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Majuba Power Station

Majuba Ash Disposal Facilities Continuation: Groundwater Scoping Study

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Lidwala Consulting Engineers

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MAJUBA ASH DISPOSAL FACILITIES CONTINUATION: GROUNDWATER SCOPING STUDY

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ACRONYMS AND ABBREVIATIONS

Below a list of acronyms and abbreviations used in this report.

Acronyms / Abbreviations	**Definition**
L/s	Litres per second
mg/l	Milligrams per liter

EXECUTIVE SUMMARY

This Groundwater report was compiled by SLR Consulting (South Africa) (Pty) Ltd in their capacity as groundwater specialists. A groundwater vulnerability map was produced based on the literature and available infromation. This Scoping Phase report considers the Majuba power station from a groundwater perspective, and assesses the area in terms of the estimated impact on groundwater resources in the area. The work relies on one site visit to Majuba power station, and a review of existing data. All sites close to the power station and the ash disposal facility fall on the same Department of Water Affairs hydrogeological classification (i.e. D2, intergranular and fractured aquifer with expected median borehole yields of 0.1 to 0.5 L/s), and on the same geological formation (Volkrust Formation of the Ecca Group). An area classified as "D3" (i.e. intergranular and fractured aquifer with expected median borehole yields of 0.5 to 2.0 L/s) is found to the south of the area within the 12 km radius of the power station. At this stage of the study, proximity to surface water resources was considered to be the main factor affecting groundwater vulnerability to potential contamination. Surface water courses (both perennial and ephemeral) were buffered by 250 m, and these buffer zones were added to the area classified as "D3" on the hydrogeological map and to a small area of potentially vulnerable Quaternary sediment on the western edge of the area to form a "not preferred" area for the ash disposal facility continuation. Field work and data analysis will allow these zones to be refined in the near future, and will take into account further factors impacting on groundwater.

MAJUBA ASH DUMP EXTENSION GROUNDWATER SCREENING STUDY

1 INTRODUCTION

1.1 BACKGROUND

This Majuba power station groundwater report was undertaken and compiled by SLR Consulting (South Africa) (Pty) Ltd in their capacity as project groundwater specialists.

The purpose of the scoping study was to distinguish less favourable from more favourable areas within an 12 km radius of the Majuba power station on which to site the proposed ash disposal facilities. At this stage of the study,groundwater information is available, and used was made of commonly available national and regional groundwater datasets.

1.2 GEOLOGY AND HYDROGEOLOGY

The site falls within the Carboniferous to early Jurassic aged Karoo Supergroup. Sediments in this part of Mpumalunga 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 Volkrust 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 (Figure 1.1).

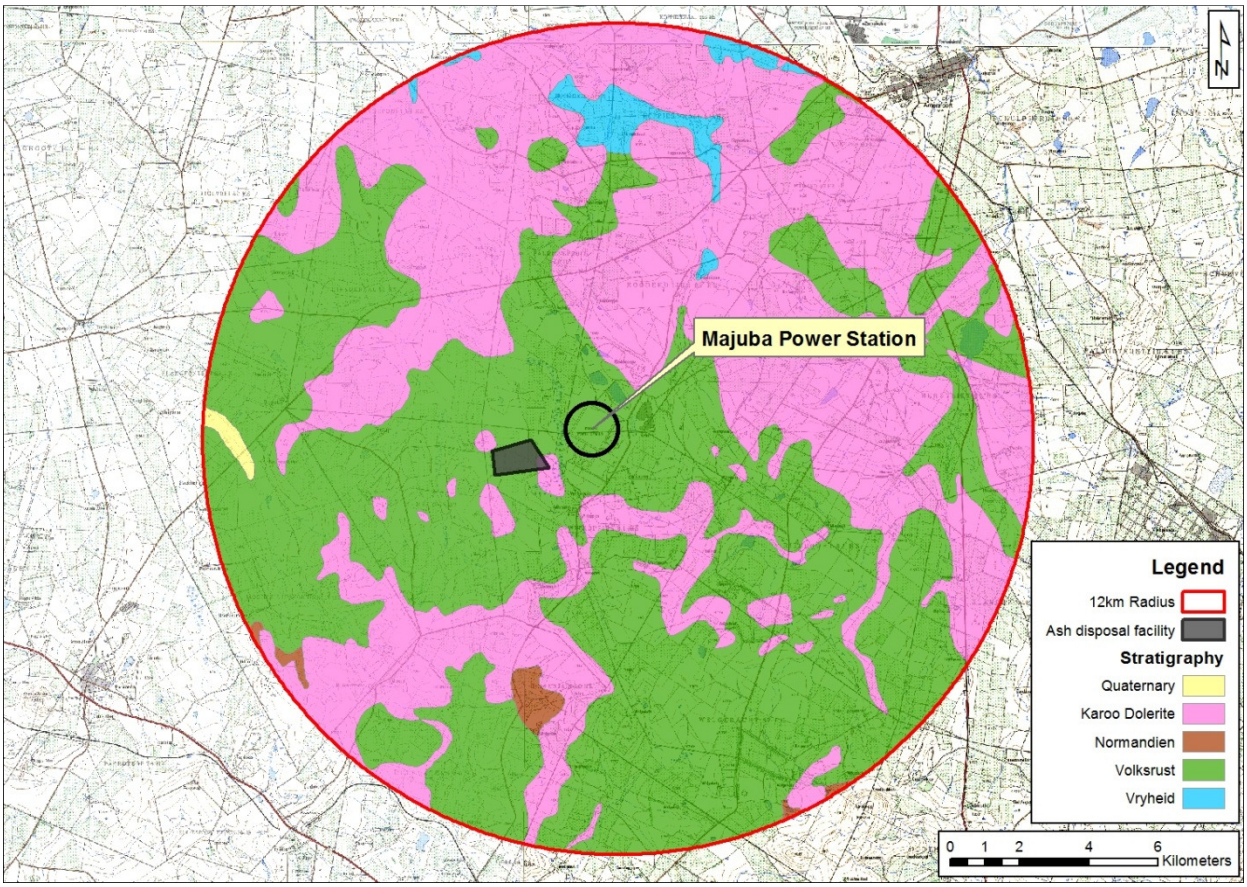

FIGURE 1.1: GEOLOGY OF THE STUDY AREA

1.2.1 AQUIFER CLASSIFICATION

The classification of the aquifer system in the Majuba power station is based on the following modified aquifer system management classes (Parsons and Conrad, 1998):

- Sole Aquifer System: An aquifer used to supply 50% or more of urban domestic water for a given area and for which there are no reasonably available alternative sources of water.
- Major Aquifer System: A high-yielding aquifer system of good quality water.
- Minor Aquifer System: 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).
- Poor Groundwater Region: A low to negligible yielding aquifer system of moderate to poor water quality.
- Special Aquifer Region: An aquifer designated as such by the Minister of Water Affairs and Environment, after due process.

Groundwater storage and transport in the unweathered Volkrust 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 Volkrust Formation is considered to be a **minor aquifer**, with some abstractions of local importance.

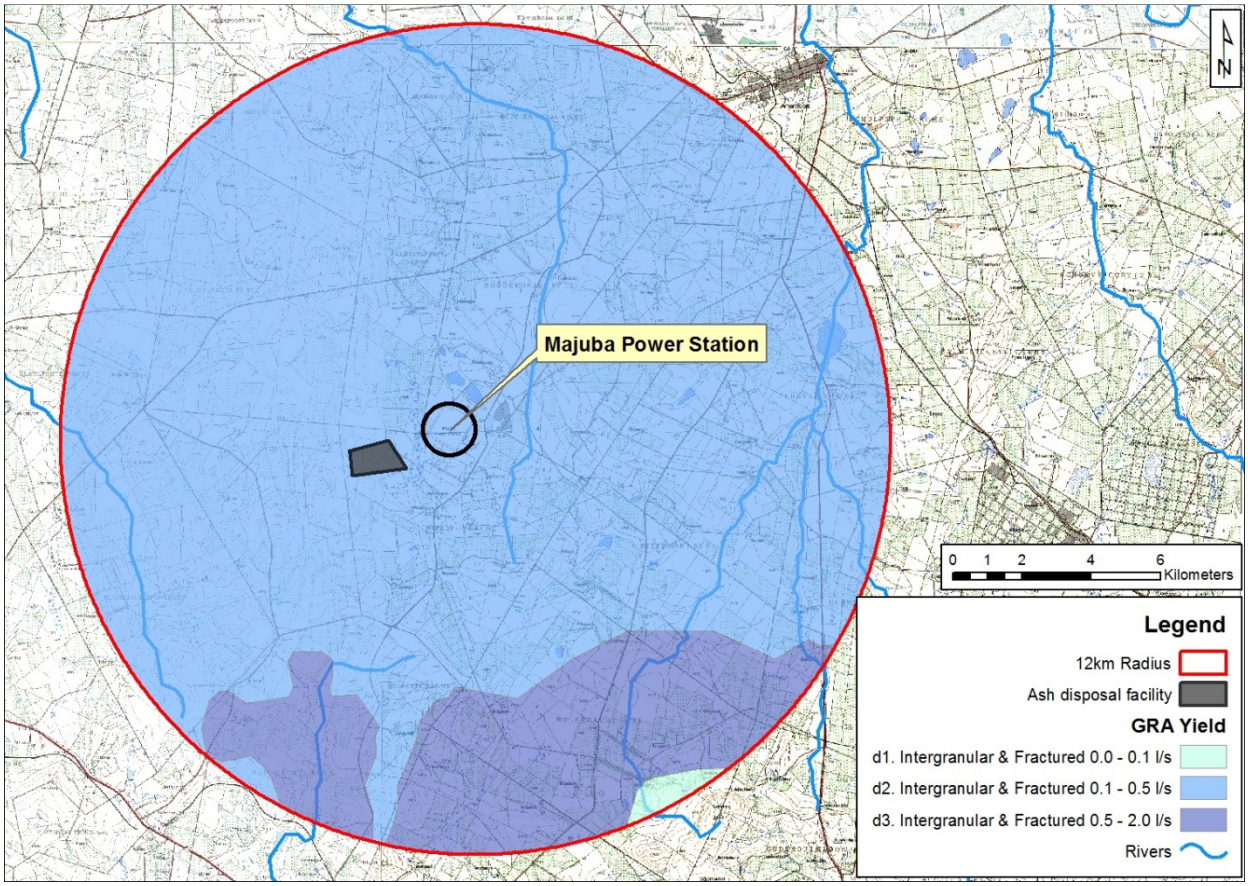

FIGURE 1.2: HYDROGEOLOGY OF THE STUDY AREA.

1.3 PRE-SCREENING PHASE GROUNDWATER STUDY

A sensitivity analysis was completed for the scoping stage of the EIA process, and an interim groundwater vulnerability map 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 within12 km of the power station, combined with a 250 m buffer zone placed around surface water features and information from the geology map. This allowed two zones (more and less favourable) to be defined within the 12 km buffer zone, as shown in Table 1.1 below:

TABLE 1.1: SENSITIVITY CLASSIFICATIONS USED IN THE SCOPING PHASE STUDY

	Description
More favourable	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)
Less favourable	Lies within the 250 m river buffer zones, or falls on D3 aquifer type, or on Quaternary sediment.

See Figure 4.1 for a map of the sensitivity zones.

2 SCOPE AND LIMITATIONS

This study is limited to a consideration of geology and hydrogeology in the study area.. This study relies on available published information about the geology and hydrogeology of the area. It is assumed that the available data is correct in its representation of the groundwater conditions in the area. This document does not evaluate the existing groundwater monitoring and management programme at Majuba; it is assumed that this is in line with best practice (see DWA, 2008 for more information). Further work, including a site investigation, is planned for a later stage of this study and this will include evaluating available previous groundwater studies done at the Majuba power station.

3 METHODOLOGY

3.1 DESCRIPTION OF THE METHODOLOGY/IES USED.

The DWA Best Practice Guideline – Water Management for Mine Residue Deposits (DWA, 2008) suggests that the groundwater impacts of a mine residue deposit (similar to an ash disposal facility) should be identified before a final site is chosen. Suggested criteria (DWA, 2008) include:

- The impact on downstream water users
- Impacts on sensitive or protected areas
- Impacts on any open-cast or underground workings, shafts or occupied premises; the stability of the underground/excavated workings can be affected by possible seepage and the mass of the MRD,
- Effects of seepage on dump stability, and/or
- Groundwater quality impacts

This study restricts itself to a basic consideration of groundwater vulnerability. Areas that fall within 250 m of river courses, or which are underlain by higher-yielding hydrogeology map classes, or which are underlain by Quaternary sediment, are assumed to be more vulnerable. These areas have been classified as "less preferred" at this stage.

3.2 SUMMARY OF EXISTING DATA

The Department of Water Affairs (DWA) have produced a series of 1:500 000 scale hydrogeology maps (General Hydrogeology Map Series), together covering the whole of South Africa. Analysis of median borehole yields and aquifer types has allowed DWA to classify the hydrogeology of the country according to an alphanumeric code incorporating aquifer type and borehole yield, as follows:

TABLE 3.1: GENERAL HYDROGEOLOGY MAP CLASSIFICATION OF SOUTH AFRICA

Aquifer Type	Borehole Yield Class (L/s)				
	Class "1" 0 - 0.1	Class "2" 0.1 - 0.5	Class "3" 0.5 - 2.0	Class "4" 2.0 - 5.0	Class "5" >5.0
Type "a": Intergranular	A1	A2	A3	A4	A5
Type "b": Fractured	B1	B2	B3	B4	B5
Type "c": Karst	C1	C2	C3	C4	C5
Type "d": Intergranular and fractured	D1	D2	D3	D4	D5

The area within an 12 km radius of the Majuba site is mainly classified as "D2" (**Error! Reference source not found.**). The study area is located in quaternary catchment C13D, within the Grootdraai Catchment. The Groundwater Harvest Potential Map of South Africa (Baron et al, 1998) classifies the study area as having an estimated groundwater harvest potential of 15 000 to 25 000 m^3/km^2/year (i.e. relatively low). The average borehole yield is < 0.4 litres per second (L/s), and the total dissolved solids concentration of the (unpolluted) groundwater is between 200 and 300 mg/l (i.e. relatively fresh). The GRA2 data for the quaternary catchment C13D is summarized in Table 3.2 below:

TABLE 3.2: SUMMARY OF THE GRA2 DATA

QUATERNARY CATCHMENT	C13D
Area (km^2)	895
Average water level (metres below ground level)	10.95
Volume of water in aquifer storage (Mm^3/km^2)	589.8
Specific Yield	0.003
Harvest Potential (Mm^3/a)	12.7
Contribution to river base flow (Mm^3/a)	8.3
Utilizable groundwater exploitation potential in a wet season (Mm^3/a)	7.3
Utilizable groundwater exploitation potential in a dry season (Mm^3/a)	4.9

3.3 CRITERIA USED TO RANK STUDY AREA

At this stage a simple system based on the hydrogeology map classification, the geology map of the area, and buffer zones around surface water courses was used to provide a preliminary classification into "less preferred" and "preferred" areas. Other factors will be taken into account in future. For example, a site that is close to the existing ash disposal facilities may be preferred, since not only is the ash haulage or pumpage distance reduced, but it is probably easier to monitor and manage leachate at one site than

at two. Sites close to existing mining operations or existing groundwater users are generally not preferred, because of the increased risk of pollution.

4 STUDY AREA OVERVIEW

An area within a 12 km radius of the Majuba power station was considered. The area around the power station is located on similar geology, and shares similar hydrogeological characteristics. At this stage of the Majuba power station area investigation, recharge, aquifer media and vadose zone media are assumed to be constant across the site.

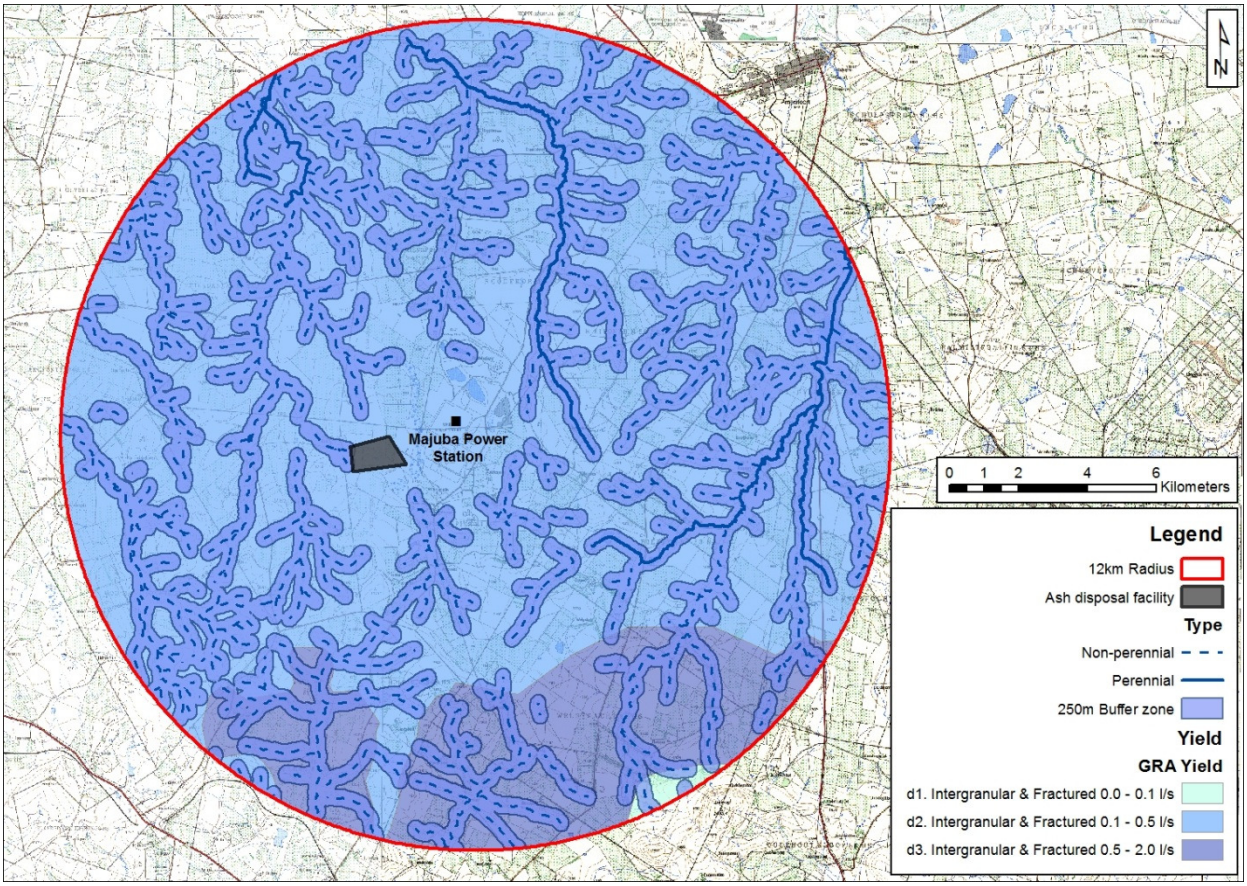

FIGURE 4.1: MAP OF PREFERRED AND LESS PREFERRED AREAS, ON SCOPING MAP BACKGROUND.

Perennial and ephemeral surface water courses derived from the 1:50 000 topgraphy maps were buffered by 250 m using ARC-GIS software since these zones were assumed to have shallower (and therefore more vulnerable) groundwater. In some cases it is possible that shallow groundwater is in hydraulic continuity with surface water features. The final map (Figure 4.1) shows that a combination of the buffered surface water features area classified as “D3” according to the GRA2 yield, and a small area of Quaternary sediment on the western edge of the study area are “less preferred”. Other areas are preferred.

5 CONCLUSION

An area within a 12 km radius around Majuba power station has been evaluated by utilizing basic groundwater and geology data. All sites close to the existing ash disposal facility are located on very similar geology and aquifer type. No major groundwater abstractions are shown on the DWA 1:500 000 scale hydrogeology map of the area (Sheet 2526 Johannesburg) in the area. The study area was divided into more and less preferred zones for the disposal facilities continuation project based on available data. Furthermore, a site that is adjacent to the existing ash disposal facility may be most suitable, since this is likely to minimise infrastructure costs and make groundwater monitoring easier. Further work, including a field investigation, will follow this Scoping Report.

The EIA phase will go into more detail, using existing data including the Department of Water Affairs' (DWA) GRA I and GRA II datasets, the NGDB and the WARMS database. A further site visit will be conducted, and water samples will be taken from accessible boreholes (up to eight samples) and submitted to an accredited laboratory for major and minor ion analysis. This will allow ambient groundwater quality to be characterised, prior to the establishment of the ash disposal facility continuation.

6 REFERENCES

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