Mkhombi Mining (Pty) Ltd

The Cascade Iron Ore Mining Project
Gert Sibande District Municipality, Mpumalanga

Hydrogeology Specialist Screening Report

For review by DMR and Intested and Affected Parties

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Project Information Sheet

PROJECT:
The Cascade Iron Ore Mining Project

PROJECT LOCATION:
Gert Sibande District Municipality, Mpumalanga

SPECIALIST ASSESSMENT DETAILS:
Report Name: The Cascade Iron Ore Mining Project: Hydrogeological Specialist Screening Report
Nature of specialist study: Hydrogeological screening assessment report for Cascade Iron Ore Mining Project
Report Number: X0079/DMR-EIA/SPE-GRW
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The Cascade Iron Ore Mining Project

SPECIALIST SCREENING REPORT

Executive Summary

A screening hydrogeological impact assessment has been done for the proposed Cascade Iron Ore Project using existing available information and a simplistic numerical model.

The study area is underlain by rocks of the Pongola Sequence and associated intrusives. These rocks are expected to be low groundwater yielding (median borehole yields 0.1l/s – 0.5l/s) with the intrusives having slightly higher yields especially at the contact zones where yields of up to 2l/s can be obtained.

Numerous boreholes exist in the area and are used mainly for water supply to communities and farmsteads. Water levels are generally shallow with flow towards the rivers and streams. Recharge is high (85 mm/a) due mainly to the high rainfall in the area. Most of the recharge (up to 95%) sustains the baseflow in the rivers and streams. Any significant abstraction will thus have an impact on flow in the rivers.

The groundwater quality is excellent and is a Ca/Mg Bicarbonate type water, which suggests the groundwater was recently recharged.

The pre-mining hydrogeological environment has been affected by various forestry and other agricultural activities probably reducing recharge and abstracting water from the shallow water table. This could have resulted in the seasonal drying up of some springs and a local lowering of the water table. The impacts of the pre-mining activities are however expected to be very low.

A simplistic groundwater model was set up to determine the impacts of the mine on groundwater levels and to determine potential inflows into the pits. The results show that the impact on water levels (drawdown > 1m) extends over some 6 300ha of which about 65% is outside the mining right area to the north. Significant impact on water levels (drawdown > 10m) extends over some 2 700ha of which about 50% is outside the mining right area. Further, the model shows that inflows into the pits can be as much as 2 300 m³/day depending on the extent and depth of the pits. This could result in a decrease in the baseflow to the rivers and streams of up to 2 100 m³/day. The assessment was conducted for mining of the entire mining blocks as indicted on Figure 4.1 and Figure 7.8.1. Based on the proposed mine plan, only about 12% of the ore in the mining blocks will be mined (~120 million tonnes over 20 years, of the ~1000 million tonnes of ore that are potentially available within the mining blocks.

Other impacts of the mine could be hydrocarbon pollution of the aquifers due to oil and fuel spillages by construction and production vehicles, decrease in water quality due to increased salt loads and other pollutants from treated sewage effluent and the mining process. The formation of acid mine drainage is unlikely as there is little or no sulphides associated with the ore body (Magnetite, FeO. Fe₂O₃ and Hematite, Fe₂O₃).

The impact assessment shows that potential impacts of the proposed Cascade Iron Ore Mine on the groundwater are manageable and that further more detailed studies be initiated to confirm these findings.
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List of Abbreviations

EIA    Environmental Impact Assessment
ha    Hectares
mamsl  Metres above mean sea level
mbgl  Metres below ground level
mm/a  Millimetres per annum

Terms and Definitions

Aquifer
A formation, group of formations, or part of a formation that contains sufficient saturated permeable material to yield economical quantities of water to boreholes, wells or springs

Baseflow
Sustained low flow in a river during dry or fair weather conditions, but not necessarily all contributed by groundwater; includes contributions from interflow and groundwater discharge.

Baseline Environment
Pre-development environmental conditions. The prevailing environmental conditions (or status quo) prior to the start of an activity or project, including current / existing environmental damage / degradation.

Baseline Impacts (Existing Impacts)
The current level of environmental degradation associated with existing developments, including those currently under construction. Determination of the current level of degradation associated with existing developments is essential to understand and enable the assessment of cumulative impacts.
Community
A group of historically disadvantaged persons with interest or rights in a particular area of land on which the members have or exercise communal rights in terms of an agreement, custom or law: Provided that, where as a consequence of the provisions of the Mineral and Petroleum Resources Development Act (MPRDA) negotiations or consultations with the community are required, the community shall include the members or part of the community, directly affected by prospecting or mining, on land occupied by such members or part of the community.

Cone of Depression
A depression in the groundwater table that has the shape of an inverted cone and has developed around an abstraction point where groundwater is being withdrawn. It defines the area of influence of the abstraction.

Cumulative Impacts
Combined impacts of two or more activities, or the combined impacts of an activity with that of current activities. For this report, cumulative impacts are described as:
Existing Impacts + Incremental Impacts of the Project = Cumulative Impacts

Drawdown
The distance between the natural water table and the surface of the cone of depression

Environment
Surroundings in which organisms operate, including air, water, land, natural resources, flora, fauna, humans and their inter-relations (includes bio-physical and socio-economic components).

Environmental Impact Assessment (EIA)
An EIA is an assessment of the positive and negative environmental consequences of the proposed project. The primary objective of the EIA is to aid decision-making by providing factual information on the assessment of these impacts, and determining their significance, as well as making valued judgements in choosing one alternative over another. For this EIA a combination of checklists, overlays and mapping, scoping and professional experience will be used to identify the possible negative and positive impacts on the environmental components.

Fatal Flaw
A factor or situation, which prevents the development of an environmentally acceptable project, except at prohibitive cost. These are critical issues with the ability to stop a project’s implementation.

Hydrogeology
Those factors that deal with subsurface waters and the related geologic aspects.

Incremental Impact
This is the impact of an activity looked at in isolation (impact of an individual activity), thus not considering the combined, cumulative or synergistic impacts of the activity, or the cumulative impacts of the activity with other activities or the current level of degradation.
Interested and Affected Parties (IAP's)
These are individuals or groups concerned with or affected by the environmental impacts and performance of a project. Interested groups include those exercising statutory environmental control over the project, local residents/communities (people living and/or working close to the project), the project’s employees, customers, consumers, investors and insurers, environmental interest groups, the general public, etc. It covers:

- Host Communities
- Landowners (Traditional and Title Deed owners)
- Traditional Authority
- Land Claimants
- Lawful land occupier
- The Department of Land Affairs,
- Any other person (including on adjacent and non-adjacent properties) whose socio-economic conditions may be directly affected by the proposed prospecting or mining operation
- The Local Municipality
- The relevant Government Departments, agencies and institutions responsible for the various aspects of the environment and for infrastructure which may be affected by the proposed project.

Interflow
The rapid flow of water along essentially unsaturated flow paths, water that infiltrates the subsurface and moves both vertically and laterally before discharging into other water bodies.

Piezometry
An imaginary surface representing the total head of groundwater in a confined aquifer that is defined by the level to which the water will rise in a borehole

Receptor
A receptor is the target or object on which the impact, stressor or hazard is expected to have an effect.

Sensitive Area
A sensitive area or environment can be described as an area or environment where a unique ecosystem, habitat for plant and animal life, wetlands or conservation activity exists. Sensitive areas are often associated with eco-tourism activities or have a high potential for future eco-tourism.

Significant Impact
An impact can be deemed significant if scientific environmental studies, consultation with the relevant authorities and other interested and affected parties, on the context and intensity of its effects, provide reasonable grounds for mitigating measures to be included in the environmental management report and environmental management programme. The onus will be on the proponent to include the relevant authorities and other interested and affected parties in the consultation process. Present and potential future, cumulative and synergistic effects should all be taken into account.
1. Description of Proposed Project

1.1 Location of the Project

The proposed The Cascade Iron Ore Project is situated ~350 km south-east of Johannesburg, between the towns of Amsterdam and Piet Retief along the R33 provincial road. The area is located in the Mkhondo Local Municipality, Gert Sibande District Municipality, and Mpumalanga Province, and is just west of the Swaziland border.

1.2 Project Size and Life of Mine

The mining right application covers an area of approximately 8,000 ha in extent on the farms: Remaining Extent (R/E) of Farm Cascade 442 IT, Portion 1 – 9 and R/E of Farm Ishelo 441 IT, Portion 4 and R/E of Farm Haarlem 443 IT.

The proposed iron ore mine is planned as an opencast mining operation. Based on the results of a conceptual mine planning study that was completed in 2012, Mkhombi Mining is proposing to develop an opencast mine with an iron ore concentrate output of 2 Million tonnes per annum (Mtpa). The reason for the 2 Mtpa concentrate output is due to the fact that it has become apparent that there is potential for 2 Mtpa rail capacity to be available on the coal line to Richards Bay and furthermore, there is potential access to facilities at the port of Richards Bay to export iron ore pellets.

The conceptual mine planning study stated that the mineral resource on the farm The Cascade is sufficient to support a mining project with a 2 Mtpa concentrate output for more than 20 years. 6 Million tonnes of run off ore will be mined per annum in order to produce 2 Mtpa of pelletized iron ore concentrate. Thus, for a 20 year life of mine, 120.5 million tonnes of ore will be mined from the open pits. With a waste to ore strip ratio of 1.61:1, some 194 million tonnes of waste will have to be mined to access all the ore.

1.3 Mining Method

On the farm, The Cascades 442 IT, the iron ore bearing magnetite has been identified in three distinct minable blocks that outcrop on surface. The mineable blocks are separated from each other by a series of horst and or graben structures. The deposits are generally tabular in nature with gentle dips that vary between 7-15 degrees. Anomalous deposit dips of up to 25 degrees are present sporadically across the property. For this type of ore body outcropping to surface, the conventional drill, blast, load and haul open cast mining would be adopted. There is no free dig material so all material will be drilled and blasted from the start of mining.

1.4 Overview of the Mining and Operational Process

The envisaged overall process from pit to port involves the following:

- Mining of iron ore resource on the farm The Cascade.
- Processing of mine ore to produce a fine concentrate on the mining area.
• Slurry transport, via pipeline, of the concentrate fines from the mining area to the existing Wildrand rail siding.
• Dewatering of the concentrate at the rail siding.
• Pelletising of the concentrate at the rail siding.
• Storage and loading of the pellets onto rail trucks and transport to Richards Bay Port.
• Storage and handling of the pellets onto vessels for export.

1.5 Concentrator Plant

Processing of mine ore to a concentrate will consist of the following:
• Primary milling and magnetic separation.
• Ball milling and secondary magnetic separation.
• Fine milling and third stage magnetic separation.
• Cleaning of the concentrate through flotation.

1.6 Tailings Storage Facility

The mine will produce 4,250,000 tonnes of tailings per annum over the 20 year life of mine. The total volume of tailings to be deposited 53,125,000 m³ over the mine life. The tailings storage facility will be approximately 180 hectares, or an area of 1298 x 1388 metres, which includes the tailings dam, the external paddocks, solution trench, road around the tailings dam and the return water dam. It will have a final height of 34 to 40 m, and overall slope of 1:3.

The dam will be constructed with a clay underliner to prevent seepage of water associated with the tailings into the groundwater. Return water from the tailings dam will be decanted via a penstock system to the return water dams prior to being returned to the plant for reuse. It is likely that a cyclone deposition system will be employed, to allow the coarse size fraction in the tailings to be used for wall construction.

1.7 Slurry Pipeline and Pelletising Plant

The finely milled concentrate will be slurry pumped to the pelletising plant at the Wildrand rail siding where it will be pelletised to make it suitable for the steel plant processes and it also makes the product easier for rail transport. The direct distance from plant to rail siding is approximately 11 km.

The pelletising process consists of a balling section, a sintering section and a product screening and dispatch section. The concentrate is mixed with a binder and formed into balls in a rotating drum or disc. The balls are normally sized between 10 mm and 16 mm with a nominal size of 12 mm. They are transported via conveyors to the sintering furnace. Once fed through the furnace, the cooled pellets are screened. The pellets produced will then be stockpiled, loaded and railed (see rail siding description below).
1.8 Water Supply

The mine and plant will be designed to reclaim as much water as possible from each process stage. The plan is that the concentrate will be pumped to a pelletizing plant as a slurry, and water filtrate will be returned back to the mine for re-use in the process.

The expected make-up water requirement for the plant to produce 2 Mtpa of concentrate, is about 2,000,000 m³/annum, and mining operations will require a further 300,000 m³/annum, bringing the total to 2,300,000 m³/annum.

For the water supply to the project, exploratory discussions with the Department of Water and Sanitation (DWS) indicated that there are no significant supplies of water available from the existing storage sources in the area such as the Jerico and Morgenstond dams, or a weir in the Hlelo River. Therefore, different options for building new storage dams in one of the local catchment areas are being considered. Options for water supply to the mine will be further investigated during the feasibility study and in consultation with DWA, relevant catchment management agencies and stakeholders dealing with water-related matters.

1.9 Power Supply

Total power requirements for the mine and associated plant to produce 2 Mtpa of pelletised concentrate is estimated at 35 megavolt ampere (MVA). Initial discussions with Eskom representatives have indicated that the local area distribution network would not be able to supply this requirement. Different power supply options are being investigated, such as supply from the nearby 400 kV transmission line to Mozambique, supply from the Camden Power Station some 80 km away, or locally generated power. Options for power supply to the mine will be further investigated during the feasibility study and in consultation with relevant stakeholders. It is assumed that there will be an overhead power line, 11 kV or 33 kV, to both the concentrator plant and the pelletising plant and that the line will run adjacent to the R33 between the plants.

1.10 Surface Infrastructure

Associated surface infrastructure for the project will include:

- Offices
- Stores
- Security
- Road construction
- Potable Water Supply and Management
- Sewerage Management
- Storm Water Management
- Dirty Water Management
- Electrical Infrastructure, Power Lines and Substations
- Fire Prevention
- Change houses
- Refuelling Bays
1.11 Rail Siding and Transport of Product

Different options are being considered for the position of the pelletising plant and the associated stockpile requirements. The sites are all located in close proximity to the Wildrand Siding, assuming that the pellets will not be transported on public roads. The pellets produced at the pelletising plant will be stockpiled adjacent to the Wildrand rail siding prior to loading on trains destined for Richards Bay Port. The pellets will be transported on the coal line via Piet Retief to Richards Bay Port.

2. Project Design Parameters and Assumptions Relevant to Specialist Study

The hydrogeological study is only a screening assessment based on readily available data and experience in the area. No site visits or fieldwork has been conducted due to access restrictions. It is the intention of this screening assessment to develop a simplistic model of the groundwater system and to highlight potential impacts of the proposed mining activities.

3. Scope of the Groundwater Assessment

The scope of work is limited to a desk study to determine the existing hydrogeological conditions in the area and to evaluate the potential impact that the proposed mining activities will have.

4. Study Area

The study area comprises all the areas affected by the proposed mining activities and includes a 1km zone around these activities. The study area lies mainly in the middle and lower portions of W 52 C (slimes dam, slurry pipelines, pelletizing plant and load out area) the upper and middle portions of W 52 D (pits plant and haul roads) with a small portion in the upper W 53 E quaternary catchment where the waste and topsoil stockpiles occur, see Figure 4.1 below.

5. Specialist Study Team

The study was conducted by Carel Haupt, a registered natural scientist with more than 30 years’ experience. He has a post graduate degree in Engineering Geology specialising in the evaluation of ground water potential and hydrogeological mapping. He has worked on numerous groundwater development projects, developing groundwater resources for water supply to mines, towns and villages, hydrogeological evaluations for mines and
the design and development of monitoring systems for groundwater wellfields. He is the director responsible for all the Hydrogeological aspects of the Cascade Iron Ore Project. He is a founder member and director at WSM Leshika Consulting and has held the position of Chairman of the Ground water Division of the Geological Society of South Africa as well as an executive member of the South African Chapter of the International Association of Hydrogeologists.

6. Specialist Study Approach and Methodology

WSM Leshika Consulting (Pty) Ltd has been appointed by Ethical Exchange for the provision of professional services for a desk study screening geohydrology impact study for the proposed Cascade Iron Ore Project. WSM Leshika Consulting (Pty) has been appointed in a capacity as an independent contractor.

The main deliverables are:
- Description of Baseline Hydrogeological Environment
- Identify current impacts
- Identification Project Impacts and Risks
- Recommendations of mitigation measures

7. Hydrogeology

The study area is underlain by rocks of the Pongola Sequence (Rr – ferruginous shales, Rms – quartzite, Zb - lavas and ash layers, Zmn – quartzite interlayered with lava) and associated intrusives (Jd – dolerite, Rh, Rg - various
granites, Rp – gabbro, Rt – ultrabasics). West of the site some remnants of Karoo rocks (Pe – undifferentiated Ecca, Pd – Dwyka tillite) exist, see Figure 7.1 below.

The ore body consists of magnetite rich seams within the gently dipping (7° – 15°) ferruginous shales of the Redcliffe Formation (Rr). Shearing has triplicated the ore body resulting in 3 mineable blocks separated by faulting. The exploration drilling indicates that these faults are silicified and non-water bearing. The contact zones with the intrusives, the weathered zone below the water table, faulting (east west faults to the north and south of the study area) and fracturing will be the most favourable sites for groundwater. The main aquifers will thus be weathered and fractured type aquifers.

The shales of the Redcliffe formation (Rr) are expected to be low yielding (median borehole yields 0.1l/s – 0.5l/s) with the intrusives (Jd – dolerite, Rh and Rg – granites) having slightly higher yields especially at the contact zones where yields of up to 2l/s can be obtained.
7.1 Borehole Information

Numerous boreholes exist in the area. These boreholes are used mainly for water supply to communities and farmsteads. A list of known boreholes in the area is given in table 7.1.1 below and illustrated in blue in figure 7.1.1 below. Available borehole drilling information is listed in table 7.1.2 and pumping test information in table 7.1.3 below. The localities of these boreholes are shown in red in the figure 7.1.1 below. Borehole information available from WSM Leshika Consulting Reports:
TABLE 7.1.1 EXISTING BOREHOLE INFORMATION

<table>
<thead>
<tr>
<th>Site name</th>
<th>Latitude</th>
<th>Longitude</th>
<th>Elev (mamsl)</th>
<th>Pumps</th>
<th>Quality</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>kwathlatuvo MK60</td>
<td>-26.86627</td>
<td>30.73368</td>
<td>1292</td>
<td>Handpump</td>
<td></td>
<td>Handpump, lots of dirty water acc to community</td>
</tr>
<tr>
<td>Cascade</td>
<td>-26.78405</td>
<td>30.71352</td>
<td>1298</td>
<td>Handpump</td>
<td>Turbid</td>
<td>handpump, need water for new development of 250 houses</td>
</tr>
<tr>
<td>Ezakheni 1</td>
<td>-26.90683</td>
<td>30.74615</td>
<td>1361</td>
<td>Handpump</td>
<td>Clean</td>
<td>handpump, submersible pump has been removed</td>
</tr>
<tr>
<td>Ezakheni 2</td>
<td>-26.90569</td>
<td>30.74382</td>
<td>1343</td>
<td>Handpump</td>
<td>Clean</td>
<td>borehole not equipped, for irrigation for gardening</td>
</tr>
<tr>
<td>Ezakheni 3</td>
<td>-26.90194</td>
<td>30.74007</td>
<td>1321</td>
<td>No Equipment</td>
<td></td>
<td>broken submersible in pumphouse, truck supply water once a week</td>
</tr>
<tr>
<td>Eznithandanei (rustplaats)</td>
<td>-26.91822</td>
<td>30.75940</td>
<td>1358</td>
<td>Submersible</td>
<td></td>
<td>in use submersible in pumphouse, with reservoir and tank 50m away</td>
</tr>
<tr>
<td>Geluk</td>
<td>-26.80680</td>
<td>30.66693</td>
<td>1386</td>
<td>Submersible</td>
<td></td>
<td>Low yielding borehole, use spring as back-up located down slope of the village</td>
</tr>
<tr>
<td>Harlem</td>
<td>-26.84150</td>
<td>30.79978</td>
<td>1375</td>
<td>Handpump</td>
<td>Clean</td>
<td>handpump MK 60</td>
</tr>
<tr>
<td>Harlen</td>
<td>-26.83512</td>
<td>30.80401</td>
<td>1375</td>
<td>Handpump</td>
<td>Clean</td>
<td>handpump MK 60</td>
</tr>
<tr>
<td>Harlen (Mechemawamba Sch)</td>
<td>-26.83479</td>
<td>30.79084</td>
<td>1378</td>
<td>Submersible</td>
<td></td>
<td>submersible pump in pumphouse pumps to reservoir</td>
</tr>
<tr>
<td>Hlelo</td>
<td>-26.83678</td>
<td>30.71528</td>
<td>1284</td>
<td>Handpump</td>
<td></td>
<td>handpump Hlelo river site</td>
</tr>
<tr>
<td>Hlelo</td>
<td>-26.82196</td>
<td>30.72155</td>
<td>1231</td>
<td>Handpump</td>
<td></td>
<td>trucks in water</td>
</tr>
<tr>
<td>Holdesheim Primary school</td>
<td>-26.86001</td>
<td>30.73883</td>
<td>1252</td>
<td>Handpump</td>
<td>Turbid</td>
<td>handpump dirty water, people go to clinic daily because of water</td>
</tr>
<tr>
<td>Kromriver village</td>
<td>-26.88111</td>
<td>30.73992</td>
<td>1321</td>
<td>Handpump</td>
<td>Clean</td>
<td>handpump</td>
</tr>
<tr>
<td>Kromriver village</td>
<td>-26.87990</td>
<td>30.71558</td>
<td>1348</td>
<td>Handpump</td>
<td>Clean</td>
<td>handpump upgrade of village</td>
</tr>
<tr>
<td>Makwabane (uhlelo)</td>
<td>-26.85485</td>
<td>30.65798</td>
<td>1296</td>
<td>Handpump</td>
<td>Clean</td>
<td>handpump, garden and drinking</td>
</tr>
<tr>
<td>Makwabane (uhlelo)</td>
<td>-26.85342</td>
<td>30.64746</td>
<td>1334</td>
<td>Handpump</td>
<td>Clean</td>
<td>handpump, 75 m depth</td>
</tr>
<tr>
<td>Makwabane (uhlelo)</td>
<td>-26.85274</td>
<td>30.64757</td>
<td>1337</td>
<td>Spring</td>
<td></td>
<td>spring flowing into Hlelo river below</td>
</tr>
<tr>
<td>Makwabane (uhlelo)</td>
<td>-26.85110</td>
<td>30.65062</td>
<td>1327</td>
<td>Handpump</td>
<td>Clean</td>
<td>handpump, also drinking stream water</td>
</tr>
<tr>
<td>Makwabane (uhlelo)</td>
<td>-26.84559</td>
<td>30.65085</td>
<td>1350</td>
<td>Handpump</td>
<td>Turbid</td>
<td>handpump, dirty water</td>
</tr>
<tr>
<td>Malayan</td>
<td>-26.84413</td>
<td>30.74039</td>
<td>1388</td>
<td>Handpump</td>
<td>Clean</td>
<td>handpump</td>
</tr>
<tr>
<td>Redcliff (Nkomponi)</td>
<td>-26.74284</td>
<td>30.72989</td>
<td>1316</td>
<td>Mono Pump</td>
<td></td>
<td>borehole with diesel pump</td>
</tr>
<tr>
<td>Rustplaats</td>
<td>-26.90678</td>
<td>30.76559</td>
<td>1322</td>
<td>Submersible</td>
<td></td>
<td>equipped but not in use</td>
</tr>
<tr>
<td>Rustplaats</td>
<td>-26.90678</td>
<td>30.76568</td>
<td>1322</td>
<td>Submersible</td>
<td></td>
<td>Submersible bh in pumphouse not in use</td>
</tr>
<tr>
<td>Rustplaats</td>
<td>-26.90640</td>
<td>30.76056</td>
<td>1322</td>
<td>Submersible</td>
<td></td>
<td>bh at clinic submersible pump</td>
</tr>
<tr>
<td>Rustplaats</td>
<td>-26.90454</td>
<td>30.76808</td>
<td>1335</td>
<td>Submersible</td>
<td></td>
<td>bh at primary school, sewage contamination 1m from submersible pumps to reservoir on top and gravitate to taps</td>
</tr>
<tr>
<td>Rustplaats</td>
<td>-26.90281</td>
<td>30.76738</td>
<td>1325</td>
<td>Submersible</td>
<td></td>
<td>Submersible bh in pumphouse not in use</td>
</tr>
<tr>
<td>Rustplaats</td>
<td>-26.90220</td>
<td>30.76198</td>
<td>1325</td>
<td>Submersible</td>
<td></td>
<td>Submersible not equipped</td>
</tr>
<tr>
<td>Rustplaats</td>
<td>-26.90160</td>
<td>30.76711</td>
<td>1325</td>
<td>Submersible</td>
<td></td>
<td>Submersible bh in pumphouse not in use</td>
</tr>
<tr>
<td>Sidiayi</td>
<td>-26.85495</td>
<td>30.74886</td>
<td></td>
<td>Handpump</td>
<td>Clean</td>
<td>handpump</td>
</tr>
<tr>
<td>Wolwenkop</td>
<td>-26.78451</td>
<td>30.67647</td>
<td>1379</td>
<td>Handpump</td>
<td></td>
<td>handpump, rocky outcrops, part of kromriver</td>
</tr>
<tr>
<td>Wolwenkop (amaswazini)</td>
<td>-26.77919</td>
<td>30.68799</td>
<td>1322</td>
<td>Handpump</td>
<td>Clean</td>
<td>handpump, village had no water before</td>
</tr>
<tr>
<td>Wolwenkop (amaswazini)</td>
<td>-26.77870</td>
<td>30.69708</td>
<td>1318</td>
<td>Handpump</td>
<td>Clean</td>
<td>fresh water, handpump,</td>
</tr>
<tr>
<td>Wolwenkop (amaswazini)</td>
<td>-26.77509</td>
<td>30.69460</td>
<td>1312</td>
<td>Handpump</td>
<td>Clean</td>
<td>handpump upgrade of village</td>
</tr>
<tr>
<td>Wolwenkop (Tutuga)</td>
<td>-26.79227</td>
<td>30.68527</td>
<td>1326</td>
<td>Handpump</td>
<td>Turbid</td>
<td>handpump, pumps too little, after while water gets</td>
</tr>
<tr>
<td>Yellowstone Primary school</td>
<td>-26.78481</td>
<td>30.68296</td>
<td>1336</td>
<td>Submersible</td>
<td></td>
<td>submersible pump in pumphouse pumps to reservoir</td>
</tr>
</tbody>
</table>

TABLE 7.1.2 AVAILABLE DRILLING INFORMATION

<table>
<thead>
<tr>
<th>FARM or VILLAGE NAME</th>
<th>BOREHOLE No</th>
<th>COORDINATES</th>
<th>DATE DRILLED</th>
<th>DEPTH (m)</th>
<th>WATER STRIKE (mbgl)</th>
<th>BLOW YIELD (l/sec)</th>
<th>MAIN GEOLOGY</th>
<th>DRILLING</th>
<th>CASING</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>South East</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>150 mm</td>
<td>130 mm</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>130 mm</td>
<td>110 mm</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>110 mm</td>
<td>90 mm</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>90 mm</td>
<td>60 mm</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>60 mm</td>
<td>40 mm</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>40 mm</td>
<td>30 mm</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>30 mm</td>
<td>17 mm</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>17 mm</td>
<td>10 mm</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>10 mm</td>
<td>6 mm</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>6 mm</td>
<td>3 mm</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>3 mm</td>
<td>1 mm</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1 mm</td>
<td>0.5 mm</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.5 mm</td>
<td>0 mm</td>
</tr>
</tbody>
</table>

- Hydrogeological Desk Study for the Mkhondo Municipal Area, Mpumalanga Province. Report WMP 09114 April 2010
# TABLE 7.1.3: AVAILABLE PUMPING TEST INFORMATION

<table>
<thead>
<tr>
<th>FARM or VILLAGE NAME</th>
<th>BOREHOLE No</th>
<th>ELEVATION (mamsl)</th>
<th>PEIZOMETRIC ELEVATION (mamsl)</th>
<th>DATE TESTED</th>
<th>WATER LEVEL (mbgl)</th>
<th>STEPS TEST</th>
<th>CONSTANT DISCHARGE TEST</th>
<th>RECOMMENDATIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Time (mins)</td>
<td>% Rec</td>
<td>Duration (mins)</td>
<td>Rate (l/sec)</td>
</tr>
<tr>
<td>UHLELO</td>
<td>22</td>
<td>1257</td>
<td>1254</td>
<td>16/02/11</td>
<td>3</td>
<td>300</td>
<td>97</td>
<td>1440</td>
</tr>
<tr>
<td>EVERGREEN</td>
<td>23</td>
<td>1354</td>
<td>1340</td>
<td>18/02/11</td>
<td>14</td>
<td>210</td>
<td>100</td>
<td>1440</td>
</tr>
<tr>
<td>REDCLIFF (CALAMAZO)</td>
<td>24</td>
<td>1334</td>
<td>1319</td>
<td>24/02/11</td>
<td>5</td>
<td>189</td>
<td>100</td>
<td>1440</td>
</tr>
<tr>
<td>CASCADE</td>
<td>27</td>
<td>1318</td>
<td>1313</td>
<td>21/02/11</td>
<td>5</td>
<td>300</td>
<td>93</td>
<td>1440</td>
</tr>
<tr>
<td>MBUYISA</td>
<td>32</td>
<td>1331</td>
<td>1324</td>
<td>18/03/11</td>
<td>7</td>
<td>110</td>
<td>100</td>
<td>1440</td>
</tr>
</tbody>
</table>
7.2 Piezometry

Available borehole information shows that water levels are generally shallow (3 mbgl – 14 mbgl). Too little data is available to construct a piezometric contour map, but the information available indicates that the piezometric surface will follow a subdued form of the surface topography with flow towards the streams.
7.3  Groundwater Resources

Average recharge (based on data from the W 52 D quaternary catchment, Groundwater Resources Situation Assessment, Department of Water Affairs, 2003) from rainfall is estimated at 85 mm/a of which 20 mm/a recharges aquifers. For the mining right area of some 10 135ha this amounts to about 2.0 Million m$^3$/a. The remaining 65 mm/a is lost to interflow. Of the 20 mm/a which recharges the aquifers, 15 mm/a returns to the rivers as the groundwater portion of baseflow. Therefore, of the 85 mm/a recharged 80 mm/a ends up as baseflow in the rivers. Since a large proportion of recharge emerges in rivers as baseflow, it is expected that any significant groundwater abstraction will reduce baseflow in rivers.

7.4  Groundwater Quality

The existing groundwater quality is excellent, with the available data showing that boreholes in the area have class 0 water. From the chemistry results the water can be classified as a Ca-Mg Bicarbonate type water which suggests the groundwater was recently recharged.

<table>
<thead>
<tr>
<th>TABLE 7.4.1 : WATER CHEMISTRY</th>
</tr>
</thead>
<tbody>
<tr>
<td>pH</td>
</tr>
<tr>
<td>----</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Conductivity (mS/m)</td>
</tr>
<tr>
<td>TDS (mg/l)</td>
</tr>
<tr>
<td>Nitrate (N) (mg/l)</td>
</tr>
<tr>
<td>Fluoride (mg/l)</td>
</tr>
<tr>
<td>Sulphate (mg/l)</td>
</tr>
<tr>
<td>Chloride (mg/l)</td>
</tr>
<tr>
<td>P - Alkalinity</td>
</tr>
<tr>
<td>M - Alkalinity</td>
</tr>
<tr>
<td>Carbonate</td>
</tr>
<tr>
<td>Bicarbonate</td>
</tr>
<tr>
<td>Total Hardness</td>
</tr>
<tr>
<td>Ca - Hardness</td>
</tr>
<tr>
<td>Mg - Hardness</td>
</tr>
<tr>
<td>Calcium (mg/l)</td>
</tr>
<tr>
<td>Magnesium (mg/l)</td>
</tr>
<tr>
<td>Sodium (mg/l)</td>
</tr>
<tr>
<td>Potassium (mg/l)</td>
</tr>
<tr>
<td>Iron (mg/l)</td>
</tr>
<tr>
<td>Manganese (mg/l)</td>
</tr>
<tr>
<td>WATER CLASS</td>
</tr>
<tr>
<td>Sum Cations</td>
</tr>
<tr>
<td>Sum Anions</td>
</tr>
</tbody>
</table>

7.5  Impact Assessment

A simplistic groundwater model was set up to determine the impacts of the mine on groundwater levels in the area and give an indication of the potential inflow into the pits using MODFLOW 2000 in the US Department of Defence GMS 9.0 software. The model was constrained by lack of data and only three observation boreholes were available, two of which are located next to streams. Consequently, the results are of low confidence and only give an indication of the likely extent of impact.

The following assumptions and limitations were made:

- The model was set up as 3 layers, each of 70 meters thickness
- The pits were considered to extend to a depth of 1170 m.a.m.s.l. (approximately 200m below surface)
- The pits were considered as steady state drains as no mining plan is available and hence represent a worse case long term scenario
- The model domain was constrained by the Hlelo and Ngwempisi rivers, which were considered to be constant head boundaries
- Recharge was taken as 85 mm/a
- The escarpment south of the pits down to the Hlelo was considered to be a lower permeability zone

To improve the confidence of the model a detailed hydrocensus of existing boreholes and groundwater use will be required. Further, determination of aquifer parameters by drilling, pump testing and packer testing of boreholes, will have to be undertaken.

The results of the drawdown determined from the simplistic model are shown in figure 7.7.1 below. From this it can be seen that the impact on water levels (drawdown > 1m) extends over some 6 300ha of which about 65% is outside the mining right area to the north. Significant impact on water levels (drawdown > 10m) extends over some 2 700ha of which about 50% is outside the mining right area.

The assessment was conducted for mining of the entire mining blocks as indicted on Figure 4.1 and Figure 7.8.1. Based on the proposed mine plan, only about 12% of the ore in the mining blocks will be mined (~million tonnes over 20 years of the ~ 999 million tonnes of ore within the mining blocks. The assessment it thus for the worst case scenario. Once a more detailed mine plan has been developed, and a detailed hydrocensus of boreholes have been conducted, the zones of impact can be refined.

The estimated long term inflow into the pit was calculated by the model as 2 300 m³/day. This is considered the maximum and will vary depending on the extent and depth of the pits at various times in the mining programme. Dewatering of the pits will result in a decrease in the baseflow to the rivers and streams of up to 2 100 m³/day. This assessment for mining of the entire mining blocks, mining at a rate 2 Mpta for 20 years, will only affect ~12% of the mining blocks and thus the impact will be less that for mining of the full extent of the mining blocks.

Other impacts of the mine could be hydrocarbon pollution of the aquifers due to oil and fuel spillages by construction and production vehicles, decrease in water quality due to increased salt loads and other pollutants from treated sewage effluent and the mining process. The formation of Acid Mine Drainage (AMD) is unlikely as there is little or no sulphides associated with the ore body (Magnetite, FeO.Fe₂O₃ and Hematite, Fe₂O₃).

A detailed geochemical assessment of mine materials will be required to confirm the low estimated potential for AMD. The geochemical assessment aims to map the distribution and variability of key geochemical parameters, acid generating and element leaching characteristics.

The assessment may include:
1. Sampling;
2. Static geochemical testwork (e.g. acid-base accounting, sulfur speciation);
3. Kinetic geochemical testwork - Conducting oxygen consumption tests, such as the OxCon, to quantify acidity generation rates
4. Modelling of oxidation, pollutant generation and release; and
5. Modelling of material composition.
The Cascade Iron Ore Mining Project
SPECIALIST SCREENING REPORT

ESTIMATED DRAWDOWN AT LIFE OF MINE

FIGURE 7.8.1
8. Baseline Environmental Description

The pre-mining hydrogeological environment has been affected by various forestry and other agricultural activities that have taken place in the area. Forestry has probably reduced the recharge potential and abstracted water from the shallow water table. This could have resulted in the seasonal drying up of some springs and a local lowering of the water table. Existing communities and farm homesteads rely on groundwater and springs for their water supply. The impacts of the pre-mining activities are however expected to be very low.

<table>
<thead>
<tr>
<th>Baseline Description:</th>
<th>Existing Impact Sources:</th>
<th>Significance of Existing Impacts and Current Degradation:</th>
<th>Sensitive Receptors and Comment on Importance / Sensitivity of Area:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shallow groundwater with springs and significant contribution to baseflow of rivers and streams</td>
<td>Forestry</td>
<td>Low</td>
<td>Local lowering of the water table (decrease in borehole yield) drying up / reduce flow of springs and reduced baseflow to the rivers and streams</td>
</tr>
<tr>
<td>Excellent groundwater quality</td>
<td>Fuel and oil spills</td>
<td>Low, very localised</td>
<td>Hydrocarbon contamination of groundwater highly sensitive due to shallow groundwater</td>
</tr>
</tbody>
</table>

9. Description of Potential Project (Incremental) Impacts and Mitigation

The proposed iron ore mine will impact on the hydrogeological environment by lowering the water table causing a cone of depression around the pit areas due to dewatering, see Figure 8.8.1 for extent. The dewatering will also reduce the baseflow to the rivers and streams. The potential for groundwater pollution also exists from increased traffic (hydrocarbon pollutants) and salts and other pollutants from sewage and the mining processes.
<table>
<thead>
<tr>
<th>Construction:</th>
<th>Impact:</th>
<th>Impact Source:</th>
<th>Proposed Mitigation:</th>
<th>Impact Significance and Potential to Mitigate:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hydrocarbon pollution of aquifers</td>
<td>Construction vehicles</td>
<td>Sealed workshop and fuel dispensing areas with dirty and clean water separation</td>
<td>Low significance with good potential to mitigate</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Operation:</th>
<th>Impact:</th>
<th>Impact Source:</th>
<th>Proposed Mitigation:</th>
<th>Impact Significance and Potential to Mitigate:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lowering of the water table resulting in borehole yields reducing in the zone of influence</td>
<td>Dewatering of the pits</td>
<td>Replace water source of affected users</td>
<td>Limited to some 4,000 ha north of the pits. High significance as this is the only safe water source. The water use volumes affected are however low and can easily be mitigated by supply from other sources</td>
<td></td>
</tr>
<tr>
<td>Decrease in the groundwater quality</td>
<td>Salts and other pollutants from the mining operation and sewage</td>
<td>Keep dirty water in a closed circuit</td>
<td>Significant due to the high quality of the groundwater resource</td>
<td></td>
</tr>
<tr>
<td>Hydrocarbon pollution of aquifers</td>
<td>Production vehicles and haul trucks</td>
<td>Sealed workshop and fuel dispensing areas with dirty and clean water separation</td>
<td>Low significance with good potential to mitigate</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Closure and Decommissioning:</th>
<th>Impact:</th>
<th>Impact Source:</th>
<th>Proposed Mitigation:</th>
<th>Impact Significance and Potential to Mitigate:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Groundwater pollution</td>
<td>Dirty water areas no longer managed and spilling into clean water area</td>
<td>Rehabilitate dirty water areas</td>
<td>Moderate significance with a good potential to mitigate</td>
<td></td>
</tr>
</tbody>
</table>
## Post Closure / Residual:

<table>
<thead>
<tr>
<th>Impact</th>
<th>Impact Source</th>
<th>Proposed Mitigation</th>
<th>Impact Significance and Potential to Mitigate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Decanting of water from pits</td>
<td>Refilling of the pits with water</td>
<td>Treat if required and use</td>
<td>Low impact significance as the water can be used as a potential supply</td>
</tr>
</tbody>
</table>
10. **Comment on Cumulative Impacts**

As the impacts of the existing land uses on the groundwater environment are very low the cumulative effects will therefore not be significantly greater than the impacts of the mining project alone.

11. **Comment on Cumulative Impacts of Extended Mining Project**

The assessment was conducted for mining of the entire mining blocks as indicted on Figure 4.1 and Figure 7.8.1 and thus represents the impacts as if the pits were mined to the full extent of the mining blocks.

12. **Potential Zone of Influence**

The impact of the mine on the groundwater availability can be delineated in accordance with the 1 metre drawdown contour, see Figure 8.8.1 above. Due to the dewatering and drawdown cone baseflow to the Ngwempisi and Hlelo rivers downstream of the mining area and will be affected by up to 2 100 m³/day. This is however a small portion of the total flow in these rivers, although this could be significant during low flow or drought periods.

The impact on groundwater quality (mainly elevated salts) will be limited to the pits, plant, slurry pipeline and slimes dam areas extending to about 500 m downstream of these activities. The hydrocarbon pollution potential will be along and 500 m downstream of all haul roads, access roads and the R33 and N2 between the mine, plant, slimes dam and railway siding.

13. **Information Gaps and Study Limitations**

The study was constrained by lack of data and only three boreholes with hydrogeological information were available in the study area, two of which are located next to streams. Consequently, the results are of low confidence and only give an indication of the likely extent of impact.

14. **Further Work Required**

To improve the confidence of the study a detailed hydrocensus of existing boreholes and groundwater use will be required. Further, determination of aquifer parameters by drilling, pump testing and packer testing of boreholes, will have to be undertaken.

A detailed geochemical assessment of mine materials will be required to confirm the low estimated AMD potential.
15. Conclusions and Recommendations

The screening hydrogeological impact assessment done shows that the impact of the mine on the existing hydrogeological environment will be limited to the mining right application area as well as an area of some 4100 ha north of the mining right application area in terms of reduced water availability. The existing land use in this area consists of a few communities, homesteads, a lodge and about 400 ha of forestry. Impacts on these land uses and land owners will have to be assessed and predicted in a more detailed assessment. Monitoring will have to take place to confirm the predicted impacts. Based on the defined impacts, compensation will have to be put in place. Options could include supplying alternative water sources, moving the communities, and/or buying the land. Baseflow in the Ngwempisi and Hlelo rivers downstream of the mining area and will also be affected. Although this will be a small portion of the total flow in these rivers, this could be significant during low flow or drought periods.

In terms of pollution of the aquifers, this will be limited to the pits, plant, slurry pipeline and slimes dam areas extending to about 500 m downstream of these activities in terms of elevated salts from the mining process and Treated sewage effluent. As the dirty water will be kept separate from clean water systems and the slimes dam lined with leachate collection drains, the risk of pollution will however be low. The hydrocarbon pollution potential will be along and 500 m downstream of all haul roads, access roads and the R33 and N2 between the mine, plant, slimes dam and railway siding. A sealed workshop and fuel dispensing area as well as regular maintenance of vehicles will significantly reduce the pollution risk.

Although the level of confidence of the results of the study is low, the study does show that the potential impacts of the proposed Cascade Iron Ore Mine on the groundwater are manageable and that further more detailed studies be initiated to confirm these findings.

16. References

Department of Water Affairs and Forestry, Groundwater resources Situation Assessment, Phase 2, 2005


17. Specialist Declaration of Interest

Name: Carel Haupt

Qualifications: B.Sc (Hons) Engineering Geology

Relevant experience:
Evaluation of ground water potential and hydrogeological mapping - 33 years

Professional affiliations:
SACNASP Pr Sci Nat
Director at WSM Leshika Consulting
Held the position of Chairman of Groundwater Division of the Geological Society of South Africa
Executive member of the South African Chapter of the International Association of hydrogeologists

Declaration:
I Carel Haupt, declare that:
- I act as an independent specialist
- I have performed the work relating to this assessment in an objective manner;
- I declare that there are no circumstances that compromised my objectivity in carrying out this assessment;
- I have expertise in conducting the specialist report, including knowledge of the regulations and any guidelines that have relevance to the proposed activity;
- I have no conflicting interests in the undertaking of the activity;
- I have no interest in the project other than fair remuneration for work carried out;
- I undertake to disclose to the applicant and the competent authority all material information in my possession that reasonably has the potential of influencing any decision to be taken with respect to the proposed project by the competent authority;
- All the particulars furnished by me are correct;

___________________________________________
Signature