6 RECEIVING ENVIRONMENT

6.1 Introduction

According to section 28(e) of the NEMA EIA Regulations, this section includes a description of the baseline environment that may be affected by the proposed activity and the manner in which the biophysical, social, economic and cultural aspects of the environment may be affected by the proposed activity as well as a description of the environmental issues that were identified during the impact assessment process. These issues are then further analysed in Chapter 8 of this report.

6.2 Study Area in Regional Context

6.2.1 Locality

Majuba Power Station is located approximately 16 km southwest (SW) of Amersfoort and approximately 40km north-northwest (NNW) of Volksrust in the Mpumalanga Province (**Figure 6.1**). The power station falls within the Pixley Ka Seme Local Municipality which falls within the Gert Sibande District Municipality (**Figure 6.2**).

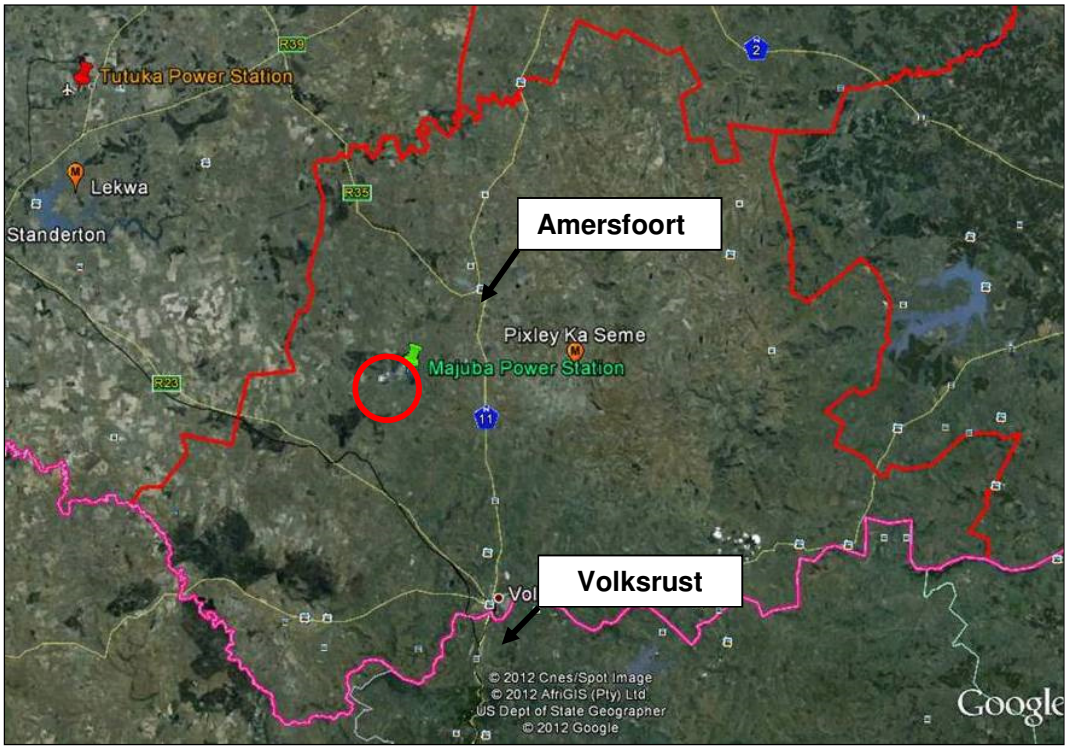

Figure 6.1: Location of Majuba Power Station within the Pixley Ka Seme Local Municipality

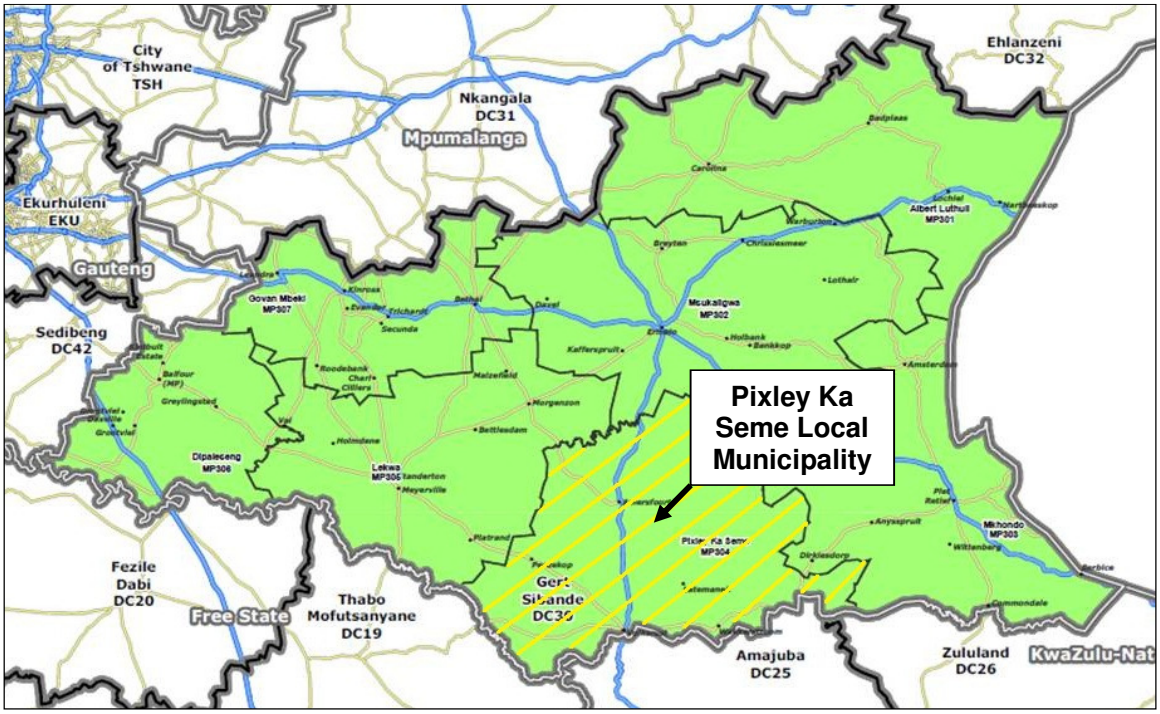

Figure 6.2: Location of Pixley Ka Seme Local Municipality within the Gert Sibande District Municipality

6.2.2 Study Area

The particular area required for the proposed continuous ashing facility is approximately 800 ha. In order to allow for a robust environmental process, all land within a radius of 12 km from the power station was assessed in order to identify potential alternatives sites. The Majuba Continuous Ashing EIA study area is therefore located within a 12 km radius around source of ash, the Majuba Power Station (**Figure 6.3**). The study area is approximately 450 square kilometres in size and includes a total of 40 different farms divided into 195 farm portions. A list of the farm portions are included in **Table 6.1** which outlines the farms associated with the proposed Majuba Continuous Ashing Study? Area.

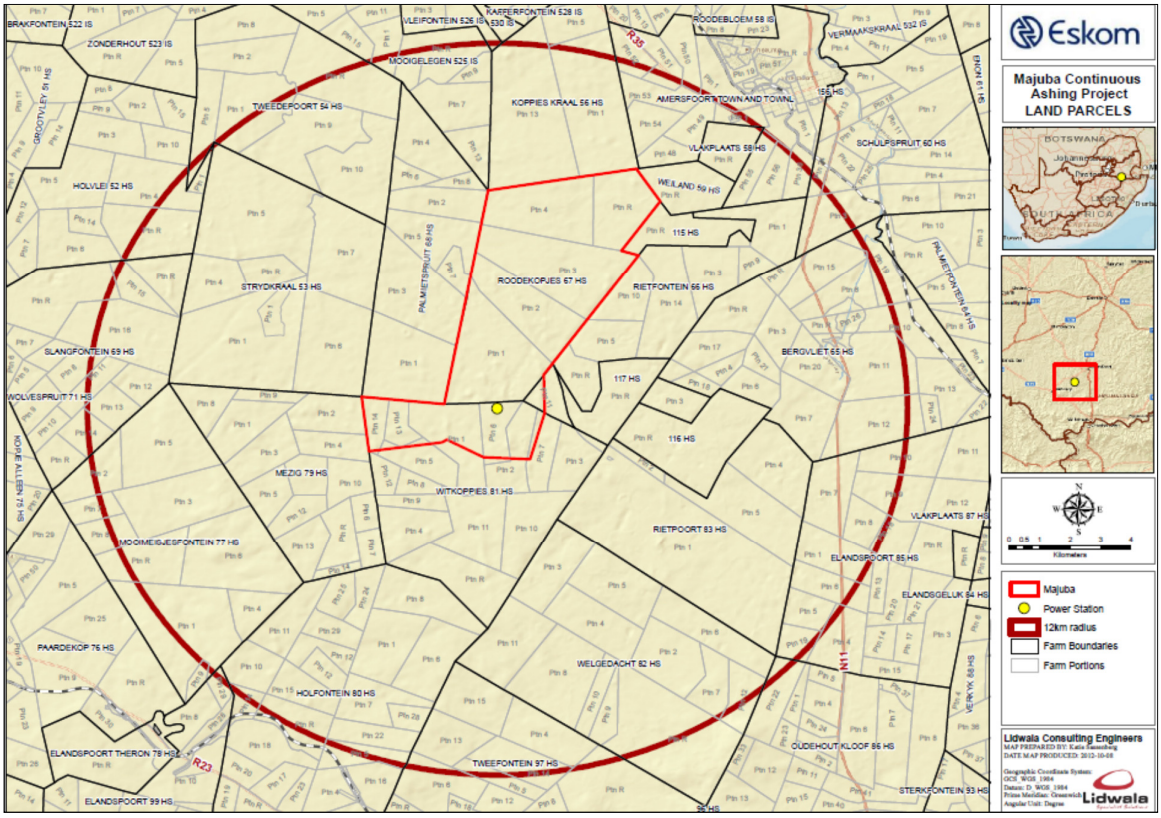

Figure 6.3: Majuba Continuous Ashing EIA Study Area

Table 6.1: Farm Portions situated within the Majuba Continuous Ashing EIA Study Area

SG Code	Farm No.	Portion No.	Farm Name
T0HS00000000008200005	82	5	WELGEDACHT 82 HS
T0HS00000000008200006	82	6	WELGEDACHT 82 HS
T0HS00000000008200007	82	7	WELGEDACHT 82 HS
T0HS00000000008200008	82	8	WELGEDACHT 82 HS
T0HS00000000008200009	82	9	WELGEDACHT 82 HS
T0HS00000000008200010	82	10	WELGEDACHT 82 HS
T0HS00000000008200011	82	11	WELGEDACHT 82 HS
T0HS00000000008200012	82	12	WELGEDACHT 82 HS
T0HS00000000008300001	83	1	RIETPOORT 83 HS
T0HS00000000008300002	83	2	RIETPOORT 83 HS
T0HS00000000008300003	83	3	RIETPOORT 83 HS
T0HS00000000008300004	83	4	RIETPOORT 83 HS
T0HS00000000008300005	83	5	RIETPOORT 83 HS
T0HS00000000008300007	83	7	RIETPOORT 83 HS
T0HS00000000005200000	52	R	HOLVLEI 52 HS
T0HS00000000005200001	52	1	HOLVLEI 52 HS

SG Code	Farm No.	Portion No.	Farm Name
T0HS00000000005200004	52	4	HOLVLEI 52 HS
T0HS00000000006500000	65	R	BERGVLIET 65 HS
T0HS00000000006500000	65	R	BERGVLIET 65 HS
T0HS00000000006500000	65	R	BERGVLIET 65 HS
T0HS00000000006500003	65	3	BERGVLIET 65 HS
T0HS00000000006500004	65	4	BERGVLIET 65 HS
T0HS00000000006500006	65	6	BERGVLIET 65 HS
T0HS00000000006500007	65	7	BERGVLIET 65 HS
T0HS00000000006500008	65	8	BERGVLIET 65 HS
T0HS00000000006900000	69	R	SLANGFONTEIN 69 HS
T0HS00000000006900008	69	8	SLANGFONTEIN 69 HS
T0HS00000000006900011	69	11	SLANGFONTEIN 69 HS
T0HS00000000006900012	69	12	SLANGFONTEIN 69 HS
T0HS00000000006900013	69	13	SLANGFONTEIN 69 HS
T0HS00000000006900014	69	14	SLANGFONTEIN 69 HS
T0HS00000000006900015	69	15	SLANGFONTEIN 69 HS
T0HS00000000006900016	69	16	SLANGFONTEIN 69 HS
T0HS00000000008500001	85	1	ELANDSPOORT 85 HS
T0HS00000000008500004	85	4	ELANDSPOORT 85 HS
T0HS00000000008000028	80	28	HOLFONTEIN 80 HS
T0HS00000000008000029	80	29	HOLFONTEIN 80 HS
T0HS00000000008100000	81	R	WITKOPPIES 81 HS
T0HS00000000008100001	81	1	WITKOPPIES 81 HS
T0HS00000000008100002	81	2	WITKOPPIES 81 HS
T0HS00000000008100003	81	3	WITKOPPIES 81 HS
T0HS00000000008100004	81	4	WITKOPPIES 81 HS
T0HS00000000008100005	81	5	WITKOPPIES 81 HS
T0HS00000000008100006	81	6	WITKOPPIES 81 HS
T0HS00000000008100007	81	7	WITKOPPIES 81 HS
T0HS00000000008100008	81	8	WITKOPPIES 81 HS
T0HS00000000008100009	81	9	WITKOPPIES 81 HS
T0HS00000000008100010	81	10	WITKOPPIES 81 HS
T0HS00000000008100011	81	11	WITKOPPIES 81 HS
T0HS00000000008100012	81	12	WITKOPPIES 81 HS
T0HS00000000008100013	81	13	WITKOPPIES 81 HS
T0HS00000000008100014	81	14	WITKOPPIES 81 HS
T0HS00000000009700013	97	13	TWEEFONTEIN 97 HS
T0HS00000000005400005	54	5	TWEEDEPOORT 54 HS
T0HS00000000005400009	54	9	TWEEDEPOORT 54 HS

SG Code	Farm No.	Portion No.	Farm Name
T0HS00000000009700014	97	14	TWEEFONTEIN 97 HS
T0HS00000000009700015	97	15	TWEEFONTEIN 97 HS
T0HS00000000009700000	97	R	TWEEFONTEIN 97 HS
T0HS00000000006600008	66	8	RIETFONTEIN 66 HS
T0HS00000000006600009	66	9	RIETFONTEIN 66 HS
T0HS00000000006600010	66	10	RIETFONTEIN 66 HS
T0HS00000000006600011	66	11	RIETFONTEIN 66 HS
T0HS00000000006600014	66	14	RIETFONTEIN 66 HS
T0HS00000000006700000	67	R	ROODEKOPJES 67 HS
T0HS00000000006700001	67	1	ROODEKOPJES 67 HS
T0HS00000000006700002	67	2	ROODEKOPJES 67 HS
T0HS00000000006700003	67	3	ROODEKOPJES 67 HS
T0HS00000000006700004	67	4	ROODEKOPJES 67 HS
T0HS00000000006800001	68	1	PALMIETSPRUIT 68 HS
T0HS00000000006800002	68	2	PALMIETSPRUIT 68 HS
T0HS00000000006800003	68	3	PALMIETSPRUIT 68 HS
T0HS00000000006800004	68	4	PALMIETSPRUIT 68 HS
T0HS00000000006800005	68	5	PALMIETSPRUIT 68 HS
T0HS00000000006800006	68	6	PALMIETSPRUIT 68 HS
T0HS00000000006800007	68	7	PALMIETSPRUIT 68 HS
T0HS00000000006800008	68	8	PALMIETSPRUIT 68 HS
T0HS00000000006900000	69	R	SLANGFONTEIN 69 HS
T0HS00000000005300000	53	R	STRYDKRAAL 53 HS
T0HS00000000005300001	53	1	STRYDKRAAL 53 HS
T0HS00000000005300001	53	1	STRYDKRAAL 53 HS
T0HS00000000005300004	53	4	STRYDKRAAL 53 HS
T0HS00000000005300005	53	5	STRYDKRAAL 53 HS
T0HS00000000005300006	53	6	STRYDKRAAL 53 HS
T0HS00000000005300007	53	7	STRYDKRAAL 53 HS
T0HS00000000005400000	54	R	TWEEDEPOORT 54 HS
T0HS00000000005400001	54	1	TWEEDEPOORT 54 HS
T0HS00000000005400010	54	10	TWEEDEPOORT 54 HS
T0HS00000000006500010	65	10	BERGVLIET 65 HS
T0HS00000000006500011	65	11	BERGVLIET 65 HS
T0HS00000000006500012	65	12	BERGVLIET 65 HS
T0HS00000000006500015	65	15	BERGVLIET 65 HS
T0HS00000000006500016	65	16	BERGVLIET 65 HS
T0HS00000000006500017	65	17	BERGVLIET 65 HS
T0HS00000000006500018	65	18	BERGVLIET 65 HS

SG Code	Farm No.	Portion No.	Farm Name
T0HS00000000006500019	65	19	BERGVLIET 65 HS
T0HS00000000006500020	65	20	BERGVLIET 65 HS
T0HS00000000006500021	65	21	BERGVLIET 65 HS
T0HS00000000006500025	65	25	BERGVLIET 65 HS
T0HS00000000006500026	65	26	BERGVLIET 65 HS
T0HS00000000006500027	65	27	BERGVLIET 65 HS
T0HS00000000006600000	66	R	RIETFONTEIN 66 HS
T0HS00000000006600001	66	1	RIETFONTEIN 66 HS
T0HS00000000006600003	66	3	RIETFONTEIN 66 HS
T0HS00000000006600005	66	5	RIETFONTEIN 66 HS
T0HS00000000005600001	56	1	KOPPIES KRAAL 56 HS
T0HS00000000005600005	56	5	KOPPIES KRAAL 56 HS
T0HS00000000005600013	56	13	KOPPIES KRAAL 56 HS
T0HS00000000005700001	57	1	AMERSFOORT TOWN AND TOWNL
T0HS00000000005700001	57	1	AMERSFOORT TOWN AND TOWNL
T0HS00000000005700001	57	1	AMERSFOORT TOWN AND TOWNL
T0HS00000000005700035	57	35	AMERSFOORT TOWN AND TOWNL
T0HS00000000005700036	57	36	AMERSFOORT TOWN AND TOWNL
T0HS00000000005700048	57	48	AMERSFOORT TOWN AND TOWNL
T0HS00000000005700049	57	49	AMERSFOORT TOWN AND TOWNL
T0HS00000000005700050	57	50	AMERSFOORT TOWN AND TOWNL
T0HS00000000005700051	57	51	AMERSFOORT TOWN AND TOWNL
T0HS00000000005700052	57	52	AMERSFOORT TOWN AND TOWNL
T0HS00000000005700053	57	53	AMERSFOORT TOWN AND TOWNL
T0HS00000000005700054	57	54	AMERSFOORT TOWN AND TOWNL
T0HS00000000005700055	57	55	AMERSFOORT TOWN AND TOWNL
T0HS00000000005700056	57	56	AMERSFOORT TOWN AND TOWNL
T0HS00000000005800000	58	R	VLAKPLAATS 58 HS
T0HS00000000006000003	60	3	SCHULPSPRUIT 60 HS
T0HS00000000006000023	60	23	SCHULPSPRUIT 60 HS
T0HS00000000006000024	60	24	SCHULPSPRUIT 60 HS
T0HS00000000008500010	85	10	ELANDSPOORT 85 HS
T0HS00000000008500018	85	18	ELANDSPOORT 85 HS
T0HS00000000008500019	85	19	ELANDSPOORT 85 HS
T0HS00000000007700000	77	R	MOOIMEISJESFONTEIN 77 HS
T0HS00000000007700001	77	1	MOOIMEISJESFONTEIN 77 HS
T0HS00000000007700002	77	2	MOOIMEISJESFONTEIN 77 HS
T0HS00000000007700003	77	3	MOOIMEISJESFONTEIN 77 HS
T0HS00000000007700004	77	4	MOOIMEISJESFONTEIN 77 HS

SG Code	Farm No.	Portion No.	Farm Name
T0HS00000000007700005	77	5	MOOIMEISJESFONTEIN 77 HS
T0HS00000000007700006	77	6	MOOIMEISJESFONTEIN 77 HS
T0HS00000000007700007	77	7	MOOIMEISJESFONTEIN 77 HS
T0HS00000000007700008	77	8	MOOIMEISJESFONTEIN 77 HS
T0HS00000000007700009	77	9	MOOIMEISJESFONTEIN 77 HS
T0HS00000000007900000	79	R	MEZIG 79 HS
T0HS00000000007900001	79	1	MEZIG 79 HS
T0HS00000000007900002	79	2	MEZIG 79 HS
T0HS00000000007900003	79	3	MEZIG 79 HS
T0HS00000000007900004	79	4	MEZIG 79 HS
T0HS00000000007900005	79	5	MEZIG 79 HS
T0HS00000000007900006	79	6	MEZIG 79 HS
T0HS00000000007900007	79	7	MEZIG 79 HS
T0HS00000000007900008	79	8	MEZIG 79 HS
T0HS00000000007900009	79	9	MEZIG 79 HS
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T0HS00000000008000007	80	7	HOLFONTEIN 80 HS
T0HS00000000008000008	80	8	HOLFONTEIN 80 HS
T0HS00000000008000010	80	10	HOLFONTEIN 80 HS
T0HS00000000008000011	80	11	HOLFONTEIN 80 HS
T0HS00000000008000012	80	12	HOLFONTEIN 80 HS
T0HS00000000008000012	80	12	HOLFONTEIN 80 HS
T0HS00000000008000014	80	14	HOLFONTEIN 80 HS
T0HS00000000008000015	80	15	HOLFONTEIN 80 HS
T0HS00000000008000022	80	22	HOLFONTEIN 80 HS
T0HS00000000008000024	80	24	HOLFONTEIN 80 HS
T0HS00000000008000025	80	25	HOLFONTEIN 80 HS
T0HS00000000008500005	85	5	ELANDSPOORT 85 HS
T0HS00000000008500006	85	6	ELANDSPOORT 85 HS
T0HS00000000008500007	85	7	ELANDSPOORT 85 HS
T0HS00000000008500008	85	8	ELANDSPOORT 85 HS

SG Code	Farm No.	Portion No.	Farm Name
T0HS00000000008500009	85	9	ELANDSPOORT 85 HS
T0HS00000000005900000	59	R	WEILAND 59 HS
T0HS00000000009700004	97	4	TWEEFONTEIN 97 HS
T0HS00000000009700005	97	5	TWEEFONTEIN 97 HS
T0HS00000000009700006	97	6	TWEEFONTEIN 97 HS
T0HS00000000007800029	78	29	ELANDSPOORT THERON 78 HS
T0HS00000000008100015	81	15	WITKOPPIES 81 HS
T0HS00000000008200000	82	R	WELGEDACHT 82 HS
T0HS00000000008200002	82	2	WELGEDACHT 82 HS
T0HS00000000008200003	82	3	WELGEDACHT 82 HS
T0HS00000000008200004	82	4	WELGEDACHT 82 HS
T0HS00000000008600022	86	22	OUDEHOUT KLOOF 86 HS
T0HS00000000011500000	115	R	JAPTRAP 115 HS
T0HS00000000011600000	116	R	WERDA 116 HS
T0HS00000000011700000	117	R	KLEIN RIETFONTEIN 117 HS
T0IS00000000052500007	525	7	MOOIGELEGEN 525 IS
T0IS00000000052500009	525	9	MOOIGELEGEN 525 IS
T0IS00000000052500010	525	10	MOOIGELEGEN 525 IS
T0IS00000000052500013	525	13	MOOIGELEGEN 525 IS
T0IS00000000052500015	525	15	MOOIGELEGEN 525 IS
T0IS00000000052600002	526	2	VLEIFONTEIN 526 IS
T0IS00000000052500000	525	R	MOOIGELEGEN 525 IS
T0IS00000000052500001	525	1	MOOIGELEGEN 525 IS

6.3 Description of the Baseline Environment

6.3.1 Topography

The study area, within the 12 km radius, is characterised by strong undulating character typical of the Mpumalanga province with hills and koppies to the south and east. The natural topography of the area has been disturbed as a result of various mining, agricultural and power generation activities.

6.3.2 Climate

The climate in the study area can be described as typical highveld conditions with summers that are moderate and wet, while winters are cold and dry. Severe frost and snow are sometimes experienced. The area also falls within the mist belt.

According to data from the Majuba monitoring station for 2009 – 2011, the mean annual precipitation is approximately 760 mm/year. The study area falls within a summer rainfall region, with over 85% of the annual rainfall occurring during the October to March period. Between October 2011 and March 2012, monthly rainfall ranged between 21 and 128 mm. **Figure 6.4** shows the monthly rainfall for the Majuba Power Station experienced during the period August 2011 to July 2012.

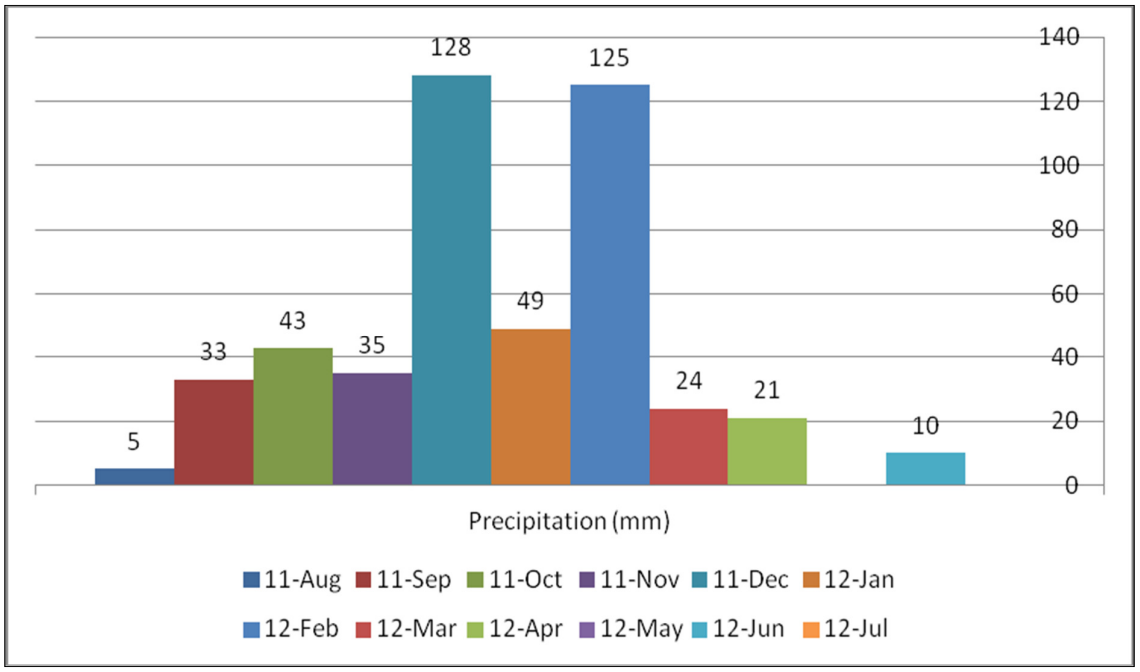

Figure 6.4: The monthly rainfall as measured at Majuba Power Station (mm/annum) during the period August 2011 to July 2012

Based on the measured data at Eskom's Majuba monitoring station for the period 2009-2011. Average daily maximum temperatures range from 34.6°C in December to 22.8°C in July, with daily minima ranging from 14.6°C in January to 2.6°C in June (**Figure 6.5**).

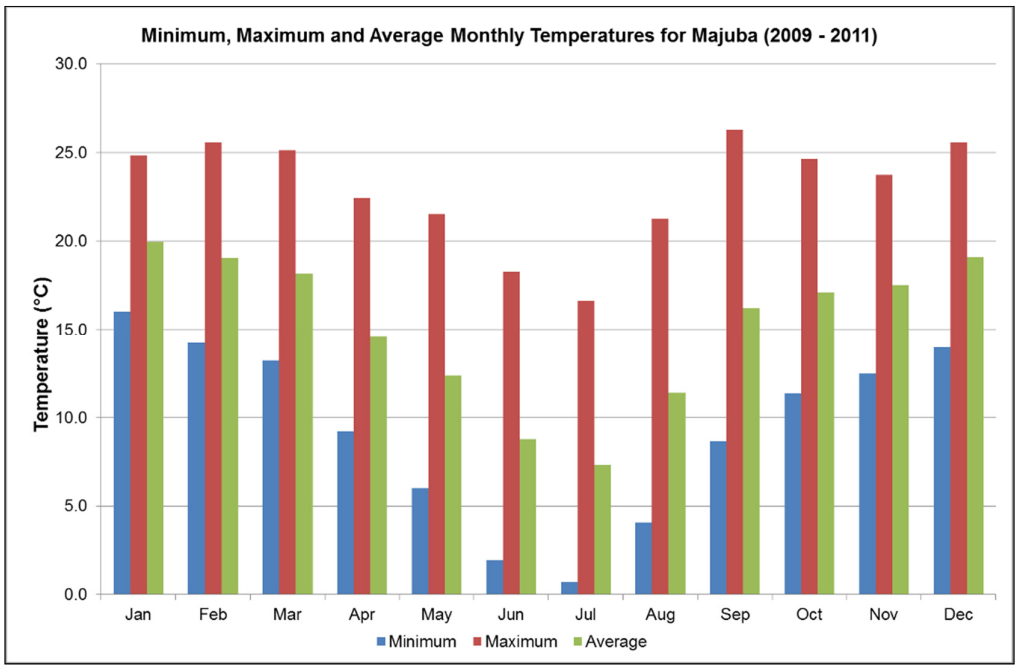

Figure 6.5: Average monthly maximum, minimum and mean temperatures for Majuba Power Station

The prevailing wind direction is recorded as being co-dominant, with both easterly and west-north-westerly winds. **Figure 6.6** shows the period, day-time and night-time wind roses for the Majuba Power Station.

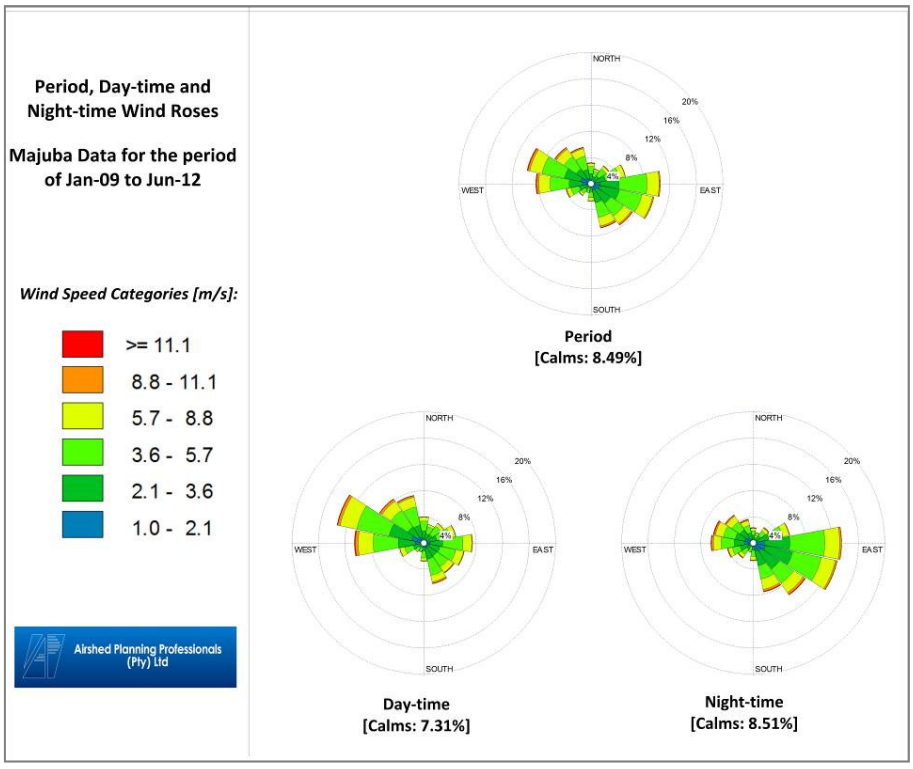

Figure 6.6: Period, day-time and night-time wind roses for the Majuba Power Station

6.3.3 Geology

Majuba Power Station falls within the Carboniferous to early Jurassic aged Karoo Supergroup. Sediments in this part of Mpumalanga Province fall within the Permian Ecca group which comprises of a total of 16 formations. The study area is underlain by Karoo Supergroup sedimentary rocks of the Vryheid and Volksrust Formations of the Ecca Group. These are largely comprised of sandstone, mudstone, shale, siltstone, and coal seams. The Volksrust Formation is predominantly argillaceous unit with interfingers with the overlying Beaufort Group and underlying Vryheid Formation. Considerable intrusive Karoo dolerite is also mapped in the area. The geology of the study area is shown in **Figure 6.7.**

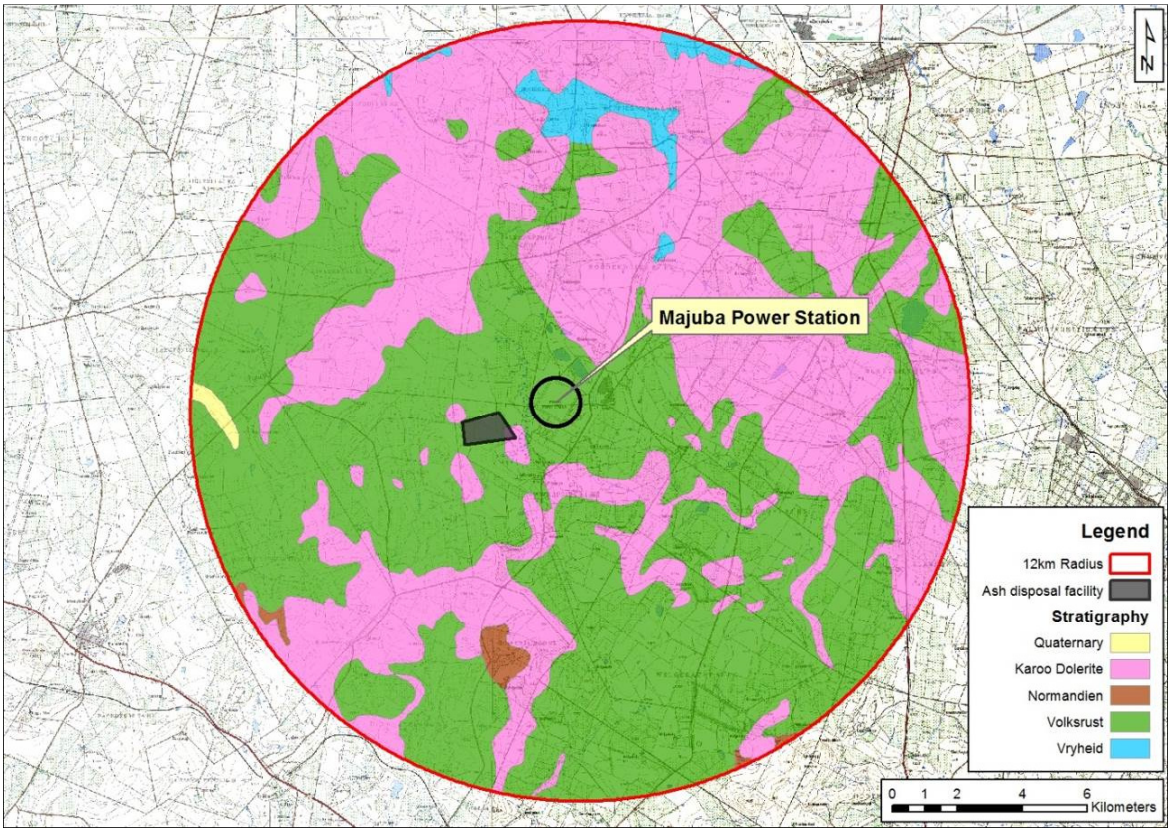

Figure 6.7: Geology of the Study area

6.3.4 Land Cover and Land Use

Land cover categories are presented in **Figure 6.8**. For the purpose of this assessment, land cover are loosely categorised into classes that represent natural habitat and categories that contribute to habitat degradation and transformation on a local or regional scale. In terms of the importance for biodiversity, the assumption is that landscapes exhibiting high transformation levels are normally occupied by plant communities and faunal assemblages

that do not necessarily reflect the original or pristine status. This is particularly important in the case of conservation important taxa as these plants and animals generally exhibit extremely low tolerance levels towards disturbances. This is one of the main reasons for the threatened status of these species. Changes in the natural environment available to these species are therefore likely to result in severe impacts on these species and, subsequently, their conservation status.

Three important aspects are associated with habitat changes that accompany certain land uses. Permanent transformation of natural habitat by land uses such as agriculture, mining and urbanisation results in the permanent decimation of available habitat as these areas will not recover to the original pristine status. A second aspect of habitat transformation or degradation is that it affects species directly, namely changes in species presence/ absence and –composition. This result from the exodus of species for which habitat conditions have become unfavourable, the decrease in abundance of certain species because of decreased habitat size, or an influx of species that are better adapted to the altered environment. While some, or most, of the new species that occupy an area might be indigenous, they are not necessarily endemic to the affected area. Lastly, a larger threat to the natural biodiversity of a region is represented by the influx of invasive exotic species that can effectively sterilise large tracts of remaining natural habitat.

The study area is situated within the Pixley Ka Seme Municipality, which comprises a total of 522,723ha. The BGIS (2007) assessment indicates that approximately 88% of the municipality are currently considered untransformed. This figure is however regarded an overestimation of the true extent of remaining natural (pristine) grassland habitat in the region. This statement is based on the following:

- The current land cover, as presented in ENPAT does not accurately reflect the current land cover status in all instances; in particular, recent agricultural activities and localised stands of exotics are not captured within the existing data (pers. obs.); and
- It is well established that the status of much of the remaining portions of 'natural grassland' is not accurately summarized in the assessment. These 'natural grasslands' frequently comprehend poor quality grassland or even pastures that exhibit severely altered species compositions and depleted diversity that does not reflect the natural grassland of the region (pers. obs.).

By inclusion of portions of other land cover categories, sub-climax grassland types in particular, within the category of 'Natural Grassland' a fallacious view is created of the extent of remaining natural habitat in the region. It is therefore extremely likely that remaining

untransformed habitat within the municipality is much lower than initially anticipated. Ultimately, the greater region is characterised by high levels of habitat transformation, isolation and habitat fragmentation, resulting from persistent increases in mining and agricultural activities, urban developments, linear infrastructure and poor management practices.

The effects of commercial agriculture (maize production), infestation by alien invasive trees and recent increase in mining activities are evident from the mosaical appearance of land cover in the immediate region. Other noteworthy land transformation effects result from mining, industrial and urban development. Road and railway infrastructure in the region caused a moderate level of habitat fragmentation and isolation.

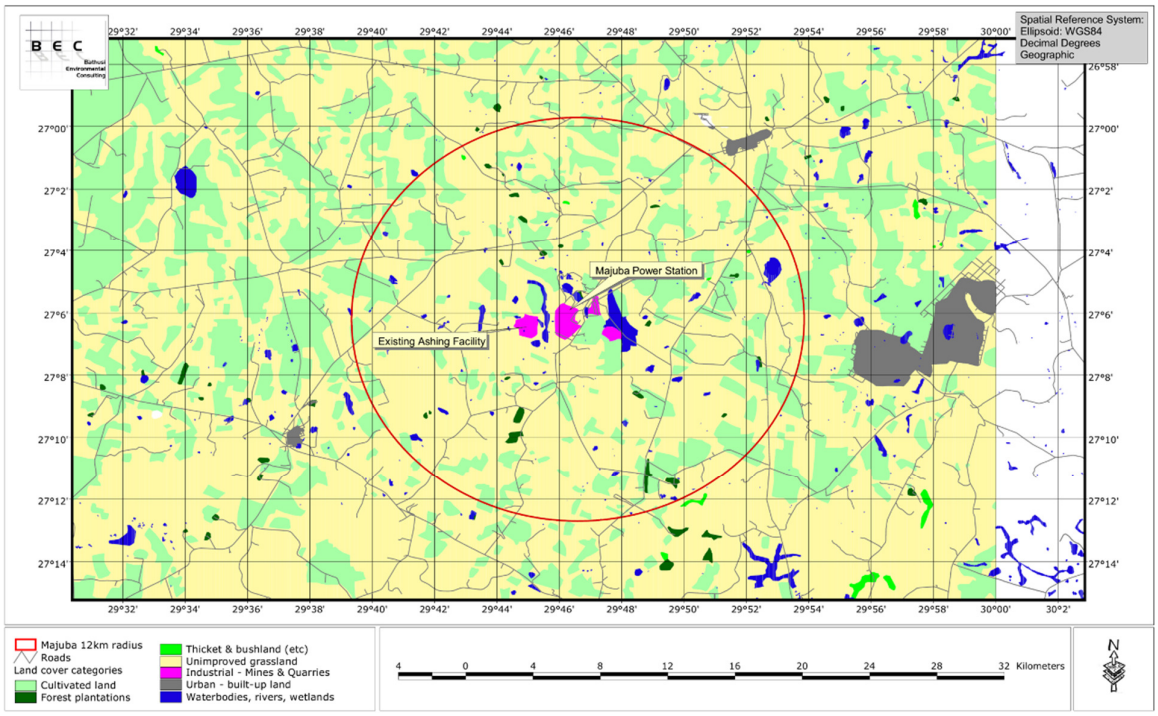

Figure 6.8: Land cover categories in the study area

6.3.5 Land Type

The existing ash disposal facility is situated within the Bd46 land type unit (**Figure 6.9**). Other land types represented within the 12km buffer zone include Ae252, Ah86, Bc44 and Bd44.

Map units Aa to Ai refer to yellow and red soils without water tables and belonging in one or more of the following soil form: Inanda, Kranskop, Magwa, Hutton, Griffin and Clovelly.

The map units refer to land that does not qualify as a plinthic catena and in which one or more of the above soil forms occupy at least 40% of the area. In Ab (red, dystrophic and/ or mesotrophic), yellow soils occupy less than 10% of the area and /or mesotrophic soils occupy a larger area than high base status red-yellow apedal soils.

The B- group includes a large area of the South African interior that is occupied by a catena, which in its perfect form is represented by (in order from highest to lowest in the upland landscape) Hutton, Bainsvlei, Avalon and Longlands forms. The valley bottoms are occupied by one or other grey soil. Soils with hard plinthite are common over sandstones in the moist climate zones in the eastern part of the country. Depending on the extent to which water tables have been operative over a landscape, Longlands, Avalon and related grey and yellow soils may predominate, even to the exclusion of red soils. Where water tables have not extended beyond the valley bottoms, red soils may predominate with plinthic soils restricted to narrow strips of land around valley bottoms or pans. For inclusion into Bc and Bd plinthic soils must cover more than 10% of the area. Unit Bc indicates land in which yellow and/ or red apedal soils are eutrophic and red soils are widespread, while red soils are not widespread in unit Bd.

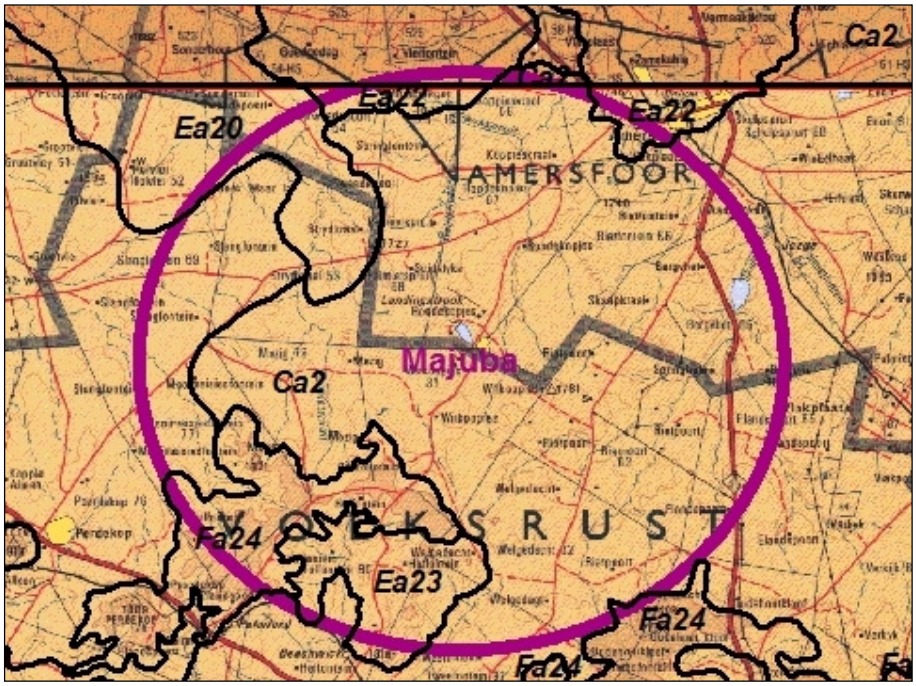

Figure 6.9: Land type units with the study area

6.3.6 Natural Vegetation

- **Regional Vegetation - VEGMAP**

The study area corresponds to the Grassland Biome as defined by Mucina & Rutherford (VegMap, 2006). This unit is found in the eastern, precipitation-rich regions of the Highveld. Grasslands of these parts are regarded 'sour grasslands'. The following ecological types are represented within the 12km radius (**Figure 6.10**):

- Amersfoort Highveld Clay Grassland;
- Bloemfontein Karroid Shrubland;
- Eastern Temperate Freshwater Wetlands;
- Soweto Highveld Grassland; and
- Wakkerstroom Montane Grassland.

A map with the conservation status of respective vegetation types are presented in **Figure 6.11**.

- *Amersfoort Highveld Clay Grassland*

  This grassland comprises undulating plains, with small, scattered patches of dolerite outcrops. The vegetation comprises of short, closed grassland, largely dominated by a dense *Themeda triandra* sward, often severely grazed. Overgrazing leads to invasion of *Seriphium plumosum*. Parts of this unit were once cultivated and these transformed areas are not picked up by satellite for transformation coverage; the percentage of grasslands still in a natural state may therefore be underestimated.

  The conservation status is regarded as '**Vulnerable**'; none is formally protected. Some 25% of this vegetation type is transformed, predominantly by cultivation (22%). The area is not suited to forestation. Silver and black wattle and *Salix babylonica* invade drainage areas.

- *Bloemfontein Karroid Shrubland*

  Vegetation of this unit comprehends plateaus or slightly sloping flanks of dolerite outcrops supporting low shrubland dominated by dwarf small-leaved karroid and succulent shrubs. Grasses are restricted to depressions and crevices filled with fine soils. Remarkable is the presence of abundant geophytic herbs. Solitary shrubs or small shrub groups with *Diospyros austro-africana, Euclea crisps* subsp. *ovata, Searsia*

burchelli S. ciliata and *S. erosa* are occasionally present, especially in habitats where root penetration into deeper crevices is possible.

Some sites of this vegetation are exposed to considerable urban developmental pressures, especially within the borders of the Mangaung Municipality. None is conserved in statutory conservation areas, but small portions are found on the premises of the Free State National Botanical Garden in Bloemfontein; a '**Least Threatened**' status is currently afforded. About 10% is already transformed, mainly by cultivation. Potts & Tidmarsh (1937) were the first to describe this vegetation and to recognise the fact that it is a unique island of succulent-dominated karroid shrub community within the Grassland Biome. Although there is a strong affinity to the vegetation of the arid west, it also has a notable grass component. It is therefore suggested that the occurrence of karroid shrubland within highveld grasslands relates to physiological drought due to shallow soils, high runoff, high evaporation rates and impeded infiltration of rainwater. These factors create soil-controlled microhabitat for vegetation that might be considered a relic of drier (and presumable colder) past climatic periods.

- *Eastern Temperate Freshwater Wetlands*

  This vegetation type occurs around water bodies with stagnant water (lakes, pans, periodically flooded vleis and edges of calmly flowing rivers) and is embedded within the Grassland Biome. The landscape is generally flat, or shallow depressions filled with (temporary) water bodies supporting zoned systems of aquatic and hygrophilous vegetation of temporarily flooded grasslands and ephemeral herblands. The vleis form where flow of water is impeded by impermeable soils and/ or by erosion resistant features, such as dolerite intrusions. Many vleis and pans of this type of wetlands are inundated and/ or saturated only during the summer rainfall season and for some months after this into the middle of the dry winter season, but they may remain saturated all year round. About 5% is statutorily conserved in the Blesbokspruit, Hogsback, Marievale, Olifantsvlei, Seekoeivlei, Wakkerstroom Wetland, Umgeni Vlei and Pamula Park Nature Reserves. It is also protected in private nature reserves such as the Korsman Bird Sanctuary and Langfontein. A '**Vulnerable**' conservation status is ascribed to this unit. Some 15% has been transformed to cultivated land, urban areas or plantations.

- *Soweto Highveld Grassland*

  The Soweto Highveld Grassland comprises a gently to moderately undulating landscape on the Highveld plateau supporting short to medium-high, dense, tufted grassland dominated almost entirely by *Themeda triandra* and accompanied by a variety of other

grasses such as *Elionurus muticus, Eragrostis racemosa, Heteropogon contortus* and *Tristachya leucothrix*. Only scattered small wetlands, narrow stream alluvia, pans and occasional ridges or rocky outcrops interrupt the continuous grassland cover in undisturbed areas. This vegetation type is regarded '**Endangered**' with a target of 24%. Only a handful of patches are statutorily conserved, including Wadrift, Krugersdorp, Leeuwkuil, Suikerboschrand and Rolfe's Pan Nature Reserve. Almost half of the area is already transformed by cultivation, urban sprawl, mining and building of road infrastructure. Some areas have been flooded by dams (Grootdraai, Leeukuil, Trichardtsfontein, Vaal, Willem Brummer). Erosion is generally very low.

- *Wakkerstroom Montane Grassland*

  A small portion of this ecological type is represented in the southeast of the 12km radius. Vegetation of this unit is a less obvious continuation of the Escarpment that links the southern and northern Drakensberg escarpments; it straddles this divide and comprises of low mountains and undulating plains. The vegetation comprises predominantly short montane grasslands on the plateaus and the relatively flat areas, with short forest and *Leucosidea* thickets occurring along steep, mainly east-facing slopes and drainage lines. *L. sericea* is the dominant woody pioneer species that invades areas as a result of grazing mismanagement. A status of '**Least Threatened**' is afforded to these parts; although less than 1% is statutorily conserved in the Paardeplaats Nature Reserve. There are 10 Natural Heritage Sites in this unit, although very little of it is formally protected. Land use pressures from agriculture are low, probable owing to the colder climate and shallower soils. The area is also suited to afforestation, with more than 1% under *Acacia mearnsii* and *Eucalyptus* plantations.

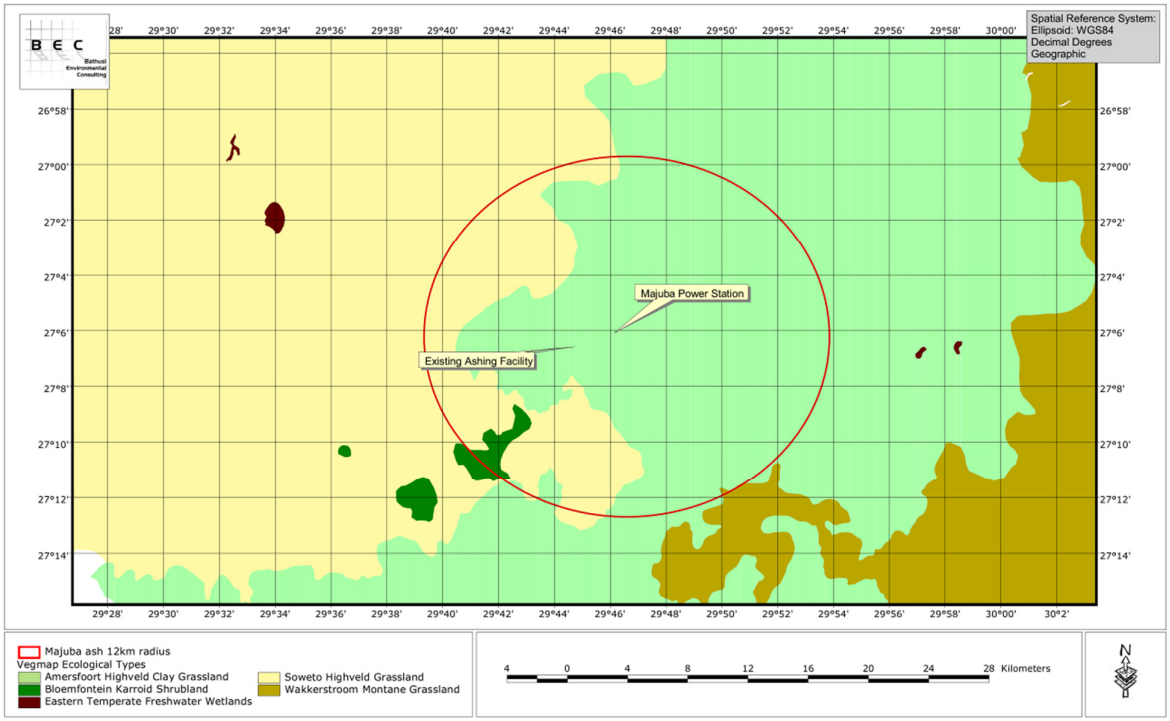

Figure 6.10: VEGMAP Categories in the Study area (according to Mucina and Rutherford 2006)

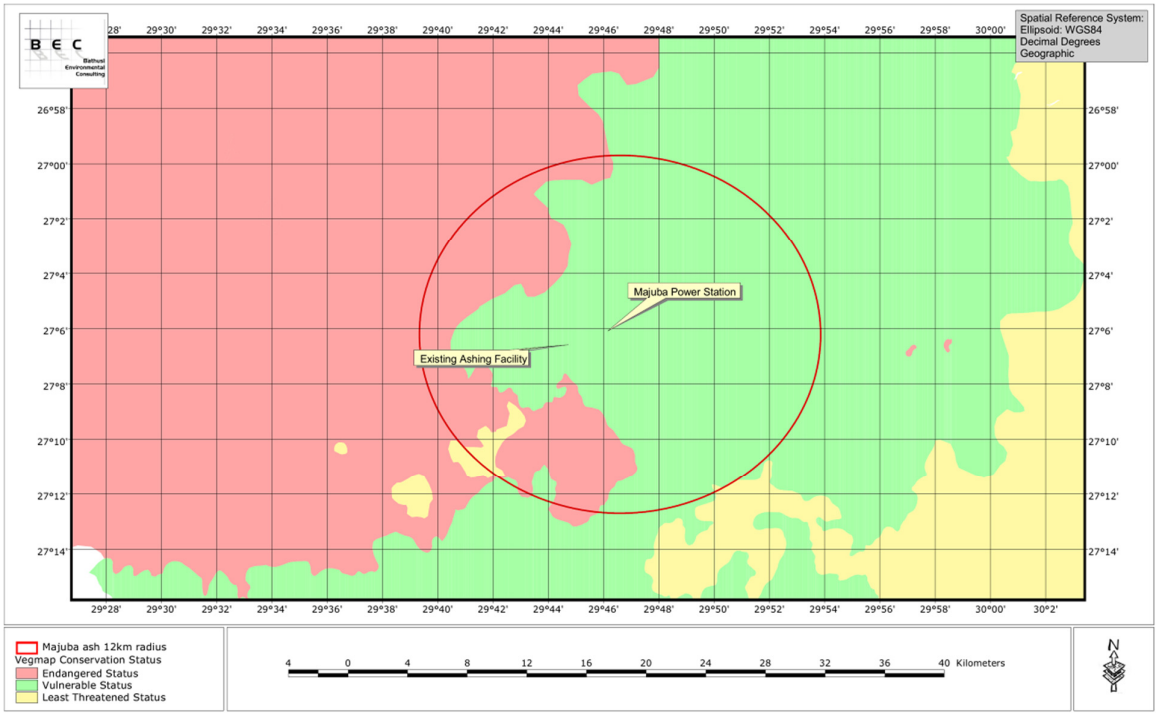

Figure 6.11: VEGMAP conservation status of vegetation types (according to Mucina and Rutherford 2006)

- **MBCP Categories**

The local and regional designation of Mpumalanga Terrestrial Biodiversity Conservation Categories (MBCP) is illustrated in **Figure 6.12**.

The mandate for conserving biodiversity lies with state agencies at national, provincial and local levels of government, forming part of a wider responsibility for the environment and the sustainable use of natural resources. Constitutional and national laws require these environmental issues to be dealt with in cooperative, participatory, transparent and integrated ways. The MBCP is the first spatial biodiversity plan for Mpumalanga that is based on scientifically determined and quantified biodiversity objectives. The purpose of the MBCP is to contribute to sustainable development in Mpumalanga.

The MBCP maps the distribution of Mpumalanga Province's known biodiversity into seven categories (Lötter & Ferrar, 2006). These are ranked according to ecological and biodiversity importance and their contribution to meeting the quantitative targets set for each biodiversity feature. The categories are:

- **Protected areas** - already protected and managed for conservation;
- **Irreplaceable areas** - no other options available to meet targets––protection crucial;
- **Highly Significant areas** - protection needed, very limited choice for meeting targets;
- **Important and Necessary areas** - protection needed, greater choice in meeting targets;
- **Ecological Corridors** – mixed natural and transformed areas, identified for long term connectivity and biological movement;
- **Areas of Least Concern** – natural areas with most choices, including for development;
- **Areas with No Natural Habitat Remaining** – transformed areas that do not contribute to meeting targets.

The study area comprises four of these categories (**Figure 6.12**), namely:

- Highly Significant (red);
- Important & Necessary (green);
- No Natural Habitat Remaining (grey); and
- Least Concern (yellow).

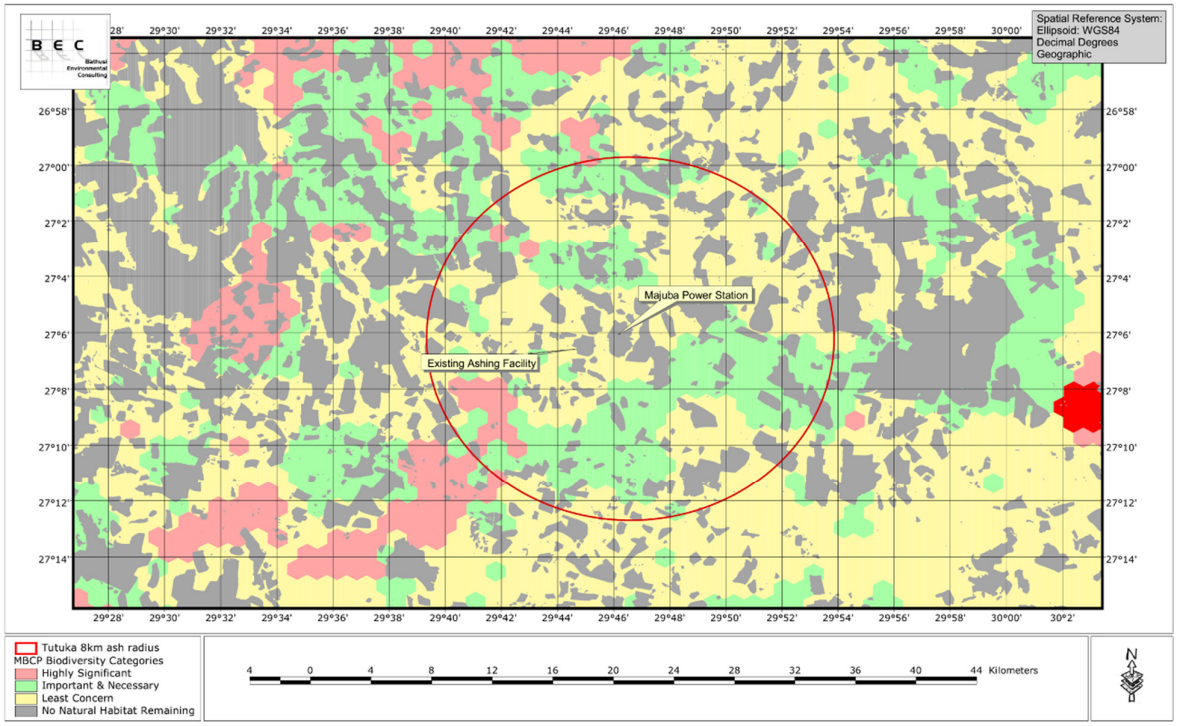

Figure 6.12: The MBCP categories as they relate to the study area**.**

- **Species of Conservation Importance**

South Africa's Red List system is based on the IUCN Red List Categories and Criteria Version 3.1 (finalized in 2001), amended to include additional categories to indicate species that are of local conservation concern. The IUCN Red List system is designed to detect risk of extinction. Species that are at risk of extinction, also known as threatened or endangered species are those that are classified in the categories Critically Endangered (CR), Endangered (EN) and Vulnerable (VU). Species included in these categories are presented in **Table 6.2**. Taking the habitat that is available as well as the status thereof into consideration, it is regarded likely that plant species included in the Threatened category might be present within the study areas.

Mpumalanga Province comprises 4,256 plant species of which 276 are included in the following conservation categories:

1 Extinct;

30 Endangered;

80 Vulnerable;

36 Near Threatened;

2 Critically Rare;

47 Rare;

25 Declining;

19 Data Deficient – insufficient information (DDD); and

36 Data Deficient – taxonomical problem (DDT).

Data records indicate the presence of a number of plant species of conservation importance within the ¼-degree grids that are sympatric to the study area (**Table 6.2).**

Table 6.2: Plant species of conservation importance within the region of the study area

Species Name	Family	Status
Argyrolobium campicola	Fabaceae	Near Threatened
Crinum bulbispermum	Amaryllidaceae	Declining
Gladiolus robertsoniae	Iridaceae	Near Threatened
Ilex mitis	Aquifoliaceae	Declining
Khadia alticola	Mesembryanthemaceae	Rare
Kniphofia typhoides	Asphodelaceae	Near Threatened
Miraglossum davyi	Apocynaceae	Vulnerable
Nerine platypetala	Amaryllidaceae	Vulnerable
Stenostelma umbelluliferum	Apocynaceae	Near Threatened

In addition to the species currently captured in the SANBI infobase (POSA, 2011), the following provincially protected plants are known to occur within the region of the study area (Mpumalanga Nature Conservation Act No.10 of 1998) (**Table 6.3**)

Table 6.3: Protected plant species within the region of the study area

Species Name	Family	Status
Agapanthus inapertus subsp. intermedius	Agapanthaceae	Provincially protected
Aloe ecklonis	Asphodelaceae	Provincially protected
Corycium nigrescens	Orchidaceae	Provincially protected
Crinum bulbispermum	Amaryllidaceae	Provincially protected
Cyrtanthus breviflorus	Amaryllidaceae	Provincially protected
Cyrtanthus tuckii var. transvaalensis	Amaryllidaceae	Provincially protected
Cyrtanthus tuckii var. tuckii	Amaryllidaceae	Provincially protected
Eulophia foliosa	Orchidaceae	Provincially protected
Gladiolus crassifolius	Iridaceae	Provincially protected
Gladiolus dalenii subsp. dalenii	Iridaceae	Provincially protected
Gladiolus permeabilis subsp. edulis	Iridaceae	Provincially protected
Gladiolus robertsoniae	Iridaceae	Provincially protected
Gladiolus sericeovillosus subsp. calvatus	Iridaceae	Provincially protected
Gladiolus sericeovillosus subsp. sericeovillosus	Iridaceae	Provincially protected
Haemanthus montanus	Amaryllidaceae	Provincially protected
Kniphofia albescens	Asphodelaceae	Provincially protected
Kniphofia typhoides	Asphodelaceae	Provincially protected
Leucospermum cuneiforme	Proteaceae	Provincially protected
Satyrium neglectum subsp. neglectum var.	Orchidaceae	Provincially protected

Zantedeschia albomaculata subsp. macrocarpa	Araceae	Provincially protected

Further detail can be obtained from the Biodiversity Specialist Report in **Appendix M**.

6.3.7 Animal Life

A total of 115 Red Data species from five categories (IUCN) are known to occur in the Mpumalanga Province (Invertebrates, Reptiles, Frogs and Mammals) and the Q-grids 2729BA and 2729BB (birds), included in the following conservation categories:

- 23 species are listed as Data Deficient (DD);
- 42 species are listed as Near Threatened (NT);
- 34 species are listed as Vulnerable (VU);
- 11 species are listed as Endangered (EN); and
- 5 species are listed as Critically Endangered (CR).

Estimations for the probability of occurrence (PoC) for Red Data fauna taxa for the study area yielded the following results (**Table 6.4**):

- 41 species have a low PoC;
- 14 species have a moderate-low PoC;
- 31 species have a moderate PoC;
- 7 species have a moderate-high PoC; and
- 15 species have a high PoC.

Seven Red Data species have been recorded, or are known to occur, in the study area.

Table 6.4: Red Data Faunal assessment for the study area

Species Details			**Probability**
Binomial Name	**Colloquial Name**	**RD Status**	**Assessment**
Dragonflies and Damselflies			
Pseudagrion inopinatum	Balinsky's Sprite	Endangered	low
Pseudagrion newtoni	Newton's Sprite	Vulnerable	moderate-low
Butterflies			
Aloeides barbarae	Barbara's Copper	Endangered	low
Aloeides merces	Wakkerstroom Copper	Vulnerable	moderate-low
Aloeides nubilus	Cloud Copper	Endangered	low
Aloeides rossouwi	Rossouw's Copper	Endangered	low
Chrysoritis aureus	Heidelberg Opal	Vulnerable	low
Chrysoritis phosphor borealis	Scarce Scarlet	Data Deficient	low
Lepidochrysops irvingi	Irving's Blue	Vulnerable	low
Lepidochrysops jefferyi	Jeffrey's Blue	Endangered	low

Lepidochrysops swanepoeli	Swanepoel's Blue	Vulnerable	low
Metisella meninx	Marsh Sylph	Vulnerable	high
Frogs			
Breviceps sopranus	Whistling Rain Frog	Data Deficient	low
Hemisus guttatus	Spotted Shovel-nosed Frog	Vulnerable	moderate
Pyxicephalus adspersus	Giant Bullfrog	Near Threatened	moderate-low
Strongylopus wageri	Plain Stream Frog	Near Threatened	moderate-low
Reptiles			
Acontias breviceps	Short-headed Legless Skink	Near Threatened	moderate
Afroedura major	Swazi Flat Gecko	Near Threatened	moderate-low
Chamaesaura aenea	Coppery Grass Lizard	Near Threatened	moderate
Chamaesaura macrolepis	Large-scaled Grass Lizard	Near Threatened	moderate
Homoroselaps dorsalis	Striped Harlequin Snake	Near Threatened	moderate
Kininyx natalensis	Natal Hinged Tortoise	Near Threatened	moderate
Lamprophis fuscus	Yellow-bellied House Snake	Near Threatened	moderate
Smaug giganteus	Sungazer	Vulnerable	confirmed
Tetradactylus breyeri	Breyer's Long-tailed Seps	Vulnerable	moderate-low
Birds			
Phoenicopterus roseus	Greater Flamingo	Near Threatened	moderate-low
Phoenicopterus minor	Lesser Flamingo	Near Threatened	moderate-low
Mycteria ibis	Yellow-billed Stork	Near Threatened	moderate-low
Ciconia nigra	Black Stork	Near Threatened	moderate-low
Leptoptilos crumeniferus	Marabou Stork	Near Threatened	moderate-low
Geronticus calvus	Southern Bald Ibis	Vulnerable	confirmed
Botaurus stellaris	Eurasian Bittern	Critically Endangered	moderate
Sagittarius serpentarius	Secretarybird	Near Threatened	high
Gyps coprotheres	Cape Vulture	Vulnerable	moderate-low
Circus ranivorus	African Marsh Harrier	Vulnerable	high
Circus maurus	Black Harrier	Vulnerable	moderate-high
Circus macrourus	Pallid Harrier	Near Threatened	high
Polemaetus bellicosus	Martial Eagle	Vulnerable	moderate-high
Stephanoaetus coronatus	Crowned Eagle	Near Threatened	low
Falco naumanni	Lesser Kestrel	Vulnerable	high
Falco biarmicus	Lanner Falcon	Near Threatened	high
Neotis denhami	Denham's Bustard	Vulnerable	moderate-high
Eupodotis caerulescens	Blue Korhaan	Near Threatened	confirmed
Eupodotis senegalensis	White-bellied Korhaan	Vulnerable	moderate
Lissotis melanogaster	Black-bellied Bustard	Near Threatened	moderate-low
Sarothrura affinis	Striped Flufftail	Vulnerable	moderate-low
Crex crex	Corn Crake	Vulnerable	moderate
Balearica regulorum	Grey Crowned Crane	Vulnerable	moderate-high
Anthropoides paradiseus	Blue Crane	Vulnerable	high
Bugeranus carunculatus	Wattled Crane	Critically Endangered	moderate-high
Turnix nanus	Black-rumped Buttonquail	Endangered	moderate
Vanellus melanopterus	Black-winged Lapwing	Near Threatened	moderate
Rostratula benghalensis	Greater Painted-snipe	Near Threatened	moderate
Glareola nordmanni	Black-winged Pratincole	Near Threatened	moderate
Tyto capensis	African Grass-owl	Vulnerable	moderate-high
Alcedo semitorquata	Half-collared Kingfisher	Near Threatened	moderate-low
Heteromirafra ruddi	Rudd's Lark	Critically Endangered	moderate-low
Spizocorys fringillaris	Botha's Lark	Endangered	moderate-low
Lioptilus nigricapillus	Bush Blackcap	Near Threatened	low
Zoothera gurneyi	Orange Ground Thrush	Near Threatened	low
Anthus brachyurus	Short-tailed Pipit	Vulnerable	low

Anthus chloris	Yellow-breasted Pipit	Vulnerable	low
Mammals			
Chrysospalax villosus	Rough-haired Golden Mole	Critically Endangered	moderate-low
Amblysomus hottentotus	Hottentot's Golden Mole	Data Deficient	moderate-low
Amblysomus robustus	Robust Golden Mole	Endangered	low
Amblysomus septentrionalis	Highveld Golden Mole	Near Threatened	moderate-high
Neamblysomus julianae	Juliana's Golden Mole	Vulnerable	low
Atelerix frontalis	South African Hedgehog	Near Threatened	moderate
Elephantulus brachyrhynchus	Short-snouted Elephant-shrew	Data Deficient	low
Myosorex cafer	Dark-footed Forest Shrew	Data Deficient	low
Myosorex varius	Forest Shrew	Data Deficient	high
Crocidura cyanea	Reddish-grey Musk Shrew	Data Deficient	high
Crocidura flavescens	Greater Musk Shrew	Data Deficient	moderate-high
Crocidura fuscomurina	Tiny Musk Shrew	Data Deficient	moderate
Crocidura hirta	Lesser Red Musk Shrew	Data Deficient	moderate
Crocidura maquassiensis	Maquassie Musk Shrew	Vulnerable	low
Crocidura mariquensis	Swamp Musk Shrew	Data Deficient	moderate-high
Crocidura silacea	Lesser Grey-brown Musk Shrew	Data Deficient	moderate-high
Suncus infinitesimus	Least Dwarf Shrew	Data Deficient	moderate
Suncus lixus	Greater Dwarf Shrew	Data Deficient	low
Suncus varilla	Lesser Dwarf Shrew	Data Deficient	moderate
Cloeotis percivali	Percival's Short-eared Trident Bat	Vulnerable	moderate-low
Rhinolophus blasii	Blasius's Horseshoe Bat	Near Threatened	moderate
Rhinolophus swinnyi	Swinny's Horseshoe Bat	Near Threatened	moderate-low
Miniopterus natalensis	Natal Long-fingered Bat	Near Threatened	moderate-high
Scotophilus nigrita	Giant Yellow House Bat	Near Threatened	low
Cercopithecus mitis	Samango Monkey	Vulnerable	low
Cercopithecus mitis labiatus	Samango Monkey	Endangered	low
Manis temminckii	Ground Pangolin	Vulnerable	moderate-low
Graphiurus platyops	Rock Dormouse	Data Deficient	low
Mystromys albicaudatus	White-tailed Rat	Endangered	moderate
Tatera leucogaster	Bushveld Gerbil	Data Deficient	low
Lemniscomys rosalia	Single-striped Mouse	Data Deficient	moderate
Dasymys incomtus	Water Rat	Near Threatened	moderate
Grammomys dolichurus	Woodland Mouse	Data Deficient	low
Otomys slogetti	Sloggett's Rat	Data Deficient	low
Panthera pardus	Leopard	Near Threatened	moderate
Panthera leo	Lion	Vulnerable	low
Leptailurus serval	Serval	Near Threatened	confirmed
Acinonyx jubatus	Cheetah	Vulnerable	low
Felis nigripes	Black-footed Cat	Vulnerable	low
Crocuta crocuta	Spotted Hyaena	Near Threatened	low
Parahyaena brunnea	Brown Hyaena	Near Threatened	high
Paracynictis selousi	Selous's Mongoose	Data Deficient	low
Rhynchogale melleri	Meller's Mongoose	Data Deficient	low
Canis adustus	Side-striped Jackal	Near Threatened	low
Lycaon pictus	African Wild Dog	Endangered	low
Mellivora capensis	Honey Badger	Near Threatened	high
Poecilogale albinucha	African Striped Weasel	Data Deficient	moderate
Hydrictis maculicollis	Spotted-necked Otter	Near Threatened	moderate-low
Loxodonta africana	African Savanna Elephant	Vulnerable	low
Diceros bicornis	Black Rhinoceros	Critically Endangered	low
Ceratotherium simum	White Rhinoceros	Near Threatened	low
Hippopotamus amphibius	Common Hippopotamus	Vulnerable	low

Raphicerus sharpei	Sharpe's Grysbok	Near Threatened	low
Ourebia ourebi	Southern Oribi	Endangered	low
Hippotragus equinus	Roan Antelope	Vulnerable	low
Hippotragus niger	Southern Sable Antelope	Vulnerable	low
Damaliscus lunatus	Western Tsessebe	Endangered	low

Mpumalanga includes 31 provincially listed protected species (www.speciesstatus.sanbi.org – NEMBA status, **Table 6.5**) of which one was recorded within the study area.

Table 6.5: Protected Fauna species of Mpumalanga

Species Details			**Probability Assessment**
Binomial Name	***Colloquial Name***	***NEMBA status***	
Aonyx capensis	African Clawless Otter	protected	high
Atelerix frontalis	South African Hedgehog	protected	moderate
Bucorvus leadbeateri	Southern Ground-Hornbill	protected	low
Ceratogyrus bechuanicus	Starbust Horned Baboon Spider	protected	moderate-low
Ceratotherium simum	White Rhinoceros	protected	low
Circus ranivorus	African Marsh Harrier	protected	high
Connachaetus gnou	Black Wildebeest	protected	low
Crocuta crocuta	Spotted Hyaena	protected	low
Dromica species	Flightless Tiger Beetle species	protected	moderate-low
Felis nigripes	Black-footed Cat	protected	low
Graphipterus assimilis	Velvet Ground Beetle	protected	moderate-low
Harpactira gigas	Transvaal Banded Baboon Spider	protected	moderate-low
Hydrictis maculicollis	Spotted-necked Otter	protected	moderate-low
Leptailurus serval	Serval	protected	confirmed
Loxodonta africana	African Savanna Elephant	protected	low
Manticora species	Monster Tiger Beetle species	protected	moderate-low
Megacephala asperata	Tiger Beetle	protected	moderate-low
Megacephala regalis	Tiger Beetle	protected	moderate-low
Neotis denhami	Denham's Bustard	protected	moderate-high
Nigidius auriculatus	Stag Beetle	protected	moderate-low
Oonotus adspersus	Stag Beetle	protected	moderate-low
Oonotus interioris	Stag Beetle	protected	moderate-low
Oonotus rex	Stag Beetle	protected	moderate-low
Oonotus sericeus	Stag Beetle	protected	moderate-low
Parahyaena brunnea	Brown Hyaena	protected	high
Prosopocoilus petitclerci	Stag Beetle	protected	moderate-low
Prothyma guttipennis	Tiger Beetle	protected	moderate-low
Pterinochilus breyeri	Malelane Golden-brown Baboon Spider	protected	moderate-low
Pterinochilus nigrofulvus	Transvaal Golden Baboon Spider	protected	moderate-low
Raphicerus sharpei	Sharpe's Grysbok	protected	low
Redunca arundinum	Southern Reedbuck	protected	low

It is estimated that three of the eight species listed in **Table 6.5** are unlikely to occur in the study area (low) and 16 species moderately unlikely (moderate-low). Three species are considered at least moderately likely (moderate) and four species highly likely to occur in the study area (high).

Further detail can be obtained from the Biodiversity Specialist Report in **Appendix M**.

6.3.8 Avifauna

- ***Bird Micro Habitats***

It is important to understand the habitats available to birds at a smaller spatial scale, i.e. micro habitats. Micro habitats are shaped by factors other than vegetation, such as topography, land use, food sources and man-made factors. Investigation of this study area revealed the following bird micro habitats.

- *Arable and/or cultivated lands*

  Arable or cultivated lands (**Figure 6.13**) can represent significant feeding areas for many bird species in any landscape for the following reasons: through opening up the soil surface, land preparation makes many insects, seeds, bulbs and other food sources readily accessible to birds and other predators; the crop or pasture plants cultivated are also often eaten by birds, or attract insects which are in turn eaten by birds; during the dry season arable lands often represent the only green or attractive food sources in an otherwise dry landscape. Relevant bird species that may be attracted to these areas include most importantly the Blue Crane, Grey Crowned Crane, Southern Bald Ibis, Blue Korhaan and White Stork.

Figure 6.13: Agricultural lands**.**

- *Open Grasslands:*

  As can be seen from the earlier discussion regarding vegetation types, the major vegetation types present all fall within the greater Grasslands Biome. It was not surprising, therefore, that the most extensive bird micro habitat available on this site, is that of Grassland (**Figure 6.14**). Grasslands represent a significant foraging and/or hunting area for many bird species. Grassland may attract the Blue Crane, Grey Crowned Crane, Southern Bald Ibis, Blue Korhaan, White-bellied Korhaan, Secretarybird, Denham's Bustard, Black-winged Pratincole, and White Stork, although most of these species would tend to avoid grassland patches in close proximity to human disturbance. Pristine patches of grassland, near to water, may provide breeding habitat for the African Grass Owl. The grassland patches are also a favourite foraging area for game birds such as francolins and Helmeted Guineafowl, as well as being hunting habitat for raptors such as African Marsh Harrier, Lanner Falcon, Lesser Kestrel, Amur Falcon and Black-shouldered kite. Important to this study is that two sensitive species, Rudd's Lark (Critically Endangered) and Botha's Lark (Endangered), have been recorded in the quarter degree squares (SABAP1 data) examined and both species are grassland species (**Figures 6.15 and 6.16**).

Figure 6.14: Relatively undisturbed grassland observed in the broader study area.

Figure 6.15: The Critically Endangered Rudd's Lark

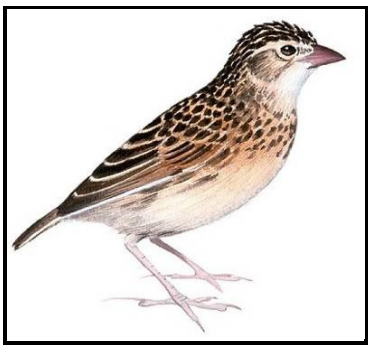

Figure 6.16: The Endangered Botha's Lark

- *Dams:*

  Dams have become important attractants to various bird species in the South African landscape. Various waterfowl, such as Spur-winged geese, Egyptian geese, and numerous duck species, may frequent these areas and are vulnerable to collision with power lines, where the dams are in close proximity or on-route to dams. More importantly, Blue Cranes use dams to roost in communally, and Flamingos may use these areas as stop over points while moving between larger water bodies. Various Storks may also frequent these water bodies. Numerous dams were observed in the study area, of varying sizes, and varying importance to avifauna. A pair of Blue Cranes as well as a flock of 40 Greater Flamingos were observed at a particular dam (270 06' 05.8"S 290 41' 33.1" E) in the study area during the site visit (**Figure 6.17**).

Figure 6.17: A dam in the study area where both Greater Flamingos and Blue Cranes were observed.

- *Wetlands and Rivers or drainage lines:*
  Wetlands and rivers can be very attractive micro habitats for birds as well as habitats for water birds etc. In this area species such as Greater Flamingo, Lesser Flamingo, Yellow-billed Stork and Caspian Tern are attracted to water. The Blue Crane and Grey-Crowned Crane are also known to occur near vleis, pans and inland water sources. Non Red Data species may also occur in these areas for example herons.

  Rivers in their true form represent an important habitat for many species, including Black Stork and a variety of other water birds, while the wooded riparian habitat along a river may provide habitat for various species such as the Hamerkop, African Darter, various cormorants, kingfishers, bee-eaters, robin-chats and numerous smaller species.

  Small rivers are represented in the study area by the Geelklipspruit, Witbankspruit and Skulpspruit. Numerous smaller drainage lines, some of which do not always carry water are also present in the broader area. Drainage lines, as well as all of the Rivers/"Spruite" discussed above, may serve as flight paths for several bird species.

- *Stands of Alien vegetation:*
  Patches of alien trees were observed throughout the study area, often associated with a farm stead, or along farm roads (**Figure 6.18**). These areas will mostly be important to physically smaller bird species. These also provide perching, roosting and nesting

habitats for various raptor species and larger birds such as francolins, Guineafowl, Herons and Hadeda Ibises.

Figure 6.18: A stand of Alien Trees associated with a farm access road in the study area.

- ***Relevant bird populations***

The relevant bird populations that have been reported by the South African Bird Atlas Project (1 and 2) (SABAP) can be found below in **Tables 6.6** and **6.7**. In addition the preferred habitat as well as likelihood of occurrence can be seen in the last two columns of **Table 6.6**. Report rates are essentially an expression of the number of times a species was recorded in a either a pentad or a quarter degree square, as a percentage of the number of times that square was counted. A report rate of 0 means that the species was recorded in the square, but at a very low frequency. It is important to note that these species could have been recorded anywhere in the square, and not necessarily in the exact study area.

SABAP 2 data for the pentads (2705_2940 and 2705_2945) in the study area was examined, and in general the area is poorly counted. Pentads 2700_2945, 2700_2940 and 2700_2950 were also considered due to their close proximity to the site. **Table 6.6** below shows report rates, based on the number of cards submitted, for the Red Data species identified during SABAP2 counts. Interestingly, of the 17 red listed species identified in the SABAP 1 data, only 7 species have again been recorded in the SABAP 2 data for the pentads examined. This however, does not necessarily mean that these species do not occur here, or that they have moved from the area, post SABAP1, but may merely be due to the low counting effort

of the pentads or selective micro habitat counting by the SABAP2 field counters. White Stork, protected through the Bonn Convention, was recorded in both data sets. Rudd's Lark was not recorded in the pentads examined, while Botha's Lark was recorded in one of the five pentads, with only one record from that pentad (which in fact does not incorporate the site). Blue Korhaan was recorded in four pentads, and was observed in the area during the site visit.

Table 6.6: Red Data species report rates for the two quarter degree squares which cover the study area-SABAP 1 (Harrison et al, 1997)

Species	Cons. status	Report rate (%)		Preferred Habitat	Likelihood of occurrence
QDGS		**2729BA**	**2729BB**		
Number of cards submitted		*42*	*62*		
Total Species		*165*	*162*		
Rudd's Lark	CR		5	High altitude, dense, montane grassland on ridges	Unlikely
Botha's Lark	EN		6	Heavily grazed upland grasslands	Possible
African Marsh Harrier	VU	10	5	Wetlands; Grasslands; Cultivated lands	Likely
Lesser Kestrel	VU	2	3	Open grasslands	Possible
Blue Crane	VU	2	13	Grasslands; Cultivated lands; Shrublands	Highly Likely
Grey Crowned Crane	VU	2	3	Vleis; Wetlands; Moist Grassland; Cultivated lands	Possible
Southern Bald Ibis	VU	14	24	High altitude Grasslands; Pastures and Cultivated lands	Highly Likely
White-bellied Korhaan	VU	2	2	Open Grasslands	Possible
Denham's Bustard	VU		2	Grasslands; Pastures; Karoo Shrublands	Unlikely
Yellow-billed Stork	NT	5		Rivers; Pans; Dams	Possible
Secretary Bird	NT	2	5		Possible
Greater Flamingo	NT	7	3	Large, shallow bodies of Saline and brackish water	Highly Likely
Lesser Flamingo	NT	2		Large inland and coastal saline water bodies.	Possible

Black-winged Pratincole	NT	2	3	Open Grassland	Possible
Lanner Falcon	NT		3	Grasslands; Open Savannah	Possible
Blue Korhaan	NT	21	52	Open Grasslands; Cultivated lands	Highly Likely
Caspian Tern	NT	2		Large inland Waterbodies; Estuaries	Possible
White Stork	Bonn	7	6	Grasslands; Pastures; Cultivated lands; Karoo	Likely

CR = Critically Endangered; EN = Endangered; VU = Vulnerable; NT = Near-threatened; Bonn = Protected Internationally under the Bonn Convention on Migratory Species.

Table 6.7: Report rates from Southern African Bird Atlas Project 2 (SABAP2) as of 11/06/2013.

Species	**Cons. status**	**Pentad Report Rate (%)**				
		2705_2945	2705_2940	2700_2945	2700_2940	2700_2950
No Cards		*2*	*2*	*3*	*1*	*5*
Total Species		*68*	*51*	*70*	*35*	*82*
Botha's Lark	EN	-	-	33.3	-	-
Lesser Kestrel	VU	50	-	-	100	-
Southern Bald Ibis	VU	-	-	-	-	20
Blue Crane	VU	-	-	-	-	20
Secretarybird	NT	50	-	-	incidental	-
Blue Korhaan	NT	50	50	100	-	60
White Stork	Bonn	-	-	33.3	-	20

CR = Critically Endangered; EN = Endangered; VU = Vulnerable; NT = Near-threatened; Bonn = Protected Internationally under the Bonn Convention on Migratory Species.

Further detail can be obtained from the Avifauna Specialist Report in **Appendix J**.

6.3.9 Surface Water

As mentioned the study area encompasses a 12 km radius around the current infrastructure, and falls over five quaternary catchments in the Upper Vaal Water Management Area (WMA) with the Majuba Power Station located in C11J (**Figure 6.19**). The study area in relation to the National Freshwater Ecosystem Priority Areas (NFEPA) and the Mpumalanga Biodiversity Conservation Plan are provided in **Figure 6.20** and **Figure 6.21**. Portions of the study area

are located in a Freshwater Ecosystem Priority Area (FEPA) and these systems were identified as being in a good condition (NFEPA – Nel et al., 2011) and therefore need to be maintained in order to contribute to the biodiversity of the area (**Figure 6.20**). The remainder of the study area is located in an Upstream Management Area. Anthropogenic activities taking place in these areas need to be monitored in order to prevent the degradation of FEPAs and Fish Support Areas located downstream (**Figure 6.20**). According to the MBCP (Ferrrar & Lötter, 2007) the study area is located in an "Ecosystem Maintenance" sub-catchment (**Figure 6.21**).

The characterisation of the rivers located within the study area (12 km radius) showed that with the exception of the Skulpspruit (order two river) all of the remaining associated systems are order one rivers/streams The Witbankspruit (running along the eastern boundary of the Majuba Power Station), Skulpspruit and the Markgraafspruit are all perennial with the remainder of the systems being classed as non-perennial (**Figure 6.20**; **Table 6.8**). Numerous smaller streams are shown in the 1:50 000 river coverage (**Figure 6.20**). Non perennial rivers located in drier climates hold different characteristics to those located in wetter climates and function differently to their perennial counterparts (Rossouw et al., 2005). They therefore require focused attention with regards to ecosystem management.

The tributary of the Witbankspruit as indicated in **Figure 6.20** will be affected by the proposed continuation of ashing. The aquatic ecosystems in the immediate vicinity include:

- A pan to the south of the existing ashing activity (**Figure 6.19**);
- The tributary of the Witbankspruit which is a valley bottom system to the east of the current ash disposal facility footprint (running south to north) (**Figure 6.19**);
- A tributary of the Witbankspruit to the west of the existing ash disposal facility;
- Various zero order tributaries of the aforementioned system; and
- Visually observed seeps.

Figure 6.19: Photographs taken during the screening/scoping survey: facing south towards the pan and channelled valley bottom system (A); facing north at the existing ash disposal facility on the 35 year ashing line (B); facing east toward a dam and the Majuba Power station (C); and facing southeast at the tributary of the Witbankspruit.

Six attributes were used to obtain the Present Ecological State (PES) on desktop quaternary catchment level by the National Spatial Biodiversity Assessment (NSBA - Nel et al., 2004). These attributes predominantly refer to habitat integrity of instream and riparian habitat. The surrounding catchments are affected by agricultural activities, waste water treatment works, infrastructural development in the form of power stations and mines.

According to the NSBA (Nel et al., 2004) and DWAF (2007) with the exception of the Wolwespruit, all the associated systems fall in a **C** ecological category, indicating a moderately modified ecosystem state (**Table 6.8**). The Wolwespruit, however, classed in an **E-F** ecological category, indicating that this system is critically modified and is in an unacceptable state. The Ecological Importance and Sensitivity (EIS - DWAF, 2007) of all the associated catchments are considered moderately sensitive due to the expected presence of flow intolerant (*Labeobarbus aeneus* & *Labeobarbus kimberleyensis*) and unique /

endemic (*Labeo capensis* & *Austroglanis sclateri*) fish species, and the system's sensitivity to changes in flow and water quality.

The systems in the immediate area have "Highveld 3" river signatures, which Nel et al. (2004) assigns a status of critically endangered (**Table 6.8**). The ascribed river status indicates a limited amount of intact river systems carrying the same heterogeneity signatures nationally. This implies a severe loss in aquatic ecological functioning and aquatic diversity in similar river signatures on a national scale (Nel et al., 2004).

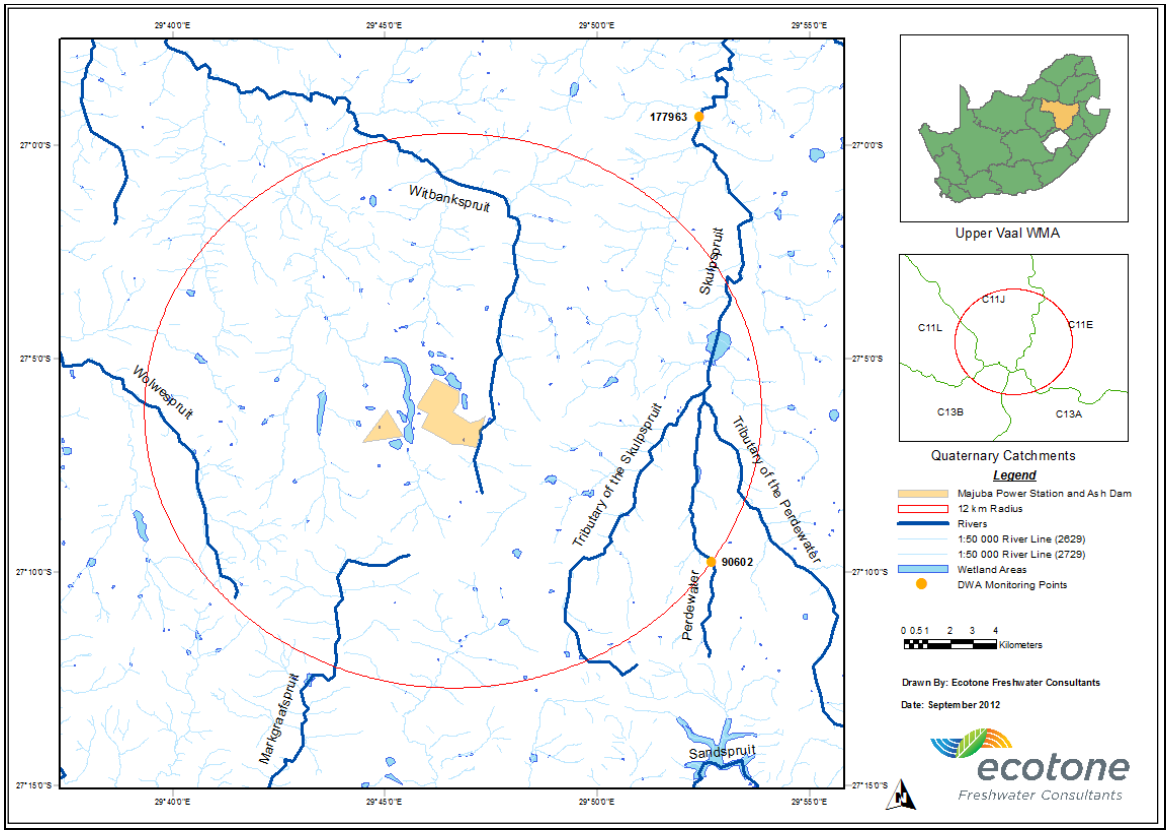

Figure 6.20: Map indicating the 12 km radius study area and DWA monitoring points associated with the proposed continuation of Majuba ashing activities (Nel et al., 2004; Chief Directorate – Surveys and Mapping, 2629 and 2729; SANBI, 2010).

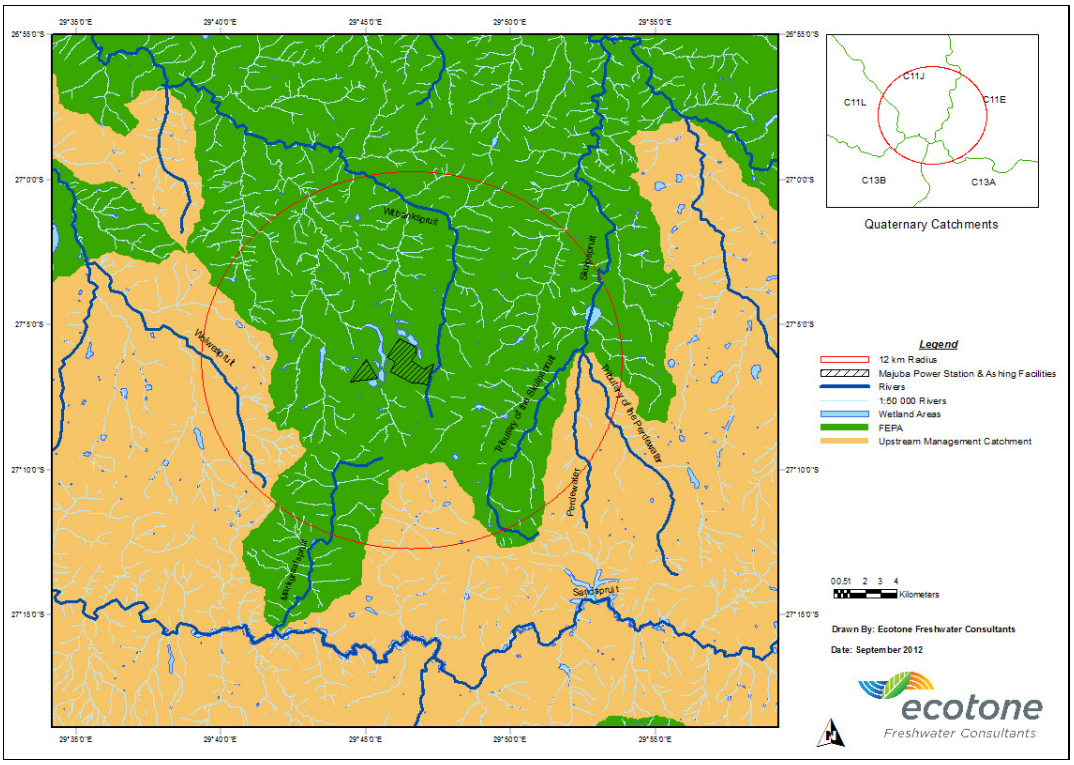

Figure 6.21: Map indicating the study area in relation to the NFEPAs (Nel et al., 2004; SANBI, 2010; Nel et al., 2011).

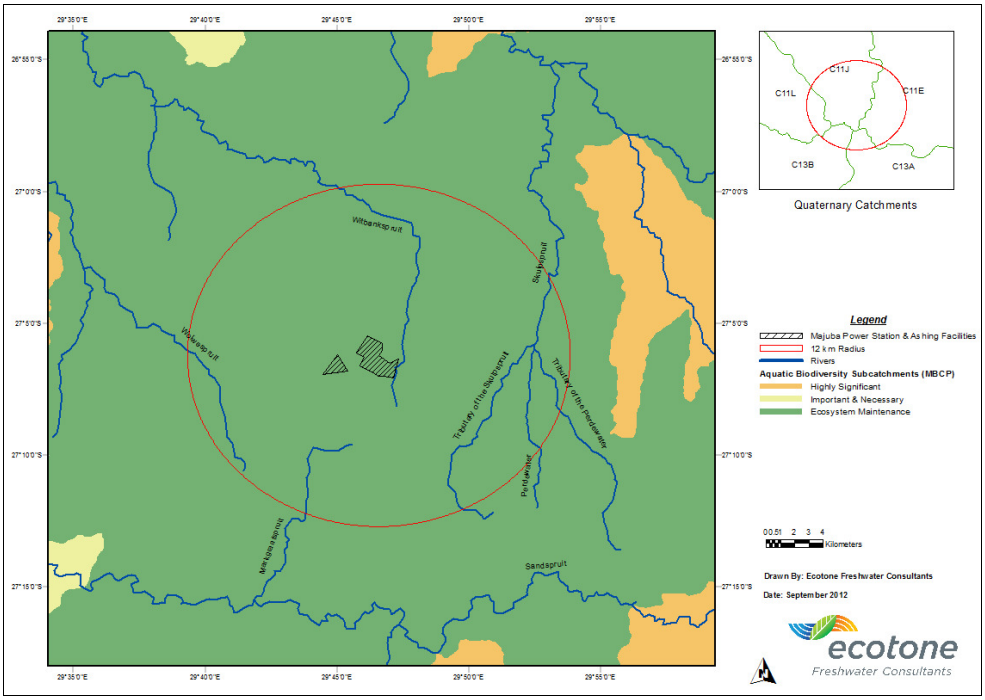

Figure 6.22: Map indicating the study area in relation to the MBCP (Nel et al., 2004; Ferrrar & Lötter, 2007).

Table 6.8: Characterisation of the system associated with the study area.

River name	Perde-water	Tributary of Perdewater	Skulp-spruit	Tributary of Skultspruit	Witbank-spruit	Wolve-spruit	Markgraaf-spruit
River Order	1	1	2	1	1	1	1
Hydrological Class	-	Non-perennial	Perennial	Non-perennial	Perennial	Non-perennial	Perennial
River Signature	Highveld3						
Conservation status	Critically Endangered						
PES (Nel et al., 2004)	C	C	C	C	C	E-F	C
Aquatic Ecoregion	Highveld						
Water Management Area	Upper Vaal						
Quaternary catchment	C11E	C11E	C11E	C11E	C11J	C11L	C13B
PES (DWAF, 2007)	C	C	C	C	C	E-F*	C
EIS (DWAF, 2007)	Moderate						
PES: Present Ecological State; EIS: Ecological Importance and Sensitivity; DWAF, 2000							

- ***Catchment Drivers of Ecological Change***

The study area falls within the Upper Vaal Water Management Area (WMA) which includes the Vaal, Klip, Wilge, Liebenbergsvlei and Mooi Rivers. It covers a catchment area of 55 565 km^2 and includes the Vaal Dam, Grootdraai Dam and Sterkfontein Dam (DWAF, 2004). The Upper Vaal WMA is the most populous WMA in South Africa, with more than 80 % of the population residing in the area downstream of the Vaal Dam, and approximately 97 % living in an urban environment. Land use in the WMA is dominated by cultivated dry land agriculture with the main crops being maize and wheat. About 75 % of the irrigation is upstream of major storage dams and is supplied from rivers or farm dams DWAF, 2004).

The majority of the water requirements of the WMA are for the urban, industrial and mining sectors (77 %), with 11 % for irrigation, 8 % for power generation and the remaining 4 % for rural water supplies. The Upper Vaal WMA is subdivided into three sub-areas, with the study area located in the "upstream of the Vaal Dam" sub-area. Geographically, over 73 % of the total requirements for water are in the sub-area "downstream of the Vaal Dam" and

nearly 20 % in the sub-area upstream of the Vaal Dam. Most of the irrigation in the WMA is in the sub-area downstream of the Vaal Dam (DWAF, 2004). The available water and total requirements for the year 2000, including transfers between WMAs is shown in **Table 6.10**.

Table 6.9: Reconciliation of requirements and available water for the year 2000 (million m^3/a) without yield of Mohale Dam (DWAF, 2004)

Sub-area	MAR	Local yield	Transfers in	Transfers out	Local requirement	Deficit
Wilge	868	59	0	0	60	-1
US of Vaal Dam	1109	184	118	67	216	19
DS of Vaal Dam	446	889	1224	1343	769	1
MAR: Natural Mean Annual Run-off; US: Upstream, DS: Downstream						

The majority of the water requirements in the sub-area upstream of Vaal Dam are for mining and bulk industrial use, with a considerable portion allocated for urban use and power generation (DWAF, 2004). The expected future growth in the petro-chemical industry and the increasing need of power generation in the region are putting pressure on the water requirements of the sub-area at present.

- ***Historical Water Quality***

Historical water quality data was obtained from DWA water monitoring points located on the Perdewater and Skulpspruit (**Figure 6.20**):

- Upstream of the Majuba Power Station at DWA gauging station C11_90606 on the Perdewater, upstream of the confluence with the Skulpspruit.
- Downstream of the Majuba Power Station at DWA gauging station C11_177963, downstream of the Amersfoort Waste Water Treatment Works.

These monitoring stations provide minimum, maximum, median and 90th percentile values for the variables measured between the period of 1996 and 2007 (**Table 6.10**). The monitoring points are located Upstream (Perdewater – 90602) and downstream (Skulpspruit – 177963) of the study area. The monitoring point located on the Perdewater showed better water quality when compared to monitoring point located downstream on the Skulpspruit. Despite the pH values falling above CEV, the remainder of the values were within the TWQRs and benchmark criteria (DWAF, 1996; Kotze, 2002).

The Skulpspruit (downstream) reflected poor water quality with all the variables measured being considerably higher than the values obtained at the Perdewater weir (**Table 6.10**). Na, Cl, SO_4 and NH_4(N) values were all within the tolerable range while the electrical conductivity fell within the intolerable range (Kotze, 2002). The NO_3(N) and PO_4(P) values were considerably higher when compared to Perdewater, indicating severe organic enrichment, most likely as a result of effluent from the Amersfoort Waste Water Treatment Works.

Table 6.10: DWA 90th percentile water quality values for monitoring stations located on the Perdewater and Skulpsruit systems

Variable	Abb	Unit	C11_90602			C11_177963		
			Perdewater			Skulpspruit		
			Min	90th percentile		Min	90th percentile	
			Max	Median		Max	Median	
Position in relation to the Majuba Power Station			Upstream			Downstream		
Flow		**m3s**	4.1	3.0		No data		
			0	0	n=6604			
pH		**H¹+ ions**	9.73	8.74		8.8	7.9	
			6.85	7.88	n=90	6.4	7.5	n=61
Electrical Conductivity	**EC**	**mS-m⁻¹**	29.5	13.3		137	115	
			7.8	11.51	6.4	35	97	n=61
Total Dissolved Solids	**TDS**	**ppm**	223	94.24		No data		
			56.88	85.0	n=88			
Calcium	**Ca**	**mg/l**	33.03	12.6		60.3	44.22	
			5.759	8.16	n=90	13.4	28.2	n=39
Magnesium	**Mg**	**mg/l**	13.06	5.53		42.8	32.97	
			0.75	4.6	n=90	4.6	18.3	n=39
Potassium	**K**	**mg/l**	3.12	1.73		26.1	26.02	
			0.592	1.24	n=89	25.7	25.9	n=2
Sodium	**Na**	**mg/l**	13.79	6.03		110	83.74	
			1.0	5.2	n=89	9.8	62.3	n=23
TAlkilinity	**Tal**	**mg/l**	120.0	45.3		494	423	
			23.85	40.53	n=90	141	318	n=2
Chloride	**Cl**	**mg/l**	10.52	6.65		101	84.6	
			2.0	5.0	n=90	15.0	63.5	n=52
Fluoride	**F**	**mg/l**	0.23	0.18		0.6	0.4	
			0.05	0.13	n=88	0.05	0.2	n=34
Silica	**Si**	**mg/l**	11.06	6.16		No data		

Variable	Abb	Unit	C11_90602			C11_177963		
			Perdewater			Skulpspruit		
			Min	90th percentile		Min	90th percentile	
			Max	Median		Max	Median	
Position in relation to the Majuba Power Station			Upstream			Downstream		
			0.57	5.18	n=90			
Sulphate	**SO4**	**mg/l**	44.6	14.4		130.0	98	
			2.0	10.9	n=90	29.0	67	n=40
Ammonium	**NH4(N)**	**mg/l**	0.1	0.06		75.0	58.56	
			0.015	0.02	n=90	0.05	36.2	n=61
Nitrate	**NO3(N)**	**mg/l**	1.14	0.29		31.2	18.87	
			0.005	0.2	n=90	0.05	0.3	n=61
Phosphate	**PO4(P)**	**mg/l**	0.1	0.03		17.4	14.5	
			0.003	0.02	n=	0.05	8.6	n=60

- ***Expected Macroinvertebrate Species***

A list of macroinvertebrates expected to occur in the study area or indicating the possibility of occurrence was determined for the major drainage lines (**Table 6.11; Figure 6.23**). Each taxon was allocated a rating score of either 1, 3 or 5: a rating of 5 indicates that the specific taxon has been sampled within that sub-quaternary (SQ) reach and is likely to be sampled; a rating of 3 indicates that the taxon has not been sampled in the SQ reach but has been sampled in a similar SQ reach and the probability of occurrence has been extrapolated; a rating of 1 indicates that the taxon has not been sampled in the SQ reach or any other similar SQ reach but is thought to be potentially present taking into account the available habitat, water quality and associated land use activities. The majority of expected macroinvertebrates are of low to moderate sensitivity, scoring between 3 and 8 (Gerber & Gabriel, 2002). A total of five relatively sensitive taxa are expected to occur within the study area, namely Heptageniidae, Athericidae, Dixidae, Leptophlebiidae and Tricorythidae. Sensitivity scores of these taxa ranged between 9 and 13 (Gerber & Gabriel, 2002) representing taxa that are moderately to highly intolerant to alterations in water quality (pollution).

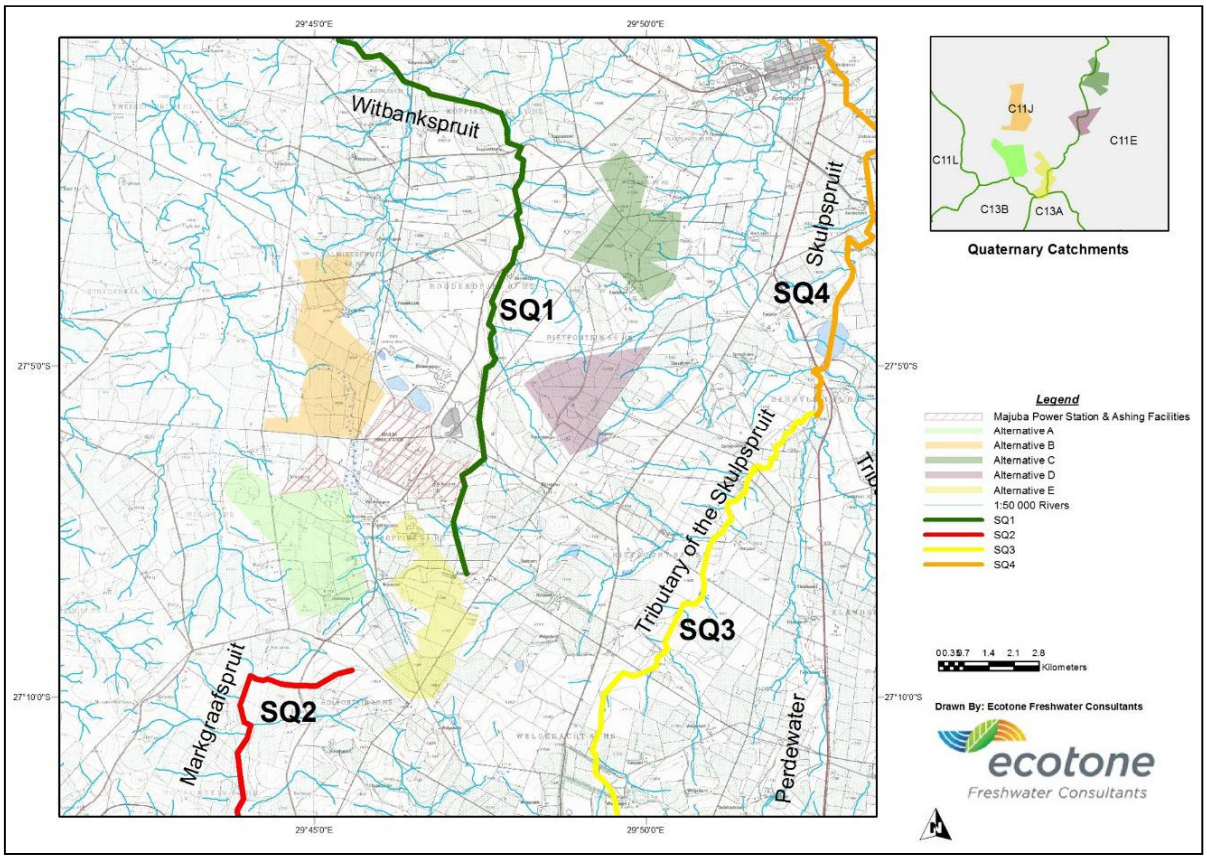

Figure 6.23: Sub-quaternary catchments related to the expected macroinvertebrate species lists (Chief Directorate – Surveys and Mapping, 2629 and 2729; Pers. Comm. Mrs. Christa Thirion, 2012)

Table 6.11: Macroinvertebrate species expected to occur, or indicating the possibility of occurrence, in the different sub-quaternary reaches located within the study area. Taxa in red are considered sensitive taxa

ID		A	B	C	D	E	F	G	H
	SS	Perdewater	Tributary of the Perdewater	-	Skulpspruit	Tributary of the Skulpspruit	Witbank-spruit	Wolwespruit	Markgraaff-spruit
Porifera	5				5				
Turbellaria	3	1	1	1	5	1	1	1	1
Oligochaeta	1	1	1	1	5	1	1	1	1
Hirudinea	3	1	1	1	1	1	1	1	1
Potamonautidae	3	1	1	1	5	1	1	1	1
Atyidae	8	1	1	1	5	1	1	1	1
Hydracarina	8	1	1	1	5	1	1	1	1
Baetidae > 2 Sp	12	1	1	1	5	1	1	1	1
Caenidae	6	1	1	1	5	1	1	1	1
Heptageniidae	13							1	
Leptophlebiidae	9	1	1	1	5	1	1	1	1
Tricorythidae	9				5				
Coenagrionidae	4	1	1	1	5	1	1	1	1
Lestidae	8				5				
Aeshnidae	8	1	1	1	1	1	1	1	1
Gomphidae	6	1	1	1	5	1	1	1	1
Libellulidae	4	1	1	1	5	1	1	1	1
Belostomatidae	3	1	1	1	1	1	1	1	1

ID		A	B	C	D	E	F	G	H
	SS	Perdewater	Tributary of the Perdewater	-	Skulpspruit	Tributary of the Skulpspruit	Witbank-spruit	Wolwespruit	Markgraaff-spruit
Corixidae	3	1	1	1	5	1	1	1	1
Gerridae	5	1	1	1	1	1	1	1	1
Hydrometridae	6	1	1	1	1	1	1	1	1
Naucoridae	7	1	1	1	1	1	1	1	1
Nepidae	3	1	1	1	1	1	1	1	1
Notonectidae	3	1	1	1	5	1	1	1	1
Pleidae	4	1	1	1	1	1	1	1	1
Veliidae/Mesoveliidae	5	1	1	1	5	1	1	1	1
Ecnomidae	8								1
Hydropsychidae 1 Sp	4	1	1	1		1	1	1	1
Hydropsychidae > 2 Sp	12				5				
Hydroptilidae	6	1	1	1	1	1	1	1	1
Leptoceridae	6	1	1	1	1	1	1	1	1
Dytiscidae	5	1	1	1	5	1	1	1	1
Elmidae/Dryopidae	8	1	1	1	1	1	1	1	
Gyrinidae	5	1	1	1	5	1	1	1	1
Haliplidae	5				5				
Hydraenidae	8				5				
Hydrophilidae	5	1	1	1	5	1	1	1	1
Athericidae	10								1
Ceratopogonidae	5	1	1	1	5	1	1	1	1

ID		A	B	C	D	E	F	G	H
	SS	**Perdewater**	**Tributary of the Perdewater**	**-**	**Skulpspruit**	**Tributary of the Skulpspruit**	**Witbank-spruit**	**Wolwespruit**	**Markgraaff-spruit**
Chironomidae	2	1	1	1	5	1	1	1	1
Culicidae	1	1	1	1	1	1	1	1	1
Dixidae	10								1
Muscidae	1	1	1	1	1	1	1	1	1
Simuliidae	5	1	1	1	5	1	1	1	1
Tabanidae	5	1	1	1	1	1	1	1	1
Tipulidae	5								1
Ancylidae	6	1	1	1	5	1	1	1	1
Lymnaeidae	3								1
Physidae	3	1	1	1	1	1	1	1	1
Planorbinae	3	1	1	1	1	1	1	1	1
Corbiculidae	5	1	1	1	5	1	1	1	1
Sphaeriidae	3	1	1	1	1	1	1	1	1
SS = Sensitivity Score (Dickens & Graham, 2001)									

- ***Expected Fish Species***

A summary of the expected fish families, species and IUCN conservation status is provided in **Table 6.12**. The area of study provides potential refuge for four fish families represented by approximately 12 species, none of which have conservation status and are listed as Least Concern (LC) by the IUCN (2012). *Barbus neefi* and *Barbus pallidus* are expected to occur in the study area (IUCN, 2012) and both species are moderately intolerant to alterations in water quality, making them good indicators of ecosystem health.

Table 6.12: Fish species expected to occur, or indicating the possibility of occurrence, in the river systems associated with the study area

Family	Genus and Species	Common Name	IUCN Status
Austroglanididae	*Austroglanis sclateri*	Rock Catfish	LC
Clariidae	*Clarias gariepinus*	Sharptooth Catfish	LC
Cyprinidae	*Barbus anoplus*	Chubbyhead Barb	LC
Cyprinidae	*Barbus neefi*	Sidespot Barb	LC
Cyprinidae	*Barbus pallidus*	Goldie Barb	LC
Cyprinidae	*Barbus paludinosus*	Straightfin Barb	LC
Cyprinidae	*Cyprinus carpio*	Common Carp	EX
Cyprinidae	*Labeobarbus aeneus*	Smallmouth Yellowfish	LC
Cyprinidae	*Labeo capensis*	Orange River Labeo	LC
Cyprinidae	*Labeo umbratus*	Moggel	LC
Cichlidae	*Pseudocrenilabrus philander*	Southern Mouthbrooder	LC
Cichlidae	*Tilapia sparrmanii*	Banded Tilapia	LC
LC: Least Concern; EX: Exotic			

- ***Expected Odonata (dragonflies) Species***

Approximately 58 Odonata species are expected to occur in the study area. All of the 58 species are listed as LC according to the IUCN database (IUCN, 2012).

- ***Expected Mollusca (snails, limpets) Species***

A total of 10 mollusc species are expected to occur in the study area, of which 9 species are listed as LC. Only one species, namely *Burnupia caffra,* is listed as Data Deficient (DD) due to taxonomic uncertainty. *Burnupia caffra* are frequently unobserved during sampling

surveys due to their extremely small size (2 - 4 mm). The genus *Burnupia* needs taxonomic revision as the numbers of species are extremely uncertain (Appleton *et al*., 2010).

Further detail can be obtained from the Surface Water Specialist Report in **Appendix Q**.

6.3.10 Groundwater

Groundwater storage and transport in the unweathered Volksrust Formation is likely to be mainly via fractures, bedding planes, joints and other secondary discontinuities. The success of a water supply borehole in these rocks depends on whether one or more of these structures are intersected. In general the Volksrust Formation is considered to be a **minor aquifer**, with some abstractions of local importance. A minor aquifer is a moderately-yielding aquifer system of variable water quality. Although these aquifers seldom produce large quantities of water, they are important for local supplies and in supplying base flow to rivers. **Figure 6.24** Illustrates the hydrogeology of the study area.

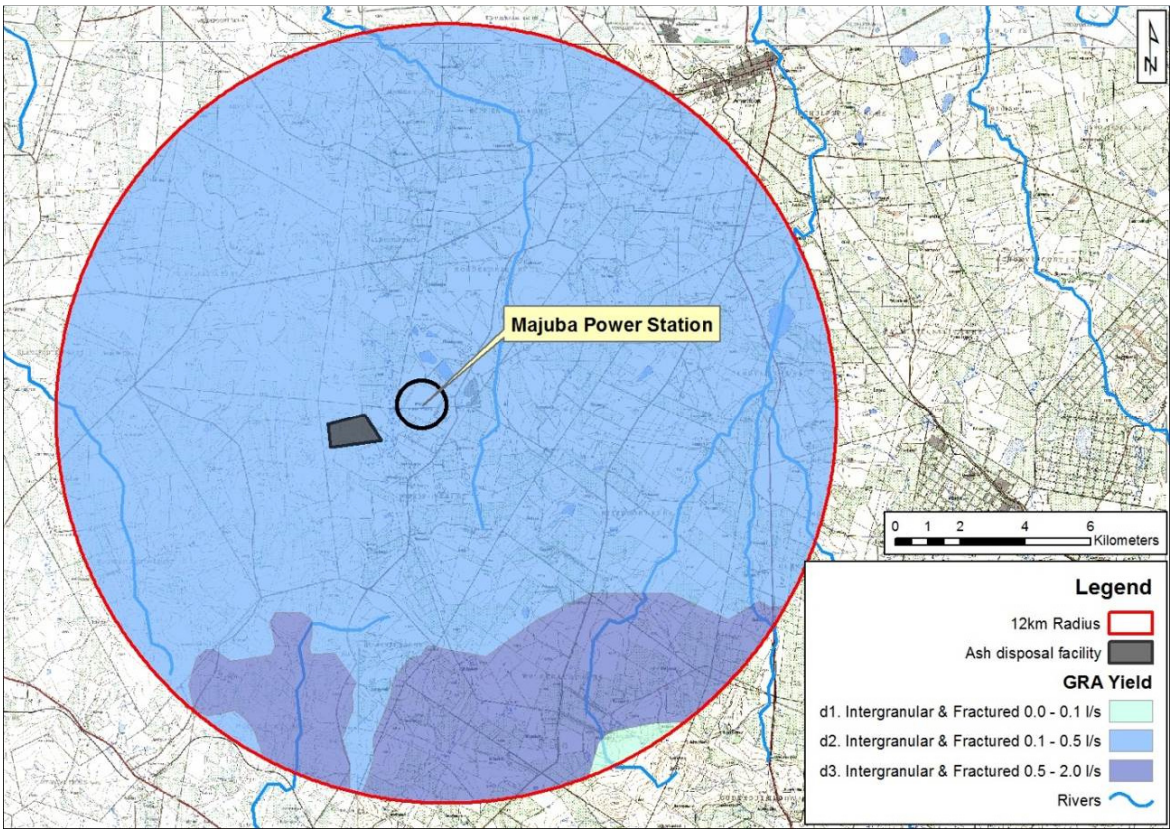

Figure 6.24: An overview of the hydrogeology of the study area**.**

Further detail can be obtained from the Groundwater Specialist Report in **Appendix N**.

6.3.11 Sites of Archaeological, Historical and Cultural Interest

The cultural landscape qualities of the study area essentially consist of a rural setup. In this setup the human occupation is made up of a pre-colonial element consisting of limited Stone Age occupation and a Late Iron Age occupation, as well as a much later colonial (farmer) component.

- ***Rural landscape***

The rural landscape has always been sparsely populated and it was only during the last couple of hundred years that people, through the application of specific economic strategies, succeeded to occupy a section of the region for any length of time.

- ***Archaeological sites***

Archaeological sites in this area predominantly date to the Late Iron Age, although some sites dating to the Stone Age are also found in the larger area.

Human occupation of the larger geographical region took place since Early Stone Age (ESA) times. This is evidenced by the scattered stone tools found in a secondary context (open surface material), where they have been exposed in gravel terraces by rivers and streams. Normally this material is viewed to have a low significance.

As this area was probably too cold and it does not have many rock shelters, occupation during Stone Age times remained low, resulting in very few sites dating to this period occurring in the area.

Iron Age people started to settle in southern Africa c. AD 300, with one of the oldest known sites at Silver Leaves, south east of Tzaneen dating to AD 270. However, Iron Age occupation of the eastern highveld area (including the study area) did not start much before the 1500s. Some sites dating to the Late Iron Age is known to exist to the north west of the study area.

As this was a period signified by high stress levels, people tended to settle in towns, usually located on hill tops for protection. The villages were laid out in complex manner and different areas were demarcated by stone walled enclosures.

- ***Farmsteads***

Farmsteads are complex features in the landscape, being made up of different yet interconnected elements. Typically these consist of a main house, gardens, outbuildings, sheds and barns, with some distance from the labourer housing and various cemeteries. In addition roads and tracks, stock pens and wind mills complete the setup. An impact on one element therefore impacts on the whole.

By the early 19th century white settlers took up farms. An investigation of the Title Deeds of most of the farms in the region indicates that they were surveyed as early as the 1860s, implying that they would have been occupied by colonists since then.

The town of Amersfoort was founded in 1876 and proclaimed in 1888. From its earliest days it was well-known for its wealthy farmer community (Praagh 1906; Raper 2004).

Many farmsteads and even houses in Amersfoort were destroyed during the Anglo Boer War. As a result most structures date to the period after that. The architecture of these farmsteads can be described as eclectic as they were built and added to as required over a period of time. In some cases outbuildings would be in the same style as the main house, if they date to the same period. However, they tend to vary considerably in style and materials used.

- ***Cemeteries***

Apart from the formal cemeteries that occur in municipal areas (towns or villages), a number of these cemeteries, some quite informal, i.e. without fencing, occur sporadically all over. Many also seem to have been forgotten, making it very difficult to trace the descendants in a case where the graves are to be relocated.

Most of these cemeteries, irrespective of the fact that they are for land owner or farm labourers (with a few exceptions where they were integrated), are family orientated. They therefore serve as important 'documents' linking people directly by name to the land.

- ***Infrastructure and industrial heritage***

In many cases this aspect of heritage is left out of surveys, largely due to the fact that it is taken for granted. However, the land and its resources could not be accessed and exploited

without the development of features such as roads, bridges, railway lines, electricity lines and telephone lines.

A variety of bridges, railway lines and other features that can be included in this category occur within the study area.

Further detail can be obtained from the Heritage Specialist Report in **Appendix O**.

6.3.12 Visual Aspects

A number of farms and homesteads occur throughout the study area, and in close proximity to the power station.

The visual character of the Majuba Power Station and its associated infrastructure is shaped by a unique combination of the following features:

- Grassland;
- An undulating topography with isolated koppies and ridges;
- Perennial and non-perennial streams and isolated dams;
- Cultivated land;
- Majuba Power Station and associated infrastructure (being a visually dominant feature in the area);
- Mining areas;
- Dispersed farmsteads, and
- Roads, including the N11 national road from Amersfoort to Volksrust, arterial routes (R23, R35) and a number of access roads to farms in the region.

The closest towns are Amersfoort and Perdekop, both of which are further than 12 km from the power station, situated beyond the zone of visual influence of the proposed continuous ash disposal facility.

The topography is an important form giving element of the landscape. On the one hand, it opens up vast panoramic views of the landscape, and on the other hand it creates visual barriers. The topography in the study area has a strong undulating character with hills and koppies south and east. This is significant in terms of the location of the proposed continuous ash disposal facility, since the topography will be the primary factor determining the visibility and level of exposure thereof. In this regard, the screening effect of hills in the south must be noted.

Visibility of an object is one of the primary attributes by which visual impact can be concluded. This is determined by a line of sight where nothing obscures the view of an object. Exposure is defined by the degree of visibility, in other words "how much" or "which part" of an object is visible to the observer. This is influenced by topography and the incidence of objects such as trees and buildings that obscure the view partially or in total. Visibility can be modelled by making use of a digital terrain model (DTM), created from contour data, and performing a viewshed analysis using GIS software. It must be noted that the viewshed analysis only accounts for topographical influences, and that the screening effect of vegetation is not included. This indicates a worst-case scenario, where the possibility of visual exposure is mapped, from which possible sensitive viewer locations can be identified.

In addition to viewshed analyses as described above, a proximity analysis is required to incorporate the effect of reduced visibility over distance. By integrating the two types of analyses, an index of possible visual impact is generated, as shown on the map in **Figure 6.25.**

The map indicates a core area of high visibility and a high degree of visual exposure within 3km from the ash dam. The continuous disposal of ash in a southern direction from the existing facility (i.e on the extended Alternative area A) is expected to impact on a number of sensitive receptors within 3km from the site. Permanent residents within this zone have been identified and requirements with regard to mitigation measures has been investigated.

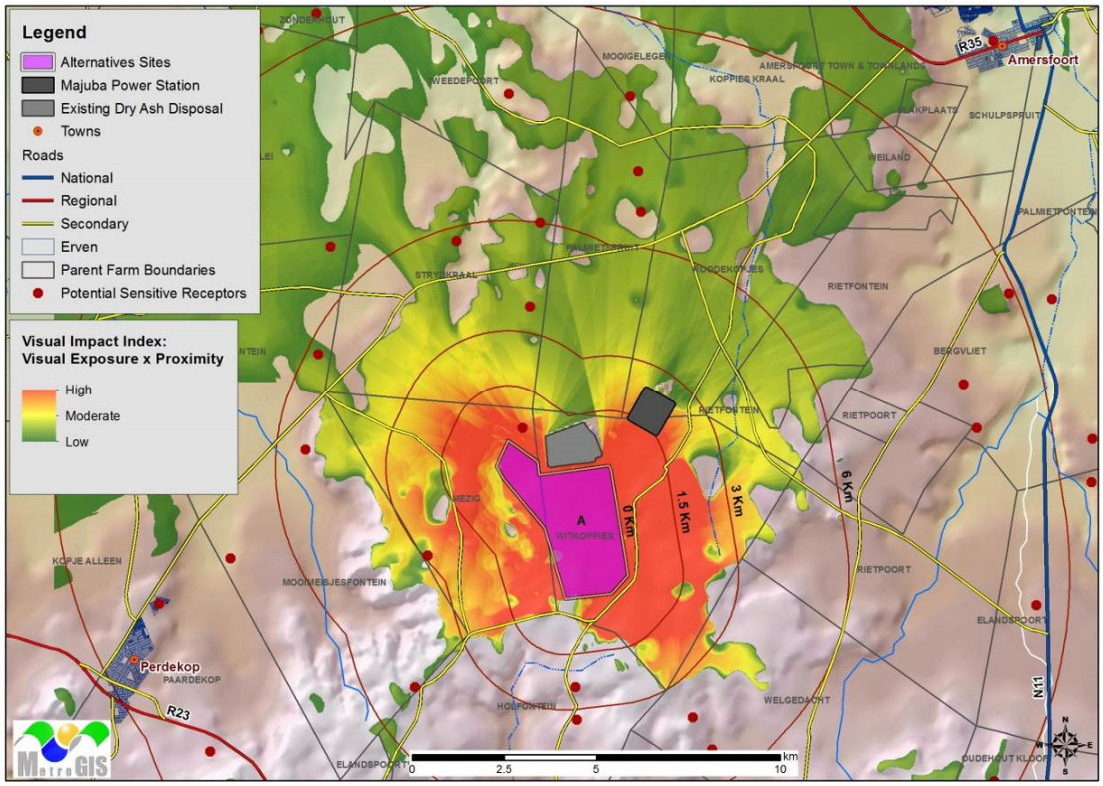

Figure 6.25: Visual exposure index for the proposed Alternative A

Further detail can be obtained from the Visual Impact Specialist Report in **Appendix S**.

6.3.13 Ambient Air Quality

Eskom manages an ambient air quality monitoring station near Majuba to assess impacts on air quality from Majuba Power Station and other pollution sources in the area (data provided with permission, for the current evaluation study, by Gerhardt de Beer, 2012-09-06). The monitoring station is located 3 km east-south-east of the power station and is equipped for continuous monitoring of ambient concentrations of sulphur dioxide (SO_2), nitrogen dioxide (NO_2), and fine particulate matter of particulate size <10 µm in diameter (PM_{10}). The average daily PM_{10} concentrations for the period January 2009 to June 2012 are presented in **Figure 6.26.**

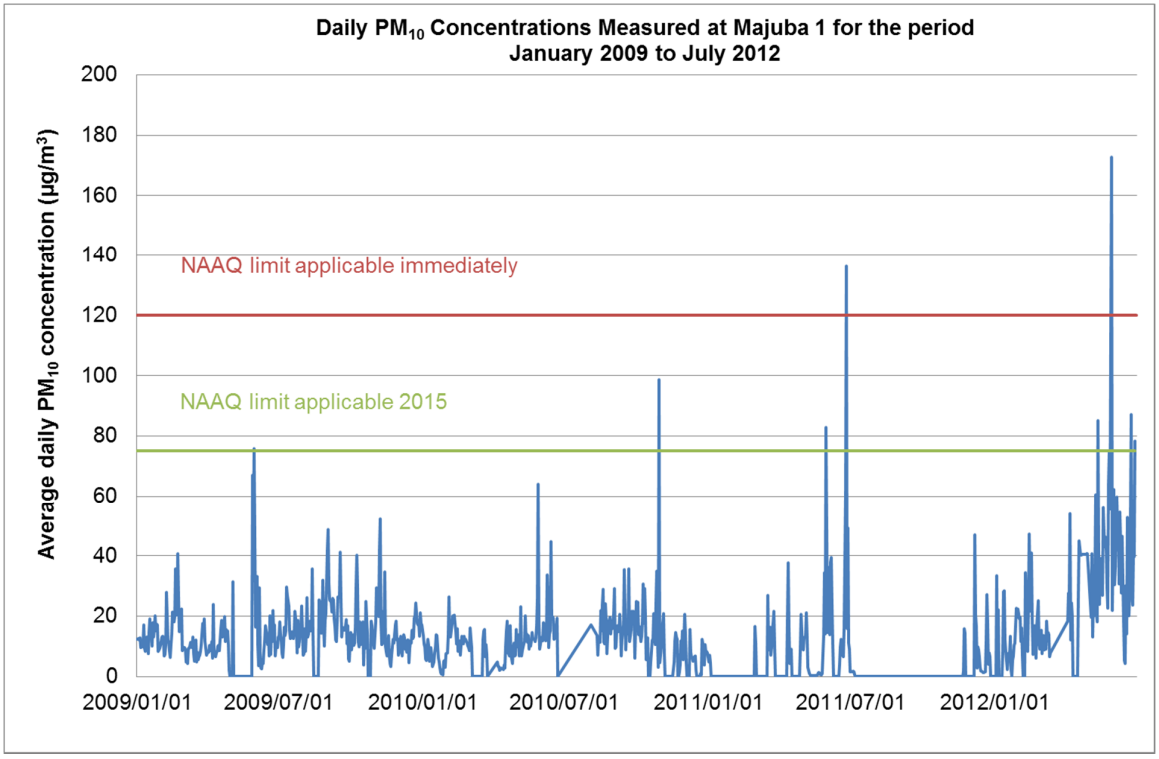

Figure 6.26: Daily measured PM_{10} ground level concentrations (µg/m³) at the Eskom Majuba 1 monitoring station (for the period January 2009 – June 2012)

The current National Ambient Air Quality limit value for PM_{10} daily concentrations (120 µg/m^3) was exceeded on two occasions during the period reported (once each in 2011 and 2012) (**Table 6.13**). The more stringent National Ambient Air Quality limit for PM10 daily concentrations effective from 1 January 2015 (75 µg/m^3) would have been exceeded once each in 2009 and 2010, and twice in 2011. In the first six months of 2012 the more stringent 75 µg/m^3 limit value was exceeded on six occasions resulting in non-compliance with the PM_{10} 2015 National Ambient Air Quality Standard (NAAQS), which allows for four daily limit value exceedances. The more stringent standard is mentioned because the operational phase of the proposed Majuba ash disposal facility will continue after the standard becomes enforceable.

Table 6.13: Measured daily ambient PM_{10} concentrations at Eskom's Majuba 1 monitoring station for the period 2009 to 2011

Monitoring Period	Data Availability (%)	Number of Exceedances of the NAAQ limit of 120 µg/m³ (applicable immediately)	Exceedance of the NAAQS (applicable immediately) (Y/N)	Number of Exceedances of the NAAQ limit of 75 µg/m³ (applicable 2015)	Exceedance of the NAAQS (applicable 2015) (Y/N)
2009	86	0	N	1	N
2010	82	0	N	1	N
2011	30	1	N	2	N

High ambient particulate concentrations have been found to coincide with low ambient temperatures and low rainfall (Burger, 1994). Increases in domestic coal burning and poor atmospheric dispersion potentials, together with persistent industrial emissions, combine to produce elevated ambient concentrations during winter months. High concentrations during summer months are usually associated with increases in fugitive dust emissions. Rainfall events result in a reduction of airborne concentrations due to reductions in the potential for fugitive dust emissions and due to the removal of particulates in the atmosphere by raindrops.

Further detail can be obtained from the Air Quality Specialist Report in **Appendix I**.

6.3.14 Social Environment

The town of Amersfoort was established in 1888 around a Dutch Reformed Church which was built in 1876. The area was first settled in 1876 when two farmers of the area donated land to the church, where Rev. Frans Lion Cachet proceeded to build a Dutch Reformed church. The new village was named after the hometown (in the Netherlands) of the Dutch farmers. When the area became too small for the growing village, more land was purchased from one of the original donors and the town was proclaimed in 1888. The bridge over the Vaal River was built in 1896 and is a national monument. The township of eZamokuhle lies adjacent to the town and contributes greatly to its economy.

The history of Volksrust began in 1888 when the Transvaal government decided to establish a town on the edge of the Drakensberg escarpment, on the border of Natal. A place was chosen near where the Boers won a decisive battle in first Anglo-Boer War (December 1880 – March 1881) to regain their independence from the British. Several farms were bought for

the purpose and named Volksrust (People's Rest) presumably by Dorie de Jager (sister of Dirk Uys) because the Transvaal forces rested there after the Battle of Majuba. Today the town is a commercial centre of which the main products are maize, wool, sorghum, sunflower seed, beef and dairy. The town is the junction for the main Johannesburg-Durban railway line with other towns in the eastern part of Mpumalanga.

Perdekop was established due to an equine sickness epidemic during the second Anglo-Boer war. The people realised that the higher altitude protected the animals from the epidemic and a settlement was established there due to the fact that it was a safe haven from the epidemic.

The socioeconomic analysis is specifically aimed at spatial related matters, i.e. demographics, employment and income and economic profile. The 2006 Demarcation Board Data have been utilised. It must be borne in mind that with the 2006 Municipal elections certain ward changes came about. In the case of Pixley Ka Seme Local Municipality an extra ward was created. The figures were appended by the Municipal Demarcation board in conjunction with Statistics South Africa.

- ***Demographics***

Table 6.14 below gives an indication of the different geographic areas within the Pixley Ka Seme Local Municipality as well as the wards within which these areas are situated. The number of households is also indicated.

Table 6.14: Ward Demographic areas and number of households

Demographic Area	Ward	Number of Households
Vukuzakhe	1-2	2600
Volksrust	3-4	3421
Wakkerstroom & eSizameleni	5	1832
Perdekop & Siyazenzela	6	2253
Amersfoort	7	1565
Ezamokuhle	8	1794
Daggakraal & Sinqobile	9-11	4946
TOTAL		**18 412**

- ***Population Estimates***

Population estimates for Pixley ka Seme Local Municipality are reflected in **Table 6.15** below and includes the total number of people.

Table 6.15: Population and Household Status Quo

	Formal Households 2006	Informal Households 2006	Traditional Household 2006	Population Census 2001	Population 2% growth 2001-2008
Pixley ka Seme LM	10 524	5 475	2 001	80 737	91 091

Table 6.16: Population Distribution per ward

Wards 2007	Black / African	Coloured	Indian / Asian	White	Total Persons
1	7 454	8	0	106	**7 568**
2	4 996	23	0	0	**5 019**
3	7 425	221	131	1 927	**9 704**
4	3 901	20	182	1 603	**5 706**
5	8 442	22	37	466	**8 967**
6	11 323	49	25	722	**12 119**
7	4 261	0	95	452	**4 808**
8	8 675	29	4	181	**8 882**
9	7 095	0	0	13	**7 100**
10	10 983	19	5	146	**11 153**
11	10 020	19	0	16	**10 055**
Total	**84 575**	**410**	**477**	**5 628**	**91 091**

Table 6.17: Population Size and Number of Households

	Population				Number of Households (HH)			HH Density (2007)
	1996	2001	2007	Annual Growth	1996	2001	2007	
Pixley ka Seme LM	71 653	77 565	91 091	**2.5%**	14 912	19 305	22 627	**4.03**
Gert Sibande DM	823 973	856 214	981 569	**1.7%**	179 534	228 256	258 798	**3.79**
Mpumalanga	3 143 918	3 442 199	3 680 733	**1.6%**	674 875	832 070	969 997	**3.79**
National	41 780 470	45 145 618	47 963 626	**1.3%**	9 370 586	11 364 451	13 043 694	**3.68**

- ***Level of Education***

The level of education for the population in the study area is reflected in **Table 6.18** below.

Table 6.18: Level of Education in Pixley Ka Seme Local Municipality

Level of Education	Pixley Ka Seme Local municipality	Gert Sibande District Municipality
None	11.97%	25.39%
Grade 0-2	10.49%	32.89%
Grade 3-6	9.87%	31.07%
Grade 7-9	8.70%	27.80%
Grade 10-11	7.21%	26.91%
Less than Grade 12	8.25% %	22.78
Grade 12 only	6.53%	24.92%
Certificate/Diploma	7.19%	24.54%
Bachelor's Degree	7.96%	24.02%
Postgraduate Degree	8.31%	25.22%

- Only 6,53% of the population has completed education up to the level of Grade 12 which is better than that of the district municipality.
- 97% of the population has no qualification (it is noted that infants and children less than 5 years are excluded from this figure) which is a better situation than that of the district municipality.
- Only 7.96% of the population has a bachelor's degree which is much lower than the percentage in the district municipality

- **Economic:**

o *Employment*

The analysis of employment levels in the study area are reflected as the economically active part of the population, the inactive part, the unemployed and the people living in poverty (total household monthly income < R 1 100-00).

The percentage of the economically active part of the total population for each year is also indicated in brackets and the same with the inactive part of the population. The unemployed part of the population and the people living in poverty is already included in the Inactive part of the population and therefore the percentage represents the percentage of the inactive population that is unemployed or living beneath the bread line.

Table 6.19: Employment within the Pixley ka Seme Local Municipality

Area	2005	2006	2007	2008
Economically active (% of population)	21 053 *(23.7%)*	21 314 *(23.6%)*	21 657 *(23.7%)*	22 455 *(24.4%)*
Inactive (% of population)	67 857 *(76.3%)*	68 835 *(76.4%)*	69 560 *(76.3%)*	69 755 *(75.6%)*
Unemployed (% of Inactive pop.)	5 053 *(24%)*	4 902 *(23%)*	4 981 *(23%)*	4 940 *(22%)*
People in poverty (% of population)	52 314 *(58.8%)*	49 805 *(55.3%)*	49 209 *(53.9%)*	47 811 *(51.9%)*
Total population	**88 910**	**90 149**	**91 216**	**92 210**

The information above indicates that an alarming number of the population is inactive and not contributing to the economy of the municipality. However, this figure also includes infants and scholars which cannot contribute to the economy.

- *Income*

The distribution of the income in the municipal area is another indication of growth for development. The levels of income under the bread line indicate the growth of poverty in the municipal area and ultimately make a difference in the provision of housing and other facilities.

A poor household can be defined as a household with no basic services or without a house (a home) and with a total household monthly income of less than R 1 100-00. The following table provides a breakdown of the monthly income groups in the municipal area for the year 2008 as defined by Global Insight Southern Africa.

Table 6.20: Monthly Income in Pixley ka Seme Local Municipality

Income Range	Households Global Insight 2008	%	
R 0-200	109	0.5%	**13.1%**
R 201- R 500	439	1.9%	
R 501- R 1 000	2 443	10.7%	
R 1001 – R 1 500	2 810	12.3%	**41%**
R 1 501 – R 3 500	6 571	28.7%	
R 3 501 – R 6 000	4 050	17.7%	
R 6 001 – R 11 000	2 646	11.6%	
R 11 001 – R 30 000	2 489	10.9%	

R 30 001 – R 50 000	767	3.4%
R 50 001 – R 100 000	414	1.8%
R 100 001 – R 200 000	127	0.6%
R 200 001 and more	30	0.1%
TOTAL	**22 895**	**100%**

The above table indicates that 13.1% of the households in Pixley Ka Isaka Seme Local Municipality fall within the income group earning less than R 1000-00 per month which can be considered as poor households that will qualify for grants and housing subsidies. A further 41% of the households earn between R 1000-00 and R 3 500-00 per month which can also be considered as a very low level of income and grants and subsidies will also apply to these households. Therefore a total of 54.1% of the households falls within the lower income group which indicates that more than half of the households in the municipal area are in need of government support in some or other way. It further indicates that more than half of the households will probably not be able to pay for basic services and needs to be subsidised by the remaining households who will be able to afford basic services the municipality provides.

- *GVA Contribution to the Local Economy*

The municipality has many different economic sectors that contribute to the economy of the area and the district and ultimately the province and the country. These sectors include agriculture, mining, manufacturing, electricity, construction, trade, transport, finance and community services.

The following table provides a summary of the different economic sectors that contributes towards the local economy.

Table 6.21: Economic sectors and contribution to the GVA of the municipality

Economic Sector	GVA added(R 1000)	Contribution to total
Agriculture	R 176 647	18.85%
Mining	R 8 656	0.92%
Manufacturing	R 14 176	1.51%
Electricity	R 100 610	10.74%
Construction	R 66 027	7.05%
Trade	R 152 990	16.33%
Transport	R 144 773	15.45%
Finance	R 106 148	11.33%
Community Services	R 167 009	17.82%
Total	**R 937 036**	**100%**

The results from the above table indicate that the agricultural sector contributes the most to the GVA of the municipal area with community services and trade as the second and third highest contributors. The transport, finance and electricity sectors contributes between 10% and 15% to the GVA of the municipal area with the mining sector contributing the least to the economy of the municipal area.