- The continual monitoring and maintenance of all infrastructure;
- Logging of all storm water events;
- The marking of the physical terrain during and after flood events;
- The taking of photographs of flows during and after storm events; and
- Keeping record of all spillages and/or leakages that occur on site.

10.2.6 Performance assessments

In addition to the implementation of the monitoring programmes detailed above, environmental performance assessments will be conducted once every two years in order to monitor success in the implementation of the EMPR.

10.3 ENVIRONMENTAL AWARENESS PLAN

An Environmental Awareness Plan (EAP) will be implemented as part of the proposed mining operation. The source of information for this plan will to a large extent be the contents of the approved EMPR, as well as the relevant specialist reports. The EAP will consist of the following sections:

- **Environmental policy.** This section will explain the company's environmental values and communicate its commitment to environmental policy.
- **HSEC Management System.** This section will focus on identifying, assessing and managing risks to employees, non-employees, the environment and the communities within which the proposed mining operation is performed.
- **Communication:** This section will detail the manner in which the applicant informs employees of environmental risks that may result from their work, as well as detail the manner in which these risks must be dealt with in order to avoid pollution or the degradation of the environment;
- **Information:** Information contained in the EMPR should be translated into a language understandable to employees and be communicated to employees via the channels identified in the "communications" section of this document.

- **Training.** This section should outline the basic environmental awareness training to be given to all employees and contractors. Levels of responsibility of each employee should be clearly set out in this section.
- **Reporting.** Every environmental incident that takes place on site or that employees become aware of, should be communicated to the mine manager. This section of the EAP will deal with the reporting procedure to be followed in this regard.

10.4 ENVIRONMENTAL EMERGENCIES

10.4.1 Oil, grease or hydraulic fluid spills

In the event of an oil, grease and hydraulic fluid spill, such spill will be cleaned up immediately by removing the spillage, together with the contaminated soil, and disposing of it at a licensed facility, as is required by Regulation 70(5) of the Mineral and Petroleum Resources Development Act, 2002 (Act No. 28 of 2002). This will be done according to the following spill response plan:

1) The applicant will familiarize himself with the contents of Section 30 of the National Environmental Management Act, 1998 (Act No. 107 of 1998) ("Control of emergency incidents") prior to the commencement of the proposed mining operation.
2) All possible sources of heat or ignition in the areas surrounding the spill will be removed immediately.
3) The leak will be stopped if without risk.
4) Personnel will immediately be evacuated from the area.
5) Any contaminated clothing will be taken off immediately.
6) Care will be taken to avoid contact with the skin, eyes and clothing in the process of cleaning up the spill.
7) The following personal protective wear will be worn during the clean-up process: impervious overalls, PVC or nitrile rubber gloves, safety shoes or boots, and chemically resistant monogoggles.

8) The applicant will ensure that there is always a sufficient supply of absorbent material (sand, earth or a spill control material) readily available to absorb minor spillages.

9) Minor spills will be cleaned-up by absorbing or containing the spilled liquid with sand, earth or a spill control material. The spillage, together with contaminated soil, will be shovelled up and placed in a labelled, sealable container for subsequent safe disposal at a recognised disposal facility by a recognised collector or contractor in accordance with current applicable laws and regulations. The competence of the collector/contractor will be established before the commencement of the proposed activity.

10) Larger spills will be transferred to a labelled, sealable container for product recovery or safe disposal. The same procedure listed for the treatment of minor spills will subsequently be followed.

11) Spillages will not be disposed of in the environment, in ditches, in drains or in water courses.

12) The relevant local authorities will be notified immediately if a significant spillage cannot be contained.

13) As is required by Section 30(3) of the National Environmental Management Act (Act No. 107 of 1998) (hereinafter "NEMA"), an incident as is described in Section 30(a) (including the nature of the incident; any risks posed by the incident to public health, safety and property; the toxicity of substances or by-products released by the incident; and any steps that would be taken in order to avoid or minimise the effects of the incident to public health and the environment) will be reported through the most effective means reasonably available to the following parties:

- The Director-General;
- The South African Police Services;
- The local fire prevention service;
- The relevant provincial head of department or municipality; and
- All persons whose health may be affected by the incident.

14) As is required by Section 30(5) of NEMA, an incident as described in Section 30(a) of the said Act will furthermore be reported to the Director-General, provincial head of department of the Department of Tourism, Environment

and Conservation, and the Dikgatlong Local Municipality via an emergency incident report.

10.4.2 Fire

The following fire prevention and –control plan will be used by the applicant:

1) The following three safety signs, all of which will conform to the requirements of SANS 1186-1:2003 (SABS 1186-1:2003), will be prominently displayed on fuel storage receptacles: a no smoking sign, a danger sign, and a sign which prohibits the use of fire and open lights.
2) The above mentioned signs will be well maintained.
3) Employees will be briefed on the prohibition of smoking and the use of fire and open lights near fuel storage receptacles prior to the commencement of the proposed mining operation.
4) Rubbish and anything combustible will be kept well away from fuel storage receptacles.
5) Grasses surrounding fuel storage receptacles (if and when present) will be kept down.
6) A fire extinguisher in a weather proof casing will be installed in close proximity to fuel storage receptacles.
7) Halon extinguishers will be avoided for environmental reasons.
8) All employees will be briefed on the correct use of a fire extinguisher prior to the commencement of the proposed operation.
9) Runoff from fire control or dilution will be prevented from entering streams or sewers.
10) Major fires or explosions, as defined by Section 30(a) of the National Environmental Management Act, 1998 (Act No. 107 of 1998) will be reported through the most effective means reasonably available to the following parties:
    - The Director-General;
    - The South African Police Services;
    - The local fire prevention service;
    - The relevant provincial head of department or municipality; and

- All persons whose health may be affected by the incident.

Such a report will include the nature of the incident; any risks posed by the incident to public health, safety and property; the toxicity of substances or by-products released by the incident; and any steps that would be taken in order to avoid or minimise the effects of the incident to public health and the environment.

11) As is required by Section 30(5) of NEMA, an incident as described in Section 30(a) of the said Act will furthermore be reported to the Director-General, provincial head of department of the Department of Tourism, Environment and Conservation, and the Dikgatlong Local Municipality via an emergency incident report.
12) Fires will only be allowed in facilities or equipment specially constructed for this purpose.
13) Cooking will only be done on gas equipment in a shelter.
14) If required by applicable legislation, fire breaks will be constructed on the sites specified.

10.4.3 Other emergency incidents

Any other emergency incidents will be handled as is prescribed by Section 30 of the National Environmental Management Act, 1998 (Act No. 107 of 1998), as amended.

11. IDENTIFICATION OF INFORMATION GAPS

11.1 AUTHORITY FEECBACK ON ENVIRONMENTAL SCOPING REPORT

No feedback has been received from any authorities regarding the initial scoping report compiled as part of the requirements of this mining right application to date.

A revised scoping report has, however, been prepared after the submission of the initial report submitted to DMR and will be submitted to the aforementioned authority in conjunction with the EIA/EMPR document.

11.2 DUST ASSESSMENT

Although a suitably qualified specialist has been appointed to conduct a dust assessment and such an assessment is therefore currently underway, the results of this assessment (which is conducted over a three month period and commenced on 1 November 2010) were not available to the appointed environmental practitioner during the compilation of this EIA/EMPR document.

Dust pollution was identified as one of the major issues of importance to registered I&APs and therefore the results of this study are regarded as being vital with regard to the completeness of the EIA-process. It is strongly suggested that the current EIA/EMPR document be revised as soon as the results of the dust assessment are available to include these results, as well as any mitigation measures proposed in this regard.

11.3 NOISE- AND VIBRATION ASSESSMENT

Although a suitably qualified specialist has been appointed to conduct a noise- and vibration assessment and such an assessment is therefore currently in process, the results of this assessment were not available to the appointed environmental practitioner during the compilation of this EIA/EMPR document.

Noise pollution and the anticipated impact of blasting tremors on various aspects of the environment were identified as some of the major issues of importance to registered I&APs and therefore the results of this study are regarded as being vital with regard to the completeness of the EIA-process. It is strongly suggested that the current EIA/EMPR document be revised as soon as the results of the noise- and vibration assessment are available to incorporate the latter, as well as any mitigation measures proposed in this regard.

11.4 WATER BALANCE

It is recommended that, as part of the Integrated Surface Water Management Plan to be implemented on site, a water balance be calculated that is representative of all possible elements of the system. This water balance should be used as a guide in the identification of potential challenges, such as excesses or shortages of water.

It is furthermore recommended that this water balance be updated at least once a year.

12. CONCLUSIONS

12.1 CONCLUSIONS: SPECIALIST STUDIES

12.1.1 Phase 1 Heritage Assessment

The Phase 1 Heritage Assessment conducted as part of this EIA-process concluded that "*there are not obvious reasons to delay the commencement of further planning and development of the site*". It was further recommended that the proposed developments and planning of the site may proceed, provided that caution be taken during excavations.

The mitigation and management measures with regard to the preservation of heritage resources listed in this document should, however, be implemented as part of the management of the proposed mining operation.

12.1.2 Botanical Study

A number of significant anticipated negative impacts on the natural vegetation of the proposed mining area were identified as part of the botanical assessment conducted as part of this EIA-process.

Although a number of these anticipated impacts cannot be prevented altogether, the mitigation and management proposed in this document should be implemented as part of the management of the proposed mining operation. The establishment of a biodiversity offset area is regarded as being of vital importance.

12.1.3 Soil Study

The soil assessment conducted as part of this EIA-process concludes that the soils of the proposed mining area should be able to recover upon completion of the mining operation, if careful management measures are applied.

12.1.4 Groundwater Study

The groundwater study conducted as part of the EIA-process concludes that the dewatering of aquifers in close proximity to the proposed mining area is not considered a risk, as a result of these areas already being dewatered to a depth below the elevation of the proposed mining depth by existing surrounding mining operations.

The groundwater study furthermore concludes that the risk to the environment in the form of potential contaminant water from mine infrastructure (tailings dams, sewage treatment plant and waste rock dumps) is also low as a result of aquifer dewatering by existing mines. The contamination potential of mine waste material (tailings and waste rock) is also regarded as low. Based on the aforementioned information, it is finally concluded that contamination risk is site specific with no foreseen impact on groundwater users and environmental receptors.

12.1.5 Surface Water Study

The surface water study conducted as part of this EIA-process concludes that:

- The proposed mining development poses no great threat to potential stream flow reduction of any surface water resources in the surrounding natural environment;
- The proposed conceptual SWMP would be sufficient to minimise and mitigate the potential impact of flooding;
- The implementation of the maintenance and monitoring plans form an essential part of the SWMP;

- Conceptual and technical designs of the proposed conceptual infrastructure associated with the proposed SWMP should be undertaken by a registered civil engineer;
- Even though particular measures contained within the SWMP are only applicable in extreme and less frequent conditions, these measures, if enforced, will contribute greatly to the overall management within DWA specifications; and
- The undertaking of a water balance study would be beneficial for the overall management within government regulations.

12.1.6 Screening Level Social Assessment

The screening level social assessment conducted as part of this EIA-process concludes that the proposed mining operation will continue to impact negatively on the farming practices and the livelihood of the holder of grazing rights over the said property, as well as his family and workers, to such an extent that the long term sustainability of commercial farming in the affected environment might be seriously jeopardised.

The study furthermore concludes that, although it would be possible to consider several measures to mitigate the impacts of the proposed development on the above-mentioned parties, a more viable option would probably be for these parties to sell the farm to the applicant or another mining company.

12.2 FINAL CONCLUSION

Two of the anticipated impacts identified as part of this EIA-process are regarded as being quite significant, namely the anticipated social impact on the holder of grazing rights over the proposed mining area, as well as the anticipated impact of the proposed operation on the natural vegetation of the proposed mining area.

It is, however, anticipated that the implementation of the management and mitigation measures listed in this document, especially with regard to the above-mentioned two anticipated impacts, will either mitigate or offset the impacts anticipated.

13. UNDERTAKING

I, **PIETER ANDRIES KOTZEE (ID #: 530412 5129 081)**, the undersigned and duly authorised thereto by SA Manganese (Pty) Ltd., have studied and understand the contents of this document in its entirety and hereby duly undertake to adhere to the conditions set out therein.

Signed at **KIMBERLEY** this **10th** day of **DECEMBER** 2010.

....

Signature of applicant

Agency declaration: This document was completed by **KARIEN VAN DER MERWE** on behalf of **SA Manganese (Pty) Ltd.**

APPROVAL

Approved at **KIMBERLEY** this ________ day of ______________________ 20___.

______________________ ______________________

Signature **Capacity**

SA MANGANESE

DEMANENG MINE

Soil Impact Survey

Environmentalist : K. van der Merwe

Kimberley

Mobile : 082 964 1667

E – mail : karienvdm@vodamail.co.za

Geologist : C.H.E. Visser

Kimberley

Mobile : 082 821 0217

E – mail : geokon@vodamail.co.za

November 2010

SA MANGANESE : DEMANENG MINE

Soil Impact Survey

1 Background :
SA Manganese intend to develop an iron ore mine on the farm, Demaneng, Ptn 2 in the District of Postmasburg, near Kathu.

The farm is presently owned by Mr. D. van Rensburg, who is practicing stock farming for a living.

Messrs. Karien van der Merwe was instructed by SA Manganese to conduct an EIA on the farm for the purpose of a mining right for SA Manganese.

NK Geokon of Kimberley was sub contracted by messrs. Van der Merwe to assist with a soil impact survey for the purpose of land use definition on the farm.

The site was inspected by Mr. C. Visser of NK Geokon on 18 October 2010, in the presence of the farmer, Mr. Van Rensburg.

2 Location of the Farm :
The farm is situated almost directly next to the R28 between Kathu and Postmasburg and about 3 km along road D 3333 in a south easterly direction. (Refer to enclosed site map)

3 Weather and Climate :
The climate at Demaneng is harsh in summer, with temperatures up to 36 degrees C and in winter as low as – 4 degrees.

Rain falls mainly in summer as thunder storms with an average of 300 mm per year.

Reigning wind directions are north to north west in summer and south to south west in winter. Easterly wind is very scarce.

Humidity is very low, with a great part of the year clear sunny skies.

4 Geology :
The farm is situated on a typical Griqualand West lithological setting – Makganyene chert, flagstone, conglomerate, diamictite and dolomite underneath a layer of mineralized haematite and manganese ore.

The dolomite and chert is exposed over most of the farm, with the iron ore and manganese forming the higher parts of the farm in the form of near circular resistant hills or "koppies."

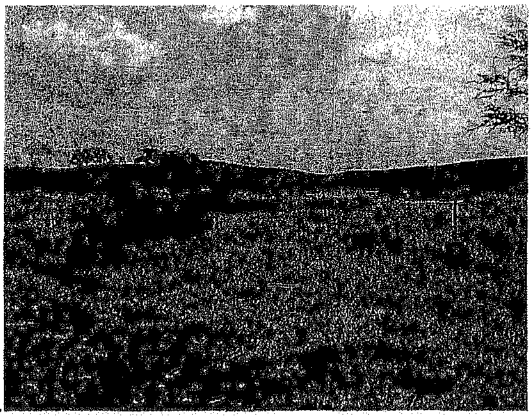
5 Geomorphology :

The mineralized "koppies" presently form the higher ground on the farm, from which slope wash material crept along the slopes of the hills covering the underlying dolomite with a scree of fine, red, windblown sand blended with cobble sized stone from the upper iron ore layer.

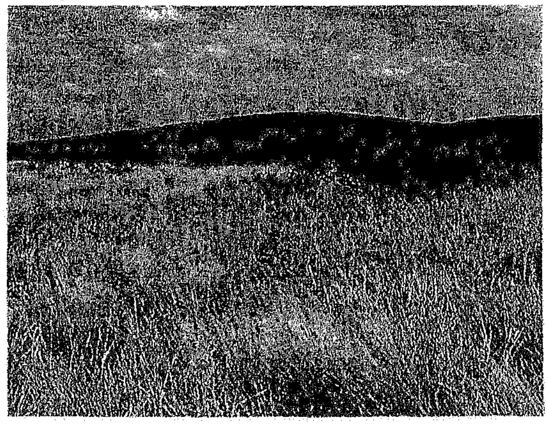
5.1 Drainage :

Drainage flows from east to west, formed by two joined, dry, rivulets both named Ga-mogara.

These rivulets are perennial water courses, and are dry for most of the time.



Dry Ga – mogara river bed



Older terrace along river course

The underlying dolomite formation is probably very porous and absorbs all water that runs along the river courses.

During the time that water was flowing along these courses, they deposited their sediment on different terraces along the river.

The sediment consist of sand and gravel, the latter washed in from the nearby hills, or transported from upstream by great volumes of water, such as happened during 1987, when the region had a record rainfall occurrence.

5.2 Weathering :

The manganese formation is a very hard, extremely resistant rock containing from 30 to 50 % siliceous iron ore. Thus it was not influenced by solution activity like the dolomite and chert formation underlying it.

The latter is much more susceptible to weathering and was therefore eroded down to much lower levels than the manganese formation.

Dolomite rock outcrop Scree gravel on dolomite

Weathering of the region produced sand and gravel that washed down the Ga mogara river to be deposited in present day alluvium in the lowest parts of the river, showing older terraces of previous climatic eras.

5.4 Soil Types :

5.4.1 Mineralized zone :

This is the areas that form the target for the mining company to exploit. It consist of ferriginous silicate deposited on top of a chert, conglomerate, diamictite and dolomitic formation.

The iron ore formation forms the crests of local ridges, and was thermo-mechanically eroded to cracked, blocky material that rolled and was washed down slope to rest on the slopes of the ridges.

5.4.2 Dolomitic zone :

This formation is termed the "Makganyene diamictite" and consists of chert, conglomerate, and dolomite. Weathering of this material results in formation of gravel, grit and sand.

Much gravel is released from this formation, trapping windblown quartzitic sand and dust.

The surface of this formation forms uneven outcrops of dolomite, with solution cavities filled with sand and gravel.

5.4.3 Alluvium :

Because of steep slopes in this area, fine material is being washed into the drainage pattern which is no more than directed lows where rainwater only finds it's way during seasonal high rainfall spells.

In the river bed of the Ga-mogara river, some lime was deposited, due to evaporative processes of dissolved lime from the nearby dolomite formation.

The alluvium also contain some gravel and grit, deposited in the normal sequence of sedimentary processes.

The sand part of the alluvium mainly consists of windblown quartzitic material, reddish stained by ferric oxides that occur in the iron ore formation.

6 Vegetation :

Grass occur on sandy areas, whether it be on the hills, or in the dry river beds, while bush occur mainly on gravel slopes, with trees and shrubs on lower alluvium in the dry river beds.

7 Mining Development :

The mining development is being handled in great detail in by other specialists.
This survey was called for to address the impact of this action on the soil of the affected areas.

7.1 Mining Areas:

The proposed mining areas are being indicated on the enclosed map.
It is obvious that soil, as a medium to facilitate the growth of plant matter in these areas, would be totally destroyed, and that it would take decades to rehabilitate, unless special actions are being taken.

7.2 Roads :

All roads will resort under the same impact as the mining areas, because they will be in use even after all mining activities have ceased.

7.3 Slimes dams, plant and offices :

The natural soil conditions will be destroyed where the slimes dams, sewage works, offices, workshops and plant areas are situated. Apart from destruction, contamination will occur and will be irreversible.

The impact is rated as follows :

DEMANENG : IMPACT RATING FOR SOIL						
Activity	Area (ha)	Probability	Extent	Duration	Intensity	**Signif Rate**
Waste Dump	10	4	2	6	6	**18**
Slimes dam	5	4	1	6	6	**17**
Plant	5	4	2	5	6	**17**
Roads	10	4	1	3	4	**12**
Stockpiles	5	4	2	4	6	**16**
Buildings	2	4	1	3	6	**14**
Sewage plant	2	4	2	4	6	**16**
Load out plant	2	4	2	4	6	**16**
Conveyor	2	4	2	4	6	**16**
Mining Areas	40	4	2	6	8	**20**

8 Rehabilitation :

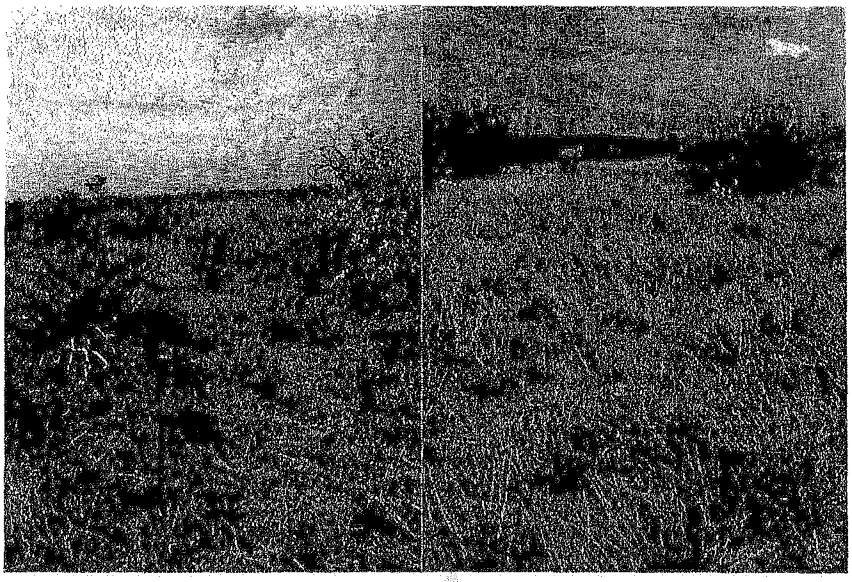
While it is a guarantee that natural soil will be destroyed on all areas of mining activity, it is a given fact that nature has the potential to recover from such actions by the covering up of all damaged areas by depositing sand, dust and seeds onto such areas.

We should do two things to help nature in this process –

Firstly, by taking care not to destroy unnecessarily

Secondly, by covering up damaged areas with sand and plant growth medium from other sources, after completion of the project

And lastly, by creating preservation areas where indigenous species could be protected to provide a gene pool of plants adapted to the environment which could repopulate the damaged areas in years after the mining activities ceased.



With the last point in mind, such areas were being proposed and indicated on the map for this purpose, if practically possible for the mining management to effect.

The area in the northern corner of the farm, is considered to be of a high priority for this purpose, because the seeds of plants get transported by wind, and this site is ideally situated for such a purpose.

9 Preventative Actions :
It is further proposed that the mining company should endeavor to use natural materials for building as far as possible.

In stead of using tarred surfaces or chemical stabilization on haul roads, durable surfaces could be constructed by careful selection and mechanical stabilization of construction materials.

The same applies to construction of walls for the slimes dams.

Dust from the processing plant can be utilized by other industries and need not just be dumped or stockpiled to be blown and washed away by run off of rain water.

Storm water runoff must be managed to prevent pollution being spread along the natural river courses.

Used water can be utilized to create new plant sites which will attract birds, provide more humidity and act as dust a collector area.

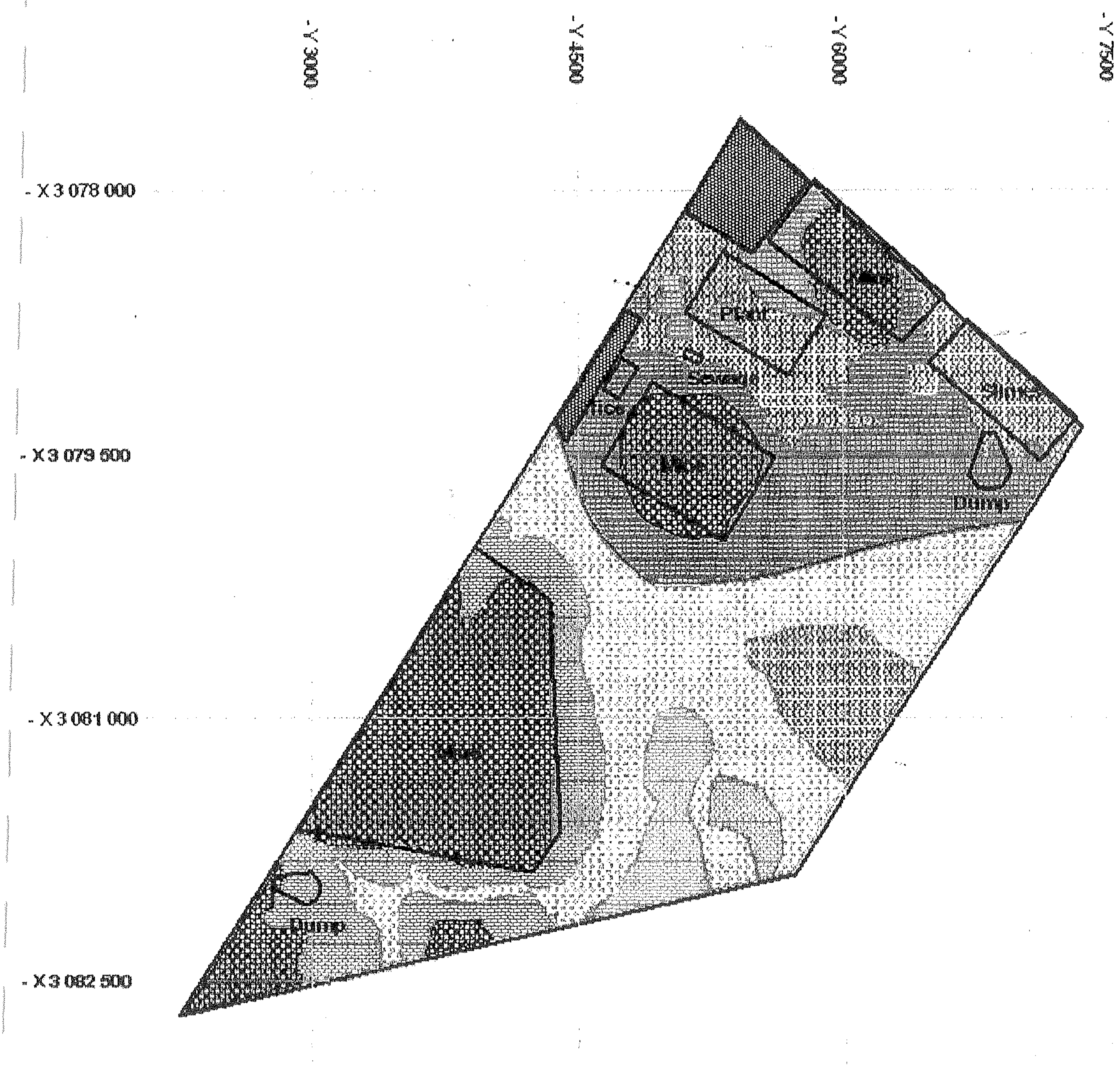
10 Conclusion :

Although mining is necessary, it should not be the end of the world for this environment.

However, careful management must be applied, and a lifestyle of protection of the environment be exercised by all ranks in this industry.

C.H.E. Visser B.Sc (Geol) NDT
NOORDKAAP GEOKON

DEMANENG : SOIL IMPACT SURVEY



Legend

letaliferous formation
olomite and slope
ash gravel
errace deposit and
hallow ground
lluvium
onservation
reas

S.A. MANGANESE

DEMANENG MINE

Mine Dvelopment

NK GEOKON
KIMBERLEY

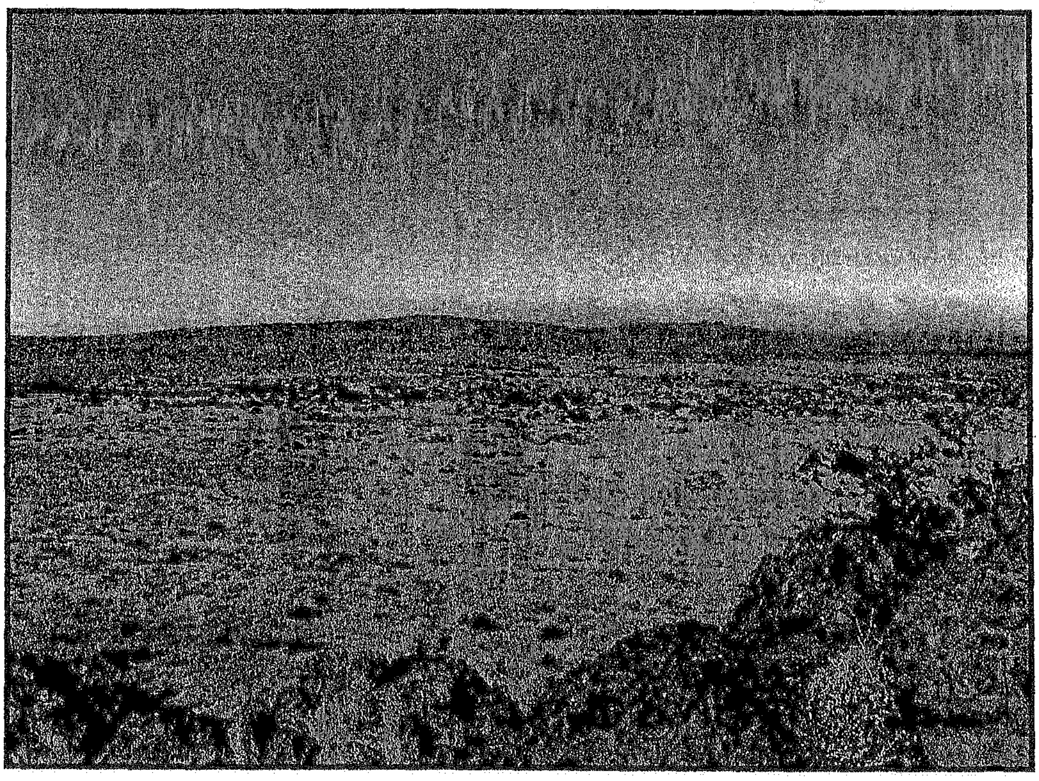
Cell 082 821 0217

November 2010

APPENDIX B

Report: Botanical Study

BOTANICAL REPORT: PROPOSED MINING OF IRON ORE AND MANGANESE ORE ON PORTION 2 OF THE FARM DEMANENG NO. 546, DISTRICT OF KURUMAN, NORTHERN CAPE PROVINCE BY SA MANGANESE (PTY) LTD.



Compiled by:	Karien van der Merwe	Compiled for:	SA Manganese (Pty) Ltd.
Address:	P.O. Box 3620 DIAMOND 8305	Address:	1st Floor, Lakefield Office Park C/o Lenchen & West Streets CENTURION 0157
Phone:	082 964 1667	Phone:	012 643 0118

NOVEMBER 2010

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BOTANICAL REPORT: PROPOSED MINING OF IRON ORE AND MANGANESE ORE ON PORTION 2 OF THE FARM DEMANENG NO. 546, DISTRICT OF KURUMAN, NORTHERN CAPE PROVINCE BY SA MANGANESE (PTY) LTD.

1. INTRODUCTION

SA Manganese (Pty) Ltd. (SA Manganese) has applied for a Mining Right over Portion 2 of the farm Demaneng No. 546, District of Kuruman, Northern Cape Province (Figure 1) in terms of Section 22 of the Mineral and Petroleum Resources Development Act, 2002 (Act No. 28 of 2002) (MPRDA). This botanical study forms part of the environmental impact assessment (EIA) conducted as part of the mining right application process, as per the requirements of Section 22(4)(a) of the MPRDA.

The main aim of the present study, bearing in mind the limitations thereof, is to identify and assess the anticipated impacts of the proposed mining operation on the natural vegetation of the study area, as well as to propose mitigation measures with the aim of eliminating or mitigating these impacts. This was done by means of several visits to the study area; an intensive literature study; consultation with the holder of grazing rights over the said property; as well as the process of public participation.

2. BACKGROUND INFORMATION

2.1 LOCALITY

The proposed mining area is located approximately 12 km to the south of Kathu (Figure 1), in the Northern Cape Province of South Africa and covers a total of 1 135.9468 ha (as per Title Deed 823/1953). This area falls within the Kalahari region of the Northern Cape Province (Figure 2) and has an average annual rainfall of 335.07 mm [based on data obtained from the South African Weather Service[1] for Kathu Weather Station No. 0356880 4 (Latitude: -27.6710; Longitude: 23.0100; Altitude: 1186 m above sea level) for the period January 1993 to December 2008].

[1] South African Weather Service. ✉: Private Bag X097, Pretoria, 0001.

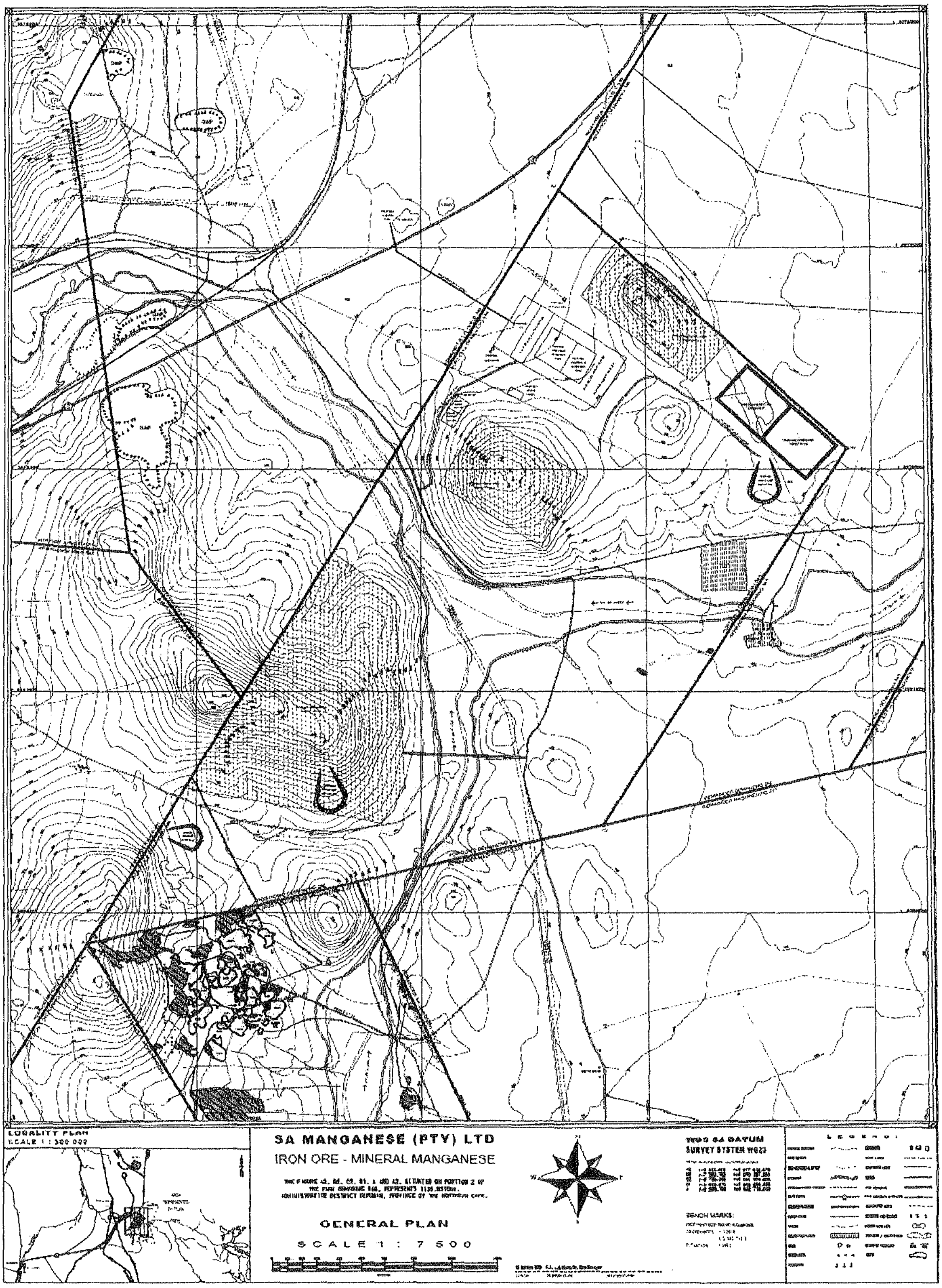


Figure 1. Draft lay-out plan and locality plan of the proposed mining area.

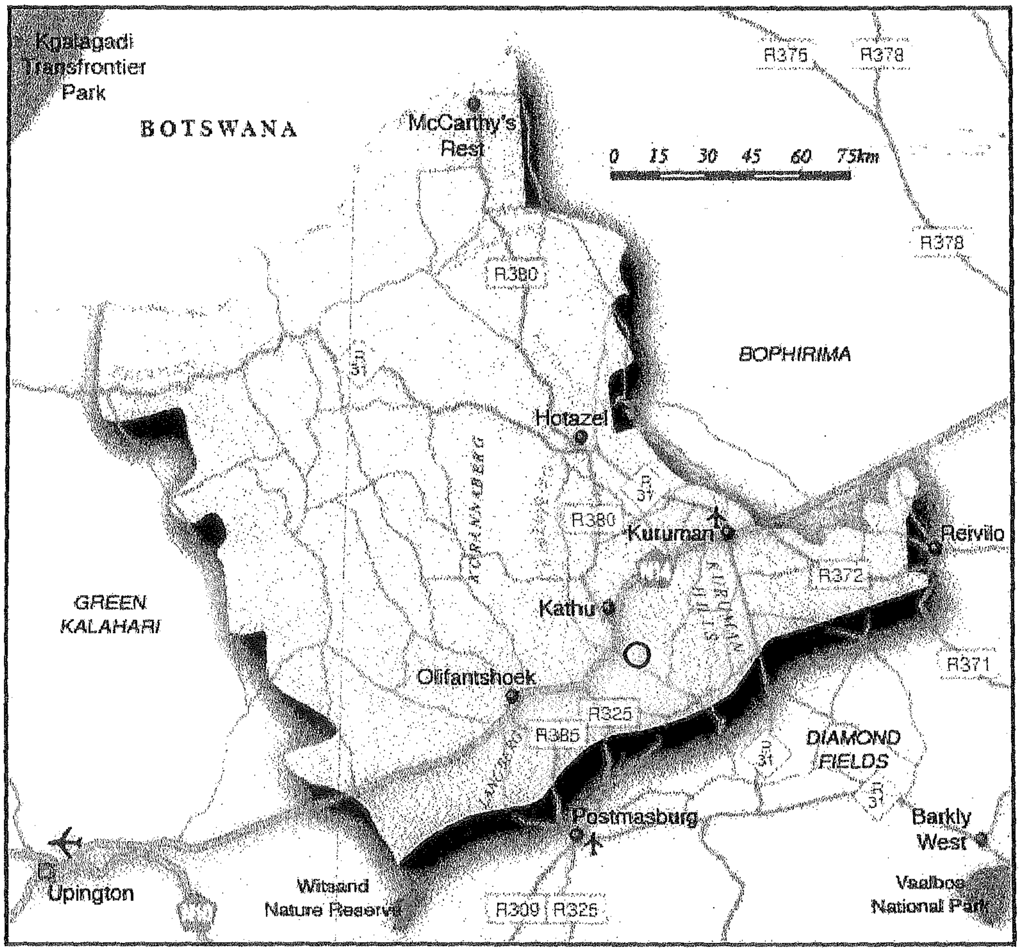


Figure 2. The Kalahari region of the Northern Cape Province (from http://www.roomsforafrica.com/accommodation-images/maps/south-africa/northern-cape/regions/kalahari.gif). [The approximate location of the proposed mining area is indicated with a O .]

2.2 CURRENT LAND USE

The proposed mining area is currently utilised for livestock farming by Mr. Dihan Jansen van Rensburg, the holder of grazing rights over the said property in terms of Deed of Transfer No. T450/1989.

Mr. Jansen van Rensburg uses a grazing management strategy that is based on a rotational grazing system: The proposed mining area forms an integral part of a larger livestock farming unit, which Mr. Jansen van Rensburg has divided into two sets of 16 camps each. Livestock is rotated between the 16 camps of one set before it is then rotated between the 16 camps of the remaining set. This grazing system allows Mr. Jansen van Rensburg to rest each of the 32 camps for a period of 105 days after being grazed for a maximum period of one week.

This system has been successfully implemented by the Jansen van Rensburg family for a period of 22 years and, according to Mr. Jansen van Rensburg (pers. comm.[2]), has resulted in the farming unit having a higher grazing capacity than that of the surrounding livestock farming areas. According to Mr. Jansen van Rensburg (pers. comm.[2]) this has been confirmed by the preliminary results of an ongoing study jointly conducted by the University of Pretoria, the Department of Agriculture and KK Animal Nutrition on the larger livestock farming unit: The latter unit has a grazing capacity of approximately 7 to 8 hectares per livestock unit, while the surrounding areas have a grazing capacity of approximately 14 to 15 hectares per livestock unit.

2.3 LIMITATIONS OF THE PRESENT STUDY

Various site visits to the proposed mining area were undertaken as part of this project for the purpose of conducting field surveys, namely on 7 October 2010, 14-15 October 2010 and 19-20 October 2010. Since the deadline for the completion of this report was the end of October 2010, all of these site visits took place prior to the commencement of the first summer rains in the area – i.e. right at the end of the winter season, which is regarded as the least desirable time for conducting field surveys.

[2] Mr. Dihan Jansen van Rensburg. Holder of grazing rights over the proposed mining area.

As a result of the aforementioned limitation, and the difficulty in correctly identifying grass, herb and forb species at the end of the winter season, this report mainly focuses on the tree and shrub species identified in the study area (a small number of identifiable herb and grass species were also included).

2.4 THE PROPOSED MINING OPERATION

As a result of the fact that the ore body identified in the proposed mining area is outcropping, open cast mining with machinery will be used in the exploitation of manganese and iron ore as part of the proposed mining operation.

It is anticipated that the maximum height of benches will not exceed 10 m, while the minimum lead is anticipated to be 30 m.

Blast holes will be percussion drilled in identified target areas, with the diameter of each blast hole measuring 150 mm. After blasting, waste material will be loaded and hauled to a waste dump, while ore will be loaded and hauled to a primary crusher (jaw crusher). The ore will be crushed to -32 mm via a primary (jaw), secondary (cone) and tertiary (cone) crushing system, where-after crushed material will be washed and screened into different sized fractions, as dictated by the market. Slimes resulting from the washing process will be pumped into one of two slimes dams.

Washed material will be upgraded by means of a dense media separation process and/or jigging process. Slimes from this process will also be pumped into one of two slimes dams.

The final product will be loaded and hauled to stockpiles, while process waste will be stockpiled on waste dumps. Final product will then be transported to a loading plant via conveyor belt, from where it will be loaded onto rail trucks and exported via Saldanha.

The production rate of the proposed mining operation will be approximately 1 736 tons. $month^{-1}$ of manganese ore bearing material and approximately 200 000 $tons.month^{-1}$ of iron ore bearing material, which adds up to a combined total of approximately 201 736 tons. $annum^{-1}$. Based on these production figures, the anticipated lifespan of the proposed mining operation is 20 years.

The following mobile equipment will be used for the handling of material:

- 1 x 150 ton haul truck;
- 2 x 20 m^3 loaders;
- 3 x percussion drills;
- 4 x 40 000 ℓ water bowsers (to be used for dust suppression purposes);
- 5 x dozers;
- 6 x graders;
- 7 x 10 m^3 excavators; and
- 8 x utility vehicles.

3. VEGETATION OF THE STUDY AREA

3.1 GENERAL

The proposed mining area is located within the Kuruman Thornveld and Kuruman Mountain Bushveld vegetation types of southern Africa (Mucina & Rutherford, 2006) (Figure 3).

3.1.1 The Kuruman Thornveld Vegetation Type

According to Mucina and Rutherford (2006), the Kuruman Thornveld vegetation type can generally be associated with flat, rocky plains, as well as some gentle sloping hills. As is evident from Figure 3, a map indicating the general vegetation classification of the study area according to Mucina and Rutherford (2006), this vegetation type can be generally associated with the lower lying parts of the study area.

The Kuruman Thornveld vegetation type is characterised by a very well-developed, closed shrub layer and a well-developed open tree stratum of Camel Thorn Tree *Acacia erioloba* (Mucina & Rutherford, 2006). Other important plant species occurring in this vegetation type include: *Acacia mellifera* subsp. *detinens, Boscia albitrunca, Grewia flava, Lycium hirsutum, Tarchonanthus camphoratus, Gymnosporia buxifolia, Acacia hebeclada* subsp. *hebeclada, Monechma divaricatum,*

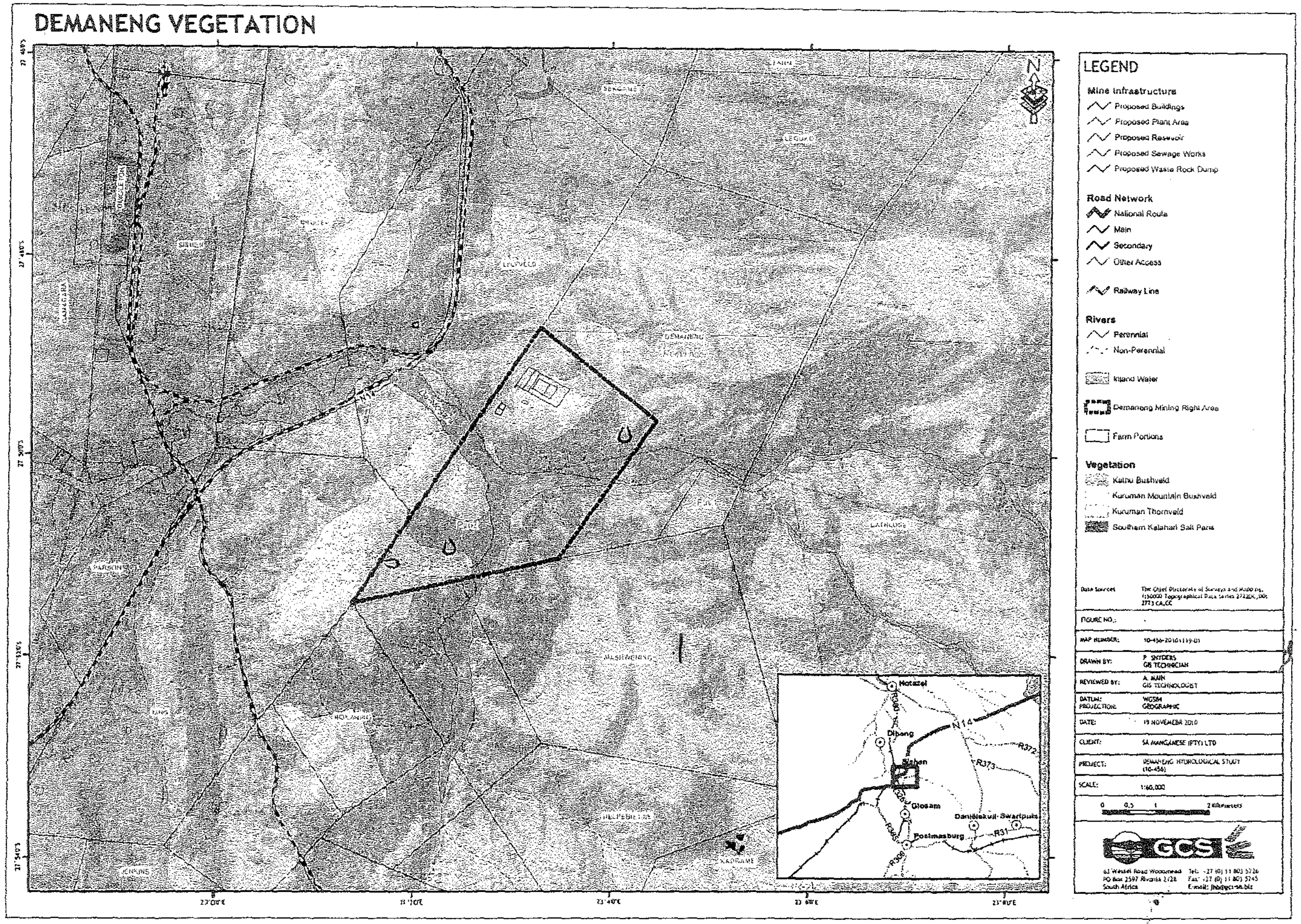


Figure 3. Map indicating the general classification of the natural vegetation of the study area according to Mucina and Rutherford (2006).

Gnidia polycephala, Helichrysum zeyheri, Hermannia comosa, Pentzia calcarea, Plinthus sericeus, Elephantorrhiza elephantina, Aristida meridionalis, A. stipitata subsp. *stipitata, Eragrostis lehmanniana, E. echinochloidea, Melinis repens, Dicoma schinzii, Gisekia africana, Harpagophytum procumbens* subsp. *procumbens, Indigofera daleoides, Limeum fenestratum, Nolletia ciliaris, Seddera capensis, Tripteris aghillana* and *Vahlia capensis* subsp. *vulgaris* (Mucina & Rutherford, 2006).

In addition to the species listed, the following biogeographically important taxa can also be found in the Kuruman Thornveld vegetation type (Mucina & Rutherford, 2006): *Acacia luederitzii* var. *luederitzii* and *Acacia haematoxylon* (Kalahari endemics); *Blepharis marginata, Digitaria polyphylla* and *Corchorus pinnatipartitus* (Griqualand West endemics); and *Terminalia sericea* (southernmost distribution in the interior of southern Africa).

3.1.2 The Kuruman Mountain Bushveld Vegetation Type

According to Mucina and Rutherford (2006), the Kuruman Mountain Bushveld vegetation type can generally be associated with rolling hills with gentle to moderate slopes, as well as hill pediment areas. This corresponds to what is evident from Figure 3: The Kuruman Mountain Bushveld vegetation type can generally be associated with the hillier parts of the proposed mining area.

The grass layer of the Kuruman Mountain Bushveld vegetation type is well-developed (Mucina & Rutherford, 2006). The following important plant species can generally be associated with this vegetation type (Mucina & Rutherford, 2006): *Rhus lancea, Diospyros austro-africana, Euclea crispa* subsp. *crispa, E. undulata, Olea europaea* subsp. *africana, Rhus pyroides* var. *pyroides, R. tridactyla, Tarchonanthus camphoratus, Tephrosia longipes, Rhus ciliata, Amphiglossa triflora, Anthospermum rigidum* subsp. *pumilum, Gomphocarpus fruticosus* subsp. *fruticosus, Helichrysum zeyheri, Lantana rugosa, Wahlenbergia nodosa, Ebracteola wilmaniae, Hertia pallens, Rhynchosia totta, Andropogon chinensis, A. schirensis, Anthephora pubescens, Aristida congesta, Digitaria eriantha* subsp. *eriantha, Themeda triandra, Triraphis andropogonoides, Aristida diffusa, Brachiaria nigropedata, Bulbostylis burchellii, Cymbopogon caesius, Diheteropogon amplectens, Elionurus muticus, Eragrostis chloromelas, E. nindensis, Eustachys paspaloides, Heteropogon contortus, Melinis repens, Schizachyrium sanguineum, Trichoneura grandiglumis, Dicoma anomala, D. schinzii, Geigeria ornativa, Helichrysum cerastioides,* *Heliotropium strigosum, Hibiscus marlothianus, Kohautia cynanchica, Kyphocarpa angustifolia, Boophane disticha* and *Pellaea calomelanos*.

In addition to the aforementioned important species, the following Griqualand West endemics are also known to occur in this vegetation type: *Lebeckia macrantha, Justicia puberula, Tarchonanthus obovatus, Euphorbia wilmaniae, Digitaria polyphylla* and *Sutera griquensis* (Mucina & Rutherford, 2006).

3.2 VEGETATION COMMUNITIES

Keeping in mind the limitations of the present study (Section 2.3), a finer breakdown of the vegetation types of the study area into vegetation communities is given in this section, along with lists of the *most conspicuous* plant species recorded within each community (a complete list of species recorded in the study area is attached hereto as Appendix A). Species of conservation importance are highlighted in green, while alien weeds and invasive plant species are highlighted in red.

Vegetation structure was described by using the broad scale structural classification system of Edwards (1983).

3.2.1 *Euclea undulata* Tall Open Shrubland

The *Euclea undulata* Tall Open Shrubland (Photo Plate 1) can generally be associated with the hilltops located within the proposed mining area and is generally characterised by the following plant species:

Trees	: *Boscia albitrunca, Ficus cordata, Acacia erioloba (small).*
Shrubs	: *Euclea undulata, Rhus tridactyla, Grewia flava, Ziziphus mucronata, Rhus lancea, Acacia tortilis, Tarchonanthus camphoratus, Acacia mellifera, Cadaba aphylla, Rhigozum trichotomum, Asparagus* spp., *Acacia hebeclada* subsp. *hebeclada.*
Forbs	: *Gomphocarpus fruticosus* subsp. *fruticosus, Indigofera alternans, Hermbstaedtia fleckii, Lantana rugosa.*
Grasses	: *Cymbopogon plurinodis, Eragrostis lehmanniana, Aristida meridionalis, Heteropogon contortus.*

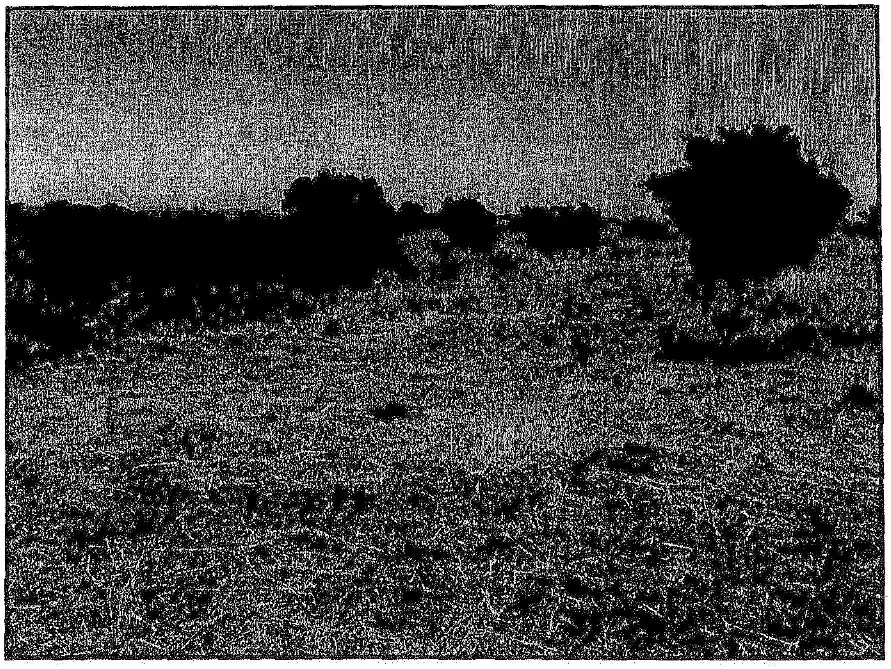


Photo Plate 1. *Euclea undulata* Tall Open Shrubland.

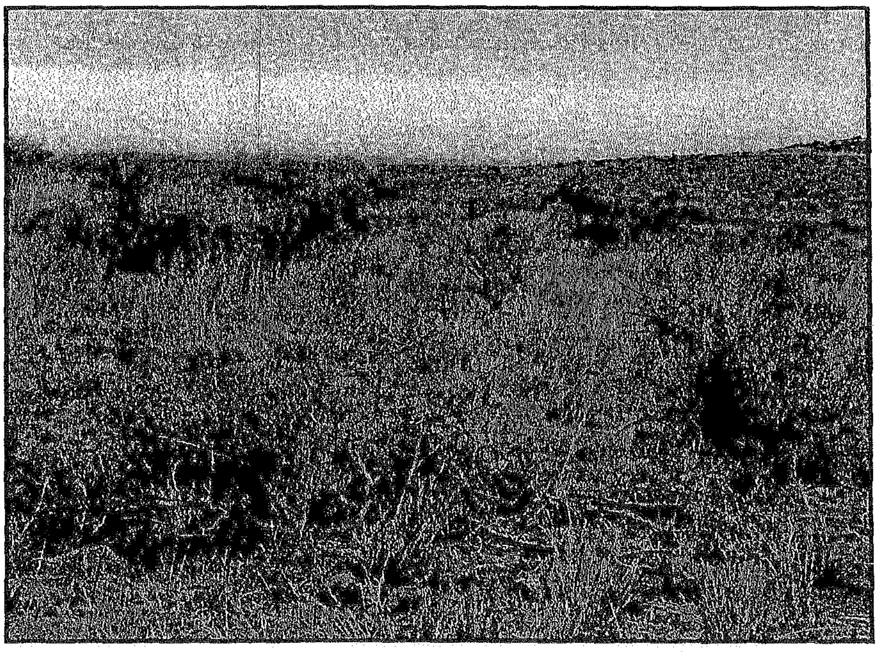


Photo Plate 2. *Tarchonanthus camphoratus* Tall Open Shrubland.

3.2.2 *Tarchonanthus camphoratus* Tall Open Shrubland

The *Tarchonanthus camphoratus* Tall Open Shrubland (Photo Plate 2) is generally associated with the slopes of the hills located within the mining area and is generally characterised by the following plant species:

Small trees	: *Acacia erioloba, Boscia albitrunca, Acacia tortilis.*
Shrubs	: *Acacia mellifera, Grewia flava, Tarchonanthus camphoratus, Ziziphus mucronata, Acacia hebeclada* subsp. *hebeclada, Gymnosporia buxifolia, Rhigozum trichotomum, Cadaba aphylla, Lycium cinereum.*
Grasses	: *Aristida adscensionis.*
Forbs	: *Protasparagus* spp., *Aptosimum elongatum.*

3.2.3 *Acacia erioloba* Low Open Woodland

The *Acacia erioloba* Low Open Woodland (Photo Plate 3) can generally be associated with the low-lying parts of the proposed mining area covered with a deep layer of Kalahari sand, as well as the dry run of the Gamagara River. This vegetation community is generally characterised by the following plant species:

Trees	: *Acacia erioloba, Acacia haematoxylon, Prosopis glandulosa* var. *torreyana.*
Shrubs	: *Acacia hebeclada* subsp. *hebeclada, Acacia mellifera, Grewia flava, Tarchonanthus camphoratus.*
Forbs	: *Senna italica* subsp. *arachoides, Tribulus terrestris*
Grasses	: *Aristida congesta* subsp. *congesta*, *Eragrostis lehmanniana.*

3.3 SPECIES PROTECTED IN TERMS OF THE NATIONAL FORESTS ACT, 1998

3.3.1 General

Three tree species protected in terms of Section 12 of the National Forests Act, 1998 (Act No. 84 of 1998) (NFA), as published in Government Notice No. 1106 of 27 November 2009, were recorded within the boundaries of the proposed mining area. These are: Camel Thorn *A. erioloba* (Photo Plate 4), Shepherd's Tree *B. albitrunca* (Photo Plate 5) and Grey Camel Thorn *A. haematoxylon* (Photo Plate 6).

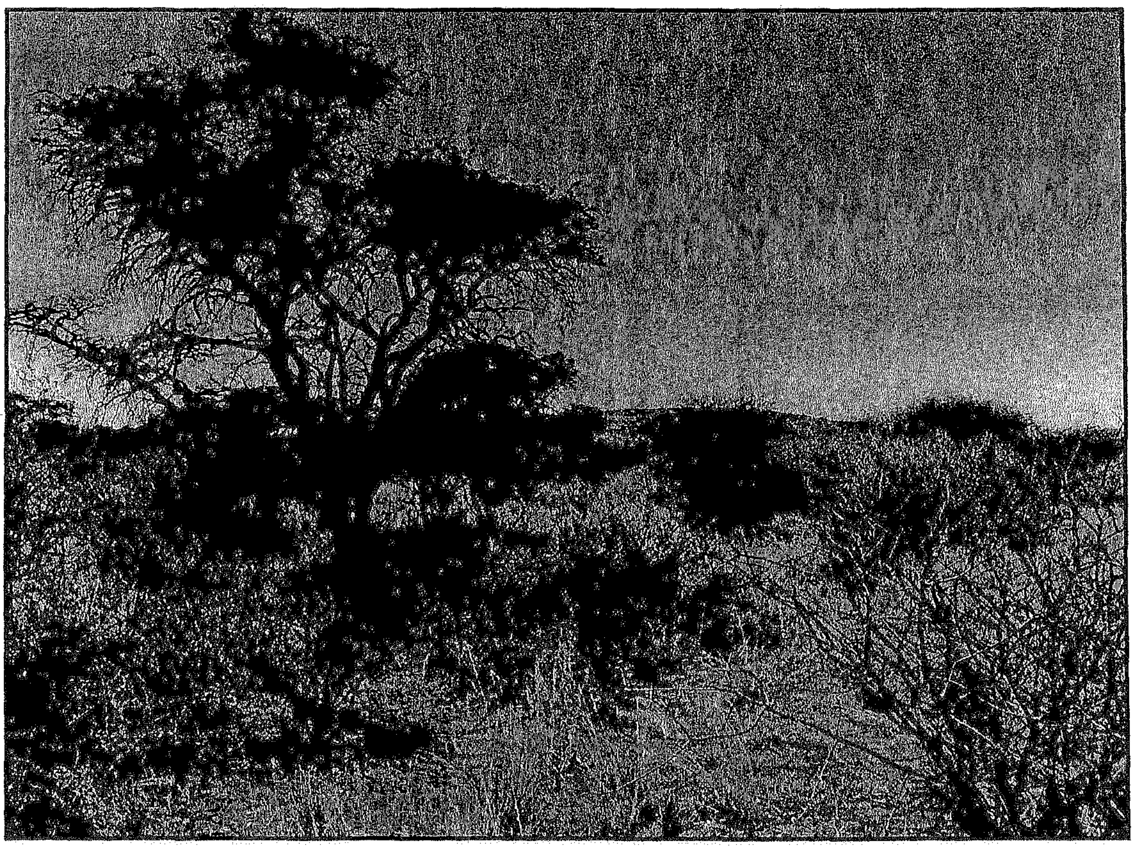


Photo Plate 3. *Acacia erioloba* Low Open Woodland.

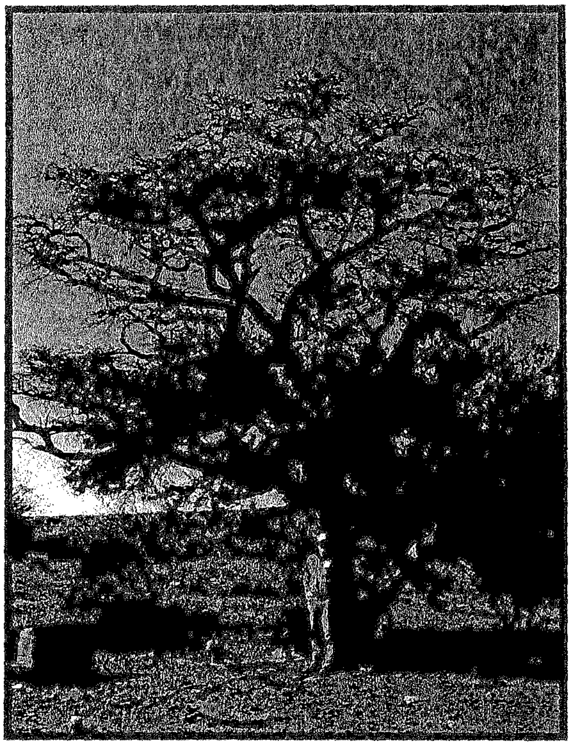


Photo Plate 4. Camel Thorn Tree *Acacia erioloba.*

Photo Plate 5. Shepherd's Tree *Boscia albitrunca.*

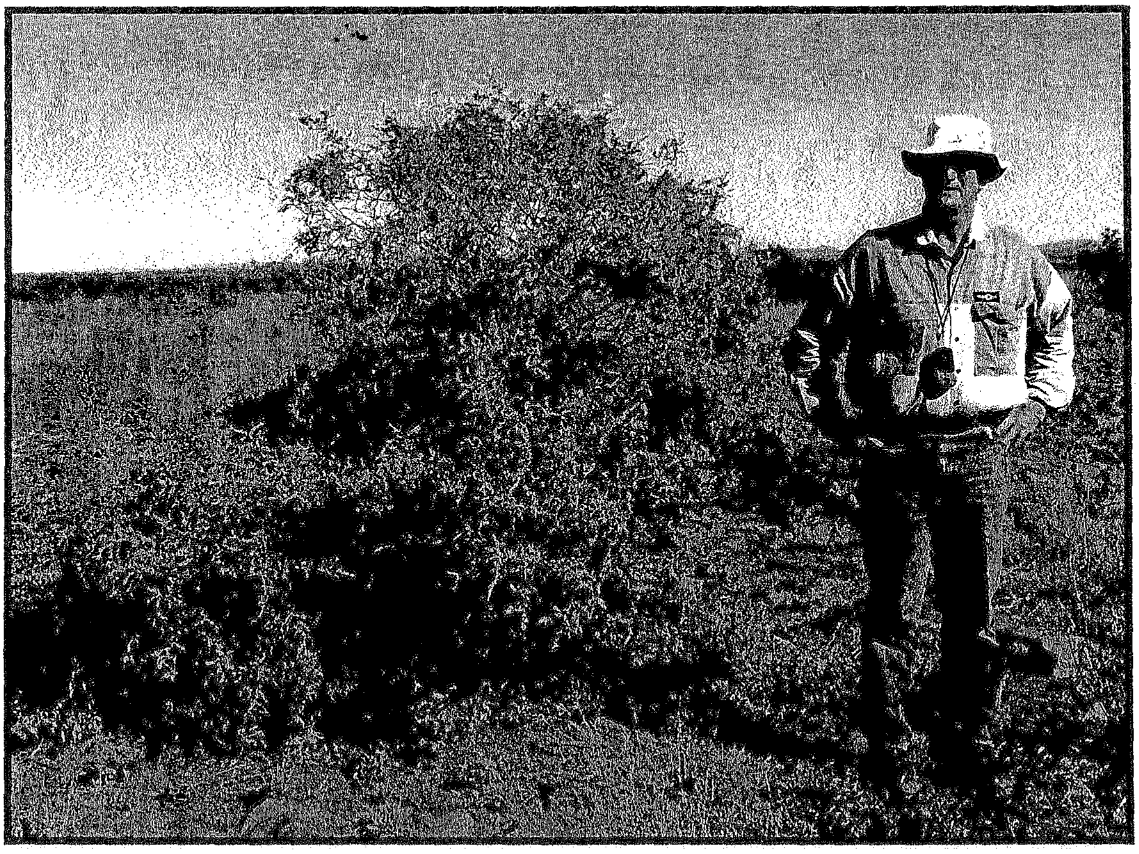


Photo Plate 6. Grey Camel Thorn Tree *Acacia haematoxylon*.

According to Section 15 of the NFA, no person may cut, disturb, damage or destroy any protected tree, or possess, collect, remove, transport, export, donate, purchase or sell or in any other manner acquire or dispose of any protected tree or any forest product derived from a protected tree without a license from the Department of Agriculture, Forestry and Fisheries.

3.3.2 Camel Thorn Tree *A. erioloba*

The Camel Thorn Tree *A. erioloba* (Photo Plate 4) is regarded as a keystone species in the Kalahari region (Van Rooyen, 2001; Colvin *et al.*, 2007), meaning that it is a species upon which a large number of other plant and animal species depend for survival. This tree species often acts as the primary source of food and shelter for a number of mammals, birds and insects whose life cycles are intimately bound up with the tree (Van Rooyen, 2001). In addition to being a primary source of food and shelter to a large number of other species, it is believed that *A. erioloba* might also be capable of hydraulic lift, i.e. "*the process by which deep-rooted plants absorb water during the day and then release it from their shallow root systems at night*". Research is currently underway to confirm whether this is indeed the case and, if so, to determine the ecological importance of this phenomenon (Colvin *et al.*, 2007).

In addition to the important role *A. erioloba* plays in the ecology of the natural ecosystems of the Kalahari, its leaves and pods furthermore form an excellent fodder for both game and livestock (Van Wyk & Van Wyk, 1997; Van der Walt & Le Riche, 1999; Van Rooyen, 2001; Coates Palgrave, 2002). The leaves of this tree species are highly nutritious, with a protein content of 17% (Van der Walt & Le Riche, 1999; Van Rooyen, 2001), while cows feeding on its pods are believed to show a noticeable increase in milk production (Van Rooyen, 2001; Coates Palgrave, 2002). The seeds of *A. erioloba* have a protein content of up to 33% (Van der Walt & Le Riche, 1999).

A. erioloba is a slow-growing species and as a result of its deep tap root system, is difficult to transplant (Coates Palgrave, 2001).

3.3.3 Shepherd's Tree *B. albitrunca*

Similar to *A. erioloba* (refer to Section 2.3.2), *B. albitrunca* (Photo Plate 5) has an important function in the Kalahari region, and is often referred to as "the tree of life" based on the fact that it affords sustenance to both man and animals (Van der Walt & Le Riche, 1999; Coates Palgrave, 2002).

One of the important roles of *B. albitrunca* is creating a cavern of cool shade for animals in an often shadeless region (Van Rooyen, 2001). According to Van Rooyen (2001) the shaded sand beneath the tree can be up to 20°C cooler than in the sun.

In addition to providing shade, *B. albitrunca* is heavily browsed by both game and livestock (Van Wyk & Van Wyk, 1997; Van der Walt & Le Riche, 1999; Van Rooyen, 2001; Coates Palgrave, 2002), although it is said that the milk of cows feeding on its leaves may be tainted (Van Rooyen, 2001; Coates Palgrave, 2002). The leaves of this species are highly nutritious, with a protein content of 14% and a relatively high Vitamin A content (Van der Walt & Le Riche, 1999; Van Rooyen, 2001).

According to Coates Palgrave (2002) the seeds of *B. albitrunca* germinate easily. However, growth after germination appears to be unpredictable. Van der Walt and Le Riche (1999) speculate that heavy browsing as a result of the palatability of the leaves may contribute to this phenomenon.

3.3.4 Grey Camel Thorn Tree *A. haematoxylon*

The Grey Camel Thorn Tree *A. haematoxylon* (Photo Plate 6) is endemic to the Kalahari region (Van der Walt & Le Riche, 1999; Van Rooyen, 2001; Mucina & Rutherford, 2006) and, as a result of the palatability of its leaves, is regarded as one of the most valuable sources of fodder of this region (Van der Walt & Le Riche, 1999).

A. haematoxylon is regarded as being difficult to cultivate away from its natural habitat (Coates Palgrave, 2001).

3.3.5 Approximate density of protected tree species throughout the study area

3.3.5.1 Methodology, aim and limitations

Figure 4 attempts to give a visual representation of the density of the protected tree species recorded in the study area (i.e. *A. erioloba, B. albitrunca* and *A.*

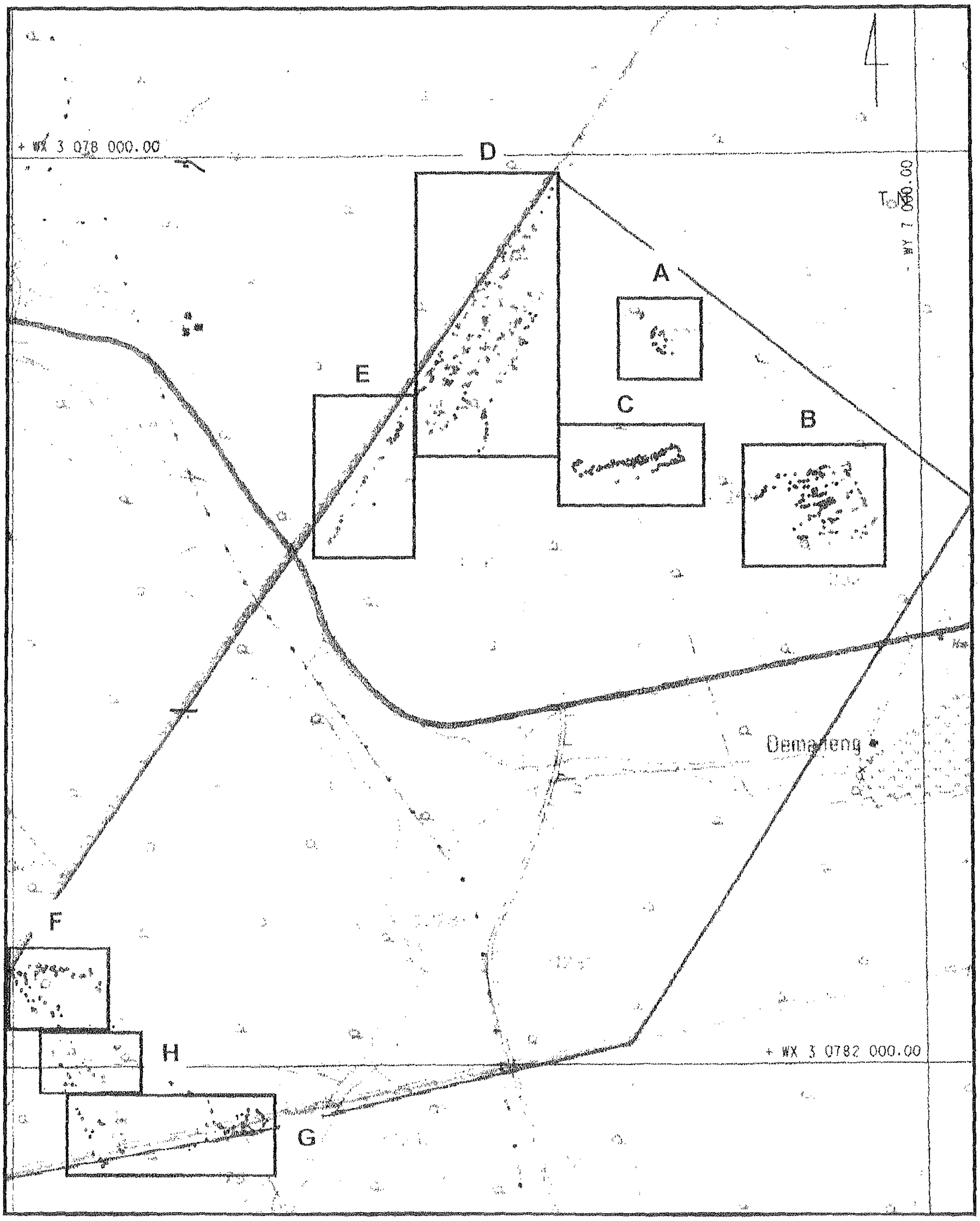


Figure 4. Visual representation of the approximate density of protected trees within blocks representative of the identified vegetation communities of the proposed mining area.

haematoxylon) within the various sub-vegetation types identified in the area (Appendix B). It is important to note that Figure 4 does not aim to illustrate the exact number of individuals of the aforementioned protected tree species located in the study area as a result of the time constraints and scope of the present study. Instead, areas representing each of the identified sub-vegetation communities were randomly selected and divided into 30 m-transects. These transects were traversed on foot while geo-referencing each individual of the above-mentioned protected tree species within each transect. The approximate density obtained for each randomly selected block of each sub-vegetation type was then regarded as being representative of the entire sub-vegetation type.

No geo-referencing took place within the dry run of the Gamagara River, as no construction or mining activities are planned for this area (Figure 1).

In light of the above it is therefore clear that, even though the vegetation of most parts of the study area were visually inspected on foot, the entire area was not covered for the purpose of the geo-referencing of protected tree species.

3.3.5.2 Results

From Figure 4 it is evident that *B. albitrunca* can generally be associated with the hilly parts of the proposed mining area, as well as the slopes of the hills located in the area.

No individuals of *A. erioloba* or *A. haematoxylon* were recorded on the top of the hill located in the northern corner of the study area (Block A). Since the approximate density of *B. albitrunca* individuals found on this hill is regarded as being similar to that found on the other hill tops located in the proposed mining area, it is clear that quite a large number of *B. albitrunca* individuals is anticipated to be destroyed as a result of the physical mining activities of the applicant, which will mostly be limited to the hilly parts of the study area (Figure 1).

In addition to occurring on the hill tops, *B. albitrunca* is also associated with the slopes of the hills located in the proposed mining area (Figure 4 – Blocks B, C, E, F and G). It should be kept in mind that, since only representative parts of the study area were geo-referenced, a similar density of *B. albitrunca* individuals recorded on the aforementioned slopes is anticipated for the other slopes found in the area.

Individuals of *A. haematoxylon* were only recorded in Blocks D, H and the lower-lying parts of Block B (Figure 4). All three of these areas are associated with the lower-lying parts of the proposed mining area, which are covered with a relatively thick layer of Kalahari sand. It is evident from Figure 1 that all three these areas are anticipated to be disturbed as a result of both the construction (Blocks D and B) and operational phases (Block H) of the proposed operation, since the process plant, slimes dams and a tailings dump are planned for these areas.

Individuals of *A. erioloba* are, like *A. haematoxylon*, mostly limited to the lower-lying parts of the study area, which are covered with a thick layer of Kalahari sand (Figure 4 – Blocks D, H and the lower-lying parts of Block C). [It should be kept in mind that the entire dry run of the Gamagara River, which wasn't geo-referenced for the purpose of this study, also has a relatively high density of *A. erioloba* trees. In addition, the entire area linking Blocks D and C is anticipated to have a density of *A. erioloba* similar to that recorded in the central parts of Block D. This entire area was not geo-referenced.] Unlike *A. haematoxylon*, *A. erioloba* was, however, also found to occur in the transitional areas between the lower-lying, sandy parts of the study area and the hill slopes. It is therefore evident from Figures 1 and 4 that a large number of *A. erioloba* individuals will be destroyed as a result of site clearance for plant construction, based on the draft site lay-out plan provided by the applicant.

3.4 RED DATA SPECIES

Although no individuals of Red Data plant species were recorded within the study area as part of the field surveys conducted during October 2010, the following Red Data plant species (as per Hilton-Taylor, 1996) have been recorded in the surrounding areas and may therefore also occur within the borders of the proposed mining area: Devil's Claw *Harpagophytum procumbens* subsp. *procumbens*, Ghaap *Hoodia gordonii*, *Adenia repanda*, *Antimima lawsonii* and *Euphorbia planiceps* (Anderson, 2003; Mucina & Rutherford, 2006; Van der Merwe, 2006).

3.5 SPECIES OF BIOGEOGRAPHIC IMPORTANCE

The proposed mining area is located within the borders of the Griqualand West Centre of Endemism (GWCE) (Figure 5). The following plant species endemic or near-endemic to the GWCE were either recorded within the borders of the proposed mining area, or are anticipated to occur in the proposed mining area and surrounds: *Rhus tridactyla* (endemic) (Van Wyk & Smith, 2001; Anderson, 2003), *Tarchonanthus obovatus* (near-endemic) (Van Wyk & Smith, 2001; Anderson, 2003), *Triaspis* spp. (possibly endemic) (Anderson, 2003), *Blepharis marginata* (Van Wyk & Smith, 2001; Mucina & Rutherford, 2006), *Digitaria polyphylla* (Van Wyk & Smith, 2001; Mucina & Rutherford, 2006), *Corchorus pinnatipartitus* (Van Wyk & Smith, 2001; Mucina & Rutherford, 2006), *Lebeckia macrantha* (Van Wyk & Smith, 2001; Mucina & Rutherford, 2006), *Justicia puberula* (Van Wyk & Smith, 2001; Mucina & Rutherford, 2006), *Euphorbia wilmaniae* (Mucina & Rutherford, 2006) and *Sutera griquensis* (Van Wyk & Smith, 2001; Mucina & Rutherford, 2006).

According to Van Wyk and Smith (2001) the vegetation of the GWCE is still fairly intact, although it is very poorly conserved. Bush encroachment, especially by Black Thorn *Acacia mellifera*, is a major problem in large parts of this area, mainly as a result of inappropriate veld management practices such as overgrazing. (It should be noted, however, that encroachment by *A. mellifera* was not noted within the borders of the proposed mining area. It is highly probable that this is the result of the rotational grazing system implemented by Mr. Dihan Jansen van Rensburg.)

3.6 SPECIES PROTECTED IN TERMS OF THE NATURE AND ENVIRONMENTAL CONSERVATION ORDINANCE, 1974

Plant species protected in the Northern Cape Province in terms of the Nature and Environmental Conservation Ordinance, 1974 (Ordinance No. 19 of 1974) that were either recorded in the study area (Appendix A) or are expected to occur in the study area according to Anderson (2003), Mucina and Rutherford (2006) and Van der Merwe (2006), include: *Aloe grandidentata*, *Aloe claviflora*, *Aloe hereroensis*, *Ammocharis coranica*, *Anacampseros* cf. *subnuda*, *Babiana hypogea*, *Boophane disticha*, *Crinum bulbispermum*, *Ebracteola wilmaniae*, *Fockea angustifolia*, *Gomphocarpus fruticosus* subsp. *fruticosus*, *Haworthia* spp., *Huerniopsis decipiens*, *Lithops aucampiae* subsp. *aucampiae*, *Mestoklema arboriforma*, *Nerine laticoma*,

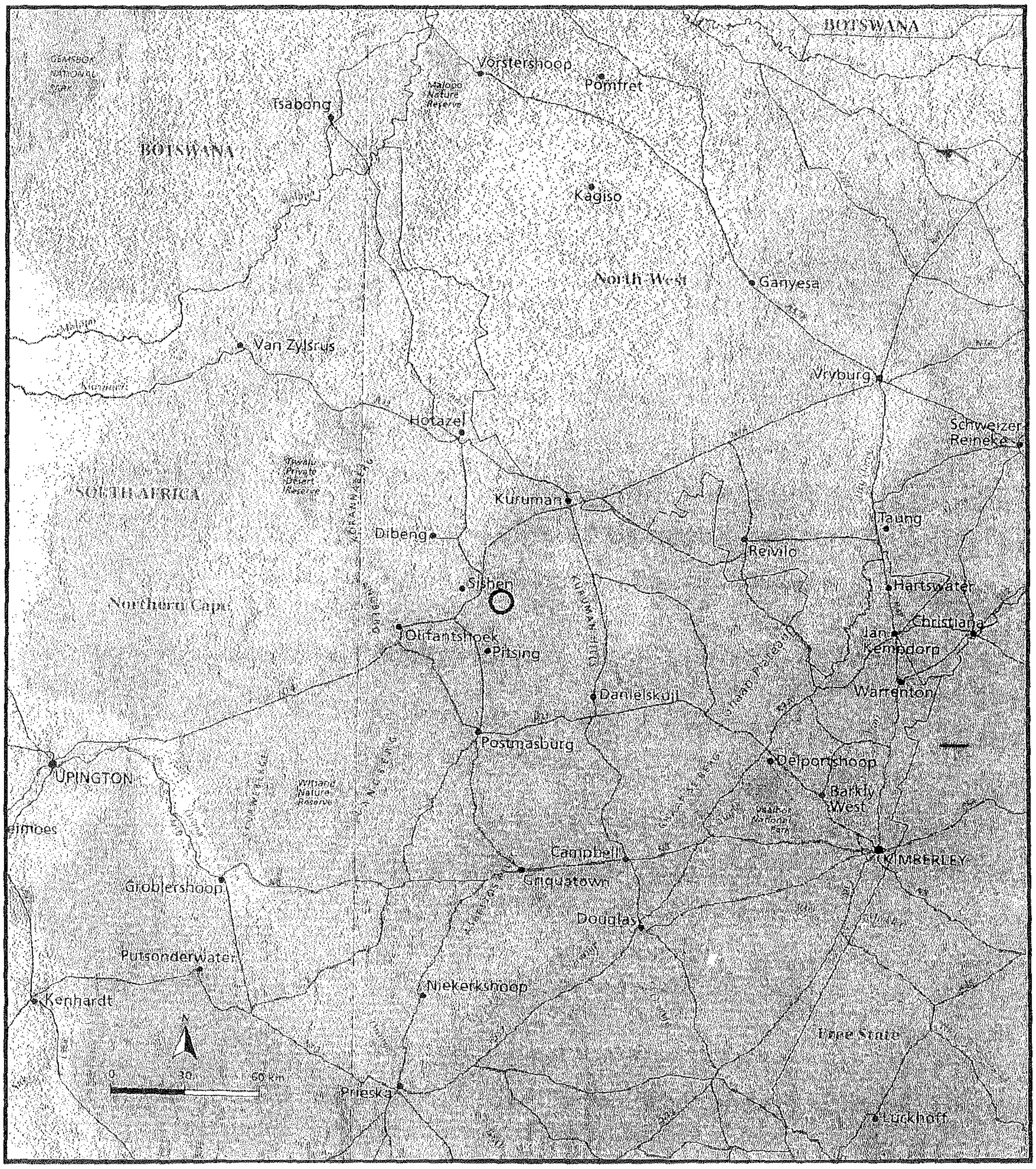


Figure 5. The Griqualand West Centre of Endemism (highlighted) [from Van Wyk and Smith (2001)]. [The approximate location of the proposed mining area is indicated with O .]

Orbea lutea, Rushcia spp., *Stapelia olivacea* and *Trichodiadema* spp.

3.7 AQUIFER DEPENDENT ECOSYSTEMS

Colvin *et al.* (2007) defines aquifer dependent ecosystems (ADEs) as "…*ecosystems which depend on groundwater in, or discharging from, an aquifer. They are distinctive because of their connection to the aquifer and would be fundamentally altered in terms of their structure and functions if groundwater was no longer available*". An aquifer, in turn, is defined by the National Water Act, 1998 (Act No. 36 of 1998) as "…*a geological formation which has structures or textures that hold water or permit appreciable water movement through them*". For the purpose of ADEs, the term "appreciable" is regarded as meaning that there are sufficient quantities of water available to sustain a dependent ecosystem, even though the quality may not meet human consumption standards (Colvin *et al.*, 2007).

ADEs oftentimes play in important role in sustaining surrounding ecosystems in what is known as the "oasis effect" (Colvin *et al.*, 2008). As a result of their access to groundwater, ADEs often stand in contrast to their surrounding environments. As a result, they act as particularly productive ecosystems that provide important ecological services and goods to surrounding, contrasting communities (Colvin *et al.*, 2007).

Although research into South African ADEs is still at an early stage, terrestrial keystone species such as the Camel Thorn Tree *A. erioloba* of the Kalahari region of South Africa (refer to Section 2.3.2) is regarded as having a high probability of being linked to aquifers (Colvin *et al.*, 2007) and is therefore regarded as a South African ADE (Colvin *et al.*, 2008). [*A. erioloba* has a deep tap root system (Coates Palgrave, 2002), with tap roots reaching depths of between 30 and 60 m according to Colvin *et al.* (2007), or up to 40 m according to Van der Walt and Le Riche (1999) and, as a result, oftentimes have access to aquifers.]

In light of the above it is therefore anticipated that *A. erioloba* individuals within the proposed mining area may play an important role in sustaining the surrounding ecosystem, based on its status as an ADE, the latter which is oftentimes associated with the "oasis effect".

3.8 PLANT SPECIES PROTECTED IN TERMS OF THE NATIONAL ENVIRONMENTAL MANAGEMENT: BIODIVERSITY ACT, 2004

The following plant species known to occur in the areas surrounding the proposed mining area (Anderson, 2003; Mucina & Rutherford, 2006; Van der Merwe, 2006), and therefore also anticipated to occur within the mining area, are included in the list of critically endangered, endangered, vulnerable and protected species published in terms of Section 56(1) of the National Environmental Management: Biodiversity Act, 2004 (Act No. 10 of 2004): Devil's Claw *H. procumbens* subsp. *procumbens* and Ghaap *H. gordonii*. Both of these plant species are classified as "protected".

3.9 ALIEN WEEDS AND INVASIVE PLANTS

A wide variety or large numbers of alien weeds and invasive plants, declared as such in terms of the Conservation of Agricultural Resources Act, 1983 (Act No. 43 of 1983) (CARA), as amended, were not recorded within the borders of the study area.

A few individuals of *Prosopis glandulosa* subsp. *torreyana*, classified as a "Category 2 Invader" in terms of Regulation 15 of the regulations made in terms of Section 29 of CARA, were recorded within the dry run of the Gamagara River. This distribution pattern is in line with the observations of Henderson (2001), who states that this species is known to invade riverbanks, riverbeds and drainage lines in semi-arid to arid regions.

In addition, a few individuals of *Lantana rugosa* were recorded within the *Euclea undulata* Tall Open Shrubland vegetation community (Section 2.2.1). This species is classified as a "Category 1 Weed) in terms of Regulation 15 of the regulations made in terms of Section 29 of CARA.

4. ANTICIPATED IMPACTS ON THE NATURAL VEGETATION OF THE STUDY AREA

Table 1 summarises the mitigated significance ratings of the anticipated impacts of the proposed mining operation on the natural vegetation of the study area. Mitigation measures proposed for each anticipated impact are detailed in Section 4.

Table 1. Summary and mitigated significance ratings of the anticipated impacts of the proposed mining operation on the natural vegetation of the study area.

No.	Anticipated Impact	Probability	Extent	Duration	Intensity	Significance
1	Anticipated destruction of *Acacia erioloba* individuals and, as a result, the entire ecology of the area	3	2	6	4	Moderate to High
2	Anticipated destruction of *Boscia albitrunca* individuals	4	1	6	4	Moderate to High
3	Anticipated destruction of *Acacia haematoxylon*	2	1	5	4	Moderate to High
4	Anticipated impact on an aquifer dependent ecosystem	2	3	5	4	Moderate to High
5	Anticipated impact on the rotational grazing system of the grazing rights holder	3	2	5	4	Moderate to High
6	Anticipated impact on the grazing capacity of the larger livestock farming unit	3	2	5	4	Moderate to High
7	Anticipated destruction of Red Data species	2	1	2	4	Moderate
8	Anticipated destruction of plant species protected in terms of the Nature and Environmental Conservation Ordinance, 1974 (Ordinance No. 19 of 1974)	2	1	2	4	Moderate
9	Anticipated destruction of plant species protected in terms of the National Environmental Mangement: Biodiversity Act, 2004 (Act No. 10 of 2004)	2	1	2	4	Moderate
10	Anticipated impact of dust on vegetation	4	2	5	2	Moderate to High
11	Anticipated increase in alien weeds and invasive species	2	3	2	2	Moderate
12	Anticipated increase in fire hazard	2	2	2	4	Moderate

4.1 ANTICIPATED DESTRUCTION OF TREE SPECIES PROTECTED IN TERMS OF THE NATIONAL FORESTS ACT, 1998 (ACT NO. 84 OF 1998)

4.1.1 Anticipated impact on *Acacia erioloba*

With the current proposed site lay-out (Figure 1), it is anticipated that a large number of *A. erioloba* individuals will be destructed as a result of site clearance activities to be associated with the construction of the processing plant and slimes dams in the northern parts of the proposed mining area, as well as the rock dump in the south-eastern part of thereof.

An increase in the destruction of *A. erioloba* as a result of an increase in the collection of firewood by mine workers is also anticipated.

The destruction of individuals of *A. erioloba* is anticipated to have a negative impact on the entire ecology of the area, as *A. erioloba* acts as a keystone species in the Kalahari region (Van Rooyen, 2001; Colvin *et al.*, 2007) (Section 2.3.2).

4.1.2 Anticipated impact on *Boscia albitrunca*

It is anticipated that a relatively large number of *B. albitrunca* individuals will be destroyed as a result of the mining activities planned for the hills and hill slopes of the proposed mining area (Figure 1), which coincides with a relatively high density of this species (Figure 4).

4.1.3 Anticipated impact on *Acacia haematoxylon*

With the current proposed site lay-out (Figure 1), it is anticipated that a small number of *A. haematoxylon* individuals may be destructed as a result of site clearance activities to be associated with the construction of the processing plant and slimes dams in the northern parts of the proposed mining area, as well as the rock dump in the south-eastern part of thereof (Figures 1 & 4).

4.2 ANTICIPATED IMPACT ON AN AQUIFER DEPENDENT ECOSYSTEM

As is mentioned in Section 2.7, terrestrial keystone species such as *A. erioloba* of the Kalahari region of South Africa (refer to Section 3.3.2) is regarded as having a high probability of being linked to aquifers (Colvin *et al.*, 2007) and is therefore regarded as a South African ADE (Colvin *et al.*, 2008).

From Section 4.1.1 above it is clear that the destruction of a number of *A. erioloba* individuals is anticipated as a result of the site construction activities to be associated with the proposed mining operation, and therefore it is anticipated that a negative impact on the "oasis effect" (Section 3.7) of this ADE in the area may be experienced. It is not certain at this stage what the impact of the surrounding mining operations have been on this ADE to date and therefore it is anticipated that the quantification of this anticipated impact may be difficult.

4.3 ANTICIPATED IMPACT ON THE ROTATIONAL GRAZING SYSTEM AND, ULTEMATELY THE FINANCIAL POSITION, OF THE GRAZING RIGHTS HOLDER

As is mentioned in Section 2.2, the holder of grazing rights over the proposed mining area makes use of a rotational grazing system in which the proposed mining area forms part of a larger livestock farming unit. This livestock farming unit is divided into 32 camps of approximately 100 ha each.

Based on the assumption that the entire proposed mining area (i.e. 1 136.8563 ha) will not be used for livestock farming purposes during the anticipated life of mine of 20 years of the proposed mine as a result of a potential risk of injury to livestock, it is anticipated that approximately 35% (or 11 camps) of the livestock farming unit of the grazing rights holder will not be available for grazing purposes during this period. It is furthermore anticipated that it will not be possible to rehabilitate a large part of the proposed mining area to its natural state upon mine closure as a result of the mining method to be used.

In light of the above it is therefore anticipated that decreasing the size of the livestock farming unit of the grazing rights holder by 35% for an extended period of time will result in an increased grazing pressure in the remaining parts of the livestock farming unit, which, in turn, is anticipated to potentially result in overgrazing (assuming that the number of livestock is kept unchanged) and a gradual decrease in the grazing capacity of the area. This may have serious financial implications for the grazing rights holder.

4.4 ANTICIPATED DECREASE IN GRAZING CAPACITY

Refer to Paragraph 3 of Section 4.3 above.

4.5 ANTICIPATED DESTRUCTION OF RED DATA SPECIES

Although no red data species were recorded in the proposed mining area as part of field surveys conducted in the area in October 2010, it is anticipated that such species may indeed occur in the area, based on the occurrence thereof on surrounding properties.

It is anticipated that some of these individuals may be destructed as a result of site construction and/or mining activities.

4.6 ANTICIPATED IMPACT ON PLANT SPECIES PROTECTED IN TERMS OF THE NATURE AND ENVIRONMENTAL CONSERVATION ORDINANCE, 1974 (ORDINANCE NO. 19 OF 1974)

A small number of plant species protected in terms of the Nature and Environmental Conservation Ordinance, 1974 (Ordinance No. 19 of 1974) were recorded in the proposed mining area. A number of additional plant species protected by the same Ordinance is also anticipated to occur in the area, based on the occurrence thereof on surrounding properties.

It is anticipated that some of these individuals may be destructed as a result of site construction and/or mining activities.

4.7 ANTICIPATED IMPACT OF DUST ON VEGETATION

An increase in the current levels of dust pollution present in the study area as a result of the mining activities of neighbouring mining operations is anticipated upon commencement of the proposed mining operation of the client. It is anticipated that the dust pollution resulting from the existing mining operations, as well as the proposed mining activities of the applicant, may over time negatively impact on the natural vegetation of the study area.

Van der Merwe (2001) summarised the potential impact of dust or particulate deposits on vegetation as being chemical, physical and physiological. Chemical impacts can, for example, occur via changes in soil chemistry when dust or particulate deposits leach into soils; or where chemically active aerial pollutants cause a chemical reaction upon physical contact with leaves. Physical effects may include, among other things, the abrasion of the leaf surface by dust transported in wind and spray; shading via crust formation; and/or smothering. The physiological effect of chemical and physical impacts (or a combination thereof) may include the following, among others: An overall reduction in size; stunted growth; a reduction in seed weight in certain species; plant defoliation and shoot death in certain species; decreased plant cover and density; a reduction in seed production; changes in transpiration rate; cessation of gaseous exchange; a reduction in chlorophyll content; a modification in leaf temperature; and a change in the composition of micro flora supported by plant leaves (Van der Merwe, 2001).

Van der Merwe (2001) reported instances of physical damage caused to the leaf surfaces of *A. erioloba* in leaf samples collected from the farm Lyleveld No. 545, which is located adjacent to the proposed mining area (Figure 6). The physiological changes caused by this physical damage could, however, not be quantified by Van der Merwe (2001), who proposed that a long-term study be conducted in this regard.

It is furthermore anticipated that the grazing capacity of the larger livestock farming unit of the grazing rights holder may, over the long term, be adversely impacted by this phenomenon.

4.8 ANTICIPATED INCREASE OF ALIEN WEEDS AND INVASIVE SPECIES

Only a small number of alien weeds and invasive plant species were recorded within the borders of the proposed mining area as part of the present study. It is anticipated that these species may spread to areas disturbed by the proposed site construction or mining activities of the applicant, or that alien weeds and invasive plant species present in the mining areas of adjacent mines may spread to these areas.

4.9 ANTICIPATED INCREASE IN THE FIRE HAZARD OF THE AREA

A potential increased fire hazard is anticipated in the study area as a result of a) the storage of dangerous goods on site; b) the potential of open fires being made by

A

B

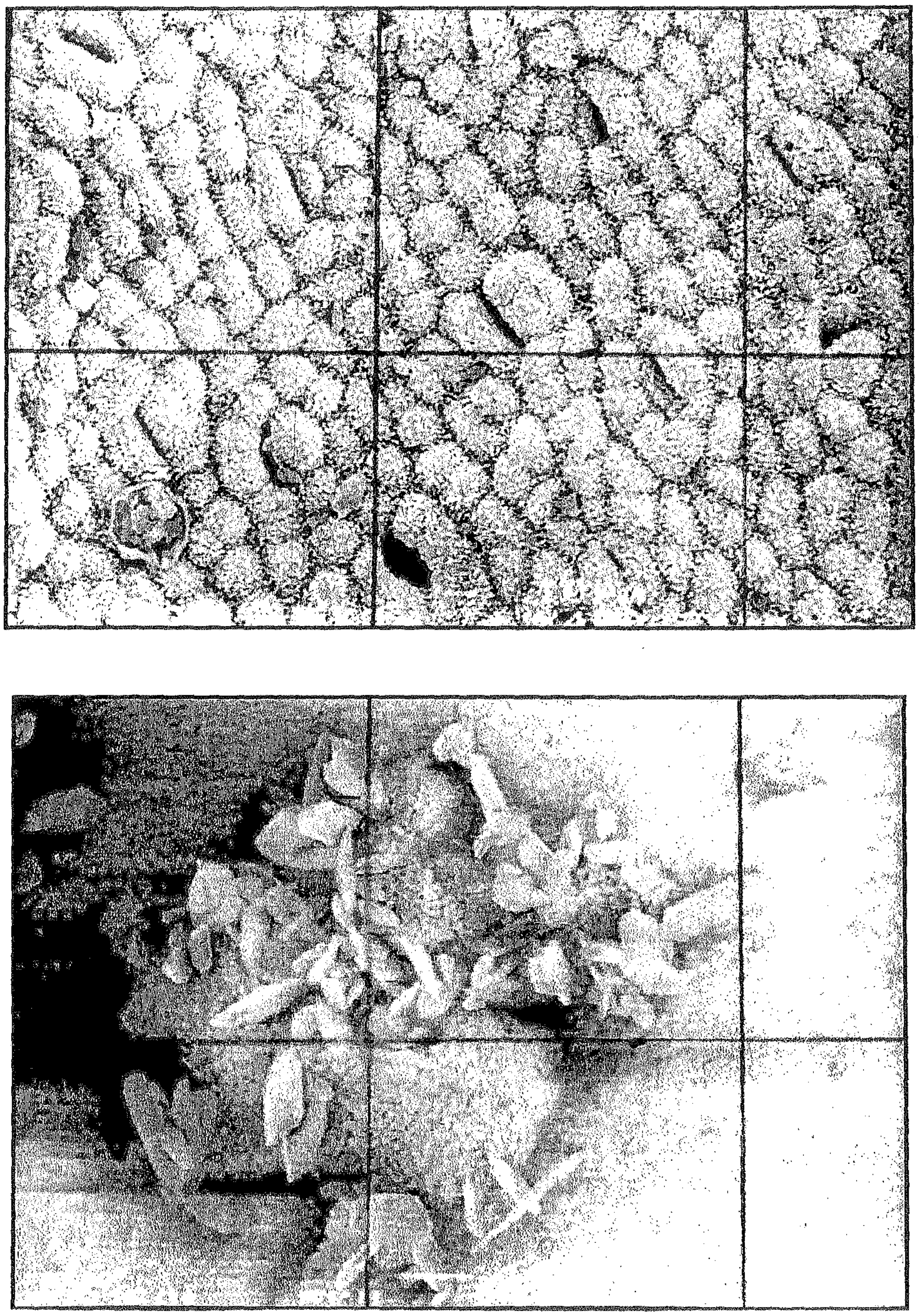


Figure 6. Physical damage caused to the leaf surface of an *A. erioloba* individual located down-wind with regard to a major existing mining operation (B), compared to a leaf sample collected from an up-wind location (A) [from Van der Merwe (2001)].

employees of the mine; and c) the potential of cigarette butts being discarded into the veld by employees of the mine.

5. PROPOSED MITIGATION MEASURES

5.1 PROTECTED, ENDANGERED AND RED DATA SPECIES

5.1.1 Avoiding damage or disturbance

5.1.1.1 Alternative site lay-out

The draft lay-out of the proposed processing plant is anticipated to result in the destruction of a large number of *A. erioloba* individuals, as well as a handful of individuals of *A. haematoxylon*. It is anticipated that a smaller number of individuals of these two protected tree species will be destructed in the event of the processing plant being turned on its side and moved to the most north-westerly corner of the study area, i.e. into the *Tarchonanthus camphoratus* Tall Open Shrubveld.

5.1.1.2 Constructing roads/smaller structures around individuals of protected tree species

With regard to the construction of smaller structures, e.g. roads, it is recommended that the construction of such structures in all instances take place keeping in mind the location of individuals of protected tree species. It is therefore recommended that the construction of roads take place around such individuals and not by going through, for example, a cluster of *A. erioloba*.

5.1.2 Awareness training

Employees should be briefed on the identification and conservation status of endangered, protected and red data species prior to the commencement of the proposed mining operation. This will enable employees to prevent damage to such species wherever possible, e.g. by the making of smaller roads around such species instead of through a cluster of plants, etc.

It is furthermore recommended that reference or identification guides or pamphlets or posters be readily available on site for use by employees and that refresher protected plant identification courses be presented at the mine on a quarterly basis.

5.1.3 Sweeping of areas prior to commencement of construction/mining

It is recommended that, prior to the commencement of each new phase of the mining operation, a specialist be contracted to sweep areas to be cleared/disturbed with the aim of identifying and locating endangered, protected and/or red data species. As a result of the fact that field surveys for the present study were conducted over a limited time period and during a time of the year that is not ideal for such surveys, some protected species may not be included in the results thereof.

In the event of such species being located during a sweeping operation, the recommendations listed in Sections 5.1.1, 5.1.4 and 5.1.6 (whichever is relevant) should be followed with regard to the newly identified/located species of conservation importance.

5.1.4 Plant relocation

With regard to the protected tree species located in the study area (*A. erioloba, A. haematoxylon* and *B. albitrunca*), plant relocation is not regarded as being a viable option. *A. erioloba* is typically phreatophytic, with its tap root reaching depths of up to 40 meters (Fagg & Stewart, 1994; Van der Walt & Le Riche, 1999). For this reason *A. erioloba* plants are not easily transplanted (Coates-Palgrave, 2002). Coates-Palgrave (2002) describes *A. haematoxylon* as "*being difficult to cultivate away from its natural habitat*", while *B. albitrunca* is described as germinating easily, but having unpredictable growth from then on.

It is, however, anticipated that most of the smaller endangered, protected and/or red data species can be relocated with success from areas where disturbance will take place. It is recommended that a plant relocation specialist be contracted in this regard and be included in sweeping operations to be conducted prior to the commencement of construction/mining activities in any specific area. Such a specialist should provide the applicant with information and guidance on the best procedures to be followed in terms of plant relocation, including options regarding the most desirable final destinations.

5.1.5 Biodiversity offset area

Biodiversity offsets are conservation activities aimed at compensating for residual, unavoidable harm to biodiversity caused by development projects (Ten Kate *et al.*, 2004). It is, however, important that biodiversity offsets keep their proper place in the "mitigation hierarchy": First developers should seek to avoid, minimise and mitigate the harm that their projects cause.

In the present situation it is anticipated that a large number of individuals of protected tree species, including *A. erioloba*, which is regarded as a keystone species in the Kalahari (Van Rooyen, 2001), will be damaged or destroyed as a result of the proposed mining operation. Plant relocation is not anticipated to be successful with regard to the protected tree species identified (refer to Section 4.1.4), while avoiding damage to these trees on small scale (e.g. making smaller roads around such species) is not anticipated to result in the conservation of a large number of individuals.

In view of the discussion above, from which it is clear that the impact of the proposed mining operation on especially protected tree species is anticipated to be high, it is recommended that the option of a biodiversity offset area be implemented.

According to Ten Kate *et al.* (2004) the establishment of ecological equivalence between the affected and offset sites – sometimes referred to as trading "like for like"- appears to be a good basis for ensuring no net loss of biodiversity. Ten Kate *et al.* (2004) further state that the appropriate goal for biodiversity offsets is to go beyond "no net loss" and to seek to achieve "net benefit", i.e. a measurable improvement in biodiversity compared to the *status quo ante*. It would, for example, be a good idea to select an area containing, in addition to the species of conservation importance recorded in the study area, plant species endemic or near-endemic to the Griqualand West Centre of Endemism, as these species are of global significance and high regional conservation importance.

The location and size of the proposed biodiversity offset area requires further investigation by relevant specialists.

5.1.6 Permits

In all instances where the avoidance of damage to, or the relocation of protected, endangered and red data plant species is not possible, permits should be obtained for the cutting, disturbance, damaging, destruction or relocation of such species.

5.2 ALIEN WEEDS AND INVASIVE PLANTS

Declared weeds and invaders (Section 2.8) should be combated according to the requirements of Regulation 15 of the Regulations published under Section 29 of the Conservation of Agricultural Resources Act, 1983 (Act No. 43 of 1983), as amended. Appropriate methods of control for each category of invaders/weeds are listed in Regulation 15E of the aforementioned Act.

The spreading of declared weeds and invaders should furthermore be carefully and regularly monitored and controlled, especially with regard to rehabilitated and disturbed areas. Proper records (including photographic records) should be kept in this regard.

5.3 FIRE PREVENTION AND -CONTROL

It is recommended that a proper fire prevention and -control plan be compiled for the proposed mining operation and that this plan be implemented on site. Awareness training should be given on a regular basis in this regard.

5.4 DUST POLLUTION

It is recommended that a suitably qualified specialist be appointed to conduct a fall-out dust study in the study area prior to the commencement of the proposed mining operation and that continual monitoring be done in this regard.

Mitigation measures aimed at decreasing the level of dust pollution in the area, as proposed by the aforementioned specialist, should be implemented and strictly adhered to. Awareness training regarding these measures should be given on a regular basis.

5.5 GRAZING

It is anticipated that the financial implications on the grazing rights holder of a) a relatively large reduction in the size of his livestock farming unit; and b) a gradual decrease in grazing capacity, may be severe, not only in the short term, but especially in the long term.

It is therefore recommended that the grazing rights holder be sufficiently compensated in this regard, taking into consideration not only the anticipated direct impacts, but also the anticipated indirect impacts of the proposed mining operation on his livestock farming enterprise over both the short- and the long term. Simply compensating him for the loss of physical grazing in the short term is not regarded as being sufficient in this instance.

6. REFERENCES

Anderson, T.A. 2003. *Sishen Iron Ore Farms botanical survey report.* WPS Walmsley.

Colvin, C., Le Maitre, D., Saaiman, I. & Hughes, S. 2007. *An introduction to Aquifer Dependent Ecosystems in South Africa.* WRC TT301/07.

Colvin, C., Tredoux, G., Clarke, S., Le Maitre, D., Engelbrecht, P. & Maherry, A. 2008. *Integration goes underground: A review of groundwater research in support of sustainable development in South Africa.* CSIR CPO-0076.

Coates Palgrave, K. 2002. *Trees of Southern Africa.* Cape Town: Struik Publishers.

Edwards, D. 1983. A broad-scale structural classification of vegetation for practical purposes. *Bothalia* 14: 707-812.

Fagg, C.W. & Stewart, J.L. 1994. The value of *Acacia* and *Prosopis* in arid and semi-arid environments. *Journal of Arid Environments* 27: 3-25.

Henderson, L. 2001. *Alien Weeds and Invasive Plants.* Cape Town: Agricultural Research Council.

Hilton-Taylor, C. 1996. Red data list of Southern African plants. *Strelitzia* 4. Pretoria: South African National Biodiversity Institute.

Mucina, L. & Rutherford, M.C. (eds). 2006. The vegetation of South Africa, Lesotho and Swaziland. *Strelitzia* 19. Pretoria: South African National Biodiversity Institute.

Ten Kate, K., Bishop, J. & Bayon, R. 2004. *Biodiversity Offsets: Views, Experience and the Business Case.* Cambridge: IUCN.

Van der Merwe, K. 2001. *An investigation into the possible causes of decline in the Acacia erioloba population of the Kathu area.* M.Sc. thesis.

Van der Merwe, K. 2006. Botanical Report: Khumani Mine Project. Unpublished report.

Van der Walt, P. & Le Riche, E. 1999. *Die Kalahari en sy plante.* Pretoria: P. van der Walt & E. le Riche.

Van Rooyen, N. 2001. *Flowering Plants of the Kalahari Dunes.* Pretoria: Van Rooyen, Bezuidenhout & De Kock.

Van Wyk, A.E. & Smith, G.F. 2001. *Regions of floristic endemism in Southern Africa.* Pretoria: Umdaus Press.

Van Wyk, B. & Van Wyk, P. 1997. *Field guide to trees of Southern Africa.* Cape Town: Struik Publishers.

APPENDIX A

List of species recorded within the borders of the study area

LIST OF SPECIES

AMARANTHACEAE

Hermbstaedtia fleckii

ANACARDIACEAE

Rhus lancea
Rhus tridactyla

ASCLEPIADACEAE

Gomphocarpus fritucosus subsp. *fruticosus*

ASPARAGACEAE

Asparagus spp.

ASTERACEAE

Tarchonanthus camphoratus

BIGNONIACEAE

Rhigozum trichotomum

CAPPARACEAE

Boscia albitrunca
Cadaba aphylla

CELASTRACEAE

Gymnosporia buxifolia

EBENACEAE

Euclea undulata

FABACEAE

Indigofera alternans
Prosopis glandulosa var. *torreyana*
Senna italica subsp. *arachoides*

MIMOSOIDEAE

Acacia erioloba
Acacia haematoxylon
Acacia hebeclada subsp. *hebeclada*
Acacia mellifera subsp. *detinens*
Acacia tortilis

MORACEAE

Ficus cordata

POACEAE

Aristida adscensionis
Aristida congesta subsp. *congesta*
Aristida meridionalis
Cymbopogon plurinodis
Eragrostis lehmanniana
Heteropogon contortus

RHAMNACEAE

Ziziphus mucronata

SCROPHULARIACEAE

Aptosimum elongatum

SOLANACEAE

Lycium cinereum

TILIACEAE

Grewia flava

VERBENACEAE

Lantana rugosa

ZYGOPHYLLACEAE

Tribulus terrestris

APPENDIX B

GPS co-ordinates of geo-referenced individuals of tree species protected in terms of the National Forests Act, 1998 (Act No. 84 of 1998)

Table B1. Acacia haematoxylon.

Number	South	East
1	27°51.139'	23°01.997'
2	27°51.137'	23°01.979'
3	27°51.121'	23°01.990'
4	27°49.114'	23°03.096'
5	27°49.115'	23°03.097'
6	27°49.117'	23°03.097'
7	27°49.192'	23°03.048'
8	27°49.509'	23°03.614'
9	27°49.524'	23°03.505'
10	27°49.164'	23°03.132'
11	27°49.151'	23°03.167'
12	27°49.104'	23°03.215'
13	27°49.136'	23°03.211'
14	27°49.138'	23°03.202'
15	27°49.471'	23°03.998'
16	27°49.479'	23°04.064'
17	27°49'482'	23°04.052'
18	27°49.512'	23°04.025'
19	27°49.491'	23°04.058'
20	27°49.510'	23°04.078'
21	27°49.615'	23°04.101'
22	27°49.604'	23°04.123'
23	27°49.632'	23°04.102'

Table B2. Acacia erioloba.

Number	South	East
1	27°51.154'	23°01.976'
2	27°51.116'	23°01.986'
3	27°51.113'	23°01.983'
4	27°51.061'	23°01.944'
5	27°51.005'	23°01.910'
6	27°50.966'	23°01.900'
7	27°51.035'	23°01.965'
8	27°51.066'	23°01.988'
9	27°51.097'	23°02.010'
10	27°51.112'	23°02.015'
11	27°51.142'	23°02.006'
12	27°51.165'	23°02.027'
13	27°51.260'	23°02.103'
14	27°51.283'	23°02.119'
15	27°51.289'	23°02.137'
16	27°51.271'	23°02.135'
17	27°51.257'	23°02.129'
18	27°51.240'	23°02.131'
19	27°51.227'	23°02.140'
20	27°51.220'	23°02.129'
21	27°51.226'	23°02.128'
22	27°51.222'	23°02.117'
23	27°51.226'	23°02.112'
24	27°51.205'	23°02.115'
25	27°51.135'	23°02.081'
26	27°51.121'	23°02.081'
27	27°51.116'	23°02.055'
28	27°51.104'	23°02.044'
29	27°51.098'	23°02.036'
30	27°51.087'	23°02.026'
31	27°51.065'	23°02.001'
32	27°51.060'	23°02.004'
33	27°51.054'	23°01.998'
34	27°51.038'	23°01.994'
35	27°50.889'	23°01.897'
36	27°50.873'	23°01.904'
37	27°50.858'	23°01.880'
38	27°50.853'	23°01.905'
39	27°50.862'	23°01.910'
40	27°50.863'	23°01.911'
41	27°50.864'	23°01.912'
42	27°50.879'	23°02.048'
43	27°50.907'	23°02.062'
44	27°50.911'	23°02.073'
45	27°50.913'	23°02.073'
46	27°50.983'	23°02.129'
47	27°51.050'	23°02.123'
48	27°51.055'	23°02.114'

Table B2 (contd.). Acacia erioloba.

Number	South	East
49	27°51.253'	23°02.487'
50	27°49.564'	23°03.457'
51	27°49'560'	23°03.464'
52	27°49.553'	23°03.511'
53	27°49.552'	23°03.514'
54	27°49.497'	23°03.555'
55	27°49.504'	23°03.550'
56	27°49.505'	23°03.551'
57	27°49.501'	23°03.535'
58	27°49'511'	23°03.446'
59	27°49.526'	23°03.445'
60	27°49'525'	23°03.440'
61	27°49.394'	23°02.958'
62	27°49.379'	23°02.977'
63	27°49.377'	23°02.974'
64	27°49.375'	23°02.973'
65	27°49.359'	23°02.992'
66	27°49.326'	23°03.033'
67	27°49.328'	23°03.043'
68	27°49.313'	23°03.046'
69	27°49.276'	23°03.035'
70	27°49.271'	23°03.039'
71	27°49.270'	23°03.050'
72	27°49.267'	23°03.054'
73	27°49.243'	23°03.060'
74	27°49.244'	23°03.059'
75	27°49.238'	23°03.068'
76	27°49.216'	23°03.079'
77	27°49.216'	23°03.102'
78	27°49.207'	23°03.100'
79	27°49.189'	23°03.094'
80	27°49.186'	23°03.084'
81	27°49.184'	23°03.095'
82	27°49.183'	23°03.107'
83	27°49.190'	23°03.121'
84	27°49.180'	23°03.126'
85	27°49.166'	23°03.129'
86	27°49.150'	23°03.140'
87	27°49.157'	23°03.142'
88	27°49.160'	23°03.143'
89	27°49.142'	23°03.161'
90	27°49.136'	23°03.176'
91	27°49.126'	23°03.180'
92	27°49.125'	23°03.163'
93	27°49.126'	23°03.180'
94	27°49.120'	23°03.178'
95	27°49.125'	23°03.187'
96	27°49.118'	23°03.188'

Table B2 (contd.). Acacia erioloba.

Number	South	East
97	27°49.120'	23°03.193'
98	27°49.095'	23°03.180'
99	27°49.092'	23°03.177'
100	27°49.087'	23°03.167'
101	27°49.086'	23°03.168'
102	27°49.100'	23°03.201'
103	27°49.087'	23°03.200'
104	27°49.063'	23°03.215'
105	27°49.056'	23°03.210'
106	27°49.053'	23°03.214'
107	27°49.067'	23°03.240'
108	27°49.115'	23°03.220'
109	27°49.167'	23°03.193'
110	27°49.160'	23°03.187'
111	27°49.173'	23°03.187'
112	27°49.192'	23°03.179'
113	27°49.209'	23°03.181'
114	27°49.210'	23°03.170'
115	27°49.216'	23°03.167'
116	27°49.226'	23°03.157'
117	27°49.227'	23°03.171'
118	27°49.235'	23°03.170'
119	27°49.235'	23°03.180'
120	27°49.246'	23°03.150'
121	27°49.246'	23°03.135'
122	27°49.200'	23°03.132'
123	27°49.265'	23°03.135'
124	27°49.265'	23°03.124'
125	27°49.300'	23°03.116'
126	27°49.405'	23°03.093'
127	27°49.423'	23°03.090'
128	27°49.646'	23°02.673'
129	27°49.644'	23°02.673'
130	27°49.636'	23°02.677'
131	27°49.630'	23°02.689'
132	27°49.619'	23°02.696'
133	27°49.608'	23°02.703'
134	27°49.582'	23°02.707'
135	27°49.557'	23°02.735'
136	27°49.554'	23°02.739'
137	27°49.525'	23°02.746'
138	27°49.511'	23°02.757'
139	27°49.493'	23°02.773'
140	27°49.469'	23°02.735'
141	27°49.468'	23°02.794'
142	27°49.448'	23°02.809'
143	27°49.402'	23°02.831'
144	27°49.361'	23°02.859'

Table B2 (contd.). Acacia erioloba.

Number	South	East
145	27°49.346'	23°02.868'
146	27°49.249'	23°02.937'
147	27°49.236'	23°02.958'
148	27°49.035'	23°03.085'
149	27°49.203'	23°02.973'
150	27°49.199'	23°02.971'
151	27°49.151'	23°03.008'
152	27°49.154'	23°03.018'
153	27°49.138'	23°03.026'
154	27°49.130'	23°03.026'
155	27°49.129'	23°03.026'
156	27°49.133'	23°03.020'
157	27°49.113'	23°03.041'
158	27°49.104'	23°03.046'
159	27°49.083'	23°03.063'
160	27°49.072'	23°03.070'
161	27°49.062'	23°03.066'
162	27°49.050'	23°03.080'
163	27°49.045'	23°03.093'
164	27°49.027'	23°03.089'
165	27°49.030'	23°03.101'
166	27°49.037'	23°03.103'
167	27°49.032'	23°03.122'
168	27°49.017'	23°03.099'
169	27°49.008'	23°03.102'
170	27°49.005'	23°03.110'
171	27°48.994'	23°03.117'
172	27°48.979'	23°03.123'
173	27°48.966'	23°03.131'
174	27°48.981'	23°03.146'
175	27°48.970'	23°03.144'
176	27°48.962'	23°03.137'
177	27°48.959'	23°03.154'
178	27°48.953'	23°03.146'
179	27°48.951'	23°03.143'
180	27°48.935'	23°03.156'
181	27°48.944'	23°03.164'
182	27°48.917'	23°03.161'
183	27°48.919'	23°03.172'
184	27°48.917'	23°03.176'
185	27°48.911'	23°03.175'
186	27°48.909'	23°03.190'
187	27°48.898'	23°03.184'
188	27°48.884'	23°03.198'
189	27°48.876'	23°03.198'
190	27°48.874'	23°03.200'
191	27°48.869'	23°03.214'
192	27°48.861'	23°03.208'

Table B2 (contd.). Acacia erioloba.

Number	South	East
193	27°48.859'	23°03.210'
194	27°48.867'	23°03.217'
195	27°48.837'	23°03.222'
196	27°48.835'	23°03.223'
197	27°48.822'	23°03.235'
198	27°48.812'	23°03.241'
199	27°48.795'	23°03.254'
200	27°48.785'	23°03.258'
201	27°48.778'	23°03.270'
202	27°48.821'	23°03.207'
203	27°48.892'	23°03.225'
204	27°48.895'	23°03.225'
205	27°48.898'	23°03.225'
206	27°48.906'	23°03.227'
207	27°48.904'	23°03.234'
208	27°48.924'	23°03.213'
209	27°48.924'	23°03.203'
210	27°48.918'	23°03.204'
211	27°48.945'	23°03.196'
212	27°48.952'	23°03.199'
213	27°48.954'	23°03.188'
214	27°48.955'	23°03.179'
215	27°48.958'	23°03.171'
216	27°48.975'	23°03.165'
217	27°48.999'	23°03.161'
218	27°49.005'	23°03.158'
219	27°49.006'	23°03.155'
220	27°49.012'	23°03.152'
221	27°49.018'	23°03.141'
222	27°49.040'	23°03.137'
223	27°49.042'	23°03.138'
224	27°49.073'	23°03.136'
225	27°49.085'	23°03.140'
226	27°49.065'	23°03.102'
227	27°49.088'	23°03.093'
228	27°49.107'	23°03.107'
229	27°49.124'	23°03.102'
230	27°49.122'	23°03.094'
231	27°49.129'	23°03.098'
232	27°49.141'	23°03.091'
233	27°49.147'	23°03.101'
234	27°49.145'	23°03.109'
235	27°49.159'	23°03.079'
236	27°49.157'	23°03.061'
237	27°49.155'	23°03.049'
238	27°49.161'	23°03.049'
239	27°49.167'	23°03.049'
240	27°49.187'	23°03.052'

Table B2 (contd.). Acacia erioloba.

Number	South	East
241	27°49.183'	23°03.039'
242	27°49.189'	23°03.042'
243	27°49.196'	23°03.036'
244	27°49.196'	23°03.036'
245	27°49.204'	23°03.018'
246	27°49.206'	23°03.015'
247	27°49.220'	23°03.029'
248	27°49.231'	23°03.017'
249	27°49.234'	23°03.010'
250	27°49.231'	23°03.002'
251	27°49.243'	23°03.010'
252	27°49.244'	23°03.014°
253	27°49.233'	23°02.989'
254	27°49.228'	23°02.993'
255	27°49.249'	23°03.001'
256	27°49.256'	23°02.983'
257	27°49.260'	23°02.985'
258	27°49.264'	23°03.005'
259	27°49.272'	23°03.001'
260	27°49.273'	23°02.982'
261	27°49.312'	23°02.973'
262	27°49.319'	23°02.975'
263	27°49.326'	23°02.962'
264	27°49.322'	23°02.945'
265	27°49.335'	23°02.973'
266	27°49.338'	23°02.984'
267	27°49.343'	23°02.970'
268	27°49.365'	23°02.957'
269	27°49.363'	23°02.941'
270	27°49.360'	23°02.936'
271	27°49.386'	23°02.944'
272	27°49.381'	23°02.949'
273	27°49.473'	23°03.992'
274	27°49.474'	23°04.008'
275	27°49.470'	23°04.044'
276	27°49.465'	23°04.055'
277	27°49.464'	23°04.056'
278	27°49.465'	23°04.058'
279	27°49.469'	23°04.058'
280	27°49.474'	23°04.063'
281	27°49.488'	23°04.022'
282	27°49.486'	23°04.019'
283	27°49.525'	23°03.961'
284	27°49.512'	23°04.014'
285	27°49.503'	23°04.039'
286	27°49.493'	23°04.061'
287	27°49.539'	23°04.057'
288	27°49.527'	23°04.085'

Table B2 (contd.). Acacia erioloba.

Number	South	East
289	27°49.536'	23°04.090'
290	27°49.587'	23°03.976'
291	27°49.548'	23°04.091'
292	27°49.548'	23°04.095'
293	27°49.550'	23°04.098'
294	27°49.551'	23°04.099'
295	27°49.553'	23°04.098'
296	27°49.557'	23°04.100'
297	27°49.566'	23°04.104'
298	27°49.564'	23°04.098'
299	27°49.574'	23°04.079'
300	27°49.577'	23°04.067'
301	27°49.634'	23°03.988'
302	27°49.629'	23°04.007'
303	27°49.629'	23°04.011'
304	27°49.607'	23°04.121'
305	27°49.600'	23°04.127'
306	27°49.630'	23°04.096'
307	27°49.641'	23°04.088'
308	27°49.644'	23°04.064'
309	27°49.655'	23°04.007'
310	27°48.948'	23°03.744'
311	27°48.944'	23°03.740'
312	27°48.941'	23°03.736'
313	27°48.921'	23°03.723'
314	27°48.915'	23°03.719'
315	27°48.911'	23°03.698'
316	27°48.905'	23°03.701'
317	27°48.895'	23°03.695'
318	27°48.894'	23°03.688'
319	27°48.888'	23°03.691'
320	27°48.880'	23°03.681'
321	27°48.878'	23°03.677'
322	27°48.853'	23°03.671'
323	27°48.831'	23°03.652'
324	27°48.816'	23°03.639'
325	27°48.807'	23°03.626'
326	27°48.800'	23°03.620'
327	27°48.794'	23°03.616'
328	27°48.788'	23°03.609'
329	27°48.786'	23°03.609'
330	27°48.779'	23°03.603'
331	27°48.761'	23°03.588'

Table B3. Boscia albitrunca.

Number	South	East
1	27°51.335	23°02.078
2	27°51.333'	23°02.085'
3	27°51.329'	23°02.086'
4	27°51.325'	23°02.084'
5	27°51.324'	23°02.083'
6	27°51.323'	23°02.083'
7	27°51.319'	23°02.072'
8	27°51.304'	23°02.052'
9	27°51.262'	23°02.045'
10	27°51.251'	23°02.050'
11	27°51.246'	23°02.032'
12	27°51.223'	23°02.027'
13	27°51.221'	23°02.024'
14	27°51.208'	23°02.015'
15	27°51.197'	23°02.009'
16	27°51.093'	23°01.966'
17	27°51.092'	23°01.965'
18	27°50.963'	23°01.890'
19	27°50.962'	23°01.890'
20	27°50.960'	23°01.897'
21	27°50.955'	23°01.889'
22	27°50.945'	23°01.886'
23	27°50.939'	23°01.891'
24	27°50.939'	23°01.890'
25	27°50.937'	23°01.876'
26	27°50.926'	23°01.869'
27	27°50.924'	23°01.868'
28	27°50.913'	23°01.855'
29	27°50.899'	23°01.841'
30	27°50.896'	23°01.839'
31	27°50.884'	23°01.828'
32	27°50.878'	23°01.826'
33	27°50.872'	23°01.820'
34	27°50.866'	23°01.829'
35	27°50.873'	23°01.845'
36	27°50.873'	23°01.850'
37	27°50.875'	23°01.853'
38	27°50.876'	23°01.866'
39	27°50.883'	23°01.866'
40	27°50.890'	23°01.869'
41	27°50.896'	23°01.871'
42	27°50.908'	23°01.883'
43	27°50.933'	23°01.910'
44	27°50.942'	23°01.923'
45	27°50.944'	23°01.923'
46	27°50.968'	23°01.944'
47	27°50.974'	23°01.946'
48	27°50.999'	23°01.960'

Table B3 (contd.). Boscia albitrunca.

Number	South	East
49	27°51.003'	23°01.963'
50	27°51.226'	23°02.069'
51	27°51.232'	23°02.074'
52	27°51.233'	23°02.080'
53	27°51.296'	23°02.122'
54	27°51.300'	23°02.131'
55	27°51.305'	23°02.138'
56	27°51.027'	23°01.992'
57	27°50.990'	23°01.975'
58	27°50.975'	23°01.968'
59	27°50.961'	23°01.960'
60	27°50.952'	23°01.961'
61	27°50.906'	23°01.915'
62	27°50.875'	23°01.897'
63	27°50.873'	23°01.898'
64	27°50.855'	23°01.903'
65	27°50.858'	23°01.910'
66	27°50.863'	23°01.912'
67	27°50.863'	23°01.916'
68	27°50.867'	23°01.915'
69	27°50.868'	23°01.917'
70	27°50.873'	23°01.919'
71	27°50.869'	23°01.919'
72	27°50.866'	23°01.923'
73	27°50.865'	23°01.925'
74	27°50.856'	23°01.929'
75	27°50.862'	23°01.941'
76	27°50.859'	23°01.947'
77	27°50.867'	23°01.945'
78	27°50.870'	23°01.954'
79	27°50.878'	23°01.954'
80	27°50.865'	23°01.967'
81	27°50.868'	23°01.972'
82	27°50.870'	23°01.971'
83	27°50.865'	23°01.983'
84	27°50.876'	23°01.998'
85	27°50.881'	23°01.999'
86	27°50.882'	23°02.019'
87	27°50.882'	23°02.020'
88	27°50.881'	23°02.029'
89	27°50.866'	23°02.045'
90	27°50.877'	23°02.049'
91	27°50.897'	23°02.060'
92	27°50.911'	23°02.074'
93	27°50.914'	23°02.072'
94	27°50.989'	23°02.097'
95	27°51.000'	23°02.108'
96	27°51.051'	23°02.110'

Table B3 (contd.). Boscia albitrunca.

Number	South	East
97	27°51.135'	23°02.258'
98	27°51.140'	23°02.261'
99	27°51.157'	23°02.306'
100	27°51.164'	23°02.314'
101	27°51.181'	23°02.356'
102	27°51.201'	23°02.367'
103	27°51.207'	23°02.366'
104	27°51.218'	23°02.351'
105	27°51.234'	23°02.366'
106	27°51.229'	23°02.372'
107	27°51.238'	23°02.385'
108	27°51.242'	23°02.389'
109	27°51.242'	23°02.394'
110	27°51.243'	23°02.394'
111	27°51.256'	23°02.402'
112	27°51.256'	23°02.403'
113	27°51.257'	23°02.407'
114	27°51.251'	23°02.411'
115	27°51.263'	23°02.422'
116	27°51.253'	23°02.426'
117	27°51.240'	23°02.426'
118	27°51.242'	23°02.428'
119	27°51.246'	23°02.423'
120	27°51.239'	23°02.451'
121	27°51.238'	23°02.451'
122	27°51.231'	23°02.446'
123	27°51.217'	23°02.436'
124	27°51.216'	23°02.435'
125	27°51.212'	23°02.447'
126	27°51.222'	23°02.458'
127	27°51.215'	23°02.461'
128	27°51.212'	23°02.464'
129	27°51.202'	23°02.464'
130	27°51.199'	23°02.465'
131	27°51.202'	23°02.486'
132	27°51.200'	23°02.489'
133	27°51.207'	23°02.494'
134	27°51.216'	23°02.500'
135	27°51.219'	23°02.501'
136	27°51.227'	23°02.509'
137	27°51.236'	23°02.502'
138	27°51.239'	23°02.501'
139	27°51.251'	23°02.492'
140	27°51.253'	23°02.484'
141	27°51.252'	23°02.484'
142	27°51.256'	23°02.478'
143	27°51.251'	23°02.476'
144	27°51.257'	23°02.471'

Table B3 (contd.). Boscia albitrunca.

Number	South	East
145	27°51.256'	23°02.469'
146	27°51.258'	23°02.463'
147	27°51.260'	23°02.457'
148	27°51.260'	23°02.457'
149	27°51.253'	23°02.454'
150	27°51.253'	23°02.452'
151	27°51.255'	23°02.449'
152	27°51.257'	23°02.445'
153	27°51.256'	23°02.434'
154	27°51.257'	23°02.428'
155	27°51.262'	23°02.419'
156	27°51.273'	23°02.409'
157	27°51.270'	23°02.385'
158	27°51.272'	23°02.383'
159	27°51.275'	23°02.379'
160	27°51.275'	23°02.379'
161	27°51.280'	23°02.372'
162	27°51.271'	23°02.351'
163	27°51.285'	23°02.321'
164	27°51.295'	23°02.307'
165	27°49.521'	23°03.437'
166	27°49.524'	23°03.434'
167	27°49.524'	23°03.430'
168	27°49.527'	23°03.418'
169	27°49.524'	23°03.415'
170	27°49.531'	23°03.413'
171	27°49.532'	23°03.414'
172	27°49.532'	23°03.407'
173	27°49.525'	23°03.397'
174	27°49.533'	23°03.391'
175	27°49.536'	23°03.388'
176	27°49.537'	23°03.391'
177	27°49.540'	23°03.393'
178	27°49.540'	23°03.390'
179	27°49.538'	23°03.378'
180	27°49.546'	23°03.367'
181	27°49.543'	23°03.365'
182	27°49.534'	23°03.352'
183	27°49.530'	23°03.350'
184	27°49.524'	23°03.346'
185	27°49.517'	23°03.350'
186	27°49.517'	23°03.353'
187	27°49.519'	23°03.357'
188	27°49.510'	23°03.358'
189	27°49.514'	23°03.365'
190	27°49.513'	23°03.366'
191	27°49.513'	23°03.368'
192	27°49.370'	23°02.987'

Table B3 (contd.). Boscia albitrunca.

Number	South	East
193	27°49.351'	23°03.014'
194	27°49.343'	23°03.012'
195	27°49.329'	23°03.021'
196	27°49.316'	23°03.050'
197	27°49.308'	23°03.039'
198	27°49.306'	23°03.036'
199	27°49.291'	23°03.040'
200	27°49.267'	23°03.047'
201	27°49.246'	23°03.053'
202	27°49.246'	23°03.074'
203	27°49.215'	23°03.104'
204	27°49.121'	23°03.177'
205	27°49.118'	23°03.190'
206	27°49.094'	23°03.180'
207	27°49.107'	23°03.230'
208	27°49.119'	23°03.220'
209	27°49.170'	23°03.189'
210	27°49.172'	23°03.200'
211	27°49.173'	23°03.204'
212	27°49.173'	23°03.189'
213	27°49.310'	23°03.109'
214	27°49.332'	23°03.092'
215	27°49.338'	23°03.094'
216	27°49.342'	23°03.090'
217	27°49.349'	23°03.095'
218	27°49.351'	23°03.089'
219	27°49.364'	23°03.096'
220	27°49.376'	23°03.098'
221	27°49.385'	23°03.096'
222	27°49.390'	23°03.096'
223	27°49.398'	23°03.092'
224	27°49.424'	23°03.075'
225	27°49.429'	23°03.077'
226	27°49.553'	23°03.515'
227	27°49.536'	23°03.554'
228	27°49.532'	23°03.566'
229	27°49.523'	23°03.574'
230	27°49.521'	23°03.579'
231	27°49.521'	23°03.582'
232	27°49.520'	23°03.587'
233	27°49.520'	23°03.593'
234	27°49.521'	23°03.595'
235	27°49.520'	23°03.599'
236	27°49.513'	23°03.604'
237	27°49.510'	23°03.606'
238	27°49.511'	23°03.611'
239	27°49.515'	23°03.614'
240	27°49.515'	23°03.618'

Table 11: Construction phase EIA/EMP evaluation

Identified potential impact rating table CONSTRUCTION PHASE Surface water																
ACTIVITY	CONSEQUENCE	POTENTIAL ENVIRONMENTAL IMPACT	POSITIVE OR NEGATIVE IMPLICATION	ENVIRONMENTAL SIGNIFICANCE BEFORE MITIGATION						RECOMMENDED MITIGATION MEASURES/ REMARKS	ENVIRONMENTAL SIGNIFICANCE AFTER MITIGATION					
				P	E	D	I	TOTAL	SP		P	E	D	I	TOTAL	SP
Discard Dump	Change in catchment characteristics	Change in flow regime	Negative	4	1	3	2	[redacted]	M	Redirect and/or divert water to maintain water balance (SWMP)	4	1	3	2	[redacted]	M
	Dirty area	Contamination of clean runoff due to rainfall ????????	Negative	1	2	3	2	[redacted]	M	Restrict by containing water in closed system with berms (SWMP)	1	1	2	2		L-M
Slime Dam	Change in catchment characteristics	Change in flow regime	Negative	4	1	3	2	[redacted]	M	Restrict by redirecting water with a berm (SWMP)	4	1	2	2	[redacted]	M
Connection	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Roads	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	2	1	3	2	[redacted]	M
										n/a	2	1	3	2	[redacted]	M
	Spillage of diesel or material during transportation	Contamination of clean water	Negative	2	2	3	2	[redacted]	M	Cover the back and open part of the trucks with sails to minimize exposure of transported material	2	1	3	2	[redacted]	M
										Treat roads with prevention chemicals	2	1	3	2	[redacted]	M
Stock piles	Change in catchment characteristics	Change in flow regime	Negative	4	2	3	2	11	M-H	Redirect and/or divert water to maintain water balance (SWMP)	4	2	3	2	11	M-H

Table 10: Impact rating table description

1. Probability		
Category	**Rating**	**Description**
Definite	4	The impact will definitely occur.
Probable	3	The impact is highly likely to occur.
Possible	2	The impact has some possibility, but a low likelihood of occurring.
Improbable	1	The impact is not likely to occur, except in extreme and/or rare conditions.
2. Extent/Scale		
Category	**Rating**	**Description**
Site	1	Impact anticipated to be limited to the immediate project site.
Local	2	Impact anticipated up to 5 km from the project site.
Regional	3	Impact anticipated within a 20 km radius from the project site.
Provincial	4	Impact anticipated to be provincial.
National	5	Impact anticipated to be national (i.e. within the borders of South Africa).
International	6	Impact anticipated to be international.
3. Duration		
Category	**Rating**	**Description**
Very short-term	1	Less than 24 hours.
Short-term	2	Less than 1 year.
Medium-term	3	1 to 5 years.
Long-term	4	5 to 15 years.
Very long-term	5	More than 15 years.
Permanent	6	Permanent.
4. Intensity		
Category	**Rating**	**Description**
Very low	0	Where the impact is anticipated to affect the environment in such a way that natural, cultural and social functions will not be affected.
Low	2	Where the impact is anticipated to affect the environment in such a way that natural, cultural and social functions are only marginally affected.
Medium	4	Where the affected environment is altered but natural, cultural and social function and processes continue, albeit in a modified way.
High	6	Where natural, cultural or social functions or processes are anticipated to be altered to the extent that they will temporarily cease.
Very high	8	Where natural, cultural or social functions or processes are anticipated to be altered to the extent that they will permanently cease.

The potential impacts that were identified by CGS were categorised according to three phases of mining (Section 5). The potential impact associated with each proposed activity is described in Table 11, Table 12 and Table 13.

Possible mitigation measures are also provided for the identified impacts.

Table 9: Significance rating table

Score	Significant rating	Color assighned:
2-4	Low	L
5-7	Low to moderate	LM
8-10	Moderate	M
16-19	Moderate to high	[illegible]
20-24	High	[illegible]

The following table (Table 10) describes the magnitude of each element that was used in the evaluation of the impacts. The ultimate significance rating (Table 99) is equal to the cumulative total of each component namely, probability, extent, duration and intensity.

11 MAINTANENCE

In order for the proposed measures in Sections 9 & 10 to function optimally the structures and equipment should be checked and maintained on a regular basis.

Channels should be kept clear of weeds and any potential vegetation growth that could alter flow regimes. The pump meters and volume measuring equipment should be checked and kept in working order.

12 IMPACT AND RISK RATING AND EVALUATION

An EIA evaluation was conducted in which the potential impacts and their corresponding risks associated to the proposed mining development with regard to natural surface water resources in the area were examined.

The impacts were rated on a scale of low, low to moderate, moderate, moderate to high, and high. Each rating was determined by calculating the probability, extent, duration and intensity of each impact.

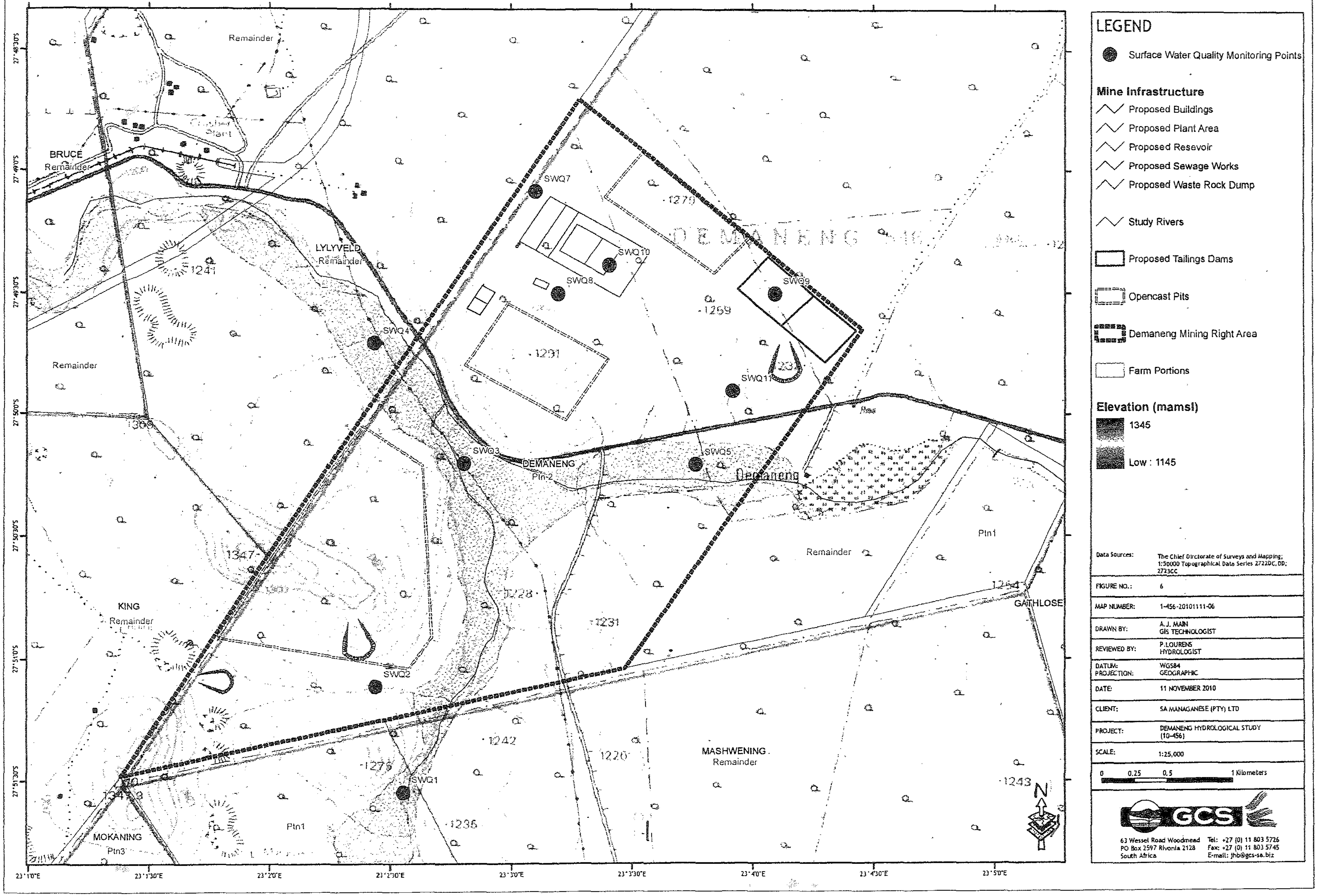
All the proposed activities that could have potential impacts on the natural surface water resources in the area are listed in Table 8.

Table 8: Summary of proposed mining activities

Activities:
Discard Dump
Slime Dam
Connection
Roads
Stock piles
Offices and Workshops
Sewage
Removal layout
Conveyor belt
Open cast mining area

Table 9 describes the total rating of each category as described earlier in Section 12.

FIGURE 6: DEMANENG HYDROLOGICAL STUDY - QUALITY MONITORING POINTS



10 MONITORING PLAN

Due to the fact that the area is dry and no surface water is present during most of the year, monitoring can be challenging and can only take place in the Ga-Mogara River when water is present. Water samples could also be taken in small non-perennial streams should they flow.

Regular water sampling can be done within the mining infrastructure areas such as the slimes dams, the sewage works, the plant area and the proposed PCD (Figure 6).

The quantity of water should also be measured (by means of stream flow measurement) at these locations in order to assist in the managing of the system's water balance. The stream flow measurements can be used to compare against modeled values and to update values in the water balance.

Even though rainfall is scarce, it is proposed that rainfall be measured on site. It is very important to measure large storm events when they do occur.

Data logging and data capturing of all representative flows and qualities of surface water should take place in order to manage surface water effectively.

FIGURE 5: DEMANENG HYDROLOGICAL STUDY - CONCEPTUAL STORMWATER MANAGAMENT PLAN

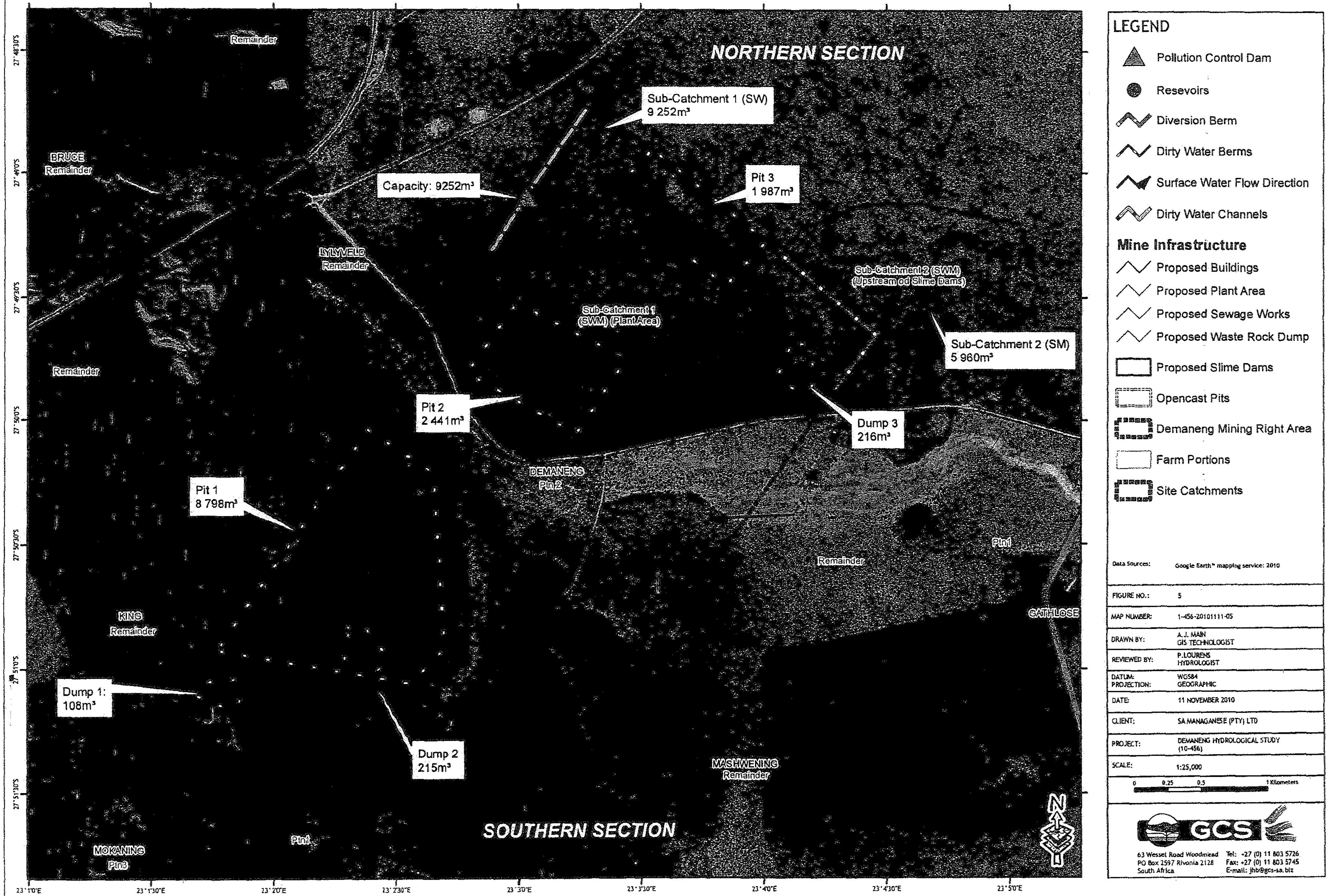


FIGURE NO.:	5
MAP NUMBER:	1-456-20101111-05
DRAWN BY:	A. J. MAIN GIS TECHNOLOGIST
REVIEWED BY:	P.LOURENS HYDROLOGIST
DATUM: PROJECTION:	WGS84 GEOGRAPHIC
DATE:	11 NOVEMBER 2010
CLIENT:	SA MANAGANESE (PTY) LTD
PROJECT:	DEMANENG HYDROLOGICAL STUDY (10-456)
SCALE:	1:25,000

0 0.25 0.5 1 Kilometers

GCS
63 Wesset Road Woodmead
PO Box 2597 Rivonia 2128
South Africa
Tel: +27 (0) 11 803 5726
Fax: +27 (0) 11 803 5745
E-mail: jhb@gcs-sa.biz

Table 7: Summary of storm flows over northern section

Catchment	Area	Strom flow
		1:50 year event
	(km²)	*(m³)*
Sub-catchment 1 (SWM) (plant area)	1.63	9 251.88
Sub-catchment 2 (SWM) (upstream of slimes dams)	1.05	5 959.80
Pit 2	0.43	2 440.68
Pit 3	0.35	1 986.60
Waste rock dump 3	0.038	215.69

Dirty sub-catchment 1 (SWM) (plant area) will be managed to contain water that could be potentially contaminated by flowing over the plant area (Figure 5). A PCD (PCD 1) is proposed at the lowest point of this sub-catchment to collect water draining in the natural direction.

Two dirty water channels are proposed on either side of the PCD and adjacent to the site boundary. These channels should be sloped in order to allow the water to flow into the PCD, since the natural flow direction of water would be to the west. The channels and PCD will thus form the boundary of the site area as well as the potential dirty area, and all water that occurs beyond this boundary will be allowed to drain freely into the natural environment as clean water.

Dirty sub-catchment 2 (SWM) (upstream of slimes dams) will be managed by a diversion berm around the slime dams which will direct all natural clean water away from the slime dams and back into the natural system towards the Ga-Mogara River. A berm should be constructed around the waste rock dump in order to contain all potential dirty water that could be generated over the dump area. As in the case of SWM measures in the southern part of the site area, the potential water that could accumulate on the waste rock dump is minimal and can be allowed to evaporate naturally.

Each of the three pit areas should also have a berm surrounding it. These berms will contain the dirty water within the pit and allow clean water to runoff around the pits naturally.

Open pit will be dewatered to allow for mining . Water will be pumped into the PCD and used in the pant.

9 CONCEPTUAL STORM WATER MANAGEMENT PLAN

In accordance with Government Notice 704 (GN 704), there are four main objectives of a SWMP, namely;

1. To keep clean and dirty water separated;
2. To contain any dirty water within a system;
3. To prevent contamination of clean water; and
4. To return clean water to the catchment .

The conceptual SWMP is presented in Figure 5.

Storm water management (SWM) measures for the southern part of the proposed development are:

- dirty water berms around the pit area
- dirty water berms around the waste rock dump to the south of the pit.

These berms will contain any surface water running over these areas. The water that will be contained around the waste rock dump is minimal and as such could be allowed to evaporate naturally. The water in the pit WILL be re-used and pumped to the plant area. Table 6 is a summary of the quantity of water that will occur on the areas in the southern section of the site boundary.

Table 6: Summary of storm flows over southern section

Area	Size	Strom flow 1:50 year event
	(km^2)	(m^3)
Waste rock dump 1	0.019	107.84
Pit 1	1.55	8 797.80

According to DWA legislation (GN 704) all designs are according to the 1:50 year flood event.

SMW measures for the northern part of the proposed development where most activities will take place will consist of:

- berms;
- dirty water channels; and
- a Pollution Control Dam (PCD).

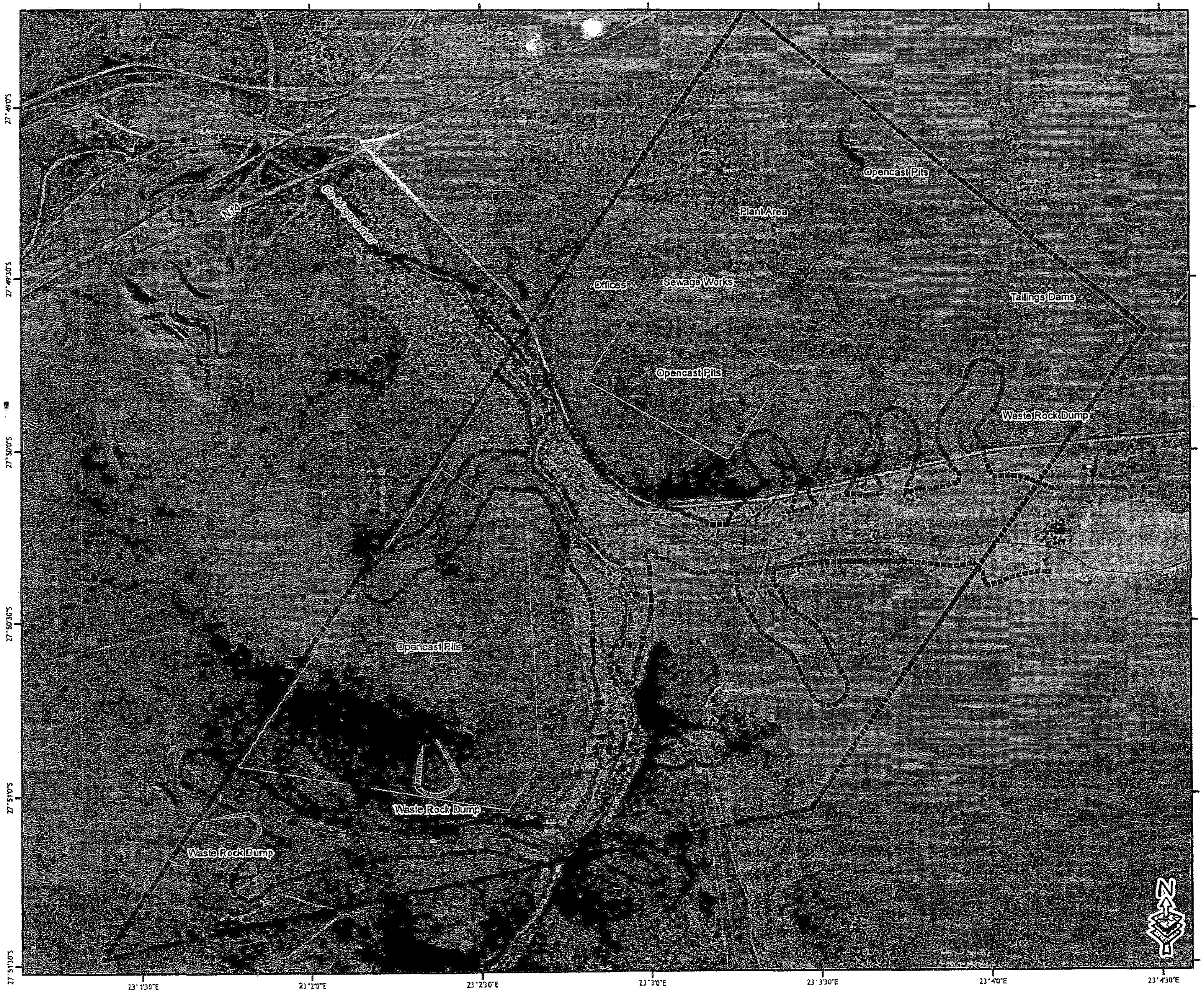
The flow dynamics over the site area is not complicated and the koppies and hills serve as natural catchment divides, ensuring natural drainage.

The site area was divided into two potential dirty water sub-catchments as listed in Table 7.

8.8 Surface water quality

During the site visit, it was found that no surface water was present in any river channels. No surface water quality assessment was conducted.

FIGURE 4: DEMANENG HYDROLOGICAL STUDY - EXCLUSION ZONE



LEGEND

Mine Infrastructure

- Proposed Buildings
- Proposed Plant Area
- Proposed Resevoir
- Proposed Sewage Works
- Proposed Waste Rock Dump
- Exclusion Zone
- Study Rivers
- Proposed Tailings Dams
- Opencast Pits
- Demaneng Mining Right Area

Data Sources: Google Earth™ mapping service: 2010

FIGURE NO.:	4
MAP NUMBER:	1-456-20101111-04
DRAWN BY:	A. J. MAIN GIS TECHNOLOGIST
REVIEWED BY:	P.LOURENS HYDROLOGIST
DATUM: PROJECTION:	WGS84 GEOGRAPHIC
DATE:	11 NOVEMBER 2010
CLIENT:	SA MANAGANESE (PTY) LTD
PROJECT:	DEMANENG HYDROLOGICAL STUDY (10-456)
SCALE:	1:20,000

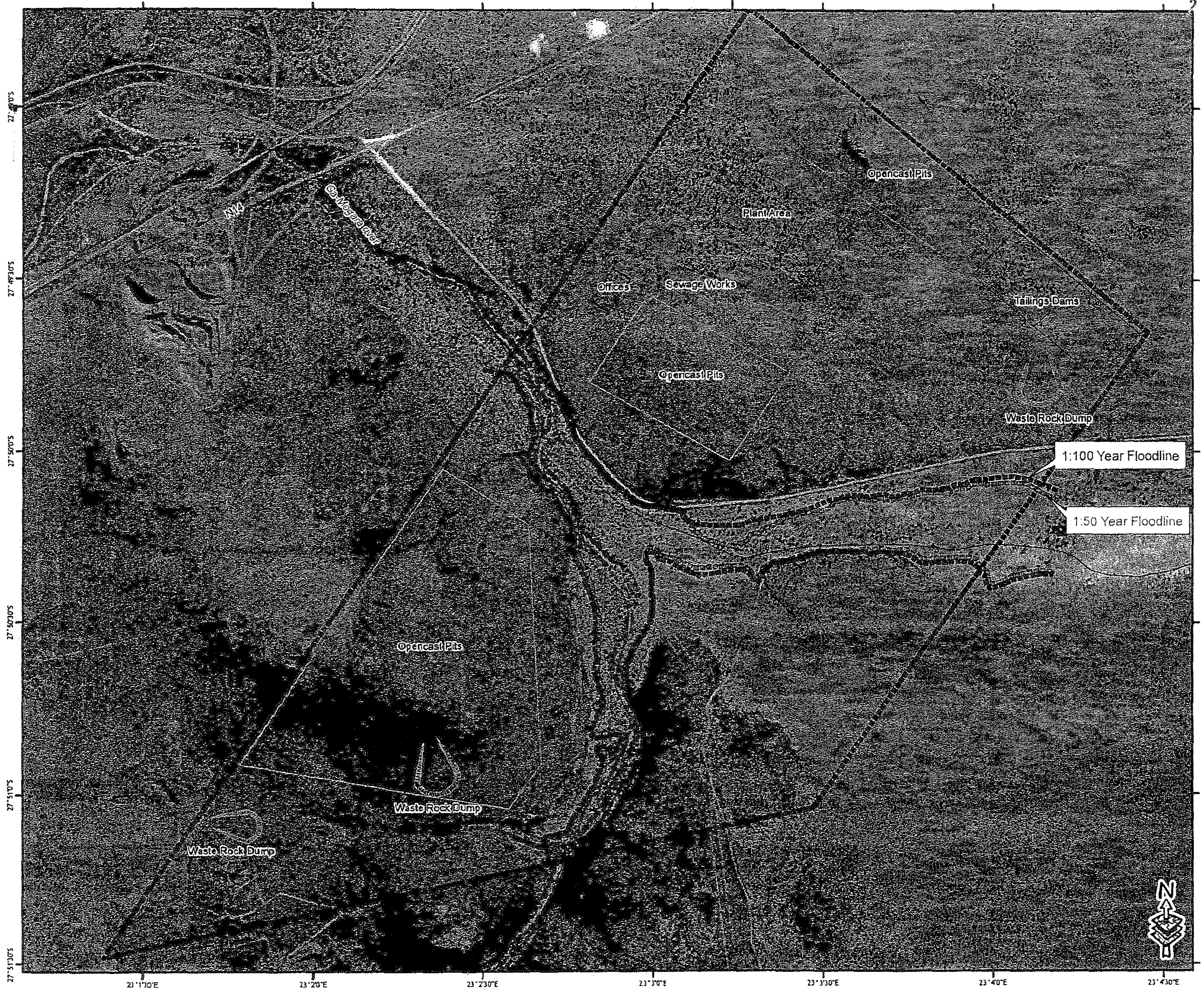
0 0.25 0.5 1 Kilometers

GCS
63 Wessel Road Woodmead
PO Box 2597 Rivonia 2128
South Africa
Tel: +27 (0) 11 803 5726
Fax: +27 (0) 11 803 5745
E-mail: jhb@gcs-sa.biz

A 100 m buffer zone around the river sections was also determined (as prescribed by DWA).

An exclusion zone based on Regulation 704 (explained in Section 4) was determined. This zone is a combination of the 100 m buffer zone as well as the potential 1:50 and 1:100 year flood lines (Figure 4). These flood lines can be used to asses and guide the planning team to operate under legal requirements.

FIGURE 3: DEMANENG HYDROLOGICAL STUDY - FLOODLINES



LEGEND

Mine Infrastructure

- Proposed Buildings
- Proposed Plant Area
- Proposed Resevoir
- Proposed Sewage Works
- Proposed Waste Rock Dump
- 1:100yr Floodline
- 1:50yr Floodline
- Study Rivers
- Proposed Tailings Dams
- Opencast Pits
- Demaneng Mining Right Area

Data Sources:	Google Earth* mapping service: 2010
FIGURE NO.:	3
MAP NUMBER:	1-456-20101111-03
DRAWN BY:	A. J. MAIN GIS TECHNOLOGIST
REVIEWED BY:	P.LOURENS HYDROLOGIST
DATUM: PROJECTION:	WGS84 GEOGRAPHIC
DATE:	11 NOVEMBER 2010
CLIENT:	SA MANAGANESE (PTY) LTD
PROJECT:	DEMANENG HYDROLOGICAL STUDY (10-456)
SCALE:	1:20,000

0 0.25 0.5 1 Kilometers

GCS

63 Wessel Road Woodmead
PO Box 2597 Rivonia 2128
South Africa
Tel: +27 (0) 11 803 5726
Fax: +27 (0) 11 803 5745
E-mail: jhb@gcs-sa.biz

8.6 Flood Flows

Flood flows from 1:50 and 1:100 year rainfall storm events were calculated for the two main tributaries of the Ga-Mogara River. The purpose of these calculations is to link these flows to specific water level elevations in order to determine a flood line.

The flood line is used to determine whether or not the proposed mining activities comply with government Regulation 704 as described in Section 4.

Table 4 below summarises the peak flow rates calculated using different methods (as explained in Section 7.7) over the two sub-catchments of the Ga-Mogara River.

Table 4: Flood flow summary of Ga-Mogara River sub-catchments

Method	Catchment 1		Catchment 2	
	1:50	1:100	1:50	1:100
	(peak flow in m^3/s)	*(peak flow in m^3/s)*	*(peak flow in m^3/s)*	*(peak flow in m^3/s)*
Rational	221.68	282.35	640.27	819.15
Alternative Rational	334.04	402.32	1247.49	1511.19
SDF	170.78	213.91	664.55	832.41

As described in Section 7.7 the values from the Rational Method were used for the purposes of the study.

The flood flows were then used to calculate the flood volumes for the same potential storm events over site-specific sub-catchments.

Table 5 is a summary of the Ga-Mogara River sub-catchments around the site area as well as the site area itself and their predicted storm water volumes during 1:50 and 1:100 year flood events.

Table 5: Summary of storm water volumes

Catchment	Area	1:50	1:100
	(km^2)	*(volume in m^3)*	*(volume in m^3)*
Sub-catchment 1 (GR)	236.78	1,343,963.28	1,941,359.22
Sub-catchment 2 (GR)	1802.79	10,232,636.04	14,781,075.21
Sub-catchment 3 (Site area)	32.32	183,448.32	264,991.68

8.7 Flood Lines

Flood heights were used to model flood lines of both the 1:50 and the 1:100 year flood events in the Ga-Mogara River (Figure 3). Only river sections that flow within the proposed site boundary area were analysed, as required by Regulation 704.

Table 2: Summary of catchment MAP

Catchment	MAP *(annual runoff)* *(WR2005)* (mm)	MAP *(storm runoff)* *(Gheyling (357774))* (mm)
Sub-catchment 1	358	364
Sub-catchment 2	358	364
Site area	358	364
Sub-catchment 1 (SWM) (plant area)	358	364
Sub-catchment 2 (SWM) (upstream of slimes dams)	358	364
Pit 1	358	364
Pit 2	358	364
Pit 3	358	364
Waste rock dump 1	358	364
Waste rock dump 2	358	364
Waste rock dump 3	358	364

8.4 Mean Annual Runoff

A mean annual runoff (MAR) of 1.75 million cubic meters (mcm) was used to describe the general flow of surface water over the quaternary catchment D41J. Based on an area and volume relationship, this MAR was used to obtain a site specific MAR of both sub-catchments as well as a site-specific MAR. Table 3 shows the different MAR values for each sub-catchment.

Table 3: Mean annual runoff (MAR) contributions

Catchment area	MAR *(mcm)*
WMA 10	201
Quaternary catchment D41J	1.75
Sub-catchment 1	0.16
Sub-catchment 2	1.25
Site area	0.022

8.5 Normal Dry Weather Flow

Based on all available data and information there is no Normal Dry Weather Flow (NDWF) that occurs within the entire quaternary catchment D41J. As such, no NDWF will occur over the site area.

Table 1: Summary of catchment sises

Catchment	Area
	(km^2)
WMA 10	83 788
Quaternary catchment area D41J	2 518
Sub-catchment 1 (GR)	237
Sub-catchment 2 (GR)	1803
Sub-catchment 3 (Site area)	32

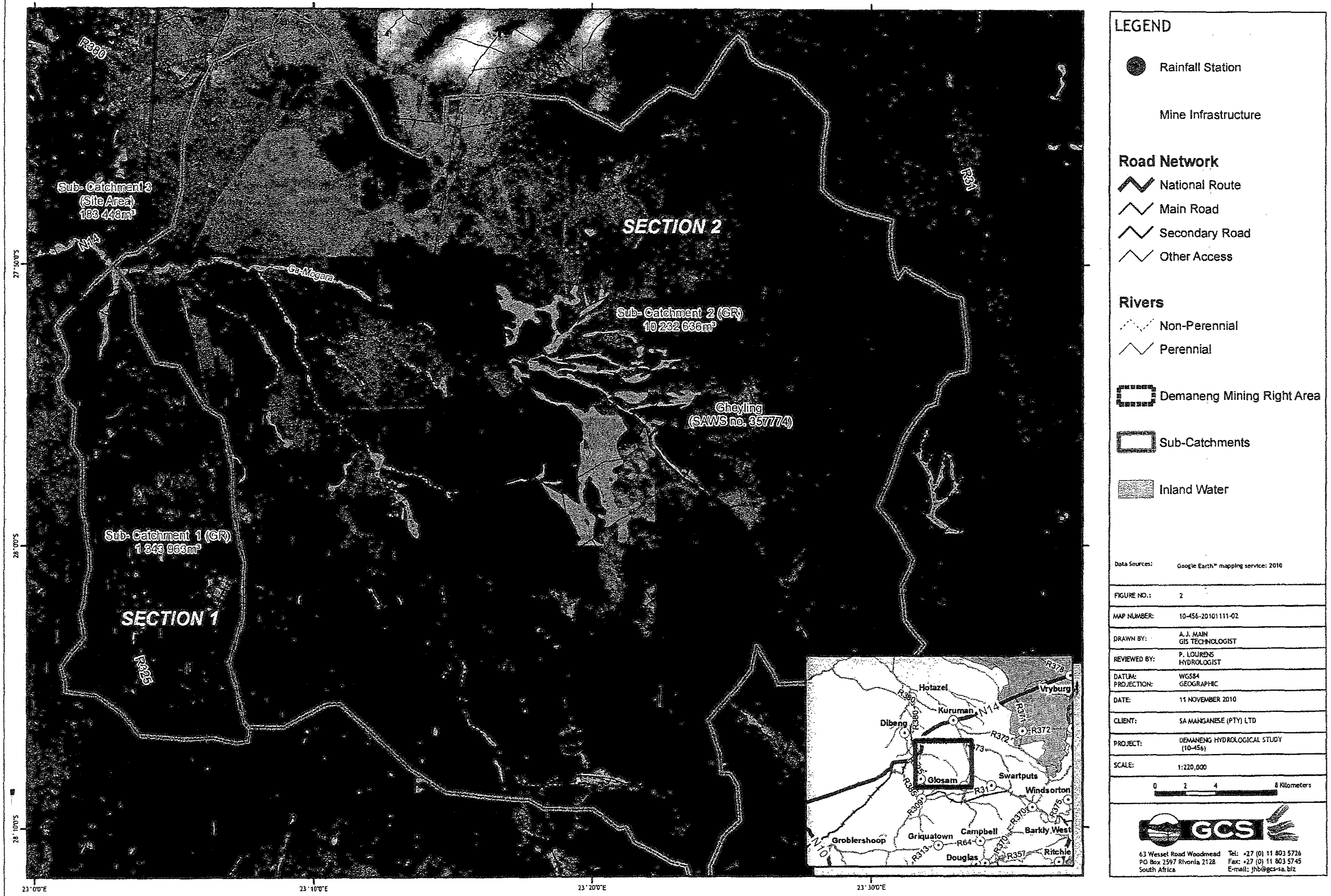
Small sub-catchment areas were delineated over the site area in order to describe the potential flow over the plant area, which includes washing, screening and crusher areas.

8.3 Rainfall and Mean Annual Precipitation

A Mean Annual Precipitation (MAP) of 357 mm was used . A site specific MAP of 364 mm from the SAWS station number 357774 (Gheyling) was used to calculate the flood rainfall conditions that will occur over not only the site area, but also the sub-catchments draining towards the site area (Figure 2).

The reason for using the different MAP values where are the different values is to achieve the most accurate and representative rainfall over the site area. The MAP of the Gheyling stations is located within the sub-catchment areas of the site and is thus the more representative than the general D41J quaternary catchment MAP. A summary of the catchment MAP values can be seen in Table 2.

FIGURE 2: DEMANENG HYDROLOGICAL STUDY - CATCHMENTS



8.1 Site visit

During the site visit cross-sectional surveys were conducted at strategic points along the Ga-Mogara River. No water was present in any of the water courses in the area and hence no quality samples or stream flow measurements could be made.

A general understanding of the surrounding catchment area was obtained and information on land cover, river bed characteristics and flood plain areas were identified. Information was obtained on the history of the Ga-Mogara River from a local farmer in the area. This information assisted in the understanding of the general properties of the Ga-Mogara River and its catchment area.

The following information was obtained from the site visit:

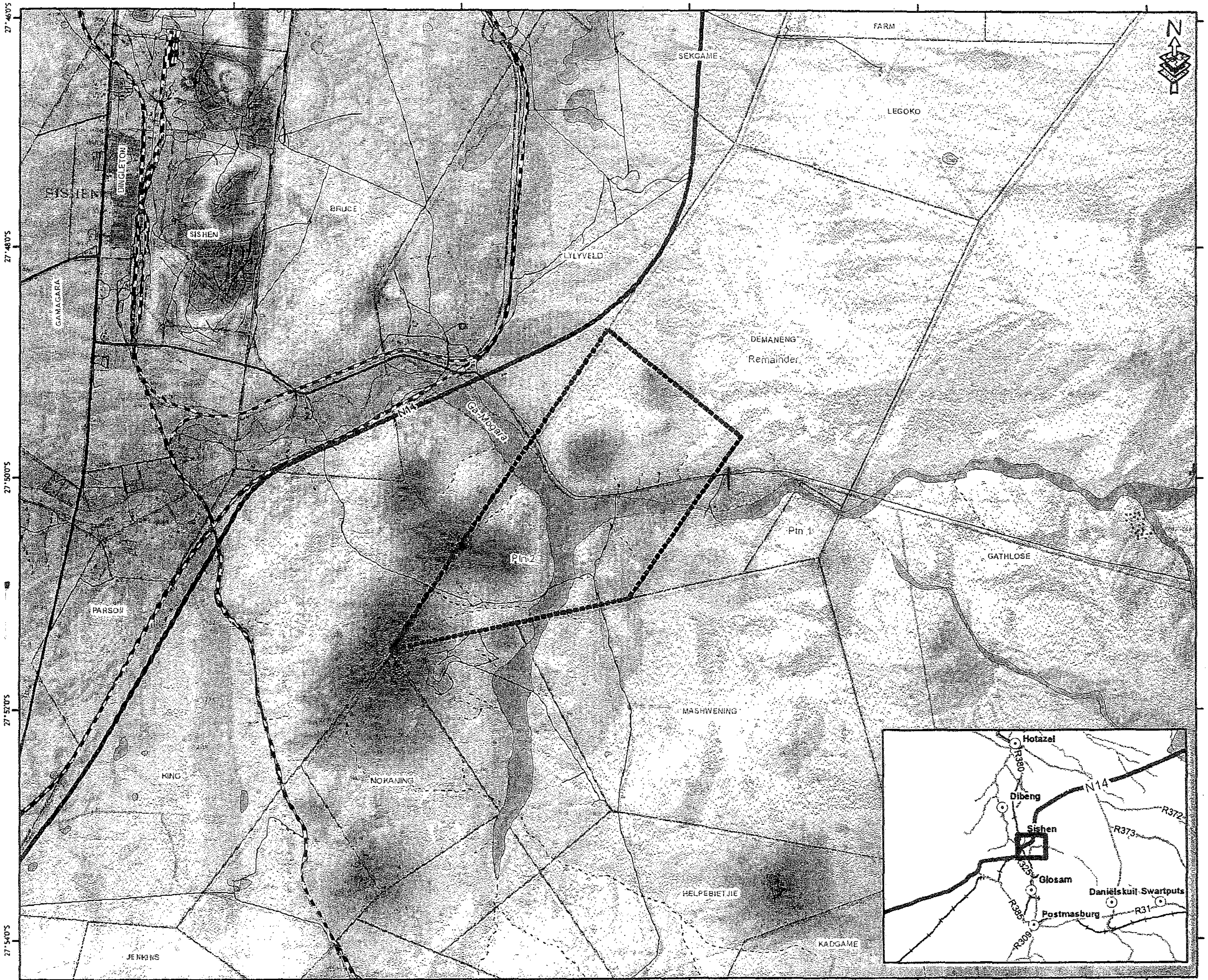
- There are very large flat flood plains along some parts of the Ga-Mogara River which gives an indication of flood levels during storm events. These areas give an indication of the location of the 1:50 and 1:100 year flood lines.
- Along other parts of the Ga-Mogara River deeper and well defined river beds are present.
- The average height above sea level of the area is 1340m;
- The river bed is not always well-defined and potential sheet flow is possible in some areas;
- Mining activities and farming where the most visible and dominant land uses in the area.
- The two sections (1 and 2) of the Ga-Mogara River have different, clearly defined river bed characteristics, one sandy and filled with grass, the other filled with rocks ranging in size from small to boulders. These differences in characteristics clearly indicate the different flow regimes and hydraulics of each section;
- Some historical information in the form of specific dates of when the Ga-Mogara River flowed was obtained from a local farmer (Mr Dihan Van Rensburg) in the area.

Refer to Appendix B for photographs of the local area and the Ga-Mogara River.

8.2 Catchment delineation, characterization, and properties

The total sub-catchment area that drains towards the site comprises 51% of the entire D41J quaternary catchment area (Figure 2) and is summarized in Table 1.

FIGURE 1: DEMANENG HYDROLOGICAL STUDY - LOCALITY



LEGEND

Road Network
- National Route
- Main
- Secondary
- Other Access
- Railway Line

Rivers
- Perennial
- Non-Perennial

- Inland Water
- Demaneng Mining Right Area
- Farm Portions

Elevation (mamsl)
- High : 1475
- Low : 1050

Data Sources: The Chief Directorate of Surveys and Mapping; 1:50000 Topographical Data Series 2722DC,DD; 2723 CA,CC

FIGURE NO.:	1
MAP NUMBER:	10-456-20101111-01
DRAWN BY:	A.J. MAIN GIS TECHNOLOGIST
REVIEWED BY:	P. LOURENS HYDROLOGIST
DATUM: PROJECTION:	WGS84 GEOGRAPHIC
DATE:	11 NOVEMEBR 2010
CLIENT:	NAMAKWA DIAMONDS
PROJECT:	DEMANENG HYDROLOGICAL STUDY (10-456)
SCALE:	1:60,000

0 0.4 0.8 1.6 Kilometers

GCS

63 Wessel Road Woodmead
PO Box 2597 Rivonia 2128
South Africa
Tel: +27 (0) 11 803 5726
Fax: +27 (0) 11 803 5745
E-mail: jhb@gcs-sa.biz

8 CATCHMENT HYDROLOGY

The site area is located in Water Management Area 10, Lower Vaal (WMA 10) and in Ga- Mogara Quaternary Catchment Area D41J,.

Demaneng farm is situated 15 km south of the town of Kathu and to the west of the N14 main road between passing in a southerly Postmansburg and Kathu (**Error! Reference source not found.**, Appendix A). The site area is located upstream of the the Sishen and Khumani iron ore mines.

According to the South African Atlas of Climatology and Agrohydrology the area is classified as Kalahari Thornveld and Shrub Bushveld (WRC, August 2008).

The main water resources near the site are the Ga-Mogara River and a few of its tributaries. The Ga-Mogara River is non-perennial, flowing only during the rainy season.

The confluence of the 2 main tributaries of the The Ga-Mogara River occurs the south western part of the site. The southern tributatry of the river flows from south to north and then continues westwards. The northern tributary of the river flows from east to west across the site boundary area (Figure 1).

The specific geographical, meteorological and hydrological characteristics of the site area are described in the sections to follow.

where I is the rainfall intensity, A is the runoff area and C is the runoff coefficient. Q is the peak flow.

7.7.1.2 Alternative Rational Method

The alternative rational method is based on the rational method with the point precipitation being adjusted to take into account local South African conditions.

7.7.1.3 Standard Design Flood Method

The standard design flood (SDF) method was developed by Alexander (2002) specifically to address the uncertainty in flood prediction under South African conditions.

The runoff coefficient (C) is replaced by a calibrated value based on the subdivision of the country into 26 regions or WMAs. The method is generally a more conservative estimate than the other methods, such as the rational method or the unit hydrograph methods.

7.8 Flood Lines

For determination of flood lines , flood flows were used to calculate corresponding heights (water levels) of a river by using HEC-RAS. These heights are modeled with GIS to produce a flood line.

7.8.1 HEC-RAS

HEC-RAS is a hydrological and engineering program which uses flood flows and the geometry of a certain geographical area to determine the height of the water level that will be reached during a specific flood event.

7.8.2 ArcView9.3

ArcView9.3 is a GIS based software program that uses height above sea level to model flood lines on a topographical map by making use of different contour lines. This software program creates the specific 1:50 and 1:100 year flood lines of the study area.

7.9 Surface water quality

No water samples were taken during the site visit and hence no quality tests could be conducted.

7.4 Rainfall and Mean Annual Precipitation

Rainfall data provided by the South African Weather Service (SAWS) was used for hydrological calculations. The WR2005 database as well as the rainfall runoff program Utility Program for Drainage (UPD) contains rainfall data of the Greyling (357774) rainfall station.

The Geyling (357774) SAWS rainfall station was used to calculate storm flows. The location of this rainfall station can be seen on Figure 2.

7.5 Mean Annual Runoff

Runoff data from the WR2005 database was used to determine the site specific mean annual rainfall (MAR). Area and volume calculations were done in order to reduce the quaternary catchment MAR to site specific MAR.

7.6 Normal Dry Weather Flow

The Groundwater-Surface Water Interactions National Data Base supplied by DWA (2004) was utilised in order to derive normal dry weather flow (NDWF).

The flow volumes in millions of cubic metres per annum (Mm^3/a) that are presented for the quaternary catchment scale were reduced to site specific sub-catchment scale. The calculation was based on an area and volume relationship between the quaternary and the site catchment areas.

7.7 Flood Flows

The potential flood flows that could occur over the catchment area were determined using the software Utility Program for Drainage (UPD).

The UPD program was specifically designed and developed for South African conditions and contains hydrological variables such as roughness coefficients (Manning's values) and rainfall records from available measuring stations from SAWS. The software also includes hydrological formulae to determine specific flood volumes.

A short description of the different methods to determine flood flows which were used in this project is given in the sections to follow.

7.7.1.1 Rational Method

The rational method was developed in the mid 19th century and is one of the most widely used methods for the calculation of peak flows for small catchments.

The formula indicates that $Q = CiA$,

7 METHODOLOGY

All the potential impacts of each proposed activity with regards to the surface water environment were evaluated. The findings quantify the potential impacts on the relevant Water Management Area as well as on the Quaternary drainage region as derived by DWA.

A field investigation was undertaken, which involved a site evaluation and surveying of river cross-sections. A desktop study is this not part of the investigation was undertaken to complete the hydrological study. The data that was obtained from the field investigation was used to undertake and supplement the desktop study.

7.1 Main data sources

The main source of hydrological data and information is the WR2005 database. Quaternary and WMA data is presented in this database as well as rainfall stations that were used. The Khumani Iron Ore Storm Water Management Study (GCS, 2010) was used for runoff coefficient comparisons of the catchments.

7.2 Site visit

A two day site visit was undertaken. The site visit included a basic site evaluation and the identification of potential impacts on the surface water resources of the area.

Hydrological information such as slope, land cover, river bed characteristics, flood plain characteristics, climate and land use capabilities were obtained from the field visit. This information was evaluated and used in the in the hydrological study. Much of this information was used as input data into the rainfall runoff model that is described in sections to follow.

7.3 Catchment delineation, characterisation, and properties

The Geographic Information Systems (GIS) software package ArcView9.3 together with the 1:50 000 topographical data was used to delineate catchments in and around the proposed site area.

Catchment characteristics were evaluated by means of Google Earth images, topographical data in ArcView9.3 and information obtained from the site visit.

5 ASSUMPTIONS AND LIMITATIONS

The following are the assumptions and limitations of the study:

- The survey data was sufficient to complete the flood line study;
- The data from the conceptual SWMP can be used as input data into the detailed design of infrastructure;
- Only three phases namely: Construction Phase, Operational Phase, and Decommissioning Phase of mining were be evaluated during the EIA process; and
- No baseline surface water quality measurements were undertake during this study as there was no runoff during the site visits. We recommend that samples be take at the selected sample points

6 DELIVERABLES

The deliverables are described below.

- Topographical plan showing the catchment boundaries streams with a summary of the catchment characteristics;
- The 1:50 and 1:100-year flood lines;
- Tables and graphs illustrating meteorological and hydrological data;
- Impacts and mitigation measures for incorporation into the EMP report;
- A plan of the proposed conceptual SWMP indicating the recommended infrastructure required for the separation of clean and dirty water systems; and
- An Integrated Surface Water Management Plan (ISWMP) with implementation strategies and guidelines. The ISWMP will take into consideration not only the SWMP but also monitoring plans, maintenance and proposed mitigation measures.

- Compilation of conceptual Storm Water Management Plan (SWMP), which includes the identification and separation of clean and dirty water areas;
- Indication of the placement of all associated infrastructure in order to separate, manage and maintain clean and dirty water systems;
- Design of flood lines;
- Compilation of a surface water quantity and quality monitoring plan; and
- Compilation of an integrated surface water management plan which combines all the storm water measures, maintenance measures, and the monitoring plan.

4 LEGISLATIVE REQUIREMENTS

The most relevant legislation pertaining to this study is Regulation 704 of the National Water Act (DWA 1998). This regulation stipulates that no opencast mining activity may take place within the 1:50 year flood line or at a horizontal distance of 100 m from a river bed, whichever is furthest.

The regulation further states that no mining infrastructure may be placed within the 1:100 year flood line or at a horizontal distance of 100 m from a river bed, whichever is furthest. Hence, the 1:50 and 1:100 year flood lines were determined as well as the horizontal 100 m exclusion zone around each water course .

The Department of Water Affairs (DWA) uses the 1:50 000 topographical maps as the core reference to which hydrology and applications are evaluated. The Act states that any defined watercourse, be it a perennial or non-perennial stream that appears on the 1:50 000 topographical maps qualifies as a stream for which a flood line need to be determined.

In large river systems like the Ga-Mogara River with small tributaries and the flood line of the larger river is likely to extend beyond the small tributary, there is no need for the determination of the flood line of the tributary. In dry areas (such as the study area) where the flood peak of a very small catchment is not likely to be much larger (if at all) than the MAR of the specific tributary, it is assumed that the 100 m horizontal distance from the tributary river bed will exceed the 1:50 and 1:100 year flood line and is therefore not necessary to determine the respective flood lines.

1 INTRODUCTION

GCS (Pty) Ltd was appointed by South African Manganese (Pty) Ltd to conduct a hydrological study for the proposed open cast mining activities on the farm Demaneng near Kathu in the Northern Cape province of South Africa. This study is part of the specialist investigations required for the Environmental Impact Assessment (EIA) and the Environmental Management Plan (EMP) applications for the South African Manganese Mining Right Application (MRA).

2 AIMS AND OBJECTIVES

The main purpose of the hydrological study is to determine to what extent the proposed mining activity could impact on the surface water resources of the catchment . Consequently, the aim is to recommend mitigation measure to minimise the potential impact of the proposed mining activities on surface water resources of the catchment.

The hydrological study also determines hydrological aspects in order to ensure compliance with specific legal requirements concerning mining activities and water resources.

In order to achieve each of the abovementioned aims the following objectives were completed

- delineation of the catchment Determine area to be impacted on;
- quantify hydrological properties of the catchment;
- To identify potential impacts on surface water resources; and
- To provide possible mitigation measures to minimise the potential impacts.

3 SCOPE OF WORK

The scope of work includes the following:

- A two day site visit, which included site evaluation, potential impact identification and a summary of the general hydrological elements;
- Catchment boundary delineation, characteristics and properties;
- Area and volume calculations in order to determine Mean Annual Runoff (MAR);
- Determination of the volumes for the 1:50 & 1:100 year recurrence intervals;
- Determination of flood lines on the Ga-Mogara River sections within the site

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Hydraulics: The study of the mechanical behaviour of water in physical systems and processes. In floodplain management, hydraulics refers to the determination of the lateral and vertical extent of a particular flood. Hydraulics also encompasses the flow characteristics around and through hydraulic structures such as bridges, culverts and weirs.

Hydrology: Hydrology refers to addressing the occurrence, circulation and distribution of water. In floodplain management, hydrology refers to the rainfall - runoff portion of the hydrological cycle as it applies to extreme events. In a floodplain study, hydrology is used to estimate flood flow rates. Common methods are stream gauge analysis, rainfall-run-off models, or a combination of the two.

Runoff: Surface runoff is defined as the water that finds its way into a surface stream channel without infiltration into the soil and may include overland flow, interflow and base flow.

Watercourse: Watercourse refers to a river or spring; a natural channel in which water flows regularly or intermittently; a wetland, lake or dam into which, or from which water flows and any collection of water which the Minister may by notice in the Gazette, declare to be a watercourse, and a reference to a watercourse includes, where relevant, its beds and banks (National Water Act 1998 (Act 36 of 1998)).

GLOSARY OF TERMINONOLGY

Berm: A wall type construction which is built to assist in the change of the natural direction of water flow.

Buffer zone: A buffer zone is an enclose line (area) around a specific entity that is exactly at the same distance away from and all around the specific entity itself. A 100m buffer zone around a watercourse is thus an area which is at exactly 100m away from the watercourse at all locations around the watercourse

Catchment: The area from which any rainfall will drain into the watercourse or watercourses or part of the watercourse, through surface flow to a common point or common points.

Channel: An artificial path that is constructed to transport water in.

Clean water: Uncontaminated water such as runoff due to rainfall over a natural landscape.

Clean water system: Includes any dam, other form of impoundment, canal, works, pipeline and any other structure or facility constructed for the retention or conveyance of uncontaminated water.

Dirty water: Contaminated water of any kind or water containing waste of any kind. Natural runoff flowing over a dirty or potentially dirty area where it is likely to be polluted will thus become dirty water.

Dirty water system: Includes any dam, other form of impoundment, canal, works, pipeline, residue deposit and any other structure or facility constructed for the retention or conveyance of water containing waste.

Exclusion zone: An exclusion zone is an enclosed line (area) around a specific entity which represents an area of exception. This means that the area contained within the exclusion zone is off limits to development. The exclusion zone is obtained by combining the 100m buffer zone with the 1:50 and 1:100 year flood line.

Flooding: Flooding is a result of heavy or continuous rainfall exceeding the absorptive capacity of soil and the flow capacity of rivers and streams.

Flood line: A flood line is a horizontal line on a map that represents the vertical height that water will reach with regard to a specific flow at a specific geographical point. This height (water level) is represented in meters above sea level (m) (geographical) and the flow is represented in cubic meters per second (m3/s).

EXECUTIVE SUMMARY

GCS was appointed by South African Manganese (Pty) Ltd to conduct a hydrological study for the proposed open cast mining activities on the Demaneng farm near Kathu in the Northern Cape province of South Africa. The hydrological study evaluated the surface water resources in and around the proposed study area and will serve as a specialist study for the Environmental Impact Assessment (EIA) and the Environmental Management Plan (EMP), The site is located in the D41J Ga-Mogara catchment which is part of the Kuruman catchment

The following aspects were included in the scope of work:

- Catchment boundary determination;
- Catchment characteristics and properties;
- Area and volume calculations in order to determine Mean Annual Runoff (MAR);
- Determination of the flood flow volumes (1:50 & 1:100 year recurrence intervals);
- Flood lines on Ga-Mogara River where it crosses the site A conceptual Storm Water Management Plan (SWMP) which includes the identification and separation of clean and dirty water areas.

The study area relative is 1.28% of the Ga- Mogara catchment
The stream flow reduction due to the activities on the study area is 1.28% of the D41 j Ga- Mogara and 0.039% of the Water Management Area (WMA)10.
The following conclusions can be made from the hydrological study:
Reduction in catchment runoff is 1.28% of the Ga- Mogara catchment area.
SWMP will separate clean and dirty water and contain all dirty water on site.
Proposed development is a category C mine and potential risk of surface water contamination is related to suspended solids only.

Demaneng Hydrological Study

Report
Version - Draft 1

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WATER • ENVIRONMENTAL • EARTH SCIENCES • GIS

63 Wessel Road Rivonia 2128 PO Box 2597 Rivonia 2128 South Africa

Telephone: +27 (0)11 803 5726 Facsimile: +27 (0)11 803 5745 Web: www.gcs-sa.biz

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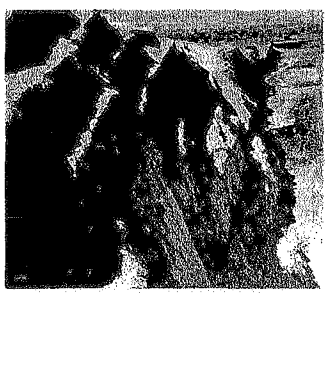
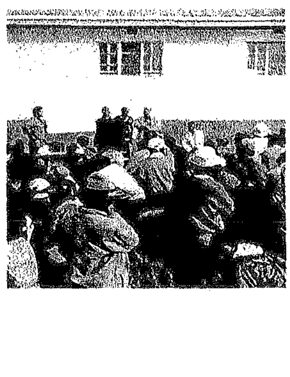




APPENDIX C

Report: Hydrological Study

	Dirty area	Contamination of clean water	Negative	2	2	3	2	[redacted]	M	Restrict by containing water in closed system with berms (SWMP)	1	1	3	0	[illegible]	L-M
Offices and Workshops	Change in catchment characteristics		Negative	3	1	3	2	[redacted]	M	Redirect and/or divert water to maintain water balance (SWMP)	1	1	3	0	[illegible]	L-M
Sewage	Change in catchment characteristics	Change in flow regime	Negative	1	1	2	0	[illegible]	L	Treatment to improve quality could lead to alternative use of water	n/a	n/a	n/a	n/a	n/a	n/a
Removal layout	Change in catchment characteristics	Change in flow regime	Negative	4	2	3	4	13	M-H	Redirect and/or divert water to maintain water balance (SWMP)	2	1	2	2	[illegible]	L-M
Conveyor belt	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Open cast mining area	Change in catchment characteristics	Change in flow regime	Negative	4	1	3	2	[illegible]	M	Redirect and/or divert water to maintain water balance (SWMP)	2	1	2	2	[illegible]	L-M

Table 12: Operational phase EIA/EMP evaluation

Identified potential impact rating table																
OPERATIONAL PHASE																
Surface water																
ACTIVITY	CONSEQUENCE	POTENTIAL ENVIRONMENTAL IMPACT	POSITIVE OR NEGATIVE IMPLICATION	ENVIRONMENTAL SIGNIFICANCE BEFORE MITIGATION						RECOMMENDED MITIGATION MEASURES/ REMARKS	ENVIRONMENTAL SIGNIFICANCE AFTER MITIGATION					
				P	E	D	I	TOTAL	SP		P	E	D	I	TOTAL	SP
Discard Dump	Dirty area	Contamination of clean water	Negative	2	1	5	2		M	Redirect and/or divert water to maintain water balance (SWMP)	1	1	3	0		L-M
		Change in flow regime	Negative	2	1	5	0		M	Restrict by containing water in closed system with berms (SWMP)	1	1	3	0		L-M
Slime Dam	Dirty area	Contamination of clean water	Negative	1	1	5	0		L-M	Restrict by containing water in closed system with lined bed and wall	1	1	3	0		L-M
										Regular quality monitoring and quantity measuring of contents	1	1	3	0		L-M
										Log keeping of data in order to analise, update, modify, improve, and detect any changes	1	1	3	0		L-M
Connection	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Roads	Exxessive dust	Exxessive siltation	Negative	2	2	5	2	11	M-H	Keep to slow speed limits	1	1	3	0		L-M
										Regular dust suprresion	1	1	3	0		L-M
	Spillage of diesel or material during transportation	Contamination of clean water	Negative	2	2	5	2	11	M-H	Cover the back and open part of the trucks with sails to minimize exposure of transported material	1	1	3	0		L-M
										Treat roads with prevention chemicals	1	1	3	0		L-M
Stock piles	Dirty area	Contamination of clean water	Negative	2	1	5	2		M	Redirect and/or divert water to maintain water balance (SWMP)	1	1	3	0		L-M

		Change in flow regime	n/a	2	1	5	2	[illegible]	M	Restrict by containing water in closed system with berms (SWMP)	1	1	3	0	[illegible]	L-M
Offices and Workshops	Dirty area	Contamination of clean water	Negative	2	1	5	2	[illegible]	M	Restrict by containing water in closed system with berms (SWMP)	1	1	3	0	[illegible]	L-M
		Change in flow regime	Negative	2	1	5	2	[illegible]	M	Redirect and/or divert water to maintain water balance (SWMP)	1	1	3	0	[illegible]	L-M
										Regular quality monitoring and quantity measuring of contents	1	1	3	0	[illegible]	L-M
										Log keeping of data in order to analise, update, modify, improve, and detect any changes	1	1	3	0	[illegible]	L-M
Sewage	Dirty area	Contamination of clean water	Negative	1	1	5	0	[illegible]	L-M	Restrict by containing water in closed system	1	1	3	0	[illegible]	L-M
										Regular maintanence and checks for potential leakage	1	1	3	0	[illegible]	L-M
										Regular quality monitoring and quantity measuring of contents	1	1	3	0	[illegible]	L-M
										Log keeping of data in order to analise, update, modify, improve, and detect any changes	1	1	3	0	[illegible]	L-M
Removal layout	Change in catchment characteristics	Change in flow regime	Negative	3	1	5	4	13	H	Redirect and/or divert water to maintain water balance (SWMP)	2	1	3	2	[illegible]	M
Conveyor belt	Spillage of material during displacement	Contamination of clean water	Negative	1	1	5	0	[illegible]	H	Keep to limited volume of material per transition	2	1	3	2	[illegible]	M
										Regular maintanence and checks for potential spillage	1	1	3	2	[illegible]	L-M
Open cast mining area	Dirty area	Contamination of clean water	Negative	2	3	5	6	16	M-H	Restrict by containing water in closed system with berms (SWMP)	2	1	3	4	[illegible]	M
	Change in catchment characteristics	Change in flow regime	Negative	2	2	5	6	15	M-H	Redirect and/or divert water to maintain water balance (SWMP)	2	1	3	4	[illegible]	M

Table 13: Decommissioning phase EIA/EMP evaluation

Identified potential impact rating table																	
DECOMISIONING PHASE																	
Surface water																	
ACTIVITY	CONSEQUENCE	POTENTIAL ENVIRONMENTAL IMPACT	POSITIVE OR NEGATIVE IMPLICATION	ENVIRONMENTAL SIGNIFICANCE BEFORE MITIGATION						RECOMMENDED MITIGATION MEASURES/ REMARKS	ENVIRONMENTAL SIGNIFICANCE AFTER MITIGATION						
				P	E	D	I	TOTAL	SP		P	E	D	I	TOTAL	SP
Discard Dump	Returned to natural characteristics	Contribution to balance of initial environmental equilibrium	Positive	3	1	5	4	13	M-H	Rehabilitation of natural top soil and land cover	4	2	6	6	18	M-H
		Change in flow regime	Positive	3	1	5	4	13	M-H	Remove diry water berms	4	2	6	6	18	M-H
Slime Dam	Emptied and back filled with natural material	Contribution to balance of initial environmental equilibrium	Positive	2	1	5	4	12	M-H	Rehabilitation of natural characteristics	2	1	6	6	15	M-H
Connection	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Roads	Out of use and not contributing	Contribution to balance of initial environmental equilibrium	Positive	2	1	5	4	12	M-H	Treat road after final use	3	1	6	6	16	M-H
Stock piles	Returned to natural characteristics	Contribution to balance of initial environmental equilibrium	Positive	3	1	5	4	13	M-H	Rehabilitation of natural top soil and land cover	4	2	6	6	18	M-H

		Change in flow regime	Positive	3	1	5	4	13	M-H	Remove diry water berms	4	2	6	6	18	M-H
Offices and Workshops	SWM measures will stay in place	Contribution to balance of initial environmental equilibrium	Positive	2	1	5	4	12	M-H	Ensure SWM structures	2	1	6	6	15	M-H
Sewage	Out of use and not contributing	Contribution to balance of initial environmental equilibrium	Positive	2	1	5	4	12	M-H	Ensure closed system with no leakages could lead to re-use options of water	3	1	6	6	16	M-H
Removal layout	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Conveyor belt	Out of use and not contributing	Contribution to balance of initial environmental equilibrium	Positive	2	1	5	4	12	M-H	Ensure conveyor belt is clean after final use	3	1	6	6	16	M-H
Open cast mining area	Back filled with natural material	Contribution to balance of initial environmental equilibrium	Positive	3	1	5	4	13	M-H	Rehabilitation and back filling of natural characteristics	4	2	6	6	18	M-H

13 INTEGRATED SURFACE WATER MANAGEMENT PLAN

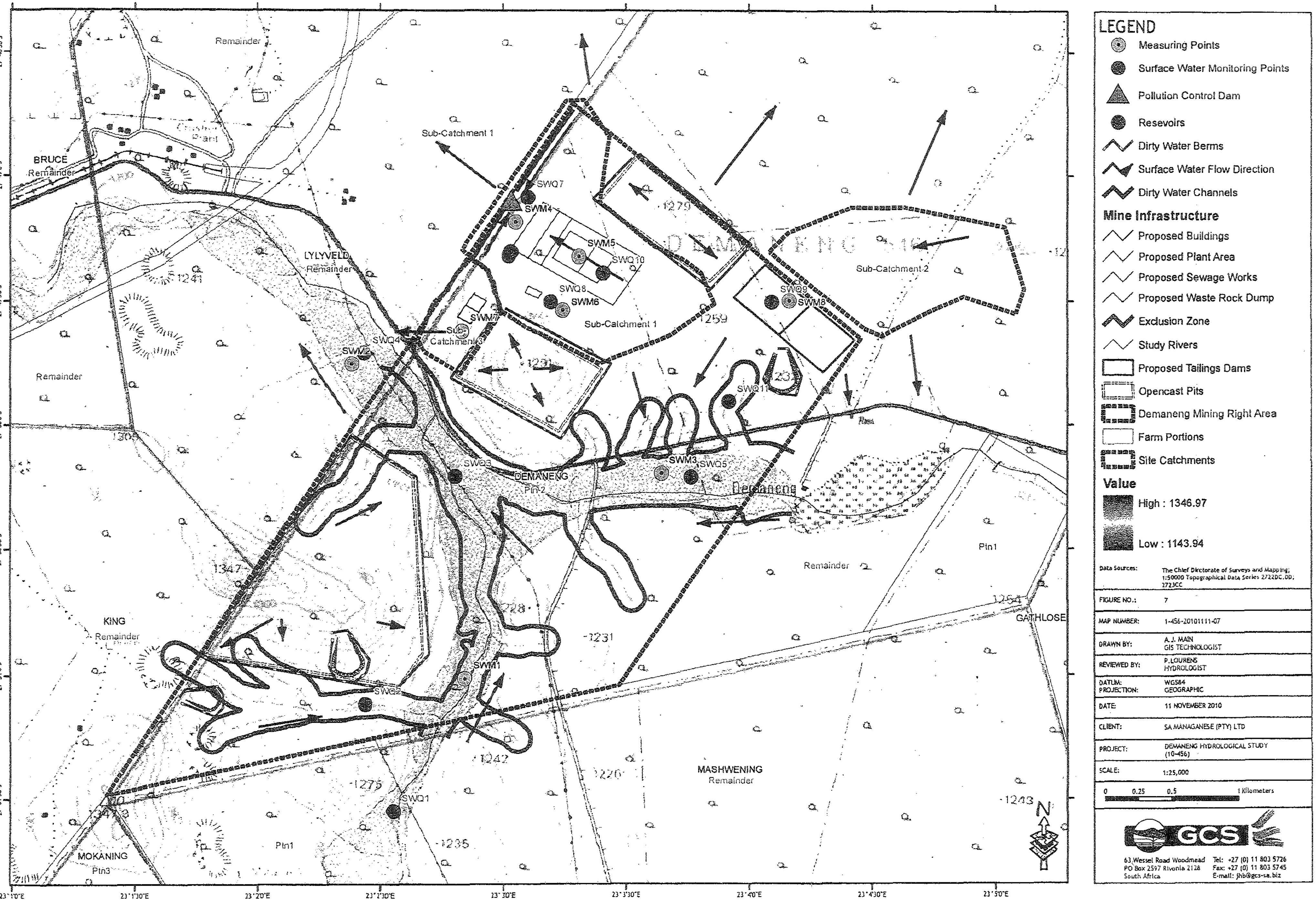
In order to manage surface water effectively during the life of mine, different aspects have to be taken into account and integrated. The measures described in the above sections have to be combined in order to supplement each other and to obtain optimal surface water management.

In order to achieve optimal surface water management the following aspects are recommended:

- To set the SWM measures in place;
- To implement all the proposed quality and quantity measures;
- To continuously maintain all infrastructure;
- Calculate a water balance that is representative of all possible elements of the system;
- To use this balance as a guide for identification of potential challenges such as excesses or shortages of water;
- Update the water balance at least once a year;
- To have data logging measures in place for when a storm event does take place;
- To mark the physical terrain during and after a flood event;
- To take photographs of flows during and after a storm event;
- To keep track of spillages and/or leakages that could occur on site; and
- To give responsibility to specific employees with regard to surface water management.

Figure 7 shows a conceptual plan of the ISWMP which includes the exclusion zones as described in Section 8.7.

FIGURE 7: DEMANENG HYDROLOGICAL STUDY - INTEGRATED SURFACE WATER MANAGAMENT PLAN



14 DATA GAP ANALYSIS

During the undertaking of the hydrological study the following data gaps were identified:

- No surface water quality data is available for analyses; and
- Information concerning the water use during operation of the mine need to be confirmed in order to enforce optimal water management.

15 CONCLUSIONS AND RECOMMENDATIONS

The catchment area that drains towards the confluence of two sections of the Ga-Mogara River within the proposed site area is very large. The actual size of the site area itself is however small. This means that the potential stream flow reduction impact of the site itself towards the greater WMA and quaternary catchment area is very small and only comprises of 0.039%.

Table 144 describes the total percentage of the potential stream flow influence that the site itself could have on the greater catchments.

Table 14: Potential stream flow reduction percentage of site towards greater catchments give sizes

Catchment	% of Quaternary catchment MAR	% of WMA MAR
Demaneng site	1.284	0.039

From the percentages in Table 144 it is clear that the potential stream flow reduction influence if any on the natural water resource systems in the surrounding environment is very low to negligible.

After evaluating all the available information and data and taking into consideration of the legal requirements associated with a conceptual SWMP the following conclusions and recommendations are outlined:

- The proposed mining development poses no great threat to potential stream flow reduction of any surface water resources in the surrounding natural environment as illustrated in Table 14;
- The proposed conceptual SWMP would be sufficient to minimise and mitigate the potential impact of flooding.
- The implementation of the maintenance and monitoring plans are essential in the functioning of the SWMP.
- Conceptual and technical designs of the proposed conceptual infrastructures associated with the proposed conceptual SWMP should be undertaken by a registered civil engineer.
- Even though particular measures contained within Section 12 (ISWMP) are only applicable in extreme and less frequent conditions, these measures if enforced would contribute greatly to the overall management within DWA specifications.
- The undertaking of a water balance study would be beneficial for the overall management within government regulations.

16 REFERENCES

Water Research Commission, 2008, Surface Water Resources of South Africa, 2005, WR2005 Report No. TT 382/08.

Water Research Commission, 2008, Atlas of Climatology and Agrohydrology, 2008, Report No. K5/1489.

The South African National Roads Agency 5th edition, 2007. Drainage Manual.

Department of Environmental Affairs, 2006, National Environmental Management Act No. 107 of 1998, GN R 386 in Government Gazette No. 28753 of 21 April 2006.

Department of Water Affairs, 1998, Groundwater-Surface Water Interactions, Appendix B: Summary of National Data Base, Version1

Council for Scientific and Industrial Research (CSIR), 1995. Guidelines for the provision of engineering services, Chapter 4, Storm Water Management.

Best Practical Guidelines G1, 2006.

GCS Consulting, 2010, Khumani Iron Ore Storm Water Management Report, Project number 10-070.

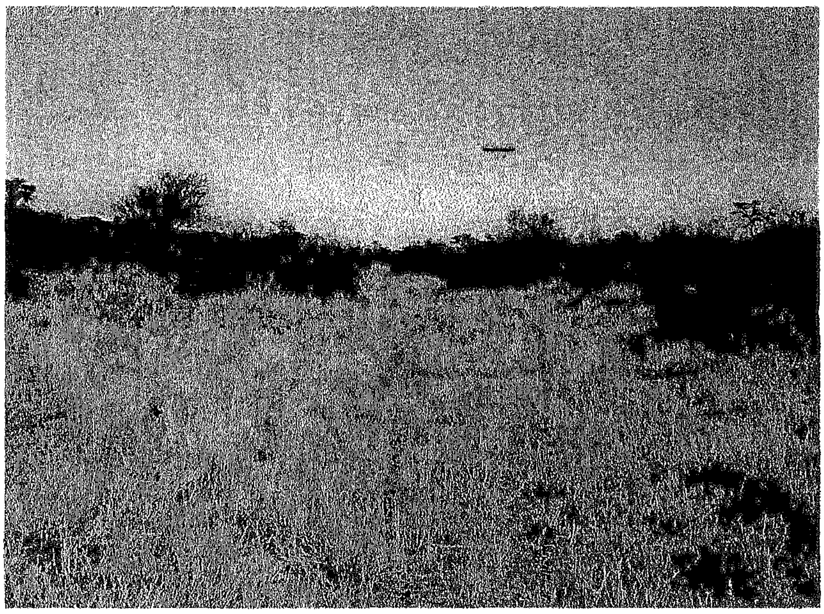
APPENDIX A

Photographs of the proposed site and surroundings

Picture 1: General catchment area

Picture 2: Large flood plain

Picture 3: Defined river bed with rocks



Picture 4: Undefined river bed with grass

APPENDIX D

Report: Geo-hydrological Study

WATER • ENVIRONMENTAL • EARTH SCIENCES • GIS

63 Wessel Road Rivonia 2128 PO Box 2597 Rivonia 2128 South Africa

Telephone: +27 (0)11 803 5726 Facsimile: +27 (0)11 803 5745 Web: www.gcs-sa.biz

Demaneng Hydrogeological Study

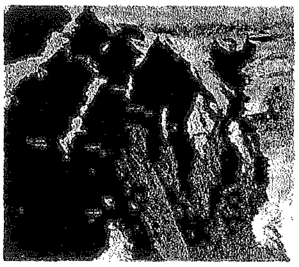
Report

Version - Final

November 10

SA Manganese (Pty) Ltd.
GCS Project Number: 10-510
Client Reference: H 8009





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EXECUTIVE SUMMARY

Introduction

GCS (Pty) Ltd. was appointed by Ms Karien van der Merwe on behalf of SA Manganese (Pty) Ltd. to carry out a baseline hydrogeological study and gap analysis for the proposed mining activities on the Demaneng farm near Kathu in the Northern Cape Province of South Africa. The hydrogeological study will form part of the Environmental Impact Assessment (EIA) application.

Baseline description

The topography is fairly flat with the iron and manganese rich hills of the Kuruman Formation rising to an elevation of 1345 mamsl at some places. The lowest part in the area is in the dry river bed of the Ga-Mogara River where the elevation drops to 1190 mamsl. The dry Ga-Mogara River bed drains in between two of the hills that are proposed mining areas. All three the proposed mining areas are in the Kuruman Formation with its iron and manganese rich hills. The proposed mining is scheduled to take place on Portion 2 of the farm Demaneng 546.

The regional geology for the area comprises sediments and intrusive rocks of the Transvaal Supergoup with the Ghaap and Postmasburg Groups that are found in the area of interest. The Ghaap Group is subdivided into the Schmidtsdrif, Campbellrand, Asbestos Hills and Koegas Subgroups, and the Postmasburg Group is subdivided into the Makganyene and Ongeluk Formations and overlying Voëlwater Subgroup. Aquifers consist of secondary bedrock aquifers comprising fractured strata and contact zones between resident geology and intrusive formation.

During the hydrocensus, forty nine (49) boreholes and one surface water pond was visited within the planned mining area. The regional groundwater level varies between 13.05 to 54.89 metres below ground level. However, the groundwater level at the proposed mine site is more than 100 metres below ground level (mbgl) on the elevated areas where the exploration holes were drilled. The depth to groundwater level is primarily determined by the type of aquifer and the hydraulic characteristics of the water-bearing formations, as well as human induced activities. .

Groundwater quality in the area can be classified as a calcium-magnesium-bicarbonate water type. The overall groundwater quality of the boreholes in the vicinity is good except for DM4 that has been chloride enriched and DM5 with iron above the maximum allowable limit.

Groundwater risks

There are 3 areas that proposed mining are going to take place on the farm Portion 2 of Demaneng. There is a southern, a central and a northern proposed mining area which targets the hills of the Kuruman Formation. The mining method to be applied is open cast mining to extract the manganese and iron ore. The elevation of the proposed northern mining area is 1276 meters above mean sea level (mamsl), the proposed central mining area is 1284 mamsl and 1330 mamsl in the southern proposed mining area. The final mining depths of the open casts are going to be at an elevation of 1178 mamsl. Groundwater levels were measured in exploration boreholes DEX10 and DM3 in order to investigate the potential depth of water intersection by mining activities.

Exploration borehole DEX10 was drilled to 108 mbgl (1179 mamsl) one metre above the bottom elevation of the open cast pit. No water level was measured up to a depth of 100 mbgl (1187 mamsl). The static water level in borehole DM3 was recorded to be at an elevation of 1172 mamsl, which is 6 metres below the proposed pit elevation. Boreholes DM9, DM10 and DM11 which are approximately 0.7km from the central mining area are dry at depths between 30 and 50 metres.

The deep groundwater level at the proposed mining site can be contributed to dewatering activities taking place at surrounding mines. Based on the fact that the aquifer associated with mining is mainly dewatered, it can be assumed that dewatering at the proposed Demaneng Mine will be limited. The proposed mining areas on Portion 2 of Demaneng are bordered in the north and south by Khumba Iron Ore, to the west by Khumani Iron Ore, further west (approximately 5 kilomtres) by Sishen Iron Ore and in the east by the farmer Mr. Dihan Van Rensburg. Based on current reserves Khumani mine producing 8.4 ton per year (tpy) would have a life in excess of 40 years and at 16.8 million tpy a life in excess of about 25 years (http://www.assmang.co.za/o/iron/khumani.asp), Sishen mine has a mine life expectancy of 27 years at the current minning rate (http://www.kumba.co.za/ob_sishen.php). The proposed Demaneng mine will only have a mine lifetime of 20 years (data obtained from Karien van der Merwe) and therefore no dewatering is expected to take place at the proposed mining area. Dewatering activities is taking place on a regional scale in the area. The risk recognized for impact on surrounding groundwater users and the Gamagara River, as a result of groundwater dewatering, is therefore seen as low based on the data obtained during the study. The dewatering of the aquifers in close proximity of the mining areas was not considered a risk due to the areas being dewatered to a depth below the elevation of the proposed mining depth.

The risk to the environment is in the form of potential contaminant water from the mine infrastructure (tailings dams, sewage treatment and waste rock dumps) is limited due to the aquifer dewatering by existing mines. The contamination potential of mine waste material (tailings and waste rock) is furthermore low. Based on the above it is concluded the contamination risk is site specific with no foreseen impact on groundwater users and environmental receptors.

Water management

A groundwater level and quality monitoring program must be put in place at Demaneng Mine. Monitoring boreholes must be installed in the vicinity of each of the mining components, i.e. the tailings storage facility (3 - potential shallow seepage), the sewage treatment facility (1) and the waste rock dump (1), processing plant (1), at each of the three open cast pit area (2 - deep boreholes to verify groundwater depth).

These monitoring boreholes must sampled on a four (4) month interval and analysed for standard anions & cations, ICP-scan (heavy metals), ph, total dissolved solids (TDS), electrical conductivity (EC), and total hardness. The main focus should be in monitoring and comparing the iron, manganese and selected heavy metals to monitor groundwater concentrations over time.

There are certain mitigation measures that need to be put in place at the operational phase of the mine to prevent environmental degradation. A proper storm water system needs to be put in place with a storm water management plan. There needs to be a pollution control dam in place for all polluted storm water to be stored in. The proposed sewage treatment works needs to be built to engineered specification.

Recommendations

- A groundwater monitoring network should be put in place at Demaneng in the vicinity of the proposed mining areas, tailings dams, waste rock dumps and sewage treatment facility;
- There should at least be two monitoring boreholes drilled at each mining area, the tailings dams the sewage treatment facility and the waste dump;

- The monitoring boreholes must be sampled on a six (6) month interval and be analysed for standard anions & cations, ICP-scan (heavy metals), pH, Total Dissolved Solids (TDS), Electrical Conductivity (EC), and Total Hardness;
- The main focus should be in monitoring and comparing iron, manganese and heavy metals to determine a potential for groundwater deterioration over time.
- Mitigations measures to be put in place at Operational Phase
- Proper storm water system needs to be in place with storm water management plan;
- Pollution control dams needs to be in place as well;
- Proposed sewage treatment works needs to be to specification.

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1 INTRODUCTION

GCS (Pty) Ltd. was appointed by Ms Karien van der Merwe on behalf of SA Manganese (Pty) Ltd. to carry out a baseline hydrogeological study and gap analyses for the proposed mining activities on the Demaneng farm near Kuruman in the Northern Cape Province of South Africa. The hydrogeological study will form part of the Environmental Impact Assessment application.

GCS received a letter of appointment, dated 11 October 2010, to conduct the necessary hydrogeological baseline assessments and GAP analysis.

2 SCOPE OF WORK

The scope of work for the hydrogeological assessment is listed below:

- Assessment of the hydrocensus information;
- Hydrochemical groundwater quality classification;
- GAP analysis.

3 METHODOLOGY

3.1 Data Sources

- Topographic Map 2722 DC and DD and 2723 CA and CC (1:50 000);
- Geological Map: Counsel of Geoscience, Map 2722(1:250 000);
- Google Satellite Image: Imagery Date is 6 May 2005

3.2 Hydrocensus

Information was gathered on the existing boreholes in the vicinity of the site. The hydrocensus was undertaken within a 5km radius of the proposed mining site on properties to which access were allowed. The following information was recorded where available during the hydrocensus:

- The GPS localities of boreholes, dams, and surface water entities;
- Aquifer data including: static water level measurements, water quality and borehole yield where possible;
- General status of boreholes; and
- Groundwater use.

3.3 Groundwater quality and sampling

The methodology in the collection and preservation of groundwater samples is important for the reliability of the analysis. Samples were taken and preserved to ensure a correct version of the on-site conditions at the site areas. This work is undertaken in accordance to the following publications:

- SABS ISO 5667-11:1993 Guidance on sampling of groundwater.
- SABS ISO 5667-1:1980 Guidance on the design of sampling programs.
- SABS ISO 5667-2:1991 Guidance on sampling techniques.
- SABS ISO 5667-3:1994 Guidance on the preservation and handling of samples.

Samples were submitted to an accredited laboratory, M&L Laboratory, services for analysis. Laboratory analyses included:

- Standard anion and cations;
- ICP - scan; and
- pH, Total Dissolved Solids (TDS), Electrical Conductivity (EC), and Total Hardness.

Analysis was carried out in accordance with methods prescribed by and obtained from the South African Bureau of Standards, in terms of the Standards Act, Act 30 of 1982.

The following aspects were also adhered to:

- Water sampling was undertaken according to laboratory requirements (filtration, specific preservative, etc); and
- Care was taken to ensure that the samples taken are sufficiently large enough (1ℓ) as to allow the laboratory to run duplicate analysis if required.

4 SITE DESCRIPTION

4.1 Climate

The Kathu area has a mean annual rainfall of about 240 mm (Kathu Airfield Weather Station), with summer being the months during which most of the rainfall occurs. The lowest monthly rainfall (0 mm) occurs in June and the highest rainfall (55mm) occurs in February.

Iron ore at the area is preserved in chemical and clastic sediments of the Proterozoic Transvaal Supergroup. These sediments define the western margin of the Kaapvaal Craton in the Northern Cape Province. The stratigraphy has been deformed by thrusting from the west and has also undergone extensive karstification. The thrusting has produced a series of open, north south plunging, anticlines, synclines and grabens. Karstification has been responsible for the development of deep sinkholes. The iron ore in the area has been preserved from erosion, within these geological structures. For 400km from Pomfret in the north, to Prieska in the south, these structures can be traced and are therefore extremely important targets in the exploration process. These iron formations can be traced as a prominent range of hills in a broken arc. In this area the bulk of the hematite mineralisation is found in the vicinity of Postmasburg and Kathu (Grobbelaar et al).

The Transvaal Supergroup lithologies have been deposited on a basement of Archaean granite gneisses and greenstones, and / or lavas of the Ventersdorp Supergroup. In the Sishen - Postmasburg region, the oldest rocks of the Transvaal Supergroup form a carbonate platform sequence (dolomites with minor limestone, chert and shale) known as the Campbell Rand Subgroup. The upper part of the Transvaal Supergroup comprises a banded iron formation unit, the Asbestos Hills Subgroup, which has been conformably deposited on the carbonates. The upper portion of the banded iron formations, has in places, been supergene-enriched to ore grade i.e. Fe - 60%. The iron ore / banded iron formation zone is often referred to as the Kuruman Formation. The ores found within this formation comprise the bulk of the higher-grade iron ores in the region.

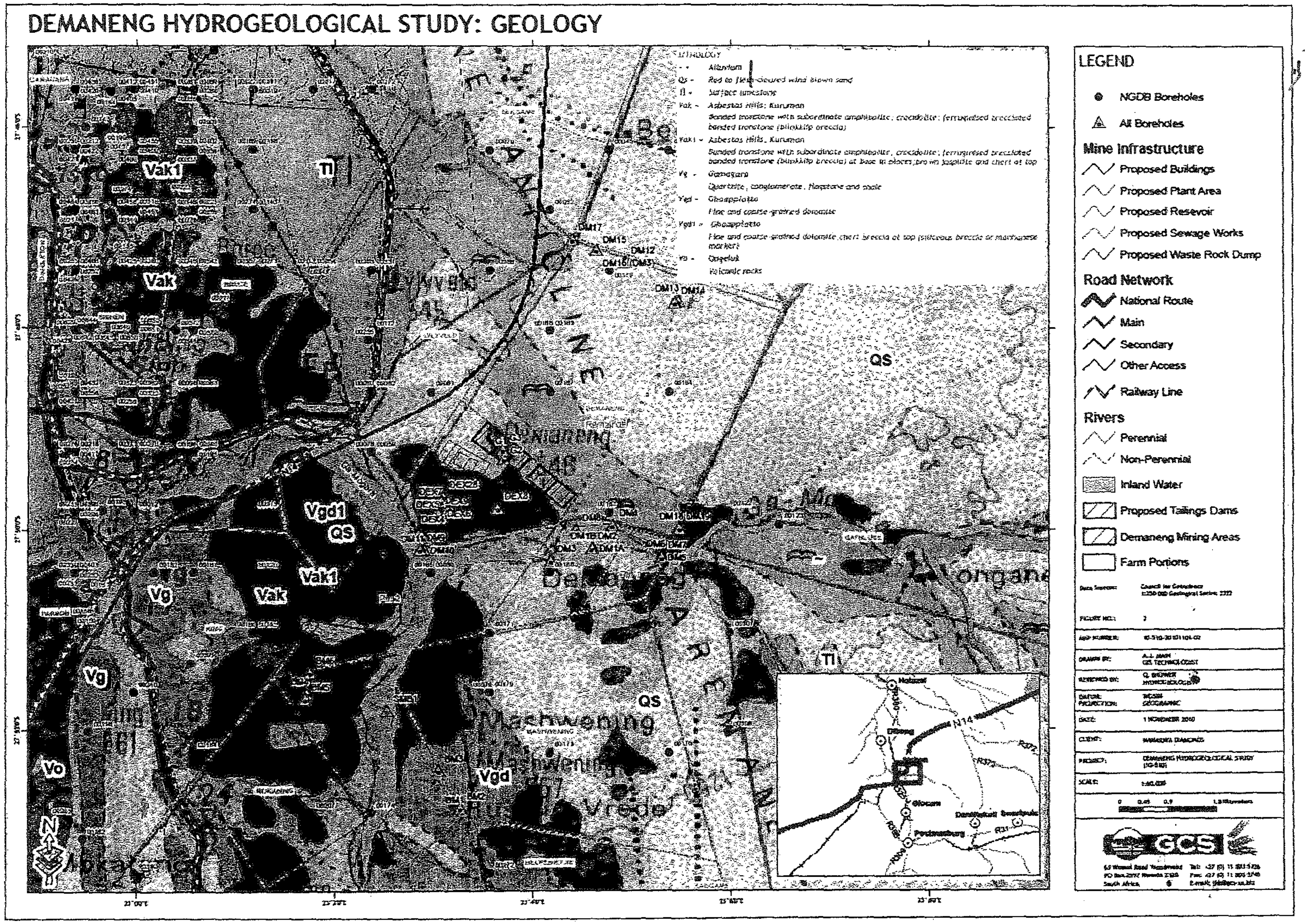
A thick sequence of younger clastic sediments (shale's, quartzite's and conglomerates) belonging to the Gamagara Subgroup unconformably overlies the banded iron formations. Some of the conglomerates consist almost entirely of hematite and are of lower-grade ore quality.

The unconformity separating the iron formations from the overlying clastic sediments represents a period of folding, uplift and erosion. At the time, solution and karstification took place in the upper dolomitic units. A residual solution breccia, referred to as the 'Manganese Marker' or 'Wolhaarkop Breccia', developed between the basal dolomites and overlying banded iron formations.

Diamictite of the Makganyene Formation and lava belonging to the Ongeluk Formation have been thrusted over the Gamagara sediments. It is now preserved only within the larger synclinal structures. A considerable portion of the upper parts of the stratigraphy have been eroded during Dwyka glaciation and re-deposited as tillite.

The entire, folded sequence was later truncated by Tertiary erosion. A thick (10 to around 60 m) blanket of calcrete, dolocrete, clays and pebble layers belonging to the Kalahari Supergroup was unconformably deposited over the older lithologies.

Figure 2: Geological Map



4.5 Regional Hydrogeology

The hydrocensus boreholes water levels vary between 13.05 to 54.89mbgl. The depth to groundwater level is primarily determined by the type of aquifer and the hydraulic characteristics of the water-bearing formations and reflects piezometric levels in hard bedrock aquifers comprising fractured strata and contact zones between resident geology and intrusions of dolerite.

The recharge in the area is between 5 and 10 millimeters per annum and the regional depth to ground water is 15 to 25 mbgl (Vegter, 2005).

There are no natural ground-water seeps and springs, discharging continuously and indicative of shallow ground-water discharge in close proximity to the study area within the zone, which may be affected by mining.

5 HYDROCENSUS RESULTS

5.1 Hydrocensus

During the hydrocensus forty nine (49) boreholes and one surface water pond was located within the vicinity of the proposed mine (Figure 3). A review of the Department of Water Affairs database, the National Groundwater Archive (NGA) indicates there are sixty nine (69) boreholes within the 5 km radius of the site but no recent data was available.The information gathered during the hydrocensus is summarized in Table 2 below.

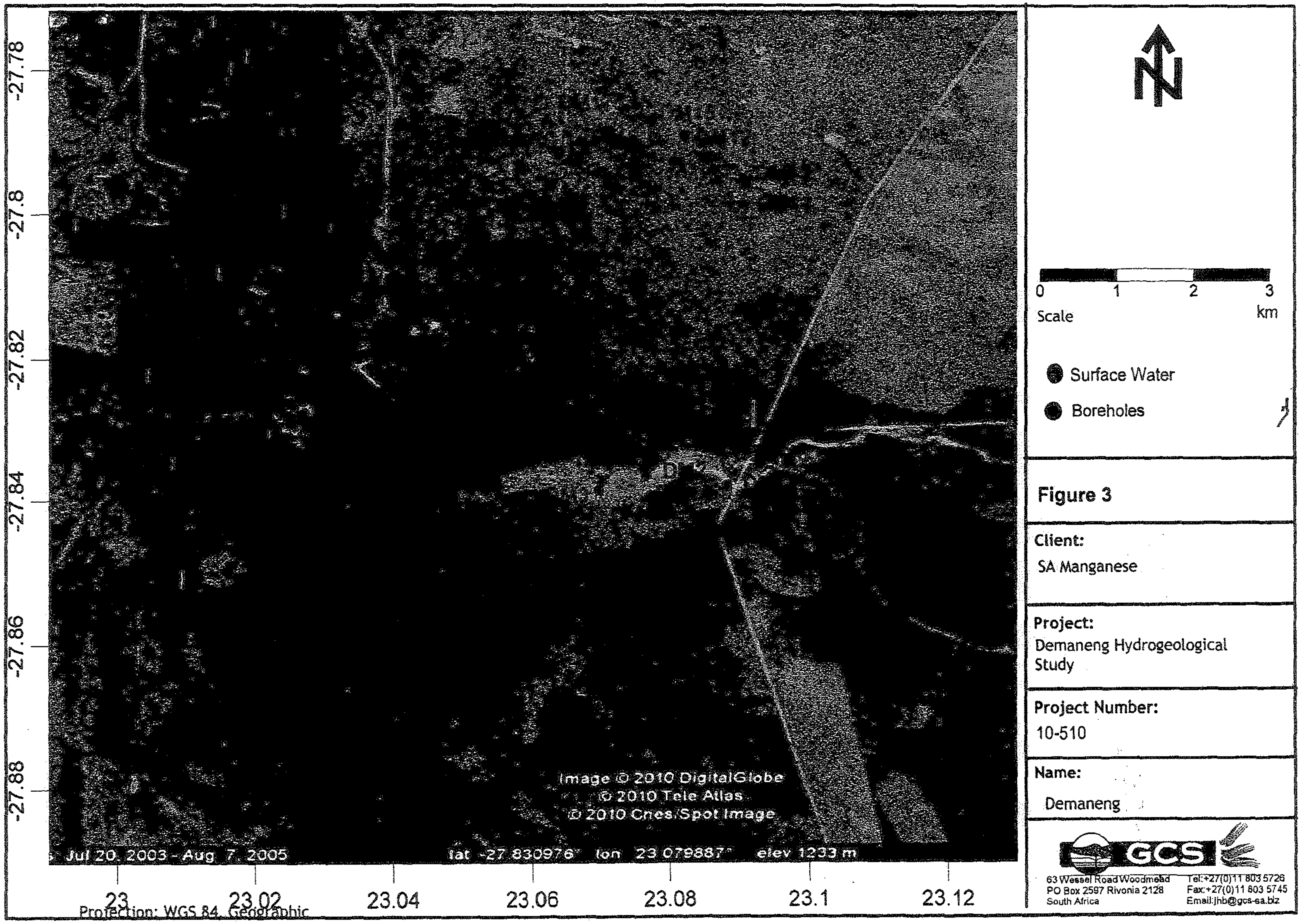
Table 2: Hydrocensus Points

BH ID	Owner	Location	Y-Coordinates[1]	X-Coordinates	Elevation[2]	SWL	Collar
DEX1	SA Manganese	Demaneng	-5088	3079547	1291	no water	
DEX10	SA Manganese	Demaneng	-5138	3079546	1287	>100	
DEX12	SA Manganese	Demaneng	-5087	3079470	1291	no water	
DEX13	SA Manganese	Demaneng	-5049	3079496	1292	no water	
DEX14	SA Manganese	Demaneng	-5049	3079597	1289	no water	
DEX15	SA Manganese	Demaneng	-5188	3079556	1278	no water	
DEX16	SA Manganese	Demaneng	-5170	3079507	1288	no water	
DEX17	SA Manganese	Demaneng	-5060	3079643	1291	no water	
DEX2	SA Manganese	Demaneng	-5108	3079620	1288	no water	
DEX27	SA Manganese	Demaneng	-5082	3079425	1291	no water	
DEX28	SA Manganese	Demaneng	-5074	3079370	1282	no water	

[1] LO23 WGS84
[2] Estimated from 5 m Orthophoto topographic contours and surveyed with water levels

DEX3	SA Manganese	Demaneng	-5049	3079547	1291	no water	
DEX4	SA Manganese	Demaneng	-5094	3079520	1290	no water	
DEX5	SA Manganese	Demaneng	-5152	3079594	1288	no water	
DEX6	SA Manganese	Demaneng	-5043	3079447	1290	no water	
DEX7	SA Manganese	Demaneng	-4952	3079489	1284	no water	
DEX8	SA Manganese	Demaneng	-5985	3079586	1288	no water	
DEX9	SA Manganese	Demaneng	-5000	3079675	1284	no water	
DM10	Dihan Van Rensburg	Demaneng	-4760	3080346	1213	no water	
DM11	Dihan Van Rensburg	Demaneng	-4709	3080355	1213	no water	
DM1A	Dihan Van Rensburg	Demaneng	-7548	3080320	1211	48.52	0.73
DM1B	Dihan Van Rensburg	Demaneng	-7544	3080318	1223	No Access	
DM2	Dihan Van Rensburg	Demaneng	-7534	3080317	1213	48.9	0.72
DM3	Dihan Van Rensburg	Demaneng	-6857	3080555	1211	46.5	0.08
DM4	Dihan Van Rensburg	Demaneng	-7878	3079898	1218	16.4	0.48
DM5	Dihan Van Rensburg	Demaneng	-8684	3080474	1221	13.07	0.3
DM6	Dihan Van Rensburg	Demaneng	-8689	3080473	1221	13.05	0.19
DM7	Dihan Van Rensburg	Demaneng	-8689	3080488	1227	No Access	
DM8	Dihan Van Rensburg	Demaneng	-7272	3079990	1225	no water	
DM9	Dihan Van Rensburg	Demaneng	-4697	3080333	1212	no water	
DM10	Dihan Van Rensburg	Demaneng	-4706	3080346	1213	no water	
DM11	Dihan Van Rensburg	Demaneng	-4709	3080333	1213	no water	
DM12	Dihan Van Rensburg	Demaneng	-8082	3075095	1230	16.79	0.14
DM13	Dihan Van Rensburg	Demaneng	-8970	3075792	1247	Blocked	
DM14	Dihan Van Rensburg	Demaneng	-8912	3075821	1248	no water	
DM15	Dihan Van Rensburg	Demaneng	-7608	3074846	1226	15.46	0.58
DM16	Dihan Van Rensburg	Demaneng	-7612	3074854	1234	15.32	0.24
DM17	Khumba	Lylyveld	-7207	3074671	1221	20.94	0.64
DM18	Dihan Van Rensburg	Demaneng	-8983	3079964	1226	15.72	0.53
DM19	Dihan Van Rensburg	Demaneng	-8984	3079967	1226	15.73	0.54
G1	Dihan Van Rensburg	Demaneng	-6081	3078574	1259	no water	
G2	Dihan Van Rensburg	Demaneng	-6082	3078673	1258	no water	
G3	Dihan Van Rensburg	Demaneng	-6069	3078512	1274	no water	
BM1	Burk Mine	Mashwening	-5396	3085174	1229	36.24	0.38
BM2	Burk Mine	Mashwening	-5363	3085113	1236	54.89	0.29
BM3	Burk Mine	Mashwening	-5002	3084419	1232	Dry at 17.2m	
BM4	Burk Mine	Mashwening	-2816	3082997	1281	> 100m	
BM5	Burk Mine	Mashwening	-2788	3083100	1282	> 100m	
BM6	Burk Mine	Mashwening	-2869	3082610	1277	> 100m	
SBM1	Burk Mine	Mashwening	-4148	3083308	1210	Surface Water	

Figure 3: Hydrocensus Points



5.2 Groundwater Quality

Groundwater samples from boreholes BM1, DM1B, DM3, DM4 and DM5 were taken during the hydrocensus and submitted for analyses at an accredited laboratory M&L Laboratory Services (Pty) Ltd. The chemistry results are presented in Appendix A and below in Table 3.

The samples were analysed for the following:

- Standard anions and cations; and
- ICP-scan for heavy metals.

Table 3: Groundwater Quality

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
pH Value @ 19°C	<4 or >10	8.4	8.6	8.6	8.5	8.6
Conductivity mS/m @ 25°C	370mS/m	88.1	99.9	89.9	237	144
Total Dissolved Solids	2400mg/l	592	672	610	1596	988
Calcium, Ca	300mg/l	72	56	51	97	51
Calcium Hardness as $CaCO_3$		180	140	127	242	127
Magnesium, Mg	100mg/l	49	58	51	119	79
Magnesium Hardness as $CaCO_3$		202	239	210	490	325
Total Hardness as $CaCO_3$		976	379	337	732	453
Sodium, Na	400mg/l	12.3	29	25	117	72
Potassium, K	100mg/l	0.8	3	3	4.4	78
Free and Saline Ammonia as NH_4		<0.1	<0.1	<0.1	<0.1	3.6
Total Alkalinity as $CaCO_3$		388	354	313	396	473
P Alk as $CaCO_3$		11	15	14	17	20
Bicarbonate, HCO_3		446	395	347	441	528
Carbonate, CO_3		13	18	17	20	24
Chloride, Cl	600mg/l	25	52	43	330	148
Sulfate, SO_4	600mg/l	9.3	12.6	25	110	1.3
Nitrate, NO_3	90mg/l	19.1	47	42	60	1.5
Nitrate as N	20mg/l	4.3	10.6	9.5	13.6	0.3
Fluoride, F	1.5mg/l	0.1	0.1	0.1	0.2	<0.1
Total Suspended Solids		<1	<1	<1	2	12
Turbidity, NTU		0.45	0.25	0.9	0.32	17
Sum of Cations meq/ℓ		8.178	8.903	7.903	19.829	14.426
Sum of Anions meq/ℓ		8.964	9.565	8.67	20.487	13.675
% Error		-4.586	-3.587	-4.623	-1.631	2.67
Aluminium, Al	0.5mg/l	0.017	<0.009	<0.009	0.025	0.026

Manganese, Mn	1mg/l	0.078	<0.001	0.023	0.042	0.66
Iron, Fe	2mg/l	0.11	<0.001	0.096	0.33	[illegible]
Zinc, Zn	10mg/l	<0.005	<0.005	0.081	<0.005	<0.005
Lead, Pb	0.05mg/l	<0.01	<0.01	<0.01	<0.01	0.02
Cobalt, Co	1mg/l	0.081	0.19	0.27	0.31	0.32
Copper, Cu	2mg/l	<0.002	<0.002	<0.002	<0.002	<0.002

*All concentrations are given in mg/L except if otherwise stated

STANDARDS USED:

SANS GUIDE 241: 2006 WITH CLASSES	
	Class 0 Ideal
	Class I Acceptable
	Class II Max. Allowable
	Above Max.

BM1 is located on the neighbouring property Mashwening, owned by Burk Mining. All its concentrations are Class 0.
DM1B is located on the farm Remainder of Demaneng 546 and all its concentrations are Class 0 accept for Nitrate which is Class II.
DM3 is located on the farm Remainder of Demaneng 546 and all its concentrations are Class 0.
DM4 is located on the farm Remainder of Demaneng 546 and all its concentrations are Class 0 accept for conductivity, total dissolved solids, chloride, nitrate and iron is Class II.
DM5 is located on the farm Remainder of Demaneng 546 and all its concentrations are Class 0 accept for potassium, manganese and lead are Class II and iron is above the maximum limit.

The majority of constituent concentrations are within the Class 0 ideal target range. DM4 has elevated conductivity and total dissolved solids readings because of the concentrated salts in the dry river bed. DM5 also has elevated conductivity and total dissolved solids readings because of the calcrete in the vicinity that it was drilled. The elevated iron concentrations are due to the natural high levels of iron in the geology, the Banded Iron Stone Formations.

The macro chemistry of the samples is represented graphically by means of trilinear plots (Figure 4).

Piper diagrams are useful graphical presentations of the various percentages of anion and cation constituents of water. Briefly, the cation and anion percentages are illustrated in two triangular fields and extrapolated onto a central diamond-shaped field as a combination of both anions and cations. Piper plots are a useful way of revealing differences and similarities among waters. In addition their actual positions on the diagram allows for classification based on the major cations and anions.

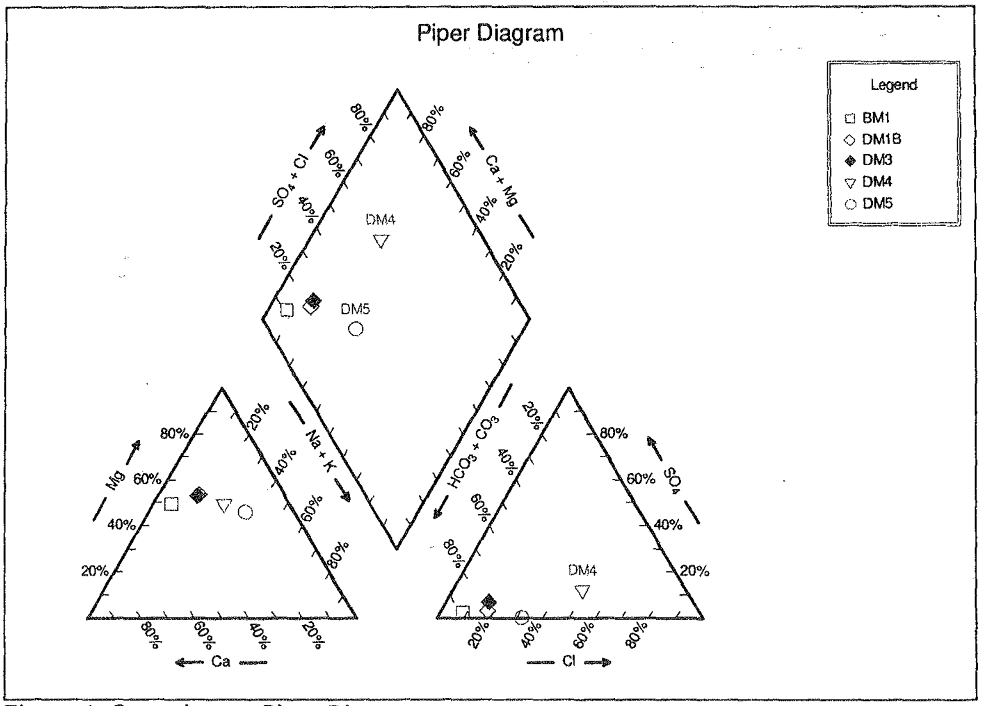


Figure 4: Groundwater Piper Diagram

The sampled boreholes can be classified as:

- Calcium-Magnesium-Bicarbonate water with chloride enrichment in DM4 and DM5.

5.3 Water Use

The Ga-Mogara River drains the area and is a non-perennial river that does not flow every year. The main groundwater use in the area is domestic use and stock watering as seen in Table 4 below.

Table 4: Groundwater Use

BH ID	Y-Coordinates	X-Coordinates	Location	Equipment	Use
BM1	-5396	3085174	Mashwening	Submersible	Domestic-Fill 10000l tank
DM16	-7612	3074854	Demaneng	Wind pump	Stock watering

DM17	-7207	3074671	Demaneng	Wind pump	Into Dam (no use)
DM7	-8689	3080488	Demaneng	Wind pump	Stock watering
DM3	-6858	3080556	Demaneng	Monopump	Domestic
DM1B	-7544	3080318	Demaneng	Submersible	Stock watering

6 POTENTIAL GROUNDWATER RISKS

Potential groundwater risks that are typically associated with mining include:

- Dewatering of aquifer and potential impact on groundwater users; and
- Water quality impacts, often associated with seepage from mine waste.

6.1 Groundwater dewatering

Groundwater levels do not correlate with the local topography, as seen in Figure 6. The groundwater level in the study area varies between 13.05m to 54.89m deep below the surface. From the interpolation plot it is evident that the groundwater levels were affected by dewatering of existing mining.

Figure 5: Linear Correlation of Topography versus Groundwater Levels

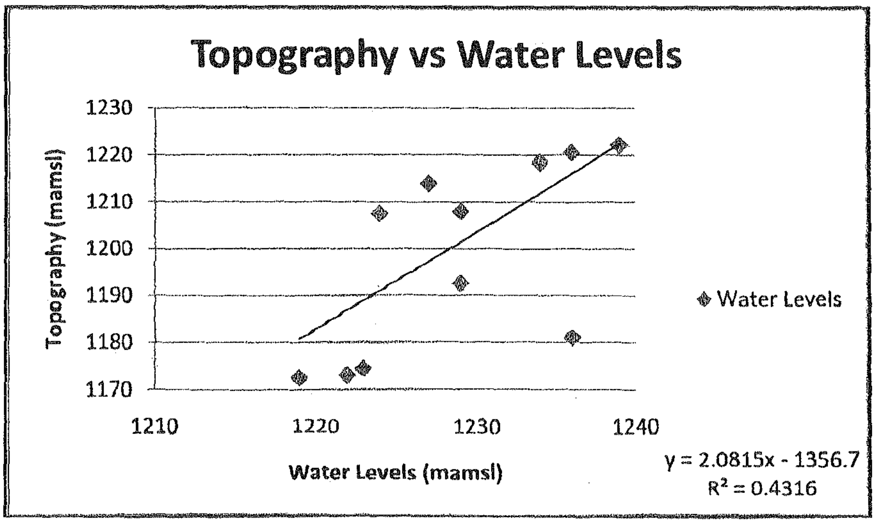
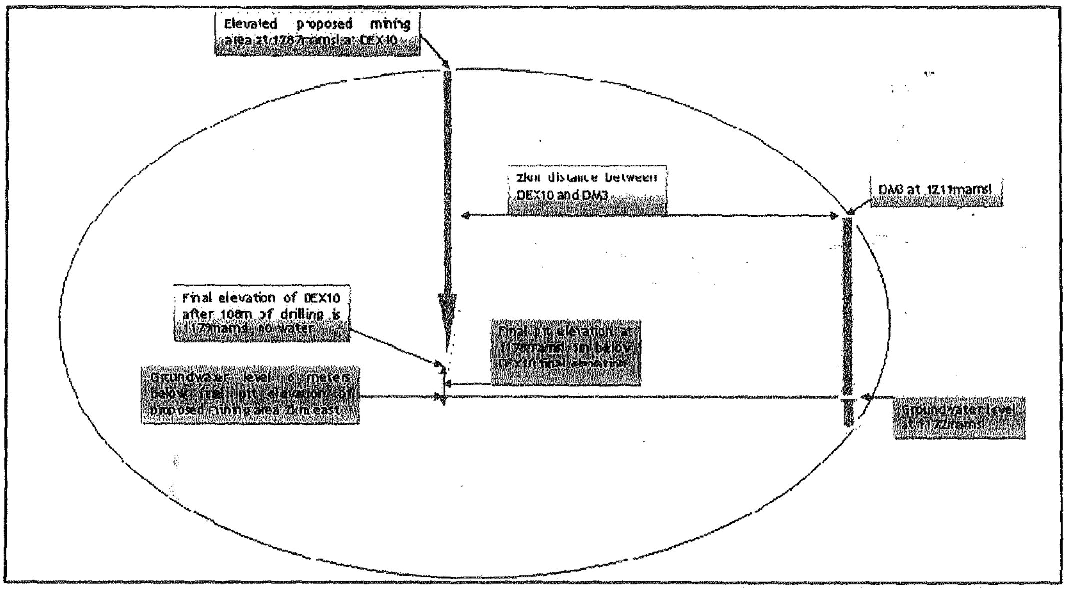


Figure 6: Schematic Representation of Final Mining Elevation and Water Level



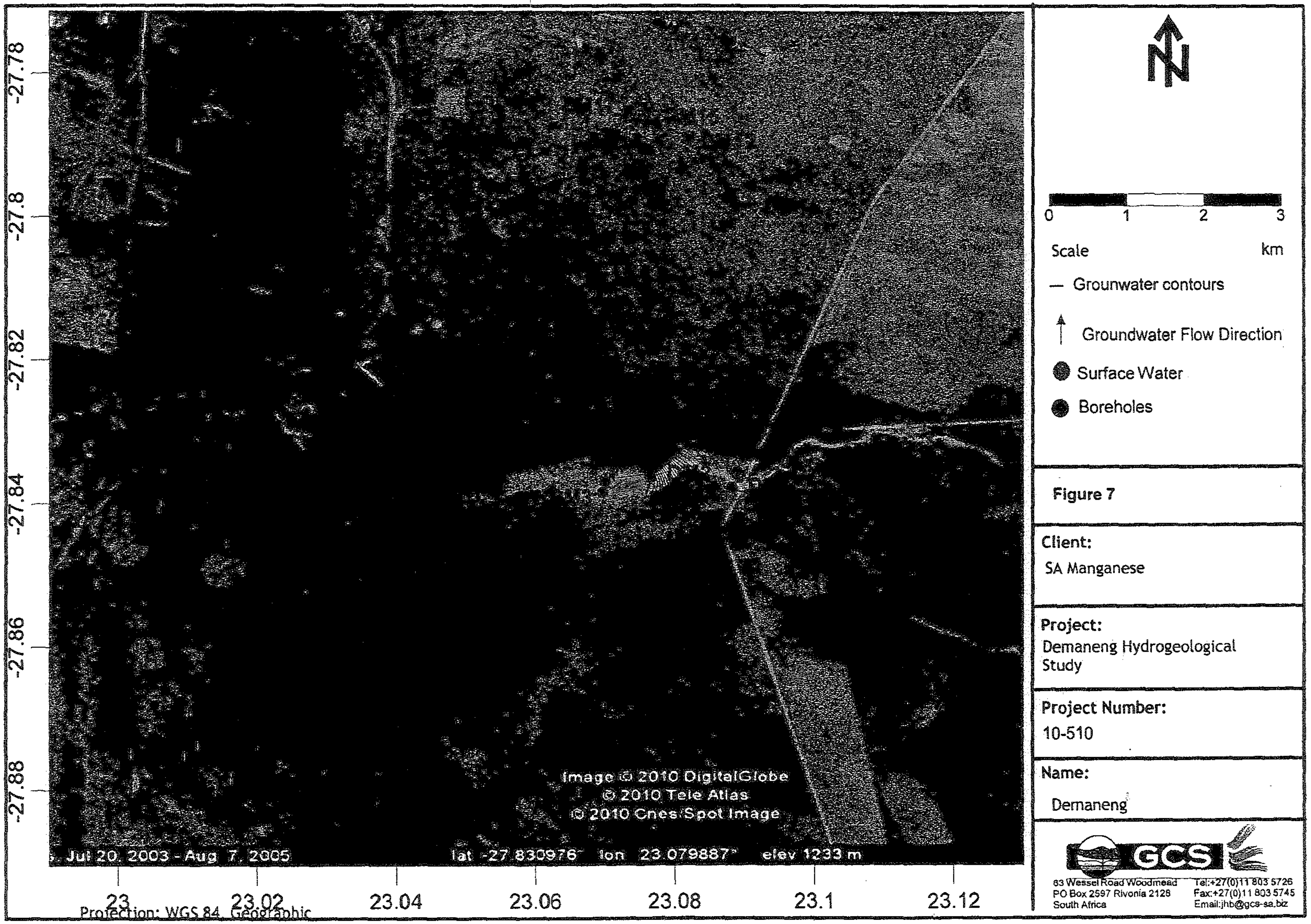
The elevation of the proposed mining areas is 1276 meters above mean sea level (mamsl) in the north east, 1284 mamsl in the central region and 1330 mamsl in the south west. The final mining depth of the open cast is going to be at an elevation of 1178 mamsl.

DEX10 exploration hole was drilled to 108 mbgl (1179 mamsl) one meter above the bottom elevation of the open cast pit. The borehole did not intersect any groundwater with depth and levels in the borehole were recorded dry up to a depth of 100 meters below ground level (1187 mamsl).

The static water level in borehole DM3 was recorded to be at an elevation of 1172 mamsl, which is 6 metres below the proposed pit elevation. The risk recognized for dewatering is therefore recognized to be negligible based on the data obtained during the borehole census. Borehole DM3 was used in the schematic diagram because it is the closest borehole with a water level to the proposed mining areas. Boreholes DM9, DM10 and DM11 which are approximately 0.7km from the central mining area are dry at depths between 30 and 50 metres.

Dewatering of the aquifers by current mining activities is evident from the data recorded and reduces the risk from dewatering from the Demaneng mine. The groundwater flow directions are seen in figure 7 below and are affected by dewatering.

Figure 7: Groundwater Flow Direction



6.2 Groundwater quality

The risk to the environment is in the form of potential contaminant water from the mine infrastructure (tailings dams, sewage treatment and waste rock dumps) is limited due to the aquifer dewatering by existing mines. The contamination potential of mine waste material (tailings and waste rock) is furthermore low. Based on the above it is concluded the contamination risk is site specific with no foreseen impact on groundwater users and environmental receptors.

6.3 Risk rating system

The need to make predictions of future impacts on the water resource as well as the environment at large, is fundamental to the discipline of environmental management at mines, and is a requirement of Environmental Impact Assessments (EIA's), Environmental Management Programmes (EMP's), Water Use License Applications (WULA's), Water Management Studies, Mine Closure Plans and others. In each instance, investigations were conducted to understand the future and try to put management plans in action to minimize the impact on water resources and the environment.

For the above reasons caution was fully exercised in applying impact prediction approaches and protocols developed to suit the regulatory environment.

6.3.1 Criteria for risk assessment

The following rating criterion was used:

Table 5: Probability

Category	Rating	Description
Definite	3	Likelihood of that impact occurring
Probable	2	Likelihood of that impact occurring
Possible	1	Likelihood of that impact occurring
Improbable	0	Likelihood of that impact occurring

Table 6: Extent

Category	Rating	Description
Site	1	Immediate project site
Local	2	Up to 5km from project site
Regional	3	20km radius from project site
Provincial	4	Provincial
National	5	South Africa
International	6	Neighbouring countries/overseas