APPENDIX 5.7(A)

SPECIALIST REPORT
SURFACE WATER

JMA CONSULTING (PTY) LTD

SURFACE WATER SPECIALIST REPORT FOR THE ENVIRONMENTAL MANAGEMENT PLAN AND ENVIRONMENTAL IMPACT ASSESSMENT FOR THE SASOL SHONDONI PROJECT

Report No.: JW07/10/C119 – RevC

October 2010

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SASOL SHONDONI PROJECT REPORT NO: JW07/10/C119 – RevC

1 INTRODUCTION

JMA Consulting (Pty) Ltd have appointed Jones & Wagener (Pty) Ltd for the specialist surface water inputs to the Environmental Impact Assessment (EIA) and Environmental Management Programme (EMP) applications, as well as the Integrated Water and Waste Management Plan (IWWMP) for the Sasol Shondoni Project, Middelbult Colliery.

Jones & Wagener were part of the team responsible for the original EMP, compiled in 2002. A new EMP is required in order to include a proposed infrastructure expansion for the Middelbult operations.

This consists of an additional shaft complex known as Shondoni Shaft, with associated infrastructure in the Block 8 Reserves, a new overland conveyor to convey the coal to the Middelbult Main Shaft, from where it will be transported via an existing conveyor to the Sasol Mining central coal stockpile area (Sasol Coal Supply or SCS) and underground workings for the additional reserve blocks, namely the Block 8 (Shondoni) Reserves, Block 8 Northern Reserves, the Springbokdraai Reserves and the Leeuwpan Reserves.

The proposed expansions require environmental authorisations in terms of the requirements of the Department of Mineral Resources (DMR) as well as ensuring the requirements of the Mineral and Petroleum Resources Development Act (MRPDA) and National Environmental Management Act (NEMA) are complied with.

This report serves as the specialist surface water study for the project. The information, impacts and water management measures apply to the Shondoni shaft complex and conveyor only.

2 LEGISLATIVE ASPECTS

2.1 Regulatory requirements

The legal basis for the EMPR is discussed in the main document. Those relevant to water are given in Section 2.3. However, the key acts involved in the surface water assessment include the following:

- The Mineral Petroleum Resource Development Act, Act 28 of 2002 (hereafter referred to as MPRDA, 2002) refers to specific acts related to water management.
- National Environmental Management Act, Act 107 of 1998 indicates the need for sustainable development.
- National Water Act 36 of 1998 forms the basis for the surface water management.

2.2 Process

The process is dealt with in the main EMPR

2.3 Applicable legislation, policies and / or guidelines

Applicable legislation relevant to surface water is given in **Table 2.3**.

Table 2.3 Applicable legislation, policies and / or guidelines

Title of legislation, policy or guideline	Administering authority	Date
National Water Act, Act 36 of 1998 (NWA, 1998).	Department of Water Affairs (DWA)	Act 36 of 1998
Government Notice (GN) 704, dated June 1999, under the NWA, 1998.	Department of Water Affairs (DWA)	June 1999
General authorisations under the NWA 1998: GN 398, dated March 2004	Department of Water Affairs (DWA)	March 2004
General authorisations under the NWA 1998: GN 399, dated March 2004	Department of Water Affairs (DWA)	March 2004
DWAF best practice guidelines (operation guidelines)	Department of Water Affairs (DWA)	August 2006

3 PUBLIC PARTICIPATION PROGRAMME

The public participation process is currently being undertaken in line with the requirements of NEMA, 1998, the NWA, 1998, and the MPRDA, 2002.

The process being followed, together with the relevant issues are discussed in the main EMP report.

4 PROJECT / ACTIVITY DESCRIPTION

Middelbult Colliery is part of the Sasol Mining Group, which has legal authorisation to mine coal from the Middelbult and Block 8 reserves. Middelbult Block 8 holds an approved EMPR and EMPR Addendum and is in possession of the required mining authorisations from the Department of Minerals and Energy (DME), now DMR (Department of Mineral Resources). The proposed Shondoni Project relates primarily to the establishment of additional infrastructure, including a shaft complex, conveyor and powerline, to optimally extract the already authorised reserves.

In addition to the Shondoni shaft and related infrastructure, Middelbult Colliery proposes to mine three additional reserve blocks, known as Block 8 Northern Reserves, Springbokdraai and Leeuwpan. The mining of these reserves also forms part of the current application.

The overall project is described in the main EMP. Aspects relevant to the surface water component are detailed below.

4.1 The Surface Infrastructure

4.1.1 The mine plan

The mine layout used for the assessment of the overall water balance is shown in **Figure 4.1.1(a)** for reference purposes.

It is currently planned to mine the No. 2 Seam (C2) and the No. 4 Seam (C4L) within the Middelbult/Block 8/Leeuwpan/Springbokdraai/Block 8 Northern Reserve area. The No. C4L Seam lies on average 117 m below surface, with the No. C2 Seam being 20 to 30 m deeper. It is estimated that the depth of mining will vary between 70 and 160 m below surface.

The run of mine (ROM) coal will be crushed below surface, brought to surface at the Shondoni Shaft and transported by conveyor to the SCS area, and used in the Sasol Synfuels plant in Secunda.

At the planned production rate of 8.5 to 9.5 million tons ROM coal per year for the entire Middelbult Colliery, it is estimated that mining will continue until 2041.

4.1.2 Subsidence

Subsidence is of particular importance in terms of the overall water balance, since not only do the areas of subsidence result in increased groundwater make through dewatering, but also increased surface water ingress.

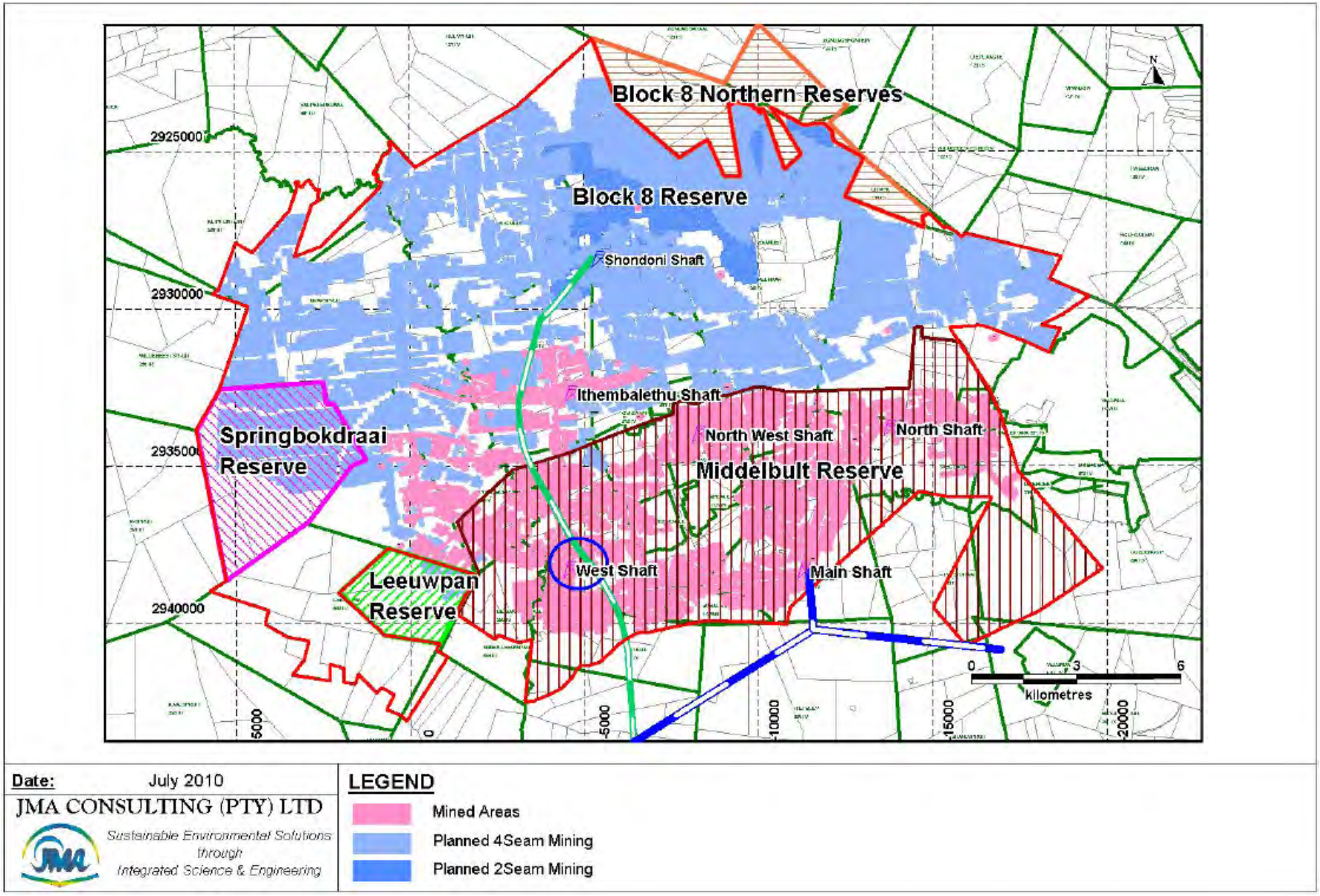


Figure 4.1.1(a) **Mine layout used for water balance**

4.1.2.1 Expected location, extent and depth of surface subsidence

The mine is planning to undertake high extraction at all of the mining areas with the exception of the following:

- No stooping or high extraction will occur under the river systems (within the 1:50 year floodline or 100m from the watercourse whichever is the greater). Note that this applies to all major streams; for small ephemeral or non-perennial drainage lines, the 1:50 year floodline will be used.
- Areas of rocky outcrop because of both the sensitivity of some of these areas, and the potential for exposed cracking on surface with associated larger inflows.
- Areas of infrastructure are also excluded.

These areas reduce the total area available for high extraction, and current planning is for high extraction over roughly 27% of the area still to be mined at Block 8.
Planned areas to be targeted for high extraction are shown in **Figure 4.1.2.1(a)**.

4.1.2.2 Drainage paths that may be affected by surface subsidence

These areas are shown in **Figure 4.1.2.1(a)** and will be excluded from high extraction. Mining by means of bord and pillar will be undertaken, and the risk of settlement is discussed later.

4.1.3 Sources of water

4.1.3.1 Process water

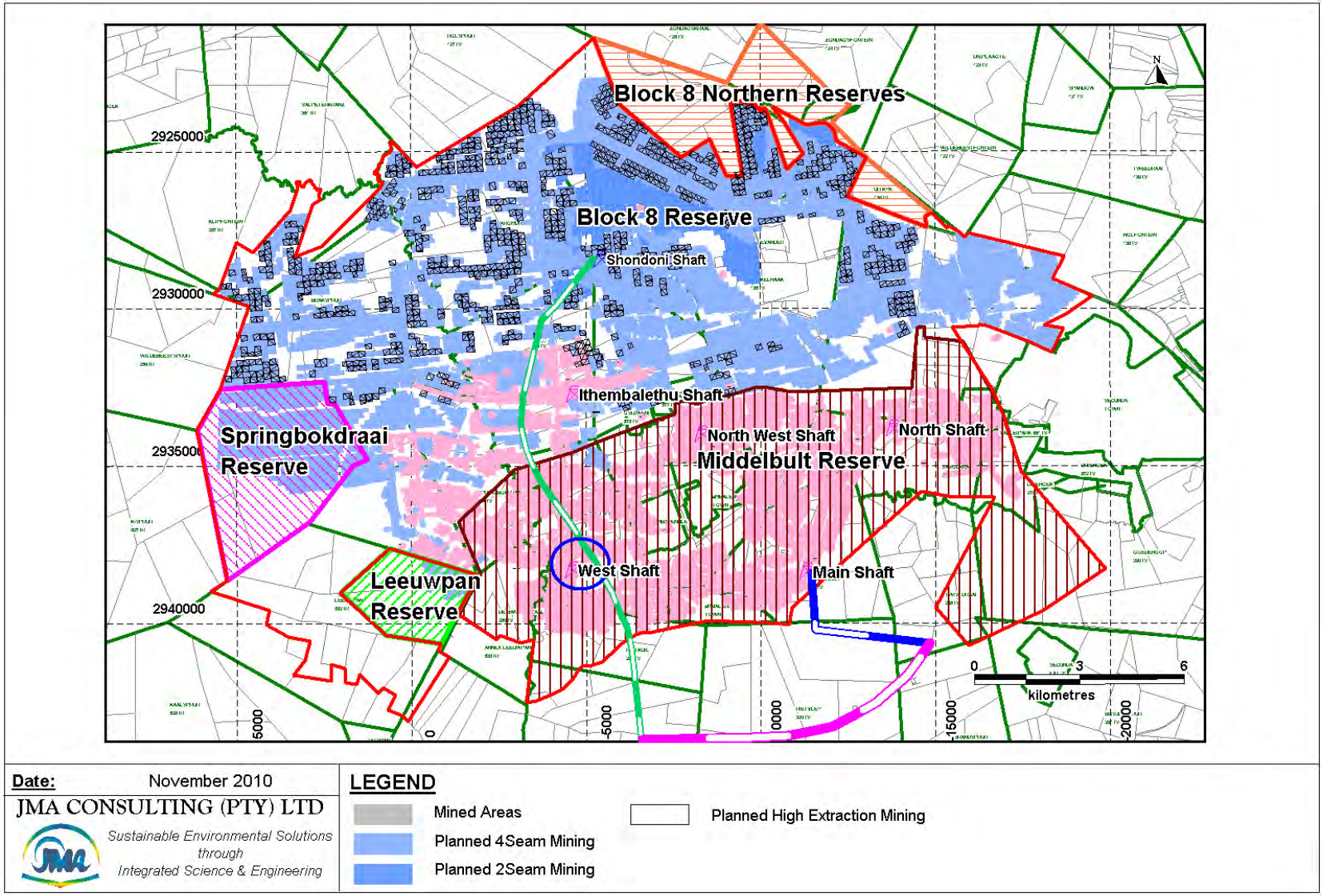
Coal processing will be limited to some crushing and screening prior to the coal being placed on conveyors. No washing or other beneficiation will be undertaken on the site. Water will be obtained from underground for use in dust suppression.

In terms of supplying the Continuous Miners (CMs), water will be supplied from service water dams on surface. This water will be water from the underground mining areas.

4.1.3.2 Potable water

Potable water for use at the Shondoni shaft complex will initially be sourced from a borehole within the Block 8 reserve area. This will be until a permanent supply is established from Rand Water. The water will be delivered via a pipeline and stored in surface reservoirs and/or elevated header tanks.

Figure 4.1.2.1(a) Targeted areas for high extraction mining



4.2 Solid Waste Water Management

Solid waste has the potential to impact on surface water. The waste management proposed for the site is discussed below.

4.2.1 Industrial waste disposal (excluding mine waste)

Industrial waste to be managed on the site includes oily wastes from the workshops and servicing areas, petroleum products (although spillage is expected to be negligible), various cleaning materials used in the workshops, tyres and other related materials used either in the mining equipment or in maintaining such equipment.

All hazardous waste will be removed by a contracted waste company, with disposal to a licensed landfill, most likely Holfontein.

4.2.2 Domestic waste disposal

Domestic waste will include general office waste such as paper and other degradable materials, light bulbs including fluorescent tubes, and electronic waste.

General waste will be disposed of off site to a licensed facility, while electronic waste and fluorescent tubes will be removed of by an appropriate licensed waste company.

4.2.3 Mine residue disposal

There will be no coal residue disposal at the Block 8/Shondoni facilities. Coal will not be washed or beneficiated on site. However, coal will be crushed and screened prior to being loaded on to the conveyor system, and carbonaceous waste from this process will be placed back underground.

4.3 Water pollution management facilities

The following water pollution management facilities are planned.

4.3.1 Domestic wastewater management

Provision has been made for a sewage plant on site. This will be a package plant such as a Prentec Plant or similar approved. Details will be supplied in the Water Use Licence and are given briefly in subsequent sections.

4.3.2 Stormwater management

Being an underground mine, the areas of disturbance on surface are limited, with coal being transported primarily by conveyor. The infrastructure and associated management is discussed below.

4.3.2.1 Stormwater management in dirty areas

A layout of the proposed infrastructure at the shaft is shown in **Figure 4.3.2.1(a)**.

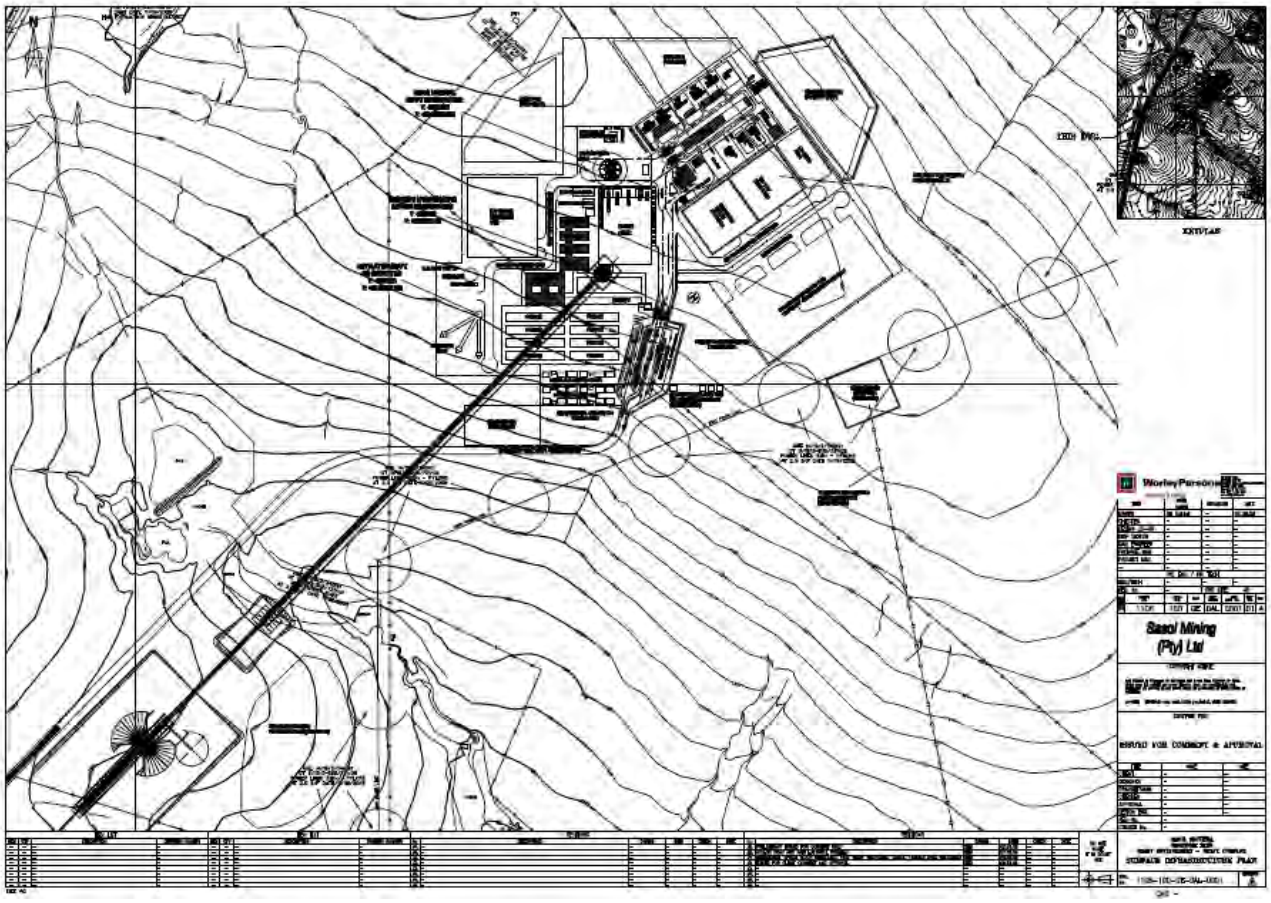


Figure 4.3.2.1(a) Stormwater infrastructure

Current planning is for the following to be present at the Shondoni shaft:

- An incline shaft
- A man & materials shaft
- A ventilation shaft
- An overburden dump, being material excavated from the shaft potentially carbonaceous in nature.
- A coal bunker used for the primary storage of coal prior to placement on to the overland conveyor.
- An emergency coal storage area in the event that there is mechanical failure or associated difficulties with either the conveyor or the coal bunker.
- Workshops and storage areas for industrial wastes including oils, tyres and related equipment. These areas have the potential for spillage of hazardous materials, and include washing bays.

The incline shaft, coal bunker and emergency coal storage areas will be located on the southern banks of a watercourse.

Clean runoff from upslope areas will be diverted around the dirty areas by means of a system of berms and canals. Dirty runoff from these areas will be collected in stormwater canals and will pass through a silt trap into a Pollution Control Dam (PCD).

The man & materials and ventilation shafts, together with the offices, workshops and other related infrastructure will be located to the north of the watercourse, on a watershed. The layout is such that the watershed forms the divide beteween the clean and dirty areas, with the clean offices and shaft areas located to the south and the workshops and waste stockpile areas located to the north. Clean runoff from the clean areas will be allowed to drain to the watercourse. Dirty runoff will be collected in a series of stormwater canals and will pass through a silt trap into a PCD.

All stormwater management facilities will be designed in accordance with the requirements of GN704, as well as the DWAF Best Practice Guidelines.

Along the conveyor route there is the potential for coal spillage at the transfer stations. Small PCDs are proposed for these areas.

4.3.2.2 Storm water management in clean areas

Areas such as the parking areas, office areas and other related infrastructure that represents a low to negligible risk to the environment in terms of surface water will have runoff drained back to the clean catchment via a small sampling dam. This dam serves both to allow sampling of the quality of runoff, as well as the opportunity for a preventative skimmer in the event of any unexpected spillages.

4.3.2.3 Surface topography after rehabilitation (Post-closure)

During the operational phase, the infrastructure and overburden dump will be visible on surface. Post closure, it is planned to use the overburden dump material to close up the shaft, while coal processing infrastructure will be removed if it cannot be re-utilised for agriculture or some suitable purposes in line with the final land use. Thus the topography around the shaft area will be largely returned to the pre-mining land form.

At areas of high extraction, some subsidence is possible. While the impacts of this are assessed in this document and commitments made to make these areas free-draining as far as is practical, it is not intended to backfill any subsidence so that it returns to the original topography.

4.3.3 Pollution control facilities

4.3.3.1 General description of dams and ponds

The following pollution control facilities are planned: -

- A PCD, located at the main inclined shaft area. The capacity of this dam will be 25000 m^3.
- A PCD, located at the workshops area. The capacity of this dam will be 80000 m^3.
- A sediment trap will be located upstream of each PCD.
- A small sampling pond will be located downstream of the clean water system to allow for sampling of runoff from this area.
- A small dam (10 000m^3) will be provided at the conveyor transfer stations to control affected runoff and spillage of water that may occur in these areas.

4.3.3.2 Safety aspects

The need for the PCD at the workshops area to be classified in terms of the Dam Safety Legislation will be determined during the design phase. If classified, the design and construction will require the supervision of a suitably experienced Approved Professional Person in terms of the National Water Act, as well as requiring approval by the Department of Water and the Environment at various stages of the project.

Other safety aspects will include the provision of warning signs at the dam as to the dangers of drowning, warnings against drinking of the water and provision of emergency flotation devices. Access in and out of all water retaining structures will be ensured by means of ramps or ladders (where ramps or slopes cannot be provided).

4.3.3.3 Sizing of dams

The sizing of the PCDs is detailed under the Water Balance. However, key features are summarised below.

4.3.3.3.1 *Legislation*

The dam is sized to have a 2% risk of spilling in any one year in line with the National Water Act. However, the dam is only part of the overall water management strategy, and as such the risk of spilling is dependent on several other components of the water management system, including:

- The actual water make as opposed to the theoretical predicted water make. A commitment is made to calibrate the water model once data is available from the site.
- The availability of storage underground compared to the theoretically predicted storage available. A commitment has been made to review the availability of storage on a regular basis, but as a minimum whenever the mine plan changes or storage conditions are found to differ from those assumed at the planning stage.

4.3.3.3.2 *Assumptions*

The assumptions used in the overall water balance model are set out this document. These include aspects such as the following: -

- The overall mining plan (given earlier in this section). It is likely that this plan will change as the mine develops and more information is obtained on the actual geology as opposed to that predicted at the planning stage.
- Areas where stooping will not be undertaken (also give earlier in this section).
- The water use and water losses are assumed based on information collected from previous mining in the Secunda area. These will need to be refined as data becomes available.
- The surface and groundwater inflows are predicted based on geohydrological and surface runoff models, with the geohydrological information provided by JMA.
- By their very nature, models are theoretical estimates of natural phenomenon that are too complex to be derived exactly. It is inevitable that there will be variations in the actual flows compared to the predicted flows that can only addressed by recalibration of modelled data with measured data, from which more reliable estimates of extreme and average water make can be developed.

4.3.3.3.3 *Rainfall and evaporation inputs*

The rainfall and evaporation inputs are discussed in the section on water balance modelling.

4.3.3.4 Technical design of the proposed dam(s)

The design of the Dirty Water Dams will be based on the principles set out below. However, the detailed geological investigations required have still to be completed which may result in changes to the final design. Any changes will be incorporated into the Water Use Licence application.

It should be noted that none of the surface storage facilities will be used to handle water from underground, since there is both existing storage in the mined out areas to the south, as well as new storage in the areas to be mined, and these are considered adequate to handle both average and extreme water makes.

4.3.3.4.1 *Design parameters*

Two dams are required primarily to contain runoff from the Shondoni workshops and shaft / plant areas, and from the coal stockpile area. No coal is washed in the area, and coal is generally stored in concrete bunkers, but provision has been made for an emergency throw out system, and this area is therefore considered dirty.

4.3.3.4.2 *Embankments*

As per the most recent design of dams for Sasol Mining surface water management, the dams will have an HDPE liner system underlain by a clay layer of at least 500mm. Leakage detection will also be provided.

4.3.3.4.3 *Seepage and siltation minimisation*

Silt traps will be provided on the upstream side of the Dirty Water Dams. These will be cleaned on a regular basis, the lack of a proper maintenance plan being the primary reason for the failure of silt trap systems.

The potential for seepage will be addressed by the use of a synthetic and clay liner system.

4.3.3.4.4 *Inlets*

Inflow to the dam will be via the silt traps on the upstream side of the dam, with water gravitating into the dam basin.

4.3.3.4.5 *Emergency overflow*

The dam will be classified and the spillway designed for the appropriate capacity, including allowance for wave surge and run up and the freeboard required to pass the Design Flood and the Safety Evaluation Flood.

4.3.3.5 Monitoring

Monitoring will be undertaken upstream (where practical) and downstream of the dirty water facilities. Monitoring is detailed in Chapter 8.

4.3.4 Polluted water treatment facility

Treatment of mine water is envisaged only post closure, as discussed below.

4.3.4.1 Mine / process water treatment

Treatment is expected to be required during the life of the project as follows: -

- To facilitate use of water generated during mining in the continuous miners, provision has been made for the use of sand filters as well as some possible softening (such as lime softening), depending on the hardness of the dirty water on the mine.
- The mine has been planned so as to avoid the need for mine water treatment for as long as is possible. This has been achieved through the use of bord and pillar mining at the existing operations, allowing storage of surplus water in these mined out areas from the start of mining. Further, as mining progresses, additional areas will be flooded to prevent spontaneous combustion and reduce the rate of pyrite oxidation, and the flooding of these areas will allow the predicted water make to be managed without a water treatment plant until many years after closure. There is a possibility that, with stratification of water post closure, there may not be a need to treat water even post closure, but this is not proven yet and provision has been made for treatment if required post closure.

The need for RO or similar techniques is discussed in terms of the water balance. Note that, should such a plant be constructed, it will require a full Environmental Impact Assessment, which will include detailing of the processes and management of the waste streams.

4.3.4.2 Sewage water treatment

There will be no accommodation provided at the Shondoni site, and sewage treatment is only required for the staff during working hours. The number of staff expected to be on site on a daily basis will be as follows: -

The anticipated loading from the administration building, change houses and workshops is around 380m^3/day with a peak flow of nearly 3.8 times this volume.

A batch plant is proposed for the sewage, probably similar to the Prentec system, and this will be addressed in the Water Use Licence application.

The plant will include the following:

- Inlet works comprising screening facilities and emergency bypass facilities.

- A batch reactor tank in which organic constituents will be biologically oxidised, and in which mixing and aeration occur. A mechanical surface aerator will be on the batch reactor tank, either floating or fixed.

The tank will typically be decanted 3 times a day when the volume reaches a predetermined level, using a fully automated system to manage water levels and quality.

- Clarifying and chlorination of water will occur prior to discharge of the water, the water being discharged to the water management dam for reuse in dust suppression.

Sludge facilities will be used to store and dry the sludge, the material being discharged from the clarifier as and when required. The sludge is then dried and eventually disposed of as per the licence requirements.

4.3.5 Water and salt balances

4.3.5.1 Water balance

The water balance calculation method is described below:

4.3.5.1.1 *Rainfall data*

The water balance modelling approach used historical daily rainfall data from gauges in the area. The rainfall data from Langsloot was evaluated as having reliable data, together with reasonably representative extremes for the duration of sampling. The gauge is located close to the site, and has a rainfall record from 1914 to 1998. The data was augmented by data from Secunda. A motivation for the use of this rain data is given in the baseline discussion on rainfall.

Note that there is no right or wrong rainfall gauge to utilise for the various hydrological inputs to the EMP. The Langsloot gauge has extreme rainfall data that make it useful for the water balance modelling.

4.3.5.1.2 *Computational methodology*

The methodology used is detailed in the text box below.

Modelling methodology

The daily rainfall files were input to a hydrological model based on the Soil Conservation Services method to determine runoff on a daily basis using antecedent conditions. The method (as adapted to South Africa by Schmidt and Schulze) is believed to be highly suitable to the site, having been developed in catchments of around 8 km2 and agricultural areas.

The underground water inflows were derived by Jasper Muller & Associates (JMA) using the modelling approach developed for the Secunda area. This involves developing of grids for which the recharge rates can be computed. Account is taken of recharge and dewatering through fracturing of strata.

These rates of inflow are then brought into the J&W model, where extreme rainfall impacts, and surface water make can be assessed.

From this, the water use/storage requirements to have a 2% or less risk of spilling can be computed.

4.3.5.2 Water Make

Water make refers to the water generated through the mining activities. This includes rainfall related inflows as well as groundwater inflows.

The total water make from the underground mining areas is given in Figure 4.3.5.2(a) for the period through to closure showing seasonality. Note that these water makes

include the bord and pillar areas already mined, since the storage calculations are also for both the historical and future mining at Block 8.

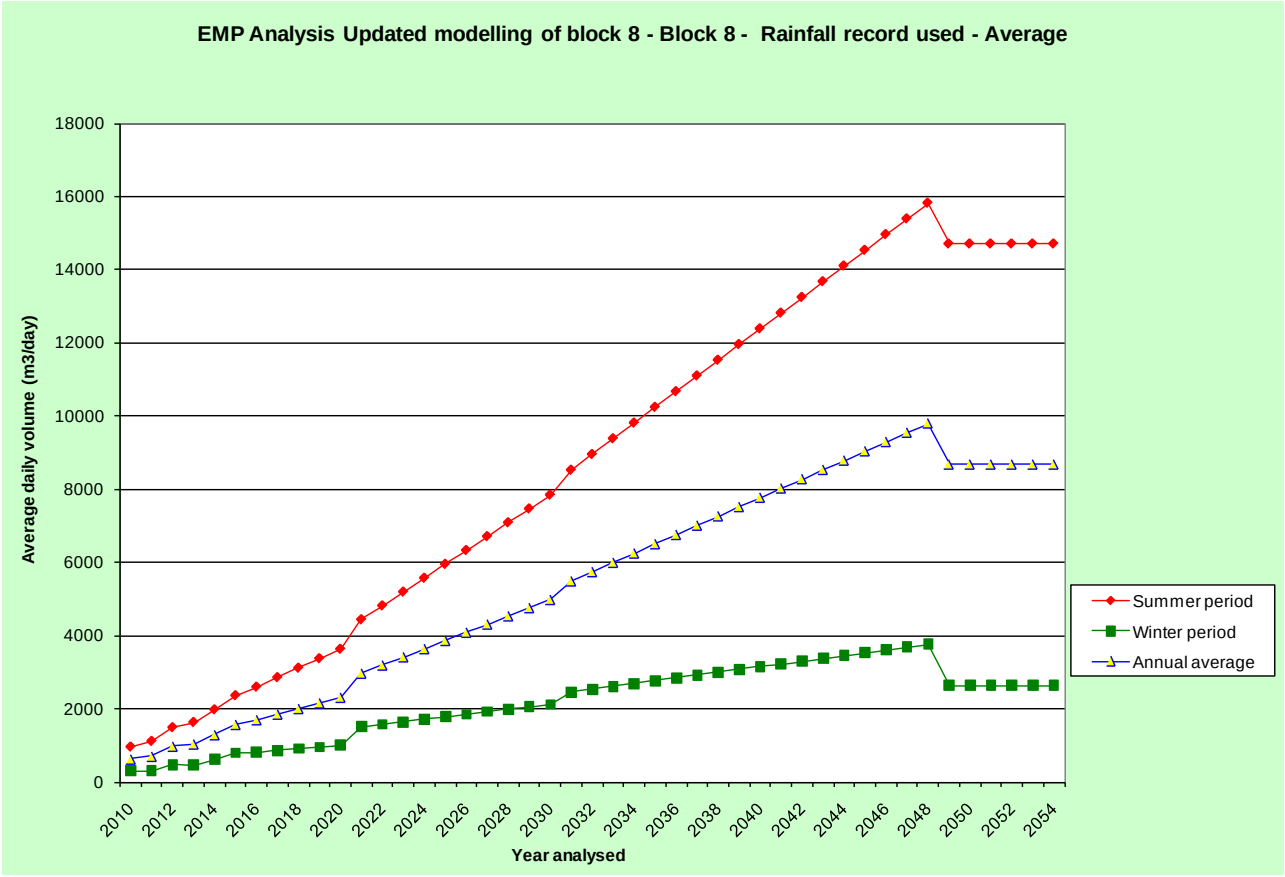


Figure 4.3.5.2(a) Current predicted water make at Block 8 for average rainfall.

Key points to note include:

- The mining of 2 seam workings only commences around 2020, indicated as a small increase in the water make trend.
- Post closure, the dewatering of the aquifer associated with high extraction mining reduces, with an associated reduction in the overall water make.
- The assessment is based on a macro level review of mine water make, and there is a need for detailed review of the high extraction areas as the project progresses to ensure that inflows from non-freedraining areas are minimised.

The contribution of the various mining areas to the net water make is given in Figure 4.3.5.2(b).

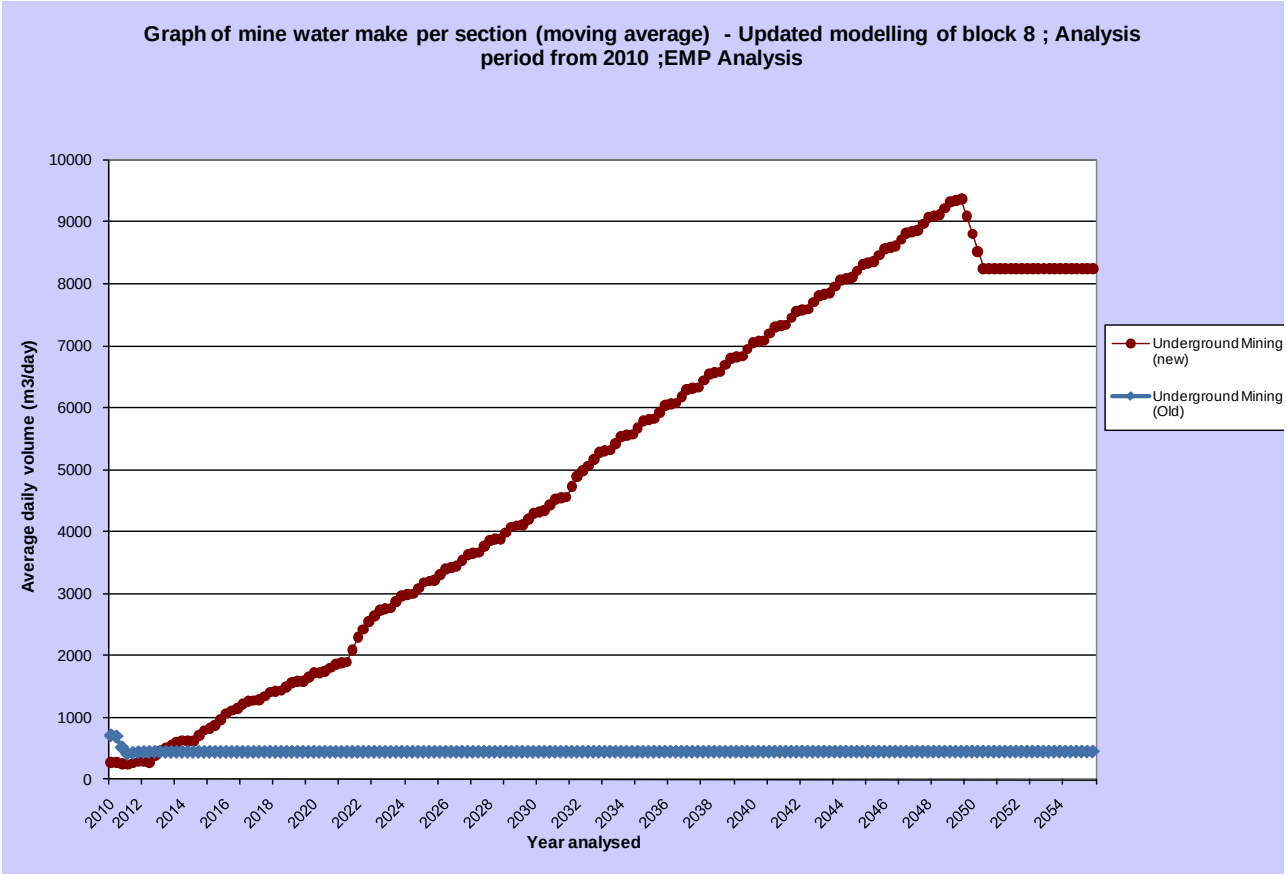


Figure 4.3.5.2(b) Contribution of the various areas to the net water make.

It is apparent that the bord and pillar mining in the current workings contributes very little to the overall water make compared to the new high extraction developments to the north.

A schematic of the overall water balance for the life of the mine is given in Figure 4.3.5.2(c).

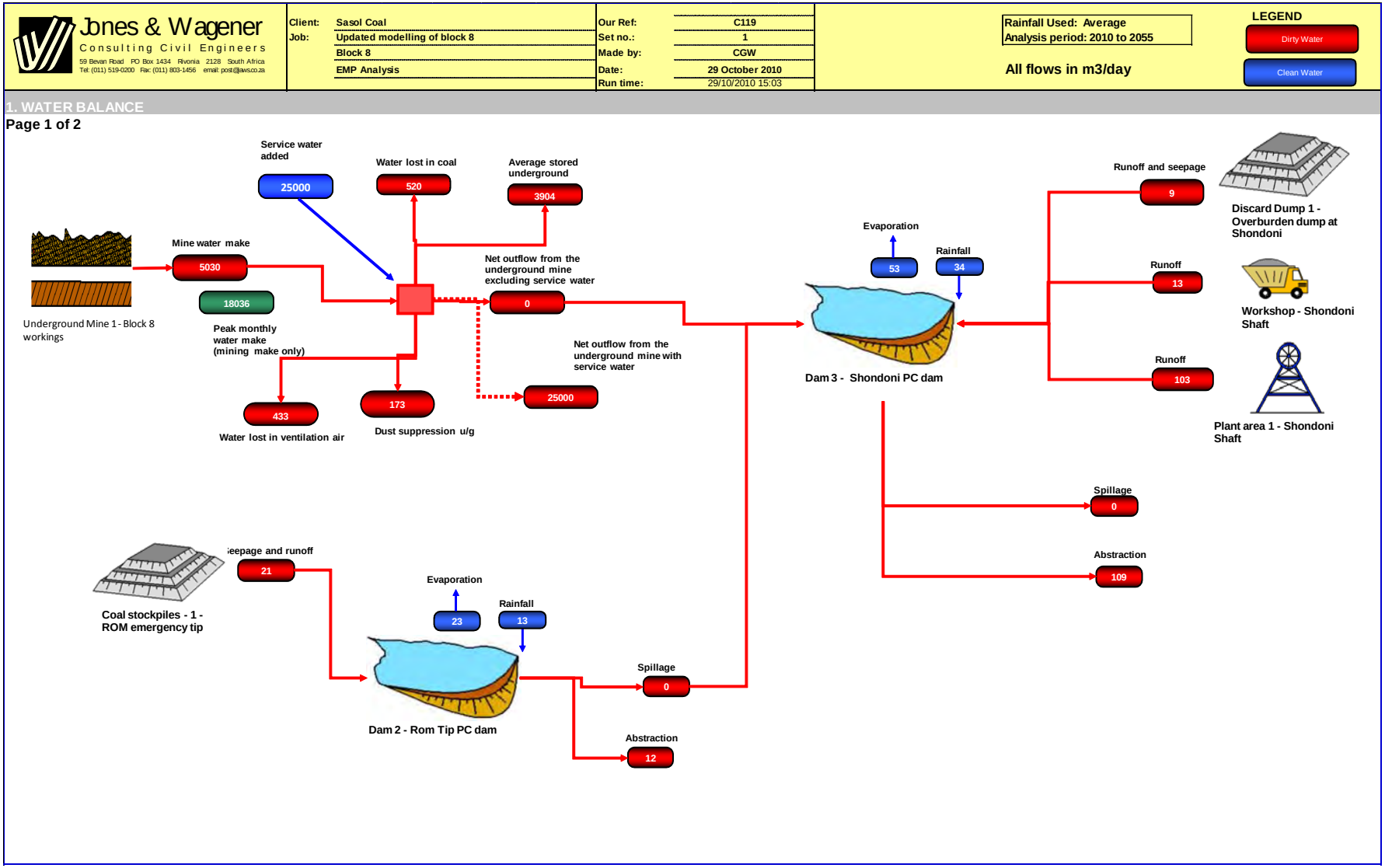


Figure 4.3.5.2(c) Schematic water balance over the life of mine.

4.3.5.3 Water use

Water use relates to water lost from the mine water circuit. This excludes water that is recycled.

The net water use includes the use of water for dust suppression, losses through the ventilation systems, and water "lost" with coal, i.e. transported with the coal to the Sasol Coal Supply (SCS).

Available information and best estimates indicate the usage to be as follows: -

- Dust suppression = 200m^3/day
- Sampling plant = 30m^3/day
- Lost with coal = 600m^3/day.
- Lost through increasing moisture content in air in the ventilation system = 500m^3/day

Note that although the continuous miners utilise significant volumes of water, the water is generally recycled and the losses are not attributable to the mining itself, but to "wetting" of coal mined by the equipment.

The graph of water make versus usage given below indicates that there is a net shortfall of water for the initial mining period, after which water will be available.

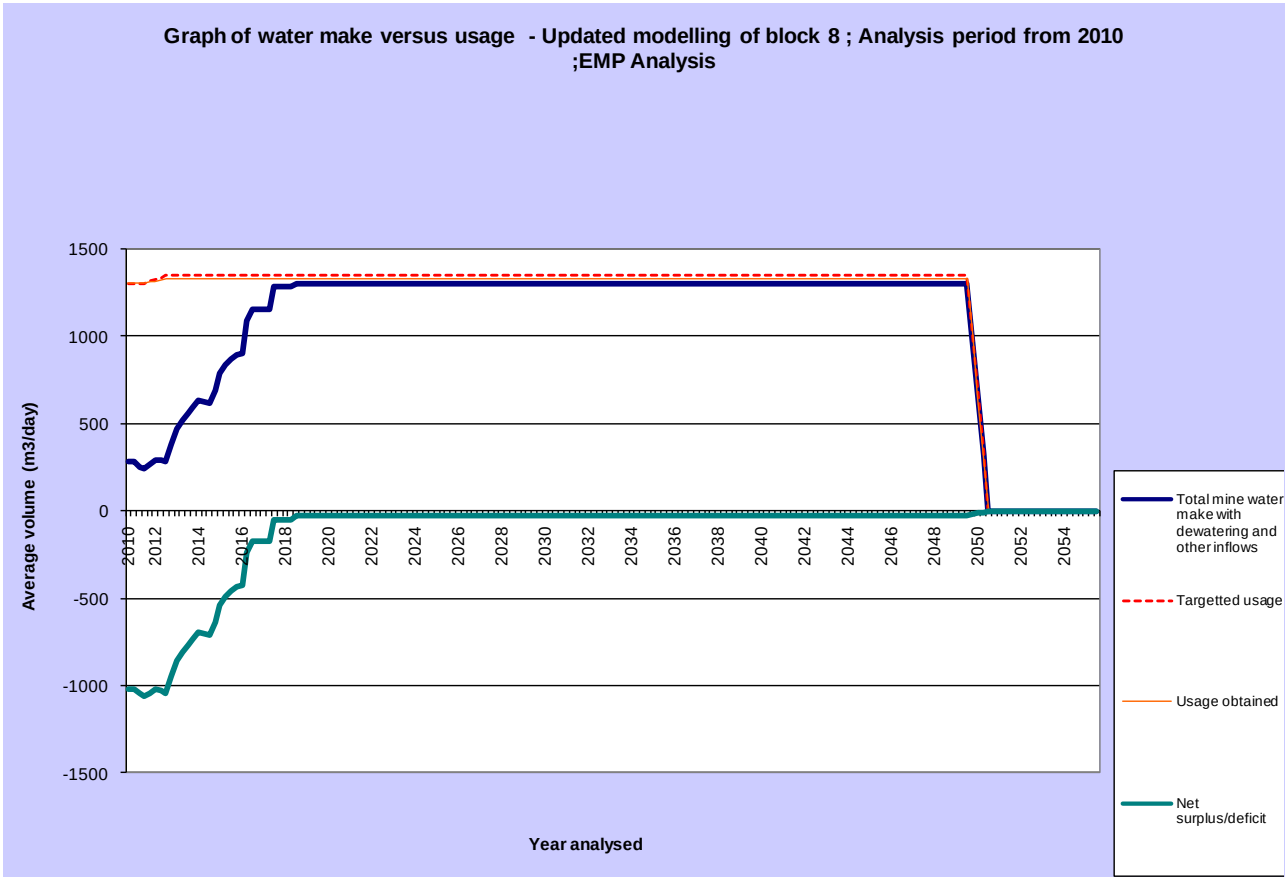


Figure 4.3.5.3(a) Water make taking into account storage available within mined out areas.

Note that Figure 4.3.5.3(a) should be qualified in that:

- The figure indicates a net shortfall for the next 7 years. However, that assumes that water is not pumped from low lying areas within the mine i.e. that available storage underground is maximised. There will be water available for dust suppression from the underground workings.
- With the exception of dust suppression, none of the other "uses" is essential – e.g. ventilation losses will not be maximised if there is not available moisture within the mine.

4.3.5.4 Storage

As indicated previously, it is environmentally desirable to flood as much of the mined out area as possible to reduce the oxidation of pyrites and reduce spontaneous combustion risks. Because the mining to date has been bord and pillar, there is storage capacity available in the mined out workings. This is shown in Figure 4.3.5.4(a).

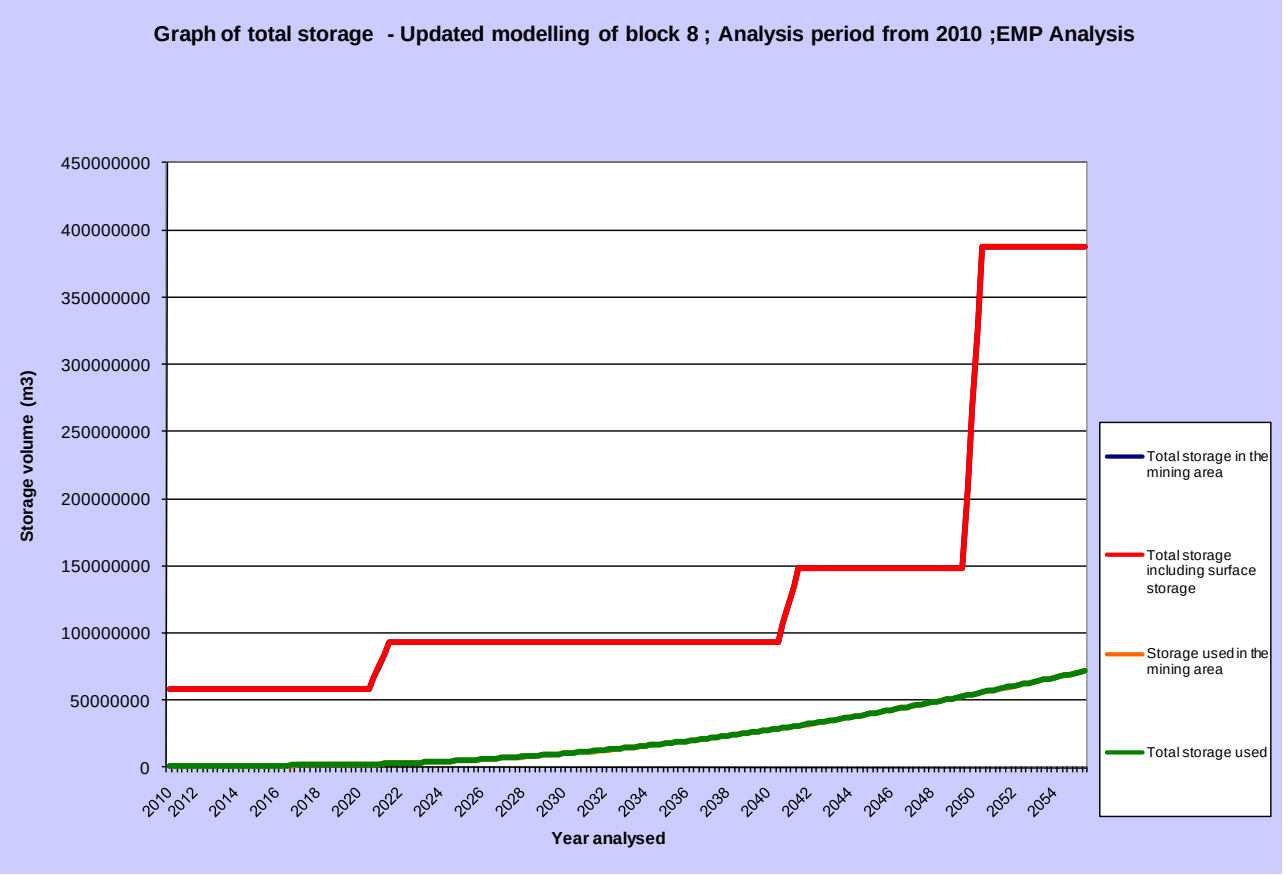


Figure 4.3.5.4(a) Plot of expected storage to be used based on average rainfall

It is apparent that:

- Currently, just over 50 million m^3 of storage is available in the mined out areas at Block 8.
- Around 35 million m^3 will become available in the western areas around 2020.
- It is anticipated that around 20% of the remaining storage will become available around 2040, if not sooner.

Surface storage

Dirty water will be stored in two dirty water dams. These are located downstream of the ROM emergency stockpile, and the shaft workshops and overburden dumps.

Modelling of the pollution control dam at Shondoni Shaft indicates that a dam of around 80 000m^3 has a risk of spilling of 1:50years, based on abstracting around 160m^3/day to both the sampling plant and dust suppression underground. Some optimisation of this dam can be done at final design. The modelling output is shown in Figure 4.3.5.4(b).

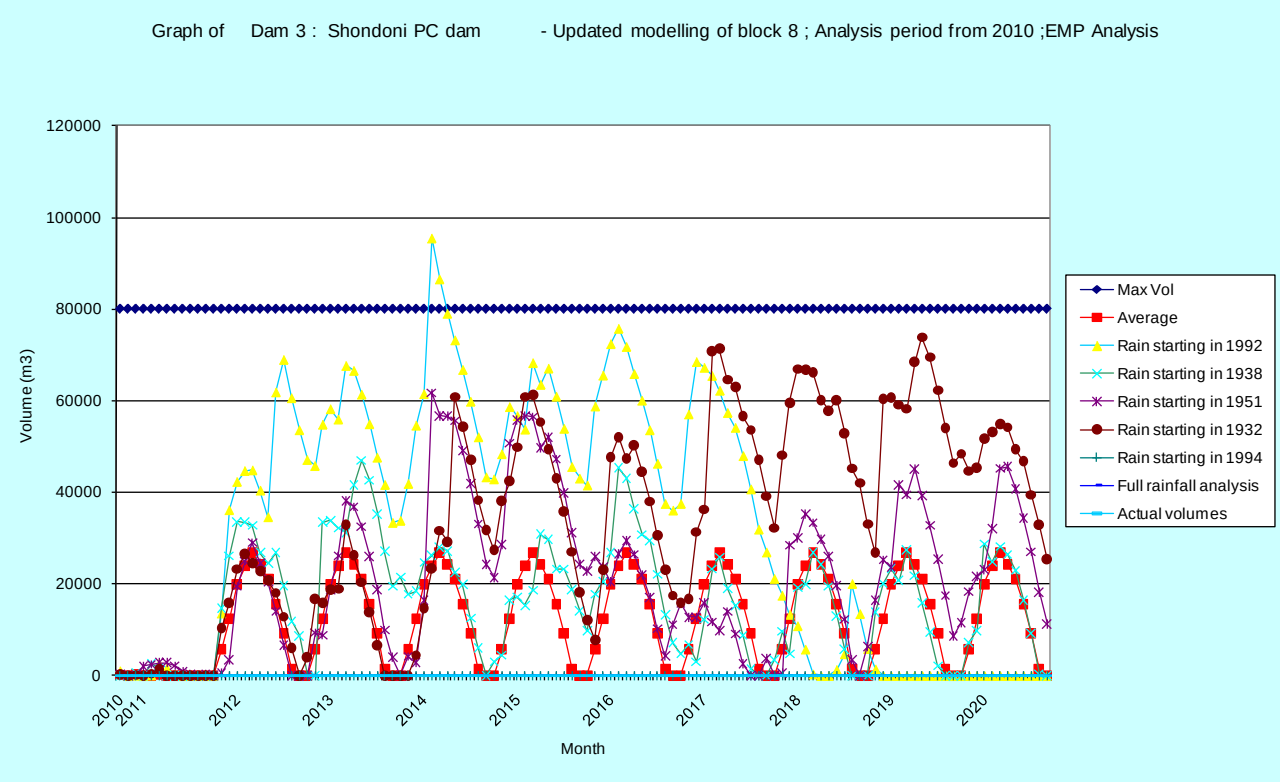


Figure 4.3.5.4(b) Storage required for the Shondoni Pollution Control Dam

For the ROM tip area, it is proposed to also abstract a nominal amount of water for the sampling plant and for dust suppression of some 25m^3/day, giving a required storage capacity of around 25 000m^3 for this dam.

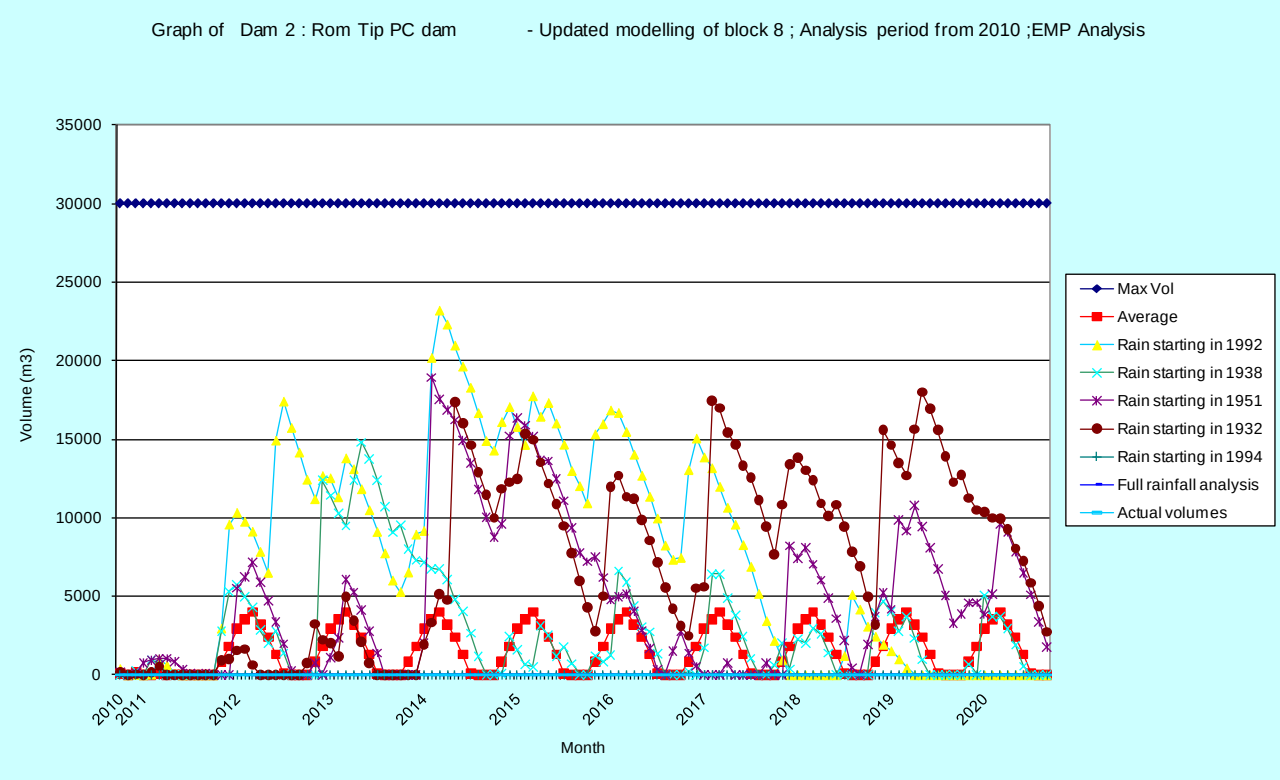


Figure 4.3.5.4(c) Storage required for the Shondoni ROM tip Pollution Control Dam

From the above figures it can be concluded that:

- Surface storage can be relatively low, provided that some levels of abstraction can be made back to underground for use in dust suppression in the workings. During the initial shaft drilling operation, there may be additional water ingress and some allowance may need to be made to remove water by tanker if required, but as soon as the site is established, the surplus water should easily be accommodated within the dust suppression requirements underground.
- The costs associated with the surface dams are not insignificant due to the relatively expensive liner system required by the authorities, and for this reason it is suggested that further optimisation may be possible at final design.

4.3.5.5 Overall management of the water balance

The following is apparent:

- The storage of water within mined out areas will be effective in managing the water make over the operational phase of the life of mine.
- This assessment is based on relatively conservative values for the recharge at high extraction areas and therefore should be conservative.
- However, there is some risk in the overall strategy in that the graph of increasing available storage and increasing water make run in parallel, so that the water balance is sensitive to possible changes such as much higher than expected water make (be it due to higher rainfall or increased recharge) or loss of storage for whatever reason (such as boreholes through compartments that result in inability to maximise the flooding of certain areas).

- The above implies that ongoing monitoring and measurement will be required to ensure that, if active treatment is required during the life of mine, this can be constructed timeously.

4.3.5.6 Salt balance

The salt balance is given below for the life of the mine. This should be seen as a provisional salt balance using the water balance in the previous sections, average rainfall, and predicted water qualities for the mining area and surface infrastructure. The balance will need to be updated once actual water qualities are measured.

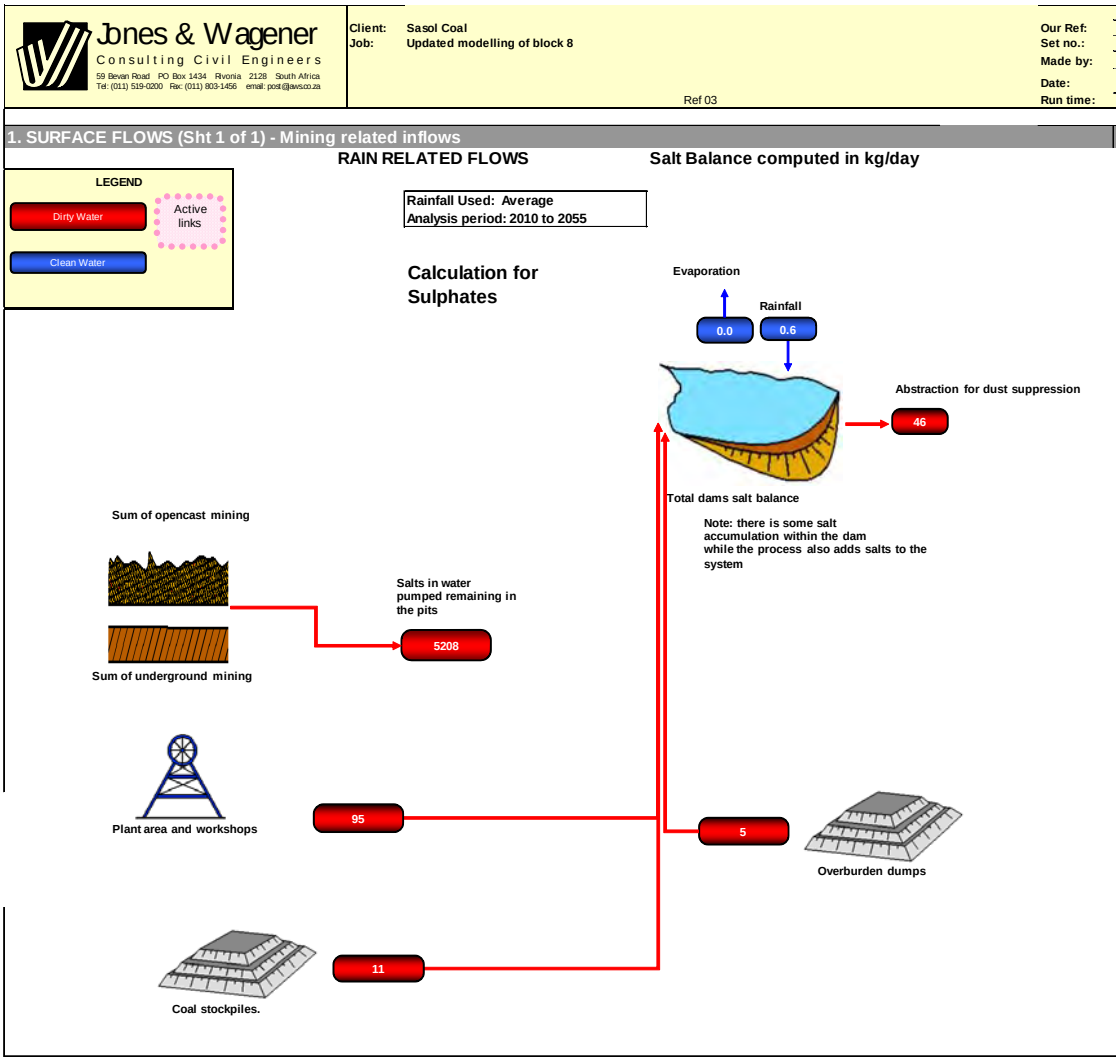


Figure 4.3.5.6(a) Salt balance over the life of mine

4.4 Project alternatives

In accordance with Section 50 (d) of the Mineral and Petroleum Resources Development Regulations, GN R527, under the MPRDA, 2002, as well as Section 32 (2) (f) of the Environmental Impact Assessment (EIA) Regulations R.385, dated April 2006 under Act 107 of NEMA, 1998 the alternatives considered in terms of minimising the impacts on surface water and the overall water balance are discussed here.

4.5 Alternatives considered during the Environment Impact Assessment (EIA) phase

Various alternatives were evaluated in terms of the overall water management, including the following issues:

Clean water management

The environmental team have made inputs to the mining alternatives in order to minimise the impacts on surface water. For Block 8 in the original design phase, this involved excluding high risk areas such as areas of rocky outcrop. With this update, inputs were largely confined to: -

- Evaluation of alternatives around the shaft location so as to minimise the impacts on the drainage line overlying the access shaft, particularly where the shaft is relatively shallow. Options were considered that involved impeding the flow of the drainage line, but the final option has largely moved away from the stream.
- Ensuring the clean areas at the plant are located on the southern side of the terrain, so that there is a natural split in terms of the direction of drainage of clean and dirty areas.

Minimising dirty water make

The minimisation of dirty water make will be achieved as follows: -

- No watercourses will be directly impacted on by the workings by ensuring high extraction is not undertaken beneath these features.
- Consideration has been given to forming compartments underground to allow storage of water within the mined out areas. By implication, the volume of water to be pumped to surface or managed on surface can be reduced by strategies such as mining uphill on the coal seam where practical, mining compartments that can be easily sealed post mining for storage of water, and delaying high extraction for as long as is practical within the mine plan. There are also advantages associated with water chemistry where mined out areas are flooded, since by excluding oxygen from these areas, the oxidation of pyrites can be significantly reduced.

Maximising the reuse of dirty water

Dirty water will be collected and stored at the PCDs for reuse as dust suppression. Dirty water will also be used at the coal crushing areas for dust suppression.

Post closure it is intended to pump water to a facility for treatment if required.

Implementing treatment where required

The treatment of water generated by mining activities is only expected post closure. The current expected time to decant is between 80 and 90 years depending on the final calibrated water balance and the actual storage available during mining.

4.5.1 Alternatives in terms of technology

- Use of Reverse Osmosis or similar technologies

As indicated previously, if the average water make is positive then over a short period of time, a significant volume of water can potentially be generated. Options to manage a surplus are numerous, including alternatives such as large surface water dams or pans with associated significant evaporative losses, irrigation with mine water, and storage underground. Of those considered:

- Storage underground has a positive benefit in terms of excluding oxygen, a major factor in the generation of acid mine drainage.
- Irrigation with mine water has the potential of reducing clean water usage from catchments for irrigation, but has not been approved by the authorities due to concerns around soil and groundwater contamination.
- Large dams constructed purely for evaporation purposes are problematic in the Highveld because the topography is not favourable, evaporative losses are not as significant as in the more arid areas, and potential concerns exist around the hazardous nature of evaporated mine water specifically if it contains elevated metals.

Because of the above and the need for potable water in the Highveld area, several water treatment plants have been constructed and are being planned to produce potable water from mine water. Should a plant be constructed, an EIA will be required for the plant, and this will be undertaken prior to construction addressing the plant, the potential waste products and the required Water Use Licences.

4.5.2 Alternatives in terms of mine plan

The options considered to exclude sensitive areas and areas of higher ingress have been described previously. While options were also considered in terms of mining uphill on the coal seam to minimise the water make from the operational phase, the shaft location has been pre-determined based on the required surface infrastructure and the significant extent of the mine. No further options have been considered at this stage.

4.5.3 Coal transportation alternatives

Given the significant distance of the shaft from the Sasol Synfuels complex, conveyors were considered the only viable and environmentally acceptable option over the life of the mine.

4.5.4 Other infrastructure alternatives

Alternatives around the infrastructure layout have been considered to minimise the dirty water footprint. Some further optimisation is likely before the final submission of the EMP document.

5 CURRENT ENVIRONMENTAL STATUS

The baseline information is important for several reasons. These include assessment of possible impacts and setting of objectives for closure. However, for surface water, it is also important that the mine is able to identify other point sources that may be impacting on surface water so that the origin of any future impacts can be identified.

AREA	DEFINITION
Shondoni mine boundary	This area includes the proposed Shondoni mining area consisting of the Shondoni Shaft, Middelbult Main Shaft, Block 8 Northern Reserves, the Springbokdraai Reserves and the Leeuwpan Reserves which is approximately 46301 ha in size.
Study area	In terms of surface water, the study area is the extent of the mining area but also extending downstream of the area to allow generation of floodlines from points where water will flow through critical depth, such as at culverts or other hydraulic constrictions.
Shondoni land use area	The Shondoni land use area includes the proposed underground mining area, and associated infrastructure area.
Area of surface disturbance	This refers to the area where the soil and vegetation will be physically disturbed due to proposed activities, i.e. the infrastructure associated with the workshops and office complex, conveyors and areas mined.
Dirty water management area	The surface area where surface water will probably be impacted upon by mining activities and thus will be retained in order to prevent spillage to the catchment.

5.1 Climate

In terms of surface water, key aspects are the rainfall, evaporation, runoff and infiltration. In terms of the water balance, the rainfall and associated infiltration are important drivers to determine the overall water balance.

5.1.1 Regional climate

The regional climate is discussed in the main EMPR.

5.1.2 Mean monthly and annual rainfall

The Daily Rainfall Extraction Utility, developed by the Institute for Commercial Forestry Research (ICFR) in conjunction with the School of Bio-resources Engineering and Environmental Hydrology (BEEH) at the University of KwaZulu-Natal, Pietermaritzburg, was used to obtain summary data for all rainfall stations within the vicinity of the proposed mine. These data were assessed in terms of length of record, completeness of the data set, mean annual precipitation (MAP) and location with respect to the site and the catchment.

Based on its proximity to the site (approximately 17 km from the centre of the Shondoni area) and its reasonable length of reliable record, station number 0478292 Langsloot was selected as the representative rainfall data set for the site. Average monthly rainfall depths are presented in **Table 5.1.2(a)**.

Table 5.1.2(a) Average monthly rainfall depths for SAWS station 0478292 Langsloot (based on the period 1914 to 2000)

Month	Average rainfall (mm)
October	73
November	111
December	113
January	118
February	87
March	79
April	37
May	19
June	6
July	6
August	9
September	21
Mean Annual Precipitation	**679.5**

5.2 Surface Water

This section defines the quantity and quality of the baseline surface water. Water quality sampling on Shodoni/Sasol Block 8 area was undertaken by Jones & Wagener in October 2002 . On the southern section of the mining area, existing data from Sasol's monitoring programme was used.

5.2.1 Surface water quantity

This section details the baseline surface water information related to water quantity, being rainfall, flood events and stream flow, in essence, the hydrology.

The drainage density of the total Shondoni mining area is given below. The values given are based on the mining area outlined on the locality plan in **Figure 5.2.1(a).**

Length of drainage paths	=	293.00 km
Proposed total mining area	=	463.01 km^2
Drainage density	=	0.63 km/km^2

5.2.1.1 Catchment boundaries

The Shondoni mining area is located in the Waterval River catchment within quaternary sub-catchment C12D of the Vaal Primary Drainage region **Figure 5.2.1.1(a)** taken from *"Surface Water Resources of South Africa – 1990"* Vol II (*Midgley, Pitman & Middleton, 1995*) (WR90)). The Waterval river catchment forms part of the Upper Vaal Water Management Area (WMA) number 10. This can be seen in **Figure 5.2.1.1(b)**.

Figure 5.2.1(a) Locality Plan

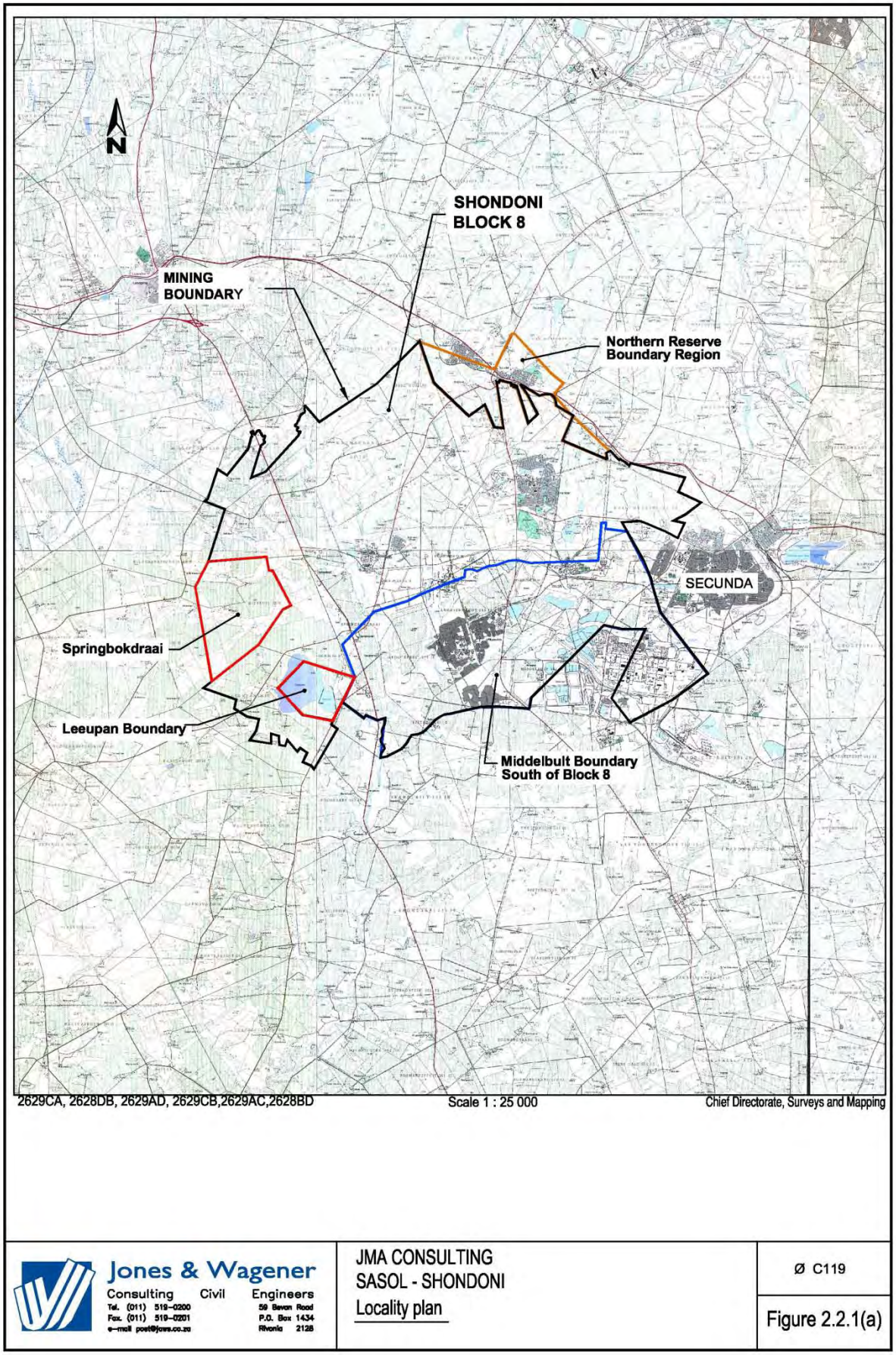
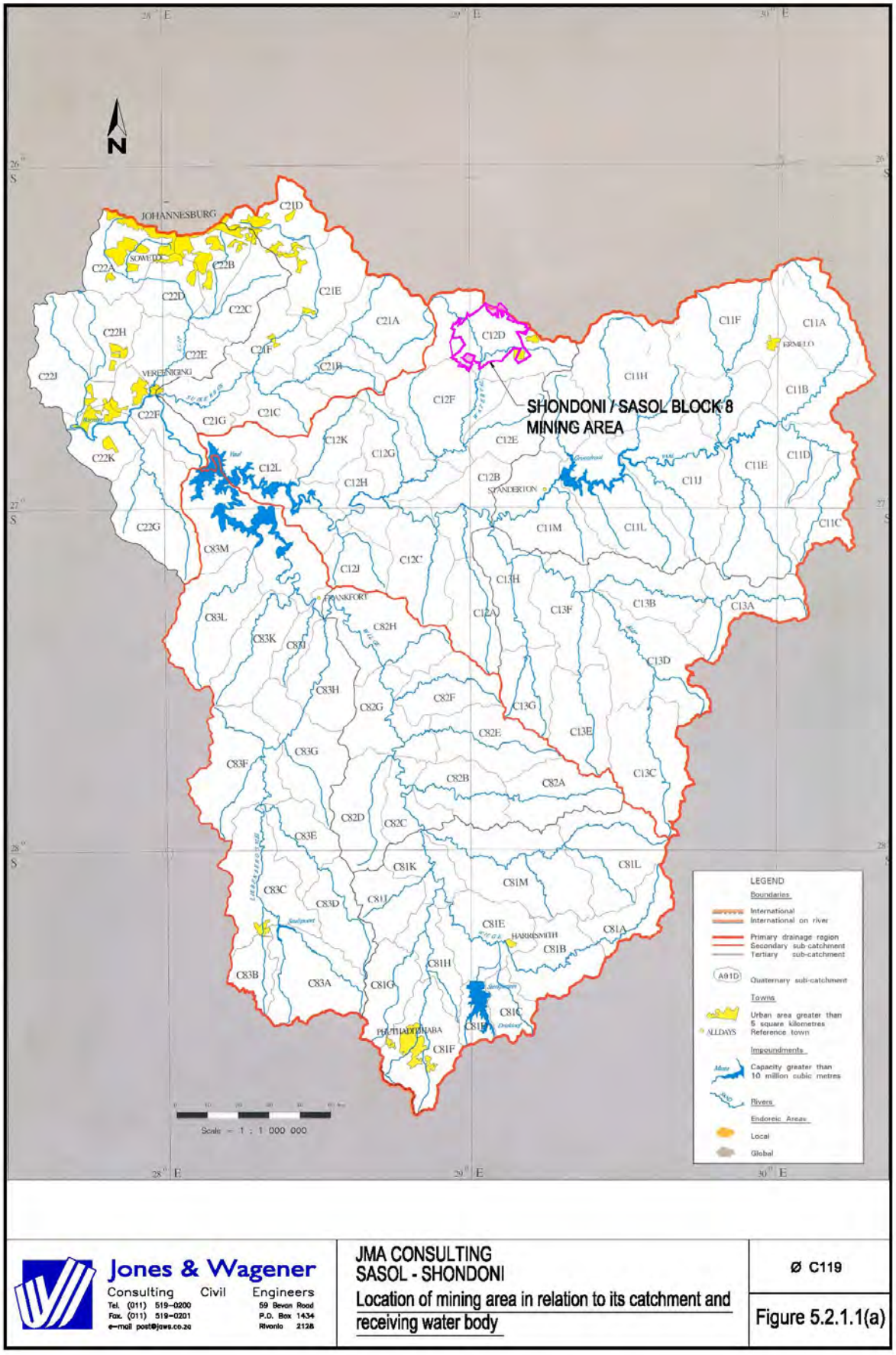


Figure 5.2.1.1(a) Quaternary Sub-catchments and Boundaries



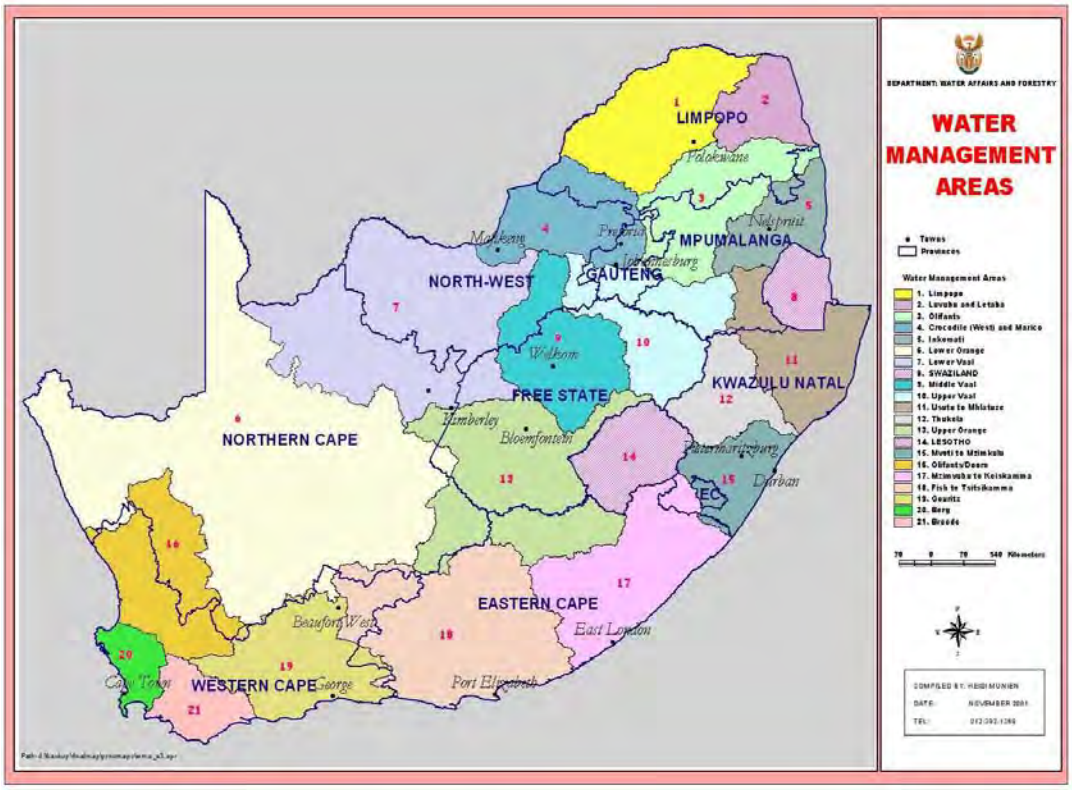


Figure 5.2.1.1 (b) Water Management Areas

(Department Water Affairs : Water Quality Status Report: Upper Vaal Management Area, 2000-2005, R.Munnik)

The Shondoni mining area includes portions of the farms Kromdraai 128 IS, Leeuwpan 532 IR, Rietkuil 531 IR, Grootspruit 279 IS, Rietkuil 283 IS, Langverwacht 282 IS, Winkelhaak 135 IS, Driefontien 137 IS, Kinross 133 IS, Ruigtekuilen 129 IS and Brakspruit 359 IR.

The mining area is drained by the Grootspruit, Winkelhaakspruit, and Trichardtspruit, which join the Waterval River upstream of the confluence with the upper Kaalspruit. The Waterval River eventually drains to the Vaal River upstream of the Vaal dam, from where the stream flows in a westerly direction to the Vaal barrage, Bloemhof Dam, eventually joining the Orange River, which flows into the Atlantic Ocean on the west coast of South Africa.

5.2.1.2 Receiving water body

In terms of the catchment description, the receiving water body is an important concept. The receiving water body is the point below which the mine's impact on the catchment is considered to be negligible. This implies that aspects such as surface water users need only be defined down to the receiving water body.

The receiving water body for the assessment of potential surface water quality impacts of the mine is taken as the Vaal Dam.

The use of this location is motivated on the basis that:

- By implication, potential impacts on the Vaal dam will be included in the impact assessment.
- Further, by the time the water reaches the receiving water body, it is required to be suitable for use for all of the expected uses (drinking water, agricultural, industrial and aquatic ecosystems). Thus, by achieving compliance in terms of these, no additional impacts are expected downstream of the receiving water body. The receiving water body is relevant only in so far as it defines the aerial extent of the catchment to be considered in the impact assessment, and described in the baseline study.
- Beyond the Receiving Water Body the potential impact of the mine becomes extremely small due to the water volumes in the catchment and dilution effects.
- In terms of impact assessment, the total mining area is small compared to the receiving water body catchment. The mining area is estimated at some 463 km^2, compared to a catchment of approximately 38500 km^2 for the Vaal River to the Vaal Dam (or some 1.2% of the catchment area).

The MAR for the Vaal River at the Vaal Dam 1929 x 10^6 m^3, while the MAR for the mine area is estimated at 27.05 x 10^6 m^3.

5.2.1.3 Mean Annual Runoff (MAR)

The MAR for the various sub-catchments was computed using the WRSM90 synthetic streamflow generation model. This software utilises rainfall and evaporation data, together with a number of parameters that characterise the catchment, to compute synthetic monthly streamflow data from monthly rainfall data. The Langsloot rainfall station (0478292) was used in the simulations. The catchment parameters, as published in WR90 were used in the computations.

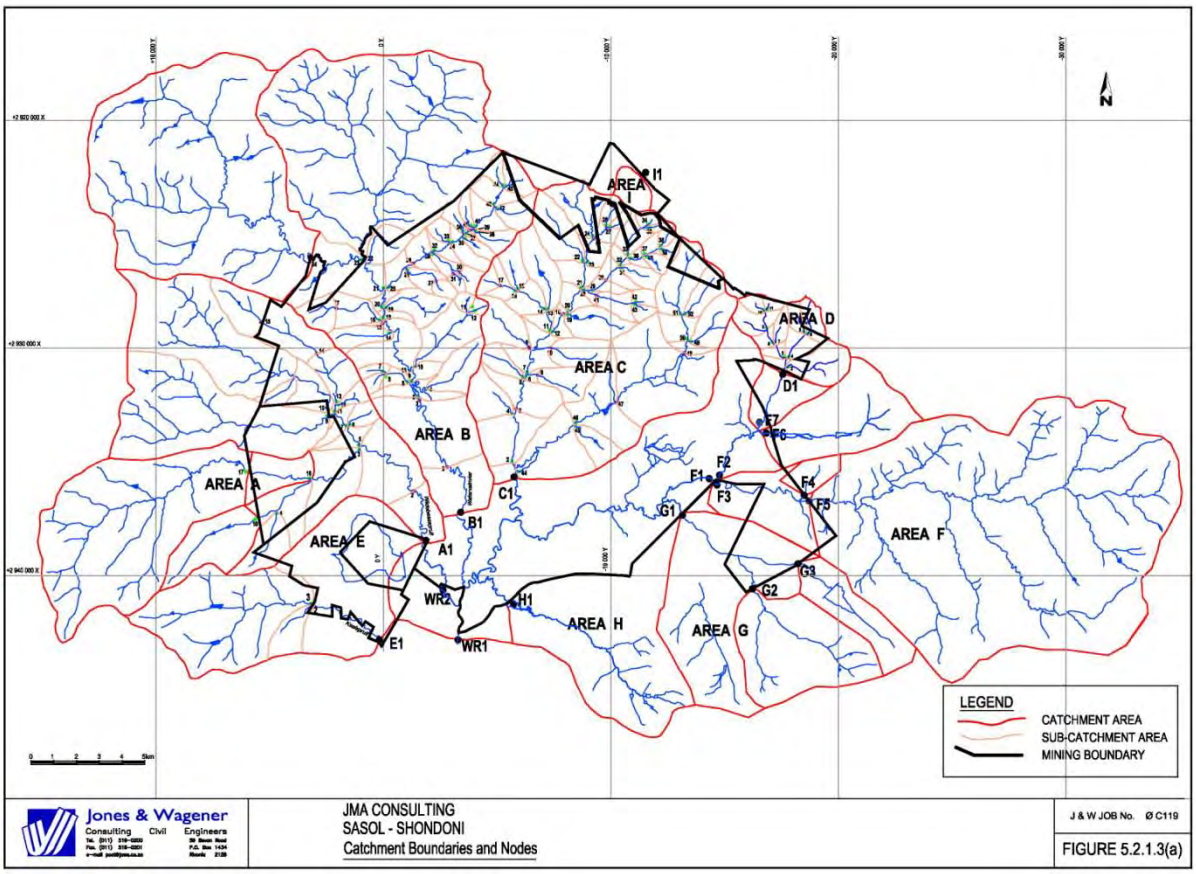
The results of the modelling are shown in **Table 5.2.1.3(a)**. The catchments and nodes are shown in **Figure 5.2.1.3(a)**.

Table 5.2.1.3(a) Mean Annual Runoff (MAR) for the Shondoni /Sasol Block 8 mining area

Catchment		Catchment Area (km^2)	MAR ($x10^6m^3$)	% of MAR at Vaal Dam
Area A Western portion of the mining area (Wildebeestspruit, Rietkull and Brakspruit).	Node A1	153.7	8.98	0.47
	Node A3	72	4.22	1.22
	Node A8	28.1	1.65	0.086
	Node A15	3.9	0.23	0.012
	Node A17	27.9	1.63	0.085
	Node A18	69	4.04	0.21
Area B Slightly west of the main mining area in the confluence of Brakspruit and Springbokdraai.	Node B1	221.3	12.92	0.67
	Node B22	67.7	3.97	0.21
	Node B23	81.5	4.78	0.25
	Node B45	1.7	0.1	0.0052

Catchment		Catchment Area (km^2)	MAR ($x10^6m^3$)	% of MAR at Vaal Dam
Area C Central mining area on Zandfontein and Brakspruit.	Node C1	109.4	6.39	0.33
	Node C2	66.4	3.89	0.2
	Node C23	7.3	0.43	0.022
	Node C33	2.7	0.16	0.008
	Node C44	42.2	2.47	0.13
Area D Easterly extreme of the Block 8 mining area.	Node D1	12.9	0.74	0.04
	Node D2	3.7	0.21	0.01
	Node D6	1.4	0.08	0.004
Area E South west catchment downstream of mining area on the Leeuwpan.	Node E1	53.5	3.12	0.16
	Node E2	2.5	0.15	0.008
	Node E3	24.3	1.43	0.074
Area F North west of the mining area on Trichardspruit	Node F1	191.93	11.23	0.58
	Node F2	154.6	9.04	0.47
	Node F3	37.33	2.18	0.11
	Node F4	2.7	0.16	0.008
	Node F5	141.78	8.29	0.43
	Node F7	5.96	0.35	0.018
	Node F8	17.64	1.03	0.053
Area G South east of the mining area	Node G1	65.2	3.81	0.20
	Node G2	21.9	1.28	0.066
	Node G3	9.51	0.56	0.029
Area H Southern tip of the mining area	Node H1	28.28	1.65	0.086
Area I Northern Tip of the mining area	Node I1	2.48	0.15	0.008
On the Southern tip of the watervalrivier just out side the mining area	Node WR1	864.72	50.58	2.62
	Node WR2	157.38	9.21	0.48
Entire Mine Boundary		463.01	27.05	1.40

Figure 5.2.1.3(a) Catchment Boundaries and Nodes



5.2.1.4 Dry weather flow

In the absence of any streamflow monitoring, the conventional approach to compute the dry weather flow (also often termed "normal flow") is to analyse the long term synthetic monthly streamflow time series in order to develop a flow-duration relationship. An accepted definition of the dry weather flow in a stream is that flow in the stream that is equalled or exceeded for 70% of the time, a value which can readily be ascertained from an analysis of the flow-duration relationship.

The WRSM90 Model was used to determine monthly flows for the associated catchments for the Block 8 site. Again, the langsloot rain gauge (0478292) was used for the runoff simulations. The monthly flow exceeded in 70% of all months modelled is shown in **Table 5.2.1.4(a).** The catchments and nodes are shown in **Figure 5.2.1.3(a)**.

Table 5.2.1.4(a) Computed dry weather flows for the Shondoni /Sasol Block 8 Mining area

River	Point of Measurement (nodes)	Computed monthly flow exceeded in 70% of months modelled (x 10^6 m^3/s)	Computed DWF (l/s average over month)
Wildebeestspruit	A1	0.02	7.72
Waterval	B1	0.03	11.57
Grootspruit	C1	0.01	3.86
Trichardtspruit	D1	0.00*	0.00
Kaalspruit	E1	0.01	3.86
Klipspruit	F1	0.02	7.72
Waterval River	WR1	0.07	27.00

Note: * denotes DWF less than 0.01 X $10^6 m^3$ per month

Flood peaks and volumes

Several points of interest, or nodes, were identified for peak flow calculations. These were located where streams enter and exit the mining area, and are indicated on **Figure 5.2.1.3(a)**. Catchment areas and slopes were determined from the 1:50 000 topograpical map, published by the chief directorate, surveys and mapping. The reference numbers for the maps are 2628 DB, 2628DB,2629 AC, 2629 CB, 2629 CA and 2629 AD.
There are a multitude of methods available for the determination of peak flows. The methods used were the Rational method, the Standard Design Flood (SDF) method (Alexander, 2002), the Regional Maximum Flood (RMF) method (kovacs, 1988) and the Direct Run-off Hydrograph (DRH) method.

The peak flows calculated using each method were evaluated for each node and a representative value adopted. The computed peak flows and volumes are given in **Table 5.2.1.5(a)**.

Table 5.2.1.5(a) Flood peaks and flood volumes for Shondoni /Sasol Block 8 mining area

Catchment	Node	Area (km^2)	Recurrence Interval	Flood Peaks (m^3/s)	Flood Volume (m^3x10^6)
A Western portion of the mining area(Wildebeestspruit, Rietkull).	A1	153.7	20 year	169	6.3
			50 year	221	8.2
			100 year	308	11.5
			RMF	726	27
	A3	72	20 year	119	2.9
			50 year	159	3.9
			100 year	220	5.5
			RMF	508	12.6
	A8	28.1	20 year	77	1.07
			50 year	105	1.46
			100 year	145	2.02
			RMF	355	4.95
	A15	3.9	20 year	31	0.127
			50 year	45	0.184
			100 year	61	0.25
			RMF	168	0.69
	A17	27.9	20 year	77	1.06
			50 year	113	1.56
			100 year	142	1.96
			RMF	354	4.89
	A18	69	20 year	122	2.96
			50 year	176	4.27
			100 year	222	5.38
			RMF	500	12.12

Catchment	Node	Area (km^2)	Recurrence Interval	Flood Peaks (m^3/s)	Flood Volume (m^3x10^6)
B Slightly west of the main mining area in the confluence of Brakspruit and Springbok-draai.	B1	221.3	20 year	200	8.8
			50 year	251	11.05
			100 year	361	15.8
			RMF	884	38.91
	B22	67.7	20 year	116	2.78
			50 year	154	3.70
			100 year	214	5.14
			RMF	496	11.9
	B23	81.5	20 year	126	3.40
			50 year	167	4.50
			100 year	232	6.25
			RMF	532	14.34
	B45	1.7	20 year	21	0.051
			50 year	31	0.076
			100 year	42	0.1
			RMF	123	0.3
C Central mining area on Zandfontein and Brakspruit.	C1	109.4	20 year	145	4.61
			50 year	190	6.04
			100 year	265	8.42
			RMF	605	19.23
	C1	109.4	20 year	145	4.61
			50 year	190	6.04
			100 year	265	8.42
			RMF	605	19.23
	C2	66.4	20 year	115	2.72
			50 year	153	3.62
			100 year	212	5.02
			RMF	493	11.67
	C23	7.3	20 year	42	0.25
			50 year	59	0.36
			100 year	80	0.48
			RMF	213	1.29
	C33	2.7	20 year	26	0.08
			50 year	38	0.125
			100 year	51	0.167
			RMF	146	0.48
	C44	42.2	20 year	93	1.66
			50 year	126	2.25
			100 year	174	3.11
			RMF	414	7.41
D Easterly extreme of the Shondoni mining area.	D1	12.9	20 year	54	0.46
			50 year	75	0.64
			100 year	103	0.88
			RMF	264	2.28
	D2	3.7	20 year	30	0.115
			50 year	43	0.165
			100 year	59	0.23
			RMF	164	0.63
	D6	1.4	20 year	20	0.042
			50 year	29	0.06
			100 year	39	0.081

Catchment	Node	Area (km^2)	Recurrence Interval	Flood Peaks (m^3/s)	Flood Volume (m^3x10^6)
			RMF	115	0.24
E Southwest catchment downstream of mining area on Leeuwpan.	E1	53.5	20 year	104	2.15
			50 year	139	2.87
			100 year	193	3.99
			RMF	454	9.39
	E2	2.5	20 year	26	0.08
			50 year	37	0.12
			100 year	50	0.158
			RMF	142	0.45
	E3	24.3	20 year	72	0.92
			50 year	99	1.26
			100 year	136	1.74
			RMF	336	4.29
F North west of the mining area on Trichardspruit	F1	191.9	20 year	207	8.52
			50 year	298	12.26
			100 year	378	15.55
			RMF	819	33.69
	F2	154.6	20 year	170	6.32
			50 year	243	9.04
			100 year	308	11.46
			RMF	729	27.12
	F3	37.3	20 year	104	1.72
			50 year	157	2.59
			100 year	198	3.27
			RMF	396	6.54
	F4	2.7	20 year	25	0.08
			50 year	38	0.12
			100 year	48	0.16
			RMF	146	0.48
	F5	141.8	20 year	181	6.48
			50 year	258	9.23
			100 year	327	11.70
			RMF	695	24.87
	F7	5.96	20 year	36	0.30
			50 year	53	0.45
			100 year	68	0.58
			RMF	124	1.05
	F8	17.6	20 year	78	0.81
			50 year	121	1.25
			100 year	157	1.63
			RMF	298	3.09
G South west of the mining area	G1	65.2	20 year	145	3.39
			50 year	205	4.79
			100 year	257	6.01
			RMF	489	11.43
	G2	21.9	20 year	81	0.96
			50 year	117	1.39
			100 year	147	1.75
			RMF	323	3.84
	G3	9.51	20 year	37	0.26

Catchment	Node	Area (km^2)	Recurrence Interval	Flood Peaks (m^3/s)	Flood Volume (m^3x10^6)
			50 year	57	0.41
			100 year	71	0.51
			RMF	235	1.68
H Southern tip of the mining area	H1	28.3	20 year	82	1.14
			50 year	120	1.67
			100 year	151	2.10
			RMF	356	4.95
I Northern Tip of the mining area	I1	28.3	20 year	28	0.09
			50 year	45	0.14
			100 year	57	0.18
			RMF	141	0.45
WR On the Southern tip of the Waterval Rivier just out-side the mining area	WR1	864.7	20 year	482	39.62
			50 year	706	58.03
			100 year	889	73.08
			RMF	1846	151.74
	WR2	157.4	20 year	157	5.89
			50 year	227	8.52
			100 year	286	10.74
			RMF	736	27.63

Note: The values given in the tables above were determined using Regional Maximum Flood factored as per Kovacs (TR 137). In order to determine the flood volumes, the floods were factored down from the Regional Maximum Flood (RMF). It was assumed that this flood would have a volume of the order of 2 to 3 times the MAR.

5.2.1.5 Floodlines

1:50 and 1:100 year Floodlines were determined for the Shondoni/Sasol Block 8 mining area in October 2002, Report No.: JW98/02/8068. These can be seen in **Figures 5.2.1.6 (a-g)**.

5.2.1.6 Watercourse alterations

No physical watercourse alterations have been planned. The proposed mine plan indicates that some streams will be undermined and therefore an exemption will be required in terms of GN704 for undermining of streams.

Figure 5.2.1.6(a) Middelbult Block 8/ Shondoni Floodlines: Catchment Area A

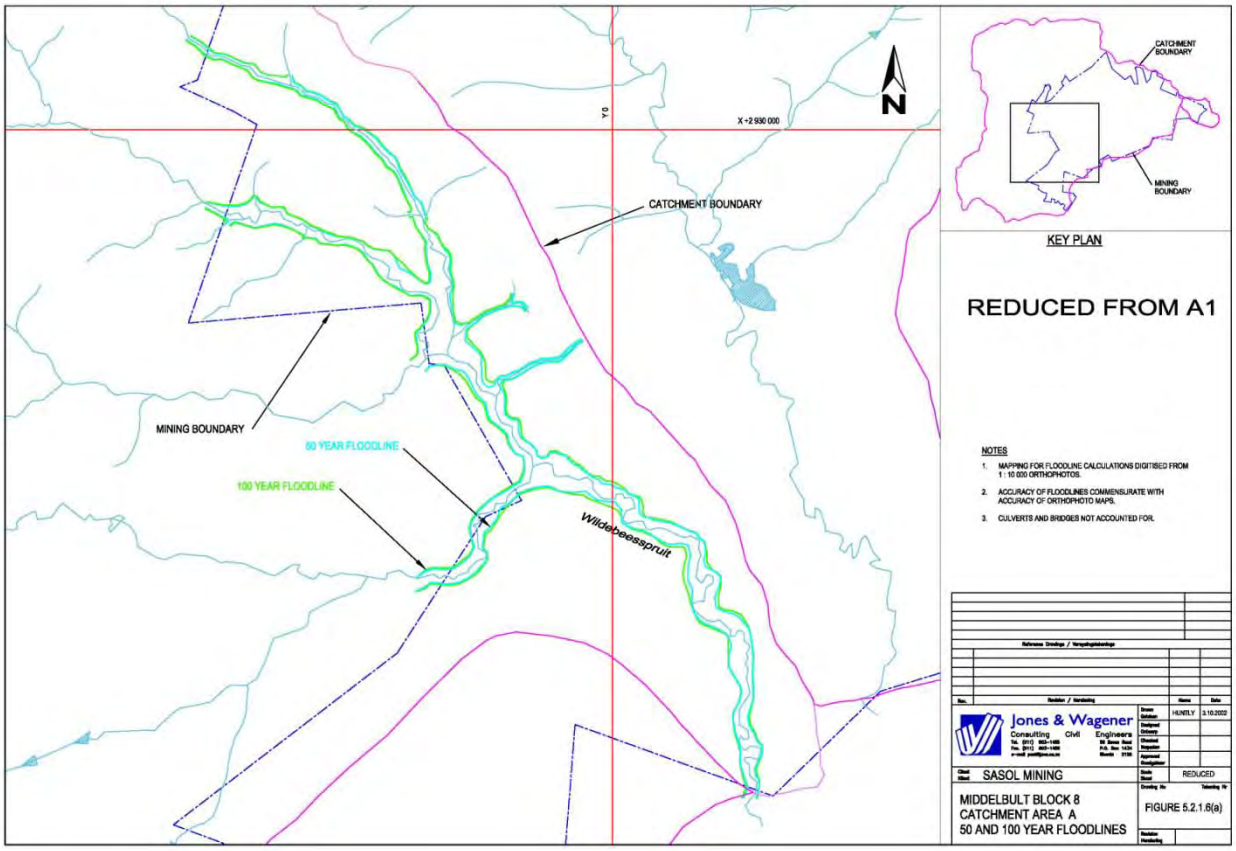


Figure 5.2.1.6(b) Middelbult Block 8/ Shondoni Floodlines: Catchment Area B South

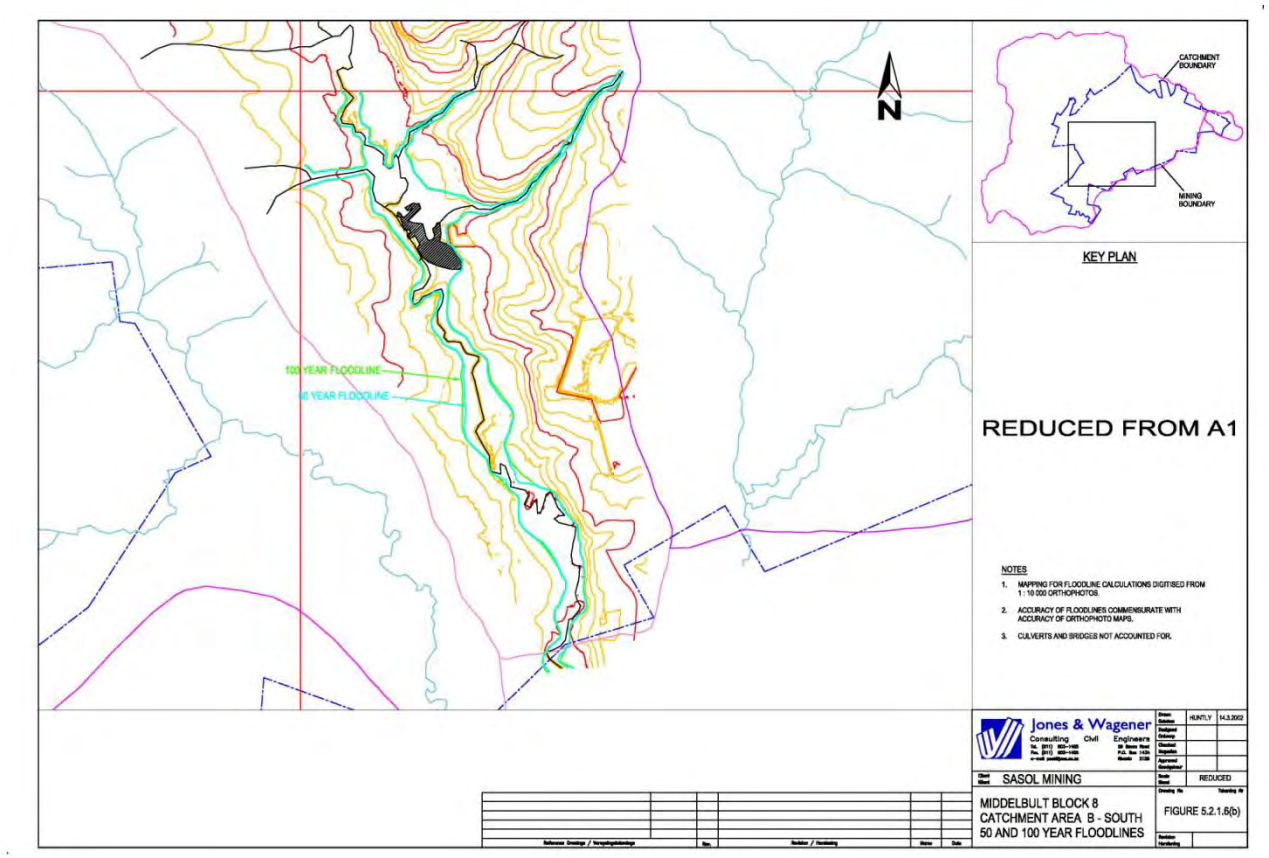


Figure 5.2.1.6(c) Middelbult Block 8/ Shondoni Floodlines: Catchment Area B North

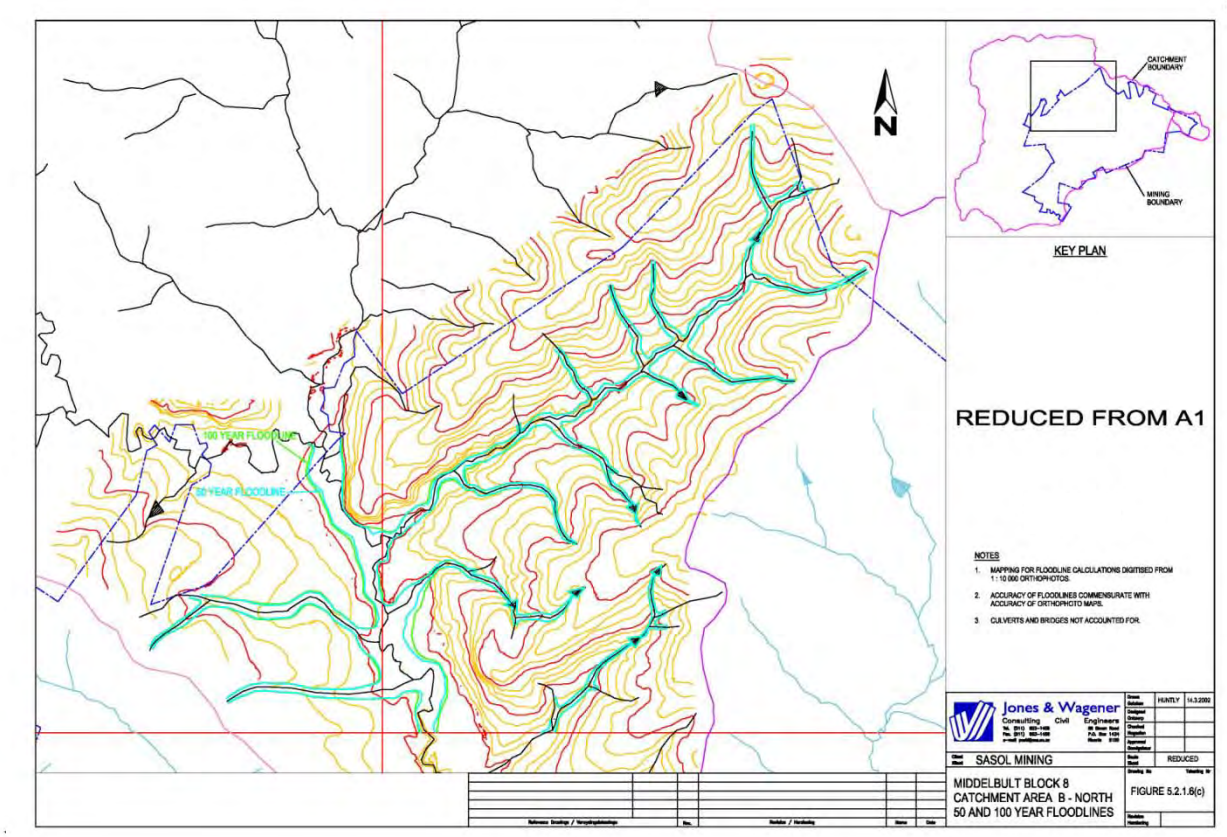


Figure 5.2.1.6(d) Middelbult Block 8/ Shondoni Floodlines: Catchment Area C South

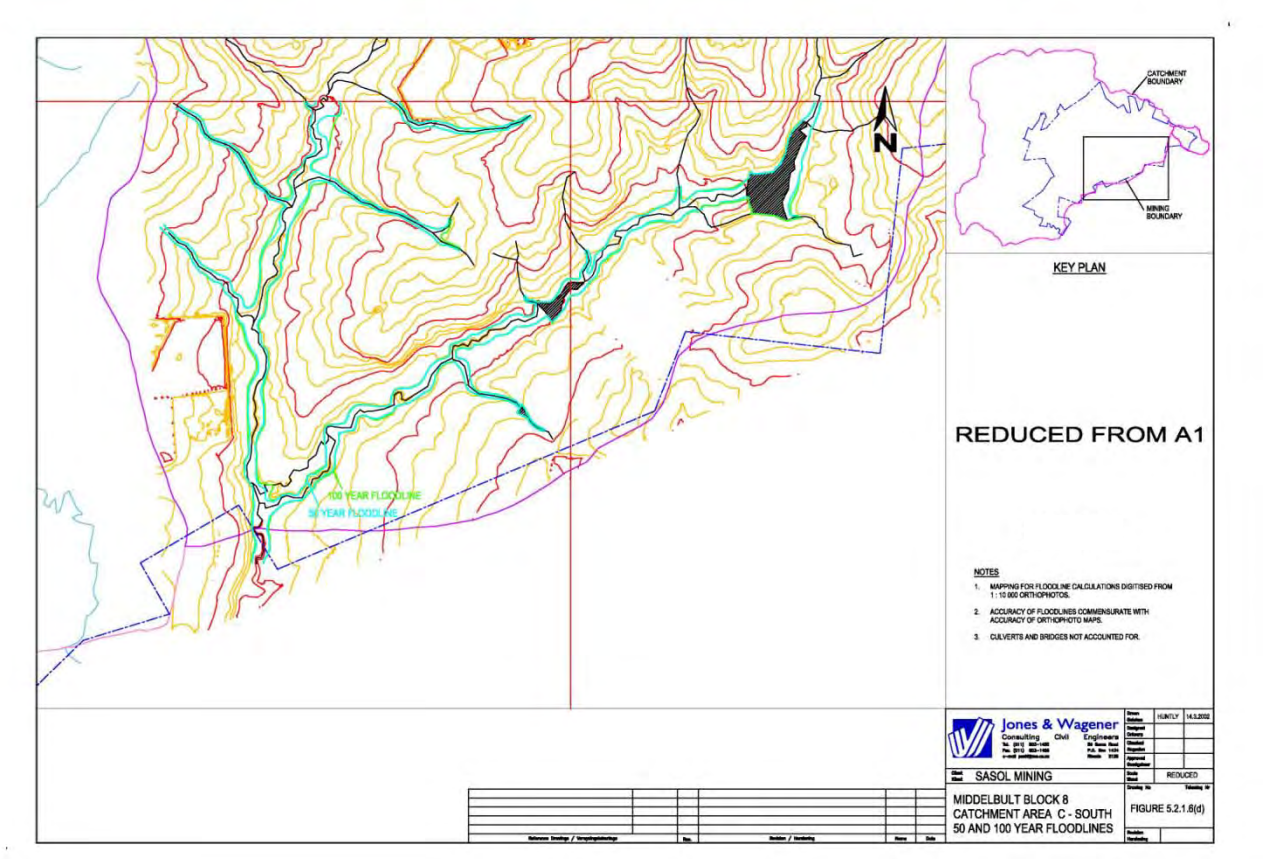


Figure 5.2.1.6(e) Middelbult Block 8/ Shondoni Floodlines: Catchment Area C North

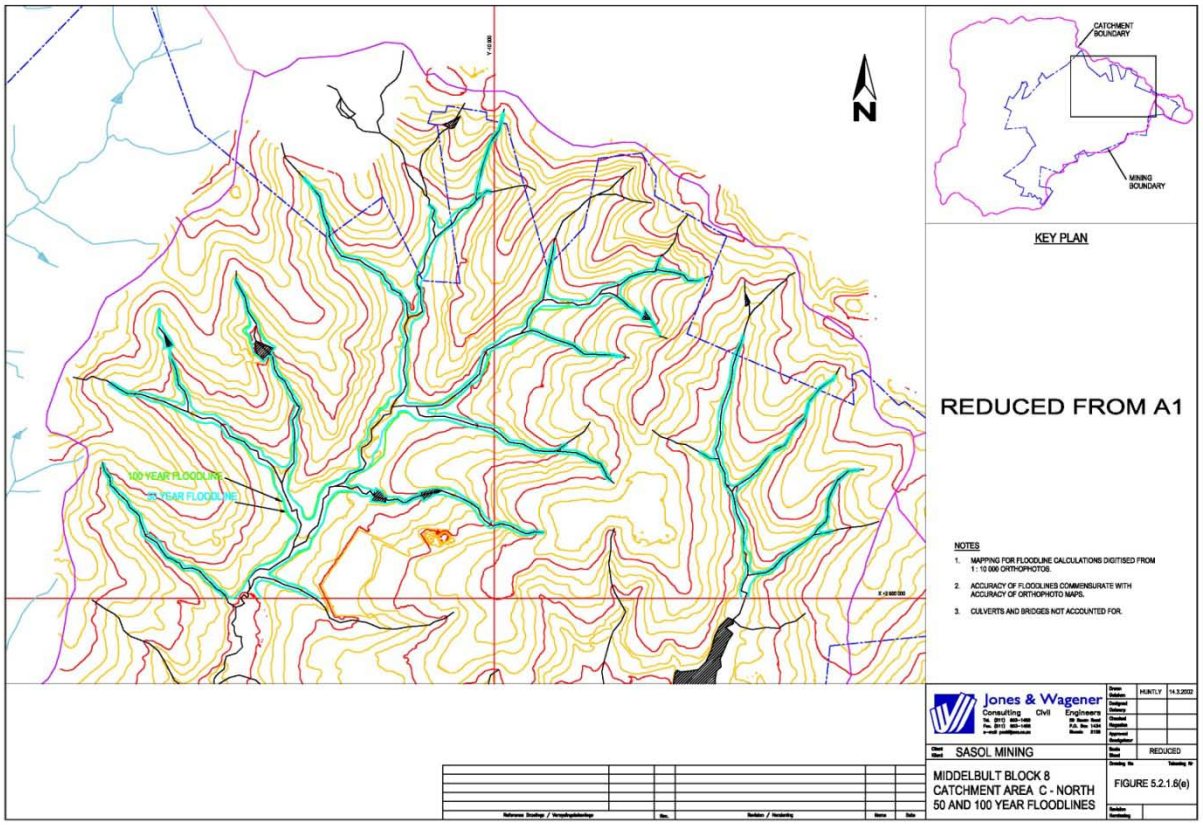


Figure 5.2.1.6(f) Middelbult Block 8/ Shondoni Floodlines: Catchment Area D

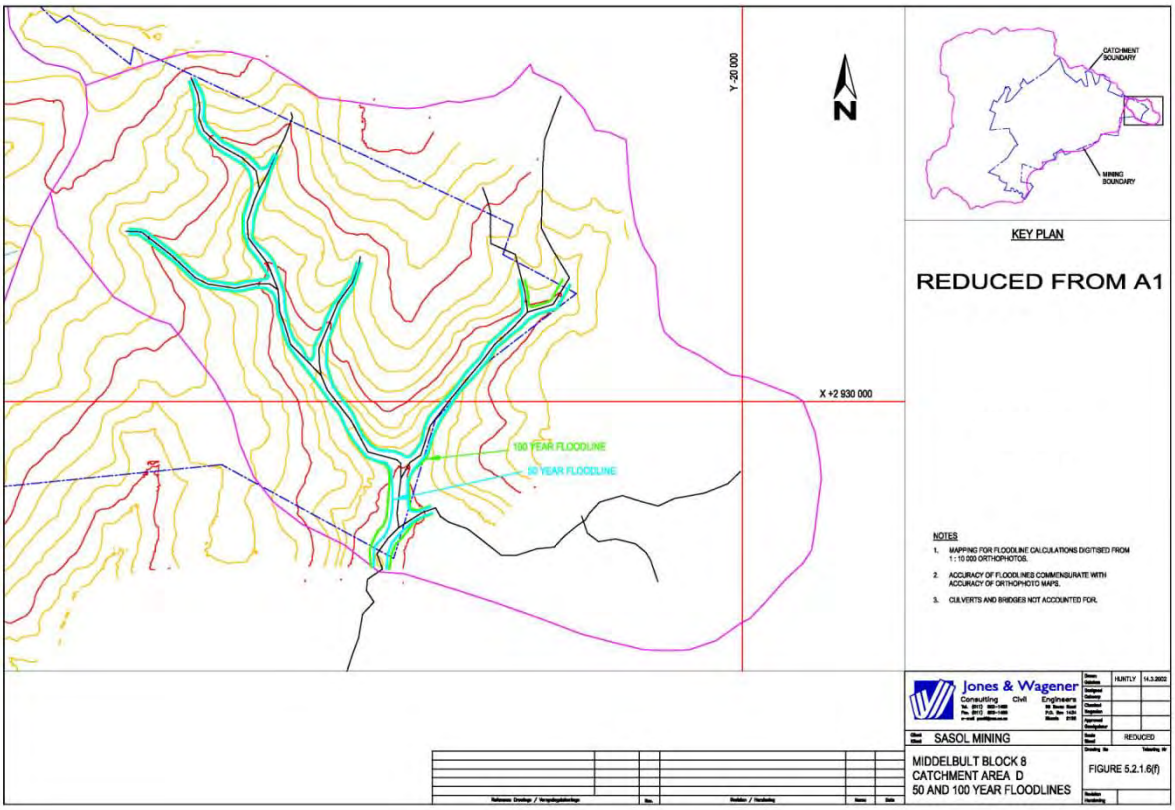
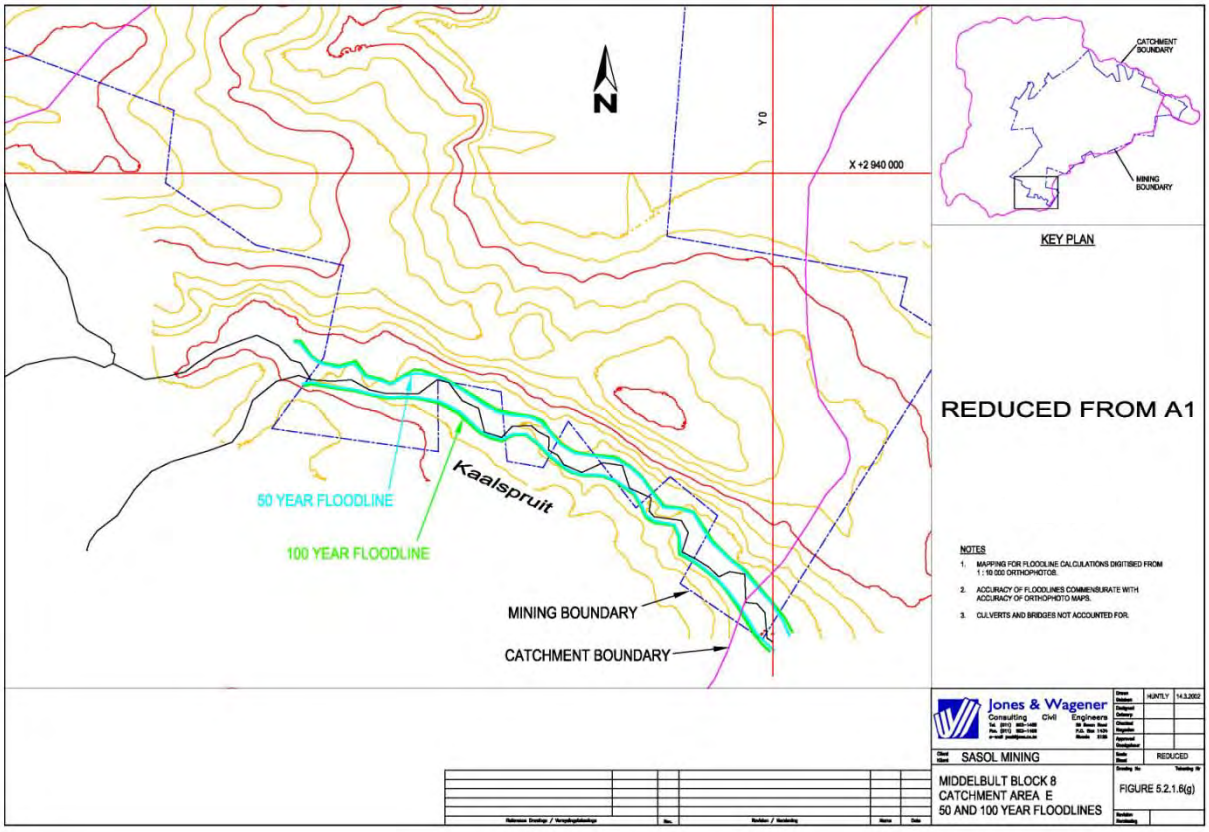


Figure 5.2.1.6(g) Middelbult Block 8/ Shondoni Floodlines: Catchment Area E



5.2.2 Surface water quality

Water quality sampling for the Sasol Block 8 mining area was undertaken by Jones & Wagener in October 2002 at the following locations:

- In the Kaalspruit, downstream of the mining area and upstream of the confluence with the Watervalrivier on the farm Roodebank 323 IS (sampling location B1)
- In the Watervalrivier, downstream of the mining area and upstream of the confluence with the Kaalspruit on the farm Vaalbank 280 IS. (sampling location B2)
- In the Kaalspruit immediately upstream of the mining area on the farm Kaalspruit 528 JR. (sampling location B3)
- In a tributary of the Wildebeestspruit, upstream of the mining area on the farm 527 IR(sampling location B4)
- In the Wildebeestspruit, upstream of the mining area on the farm Wildebeestspruit 356 IR. (sampling location B5)
- In the tributary to the south of the Wildebeestspruit, draining into the Wildebeestspruit, upstream of the mining area on the farm Wildebeestspruit 356 IR. (sampling location B6)

Surface water sampling is also undertaken by Sasol Chemical Industries, DWA and active mines in the area at the following locations:

- In the Kleinspruit downstream of the Sasol Secunda Industrial and Mining Complex. (sampling location RESM1)
- In the Trichardspruit downstream of Secunda. (sampling location RESM5)
- Upstream of the Bossiespruit Dam(sampling location RESM 20)
- In the Waterval river downstream of the confluence with the Kaalspruit and downstream of the mining area. (sampling location LM2,LM4,KM 6, KM4)
- In the Grootspruit to the west of Evander. (sampling location KM6)
- In the Waterval River, both upstream and downstream of Leslie Gold Mine. In the Winkelhaakspruit, downstream of the Evander Sewage treatment works. (sampling location LM 4, LM2)

The sampling locations are shown in **Figure 5.2.2 (a)** and detailed in **Table 5.2.2.2(a)** overleaf.

5.2.2.1 Surface water analysis

The results for the pre-mining background water quality, were compared to the South African Water Quality Guidelines and catchment objectives (DWAF, 1996a) as presented in **Table 5.2.1(a)**. In addition, the Water Quality Guideline values (DWAF, 1998) are included in **Table 5.2.2.2(a)** also for comparison.

However, due to the location of the site falling within the Vaal Dam sub-catchment area, as defined by DWAF (1999), *catchment specific* water quality objectives for certain constituents, namely EC and TDS are available and results have been compared with these values as seen in **Table 5.2.1(b)**. The catchment specific water quality guidelines are similar to the South African Water Quality Guidelines; they differ in that, the *catchment specific* water quality guidelines are more stringent for particular

constituents than the DWAF Domestic water quality guidelines. This can be seen by comparing **Tables 5.2.1(a) and (b)**.

The analyses indicates that: -

- The water draining upstream of the Block 8 mining complex in the confluence of Wildebeestspruit and the Kaalspruit contains elevated iron and manganese (even after filtering) and this may affect sensitive groups. The variation in the upstream concentrations compared to the downstream concentrations is small.
- The water draining southwards is considered fit for aquatic use.
- The pH value of the drainage basin shows a slightly high value of 7.7 to 8.3, probably due to the elevated levels of calcium.
- Sampling also indicated aluminium (Al) and Iron (Fe) to be above the limit required for drinking purposes according to Water Quality Guideline values (DWAF, 1998).
- TDS values in the area are generally above the target levels for the catchment.
- EC values in the area are above the target levels as indicated in **Table 5.2.1(b).**

Table 5.2.1(a) South African Water Quality Guidelines (DWAF, 1996)

CONSTITUENT	WATER QUALITY GUIDELINE VALUE FOR:					
	AQUATIC ECOSYSTEMS	DOMESTIC	RECREATION (FULL CONTACT)	INDUSTRY (CAT. 3)	AGRICULTURE	
					LIVESTOCK	IRRIGATION
pH	within 5% or 0.5 units of background	6 - 9	6.5 - 8.5	6.5 - 8.0	NA	6.5 - 8.4
EC (mS/m)**	-	-	-	-	-	-
SO_4	NA	0 - 200	NA	0 - 200	0 - 1000	NA
TDS	within 15% of background	0 - 450	NA	0 - 450	0 – 1000 *	< 40
V	NA	0 - 0.1	NA	NA	0 - 1	0 - 0.10
Cl	NA	0 - 100	NA	0 - 100	0 – 1500 *	0 - 1.00
Alkalinity	NA	NA	NA	0 - 300	NA	NA
Ca	NA	0 - 32	NA	NA	0 - 1000	NA
Mg	NA	0 - 30	NA	NA	0 - 500	NA
Na	NA	0 - 100	Na	NA	0 - 2000	< 70
Fe	NA	0 - 0.1	NA	0 - 0.3	0 - 10	0 - 5
F	< 0.75	0 - 1	NA	NA	0 - 2	0 - 2
Mn	< 0.18	0 - 0.05	NA	0 - 0.2	0 - 10	0 - 0.02
K	NA	0 - 50	NA	NA	NA	NA

NA - Not Available

**** Most stringent guideline taken (dairy, pigs and poultry)***

*****The potable water standard for EC is 70mS/m (Quality of Domestic Water Supplies, 1998)***

Table 5.2.1 (b) South African Water Quality Guidelines (DWAF, 1999)

Constituent	Water Quality Guideline value
TDS	160-170mg/l
EC	25mS/m

5.2.2.2 Surface water monitoring results

The surface water monitoring results are shown in Table 5.2.2.2(a) overleaf.

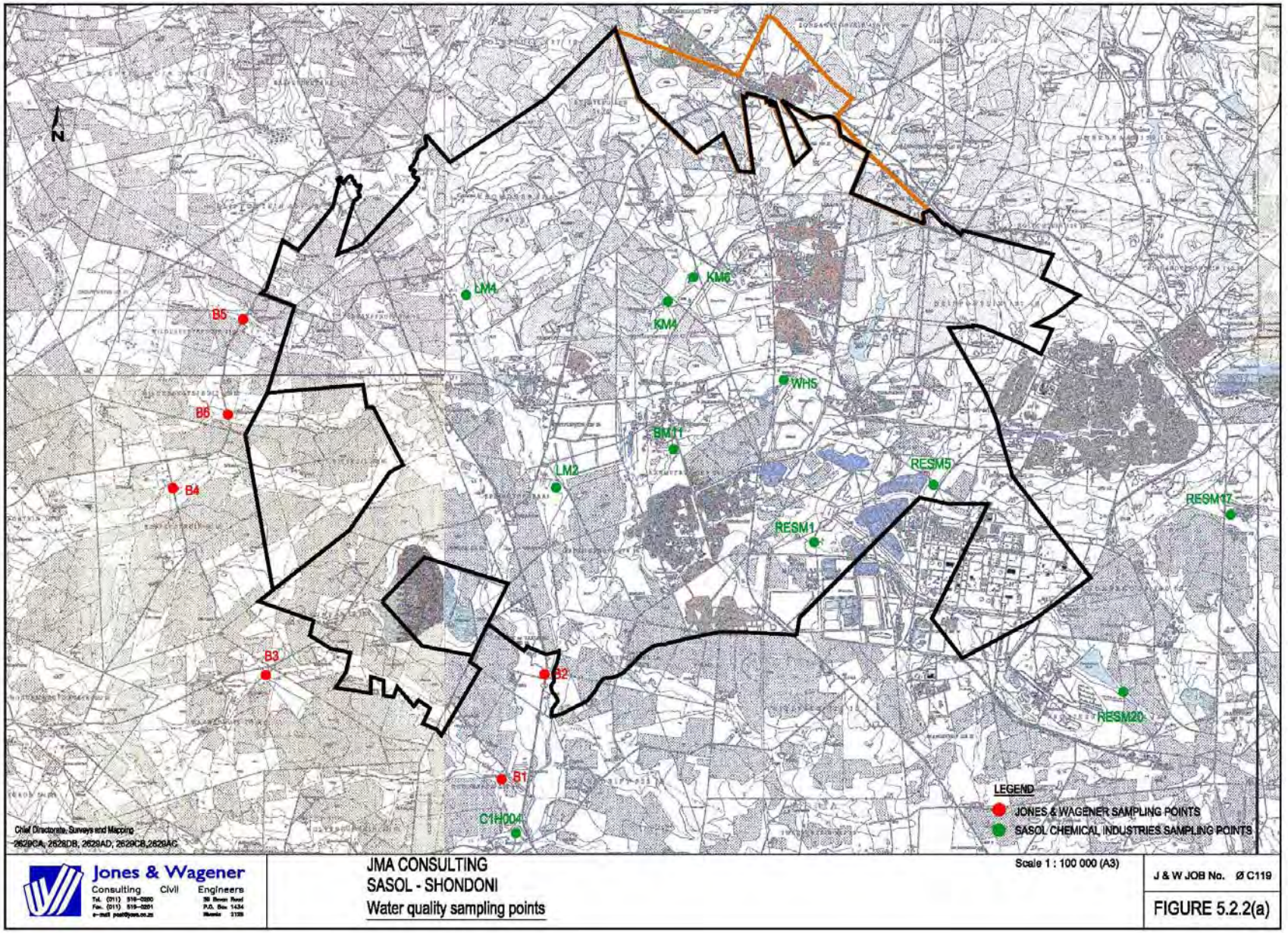
Table 5.2.2.2(a) Pre-mining water quality of rivers draining over the Shondoni /Sasol Block 8 mining area.

Sample	Guideline for domestic water use (DWAF, 1998)	B1 Downstream of mining area on the Kaalspruit		B2 Downstream of the mining area on the Watervalrivier		B3 Upstream of the mining area on the Kaalspruit		B4 Upstream of the mining area on the farm 527IR		B5 Upstream of mining area on the Wildebeestspruit		B6 Upstream of mining area on a tributary of the Wildebeestspruit	
pH Ave	5-9.5	7.9		7.8		7.7		8.3		8.0		8.1	
Min-Max		7.3-8.4		7.4-8.3		7.2-8.1		7.4-8.9		7.6-8.4		7.6-8.6	
Coeff of Var. (%)		7.1		5.2		4.9		7.7		4.3		6.2	
EC (mSm) Ave	150	39.3		40.1		35.2		46		59.7		59.7	
Min-Max		20.1-50.6		25.8-51.2		27-43.1		29.8-53.4		51.5-65.0		53.3-70.1	
Coeff of Var. (%)		35		28.8		19.9		24.1		9.7		15.2	
Fe (mg/l) Ave	0.2	Filt. 0.52	Unfilt 0.89	Filt. 0.15	Unfilt 1.11	Filt. 0.81	Unfilt 1.97	Filt. 0.34	Unfilt. 0.76	Filt. 0.08	Unfilt. 0.37	Filt. 0.34*	Unfilt 0.85
Min- Max		0.14-0.91	0.35-1.78	0.12-0.18	0.49-1.58	0.71-0.97	0.75-4.12	0.23-0.45	0.29-1.50	BDL-0.08	0.16-0.51		0.58-1.24
Coeff of Var. (%)		104.7	76.8	26.2	48.5	17.3	76.4	47.6	70.1		44.1		41.3
Alk (as $CaCO_3$) (mg/l) Ave	-	152.5		165.5		150		188.8		248		273	
Min-Max		70-205		100-220		110-175		120-232		200-287		245-324	
Coeff of Var. (%)		38.5		31.3		19.8		25.5		15.6		16.2	
Na (mg/l) Ave	200	30		30		30.8		38.3		38.8		53.3	
Min-Max		18-34		26-35		28-33		28-45		37-40		48-61	
Coeff of Var. (%)		26.7		13.1		7.2		18.9		3.2		12.8	
K (mg/l) Ave	50	7.5		5.1		6.3		4.2		3.4		3.3	
Min-Max		6.5-8.4		4.6-5.7		5-8.5		3.5-4.9		3.1-3.6		2.4-4.3	
Coeff of Var. (%)		12.0		10.8		24.6		17.0		6.2		28.5	
Ca (mg/l) Ave	150	29.3		25.5		20.3		25.3		43.5		35.3	
Min-Max		13-39		15-30		14-23		18-35		32-58		20-54	
Coeff of Var. (%)		41.4		27.6		21.1		29.7		26.4		48.8	
Mg (mg/l) Ave	70	14.5		18.8		15		24		32.5		31.3	
Min-Max		7-21		11-24		8-19		14-31		28-37		26-39	
Coeff of Var. (%)		40		34.1		28.8		33.5		14.3		21.7	

Sample	Guideline for domestic water use (DWAF, 1998)	B1 Downstream of mining area on the Kaalspruit		B2 Downstream of the mining area on the Watervalrivier		B3 Upstream of the mining area on the Kaalspruit		B4 Upstream of the mining area on the farm 527IR		B5 Upstream of mining area on the Wildebeestspruit		B6 Upstream of mining area on a tributary of the Wildebeestspruit	
Cl (mg/l) Ave	200	15		15.3		13		19.3		19.8		16.7	
Min-Max		6-22		6-20		8-19		7-27		14-24		12-21	
Coeff of Var. (%)		47.1		43.3		35.0		45.0		25.6		27.1	
SO_4 (mg/l) Ave	400	21.5		27.3		12.8		32.3		50.8		32.7	
Min-Max		15-34		20-40		10-18		20-48		43-61		22-46	
Coeff of Var. (%)		39.9		32.5		29.6		36.5		15.0		37.4	
Mn (mg/l) Ave	0.5	Filt. 0.09	Unfilt 0.18	Filt. 0.09	Unfilt 0.48	Filt. 0.10	Unfilt 0.80	Filt. 0.16	Unfilt. 0.24	Filt. 0.26	Unfilt. 0.42	Filt. 0.07*	Unfilt 0.40
Min- Max		0.06-0.13	0.06-0.26	0.06-0.12	0.36-0.60	0.03-0.23	0.11-2.55	0.13-0.18	0.06-0.56	0.12-0.40	0.36-0.49		0.12-0.89
Coeff of Var. (%)		54.4	48.2	47.1	26.8	122.3	147.6	24.2	93.9	76.2	13.8		108.1
Al (mg/l) Ave	0.3	Filt. 0.79	Unfilt 0.98	Filt. 0.16	Unfilt 0.86	Filt. 0.1	Unfilt 0.18	Filt. 0.38	Unfilt. 0.59	Filt. BLD	Unfilt. 0.36	Filt. 0.45*	Unfilt 0.55
Min- Max		BDL-0.79	0.20-2.51	BDL-0.16	0.63-1.31	BDL-0.1	0.08-0.29	BDL-0.38	0.16-1.29		0.24-0.46		0.33-0.81
Coeff of Var. (%)			106.9		35.2		59.2		84.8		25.6		44.8

Note: Fe, Mn, Al, and Zn samples were all filtered, BDL = below detection limit, Filt = Filtered samples, *Only 1 sample was taken

Figure 5.2.2(a) Surface Water Sampling Locations



5.2.3 Surface water use

Surface water use downstream of the site is used primarily for informal domestic purposes, agricultural and natural aquatic systems. There are no major dams immediately downstream of the site. The site is within the Vaal Dam catchment, which is located downstream on the Vaal River.

Details of the affected Land Owners are shown in **Table 5.2.3 (a)** and most downstream surface water users are shown in **Table 5.2.3 (b)**.

Table 5.2.3(a) Affected Land Owners (From Shondoni Scoping Report No. Prj 5405, April 2010)

No	PropertyName	Portion	Owner		Zoning Status	21 Digit Surveyor General ID Number
Shaft Complex Area						
1	Leeuwspruit 134 IS	Remaining Extent	Name	Evander Gold Mines Ltd	Agricultural	T0IS00000000013400000
			Contact Person	B Conradie		
			Postal Address	Private Bag X1012, Evander, 2280		
			Telephone	(017) 620 1620		
			Facsimile	(017) 632 4046		
			Cellular	072 603 0622		
			e-mail	boet.conradie@harmony.co.za		
2	Witkleifontein 131 IS	Portion 1	Name	Sakhisiswe CPA	Agricultural	T0IS00000000013100001
			Contact Person	S Ndlovu		
			Postal Address	P.O. Box 818, Evander, 2280		
			Cellular	082 044 2820		
3	Zandfontein 130 IS	Portion 4	Name	E.L. du Plooy	Agricultural	T0IS00000000013000004
			Contact Person	L du Plooy		
			Postal Address	P.O. Box 655, Evander, 2280		
			Cellular	082 492 7672		
Preferred Western Conveyor Option (Green)						
4	Zandfontein 130 IS	Portion 4	Name	E.L. du Plooy	Agricultural	T0IS00000000013000004
			Contact Person	L du Plooy		
			Postal Address	P.O. Box 655, Evander, 2280		
			Cellular	082 492 7672		
5	Zandfontein 130 IS	Portions 2, 5, 12	Name	Brendan Village	Portion 2 – Agricultural Portion 5 – Agricultural Portion 12 – Agricultural	Portion 2 – T0IS00000000013000002 Portion 5 – T0IS00000000013000005 Portion 12 – T0IS00000000013000012
			Contact Person	Carel Dirker		
			Postal Address	P.O. Box 3897, Witbank, 1035		
			Telephone	(013) 656 3816		
			Facsimile	(013) 656 5954		
			Cellular	082 325 6108		

No	PropertyName	Portion	Owner		Zoning Status	21 Digit Surveyor General ID Number
Shaft Complex Area						
			e-mail	carel@brendanvillage.com		
6	Zandfontein 130 IS	Portions 8, 9	Name	Evander Gold Mines Ltd	Portion 8 – Agricultural Portion 9 – Agricultural	Portion 8 – T0IS00000000013000008 Portion 9 – T0IS00000000013000009
			Contact Person	B Conradie		
			Postal Address	Private Bag X1012, Evander		
			Telephone	(017) 620 1620		
			Facsimile	(017) 632 4046		
			Cellular	072 603 0622		
			e-mail	boet.conradie@harmony.co.za		
7	Grootspruit 279 IS	Portions 3, 5, Remaining Extent	Name	Evander Gold Mines Ltd	Portion 3 – Agricultural Portion 5 – Agricultural Rem Ext – Agricultural	Portion 3 – T0IS00000000027900003 Portion 5 – T0IS00000000027900005 Rem Ext – T0IS00000000027900000
			Contact Person	B Conradie		
			Postal Address	Private Bag X1012, Evander		
			Telephone	(017) 620 1620		
			Facsimile	(017) 632 4046		
			Cellular	072 603 0622		
			e-mail	boet.conradie@harmony.co.za		
8	Grootspruit 279 IS	Portion 7	Name	J.C. Els	Agricultural	T0IS00000000027900007
			Contact Person	S van Niekerk		
			Postal Address	P.O. Box 35, Standerton,		
			Telephone	(017) 712 5211		
			Facsimile	086 614 1755		
			e-mail	svniekerk@ipsojure.co.za		
9	Grootspruit 279 IS	Portions 12, 14	Name	Siyalinga Small Scale Farmers Co-Operative	Portion 12 - Agricultural Portion 14 – Agricultural	Portion 12 – T0IS00000000027900012 Portion 14 – T0IS00000000027900014
			Contact Person	Daniel Vilakazi		

No	PropertyName	Portion	Owner		Zoning Status	21 Digit Surveyor General ID Number
Shaft Complex Area						
			Cellular	076 095 673		
10	Grootspruit 279 IS	Portions 2, 9, 10	Name	Govan Mbeki Local Municipality	Portion 2 – Agricultural Portion 9 – Agricultural Portion 10 – Agricultural	Portion 2 – T0IS00000000027900002 Portion 9 – T0IS00000000027900009 Portion 10 – T0IS00000000027900010
			Contact Person	Albert Olivier		
			Postal Address	Private Bag X 1017, Secunda, 2302		
			Telephone	(017) 620 6000		
			Facsimile	(017) 631 3599		
			e-mail	albert.o@govanmbeki.gov.za		
11	Rietkuil 283 IS	Portion 8	Name	eMbalenhle Community Trust	Agricultural	T0IS00000000028300008
			Contact Person			
			Postal Address			
			Telephone			
			Facsimile			
			Cellular			
			e-mail			
12	Rietkuil 283 IS	Portion 6	Name	J.F.N.T. Pistorius	Agricultural	T0IS00000000028300006
			Contact Person	Willem Pistorius		
			Postal Address	PO Box 599, Standerton 2280		
			Telephone	(017) 702 3033		
			Cellular	083 282 4132		
13	Rietkuil 283 IS	Portion 5	Name	Republic of South Africa	Agricultural	T0IS00000000028300005
			Contact Person	Basil Louw		
			Postal Address	Private Bag X3, Braamfontein		
			Telephone	(011) 339 6442		
14	Rietvley 320 IS	Portion 3, Remaining Extent	Name	Sasol Synfuels (Pty) Ltd	Portion 3 - Agricultural Rem Ext – Agricultural	Portion 3 – T0IS00000000032000003 Rem Ext – T0IS00000000032000000
			Contact Person	AS Potgieter		
			Postal Address	P O Box 699, Trichardt 2300		
			Telephone	(017) 614 8000		
			Facsimile	(011) 522 5882		

No	PropertyName	Portion	Owner		Zoning Status	21 Digit Surveyor General ID Number
Shaft Complex Area						
			Cellular	082 499 4379		
			e-mail	ampie.potgieter@sasol.com		
15	Rietvley 320 IS	Portion 4	Name	Sasol Mining (Pty) Ltd	Agricultural	T0IS00000000032000004
			Contact Person	AS Potgieter		
			Postal Address	P O Box 699, Trichardt 2300		
			Telephone	(017) 614 8000		
			Facsimile	(011) 522 5882		
			Cellular	082 499 4379		
			e-mail	ampie.potgieter@sasol.com		
16	Rietvley 320 IS	Portion 8	Name	Amos, Jiyana Buti	Agricultural	T0IS00000000032000008
			Contact Person	Amos Buti		
			Postal Address	9 Hulu Str Embalenthle		
			Cellular	072 120 8098		
Centre Conveyor Option (Red)						
17	Witkleifontein 131 IS	Portion 1	Name	Sakhisiswe CPA	Agricultural	T0IS00000000013100001
			Contact Person	S Ndlovu		
			Postal Address	P.O. Box 818, Evander, 2280		
			Cellular	082 044 2820		
18	Witkleifontein 131 IS	Portion 2, 3, 4, Remaining Extent	Name	Evander Gold Mines Ltd	Portion 2 – Agricultural Portion 3 – Agricultural Portion 4 – Agricultural Rem Ext – Agricultural	Portion 2 – T0IS00000000013100002 Portion 3 – T0IS00000000013100003 Portion 4 – T0IS00000000013100004 Rem Ext – T0IS00000000013100000
			Contact Person	B Conradie		
			Postal Address	Private Bag X1012, Evander		
			Telephone	(017) 620 1620		
			Facsimile	(017) 632 4046		
			Cellular	072 603 0622		
			e-mail	boet.conradie@harmony.co.za		
19	Langverwacht 282 IS	Portion 2	Name	Evander Gold Mines Ltd	Agricultural	T0IS00000000028200002
			Contact Person	B Conradie		
			Postal Address	Private Bag X1012, Evander		

No	PropertyName	Portion	Owner		Zoning Status	21 Digit Surveyor General ID Number
Shaft Complex Area						
			Telephone	(017) 620 1620		
			Facsimile	(017) 632 4046		
			Cellular	072 603 0622		
			e-mail	boet.conradie@harmony.co.za		
20	Langverwacht 282 IS	Portion 11	Name	Hoëvelddrif Plaaslike Oorgangs Raad	Agricultural	T0IS00000000028200011
			Contact Person	Albert Olivier		
			Postal Address	Private Bag X 1017, Secunda, 2302		
			Telephone	(017) 620 6000		
			Facsimile	(017) 631 3599		
			e-mail	albert.o@govanmbeki.gov.za		
21	Grootspruit 279 IS	Portion 4	Name	M.L. Wienand	Agricultural	T0IS00000000027900004
			Contact Person	M Wienand		
			Postal Address	P.O. Box 1911, Manaba Beach, 4276		
			Telephone	(012) 991 1666		
			Cellular	083 441 2733		
			e-mail	familysmit@telkonsa.net		
22	Grootspruit 279 IS	Portion 7	Name	J.C. Els	Agricultural	T0IS00000000027900007
			Contact Person	S van Niekerk		
			Postal Address	P.O. Box 35, Standerton,		
			Telephone	(017) 712 5211		
			Facsimile	086 614 1755		
			e-mail	svniekerk@ipsojure.co.za		
23	Grootspruit 279 IS	Portions 9, 10	Name	Govan Mbeki Local Municipality	Portion 9 – Agricultural Portion 10 - Agricultural	Portion 9 – T0IS00000000027900009 Portion 10 – T0IS00000000027900010
			Contact Person	Albert Olivier		
			Postal Address	Private Bag X 1017, Secunda, 2302		
			Telephone	(017) 620 6000		
			Facsimile	(017) 631 3599		
			e-mail	albert.o@govanmbeki.gov.za		
24	Grootspruit 279 IS	Portions 8, 20	Name	Republic of South Africa	Portion 8 – Agricultural	Portion 8 – T0IS00000000027900015

No	PropertyName	Portion	Owner		Zoning Status	21 Digit Surveyor General ID Number
Shaft Complex Area						
			Contact Person	Basil Louw	Portion 20 - Agricultural	Portion 20 – T0IS00000000027900020
			Postal Address	Private Bag X3, Braamfontein		
			Telephone	(011) 339 6442		
25	Rietkuil 283 IS	Portion 8	Name	eMbalenhle Community Trust	Agricultural	T0IS00000000028300008
			Contact Person			
			Postal Address			
			Telephone			
			Facsimile			
			Cellular			
			e-mail			
26	Rietkuil 283 IS	Portion 6	Name	J.F.N.T. Pistorius	Agricultural	T0IS00000000028300006
			Contact Person	Willem Pistorius		
			Postal Address	PO Box 599, Standerton 2280		
			Telephone	(017) 702 3033		
			Cellular	083 282 4132		
27	Rietkuil 283 IS	Portion 5	Name	Republic of South Africa	Agricultural	T0IS00000000028300005
			Contact Person	Basil Louw		
			Postal Address	Private Bag X3, Braamfontein		
			Telephone	(011) 339 6442		
28	Rietvley 320 IS	Portion 3, Remaining Extent	Name	Sasol Synfuels (Pty) Ltd	Agricultural	Portion 3 – T0IS00000000032000003 Rem Ext – T0IS00000000032000000
			Contact Person	AS Potgieter		
			Postal Address	P O Box 699, Trichardt 2300		
			Telephone	(017) 614 8000		
			Facsimile	(011) 522 5882		
			Cellular	082 499 4379		
			e-mail	ampie.potgieter@sasol.com		
29	Rietvley 320 IS	Portion 4	Name	Sasol Mining (Pty) Ltd	Agricultural	T0IS00000000032000004
			Contact Person	AS Potgieter		
			Postal Address	P O Box 699, Trichardt 2300		
			Telephone	(017) 614 8000		
			Facsimile	(011) 522 5882		
			Cellular	082 499 4379		

No	PropertyName	Portion	Owner		Zoning Status	21 Digit Surveyor General ID Number
Shaft Complex Area						
			e-mail	ampie.potgieter@sasol.com		
30	Rietvley 320 IS	Portion 8	Name	Amos, Jiyana Buti	Agricultural	T0IS00000000032000008
			Contact Person	Amos Buti		
			Postal Address	9 Hulu Str Embalenthle		
			Cellular	072 120 8098		
Eastern Conveyor Option (Purple)						
31	Witkleifontein 131 IS	Portion 1	Name	Sakhisiswe CPA	Agricultural	T0IS00000000013100001
			Contact Person	S Ndlovu		
			Postal Address	P.O. Box 818, Evander, 2280		
			Cellular	082 044 2820		
32	Witkleifontein 131 IS	Portion 4, Remaining Extent	Name	Evander Gold Mines Ltd	Portion 4 – Agricultural Rem Ext – Agricultural	Portion 4 – T0IS00000000013100004 Rem Ext – T0IS00000000013100000
			Contact Person	B Conradie		
			Postal Address	Private Bag X1012, Evander		
			Telephone	(017) 620 1620		
			Facsimile	(017) 632 4046		
			Cellular	072 603 0622		
			e-mail	boet.conradie@harmony.co.za		
33	Adullam 577 IS	Remaining Extent	Name	Adullam Trust	Agricultural	T0IS00000000057700000
			Contact Person			
			Postal Address			
			Telephone			
			Facsimile			
			Cellular			
			e-mail			
34	Goedverwachting 287 IS	Remaining Extent	Name	Evander Gold Mines Ltd	Agricultural	T0IS00000000028700000
			Contact Person	B Conradie		
			Postal Address	Private Bag X1012, Evander		
			Telephone	(017) 620 1620		
			Facsimile	(017) 632 4046		

No	PropertyName	Portion	Owner		Zoning Status	21 Digit Surveyor General ID Number
Shaft Complex Area						
			Cellular	072 603 0622		
			e-mail	boet.conradie@harmony.co.za		
35	Winkelhaak 135 IS	Portion 13	Name	Evander Gold Mines Ltd	Agricultural	T0IS00000000013500013
			Contact Person	B Conradie		
			Postal Address	Private Bag X1012, Evander		
			Telephone	(017) 620 1620		
			Facsimile	(017) 632 4046		
			Cellular	072 603 0622		
			e-mail	boet.conradie@harmony.co.za		
36	Halvepan 286 IS	Remaining Extent	Name	Sasol Synfuels (Pty) Ltd	Agricultural	T0IS00000000028600000
			Contact Person	A Potgieter		
			Postal Address	P.O. Box 699,Trichardt, 2300		
			Telephone	(017) 614 8000		
			Facsimile	(011) 522 5882		
			Cellular	082 499 4379		
			e-mail	anpie.potgieter@sasol.com		
37	Sasolkraal 289 IS	Portion 1	Name	Sasol Synfuels (Pty) Ltd	Agricultural	T0IS00000000028900001
			Contact Person	A Potgieter		
			Postal Address	P.O. Box 699,Trichardt, 2300		
			Telephone	(017) 614 8000		
			Facsimile	(011) 522 5882		
			Cellular	082 499 4379		
			e-mail	anpie.potgieter@sasol.com		
38	Middelbult 284 IS	Portion 23	Name	Eskom Holdings	Agricultural	T0IS00000000028400023
			Contact Person	E. Grunewald		
			Postal Address	P.O. Box 1491, Johannesburg, 2000		
			Telephone	011 800 5732		
			Facsimile	086 655 7036		
			Cellular	083 632 7668		
			e-mail	ernest.grunewald@eskom.co.za		
39	Middelbult 284 IS	Portions 9, 12, 13	Name	Sasol Synfuels (Pty) Ltd	Portion 9 – Agricultural	Portion 9 – T0IS00000000028400009

No	PropertyName	Portion	Owner		Zoning Status	21 Digit Surveyor General ID Number
Shaft Complex Area						
			Contact Person	**A Potgieter**	**Portion 12 – Agricultural** **Portion 13 - Agricultural**	**Portion 12 – T0IS00000000028400012** **Portion 13 – T0IS00000000028400013**
			Postal Address	**P.O. Box 699,Trichardt, 2300**		
			Telephone	**(017) 614 8000**		
			Facsimile	**(011) 522 5882**		
			Cellular	**082 499 4379**		
			e-mail	anpie.potgieter@sasol.com		

Table 5.2.3(b) Downstream Surface Water Users

Name of owner	Farm Name	Farm Portion	Usage		
			Irrigation	Livestock	Domestic
Anderson, Hendrik J	Klipfontein 621 IR	5			
Badenhorst, H	Wolvenfontein 534 IR	2			
Bierman, Gerhard	Paardefontein 584 IR	7		✓	✓
	Paardefontein 584 IR	18		✓	✓
	Klipdrift 324 IS	0	✓	✓	✓
	Klipdrift 324 IS	1	✓	✓	✓
	Klipdrift 324 IS	2	✓	✓	✓
	Paardefontein 584 IR	21	✓	✓	✓
	Paardekuil 583 IR	0	✓	✓	✓
Bowker, Rodney Miles	Poortjesfontein 398 IS	2		✓	
Cronje, AH	Zandbaken 585 IR	5		✓	✓
De Witt, Wynand	Paardefontein 584 IR	12		✓	✓
	Paardefontein 584 IR	17		✓	✓
Jankowitz, JA	Klipdrift 324 IS	5		✓	✓
	Klipdrift 324 IS	6		✓	✓
	Klipdrift 324 IS	7		✓	✓
J van Vuuren, Anna M	Poortjesfontein 398 IS	13			
J van Rensburg, Stephanus, Johannes	Klipfontein 621 IR	19			
Kerslake, Dick	Paardefontein 584 IR	10		✓	✓
	Sandbaken 363 IS	0		✓	✓
	Sandbaken 363 IS	4		✓	✓
Kruger, Albertus JA	Groenvley 590 IR	4			
	Groenvley 590 IR	8			
	Groenvley 590 IR	10			
Kruger, Martha EA	Groenvley 590 IR	9			
Kruger, Pik	Greonvlei	1			
Lamplough, Pamela Mary	Oudehoutspruit 586 IR	0			
Louwrens, Koos	Kaalspruit 528 IR	0		✓	✓
	Kaalspruit 528 IR	2		✓	✓
Pistorius, Tinus	Kaalspruit 528 IR	13		✓	✓
Pistorius, Willem	Paardefontein 584 IR	1		✓	✓
	Paardefontein 584 IR	3		✓	✓
	Paardefontein 584 IR	4		✓	✓
	Paardefontein 584 IR	13		✓	✓
	Paardefontein 584 IR	16		✓	✓
	Paardefontein 584 IR	9		✓	✓
	Paardefontein 584 IR	20		✓	✓
Shabangu, Thandiwe	Oudehoutspruit 586 IR	1			
	Oudehoutspruit 586 IR	2			
	Oudehoutspruit 586 IR	17			
	Oudehoutspruit 586 IR	22			
	Oudehoutspruit 586 IR	23			

Name of owner	Farm Name	Farm Portion	Usage		
			Irrigation	Livestock	Domestic
Spies, L P A	Klipdrift 324 IS	8		✓	✓
	Kromdraai 325 IS	8		✓	✓
Urquhart, AA	Kaalspruit 528 IR	6	✓	✓	✓
Urquhart, AA	Kaalspruit 528 IR	9	✓	✓	✓
	Roodebank 323 IS	1	✓	✓	✓
	Roodebank 323 IS	13	✓	✓	✓
	Roodebank 323 IS	20	✓	✓	✓
Wessels, AH	Klipdrift 324 IS	3		✓	✓
	Klipdrift 324 IS	4		✓	✓
	Roodebank 323 IS	6		✓	✓
	Roodebank 323 IS	7		✓	✓
	Roodebank 323 IS	9		✓	✓
	Roodebank 323 IS	10		✓	✓
	Roodebank 323 IS	11		✓	✓
	Roodebank 323 IS	12		✓	✓
	Roodebank 323 IS	18		✓	✓
	Roodebank 323 IS	19		✓	✓
	Groenvley 590 IR	7			
	Klipfontein 621 IR	2			
	Klipfontein 621 IR	16			
	Klipfontein 621 IR	21			
	Klipfontein 621 IR	6			
	Klipfontein 621 IR	8			
Earlybird Farm	Klipdrift 324 IS	9			✓
	Klipdrift 324 IS	10			✓
	Paardefontein 584 IR	8			
	Paardefontein 584 IR	0			
	Oudehoutspruit 586 IR	4			
	Oudehoutspruit 586 IR	21			
Terblanche, CJ	Roodebank 323 IS	00024			
Sawyer, Tom	Oudehoutspruit 586 IR				
Hatting, Phillipus W	Hartbeestdraai 620 IR	4		✓	✓
Hatting, Frank Philip	Hartbeestdraai 620 IR	5			
Kerslake, Dick	Hartbeestdraai 619 IR	0		✓	✓
	Hartbeestdraai 619 IR	2		✓	✓
	Grootspruit 617 IR	2		✓	✓
	Grootspruit 617 IR	9		✓	✓
	Grootspruit 617 IR	17		✓	✓
Kruger, Albertus JA	Groenvley 590 IR	4			
	Groenvley 590 IR	8			
	Groenvley 590 IR	10			
Kruger, Martha EA	Groenvley 590 IR	9			

Name of owner	Farm Name	Farm Portion	Usage		
			Irrigation	Livestock	Domestic
Kruger, Pik	Greonvlei	1			
Moolman, Theuns	Hartbeesdraai			✓	
Riekert, Dirk	de Pan 615 IR	0		✓	
	de Pan 615 IR	2		✓	
	de Pan 615 IR	14		✓	
	de Pan 615 IR	15		✓	
Shabangu, Thandiwe	Groenvley 589 IR	3			
Swanepoel, Pieter A	Elandslaagte 618 IR	10		✓	✓
van Dyk, Johan	Hartbeestdraai 620 IR	6			
	Hartbeestdraai 620 IR	7			
	Hartbeestdraai 620 IR	8			
	Hartbeestdraai 620 IR	0			
	Hartbeestdraai 620 IR	1			
	Hartbeestdraai 620 IR	9			
	Hartbeestdraai 620 IR	10			
	Hartbeestdraai 620 IR	11			
	Grootspruit 617 IR	3			
	Grootspruit 617 IR	10			
Lane Reynolds Trust	Grootspruit 617 IR	5		✓	✓
	Grootspruit 617 IR	11		✓	✓
	Grootspruit 617 IR	14		✓	✓
	Grootspruit 617 IR	15		✓	✓
	Grootspruit 617 IR	19		✓	✓
	Grootspruit 617 IR	18		✓	✓
	Groenvley 590 IR	1			
	Groenvley 590 IR	2			
	Groenvley 589 IR	1			
	Groenvley 589 IR	2			

5.2.4 Biomonitoring

Biomonitoring will be addressed by the relevant specialists.

5.2.5 Water authority

The mine falls within the Department of Water Affairs Gauteng Region.

5.2.6 Wetlands

The wetlands have been addressed in a separate report by the wetland specialist.

5.2.7 Interested and Affected Parties

To be determined as part of the Public Participation process.

6 ENVIRONMENTAL IMPACT ASSESSMENT

6.1 Impact assessment methodology

The impact assessment methodology employed was provided by JMA and is based on Sasol's risk assessment system. The rating of impacts has therefore been standardised for all of the specialists assessing the potential impacts of the Shondoni Project on the environment. The key criteria are listed in **Tables 6.1(a) to (d)** below.

Table 6.1(a) Severity ratings

TABLE 1: CRITERIA FOR DETERMINING SEVERITY		
Criteria	**Definition**	**Points**
Quantity	**The quantity (Volume) that will impact on the environment**	
	Less than 1m^3 / incident or > 10 mg/ m^3 or < 61dBa	0
	More than 1 m^3 but less than 10 m^3 per incident or > 25 mg/ m^3	1
	More than 10 m^3 but less than 100 m^3 per incident > 50 mg/ m^3 or > 61dBa	2
	More than 100 m^3 but less than 1000 m^3 per incident or > 100mg/ m^3	3
	More than 1000 m^3 per incident \ continuous or > 120 mg/ m^3 or > 85dBa	4
Toxicity	**Hazard rating (Dangerous properties of hazardous material)**	
	Non-hazardous – (substances which will not result in any risk)	0
	Hazard rating 1 – (Substances which could result in relatively low risk)	1
	Hazard rating 2 – (Substances which could result in serious risk)	2
	Hazard rating 3 – (Substance which could result in severe risk)	3
Extend	**How far does the impact extend?**	
	Limited to Business unit	0
	Limited to mine lease area	1
	Regional (Refer to TEKSA area)	2
	National (Refer to Mpumalanga area)	3
	International (refer to beyond South Africa's boundaries)	4
Duration	**How long will the impact last?**	
	Less than 5 years	0
	Between 5 – 15 years	1
	Exceeding mine lifetime	2
	Impact permanently present	3
Status	**Status of impact**	
	Beneficial (Improve the environment) – no risk reduction needed	-1
	Neutral (No change to the environment) – No risk reduction needed	0
	Adverse (Degradation of the environment) – Risk reduction needed	1
Legislation	**Are there any regulatory requirements applicable to aspects – impacts?**	
	None	0
	Yes, No fines, not cause loss of operating permit, but still reportable incident	1
	Yes, and will result in / prosecution or loss in production	2
	Yes, and will cause loss of operating permit or mine stoppage.	3
	Yes, and may lead to closing down of mine	4
I & AP's	**Interested and affected parties (I&AP)**	
	No impact	0
	Impact to employees in unit	1
	Impact to local community / stakeholders	2
	Impact to general public – beyond TEKSA area (Bad publicity)	3

Table 6.1(b) Consequence category

TABLE 2: CONSEQUENCE CATEGORY (C-VALUE)	
Severity score	**Risk matrix Consequence category**
21 - 22	C7
19 - 20	C6
17 - 18	C5
14 - 16	C4
^10 - 13	C3
^5 - 9	C2
Less than 5	C1

Table 6.1(c) Probability value

TABLE 3: PROBABILITY MATRIX (P-VALUE)			
Likelihood Descriptors	**Prob Intervals**	**Likelihood Definitions**	**P-value**
Unforeseen	0 – 0.1%	The event is not foreseen to occur	P1
Highly unlikely	0.1 – 1%	The event may occur in exceptional circumstances (very remote)	P2
Very unlikely	1 – 5%	The event may occur in certain circumstances (remote chance)	P3
Low	5 – 15%	The event could occur (moderate chance)	P4
Possible	15 – 40%	The event may occur (realistic chance)	P5
Likely	40 – 75%	The event will probably occur (significant chance)	P6
Almost Certain	75 – 100%	The event is expected to occur or occurs regularly	P7

Table 6.1(d) Risk level table

TABLE 4: RISK LEVEL TABLE

LIKELIHOOD

P1	P2	P3	P4	P5	P6	P7
Unforeseen	Highly unlikely	Very unlikely	Low	Possible	Likely	Almost certain
Level 3 Risk	Level 3 Risk	Level 3 Risk	Level 1 Risk	Level 1 Risk	Level 1 Risk	Level 1 Risk
Level 3 Risk	Level 3 Risk	Level 3 Risk	Level 2 Risk	Level 2 Risk	Level 2 Risk	Level 1 Risk
Level 4 Risk	Level 4 Risk	Level 4 Risk	Level 3 Risk	Level 2 Risk	Level 2 Risk	Level 2 Risk
Level 5 Risk	Level 5 Risk	Level 5 Risk	Level 3 Risk	Level 3 Risk	Level 3 Risk	Level 3 Risk
Level 6 Risk	Level 6 Risk	Level 6 Risk	Level 5 Risk	Level 5 Risk	Level 5 Risk	Level 4Risk
Level 6 Risk	Level 6 Risk	Level 6 Risk	Level 6 Risk	Level 6 Risk	Level 6 Risk	Level 5 Risk
Level 6 Risk	Level 6 Risk	Level 6 Risk	Level 6 Risk	Level 6 Risk	Level 6 Risk	Level 6 Risk
P1	P2	P3	P4	P5	P6	P7
Unforeseen	Highly unlikely	Very unlikely	Low	Possible	Likely	Almost certain

It is important to note that in order to quantify the potential impacts, the general format of the assessment is to first assess the impact assuming no mitigatory measures are applied. In some instances, these impacts could not result without extreme or unlawful practices, such as discharging all of the affected water from mining into the river system. However, this provides a basis for the "worst case" scenario, from which mitigation measures can be evaluated (such as containment or treatment, for example) and the residual impact indicated.

As required by the MPRDA, cumulative impacts are also assessed as and where this is practical.

6.2 Constraints and limitations of impact assessment

The impact assessment has been carried out according to the methodology detailed above. The impacts and risks have been well quantified, based on the information available at the time of writing.

6.3 Identification of activities

Activities have been categorised and assessed according to the applicable legislation, namely listed activities in terms of the National Environmental Management Act, Act No. 107 of 1998 (NEMA), Section 21 water uses in terms of the National Water Act, Act 36 of 1998 (NWA), regulations in terms of Government Notice 704 of 1999 (GN704) (under the NWA) and any additional mining related activities that are not covered under the acts and regulations above.

All activities relating to the above have been identified by JMA and are detailed in the main EMP document. A general description of activities related to surface water is given in the sections that follow

6.3.1 Construction phase

This phase will commence when the contractors arrive on site to begin with the infrastructure construction, and will end as soon as mining of the coal seam commences. Note that during shaft sinking, there will be some carbonaceous material removed from the shaft, as well as potentially water encountered during the sinking of the shaft.

Activities to be undertaken that will potentially impact on surface water include the following:

- Construction of water management infrastructure, including clean water canals keeping runoff away from coal handling areas, and dirty water management systems, primarily canals and dams.
- Sinking of the inclined and vertical shafts. This will include placement of overburden removed from the shafts into a dump within the dirty water system and management of any water generated during the shaft sinking.
- Construction of coal handling infrastructure, including conveyors, screens and crushers, stockpile areas and a coal bunker. Various roads are also part of the infrastructure such as service roads for the conveyor, and access roads.

6.3.2 Operational phase

This phase commences at the end of the construction period, and will end when the last load of coal is removed from the underground mine.

Mining activities will involve the removal of coal from underground. This removal of coal does not necessarily impact directly on surface water, but the indirect activities that can impact on surface water include the following:

- Water will be pumped from the underground workings, and managed both on surface and underground. The potential for spillage of water affected by mining therefore exists.

- Because high extraction will be utilised, collapse of sections of the workings can be expected, with some associated disturbance of the surface. These areas can result in loss of yield for surface water, increased ingress to underground, and sometimes the development of areas that pond, potentially affecting the surface use.
- Coal is handled on surface, being screened and crushed, stored prior to transportation, and then transported on an overland conveyor. All of these activities have the potential for rain water or surface water to contact with the coal which will in turn impact on water quality.

6.3.3 Decommissioning and closure phase

This phase starts at the end of the operational phase, and involves the closing down of the mine. In theory this phase ends when the mine obtains Closure from the authorities, but it may include a period where there is no activity on the mine other than monitoring prior to Closure being obtained. Note that Closure refers to the point at which the State assumes responsibility for the liabilities associated with the mine. This acceptance is in turn based on the mine providing an acceptable financial provision to meet any future costs, and the attainment of various closure objectives set for the mine.

Activities expected for this period include:

- Closing of the shafts, including placement of material back into the shaft.
- Removal or cleaning of the coal handling infrastructure. For example, coal bunkers may not need to be demolished if they can be reused for other purposes after cleaning to ensure there is no residual impact on surface and ground water.
- Removal or cleaning of dirty water facilities. In some instances, dirty water dams (for example) may be retained to manage post mining water make.

6.3.4 Post closure phase

This phase will commence once the mine has obtained Closure. It has no defined end, with the State managing the post closure impacts related to mining. However, should the authorities deem that the mine has not correctly defined the residual impacts, the mine could also be required to address future impacts even after a closure certificate has been issued.

Activities expected for this period include:

- Management of water entering the underground workings assuming that the upper layers of water within the mined out area or at decant level are not suitable for discharge.
- Monitoring of aspects such as surface and ground water quality, the potential unauthorised use of water from the mine, and land stability.

6.4 Environmental impact assessment and mitigation measures

The environmental impacts related to the various activities are discussed in this section in terms of the nature of the activity that could potentially impact on surface water, the nature of the impact if not mitigated and mitigation measures to be applied. The significance of the impacts is not described in this section, but is included in the Impact Significance Assessment Summary Tables in Section 6.5.

6.4.1 Mining activity

This section details activities and consequences related to the removal of coal from the coal seam. It should be noted that the mining area at Shondoni is significant, involving the undermining of extensive farm land as well as stream (although with only bord and pillar mining beneath the streams). The potential impacts are discussed below.

6.4.1.1 Construction Phase

6.4.1.1.1 *Material from the shaft sinking activities*

Impact assessment

The construction phase is considered to end once carbonaceous material is exposed within the shafts. However, much of the initial rock removed prior to the exposing of coal has the potential to contain some carbonaceous material.

The hard rock removed from the initial box cut will be placed in the overburden dump area as indicated in **Figure 4.3.2.1(a)**. This material will remain in the dump for the duration of mining, where after it will be placed back into the shafts.

Without mitigation, the dumps have the potential to affect the downstream rivers in terms of water quality.

Mitigation

Mitigation of runoff discharging to the catchment: -

- A clean water cut-off system will be constructed upstream of the overburden dump.
- The overburden dump will be located within the dirty water system, and drain to the dirty water dam. From here, water will be abstracted for dust suppression purposes.
- Monitoring of the water qualities in the streams downstream will be undertaken.
- The overburden dump design will include consideration of possible seepage to ensure this will drain to the dirty water system. At this stage it is not expected that subsurface seepage collection will be required.

6.4.1.1.2 *Dewatering of water ingress to the shaft*

While an overall assessment of the expected water make to mining has been compiled by the geohydrologists, no localised specific investigations to quantify the inflows to the shaft area have not been undertaken to date. The information below is based on Sasol Mining's experience with similar shafts.

Impact assessment

The groundwater quality from the shafts is likely to be slightly to moderately impacted on in terms of sulphates and TDS. If the water were to be allowed to spill to the catchment there would be a potential impact in terms of water quality.

Mitigation

The water will be contained at the site for use for dust suppression and to assist with drilling, and not discharged. The volumes of water expected to be generated are likely to be less than 100m^3/day, the volume expected to be covered in a General Authorisation. A Water Use Licence for the dewatering of groundwater encountered during mining will be applied for, including the reuse of this water for dust suppression. Surplus water will be placed into the Dirty Water Dam as soon as construction is completed.

6.4.1.2 Operational Phase

6.4.1.2.1 *Catchment yield*

Impact assessment

The Shondoni reserve is located in the headwaters of the Waterval catchment, in the Vaal Dam catchment downstream of Grootdraai Dam. Surface water is used primarily for agricultural and livestock watering purposes, with abstraction from Vaal Dam and the barrage (upstream of the Klip River) for both agricultural and potable use.

The receiving water body for the assessment of potential surface water quality impacts of the mine is taken as the Vaal Dam.

The loss in yield associated with mining is primarily due to the shaft areas, overburden dumps (isolated from the catchment) and the related surface infrastructure areas. Because the mining is underground mining, the loss in yield is relatively small, but increased by the extent of high extraction (compared to bord and pillar).

The loss of yield is quantified as follows; -

- The total area disturbed by mining totals some 463 km^2, compared to a catchment of 38 500km^2 for Vaal Dam. However, over the underground mining area that is not stooped the impact on surface and groundwater is considered to be negligible. The proposed mining area that will be stooped is approximately 125 km^2, or some 0.3% of the Vaal Dam catchment. However, over the stooped area it is expected that most of the surface water will be largely unaffected, and only the groundwater component will be lost.
- The infrastructure on surface totals less than 30 ha and is considered to be negligible in terms of yield.

The naturalised flow MAR for Vaal Dam is some 1950 x 10^6 m^3 but this reduces to 1400 x 10^6 m^3. To conservatively quantify the potential impact on yield, the full 0,3% reduction has been indicated in the table below. This figure assumes that non of the stooped areas will still drain to the catchment; in reality the actual loss in yield is less since not all runoff will be lost to the catchment.

Table 6.4.1.2.1(a) Expected total loss in catchment yield (groundwater and surface water)

Description	Total Catchment (km^2)	MAR Pre-mining x 10^6 m^3	MAR during mining x 10^6 m^3	% Reduction
Vaal Dam	38 500	1400	1395.8	0.3

Note: Data taken from DWA published figures.

Note that the above loss is equivalent to some 11 500 m^3/day, which is more than the currently predicted average water make, which emphasises that the above values are conservative with the actual value probably of the order of 30 to 50% less than the above value based on the predicted water ingress to the mine workings.

Mitigation

Mitigation of the loss of yield during the operational phase will be undertaken as follows:

- The area of disturbance at the shafts will be kept to as small a footprint as is practical.
- The surface of stooped areas will be inspected to ensure they remain free draining. This will involve the use of surface teams undertaking civil works such as cutting drains where required to ensure areas of settlement can drain. Sasol Mining has developed a range of strategies for stooped areas based on their experiences elsewhere.

6.4.1.2.2 *Water quality*

The final receiving water body for the Shondoni shaft is the Vaal Dam. The downstream users have been identified as the aquatic life, informal and formal domestic use, recreation, and agricultural practices. Stock farming occurs within the general area.

It is important to indicate that the water balance assessment undertaken in Chapter 4 is aimed at ensuring that the mine does not spill water during the operational phase, except for very extreme events related to floods in excess of 1:50 years (or 2% in any one year). The management measures detailed in Chapter 4 are mitigation measures, primarily the re-use of dirty water and storage underground.

However, to merely indicate that the mine will not spill dirty water does not allow an assessment of the potential impact of non-compliance with the water management measures proposed. In order to assess the impact without mitigation, the impact assessment first assumes that all dirty water could be discharged to the catchment, where after detail is provided on how this will be prevented.

Impact assessment

The water balance modelling in Chapter 4 indicates that the mine will have a water shortage for the initial approximately 6 to 7 years of mining. The water make, including dewatering and other inflows, exceeds the targeted usage at approximately 2017/2018. For the period from 2017 to the end of life of mine, the mine will have a water surplus.

However, there is sufficient storage available in the underground workings to store the full water make without spilling.

For evaluation purposes, assume provisionally that up to 5030 m^3/day could potentially spill to the catchment, this being the average net water make over the operational period, the water make being up to 10 Ml/day towards the end of the mining period.

Water quality predictions have been derived from the acid base accounting and interpretation of water qualities in the adjacent mines by the groundwater specialist. Predictions indicate that sulphate concentrations of around 500 to 650mg/l could result, with the possibility of levels around 2500mg/l to 3200mg/l in total extraction compartments towards or after closure. The risk of acidic water appears to be low for the operational phase at this stage, but increasing to a higher risk, particularly during the post closure phase, and specifically for total extraction compartments.

Potential impact on instream aquatic life and downstream users

The potential impact on aquatic life or downstream users of water within the rivers is highly dependent on the pH of the water discharged. This is because acidic conditions will result in mobilisation of metals, and this would be a major contributing factor to the potential toxicity of the water.

Based on the prediction that the water is unlikely to be acidic during the operational phase, the following is predicted:

- An increase in electrical conductivity and overall salinity. The surface water in the area has EC values averaging around 20 to 70mS/m with the mine water likely to be an order of magnitude higher towards the end of mining. Discharge of this water could affect irrigation practices downstream.
- Certain constituents are likely to be problematic for drinking water usage. Typically sodium, sulphate, chloride and fluoride levels could be elevated, each of which has the potential to cause certain health impacts. The most likely risk is the development of diarrhoea in infants that may drink the water.
- Without dilution, the mine water is expected to be Class 3 or 4 in terms of salinity, while sodium and SAR levels (Sodium Adsorption Ratio) are likely to be problematic. The water quality could affect irrigation, primarily maize being grown downstream although the extent of irrigation is uncertain.
- The water is not expected to be suitable for potable use, and will most likely be outside the limits set for informal use of water for drinking purposes. It should be noted that residents in the township area make use of surface water, generally for cleaning and washing, but potentially for informal drinking as well. Exposure of children to the surface water is highly likely.

Impacts in terms of salt loading on dam systems

The salt loading within the Vaal Dam catchment is vitally important due to the significance to the country of supplying water of an acceptable quality to the Witwatersrand area.

Based on an average water make of some 10 Ml/day, and a sulphate concentration of around 2500mg/l close to closure (refer Section 5.4.2), the mine could generate an average of 25 tons SO_4 per day. Note that this is conservative, in that JMA predict

sulphate concentrations varying at around 650mg/l for the operational phase, tending to 2500 to 3200mg/l after total acidification (within the total extraction panels only). Since total acidification is not predicted to occur for some time after closure, a value of 2500mg/l as an average sulphate concentration is thus conservative, but not unreasonable. The TDS would be expected to be around double this, with a total loading of around 50 tons per day.
The impact of this on the Waterval River would be highly variable, depending on the flow conditions at the time. A preliminary assessment into the possible impact of discharges on compliance at points C1H004 and C1H008 (Jones & Wagener report JW74/01/7813) indicated that, under certain assumptions in terms of compliance, around 1Ml/day of water with a TDS of around 5000mg/l could potentially still achieve compliance with fitness for use through dilution at C1H004. However, there is currently no intention to discharge water, and certainly at 10Ml/day, fitness for use by C1H004 could not be achieved.

The Vaal Dam has a capacity of some 2122 x $10^6 m^3$, with an MAR of 1929 x $10^6 m^3$. Using an average of 50 tons/day for the mine discharge (conservative) and a TDS loading to the dam of around 100mg/l (EC around 15mS/m), the mine loading could comprise as much as 9,5% of the total annual TDS load on Vaal Dam towards the end of the life of mine. It must be emphasised that this is a worst case scenario assessment.

Viewed another way, this mass of discharge would result in an increase in TDS within the dam of some 0,38mg/l per month, assuming no inflows or outflows and perfect mixing in the dam.

Mitigation

The mine water balance will be managed as detailed in Part 4. These measures will include the following:

- Use of bord and pillar mining to create usable compartments underground in the low lying areas prior to the generation of the larger inflows related to total extraction.
- Planning of compartments for total extraction to allow the isolation of these areas from the rest of the mining area.
- Exclusion of higher yielding areas from total extraction mining.
- Re-use of dirty water within the system, including the Plant and for dust suppression.
- Treatment of mine water surpluses where necessary.
- Provision of water management containment facilities sized to ensure a lower than 2% risk of spilling in any one year, based on the water re-use volume given in this document. This includes underground storage compartments to minimise the storage of water affected by mining on surface.
  It should be noted that this document does not address the entire Secunda Complex, and the assessment of the risk of spilling is dependent on a variety of factors associated with each of the different underground mines in the complex. The emphasis in this document is ensuring that the Block 8 reserves can be managed in terms of their water balances.
- Provision for monitoring of both the water balances and management of the water balance, as well as upstream and downstream river qualities to ensure that the above is achieved.

Any discharge from the mine would be in accordance with any licence that may be issued to the mine by the Department of Water Affairs, and managed by them. The only situation for which mine discharge is currently envisaged would be in the event of extreme rainfall in excess of the 1:50year recurrence interval flood.

6.4.1.3 Decommissioning Phase

6.4.1.3.1 *Catchment yield*

The decommissioning phase will not significantly change the operational loss in yield, although some work may be undertaken to address any areas of subsidence, resulting in a reduction in a loss in yield.

6.4.1.3.2 *Water quality*

Once dewatering ceases, water levels will begin to recover. It is predicted that water levels will only reach decant levels 80 to 100 years after mining ceases, well after decommissioning.

It is therefore likely that water from the mining area will not affect the environment during decommissioning.

6.4.1.4 Post Closure

Impact Assessment

Two aspects have been considered here, namely, the volume of leachate that could be generated, and the potential quality of decant. The possible exposure pathway is also of importance, since poor quality leachate is of concern where aquatic systems or other users are at risk of exposure.

Time to Decant

The rate of recharge to the mine areas is expected to vary, with groundwater inflows reducing as the water level increases within the mine due to a reduced hydraulic gradient towards the mined out areas. However, for the purposes of the calculation, recharge rates are assumed to be relatively constant over the period from cessation of dewatering until (without mitigation) decant reaches the potential decant level. The output from the calculations is given in Table 6.4.1.4 (a), based on an average recharge rate of 8700m^3/day.

Table 6.4.1.4(a) Post closure decant assessment for Shondoni

Rainfall conditions	Flooding Rate (m^3/annum)	Volume to decant level (m3)	Time to flood (Years)
Average rainfall	Around 2,750,000	260 x 10^6m³ based on 60 x 10^6m^3 being used in the operational phase	Predicted time to flood = 80 to 100 years, but some areas will be filling during the operational phase.

Note: Decant elevations and decant times are provisional, and will be confirmed as models are calibrated with actual inflows.

If the decant is not managed (as detailed below), there could be an impact on both the downstream catchment and the downstream dams.

This impact is quantified following the discussion of the potential decant qualities.

Assessment of the quality of decant

Table 6.4.1.4(b) below gives the expected range in decant quality that can be expected at Shondoni for selected parameters.

Table 6.4.1.4(b) Decant quality to be expected at Shondoni

Parameter	Most likely scenario: Bord & pillar areas	Possible scenario: Total extraction areas
pH	7.5	2.5
EC	1100 mS/m	800 mS/m
SO_4	< 50 mg/l	3200 mg/l

The impact of decant quality on downstream users is potentially significant. The water is unlikely to be fit for use for the aquatic systems, nor for irrigation nor livestock watering, primarily due to the potentially elevated metals, sulphates and EC. Note that JMA are indicating possible acidification only for local areas within the mine, with the overall pH expected to be as low as 2.5.

Possible sulphate loading

It is considered of value to assess the potential sulphate loading of the mine on the catchment. This assessment is based on the assumption that the entire water make were to be discharged to the catchment.

The water balance at closure indicates that an average water make in the order of 8700m^3/day can be expected. Using a sulphate concentration of 3200 mg/l, this equates to around 28 ton SO_4 per day, or around 10 160 tons SO_4 per year.

The loading from the mine equates to around 0,9t SO_4/yr/ha, which is reasonable compared to field observations, which indicate some 0,5 to 1,0t SO_4/yr/ha is typical for underground mines.

The estimates given above are proposed to be refined over the life of mine as follows:

- Ongoing sampling and monitoring of parameters important to the final water quality and water volumes,
- Quantification and verification of the groundwater model, the water balance model, and the geochemical model.
- Evaluation and reassessment of alternative options for the final water use and required associated water quality, together with the technologies required to achieve the required quality.

Mitigation

Mitigation measures will include the following:

- Monitoring of water levels in the mine and the associated water quality is committed to. This will allow both calibration of the post mining water quality and water volumes, as well as enhanced prediction on the timing of intervention measures.
- Prior to construction of any water treatment plant the necessary permitting and EIA studies will be undertaken to address issues around brine management and disposal, as well as the preferred final water quality to be delivered.

6.4.2 Coal handling infrastructure

This section details activities and consequences related to the processing of coal and transport of the product from the underground pit through to the coal stockpile at the main coal stockyard at Sasol Synfuels.

6.4.2.1 Construction Phase

6.4.2.1.1 *Civil activities related to the construction*

Impact assessment

The plant infrastructure will be constructed close to and on the watershed.

During the construction phase, topsoil will be stripped and the civil works undertaken as part of preparation for coal handling, but no carbonaceous material will be placed on site during this period. The main impact thus relates to potentially increased suspended solids and some risk of erosion, with a potential impact on surface water quality.

Mitigation

No further mitigation envisaged.

6.4.2.2 Operational Phase

6.4.2.2.1 *Workshops, offices and stockyard areas*

The workshops, offices and stockyard area will be constructed at the start of the project, and will remain in place for the duration of mining.

Impact assessment

Possible impacts include the following:
- Contamination of runoff water that contacts with the carbonaceous material on the coal handling area, typically in terms of sulphates and salinity.
- Groundwater could be affected by the emergency coal stockyard area.
- Seepage from the dirty water dam.
- The risk of overspill from the dirty water dam.

Mitigation

All of the facilities are located within areas designated dirty water areas. The facilities include the following:

- Dirty areas are characterised by the cutting off of clean water upstream of the area (where there is a catchment), and provision of canals with a 1:50 year risk of spilling. The canals are generally designed to take the 1:50year event within the excavated section of the canal, and a berm adjacent to the canal increases the capacity to around the 1:100year event.
- Storage facilities have been provided to ensure a 2% or lower risk of spilling for the life of the project. The mine water make will be stored underground. It should be noted that a storage capacity of 105 000m^3 is required on surface to contain runoff from the dirty areas, based on the current layouts.
- The wash bays and workshops will be equipped with oil skimming facilities to remove oil and grease from the wash down water.
- As shown in Chapter 4, clean run-off will be directed around these facilities, and directed back to the clean water catchment. Groundwater monitoring will also occur in the vicinity of these structures. This is detailed in the groundwater specialist report.
- The emergency coal stockpile area will be engineered with measures to contain seepage and minimise ingress to the groundwater system.

6.4.2.2.2 *Extreme flooding events*

All of the shafts to the underground workings, as well as the workshop, office and stockyard area have been located outside of the 1:100year floodline.

Impact Assessment

Even in very extreme flood events, it is improbable that flood waters could affect the shafts areas.

6.4.2.2.3 *Coal conveyance*

Coal from the site will be transported via conveyor to the coal stockyard at Sasol Synfuels.

Impact assessment

It is known that the haulage of coal by conveyors has the potential to impact on watercourses and general runoff water qualities, primarily due to spillage of coal related to overloading and at transfer stations.

Mitigation

The possible impacts will be minimised as follows:
- Conveyor rotated (dirty side up).
- Conveyors boxed in at watercourse crossings.

6.4.2.3 Decommissioning Phase

6.4.2.3.1 *Water quality*

Impact Assessment

The removal of surface infrastructure will take place during this period. Potentially, there will be an increase in suspended solids in runoff from the site, but in most respects the removal of infrastructure will have positive benefits in terms of storm water management.

Mitigation

The following measures will be implemented:
- The dirty water dam will remain in place during decommissioning and beyond, so that the infrastructure will be contained until fully rehabilitated.
- Water quality monitoring and rehabilitation monitoring will be implemented during the decommissioning phase to establish the success of the final rehabilitation, and to determine any shortcomings.

6.4.3 Water Management Infrastructure

This section details impacts related to the construction and operation of the various water management structures, primarily canals and dams.

6.4.3.1 Construction Phase

6.4.3.1.1 *Construction of the water management measures*

Impact assessment

During the initial phase of work, the following infrastructure will be constructed:
- At the inclined and vertical shafts, clean water will be diverted around the construction site, including the overburden dump for material excavated from the shafts.
- Construction of dirty water storage areas at the shafts will be undertaken.
- Dirty water containment canals will be constructed for the coal processing infrastructure and at the overburden dump.

During this phase, vegetation will be stripped in areas of construction. These construction activities could result in additional erosion by runoff, thereby increasing the suspended solids content of the downstream watercourse.

Mitigation

Mitigation of the impacts will include the following:
- Water quality monitoring will be taken downstream of the mining area, before and during construction where practical, in order to detect any increase in suspended solids or turbidity.
- If erosion is evident or the water quality monitoring indicates an increase in suspended solids, water management around the construction areas will be reviewed.

6.4.3.2 Operational Phase

6.4.3.2.1 *Operation and maintenance of dams and canals*

It is known that water management systems often fail through poor maintenance. The systems at Shondoni will be sized to limit the extent to which maintenance will be required on aspects such as the silt traps.

However, regular maintenance will be undertaken, and will be reviewed as part of the monitoring on the mine.

6.4.3.3 Decommissioning Phase

6.4.3.3.1 *Water management dams*

Impact assessment

The Dirty Water Dam will remain for use with water treatment when required. The overburden dumps will be placed back into the shaft.

Potentially, there will be an increase in suspended solids in runoff from the site during clearing and material moving, but in most respects the removal of infrastructure will have positive benefits. The area will still be within the dirty water area, and as such, the impacts will be contained within the Dirty Water Dam.

There is therefore no impact expected during the decommissioning phase.

6.4.3.4 Post Closure

6.4.3.4.1 *Water management dams*

The Dirty Water Dam will be retained post closure so as to assist with management of the surplus water make, expected to require treatment within 80 to 100 years after closure unless stratification results in a water quality of an acceptable quality for discharge post closure. Financial provision has been made to treat the water if required.

6.4.4 Post-closure Residual Impacts

6.4.4.1 Surface water related residual impacts

The residual impact on surface water post closure relates to two primary aspects:

- Loss in yield associated with both non-freedraining areas and groundwater seepage lost from the catchment through drainage to the mined out areas.
- A potential impact on water quality associated with unplanned decant of water affected by mining.

Both of these issues have been discussed previously. However, the following should be noted:

- Non-freedraining areas are identifiable through mapping of the surface topography. Where these settlements occur on sloped areas, rehabilitation can be implemented to maximise the amount of water that can be returned to the catchment. This can

involve earth moving, plugging of cracks, and cutting of drainage canals. Nevertheless, it is inevitable that some loss of yield will remain.

- The potential for poor quality decant is a major concern on any mining project. At Shondoni, the mining is deep enough to allow water levels to be managed below the decant level.

If the water qualities do not stratify so that the decant quality is acceptable, water treatment will be implemented to ensure that poor quality decant does not affect the catchment.

6.5 Impact significance assessment summary tables

The potential impacts described above are quantified in Tables 6.5(a), (b), (c) and (d), attached, for the construction, operational, decommissioning and post closure phases respectively.

6.6 Cumulative impacts

Sasol Mining is the only coal mining operation that potentially impacts on the Waterval River catchment. This includes all of Sasol's Secunda mining complexes, with the exception of Syferfontein Colliery and TCTS.

At present all mining in the catchment is underground, with no current plans for opencast mining. Of the underground, the vast majority is bord & pillar, with some 25 to 30% of the mined out areas being high extraction.

The cumulative impact on catchment yield is therefore expected to be relatively low. In addition, with dirty water contained in underground workings, the impact on water quality is also expected to be relatively low.

Other industrial and mining activities that potentially impact on the Waterval River catchment include the Sasol Secunda Industrial Complex, as well as some gold mines in the vicinity.

7 SUMMARISED ENVIRONMENTAL MANAGEMENT MEASURES

In the previous chapters, various mitigation measures have been indicated to manage the impacts assessed. These measures need to be incorporated into an Integrated Water Management Plan that can be used to implement, audit and measure the performance of the water management measures detailed in the EMPR.

This section is intended only to provide inputs on the key aspects of the water management plan.

7.1 Construction phase

7.1.1 Key issues and objectives

- To prevent contamination of surface water runoff from the shaft construction and associated overburden dumps.
- To ensure that the required water management infrastructure is constructed in time ahead of mining.

7.1.2 Key strategies

Areas where impacts in terms of construction activities could occur are listed below.

- Construction of water management measures.
  - Dirty Water Dam and settling facility will be constructed prior to the shaft construction commencing.
  - Clean water diversion will be constructed upstream of the shaft area.
  - Pollution control measures at the plant area will also be constructed at the start of mining activities. This will include the clean water diversion system.

- Construction of the materials handling area.
  - The overburden dump will be within the dirty water area.
  - Emergency coal stockpile area also within dirty area.
  - Separate material excavated from the shafts, with topsoil placed separately to the hard rock material. The overburden dump is expected to contain carbonaceous material.

- Construction of Infrastructure.
  - The river crossings (for the conveyor) will be constructed. Note that the details for the crossings are included in the Water Use Licence applications.

7.1.3 Knowledge gaps

None.

7.2 Operational phase

7.2.1 Key issues and objectives

- To minimise the impact on catchment yield and water quality.

To identify and control surface water runoff that may be affected by mining, as well as the water balance associated with the mining operations, and to ensure the risk of spilling of this water to the clean catchment is:

- In line with licensing requirements
- Legislative requirements
- Commensurate with the risks to downstream users associated with this spillage. This is taken currently at a 2% risk in any one year, or the 1:50year flood occurrence.

To ensure adequate monitoring so that the objectives of the water management system can be met.

7.2.2 Key strategies

- Minimising yield loss

  Because all of the mining is underground, the actual surface disturbance and associated loss of yield is considered small.

  The loss of yield will be managed by keeping the disturbed footprint as small as is practical.

  Remediation of stooped areas, specifically making them free draining will be a key component to minimise the loss of yield.

- Managing the dirty water make.

  The objective is to keeping clean water clean with a 2% or lower risk of spilling to the dirty water system in any one year, and to prevent spilling of dirty water to the clean water system with a 2% or lower risk in any one year.

  Provision has been made to collect, store and reuse dirty water generated by the mining operation. The mine is committed to having a 2% or less risk of spilling in any one year, and the surface dam system has been sized to ensure that this risk can be achieved. The risk of spilling is a function of adequate storage on surface, reuse underground, and storage underground.

  Subject to calibration of the overall water balances, it is expected that some water may need to be pumped back to the plant area during extreme events for short periods. The water balances will be calibrated during mining to determine if and when additional surface storage is required.

7.2.3 Knowledge Gaps

The Shondoni mining operation has been planned up to a conceptual level. Detailed construction drawings have not yet been generated. Once the details are produced for the Water Use Licence, there will be a need to review the details in terms of the commitments made in the EMPR.

7.3 Decommissioning

7.3.1 Key issues and objectives

- To make the coal processing area freedraining.
- To remove all carbonaceous and mining related material at the shafts.
- To limit the risk of increased erosion downstream related off areas being rehabilitated, consequently impacting on water quality.

7.3.2 Key strategies

- The free draining issue.
  - At the coal processing area, all coal processing infrastructure will be removed, and carbonaceous material removed.
  - The overburden removed from the shafts will be placed back into the underground workings. The shaft area will be filled to ground level, topsoiled and rehabilitated. Allowance will be made for future settlement to ensure that the area remains free draining.
  - Any surplus material will be removed from the mining area.
  - All stooped areas will be monitored and managed to ensure they are free draining (as far as is practical) and are stable post mining.

- Erosion protection
  - The general area is vulnerable to erosion. During rehabilitation, the areas where grass has not yet established will be monitored to ensure there is not excessive erosion prior to the grass establishing, and where necessary additional erosion protection such as the use of dump rock or repair of gullies will be undertaken until such time that the rehabilitated surfaces can be shown to be sustainable.

7.3.3 Monitoring

Monitoring during the decommissioning will be based on the operational phase monitoring, adapted to suit the final works to be implemented during this phase. However, in terms of surface water this will be primarily downstream of the area as for the operational phase.

7.3.4 Knowledge gaps

No knowledge gaps identified.

7.4 Post Closure

7.4.1 Key issues and objectives

- To manage the post closure water make.

7.4.2 Key strategies

- Water management to avoid decant.

It is expected that the water level within the mine workings will recover over a period of 80 to 100 years from the date mining ceases. Eventually, if no management measures were implemented, water would decant at a predicted rate of around 8700 m^3/day, or around 100 l/s.

Water from the workings will be collected, and pumped to a water treatment facility. A full EIA will be undertaken for the water treatment plant if and when it is constructed, and this will include the necessary permits and licence applications.

Note that the mine is committed to responsible environmental management, which includes the containment and treatment (where necessary) of decant to ensure that there is no downstream impact on water quality associated with future decant from the mine.

7.4.3 Monitoring

Monitoring post closure will be undertaken only where required to prove the sustainability of the site. In terms of surface water, this relates primarily to managing the surface topography (monitoring for settlements), and water quality and levels within the mined out area.

7.4.4 Knowledge gaps

The water balance model and final qualities are conceptual, and will need to be verified over the operational life of the mine.

7.5 Summarised impacts and action plan

See **Table 7.5(a)** overleaf for a summary action plan, which includes a summary of the mitigation measures (as described above) to be taken for the possible environmental impacts that may occur, as well as the financial provision to be made for the mitigation and management measures identified.

Table 7.5(a) Action plan for the proposed Shondoni

Activity	Potential impact on environmental components	Mitigation Measures	Timeframe / frequency	Responsible Person
Mining Activity	Material from the shaft sinking activities	• Clean Water Cut-off System • Overburden Dump • Water Quality Monitoring • Possible Seepage to be considered to ensure water draining to dirty water system.	Construction Phase	
	Dewatering of water ingress to the shaft	• Water to be contained and not discharged	Construction Phase	
	Catchment Yield	• Disturbance to be kept to as small a footprint as possible • Stooped areas surface will to be inspected and modified to ensure they remain free draining as far as is practical.	Construction Phase	
	Water Quality	• Underground Storage • Re-use of dirty water • Water management containment facilities (lower than 2% risk of spilling p/a) • Provision for treatment of water for the period where surplus exists. • Monitoring and management of water balances	Construction Phase	
	Post Closure Decant	• Water level monitoring and water quality monitoring • Relevant Permitting and EIA studies to be undertaken prior to construction	Post Closure	

Activity	Potential impact on environmental components	Mitigation Measures	Timeframe / frequency	Responsible Person
Coal Handling Infrastructure	Civil activities related to the construction	No further Mitigation Envisaged	Construction Phase	
	Workshops, Offices and Stockyard Areas	• Cutting off clean water upstream of areas • Storage facilities have been provided to ensure a 2% or lower risk of spilling for the life of the project. • Equip wash bays and workshops with oil skimming facilities to remove oil and grease from wash down water. • Clean run-off directed around facilities and directed back to the clean water catchment. • The emergency coal stockpile area will be engineered with measures to contain seepage and minimise ingress to the groundwater system.	Operational Phase	
	Extreme flooding events	No further mitigation is proposed, given the low risk of occurrence.	Operational Phase	
	Coal Conveyance	Impacts will be minimised by: • Conveyor Rotated (dirty side up) • Conveyors boxed in at watercourse crossings.	Operational Phase	
	Water Quality	• Dirty water dam to remain in place during decommissioning and beyond. • Water quality monitoring and rehabilitation monitoring will be implemented during the decommissioning phase.	Decommissioning Phase	
Water Management Infrastructure	Construction of the water management measures	• Water quality monitoring downstream of the mining area. • If erosion is evident or the water quality monitoring indicated an increase in suspended solids, water management around the construction areas will be reviewed.	Construction Phase	

7.6 Financial Provision

For the operational phase, the water management costs are included in the infrastructure costs in most respects, including the Dirty Water Dam construction and associated canals.

In order to form the various storage compartments, seals will be required underground, and these could potentially cost of the order of R50 to R60 million in total although this is highly provisional and subject to confirmation once final designs are produced.

The financial provision related to water management during the operational phase and post closure includes the following:

- Construction of a collection system, bringing water to the centralised water treatment plant from the various mining areas. This is part of the operational water management, and has not been included in the financial provision for water treatment.
- Installation of a water treatment plant, treating up to 8700m^3/day of mine water, but varying from much less than this initially. The proposed financial provision is based on the final treatment plant size, with the option to pro-rata this over the life of the mine. Note that smaller plants are more expensive in terms of a unit rate of water treated due to economies of scale and have been priced accordingly.
- Construction of a pipeline to be able to discharge to the river system. The alternative to this is the construction of a distribution network providing clean water back to the municipality for use as drinking water. This has not been priced, and the potential income associated with the sale of water has also been excluded in the initial cost estimate.
- Storage for brine and sludge generated by the water treatment process, assuming that both liming and reverse osmosis will be required.

For future costs, a discount rate of 6% has been applied, with water treatment costs estimated at around R9/m^3 to take account of the possibility of elevated sodium in the water, and the potential revenue stream excluded.

These costs are based on water treatment costs obtained from a plant supplier running plants in the Witbank area adjusted for the expected water qualities in the Secunda area.

(a) Premature closure regarding water treatment

The costs to treat water post closure are given in Section C below. These costs will be reduced if mining ceases before the total area is mined out, but conversely, the discount rate will also be less significant due to treatment being required sooner than currently planned.

Estimates have been undertaken for closure after 10 years and 20 years, suggesting that the discounted treatment cost would be as follows: -

- For premature closure after 10 years, treating from 2095 approximately, the total discounted cost is R1.0 million.
- For premature closure after 20years, treating from 2075 approximately, the total discounted cost is R6.9 million.

Note that the above values are conservative in that the time to decant has been estimated at around 75 and 45 years after closure, respectively, which is sooner than the current predicted time to decant. However, there are uncertainties as to the exact available storage and the actual water make at the time, depending on the extent of total extraction at the point of closure.

(b) Decommissioning and final Closure of the operation

The costs associated with decommissioning relate to removal of infrastructure and backfilling of the shafts. These costs form part of the general closure costs and are not specific to surface water and are addressed by the mine elsewhere.

(c) Decommissioning and final Closure of the operation

The post closure management costs are given in **Table 7.6(a)**. Please note that the costs are based on having to treat water within 80 years of mining. This date takes cognisance of the possible variations in post closure water make implied in the groundwater modelling, as well as uncertainties on the overall storage due to possible collapse of certain mined out areas (high extraction mining). The overall costing is based on treatment by 2130, with possible cost savings should treatment be required only at 2145 (the upper limit of the predicted time to decant).

Table 7.6(a) Post closure water treatment costs for Shondoni

Post closure treatment		
CAPITAL COSTS		
Capital infrastructure	**Present day costs**	**Discounted costs**
Collection infrastructure not required (use operational infrastructure)	R 8,250,000	R 7,581
Water Treatment plant capital		
Initial cost (in 50years time)	R 156,600,000	R 143,909
Refurbishment cost (year 70 to 170)	R 156,600,000	R 18,143
Water Treatment plant brine disposal cost (initial capital taken as 75% of plant capital)	R 117,450,000	R 107,932
Distribution network - exclude for now		
Total capital costs	**R 438,900,000**	**R 277,565**
OPERATIONAL COSTS		
Annualised costs		
Water Treatment plant annualised operational cost	**Present day costs (annual)**	**Annual cost in first year of operation at 6% discount i.e. in 2060**
Operational cost	R 2,565,804,000	R 411,286
Income stream	R 1,282,902,000	R 205,643
Net annual cost	**R 1,282,902,000**	**R 205,643**
Total costs for 100years after treatment commences		
Water Treatment plant operational, over 100years from 2060	**Total costs at present day value**	**Discounted costs at 6% discount rate, total cost**
Operational cost	R 3,004,704,000	R 688,851
Income stream	R 1,282,902,000	R 205,643
Net cost	**R 1,721,802,000**	**R 483,208**

*Note: The costs of brine ponds is most likely a very conservative estimate, although it does represent recent costs for ponds for water treatment works. However, technology is fast reducing the volumes of brine to be managed, and options to more cost effectively manage the brine as opposed to building new brine ponds are progressing relatively quickly. Similarly, sludge volumes are reducing as options for producing materials from the sludge are being developed.

It is highly likely that from 2060, water will be of value, and options to sell the water to offset the operational water treatment costs are likely to be available, potentially fully offsetting the operational costs.

8 ENVIRONMENTAL MONITORING

The monitoring programme developed for Shondoni is detailed in Part 8.1 below. Sampling points will tie in with the baseline water quality sampling points, which have been planned so as to be upstream and downstream of the proposed surface infrastructure.

8.1 Monitoring programme

8.1.1 Surface water monitoring programme

It is proposed to monitor water quality upstream and downstream of the mining area, as well as downstream of the coal handling area. Being on the watershed, upstream sampling will not always be practical, but any impacts on the water system will be detected downstream.

The objective of the surface water monitoring system is to ensure that the water management systems perform according to specifications, to act as a pollution early warning system, to check compliance with license requirements and for reporting purposes. The objectives of these systems will be achieved if there is no impact (attributable to the mine) on the in-stream and downstream fitness for use criteria.

8.1.1.1 Sampling

The following sampling is proposed for surface water:

Table 8.1.1.1(a). Surface water quality variables to be monitored

Item	Variables
Regular (monthly) sampling	It is proposed to regularly sample for those constituents expected to be elevated in the mine water i.e. Electrical Conductivity, pH, TDS, SS, Cl, SO_4, Na, F, Fe, Al, Mn, Zn, Total Alkalinity, Ca, Mg, K, Total Hardness.
Every 6 months	Analyses to 95% charge balance will be undertaken at 6 monthly intervals, including all metals.

The samples will be grab samples taken from non-stagnant areas of the streams as far as is practical, with the following samples taken: -

- Filtered and unfiltered samples (where colloidal matter is found to significantly influence metal concentrations).
- Acid preservation of samples for the metals analyses.
- All samples will be analysed by an accredited laboratory.

8.1.1.2 Data management

Sasol Mining has a well developed data management system for water quality samples using database systems and GIS. These systems will be utilised for the Shondoni water quality data.

8.1.1.3 Reporting

Sasol Mining already reports on water qualities for their existing mines. Data for this new area will continue to be presented in graphic and tabular form indicating maximum, minimum and average values with information being submitted annually to DWAF or more frequently if required. As is currently the practice, these submissions are included in the annual EMA.

8.2 Performance assessment / Audit

In line with their ISO accreditation, the Sasol Mining environmental systems are audited on an annual basis. These audits will include Shondoni in future.

9 CONCLUSION

The outcomes of the various studies are given in the text and summarised in the executive summary. It is apparent that: -

- Sufficient storage is available underground to store the surplus water make for the life of mine and beyond.
- Dams will be required on surface only to manage the dirty water runoff from the workshop and stockpile areas.
- Post closure, water treatment of around 8700m^3/day will most likely be required unless stratification develops within the mined out workings resulting in a good water quality close to surface and at the decant points.
- Loss of yield associated with high extraction remains a concern that is difficult to manage, although the impacts can be mitigated by minimising the amount of ponding on surface over mined out areas, and by excluding the high risk areas from the mining plan. The loss of yield can also be offset by treatment of water and discharge to the catchment, although this may not be the most financially viable option if the water is treated to potable water quality.

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APPENDIX 5.8(A)

SPECIALIST REPORT
PLANT LIFE

Vegetation baseline survey and Environmental Impact Assessment for the Sasol Mining Middelbult (Block 8) Shondoni Project, Mpumalanga Province

Prepared by

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19 August 2010

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Appointment of specialist

David Hoare of David Hoare Consulting cc was commissioned by Wetland Consulting Services (Pty) Ltd to conduct a vegetation assessment for study area of the Middelbult (Block 8) area. The terms of reference were to undertake a vegetation study to describe the vegetation and flora in the Shondoni Project study area and to assess potential impacts by the project on vegetation and flora.

Details of specialist

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0040

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Fax: 086 550 2053
Email: dhoare@lantic.net

Summary of expertise

Dr. David Hoare:

- Registered professional member of The South African Council for Natural Scientific Professions (Ecological Science), registration number 400221/05.
- Founded David Hoare Consulting CC, an independent consultancy, in 2001.
- Ecological consultant since 1995.
- Conducted, or co-conducted, over 250 specialist ecological surveys as an ecological consultant.
- Published six technical scientific reports, 15 scientific conference presentations, seven book chapters and eight refereed scientific papers.
- Attended 15 national and international congresses & 5 expert workshops, lectured vegetation science at 2 universities and referee for 2 international journals.

Independence:

David Hoare Consulting cc and its Directors have no connection Sasol Mining. David Hoare Consulting cc is not a subsidiary, legally or financially, of the proponent, remuneration for services by the proponent in relation to this proposal is not linked to approval by decision-making authorities responsible for permitting this proposal and the consultancy has no interest in secondary or downstream developments as a result of the authorisation of this project. The percentage work received directly or indirectly from the proponent in the last twelve months is 0%.

Scope and purpose of report

The scope and purpose of the report are reflected in the "Terms of reference" section of this report

Indemnity and conditions relating to this report

The findings, results, observations, conclusions and recommendations given in this report are based on the author's best scientific and professional knowledge as well as available information. David Hoare Consulting cc and its staff reserve the right to modify aspects of the report including the recommendations if and when new information may become available from ongoing research or further work in this field, or pertaining to this investigation.

This report must not be altered or added to without the prior written consent of the author. This also refers to electronic copies of this report which are supplied for the purposes of inclusion as part of other reports, including main reports. Similarly, any recommendations, statements or conclusions drawn from or based on this report must make reference to this report. If these form part of a main report relating to this investigation or report, this report must be included in its entirety as an appendix or separate section to the main report.

TABLE OF CONTENTS

1. INTRODUCTION

1.1 Terms of reference

In June 2010 David Hoare Consulting cc was appointed by Wetland Consulting Services (Pty) Ltd to conduct a vegetation survey for the study area as part of the EMP amendment process.

The following was to be provided / undertaken:

- Provide a baseline vegetation description of the study area by expanding on an existing study that was undertaken for a smaller part of the study area (EkoInfo cc 2004). Since the original study was completed, the study area has been expanded. The instruction was to take the original study and expand it to include the added areas.
- Assess potential impacts on vegetation and flora using a supplied impact assessment methodology.

1.2 Limitations and exclusions

1. The field survey for this study was undertaken in the middle of winter. It is not possible at this time of the year to undertake any floristic data collection. Therefore, no additional floristic data was collected in the field. Previous data was, however, collected during an appropriate season and the purpose of the current study was to extrapolate this information to new areas adjacent to the previously studies area.

2. DESCRIPTION OF STUDY AREA

2.1 Study area

2.1.1 Location

The study area is situated to the west of the town of Secunda in the Mpumalanga Province (Figure 1). It includes portions of the original farms Driefontein 137 IS, Kinross 133 IS, Winkelhaak 135 IS, Ruigtekuilen 129 IS, Leeuwspruit 134 IS, Witkleifontein 131 IS, Kromdraai 128 IS, Zandfontein 139 IS, Springbokdraai 277 IS, Brakspruit 359 IR and Leeupan 532 IR. The study areas fall within the quarter degree squares 2628 BD, 2628DB, 2629AC and 2629CA.

2.1.2 Topography

The landscape consists of hills, plains and lowlands. A digital terrain model based on 20 m contour intervals was used to determine slope categories. Slopes in the 5° range dominate the area.

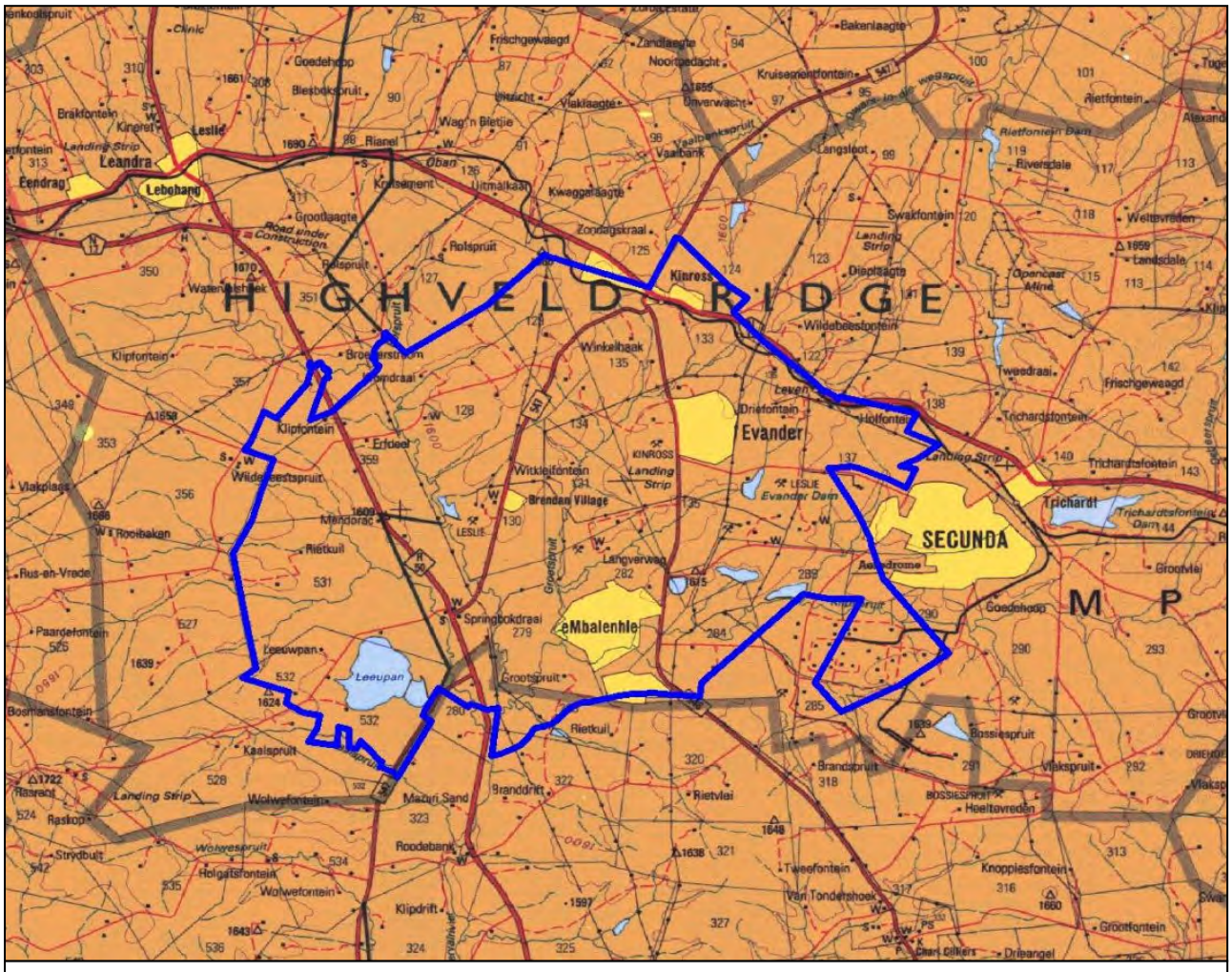

Figure 1: Location and boundaries of site.

2.1.3 Geology, soils and rainfall

Two stratigraphic units underlay the study area, namely sedimentary arenite and shale of the Vryheid Formation within the Ecca Group of the Karoo sequence and igneous Karoo dolerites. Karoo dolerites (Figure 2). Depending on their sequence and manner of exposure, these lithological units have an influence on the regional soil texture. Both the dolerites and shales are sources of fine textured soils. It is therefore expected that clayey soils would be common in the area.

The study area transects two land types (Land Type Survey Staff, 1987), the Bb and the Ea units (Figure 3). The Ea land type refers to dark, blocky clay topsoils (often swelling clays) and/or red, structured clays. This unit covers 83% of the area. The combined presence of the clayey soil form Arcadia across the crests, midslopes and foot slopes is 70% within this Ea land type unit. The Bb land type refers to moderately to highly leached, red soils with a plinthic catena. This unit covers

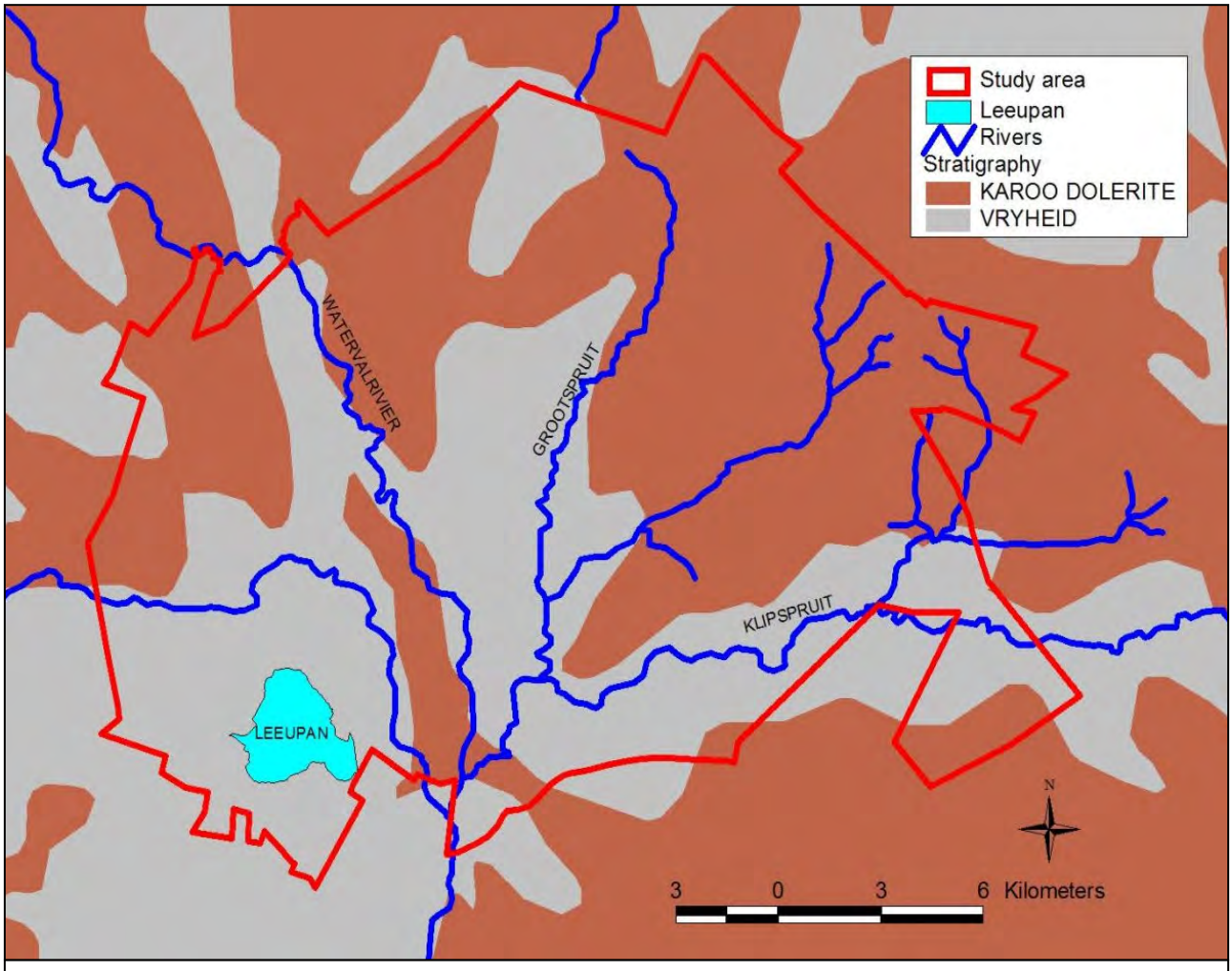

Figure 2: Lithological units of the site.

only 13% of the area. In this Bb land type unit, the same clayey soils are restricted to the valley bottoms. These clayey soils (Arcadia and Rensburg) are present within 50% of this terrain unit. Sandy soil forms cover the remaining terrain units of the Bb land type.

The rainfall in the study area is approximately 700 mm per annum and occurs mainly in the summer (Dent et al. 1989).

2.1.4 Landuse and landcover

A landcover map of the study area (Fairbanks *et al*. 2000) indicates that the site is within a grassland area that has been heavily impacted upon by cultivation. Mapped areas of cultivation are widespread on site on the Surveyor-General's 1:50 000 topocadastral map of the area. Mining and urbanisation have also led to significant amounts of transformation of natural vegetation. There are also various man-made and natural water-bodies on site and a few stands of alien trees.

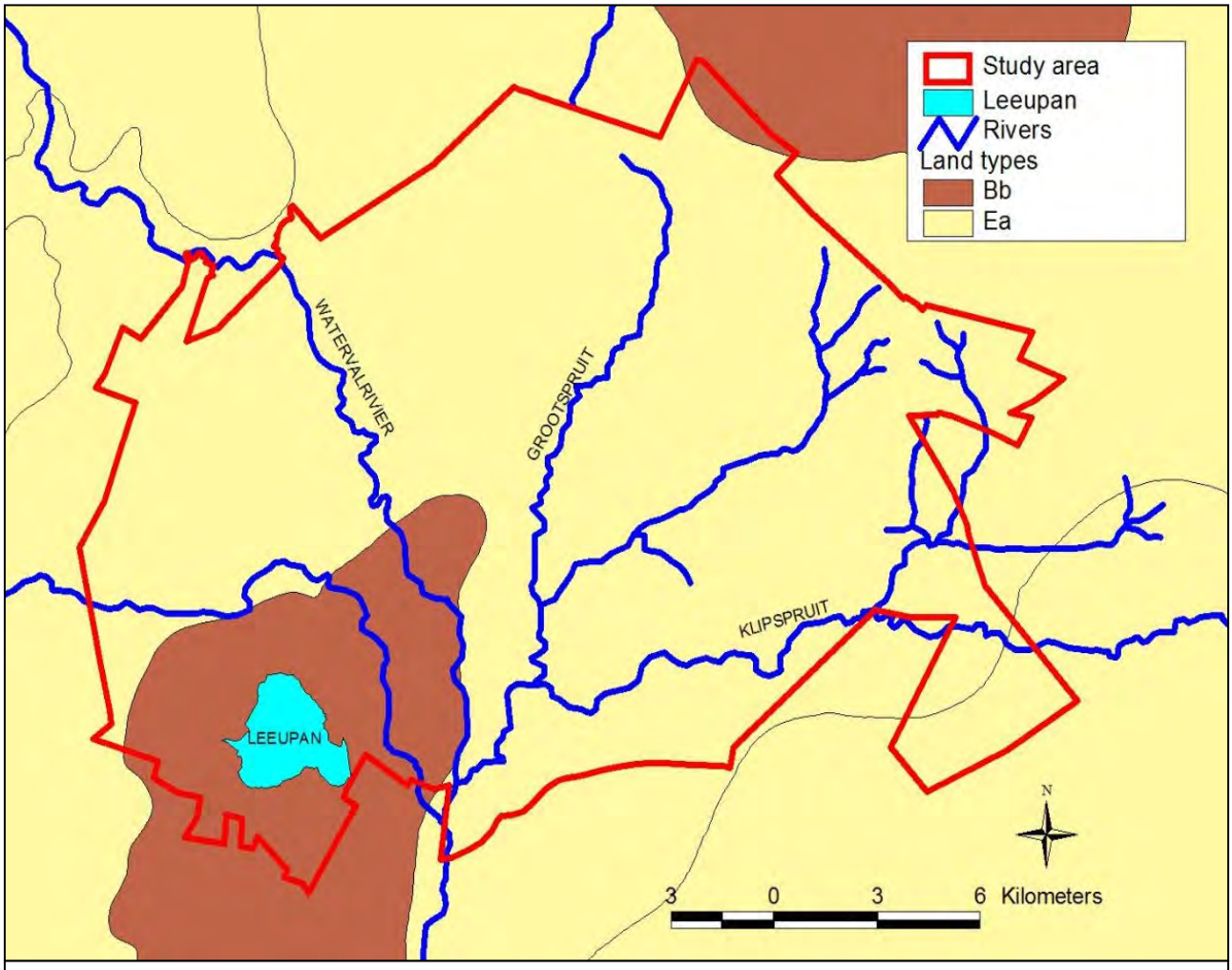

Figure 3: Land type units of the site.

2.2 Vegetation, biogeography and conservation value

The study area is located within the grassland biome of South Africa. The grassland biome, due to agricultural and mining activities is one of the most threatened biomes in South Africa. There are three general descriptions of the vegetation in the study area. Acocks (1953) published the first comprehensive description of the vegetation of South Africa, which was updated in 1988. This was followed by an attempted improvement (Low & Rebelo 1998) which became widely used due to the inclusion of conservation evaluations for each vegetation type, but is often less rigorous than Acocks's original publication. Recently, a more detailed map of the country was produced (Mucina *et al.*, 2005). A companion guide to this map (Mucina & Rutherford 2006), containing up-to-date species information and a comprehensive conservation assessment of all vegetation types, has just been published. The classification of the vegetation according to the most recent publication is given below and the distribution of different vegetation types across the study area is shown in Figure 4.

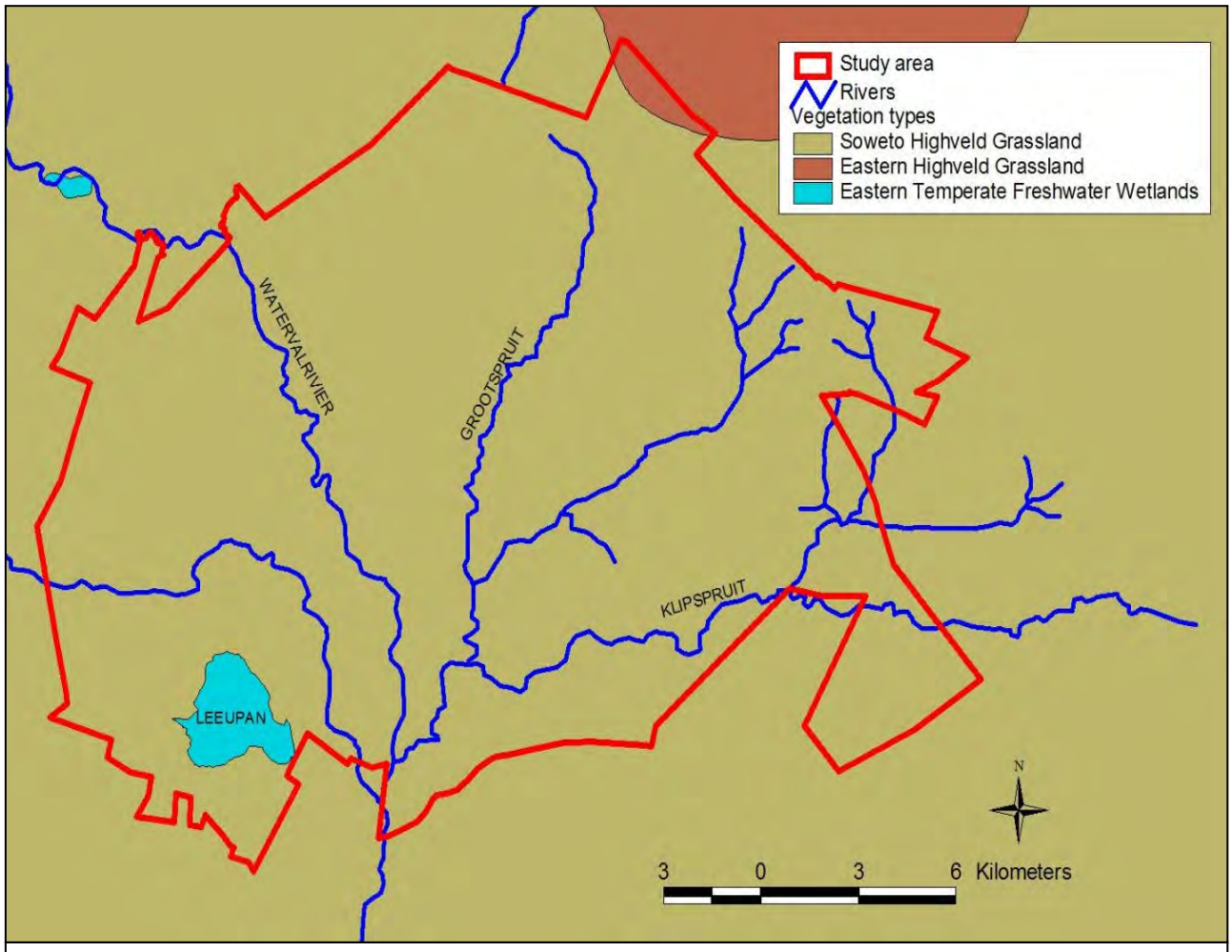

Figure 4: Vegetation types of the site.

According to this most recent vegetation map of the country the study area falls within one main vegetation type, namely Soweto Highveld Grassland. There is also a small area of Eastern Highveld Grassland and Leeupan is classified as Eastern Temperate Freshwater Wetlands.

According to (Mucina et al., 2006), Soweto Highveld Grassland occurs on gently to moderately undulating landscapes. There is a continuous grassland cover that is only occasionally interrupted by small wetlands, narrow stream alluvia, pans and ridges or rocky outcrops. Soweto Highveld Grassland occurs on shale, sandstone or mudstone of the Madzarawinge Formation or the intrusive Karoo Suite dolerites. Soils are deep, reddish on flat plains and are typically Ea, Ba and Bb landtypes. The vegetation is described as a short to medium-high, dense, tufted grassland dominated almost entirely by *Themeda triandra* accompanied by other grasses such as *Elionurus muticus*, *Eragrostis racemosa*, *Heteropogon contortus* and *Tristachya leucothrix*. A more complete list of expected species in undisturbed Soweto Highveld Grassland include the following:

Graminoids (dominant): *Andropogon appendiculatus*, *Brachiaria serrata*, *Cymbopogon pospischilii*, *Cynodon dactylon*, *Elionurus muticus*, *Eragrostis capensis*, *Eragrostis chloromelas*, *Eragrostis curvula*, *Eragrostis plana*, *Eragrostis planiculmis*, *Eragrostis racemosa*, *Heteropogon contortus*, *Hyparrhenia hirta*, *Setaria nigrirostris*, *Setaria sphacelata*, *Themeda triandra*, *Tristachya leucothrix*.

Graminoids (accompanying): *Andropogon schirensis*, *Aristida adscensionis*, *Aristida bipartita*, *Aristida congesta*, *Aristida junciformis*, *Cymbopogon caesius*, *Digitaria diagonalis*, *Diheteropogon amplectens*, *Eragrostis micrantha*, *Eragrostis superba*, *Harpochloa falx*, *Michrochloa caffra*, *Paspalum dilatatum*.

Herbs: *Hermannia depressa* (d), *Acalypha angustata*, *Berkheya setifera*, *Dicoma anomala*, *Euryops gilfillanii*, *Geigeria aspera*, *Graderia subintegra*, *Haplocarpha scaposa*, *Helichrysum miciniifolium*, *Helichrysum nudifolium*, *Helichrysum rugulosum*, *Hibiscus pusillus*, *Justicia anagalloides*, *Lippia scaberrima*, *Rhynchosia effusa*, *Schistostephium crataegifolium*, *Selago densiflora*, *Senecio coronatus*, *Vernonia oligocephala*, *Wahlenbergia undulata*

Geophytes: *Haemanthus humilis*, *Haemanthus montanus*

Herbaceous climbers: *Rhynchosia totta*

Low shrubs: *Anthospermum hispidulum*, *Anthospermum rigidum* subsp. *pumilum*, *Berkheya annectens*, *Felicia muricata*, *Ziziphus zeyheriana*.

Soweto Highveld Grassland is classified by Mucina et al. (2006) to be Endangered, with none conserved and at least 45% transformed, mostly by urbanization (8%), which is spreading rapidly, and cultivation (36%). The Draft National List of Threatened Ecosystems (GN1477 of 2009), published under the National Environmental Management: Biodiversity Act (Act No. 10, 2004), lists this vegetation type as Vulnerable.

There is a very small area of Eastern Highveld Grassland on site, just to the north of Kinross. Eastern Highveld Grassland is described as occurring on slightly to moderately undulating plains including some low hills and pan depressions (Mucina *et al*., 2006). The conservation status of this vegetation type is Endangered (Driver *et al*., 2005 and Mucina *et al*., 2006), and whilst the conservation target is 24%, only a small extent is currently protected and 44% is considered to be transformed, mostly by cultivation, urbanization, forestry, building of dams and mining (Mucina & Rutherford, 2006). The Draft National List of Threatened Ecosystems (GN1477 of 2009), published under the National Environmental Management: Biodiversity Act (Act No. 10, 2004), lists the Eastern Highveld Grassland vegetation type as Vulnerable.

The vegetation of the Ba, Bb, Ea and Ib land types in this region (just to the south of the site) has been studied in some detail (Breytenbach 1991, Breytenbach et al. 1993a, b, c), although data is not presented in a geo-referenced format. There is therefore some information that can be used to place the current study area in context (see Mucina et al. 2000), as well as the broad descriptions of Acocks (1953, 1988) and Low and Rebelo (1998) as well as the more-recently compiled national vegetation map (Mucina & Rutherford 2006).

Within the Bb land type Breytenbach (1991) identifies three plant communities:

1. The high-lying *Cynodon dactylon – Pogonarthria squarrosa* Grassland on deep (>900 mm) sandy soils;
2. the *Themeda triandra – Aristida sciurus* Grassland on shallow (<300 mm) rocky soils; and
3. the low-lying *Eragrostis curvula – Eragrostis plana* Grassland on the floodplains.

The environmental factors, which influence the distribution of these communities and sub-communities, are firstly soil texture and secondly soil moisture conditions. Community one (listed above) is mainly associated with well-drained sandy soils, while communities two and three (listed above) are associated with good to poorly drained clayey and clayey-loam soils.

During his study of the Ea land type Breytenbach (1991) distinguished between high-lying and low-lying areas, each with its own mosaic of communities and sub-communities (Breytenbach 1993). He identified the following sub-communities within the low-lying *Themeda triandra – Eragrostis curvula* Grassland:

1. *Eragrostis curvula – Pogonarthria squarossa* Grassland
2. *Themeda triandra – Elionurus muticus* Grassland
3. *Themeda triandra – Chaetacanthus burchellii* Grassland
4. *Eragrostis curvula – Schoenoplectus decipiens* Grassland
5. *Eragrostis curvula – Eragrostis plana* Grassland

Two of these communities namely the *Themeda triandra – Elionurus muticus* Grassland and the *Themeda triandra – Chaetacanthus burchellii* Grassland were divided into seven sub-communities. The environmental factors that influence the distribution of these communities are also soil texture with four of the five associated with clayey soils, while altitude is important in terms of location and terrain unit.

Within the high-lying *Themeda triandra – Heteropogon contortus* Grassland area Breytenbach identified two communities of which one has two sub-communities:

1. *Diospyros lyciodes – Eragrostis curvula* Shrubland
2. *Themeda triandra – Elionurus muticus* Grassland

The latter was divided into two sub-communities. Altitude plays a key role in the distribution of these communities and sub-communities.

In both articles Breytenbach mentions the effects and threats of poor veld management on the environment and society and the need to improve the management and conservation of these renewable resources.

3. METHODOLOGY

The main data collection for this project was undertaken for a previous study at the site (EkoInfo cc 2004). The results from this previous study have been used to extrapolate the existing vegetation map into the additional areas covered by the present study. The methodology provided below is paraphrased from the original report (EkoInfo cc 2004).

3.1 Vegetation survey

Literature surveys and Internet and Geographic Information System (GIS) reviews were completed to obtain a broad environmental overview of the area. A preliminary species list was obtained from the National Botanical Institute based on the relevant quarter degree map. This information was used to determine whether any rare or endangered species had been collected from the area. The results of this assessment were used to compile an identity kit of any rare or endangered species.

Homogenous units were delineated on the preliminary soil map of the proposed mining area. The homogenous areas were based on texture and expected soil moisture characteristics of the area. Plots were placed within homogenous units, with the aid of a Geographic Information System (GIS). The coordinates of the plots were then exported to a GPS receiver for navigation in the field. Actual location in the field was recorded within a 5 m accuracy interval.

At each plot, the following abiotic attributes were documented:

a. Topography – altitude, terrain unit, percentage slope

b. Soil – soil form, soil depth (mm), erosion, estimated percentage clay of A horizon

c. Estimated percentage rock cover – gravel, small, medium, large

The following overall vegetation characteristics were documented:

1. Vegetation cover – total, trees, shrubs, herbs, open water, rock
2. Estimated average height of trees, shrubs and herbs – highest and lowest categories

A list of all species within an approximate 200 m2 area was recorded in the following growth form categories: grasses, forbs and woodies. Cover abundance values were estimated for each species within the plot. Unknown species or potential red data species were identified using field guides (Van Oudtshoorn 1991, Van Wyk & Malan 1988), the University of Pretoria's herbarium and specialists from the National Botanical Institute.

The survey results were entered into a relational database4 for record purposes and analysis of the abiotic and vegetation characteristics. The species data was entered into TURBOVEG (Hennekens 1996) and analysed with MEGATAB (Hennekens 1996). A vegetation map was compiled, based on the results of the phytosociological table and boundaries of the homogenous units.

4. RESULTS

The following section provides a description of the floristic environment that may be affected by the proposed development. This description includes patterns of flora and vegetation within the study area. The results are based on the original survey undertaken for the site (EkoInfo 2004) and extrapolated to include the additions to the study area.

4.1 Vegetation patterns on site

Two plant communities and four variations were identified during the original vegetation survey within the study area (EkoInfo 2004). These communities are:

1. *Themeda triandra – Berkheya carlinopsis* Grassland Community on clayey soils
    a. *Themeda triandra – Berkheya carlinopsis – Cirsium vulgare* Low lying variation
    b. *Themeda triandra – Berkheya carlinopsis – Elionurus muticus* High lying variation

2. *Hyparrhenia hirta – Helichrysum nudifolium* Grassland Community on sandy soils
    a. *Hyparrhenia hirta – Helichrysum nudifolium – Trichoneura grandiglumus* Over utilised variation
    b. *Hyparrhenia hirta – Helichrysum nudifolium – Commelina africana* Disturbed variation

An indication of the floristic relationship of these communities to one another and the environmental attributes that distinguish them is provided in Figure 5. As it was not possible to map the distribution of the four variations due to the extent of the study area and the complexity of the landscape, only the potential distribution of the two major communities were mapped based on the distribution of sandy and clayey soils (Figure 6). The map also reflects the overall distribution of riparian wetlands within the area, of which only a general opinion was formed during the survey of the terrestrial vegetation and is dealt with in more detail in the wetland survey by other specialists.

Summarised descriptions of the two major plant communities are provided below. for a more detailed description, refer to the original report by EkoInfo (2004).

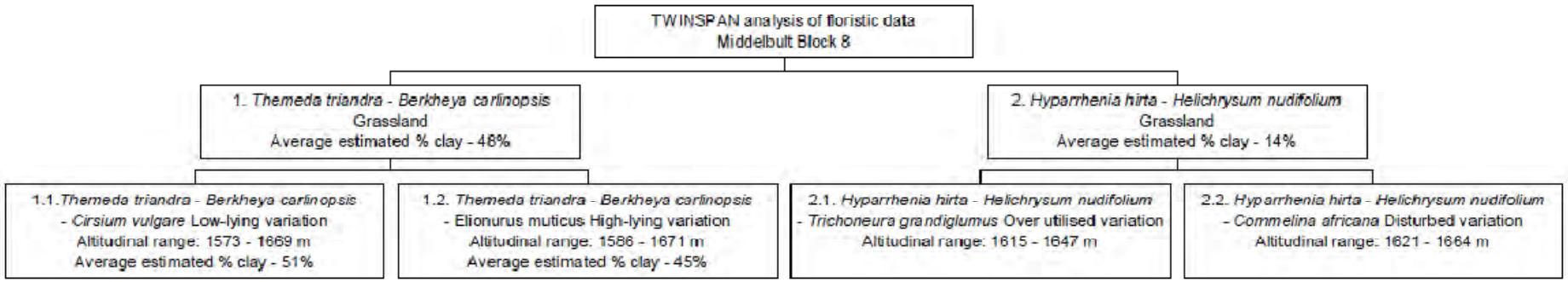

Figure 5: Dendrogram of floristic data showing four data clusters and their environmental attributes (EkoInfo 2004).

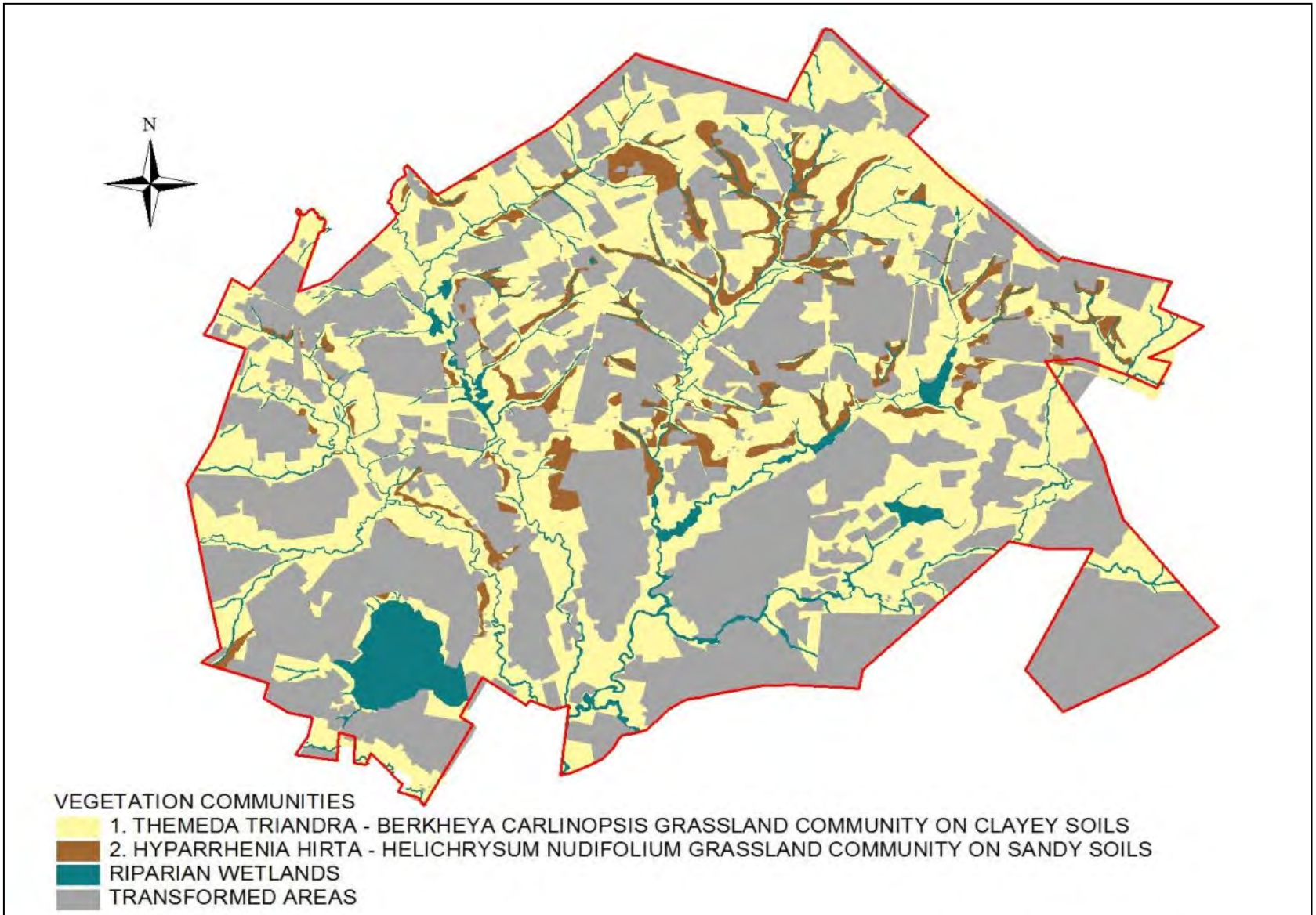

Figure 6: Distribution of main vegetation units based on soil texture.

4.1.1 Themeda triandra – Berkheya carlinopsis Grassland Community on clayey soils

The *Themeda triandra – Berkheya carlinopsis* Grassland Community on clayey soils represents approximately 44% of the study area and 83% of the natural vegetation. It is associated with clayey soils of which the average estimated clay content is 48%. Common, dominant and characteristic species are provided in Appendix 1. Two variations were identified within this community during the survey of which the *Themeda triandra – Berkheya carlinopsis – Cirsium vulgare* Low lying variation is associated with the valley bottoms and low-lying areas within the study area. This community is over utilised by livestock because it is en route to water and is higher in nutrients and soil moisture and therefore more palatable to livestock than the surrounding high-lying areas. The *Themeda triandra – Berkheya carlinopsis – Elionurus muticus* High lying variation is associated with the areas above the valley bottom to the crests. It has the most extensive distribution of the two variations and reflects both natural and human influences ranging from over utilisation to high species diversity.

4.1.2 Hyparrhenia hirta – Helichrysum nudifolium Grassland Community on sandy soils

The *Hyparrhenia hirta – Helichrysum nudifolium* Grassland Community on sandy soils occurs as islands or stands within the larger *Themeda triandra – Berkheya carlinopsis* Grassland Community on clayey soils. It is associated with sandy soils of which the average estimated clay content is 14%. This community represents approximately 8% of the study area and 17% of the natural vegetation. This does not reflect the true distribution of the sandy soils nor the vegetation associated with the soils, as large areas of the sandy soils have been transformed for cultivation. Common, dominant and characteristic species are provided in Appendix 1. The two variations identified during the survey, reflect this trend. The *Hyparrhenia hirta – Helichrysum nudifolium – Trichoneura grandiglumus* over utilised variation represents a community which has not been mechanically disturbed, but is used for grazing and whose condition can be improved through management. The *Hyparrhenia hirta – Helichrysum nudifolium – Commelina africana* Disturbed variation represents old fields or areas on the border of cultivated fields which had been abandoned due to water logging or change in land use.

4.1.3 Riparian Wetlands

The riparian wetlands found within this area are representative of floodplain/vlei's. The reed, *Phragmites australis*, and bulrush, *Typha capensis*, are characteristic of the floodplain/vlei's. The species composition of the riparian fringes is similar to terrestrial vegetation up to where the streambed starts or open water is found, but may include a high number of facultative wetland

species that would not ordinarily be found in terrestrial grassland. On the storage floodplains the location of the oxbow lakes are indicated by a change in vegetation from mesophytic species to hydrophytic species, especially sedges. The levees along the riparian wetland are eroded in most places and are degraded through trampling and over-utilization by livestock. Aesthetically appealing species found in the vicinity of the riparian wetlands include the shrub, *Erythrina zeyheri*, and the geophytes, *Nerine krigei* and *Haemanthus montanus*.

4.2 Red List Plant Species

The objective of this section was to compile a list of plant species for which there is conservation concern that may be affected by the proposed infrastructure. This includes threatened, rare, declining and protected plant species.

Lists of plant species previously recorded in the quarter degree grids in which the study area is situated were obtained from SANBI. This list contains 10 species, listed in Appendix 3 together with their conservation status categories according to the IUCN Version 3.1 criteria (IUCN, 2001). Relevant information, such as habitat, flowering time, etc., is given for all species listed. Five of these species are listed as Near Threatened and five as Declining (see Table 1 for explanation of IUCN categories).

Table 2: Explanation of IUCN Ver. 3.1 categories (IUCN, 2001), and Orange List categories (Victor & Keith, 2004).

IUCN category	Definition	Class
EX	Extinct	Extinct
CR	Critically Endangered	Threatened
EN	Endangered	Threatened
VU	Vulnerable	Threatened
NT	Near Threatened	Orange List
Declining	Least Concern, declining taxa	Orange List
Rare	Least Concern, rare	Orange List
Critically Rare	Least Concern, rare: only one subpopulation	Orange List
LC (Rare-Sparse)	Least Concern, rare: widesly distributed but rare	Orange List
DDD	Data Deficient: well known but not enough information for	Orange List

	assessment	
DDT	Data Deficient: taxonomic problems	Data Deficient
DDX	Data Deficient: unknown species	Data Deficient
LC	Least Concern	Least Concern

Of the 10 potential red data species three Declining species were recorded during the survey. They were *Boophane disticha*, *Eucomis autumnalis* subsp. *clavata* and *Hypoxis hemerocallidea*. On the basis of information, six of the remaining seven species were considered to have a high chance of occurring in the type of habitats available on site.

4.3 Protected Plant Species

ALL of the species from the genus *Gladiolus* and ALL the species from the family Orchidacea are protected in terms of the Mpumalanga Conservation Act's list of protected flora. Species previously recorded in surveys on site and within the quarter degree grid in which the study area is found are the following:

- *Bonatea speciosa*
- *Eulophia welwitschii*
- *Gladiolus crassifolius*
- *Gladiolus robertsoniae*
- *Gladiolus sericeovillosus* subsp. *calvatus*
- *Gladiolus elliotii*

4.4 Sensitivity assessment

The sensitivity assessment is an attempt to identify those parts of the study area that may have high conservation value or that may be sensitive to disturbance. Areas containing untransformed natural vegetation, high diversity or habitat complexity, Red List organisms or systems vital to sustaining

ecological functions are considered sensitive. In contrast, any transformed area that has no importance for the functioning of ecosystems is considered to have low sensitivity.

According to the Mpumalanga C-plan version there are some sensitive features in and around the study area, as follows (Figure 7):

1. the eastern side of Leeupan is classified as Irreplaceable.
2. Vegetation associated with the Watervalrivier and the Wildebeesspruit, as well as most of the remaining habitat along the northern third of the site and a small area of grassland to the south-west of Evander, are classified as Highly Significant.

Additional requirements, as per other environmental legislation are as follows:

1. All remaining untransformed grasslands in South Africa are considered to have high sensitivity and conservation value.

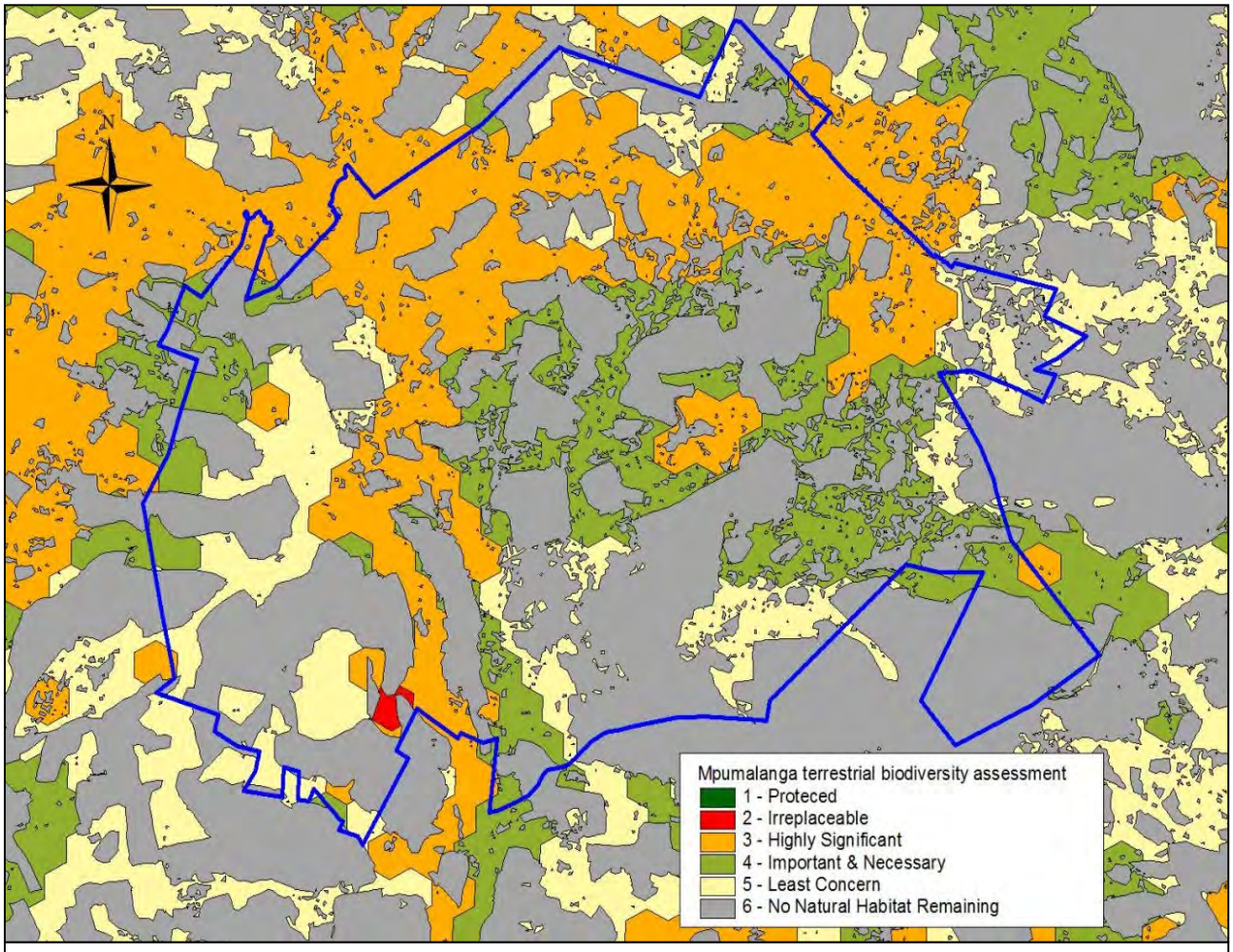

Figure 7: Sensitive parts of site, according to Mpumalanga C-Plan

The site is situated within an area that contains patches of primary grassland that occurs within the Endangered vegetation type, Soweto Highveld Grassland. There are various parts of the site that contain grassland with good species composition that is considered to be reasonably good quality Soweto Highveld Grassland.

Table 2: Factors contributing to sensitivity classification of habitats on site.

Vegetation/habitat type	**Sensitivity**	**Reason**
Grassland	High	• representative of an endangered vegetation type (Soweto Highveld Grassland) • protected under National Environmental Management: Biodiversity Act (draft ecosystem list)
Wetlands	High	• habitat in main drainage lines classified as wetlands (National Water Act).

5. IMPACT ASSESSMENT

5.1 Constraints and limitations of impact assessment

There were no major constraints or limitations associated with this assessment. Of minor concern was the fact that this study and assessment was undertaken in winter, but was based on detailed data collected during the growing season. The potential limitations of this approach are addressed by recommending a follow-up survey for threatened plants in the footprint of proposed infrastructure during the flowering season of those species that could potentially occur on site.

5.2 Impact assessment

A summary of impacts and the significance of impacts is provided in spreadsheet format. The spreadsheet accompanies this report. A summary of key findings is given below.

5.3 Cumulative impacts

The proposed project is within a relatively disturbed landscape. From a vegetation and flora point of view, there has been a large amount of change within vegetation in this region. This has led to vegetation types within the study area being classified according to the Draft National List of Threatened Ecosystems (GN1477 of 2009), published under the National Environmental Management: Biodiversity Act (Act No. 10, 2004) as Vulnerable. Additional loss of vegetation in the study area may further reduce the extent of vegetation, but will be a relatively small change compared to existing change due primarily to cultivation, urban expansion and other mining. The current project proposes underground mining with a small proportion of above-ground infrastructure. There will therefore be a small cumulative impact by this project, when taken in combination with existing changes in the area.

5.4 Environmental management measures

A small number of management measures are proposed to reduce potential impacts on vegetation and flora. These are the following:

- demarcate development areas and keep all activities within, i.e. attempt to avoid impacts on sensitive areas
- compile an alien plant management plan,
- control dust,

- undertake plant rescue for medicinal plant populations within the footprint of proposed infrastructure,
- undertake surveys within the footprint of proposed infrastructure during suitable season for detecting Red List plant species.
- determine minimum water quantity and quality requirements for maintaining ecosystem function, as per "Surface Water Assessment" and "Aquatic Ecosystem Assessment" and keep within these limits.
- prevent contamination of water in natural systems.

5.5 Monitoring requirements

The control of alien plants is required according to the *Conservation of Agricultural Resources (Act No. 43 of 1983) as amended in 2001*, as follows:

Declared Weeds and Invaders in South Africa are categorised according to one of the following categories:

- Category 1 plants: are prohibited and must be controlled.
- Category 2 plants: (commercially used plants) may be grown in demarcated areas providing that there is a permit and that steps are taken to prevent their spread.
- Category 3 plants: (ornamentally used plants) may no longer be planted; existing plants may remain, as long as all reasonable steps are taken to prevent the spreading thereof, except within the floodline of watercourses and wetlands.

The identification of all individuals of listed alien plants is required. An annual or biennial census of the density and distribution of alien plants within the mine controlled above-ground areas is required. A botanist must search the mine property for alien plants, obtain a latitude/longitude position for each plant and identify the species.

The protection of endangered ecosystems is required according to the *National Environmental Management: Biodiversity Act (Act No 10 of 2004)*

In terms of the Biodiversity Act, the developer has a responsibility for:

- The conservation of endangered ecosystems and restriction of activities according to the categorisation of the area (not just by listed activity as specified in the EIA regulations).

- Promote the application of appropriate environmental management tools in order to ensure integrated environmental management of activities thereby ensuring that all development within the area are in line with ecological sustainable development and protection of biodiversity.
- **Limit further loss of biodiversity and conserve endangered ecosystems**.

As per point three (above), it is important to ensure that no unnecessary impacts on natural systems are permitted on site since all remaining vegetation on site falls within listed ecosystems (Draft National List of Threatened Ecosystems (GN1477 of 2009), published under the National Environmental Management: Biodiversity Act (Act No. 10, 2004)).

The boundaries of sensitive areas must be demarcated (can be in GIS system). A regular census is required to ensure that transformation or degradation of these areas does not take place. This can take the form of a visual inspection of natural areas at regular intervals to ensure that boundaries are not transgressed. More detailed assessments can take place at longer intervals (~5years), where floristic data is collected at sites included in the original vegetation survey (EcoInfo 2004 - GPS locality data and original floristic data will have to be procured) and an assessment is made of species compositional change. This will provide an indication of directional change in species composition that would indicate degradation as opposed to cyclical changes that occur in natural systems.

It is assumed that monitoring requirements in wetlands, which also include natural vegetation and plant species, is covered in the "Surface Water Assessment".

5.6 Summary of key findings

Construction Phase impacts include the following:

- habitat destruction,
- loss of populations of threatened plant species,
- loss of populations of medicinal plant species,
- alien plant invasions,
- habitat fragmentation,
- habitat deterioration,
- change in physical abiotic conditions

The severity score for all of these impacts is moderate (severity score of C2, C3 or C4) and the overall significance of any impact does not exceed Level 3 and is Level 4 in most cases, which is moderate to low.

Operational Phase impacts include the following:

- alien plant invasions,
- habitat deterioration,
- change in physical abiotic conditions

The severity score for all of these impacts is moderate (severity score of C3) and the overall significance of any impact does not exceed Level 4 and is Level 4 or 5 in most cases, which is moderate to low.

Decommissioning Phase impacts include the following:

- habitat destruction,
- loss of populations of threatened plant species,
- loss of populations of medicinal plant species,
- habitat fragmentation

The severity score for all of these impacts is moderate (severity score of C2 or C3) and the overall significance of any impact is Level 6 in all cases, except 1, which is Level 5. The significance of impacts is therefore low.

Post-closure Phase impacts include the following:

- habitat destruction,
- loss of populations of threatened plant species,
- loss of populations of medicinal plant species,
- habitat fragmentation

The severity score for all of these impacts is moderate (severity score of C2 or C3) and the overall significance of any impact is Level 6 in all cases, except 1, which is Level 5. The significance of impacts is therefore low.

The severity score for all of these impacts is moderate (severity score of C3) and the overall significance of any impact does not exceed Level 4 and is Level 4 or 5 in most cases, which is moderate to low.

6. CONCLUSIONS

The requirements of this study were to undertake a specialist study to describe the vegetation and flora in the study area. The vegetation study identified two major grassland plant communities as well as wetland vegetation in drainage lines. The grassland is within a grassland vegetation type called Soweto Highveld Grassland, which is classified as Endangered and listed in the Draft List of protected ecosystems (National Environmental Management: Biodiversity Act). It is a high conservation priority nationally. All remaining areas of natural grassland are therefore considered to have high conservation value and ecological sensitivity. All wetlands are considered to be ecologically sensitive. Where natural wetland vegetation still occurs, this is considered to be an important biodiversity resource and is therefore also classified as having elevated sensitivity and conservation value. Remaining natural grasslands and all areas of wetland vegetation should be considered to have HIGH sensitivity. Remaining areas have LOW sensitivity.

The most serious impacts associated with the proposed mine infrastructure will occur during the construction phase and include the following:

- habitat destruction,
- loss of populations of threatened plant species,
- loss of populations of medicinal plant species,
- habitat fragmentation,
- alien plant invasions,
- habitat deterioration,
- change in physical abiotic conditions

The last three impacts on this list may also occur during the operational phase of the project. The potential significance of impacts on vegetation and flora were assessed as being moderate.

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APPENDIX 1: Braun-Blanquet table of the Middelbult Block 8 vegetation (EkoInfo 2004).

Community	1		2		1		2		1		2	
Variations	1.1	1.2	2.1	2.2	1.1	1.2	2.1	2.2	1.1	1.2	2.1	2.2
Explanation	% Constancy of species per cluster				% Fidelity of species				Cluster no of species			
Clusters	1	2	3	4	1	2	3	4 %	1	2	3	4 Synoptic
SPECIES GROUP A												
Berkheya carlinopsis	96	71	0	0	1	1	0	0	50	1	2	0 0 1200
Setaria sphacelata	93	46	17	0	1	1	0	0	50	1	2	0 0 1200
Cymbopogon excavatus	48	57	17	0	1	1	0	0	50	1	2	0 0 1200
Senecio affinis	41	29	0	0	1	1	0	0	50	1	2	0 0 1200
Turbina oblongata	33	64	0	0	1	1	0	0	50	1	2	0 0 1200
Hypoxis rigidula	33	57	17	0	1	1	0	0	50	1	2	0 0 1200
Chaetacanthus costatus	33	36	0	0	1	1	0	0	50	1	2	0 0 1200
Anthospermum rigidum	30	46	17	0	1	1	0	0	50	1	2	0 0 1200
Aristida bipartita	30	39	0	0	1	1	0	0	50	1	2	0 0 1200
SPECIES GROUP B												
Cirsium vulgare	41	4	0	0	1	0	0	0	25	1	0	0 0 1000
Solanum panduriforme	30	18	0	0	1	0	0	0	25	1	0	0 0 1000
Hibiscus trionum	26	7	0	0	1	0	0	0	25	1	0	0 0 1000
Schkuhria pinnata	26	11	0	0	1	0	0	0	25	1	0	0 0 1000
Digitaria eriantha	26	7	0	0	1	0	0	0	25	1	0	0 0 1000
SPECIES GROUP C												
Elionurus muticus	11	71	17	0	0	1	0	0	25	0	2	0 0 0200
Brachiaria serrata	15	57	17	0	0	1	0	0	25	0	2	0 0 0200
Haplocarpha scaposa	22	50	0	0	0	1	0	0	25	0	2	0 0 0200
Helichrysum pilosellum	7	39	0	0	0	1	0	0	25	0	2	0 0 0200

Community	1		2		1		2		1		2	
Variations	1.1	1.2	2.1	2.2	1.1	1.2	2.1	2.2	1.1	1.2	2.1	2.2
Explanation	% Constancy of species per cluster				% Fidelity of species				Cluster no of species			
Clusters	1	2	3	4	1	2	3	4 %	1	2	3	4 Synoptic
Chlorophytum fasciculatum	19	39	17	0	0	1	0	0 25	0	2	0	0 0200
Hermannia depressa	15	39	17	0	0	1	0	0 25	0	2	0	0 0200
Indigofera species	15	43	0	0	0	1	0	0 25	0	2	0	0 0200
Hypoxis hemerocallidea	15	36	17	0	0	1	0	0 25	0	2	0	0 0200
Cyanotis speciosa	0	29	0	0	0	1	0	0 25	0	2	0	0 0200
SPECIES GROUP D												
Helichrysum nudifolium	7	4	100	100	0	0	1	1 50	0	0	3	4 0034
Eragrostis gummiflua	0	7	83	67	0	0	1	1 50	0	0	3	4 0034
Stoebe vulgaris	0	0	67	100	0	0	1	1 50	0	0	3	4 0034
Eragrostis curvula	19	14	67	33	0	0	1	1 50	0	0	3	4 0034
Helichrysum aureonitens	0	11	50	67	0	0	1	1 50	0	0	3	4 0034
Helichrysum callicomum	0	0	50	33	0	0	1	1 50	0	0	3	4 0034
Walafrida tenuifolia	4	7	33	33	0	0	1	1 50	0	0	3	4 0034
SPECIES GROUP E												
Trichoneura grandiglumus	0	0	67	0	0	0	1	0 25	0	0	3	0 0030
Crabbea acaulis	15	21	33	0	0	0	1	0 25	0	0	3	0 0030
Tolpis capensis	0	7	33	0	0	0	1	0 25	0	0	3	0 0030
Hermannia transvaalensis	0	4	33	0	0	0	1	0 25	0	0	3	0 0030
Walafrida densiflora	0	4	33	0	0	0	1	0 25	0	0	3	0 0030
Asclepias multicaulis	0	4	33	0	0	0	1	0 25	0	0	3	0 0030
Boophane disticha	0	0	33	0	0	0	1	0 25	0	0	3	0 0030
SPECIES GROUP F												
Eragrostis capensis	7	57	83	0	0	1	1	0 50	0	2	3	0 0230
Heteropogon contortus	7	50	67	0	0	1	1	0 50	0	2	3	0 0230

Community	1		2		1		2		1		2	
Variations	1.1	1.2	2.1	2.2	1.1	1.2	2.1	2.2	1.1	1.2	2.1	2.2
Explanation	% Constancy of species per cluster				% Fidelity of species				Cluster no of species			

Clusters	1	2	3	4	1	2	3	4	%	1	2	3	4	Synoptic
Gladiolus crassifolius	22	43	33	0	0	1	1	0	50	0	2	3	0	0230
SPECIES GROUP G														
Commelina africana	0	7	17	67	0	0	0	1	25	0	0	0	4	0004
Abildgaardia ovata	22	25	17	33	0	0	0	1	25	0	0	0	4	0004
Aristida congesta	7	11	0	33	0	0	0	1	25	0	0	0	4	0004
Microchloa caffra	0	7	0	33	0	0	0	1	25	0	0	0	4	0004
Felicia muricata	0	4	0	33	0	0	0	1	25	0	0	0	4	0004
Sphenostylis angustifolia	4	7	17	33	0	0	0	1	25	0	0	0	4	0004
Zornia linearis	0	0	0	33	0	0	0	1	25	0	0	0	4	0004
Hypochaeris radicata	4	0	17	33	0	0	0	1	25	0	0	0	4	0004
Crepis hypochoeridea	7	4	0	33	0	0	0	1	25	0	0	0	4	0004
Verbena brasiliensis	7	11	0	33	0	0	0	1	25	0	0	0	4	0004
SPECIES GROUP H - Common species														
Themeda triandra	100	96	50	0	1	1	1	0	75	1	2	3	0	1230
Eragrostis plana	100	43	17	100	1	1	0	1	75	1	2	0	4	1204
Eragrostis chloromelas	74	50	17	33	1	1	0	1	75	1	2	0	4	1204
Conyza podocephala	44	43	67	33	1	1	1	1	100	1	2	3	4	1234
Berkheya radula	41	61	50	0	1	1	1	0	75	1	2	3	0	1230
Conyza albida	37	18	33	100	1	0	1	1	75	1	0	3	4	1034
Helichrysum rugulosum	33	61	83	33	1	1	1	1	100	1	2	3	4	1234
Wahlenbergia undulata	33	43	67	33	1	1	1	1	100	1	2	3	4	1234
Senecio inornatus	30	25	50	33	1	0	1	1	75	1	0	3	4	1034
Hyparrhenia hirta	22	29	100	67	0	1	1	1	75	0	2	3	4	0234
Eragrostis racemosa	4	75	33	33	0	1	1	1	75	0	2	3	4	0234
SPECIES GROUP I - Low frequency forbs present in the area														

Community	1		2		1		2		1		2	
Variations	1.1	1.2	2.1	2.2	1.1	1.2	2.1	2.2	1.1	1.2	2.1	2.2
Explanation	% Constancy of species per cluster				% Fidelity of species				Cluster no of species			
Clusters	1	2	3	4	1	2	3	4%	1	2	3	4 Synoptic
Acalypha angustata	0	7	0	0	0	0	0	0	0	0	0	0 0000
Acalypha capensis	0	7	0	0	0	0	0	0	0	0	0	0 0000
Aloe ecklonis	0	4	0	0	0	0	0	0	0	0	0	0 0000
Anthospermum rigidum	0	4	0	0	0	0	0	0	0	0	0	0 0000
Argyrolobium species	4	18	0	0	0	0	0	0	0	0	0	0 0000
Aspidoglossum species	0	7	0	0	0	0	0	0	0	0	0	0 0000
Bonatea speciosa	4	18	0	0	0	0	0	0	0	0	0	0 0000
Chamaecrista mimosoides	4	0	17	0	0	0	0	0	0	0	0	0 0000
Crabbea hirsuta	4	0	0	0	0	0	0	0	0	0	0	0 0000
Crassula lanceolata	0	11	0	0	0	0	0	0	0	0	0	0 0000
Euphorbia striata	4	18	0	0	0	0	0	0	0	0	0	0 0000
Euphorbia tirucalli	0	4	0	0	0	0	0	0	0	0	0	0 0000
Gazania krebsiana	7	0	0	0	0	0	0	0	0	0	0	0 0000
Gnidia capitata	0	14	0	0	0	0	0	0	0	0	0	0 0000
Gomphocarpus fruticosus	11	4	0	0	0	0	0	0	0	0	0	0 0000
Haplocarpha lyrata	4	0	0	0	0	0	0	0	0	0	0	0 0000
Hermannia erodioides	0	4	0	0	0	0	0	0	0	0	0	0 0000
Hibiscus microcarpus	0	4	0	0	0	0	0	0	0	0	0	0 0000
Indigofera hedyantha	0	4	0	0	0	0	0	0	0	0	0	0 0000
Jamesbrittenia aurantiaca	19	25	0	0	0	0	0	0	0	0	0	0 0000
Kohautia amatymbica	0	4	0	0	0	0	0	0	0	0	0	0 0000
Lotononis foliosa	0	4	0	0	0	0	0	0	0	0	0	0 0000
Lotononis laxa	0	4	0	0	0	0	0	0	0	0	0	0 0000
Mimulus gracilis	11	0	0	0	0	0	0	0	0	0	0	0 0000
Monsonia burkeana	4	4	0	0	0	0	0	0	0	0	0	0 0000

Community	1		2		1		2			1		2		
Variations	1.1	1.2	2.1	2.2	1.1	1.2	2.1	2.2		1.1	1.2	2.1	2.2	
Explanation	% Constancy of species per cluster				% Fidelity of species					Cluster no of species				
Clusters	1	2	3	4	1	2	3	4	%	1	2	3	4	Synoptic
Nemesia fruticans	7	0	0	0	0	0	0	0	0	0	0	0	0	0000
Pentzia globosa	7	0	0	0	0	0	0	0	0	0	0	0	0	0000
Phymaspermum athanasioides	7	0	0	0	0	0	0	0	0	0	0	0	0	0000
Pimpinella transvaalensis	15	4	0	0	0	0	0	0	0	0	0	0	0	0000
Polygala hottentotta	0	14	17	0	0	0	0	0	0	0	0	0	0	0000
Rhynchosia totta	4	4	0	0	0	0	0	0	0	0	0	0	0	0000
Salvia runcinata	19	7	0	0	0	0	0	0	0	0	0	0	0	0000
Scabiosa columbaria	7	18	0	0	0	0	0	0	0	0	0	0	0	0000
Sebaea grandis	0	4	17	0	0	0	0	0	0	0	0	0	0	0000
Senecio erubescens	26	25	0	33	1	0	0	1	50	1	0	0	4	1004
Striga bilabiata	0	18	17	0	0	0	0	0	0	0	0	0	0	0000
Vernonia oligocephala	7	25	17	0	0	0	0	0	0	0	0	0	0	0000
Xysmalobium undulatum	0	4	0	0	0	0	0	0	0	0	0	0	0	0000
SPECIES GROUP J - Geophytes present in the area														
Aristea woodii	0	7	0	0	0	0	0	0	0	0	0	0	0	0000
Chlorophytum cooperi	0	14	0	0	0	0	0	0	0	0	0	0	0	0000
Crinum bulbispermum	22	4	0	0	0	0	0	0	0	0	0	0	0	0000
Eucomis autumnalis	4	14	0	0	0	0	0	0	0	0	0	0	0	0000
Ledebouria cooperi	4	7	0	0	0	0	0	0	0	0	0	0	0	0000
Ledebouria ovatifolia	15	4	0	0	0	0	0	0	0	0	0	0	0	0000
Scilla nervosa	0	4	0	0	0	0	0	0	0	0	0	0	0	0000
SPECIES GROUP K - Climax grasses present in the area	0	0	0	0	0	0	0	0	0	0	0	0	0	0000
Andropogon appendiculatus	4	4	0	0	0	0	0	0	0	0	0	0	0	0000
Andropogon chinensis	7	0	0	0	0	0	0	0	0	0	0	0	0	0000
Harpochloa falx	0	7	0	0	0	0	0	0	0	0	0	0	0	0000

Community	1		2		1		2		1		2	
Variations	1.1	1.2	2.1	2.2	1.1	1.2	2.1	2.2	1.1	1.2	2.1	2.2
Explanation	% Constancy of species per cluster				% Fidelity of species				Cluster no of species			
Clusters	1	2	3	4	1	2	3	4 %	1	2	3	4 Synoptic
Hyparrhenia filipendul	0	4	0	0	0	0	0	0	0	0	0	0 00000
Panicum colcratum	0	4	0	0	0	0	0	0	0	0	0	0 00000
Panicum dregearum	4	0	0	0	0	0	0	0	0	0	0	0 00000
Panicum schinzii	7	4	0	0	0	0	0	0	0	0	0	0 00000
Pennisetum sphacelatum	0	4	0	0	0	0	0	0	0	0	0	0 00000
Setaria nigrirostris	0	4	0	0	0	0	0	0	0	0	0	0 00000
Sporobolus stapfianus	4	0	0	0	0	0	0	0	0	0	0	0 00000
Trachypogon spicatus	0	7	0	0	0	0	0	0	0	0	0	0 00000
Tristachya leucothrix	0	14	0	0	0	0	0	0	0	0	0	0 00000
SPECIES GROUP L - Grasses associated with over utilisation or disturbance in the area												
Agrostis eriantha	0	0	17	0	0	0	0	0	0	0	0	0 00000
Aristida diffusa	0	4	0	0	0	0	0	0	0	0	0	0 00000
Aristida junciformis	4	0	0	0	0	0	0	0	0	0	0	0 00000
Aristida scabrivalvis	7	0	0	0	0	0	0	0	0	0	0	0 00000
Brachiaria eruciformis	11	0	0	0	0	0	0	0	0	0	0	0 00000
Chloris virgata	7	0	0	0	0	0	0	0	0	0	0	0 00000
Cynodon dactylon	33	21	0	33	1	0	0	1	50	1	0	0 41004
Digitaria sanguinalis	22	7	0	0	0	0	0	0	0	0	0	0 00000
Digitaria ternata	7	0	0	0	0	0	0	0	0	0	0	0 00000
Eragrostis aspera	4	0	0	0	0	0	0	0	0	0	0	0 00000
Pogonarthria squarrosa	0	0	17	0	0	0	0	0	0	0	0	0 00000
Sporobolus africanus	0	11	0	0	0	0	0	0	0	0	0	0 00000
SPECIES GROUP M - Species associated with temporary or permanent wetlands												
Hemarthria altissima	0	7	0	0	0	0	0	0	0	0	0	0 00000
Imperata cylindrica	4	4	0	0	0	0	0	0	0	0	0	0 00000

Community	1	2			1	2			1	2		
Variations	1.1	1.2	2.1	2.2	1.1	1.2	2.1	2.2	1.1	1.2	2.1	2.2
Explanation	% Constancy of species per cluster				% Fidelity of species				Cluster no of species			
Clusters	1	2	3	4	1	2	3	4 %	1	2	3	4 Synoptic
Leersia hexandra	4	0	0	0	0	0	0	0	0	0	0	00000
Paspalum urvillei	11	7	0	0	0	0	0	0	0	0	0	00000
Persicaria lapathifolia	0	4	0	0	0	0	0	0	0	0	0	00000
Rumex crispus	7	4	0	0	0	0	0	0	0	0	0	00000
Senecio achilleifolius	33	4	0	33	1	0	0	1	50	1	0	0 4 1004
Typha capensis	0	4	0	0	0	0	0	0	0	0	0	00000
Verbena bonariensis	22	4	0	0	0	0	0	0	0	0	0	00000
SPECIES GROUP N - Pioneer or weed forbs of over utilised or disturbed areas												
Bidens formosa	15	11	0	0	0	0	0	0	0	0	0	00000
Bidens pilosa	7	0	0	0	0	0	0	0	0	0	0	00000
Cicliospermum leptophyllum	4	0	0	0	0	0	0	0	0	0	0	00000
Gomphrena celosioides	0	4	0	0	0	0	0	0	0	0	0	00000
Leucas glabrata	7	0	0	0	0	0	0	0	0	0	0	00000
Monsonia angustifolia	4	0	0	0	0	0	0	0	0	0	0	00000
Oenothera rosea	7	0	0	0	0	0	0	0	0	0	0	00000
Oenothera tetraptera	22	4	0	0	0	0	0	0	0	0	0	00000
Solanum elaeagnifolium	4	0	0	0	0	0	0	0	0	0	0	00000
Solanum sisymbrifolium	0	4	0	0	0	0	0	0	0	0	0	00000
Sonchus wilmsii	7	0	0	0	0	0	0	0	0	0	0	00000
Tagetes minuta	4	0	0	0	0	0	0	0	0	0	0	00000
SPECIES GROUP O - Sedges present in the area												
Bulbostylis burchellii	0	0	17	0	0	0	0	0	0	0	0	00000
Cyperus esculentus	0	7	0	0	0	0	0	0	0	0	0	00000
Cyperus rotundus	0	4	0	0	0	0	0	0	0	0	0	00000
Kyllinga alba	4	0	0	0	0	0	0	0	0	0	0	00000

Community	1		2		1		2		1		2	
Variations	1.1	1.2	2.1	2.2	1.1	1.2	2.1	2.2	1.1	1.2	2.1	2.2
Explanation	% Constancy of species per cluster				% Fidelity of species				Cluster no of species			
Clusters	1	2	3	4	1	2	3	4	%	1	2	3	4	Synoptic
SPECIES GROUP P - Woodlies species present in the area														
Erythrina zeyheri	4	11	0	0	0	0	0	0	0	0	0	0	0	0 0000
Geigeria burkei	15	25	0	0	0	0	0	0	0	0	0	0	0	0 0000

APPENDIX 2: Checklist of plant species recorded during original survey (EkoInfo 2004).
Species are grouped by class and in alphabetical order per family and species

CLASS 2. MONOCOTYLEDONAE

FAMILY: AMARYLLIDACEAE
Boophane disticha (L.f.) Herb.
Crinum bulbispermum (Burm.f.) Milne-Redh. &
Schweick.

FAMILY: ANTHERICACEAE
Chlorophytum cooperi (Baker) Nordal
Chlorophytum fasciculatum (Baker) Kativu

FAMILY: ASPHODELACEAE
Aloe ecklonis Salm-Dyck

FAMILY: COMMELINACEAE
Commelina africana
Cyanotis speciosa (L.f.) Hassk.

FAMILY: CYPERACEAE
Abildgaardia ovata (Burm.f.) Kral
Bulbostylis burchellii (Ficalho & Hiern)
C.B.Clarke
Cyperus esculentus
Cyperus rotundus
Kyllinga alba Nees

FAMILY: HYACINTHACEAE
Eucomis autumnalis
Ledebouria cooperi (Hook.f.) Jessop
Ledebouria ovatifolia (Baker) Jessop
Scilla nervosa (Burch.) Jessop

FAMILY: HYPOXIDACEAE
Hypoxis hemerocallidea Fisch. & C.A.Mey.
Hypoxis rigidula

FAMILY: IRIDACEAE
Aristea woodii N.E.Br.
Gladiolus crassifolius Baker

FAMILY: ORCHIDACEAE
Bonatea speciosa

FAMILY: POACEAE
Agrostis eriantha
Andropogon appendiculatus
Andropogon chinensis (Nees) Merr.

Aristida bipartita (Nees) Trin. & Rupr.
Aristida congesta
Aristida diffusa
Aristida junciformis
Aristida scabrivalvis
Brachiaria eruciformis (Sm.) Griseb.
Brachiaria serrata (Thunb.) Stapf
Chloris virgata Sw.
Cymbopogon excavatus (Hochst.) Stapf ex Burtt Davy
Cynodon dactylon (L.) Pers.
Digitaria eriantha Steud.
Digitaria sanguinalis (L.) Scop.
Digitaria ternata (A.Rich.) Stapf
Elionurus muticus (Spreng.) Kunth
Eragrostis aspera (Jacq.) Nees
Eragrostis capensis (Thunb.) Trin.
Eragrostis chloromelas Steud.
Eragrostis curvula (Schrad.) Nees
Eragrostis gummiflua Nees
Eragrostis plana Nees
Eragrostis racemosa (Thunb.) Steud.
Harpochloa falx (L.f.) Kuntze
Hemarthria altissima (Poir.) Stapf & C.E.Hubb.
Heteropogon contortus (L.) Roem. & Schult.
Hyparrhenia filipendul
Hyparrhenia hirta (L.) Stapf
Imperata cylindrica (L.) Raeusch.
Leersia hexandra Sw.
Microchloa caffra Nees
Panicum coloratum
Panicum dregeanum Nees
Panicum schinzii Hack.
Paspalum urvillei Steud.
Pennisetum sphacelatum (Nees) T.Durand & Schinz
Pogonarthria squarrosa (Roem. & Schult.) Pilg.
Setaria nigrirostris (Nees) T.Durand & Schinz
Setaria sphacelata
Sporobolus africanus (Poir.) Robyns & Tournay
Sporobolus stapfianus Gand.
Themeda triandra Forssk.
Trachypogon spicatus (L.f.) Kuntze
Trichoneura grandiglumus
Tristachya leucothrix Nees

FAMILY: TYPHACEAE
Typha capensis (Rohrb.) N.E.Br.

CLASS 3. DICOTYLEDONAE

FAMILY: ACANTHACEAE
Chaetacanthus costatus Nees
Crabbea acaulis N.E.Br.
Crabbea hirsuta Harv.

FAMILY: AMARANTHACEAE
Gomphrena celosioides Mart.

FAMILY: APIACEAE
Ciclospermum leptophyllum (Pers.) Eichler
Pimpinella transvaalensis H.Wolff

FAMILY: ASCLEPIADACEAE
Asclepias multicaulis (E.Mey.) Schltr.
Aspidoglossum species
Gomphocarpus fruticosus (L.) Aiton f.
Xysmalobium undulatum (L.) Aiton f.

FAMILY: ASTERACEAE
Berkheya carlinopsis
Berkheya radula (Harv.) De Wild.
Bidens formosa (Bonato) Sch.Bip.
Bidens pilosa L.
Cirsium vulgare (Savi) Ten.
Conyza albida Spreng.
Conyza podocephala DC.
Crepis hypochoeridea (DC.) Thell.
Felicia muricata
Gazania krebsiana
Geigeria burkei
Haplocarpha lyrata Harv.
Haplocarpha scaposa Harv.
Helichrysum aureonitens Sch.Bip.
Helichrysum callicomum Harv.
Helichrysum nudifolium (L.) Less.
Helichrysum pilosellum (L.f.) Less.
Helichrysum rugulosum Less.
Hypochaeris radicata L.
Pentzia globosa Less.
Phymaspermum athanasioides (S.Moore) K„llersj”
Schkuhria pinnata (Lam.) Cabrera
Senecio achilleifolius DC.
Senecio affinis DC.
Senecio erubescens
Senecio inornatus DC.
Sonchus wilmsii R.E.Fr.
Stoebe vulgaris Levyns
Tagetes minuta L.

Tolpis capensis (L.) Sch.Bip.
Vernonia oligocephala (DC.) Sch.Bip. ex Walp.

FAMILY: CAMPANULACEAE
Wahlenbergia undulata (L.f.) A.DC.

FAMILY: CONVOLVULACEAE
Turbina oblongata (E.Mey. ex Choisy) A.Meeuse

FAMILY: CRASSULACEAE
Crassula lanceolata

FAMILY: DIPSACACEAE
Scabiosa columbaria L.

FAMILY: EUPHORBIACEAE
Acalypha angustata Sond.
Acalypha capensis (L.f.) Prain & Hutch.
Euphorbia striata
Euphorbia tirucalli L.

FAMILY: FABACEAE
Argyrolobium species
Chamaecrista mimosoides (L.) Greene
Erythrina zeyheri Harv.
Indigofera hedyantha Eckl. & Zeyh.
Indigofera species
Lotononis foliosa Bolus
Lotononis laxa Eckl. & Zeyh.
Rhynchosia totta
Sphenostylis angustifolia Sond.
Zornia linearis E.Mey.

FAMILY: GENTIANACEAE
Sebaea grandis (E.Mey.) Steud.

FAMILY: GERANIACEAE
Monsonia angustifolia E.Mey. ex A.Rich.
Monsonia burkeana Planch. ex Harv.

FAMILY: LAMIACEAE
Leucas glabrata
Salvia runcinata L.f.

FAMILY: MALVACEAE
Hibiscus microcarpus Garcke
Hibiscus trionum L.

FAMILY: ONAGRACEAE
Oenothera rosea L'H,r. ex Aiton

Oenothera tetraptera Cav.

FAMILY: POLYGALACEAE
Polygala hottentotta C.Presl

FAMILY: POLYGONACEAE
Persicaria lapathifolia (L.) Gray
Rumex crispus L.

FAMILY: RUBIACEAE
Anthospermum rigidum
Anthospermum rigidum Eckl. & Zeyh. ssp. pumilum (Sond.)
Kohautia amatymbica Eckl. & Zeyh.

FAMILY: SCROPHULARIACEAE
Jamesbrittenia aurantiaca (Burch.) Hilliard
Mimulus gracilis R.Br.
Nemesia fruticans (Thunb.) Benth.
Walafrida densiflora (Rolfe) Rolfe
Walafrida tenuifolia Rolfe

FAMILY: SELAGINACEAE
Striga bilabiata (Thunb.) Kuntze

FAMILY: SOLANACEAE
Solanum elaeagnifolium Cav.
Solanum panduriforme E.Mey.
Solanum sisymbrifolium Lam.

FAMILY: STERCULIACEAE
Hermannia depressa N.E.Br.
Hermannia erodioides (Burch. ex DC.) Kuntze
Hermannia transvaalensis Schinz

FAMILY: THYMELAEACEAE
Gnidia capitata L.f.

FAMILY: VERBENACEAE
Verbena bonariensis L.
Verbena brasiliensis Vell.

APPENDIX 3: Red Data plants previously recorded in study area.

Taxon	Latest (IUCN version 3.1) Conservation Status**	Habitat	Flowering Time	Probability of occurrence*
Boophane disticha	Declining	Dry grassland and rocky areas	October-January	**DEFINITE**, found on site
Crinum bulbispermum	Declining	Along rivers and streams or in damp depressions in black clay or sandy soil.	September-November	**HIGH**, suitable habitat on site
Eucomis autumnalis subsp. *clavata*	Declining	Open grassland, marshes.	November-April	**DEFINITE**, found on site
Gladiolus robertsoniae	Near Threatened (NT)	Moist highveld grasslands, found in rocky sites, mostly dolerite outcrops. Corms are wedged in rock crevices. Restricted to seeps and stream banks where moisture is available at the end of the dry season.	October-December	**HIGH**, suitable habitat on site
Hypoxis hemerocallidea	Declining	Grassland and mixed woodland.	January-March	**DEFINITE**, found on site
Kniphofia typhoides	Near Threatened (NT)	Low-lying wetlands and seasonally wet areas in climax Themeda triandra grasslands on heavy black clay soils, tends to disappear from degraded grasslands.	February-March	**HIGH**, suitable habitat on site
Nerine gracilis	Near Threatened (NT)	Undulating grasslands in damp, moist areas; the plants grow in full sun in damp depressions, near pans or on the edges of streams; grassland, riverbanks, vleis.	February – March	**HIGH**, suitable habitat on site
Pelargonium sidoides	Declining	Open grassland, often on shallow soils.	February – March	**MEDIUM**, marginal habitat on site
Stenostelma umbelluliferum	Near Threatened (NT)	Deep black turf soil in open woodland mainly in the vicinity of drainage lines.	September – March	**MEDIUM**, marginal habitat on site
Trachyandra erythrorrhiza	Near Threatened (NT)	Marshy areas, grassland, usually in black turf marshes.	September – November	**HIGH**, suitable habitat on site

** Conservation Status Category assessment according to IUCN Ver. 3.1 (IUCN, 2001), as indicated on SANBI website (http://sibis.sanbi.org/, accessed on 28/07/2010).

*Probability of occurrence, as follows: LOW – no suitable habitats occur on site / habitats on site do not match habitat description for species, MEDIUM – habitats on site match general habitat description for species (e.g. grassland), but microhabitat requirements are absent (e.g. rocky grassland on shallow soils overlying dolomite), HIGH – habitats on site match very strongly the general and microhabitat description for the species, DEFINITE – species found on site.

APPENDIX 5.9(A)

SPECIALIST REPORT
ANIMAL LIFE

Sasol Middelbult (Block 8) – Shondoni Shaft
Terrestrial Ecology:
Fauna

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INDEMNITY AND CONDITIONS RELATING TO THIS REPORT

The findings, results, observations, conclusions and recommendations given in this report are based on the author's best scientific and professional knowledge as well as available information. The report is based on survey and assessment techniques which are limited by time and budgetary constraints relevant to the type and level of investigation undertaken and Wetland Consulting Services (Pty.) Ltd. and its staff reserve the right to modify aspects of the report including the recommendations if and when new information may become available from ongoing research or further work in this field, or pertaining to this investigation.

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1. BACKGROUND INFORMATION

Wetland Consulting Services (Pty.) Ltd. was appointed by JMA Consulting to conduct a biodiversity study of additional reserve areas to be added to the existing Sasol Middelbult (Block 8) – Shondoni project footprint.

As part of the biodiversity study, a detailed investigation of the fauna (birds and mammals) within the study area was undertaken. The aim of this investigation was to determine the faunal communities likely to occur in the study area, the relative sensitivities of the vegetation habitats which support these communities and assess the impacts to fauna likely to arise from the implementation of the mining activities.

2. TERMS OF REFERENCE

In order to meet the project objectives, the following tasks were identified:

Terrestrial Ecology (Fauna) Phase 1 – Baseline Assessment:

- Compile species lists of all mammals and birds expected to occur within the Quarter Degree Squares (QDS) over which the study area extends based on available literature, distribution maps and previous recorded sightings;
- Groundtruth within the study area to determine the nature of the vegetation and habitats available, assess the levels of disturbance present, and attempt to confirm species presence from field signs (tracks, scats, visual sightings);
- Determine the likelihood of each species occurring within the study area based on habitat requirements, habitat availability and levels of disturbance. Particular emphasis will be placed on species of special concern (Red Data List species, CITES, etc.);
- Identify habitats which are of conservation importance for mammals and birds within the study area; and
- Compile a report detailing the above information, incorporating faunal information detailed in the original EIA scoping report.

Terrestrial Ecology (Fauna) Phase 2: Impact Assessment

- Assess potential impacts of mine infrastructure and activities on terrestrial fauna using the impact assessment tables supplied by JMA Consulting.

3. APPROACH

A desktop study was conducted to determine the species potentially occurring within QDS 2629ac, 2629ca, 2628bd and 2628db based upon available information on faunal distribution ranges in southern Africa.
A field survey was then conducted over two days in June 2010 to assess the three new areas added to the study area. This assessment included identifying the types of habitat available and opportunistically surveying the site for signs of species presence (tracks, scats, skulls, visual sightings).

Using information on individual mammal species habitat requirements and the data gained during the field survey it was possible to determine the likelihood of each species occurring based on the presence or absence of important habitat features and the levels of human disturbance.

The list of bird species present within the QDS's mentioned above was obtained from the South African Bird Atlas Project (SABAP 1) conducted by the Animal Demography Unit, University of Cape Town and the South African National Biodiversity Institute.

4. LIMITATIONS

Due to the scale of the remote imagery used (1:10 000 orthophotos and Google Earth Imagery), as well as the accuracy of the handheld GPS unit used to mark points in the field, any boundaries mapped cannot be guaranteed beyond an accuracy of about 15m on the ground.

5. FINDINGS

5.1 STUDY AREA

The study area lies within the Mpumalanga Province to the west of Secunda. The towns of Evander, Kinross and eMbalenhle all lie partially or completely within the study area. The original study area was approximately 28500 ha, but three additional land reserves have been added: Leeupan, Springbokdraai, and Northern Reserve. Together, these three additional reserves add 3924.3 ha to the study area.

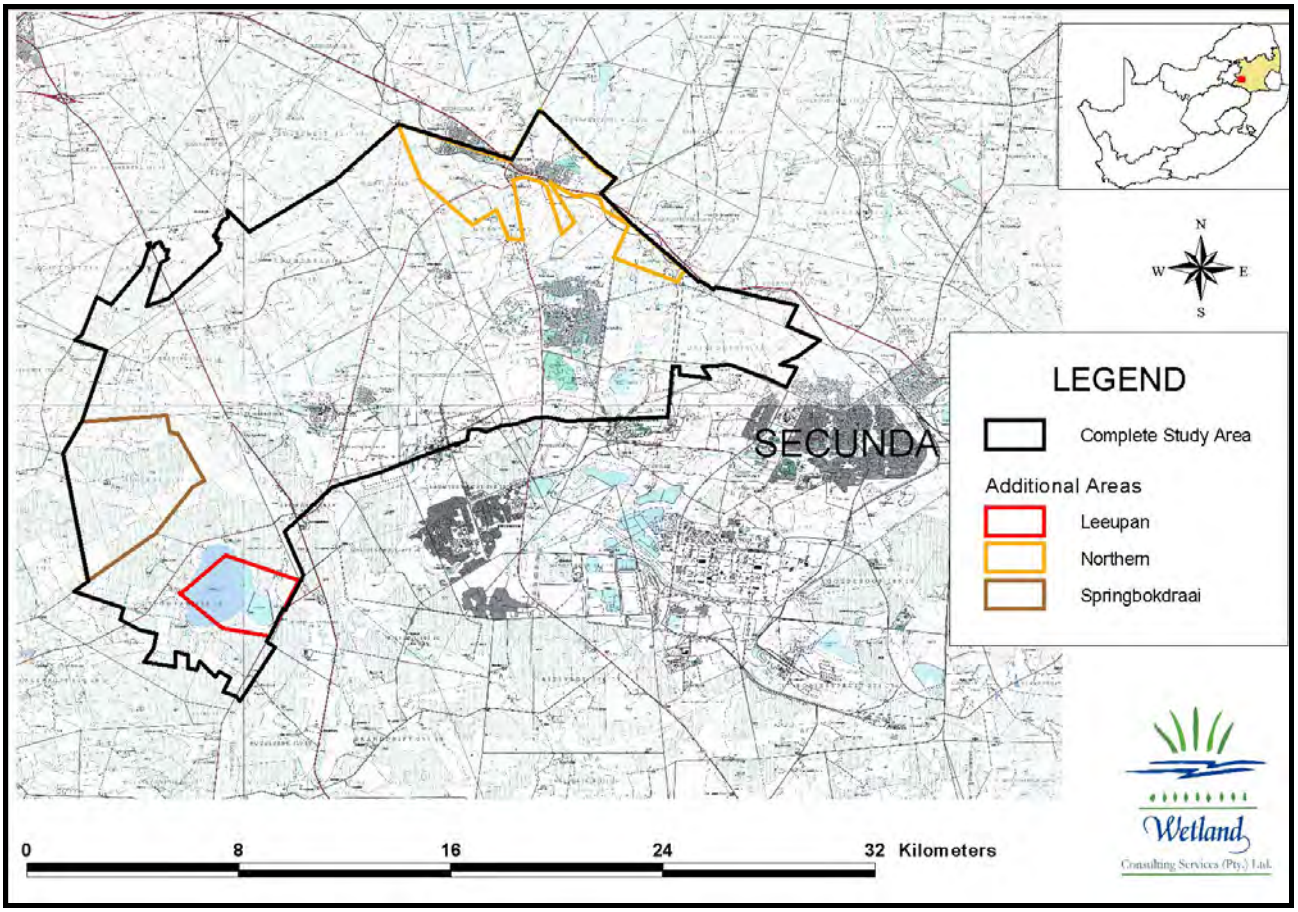

Figure 1. Location and approximate extent of the study area.

5.1.1 Catchment Information

The study area falls within a summer- rainfall region and lies across three quaternary catchments: C12F, C12D and B11D (Figure 2). The mean annual precipitation across the site is 600 – 700 mm and the mean annual runoff is 30 – 60 mm. The rainfall and runoff values for the separate catchments are detailed in the table below (Table 1).

Table 1: Characteristics of the catchments encompassing the study area.

Quaternary Catchment	*Quaternary Catchment Area (ha)*	*MAP - Mean Annual Precipitation (mm)*	*MAR - Mean Annual Runoff (mm)*	*Sediment Yield (1000 t/a)*
C12F	*75655*	*634.90*	*49.1*	*7*
C12D	*81343*	*666.88*	*59.3*	*7*
B11D	*49812*	*671.47*	*30.1*	*7*

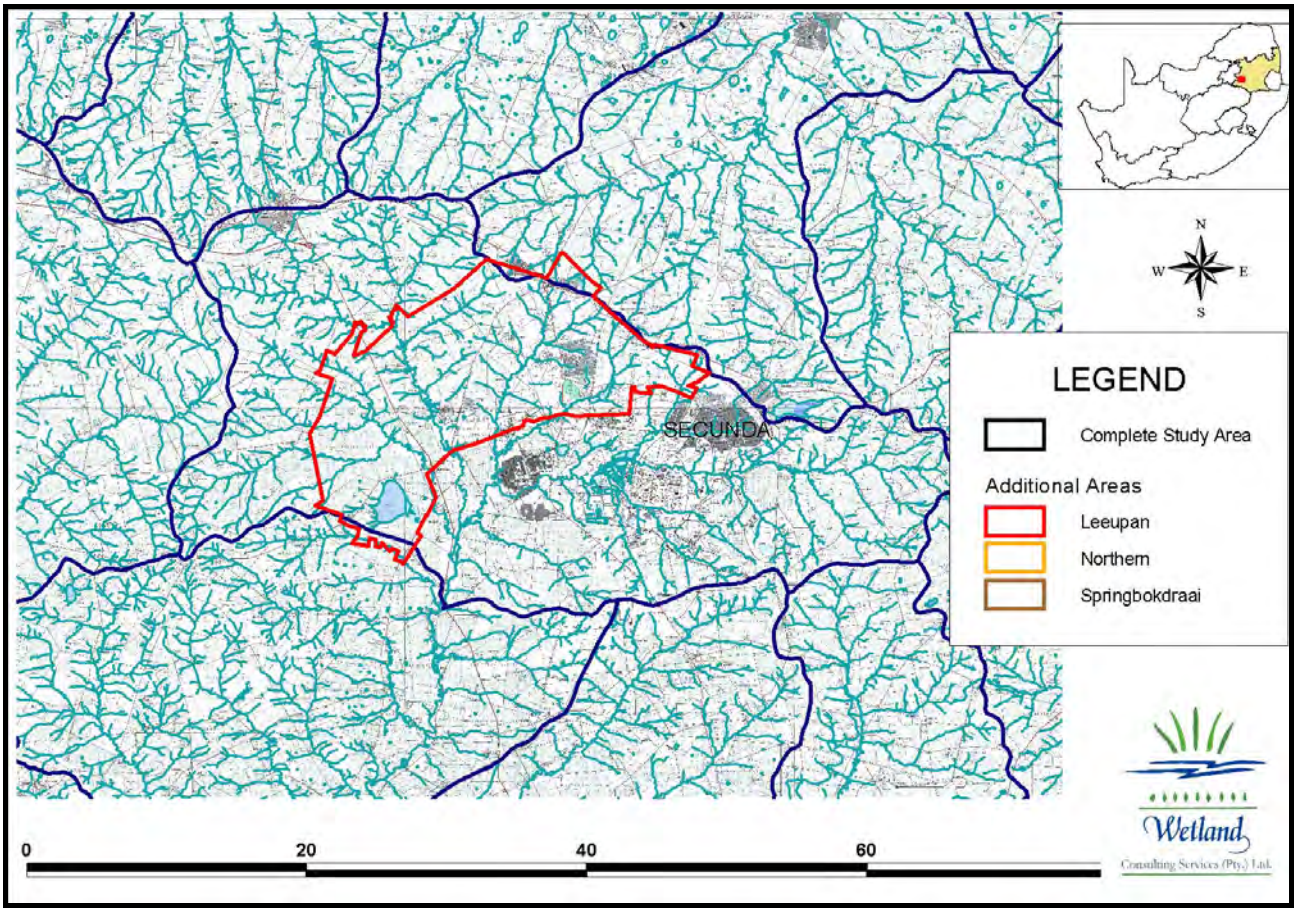

Figure 2: Study area relative to the quaternary catchments boundaries and the rivers.

5.1.2 Geology and Soils

The geology is a mosaic of sandstone, shale and coal beds of the Vryheid Formation (Karoo Sequence), intrusive dolerites, and alluvial deposits along the larger rivers. The dolerites and shales weather to fine grained clays, whereas the alluvial deposits and sandstones will produce sandier sediments. Gold, silver and coal have all been mined in this area in the past or present. The soils are generally expected to be moderate to deep, have a clayey texture and occur over undulating terrain. A combination of the rainfall and runoff characteristics and the nature of the soils leads to high erodibility potential in this area and high sediment yields (Table 1). Both vertic clay soils and sandy alluvium were observed at different points across the study area.

5.1.3 Vegetation

The vegetation across the study area is of the Grassland Biome. Soweto Highveld Grassland occurs over the majority of the study area, but a small section of the new northern area is Eastern Highveld Grassland (Mucina and Rutherford 2006). Both vegetation types are considered Endangered due to limited protection in conservation areas and habitat destruction. Soweto Highveld Grassland is characterised by short to medium-high, dense, tufted grasses dominated almost entirely by *Themeda triandra* and accompanied by such grasses as *Elionurus muticus*, *Eragrostis racemosa*, *Heteropogon contortus* and *Tristachya leucothrix*. Eastern Highveld Grassland is characterised by short, dense grasses dominated by species of the genus's *Aristida*, *Digitaria*, *Eragrostis*, *Themeda* and *Tristachya*. Small, scattered rocky outcrops with wiry, sour grasses and some woody species occur within this grassland type.

T. triandra occurred extensively in those areas not exposed to heavy grazing, as did *Hyparrhenia hirta*, although they did not necessarily occur together. Along the rivers and in the wetlands *Typha capensis* was very common and formed extensive, dense stands. The grass, *Imperata cylindrica*, also occurred frequently within areas of temporary wetness and along the river banks. Tree species, which occurred most frequently near rivers and dwellings, were mostly exotic, such as *Eucalyptus* sp. and *Salix babylonica*.

The vegetation study previously done across the original study area identified two vegetation communities:

- *Themeda triandra – Berkheya carlinopsis* Grassland Community on clayey soils; and
- *Hyparrhenia hirta – Helichrysum nudifolium* Grassland Community on sandy soils.

5.1.4 Habitat Types

Habitat selection by an animal takes into account a number of biotic and abiotic factors including: plant species present, vegetation structure, topography, pedology, climate, distance to water, presence of rocky outcrops, trees, predators and sufficient food. The level of human disturbance is also an important factor influencing habitat selection.

Within the study area the main habitat types available are short and tall mesic grasslands and riparian and wetland habitat, including floodplains, channelled and unchannelled valley bottom wetlands, and hillslope seepage wetlands. Therefore the species most likely to occur are grassland specialists, species linked to wet habitats and those with wide habitat tolerances. Some of the habitat types observed during the field survey are shown in the photographs below (Figure 3). Some of the disturbances in the study area include urban settlements, roads, cultivated and cattle-grazed land and a large coal mining operation. A number of slimes dams and water impoundments are also present.

Figure 2. Series of photographs showing the various habitats present.

5.2 FAUNA

5.2.1 Mammals

The results of the literature review suggest that 84 mammals species potentially occur within the study area based on their distribution ranges alone, 23 of these species being of conservation concern (Endangered, Near-threatened, Vulnerable) or Data Deficient. No Red Data List mammal species were observed during the field survey. A list of all Red Data List mammal species recorded for the study is provided below, including their likelihood of occurrence based upon habitat suitability within the study area (Table 2). Both the Spotted-necked otter and the Water rat (both listed as Near Threatened) are likely to occur in the study area based on their habitat requirements, the presence of suitable habitat and the levels of human disturbance. This does not preclude the possibility of other Red Data List species occurring in the study area, they are merely less likely to occur. A list of mammal species observed on site is also included in Table 3. A complete list of all mammal species potentially occurring in the area can be found in Appendix I.

Table 2: Red Data List mammal species potentially occurring within QDS 2629AC, 2629CA, 2628BD and 2628DB and their likelihood of occurrence within the study area (DD = Data Deficient, EN = Endangered, NT = Near Threatened, VU = Vulnerable and (E) = Endemic).

SPECIES	COMMON NAME	CONSERVATION STATUS	LIKELYHOOD OF OCCURRENCE
Amblysomus hottentotus	Hottentot's golden mole	DD (E)	Unlikely
Crocidura cyanea	Reddish-grey musk shrew	DD	May Occur
Crocidura mariquensis	Swamp musk shrew	DD	Unlikely
Crocidura silacea	Lesser grey-brown musk shrew	DD	May Occur
Graphiurua platyops	Rock dormouse	DD	May Occur
Lemniscomys rosalia	Single-striped mouse	DD	Likely
Myosorex varius	Forest shrew	DD (E)	May Occur
Poecilogale albinucha	Striped weasel	DD	May Occur
Suncus infinitesimus	Least dwarf shrew	DD (E)	May Occur
Suncus varilla	Lesser dwarf shrew	DD	May Occur
Tatera leucogaster	Bushveld gerbil	DD	Unlikely
Mystromys albicaudatus	White-tailed mouse	EN (E)	May Occur
Ourebia ourebi	Oribi	EN	Unlikely
Amblysomus septentrionalis	Highveld golden mole	NT	May Occur
Atelerix frontalis	South African hedgehog	NT	May Occur
Dasymys incomtus	Water rat	NT	Likely

Lutra maculicollis	Spotted-necked otter	NT	Likely
Miniopterus schreibersii	Schreibers' long-fingered bat	NT	Unlikely
Myotis tricolor	Temminck's hairy bat	NT	Unlikely
Parahyaena brunnea	Brown hyaena	NT	Unlikely
Rhinolophus clivosus	Geoffrey's horseshoe bat	NT	Unlikely
Manis temminckii	Pangolin	VU	Unlikely
Rhinolophus blasii	Peak-saddle horseshoe bat	VU	Unlikely

Table 3: List of mammal species observed during field surveys within the study area.

ORDER	SPECIES	COMMON NAME
Carnivora	*Canis mesomelas*	Black-backed jackal
Rodentia	*Otomys irroratus*	Vlei rat
Ruminantia	*Raphicerus campestris*	Steenbok
Carnivora	*Aonyx capensis*	Cape clawless otter
Carnivora	*Atilax paludinosus*	Water/Marsh mongoose
Lagomorpha	*Lepus saxatillus*	Scub hare/Savannah hare
Rodentia	*Hystrix africaeaustralis*	Porcupine
Carnivora	*Cynictis penicillata*	Yellow mongoose
Chiroptera	*Neoromicia capensis*	Cape serotine bat
Lagomorpha	*Lepus capensis*	Cape hare/Desert hare
Rodentia	*Rhabdomys pumilio*	Striped mouse

5.2.2 Birds

The list of bird species extracted from SABAP 1 for the four QDS's are actual recent sightings of those species by individuals and therefore constitute the actual bird species assemblage within the area (although it is recognised that it may not be a complete list). The bird species list includes 255 bird species, 25 of which are of conservation concern (Table 4). Four Red Data List bird species were observed during the field survey, including the Martial Eagle (*Polemaetus bellicosus*) which had not previously been recorded from this area during the SABAP 1 bird counts. Greater and Lesser Flamingo were both observed on Leeupan, a South African grass-owl was flushed from a stand of *I. cylindrica* grass along one of the watercourses in the Springbokdraai reserve, and the

Martial eagle was seen just outside and to the west of the Springbokdraai reserve study area boundary. The bulk of the species diversity is made up of grassland birds and water birds. A complete list of all bird species occurring in the area can be found in Appendix II.

Table 4: Red Data List bird species occurring within QDS 2629AC, 2629CA, 2628BD and 2628DB (CR = Critically Endangered, EN = Endangered, NT = Near Threatened, VU = Vulnerable).

SPECIES	COMMON NAME	CONSERVATION STATUS	OBSERVED ON SITE
Bugeranus carunculatus	Wattled Crane	CR	
Spizocorys fringillaris	Botha's Lark	EN	
Ciconia nigra	Black Stork	NT	
Circus macrourus	Pallid Harrier	NT	
Circus maurus	Black Harrier	NT	
Eupodotis caerulescens	Blue Korhaan	NT	
Falco biarmicus	Lanner Falcon	NT	
Glareola nordmanni	Black-winged Pratincole	NT	
Mirafra cheniana	Melodious (Latakoo) Lark	NT	
Mycteria ibis	Yellow-billed Stork	NT	
Phoenicopterus minor	Lesser Flamingo	NT	X
Phoenicopterus ruber	Greater Flamingo	NT	X
Rostratula benghalensis	Greater Painted-snipe	NT	
Sagittarius serpentarius	Secretarybird	NT	
Sterna caspia	Caspian Tern	NT	
Anthropoides paradiseus	Blue Crane	VU	
Balearica regulorum	Grey Crowned- (Crowned) Crane	VU	
Circus ranivorus	African Marsh-Harrier	VU	
Eupodotis senegalensis	White-bellied Korhaan	VU	
Falco naumanni	Lesser Kestrel	VU	
Geronticus calvus	Southern Bald (Bald) Ibis	VU	
Neotis denham	Denham's (Stanley's) Bustard	VU	

Pelecanus rufescens	Pink-backed Pelican	VU	
Polemaetus bellicosus	**Martial Eagle**	**VU**	**X**
Tyto capensis	African Grass-Owl	VU	X

5.2.3 Reptiles and Amphibians

Though the study focused primarily on bird and mammal species distribution, A list of reptile and amphibian species potentially occurring in the area has been included as Appendix III. A total of 41 herpetofauna species have been reported for the study area. These results likely reflect a general lack of herpetofaunal sampling rather than low species diversity. The distribution range of the Giant bullfrog (*Pyxicephalus adspersus*; Near Threatened) includes the study area (Du Preez & Carruthers 2009), although, according to Minter *et al.* (2004), no individuals had been recorded in the area before 2002. The Giant sungazer (*Cordylus giganteus*; Vulnerable) has been recorded from QDS 2629CD and 2629DC, some distance from the project area (Branch 1988).

5.2.4 Habitats of Conservation Importance

No information was provided on the conservation value of habitats within the original study area, therefore it was not possible to construct a complete sensitivity map for the entire study area (original study area and three additional reserves). Within the original study area only the wetlands previously delineated have been considered sensitive, however the extent of habitats of conservation value within the original study area are expected to be more extensive than mapped in this report. Within the additional reserve areas (Leeupan, Springbokdraai, Northern) the following habitats were considered to be sensitive and of conservation importance:

- Natural vegetation which has not been cultivated recently or heavily grazed;
- Wetlands and rivers;
- Large waterbodies (natural or artificial); and
- Any other areas known to support Red Data List species or which have the potential to do so.

Wetlands and rivers are considered sensitive habitat as they support a different range of species than the surrounding terrestrial landscape, they are an important water and food resource for many species, the transition zone (ecotone) between aquatic and terrestrial habitats is typically species-rich, and rivers form a network of (relatively) natural vegetation along which species can migrate and disperse. Many of the Red Data List species (birds and mammals) occurring or potentially occurring in the area are linked to water or wetland habitats, e.g.: African grass-owl, Greater flamingo, Lesser flamingo, water rat and Spotted-necked otter. Areas of undisturbed grassland are also of significance as they support a diverse granivore and insectivore community (both birds and mammals) which forms an essential food resource for many of the small to medium-sized carnivores, omnivores and birds of prey. Figure 3 below indicates those areas of high sensitivity and conservation importance within the three additional reserves.

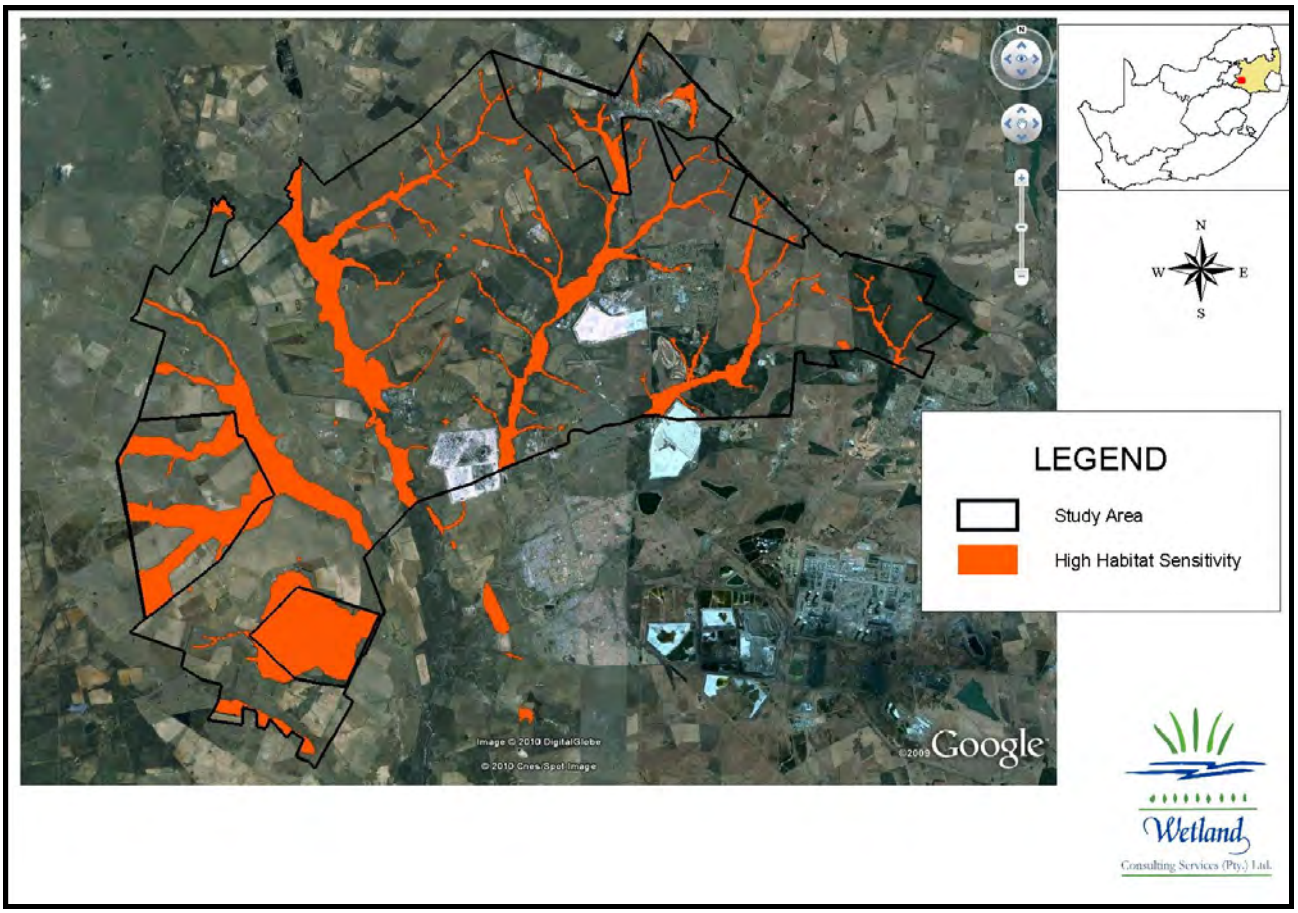

Figure 3: Habitats of conservation value within the Entire study area.

5.3 SIGNIFICANCE OF OBSERVATIONS

The study area includes a number of habitat types, such as Soweto Highveld Grassland, Eastern Highveld Grassland, rivers, wetlands and large open water bodies. This diversity of habitats helps to support a variety of faunal communities including a number of Red Data List species. A total of 84 mammal, 225 bird, 28 reptile and 13 amphibian species potentially occur within the study area. Of these, 37 Red Data List species could occur (not including those species considered Data Deficient) four of which were observed (all birds).

The presence of many of the species recorded is dependent on the presence of water - either in the form of large, open waterbodies, streams or wetlands – and natural grassland. Therefore the continued existence of these species in and around the study area relies upon the maintenance of these habitats in a condition and to an extent sufficient to meet their habitat requirements.

6. IMPACT ASSESSMENT

The proposed development of the Sasol Middelbult (Block 8) Shondoni Shaft coal mine will involve the construction of various infrastructure associated with the shaft complex, access road and coal conveyer belt (Figure 4). Impacts to the terrestrial fauna in the surrounding landscape are expected to stem from both the construction and utilization of this infrastructure, activities occurring during the lifetime of the mine and consequences of the underground mining activities. Information about the planned infrastructure and layout of the shaft complex, conveyer belt, access road and underground mining plan were obtained from the initial Sasol Mining Middelbult (Block 8) – Shondoni Project EIA Scoping Report & Plan of Study (JMA Consulting 2009).

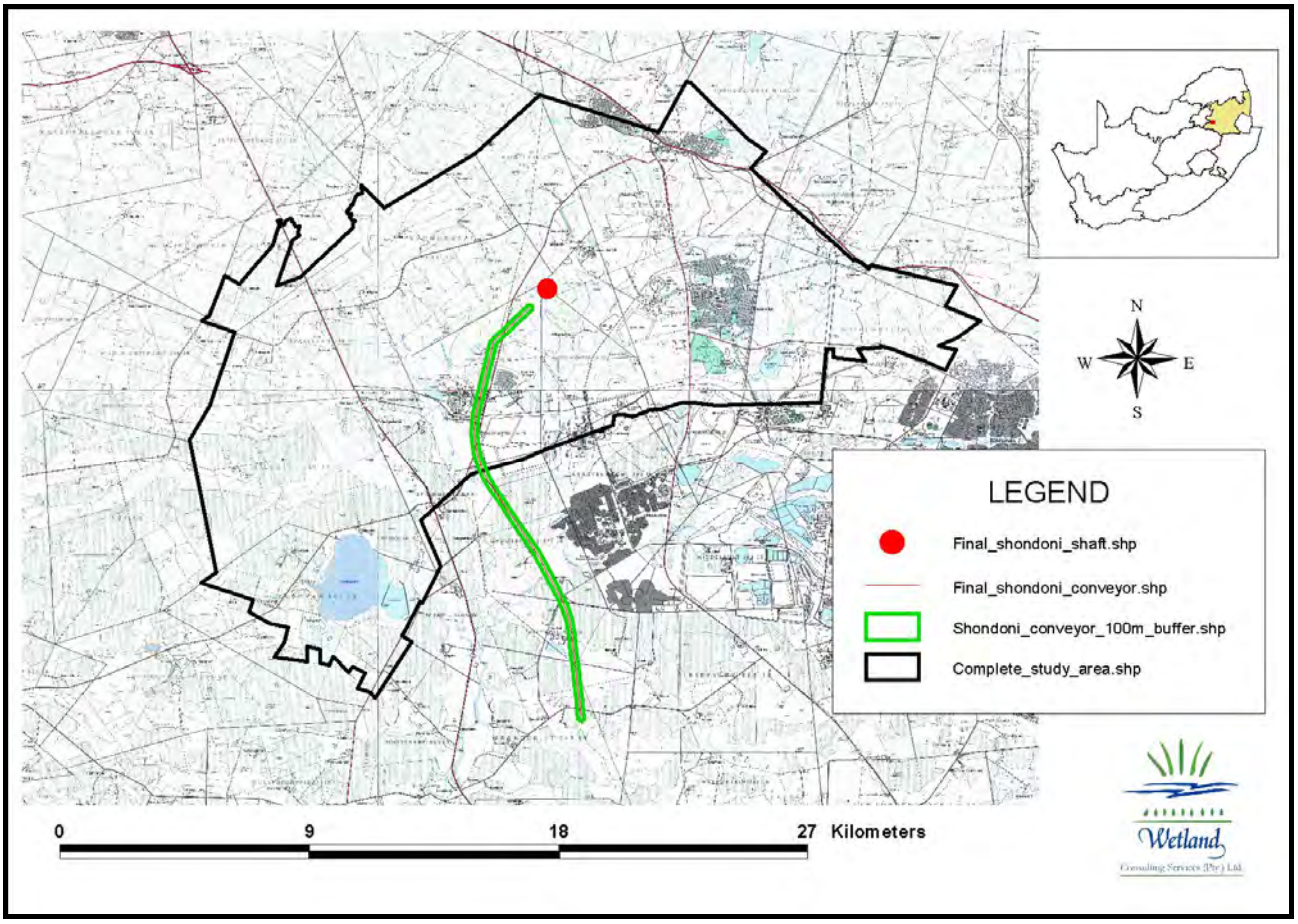

Figure 4: Map indicating the approximate location of infrastructure for the Sasol Mining Middelbult (Block 8) – Shondoni Project.

6.1 IMPACT ASSESSMENT METHODOLOGY

The methodology used to assess the impacts of the various mine-related activities during construction, operation, decommissioning, and post-closure phases was in the form of as impact assessment table supplied by JMA Consulting.

6.1.1 Constraints and Limitations of Impact Assessment Methodology

Specific quantities for the listed activities were not provided so it was necessary to estimate these in order to define the "Quantity" of each impact.

6.2 ASSESSMENT OF IMPACTS

The impact assessment tables used to assess impacts to terrestrial fauna can be found in a separate Excel document – Sasol Shondoni IA Table July 2010 – Terrestrial Fauna. The following impacts to terrestrial fauna are expected to occur:

- *Habitat Loss*

During the construction of the Shondoni Shaft Complex, Access road, Conveyer belt and associated infrastructure, large areas of vegetation will need to be cleared. This will result in a loss of habitat for those species utilizing the area. Due to the Endangered status of the Grassland vegetation types present across some of the affected area, Even small losses in vegetation could have a serious impact not only on the continued existence of these grasslands, but also the unique and Red Data List fauna they support.

- *Habitat Fragmentation*

Some habitat fragmentation on a small scale is expected to occur related to all vegetation and habitat loss and construction of infrastructure. However, the main sources of habitat fragmentation are expected to be from the construction of linear infrastructure, such as the Access road and the Conveyer belt and associated servitude, which will create act as barriers to the movement of mobile species to a greater or lesser extent.

- *Loss of Fauna*

During the construction and decommissioning phases, the activities associated with, and the machinery required for, construction/decommissioning are likely to cause the accidental death of fauna on site. The increased number of people present will also increase the likelihood of contact between people and animals, which could lead to accidental or deliberate animal deaths and/or harm to humans should the animal be poisonous or dangerous. During the operational phase, fauna may be killed by vehicles while trying to cross roads or through human contact within the shaft complex or along the conveyer route. There is the potential that the above-mentioned activities may lead to the loss of Red Data List Fauna.

- *Deterioration of Habitat Quality and Habitat Alteration*

The deterioration of habitat quality can occur due to invasion of exotic plant or declared weed species, a decrease in water quality through inputs of dirty water from the disposal of waste, water containing waste, stormwater, and any water extracted from the underground workings. An activity which causes a change in the abiotic features of a habitat will have a negative impact on those faunal species which utilize the habitat, if the change causes the habitat to become unsuitable for use by those species.

6.3 MITIGATION OBJECTIVES AND MEASURES

A description of mitigation objectives and measures for each impact has been provided in the impact assessment tables. The main mitigation objectives are to prevent the unnecessary loss of vegetation, habitat fragmentation and habitat deterioration, to minimise wherever possible the death

of fauna and to ensure the successful re-establishment of the natural vegetation after the closure of the mine. In order to meet the mitigation objectives, the following measures have been suggested for each of the potential impacts already discussed:

- *Habitat Loss*

Habitat loss during the construction activities will be unavoidable, therefore, mitigation measures are aimed at minimizing the loss of vegetation wherever possible by ensuring that all construction areas are fenced and construction activities are limited to within the fenced areas.

- *Habitat Fragmentation*

Habitat fragmentation is expected to occur wherever there is a loss of vegetation, but especially where linear activities, such as the conveyer belt servitude and the access road, will create a barrier across the landscape. To allow animals thoroughfare across the conveyer belt servitude it is suggested that materials used to fence the conveyer belt servitude should have a mesh hole diameter of at least 50 centimetres or more or should provide holes in the fence of a similar diameter at regular intervals - at least one entry point for each 500 metres of fencing (along both sides of the servitude). It is expected that the conveyor belt will be elevated off the ground, thereby allowing animals to pass under it.

- *Loss of Fauna*

An environmental officer should be appointed at the outset of the mining project. Any animals encountered by mine personnel should be carefully and safely removed to an appropriate location after consultation with the environmental officer as to the proper means of handling any animals encountered and the appropriate relocation sites.

- *Deterioration of Habitat Quality and Habitat Alteration*

Activities which alter or cause the deterioration of habitat quality are expected to occur through all four phases of the mine project. The following mitigation measures are suggested to minimize or completely mitigate the impacts.

Any activities or structures within the 1:100 year floodline or within wetland areas should be carefully controlled and regularly monitored to prevent pollution, erosion or changes in the natural hydrology. No vehicle or equipment storage or maintenance areas should be located within wetland areas or within the 1:100 year floodline. Dust should be controlled. No polluted or dirty water should be discharged into the environment. Dirty water should either be treated on site to acceptable quality standards or stored and then removed by qualified and licensed waste management contractors to be treated off-site. Any clean water discharged into the environment should be handled in such a way that its discharge does not cause erosion or alter the natural hydrology within wetlands and rivers.

During the decommissioning and closure of the mine, all exotic and declared weed species should be removed from areas affected by the mining activities, and a suitably qualified botanist should be consulted to determine the best method for re-establishing the naturally occurring vegetation communities. All demolition areas should be fenced and demolition activities should be limited to within the fenced areas. All waste materials generated during the decommissioning of the mine should be removed from site to a suitable disposal facility.

No high extraction mining should take place under those areas and habitats classed as sensitive or of high importance in the baseline study. However, should subsidence occur, measures must be

taken to ensure the continuation of, or if necessary reinstate, the natural hydrology within the landscape.

6.4 ASSESSMENT OF CUMULATIVE IMPACTS

A cumulative impact can arise due to the combination of impacts from the project being evaluated with related impacts from other projects. These cumulative impacts occur when the project impacts compound the effects of other past, present and (expected) future projects, causing an increase in environmental degradation which is greater than that expected from the project being evaluated alone.

Cumulative impacts which are likely to occur are a loss of vegetation and habitat, habitat fragmentation and a decrease in water quality, which will negatively impact the quality of remaining habitat. Urban expansion occurring in the surrounding towns and increased cultivation will cause an additional decrease in natural habitat and will lead to increasing fragmentation of the remaining habitat. Pollution originating from urban areas, roads, farming practices and other mining activities in the catchments are all expected to negatively impact the water resource, thereby further reducing the quality of available habitat, especially for those species utilizing wetland or riparian habitats. Therefore the Shondoni Project is likely to contribute to significantly negative cumulative impacts on the environment and the terrestrial fauna, and for this reason, those mining activities contributing to the above mentioned cumulative impacts need to be carefully considered and every effort must be made to prevent the impacts from occurring, and if unavoidable, suitable mitigation measures should be carried out to minimize the impact.

6.5 MONITORING MEASURES

Water quality monitoring has been recommended as part of the aquatics study and this monitoring program will also give an indication of the habitat quality of aquatic environments for the fauna utilizing them. In addition, it is suggested that a qualified ornithologist be consulted to undertake monitoring of the Greater and Lesser Flamingo populations within the Leeupan Reserve. It is expected that this monitoring could take the form of seasonal or biannual population counts throughout the lifetime of the mining project to determine whether the project is having any influence on the number of birds utilising the pan. Although this area is not expected to be directly affected by the mining activity, changes in habitat quality could occur and may negatively impact the flamingo populations.

6.6 CONCLUSION

The impact assessment indicated that the proposed Sasol Middelbult (Block 8) – Shondoni Shaft mining operation will have negative impacts on the terrestrial fauna. The majority of impacts are expected to indirectly affect the fauna through habitat loss, habitat fragmentation and deterioration in habitat quality. Direct negative impacts to the fauna will include death of individuals or populations due to contact with humans, vehicles or machinery. In many cases, mitigation measures are available to reduce the severity of the impacts, however, the success of these mitigation measures will depend on their proper implementation and continued monitoring to ensure the mitigation objectives are met during each phase of the project.

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8. APPENDIX I: COMPLETE MAMMAL SPECIES LIST

ORDER	SPECIES	COMMON NAME
Afrosoricida	***Amblysomus hottentotus***	**Hottentot's golden mole**
Afrosoricida	***Amblysomus septentrionalis***	**Highveld golden mole**
Carnivora	*Aonyx capensis*	Cape clawless otter
Carnivora	*Atilax paludinosus*	Water/Marsh mongoose
Carnivora	*Canis mesomelas*	Black-backed jackal
Carnivora	*Caracal caracal*	Caracal
Carnivora	*Cynictis penicillata*	Yellow mongoose
Carnivora	*Felis nigripes*	Black-footed cat
Carnivora	*Felis silvestris*	African wild cat
Carnivora	*Galerella sanguinea*	Slender mongoose
Carnivora	*Genetta genetta*	Small-spotted genet
Carnivora	*Genetta tigrina*	Large-spotted genet
Carnivora	*Ichneumia albicauda*	White-tailed mongoose
Carnivora	*Ictonyx striatus*	Striped polecat
Carnivora	***Lutra maculicollis***	**Spotted-necked otter**
Carnivora	*Mungos mungo*	Banded mongoose
Carnivora	***Parahyaena brunnea***	**Brown hyaena**
Carnivora	***Poecilogale albinucha***	**Striped weasel**
Carnivora	*Proteles cristatus*	Aardwolf
Carnivora	*Suricata suricatta*	Suricate
Carnivora	*Vulpes chama*	Cape fox
Chiroptera	*Eidolon helvum*	Straw-coloured fruit bat
Chiroptera	***Miniopterus schreibersii***	**Schreibers' long-fingered bat**
Chiroptera	***Myotis tricolor***	**Temminck's hairy bat**
Chiroptera	*Neoromicia capensis*	Cape serotine bat
Chiroptera	*Nycteris thebaica*	Egyptian slit-faced bat
Chiroptera	***Rhinolophus blasii***	**Peak-saddle horseshoe bat**
Chiroptera	***Rhinolophus clivosus***	**Geoffrey's horseshoe bat**
Chiroptera	*Sauromys petrophilus*	Flat-headed free-tailed bat
Chiroptera	*Tadarida aegyptiaca*	Egyptian free-tailed bat

ORDER	SPECIES	COMMON NAME
Chiroptera	*Taphozous mauritianus*	Tomb bat
Eulipotyphla	***Atelerix frontalis***	**South African hedgehog**
Eulipotyphla	***Crocidura cyanea***	**Reddish-grey musk shrew**
Eulipotyphla	***Crocidura mariquensis***	**Swamp musk shrew**
Eulipotyphla	***Crocidura silacea***	**Lesser grey-brown musk shrew**
Eulipotyphla	***Myosorex varius***	**Forest shrew**
Eulipotyphla	***Suncus infinitesimus***	**Least dwarf shrew**
Eulipotyphla	***Suncus varilla***	**Lesser dwarf shrew**
Hyracoidea	*Procavia capensis*	Rock Hyrax
Lagomorpha	*Lepus capensis*	Cape hare/Desert hare
Lagomorpha	*Lepus saxatillus*	Scub hare/Savannah hare
Lagomorpha	*Pronolagus randensis*	Jameson's red rock rabbit
Lagomorpha	*Pronolagus rupestris*	Smith's red rock rabbit
Macroscelidea	*Elephantulus myurus*	Rock elephant-shrew
Pholidota	***Manis temminckii***	**Pangolin**
Primata	*Galago moholi*	Lesser bushbaby
Primata	*Papio ursinus*	Chacma baboon
Rodentia	*Aethomys chrysophilus*	Red veld rat
Rodentia	*Aethomys ineptus*	Tete veld rat
Rodentia	*Cryptomys hottentotus*	Common mole-rat
Rodentia	***Dasymys incomtus***	**Water rat**
Rodentia	*Dendromus melanotis*	Grey climbing mouse
Rodentia	*Dendromus mesomelas*	Brant's climbing mouse
Rodentia	*Dendromus mystacalis*	Chestnut climbing mouse
Rodentia	***Graphiurua platyops***	**Rock dormouse**
Rodentia	*Graphiurus murinus*	Woodland dormouse
Rodentia	*Hystrix africaeaustralis*	Porcupine
Rodentia	***Lemniscomys rosalia***	**Single-striped mouse**
Rodentia	*Mastomys coucha*	Multimammate mouse
Rodentia	*Mastomys natalensis*	Natal multimammate mouse
Rodentia	*Micaelamys namaquensis*	Namaqua rock mouse
Rodentia	*Mus indutus*	Desert pygmy mouse

ORDER	SPECIES	COMMON NAME
Rodentia	*Mus minutoides*	Pygmy mouse
Rodentia	***Mystromys albicaudatus***	**White-tailed mouse**
Rodentia	*Otomys angoniensis*	Angoni vlei rat
Rodentia	*Otomys irroratus*	Vlei rat
Rodentia	*Pedetes capensis*	Springhare
Rodentia	*Rhabdomys pumilio*	Striped mouse
Rodentia	*Saccostomus campestris*	Pouched mouse
Rodentia	*Tatera bransii*	Highveld gerbil
Rodentia	***Tatera leucogaster***	**Bushveld gerbil**
Rodentia	*Thallomys nigricauda*	Black-tailed tree mouse
Rodentia	*Thallomys paedulcus*	Tree mouse
Rodentia	*Xerus inauris*	Cape Ground squirrel
Ruminantia	*Antidorcas marsupialis*	Springbok
Ruminantia	*Connochaetes gnou*	Black wildebeest
Ruminantia	*Damaliscus pygargus phillipsi*	Blesbok
Ruminantia	***Ourebia ourebi***	**Oribi**
Ruminantia	*Pelea capreolus*	Grey rhebok
Ruminantia	*Raphicerus campestris*	Steenbok
Ruminantia	*Sylvicapra grimmia*	Common duiker
Ruminantia	*Tragelaphus oryx*	Eland
Suiformes	*Phacochoerus africanus*	Common warthog
Tubulidentata	*Orycteropus afer*	Aardvark

9. APPENDIX II: COMPLETE BIRD SPECIES LIST

ROBERTS NUMBER	SPECIES	COMMON NAME
1	*Struthio camelus*	Common Ostrich
6	*Podiceps cristatus*	Great Crested Grebe
7	*Podiceps nigricollis*	Black-necked Grebe
8	*Tachybaptus ruficollis*	Little Grebe (Dabchick)
50	***Pelecanus rufescens***	**Pink-backed Pelican**
55	*Phalacrocorax lucidus*	White-breasted (Great) Cormorant
58	*Phalacrocorax africanus*	Reed (Long-tailed) Cormorant
60	*Anhinga rufa*	African Darter
62	*Ardea cinerea*	Grey Heron
63	*Ardea melanocephala*	Black-headed Heron
64	*Ardea goliath*	Goliath Heron
65	*Ardea purpurea*	Purple Heron
66	*Egretta alba*	Great Egret
67	*Egretta garzetta*	Little Egret
68	*Egretta intermedia*	Yellow-billed (Intermediate) Egret
69	*Egretta ardesiaca*	Black Heron
71	*Bubulcus ibis*	Cattle Egret
72	*Ardeola ralloides*	Squacco Heron
76	*Nycticorax nycticorax*	Black-crowned Night-Heron
78	*Ixobrychus minutus*	Little Bittern
81	*Scopus umbretta*	Hamerkop
83	*Ciconia ciconia*	White Stork
84	***Ciconia nigra***	**Black Stork**
85	*Ciconia abdimii*	Abdim's Stork
90	***Mycteria ibis***	**Yellow-billed Stork**
91	*Threskiornis aethiopicus*	African Sacred (Sacred) Ibis
92	***Geronticus calvus***	**Southern Bald (Bald) Ibis**
93	*Plegadis falcinellus*	Glossy Ibis
94	*Bostrychia hagedash*	Hadeda Ibis
95	*Platalea alba*	African Spoonbill
96	***Phoenicopterus ruber***	**Greater Flamingo**
97	***Phoenicopterus minor***	**Lesser Flamingo**
99	*Dendrocygna viduata*	White-faced (Whistling-) Duck
100	*Dendrocygna bicolor*	Fulvous (Whistling) Duck
101	*Thalassornis leuconotus*	White-backed Duck
102	*Alopochen aegyptiaca*	Egyptian Goose
103	*Tadorna cana*	South African Shelduck
104	*Anas undulata*	Yellow-billed Duck
105	*Anas sparsa*	African Black Duck
106	*Anas capensis*	Cape Teal
107	*Anas hottentota*	Hottentot Teal
108	*Anas erythrorhyncha*	Red-billed Teal (Duck)
112	*Anas smithii*	Cape Shoveler
113	*Netta erythrophthalma*	Southern Pochard
115	*Sarkidiornis melanotos*	Comb (Knob-billed) Duck
116	*Plectropterus gambensis*	Spur-winged Goose
117	*Oxyura maccoa*	Maccoa Duck

ROBERTS NUMBER	SPECIES	COMMON NAME
118	***Sagittarius serpentarius***	**Secretarybird**
126	*Milvus migrans*	Black & Yellowbilled Kite (pre-split)
127	*Elanus caeruleus*	Black-shouldered (Winged) Kite
140	***Polemaetus bellicosus***	**Martial Eagle**
143	*Circaetus pectoralis*	Black-chested (Breasted) Snake-Eagle
148	*Haliaeetus vocifer*	African Fish-Eagle
149	*Buteo vulpinus*	Steppe (Common) Buzzard
152	*Buteo rufofuscus*	Jackal Buzzard
165	***Circus ranivorus***	**African Marsh-Harrier**
167	***Circus macrourus***	**Pallid Harrier**
168	***Circus maurus***	**Black Harrier**
172	***Falco biarmicus***	**Lanner Falcon**
173	*Falco subbuteo*	Eurasian Hobby
179	*Falco vespertinus*	Red-footed (Western Red-footed) Falcon (Kestrel
180	*Falco amurensis*	Amur (Eastern Red-footed) Falcon (Kestrel)
181	*Falco rupicolus*	Rock Kestrel
182	*Falco rupicoloides*	Greater Kestrel
183	***Falco naumanni***	**Lesser Kestrel**
190	*Scleroptila africanus*	Grey-winged Francolin
192	*Scleroptila levaillantii*	Red-winged Francolin
193	*Scleroptila levaillantoides*	Orange River Francolin
199	*Pternistis swainsonii*	Swainson's Spurfowl (Francolin)
200	*Coturnix coturnix*	Common Quail
203	*Numida meleagris*	Helmeted Guineafowl
205	*Turnix sylvaticus*	Kurrichane (Small) Buttonquail
207	***Bugeranus carunculatus***	**Wattled Crane**
208	***Anthropoides paradiseus***	**Blue Crane**
209	***Balearica regulorum***	**Grey Crowned- (Crowned) Crane**
210	*Rallus caerulescens*	African Rail
213	*Amaurornis flavirostris*	Black Crake
217	*Sarothrura rufa*	Red-chested Flufftail
223	*Porphyrio madagascariensis*	African Purple (Purple) Swamphen (Gallinule)
226	*Gallinula chloropus*	Common Moorhen
228	*Fulica cristata*	Red-knobbed Coot
231	***Neotis denham***	**Denham's (Stanley's) Bustard**
233	***Eupodotis senegalensis***	**White-bellied Korhaan**
234	***Eupodotis caerulescens***	**Blue Korhaan**
239	*Afrotis* sp.	Black Korhaan (pre-split)
240	*Actophilornis africanus*	African Jacana
242	***Rostratula benghalensis***	**Greater Painted-snipe**
245	*Charadrius hiaticula*	Common Ringed Plover
248	*Charadrius pecuarius*	Kittlitz's Plover
249	*Charadrius tricollaris*	Three-banded Plover
255	*Vanellus coronatus*	Crowned Lapwing (Plover)
258	*Vanellus armatus*	Blacksmith Lapwing (Plover)
260	*Vanellus senegallus*	African Wattled Lapwing (Plover)
262	*Arenaria interpres*	Ruddy Turnstone
264	*Actitis hypoleucos*	Common Sandpiper
266	*Tringa glareola*	Wood Sandpiper

ROBERTS NUMBER	SPECIES	COMMON NAME
269	*Tringa stagnatilis*	Marsh Sandpiper
270	*Tringa nebularia*	Common Greenshank
272	*Calidris ferruginea*	Curlew Sandpiper
274	*Calidris minuta*	Little Stint
284	*Philomachus pugnax*	Ruff
286	*Gallinago nigripennis*	African (Ethiopian) Snipe
294	*Recurvirostra avosetta*	Pied (Avocet) Avocet
295	*Himantopus himantopus*	Black-winged Stilt
297	*Burhinus capensis*	Spotted Thick-knee (Dikkop)
305	***Glareola nordmanni***	**Black-winged Pratincole**
315	*Larus cirrocephalus*	Grey-headed Gull
322	***Sterna caspia***	**Caspian Tern**
338	*Chlidonias hybrida*	Whiskered Tern
339	*Chlidonias leucopterus*	White-winged Tern
348	*Columba livia*	Rock (Feral) Dove (Pigeon)
349	*Columba guinea*	Speckled (Rock) Pigeon
352	*Streptopelia semitorquata*	Red-eyed Dove
354	*Streptopelia capicola*	Cape Turtle (Ring-necked) Dove
355	*Streptopelia senegalensis*	Laughing (Palm) Dove
356	*Oena capensis*	Namaqua Dove
373	*Corythaixoides concolor*	Grey Go-away-bird (Lourie)
377	*Cuculus solitarius*	Red-chested Cuckoo
386	*Chrysococcyx caprius*	Dideric (Diederik) Cuckoo
392	*Tyto alba*	Barn Owl
393	***Tyto capensis***	**African Grass-Owl**
395	*Asio capensis*	Marsh Owl
401	*Bubo africanus*	Spotted Eagle-Owl
404	*Caprimulgus europaeus*	European Nightjar
411	*Apus apus*	Common (European) Swift
412	*Apus barbatus*	African Black (Black) Swift
415	*Apus caffer*	White-rumped Swift
416	*Apus horus*	Horus Swift
417	*Apus affinis*	Little Swift
421	*Cypsiurus parvus*	African Palm-Swift
424	*Colius striatus*	Speckled Mousebird
426	*Urocolius indicus*	Red-faced Mousebird
428	*Ceryle rudis*	Pied Kingfisher
429	*Megaceryle maximus*	Giant Kingfisher
431	*Alcedo cristata*	Malachite Kingfisher
446	*Coracias garrulus*	European Roller
447	*Coracias garrulus*	Lilac-breasted Roller
451	*Upupu africana*	African Hoopoe
452	*Phoeniculus purpureus*	Green (Red-billed) Wood-hoopoe
464	*Lybius torquatus*	Black-collared Barbet
465	*Tricholaema leucomelas*	Acacia Pied (Pied) Barbet
473	*Trachyphonus vailantii*	Crested Barbet
480	*Geocolaptes olivaceus*	Ground Woodpecker
489	*Jynx ruficollis*	Red-throated Wryneck
492	***Mirafra cheniana***	**Melodious (Latakoo) Lark**
494	*Mirafra africana*	Rufous-naped Lark

ROBERTS NUMBER	SPECIES	COMMON NAME
495	*Mirafra* sp.	Clapper Lark (pre-split)
498	*Calendulauda sabota*	Sabota Lark
500	*Certhilauda sp.*	Longbilled Lark (pre-split)
506	*Chersomanes albofasciata*	Spike-heeled Lark
507	*Callandrella cinerea*	Red-capped Lark
508	*Spizocorys conirostris*	Pink-billed Lark
509	***Spizocorys fringillaris***	**Botha's Lark**
515	*Eremopterix leucotis*	Chestnut-backed Sparrowlark (Finchlark)
518	*Hirundo rustica*	Barn (European) Swallow
520	*Hirundo albigularis*	White-throated Swallow
524	*Hirundo semirufa*	Red-breasted (Rufous-chested) Swallow
526	*Hirundo cucullata*	Greater Striped-Swallow
528	*Hirundo spilodera*	South African Cliff-Swallow
529	*Hirundo fuligula*	Rock Martin
530	*Delichon urbicum*	Common House-Martin
532	*Riparia riparia*	Sand Martin (Bank Swallow)
533	*Riparia paludicola*	Brown-throated (Plain) Martin
534	*Riparia cincta*	Banded Martin
543	*Oriolus oriolus*	Eurasian Golden-Oriole
545	*Oriolus larvatus*	Black-headed (Eastern) Oriole
547	*Corvus capensis*	Cape (Black) Crow
548	*Corvus albus*	Pied Crow
552	*Parus cinerascens*	Ashy Tit
567	*Pycnonotus nigricans*	African Red-eyed Bulbul
568	*Pycnonotus tricolor*	Dark-capped (Black-eyed) Bulbul
577	*Turdus olivaceus*	Olive Thrush (pre-split)
581	*Monticola rupestris*	Cape Rock-Thrush
582	*Monticola explorator*	Sentinel Rock-Thrush
586	*Oenanthe monticola*	Mountain Chat (Wheatear)
587	*Oenanthe pileata*	Capped Wheatear
589	*Cercomela familiaris*	Familiar Chat
595	*Myrmecocichla formicivora*	Ant-eating Chat
596	*Saxicola torquatus*	African (Common) Stonechat
601	*Cossypha caffra*	Cape Robin-Chat
619	*Sylvia borin*	Garden Warbler
620	*Sylvia communis*	Common (Whitethroat) Whitethroat
621	*Parisoma subcaeruleum*	Chestnut-vented Tit-Babbler
625	*Hippolais icterina*	Icterine Warbler
628	*Acrocephalus arundinaceus*	Great Reed-Warbler
631	*Acrocephalus baeticatus*	African (African Marsh-Warbler) Reed-Warbler
633	*Acrocephalus palustris*	Marsh (European Marsh) Warbler
634	*Acrocephalus schoenobaenus*	Sedge Warbler
635	*Acrocephalus gracilirostris*	Lesser Swamp- (Cape Reed) Warbler
638	*Bradypterus baboecala*	Little Rush- (African Sedge) Warbler
643	*Phylloscopus trochilus*	Willow Warbler
645	*Apalis thoracica*	Bar-throated Apalis
664	*Cisticola juncidis*	Zitting (Fan-tailed) Cisticola
665	*Cisticola aridulus*	Desert Cisticola
666	*Cisticola textrix*	Cloud (Tink-tink) Cisticola
667	*Cisticola ayresii*	Wing-snapping (Ayre's) Cisticola

ROBERTS NUMBER	SPECIES	COMMON NAME
670	*Cisticola lais*	Wailing Cisticola
677	*Cisticola tinniens*	Le Vaillant's (Tinkling) Cisticola
681	*Cisticola fulvicapilla*	Neddicky (Piping Cisticola)
683	*Prinia subflava*	Tawny-flanked Prinia
685	*Prinia flavicans*	Black-chested Prinia
689	*Muscicapa striata*	Spotted Flycatcher
698	*Sigelus silens*	Fiscal Flycatcher
706	*Stenostira scita*	Fairy Flycatcher (Warbler)
713	*Motacilla capensis*	Cape Wagtail
716	*Anthus cinnamomeus*	African (Grassveld/Grassland) Pipit
717	*Anthus similis*	Long-billed Pipit
718	*Anthus leucophrys*	Plain-backed Pipit
719	*Anthus vaalensis*	Buffy Pipit
727	*Macronyx capensis*	Cape (Orange-throated) Longclaw
731	*Lanius minor*	Lesser Grey Shrike
732	*Lanius collaris*	Common Fiscal
733	*Lanius collurio*	Red-backed Shrike
746	*Telophorus zeylonus*	Bokmakierie
758	*Acridotheres tristis*	Common Myna
759	*Spreo bicolor*	Pied (African Pied) Starling
760	*Creatophora cinerea*	Wattled Starling
764	*Lamprotornis nitens*	Cape Glossy (Glossy) Starling
769	*Onychognathus morio*	Red-winged Starling
775	*Nectarinia famosa*	Malachite Sunbird
792	*Chalcomitra amethystina*	Amethyst (Black) Sunbird
796	*Zosterops virens*	Cape White-eye (pre-split)
799	*Plocepasser mahali*	White-browed Sparrow-Weaver
801	*Passer domesticus*	House Sparrow
803	*Passer melanurus*	Cape Sparrow
804	*Passer diffusus*	Greyheaded Sparrow (pre-split)
806	*Sporopipes squamifrons*	Scaly-feathered Finch
811	*Ploceus cucullatus*	Village (Spotted-backed) Weaver
813	*Ploceus capensis*	Cape Weaver
814	*Ploceus velatus*	Southern Masked-Weaver
820	*Anomalospiza imberbis*	Cuckoo Finch (Parasitic Weaver)
821	*Quelea quelea*	Red-billed Quelea
824	*Euplectes orix*	Southern Red (Red) Bishop
826	*Euplectes afer*	Yellow-crowned (Golden) Bishop
827	*Euplectes capensis*	Yellow (Yellow-rumped) Bishop (Widow)
828	*Euplectes axillaris*	Fan-tailed (Red-shouldered) Widowbird
829	*Euplectes albonotatus*	White-winged Widowbird
831	*Euplectes ardens*	Red-collared Widowbird
832	*Euplectes progne*	Long-tailed Widowbird
834	*Pytilia melba*	Green-winged (Melba) Pytilia (Finch)
846	*Estrilda astrild*	Common Waxbill
852	*Ortygospiza atricollis*	African Quailfinch
854	*Sporaeginthus subflavus*	Orange-breasted (Zebra) Waxbill
856	*Amadina erythrocephala*	Red-headed Finch
860	*Vidua macroura*	Pin-tailed Whydah
862	*Vidua paradisaea*	Long-tailed (Paradise) Paradise-Whydah

ROBERTS NUMBER	SPECIES	COMMON NAME
869	*Crithagra mozambicus*	Yellow-fronted (eyed) Canary
870	*Crithagra atrogularis*	Black-throated Canary
872	*Serinus canicollis*	Cape (Yellow-crowned) Canary
878	*Crithagra flaviventris*	Yellow Canary
881	*Crithagra gularis*	Streaky-headed Seedeater (Canary)
885	*Emberiza capensis*	Cape Bunting
886	*Emberiza tahapisi*	Cinnamon-breasted (Rock) Bunting
888	*Milvus migrans parasitus*	Yellow-billed Kite
889	*Milvus migrans*	Black Kite

10. APPENDIX III: REPTILE AND AMPHIBIAN SPECIES LIST

FAMILY	SPECIES	COMMON NAME	CONSERVATION STATUS
Reptiles			
Gekkonidae	*Pachydactylus c. capensis*	Cape thick-toed gecko	
Gekkonidae	*Pachydactylus vansoni*	Van Son's thick-toed gecko	
Gekkonidae	*Pachydactylus affinis*	Transvaal thick-toed gecko	
Agamidae	*Agama atra*	Southern rock agama	
Agamidae	*Agama a. distanti*	Spiny agama	
Scincidae	*Mabuya capensis*	Cape skink	
Scincidae	*Mabuya varia*	Variable skink	
Scincidae	*Mabuya striata punctatissimus*	Striped skink	
Scincidae	*Acontias g. gracilicauda*	Slendertail lance skink	
Scincidae	*Acontias breviceps*	Shorthead lance skink	
Lacertidae	*Pedioplanis burchellii*	Burchell's sand lizard	
Gerrhosauridae	*Gerrhosaurus flavigularis*	Yellow-throated plated lizard	
Cordylidae	*Chamaesaura aenea*	Transvaal grass lizard	
Cordylidae	*Pseudocordylus m. melanotus*	Drakensberg crag lizard	
Typhlopidae	*Typhlops bibronii*	South African blind snake	
Leptotyphlopidae	*Leptotyphlops c. conjunctus*	Cape thread snake	
Colubridae	*Pseudaspis cana*	Mole snake	
Colubridae	*Lycodonomorphus rufulus*	Brown water snake	
Colubridae	*Lamprophis aurora*	Aurora house snake	
Colubridae	*Lamprophis fuliginosis*	Brown house snake	
Colubridae	*Duberria l. lutrix*	Common slug-eater	
Colubridae	*Psammophylax r. rhombeatus*	Rhombic skaapsteker	
Colubridae	*Psammophis s. brevirostris*	Short-snouted grass snake	
Colubridae	*Psammophis crucifer*	Cross-marked grass snake	
Colubridae	*Aparallactus capensis*	Black-headed centipede-eater	
Colubridae	*Homoreselaps lacteus*	Spotted harlequin snake	
Colubridae	*Crotaphopeltis hotamboeia*	Herald snake	
Colubridae	*Dasypeltis scabra*	Common egg-eater	
Elapidae	*Hemachatus hemachaetus*	Rinkhals	
Amphibians			
Bufonidae	Amietophrynus gutturalis	Guttural toad	
Bufonidae	Amietophrynus maculatus	Flat-backed toad	
Bufonidae	Amietophrynus rangeri	Raucous toad	
Hyperolidae	Kassina senegalensis	Bubbling kassina	
Hyperolidae	Kassina wealii	Rattling kassina	
Phrynobatrachidae	Phrynobatrachus natalensis	Snoring puddle frog	
Pipidae	Xenopus laevis	Common platanna	
Pyxicephalidae	Amietia angolensis	Common river frog	
Pyxicephalidae	Amietia fuscigula	Cape river frog	
Pyxicephalidae	Cacosternum boettgeri	Boettger's Caco	
Pyxicephalidae	**Pyxicephalus adspersus**	**Giant bullfrog**	**NT**
Pyxicephalidae	Strongylopus fasciatus	Striped stream frog	
Pyxicephalidae	Strongylopus grayii	Clicking stream frog	
Pyxicephalidae	Tomopterna cryptotis	Tremolo sand frog	

Pyxicephalidae	Tomopterna natalensis	Natal sand frog
Pyxicephalidae	Tomopterna tandyi	Tandy's sand frog