7 PROJECT ALTERNATIVES

7.1 Introduction

In terms of the EIA Regulations published in Government Notice R543 of 2 August 2010 in terms of Section 24 of the National Environmental Management Act (Act No. 107 of 1998), feasible and reasonable alternatives have to be considered within the Environmental Scoping Study, including the 'No Go' option. All identified, feasible and reasonable alternatives are required to be identified in terms of social, biophysical, economic and technical factors.

A key challenge of the EIA process is the consideration of alternatives[1]. Most guidelines use terms such as 'reasonable', 'practicable', 'feasible' or 'viable' to define the range of alternatives that should be considered. Essentially there are two types of alternatives:

- incrementally different (modifications) alternatives to the Project; and
- fundamentally (totally) different alternatives to the Project.

Fundamentally different alternatives are usually assessed at a strategic level, and EIA practitioners recognise the limitations of project-specific EIAs to address fundamentally different alternatives.

7.2 The 'no go' alternative

The 'no go' alternative is the option of not proceeding with the continuous ashing project at Majuba Power Station.

Eskom's core business is the generation, transmission and distribution of electricity throughout South Africa. Electricity by its nature cannot be stored and must be used as it is generated. Therefore electricity is generated according to supply-demand requirements. The reliable provision of electricity by Eskom is critical to industrial development and poverty alleviation in the country.

Ideally, Majuba Power Station, envisages the continuation of dry ash disposal. Prior to the promulgation of Environmental laws such as the Environment Conservation Act, Eskom purchase a portion of land which they envisaged for the disposal of ash for the life of the Station (at that stage 45 years). As part of its planning processes, Eskom developed designs which were approved internally. With the promulgation of the environmental laws such the National Environmental Management Waste Act, Act 59 of 2008, in particular,

[1] In terms of the EIA Regulations published in Government Notice R543 of 2 August 2010 in terms of Section 24 (5) of the National Environmental Management Act (Act No. 107 of 1998), the definition of "alternatives" in relation to a proposed activity, means different means of meeting the general purpose and requirements of the activity which may include alternatives to: (a) the property on which or location where it is proposed to undertake the activity; (b) the type of activity to be undertaken; (c) the design or layout of the activity; (d) the technology to be used in the activity; (e) the operational aspects of the activity and (f) the option of not implementing the activity.

Eskom would like to pro-actively align its continued ashing activities with the requirements of the waste licensing processes.

The need for this project is to allow the Majuba Power Station to continue ashing in an environmentally responsible and legally compliant manner for the duration of the remaining operating life of the power station.

In the event that the continuous ashing project does not proceed the power station will run out of land to legally dispose of its ash and the power station will ultimately be required to close down, which would contribute negatively to the provision of reliable base load power to the national grid.

Even though the 'no-go' alternative is considered to be unfeasible, it will still be investigated further in the EIA phase as an alternative as required by the EIA Regulations.

7.3 Technical Alternatives

The coal-fired power generation process results in large quantities of ash, which is disposed of at ash disposal facilities. Generally, Eskom has access to coal of a low grade (called middlings coal) which produces a larger mass of ash during combustion. Over time, the quality of the coal provided to Eskom has degraded, due to higher ash quantities in the coal. The Majuba Power Station utilises a dry ashing disposal method. This process involves ash being disposed of on an ash disposal facility by means of a stacker (**Figure 7.1**).

Figure 7.1: Stacker being used to dispose of ash at the Majuba Power Station

Due to the fact that Majuba Power Station utilises a dry ashing disposal method, it stands to reason that in order to continue ashing a dry ashing method should still be utilised.

In terms of alternative disposal options, the option of disposing of dry ash into old mine pits was identified. An old mine is located approximately 12km from the power station, however, the mine workings are underground and no open cast pit is available. Eskom has previously undertaken feasibility studies to compare the environmental risks associated with in-pit ashing and conventional ashing (i.e. dry ash disposal). Although the feasibility studies were undertaken in August 2007, specifically looking at ashing options for the Medupi Power Station in the Limpopo Province, it is felt that some of the conclusions made are still relevant to the Majuba situation. These risks are included in **Table 7.1**.

Table 7.1: Comparative Analysis on Risks (without mitigation) between in-pit and Conventional Ashing

Risk	In-Pit Option	Above-ground Ashing
Seepage	Seepage and groundwater contamination will occur	Operation is undertaken above the water table. New Legislation requires ash disposal facilities to be lined, therefore low risk of seepage and groundwater contamination
Groundwater inflow	There will be a greater groundwater in-flow into the pit area, but the water table will remain below the ash layer	No groundwater inflow would be expected into the ashing facility
Uncertainty around Life Cycle Costs	There is great uncertainty around the life cycle costing for in-pit options and in the Majuba situation; no studies have been done looking at disposal in underground workings	There is a greater degree of certainty in terms of what the life cycle costs are for conventional ashing systems – capex and opex on these systems are well know to Eskom
Level of confidence in forecasted life cycle costs	Low level of confidence due to the many uncertainties	High level of confidence due to knowledge of capex and opex
Requirement for temporary ashing solution	Temporary ashing solutions may be required during negotiations etc.	No need for a temporary solutions as the area is available immediately
Contractual complexities	Due to the nature of the operation, there would be many and significant contractual complexities	One owner-operator, hence no contractual complexities
Reliability and availability of the facility	Due to the complex nature of the operation, there is a higher degree of uncertainty around the level of plant reliability /availability	Operations and operating regimes are known and hence a high degree of certainty around plant reliability /availability
Legal Framework	Mining areas are required to adhere to additional legislation such as the Mine Health and Safety Act, making the situation legally complex	Eskom is well aware of the legal requirements and have systems in place to ensure continued compliance
Realisation of benefits for power plant water management practices	No benefits from a power plant water management perspective – the in-pit ashing option cannot assist with power plant water management	Huge benefits for power plant water management – it assists Eskom in achieving its Zero Liquid Effluent Discharge (ZLED) philosophy, in that conventional

		ash disposal facilities act as effluent sinks
Ease of rehabilitation after closure	The costs and risks associated are unknown and there may also be uncertainties in terms of who is responsible	Rehabilitation practises for conventional ashing are well known and entrenched in Eskom and extensive research has been done on it
Clarity on liability	Low confidence in terms of clarity on liability and therefore uncertainties from a cost and legal perspective	One single party involved – hence there is absolute clarity on what the liabilities are and how to make provision therefore
Future ash utilisation	Low potential for future ash utilisation once disposed of into the mine	Potential for future ash utilisation – research is ongoing and the ash would be "readily" available for this purpose

Taking the above comparative analysis into account, the use of old mine pits / underground working is still considered unfeasible at this stage due to the numerous uncertainties and low confidence in terms of the clarity with regards to ultimate liability. This alternative is therefore not considered suitable for further investigation.

A further technical alternative to limit the need for ash disposal facilities includes the use of higher grade coal which may reduce the amount of ash produced in the power generation process. The power station was originally designed for 45 years and now its life time is extended to 60 years. The boilers are designed to use a specific grade of coal and the boiler plant would require a redesign for higher grade coal. In order for this alternative to be implemented would require the complete redesign and reconstruction of the power station. The combination of the costs involved in the reconstruction of the power station as well as the higher price of the higher grade coal would have a knock on effect in terms of the country's electricity prices. Therefore, this alternative is therefore not considered feasible.

7.4 Location Alternatives

Majuba Power Station is located approximately 24 km southwest (SW) of Amersfoort and approximately 40km northnorthwest (NNW) of Volksrust in the Mpumalanga Province. The power station falls within the Pixley Ka Seme Local Municipality which falls within the Gert Sibande District Municipality.

Majuba Power Station's existing Ash Disposal Facility is almost at the 15 year boundary and urgently requires ashing infrastructure for the continuous ashing activities for the next 48 years (**Figure 7.2**). The particular area required for the continuous ashing facility is approximately 550 ha. The area, originally identified by Eskom for continuous ashing, is located on the southern portion of the existing Majuba Power Station ash disposal facility. However, Eskom is aware that a wetland exists within the footprint of the originally identified ashing area. An investigation of the wetland and other environmental concerns has been undertaken which highlighted the fact that there are Red Data plants and animals present within the wetland area.

Therefore, in order to allow for a robust environmental process, all land within a radius of 12km was assessed in order to identify potential alternative sites for ash disposal, should these sensitive environmental aspects limit the suitability of the proposed portion of land. The Majuba Continuous Ashing EIA study area is therefore located within a 12 km radius around a centre point within the Majuba Power Station (**Figure 7.3**).

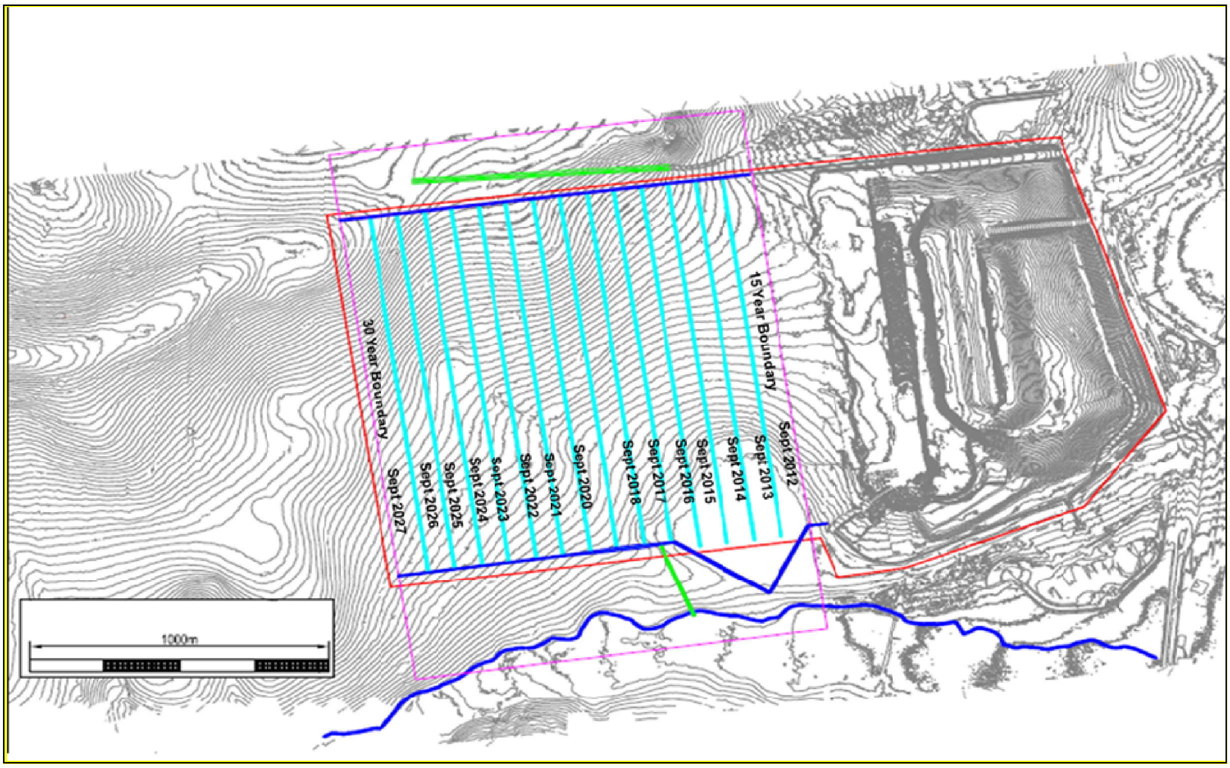


Figure 7.2: The ash disposal facility layout as currently constructed and the footprint of the Eskom's proposed future extent of the facility (blue) (It should be noted that alternatives to this proposed footprint have been identified and will be assessed during the EIA phase)

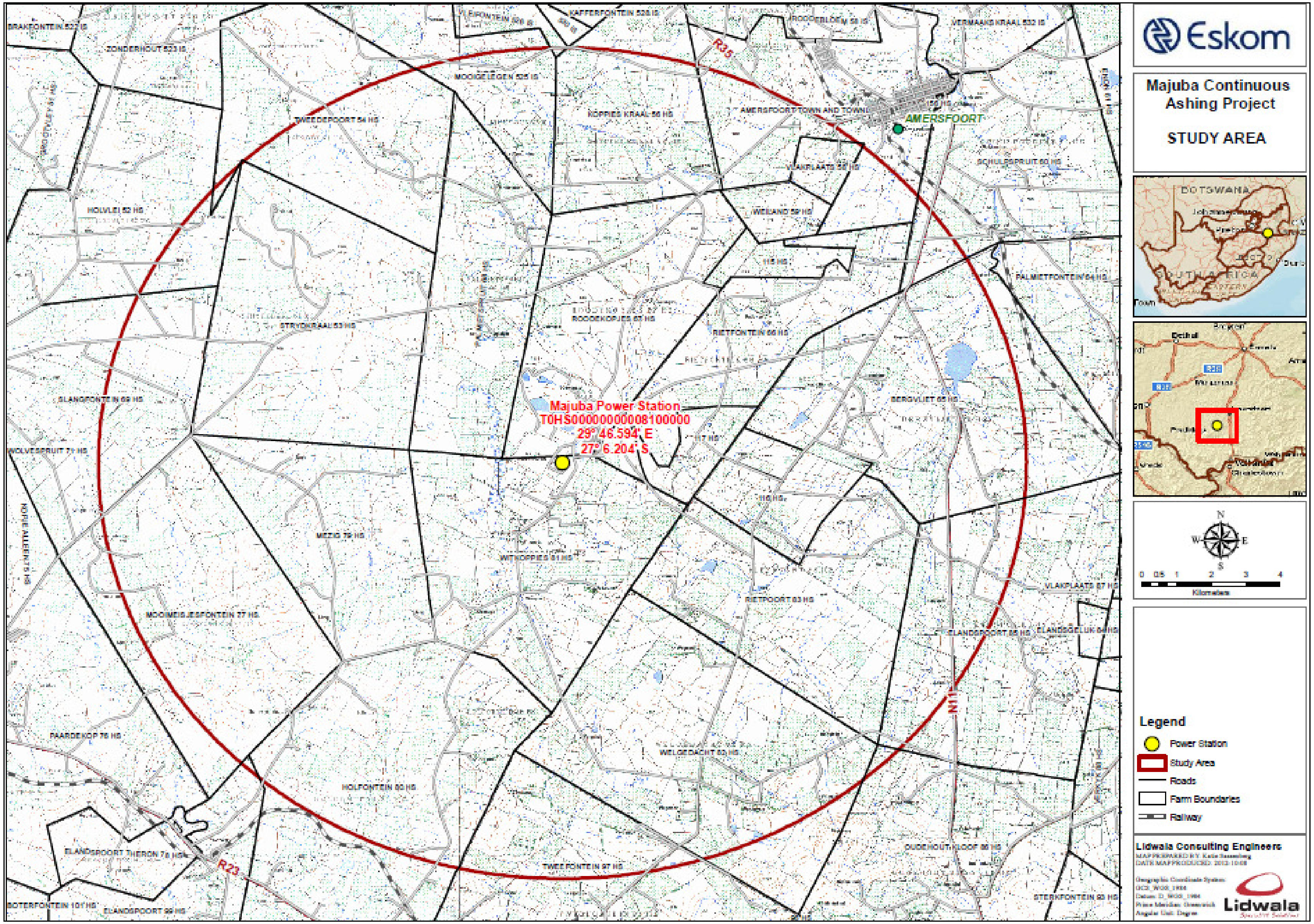


Figure 7.3: Proposed Study Area within which potential alternative sites were to be identified

7.4.1 Screening Analysis and Methodology

A screening study was initiated in order to assess where potential alternative sites are located within the study area that would be suitable for use for the proposed continuous ashing project. The study area was demarcated using a 12km radius around Majuba Power Station. The 12km radius was identified due to the existence of a previous screening study undertaken in the area to identify alternative sites for the proposed Combined Cycle Gas Turbine EIA project.

In order to ensure that sites are identified in the most objective manner possible, a sensitivity mapping exercise was undertaken for the study area. The purpose of such an exercise was to identify suitable areas within the study area that could accommodate the proposed ash disposal facility and associated infrastructure and to pro-actively identify sensitive areas (i.e. fatal flaws) that should be avoided.

- ***Sensitivity Mapping***

The qualitative sensitivity mapping exercise divided the study area into three categories *viz.* lower, medium and higher sensitivity areas. A sensitivity map for the study area was requested from each of the following specialist fields:

Biophysical
- Biodiversity (Fauna and Flora)
- Surface Water
- Groundwater
- Avifauna
- Agricultural Potential

Social
- Social (including Visual)
- Air Quality
- Noise

Table 7.2 provides a description of the various categories used in the sensitivity mapping.

Table 7.2 Description of the various categories used in the sensitivity mapping

Study Component	Category	Description
Biophysical Components		
Fauna and Flora	Higher Sensitivity	Indigenous natural vegetation that comprehends for a combination of the following attributes: - The presence of plant species of conservation importance, particularly threatened categories (Critically Endangered, Endangered, Vulnerable); - Areas where 'Threatened' plants are known to occur, or habitat that is highly suitable for the presence of these species; - Regional vegetation types that are included in the 'Threatened' categories (Critically Endangered, Endangered, Vulnerable), particularly prime examples of these vegetation types; - Habitat types are protected by national or provincial legislation (Lake Areas Act, National Forest Act, draft Ecosystem List of NEMBA, Mountain Catchment Areas Act, Ridges Development Guideline, Integrated Coastal Zone Management Act, etc.); - Areas that have an intrinsic high floristic diversity (species richness, unique ecosystems), with particular reference to Centres of Endemism; These areas are also characterised by low transformation and habitat isolation levels and contribute significantly on a local and regional scale in the ecological functionality of nearby and dependent ecosystems, with particular reference to catchment areas, pollination and migration corridors, genetic resources. A major reason for the high conservation status of these areas is the low ability to respond to disturbances (low plasticity and elasticity characteristics)
	Medium Sensitivity	Indigenous natural habitat that comprehends habitat with a high diversity, but characterised by moderate to high levels of degradation, fragmentation and habitat isolation. This category also includes areas where flora species of conservation importance could potentially occur, but habitat is regarded marginal
	Lower Sensitivity	No natural habitat remaining; this category is represented by developed/ transformed areas, nodal and linear infrastructure, areas of agriculture or cultivation, areas where exotic species dominate exclusively, mining land (particularly surface mining), etc. The possibility of these areas reverting to a natural state is impossible, even with the application of detailed and expensive rehabilitation activities. Similarly, the likelihood of plant species of conservation importance occurring in these areas is regarded negligent
Surface Water	Higher Sensitivity	100 m zone from the edge of the permanent wet zone for valley bottom and pan systems.
	Medium Sensitivity	100 m buffer zone from the edge of the temporary zones, or the edge of the riparian zones.

Study Component	Category	Description
	Lower Sensitivity	Higher lying areas, reflecting terrestrial soils and no obligate, facultative hydrophilic vegetation
Ground Water[2]	Higher Sensitivity	Lies within the 250 m river buffer zones, or falls on D3 aquifer type, or on Quaternary sediment.
	Lower Sensitivity	Areas falling outside of the 250 m buffer around surface water features, outside of mapped Quaternary sediment, and outside of the area classified as "D3" on the general hydrogeology map series (GRA1 data)
Avifauna	Higher Sensitivity	Wetlands, rivers and streams, farm dams, CWAC sites
	Medium Sensitivity	Remaining cultivated lands and farm lands
	Lower Sensitivity	Built up areas, roads, mines, existing ash disposal facilities, railway lines and high voltage power lines
Agricultural Potential	Higher Sensitivity	High Agricultural Potential
	Medium Sensitivity	Medium Agricultural Potential
	Lower Sensitivity	Low Agricultural Potential
Social Components		
Social: Demographic	Higher Sensitivity	Displacement and resettlement of people is necessary
	Medium Sensitivity	Visual, noise, air quality and traffic impacts on affected parties are acceptable during operation
	Lower Sensitivity	No displacement and resettlement of people is necessary
Social: Economic and Land use	Higher Sensitivity	Land use is affected in such a way that those who are dependent on the land to make a living are affected, and mitigation measures cannot neutralise the impacts. Good agricultural land is lost. Potential mining land is lost
	Medium Sensitivity	Land use is affected in such a way that those who are dependent on the land to make a living are affected, but mitigation measures can neutralise the impacts. Land that was mined and which is stable, not potentially putting people's safety at risk
	Lower Sensitivity	Land use activities can carry on, and people who are dependent on the land to make a living can carry on with their activities. Good agricultural land is not affected. Potential mining land is not affected
Social: Noise impact	Higher Sensitivity	Closer than 4 km to urban areas (the town of Amersfoort) and any informal settlement
	Medium Sensitivity	Areas where construction is possible, as the Majuba power station is already the centre of a noise degraded area, but less desirable than in Zone
	Lower Sensitivity	Area at or within a 10 km radius of the Majuba Power Station. Subject to consideration of isolated noise sensitive sites

[2] Depth of groundwater across the site is not known with accuracy, but is almost certainly shallower closer to surface water features - hence the higher sensitivity assigned to a 250 m buffer zone adjacent to surface water features. Permeability (rate at which water can "penetrate" ground) is covered by the DWA hydrogeological classification - essentially the same across the site ("D2"), except for the small area classified as "D3" - which has higher borehole yields and likely higher permeability, and has therefore been classified as medium sensitivity rather than lower sensitivity. The 250 m buffer is a horizontal distance, not a depth.

Study Component	Category	Description
Social: Visual Impact	Higher Sensitivity	Restricted location for the proposed development with highest visual sensitivity – no positive criteria and one or more restrictions (negative criteria)
	Medium Sensitivity	Acceptable or suitable location for the proposed development with neutral visual sensitivity – no positive criteria, but no restrictions (negative criteria) either
	Lower Sensitivity	Preferred or ideal location for the proposed development with lowest visual sensitivity – complies with the positive criteria with no restrictions (negative criteria)
Air Quality	Higher Sensitivity	Zone containing potentially expanding and permanent residential settlements within the direction of the prevailing winds
	Medium Sensitivity	Zone with potentially sensitive receptors but out of the prevailing wind direction
	Lower Sensitivity	Zone within the expected exceedance area with no potentially sensitive receptors

- ***GIS Layer Amalgamation and Sensitivity Indice Calculation***

In order to calculate a combined sensitivity rating for the study area, all the GIS layers received from each specialist area of study (e.g. ground water, biosensitivity etc) were combined to form one integrated layer (**Figure 7.4**). During this integration, string arrays were built containing information on the layer name, the assigned sensitivity rating for each particular area and the adjustment factor for the particular layer (**Figure 7.5**).

Three results (**Figure 7.5**) were then calculated from the integrated layer (**Figure 7.4**) by unnesting and summarising the string array data using the following logics:

- **maximum sensitivity wins:**
  The maximum sensitivity rating found in the array became the sensitivity index.
- **sum of all sensitivity ratings:**
  The sensitivity index was the sum of each sensitivity rating found in the array.
- **sum of all adjusted sensitivity ratings:**
  Each sensitivity rating found in the array was adjusted by the assigned adjustment factor for each particular layer. The sensitivity index was then the sum of these.

The presented maps were then created by reclassifying each logic result into five classes, namely:

- low sensitivity (green),
- low-medium sensitivity (light-green)
- medium sensitivity (yellow)
- medium-high (orange)
- high sensitivity (red).

Finally, the reclassified layer was clipped with the pre-determined no-go areas layer (to remove them from consideration – **Figure 7.6**) and further clipped with the 8km radius study area buffer to remove any extraneous features.

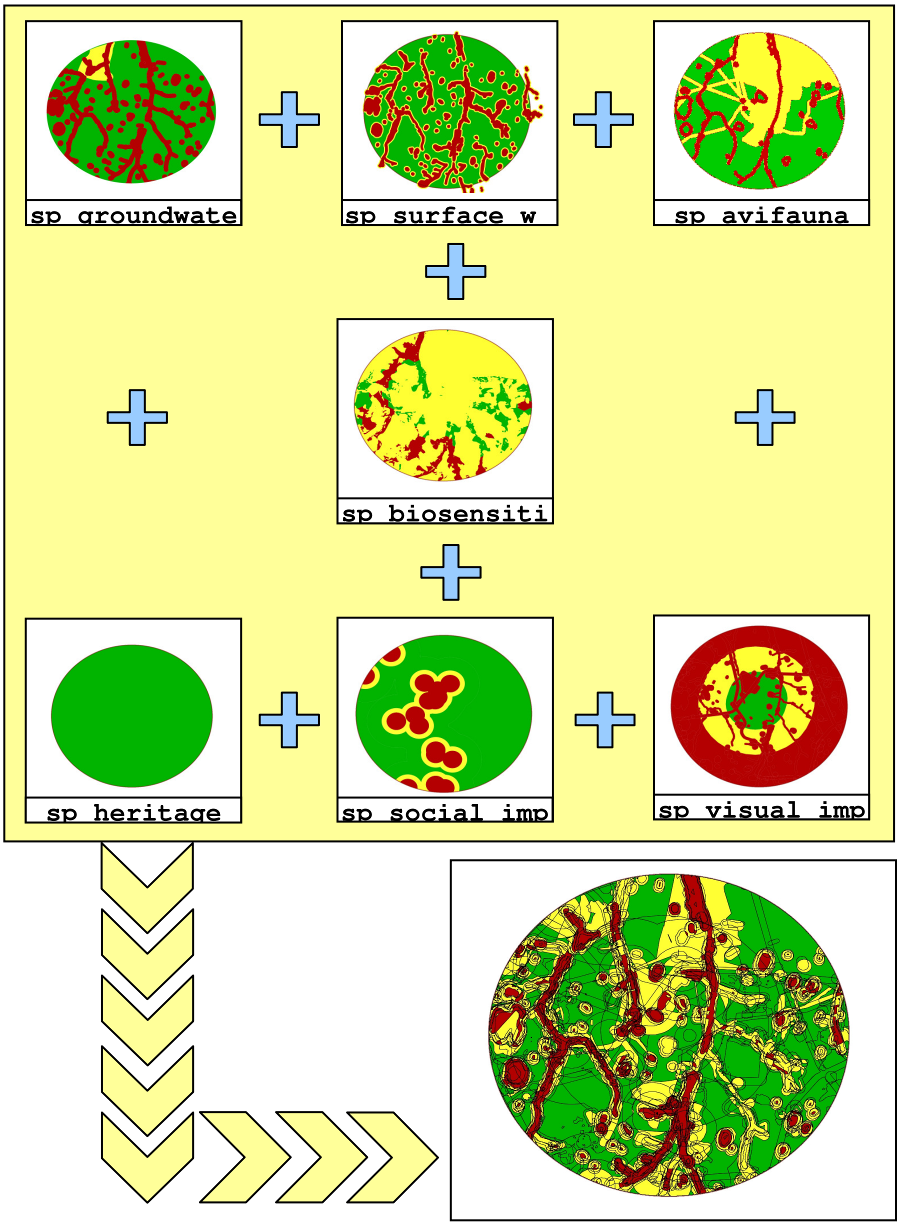
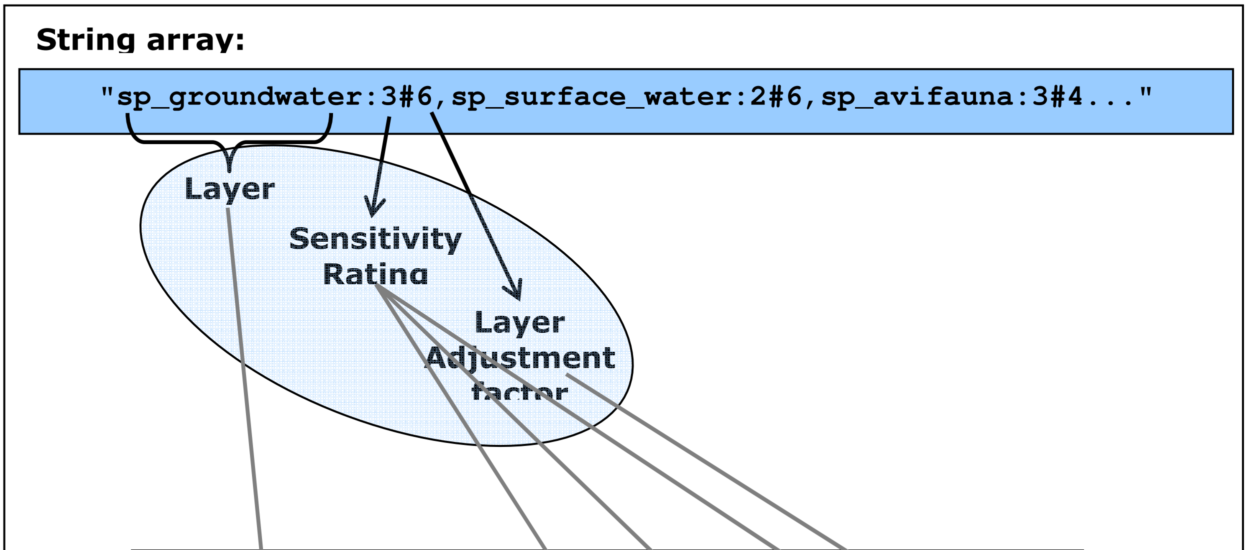


Figure 7.4: An example of typical layer integration process



Layer	Max Wins	No Factor	With Adjustment Factor
sp_g roundwater	3	3 x 1 (3)	3 x 6 (18)
sp_s urface_water	2	2 x 1 (2)	2 x 6 (12)
sp_a vifauna	3	3 x 1 (3)	3 x 4 (12)
sp_b iosensitivity	1	1 x 1 (1)	1 x 4 (4)
sp_h eritage	2	2 x 1 (2)	2 x 2 (4)
sp_v isual_impact	1	1 x 1 (1)	1 x 2 (2)
sp_s ocial_impact	1	1 x 1 (1)	1 x 2 (2)
Sensitivity Rating	**3**	**13**	**54**

Figure 7.5: String array parts and resultant indice calculations: max wins; sensitivity rating as is and sensitivity with an applied factor.

- ***Adjustment Factor / weighting factor Methodology***

In order to give each component a weighting factor with which to adjust the layers, the following methodology was utilised.

In a weighted matrix each variable / component is given a different importance weighting. In order to ensure that consensus is obtained with regards to the weighting / adjustment factors input from the project team and all specialists was obtained. Each member of the Project team was asked to rank each variable according to their own understanding of its significance, utilising the following ratings:

- 1 - low significance
- 2 - medium significance
- 3 - high significance

Once all the input was received, the rating provided for each variable was added and then divided by the number of people that took part in the exercise in order to obtain an average rating. Three sets of ratings were collected, namely:

- Specialist and Lidwala Project Team ratings (**Table 7.3**)
- Client ratings (**Table 7.4**)
- Combined ratings (**Table 7.5**)

The final decision to utilise the combined rating as the final weighting factors for the sensitivity analysis was due to the fact that the client's ratings did not dilute the weighting factors, they actually made the weighting factors stricter.

Table 7.3: Specialist and Lidwala Project Team ratings

	Specialists and Lidwala Project Team																				
Aspect	Social	Visual 1	Visual 2	Fauna	Flora	Surface Water 1	Ground water 1	Ground water 2	Design	Air	Avifauna	Project Manager	PPP1	PPP2	EIA Team	GIS	Legal	Soil	Final Total	Number participants	Average Rating
Social (including visual)	2	2	1	1	1	1	1	1	2	3	1	1	3	3	1	1	1	1	27	18	1.50
biodiversity (Fauna and flora)	2	3	3	3	3	3	2	2	1	2	2	3	2	2	3	2	3	2	43	18	2.39
surface water	2	3	3	3	3	3	2	2	2	2	2	3	3	3	2	2	2	2	44	18	2.44
groundwater	2	3	3	2	2	3	2	2	2	1	2	2	2	3	2	2	2	3	40	18	2.22
agricultural potential	1	2	2	1	1	1	2	2	1	2	1	2	2	1	1	2	2	2	28	18	1.56
air quality	2	2	3	1	1	2	2	2	3	3	2	1	3	1	2	3	3	3	39	18	2.17
Avifauna	2	2	1	3	3	3	2	2	2	2	2	3	1	2	2	2	2	2	38	18	2.11
noise	1	1	1	1	1	2	2	2	1	2	1	1	2	1	1	1	1	1	23	18	1.28

Table 7.4: Client ratings

	Eskom Team															
Aspect	E1	E2	E3	E4	E5	E6	E7	E8	E9	E10	E11	E12	E13	Final Total	Number participants	Average Rating
Social (including visual)	3	3	2	2	1	1	2	1	1	1	2	1	1	21	13	1.62
biodiversity (Fauna and flora)	3	3	3	3	3	1	3	2	3	2	3	3	3	35	13	2.69
surface water	3	3	2	2	3	1	2	3	2	2	3	2	2	30	13	2.31
groundwater	3	3	3	2	2	2	2	3	3	3	3	2	3	34	13	2.62
agricultural potential	1	3	3	2	2	2	1	2	2	1	1	1	1	22	13	1.69
air quality	3	3	3	3	2	1	2	2	1	3	3	1	2	29	13	2.23
Avifauna	3	1	3	3	2	1	3	2	2	2	2	1	2	27	13	2.08
noise	3	1	1	3	1	1	1	1	1	1	2	1	1	18	13	1.38

Table 7.5: Combined ratings

	Specialists and Lidwala Project Team			Eskom Team			Final Combined Ratings		
Aspect	Final Total	Number participants	Average Rating	Final Total	Number participants	Average Rating	Final Total Combined	Number participants	Final Average Rating
Social (including visual)	27	18	1.50	21	13	1.62	48	31	1.55
biodiversity (Fauna and flora)	43	18	2.39	35	13	2.69	78	31	2.52
surface water	44	18	2.44	30	13	2.31	74	31	2.39
groundwater	40	18	2.22	34	13	2.62	74	31	2.39
agricultural potential	28	18	1.56	22	13	1.69	50	31	1.61
air quality	39	18	2.17	29	13	2.23	68	31	2.19
Avifauna	38	18	2.11	27	13	2.08	65	31	2.10
noise	23	18	1.28	18	13	1.38	41	31	1.32

The final weighting factors for each aspect are therefore as follows:

- Social = 1.55
- Fauna and Flora = 2.52
- Surface Water = 2.39
- Ground Water = 2.39
- Agricultural Potential = 1.61

- Air Quality = 2.19
- Avifauna = 2.10
- Noise = 1.32

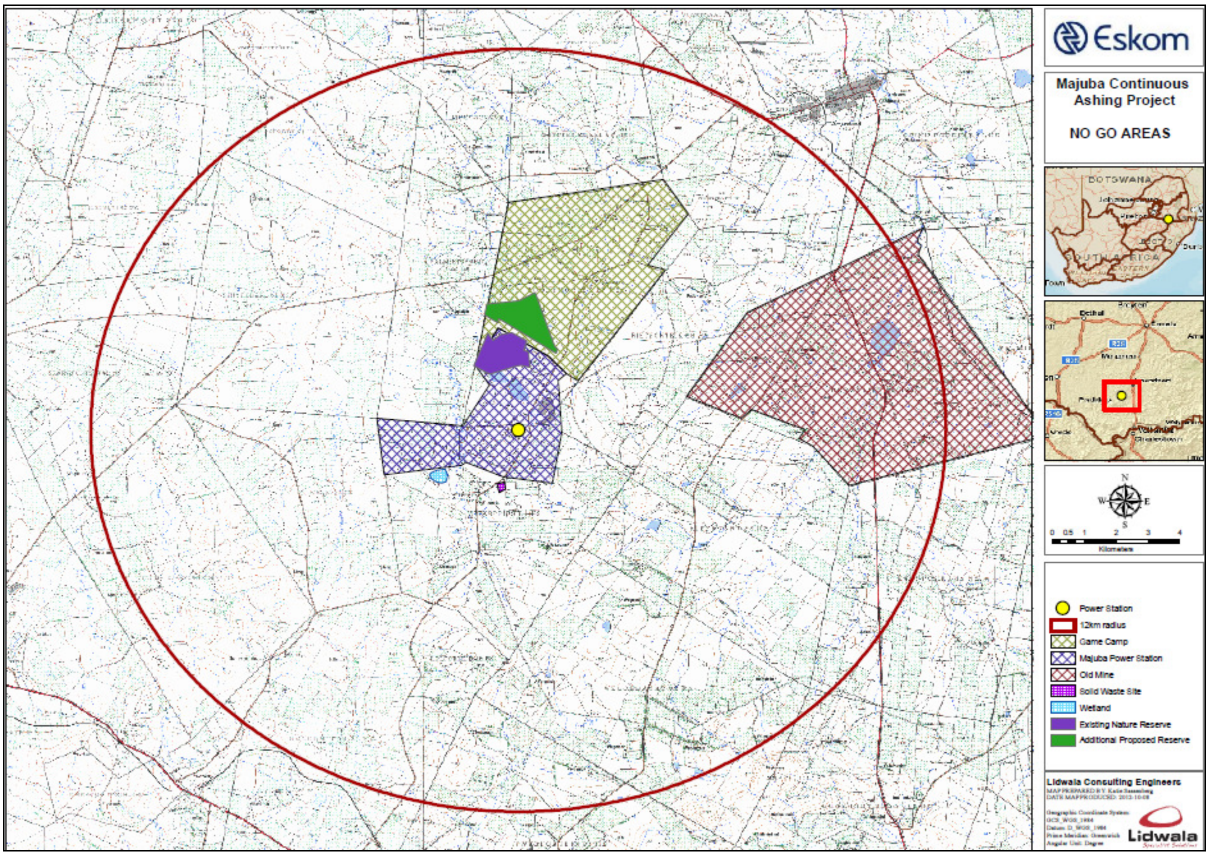


Figure 7.6: No-Go Areas Layer

7.4.2 Specialist Study Screening Results

- ***Biodiversity (Fauna and flora)***

The ecological importance ascribed to existing protected areas and species are simple and self-explanatory. Outside of protected areas but within areas that are clearly of value for biodiversity, the evaluation of importance or sensitivity is more complex and vague. The absence of protected status should therefore never be interpreted as low biodiversity importance; many areas of international biodiversity importance lie outside of protected areas.

For this particular screening assessment, the degree of transformation was used as a primary decision tool in determining the level of sensitivity of a particular site. A secondary decision was made based on the level of conservation importance ascribed to the regional vegetation type. Lastly, historic sampling records of conservation important flora and fauna taxa within the region were also implemented to ascribe a high level of importance/ sensitivity to a particular site. The ecological sensitivity of areas characterised by natural habitat was assessed using the application of the following criteria:

	YES	NO
The presence of Threatened and/or Protected:		
• plant species	X	
• animal species	X	
• ecosystems	X	
The presence of Critical conservation areas, including:		
• areas of high biodiversity	X	
• centres of endemism		X
The presence of Important Ecological Processes, including:		
• Corridors		X
• Mega-conservancy networks		X
• Rivers and wetlands	X	
• Important topographical features		X

Estimated ecological sensitivity values are presented in **Figure 7.7** and are categorised as follows:

Low (1) No natural habitat remaining; this category is represented by developed/ transformed areas, nodal and linear infrastructure, areas of agriculture or cultivation, areas where exotic species dominate exclusively, mining land (particularly surface mining), etc. The possibility of these areas reverting to a natural state is impossible, even with the application of detailed and expensive rehabilitation activities. Similarly, the likelihood of plant species of conservation importance occurring in these areas is regarded negligent.

Medium (2) Indigenous natural habitat that comprehend habitat with a high diversity, but characterised by moderate to high levels of degradation, fragmentation and habitat isolation. This category also includes areas where flora species of conservation importance could potentially occur, but habitat is regarded marginal;

High (3) Indigenous natural vegetation that comprehend for a combination of the following attributes:

- The presence of plant species of conservation importance, particularly threatened categories (Critically Endangered, Endangered, Vulnerable);
- Areas where 'threatened' plants are known to occur, or habitat that is highly suitable for the presence of these species;
- Regional vegetation types that are included in the 'threatened' categories (Critically Endangered, Endangered, Vulnerable), particularly prime examples of these vegetation types;

- Habitat types are protected by national or provincial legislation (Lake Areas Act, National Forest Act, draft Ecosystem List of NEMBA, Mountain Catchment Areas Act, Ridges Development Guideline, Integrated Coastal Zone Management Act, etc.);
- Areas that have an intrinsic high floristic diversity (species richness, unique ecosystems), with particular reference to Centres of Endemism;

These areas are also characterised by low transformation and habitat isolation levels and contribute significantly on a local and regional scale in the ecological functionality of nearby and dependent ecosystems, with particular reference to catchment areas, pollination and migration corridors, genetic resources. A major reason for the high conservation status of these areas is the low ability to respond to disturbances (low plasticity and elasticity characteristics).

Not Assessed (6) Areas not included in the assessment within the 12km radius due to unsuitability for the proposed project include the following:

- Majuba Power Station and associated infrastructure; and
- The farm Roodekopjes (proposed UCG project).

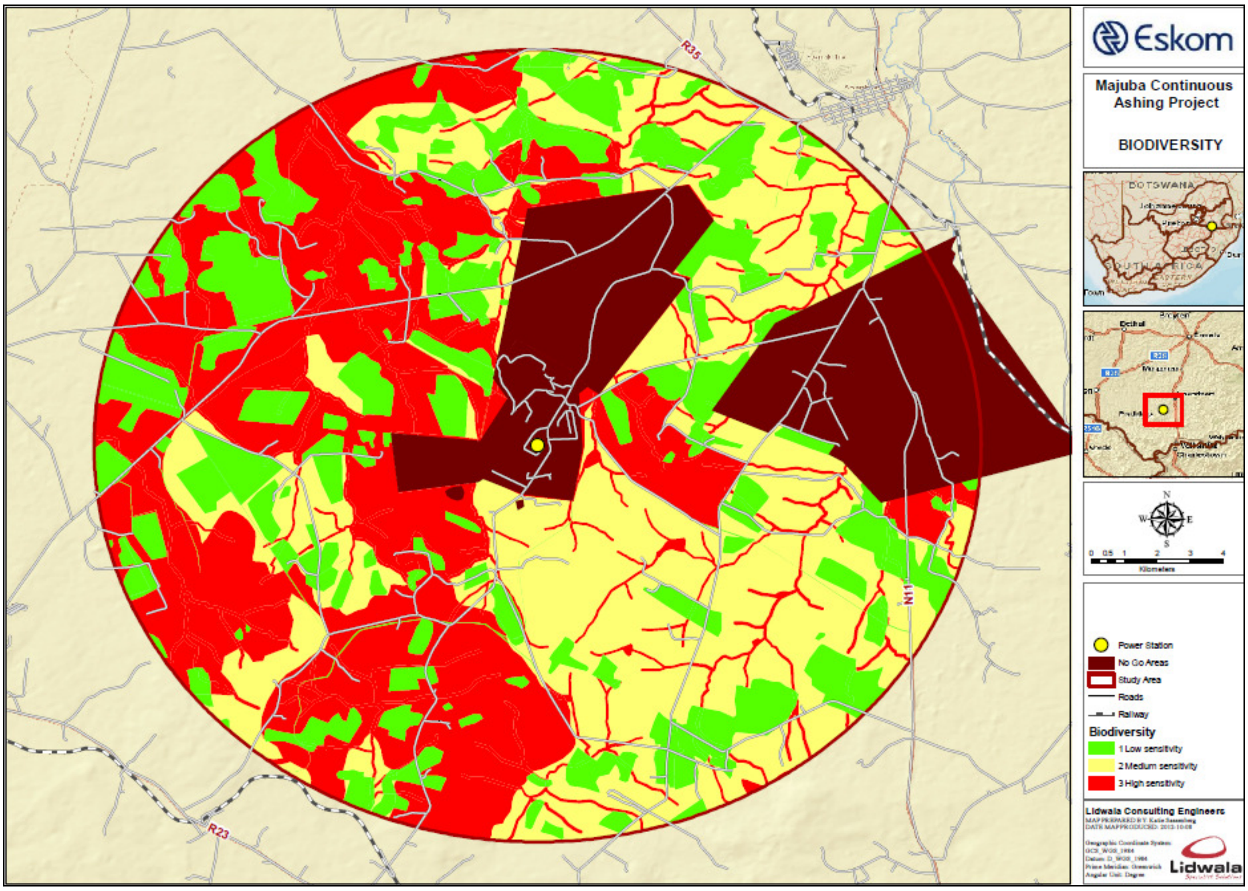


Figure 7.7: Biodiversity Sensitivity Map

Discussion & Recommendations

It is evident from the sensitivity analysis that the western part of the study area, and in particular, Eskom's proposed site, is not regarded suitable for the proposed development from a biodiversity point of view. Aspects that contributed to the high sensitivity of this area include the regional conservation status of the Soweto Highveld Grassland (Endangered) as well as the known/ confirmed presence of several conservation important flora and fauna taxa. The existence of a relocation programme within the region whereby these species (with particular reference to the Sungazer Lizard) are being relocated did not influence the sensitivity.

It is important to note that the presence of conservation important species is a confluence of numerous biological and biophysical characteristics, resulting in habitat that to which they are adapted. Of even greater importance is the fact that loss of habitat resulting from agriculture and industrial developments, results in sustained pressure on the habitat of these plants and animals. Losses to these habitat types are usually irreversible. Even though a relocation programme (*ex situ* conservation) might be successful, the *in situ* conservation of plants and animals should be a priority. The fact that a number of conservation important specie co-exist within this particular site strongly suggests the importance of this area in terms of biodiversity attributes. Various surveys in the local region have failed to indicate the presence of such a high diversity of conservation important species within a single land parcel.

It is therefore strongly recommended, from a biophysical point of view, that a suitable area be selected from the eastern side of the study area.

- ***Surface Water***

The rationale applied with the aquatic sensitivity assessment is based on the premise that all watercourses or potential watercourse areas are sensitive. The catchment size, slope and position in the landscape predominantly determine the potential for water accumulation. Once accumulated other factors such as underlying geology and soil permeability also contribute towards the nature of particular wetness expressed. For the purpose of this assessment a Wetness Index was applied and superimposed by existing drainage lines and wetland areas. The result of the Wetness Index was consistent with known drainage lines and wetland areas and the application thereof is thus deemed suitable.

The SAGA Wetness Index, which is based on a modified catchment area calculation, is similar to the Topographic Wetness Index (TWI). The modified catchment area does not consider flow as very thin film and predicts raster cells situated in valley floors with a small vertical distance to a channel, a more realistic, higher potential soil moisture compared to the standard TWI calculation (Boehner *et al.,* 2002).

The Wetness Index highlights areas with a propensity for water to accumulate within the study area, thereby indicating areas of low, moderate and high sensitivity from a soil water or possible wetland perspective (**Figure 7.8**). Areas highlighted in red have a high sensitivity and should be excluded during the planning of the proposed Majuba Continuous Ashing Project. The construction and operational phase activities may result in potential alterations/impacts to the ecological integrity of the receiving aquatic ecosystems. Areas highlighted in yellow are deemed moderately sensitive. If expansion activities infringe on these areas, suitable mitigation measures are pertinent to limit the impacts on the receiving aquatic environment. The integrity and functioning of watercourses is directly dependant on their surrounding land area (Dodds & Oaks, 2008). Areas of low sensitivity are highlighted in green and will potentially have the least impact on the rivers/streams and wetlands located in the study area (**Figure 7.8**). The field verification that will be carried out during the EIA phase will provide additional information regarding the suitability of the identified low sensitivity areas

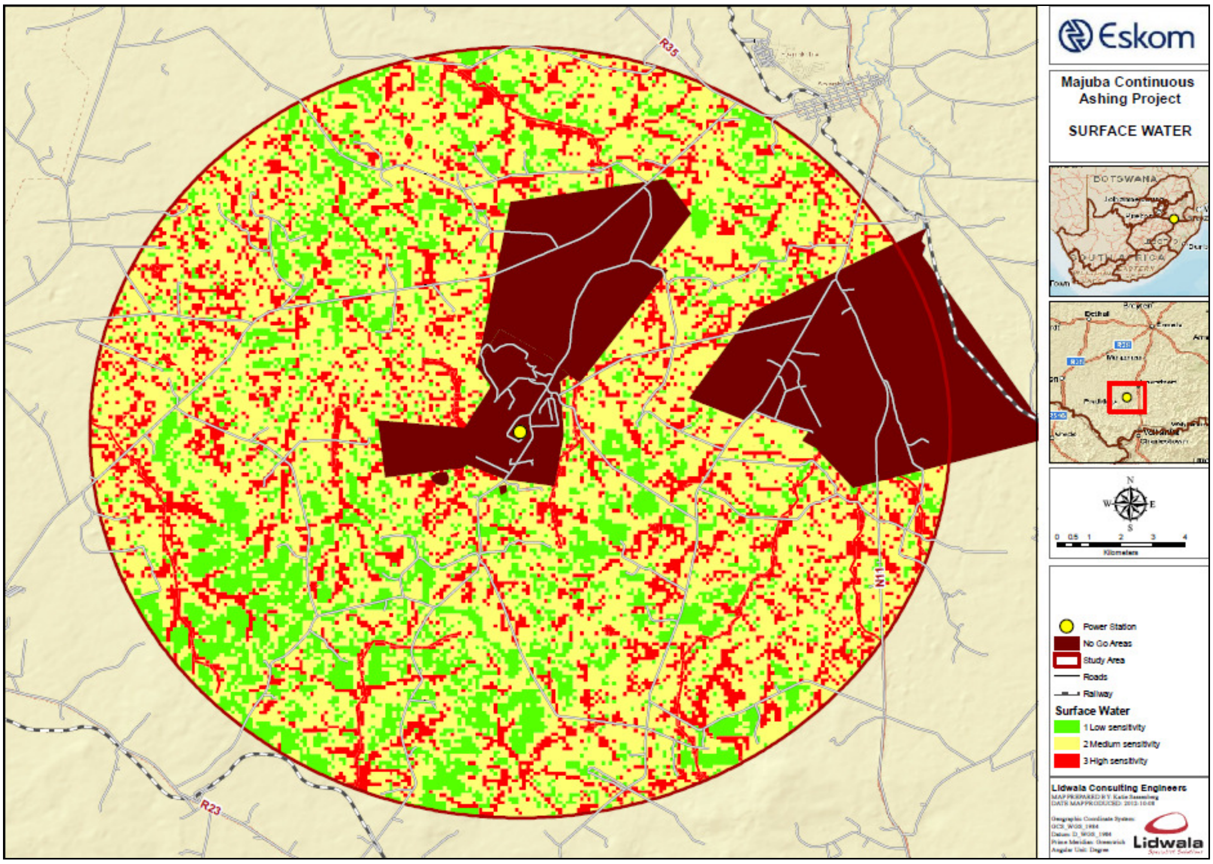


Figure 7.8: Surface Water Sensitivity Map

- ***Groundwater***

A sensitivity analysis was completed and an interim groundwater vulnerability map (**Figure 7.9**) was produced allowing a basic distinction to be made between more and less favourable areas for the siting of the proposed ash disposal facilities continuation at Majuba Power Station. This map was based on the hydrogeological map classification of the area within 12km of the power station, combined with a 250m buffer zone placed around surface water features and information from the geology map.

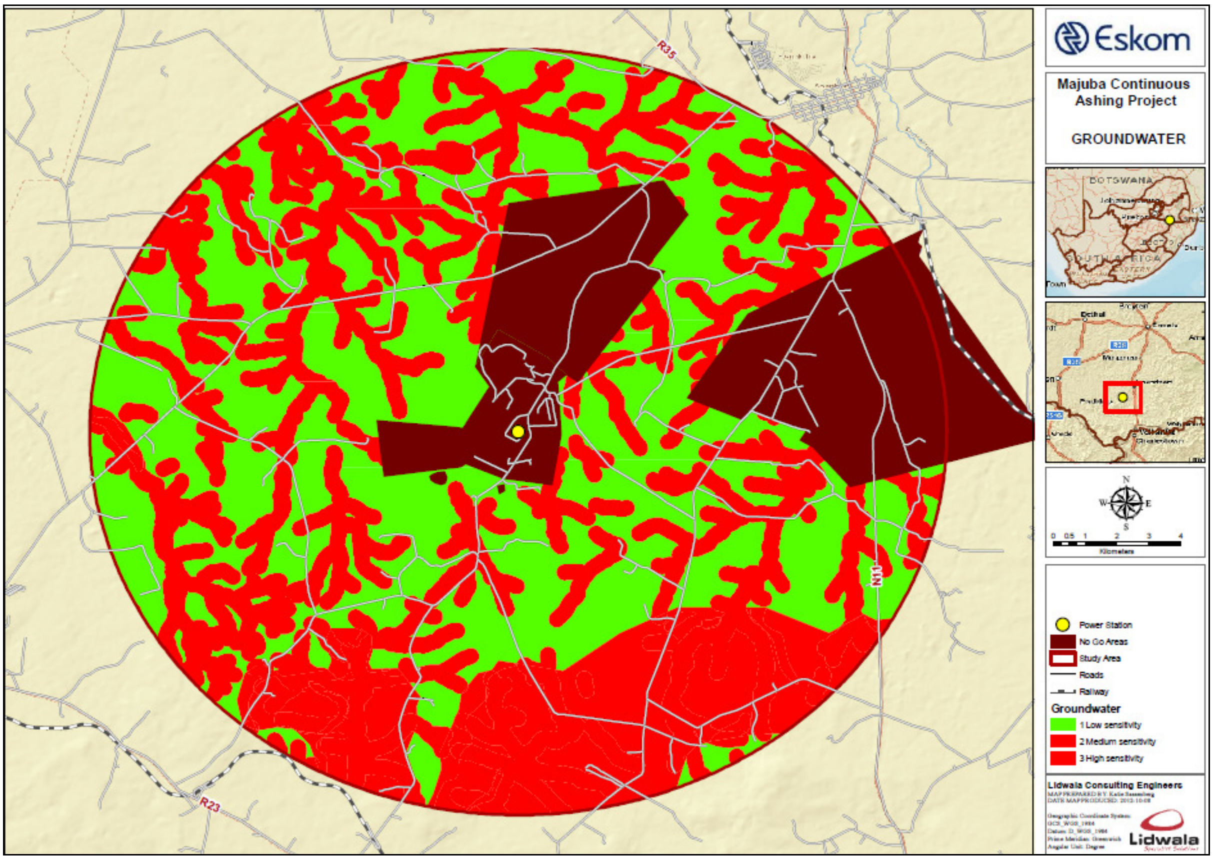


Figure 7.9: Groundwater sensitivity map

- ***Avifauna***

In general the study area is moderate to highly sensitive in terms of avifauna, based on the occurrence of a number of listed species in the study area, as well as the various micro-habitats available to avifauna. The sensitive zones are mapped and described below.

Figure 7.10 shows two features that have been buffered. These are the Rivers, and Wetland/dam areas. The rivers have been buffered by 100m using GIS, while the dams and wetlands have been buffered by 200m. The importance of these micro-habitats to avifauna has been discussed in earlier sections of this report. **All of these buffered zones are regarded as *Medium-High sensitivity areas* and if possible should be avoided.**

The remaining areas outside of these buffer zones are designated as *Low – Medium sensitivity*, although this is subject to change following the EIA phase site visit.

Note that this sensitivity analysis is subject to change, following the site visit in the EIA phase, especially as some of the GIS layers may be outdated, and may not reflect the actual situation on the ground. Also note that certain natural grassland areas, as well as other drainage lines or wetland areas may also be designated as sensitive areas, should they be identified and mapped in the EIA phase

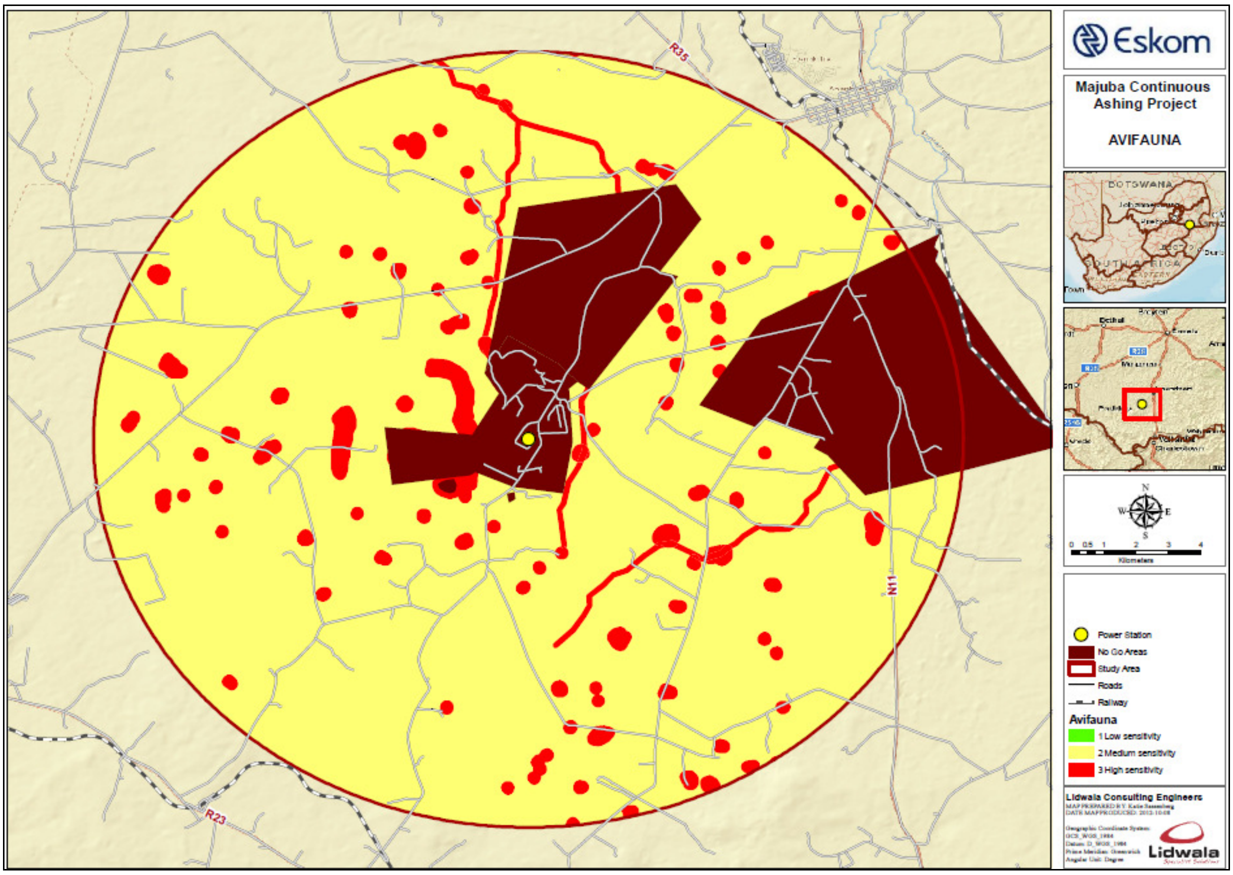


Figure 7.10: Avifauna Sensitivity Map

- ***Agricultural Potential***

The Majuba study area, it is mostly land type Ca2, with some small Ea land types also included. The study area has a large variety of soils which range from from high potential apedal soils to clays and rocky areas. Due to this variety the whole study area has been classified as medium sensitivity, subject to detailed studies on the preferred site in the EIA phase. **Figure 7.11** illustrates the agricultural potential sensitivity of the study area.

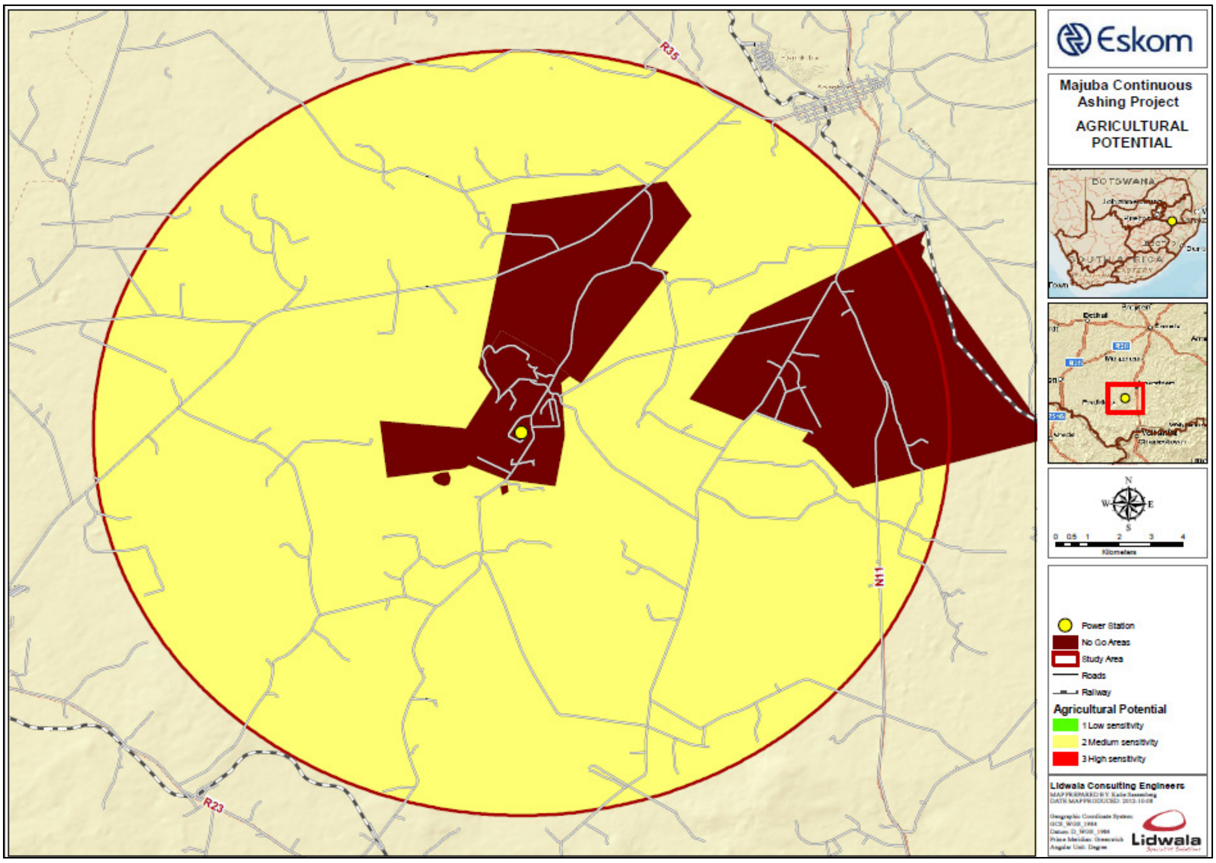


Figure 7.11: Agricultural Potential Sensitivity Map

- ***Social (including Visual)***

Demographic Processes

The study area is sparsely populated. The closest town is Amersfoort on the northern border of the study area. The informal settlement to the west of the town, north of the N11, is growing. It does not appear as if formal structures in the town are on the increase. Isolated farm houses occur in the study area, and these are depicted on the sensitivity map (**Figure 7.13)**. The total number of farm houses observed in the study area was approximately eight (8) and four (4) clusters of traditional huts / workers' huts were observed. There are on average 4-5 houses/huts in these clusters.

Economic and Land Use Processes

The Underground Coal Gasification (UCG) plant, Majuba power station and an old mine are located in the study area. Farming activities consist of the grazing of cattle and cultivation of mealies. The IDP lists the Majuba Mining Complex as an opportunity for growth, as well as the availability of agricultural land. This gives an indication that the agricultural activities are important for the economic development of the area.

Visual

Sensitive receptors in the study area are associated with the occurrence of farmsteads and road users, which are widely spread across the study area. The locations of these are presented on the map in **Figure 7.12**. The level of sensitivity is determined by proximity to the ash disposal facilities, and can be classified as follows:

- **0 – 1.5km.** Short distance view where the facility would dominate the frame of vision and constitute a very high visual prominence.
- **1.5 - 3km.** Medium distance view where the facility would be easily and comfortably visible and constitute a high to moderate visual prominence.
- **3 - 6km.** Medium to longer distance view where the facility would become part of the visual environment, but would still be visible and recognisable. This zone constitutes a moderate to low visual prominence.
- **Greater than 6km.** Long distance view of the facility where it could potentially still be visible though not as easily recognisable. This zone constitutes a very low visual prominence for the facility. It is anticipated that beyond 12km from the facility any visibility thereof would be of no significance in terms of visual impact.

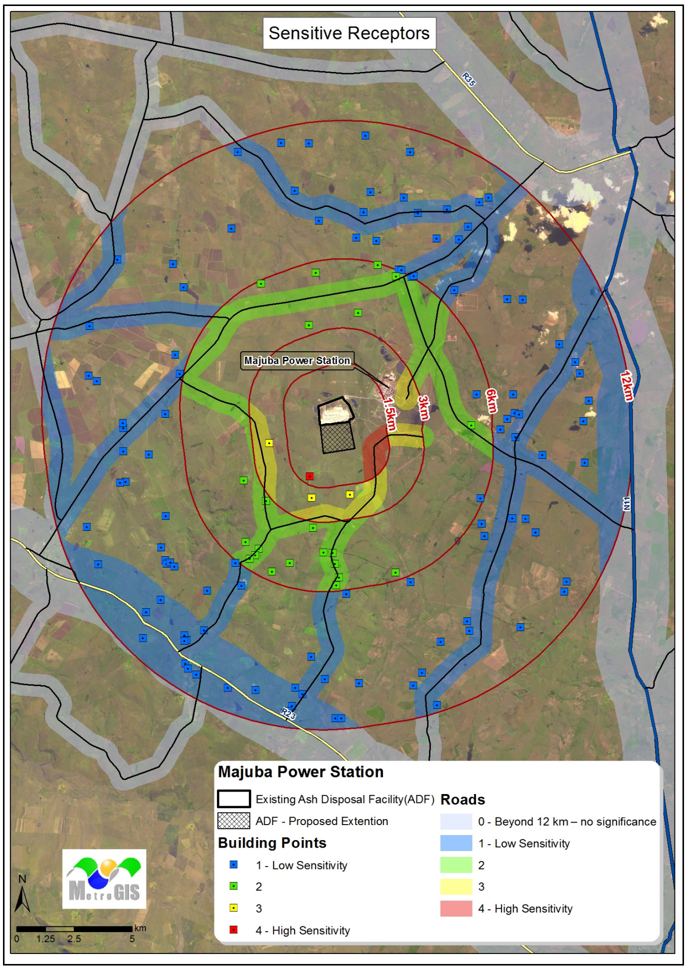


Figure 7.12: Location of possible sensitive receptor areas, i.e. farmsteads and roads.

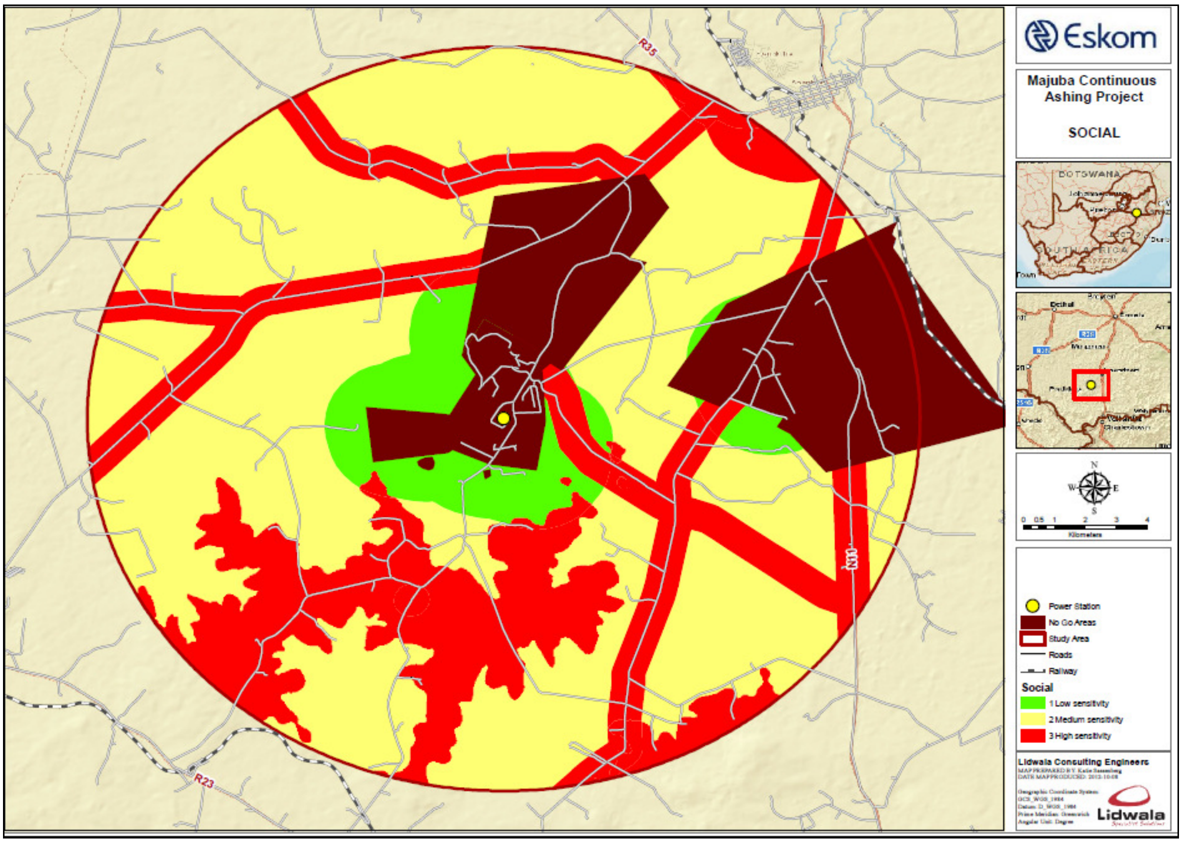


Figure 7.13: Social Sensitivity Map

- ***Air***

The co-dominant wind directions are easterly and west-north-west with a frequency of occurrence approaching 12% for each direction. Winds from the southern and south-western sectors occur relatively infrequently (<4% of the total period). Calm conditions (wind speeds <1 m/s) occur for 8.49% of the time. A frequent westerly flow dominates day-time conditions with >12% frequency of occurrence. At night, an increase in easterly flow is observed with a decrease in westerly air flow.

During summer months, winds from the east become more frequent, due to the strengthened influence of the tropical easterlies and the increasing frequency of occurrence of ridging anticyclones off the east coast. There is an increase in the frequency of calm periods (i.e. wind speeds <1 m/s) during the autumn (11.28%) and winter months (6.91%) with an increase in the westerly flow

As a result of the activities associated with ash disposal, PM_{10} concentrations are likely to exceed the NAAQS 2015 limit of 75 µg/m³ within ~500 m of the source. $PM_{2.5}$ concentrations are likely to exceed the NAAQS 2030 limit of 25 µg/m³ within ~200 m of the source. The predicted elemental concentrations from the windblown ash material are predicted to exceed the most stringent effect screening levels up to a distance of 1 500 m from the source. With water sprays in place and once vegetation is established, these impacts will reduce significantly. The potential for impacts at the sensitive receptors will also depend on the wind direction and speed, which could not be accounted for in this assessment.

If unmitigated, windblown dust from the ash disposal facility may result in exceedances of effect screening levels up to a distance of ~1 500 m from the source with exceedances of PM_{10} NAAQ limits up to a distance of 500 m. This applies to the current and proposed future ash disposal facility operations since the "active" area should essentially remain the same irrespective of the total footprint of the ash disposal facility. **Figure 7.14** shows the air quality sensitivity map.

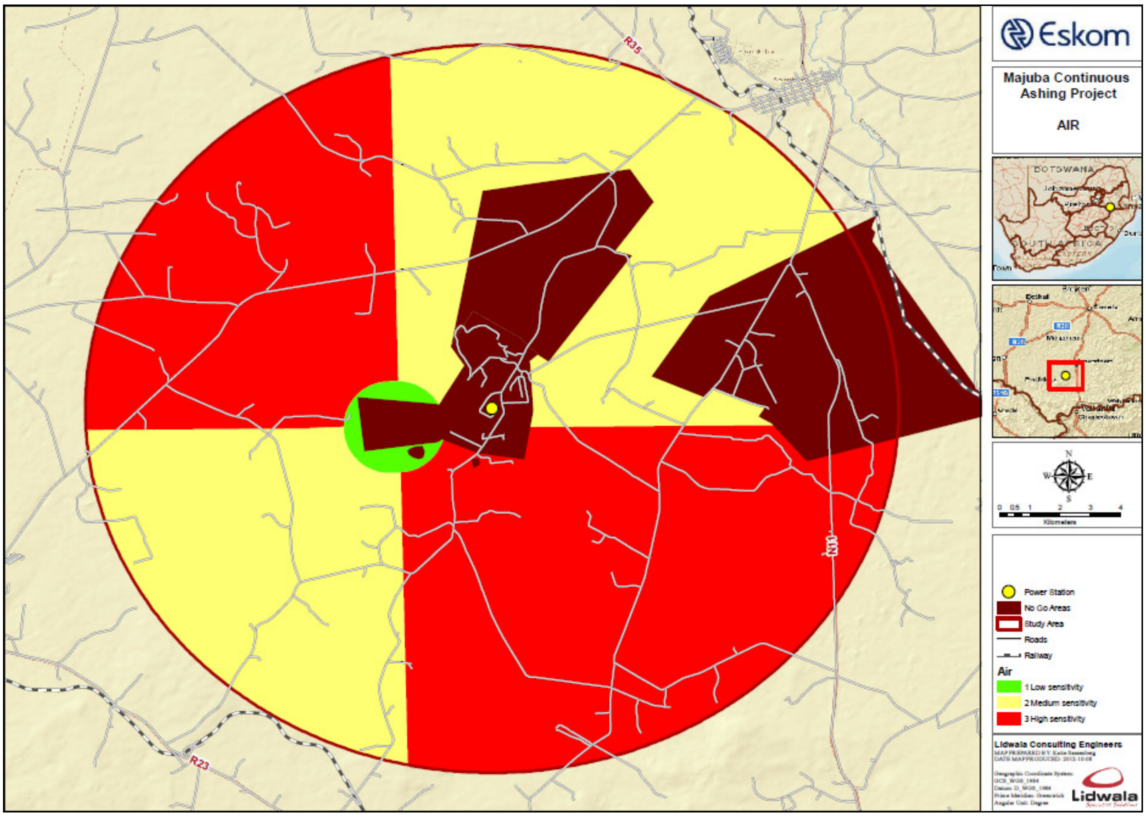


Figure 7.14: Air Quality Sensitivity Map

- ***Noise***

The area within a 12km radius of the Majuba Power Station was assessed.

The noise sensitive sites/areas are Amersfoort Town and various farm houses and farm labourer residences in the surrounding area. These are relative evenly spread out throughout the area. An analysis of the area within a 10 - 12km radius of the Majuba Power Station (but maintaining the National Road N11 as an eastern limit) indicated that there was approximately the following number of noise sensitive sites (farmhouse and farm labourer homes) in the given quadrants of the 12km circle:

Quadrant	No. Noise Sensitive Sites
North-west	20

North-east	10
South-east	19
South-west	23

Figure 7.15 indicates the zones (I, II and III) that are low, medium and high sensitivity areas for the continuous ashing project and associated infrastructure. The characteristic of each zone is described below:

Zone 1 (Green): This zone is continuous and incorporates the area at the Majuba Power Station, the area north of the power station up to the Perdekop Road, the area between the existing power station, the UCG facility and the old mine (north-eastern quadrant), the area to the south-east of the power station (inner portion of the south eastern quadrant), and small areas to the south-west and west of the power station. The existing power station is already a source of noise. Locating the ash disposal facility at or close to the existing power station will have cumulative effects, but because it is the centre of an existing noise degraded area, there are advantages to locating the ash disposal facility close to Majuba Power Station.

Zone 2 (Yellow): It is desirable not to move a new noise source into areas too far away from the existing power station as this has the potential to introduce new impact situations. These zones are generally outside Zone 1. Four areas have been categorised as Zone 2 areas, namely one to the north, two to the south-east and one to the west of the existing power station.

Zone 3 (Red): The main no-go areas are those in close proximity to urban areas and informal settlements. In order to limit the night time noise impact on the Amersfoort Town, the ash disposal facility should not be closer than 4 km to the town (SANS 10103 night time standard for urban areas). Areas east of National Road N11 should be avoided, particularly areas that get close to Vlakplaats and Daggakraal.

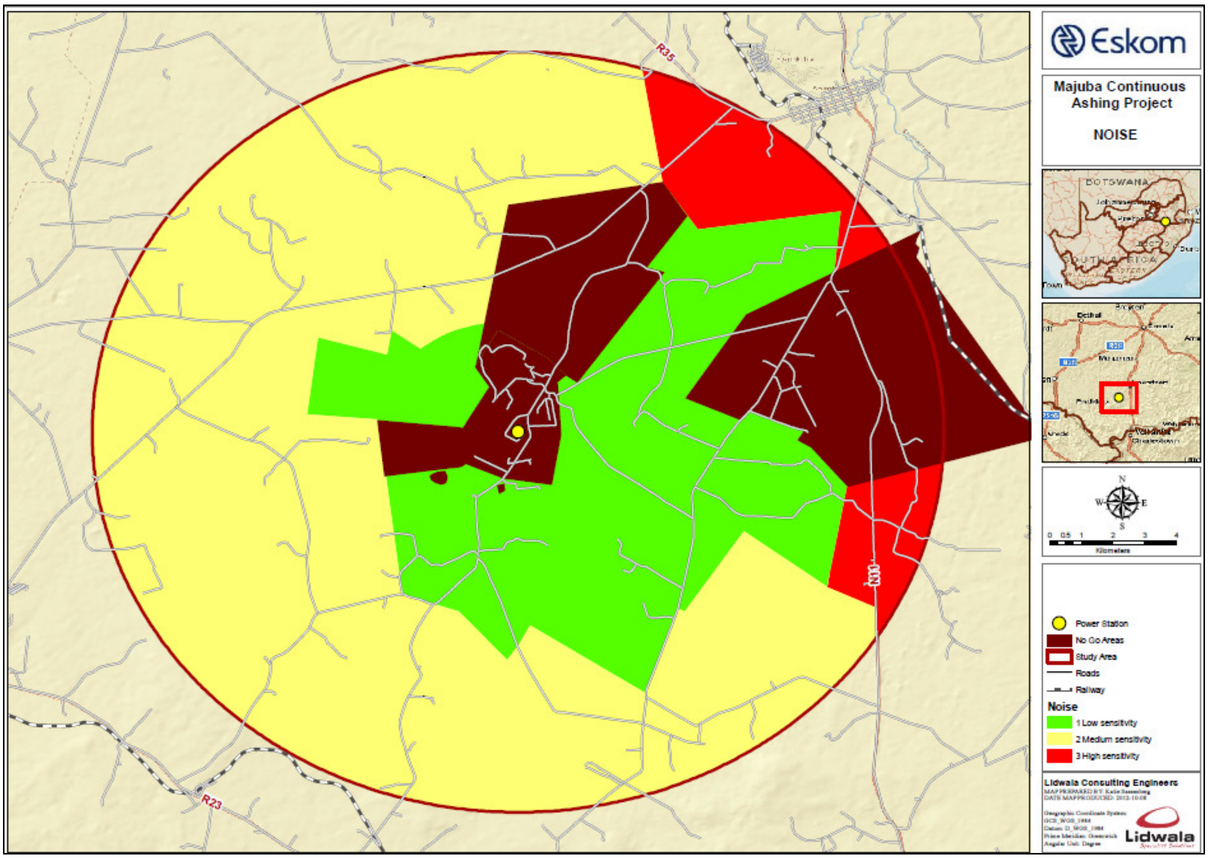


Figure 7.15: Noise Sensitivity Map

7.4.3 Final Screening Results

Figures 7.16, 7.17 and **7.18** illustrate the results of overlaying all the specialist input maps together, thereby illustrating the overall environmental sensitivity of the area.

Figure 7.16: Overall Environmental Sensitivity (Max Wins)

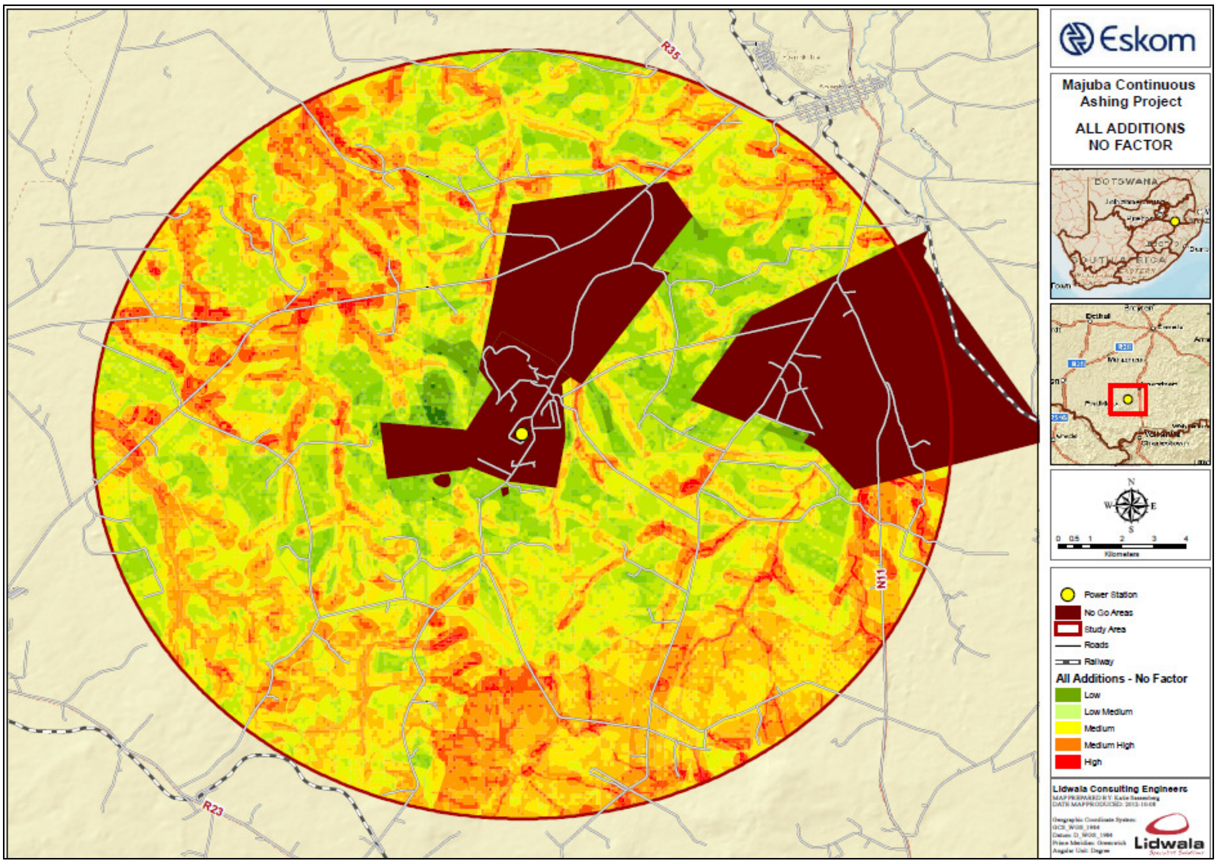


Figure 7.17: Overall Environmental Sensitivity (no factor)

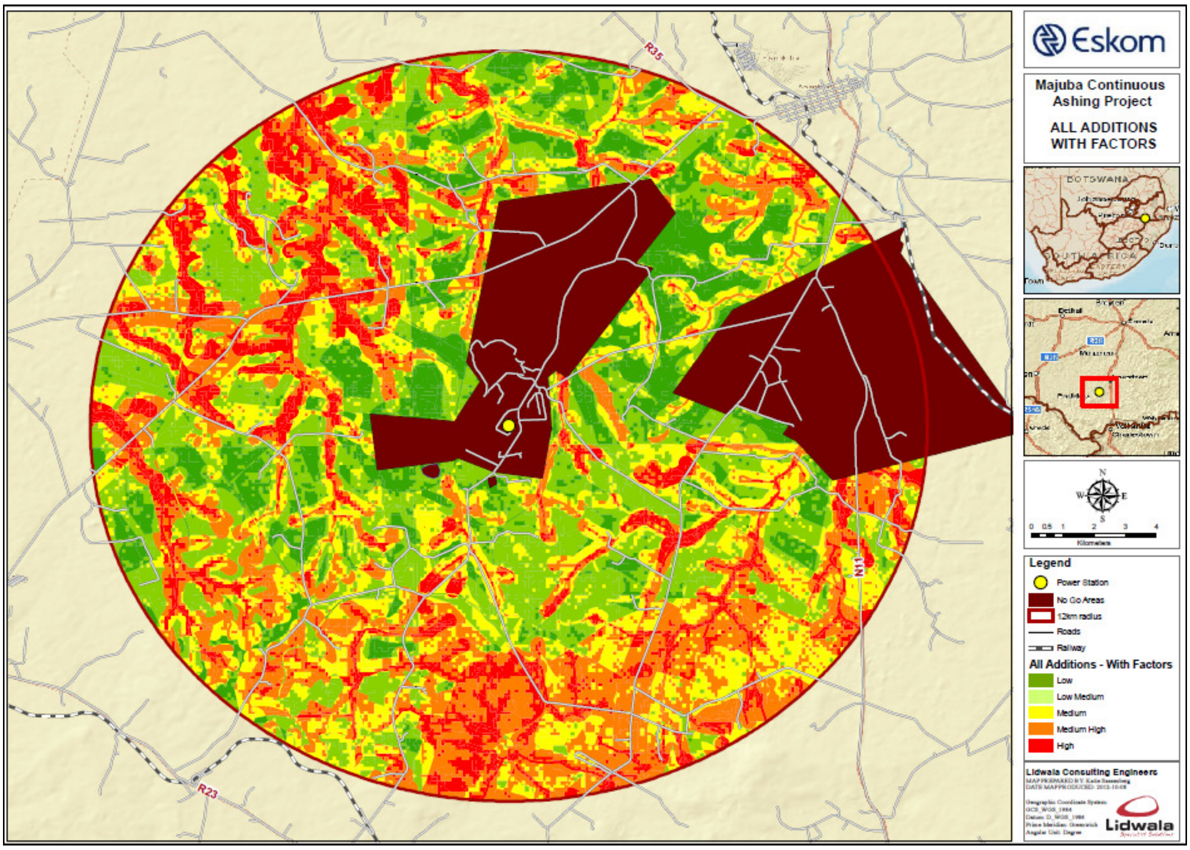


Figure 7.18: Overall Environmental Sensitivity (with adjustment factor)

Utilising the straight forward addition analysis (**Figure 4.17**) it can be concluded that the overall sensitivity of the study area falls within the Medium to medium-high sensitivity range with only small areas being considered of low sensitivity. However, if one utilises the "max wins" (**Figure 7.16**) mapping technique, where any area marked as sensitive is kept sensitive, it is clear that the majority of the study area can be deemed to be sensitive in one way or form with only a few medium sensitivity areas scattered across the study area.

The above maps were then utilized in order to determine the least sensitive areas of sufficient size that could be considered as alternative sites for the proposed ash disposal facility at Majuba Power Station. Alternative sites are required to be at least 550 ha in size and are required to fit within the low to low - medium sensitivity areas only and preferably without disturbing any existing infrastructure. It is clear from the overall sensitivity map that there are no areas that fall only within low or low-medium sensitivity areas that are big enough to accommodate the required size for the ash disposal site. However, if one also allows the ashing area to fall over medium sensitivity areas five areas become available (**Figure 7.19**).

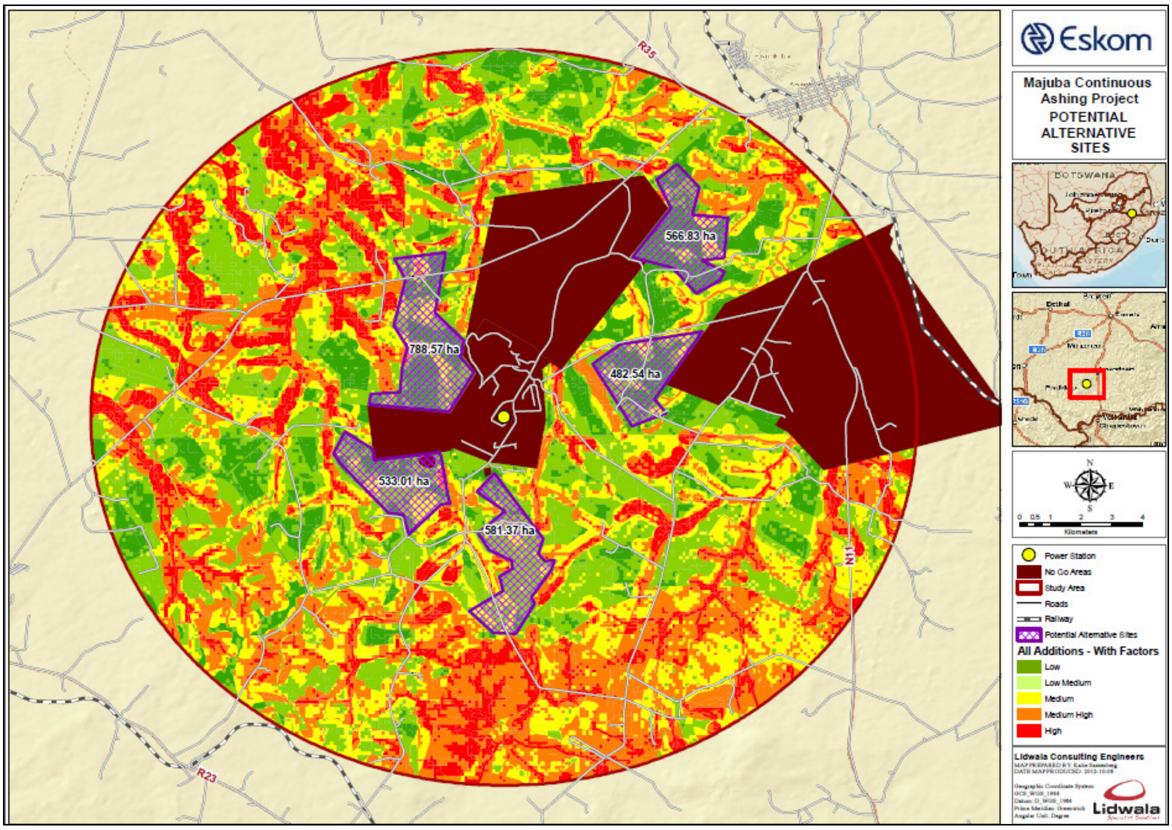


Figure 7.19: The potential alternative areas, within the study area, large enough to accommodate the required area for the ash disposal facility (overlain on sensitivity map).

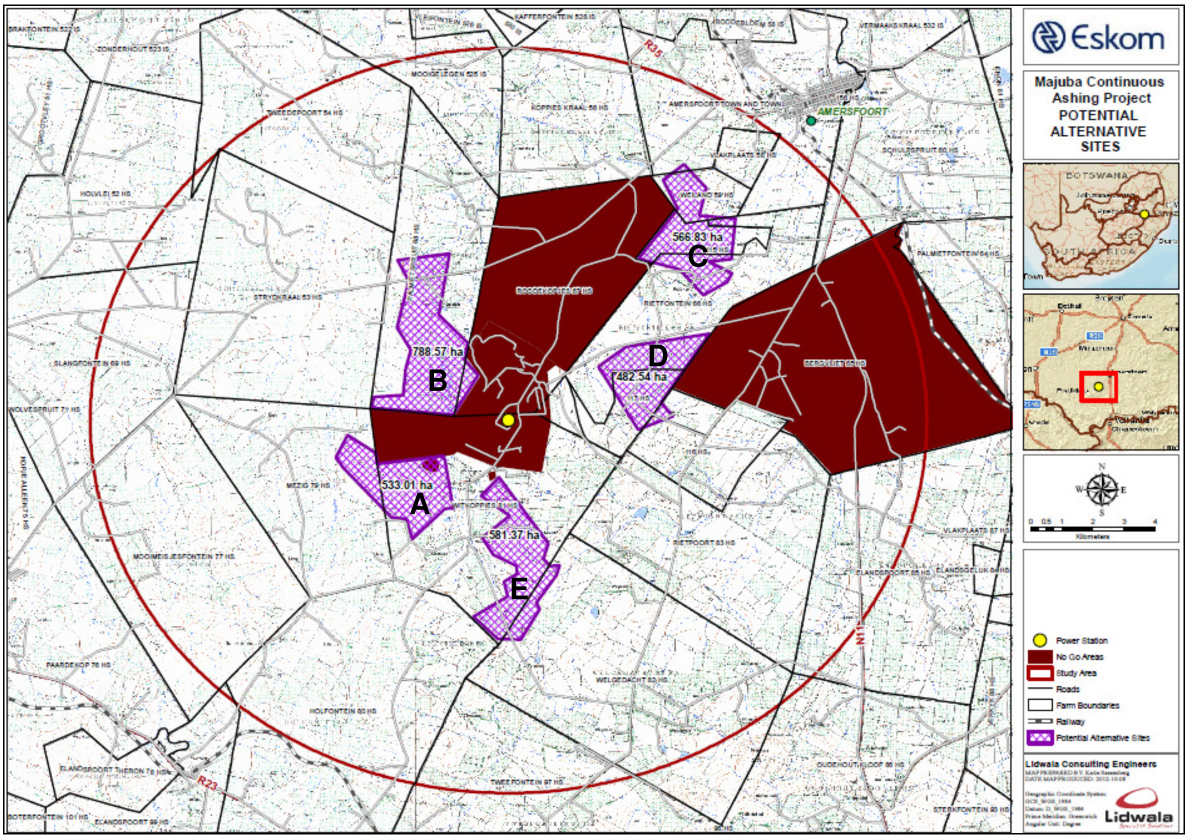


Figure 7.20: The five potentially suitable areas that can be evaluated and assessed in the EIA studies (overlain on 1 in 50 000 topographic map)

From the above analysis, five areas can be identified as potentially suitable for the continuous ashing activities required at Majuba Power Station at this stage. The area to the south of the existing ash disposal facility incorporates an area already proposed by Eskom for the continuous ashing project. It is still noted that the required ash disposal facility should be placed as close to the existing ashing activities as possible to ensure that existing impacts are kept together and to limit the impact of associated linear infrastructure such as power lines and conveyor belts.

Although these five areas have been identified through this sensitivity analysis, the detailed studies to be undertaken during the EIA phase will ground-truth and confirm any sensitivities within the identified areas. The EIA phase may well refine these areas according to the findings.

7.5 Conclusion

This chapter discussed the methodology of how the five potential suitable areas were identified through the use of sensitivity mapping during the scoping phase. These five areas and combinations thereof will be investigated and assessed through detailed specialist studies during the EIA phase of the project.

Mitigation and layout alternatives will also form part of the EIA phase, during which a more in depth study will be undertaken as to the optimal mitigation of all potential significant environmental impacts.