exhibit a collapsible grain structure that can withstand relatively large imposed stresses with small settlement at a low *in situ* moisture content (further details provided in Appendix 13).

The colluvium is sequentially underlain by a pebble marker (thickness ranging between 0.1 to 0.6m; depth ranging between 0.3 to 0.9m below surface; Table 5.1) comprising gravelly colluvium and sub-rounded ferricrete and quartz gravels mixed with fine to medium grained silty sand.

**Pedogenic material**

According to Cilliers and Meyer (2017), the transported materials are underlain by pedogenic material (present from 0.1 to 0.9m below surface; Table 5.1) described as low active, partially and well cemented, ferruginised residuum.

The pedogenic material was encountered in 24 test pits and generally comprises of soft powdery ferricrete concretions and nodules with soft ferruginised zones in a matrix of clayey, silty sand (Cilliers and Meyer, 2014). Well cemented, honeycomb hardpan ferricrete was observed in 14 test pits (Cilliers and Meyer, 2017).

**Sandstone Residuum and bedrock**

Cilliers and Meyer (2017) indicated that the north eastern, southern and south eastern portions of the site are underlain by soils derived from decomposed sandstone, surrounded by well cemented and deeply ferruginized ferricrete. Surface outcrop was noted in the south-eastern part of the site (Cilliers and Meyer, 2017).

The sandstone residuum (at a depth range of 0.1m to 1.0m below surface; Table 5.1) consists of medium dense to dense, clayey silty sand grading into very dense to very soft rock, creamy and light pinkish grey, sandy gravel of decomposed sandstone.

According to Cilliers and Meyer (2017), the southern area is waterlogged in places and seepage was recorded in a number of the test pits.

**Rhyolite residuum and bedrock**

Cilliers and Meyer (2017) indicated that soil and weathered rock materials are derived from rhyolite in the central and western areas of the site. Here the soil profile is generally shallow and frequent outcrops and sub-outcrops of rock occur with scattered boulders on surface.

A thin residuum (frequently slightly to partially ferruginized; average depth range of approximately 0.1 to 1.9m below surface; Table 5.1)) comprising of medium dense to dense, clayey silty sand overlies the completely to highly weathered (very soft becoming harder with depth) bedrock.

The transported and residual horizons were soft excavatable, whilst intermediate to hard excavation was recorded within the highly weathered sandstone and rhyolite bedrock (Cilliers and Meyer, 2017).

#### 5.3.2.2 Geotechnical zones identified

As indicated in Table 5.2, Cilliers and Meyer (2017) identified a number of geotechnical zones on site (Figure 5.5) based on the identified geotechnical constraints.

**Table 5.2: Geotechnical zones identified (taken from Cilliers and Meyer, 2017)**

| GEOTECHNICAL ZONE (Figure 5.5) | AREA (ha) | NHBRC CLASS | DESCRIPTION |
|---|---|---|---|
| Zone 1A: Normal Founding. | 197.29 | C/S/R. | Low compressibility soils less than 1m thick, with collapsing sands less than 0.5m thick. Relatively shallow bedrock with scattered outcrop.<br>Intermediate to hard excavatable <1.5m. |
| Zone 1B: Modified Normal Founding. | 22.16 | C1/S1 | Low to moderately compressible soils between 0.75m and 1.5m thick, with collapsing sands less than 0.5m thick, having a moderately compressibility beneath the foundations to a depth of 1.5m. |
| Zone 1C: Stiffened or cellular raft. | 1.36 | C2/S2. | Moderately compressible soils more than 1.5m thick, with collapsing sands more than 0.5m thick, having a moderate to high compressibility occurs beneath the foundations to a depth of >1.5m. |
| Zone 2A: Susceptible to sub-surface seepage. | 83.47 | P | A fluctuating seasonal water table and sub-surface seepage. |
| Zone 2B: Susceptible to surface ponding and seepage. | 13.02 | P | Area experiences some surface ponding and seepage. |
| Zone 3A: Remediation. | 3.49 | P | Previously used partially for borrow materials and the area is partially covered with refuse. |
| Zone 4A: Small earth embankment dam. | 0.99 | P | Small earth embankment dam. **No development is recommended within this zone.** |
| Zone 4B: Railway servitude. | 1.28 | P | This zone is reserved for the existing railway servitude. **No development is recommended within this servitude.** |
| Zone 4C: ESKOM Substation. | 1.40 | P | This zone is reserved for the existing electrical substation. **No development is recommended within this area.** |
| Zone 4D: ESKOM servitude. | 10.86 | P | This zone is reserved for the existing overhead ESKOM powerlines. **No development is recommended within this servitude.** |

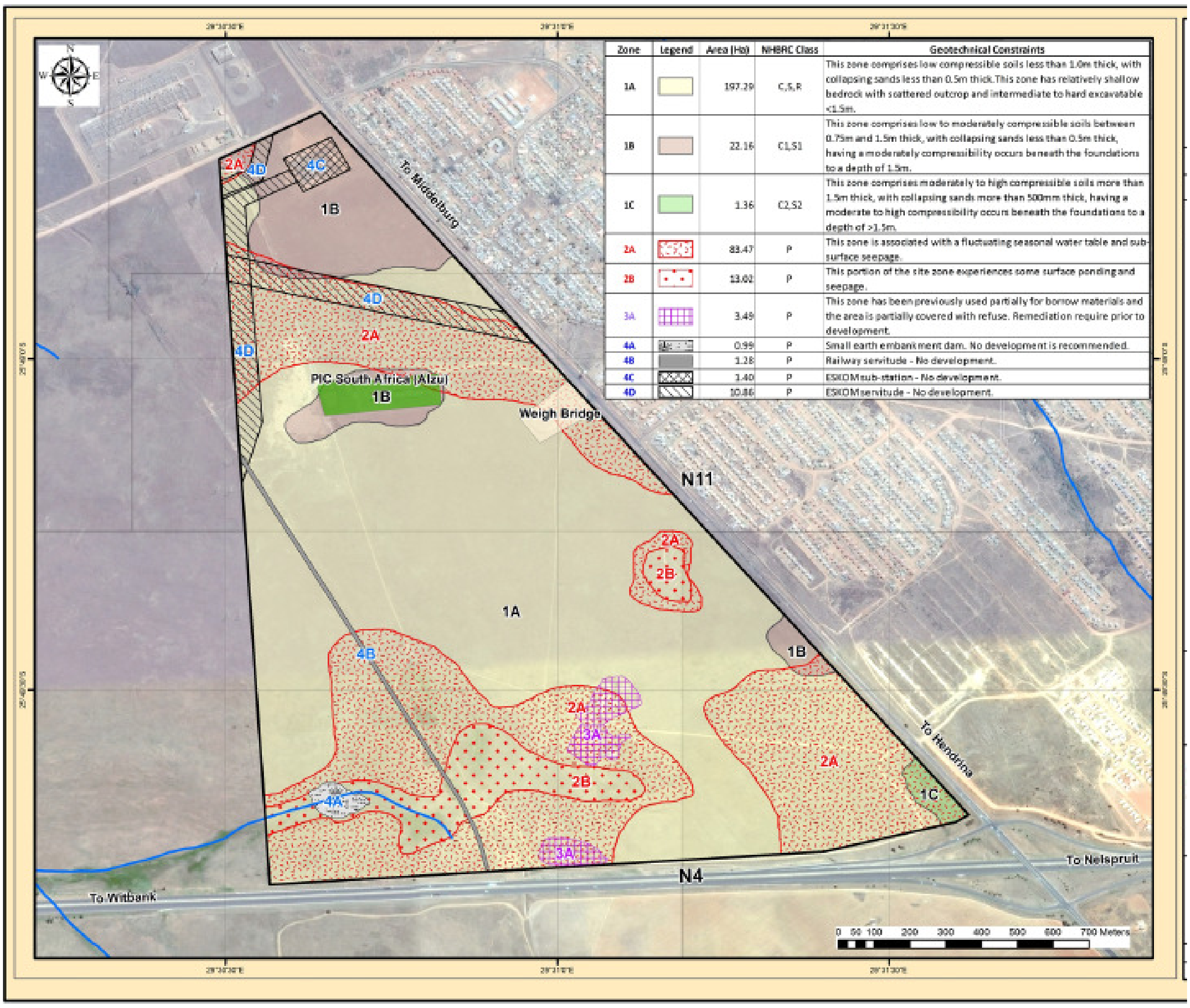


**Figure 5.5: Geotechnical zones identified (taken from Cilliers and Meyer, 2017).**

Further details regarding the identified geotechnical zones are provided in Appendix 13.

#### 5.3.2.3 Proposed cemetery site

As part of the overall development plan, a cemetery was proposed to be located in the south eastern portion of the site near the N11/N4 interchange (Figure 2.1). Difficult excavation was experienced in terms of the majority of test pits excavated within this area, with refusal of the TLB often at less than 1.0m. The proposed cemetery would have been located within geotechnical zone 1A (Table 5.1; Figure 5.5). Cilliers and Meyer (2017) therefore indicated that the proposed cemetery site was not suitable for a cemetery.

#### 5.3.2.4 Conclusion

Based on the findings of the geotechnical investigation, Cilliers and Meyer (2017) concluded the following:

- the majority of the site (197.29 ha; Table 5.1) can be developed as it is represented by geotechnical zone 1A (Figure 5.5).
- geotechnical zones 1B and 1C (Table 5.1; Figure 5.5) can also be developed subject to the implementation of mitigation measures.
- geotechnical zone 2A (Table 5.1; Figure 5.5) covers an area of 83.47ha and is susceptible to sub-surface ponding (i.e. a fluctuating seasonal water table and sub-surface seepage). Cut-off drains, sub-

surface and good surface drainage control measures will have to be implemented.
- an area of 13.02 ha is susceptible to surface ponding and seepage (geotechnical zone 2B; Table 5.1) and good surface drainage control measures will have to be implemented.
- remediation is recommended for geotechnical zone 3A (Table 5.1; Figure 5.5);
- No development is recommended in geotechnical zones 4A, 4B, 4C and 4D (Table 5.1; Figure 5.5) that cover an area of 14.53 ha.
- The development site is not suitable for a cemetery.

## 5.4 Topography

According to the AGIS Comprehensive Map drafted by the Department of Agriculture, Forestry and Fisheries, the terrain type of the proposed site is indicated as plains with open low hills or ridges as indicated in Figure 5.6.

The proposed site lies at approximately 1600 meters above mean sea level (mamsl) in the southeastern corner of the site (i.e. where N11 national road is located) to 1555m amsl near the southwestern and northwestern corners of the site (Figure 5.1).

Cilliers and Meyer (2017) indicated that most of the site has a gentle to moderate slope towards the western boundary of the site. On site, the central and northern portions slope toward the northwestern corner (Figure 5.18a) while the southern portion of the site slopes towards the southwestern corner of the site (Figure 5.18a).

Engeolab (2016) indicated that the largest part of the site is characterised by generally flat to moderate slopes, becoming steeper along the southwestern corner of the site where a tributary of the Vaalbankspruit is present (Figure 5.2).

In terms of unstable natural slopes, Engeolab (2016) indicated that few problems in this regard are foreseen due to the horizontal bedding of the Vryheid Formation that underlies two thirds of the site (Figure 5.4). In addition, no talus slopes or historical landslides areas are indicated in the published geological data (Engeolab, 2016).

The topography of the site has been impacted in terms of the existing infrastructure present on site e.g. Rockdale Substation, Eskom powerlines, weighbridge, PIC South Africa (Alzu) AI facility and associated infrastructure, small dam, two borrow pits, elevated railway embankment and trench, water pipeline, gravel roads, etc. (Figure 5.2).

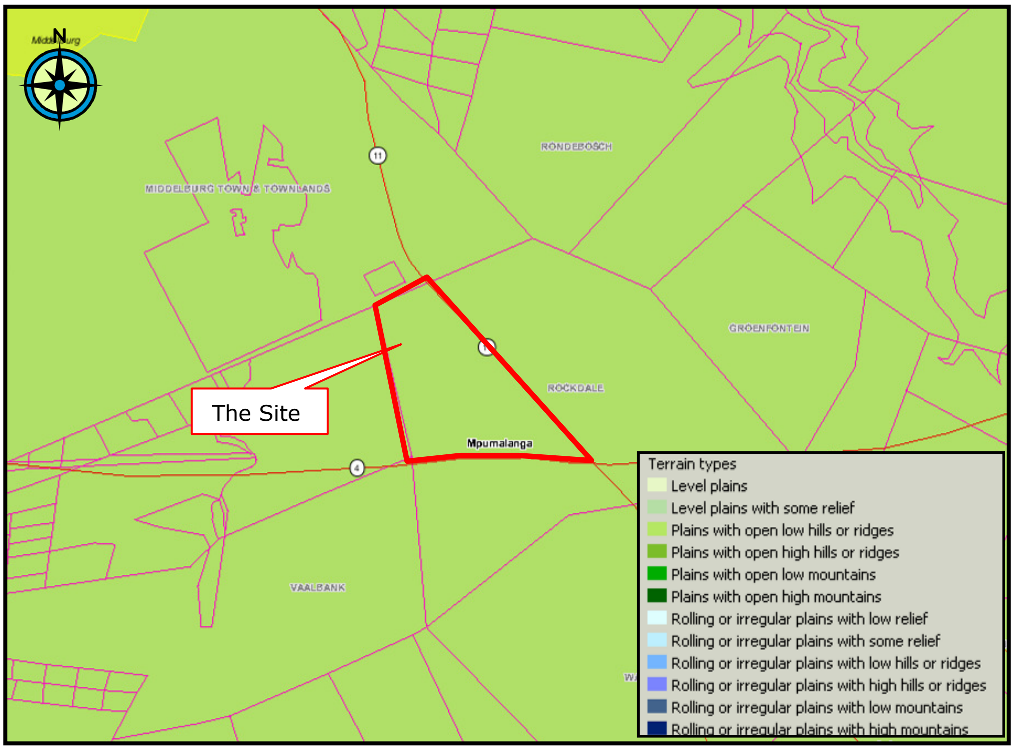


**Figure 5.6: Terrain type of the proposed site (taken from Department of Agriculture, Forestry and Fisheries)**

## 5.5 Soil/agricultural potential/land capability

### 5.5.1 Generalised soil patterns

According to the AGIS Comprehensive Atlas of the Department of Agriculture, Forestry and Fisheries, the soils of the area are red, yellow and/or greyish soils with low to medium base status as indicated in Figure 5.7.

According to Cilliers and Meyer (2017), the average soil profile in this area consists of a thin topsoil, extending to depths ranging between 0.10m and 1.90m below surface (Table 5.1).

Cilliers and Meyer (2017) indicated that the north eastern, southern and south eastern portions of the site are underlain by soils derived from decomposed sandstone, surrounded by well cemented and deeply ferruginized ferricrete. Surface outcrop was noted in the south-eastern part of the site (Cilliers and Meyer, 2017).

Cilliers and Meyer (2017) indicated that soil and weathered rock materials are derived from rhyolite in the central and western areas of the site. Here the soil profile is generally shallow and frequent outcrops and sub-outcrops of rock occur with scattered boulders on surface.

The soil of the site has been impacted in terms of the infrastructure present on site (Figure 5.2) as well as other activities taking place (e.g. dumping of waste, slaughtering of cattle/disposing of bones, manure dam, excavations, etc.).

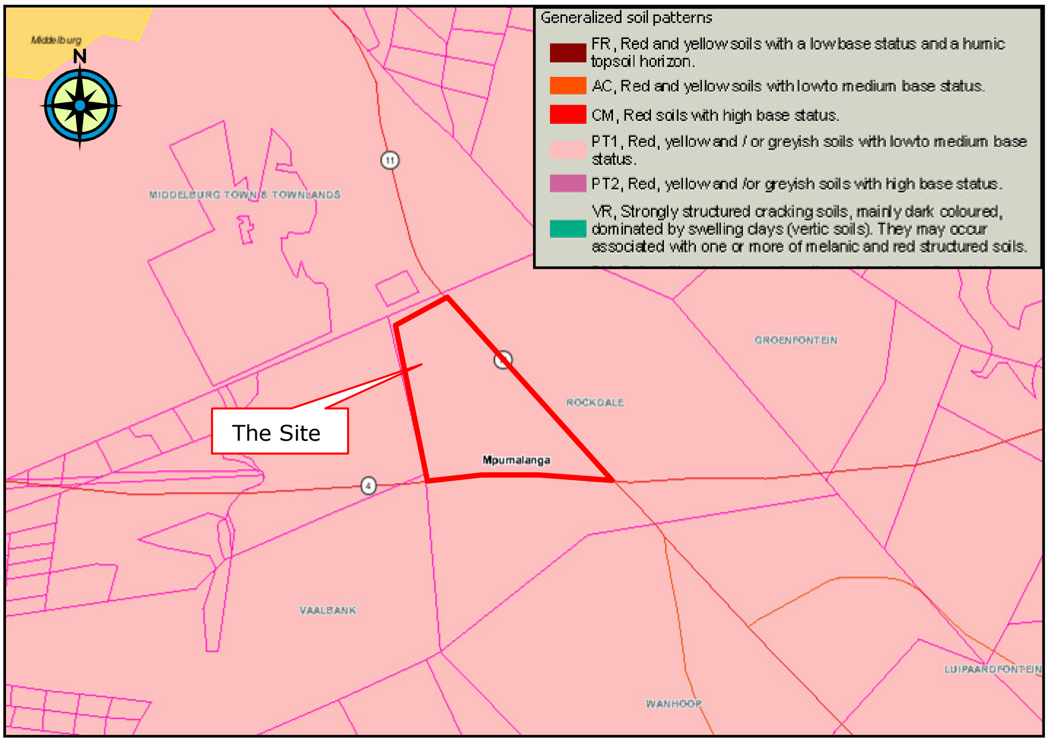


**Figure 5.7: Generalized soil patterns (taken from Department of Agriculture, Forestry and Fisheries)**

### 5.5.2 Agricultural potential/land capability

In terms of land capability, the proposed site is indicated as moderate potential arable land (Figure 5.8) according to the Department of Agriculture, Fisheries and Forestry.

The Mpumalanga Biodiversity Sector Plan (2013) classified the southeastern corner of the site as Moderately modified - Old Lands (Figure 5.16). However, no agricultural activities (cultivation, grazing, etc.) have taken place on site for a number of years.

Rocky outcrops are present in the western portion of the site (Figure 5.2) making this area not suitable for cultivation purposes.

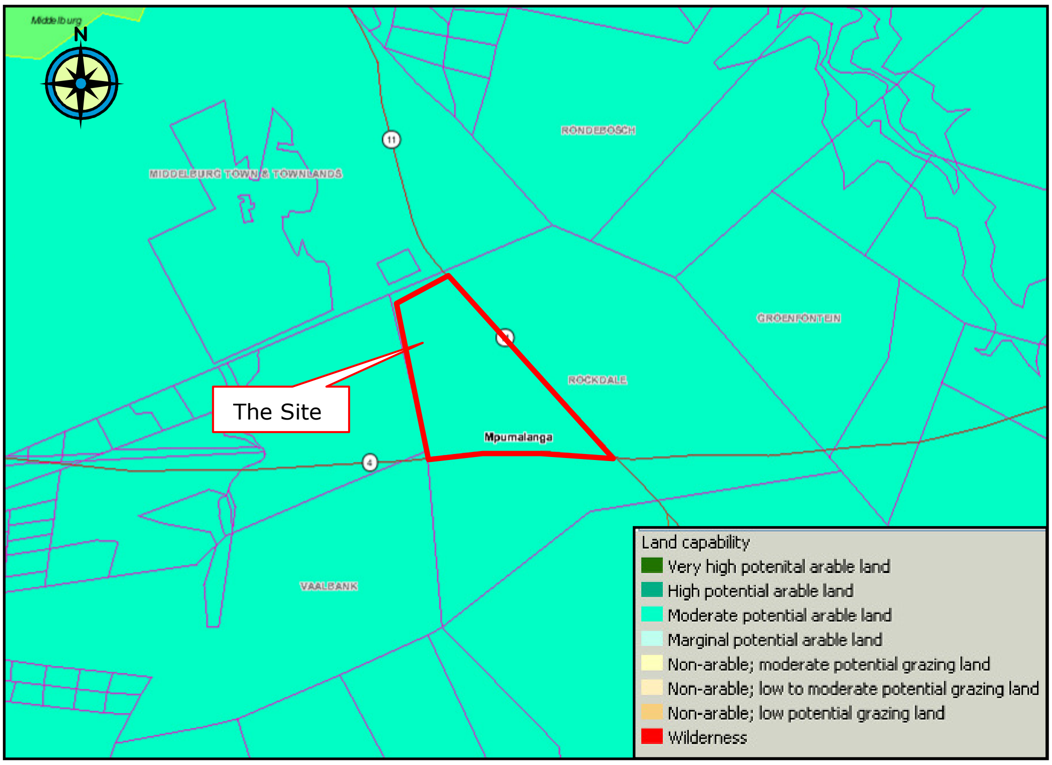


**Figure 5.8: Land capability of the proposed site (taken from Department of Agriculture, Forestry and Fisheries)**

Looking at grazing capacity, Figure 5.9 indicates the majority of the site as 5-7ha per Animal Unit (AU). No formal grazing is known to take place on site.

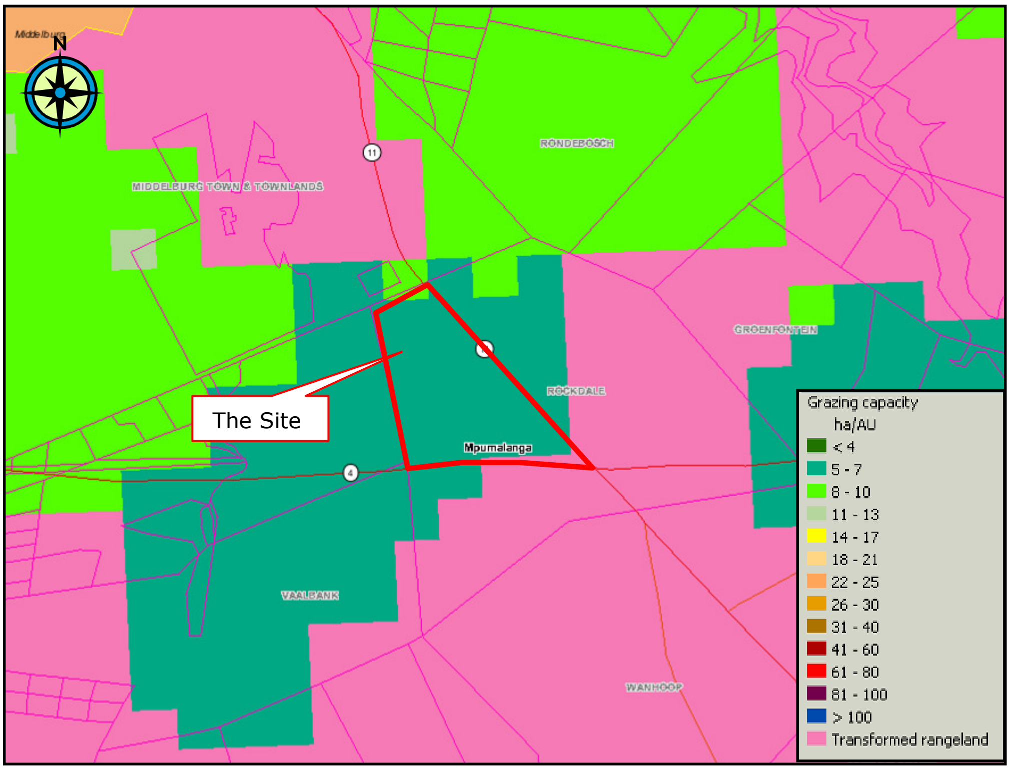


**Figure 5.9: Grazing capacity of the proposed site (taken from Department of Agriculture, Forestry and Fisheries)**

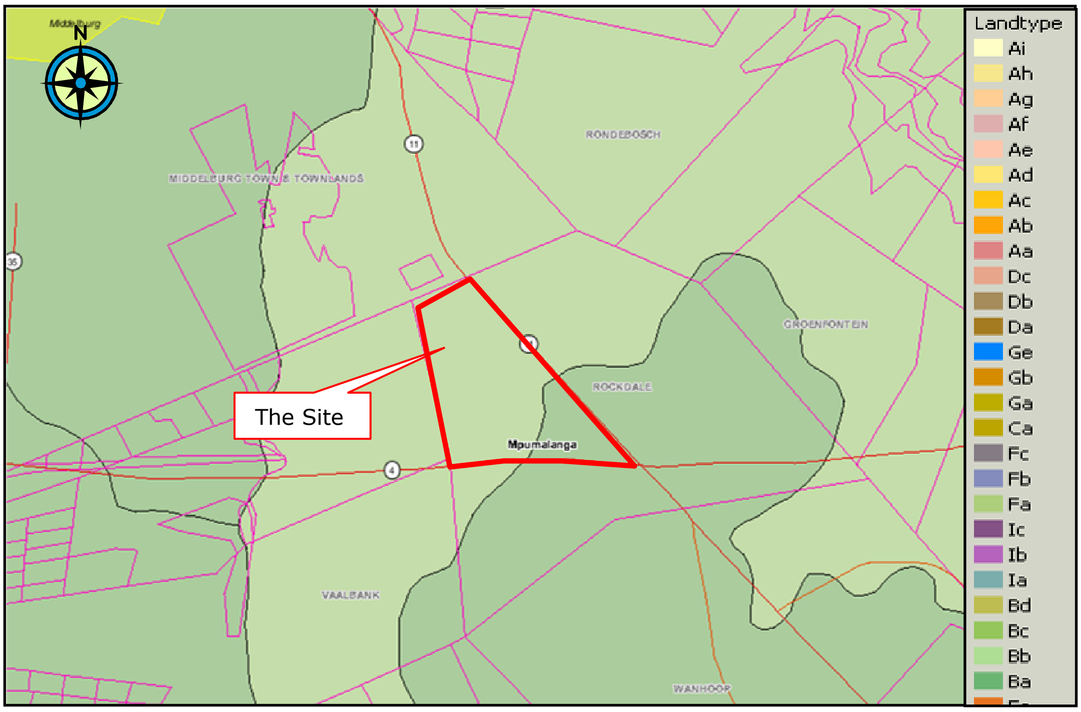


**Figure 5.10: Land type of the proposed site (taken from Department of Agriculture, Forestry and Fisheries)**

The Department of Agriculture, Forestry and Fisheries classified the land type of the majority of the site as Bb (Figure 5.10) with a small section in the southeastern corner as Ba (Figure 5.10).

The Bb and Ba land types comprise of plinthic soils (with subsurface accumulation of iron and manganese oxides due to fluctuating water table) with low to intermediate base status. Red soils are not widespread. Upland duplex and black clay soils are rare. According to Rehab Green (2004), these soils have a Moderate to High agricultural potential.

According to a general soil and agricultural assessment conducted for the Steve Tshwete Municipal area by Rehab Green (2004), the land type of the site is more specifically Bb4 and Ba4.

### 5.5.3 Soil study

A soil specialist assessment was conducted by C. Viljoen of Viljoen & Associates in order to determine the soil types present as well as the agricultural potential and land capability of the site. A copy of the soil report (referred to as Viljoen, 2017) is provided in Appendix 12. This report should be consulted with regards to methodology used and the tests carried out on the samples collected.

#### 5.5.3.1 Soil types

As indicated in Table 5.3, five soil types were identified within the proposed development site with the Mispah soil type being the dominant. Figure 5.11 provides an indication of the distribution of the various soil types on site.

**Table 5.3: Soil types identified on site (taken from Viljoen, 2017)**

| SOIL TYPE | AREA (ha) | DIAGNOSTIC HORIZONS | EFFECTIVE DEPTH (mm) |
|---|---|---|---|
| Bainsvlei | 31.593 | Orthic A – Horizon/Red Apedalic B – Horizon/Soft Plinthic B – Horizon | >300 |
| Avalon | 22.761 | Orthic A – Horizon/Yellow Brown Apedalic B – Horizon/Soft Plinthic B – Horizon | >300 |
| Westleigh | 45.507 | Orthic A – Horizon/Soft Plinthic B - Horizon | <300 |
| Mispah | 119.961 | Orthic A – Horizon/Rock | <300 |
| Katspruit | 3.917 | Orthic A – Horizon/G - Horizon | <300 |

Legend:

- *Orthic A – Horizon: Is a surface horizon containing abundance of organic material darkened by organic matter, occurring over virtually the full range of soil forming conditions encountered in South Africa. The horizon excludes the properties of organic, humic, vertic or melanic topsoil horizons.*
- *Rock: This horizon will be represented by the underlying geology, i.e. andesite, shale, sandstone, etc. It offers extreme resistance to root and water penetration.*
- *Red Apedalic B – Horizon: Characterised by 1:1 clay minerals, i.e. kaolinite and oxides of iron and manganese. The clay percentage ranges between 10 and 20% (hydrometer method) and due to the low clay content there is a lack of structure.*
- *Yellow Brown Apedalic B – Horizon: This horizon has the same characteristics as the Red Apedalic B – Horizon, being differentiated only on the basis of colour. The aerobic conditions being present in the Red Apedalic B – Horizon are replaced by anaerobic conditions causing a reduction of Fe. The horizon occurs over approximately the same climatic zones as their red counterparts.*
- *Plinthic Horizon: This horizon is a precipitate of Fe and Mn concretions under fluctuating water conditions inducing aerobic and anaerobic conditions resulting in oxidation and reduction of Fe and Mn.*
- *G - Horizon: This horizon is characterised by gley mottling colouring due to aerobic and anaerobic conditions due to fluctuating water regime with a high consistency due to the presence of 2:1 clay minerals and high bulk density.*

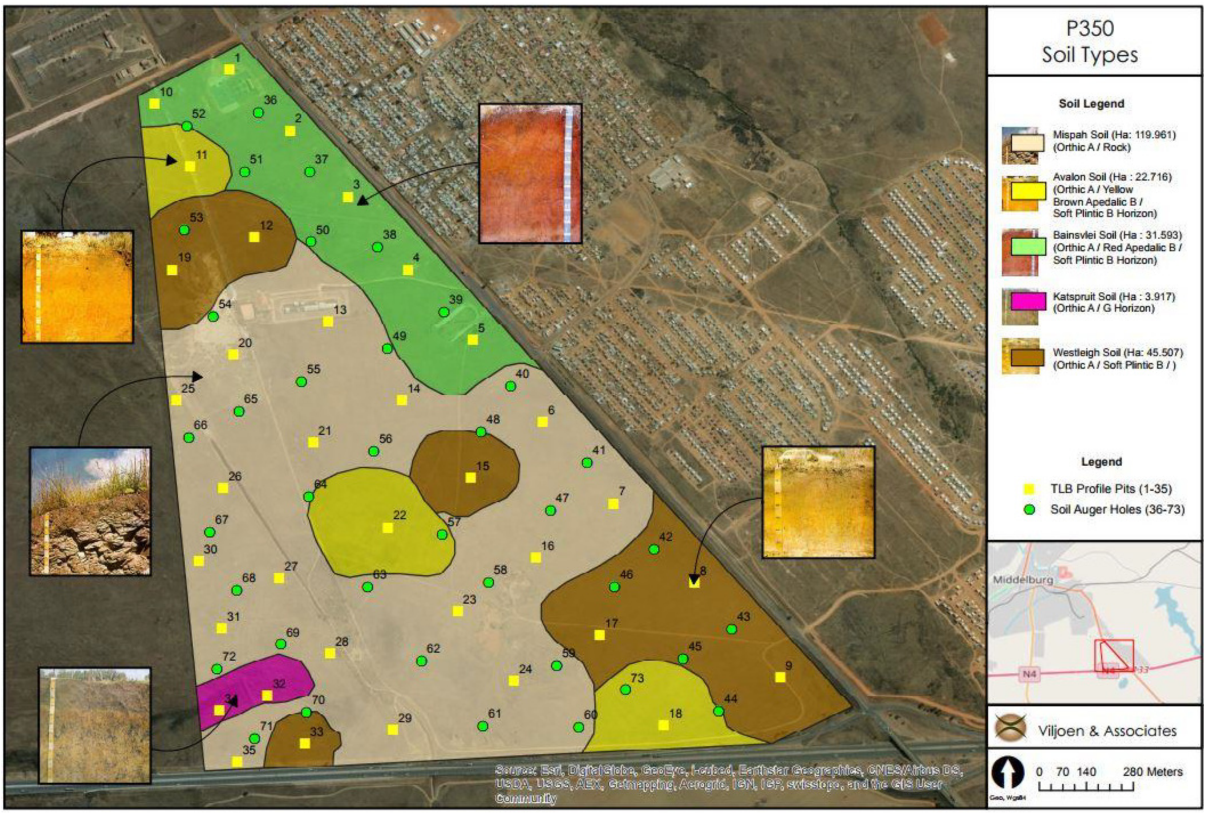


**Figure 5.11: Soil types identified on site (taken from Viljoen, 2017)**

Table 5.4 provides a conservative estimate of available topsoil per soil type identified on site.

**Table 5.4: Available topsoil for cut & fill and landscaping purposes (taken from Viljoen, 2017)**

| SOIL TYPE | AREA (ha) | EFFECTIVE DEPTH (mm) | AVAILABLE VOLUME ($m^3$) |
|---|---|---|---|
| Bainsvlei | 31.593 | >300 | 96.000 |
| Avalon | 22.761 | >300 | 69.000 |
| Westleigh | 45.507 | <300 | 138.000 |
| Mispah | 119.961 | <300 | 360.000 |
| Katspruit | 3.917 | <300 | 0 |
| **TOTAL AVAILABLE VOLUME ($m^3$)** | | | **663.000$m^3$ @ Bulk Density of 1.275 kg/$m^3$** |

### 5.5.3.2 Agricultural potential

The agricultural potential of the proposed development site was assessed using the following formula as a function of various variables:

$$YIELD\ (kg\ ha\text{-}1) = R/B \times ED/A \times C \times X$$

***R* –** Rainfall (mm); ***B*** - Species growth characteristics factor; ***ED*** - Effective depth of the soil; ***A*** - Soil wetness factor for textural classes of soil above effective depth; ***C*** - Correction factor for aeration of soil; and ***X*** - Fixed coefficient for species.

The main variables determining the soil's agricultural potential for maize include the **average rainfall** (*mm*), **soil depth** (*mm*) and **water management & holding capacity**. The yield estimates (Table 5.5) exclude any other management practices, *i.e.* fertilisation, cultivar, plant density, *etc.* that can make a significant difference in yield.

**Table 5.5: Agricultural potential of soils (taken from Viljoen, 2017)**

| SOIL TYPE | AREA (ha) | AGRICULTURAL POTENTIAL | |
|---|---|---|---|
| | | DRY LAND | IRRIGATION |
| Bainsvlei | 31.593 | Low | Low |
| Avalon | 22.761 | Low | Low |

As indicated in Table 5.5, the Bainsvlei (350mm) and Avalon (350mm) soils have low agricultural potential under dryland and irrigation conditions. Production under dryland conditions of 30,000 plants/ha with average rainfall of 650mm/year will not be sustainable, especially during the summer period with extreme heat units. Production under irrigation conditions would require 6,100$m^3$/ha/year of water for 100,000 plants/ha, which is the equivalent of 30,000l/ha 24hours, 7 days per week (Viljoen, 2017).

The Westleigh and Mispah soils are not suitable for agricultural purposes due to the effective depth being shallower than 300mm (Table 5.4). These soils will not be able to facilitate adequate root development and store enough plant available water between 33 and 1,500kPa (Viljoen, 2017).

#### 5.5.3.3 Erodibility of soils and evidence of misuse

The cation exchange capacity (CEC) can be defined as the ability of the clay particles to adsorb cations on the positively charged surface areas. Sodium (Na) should not occupy more than 15% of the CEC as this would cause dispersion and erosion of the soil (Viljoen, 2017). If Na (sodium) occupies more than 15% of the cation exchange capacity it would result in dispersion of the clays due to hydration of the Na on the exchange sites causing the double layer around the clays to swell (Viljoen, 2017).

Table 5.6 provides an indication of the exchangeable sodium percentage of the soils identified on site.

**Table 5.6: Exchangeable Sodium Percentage (ESP) of soil (taken from Viljoen, 2017)**

| SAMPLE NO | CEC (cmol $kg^{-1}$) | ESP (%) | SOIL TYPE |
|---|---|---|---|
| 4 | 2.11 | 12.23 | Bainsvlei/Avalon |
| 9 | 2.33 | 10.78 | Westleigh |
| 13 | 3.67 | 2.65 | Mispah |
| 23 | 2.45 | 9.39 | Mispah |
| 26 | 3.65 | 6.85 | Mispah |
| 32 | 2.98 | 4.03 | Katspruit |
| 35 | 4.43 | 4.06 | Mispah |

*Legend: CEC – Cation Exchange Capacity; ESP – Exchangeable Sodium Percentage.*

As indicated in Table 5.6, the exchangeable sodium percentage of the soils identified on site are below 15% of the CEC. The soils identified on site are therefore not dispersive or erodible.

#### 5.5.3.4 Soil chemical, physical and mineralogical properties of soils

The Mispah, Avalon, Bainsvlei, Westleigh and Katspruit soils are characterised by neutral pH values (5,3 and 7,2). There was only one exception namely Sample 23 (Mispah) with pH 7,9 which can be regarded as very close to the normal range.

Viljoen (2017) indicated a lime requirement of 2.0, 3.0, 3.8, 4.4 and 5t/ha for samples 2 (Mispah), 3 (Mispah), 3 (Bainsvlei), 8 (Westleigh), 13 (Mispah) respectively. According to Viljoen (2017), the Ca:Mg, Mg:K and Ca+Mg/k ratio's can be rectified through $CaMgCO_3$ applications.

There is no salinisation in the soil solution in any of the soils as reflected by the low electrical conductivity values (<250mS/m). Only Sample 4 (Bainsvlei) had a higher electrical conductivity value, i.e. 269*mS/m*, which is still acceptable (Viljoen, 2017). Under these conditions plant available nitrogen (15-20mg/kg), phosphorus (10-15mg/kg) and potassium (>50mg/kg) are readily available for plant uptake and sustainable plant growth.

None of the samples had an exchangeable sodium percentage exceeding 15% of the cation exchange capacity. The F, B, $SO_4$ (*except Sample 35*), Cl (*except Samples 4 and 9*), $NO_3$ and heavy metal concentrations were at acceptable low concentrations (Viljoen, 2017).

Viljoen (2017) indicated that no irregular anomalies occur in any one of soil types.

According to Viljoen (2017), the Orthic A-horizon is typically characterised by a low dense structure and texture distribution of approximately 65% sand, 20% silt and 15% clay with drainage properties in the order of 10mm/h.

Kaolinite (1:1 layer silicate) is the dominant clay mineral in the Orthic A–horizon and Yellow & Red Apedalic B–horizon, with a low buffer capacity due to the low cation exchange capacity (<10cmol+/kg).

#### 5.5.3.5 Land capability

Table 5.7 provides the criteria used for the determination of land capability of a site (i.e. suitability of soils for most kinds of field crops, excluding crops that require special management).

**Table 5.7: Criteria for determination of land capability (taken from Viljoen, 2017)**

| SUMMARISED DESCRIPTION OF LAND CAPABILITY CRITERIA | | |
|---|---|---|
| **Wetlands, Pans, Drainage Lines** | | Land with organic soils or supporting hygrophilous vegetation where soil and vegetation processes are water determined. |
| **Arable** | Effective soil depth: >600mm | Land that does not qualify as wetland. Soil is readily permeable to depth of 750mm. Soil has pH value between 4 and 8.4. Soil has low salinity and SAR. Soil has less than 10% (by volume) rocks or pedocrete fragments larger than 100mm in the upper 750mm. Has a slope (%) and erodibility factor (k) such that their product is <2.0. Occurs under a climate of crop yields that are at least equal to the current national average for these crops. |
| **Grazing** | Effective soil depth: 250 – 600mm | Land which does not qualify as wetland or arable land. Has soil, or soil-like material, permeable to roots of native plants, that is more than 250mm thick and contains less than 50% by volume of rocks or pedocrete fragments larger than 100mm. Supports, or is capable of supporting a stand of native or introduced grass species or other forage plants used by domesticated livestock or game animals on a commercial basis. |
| **Wilderness** | Effective soil depth: <250mm | Land which does not qualify as wetland, arable or grazing land. |

As indicated in Table 5.8 and Figure 5.12, the majority of the site is classified as Wilderness (70%). An area of approximately 20% is classified as Grazing (Table 5.8; Figure 5.12) while less than 1% is classified as Arable (Table 5.8; Figure 5.12). Wetland/seepage land capability is indicated for approximately 7% of the site (Table 5.8; Figure 5.12).

**Table 5.8: Land capability of the proposed development site (taken from Viljoen, 2017)**

| LAND CAPABILITY | SURFACE AREA (ha) | % OF TOTAL |
|---|---|---|
| Arable | 2.001 | 0.895 |
| Grazing | 43.995 | 19.667 |
| Wetland/seepage | 15.092 | 6.747 |
| Wilderness | 156.812 | 70.099 |
| Alzu AI Station | 2.649 | 1.184 |
| Substation | 1.507 | 0.674 |
| Weigh Bridge | 1.639 | 0.733 |
| **TOTAL** | **223.7** | **100** |


**Figure 5.12: Land capability of the site (taken from Viljoen, 2017)**

### 5.5.3.6 Land use

Viljoen (2017) indicated that land use can be defined as the arrangements, activities and inputs people undertake in a certain land cover type to produce, change or maintain, i.e. the human use of land.

Land use involves the management and modification of natural environment or wilderness into built environment such as settlements and semi-natural habitats such as dams, infrastructure, natural veld, pans, ploughed land, settlements, wetlands, pastures, and managed woods (Viljoen, 2017).

As indicated in Table 5.9 and Figure 5.13, 90% of the proposed development site comprises Natural Veld. Wetland and Seepage is indicated for approximately 7% of the site (Table 5.9; Figure 5.13). Approximately 2.6% of the site is developed in terms of the Alzu AI Station, Substation and Weigh Bridge (Table 5.9).

**Table 5.9: Land use of the proposed development site (taken from Viljoen, 2017)**

| LAND USE | SURFACE AREA (ha) | % OF TOTAL |
|---|---|---|
| Natural Veld | 202.809 | 90.661 |
| Wetland | 6.924 | 3.095 |
| Seepage | 8.168 | 3.651 |
| Alzu AI Station | 2.649 | 1.184 |
| Substation | 1.507 | 0.674 |
| Weigh Bridge | 1.639 | 0.733 |
| **TOTAL** | **223.7** | **100** |

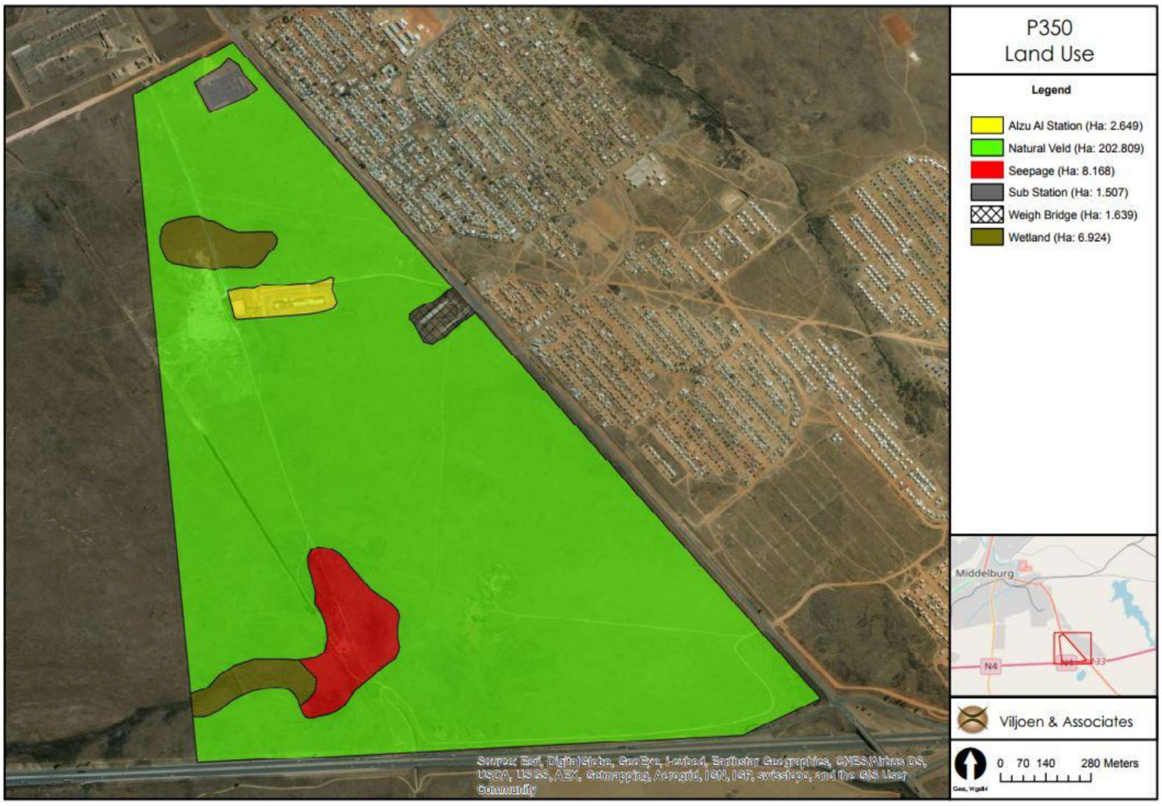


**Figure 5.13: Land Use of the site (taken from Viljoen, 2017)**

#### 5.5.3.7 Conclusion

Based on the findings of the soil survey, Viljoen (2017) concluded the following:

- Five soil types (Mispah, Avalon, Bainsvlei, Katspruit, Westleigh) are present within the proposed development site with the Mispah soil type being the dominant.
- The Bainsvlei and Avalon soils (effective depth > 300mm) have low agricultural potential under dryland and irrigation conditions. The Westleigh and Mispah soils are not suitable for agricultural purposes.
- The majority of the site is classified as Wilderness (70%) and an area of approximately 20% is classified as Grazing while less than 1% is classified as Arable. Wetland/seepage land capability is indicated for approximately 7% of the site.

- 90% of the proposed development site comprises Natural Veld. Wetland and Seepage is indicated for approximately 7% of the site. Approximately 2.6% of the site is developed.
- No evidence of soil erosion was observed on any of the soils during the investigation.
- The areas associated with the Katspruit soils (i.e. wetland zones) should not be developed.
- The exchangeable sodium percentage of the soils are below 15% of the CEC and the soils are therefore not dispersive or erodible.

## 5.6 Natural vegetation

### 5.6.1 General vegetation description

According to the 'The vegetation of South Africa, Lesotho and Swaziland', the study area falls within the Mesic Highveld Grassland Bioregion, specifically the Rand Highveld Grassland (veld type Gm11) (Mucina & Rutherford, 2006; Figure 5.14). The vegetation type was previously referred to by Low and Rebelo (1998) as Moist Sandy Highveld Grassland (38) and Rocky Highveld Grassland (34) and by Acocks (1953) as Bankenveld (61).

This grassland is found at an altitude of 1 300 metres above mean sea level (mamsl) to 1 635 mamsl in areas between rocky ridges from Pretoria to eMalahleni (Witbank). It also extends onto ridges in the Stoffberg and Roossenekal regions as well as west of Krugersdorp.

This vegetation type is species-rich and comprises wiry, sour grassland alternating with low, sour shrubland on rocky outcrops and steeper slopes. The most common grasses on the plains belong to the genera *Themeda, Eragrostis, Heteropogon* and *Elionurus*. A high diversity of herbs, many of which belong to the *Asteraceae* family, is also a typical feature. Rocky hills and ridges carry sparse woodlands with *Protea caffra* subsp. *caffra, Acacia caffra* and *Celtis africana*, accompanied by a rich suite of shrubs among which the genus *Rhus* is most prominent.

Almost half of the Rand Highveld Grassland has already been transformed by cultivation, urbanisation, plantations and dams. This vegetation type has been afforded the status of endangered with a conservation target of 24%. Only approximately 1% of this vegetation type is currently conserved.

The said project area does not fall within a nature reserve, conservancy or other protected area (Mpumalanga Biodiversity Sector Plan, 2013; Figure 5.16).

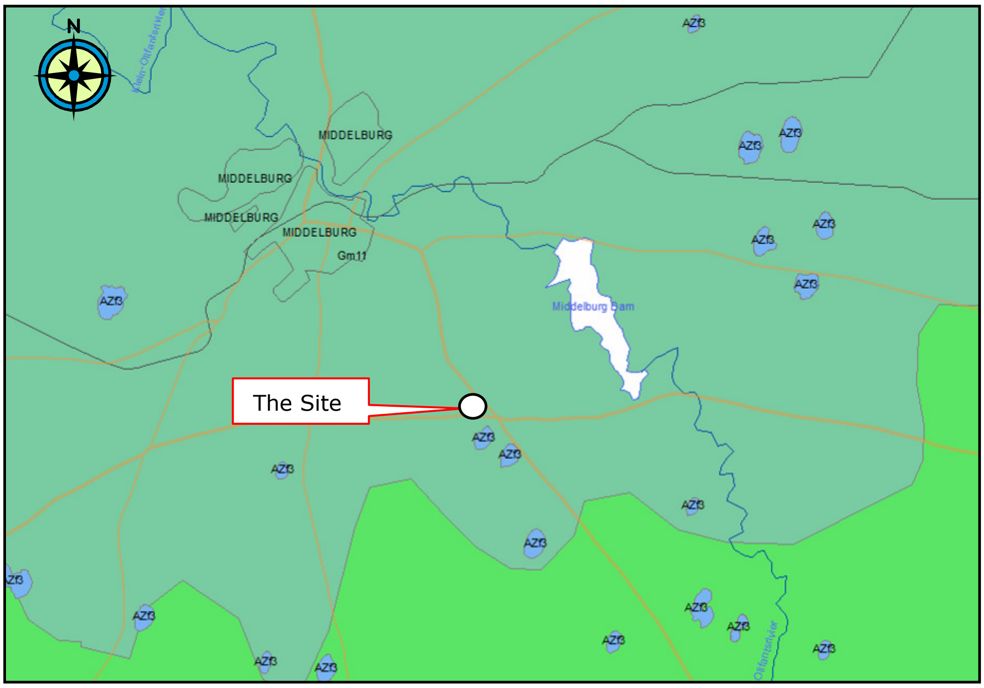


**Figure 5.14: Vegetation type (taken from Mucina and Rutherford, 2006)**

The National List of Ecosystems that are Threatened and in need of protection (GN1002 of 2011), published under the National Environmental Management: Biodiversity Act (Act No. 10, 2004), lists this vegetation type as **Vulnerable**.

**Vulnerable (VU) ecosystems -** being ecosystems that have a high risk of undergoing significant degradation of ecological structure, function or composition as a result of human intervention, although they are not critically endangered ecosystems or endangered ecosystems.

The study area is not situated within any of the South African centres of endemism recognised by Van Wyk and Smith (2001).

In Figure 5.15, the site and surrounding area are not indicated as a 'Critical Biodiversity Area' (CBA) in terms of the biodiversity assessment of the Mpumalanga Biodiversity Conservation Plan (2006). It is indicated as an 'Ecological Support Area (ESA): Aquatic (Figure 5.15).

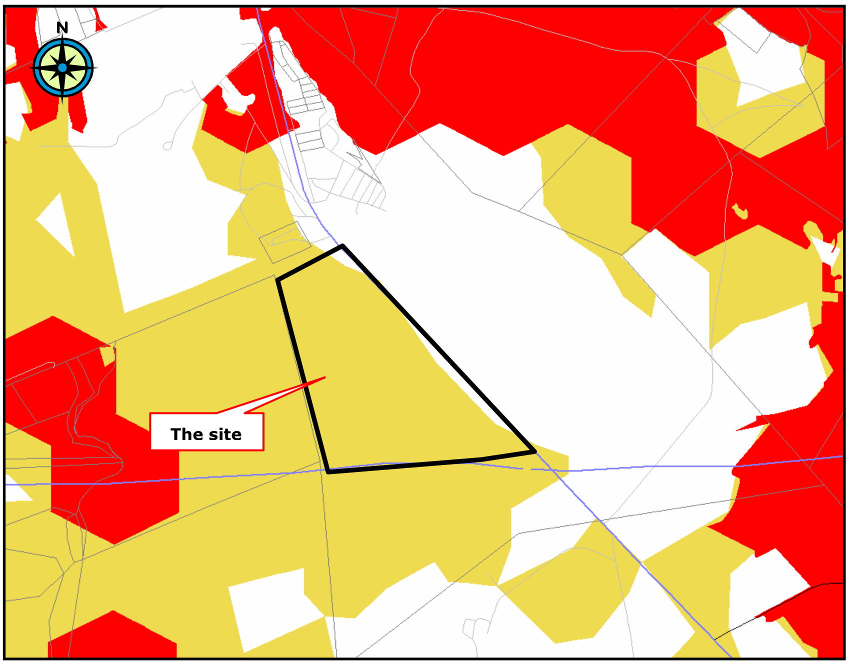


**Figure 5.15: Biodiversity assessment of the Mpumalanga Biodiversity Conservation Plan (2006)**

Over the last few years (2007 – 2013), the Mpumalanga Tourism and Parks Agency reviewed and updated the Mpumalanga Biodiversity Conservation Plan (2006) in order to align the spatial data with the bioregional plan requirements of the South African National Biodiversity Institute (SANBI) and surrounding provinces. According to the updated plan (now referred to as the Mpumalanga Biodiversity Sector Plan (MBSP, 2013)), the central and southwestern portions of the site are classified as Critical Biodiversity Area (CBA) Optimal (Figure 5.16).

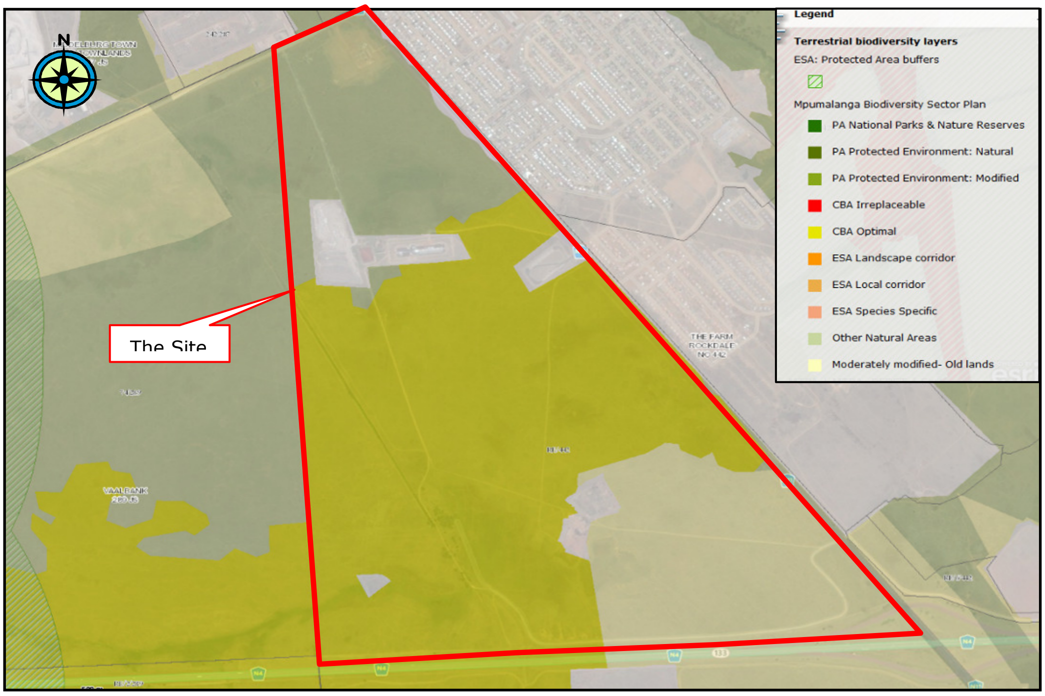


**Figure 5.16: Terrestrial biodiversity assessment (taken from the Mpumalanga Biodiversity Sector Plan, 2013)**

The northern portion of the site is classified as Other Natural Areas (Figure 5.16) while the southeastern corner of the site is classified as Moderately modified - Old Lands (Figure 16).

### 5.6.2 Vegetation on site

A vegetation survey was undertaken by I. Venter of Kyllinga Consulting (hereafter referred to as Venter and Niemand, 2017) as part of the overall ecological assessment. A copy of the report is provided in Appendix 14 and should be consulted with regards to methology used.

Venter and Niemand (2017) identified three (3) main vegetation units on site with a number of sub-units as indicated in Table 5.10 And Figure 5.17.

**Table 5.10: Vegetation units identified (taken from Venter and Niemand, 2017)**

| VEGETATION UNIT | VEGETATION SUB-UNIT | SIZE (ha) |
|---|---|---|
| Wetland | Seep | 23.4819 |
| | Channelled valley bottom | 4.8895 |
| Grassland | Rocky grassland | 103.8434 |
| | *Hyparrhenia hirta* grassland | 68.0102 |
| Disturbance | Alien trees | 1.0645 |
| | Vegetation clearing | 8.0212 |
| | Excavations | 5.7212 |
| **TOTAL AREA (ha):** | | **215.6124** |

**Wetland vegetation unit (Table 5.10; Figure 5.17)**

Within the wetland vegetation unit, two sub-units were identified namely:

- Seep;
- Channelled valley bottom.

**Seep (Table 5.10; Figure 5.17)**

Seeps are present in the northern, central and southern portions of the site (Figure 5.17). The vegetation is mostly located on fairly shallow soil.

The seep vegetation is dominated by grass species, such as *Eragrostis plana, Eragrostis gummiflua, Cynodon dactylon* and *Andropogon huillensis*, with the sedge *Kyllinga erecta.* Forb species in the wetland unit include *Senecio inornatus, Helichrysum nudifolium* and *Nidorella anomala. Hyparrhenia hirta* is fairly dominant in the seep units, indicating that the vegetation has a fair amount of disturbance (Table 2 of Appendix 14). In addition, three orchid species are also present, two *Habenaria* species and *Brachycorythis tenuior.* None of the orchid species are threatened, but the orchid species are protected in the Mpumalanga Nature Conservation Act.

The vegetation is fairly common and although the vegetation is not of specific conservation importance, **all wetlands are considered to be of high conservation importance.**

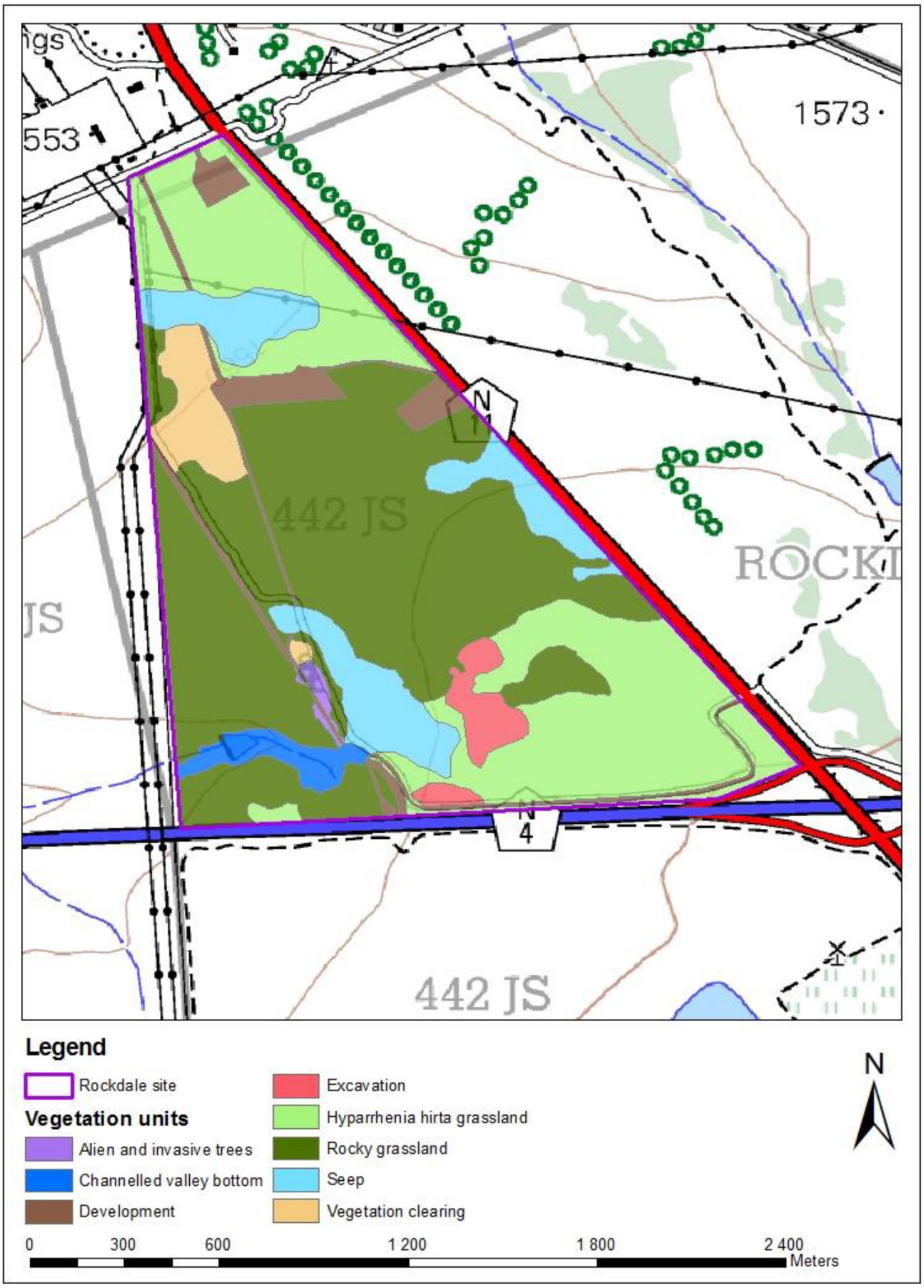


**Figure 5.17: Vegetation units present on site (taken from Venter and Niemand, 2017)**

**Channelled valley bottom (Table 5.10; Figure 5.17)**

A channelled valley bottom wetland is present in the south western corner of the site (Figure 5.17). The vegetation consists of a mix of grass and sedge species, including species common in temporary to permanent wetness. The soil in this unit is generally more than 50cm deep, with only a few exceptions.

Dominant species include *Kyllinga erecta, Leersia hexandra, Calamagrostis epigeios, Juncus effusus, Schoenoplectus* species and *Cynodon dactylon.* The vegetation is in a good condition, with a relatively high species diversity and very few alien and invasive species (Table 2 of Appendix 14). The vegetation is typical of wetland units in the Rand Highveld Grassland vegetation type. Although no species of specific conservation importance are present, **all wetlands are of high conservation importance.** The downstream portion (west of the site) of the northern seep wetland has a similar species composition to this wetland unit.

**Grassland vegetation unit (Table 5.10; Figure 5.17)**
Within the grassland vegetation unit, two sub-units were identified namely:

- Rocky grassland;
- *Hyparrhenia hirta* grassland.

**Rocky grassland (Table 5.10; Figure 5.17)**
The grassland in the central and western portions of the site (Figure 5.17) is still in primary (late successional) condition and reflects typical vegetation in the Rand Highveld Grassland vegetation type, which is Vulnerable. The grassland is located on shallow soil and has a very high species diversity (127 species) (Table 2 of Appendix 14).

The vegetation consists of a very high diversity of forb species, with a lower grass cover, but a high diversity of grass species. Few disturbances have impacted this vegetation unit. This is probably due to the presence of shallow soil which has also made cultivation impossible. Disturbances are therefore limited to poor veld management and roads/tracks on site.

Since the vegetation is part of the Rand Highveld Grassland vegetation type, which is vulnerable, the vegetation is considered to be of **high conservation importance and sensitivity**. This vegetation unit also extends westwards onto the adjacent land (Farm Vaalbank 289) where the forb and graminoid species richness was very high.

***Hyparrhenia hirta* grassland (Table 5.10; Figure 5.17)**
The dominant grass species in the grassland unit is *Hyparrhenia hirta,* which commonly occurs in modified grassland areas, such as areas subjected to long term overgrazing and historical cultivation. This unit is present on the south-eastern and northern portions of the site (Figure 5.17).

*Lopholaena coriifolia* is sparsely distributed in the southern portion of this unit. Although modified, a number of forb and shrub species are still present. The vegetation in this unit is of **moderate conservation importance and sensitivity**.

**Disturbance vegetation unit (Table 5.10; Figure 5.17)**
Within the disturbance vegetation unit, three sub-units were identified namely:

- Alien trees;
- Vegetation clearing;
- Excavations.

**Alien trees (Table 5.10; Figure 5.17)**
A clump of wattle trees is present in the south-western portion of the site, to the north of the channelled valley bottom wetland (Figure 5.17). The wattles appear to be *Acacia decurrens*, but could not be verified due to safety

concerns. All wattles are however listed as category 2 invasive plant species and must be controlled. A few grass and weedy species are present among the wattles.

One of the excavations start in this unit and stretches to the north. It appears that this unit is located on a portion of the excavation that has been filled.

This vegetation unit is of **low conservation importance and sensitivity**.

**Vegetation clearing (Table 5.10; Figure 5.17)**
The vegetation was cleared on a portion in the central western portion of the site, to the west of the PIC SA facility on site (Figure 5.17). Large bare areas are present, with *Lopholaena coriifolia* and *Melinis repens* the dominant species. Other significant species include *Hyparrhenia hirta, Pogonarthria squarrosa, Richardia braziliense* and *Seriphium plumosum* (Table 2 of Appendix 14).

Most of the species present are typical of disturbed areas and the vegetation is of **low conservation importance and sensitivity**.

**Excavations (Table 5.10; Figure 5.17)**
Two excavations, with accumulated water, are present in the southern portion of the site and several additional, dry excavations are present adjacent to the N4 (Figure 5.17). In addition, a long excavation extends from the alien tree clump to the north. Water accumulates in the excavations and allows for the establishment of wetland species in the bottoms of the excavations. These are not wetland areas although the vegetation reflects wetland conditions.

Dominant species in the wet bottoms of the excavations are *Leersia hexandra, Kyllinga erecta, Persicaria lapathifolia* and *Ludwigia palustris.* The sides of the excavations and the dry excavations are sparsely vegetated by grassland species. The dominant species include *Lopholaena coriifolia, Eragrostis gummiflua, Seriphium plumosum* and *Gomphocarpus* species (Table 2 of Appendix 14).

The vegetation is of **low conservation importance and sensitivity**.

### 5.6.3 Species of Conservation Concern

The term 'Species of Conservation Concern' refers to the IUCN threatened and Near Threatened categories as well as the South African Red List categories (i.e. Critically Rare, Rare and Declining).

Venter and Niemand (2017) indicated that possible habitat for the Endangered species *Frithia humulis* is present in the rocky grassland area on site, especially the central and eastern portions of the site, as well as rocky areas associated with the *Anacampseros subnuda* habitat to the west of the site. No individuals were observed at the time of the site visit, but the species may have been dormant at the time of the site visit.

Similar habitat is also present on site for the Vulnerable *Anacampseros subnuda* ssp. *lubbersii*, which has previously been recorded in this quarter degree grid. The best habitat for this species is to the north west of the southern wetland unit on the small outcrop/undulating rocky grassland (Venter and Niemand, 2017).

A few individuals of *Hypoxis hemerocallidea* were observed on site. This species is also declining due to demand for medicinal uses. The species is however classified as Near Threatened at present, since it is still commonly available in the veld (Venter and Niemand, 2017).

The Least Concern species *Callilepis leptophylla* was also observed in the rocky grassland on site (Venter and Niemand, 2017). This species is also declining due to use for medicinal purposes. Any individuals located in the development area may be harvested for medicinal purposes to decrease the pressure on other populations. The individuals in the open space area must however remain in place.

### 5.6.4 Invasive species

Venter and Niemand (2017) identified the following invasive species on site:

- *Opuntia ficus-indica, Verbena bonariense* and *Verbena braziliense* (Category 1b species: Invasive species which must be controlled and wherever possible, removed and destroyed. Any form of trade or planting is strictly prohibited).
- *Acacia decurrens* (Category 2 species: Invasive species, or species deemed to be potentially invasive, in that a permit is required to carry out a restricted activity).

Please note that no *Pennisetum clandestinum* (Kikuyu) was observed in the identified wetland units. This species is listed as invasive and in need of control in all wetland areas where it was absent prior to the publication of the regulations (August 2014). The species may therefore not be allowed to escape from development into the wetland areas. The management plan for the site must include the management of *Pennisetum clandestinum*, to prevent encroachment into the wetland areas.

### 5.6.5 Conclusion

Based on the findings of the vegetation study, Venter and Niemand (2017) concluded the following:

- Three vegetation units identified on site have a high ecological sensitivity namely: the seep, channelled valley bottom and rocky grassland.
- The disturbance in the central portion of the site is limited and likely due to the presence of shallow soils on a rocky substrate. These portions were therefore never ploughed and very few disturbances to the soil is present. The species diversity in the rocky grassland vegetation unit is high.
- All wetland units are considered to be of high conservation importance in terms of the functions these units provide in the landscape.
- The site may potentially provide habitat for the endangered species *Frithia humulis* and the vulnerable *Anacamperos subnuda* spp. *lubbersii.* No individuals were however observed on site. These species could have been dormant at the time and their presence can only be confirmed during a summer visit.
- Three invasive plant species were observed on site and must be controlled. It is possible that additional invasive species may be present or may encroach into the site in future.

## 5.7 Animal life

A faunal survey was undertaken by Lukas Niemand of Pachnoda Consulting (hereafter referred to as Venter and Niemand, 2017) as part of the overall ecological assessment. A copy of the report is provided in Appendix 14 and should be consulted with regards to methology used.

### 5.7.1 Mammals

#### 5.7.1.1 Overview and taxonomic diversity

The study site, according to the occurrence of suitable habitat, is expected to host approximately 56 mammal species (excluding introduced game and or escapees) (Addendum A of Appendix 14).

Thirty-five (35) of the expected mammalian species have a high probability of occurrence (63%), while nine have moderate probability of occurrence (16%). In addition, two species have a low probability of occurrence since they share distribution ranges peripheral to the study site, with the status of one species (*c*. African Striped Weasel *Poecilogale albinucha*) being uncertain although it has been recorded from QDS 2529DC grid that is sympatric to the study site. Of the 56 species expected to be present, 10 species (18 %) were confirmed during the site visit (Table 5.11). These include one leporid (hare), five rodents, one herpestid (mongoose), one hyaenid, one canid (jackal) and one ungulate.

It is worth mentioning that 11 mammal species have been previously recorded from the study region which is sympatric to QDS 2529DC (Table 4 of Appendix 14). However, only two of these species were observed on the study site during the site visit (i.e. Slender Mongoose and Brown Hyena), while eight of the observed species (observed during the site visit) have not been previously recorded for 2529DC and constitute new additional distribution records for the area.

According to reporting rates extracted from MammalMap, it shows that the near threatened Serval (*Leptailurus serval*) and near threatened Cape Clawless Otter (*Aonyx capensis*) obtained the highest number of records (c. six and four records respectively). When the MammalMap data was combined for 2529DC with records from adjacent grid 2529CD it is evident that the Black-backed Jackal (*Canis mesomelas*) was the most dominant species in the area.

#### 5.7.1.2 Mammal richness in habitat units

An analysis of the expected number of mammal taxa (c. 56) species and their habitat preferences showed that the highest number of mammal species is expected to occur on the rocky grassland (c. 46 species), followed by the *Hyparrhenia hirta* grassland (c. 26 species) and the valley bottom wetlands (c. 24 species) (Table 5.12).

The number of species expected to be present in the rocky grassland is nearly double the number on the adjacent *Hyparrhenia hirta* grassland. Although the *H. hirta* grassland is expected to sustain a fairly high richness of taxa, the majority of these species are unspecialised and not as specialised as those pertaining to the rocky grassland. Therefore, most of the species occurring in the *H. hirta* grassland is also present on the rocky grassland. More importantly, many of the species expected to be present on the rocky grassland and valley bottom wetlands will be absent on the other habitat units, thereby emphasising the specialised habits of these taxa.

The lowest number of species is expected from human modified habitat with the lowest number pertaining to areas where vegetation clearing is eminent (Table 5.12).

#### 5.7.1.3 Mammal taxa of conservation concern

The study site, according to habitat suitability and structure, provides habitat for nine (9) species of conservation concern. Seven of these are near threatened, one is vulnerable and one is endangered.

Six of these species have a high probability of occurrence (one confirmed during the site visit), and one with a moderate probability of occurrence (Table 5.13).

The remaining two species could occur based on the presence of suitable habitat and historical records, but data are scant regarding their extant distribution ranges and occurrence on the study area (*sensu* Child *et al*., 2016).

**Table 5.11: An inventory of mammalian taxa observed in the study area during the survey (taken from Venter and Niemand, 2017)**

| SCIENTIFIC NAME | VERNACULAR NAME | OBSERVATION INDICATORS | OBSERVED HABITAT |
|---|---|---|---|
| *Canis mesomelas* | Black-backed Jackal | Scats | Widespread, although observed from grassland units. |
| *Cryptomys pretoriae (=hottentotus)* | Highveld Mole-rat | Soil heaps | Widespread. |
| *Galerella sanguinea* | Slender Mongoose | Visual sightings | Widespread. |
| *Gerbilliscus (Tatera) cf. brantsii* | Highveld Gerbil | Burrow systems | Localised in the south corresponding to modified grassland on sandy soils. |
| *Hystrix africaeaustralis* | Cape Porcupine | Scats and diggings | Widespread, all habitat types. |
| *Lepus victoriae (=saxatilis)* | African Savannah Hare | Visual sightings and droppings | Widespread, mainly confined to grassland units. |
| *Micaelamys namaquensis* | Namaqua Rock Mouse | Dens in rock fissures | Localised, restricted to rocky grassland. |
| *Rhabdomys pumillio* | Four-striped Grass Mouse | Visual sightings | Seeps |
| *Parahyaena brunnea* | Brown Hyaena | Scats | Localised, recorded from the northern section of the study site in open grassland. |
| *Sylvicapra grimmia* | Common Duiker | Spoor & visual sightings | Widespread, mainly confined to grassland habitat types. |

**Table 5.12: A summary of the number of mammal species expected to be present in each habitat unit identified within the study area (taken from Venter and Niemand, 2017)**

| HABITAT | CVB* | SEEP | ROCKY GRASSLAND | *H. hirta* GRASSLAND | ALIEN TREES | VEGETATION CLEARING | EXCAVATION |
|---|---|---|---|---|---|---|---|
| Number of expected species | 24 | 19 | 46 | 26 | 15 | 10 | 13 |

*Legend: CVB = Channelled valley bottom wetland.

**Table 5.13: Mammal taxa of conservation concern (taken from Venter and Niemand, 2017)**

| VERNACULAR NAME | SCIENTIFIC NAME | STATUS | PROBABILITY OF OCCURRENCE | HABITAT |
|---|---|---|---|---|
| Vlei Rat | *Otomys auratus* | Nationally Near Threatened | High | Could occur in the northern and southern seeps and the moist grassland bordering the channelled valley bottom wetland. |
| Swamp Shrew | *Crocicidura mariquensis* | Nationally Near Threatened | High | Along the Channelled Valley Bottom Wetlands and the Seeps within the study area. |
| Serval | *Leptailurus serval* | Nationally Near Threatened | High | Could occur in the moist grassland units bordering the Channelled Valley Bottom Wetlands and Seeps. |
| Brown Hyaena | *Parahyaena brunnea* | Globally and Nationally Near Threatened | **Confirmed on site** | In the *Hyparrhenia hirta* grassland in the northern section of the study area. |
| Cape Clawless Otter | *Aonyx capensis* | Nationally Near Threatened | High | Along the Channelled Valley Bottom Wetland and small dam located on the southern part of the study area. |
| Robert's Marsh Rat | *Dasymys robertsii* | Nationally Vulnerable | Could associate | Seep habitats and moist grassland along the Channelled Valley Bottom Wetland |
| South African Hedgehog | *Atelerix frontalis* | Nationally Near Threatened | Could occur | Rocky grassland unit where waterlogged or moist conditions are less likely to occur. |
| Oribi | *Ourebia ourebi* | Nationally Endangered | Low | Rocky grassland provides potential suitable habitat. However, the study area is fairly flat and often utilised by human pedestrians which will probably deter this species from utilising the site. |
| African Striped Weasel | *Poecilogale albinucha* | Nationally Near Threatened | Uncertain | Rocky grassland. |

### 5.7.2 Amphibians

Fifteen (15) frog species are known to be sympatric to the study area (according to QDC 2529DC and adjacent grid 2529CD; Table 5.14). Eleven of these species have a high probability of occurrence on the study site based on their widespread distribution ranges and their ability to breed in temporary rain-filled depressions and along valley bottom seeps. Of these, four species were confirmed, which include Common Caco (*Cacosternum boettgeri*), Delalande's River Frog (*Amietia delalandii*), Snoring Puddle Frog (*Phrynobatrachus natalensis*) and Striped Stream Frog (*Strongylopus fasciatus*).

According to Minter et al. (2004), the amphibian richness on the study area is moderate (c. 11-20 species) with a very low prevalence of endemic species (c. 1 species, *Amietia delalandii*). Therefore, the study site is not considered as an important amphibian diversity hotspot.

**Table 5.14: A list of amphibian/frog species known from recent observations (sensu FrogMap) and historical distributional records for the study site (2529DC and adjacent grid 2529CD) (taken from Venter and Niemand, 2017).**

| Family | Genus | Species | Common name | Probability of occurrence on study site | No. records |
|---|---|---|---|---|---|
| Bufonidae | *Schismaderma* | *carens* | Red Toad | High | 2 |
| Bufonidae | *Sclerophrys* | *capensis* | Raucous Toad | High | 2 |
| Bufonidae | *Sclerophrys* | *gutturalis* | Guttural Toad | High | 5 |
| Hyperoliidae | *Kassina* | *senegalensis* | Bubbling Kassina | High | 7 |
| Hyperoliidae | *Semnodactylus* | *wealii* | Rattling Frog | High | 3 |
| Phrynobatrachidae | *Phrynobatrachus* | *natalensis* | Snoring Puddle Frog | High | 4 |
| Pipidae | *Xenopus* | *laevis* | Common Platanna | High | 3 |
| Ptychadenidae | *Ptychadena* | *porosissima* | Striped Grass Frog | Moderate | 3 |
| Pyxicephalidae | *Amietia* | *delalandii* | Delalande's River Frog | High | 6 |
| Pyxicephalidae | *Cacosternum* | *boettgeri* | Common Caco | High | 5 |
| Pyxicephalidae | *Pyxicephalus* | *adspersus* | Giant Bull Frog | Moderate | 2 |
| Pyxicephalidae | *Strongylopus* | *fasciatus* | Striped Stream Frog | High | 5 |
| Pyxicephalidae | *Tomopterna* | *cryptotis* | Tremelo Sand Frog | Moderate | 3 |
| Pyxicephalidae | *Tomopterna* | *natalensis* | Natal Sand Frog | High | 5 |
| Pyxicephalidae | *Tomopterna* | *tandyi* | Tandy's Sand Frog | Low (status uncertain) | 1 |

The Giant Bullfrog (*Pyxicephalus adspersus*) is the only frog species of conservation concern which is known from two observations (one record for QDS 2529DC) in the region (Minter et al., 2004).

In general, the study site is not considered to be an important breeding habitat as evidenced by the low reporting rates for this species in the region. However, it could occur on the southern parts of the study site and on adjacent land in the north which corresponds to small dams/depressions that provide ephemeral breeding and foraging habitat. More importantly the channelled valley bottom wetland could facilitate the dispersal of post-breeding adults and juveniles to the adjacent grassland units (Venter and Niemand, 2017).

### 5.7.3 Reptiles

A total of 48 reptile taxa are known to be sympatric to the study region (according to QDC 2529DC and adjacent grid 2529CD; *sensu* Bates et al., 2014) of which eight species are endemic to South Africa (Table 7 of Appendix 14).

According to the habitat types present, the reptile diversity on the study site is high (Bates *et al.,* 2014). However, only 30 (63 %) of these species show a high probability of occurrence, while the remaining 18 species have a medium to low probability of occurrence (Table 7 of Appendix 14). Many of the species with low probabilities of occurrences are marginal to the study area and have their distribution ranges centred in the Central Bushveld Bioregion (as opposed to the Grassland Biome).

The rocky grassland and wetland habitat types are regarded as the most important unit on the study site in maintaining reptile diversity on the study site. One additional lizard species, namely the Ornate Sandveld Lizard (*Nucras cf. ornate*) was observed on the rocky grassland which was not previously recorded in QDS 2529DC, and therefore represents a new distributional record for the study area.

The rocky grassland provides potential refuge for the near threatened Coppery Grass Lizard (*Chamaesaura aenea*) and the near threatened Striped Harlequin Snake (*Homoroselaps dorsalis*). Both species are notoriously difficult to find and detect which explains the low reporting rates obtained during the reptile atlas period (*sensu* ReptileMap). Both species have been recorded from QDS 2529CD which is located adjacent to the study area (these species have not been recorded from 2529DC which is sympatric to the study site).

*C. aenea* (Coppery Grass Lizard) occurs within fairly pristine grasslands and does not appear to tolerate any significant disturbances or habitat alterations. The national population of this species is scattered and appears to have experienced population declines over the last decade due to fragmentation and afforestation of its primary grassland habitat. It is also vulnerable towards veld fires and relies heavily on the presence of outcrops or rocky cover for protection against veld fires. However, it remains to be a very rare and unobtrusive species. For example, Whittington-Jones *et a*l. (2008) recorded only two specimens from Rietvlei Dam Nature Reserve over a period of ca. eight years.

*Homoroselaps dorsalis* (Harlequin Snake) is relatively widespread in South Africa but regarded to be rare in most parts of their geographic distribution. The population of *H. dorsalis* is highly fragmented and prone towards local extinction. Although not often encountered and mostly overlooked it could occur at low densities given the occurrence of suitable habitat, being the presence of outcrops and termitaria (both observed from the rocky grassland units).

### 5.7.4 Avifauna (birds)

#### 5.7.4.1 Species richness and composition

Approximately 156 bird species is expected to occur in the study site according to the available habitat units present (Table 5.15; Addendum B of Appendix 14). The expected richness was inferred from the South African Bird Atlas Project (SABAP1 & SABAP2)2 (Harrison et al., 1997; www.sabap2.org) and the presence of suitable habitat in the study area. The expected richness is also strongly correlated with favourable environmental conditions (e.g. when grassland has recovered from fires). This equates to 16 % of the approximate 9734 species listed for the southern African subregion5 (and approximately 18 % of the 8506 species recorded within South Africa7). However, the SABAP2 richness statistic (www.sabap2.adu.org.za) for the single pentad grid corresponding to the study site was not significantly lower with 148 species observed, thereby illustrating that the expected richness was correctly predicted.

The average number of species observed per pentad is approximately 40 species, with 63 species observed during the site visits (see Addendum C of Appendix 14). The observed richness is also on equivalence with the total observation derived for each card submitted (range from 1-63 species per card). On a national scale, the species richness per pentad on the study area is considered high (Venter and Niemand, 2017).

According to Table 5.15, the study site was not found to be particularly rich in biome-restricted bird species (it supports foraging habitat for one species, namely the Southern Bald Ibis *Geronticus calvus*) as well as endemic and near-endemic species. None of the derived totals were higher than 50% when compared against each other and the national totals. It is therefore not considered to be an important area in terms of bird endemism and evolution.

**Table 5.15: A summary table of the total number of species, Red Listed species (Taylor et al., 2015; IUCN, 2017), endemics and biome-restricted species (Marnewick et al., 2015) expected and observed on the proposed study area. Percentage values in brackets refer to derived totals compared against the number of species in South Africa8 (BirdLife South Africa, 2017) (taken from Venter and Niemand, 2017)**

| PARAMETER | EXPECTED | OBSERVED |
|---|---|---|
| Total number of species | 156 (16%) | 63 (40%) |
| Number of Red Listed species (Taylor et al., 2015 & IUCN, 2017) | 7 (5.5%) | 1 (14%) |
| Number of biome-restricted species9 (Marnewick et al., 2015) –Afrotropical Highlands) | 1 (4.2%) | 0 (0%) |
| Number of endemics | 5 (13%) | 2 (40%) |
| Number of near-endemics | 7 (23%) | 2 (29%) |

#### 5.7.4.2 Dominance and general composition

An analysis of bird data generated from the point counts showed that the dominant composition consists of Highveld grassland taxa. The majority of the composition consists of cryptic members of the Cisticolidae (cisticolas), Highveld granivores pertaining to the genera *Euplectes* (widowbirds) and *Ploceus* (weavers) and lastly also grassland Motacillids (Cape Longclaw *Macronyx capense*) (Table 5.16).

**Table 5.16: Dominant bird species recorded on the study site (taken from Venter and Niemand, 2017).**

| SPECIES | AVERAGE ABUNDANCE | CONSISTENCY | % CONTRIBUTION |
|---|---|---|---|
| Cape Longclaw (*Macronyx capense*) | 1.2 | 0.47 | 26.92 |
| Levaillant's Cisticola (*Cisticola tinniens*) | 1.1 | 0.48 | 24.63 |
| Zitting Cisticola (*Cisticola juncidis*) | 0.5 | 0.37 | 13.54 |
| Long-tailed Widowbird (*Euplectes procne*) | 1.00 | 0.38 | 10.73 |
| Southern Masked Weaver (*Ploceus velatus)* | 0.5 | 0.26 | 5.80 |
| Melodious Lark (*Mirafra cheniana*) | 0.3 | 0.15 | 5.23 |
| Cloud Cisticola (*Cisticola textrix* | 0.4 | 0.15 | 3.32 |

#### 5.7.4.3 Important Bird and Biodiversity Areas (IBAs)

The study site does not overlap with any Important Bird and Biodiversity Area as defined by Marnewick et al. (2015).

#### 5.7.4.4 Bird species of conservation concern

Table 10 of Appendix 14 provides an overview of bird species of 'conservation concern' recorded in the study region, as well as those previously recorded in the area based on their known distribution range and the presence of suitable habitat.

According to Table 10 of Appendix 14, 24 threatened and near-threatened species are known to occur in the study region according to recent (SABAP2) or historical distribution records. The majority of these species are unlikely to be present owing to the absence of suitable habitat or the habitat on the study site does not meet their ecological requirements (e.g. the habitat on the study site might be not large enough).

Of these 24 species, only seven species could occur on the study site based on the presence of suitable habitat. These species include:

- four regionally vulnerable taxa (c. Lanner Falcon *Falco biarmicus*, Southern Bald Ibis *Geronticus calvus*, Secretarybird *Sagittarius serpentarius* and African Grass-owl *Tyto capensis*),
- one regionally near threatened species (Abdim's Stork *Ciconia abdimii*);
- two globally near threatened species (c. Blue Korhaan *Eupodotis caerulescens* and Melodious Lark *Mirafra cheniana*). The latter two species are regionally least concern (Taylor et al., 2015) although regarded as globally near threatened (IUCN, 2017) owing to their

localised global distribution records for which nearly the entire populations are endemic to South Africa.

Of these seven species, only three have a high probability of occurrence (c. Melodious Lark, Southern Bald Ibis and African Grass-owl). The remaining species are regarded as irregular foraging visitors to the area and are easily displaced by the extant anthropogenic activities on the site and by human pedestrians (these taxa also show low reporting rates according to SABAP2).

A small localised population of the Melodious Lark was confirmed from the rocky grassland on site (Venter and Niemand, 2017) – see Figure 22 of Appendix 14.

The Southern Bald Ibis is regarded as a regular foraging visitor to the rocky grassland units, although it is more readily attracted to recently burnt grassland in the study area. Its occurrence is supported by the high reporting rates obtained during the SABAP1 and SABAP2. It was also recently observed in the same pentad grid which overlaps with that of the study site. Suitable roosting and breeding habitat were however absent.

The study site provides suitable habitat for Grass Owl to occur even though the presence of this species on the site could not be verified during the respective site visits. However, suitable roosting and breeding habitat consisting of dense *Arundinella nepalensis* and *Imperata cylindrica* were observed along the valley bottom wetland and the seep on the northern part on the study site. Venter and Niemand (2017) indicated that Grass Owls could thus be present during optimal environmental conditions.

#### 5.7.5 Conclusion

Based on the findings of the faunal (animal life) study, Venter and Niemand (2017) made the following conclusions:

- Three habitat types were identified with high ecological sensitivity based on their intrinsic value to support high faunal diversities and taxa of conservation concern: Rocky grassland, seeps and channelled valley bottom seeps.
- The study site is expected to host a high mammal richness with 56 species likely to occur, of which 35 species have high probability of occurrence.
- The study site provided habitat for nine mammal species of concern. Six near threatened species have a high probability of occurrence and included the Vlei Rat (*Otomys auratus*), Swamp Musk Shrew (*Crocidura mariquensis*), South African Hedgehog (*Atelerix frontalis*), Serval (*Leptailurus serval*), Cape Clawless Otter (*Aonyx capensis*) and Brown Hyaena (*Parahyaena brunnea*). The home range of a Brown Hyaena coincided with part of the study site.
- The moist grassland bordering the seeps and channelled valley bottom wetlands provide daily dispersal corridors for foraging mammal species.
- Fifteen (15) amphibian and 48 reptile species could occur.
- Approximately 156 bird species could occur. The dominant bird composition comprised of grassland taxa with widespread distribution ranges pertaining to the Grassland Biome.
- The rocky grassland and moist grassland bordering the channelled valley bottom wetlands are considered as the most important bird habitat (when compared to the other habitat types). The rocky grassland provides foraging habitat for the vulnerable Southern Bald Ibis (*Geronticus calvus*) and globally near threatened Melodious Lark (*Mirafra cheniana*). Part of the valley bottom wetland (including part of the northern seep on adjacent

land) provides suitable breeding and roosting habitat for the vulnerable African Grass Owl (*Tyto capensis*).

## 5.8 Surface water

### 5.8.1 Catchment

The said site is situated within the B12D quaternary sub-catchment of the Olifants River Catchment.

The N11 national road (eastern boundary of the site) is situated on a local watershed resulting in two local drainage directions namely towards the northwest and the northeast.

On site, the central and northern portions drain towards the northwestern boundary where a tributary of the Vaalbankspruit originates (Figure 5.1).

A non-perennial tributary of the Vaalbankspruit flows through the southwestern corner of the site (Figure 5.1 and 5.2) and flows to the west. The southern portion of the site drains towards this stream. A dam is present at the start of this system as well as a wetland (Figure 5.2).

The surface water run-off from the site could be impacted as a result of activities associated with the PIC South Africa (Alzu) AI Station (Figure 5.2) if proper waste management measures were not implemented. In addition, surface water runoff and the wetlands could have been impacted in terms of the borrow pits, the dumping site, the railway embankment, gravel roads, water pipeline, etc. (Figure 5.2).

Cilliers and Meyer (2017) indicated that most of the site has a gentle to moderate slope towards the western boundary of the site. On site, the central and northern portions slope toward the northwestern corner (Figure 5.18a) while the southern portion of the site slopes towards the southwestern corner of the site (Figure 5.18a).

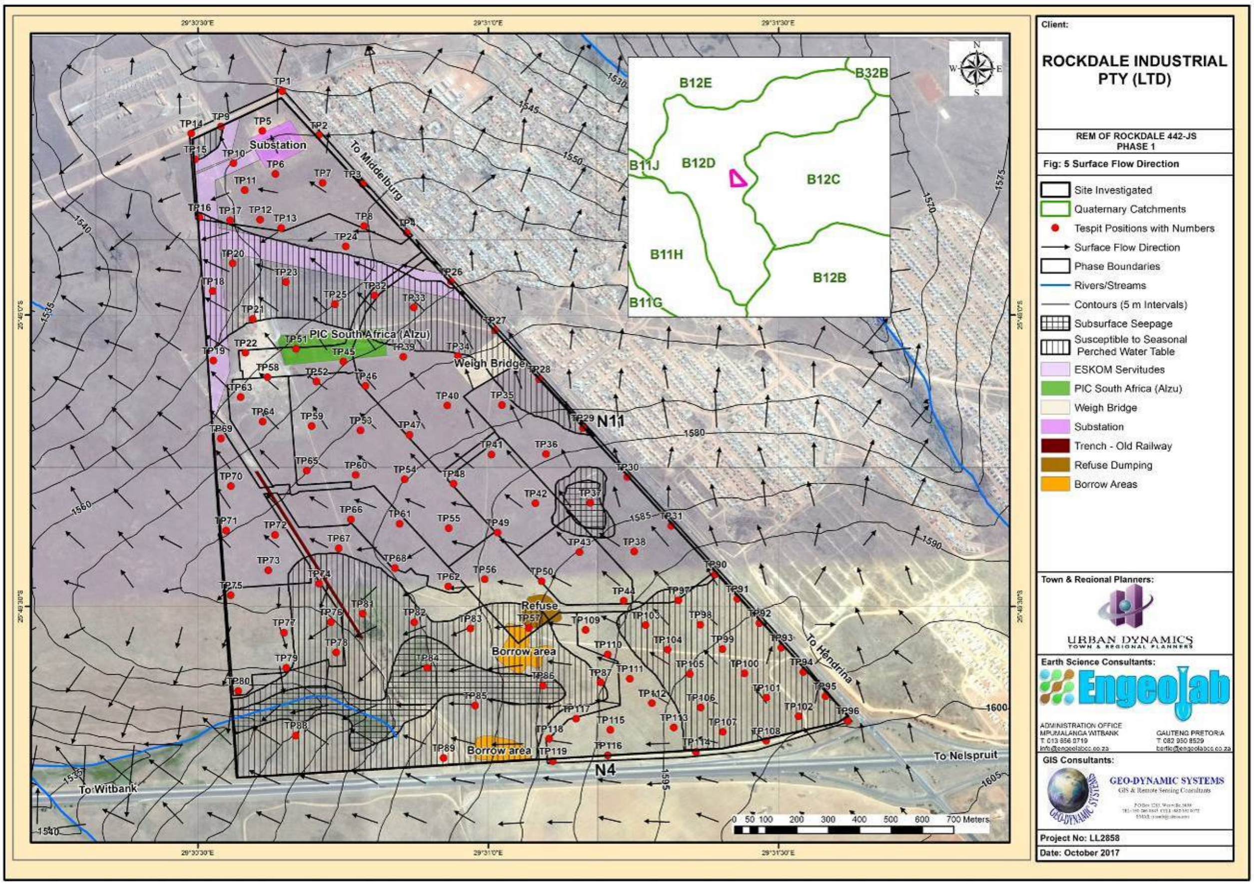


**Figure 5.18a: Surface flow direction (taken from Cilliers and Meyer, 2017)**

### 5.8.2 Wetlands

A wetland delineation study was undertaken by Ina Venter of Kyllinga Consulting as part of the overall ecological assessment (hereafter referred to as Venter, 2017). A copy of the said report is provided in Appendix 15 and should be consulted with regards to methodology used.

#### 5.8.2.1 Wetland units identified

Venter (2017) identified three wetland units on site namely:

- Two seep wetlands in the northern and eastern portions of the site (Table 5.17; Figure 5.18b);
- Channelled valley bottom wetland, with associated seep on the southern portion of the site (Table 5.17; Figure 5.18b).

**Table 5.17: Wetland units and their sizes on site (taken from Venter, 2017)**

| WETLAND | UNIT | SIZE (ha) | |
|---|---|---|---|
| Eastern seep | Seep on site | 6.1331 | |
| Northern seep | Seep on site | 7.3678 | |
| Southern wetland (CVB) | Channelled valley bottom on site | 4.8895 | 14.6173 |
| | Seep on site | 9.7278 | |

**Eastern Seep (Figure 5.18b):** This seep wetland is located on the local catchment divide in the eastern portion of the site (Figure 5.18b). According to Venter (2017), this seep is a marginal temporary wetland, which fits with the topographical location thereof.

It appears that the wetland unit extended across the N11 and that the Rockdale development to the east took place on a portion of the wetland (Figure 5.18). According to Venter (2017), it appears that approximately half of the seep was lost due to the Rockdale development. However the previous extent of the wetland is not known.

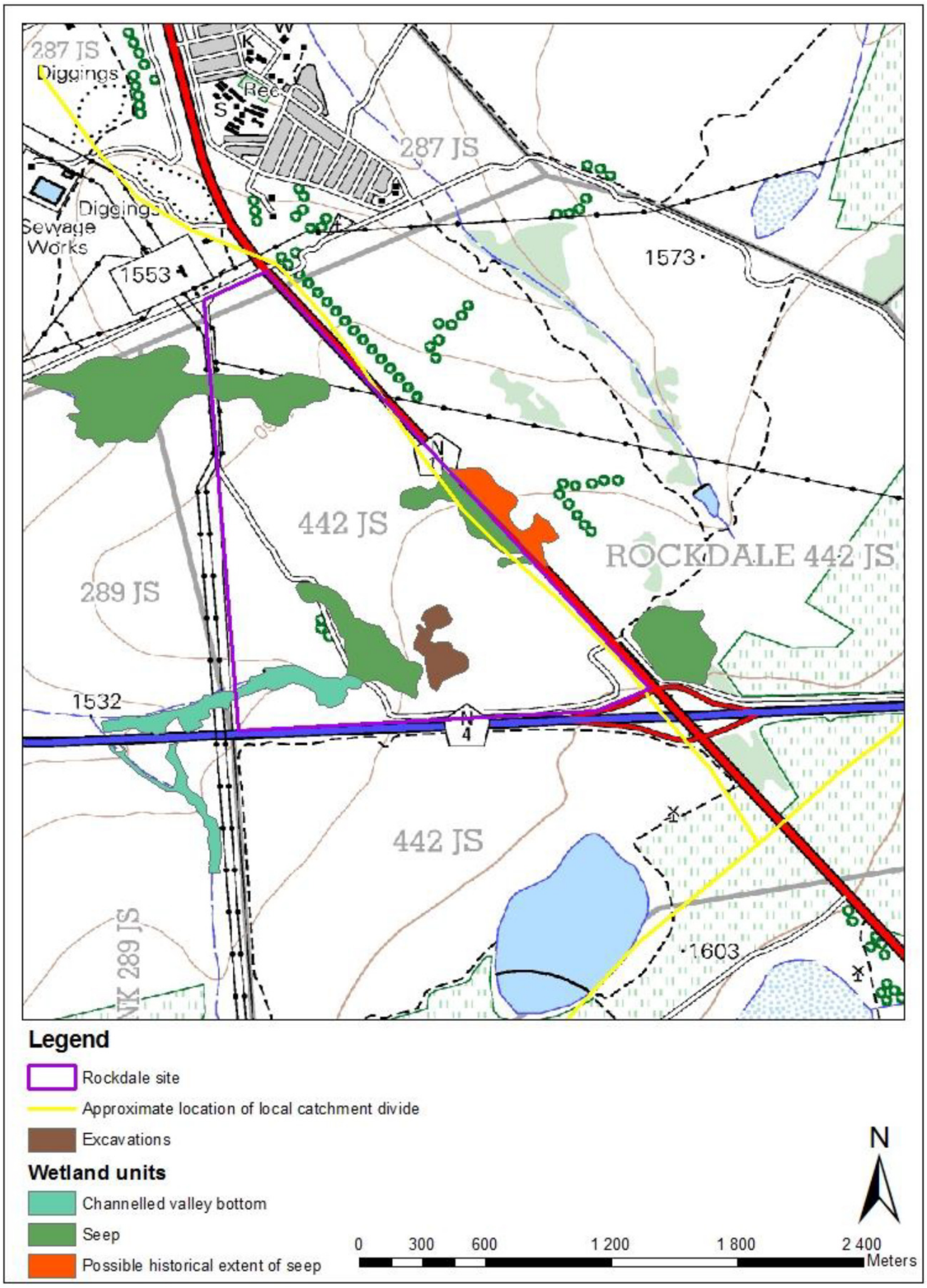


**Figure 5.18b: Wetland units identified on site (taken from Venter, 2017)**

According to Venter (2017), the vegetation of the Eastern Seep is dominated by various facultative species, including several facultative wetland species, such as *Eragrostis gummiflua, Sporobolus africana* and *Helichrysum nudifolium* (Table 5 of Appendix 15). The obligate wetland species *Kyllinga erecta, Andropogon huillensis* and *Fuirena pubescens* are also present in these units as well as a few terrestrial species (including species associated disturbance such as *Hyparrhenia hirta*). The vegetation in the wetland units are typical of temporary seep vegetation in this area.

The soil in the eastern seep is mostly very shallow (20 to 40cm deep; in places only approximately 10cm deep). This severely limits the potential for wetlands in this area, especially since the retention of water in the soil profile for prolonged periods of time is unlikely. The soil types located in this area are the Mispah and Westleigh soil forms (see Section 5.5.3; Figure 5.11).

Red mottling was observed at several locations in the wetland. The mottling observed in the soil profile may, however, be due to weathering of the bedrock material, rather than wetland conditions. A number of obligate wetland species were however observed in this area, including *Fuirena sp, Kyllinga erecta* and *Andropogon eucomis.* These species, in addition to the sparse mottling of the soil, leads to the conclusion that a temporary wetland is present on the eastern portion of the site, with a very shallow phreatic water table for part of the year.

There is some debate as to whether a system such as this, with very shallow soils and few wetland indicators should be defined as a wetland. It does fall within the definition of a wetland as defined in the National Water Act i.e. a transitional area between aquatic and terrestrial systems where sufficient water is present to affect the vegetation under natural conditions. The functionality of these systems is however severely limited, especially the functions related to hydrology, with the main importance of the wetland being the ecological support. **This system can therefore be seen as a marginal wetland system (Venter, 2017).**

Viljoen (2017) indicated that the soils associated with the Eastern Seep include Mispah and Westleigh soils. Mispah soils are not associated with wetlands and Westleigh soils are sometimes associates with wetlands. During the assessment there were no signs of wetness and gley mottling occurring in the diagnostic horizons of the Mispah and Westleigh soils to classify it as wetland soils. The soil profiles opened with a TLB and the soil auger holes showed all the profiles to be dry. **From this perspective, Viljoen (2017) did not classify the area as a wetland zone.**

**Northern Seep (Figure 5.18b):** The seep wetland unit on the northern portion of the site is also located in a slight depression flowing to the west. The wetland is not canalised. A number or disturbances are present, which has an effect on the topography of the site, including an earth embankment across the wetland to the west of the site (causes some damming in the wetland).

The wetland seep in the northern portion of the site is severely impacted to the north west of the site, where the seep is impacted by the infrastructure and activities of Columbus Stainless (Figure 5.2). Several other impacts are present within the wetland. According to Venter (2017), the wetland appears to be dominated by grass and sedge species.

The vegetation of the Northern Seep is similar to that of the Eastern Seep (Table 5 of Appendix 15).

The soil in the northern seep wetland unit is a grey sandy soil with red and orange mottles on most of the site. The soil in the western portion of the wetland is more clayey and is a darker grey colour, with a higher organic component. The soil forms in this area include the Westleigh and Bainsvlei soil forms (see Section 5.5.3; Figure 5.11).

**Channelled valley bottom wetland (referred to as CVB; Figure 5.18b):**
A channelled valley bottom wetland is present in the southwestern portion of the site (Figure 5.18b). The eastern portion is classified as a seep, while the western portion of the wetland is a channelled valley bottom wetland (Figure 5.18b). A dam is present in the wetland on the western border of the site (Figure 5.18b).

The wetland is located in a lower lying portion of the site where water flow is expected. The wetland is canalised in the western portion of the site. The eastern portion of the site is not canalised, but slopes towards the canalised section.

According to Venter (2017), the vegetation in the Channelled Valley Bottom Wetland is dominated by obligate and facultative wetland species, with facultative terrestrial species present in the edges of the wetland unit. Several sedge and grass species are present.

Species in the Channelled Valley Bottom portion of the wetland include *Calamagrostis epigeios, Leersia hexandra, Kyllinga erecta* and *Persicaria attenuata* (Table 5 of Appendix 15). Species in the Seep portion include *Andropogon huillensis, Eragrostis plana, Eragrostis gummiflua* and *Sporobolus africana* (Table 5 of Appendix 15). The vegetation in the wetland unit indicated temporary to permanent wetness in the Channelled Valley Bottom portion of the wetland and temporary wetness in the Seep portion of the wetland (Venter, 2017).

The seep in the eastern portion of the channelled valley bottom wetland unit is also a grey (leached) sandy soil with red mottles. The soil in the channelled valley bottom (CVB) portion of the wetland is more clayey and also grey in colour. The CVB portion of the wetland is mainly located on the Katspuit soil form (Figure 5.11).

**Non-wetland areas**
A leaking water pipeline is located close to the northern seep wetland where a number of wetland species are present. These are however not wetland areas and all signs of wetness will disappear completely when the pipeline is fixed.

Venter (2017) also noted wetland vegetation within the excavations in the southern portion of the site. These are not wetland units. The presence of wetland vegetation in these areas is as a result of the ponding in the bottom of the excavations.

#### 5.8.2.2 Present Ecological State (PES)
Table 5.18 provides a summary of the Present Ecological State (PES) of the identified wetlands.

**Table 5.18: Present Ecological State (PES) for the wetlands identified (taken from Venter, 2017)**

<table>
<tr><th colspan="4">PRESENT ECOLOGICAL STATE (PES)</th></tr>
<tr><th>PES SCORE</th><th>EASTERN SEEP</th><th>NORTHERN SEEP</th><th>CHANNELLED VALLEY BOTTOM</th></tr>
<tr><td>HYDROLOGY</td><td>C (moderately modified)</td><td rowspan="2">B/C (largely natural/ moderately modified)</td><td rowspan="2">B (largely natural)</td></tr>
<tr><td>GEOMORPHOLOGY</td><td>A (natural)</td></tr>
<tr><td>VEGETATION</td><td>E (seriously modified)</td><td>C (largely natural)</td><td>B (largely natural)</td></tr>
<tr><td>COMBINED PES SCORE</td><td>C (moderately modified)</td><td>B/C (largely natural/ moderately modified)</td><td>B (largely natural)</td></tr>
</table>

**Eastern Seep (Figure 5.18b):**
As indicated in Table 5.18, the overall PES of the Eastern Seep is C (i.e. moderately modified). This wetland is not directly connected to the stream network at present. It appears unlikely that the system was directly linked to the stream network in the past. The wetland is however expected to have an indirect connection to the stream network (Venter, 2017).

The most significant modifications to the wetland are as a result of the development of the existing Rockdale residential area and the N11 road that impacted directly on this wetland. According to Venter (2017), few disturbances are present on the remaining extent of the wetland, although the vegetation has been partially modified to have a higher dominance of *Hyparrhenia hirta*. Venter (2017) noted minor erosion adjacent to the N11 road.

**Northern seep (Figure 5.18b):**
As indicated in Table 5.18, the overall PES of the Northern Seep is B/C (i.e. between largely natural and moderately modified). The following impacts on this wetland unit were noted:

- An earth embankment dam is present where some ponding of water does take place.
- A tar road crosses the wetland in the western portion of the site.
- Powerlines cross the wetland from east to west;
- Vegetation under the powerlines is mowed on a regular basis resulting in minor wheel track entrenchment in the wetland area.

**Channelled valley bottom wetland (Figure 5.18b)**
As indicated in Table 5.18, the overall PES of the Channelled Valley Bottom Wetland is B (i.e. largely natural).

The main disturbances within the CVB portion of this wetland include a dam, a road crossing, a few invasive trees and some channel incision below the dam.

The seep portion is impacted by alien species and several excavations outside of the seep (i.e. two borrow pits – east and north of the site; an excavations for a dirt road, etc.). The excavations and the alien trees may partially drain the seep.

The CVB portion of the wetland located to the south west of the wetland is in PES Class C (moderately modified; Table 5.18). The wetland portion is crossed by the N4 and the culverts caused channel incision in the wetland unit that has resulted in modifications to the hydrology, geomorphology and vegetation.

#### 5.8.2.3 Ecological Importance and Sensitivity (EIS)

Table 5.19 provides a summary of the Ecological Importance and Sensitivity (EIS) of the identified wetlands.

**Table 5.19: Ecological Importance and Sensitivity (EIS) for the wetlands identified (taken from Venter, 2017)**

| ECOLOGICAL IMPORTANCE AND SENSITIVITY (EIS) | | | |
|---|---|---|---|
| **EIS SCORE** | **EASTERN SEEP** | **NORTHERN SEEP** | **CHANNELLED VALLEY BOTTOM** |
| Ecological Importance and Sensitivity | Low to moderate | High | High |
| Hydro-functional Importance | Low to moderate | Moderate | Moderate |
| Direct Human Benefits | None (does not appear to have direct human benefits) | | |

**Eastern Seep (Figure 5.18b):**

The Eastern Seep has a Low to Moderate EIS (Table 5.19) indicating that the wetland is:

- of local to provincial importance and sensitivity;
- rarely sensitive to changes to alterations in the hydrology and habitat of the wetland, since the wetland normally has a small contribution to large rivers in the catchment.

The hydro-functional importance is Low-Moderate (Table 5.19) with the functions being limited by:

- the wetland type,
- the shallow soil;
- the location in the catchment;
- the loss of wetland habitat on the other side of the N11.
- the wetland not being directly linked to the stream network.

According to Venter (2017), the wetland is however expected to still have some hydrological functions remaining, including the removal of nitrates, phosphates and toxicants. Sources of pollution are limited and are mostly confined to pollution from the N11 and the existing Rockdale development (e.g. waste).

**Northern Seep (Figure 5.18b):**

The Northern Seep has a High EIS (Table 5.19). According to Venter (2017), this EIS score is much lower than the score for the southern wetland units (i.e. channelled valley bottom wetland). This wetland is sensitive to change in the wetland habitat and hydrology.

It also has a slightly lower PES score than the southern wetland unit (channelled valley bottom wetland) as well as a slightly lower diversity of habitat (Venter, 2017). It is however still sensitive and of high conservation importance.

The hydro-functional importance of this wetland is Moderate and the wetland may perform streamflow augmentation and sediment trapping functions, as well as the trapping of phosphates, nitrates and toxicants.

**Channelled Valley Bottom Wetland (Figure 5.18b)**
This wetland has a High EIS (Table 5.19) and is therefore considered to be ecologically important and sensitive to changes in flow and habitat modification. This is influenced by, amongst others, the location of the wetland in a Vulnerable vegetation type, the diversity of habitat types, the possible occurrence of the African Grass Owl and the largely natural status of the wetland.

The hydro-functional importance of this wetland is Moderate (Table 5.19) and the wetland may perform streamflow regulation and flood attenuation functions, with the possibility of sediment trapping and phosphate, nitrate and toxicant accumulation.

#### 5.8.2.4 Conclusion
Based on the findings of the wetland study, Venter (2017) concluded the following:
- Three wetland units are present on site. Two seep wetlands are present on the northern and eastern portions of the site and the third wetland unit is a channelled valley bottom wetland, with associated seep on the southern portion of the site.
- In terms of the PES, the CVB wetland and northern seep wetland units are largely natural and largely natural to moderately modified respectively. Both have a high EIS and are considered to be of high sensitivity to changes in the wetland habitat and flow.
- The seep wetland on the eastern portion of the site is moderately modified (i.e. PES), with a portion of the existing Rockdale development located on a portion of the seep. The seep has a moderate EIS and low to moderate hydro-functional importance.

### 5.8.3 Aquatic fauna
Dr. P. Kotze and team of Clean Stream Biological Services (Pty) Ltd. (hereafter referred to as Kotze, 2017) were appointed to conduct an aquatic biota baseline assessment with regards to the unnamed tributary and the Vaalbankspruit. A copy of the report is provided in Appendix 16. This report should be consulted regarding the methodology used.

#### 5.8.3.1 Ecological status of study area
The proposed site falls within drainage region B (Olifants River System) and specifically within secondary catchment B12D. The site lies within Level II EcoRegion 11.02 (Upper Highveld) (Kleynhans *et al*., 2005).

The primary receiving water bodies to the proposed development are an unnamed (Rockdale) tributary (not classified on sub-quaternary reach level) and the Vaalbankspruit (sub-quaternary reach B12D-1144) directly downstream of the "Rockdale tributary" confluence. The Vaalbankspruit flows into the Klein Olifants River (SQ reach B12D-1118) approximately six kilometres further downstream. Table 5.20 provides an indication of the Present Ecological Status, Ecological Importance and Ecological Sensitivity of these reaches as determined by a DWS desktop study (DWS, 2013).

**Table 5.20: Ecological status of the Vaalbankspruit and downstream receiving Klein Olifants River reach (taken from Kotze, 2017).**

| | Vaalbankspruit reach (B12D-1144) | Downstream receiving Klein Olifants River reach (reach B12D-1118) |
|---|---|---|
| **Present Ecological Status (PES)** | largely modified (Category D) | largely modified (Category D) |
| **Ecological Importance** | Moderate | High |
| **Ecological Sensitivity** | High | High |

As indicated in Figure 5.16, the central and southwestern portions of the site are classified as Critical Biodiversity Area (CBA) Optimal in terms of the terrestrial biodiversity assessment of the Mpumalanga Biodiversity Sector Plan (2013). The northern portion of the site is classified as Other Natural Areas (Figure 5.16) while the southeastern corner of the site is classified as Moderately modified - Old Lands (Figure 5.16).

In terms of the freshwater assessment of the Mpumalanga Biodiversity Sector Plan (2013), the southwestern corner of the site is indicated as:

- Critical Biodiversity Area (CBA) Wetlands (Figure 5.19);
- Ecological Support Area (ESA) Wetland Clusters (Figure 5.19).

The rest of the site is classified as 'Other Natural Areas' (Figure 5.19).

According to the Mpumalanga Biodiversity Sector Plan (MBSP) map, the river reaches of concern, in close proximity to the proposed development, are classified as ***Ecological Support Areas (ESA)*** and ***Other Natural Areas*** (Figure 5.19). These are areas that are not essential for meeting targets, but play an important role in supporting the functioning of Critical Biodiversity Areas (CBAs) that deliver important ecosystem services. Some areas are also indicated as "***Mpumalanga Highveld Wetlands***" (Figure 5.19).

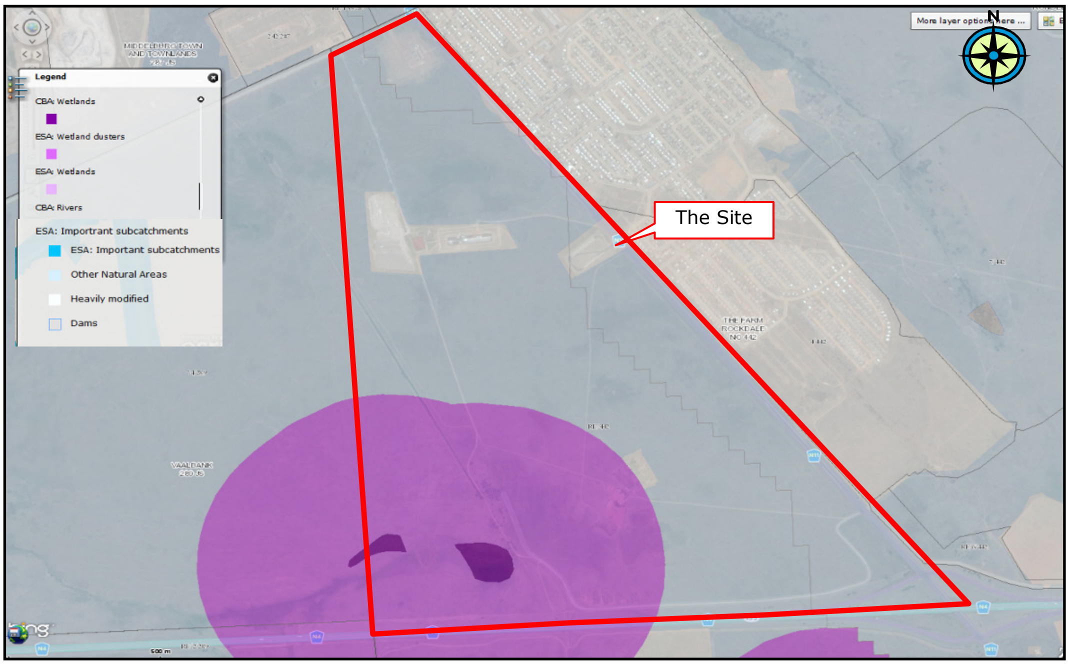


**Figure 5.19: Freshwater assessment (taken from the Mpumalanga Biodiversity Sector Plan, 2013)**

The Vaalbankspruit reach (B12D-1144) and Klein Olifants River reach (B12D-1118) are ***not classified as NFEPA*** Rivers. National Freshwater Ecosystems Priority Areas (NFEPA) are rivers, together with their associated catchment, that are currently in a good to pristine state and are important in terms of maintaining threatened or near threatened fish species. FEPA Rivers should be maintained in a high level of biotic integrity to contribute towards national biodiversity goals (Nel *et al*, 2011) The river and its surrounding catchment, including tributaries, need to be managed in a way that maintains the good condition of the receiving river (A or B ecological category) (Nel *et al*, 2011).

#### 5.8.3.2 Site selection and description

Kotze (2017) selected three (3) sites (RD1, RD2, RD3) for aquatic sampling (i.e. in-situ water quality, habitat assessment, macroinvertebrates and fish) and 4 visual (RD4, RD5, RD6, RD7) observation sites as indicated in Table 5.21. Figure 5.20 indicates the location of the said sites.

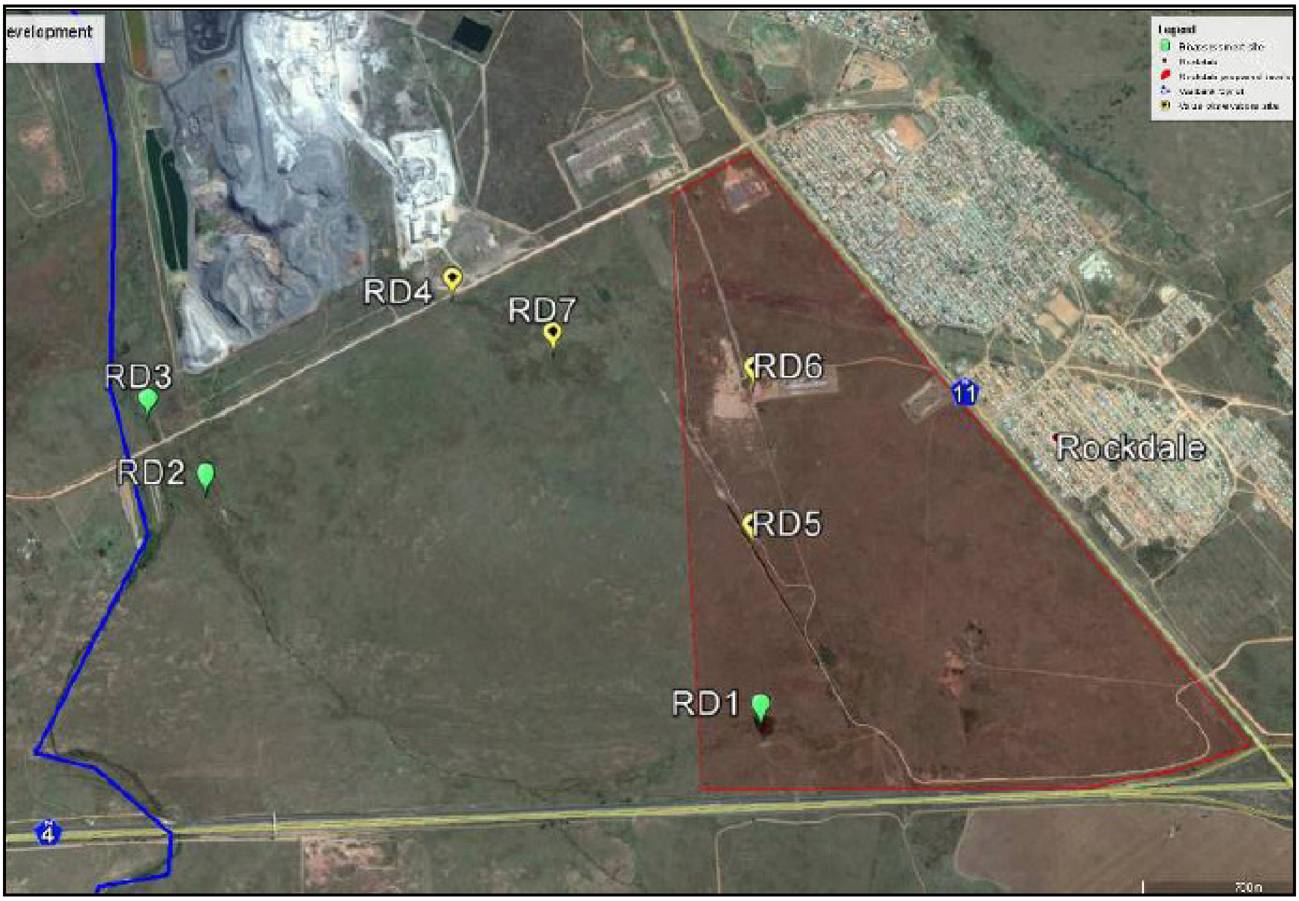


**Figure 5.20: Aerial of the location of the aquatic sampling sites (taken from Kotze, 2017)**

**Table 5.21: Description of the sampling sites (taken from Kotze, 2017)**

| Location of site (Figure 5.20) | Instream Habitat Integrity (IHI) |
|---|---|
| RD1: Site in small old farm dam in an unnamed tributary (named Rockdale tributary for purpose of this study) of the Vaalbankspruit. Within proposed Rockdale development zone. This site is situated in the upper reaches of the Rockdale tributary within a relatively undeveloped catchment area (Figure 5.20). | IHI of Site RD1 is currently in a relatively good condition, being classified in a category B (slightly modified).<br>The primary impacts on habitat integrity was associated with the presence of the small farm dam that resulted in flow modification, bed modification (also impacted by sedimentation due to catchment erosion), channel modification and inundation. Some alien vegetation (Wattle) was also evident in the catchment area of this site. It can be expected that the habitat integrity of this site will be notably impacted by the proposed development due to its position within the development zone. *(Although site RD1 consisted of an artificial aquatic ecosystem (dam) this was the only semi-natural surface water ecosystem present within the proposed development zone, and hence bioassessments were conducted at the site (cognisance should be taken of the limitations in applying of bioassessment protocols to artificial aquatic ecosystems).* |
| RD2: Site in lower reaches of unnamed (Rockdale) tributary just before the confluence with the Vaalbankspruit. Downstream of proposed Rockdale development. | IHI of Site RD2: in a very good condition (category A/B). The most notable impacts on the habitat integrity at this site included flow modification (upstream dams), bed modification (sedimentation associated with erosion) and vegetation removal (trampling and grazing by livestock). |
| RD3: Site in Vaalbankspruit after the confluence of the Rockdale (unnamed) tributary. Downstream of proposed Rockdale development. | IHI of Site RD3: in a deteriorated state due to current activities, fell in a category D/E (largely to seriously modified) while the riparian zone fell in a category C (moderately modified). The most significant impacts at this site was associated with water abstraction (upstream centre pivots, agriculture), flow modification (Pienaars Dam and other smaller farm dams), bed modification (extensive sedimentation associated with catchment erosion, and aggravated by large trucks crossing river via dirt road low water bridge), channel modification (erosion, small measuring weir, low-water bridge), and water quality deterioration (upstream mining, agriculture). |
| RD4: Site in wetland draining to the north west from the proposed development area, at dirt road crossing. | Wetland crossing at dirt road, channelised through culvert. Dry at time of sampling. Seasonal system unlikely to be significant in terms of aquatic fauna composition. |
| RD5: Deep trench/cutting with water (purpose/origin uncertain, possibly old railway track or mining activity), not rehabilitated. Artificial aquatic system. | Created an artificial aquatic ecosystem, but insignificant in terms of aquatic fauna assemblages in the study area. This feature is currently a serious danger to humans and animals (deep sidewalls, deep water) and should be rehabilitated as a matter of urgency. |
| RD6: Manure dam (Alzu). | Dam containing organic waste and very high turbidity within the proposed development zone. This dam seems not to be lined and poses a threat to natural aquatic ecosystems (including groundwater) through seepage. Scoping Report (AdiEnvironmental, 2017) indicated that this facility will be relocated. It is essential that this dam should be rehabilitated in such a way that the content of the dam does not reach the natural aquatic ecosystems in the area. It is recommended that toxicity testing be done on the water and sediment of this dam to determine its present risk to aquatic ecosystems in the area. |
| RD7: Redundant dam in wetland ecosystem draining to the north west away from the proposed development. | Dry at time of sampling. Insignificant in terms of aquatic fauna diversity. |

#### 5.8.3.3 In-situ water quality

Table 5.22 provides the in-situ water qualities as measured at the 3 aquatic sampling sites.

**Table 5.22**: ***In-situ* water quality variables measured at the time of sampling at the selected sampling sites (August 2017 survey) (taken from Kotze, 2017).**

| MONITORING SITE | RD1 | RD2 | RD3 |
|---|---|---|---|
| **EC (mS/m)** | 5.5 | 24.6 | 71.5 |
| **pH** | 9.1 | 7.9 | 7.5 |
| **Oxygen saturation (%)** | 42.5 | 80.4 | 74.0 |
| **Dissolved oxygen (mg/l)** | 4.1 | 7.1 | 6.9 |
| **Water temp (°C)** | 11.9 | 16.0 | 15.4 |
| **Turbidity (visual)** | Slightly turbid | Clear | Turbid |
| **Flow (visual)** | No flow | Low | Low |

Kotze (2017) indicated that the electrical conductivity (EC) of Site RD1 was very low, measuring 5.5 mS/m (Table 5.22). This is an indication of relatively good water quality (low salinity) with no notable impacts due to it being near the source of the Rockdale tributary.

The pH level was relatively high (9.1; Table 5.22) at Site RD1, just exceeding the target for fish health of between 6.5 and 9.0 (it is expected that most species will tolerate and reproduce successfully within this pH range, DWAF, 1996). The pH may therefore be slightly limited to biotic conditions at this site.

Oxygen saturation (42.5%; Table 5.22) and dissolved oxygen (4.1mg/l; Table 5.22) also measured low at Site RD1, falling below the guideline level of >5mg/l (Kempster *et al*., 1982) and may therefore also be limiting to the ecological integrity of the site. The low dissolved oxygen, and possibly also the high pH, may be attributed to the stagnant water (dam) and the abundance of aquatic vegetation. The decomposition of organic material can decrease oxygen levels (and increase nutrient levels) while the photosynthetic processes of plants cause a decrease in the pH at night and an increase during the day. It is expected that the water quality of Site RD1 be impacted by the proposed development (construction, urban runoff, potential leaks from sewage system, etc.) should all pollution control actions not be in place.

The EC increased downstream in the Rockdale tributary between Site RD1 and RD2 (24.6 mS/m; Table 5.22). This increase is most probably related to an inflow from the south that may be impacted by agricultural activities. The pH decreased downstream (7.9 at Site RD2; Table 5.22) and fell within target water quality ranges. Oxygen levels were also better at Site RD2 when compared to Site RD1, and should not be limiting to biota. This site is downstream of the proposed development and may potentially receive water of poor quality (urban runoff, spills, etc.) as a result of the proposed development.

The salinity (as reflected by electrical conductivity) was notably higher in the Vaalbankspruit at Site RD3 (71.5mS/m; Table 5.22). It is evident that various sources of salts (mining, agriculture) are entering the Vaalbankspruit upstream of the Rockdale tributary inflow. It is therefore important that a further increase of salinity via the Rockdale tributary should not be allowed as a result of the proposed development. The pH and dissolved oxygen levels fell within general guideline levels for the protection of aquatic ecosystems and should not be limiting to aquatic biota. The water at Site RD3 was turbid, primarily as a result of the continuous pollution caused by traffic (especially large trucks) crossing the Vaalbankspruit dirt road low water bridge. This impact should be addressed by the relevant authorities and the proposed development should not be allowed to further exaggerate this impacts (through increased traffic).

#### 5.8.3.4 Icthyofauna (Fish)

**Fish habitat assessment**
The Habitat Cover Ratings (HCRs) indicated that the diversity of habitats for fish was high at all sites, with all four velocity-depth classes being present (Table 4 of Appendix 16). Only slow habitats (slow-shallow and slow-deep) were available at the sampling sites. The primary cover feature available for fish at the sites was generally in the form of overhanging vegetation and macrophytes, with very limited rocky substrate (Table 4 of Appendix 16).

The habitat composition at a site plays an important role in determining the expected fish species assemblage of the site, which is furthermore influenced by the prevailing water quality.

**Fish species composition (pre-disturbance/reference and present)**
No fish were present at Site RD1, which is expected to be natural for the most upper reaches of the Rockdale tributary.

Kotze (2017) sampled three indigenous fish species namely *Enteromius anoplus* (Chubbyhead barb), *Pseudocrenilabrus philander* (Southern mouthbrooder) and *Tilapia sparrmanii* (Banded tilapia) at Site RD2 in the lower reaches of the Rockdale tributary. Only two fish species, namely *P. philander* and *T. sparrmanii* were present at Site RD3. The most abundant species in the study area was *P. philander* (27.4 individuals/hour) and the highest abundance of fish at all sites was observed at site RD2.

Based on all available information it is estimated that five indigenous fish species may occur (or have occurred under pre-disturbed conditions) in the Rockdale tributary, eight in the Vaalbankspruit and twelve in the Klein Olifants River receiving reach (Table 5.23).

The fish species in the Rockdale tributary and Vaalbankspruit (Table 5.23) are the most likely species to be impacted due to their proximity to the proposed development, while it is unlikely that the Klein Olifants River will be notably impacted due to its relative distance from the development. The most intolerant fish species expected in the Rockdale tributary is *Enteromius* (previously *Barbus) neefi* (Table 5.23). This species was not sampled at any of the sites during the current study and it is expected that it may already have disappeared from the study area as a result of the current impacts in the catchment.

**Table 5.23: Summarised information of fish species expected in the river reaches of concern to this study (taken from Kotze, 2017).**

| | **Stream/River:** | Rockdale tributary | Vaalbank Spruit | Klein-Olifants River |
|---|---|---|---|---|
| | **SQ reach:** | n/a | B12D-1144 | B12D-1118 |
| **SCIENTIFIC NAME** | **ENGLISH COMMON NAME** | | | |
| *Amphilius uranoscopus* | Stargazer (Mountain-Catfish) | | | X |
| *Enteromius anoplus GROUP (Barbus anoplus)* | Chubbyhead Barb | X | X | X |
| *Labeobarbus marequensis* | Largescale Yellowfish | | | X |
| *Enteromius neefi (Barbus neefi)* | Sidespot Barb | X | X | X |
| *Enteromius paludinosus (Barbus paludinosus)* | Straightfin Barb | X | X | X |
| *Labeobarbus polylepis* | Smallscale Yellowfish | | X | X |
| *Enteromius trimaculatus (Barbus trimaculatus)* | Threespot Barb | | X | X |
| *Clarias gariepinus* | Sharptooth Catfish | | X | X |
| *Chiloglanis pretoriae* | Shortspine Suckermouth (Or Rock Catlet) | | | X |
| *Labeo cylindricus* | Redeye Labeo | | | X |
| *Pseudocrenilabrus philander* | Southern mouthbrooder | X | X | X |
| *Tilapia sparrmanii* | Banded Tilapia | X | X | X |
| | **TOTAL NUMBER OF SPECIES** | **5** | **8** | **12** |

The presence of the moderately tolerant *Enteromius anoplus* was confirmed during the current survey in the lower Rockdale tributary at Site RD2 (Table 5.23). This species is overall moderately tolerant to changes in the environment and it may especially be impacted by the proposed development through reduced water quality and sedimentation. This will be the most important indicator fish species to monitor potential impacts associated with the proposed development. The third *Enteromius* species (*E. paludinosus*) expected in the Rockdale tributary (not sampled) is tolerant to changes in the environment and their absence may be attributed to natural phenomenon.

The presence of two small cichlid species namely *Pseudocrenilabrus philander* and *Tilapia sparrmanii* was also confirmed in the lower Rockdale tributary (site RD2) and Vaalbankspruit (site RD3) at the time of the survey (Table 5.23). These two species are tolerant to changes in the environment and no notable negative impacts are expected due to the proposed development.

One yellowfish species is expected in the Vaalbankspruit, namely *Labeobarbus polylepis* (Smallscale yellowfish), while this species and *Labeobarbus marequensis* (Largescale yellowfish) can be expected in the Klein-Olifants River reach (Table 5.23). *Labeobarbus marequensis* is moderately tolerant and *L. polylepis* moderately intolerant to changes in the environment. *Labeobarbus polylepis*, being moderately intolerant, may already be absent from the Vaalbankspruit as a result of the high level of disturbance associated with current activities in the catchment. Further deterioration in water and habitat quality should however not be allowed in the Vaalbankspruit catchment. *Labeobarbus marequensis*, as well as *Labeo cylindricus* (also moderately tolerant), expected to be present in the Klein-Olifants River is unlikely to be notably impacted by the proposed development.

*Clarias gariepinus* (Sharptooth catfish) was not sampled in the study area but is likely to be present. This tolerant species is unlikely to be impacted negatively by the proposed development. The intolerant *Amphilius uranoscopus* and *Chiloglanis pretoriae* is only expected to be present in the Klein-Olifants River reach and is unlikely to be impacted notably by the proposed development.

The fish species of the study area differ in their preferences for different habitats types (Table 8 of Appendix 16). Most of the observed (and expected) species (E*. anoplus, P. philander, T. sparrmanii*) in the Rockdale tributary and Vaalbankspruit prefer slow-shallow and slow deep habitats with overhanging vegetation, aquatic macrophytes or undercut banks and water column as cover features (Table 8 of Appendix 16). It is essential that natural habitat diversity as well as different cover features should be maintained in the study area to ensure the protection of aquatic biodiversity.

**Conservation status**

None of the fish species expected or observed in the study area are classified as threatened based on international criteria (IUCN) falling in the "least concern" IUCN category (Table 5.24). Although the two yellowfish species are classified as "least concern" by Wolhuter & Impson (2007) (as for most yellowfish in South Africa), their natural distribution range is shrinking, but they are however still widely distributed and relatively abundant in many rivers (Roux, F: in Wolhuter & Impson, 2007).

**Table 5.24: Conservation status of fish species of the study area (taken from Kotze, 2017).**

| Species | Common Name | Conservation status |
|---|---|---|
| *Amphilius uranoscopus* | Stargazer (mountain catfish) | Common |
| *Enteromius anoplus (group)* | Chubbyhead barb | Widespread and common. Taxonomic uncertainties in group requires further studies. |
| *Enteromius neefi* | Sidespot Barb | Common (becoming rare in Mpumalanga) |
| *Enteromius paludinosus* | Straightfin Barb | Common |
| *Labeobarbus marequensis* | Largescale yellowfish | Common |
| *Labeobarbus polylepis* | Smallscale yellowfish | **RSA Endemic. Becoming rare in Mpumalanga.** |
| *Chiloglanis pretoriae* | Shortspine suckermouth | Common |
| *Clarias gariepinus* | Sharptooth catfish | Widespread and common |
| *Labeo cylindricus* | Redeye Labeo | Common |
| *Pseudocrenilabrus philander* | Southern mouthbrooder | Common |
| *Tilapia sparrmanii* | Banded tilapia | Common |

**Alien fish**

No alien fish species were sampled in the study area (Kotze, 2017). The stocking and distribution of alien fish species should not be allowed in the study area as it will put further pressure in the indigenous fish assemblages.

**Migration**

Due to the proposed development falling within the upper reaches of the Rockdale tributary, no physical migration barrier to fish movement is expected. Should the development result in poor water quality in the

Rockdale or Vaalbankspruit, a chemical migration barrier may be created. Fish species that will be most impacted by migration barriers include the potadromous species such as *L. polylepis*.

**Biotic integrity based on fish**
The present ecological status (PES), based on fish of the Rockdale tributary reach of concern (RD1 and RD2) was calculated to fall in an ecological category C (moderately modified), with a Fish Response Assessment Index (FRAI) score of 62.9% calculated. The primary impacts responsible for the present status (based on fish) is related to sedimentation, flow modification (small dam) and slight water quality deterioration.

The PES of the Vaalbankspruit reach of concern (downstream of Rockdale tributary confluence) was estimated to fall in a category D (largely modified), with a FRAI score of 46.2% calculated. The primary impacts are associated with sedimentation, water quality deterioration (upstream mining and agriculture) and flow modification (Pienaars Dam and smaller farm dams).

#### 5.8.3.5 Aquatic macro-invertebrate diversity

**Taxa richness & relative intolerance to water quality alterations**
Twenty-one aquatic invertebrate taxa (family level) were sampled at the aquatic sampling sites in the study area during August 2017 (Table 13 of Appendix 16). No taxa with a high requirement for unmodified water quality was sampled, while two taxa with a moderate requirement for unmodified water quality was present (*Hydracarina*, *Leptophlebiidae*) (Table 13 of Appendix 16). These are the most valuable indicator taxa to be used to monitor potential deterioration associated with the proposed or other activities in the catchment, especially in terms of water quality modification (Table 13 of Appendix 16). Eleven taxa sampled in the study area have a low requirement for unmodified water quality while eight of the observed invertebrate taxa have a very low requirement for unmodified water quality.

**Habitat preferences**
The aquatic macroinvertebrates of the study area differ in their preferences for different types of aquatic habitat (including flow and substrate) (Table 14 of Appendix 16). The invertebrates of the study area require a diversity of habitats to ensure the maintenance of the present ecological integrity. Some taxa observed prefer slow or very slow habitat and may be negatively influenced by unnatural increase in flows, such as through unnaturally high velocities from paved surfaces. Only a few taxa in the study area (Rockdale tributary and Vaalbankspruit) prefer moderately fast to fast (>0.3m/s) flowing habitats.

In terms of substrate and cover requirements, the highest proportion of the invertebrate taxa prefer water column, cobbles and vegetation. It is therefore important to especially maintain these habitats, while a diversity of cover features will be essential to maintain the diversity of invertebrates. The substrate habitat features can be impacted by aspects such as erosion, resulting in sedimentation and clogging of interstitial spaces between rocks, excessive algal growth, often associated with nutrient enrichment (sewage spills, agricultural runoff).

**Biotic conditions based on aquatic macro-invertebrates**
As described earlier, the SASS5 protocol is not applicable to artificial aquatic

ecosystems (such as dams), but was applied at site RD1 to gain some perspective of the general conditions of the aquatic ecosystems within the proposed development zone (only surface water present). The results should therefore be viewed with this in mind.

A SASS5 score of 46 was calculated during August 2017 for site RD1 in the upper reaches of the Rockdale tributary (Table 5.25). This was a relatively good score when considering the site consisted only of a pool (dam) with no flow and only vegetation and limited mud available for sampling, and the fact that it was the end of the dry (winter) season (Table 5.25). The very low IHAS score of 38% further emphasise the poor habitat suitability for invertebrates prevailing at the site (Table 5.25). It must also be emphasised that this invertebrate assemblage is unnatural for this site due to the presence of the dam. The proposed development is therefore unlikely to impact notably on the macroinvertebrate assemblage of this site.

**Table 5.25: SASS5 results of sites within the study area (taken from Kotze, 2017)**

| Monitoring site | SASS5 score | ASPT | SASS5-score per biotope | | | Biotope availability and suitability (Scores) | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | $SASS_{Stones}$ | $SASS_{Vegetation}$ | $SASS_{GSM}$ | Stones | Vegetation | GSM | Combined |
| RD1 | 46 | 4.18 | 0 | 46 | 20 | 0 | 6 | 1 | 7 |
| RD2 | 67 | 4.19 | 34 | 43 | 22 | 4 | 4 | 4 | 12 |
| RD3 | 20 | 2.86 | 7 | 11 | 12 | 1 | 5 | 2 | 8 |

The IHAS score was the highest at site RD2 in the lower Rockdale tributary (88%) (Table 5.25) indicating good habitat conditions for macroinvertebrates. The SASS5 score followed the same trend, being the highest of all sites (67), indicating that this reach had the best biotic condition (based on macroinvertebrates) of all sites assessed during the current study. This site also represents the most immediate downstream receiving reach to potential impacts associated with the proposed development, and should be the most important biomonitoring site to monitor over the long term.

A very low SASS5 score of only 20 was calculated for site RD3 in the Vaalbankspruit, indicating very poor biotic conditions (in terms of macroinvertebrates) prevailing in this reach at present (Table 5.25). A similar scenario was also detected by *in-situ* water quality (high EC), habitat integrity and the fish assessment (FRAI indicating category D). It is therefore evident that the biotic integrity of this reach of the Vaalbankspruit is already in a deteriorated state and no further deterioration should be allowed. The high level of sedimentation as well as poor water quality was most probably the primary causes for the poor biotic conditions based on macroinvertebrates observed at the site.

#### 5.8.3.6 Conclusion

Based on the findings of the aquatic study, Kotze (2017) concluded the following:

- The instream and riparian zone habitat integrity of the:
    - upper Rockdale tributary (within the proposed development zone) (site RD1) is currently in a relatively good condition, being classified in a category B (slightly modified).
    - lower reach of the Rockdale tributary (site RD2) was also found to be in a very good condition (category A/B).

  - receiving Vaalbankspruit reach (site RD3) was however observed to be in a deteriorated state due to current activities and fell in a category D/E (largely to seriously modified) while the riparian zone fell in a category C (moderately modified).
- Some water quality variables (pH and oxygen) may be limiting to aquatic fauna in the upper reaches of the Rockdale tributary (site RD1) - mostly the result of it being an artificial system (dam) and hence not of significance. The variables assessed indicated that the water quality of the lower Rockdale tributary (site RD2) was in a relatively good condition. The water quality of the receiving Vaalbankspruit reach (site RD3) seems to be of poor quality (especially salinity and turbidity) as a result of current activities (mining, agriculture, road crossings, large dam).
- Five indigenous fish species may occur (or have occurred under pre-disturbed conditions) in the Rockdale tributary, eight in the Vaalbankspruit and twelve in the Klein Olifants River receiving reach. Three indigenous fish species were sampled in the Rockdale tributary and two in the Vaalbankspruit.
- None of the fish species expected or observed in the study area are classified as threatened based on international criteria (IUCN) with all falling in the "least concern" IUCN category.
- The Present Ecological Status (PES), based on fish, of the Rockdale tributary reach of concern was calculated to fall in an ecological category C (moderately modified) while the Vaalbankspruit reach falls in a category D (largely modified).
- Twenty-one aquatic invertebrate taxa (family level) were sampled. No taxa with a high requirement for unmodified water quality was sampled, while two taxa with a moderate requirement for unmodified water quality was present (Hydracarina, Leptophlebiidae). These are the most valuable indicator taxa to be used to monitor potential deterioration associated with the proposed or other activities in the catchment, especially in terms of water quality modification.
- The macroinvertebrate assemblages indicated that the Rockdale tributary is in a moderate state, while conditions are very poor in the Vaalbankspruit. A similar scenario was also detected by *in-situ* water quality, habitat integrity and the fish assessment. It is therefore evident that the biotic integrity of this reach of the Vaalbankspruit is already in a deteriorated state and no further deterioration should be allowed.

## 5.9 Ground water

### 5.9.1 Groundwater potential

Engeolab (2016) indicated that according to the hydrological map, the site is devoid of any faults. According to Cilliers and Meyer (2017), potential groundwater sources worth investigating are the contact zones between the various rocks especially between intrusive and sedimentary zones.

The most likely targets for groundwater exploration are the contact zones of the Vryheid and Selonsrivier Formations (Engeolab, 2015; Cilliers and Meyer, 2017) (Figure 5.4). However, the hydrogeological information indicates a fairly low groundwater potential (i.e. <0.5l/s) for the area (Engeolab, 2016;

Cilliers and Meyer, 2017). The site investigation revealed no boreholes to be present on site.

### 5.9.2 Groundwater quality

The generalized hydrochemical information of the area indicates groundwater of good quality (i.e. water of ideal quality (Class 0) to water suitable for long term domestic use (Class 1)) (Engeolab, 2016; Cilliers and Meyer, 2017). The site investigation revealed no boreholes to be present on site and therefore the groundwater quality could not be determined.

### 5.9.3 Seepage and subsurface drainage conditions

Cilliers and Meyer (2017) observed surface seepage at the northwestern and lower southwestern portions of the site (Figure 5.5). Here marshy conditions were noted as a result of the ponding of water.

According to Cilliers and Meyer (2017), seepage was recorded in five of the test pits. Cilliers and Meyer (2017) indicated that an area of 83.47ha was susceptible to sub-surface seepage (i.e. due to a fluctuating seasonal water table and sub-surface seepgate). A fluctuating seasonal perched water table is expected in most of the southern parts of the site as well as the portion situated north of the weigh bridge and PIC South Africa (Alzu) facility towards the northwestern boundary (Figure 5.5).

Groundwater seepage can also be expected to cover large areas during high rainfall periods as was observed during the investigation, especially adjacent to the drainage feature and specifically in areas underlain by shallow, low permeable bedrock and well cemented hardpan ferricrete (Figure 5.5).

Cilliers and Meyer (2017) identified three positions along the water pipeline that showed some leakage resulting in waterlogged conditions.

### 5.9.4 Groundwater pollution potential

Table 5.26 provides the hydraulic conductivity estimated for the soils present on site.

**Table 5.26: Hydraulic conductivity (taken from Cilliers and Meyer, 2017)**

| MATERIAL TYPE | PERMEABILITY (*K* cm/s) |
|---|---|
| Sandy gravelly colluvium and imported materials | $1 \times 10^{-1}$ to $1 \times 10^{-3}$ |
| Sandy, silty clayey residuum | $1 \times 10^{-3}$ to $1 \times 10^{-6}$ |

Cilliers and Meyer (2017) indicated that permeabilities are expected to be high in the overburden material due to the high sand fraction and fine gravel content. Any contamination is therefore likely to move fairly rapidly within the transported cover soils while the residuum is less permeable.

## 5.10 Air quality

The proposed site is located in the Steve Tshwete Municipal area hot spot, which extends across the Steve Tshwete Local Municipality from its border with eMalahleni to Arnot in the east. This is an area where measured or modelled concentrations exceed, or are predicted to exceed, ambient air quality standards as identified in the Air Quality Management Plan for the Highveld Priority Area (HPA; Republic of South Africa, 2011). This Priority Area was declared in terms of Section 18(1) of the National Environmental Management: Air Quality Act 2004 (Act 39 of 2004) due to poor air quality and associated health risks.

Three main nodes of non-compliance with ambient standards occur within this hotspot. In the Middelburg node, both modelled 24-hour $SO_2$ and PM10 standards are frequently exceeded. Ambient monitoring at Middelburg, a site influenced by industrial sources, confirms the PM10 exceedances. This hot spot is mostly attributed to emissions from the metallurgical industries and residential fuel burning. The contribution of industries in the area dominates the source contributions for all pollutants considered. In terms of PM10, residential fuel burning does contribute a sizeable percentage to ambient concentrations.

**Ambient air quality monitoring stations**

Five ambient air quality monitoring stations are operated and maintained in the Highveld Priority Area (HPA) by the South African Weather Service (SAWS). These stations are located in eMalahleni (Witbank), Middelburg, Ermelo, Secunda and Hendrina and were installed in 2008. The SAWS manages the network which includes routine maintenance, calibration, data management and reporting.

At each of the said stations the following is measured: PM10, PM2.5, $SO_2$, NO, $NO_2$, $NO_x$, $O_3$, CO, benzene, toluene, ethylbenzene and xylene. In addition, the following meteorological data is also measured: wind speed, wind direction, ambient temperature, relative humidity, rainfall, solar radiation, barometric pressure.

<u>Middelburg Station</u>

The Middelburg Station is located in the residential area of Aerorand, adjacent to the Middelburg Christian School. This site was selected to measure the impact of emissions from mining and industry especially the large industrial sources such as Columbus Stainless and Middelburg Ferrochrome.

| MONITORING STATION | COORDINATES | MONITORING PERIOD | POLLUTANT SOURCES |
|---|---|---|---|
| Middelburg | S-25.79070; E29.462801 | August 2008 - present | Large industrial sources (Columbus Stainless and Middelburg Ferrochrome, industries to the south and mine dumps to the north west, no local impact from domestic fuel burning. |

Wind roses

Wind roses summarise the occurrence of winds at a location, representing their strength, direction and frequency. Figure 5.21 provides the wind roses from August 2016 to July 2017 for the Middelburg Station while Table 5.27 summarises the dominant winds and wind speed for each month.

**Table 5.27: Dominant wind and wind speed for Middelburg from August 2016 to July 2017 (@ Middelburg Station)**

| MONTH | DOMINANT WIND | FREQUENCY OF OCCURRENCE (%) | WIND SPEED (maximum) (m/s) |
|---|---|---|---|
| August 2016 | SE | 17% | 6 |
| September 2016 | NW | 20% | 10.99 |
| October 2016 | NW | 20% | 10.99 |
| November 2016 | NW | 24% | 10.05 |
| December 2016 | NW | 20% | 6 |
| January 2017 | SE | 20% | 8.75 |
| February 2017 | SE | 22% | 6 |
| March 2017 | SE | 27% | 6.82 |
| April 2017 | SE | 18% | 4 |
| May 2017 | SE | 20% | 7.97 |
| June 2017 | NW & SE | 16% & 15% | 6 & 4 |
| July 2017 | SE | 18% | 4 |

As is evident from Table 5.27 and Figure 5.21, winds in the area are relatively stable with the dominant wind directions being north westerly and south easterly winds.

Ambient air quality

According to the HPA: Air Quality Management Plan (2011), industrial sources are by far the largest contributor of $SO_2$ and $NO_x$, accounting for approximately 99.57 % of $SO_2$ and 95.97% of $NO_x$ emissions. Mining is the largest contributor of PM10 emissions.

In general, it is expected that the air quality of the proposed development site is predominately governed by the various industrial and mining activities in and around Middelburg. The following could impact upon the air quality of the proposed development site:

- Various industrial activities (e.g. Columbus Stainless (Pty) Ltd., Middelburg Ferrochrome, Calmasil Plant, etc.), specifically dust from slag handling and various stockpiles (Figure 5.3a and Figure 5.3b).
- Various power stations and opencast mining activities in the Steve Tshwete area.
- Emissions from vehicles utilizing the surrounding roads (e.g. N11, N4, residential and gravel roads);
- Odours from the PIC South Africa (Alzu) AI Station (Figure 5.2);
- Dust from traffic utilizing the surrounding gravel roads;
- Dust from possible construction activities in the surrounding area;
- Smoke emitted from veld fires;
- Smoke from cooking fires at the adjacent Rockdale residential area;
- Odours from dumped decomposing carcasses/bones at three positions adjacent to the N11 national road.

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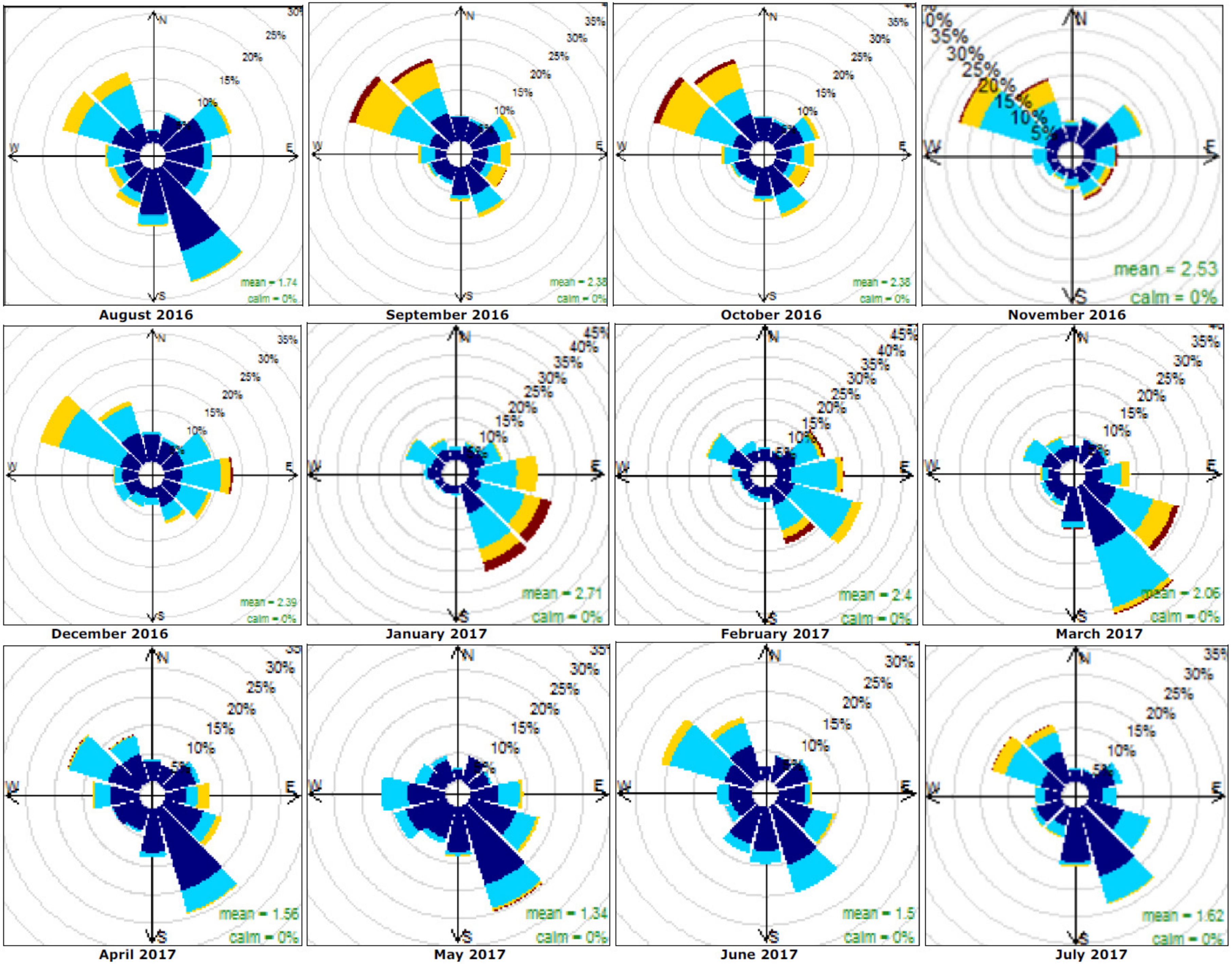


**Figure 5.21: Windroses**

## 5.11 Noise

The ambient noise of the site and surrounding area is predominantly governed by the following:

- Activities taking place at the PIC South Africa (Alzu) AI Station (Figure 5.2);
- Activities associated with the industries located to the north of the site (e.g. Columbus Stainless (Pty) Ltd., Middelburg Ferrochrome, Calmasil Plant, etc.) (Figure 5.3a and 5.3b);
- Vehicles utilizing the N11 national road to the east of the site;
- Vehicles utilizing the gravel roads on site (Figure 5.2);
- Vehicles utilising the N4 national road to the south of the site (Figure 5.2);
- Residential activities taking place in the Rockdale residential area located to the east of the site (Figure 5.2);
- Heavy vehicles utilising the weighbridge area (Figure 5.2);
- Noise emanating from the transformers at the Rockdale Substation as well as the overhead Eskom powerlines (Figure 5.2).

## 5.12 Sites of archaeological and cultural interest

### 5.12.1 Archaeological and cultural sensitivity

Prof. A.C. van Vollenhoven of Archaetnos Culture & Cultural Resource Consultants was appointed to conduct a Cultural Heritage Impact Assessment (referred to as van Vollenhoven, 2017). A copy of the said report is provided in Appendix 17 and should be consulted with regards to the methodology used.

Van Vollenhoven (2017) indicated that no sites of cultural heritage significance were located during the survey. However, the following background information is provided in order to place the surveyed area in a historical context and to contextualise possible finds that could be unearthed during construction activities.

#### 5.12.1.1 Stone Age

The Stone Age is the period in human history when lithic material was mainly used to produce tools (Coertze & Coertze, 1996). In South Africa the Stone Age can be divided into three periods. It is however important to note that dates are relative and only provide a broad framework for interpretation.

The division for the Stone Age according to Korsman & Meyer (1999) is as follows:

- Early Stone Age (ESA) 2 million – 150 000 years ago;
- Middle Stone Age (MSA) 150 000 – 30 000 years ago;
- Late Stone Age (LSA) 40 000 years ago – 1850 - A.D.

No Stone Age sites are indicated on a map contained in a historical atlas of this area (Bergh 1999). The closest known Stone Age occurrence is that of rock art close to the Olifants River to the south of Witbank (Bergh 1999). This however should rather be seen as a lack of research in the area and not as an indication that such features does not occur.

Van Vollenhoven (2017) did not record any natural shelters during the survey. It is therefore possible that people did not stay here for long times. The close vicinity of water sources and ample grazing would have made it a prime spot for hunting and obtaining water in the past. Therefore one may assume that Stone Age people probably would have moved through the area. In fact, one Middle Stone Age artefact was identified out of context, within the study area (Photo 5.6).

Photo 5.6: MSA Tool found within the surveyed area (taken from Van Vollenhoven, 2017).

#### 5.12.1.2 Iron Age

The Iron Age is the name given to the period of human history when metal was mainly used to produce metal artefacts (Coertze & Coertze, 1996).

In South Africa it can be divided in two separate phases according to Van der Ryst & Meyer (1999), namely:

- Early Iron Age (EIA) 200 – 1000 A.D.
- Late Iron Age (LIA) 1000 – 1850 A.D.

Huffman (2007) however indicates that a Middle Iron Age should be included. His dates, which now seem to be widely accepted in archaeological circles, are:

- Early Iron Age (EIA) 250 – 900 A.D.
- Middle Iron Age (MIA) 900 – 1300 A.D.
- Late Iron Age (LIA) 1300 – 1840 A.D.

No Iron Age sites are indicated around the town of Middelburg in a historical atlas, but this may only indicate a lack of research. The closest known Iron Age occurrences to the surveyed area are Late Iron Age sites that have been identified to the west of Bronkhorstspruit and in the vicinity of Bethal (Bergh 1999).

Late Iron Age sites were however identified during a previous survey on the farm Middelburg Town and Townlands 287 JS (Van Vollenhoven & Pelser 2009). The good grazing and access to water in the area would have provided a good environment for Iron Age people although building material may have been reasonably scarce. One would therefore expect that Iron Age people may have utilized the area. This is the same reason why white settlers moved into this environment later on (Van Vollenhoven, 2017).

#### 5.12.1.3 Historical Age

The historical age started with the first recorded oral histories in the area. It includes the migration of people that were able to read and write.

At the beginning of the 19th century the Phuthing, a South Sotho group, stayed to the south-east of Middelburg. The Koni of Makopole stayed to the north-east and the Ndzundza Ndebele to the east. During the Difaquane they fled to the south, southwest and north-west as Mzilikazi's impi moved in from the southeast. During this time the Swazi also moved into this area (Bergh 1999).

The first white people to move through this area were the party of the traveller, Robert Scoon who passed through in 1836 (Bergh 1999). Although the Voortrekkers moved across the Vaal River during the 1830's, it seems as if white people only settled here after 1850 (Bergh 1999).

The town of Middelburg was established in 1872 (Bergh 1999). During the Anglo-Boer War (1899-1902) both the Boer and British forces occupied the town, but no skirmishes took place close thereof (Bergh 1999). There was however concentration camps for both white and black people during this time in Middelburg (Bergh 1999).

One may therefore expect to find farm buildings, structures and objects in the area. During past surveys, many graveyards from this time period were identified in the surrounding area (Archaetnos database). One should therefore be on the lookout for graves in the surveyed area.

Van Schalkwyk (2017) identified the remains of an old homestead to the north of the surveyed area and across the N11 road. This site was assessed as being of medium cultural significance.

An old railway line servitude (Figure 5.2), dating back to 1949, is known to be present on site. The railway line was never developed. However, construction did commence as an elevated embankment with culverts (Photo 5.2 and Photo 5.3) in places is present in the south western portion of the property. In addition, a deep cutting/trench (5m wide and 5-8m deep; Photo 5.4) extending over a distance of 750m is also present. This trench is filled with water.

At certain times of the year an initiation school is held on site, but no physical remains thereof were found (Van Vollenhoven, 2017).

Three sites where cattle may be slaughtered for ritual purposes was also identified adjacent to the N11 national road – bones were noticed at these sites as indicated in Photo 3.6. Van Vollenhoven (2017) indicated that these sites have no real heritage significance (Van Vollenhoven, 2017).

Photo 5.7: Site of possible ritual cattle slaughtering

#### 5.12.1.4 Conclusion

Van Vollenhoven (2017) indicated that no sites of cultural heritage significance were identified within the proposed development area.

### 5.12.2 Palaeontological sensitivity

According to the palaeontological map supplied by the South African Heritage Resources Agency (SAHRA, 2014), the palaeontological sensitivity of the proposed site (Figure 5.22) is indicated as follows:

| **Sensitivity (Figure 5.23)** | **Geology** | **Required Action** |
|---|---|---|
| Very High (Red) | Vryheid Formation | Field assessment and protocol for finds |
| Low (Blue) | Selonsrivier Formation | No palaeontological studies are required however a protocol for finds is required. |

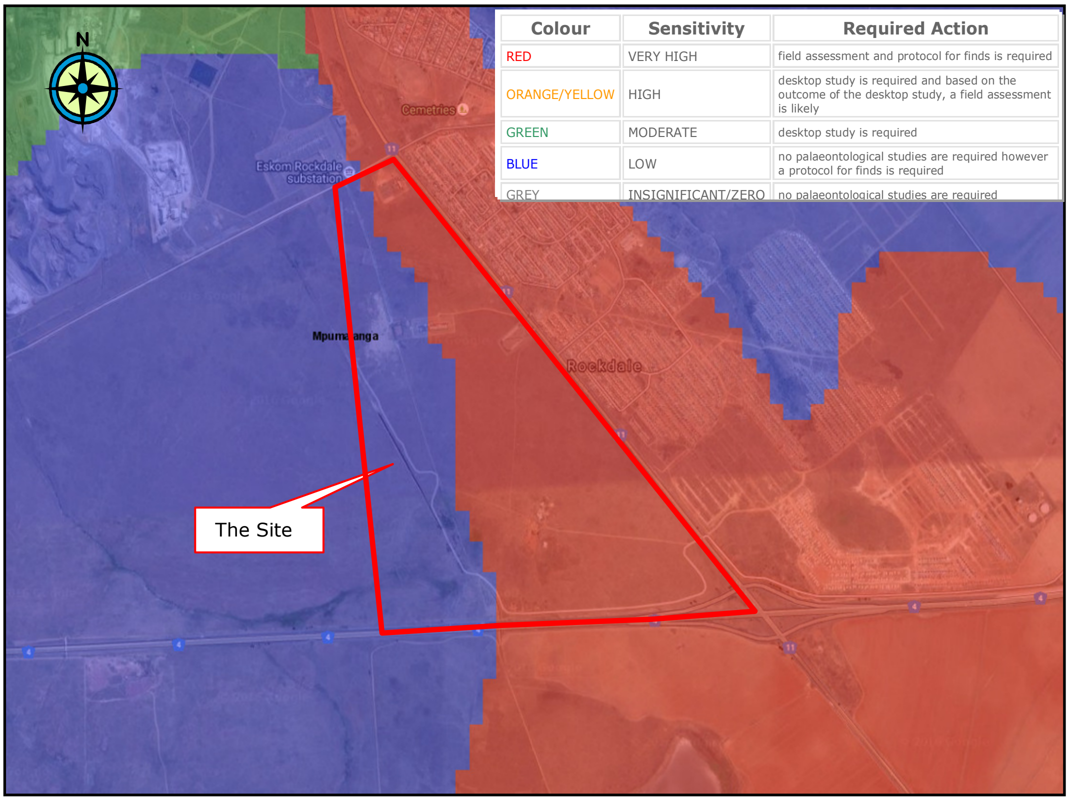


**Figure 5.22: Requirement for palaeontological study (taken from SAHRA, 2014)**

Dr. Heidi Fourie (Heidi Fourie Consulting) was appointed to conduct a Palaeontological Impact Assessment – Phase 1 Field Study (referred to as Fourie, 2017). A copy of the said report is provided in Appendix 18 and should be consulted with regards to the methodology used.

The aim of a Phase 1 Field Study is to ascertain if any palaeontological sensitive material is present within the proposed development site, to indicate the potential impact on the fossil heritage and state if any mitigation or conservation measures need to be implemented.

#### 5.12.2.1 Outline of the geology and palaeontology

The palaeontological sensitivity of a site is closely related to the underlying geology, since fossils mainly occur in rocks of sedimentary nature and not in rocks from igneous or metamorphic nature.

According to the 1: 250 000 Geological Series (number 2528 Pretoria), the eastern half of the proposed development site is underlain by the Vryheid Formation of the Ecca Group, Karoo Sequence (Figure 5.4) and the western half is underlain by Selonsrivier Formation of the Rooiberg Group, Transvaal Sequence (Figure 5.4).

The Karoo Supergroup is renowned for its fossil wealth. The Vryheid Formation (Pe,Pv), Ecca Group is rich in plant fossils such as the *Glossopteris* flora represented by stumps, leaves, pollen and fructifications (Appendix 1 of Appendix 18). This formation is early to mid-Permian (Palaeozoic) in age and consists of sandstone, shaly sandstone, grit, conglomerate, coal and shale.

Coal seams are present in the Vryheid Formation within the sandstone and shale layers. Fossils are mainly present in the grey shale which is interlayered between the coal seams (Kent, 1980; Visser, 1989). Borehole logs in the coalfields show the following layers; soil, shale and sandstone, shale and sandstone interbedded, sandstone, coal, conglomerate reworked diamictite, Dwyka Tillite, and the Pre-Karoo Basement (Fourie, 2017).

The Rooiberg Group is a 2500-6000m thick succession of feldspathic quartzites, arkoses and shales, with interbedded volcanics and felsites. It consists of two formations, the lower Damwal (Vdr) and the upper Selons River (Vs), restricted in its distribution to the central part of the basin (Kent, 1980; Snyman, 1996).

The Selons River Formation has either a sandstone or a quartzite at its base and mainly consists of red rhyolite. It was further subdivided into the lower Doornkloof Felsite Member and an upper Klipnek Felsite Member (Kent, 1980; Visser, 1989). West of Warmbath (Bela Bela) it is again subdivided into two units, the Kwaggasnek Formation and the Schrikkloof Formation. This group has an estimated age of 2,150 Ma (Visser, 1989).

Fossils in South Africa mainly occur in rocks of sedimentary nature and not in rocks from igneous or metamorphic nature. Therefore, if there is the presence of Karoo Supergroup strata the palaeontological sensitivity can generally be LOW to VERY HIGH, and here locally **VERY HIGH** for the Vryheid Formation (eastern half) and **LOW** for the Selons River Formation (western half) (Fourie, 2017).

During the survey it was confirmed that the eastern half of the site is directly underlain by sandstone of the Vryheid Formation and that the Selons River Formation is also present, but only on the western half (Fourie, 2017). Outcrops of both the Selons River Formation and the Vryheid Formation are present (Fourie, 2017).

The proposed development site is located on a sloping topography with a variety of soil types (overburden ad topsoil) present (Fourie, 2017).

Fourie (2017) indicated that the proposed development will partly take place on the Vryheid Formation known for its plant fossils. However, Fourie (2017) indicate that no fossils were found during the walk through. The shale layer was not located.

#### 5.12.2.2 Background to the palaeontology of the area

The Ecca Group may contain fossils of diverse non-marine trace, *Glossopteris* flora, mesosaurid reptiles, palaeoniscid fish, marine invertebrates, insects, and crustaceans (Johnson, 2009).

*Glossopteris* trees rapidly colonised the large deltas along the northern margin of the Karoo Sea. Dead vegetation accumulated faster than it could decay, and thick accumulations of peat formed, which were ultimately converted to coal. It is only in the northern part of the Karoo Basin that the glossopterids and cordaitales, ferns, clubmosses and horsetails thrived (McCarthy and Rubidge, 2005).

The *Glossopteris* flora is thought to have been the major contributor to the coal beds of the Ecca. These are found in Karoo-age rocks across Africa, South America, Antarctica, Australia and India. This was one of the early clues to the theory of a former unified Gondwana landmass (Norman and Whitfield, 2006).

Table 5.28 provides an indication of the occurrence of fossils in the Ecca and Rooiberg Groups.

**Table 5.28: Occurrence of fossils in the Ecca and Rooiberg Groups (Groenewald and Groenewald, 2014).**

| Subgroup/ Supergroup | Group | Formation | Fossil Heritage | Comment |
|---|---|---|---|---|
| Karoo Supergroup | Ecca | Vryheid | Rich fossil plant assemblages of the Permian *Glossopteris* flora, rare fossil wood, diverse palynomorphs. Abundant low diversity trace fossils, rare insects, possible onchostracans, nonmarine bivalves, fish scales. | Globally important and under collected |
| Transvaal Supergroup | Rooiberg | Selons River | No fossils recorded. | |

#### 5.12.2.3 Description of significant fossil occurrences (heritage value)

Fossils in South Africa mainly occur in rocks of sedimentary nature and not in rocks from igneous or metamorphic nature.

Therefore, if there is the presence of Karoo Supergroup strata, the palaeontological sensitivity is generally LOW to VERY HIGH, but here locally **VERY HIGH** for the Vryheid Formation and **LOW** for the Selons River Formation (Table 5.29).

**Table 5.29: Palaeontological sensitivity criteria used (Fossil Heritage Layer Browser/SAHRA) (taken from Fourie, 2017b)**

| Rock Unit | Description | Sensitivity | Recommended action |
|---|---|---|---|
| Vryheid Formation (Pv) (Pe) | sandstone, **shale**, gritstone, conglomerates and coal measures | Very High | Field assessment and protocol for finds is required |
| Selons River Formation (Vs) | subordinate andesite and red porphyritic rhyolite (felsite) | Low | Desktop study required |

| Rock Unit | Description | Sensitivity | Recommended action |
|---|---|---|---|
| | classified as volcanic rocks | | |

As indicated above, the proposed development will partly take place on the Vryheid Formation known for its plant fossils (Table 5.29) especially in its shale layer. However, Fourie (2017) indicate that no fossils were found during the walk through.

Rocks of Permian age (e.g. Vryheid Formation) in South Africa are particularly rich in fossil plants (Rayner and Coventry, 1985). The fossils are present in the grey shale interlayered with the coal seams. The fossils are not very rare and also occur in other parts of the Karoo stratigraphy.

The pollen of the Greenside Colliery also on the Vryheid Formation was the focus of a Ph.D study. It is often difficult to spot the greyish fossils as they are the same colour as the grey shale in which they are present as these coalified compressions have been weathered to leave surface replicas on the enclosing shale matrix (Fourie, 2017).

A locality close to Ermelo, also Vryheid Formation, has yielded *Scutum, Glossopteris* leaves, *Neoggerathiopsis* leaves, the lycopod *Cyclodendron leslii,* and various seeds and scale leaves (Prevec 2011).

Fossils likely to be found are mostly plants (Appendix 1 of Appendix 18) such as '*Glossopteris* flora' of the Vryheid Formation. The aquatic reptile *Mesosaurus* and fossil fish may also occur with marine invertebrates, arthropods and insects. Trace fossils can also be present. The marine bivalve *Megadesmus* is found in the upper part of the Volksrust Formation near Newcastle (Johnson 2009).

During storms a great variety of leaves, fructifications and twigs accumulated and because they were sandwiched between thin films of mud, they were preserved to bear record of the wealth and the density of the vegetation around the pools. They make it possible to reconstruct the plant life in these areas and wherever they are found, they constitute most valuable palaeobotanical records (Plumstead, 1963) and can be used in palaeoenvironmental reconstructions.

Details of the location and distribution of all significant fossil sites or key fossiliferous rock units are often difficult to determine due to thick topsoil, subsoil, overburden and alluvium. Depth of the overburden may vary a lot. The vast coal mining industry (Vryheid Formation) provides palaeontologists with fantastic access to coal associated plant fossils, while simultaneously resulting in the destruction of important National Palaeontological Heritage.

Fourie (2017) indicated the threats as: earth moving equipment/machinery (for example haul trucks, front end loaders, excavators, graders, dozers) during construction, the sealing-in or destruction of fossils by development, vehicle traffic, and human disturbance.

#### 5.12.2.4 Conclusion

In summary, Fourie (2017) indicated the following:

- No objection to the proposed development of the said site;
- The impact on the palaeontological heritage is **VERY HIGH** for the eastern half of the site**.**

- No fossils were found during the walk through;
- The development may go ahead with caution.

## 5.13 Visual aspects

The following infrastructure is present on site and has impacted on the visual aspect of the site:

- Rockdale Substation (Figure 5.2);
- Eskom powerlines (Figure 5.2):
    - adjacent to the N11 national road (Figure 5.2);
    - along the northwestern portion (Figure 5.2);
    - crossing from the east towards the Rockdale Substation (Figure 5.2);
- Mid-Hen overloading mass control facility (weighbridge) (Figure 5.2);
- PIC South Africa (Alzu) AI facility (Figure 5.2);
- Two abandoned borrow pits and an illegal dumping site (industrial and domestic waste) (Figure 5.2);
- Old railway line servitude (Figure 5.2);
- Yellow aboveground poles indicating the location of the water pipeline (Figure 5.2).

The proposed site is highly visible from:

- the existing Rockdale residential area – east of the site (Figure 5.2);
- the N11 National Road – east of the site (Figure 5.2);
- the N4 National Road – south of the site (Figure 5.2);
- Eskom substation located on the boundary of the Columbus Stainless (Pty) Ltd. property – north of the site (Figure 5.2);
- vacant property located to the west (Figure 5.2).

The above-mentioned surrounding land uses have thus impacted on the visual aspect of the site and surrounding area.

## 5.14 Sensitive landscapes

Venter and Niemand (2017) indicated the rocky grassland and the wetland-associated habitat (i.e. channelled valley bottom wetlands and seeps) as Areas of High Sensitivity (Table 5.30 and Figure 5.23). These habitat types support a high richness of fauna including specialised taxa with high affinities towards the presence of outcrops/rock cover or moist and inundated biotypes. In addition, the rocky outcrops and wetland types are the only habitat units which provide habitat within the study site for a number of threatened and near threatened fauna, which include the African Grass-owls (*Tyto capensis*). A small and localised subpopulation of the globally near threatened Melodious Lark (*Mirafra cheniana*) resides in the rocky grassland. These habitat types also display a high ecological connectivity with habitat of high plant species richness adjacent to the study site, thereby contributing towards faunal dispersal which is critical for taxa with large home ranges (e.g. large terrestrial mammals and bird taxa).

Areas of Low Sensitivity were indicated as transformed habitats (Alien Trees, Vegetation clearing, Excavations; *Hyparrhenia hirta* grassland; Table 5.30; Figure 5.23). These habitat types are not considered to be pristine, and occur in areas where historical and current disturbances took place. Many of these areas are composed of typical pioneer species or taxa with annual life histories, thus contributing little towards local biodiversity. In addition, the *Hyparrhenia hirta* grassland is regarded to be structurally monotonous and although supporting high mammal richness, the dominant composition was unspecialised and consisted of widespread taxa.

**Table 5.30: Sensitivity and sized of the vegetation units and sub-units on site (taken from Venter and Niemand, 2017).**

| VEGETATION UNIT | SUB-UNIT | SIZE (ha) | SENSITIVITY | | |
|---|---|---|---|---|---|
| | | | VEGETATION | FAUNA | COMBINED |
| Wetland | Seep | 23.4819 | High | High | High |
| | Channelled valley bottom | 4.8895 | High | High | High |
| Grassland | Rocky grassland | 103.8434 | High | High | High |
| | *Hyparrhenia hirta* grassland | 68.0102 | Low | Low | Low |
| Disturbance | Alien Trees | 1.0645 | Low | Low | Low |
| | Vegetation clearing | 8.0212 | Low | Low | Low |
| | Excavations | 5.7212 | Low | Low | Low |

Venter and Niemand (2017) indicated that all wetland units are of high conservation importance. The CVB wetland unit and seep in the northern portion of the site have a high sensitivity to changes in the wetland habitat and flow, while the wetland in the eastern portion of the site has a moderate sensitivity to changes in the wetland habitat and flow.

Buffer zones are intended to protect sensitive features from disturbances. The size of the buffer zone depends on the type and potential impacts of the intended activities on the sensitive features. Considering that Mpumalanga has no prescribed buffer zones, the buffer zone widths as prescribed by the Gauteng Department of Agriculture and Rural Development (GDARD) were applied to the current study. According to the GDARD sensitivity mapping rules (GDARD, 2014), a minimum terrestrial buffer of 170 m should be allocated from the edge of the wetland or stream when suitable grass-owl habitat occurs. **It was evident that the valley bottom wetland provides optimal Grass Owl habitat, and a buffer of 170m was tentatively allocated to this wetland unit (Figure 5.23**). **Suitable habitat was also identified along the northern seep**.

Habitat for *Anacapseros subnuda* is present on the western portion of the site. Some habitat is also present for *Frithia humilis* in the same area. It is therefore recommended that a 200m buffer area (Figure 5.23) is excluded from the development in this area.

Several buffer sizes are recommended for wetland units in the various provinces, but Mpumalanga does not have a buffer zone requirement. The buffer zone tool was used to determine the buffer zone for the site (Macfarlane et al., 2004). According to the buffer zone tool, a combined buffer of 39m is required around the seep wetland and a 37m buffer around the channelled valley bottom wetland. An overall buffer of 40m (Figure 5.23) is therefore considered sufficient around the wetland units, except where buffers are required for other sensitive features (Venter and Niemand, 2017).

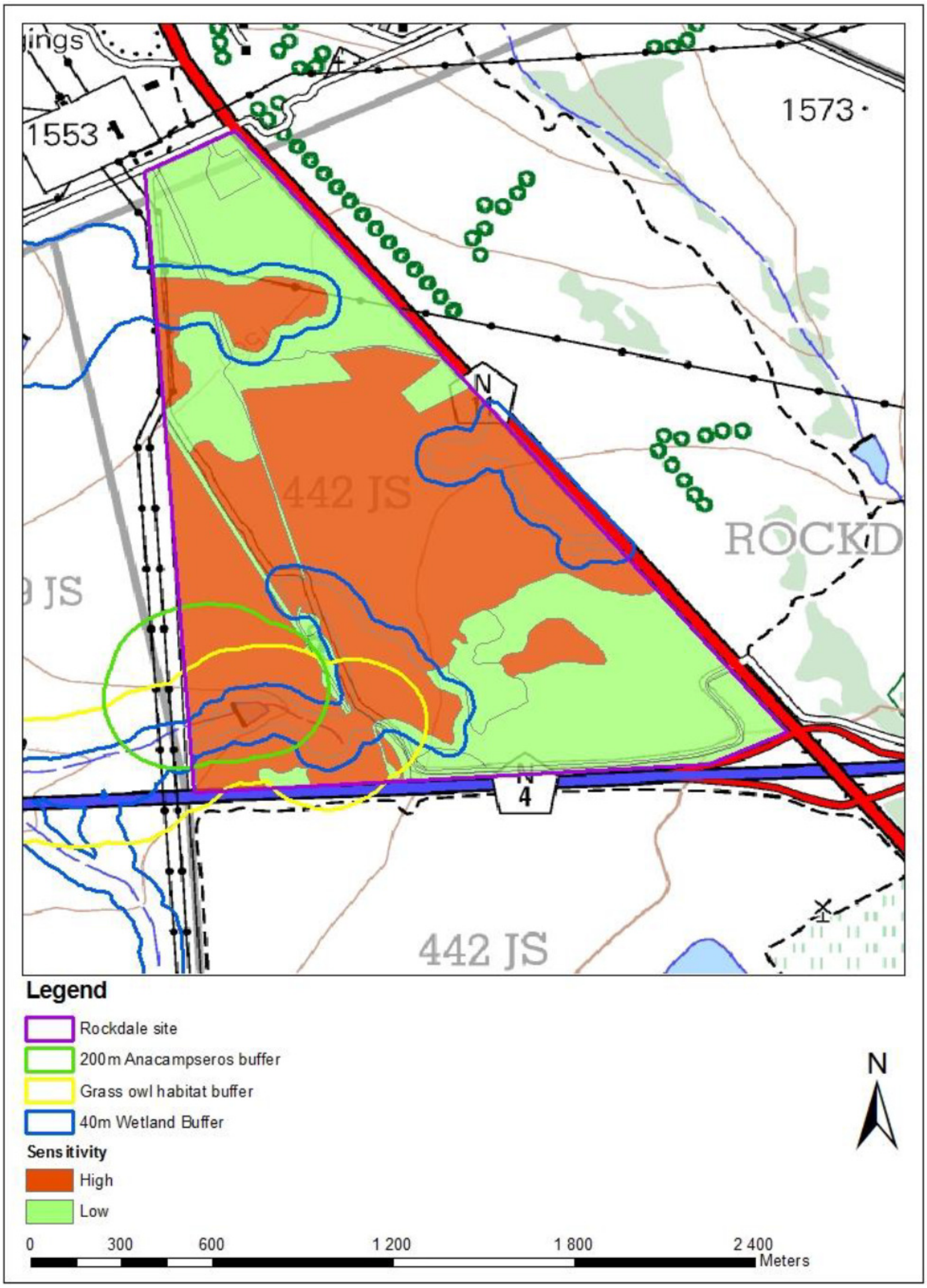


**Figure 5.23: A composite ecological sensitivity map of the study site according to faunal, floral, wetland and ecological function, with buffers (taken from Venter and Niemand, 2017).**

## 5.15 Traffic

A traffic impact assessment was undertaken by B. Roberts of Moyeni Professional Engineering (hereafter referred to as Roberts, 2017). A copy of the report is provided in Appendix 19 and should be consulted with regards to methodology used.

### 5.15.1 Existing road network and classification

The proposed site is located west of the existing Rockdale residential area and the N11 National Road (Figure 5.2). The site can be accessed from the N11 National Road.

Table 5.31 provides an indication of the existing road network and classification in the area surrounding the proposed development site. Figure 5.24 provides the location of the various roads in relation to the proposed development site.

**Table 5.31: Road network classification (taken from Roberts, 2017)**

| ROAD/STREET | LOCATION (Figure 5.24) | CLASS | CARRIAGEWAY AND NUMBER OF LANES | ROAD RESERVE WIDTH (m) | CHARACTERISTIC/ JURISDICTION |
|---|---|---|---|---|---|
| N4 | South of proposed site | 1 | Dual (4 lanes) | 90 | SANRAL |
| N11 | East of proposed site | 2 | Single (2 lanes) | 50 – 60 | SANRAL |
| Kilo Street | Main access to Middelburg Industrial Area | 3 | Single (2 lanes) | 30 | Municipal |
| Road C | Main access road to Rockdale North x1 | 4 | Single (2 lanes) | 35 | Municipal |
| Road A | Gravel road providing access to Rockdale x2 | 4 | Single (2 lanes) | 20 | Municipal |
| Road B | Main access road to Rockdale | 4 | Single (2 lanes) | 20 | Municipal |
| Adelaide Street | Main access road to Nasaret x1 | 5 | Single (2 lanes) | 30 | Municipal |
| Montagu Street | Main access road to Nasaret | 5 | Single (2 lanes) | 30 | Municipal |

According to Roberts (2017), the N11 is a Class 2 road (primary distributor; Table 5.33) linking the N4 in the south (and beyond) to the R104 in the north. The route comprises a two lane single carriageway road (Table 5.31).

The N11 interchanges with the N4 national road (a high order Class 1 freeway; Table 5.31) that passes Rockdale to the south, adjacent the southern boundary, in an east-west direction (Roberts, 2017). The proposed development site cannot be accessed from this national road.

Kilo Street (Figure 5.24) is a Class 3 road (district distributor; Table 5.31) linking the N11 in the east to the R555 in the west via Mandela Drive. It is a two-lane single carriageway road with appropriate turning lanes (Roberts, 2017).

Road A and Road B (Table 5.31; Figure 5.24) are Class 4 roads (i.e. district distributors) and link the N11 to the residential streets of Rockdale. These roads are typically constructed as two lane single carriageway roads with turning lanes where required (Roberts, 2017).

Access roads or Class 5 roads within the townships (Table 5.31) form the final interface between the domestic unit and the primary network.

### 5.15.2 Future road network

Roberts (2017) indicated that except for the future widening of the N11 and hard surfacing of some of the class 4/5 roads, no major roads are planned in this area.

### 5.15.3 Existing intersection controls

Table 5.32 provides an indication of the existing intersection controls in the area surrounding the proposed development site.

**Table 5.32: Existing intersection controls (taken from Roberts, 2017)**

| MAIN ROAD/STREET | CROSS STREET (Figure 5.24) | CONTROL |
|---|---|---|
| N4 terminals | N11 | Priority on side streets |
| N11 | Road A | Priority on side streets |
| N11 | Road B | Priority on all approaches |
| N11 | Road C | Signal |
| N11 | Adelaide Street | Signal |
| N11 | Montagu Street | Signal |
| N11 | Kilo Street | Signal |

Annexure B of Appendix 19 provides the above-mentioned intersection layouts.

### 5.15.4 Site access

Three access points are planned for the proposed development namely:

- Access 1: Extension of Road A to the west (no. 3 in Figure 5.24) – existing T-junction;
- Access 2: Extension of Road B to the west (no. 4 in Figure 5.24) – existing T-junction;
- Access 3: New full T junction on the N11 spaced 590m north of Road B and 640m south of Road C (no. 10 in Figure 5.24).

A fourth access off Road C (some 200m west of the N11; no. 6 in Figure 5.24) is planned. This access road will cater for the proposed sports complex and is not envisaged to be open at all times (i.e. will operate at selected times – event type traffic).

#### 5.15.5 Traffic data

Table 5.33 provides an indication of the intersections counted and evaluated as part of the overall traffic impact assessment. Figure 5.24 provides an indication of the location of the said intersections.

**Table 5.33: Intersections counted and evaluated (taken from Roberts, 2017)**

| INTERSECTION NO. (Figure 5.24) | DESCRIPTION AND LOCATION (Figure 5.24) |
|---|---|
| **EXISTING** | |
| 1 | N4 and N11 southern terminal |
| 2 | N4 and N11 northern terminal |
| 3 | N11 and Road A (gravel road providing access to Rockdale x2) |
| 4 | N11 and Road B (main access road to Rockdale) |
| 5 | N11 and access (SANRAL weighbridge access) |
| 6 | N11 and Road C (main access road to Rockdale North x1 and existing gravel road extending along the southern boundary of Columbus Stainless Steel) |
| 7 | N11 and Adelaide Street, entrance to Nasaret x1 |
| 8 | N11 and Montagu Street, entrance to Nasaret |
| 9 | N11 and Kilo Street, entrance to Middelburg Industrial Area |
| **PROPOSED** | |
| 10 | N11 and proposed new northern access (NNA) |

Annexure A of Appendix 19 provides the results of the detailed traffic counts.

From the traffic counts undertaken, Roberts (2017) indicated the peak hours as follows:

- Weekday AM peak hour: 06h45 to 07h45;
- Weekday PM peak hour: 17h45 to 18h45;
- Saturday peak hour: 12h30 to 13h30.


**Figure 5.24: Location of intersections counted (taken from Roberts, 2017)**

According to Roberts (2017), the traffic volumes on the N11 are in general fairly low (Table 5.34) and the link traffic flow of all the roads operated at a satisfactory level (Table 5.35). As indicated in Table 5.35, the highest one way traffic link flow was 32% of capacity (Table 5.35) which is still satisfactory.

**Table 5.34: Link traffic flows (@ September 2017) (taken from Roberts, 2017)**

| Road (Figure 5.24) | Direction | Peak hour (vph) | | | Capacity (vph)/ number of lanes required/existing | Percent (%) of capacity |
|---|---|---|---|---|---|---|
| | | AM (06h45-07h45) | PM (17h45–18h45) | Saturday (12h30-13h30) | | |
| N4 Ramps | Eastbound | 285 | 169 | 108 | 1900/1/1 | 15 |
| | Westbound | 158 | 242 | 132 | 1900/1/1 | 13 |
| N11 | Northbound | 491 | 457 | 368 | 1900/1/1 | 26 |
| | **Southbound** | **442** | **609** | **410** | **1900/1/1** | **32** |
| Kilo Street | Eastbound | 431 | 390 | 214 | 1900/1/1 | 23 |
| | Westbound | 460 | 297 | 182 | 1900/1/1 | 25 |
| Road C | Eastbound | 141 | 180 | 124 | 1900/1/1 | 10 |
| | Westbound | 166 | 141 | 102 | 1900/1/1 | 9 |
| Road A | Eastbound | 34 | 61 | 79 | 1800/1/1 | 4 |
| | Westbound | 83 | 62 | 94 | 1800/1/1 | 4 |
| Road B | Eastbound | 89 | 99 | 79 | 1800/1/1 | 5 |
| | Westbound | 104 | 83 | 94 | 1800/1/1 | 6 |
| Adelaide Street | Eastbound | 127 | 103 | 108 | 1800/1/1 | 6 |
| | Westbound | 172 | 68 | 132 | 1800/1/1 | 7 |
| Montagu Street | Eastbound | 90 | 167 | 103 | 1800/1/1 | 9 |
| | Westbound | 124 | 100 | 86 | 1800/1/1 | 7 |

Roberts (2017) indicated that a growth rate of 2% per annum for the background traffic was adopted based on the future of the greater area, the total traffic along the N11 and historical counts on a similar route to the west (i.e. the R35 provincial road).

Table 5.35 provides the modal split as derived from the said traffic counts for 2017.

**Table 5.35: Modal split @ 2017 (taken from Roberts, 2017)**

| **MODE OF TRANSPORT** | **FRIDAY** | **SATURDAY** |
|---|---|---|
| | **ALL SURVEYED HOURS** | |
| | **ALL STUDY AREA INTERSECTIONS** | |
| | **TOTAL VEHICLES** | |
| Cars | 34 979 | 22 786 |
| Minibus taxis | 5 067 | 2 430 |
| Buses | 508 | 134 |
| Trucks | 2 752 | 1 379 |
| **TOTAL** | **43 306** | **26 729** |
| | **PERCENTAGE** | **PERCENTAGE** |
| Cars | 80.8 | 85.2 |
| Minibus taxis | 11.7 | 9.1 |
| Buses | 0.2 | 0.5 |
| Trucks | 6.3 | 5.2 |
| **TOTAL** | **100.0** | **100.0** |

According to Roberts (2017), the Friday modal split is high in public transport and heavy vehicles making up 11.7% minibus taxis and 6.5% heavy vehicles.

### 5.15.6 Trip generation

Table 5.36 provides the trip generation adjustment factors used by Roberts (2017) in calculating the expected trip generation rates.

**Table 5.36: Trip generation adjustment factors (taken from Roberts, 2017)**

| LAND USE | ADJUSTMENT FACTORS (COTO TMH | |
|---|---|---|
| | COTO LAND USE CODE | VERY LOW/LOW CAR OWNERSHIP AND MIXED USE DEVELOPMENT |
| Residential 1 housing | 210 | 40% |
| Residential 3 housing | 232 | 30% |
| Retail (Business 2 & 3) | 820 | 30% |
| Combined School | 520 | 50% |
| Municipal offices | 710 | 40% |

Table 5.37 provides the expected proposed township-related trips generated (post-mode choice).

**Table 5.37: Expected proposed township-related trips generated (post-mode choice)**

| PEAK OUT | IN | OUT | TWO-WAY |
|---|---|---|---|
| **AM** | 637 | 1111 | 1747 |
| **PM** | 1169 | 784 | 1953 |
| **Saturday** | 661 | 656 | 1317 |

### 5.15.7 Trip distribution

Table 5.38 provides the trip distribution and assignment of the expected proposed township trips.

**Table 5.38: Trip distribution and assignment of the expected proposed township trips (taken from Roberts, 2017)**

| DIRECTION | IN/OUT | | ROUTE FOLLOWED |
|---|---|---|---|
| | RESIDENTIAL | BUSINESS | |
| From/to the north | 73 / 73% | 20 / 20% | N11 |
| From/to the east | 9 / 9% | 45 / 45% | Road A east/ Road B east |
| From/to the south | 18 / 18% | 5 / 5% | N4/N11 |
| Internal trips | Adjusted TG | 30 / 30% | West of N11 (internal) |

### 5.15.8 Traffic flows

Roberts (2017) indicated that the 2017 scenario was analysed in order to obtain a base for the traffic flows in the area (see Section 5.15.5 for further details).

In terms of the traffic flow estimates and associated traffic analysis, it was decided to analyse the 2019 (the fully built year) and 2024 (5 years after the opening date) design horizon scenarios. Any associated road upgrades would need to satisfactorily accommodate these traffic flows.

The following scenarios and timeframes were thus analysed:

| SCENARIO | TIMEFRAME |
|---|---|
| 1 | 2017 existing traffic situation |
| 2 | 2019 background traffic |
| 3 | 2019 background traffic plus latent and proposed Township traffic situation |
| 4 | 2024 background traffic |
| 5 | 2024 background traffic plus latent* and proposed Township traffic situation |

*: A negligible amount of latent rights exists in the Rockdale Township and was taken into account in the growth rate in this TIA.

Annexure C of Appendix 19 provide the results of the traffic flow calculations undertaken with regards to the above-mentioned scenarios and timeframes.

#### 5.15.9 Capacity analyses

The performance of intersections in urban road networks is defined by the level of service (LOS) for each approach to the intersection. During the peak hours, the road infrastructure capacity provided should ensure that the intersection approach level of service does not excess LOS D (see Table 10 of Appendix 19) as defined in the High Capacity Manual (HCM).

Roberts (2017) indicated that the capacity analysis was undertaken for the above-mentioned existing and future scenario situations. The intersection approach performance for the intersections within the study area (see Figure 5.24) was determined using the AutoJ software programme.

Annexure B of Appendix 19 provides the intersection layouts while Annexure D of Appendix 19 provides the results of the AutoJ capacity analyses undertaken with regards to the various scenarios and timeframes.

The following tables (Table 5.39; 5.40; 5.41) provide a summary of the capacity analyses for the above-mentioned scenarios.

**Table 5.39: Summary of capacity results (2017) (taken from Roberts, 2017)**

| No | Intersection description | Control | Performance Index | Result |
|---|---|---|---|---|
| 1 | N11 / S terminal | Xwe | 89% | Satisfactory in all peak hours |
| 2 | N11 / N terminal | Xwe | 70% | Satisfactory in all peak hours |
| 3 | N11 / Road A | Xwe | 95% | Satisfactory in all peak hours |
| 4 | N11 / Road B | XX<br>Xwe | 10%<br>93% | XX - Unsatisfactory in all peak hours. Needs to be changed to a Xwe |
| 6 | N11 / Road C | Signal 2 | 62% | Satisfactory in all peak hours |
| 7 | N11 / Road Adelaide | Signal 2 | 62% | Satisfactory in all peak hours |
| 8 | N11 / Montagu | Signal n3 | 69% | Satisfactory in all peak hours |
| 9 | N11 / Kilo | Signal 2 | 75% | Satisfactory in all peak hours |
| 10 | N11 / N Access | Signal 2 | 89% | Satisfactory in all peak hours |

*Legend: Xwe: West-East stop; XX: All-way stop; Signal 2: 2 Phase; Signal n3: 3 Phase (north leading right).*

**Table 5.40: Summary of capacity results (2019) without/with Site (taken from Roberts, 2017)**

| No | Intersection description | Control | Performance Index | Result |
|---|---|---|---|---|
| 1 | N11 / S terminal | Xwe | 88% / 87% | Satisfactory in all peak hours |
| 2 | N11 / N terminal | Xwe | 69% / 68% | Satisfactory in all peak hours |
| 3 | N11 / Road A | Xwe | 95% / 94% | Satisfactory in all peak hours |
| 4 | N11 / Road B | XX<br>Xwe<br>Signal 2 | 28% / 31%<br>96% / 95%<br>55% / 59% | XX - Unsatisfactory in all peak hours. Needs to be changed to a Xwe or to be signalised for pedestrians when warranted |
| 6 | N11 / Road C | Signal 2 | 63% / 70% | Satisfactory in all peak hours |
| 7 | N11 / Road Adelaide | Signal 2 | 62% / 65% | Satisfactory in all peak hours |
| 8 | N11 / Montagu | Signal n3 | 71% / 89% | Satisfactory in all peak hours |
| 9 | N11 / Kilo | Signal 2 | 77% / 88% | Satisfactory in all peak hours |
| 10 | N11 / N Access | Xwe | / 96% | Satisfactory in all peak hours |

*Legend: Xwe: West-East stop; XX: All-way stop; Signal 2: 2 Phase; Signal n3: 3 Phase (north leading right).*

**Table 5.41: Summary of capacity results (2024) without/with Site (taken from Roberts, 2017)**

| No | Intersection description | Control | Performance Index | Result |
|---|---|---|---|---|
| 1 | N11 / S terminal | Xwe | 86% / 67% | Satisfactory in all peak hours |
| 2 | N11 / N terminal | Xwe | 65% / 47% / 61% | Unsatisfactory in the AM and PM peak hours. Requires signalization |
| 3 | N11 / Road A | Xwe | 93% / 92% | Satisfactory in all peak hours |
| 4 | N11 / Road B | XX<br>Xwe | 32% / 40%<br>86% / 70% | XX - Unsatisfactory in all peak hours. Needs to be changed to be signalised for pedestrians |
| 6 | N11 / Road C | Signal 2 | 65% / 90% | Satisfactory in all peak hours |
| 7 | N11 / Road Adelaide | Signal 2 | 64% / 90% | Satisfactory in all peak hours |
| 8 | N11 / Montagu | Signal n3 | 83% / 92% | Satisfactory in all peak hours |
| 9 | N11 / Kilo | Signal 2 | 87% / 95% | Satisfactory in all peak hours |
| 10 | N11 / N Access | Xwe | / 93% | Satisfactory in all peak hours |

*Legend: Xwe: West-East stop; XX: All-way stop; Signal 2: 2 Phase; Signal n3: 3 Phase (north leading right).*

According to Roberts (2017), the analysis over time periods 2017 (Table 5.39), 2019 (Table 5.40) and 2024 (Table 5.41) showed that many intersections are still expected to operate at satisfactory levels of service and are not required to be upgraded.

Roberts (2017) however indicated that upgrades at Intersection 2, 4 and 10 (Figure 5.24) are required (Table 5.42) and are to be geometrically the same on all approaches namely:

- Separated left-turn slip lane;
- Through lane;
- 50m long right turn lane.

**Table 5.42: Required road upgrades (taken from Roberts, 2017)**

| INTERSECTION NO. (Figure 5.24) | DESCRIPTION | UPGRADE REQUIRED | RESPONSIBILITY |
|---|---|---|---|
| 2 | N11/N terminal | Requires signalization in 2024 | Developer |
| 4 | N11/Road B | Needs to be changed to a signalised control when warranted, with pedestrian phases | Developer |
| 10 | N11/New northern access | New intersection (Priority controlled from the side street) | Developer |

Annexure B of Appendix 19 provides the proposed intersection upgrading layouts.

### 5.15.10 Non-motorised transport

Roberts (2017) indicated that paved sidewalks do not exist along the N11 and associated side roads. This is typical of national roads where, for traffic safety reasons, pedestrians are not encouraged to walk along these high speed roads. Paved sidewalks, where appropriate, will be required within the proposed development site.

According to Roberts (2017), pedestrian crossings are not required as pedestrians are not expected to cross the N11 except at the signalised intersections. Provision at the intersection of the N11 and Road B for a new traffic signal is desirable since:

- It is located at the centre of the future Business area;
- It allows pedestrians to cross the N11 at one point.

Regarding the impact of adding a traffic signal, the capacity is expected to be minimally affected, remaining satisfactory. The intersection delay is expected to increase from 5 to 10 seconds (2 phase setting). The Performance Index for the side street priority control calculates to 79% and to 70% for the two phase signal control, which are satisfactory.

It is therefore recommended to install a traffic signal at intersection 4 (no 4; N11 and Road B; Figure 5.24), when warranted in the future, including pedestrian phasing to allow for safe pedestrian passage.

### 5.15.11 Public transport

Minibus taxis are the dominant mode of public transport in this area with between 35 and 45 minibus taxis passing along the N11 in one direction during the AM and PM peak hours (Table 5.43). Roberts (2017) indicated that 39 additional minibus taxis per peak hour will be required in order to service the proposed residential area (i.e. when fully developed).

**Table 5.43: Existing number of minibus taxis and buses that utilise the N11 road during peak hours (taken from Roberts, 2017)**

| Peak hours | Minibus taxis (MBT) | Buses |
|---|---|---|
| **Travelling northwards on N11** | | |
| AM | 45 | 14 |
| PM | 37 | 1 |
| Saturday | 13 | 2 |
| **Travelling southwards on N11** | | |
| AM | 37 | 1 |
| PM | 35 | 2 |
| Saturday | 18 | 0 |

As indicated in Table 5.43, between 1 and 2 buses currently pass the proposed development site. Roberts (2017) indicated that 4 additional buses per peak hour will be required in order to service the proposed residential area (i.e. when fully developed).

Roberts (2017) indicated that the walking distance between intersections is less than 300m which is well within the recommended maximum of 500m (as set out by the Department of Transport) and therefore considered acceptable.

Standard lay byes for buses and minibus taxis are proposed at the downstream side of Roads A, B and C along the N11 to facilitate the future public transport operations (Roberts, 2017).

#### 5.15.12 Conclusion

From this Traffic Impact Assessment, Roberts (2017) concluded the following:

- The traffic situation at the Site remains generally low. The N11 traffic is increasing by some 2 percent per annum.
- The maximum link flows with regards to its capacity on the N11 is at 32% and is therefore satisfactory.
- The post modal-split trip generation is as follows:
    - 637 IN and 1111 OUT in the Friday AM peak hour;
    - 1169 IN and 784 OUT in the Friday PM peak hour;
    - 660 IN and 656 OUT in the Saturday peak hour;
- The trip distributions for all three land use types are generally based on the existing traffic patterns being 73% from the north for residential while the business traffic is expected to focus on the local streets of Rockdale.
- Most intersections are operating at satisfactory levels of services both now and into the future.

### 5.16 Sense of place

The proposed site is located west of the existing Rockdale residential area and the N11 National Road (Figure 5.2). It is located north of the N4 National Road (Figure 5.2), to the south of Columbus Stainless (Pty) Ltd. (Figure 5.2) and southeast of Middelburg (Figure 5.1). No development is present to the west of the proposed development site (Figure 5.2).

Urban Dynamics (2017) indicated that the proposed site is located within the existing urban edge i.e. the area where future development of Middelburg should take place.

Any development within a municipal area needs to comply with the applicable Spatial Development Framework. In the Steve Tshwete Spatial Development Framework (2014), the proposed site is earmarked for future Industrial Activities (Figure 5.25) since it is located adjacent to the existing industrial area comprising of Columbus Stainless (Pty) Ltd., etc. (Figure 5.2). It was thus not earmarked in the SDF for residential development.

Urban Dynamics (2017) indicated that part of the formal application to the Steve Tshwete Local Municipality will be a request to change the SDF and earmark this area for residential development. According to Urban Dynamics (2017), preliminary discussions with the municipality indicated that they would consider changing the SDF to accommodate the proposed residential development if it included a cemetery and a sports complex.

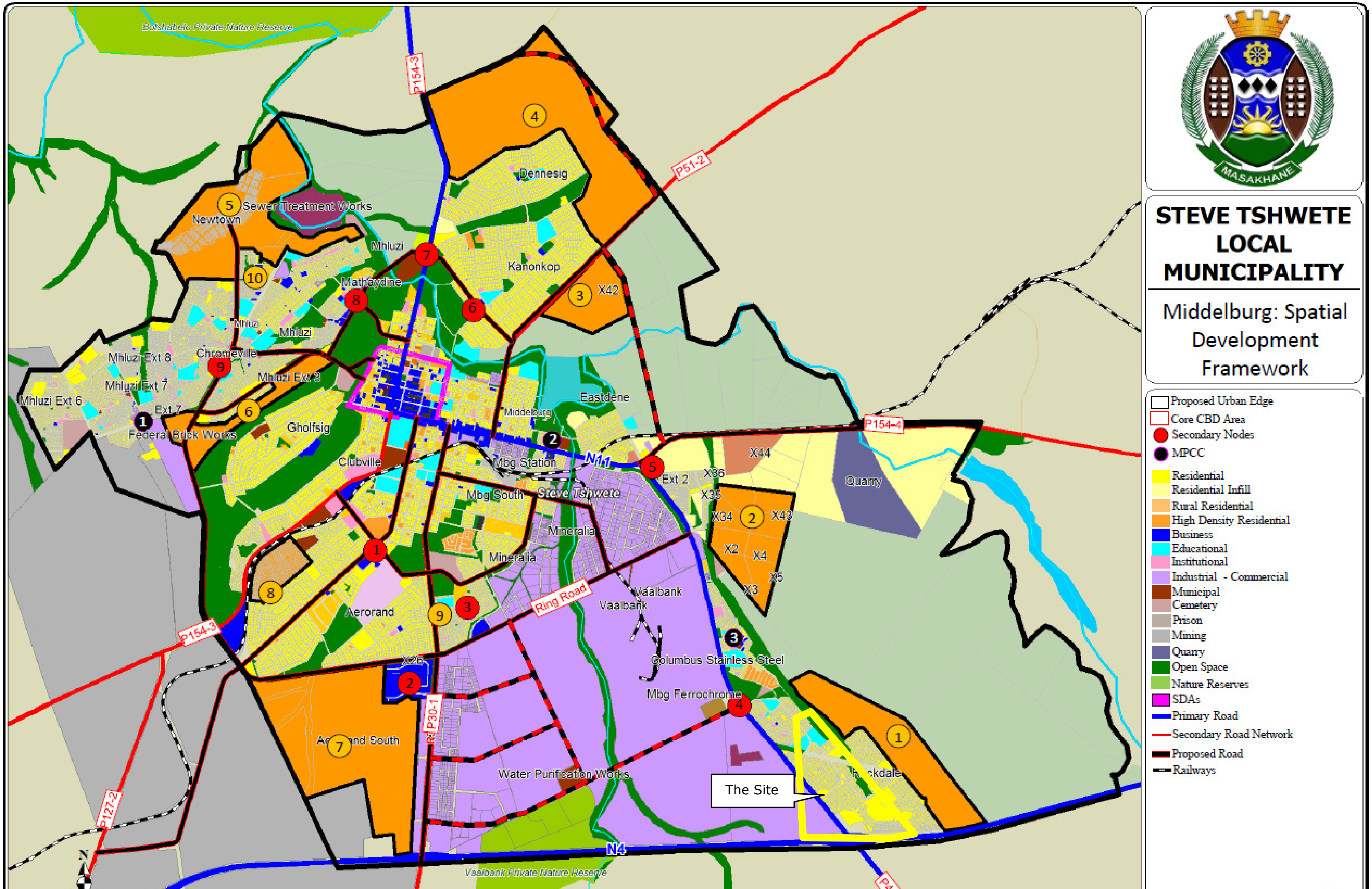


**Figure 5.25: The proposed site and the Steve Tshwete Spatial Development Framework (2014)**