4 PROJECT ALTERNATIVES

4.1 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.

4.2 The 'no go' alternative

The 'no go' alternative is the option of <u>not</u> expanding the ashing system at the Hendrina Power Station with the development of a new ash dam.

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.

If Eskom is to meet its mandate and commitment to supply the ever-increasing needs of end-users in South Africa, it has to continually expand its infrastructure of generation capacity and transmission and distribution power lines. This expansion includes not only the building of new power stations but also expanding and upgrading existing power stations to extend their life.

[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.

The Hendrina Power Station, in the Mpumalanga Province currently uses a wet ashing system for the disposal of ash. Hendrina Power Station currently have five ash dams, of which two (Ash dam 3 and 5) are currently in operation, the other three (Ash dam 1, 2 & 4) are not in use for the following reasons:

- Having reached full capacity (Dam 1)
- Stability issues (Dam 2)
- Temporary decommissioning (Dam 4). Ash dam 4 will be re-commissioned in 2011.

At the current rate of disposal on Dams 3, 4 and 5, the rate-of-rise will exceed 4m/year in 2018, which is not acceptable in terms of structural stability. The Hendrina Power Station is anticipated to ash approximately 64.2 million m^3 until the end of its life span which is currently estimated to be 2035.

It has been determined, through studies, that the existing ashing facilities are not capable to provide sufficient ash disposal capacity for this amount of ash for the full life of the station. The existing facilities (Ash Dams 3, 4 and 5) allow for the disposal of 20.9 million m^3. Therefore, Hendrina Power Station proposes to extend its ashing facilities and associated infrastructure with the following development specifications:

- Additional airspace of 43.3 million m^3
- Ash dam ground footprint of 139 ha
- Ground footprint of associated infrastructure such as Ash Water Return Dams of 70 ha

The need for this extension is to allow the Hendrina Power Station to continue ashing in an environmentally responsible way for the duration of the operating life of the Power Station. The need for the extension is related to the deteriorating coal quality, higher load factors, the installation of the Fabric filter plant (to meet requirements in terms of the National Environmental Management: Air Quality Act (Act 39 of 2004)) and the need to extend station life.

The 'no go' option will, therefore, contribute negatively to the provision of reliable base load power to the national grid. It will result in the need to close down the power station due to the lack of ash disposal facilities, causing a long term reduction in electricity supply. It is important to note that the additional power output from Hendrina Power Station is still required to meet the national demand irrespective of the new-build activities.

The 'no go' alternative will, however, be investigated further in the EIA phase as an alternative as required by the EIA Regulations.

4.3 Ash Disposal Method

The coal-fired power generation process results in large quantities of ash, which is disposed of in ash dams. Generally, Eskom uses 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. With regards to ash management, Eskom uses either wet or dry methods of ash disposal. The Hendrina Power Station utilises a wet ashing disposal method. This process entails the hydraulic conveyance of ash where ash is mixed with water and pumped in the form of slurry via steel pipelines. The slurry is allowed to settle in the ash dams, and the water decanted to storage dams for re-use.

Due to the fact that Hendrina Power Station utilises a wet ashing disposal method, a strategic decision was taken that the new proposed ash dam will be built in order to link in with the existing ashing system.

4.4 Location Alternatives

Hendrina Power Station is located in the Mpumalanga Province approximately 24 km south of Middleburg and 20 km North of the town of Hendrina. The power station and surrounds falls within the Steve Tshwete Local Municipality which forms part of the Nkangala District Municipality.

The greater part of the study area is made up of agricultural and mining activities. In order to identify alternative sites for the proposed new ash dam a study area was required to be defined. The proposed study area is located within an 8 km radius of the centre point of the Hendrina Power Station Site (**Figure 4.1**). The 8 km radius was a strategic decision by the power station as the furthest distance within which construction and operational costs, including environmental, technical and financial costs, are deemed to be feasible.

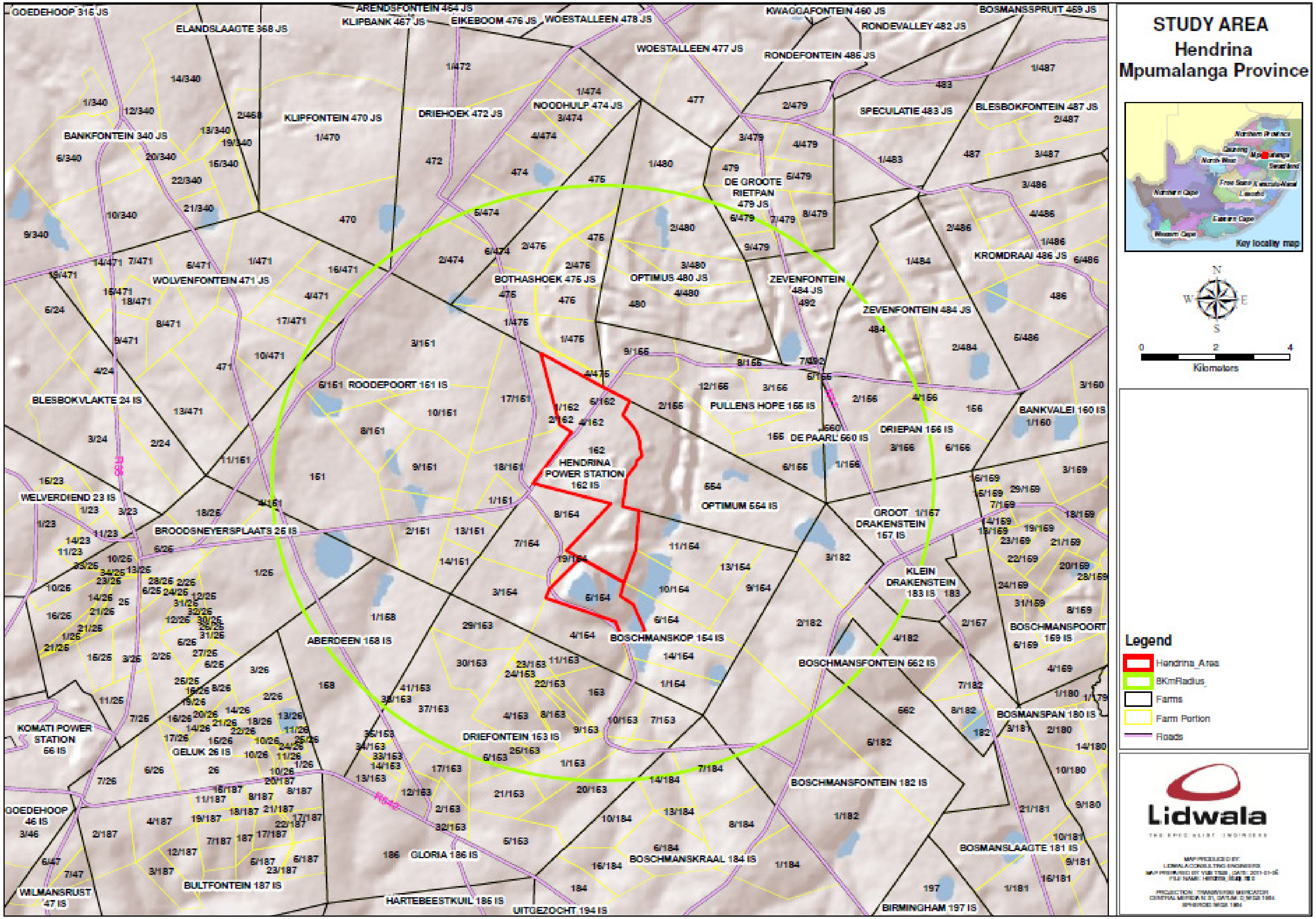


Figure 4.1: Proposed Study Area within which Alternative sites were to be identified

4.4.1 Screening Analysis and Methodology

A screening study was initiated upfront in the process in order to identify potential sites within the study area that would be suitable for use as alternative sites for the proposed new ash dam. The study area was demarcated using an 8 km radius around the Hendrina Power Station. Within this 8km radius two further demarcations where included, although based on technical impacts such as the costs involved in the project and the risk of security of supply, the distances involved also take into account the potential additional environmental impacts in terms of the distance required for new infrastructure to be constructed and operated.

- A 3 km radius within which no additional technical costs would be incurred in terms of the construction and operational of the proposed new ash dam;
- A 5 km radius within which minimal additional technical costs would be incurred in terms of the construction and operation of the proposed new ash dam.

The full Screening Report is included in **Appendix D**.

In order to ensure that sites were 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 new ash dam and associated infrastructure and to pro-actively identify sensitive areas (i.e. fatal flaws) that should be avoided. The sites identified during this exercise will be evaluated during the scoping phase of the project.

- ***<u>Sensitivity Mapping</u>***

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
- Groundwater
- Surface Water
- Fauna and Flora
- Avifauna

Social
- Social
- Heritage
- Visual

Table 4.1 provides a description of the various categories used in the sensitivity mapping.

Table 4.1 Description of the various categories used in the sensitivity mapping

Study Component	Category	Description
Biophysical Components		
Fauna and Flora	Higher Sensitivity	Areas of atypical habitat, conservation areas, riparian and wetland habitat, known presence of plant species of concern, not regarded suitable for proposed development, expected impacts likely to be unacceptable on a local or regional scale, adverse impact not possible to mitigate
	Medium Sensitivity	Associated with natural/ pristine regional habitat, moderate likelihood of harbouring species and habitat of concern, moderate suitability for proposed development. Even with careful site selection, expected impacts could be potentially significant, but possible to mitigate through site-specific mitigation measures and site selection
	Lower Sensitivity	Associated with transformed habitat, not likely to contain biodiversity attributes of sensitivity, considered suitable for proposed development, expected impacts regarded to be of low significance, possible to mitigate through generic mitigation measures. The status of specific areas is also influenced by the presence of nearby sites of sensitivity
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.
	Lower Sensitivity	Higher lying areas, reflecting terrestrial soils and no obligate, facultative hydrophilic vegetation
Ground Water[2]	Higher Sensitivity	Those areas within the 250 m surface water buffer zone.
	Medium Sensitivity	Areas falling within the area classified as D3, but still outside of all areas within the 250 m surface water buffer zone.
	Lower Sensitivity	Areas falling outside of the 250 m buffer around surface water features, and outside of the area classified as "D3" on the general hydrogeology map series (GRA1 data).

[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
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 dams, railway lines and high voltage power lines
Social Components		
Social: Distance from proposed Ash Dam	Higher Sensitivity	500 – 1000 meters
	Medium Sensitivity	1000 – 1500 meters
	Lower Sensitivity	1500 meters or more
Social: Settlement Type	Higher Sensitivity	Residential
	Medium Sensitivity	Informal Community
	Lower Sensitivity	Single Housing
Social: Settlement Farms	Higher Sensitivity	Community
	Medium Sensitivity	Farm House
	Lower Sensitivity	No housing
Social: Health Risk – air quality	Higher Sensitivity	High risk within radius of 500 – 1000m
	Medium Sensitivity	Medium risk within radius of 1000 – 1500m
	Lower Sensitivity	Low risk within radius of more than 1500m
Social: Dust pollution (visibility/health/quality)	Higher Sensitivity	Above legal standard
	Medium Sensitivity	Within limits
	Lower Sensitivity	Below legal limits
Social: Visual Impact (quality of life)	Higher Sensitivity	Within 1000m
	Medium Sensitivity	Within 1500m
	Lower Sensitivity	Within 3000m
Social: Economic impact on agriculture	Higher Sensitivity	Private farmland
	Medium Sensitivity	Eskom land (but farmed)
	Lower Sensitivity	Denuded land
Heritage	Higher Sensitivity	Heritage resources with qualities so exceptional that they are of special national significance.
	Medium Sensitivity	Heritage resources which, although forming part of the national state, can be considered to have special qualities which make them significant within the context of a province or a region. Medium sensitivity areas also include areas where little work has been undertaken and therefore the presence of significant heritage resources is not known.

Study Component	Category	Description
	Lower Sensitivity	Other heritage resources worthy of conservation, and which prescribes heritage resources assessment criteria, consistent with the criteria set out in section 3(3) of the National Heritage Resources Act (Act No 25 of 1999), which must be used by a heritage resources authority or a local authority to assess the intrinsic, comparative and contextual significance of a heritage resource and the relative benefits and costs of its protection, so that the appropriate level of grading of the resource and the consequent responsibility for its management may be allocated in terms of section 8 of the said Act.
Visual	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)

- ***<u>GIS Layer Amalgamation and Sensitivity Indice Calculation</u>***

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 4.2**). 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 4.3**).

Three results (**Figure 4.3**) were then calculated from the integrated layer (**Figure 4.2**) 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 (light green),
- low medium sensitivity (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) and further clipped with the 8km radius study area buffer to remove any extraneous features.

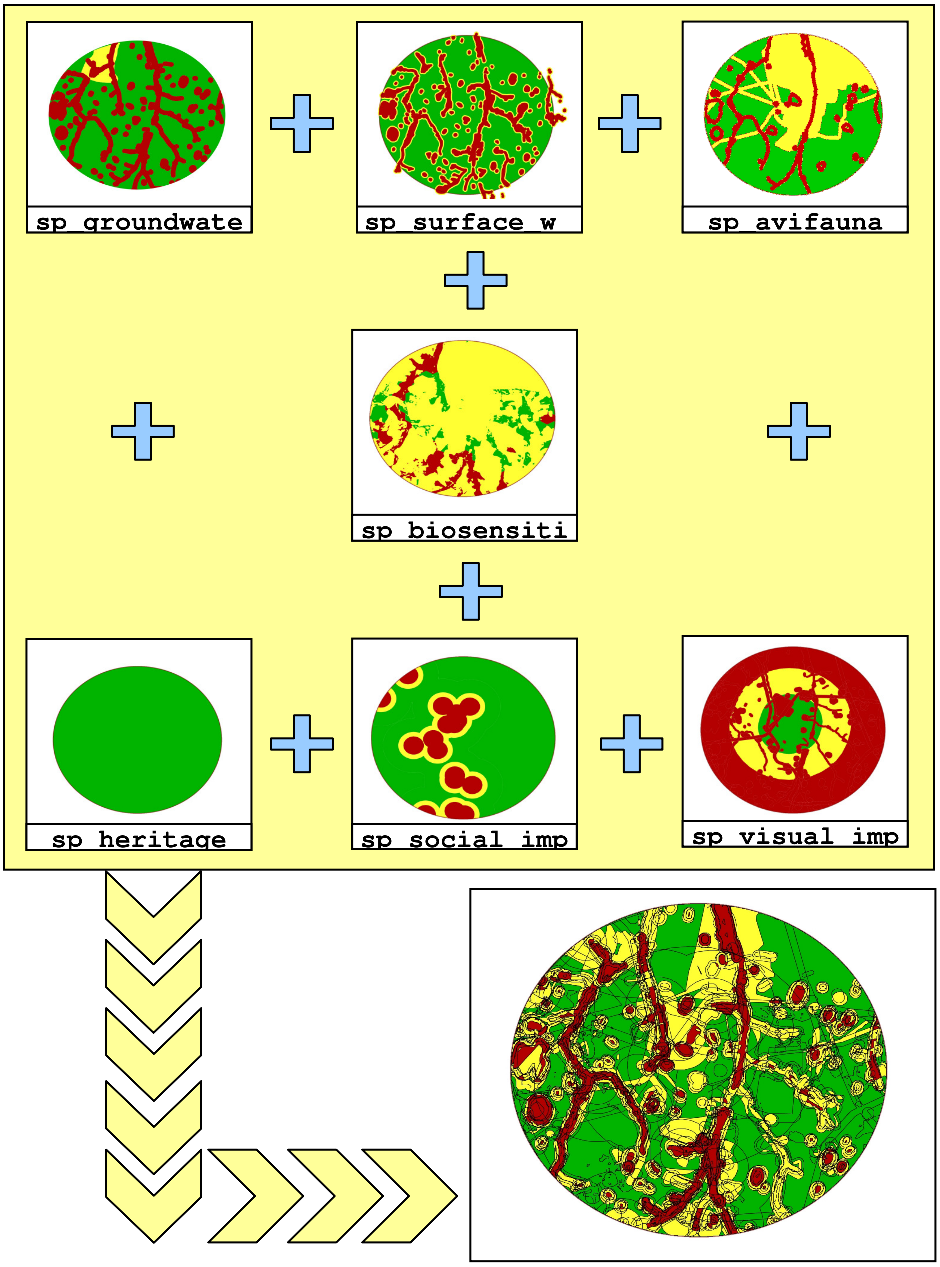
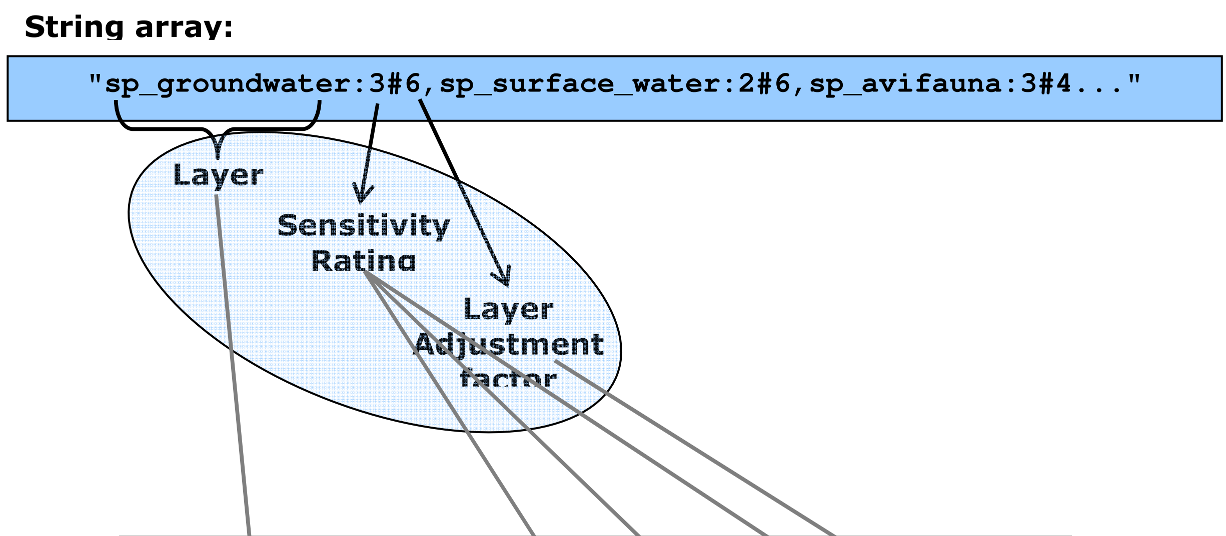


Figure 4.2: Layer integration



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 4.3: 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 4.2**)
- Client ratings (**Table 4.3**)
- Combined ratings (**Table 4.4**)

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 4.2: Specialist and Lidwala Project Team ratings

	Specialists and Lidwala Project Team												
Aspect	Social	Fauna and Flora	Surface Water	Ground water	Design	Geotech	Avifauna	Project Manager	GIS	Soil	Final Total	Number participants	Average Rating
Social	3	1	2	3	2	2	1	2	1	1	18	10	1.80
Fauna and flora	2	3	2	2	1	1	3	2	2	2	20	10	2.00
surface water	2	3	3	3	2	2	2	3	3	2	25	10	2.50
groundwater	2	3	3	2	2	2	2	3	3	2	24	10	2.40
heritage	1	2	2	1	1	1	1	1	1	1	12	10	1.20
visual	2	2	1	1	3	3	1	2	1	1	17	10	1.70
technical and cost	1	1	1	3	3	3	1	3	2	1	19	10	1.90
Avifauna	2	3	2	2	2	2	3	2	3	1	22	10	2.20

Table 4.3: Client ratings

	Eskom Team					
Aspect	Env	Civil	Mech	Final Total	Number participants	Average Rating
Social	2.5	1	2	5.5	3	1.83
Fauna and flora	2	3	1.75	6.75	3	2.25
surface water	2.5	3	2.25	7.75	3	2.58
groundwater	2.5	3	2.25	7.75	3	2.58
heritage	1	2	1.5	4.5	3	1.50
visual	1.5	1	1.25	3.75	3	1.25
technical and cost	2	2	2.75	6.75	3	2.25
Avifauna	1.5	2	1.75	5.25	3	1.75

Table 4.4: 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	18	10	1.80	5.5	3	1.83	23.5	13	1.81
Fauna and flora	20	10	2.00	6.75	3	2.25	26.75	13	2.06
surface water	25	10	2.50	7.75	3	2.58	32.75	13	2.52
groundwater	24	10	2.40	7.75	3	2.58	31.75	13	2.44
heritage	12	10	1.20	4.5	3	1.50	16.5	13	1.27
visual	17	10	1.70	3.75	3	1.25	20.75	13	1.60
technical and cost	19	10	1.90	6.75	3	2.25	25.75	13	1.98
Avifauna	22	10	2.20	5.25	3	1.75	27.25	13	2.10

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

- Social = 1.81
- Fauna and Flora = 2.06
- Surface Water = 2.52
- Ground Water = 2.44
- Heritage = 1.27
- Visual = 1.60
- Avifauna = 2.10
- Technical and Cost = 1.98

4.4.2 Final Screening Results

- ***<u>Consolidated Biophysical Sensitivity</u>***

The individual biophysical maps were overlaid and integrated to form the following combined biophysical sensitivity maps utilising the methodologies indicated above.

It can be noted that in terms of biophysical criteria, the most sensitive areas are those surrounding surface water structures, it will therefore be critical to ensure that the areas are avoided in terms of the identification of alternative sites.

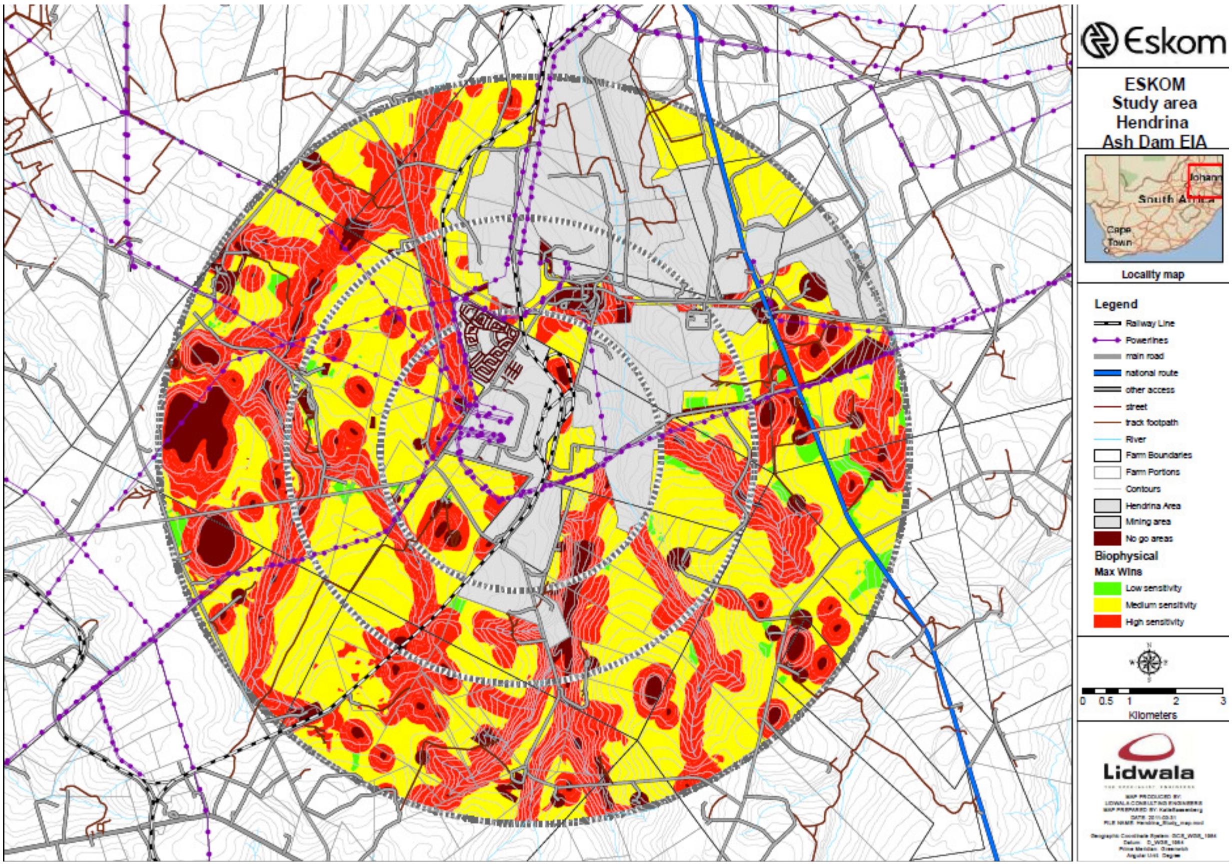


Figure 4.4: Combined Biophysical Sensitivity (Max Wins)

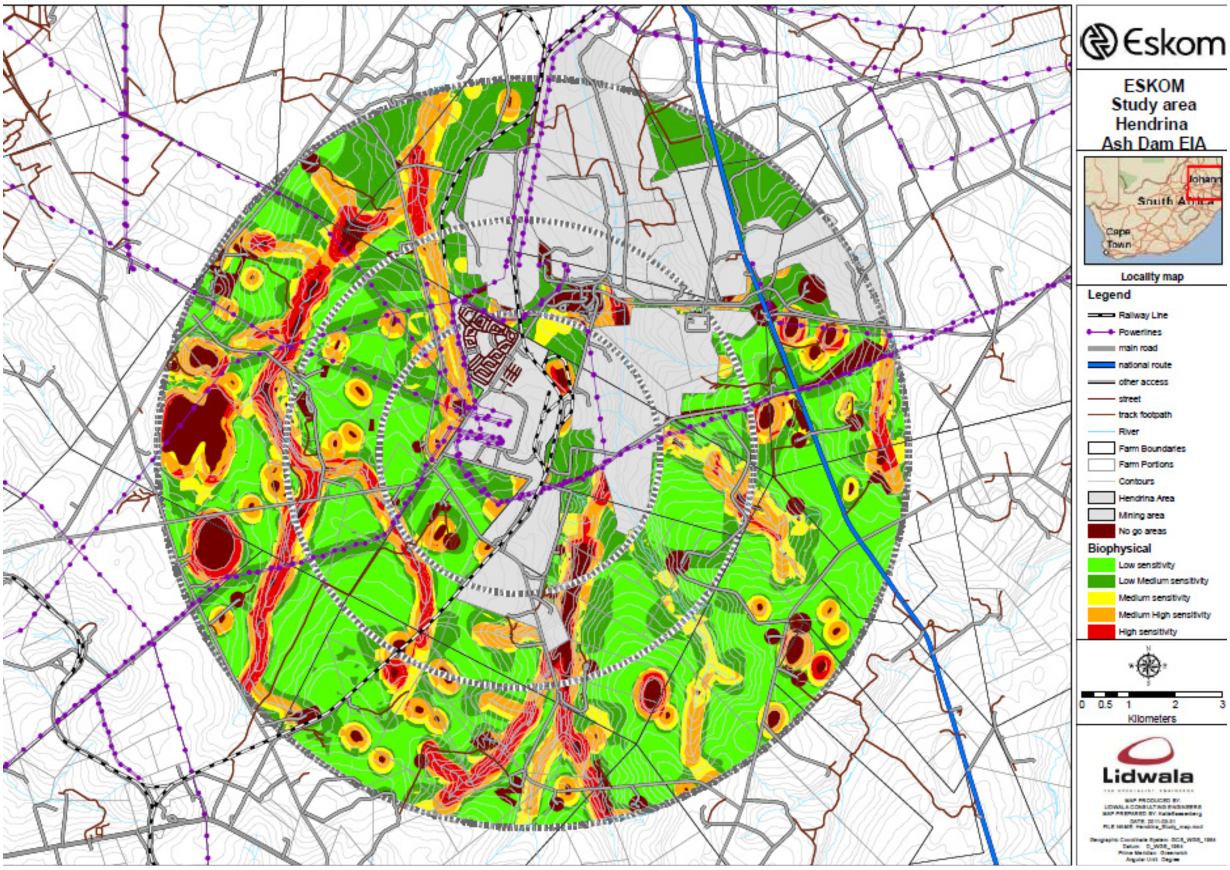


Figure 4.5: Combined Biophysical Sensitivity (no factor)

- ***Consolidated Social Sensitivity***

The individual social maps were overlaid and integrated to form the following combined social sensitivity maps utilising the methodologies indicated above.

It can be noted from the combined social sensitivity map that the closer the proposed new ash dam is to the power station, the better. It can clearly be seen that the sensitivities in terms of the social environment increase as one moves further from the power station.

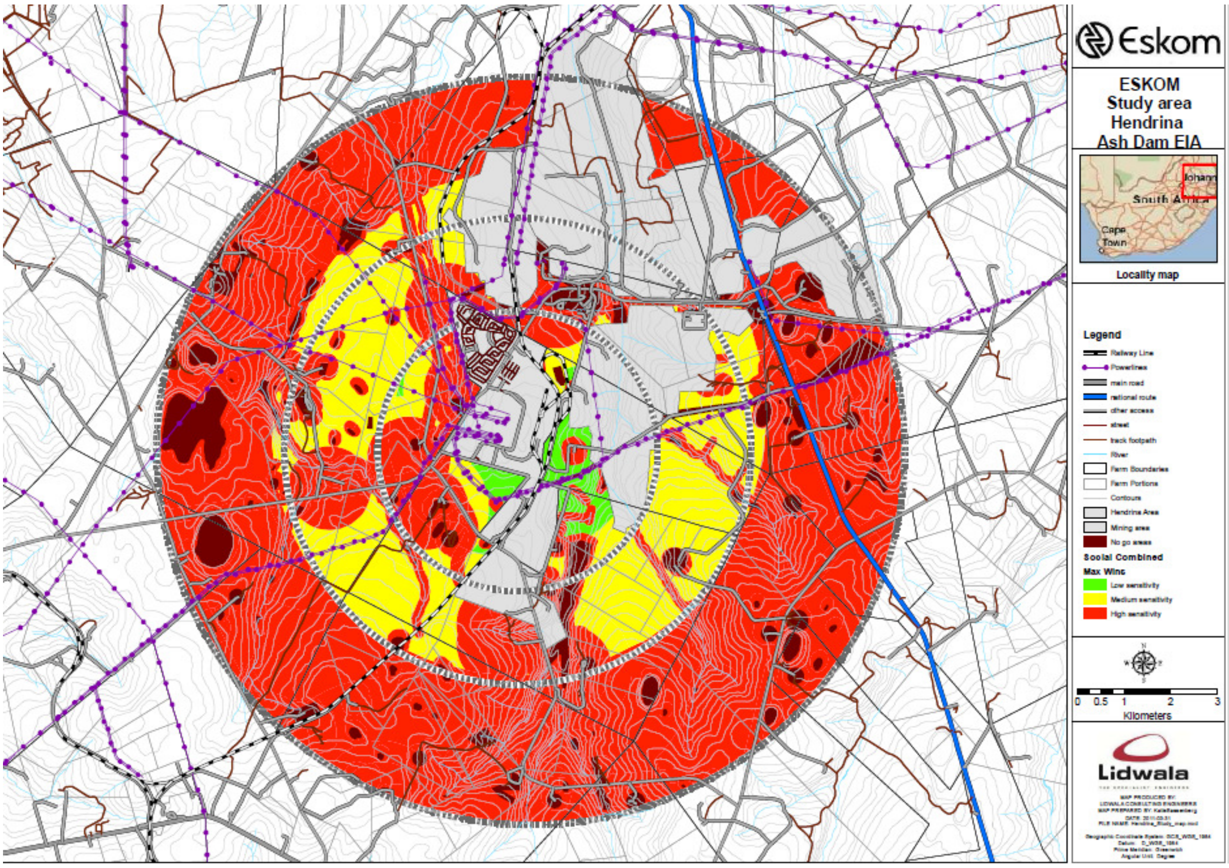


Figure 4.6: Combined Social Sensitivity (Max Wins)

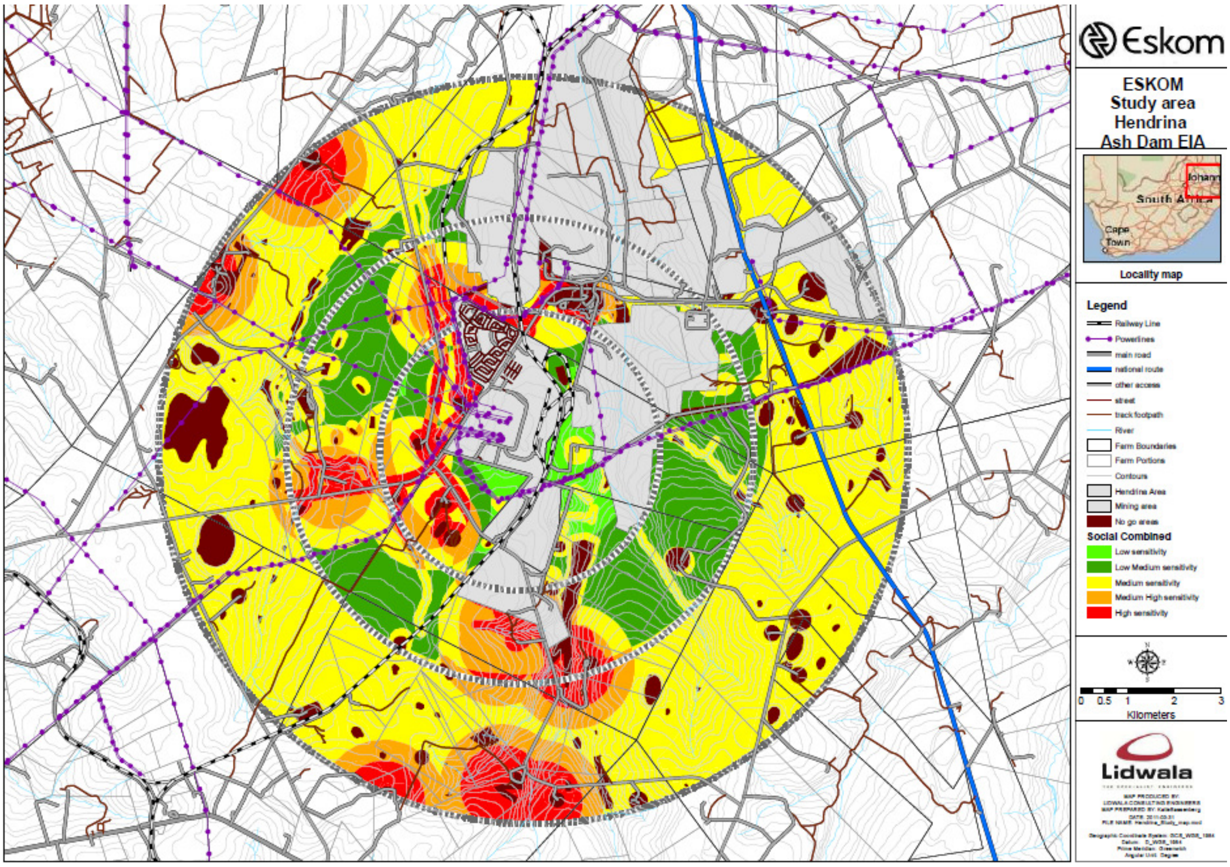


Figure 4.7: Combined Social Sensitivity (no factor)

- ***Final Combined Sensitivity Maps***

Figure 4.8 to **4.13** are the results of overlaying the social, biophysical and technical input maps together, thereby illustrating the overall environmental sensitivity of the area. These maps have been done both with and without the influence of the technical / cost layer in order to ensure that this aspect did not overshadow / influence the outcome of the mapping process.

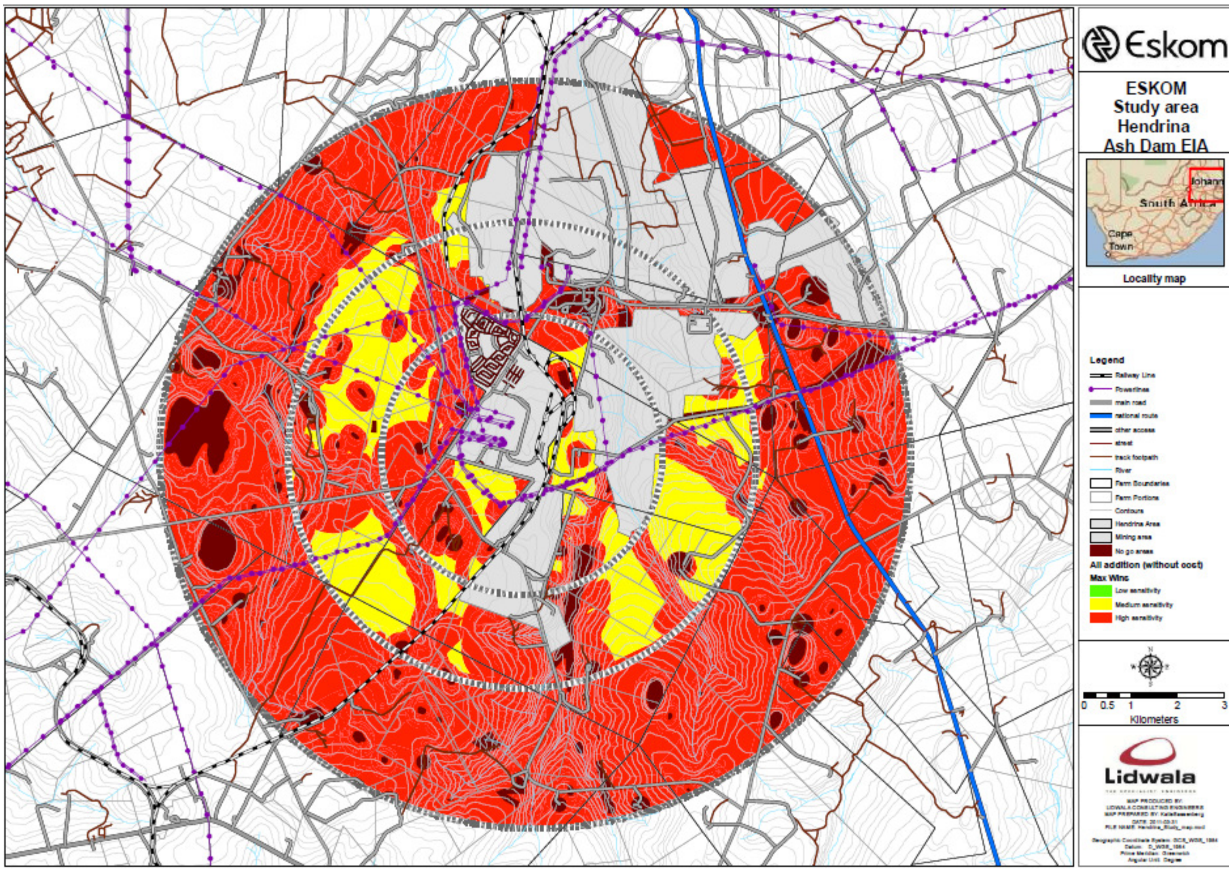


Figure 4.8: Overall Environmental Sensitivity (Max Wins – without technical / cost)

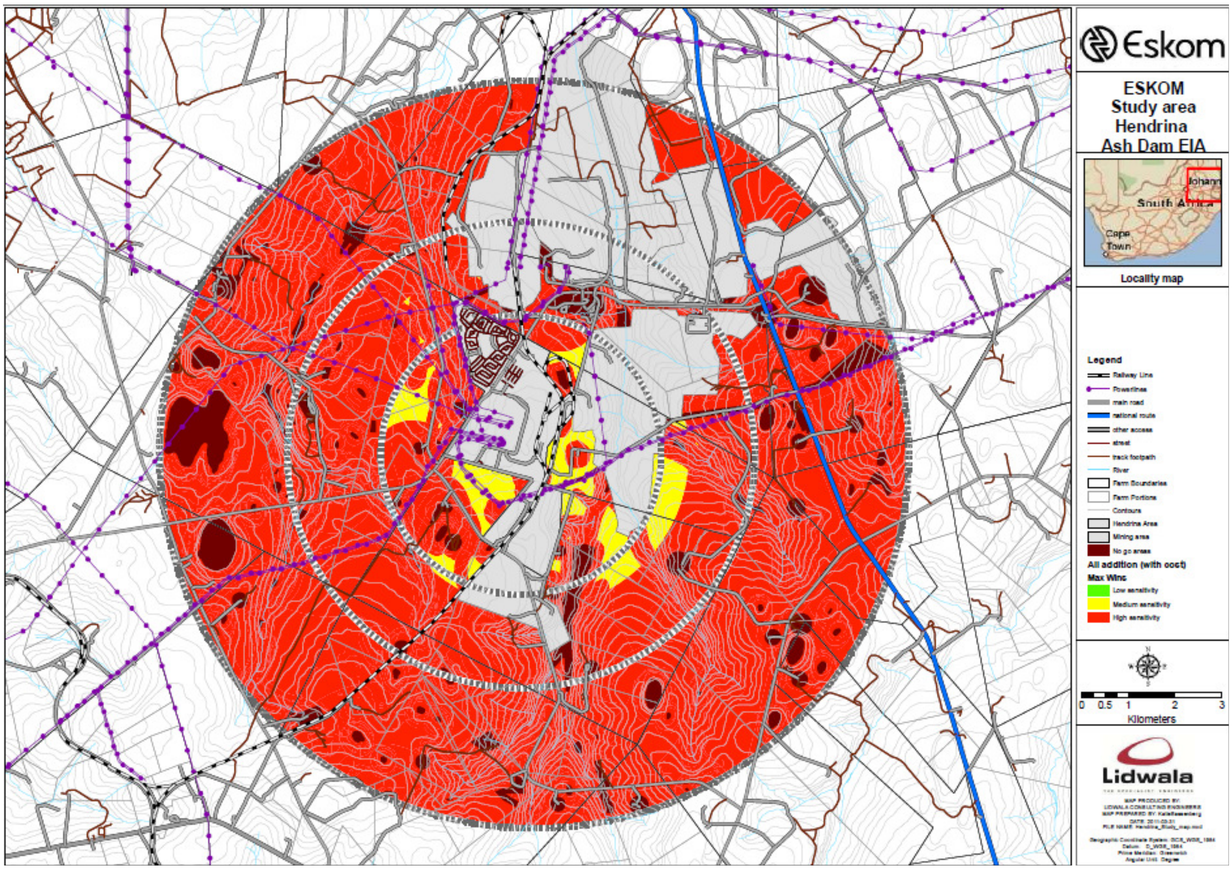


Figure 4.9: Overall Environmental Sensitivity (Max Wins – with technical / cost)

In terms of the "Max wins" mapping system, the technical / cost layer does influence the outcome with far fewer areas being considered suitable for the placement of the proposed new ash dam.

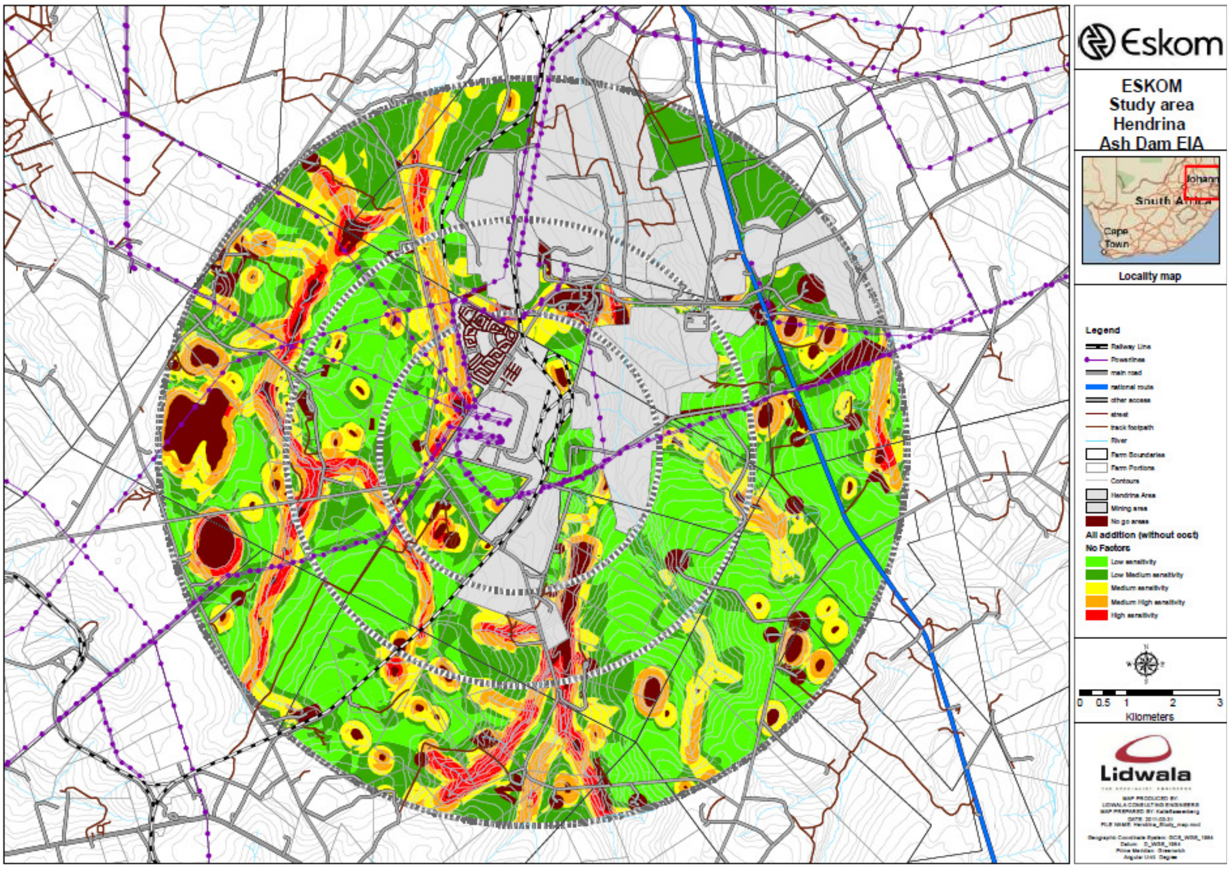


Figure 4.10: Overall Environmental Sensitivity (no factor – without technical / cost)

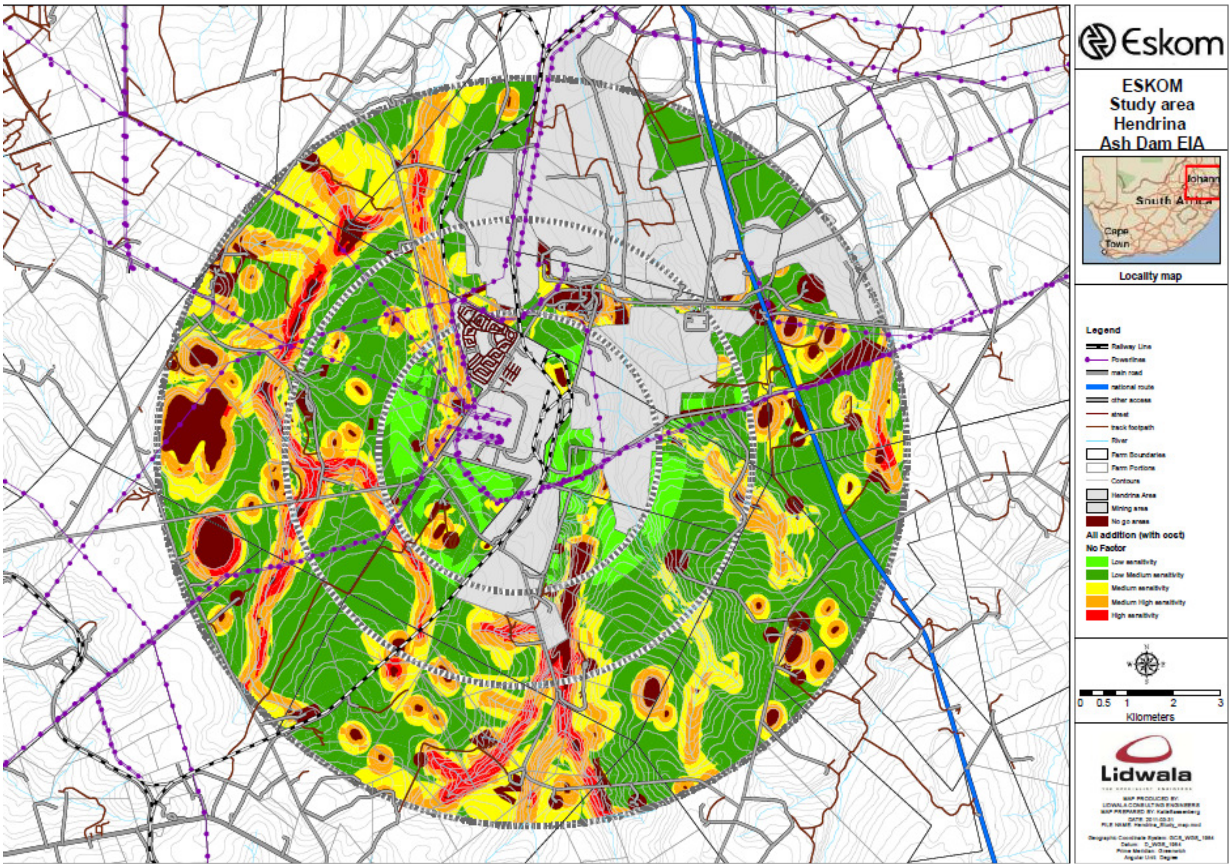


Figure 4.11: Overall Environmental Sensitivity (no factor – with technical / cost)

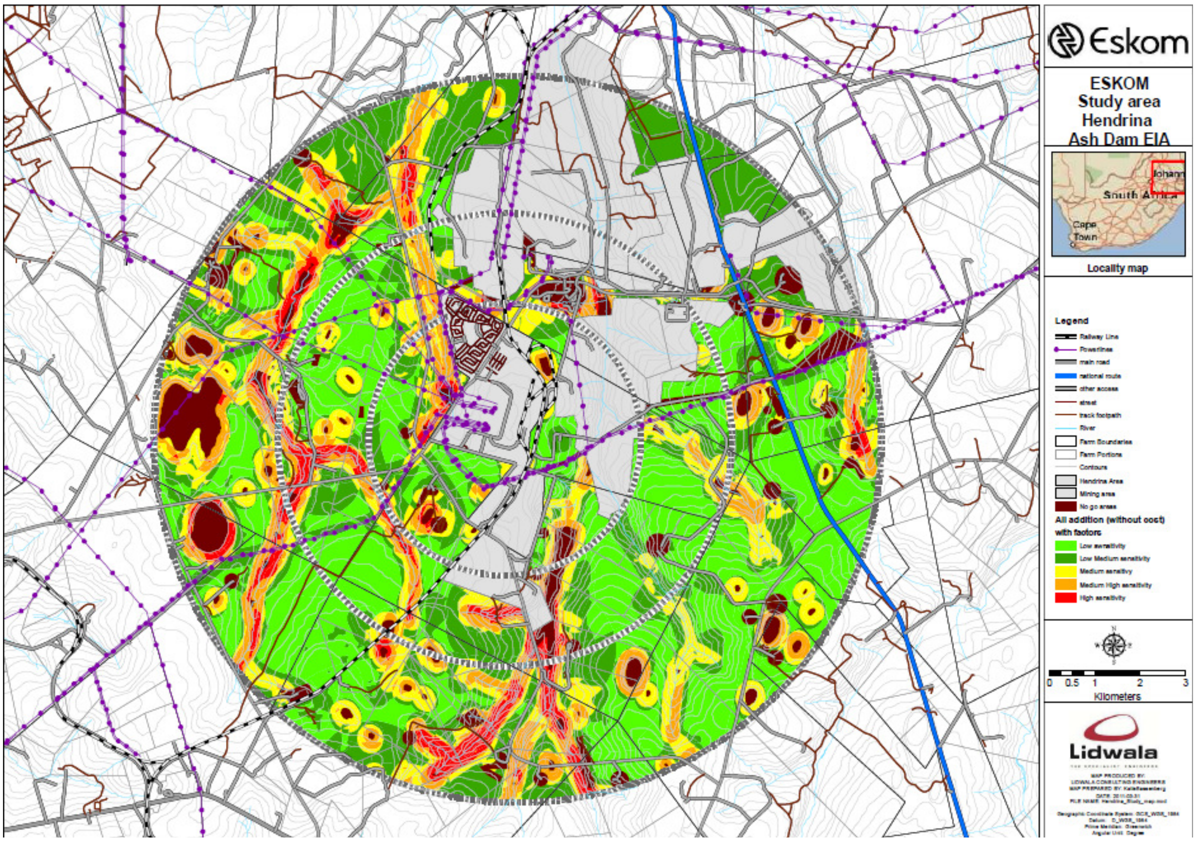


Figure 4.12: Overall Environmental Sensitivity (Adjustment factor included - without technical / cost)

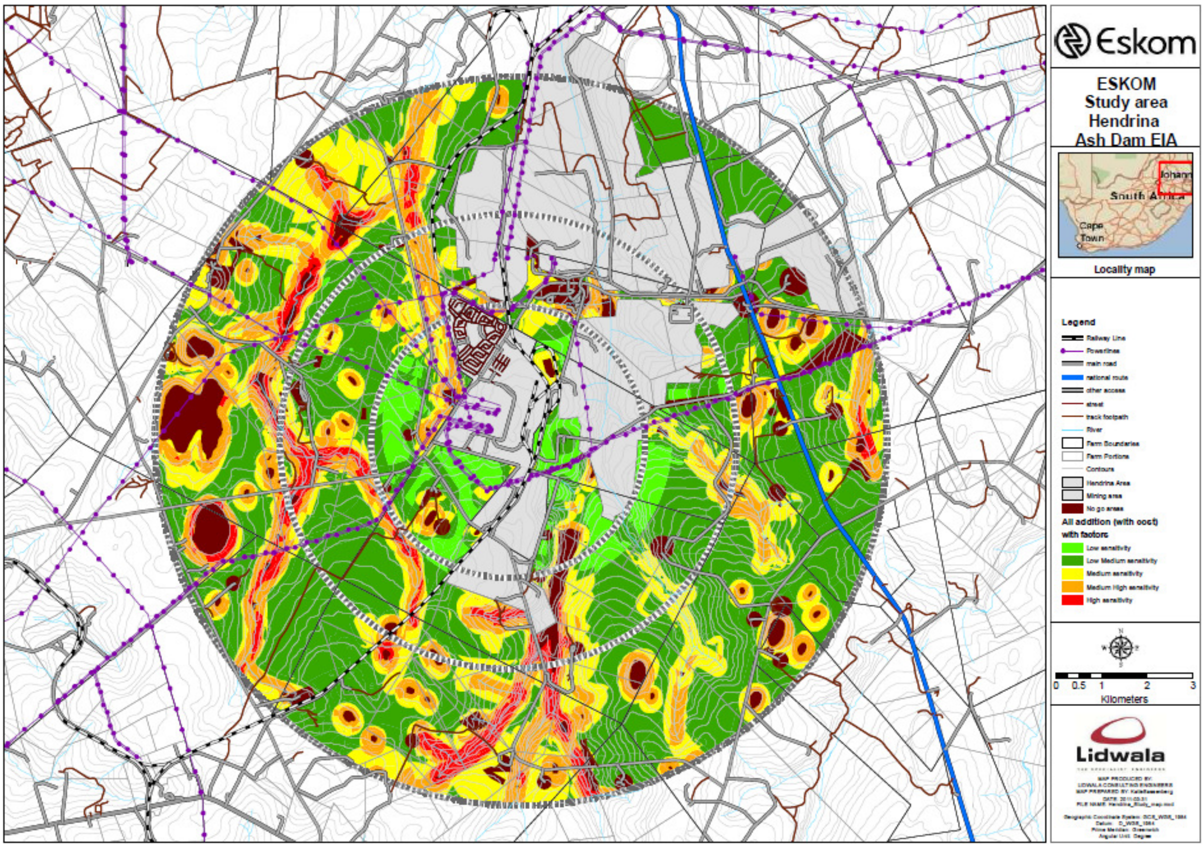


Figure 4.13: Overall Environmental Sensitivity (Adjustment factor included - with technical / cost)

Utilising the straight forward addition analysis including the cost layer (**Figure 4.11**) it can be concluded that the overall sensitivity of the study area falls within the low-medium to medium-high sensitivity range with only small areas being considered of low or high sensitivity. Where the cost layer has been removed the sensitivity reduces to an overall sensitivity of between low and medium (**Figure 4.10**). However, if one utilises the "max wins" (**Figure 4.8**) 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 closer to the power station. Once again the cost layer increases the overall sensitivity of the area by reducing the areas available for site selection. From the above analysis it is clear that the proposed new ash dam needs to be placed as close to the power station as possible.

The above maps were then utilized in order to determine the least sensitive areas of sufficient size to be considered as alternative sites for the proposed new ash dam at Hendrina Power Station. Alternative sites were required to be at least 209 ha in size and where required to fit within the low and low-medium sensitivity areas only.

Figure 4.14, 4.15 and **4.16** indicate the five alternative sites that will be evaluated and assessed in the EIA studies.

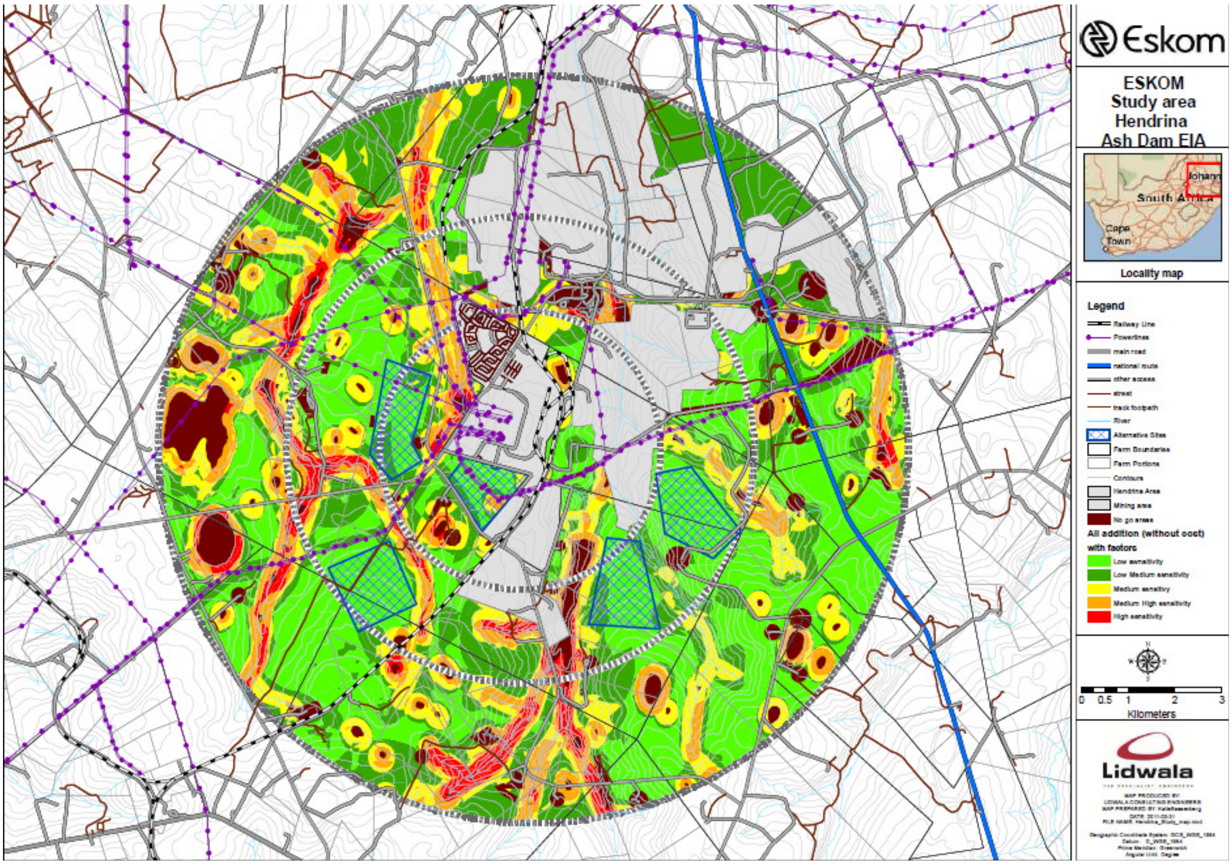


Figure 4.14: Recommended alternative sites (sensitivity map with the adjustment factors without cost)

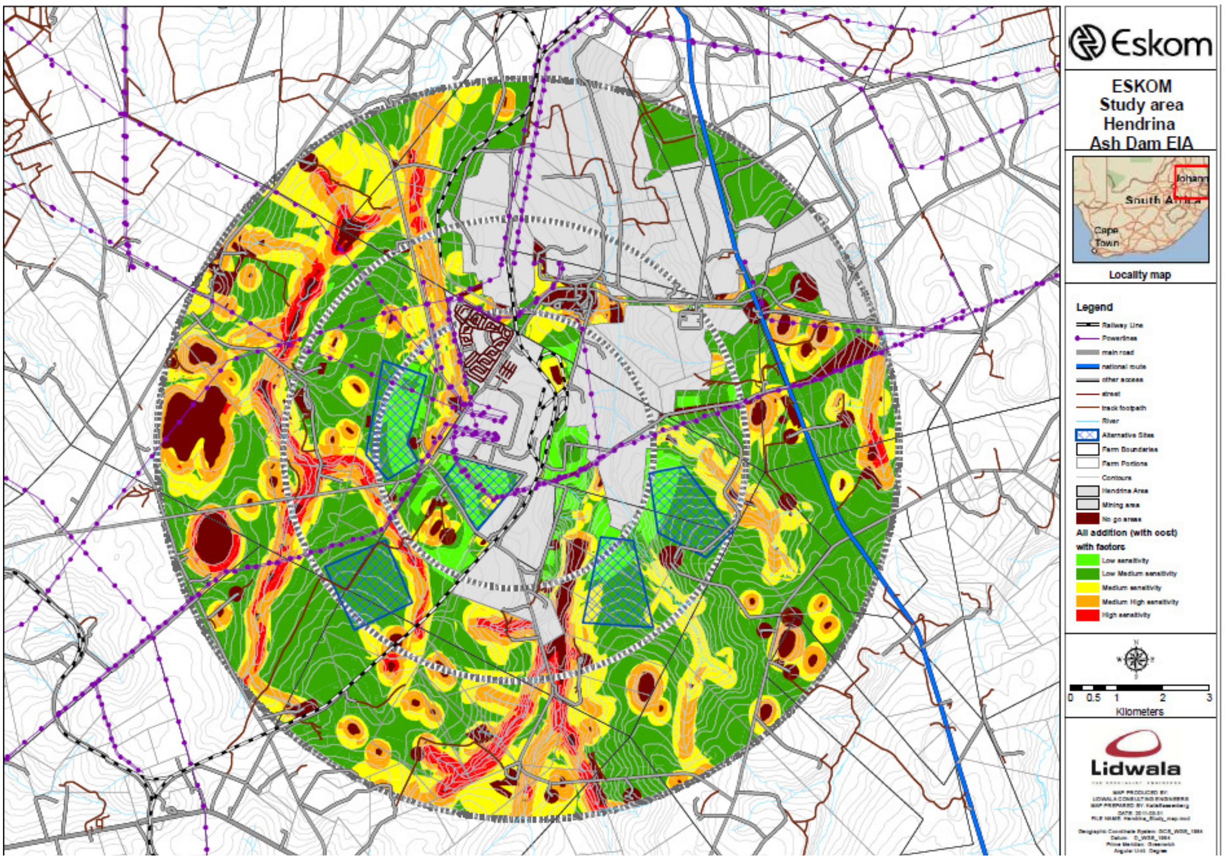


Figure 4.15: Recommended alternative sites (sensitivity map with the adjustment factors with cost)

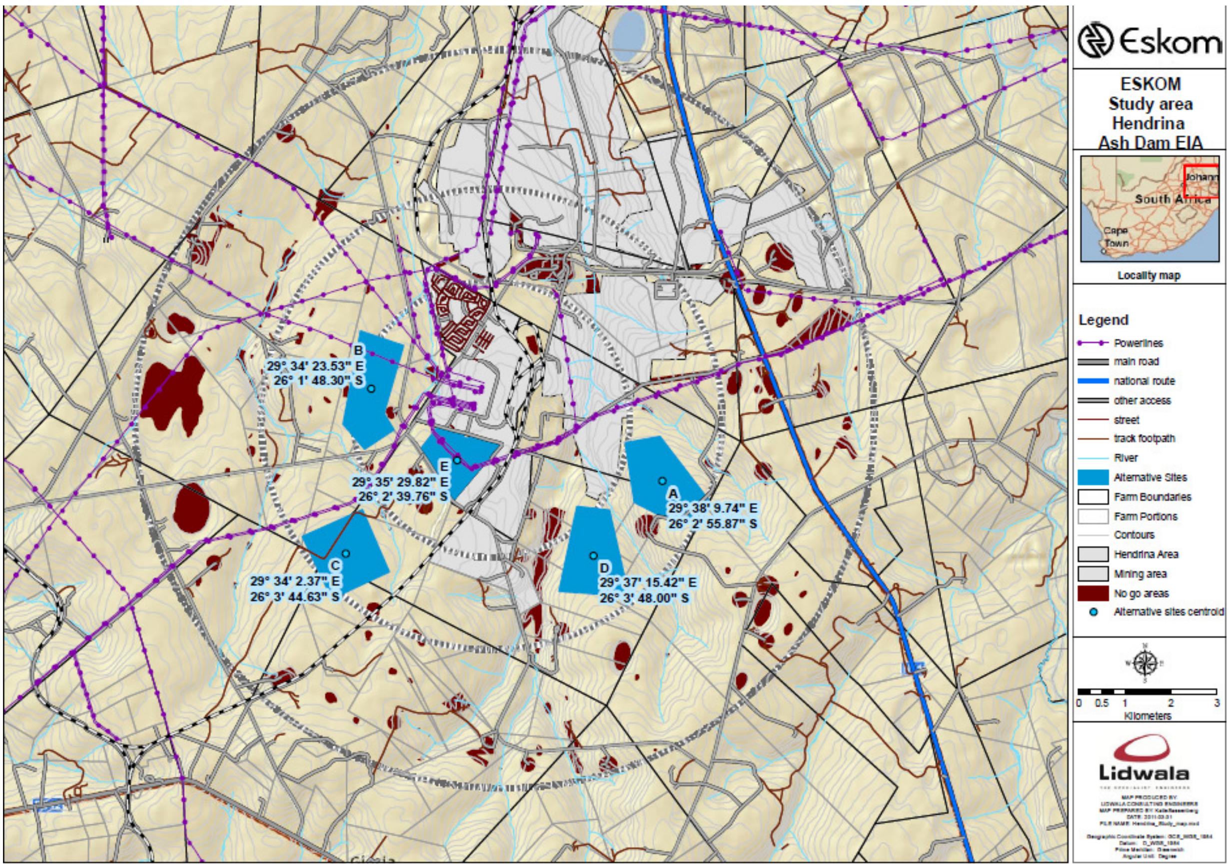


Figure 4.16: Five Alternative sites for further consideration during the Scoping Phase

4.5 Conclusion

This chapter discussed the methodology of how the proposed suitable site alternatives where identified. This report will discuss the five alternative sites identified during the screening phase, in order to identify the most preferred site/s that will be discussed and assessed in greater detail during the EIA phase of the project.

Mitigation 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.