

5. MINING

This section includes discussion and comment on the mining engineering and related aspects of the LoM Plans associated with the Material Properties. Specifically, comments are given on the applicability of the mining methods, rock mechanics and geotechnical considerations, ventilation and the planning process. The mining engineering and related aspects contained in this section support the production schedules, operating costs and capital expenditures contained in the FMs in Section 14.

5.1 Mine Planning Process

The planning process at the Material Properties is dependent upon input from the geology/resource management departments. Responsibility is assigned for addition/revision, and depletion sign-off on the Mineral Resource and Mineral Reserve models, which form the basis for subsequent design and planning and extraction sequencing incorporated into the LoM Plan. In the majority of instances this is completed using a combination of geological modelling, mine planning and production scheduling computer software.

The LoM Planning cycle (currently financial year from January to December), following ratification of key input parameters, commences with updating of the Mineral Resource statement allowing for depletion projections and generation of a SAMREC/JORC compliant statement for 31 December. On completion of this update of the Mineral Resource statement, the planning process commences and comprises:

- Targets, objectives and guidelines that are derived from the corporate headoffice business plans;
- A detailed short-term (one- to three-year) operating plan including detailed mining face positions for surface mine layouts and associated development layouts for underground operations;
- An extension to this short-term plan resulting in a five-year or ten-year plan from which a capital expenditure programme is developed;
- Extension into a full LoM Plan including mining layouts and extraction strategies, which deplete the Mineral Reserve in accordance with the pre-defined strategies.

In conjunction with the above, a detailed (one-year) operating cost budget is subsequently projected and where appropriate modified for the LoM production schedule. The one-year budget is generally prepared on a monthly basis, extending into quarterly periods and annually thereafter. Of critical importance is the utilisation of historical data for dilution and extraction factors and operating costs.

SRK concludes that the LoM Planning process and resulting LoM Plans are diligently prepared by competent professionals. SRK considers that the planning process and resulting LoM Plans, as modified and reported herein, generally reflect international practice and are appropriate for the purposes of this CPR.

5.2 Iron Ore

5.2.1 Sishen Mine

Mining Methods: Sishen Mine is a large, mature opencast mine established in 1953 to develop the extensive local iron mineralisation and resources in the area. All the RoM ore is beneficiated and, after blending to specification on product stockpiles, is railed to Saldanha Bay for the international export sales markets or inland to the domestic customers. The Mineral Resources and Mineral Reserves have historically been derived from >60%Fe material and lower grade iron ore was stockpiled or classified as waste. An investigation into mining and processing lower grade material has been completed by Kumba and the SEP Phase I is being constructed to process >58.5%Fe material.

The regional topography is flat and access into the pit areas is provided by a number of haul roads that are generally constructed to a minimum width of 30m and at a maximum gradient of 8%. Mining operations are widespread and take place over the full area of the deposit. The pit can broadly be divided into a North, Central and South pit area. Waste dumps are located on the east and west sides of the pit, and some backfilling of mined out pit areas has already commenced in the Central and South pit area. In the longer term a greater opportunity for backfilling exists.

An in-pit crusher located in the North pit area is used to reduce haul distances and crushed ore is conveyed from the in-pit crusher to the beneficiation plant.

Mining benches are cut at 12.5m intervals although smaller equipment has been introduced to enable the mining operation to mine more selectively from the bench and flitches. The mining operation is conducted using a large fleet of conventional open pit mining equipment comprising blast hole drilling rigs, electric face shovels, and 170t and 190t off-highway trucks supported by appropriate ancillary mining equipment. Where appropriate, electric trolley assist for truck haulage is used improving the up-hill truck speeds on in-pit haul

roads and roads to the waste dumps. A small proportion of the waste rock can be free dug (16%) but the majority of the rock to be mined requires drilling and blasting. The ore material consists of haematite in enriched banded iron formation. These rocks are very hard and have a high specific gravity. The mining duty is considered to be heavy.

The mining equipment fleet is maintained on an ongoing basis, with interim major overhauls and rebuilds planned during the life of each of the primary units of mining equipment. Provision is made to replace the equipment as justified by higher maintenance costs as each unit ages. The final pit as planned will require the relocation of certain surface infrastructures due to the expansion of the open pit westwards and a 500m blasting perimeter. The likely costs for infrastructure relocations have been provided for in the capital planning and have been utilised in the open pit optimisation exercises.

Dilution, Mining Losses and Reconciliation: A mining block size of 10m x 10m x 6.25m is used for ore definition in terms of the different material categories used at the mine. These blocks can be aggregated to form a bench of 12.5m in vertical height. A block is classified according to the material type in which the centroid of the block falls. The block includes estimates for dilution and for mining loss only where the centroid of both blocks falls outside the ore zone. Sishen Mine has traditionally used six material codes to derive the Mineral Reserve estimates although product quality algorithms are used to determine the likely product. An allocation percentage is attributed to each of the material codes. The six material type codes include: four for ore to define blocks above and below a grade of 64.5%Fe as well as above and below a phosphorous content of 0.08%; one for the high density (RD>3.6) hangingwall waste; and one for the low density (RD<3.6) footwall waste. Dilution and ore loss is incorporated in the two waste material categories where the orebody outline transgresses the block boundary. From reconciliation with the actual plant feed the proportion of these material categories reporting as actual plant feed is quantified and used in defining the Mineral/Ore Reserves. The latest reconciliation indicated that the following proportions report as ore: 100% of the ore blocks with low phosphorous; 58% of the ore blocks with high phosphorous; 25% of the high density hangingwall waste and 60% of the low density footwall waste. For the latest Mineral/Ore Reserves the material codes have been expanded to some 14 categories principally to include the different combinations associated with introducing the SEP plant and to formalise the contribution from selective mining. In terms of iron ore grades the material greater than 64.5%Fe is planned to report exclusively to the Main Plant whilst material between 61%Fe and 64.5%Fe can be treated at the Main Plant or SEP Plant. Ore with a grade of some 40%Fe to 61%Fe is planned to be treated exclusively at the SEP Plant. These material codes are used in the scheduling algorithms and not all the material that is defined as ore is necessarily treated in the period of the LoM Plan. A certain amount of SEP material located towards the base of the open pit remains at the end of the LoM Plan due to the treatment capacities of the two plants. This indicates the potential for increased SEP production as envisaged by Kumba in the SEP Phase II project for later expansion.

Table 5.1 Sishen Mine: Modifying Factors

Modifying Factor	Units	Value
Ore Loss	(%)	n/a ¹
Dilution	(%)	7.4%

(1) No separate ore loss figure is available as the ore loss is captured as part of the resource definition and the material code allocation percentages are based on a five-year reconciliation.

Mine Planning and Scheduling: Sishen Mine utilises standard industry techniques for the open pit design, scheduling and planning commencing with an open pit optimisation exercise that assists in the determination of the “optimum” pit for design purposes. The optimisation and design process is extensive and incorporates sufficient investigation of technical and economic parameters such as pit slope angles, existing infrastructure, boundaries, ore, stockpile and waste dumps and operating and capital costs. The reserve footprint extends for approximately 12km on strike and up to 3km on dip and ultimately the final pit is expected in parts to be 410m deep.

The open pit optimisation exercise that supports the Mineral Reserves presented in this CPR, are based on the Main Plant (≥60%Fe) ore only. The SEP ore that has been included in the current Mineral Reserve statement has been derived from the material that exists below this grade but above 58.5% beneficiated Fe and is planned to be processed through the new SEP facility over the life of the Main Plant. The SEP ore was considered as waste type material for this open pit optimisation exercise. The 2006 open pit optimisation exercise will consider the SEP material as ore instead of waste. This should materially increase the size of the optimised pit, hence increase RoM reserves but also increase waste stripping costs.

The current LoM Plan reports a remaining mine life of 24 years, based on the in-situ Mineral Reserves defined and depleted with an existing SEP stockpile of some 44Mt. Sishen is thus projected to be a long life mine. The total anticipated production of ore during the LoM is some 1,200Mt of RoM ore at an overall

stripping ratio of 2.8:1. A contribution of 670Mt is anticipated from Main Plant ore and 350Mt from SEP ore resulting in total headfeed of some 1,021Mt over the LoM Plan. The stockpile of 179Mt accounts for the difference between the RoM and the total plant headfeed. The annual RoM production to the Main Plant is scheduled to increase to some 33Mtpa from the current 32Mtpa from improvements to the process facility leading to product production of some 29Mtpa. The SEP ore is planned to commence production from 2007 leading to a product production of 13Mtpa in 2015. Waste stripping requirements range from some 64Mtpa to 105Mtpa over the LoM Plan. The waste stripping schedule is not undertaken according to minimum requirements and SRK consider that there exists flexibility in the planning requirements. The average stripping ratio is 2.8 : 1 and significantly less than that required (3.4 : 1) before the SEP ore was defined. However, the total material mined increases to some 183Mtpa from 2014 which is some 93Mt (100%) more than historically achieved (90Mt in 2004) and capital is included for additional mining equipment and re-builds.

5.2.2 Sishen South Project

Mining Methods: The regional topography is medium to flat in terms of topography and access into the various pit is provided by a number of haul roads to the crushing and screening facility and waste dumps. Mining operations are widespread and have taken place over the full area of the deposit. Production is planned from the four open pits of Welgevonden North, Welgevonden South, Kapstevl North and the Leeuwfontein pit. The Welgevonden and Kapstevl open pits are adjacent and within a strike distance of 4km. Mining benches are planned to be cut at 10m heights but loading can, if necessary, be undertaken on 5m flitch heights. The mining operation is to be conducted using a large fleet of conventional open pit mining equipment comprising blast hole drilling rigs and 100t off-highway trucks supported by appropriate ancillary mining equipment. The smaller sized truck units and comparable shovels and/or front end loaders have been selected to assist in selectivity and blending requirements as well as the more restricted working areas planned at the base of the final open pits.

All mining equipment is planned to be diesel driven and electrical power is only planned to be installed for de-watering purposes. The equipment complements have been derived through a simulation exercise using the haul parameters derived from the pit optimisation and mine design. The ore material consists of haematite and ironstone in the banded iron formation.

These rocks are very hard, and have a high specific gravity. The mining duty is considered to be heavy. The haul road design is based on ramps of 25m width at Leeuwfontein and 21m at Welgevonden and Kapstevl installed at a 10% gradient. A minimum mining width of 40m is planned and was used in the pit optimisation exercise. A total of three waste dumps are planned at the site and according to common design criteria.

In summary the waste dumps are planned to a maximum height of 40m and at a final slope angle of 18° with the location being adjacent to the open pits but not closer than 100m. Mining operations and maintenance are planned to be owner operated although certain supervision assistance on maintenance will be obtained from the original equipment manufacturer. Workshops and service bays are planned to be installed at site although the reconditioning and repair of components will be undertaken off-site.

Dilution, Mining Losses and Reconciliation: The modifying factors of dilution and ore loss used as part of the Sishen South open pit optimisation exercise and in the derivation of Mineral Reserves are based on a mining block size of 10m x 10m x 5m. The grade of the mining block is the same as the underlying resource block but at the ore and waste contacts the weighted average grade is calculated. The waste that is incorporated into a reserve block is defined as waste dilution and the quantity of material that does not meet the %Fe criteria defines the ore loss. The cut-off decision is based on achieving the product quality specification for Lump ore and Fine ore rather than those blocks that exceed a certain minimum specification. The average ore loss and dilution factors resulting from the application of this approach to the Sishen South orebodies are given in below:

Table 5.2 Sishen South Project: Modifying Factors

Modifying Factor	Units	Value
Ore Loss	(%)	10.6
Dilution	(%)	2.8

Mine Planning and Scheduling: Sishen South have developed the mine design and scheduling aspects of the feasibility study using standard industry techniques commencing with an open pit optimisation exercise to determine the “optimum” pits. The optimisation exercise was undertaken on two areas that encompass the Leeuwfontein project area and the Welgevonden/Kapstevl project areas. The open pit optimisation exercise that supports the Mineral Reserves presented in this CPR are based on Mineral Resources that have been defined > 55%Fe ore. The optimisation and design process has been undertaken on a greenfields basis and

has used geotechnical slope angles according to the different rock types and lithological units. The geotechnical assumptions are based on the results of test performed on samples and the results of specific geotechnical boreholes. Due to the high rock strength of the material at Sishen South large scale failures are unlikely. Small failures may be associated with the intersection of small scale geological features for which there is currently insufficient structural information to predict. SRK considers that it incorporates sufficient investigation of the technical and economic parameters such as pit slope angles, ore, stockpile and waste dumps and operating and capital costs. The pit shell, at each of the sites, that represented the maximum undiscounted cash flow, was selected as a basis for the mine design.

A computerised scheduling package was used to assist in generating the LoM Plan production profiles. The general methodology of the scheduling was driven by the Lump ore and Fine ore product specification and ore from the various pits and pit benches was blended and/or stockpiled to achieve these qualities. The use of RoM stockpiles is critical to the mining operation supplying product of the correct specification and RoM stockpiles of up to some 0.8Mtpa are built depending on the product qualities derived from the open pit faces. RoM re-handling is consequently planned at 100%. The current LoM Plan reports a mine life of 22 years, based on the Mineral Reserves defined and depleted at present. Sishen South is thus projected to be a long life mine. The total anticipated production of ore during the LoM is 65Mt at an overall stripping ratio of 2.2 : 1. The annual RoM production to the screening plant is planned at 3Mtpa and use is made of a RoM stockpile as a buffer between the open pits. Production is maintained from at least two open pits over the LoM Plan. The majority of the production is obtained from the Leeuwfontein open pit, some 53Mt or 82%. Four interim pits are planned over the life of the Leeuwfontein open pit. Waste stripping requirements range average some 7Mtpa over the LoM Plan.

5.2.3 Thabazimbi Mine

Mining Methods: Thabazimbi Mine is a mature operation that has been in production since 1934. It uses surface mining methods to produce haematite ore as feed to a beneficiation plant, which produces particularly high specification lump and fine iron ore for steel production. Underground mining operations ceased in 1998 and Thabazimbi Mine now mines entirely from three existing open pits and plans to develop two additional pits during the remaining mine life. Reserves are shown to be fully depleted in 2010.

The deposits are located in mountainous topography, and the hard iron formations constitute the high ridges in the region. Suitable mining haul roads have been constructed to access and develop the deposits and the ore is generally hauled downhill (maximum gradients of 6%) to one of two crushing plants. The haulage distance from the pits to the plants varies between 7km and 13km. Production is currently sourced from the Donkerpoort West, Buffelshoek West and Kwaggashoek East open pits. The Donkerpoort West pit is nearly depleted.

Mining benches are planned at 10m heights. The mining operation is conducted using conventional open pit mining equipment comprising blast hole drilling rigs, electric face shovels and 170t off-highway trucks supported by appropriate ancillary mining equipment. All the rock mined requires drilling and blasting, with the majority of the waste comprising banded ironstone formation. The ore consists of haematite and ironstone within the banded iron formation. These rocks are very hard and have a high specific gravity. The mining duty may be described as heavy.

The mining equipment fleet is ageing and the majority has been acquired second-hand from Kumba's Sishen Mine. Thabazimbi Mine has implemented a cost effective programme for refurbishing this mining fleet and the production that is being achieved with these units is competitive. The haul road and general housekeeping conditions observed at site were very good.

Within each pit, access is maintained by a single haul road that is located on stable pit walls. In-pit road gradients can be up to 10% and the standard ramp width is 25m.

Dilution, Mining Losses and Reconciliation: The block size used as the basis for ore definition is 10m x 10m x 10m. Ore definitions at Thabazimbi Mine are given in terms of six classifications at Donkerpoort and at Buffelshoek totalling 12 principal categories. The categories have different quality parameters associated with them that are carried through using algorithms in the reserving process. Thabazimbi Mine has the benefit of a large amount of historical performance data and reconciliations in which to improve and optimise the ore definitions and beneficiation algorithms. There has also been a focus on improved selectivity at the mine over the last five years and blocks can be categorised in terms of their minimum mining thickness, morphology and the type of loading equipment planned to optimise the ore definitions.

Mine Planning and Scheduling: Thabazimbi Mine utilises standard industry techniques for the open pit design, scheduling and planning commencing with an open pit optimisation exercise that assists in the determination of the "optimum" pit for design purposes. The optimisation and design process is considered by SRK to incorporate sufficient investigation of technical and economic parameters such as pit slope angles,

existing infrastructure, boundaries, ore, stockpile and waste dumps and operating and capital costs. The reserve footprint extends over a number of separate areas and ultimately the final pits are relatively shallow and haul distances generally improve as the mountainous deposit is progressively mined.

The open pit optimisation exercise that supports the Mineral Reserves presented in this CPR are based on the >60%Fe ore only. The current LoM Plan reports a remaining mine life of five years, based on the Mineral Reserves defined and depleted at present. Thabazimbi Mine is thus projected to be a short life mine. The total anticipated production of ore during the LoM is some 13.3Mt of RoM ore at an overall stripping ratio of 3.1 : 1. The LoM Plan reflects pits being developed and/or re-opened at Donkerpoort-Nek and Bobbejaanwater. The majority of the LoM reserves will be mined from Buffelshoek West (4.4Mt) and Kwaggashoek East (5.1Mt). In addition to the RoM ore some 1.1Mt is planned to be treated from stockpiles. The annual RoM production to the Main Plant is scheduled to be maintained at some 3Mt/pa for the duration of the LoM Plan. Waste stripping requirements decline from some 18Mt/pa required in 2006 over the LoM Plan.

Thabazimbi has a number of projects under investigation that may offer the opportunity to extend the life of the operation. These include:

- Recovery of a fines product from tailings materials;
- Re-opening and development of underground resources;
- Processing of the banded iron formation such as that envisaged for the Phoenix Project; and
- Regional exploration drilling.

5.3 Coal

5.3.1 Grootegeluk Mine

Grootegeluk Mine is a large open pit truck and shovel mine in operation since 1980 and was established to supply coking coal to Mittal Steel's steel plants, and under a forty-year contract to supply thermal coal to Matimba. In agreement with Eskom, additional coal beneficiation plants have been built to produce metallurgical and thermal coal products for them and other users.

The maximum pit depth is 120m and is being mined on a total of 13 benches. The coal measures are flat lying, with a shallow dip of approx 4° towards the southeast. The Coal Reserves are fully mined, enabling backfilling of mining waste.

The LoM Plan has been scheduled and evaluated for 40 years and includes the Char project, GG6 Phase I and DMS fines. In the longer term, an in-pit crusher may be established to reduce the haulage times for the RoM coal products and this option is being evaluated.

The regional topography is relatively flat and two main haul roads located on the north and the south face of the present pit provide access into the pit. Access to each bench is from these roads and additional in-pit temporary ramps are constructed as required. The in-pit haul roads are constructed to a minimum width of 40m and a maximum gradient of 8%. Permanent haul roads out of the pit and onto the waste dumps are equipped with electric trolley assist for truck haulage, which increases the up-hill truck speeds and productivity.

The planned RoM coal production is approximately 39Mt/pa to the plant to produce 14Mt/pa of power station feed for Eskom, 1.9Mt/pa of coking coal and 1.4Mt/pa of metallurgical coal products. The waste stripping that is required to maintain this coal production is approximately 20Mt/pa, which results in a waste to coal mining ratio of approximately 0.5 : 1. The required waste mining is expected to remain constant over the LoM.

Mining bench heights are determined by the respective geological contacts, and remain almost constant across the deposit. The mining bench heights range from 20m to 1.5m depending on the Seam thickness. Considerable attention is placed on ensuring that each Seam is mined to its correct geological contact, minimising both dilution across Seams and coal losses to waste. The waste benches comprise Bench 1 (being the surface and weathered materials varying up to 20m thick), Bench 7A (a 4m thick shale), Bench 8 (a 4m thick shale) and Bench 10 (a 4.5m thick sandstone). Bench Nos. 2, 3, 4, 5, 6, 7B, 9 and 11 comprise the coal Seams that are mined as units varying in thickness between 17m and 1.5m.

The mining operation is conducted using a large fleet of conventional open pit mining equipment comprising blast hole drilling rigs, electric 25m³ hydraulic shovel and 20m³ rope shovels into 10 x 180t and 14 x 200t trucks, supported by appropriate ancillary mining equipment. The surface weathered materials on Bench 1 are free dug but the majority of the coal and waste rock to be mined requires drilling and blasting.

The mining equipment fleet is maintained on an ongoing basis, with interim major overhauls/rebuilds planned during the life of each of the primary units of mining equipment. Provision is made to replace the equipment as justified by higher maintenance costs/lower productivity as each unit ages.

The Grootegeluk pit shows no sign of slope or stack scale instability. Although some benches have been affected by fault induced failures these are considered normal for open pits and should not prevent the mine from achieving its planned production profile. The pit has been designed according to best practice in terms of geotechnical procedures.

Grootegeluk Mine has projects underway to further optimise the LoM pit and mining plan. These include:

- Optimising the development of the available reserves to match Kumba's business plan and product sales;
- Determining the methodology for safe long-term disposal of mine and plant waste as backfill; and
- Optimising the timing and location for establishing an in-pit crusher for RoM coal.

5.3.2 Leeuwpan Mine

Leeuwpan Mine, a mature open pit coal mine in operation since 1992, employs strip-mining methods to access two conformable coal Seams. The mine is currently producing from two pits and the LoM Plan depletes Coal Reserves over a period of 30 years, thus classifying the Leeuwpan Mine as a long-life operation. The current LoM Plan includes 145.8Mt of RoM Coal Reserves to be extracted from the Kenbar, Witklip, Moabsvelden and Weltevreden areas.

The OWM block (84.7Mt) falls outside the mine boundary and mainly outside the Mining authorisation boundary. The LoM reserve schedule indicates that Leeuwpan mine plans on mining this block from 2007 to 2031. About 50% of the UI block falls inside the mine boundary but outside the mining authorisation boundary. Leeuwpan's application to the DME for these two blocks was refused. The LoM reserve schedule indicates that Leeuwpan Mine plans to mine this underground block from 2011 to 2035. Based on opinions expressed by Kumba's legal advisers, SRK has included the coal reserves falling within these two blocks. The LoM schedule excludes the 200ktpa RoM coal to be supplied by Stuart Coal (an independent mining company) up to 2012, with 100ktpa of saleable product. There is a concern that Stuart Coal might not have sufficient reserves. The opencast section is scheduled from 2005 to 2035. All the opencast equipment is owned by Kumba and operated and maintained by Archer Mining. The underground operation is scheduled from 2010 to 2035 at a rate of 480ktpa. The current strategy for the underground operation is to use a contractor that will supply his own equipment.

The overall planned stripping ratio is 1.04 : 1 amounting to 4.6Mm³ of overburden. The RoM Coal Reserves are planned to be depleted at a production rate of approximately 4.9Mtpa.

Mining is by conventional load and haul methods utilising hydraulic excavators that load material into 30t articulated dump trucks ("ADTs"). The use of ADTs results in a relatively large fleet size. Due to poor conditions during the wet months of the year resulting from the clay in the overburden, larger rigid frame trucks cannot be used. The overburden is typically some 20m to 25m in thickness including 1m to 2m of carbonaceous material. The majority of the overburden is now backfilled, as part of the mining process, into worked out areas. The stripping ratio for the next five years or so will remain above the average of the LoM reserves at some 1.04 : 1 and it is anticipated that more overburden will need to be drilled and blasted as the ratio of soft to hard material decreases as the mine advances.

The bench and slope design is based on a Code of Practice developed for Leeuwpan Mine. This indicates that an overall slope angle of up to 45° is stable in most areas of the mine, however localised failures in some areas of Kenbar have necessitated the use of lower slope angles of 35°. All ramps are designed at a maximum inclination of 12.5% and minimum width of 10m and 15m on surface and in-pit, respectively. The majority of the overburden and all the discards and non-coal carbonaceous material are backfilled. Top soil and sub-soil are stockpiled separately for on-going rehabilitation.

The coal is typically 12m to 14m thick and comprises a top coal and bottom coal with ash contents of 35% and 15%, respectively. The product size and ash content can be managed during the treatment process, though the volatile content of the product is dependent on the blend of coal delivered from the two pits. The planned coal qualities will be sustained through management of sufficient exposed Coal Reserve to support blending requirements.

Both Seams of coal are drilled together and lightly blasted, at a powder factor of some 0.1kg/t, such that the excavator can top load the trucks and excavate the two Seams separately. The mine delivers coal to the process plant six days per week and trucks the process discards from a bin adjacent to the primary crusher back to the pit for disposal. The targets for overburden stripping are seasonally adjusted due to problems with rain, however properly constructed roads for coal hauling result in minimal plant production losses.

The mine has introduced a half-life policy for the replacement of primary earthmoving equipment of 15,000hrs. Half of the equipment is now below 15,000hrs and half above. The objective of this is to achieve consistent availability of equipment, maintenance costs and capital replacements.

The mine has, prior to the finalisation of participation in the RBCT expansion, recently developed additional markets overseas for low volatility coal, and has brought forward the scheduling of low volatility reserves in the LoM Plan.

Future mining at Leeuwan Mine will focus on continuing improvements in utilisation of the primary earthmoving equipment and optimisation of the pit layouts and haul road design. Investigations will be made into alternative transportation methods for the Weltevrede deposit, situated some 8km from the processing plant. Currently provision is included for road transportation of the RoM product although this is considered to be sub-optimal in terms of cost.

SRK considers that the applicability of the mining method and geotechnical design to be appropriate. SRK also consider that the changes in depth and stripping ratio together with increasing distance of the mining faces to the processing facilities, as the mine advances, have been accounted for in the projected operating costs as reported in Section 14. SRK considers that the LoM projections are achievable providing sufficient exposed coal enables the flexibility in blend requirements.

5.3.3 Tshikondeni Mine

Tshikondeni Mine is a mature operation that has been in production since 1983, using underground mining methods to produce coking coal for steel production. The entire production is purchased by Mittal's steel producing works at Vanderbijlpark. The mine projects a life of some eight to nine years, thus classifying Tshikondeni as a medium life asset. The mining complex consists of four operational areas, each having separate access. These are: Nyala (two years of life left), Vhukati, Mutale and Mupani (two months of reserves left). Future mining activity will be centred on the development of the reserves of Goni (four years of reserves), Mutali and Vhukati. The Goni shaft falls inside of the mine lease area, but outside the areas covered by the approved EMP and the mining authorisation. Some 20% of the Goni resource falls outside the mine lease area. The Coal Reserves are expected to be fully depleted in 2014. The total production anticipated over this period is 6.0Mt of RoM coal. The RoM production is planned to be 0.746Mtpa to the plant, beyond 2005. Based on written advice from Kumba's legal counsel regarding the potential of Goni shaft to convert its old order mining rights to new order mining rights, these numbers include Goni shaft.

The mining method consists of a standard bord and pillar system with secondary extraction by stooping. Pillars are nominally developed at 24m – 33m centres. Primary extraction is carried out by two conventional (drill and blast) sections, one stone section and three roadheader sections to increase pit room definition and flexibility required due to the complex geological conditions. Both operations carry out stooping and the roadheaders are the preferred system to extract pillars below 220m. Extraction is planned at 75%, but in-panel geological losses and poor ground conditions encountered during stoping, have produced historic extraction levels averaging 68%.

Access to the underground Coal Reserves is gained by means of surface adits that are driven either in Seam or in the floor to intersect the ore body at a deeper elevation. Primary development consists of seven roads driven on the dip of the Seam. Where Seams are disturbed by faults, dykes or burnt coal, roadways are generally developed through these structures.

Ventilation to the workings is supplied by a standard system of intake airways from the main and satellite shaft declines. Return air is exhausted via raise bored shafts situated in the vicinity of the intake airways. These shafts are necessary to maintain an acceptable level of environmental conditions in workings that are more than 1km from the surface adit or are deeper than 300m. SRK found that a good standard of ventilation design and practice exists on the mine.

Coal clearance is facilitated by a series of conveyor belts fed by underground Ram cars and LHDs. The individual availability of conveyors and cars is acceptable and the belts are cleaned by contractors.

Tshikondeni is one of the most challenging coal mining environments in South Africa for strata control. Management has developed various strategies to combat the poor ground conditions associated with the highly disturbed coal Seam with consequent development of mine strata control skills.

The mine standards can be described as good in extremely challenging geological conditions.

Future mining activity will be centred on the development of the Coal Reserves at Goni, Mutale and Vhukati.

5.3.4 Arnot Colliery

Arnot Colliery is an Eskom-tied colliery which has been in operation since 1972. The planned production rate is currently 5,600ktpa RoM and it is anticipated that this production rate will be maintained until 2018. It is the opinion of SRK that the planned target of 5,600ktpa can be achieved with the current equipment. However, an additional suite of underground equipment is recommended to ensure that Arnot is able to meet its supply commitments to Eskom. If any additional coal is required, the option of the Mooifontein pit is also available. Mine access is via the No. 3, No. 8 and 10 Shafts, all of which are incline shafts.

Machine deployment at No. 8 Shaft will be one continuous miner section and one road header section for the first three-quarters of the year. Three new continuous miner sections will be introduced in the last quarter of 2005 to replace the shortwall operation. The mining method to be used in the low Seam areas is not a commonly used method in South Africa.

At the No.10 Shaft, machine deployment will consist of one continuous miner section and one roadheader section in multi-road development. A low Seam section will continue to develop through low areas and areas where in-Seam stone does not allow for the current equipment. This will release higher Seam reserve areas for the current equipment. Shortwall mining operations will cease on the completion of the 400 block, a section in the shaft. The decision to stop the shortwall resulted from the cost of repairs of the equipment together with the limited reserves over the remainder of the life of the colliery. The contamination levels should be lower after the shortwall has been stopped, which could result in less RoM being washed or no RoM being washed, as was historically the case at Arnot.

5.3.5 Matla Colliery

Matla Colliery is an Eskom-tied colliery which has been in operation since 1978. Matla Colliery produces 15,000 – 15,500ktpa of coal. It extracts thermal coal from the No. 2 and No. 4 Seams. This coal is mined for Eskom from underground mines: Matla No. 1 Mine, Matla No. 2 Mine and Matla No. 3 Mine. The minimum mineable coal qualities are:

- A 23MJ/kg (dry) heat value has been used for the No. 2 Seam.
- A 18MJ/kg (dry) heat value has been used for the No. 4 Seam.

The required ratio to meet the Eskom quality requirements is:

- | | |
|--------------|------|
| • No. 1 Mine | 25%. |
| • No. 2 Mine | 39%. |
| • No. 3 Mine | 36%. |

This equates to approximately 30% No. 2 Seam and 70% No. 4 Seam.

Currently all three mines are accessed via vertical shafts. Matla No. 1 Mine employs a bord and pillar mining method while the No. 4 Seam utilises continuous miners and shuttle cars. A new shaft with a capital requirement of ZAR133m is planned for 2006. The new No. 1 Mine will be accessed via a box cut highwall entry.

The No. 2 Mine has a shortwall in the No. 2 Seam with continuous miners and shuttle cars on the gate road and the main developments. No. 2 Mine only has one shearer, which means that the face move takes about four weeks. A face break, this year, caused a production delay of three months. In the next panel there is a risk that a similar face break could reoccur.

In order to minimise the risk, a pre spilt line will be drilled into the No. 4 Seam barrier pillar. This pre spilt line will then be blasted. Production has been further constrained by the fact that four face moves were planned this year, when only two face moves are usually planned per year. The capacity of the vertical shaft will be upgraded from 50tph to 80tph.

The No. 3 Mine has a shortwall in the No. 4 Seam with continuous miners and shuttle cars on the gate road and the main developments. The No. 3 Mine has two shearers, which means that face moves are reduced from four weeks to two weeks. One of the options is to mine a 17% CV product at a height of 3.9m above the mudstone band. The current method is to mine the mudstone band at a height of 3.5m. Matla has a detailed 18-month plan, five-year plan and LoM Plan. The Eyesizwe board has approved the No. 5 Seam Project, a project to supply Eskom with additional coal. However, this project remains subject to Eskom's approval and demand for metallurgical coal.

5.3.6 New Clydesdale Colliery

New Clydesdale Colliery is an export colliery which will mine the Nos. 1, 2, 4 and 5 Seams in the Vaalkrans North opencast operation and No. 2 Seam from the pillars in the Vaalkrans South Area. Future underground mining will take place in the Diepspruit No. 1 and No. 2 Seam, east of the river. The colliery currently produces coal for both export and domestic markets. No. 4 Seam Coal is currently being mined at Vaalkrans North by the truck and shovel method. The underlying No. 2 Seam in the reserve area has been mined out by bord and pillar mining method using continuous miners, as well as specific areas where pillar extraction has taken place. Capital spent on Vaalkrans South No. 2 Shaft to establish the access to the Diepspruit Coal Reserves totals an amount of ZAR9,6m. A pillar extraction programme has been initiated. The Vaalkrans South pillar extraction project has been done with the assistance of Coaltech 2020 research. It commenced in September 2004, when the old workings were entered safely and panels evaluated for pillar extraction compatibility.

Several months of development work has been completed in order to provide and partially establish the infrastructure for mining of the Diepspruit Coal Reserves. This involved extensive sweeping of the main travelling ways as well as pumping of water and slurry removal in the main developments.

The underground operation is scheduled from 2006 – 2013 at a rate of 1,400 – 1,900ktpa from 2006 up to 2012, with the production rate dropping to 400ktpa in 2013. It is the opinion of SRK that:

- The capital in the 2006 business plan (LoM) needs to be increased from ZAR72.6m to ZAR94.6m. This amount includes an additional ZAR12m for continuous miner rebuilds and an additional ZAR10m for the Middeldrift development.

5.3.7 North Block Complex

The North Block Complex comprises the following:

- Glisa opencast operations on portion 24 of Paardeplaats 380 JT, which produces coal for Eskom. The opencast at Glisa will be depleted by July 2006. Open cast mining is conducted by truck and shovel using the roll over method.
- Glisa underground operations, which comprises two sections and produces coal for the “D” grade market. Underground mining is conducted by the bord and pillar method using a Voest Alpine AM80, a Wirth Continuous miner with six shuttle cars. The underground at Glisa was depleted by March 2006 year and will be relocated to the Glisa South area. Incorporation of Glisa South into the LoM is restricted as the Coal Resources are classified as Inferred.
- Strathrae opencast operation and new pits, which comprise the Main plant Pit West, the Main plant Pit East, and the Grootpan – Klippan pits from the No. 2 Seam using the truck and shovel roll over strip mining method.

5.3.8 Mining Methods of Coal Projects

Table 5.3 below indicates the mining methods which will be employed at each of the coal projects.

Table 5.3 Mining Methods of Coal Projects

Operation	Mining Method
Inyanda Project	Opencast Mining
Mafube JV Phase II Project	Opencast Mining
Belfast Project	Opencast and Underground Mining
Incgambu Project	Opencast and Underground Mining
Strehla Project	Opencast and Underground Mining
Moranbah South Project	Opencast and Longwall Mining

5.4 Heavy Minerals

5.4.1 Hillendale Mine

A feasibility study for Hillendale Mine evaluated five different mining methods. On a net present cost basis it was found that a hydraulic monitoring method was the least expensive, with the next cheapest being an excavator – pumping system combination. The hydraulic mining method, which has been successfully used at the Hillendale Mine for the last four years, is also proposed to be used for the Fairbreeze Project C and Fairbreeze Project C Extension deposits.

Description of Hydraulic Mining Method: The Hillendale Mine hydraulic mining method consists of a series of water monitors which are used to direct a continuous high pressure (up to 40 bar at the Hillendale mine) water jet onto the face to undermine it, thus causing it to collapse. When sand from the face falls in blocks, the water is used to break up the material into a slurry which then gravitates into a satellite pump station situated at an elevation well below the lowest planned mining elevation.

Transport of the slurry from the mining area by means of a trench system is utilised. A satellite pump transfers the slurry into a plastic-lined, V-shaped surface trench down which it gravitates to a central sump area, located next to the PWP. This transport method has proved to be very successful at the Hillendale operation. A caisson structure protects the pumps in the sump area, from where the RoM is pumped into surge bins with a capacity of 1,000m³ to guarantee a constant supply and also to control the density of the feed to between 35% and 45% solids.

The mining contractor installed the required mining equipment at the start of the Hillendale mining operations during 2001. The contract with the mining contractor at the Hillendale Mine was wound up in November 2005 and Ticor SA now perform owner operator mining at Hillendale Mine.

The maximum Hillendale production rate is planned to be 1,200tph – four monitors can be operated simultaneously, with each monitor producing 300tph and two additional monitors on standby. The mining production schedule is driven by smelter demand requirements, which define the ilmenite requirements.

Mine production is between 8,000ktpa and 9,000ktpa.

Mining at the Hillendale operation takes place very close (up to 10m distance from fence lines in plan view) to inhabited properties. Special care is required when mining in these areas adjacent to these properties to ensure that no instability of the highwall occurs that is abutting onto these properties. At Hillendale a service road is positioned next to the inhabited property fence line and service pipelines for high pressure water and other services are positioned on the property fence side of the service road.

5.4.2 Tiwest JV

The Tiwest JV mining operation has a current capacity of approximately 21Mtpa of ore. Dredging operations account for approximately 16Mtpa and the remainder (5Mtpa) is sourced via scraper operations in a dry mining operation. Combined production of the HMC of up to 800kt is transported by road to the dry separation plant at Chandala.

The mining operations at Cooljarloo are divided into two separate entities, the South Mine and the North Mine, each employing a different mining method.

South Mine: The mining operations in the South Mine consist predominantly of a dredging operation. The vegetation is first stripped within the mining limits. This stripping/clearing is undertaken in preparation for the overburden stripping by a mining contractor using track dozers. Vegetation clearing is normally 50 – 100m in advance of the overburden stripping operations. Once the vegetation is removed the mining contractor utilises scrapers to remove the topsoil to a nominal depth of 0.3m, normally in two cuts one of 0.05m and the second of 0.25m. Where possible this topsoil is placed directly onto 'land formed' areas to take advantage of the active seed load.

Overburden removal is also undertaken by a mining contractor, using an excavator and haul trucks. The overburden is removed in flitches of up to 4m in depth and in minimum working widths of 50m. Mining of the overburden cycles between flitches is aimed to maintain ore exposure of at least 6 – 8 weeks in front of the dredges. This system also maintains a blend of overburden on the dump to maintain the dump integrity.

Overburden is hauled to the rear of the dredge pond and dumped on the "beach" to complete the 'land form'. After the removal of the overburden, the ore mining is undertaken by Tiwest JV using two dredges working in a purpose built pond to pump ore directly to a floating concentrator. The smaller dredge mines to a maximum depth of 9m ahead of the larger dredge which mines to a depth of 25m. Installed dredge capacity currently exceeds the concentrator capacity. Oversize rocks and debris are removed by trommel prior to the concentrator and sand tailings are returned to the mining area for use in rehabilitation. Heavy minerals are extracted from the sands and clays and pumped from the concentrator to stockpiles.

North Mine: The North Mine is currently located approximately 5km to the north of the dredging operations in the South Mine. The mining operations are based upon a dry mining operation using track dozers to firstly remove and stockpile the vegetation. Topsoil is then removed similar the South mine operations, whilst the thin layers of overburden are removed and placed by a fleet of elevating scrapers. Ore is then removed with the same scraper fleet which deposits the ore into a hopper for feed to a trommel to remove the clay and debris. Sand is then transported to a land-based wet concentrator for separation of the heavy minerals.

As the mining progresses through the orebody, sand and clay are returned to the void and the surface reformed prior to the spreading of topsoil and eventual rehabilitation. The mining methods currently employed at each of the current operational areas are appropriate for the orebodies being exploited.

The mining contracts for overburden removal in the South Mine and for mining operations in the North Mine are currently under review and re-tender. Whilst this will not alter the current methodology in both areas it is expected that pricing will increase in line with current increases in labour and fuel costs. Productivity in these areas will however, likely increase with the change of contractor. Current equipment on the most part is aged and availability is low with the incumbent contractor reluctant to upgrade at this time of retender given the uncertainty of tenure.

5.5 Base Metals

5.5.1 Rosh Pinah

Rosh Pinah is a mature underground operation with production sourced from a number of discrete zinc-lead sulphide orebodies. The mine has been in operation since 1969 and has continually replenished ore resources from extensions to the known Mineral Reserves through exploration drilling and development.

The mine has previously been able to generate Mineral Reserves based on the exploration activities sufficient only to sustain a five-year plan. The lack of Mineral Reserves and short mine life has made it difficult for the mine to attract and retain people to work on the mine, especially after the opening of the nearby Scorpion Mine, which has a significantly longer projected mine life. The short mine life also makes the raising of finance to address issues such as housing all that more difficult.

The mine has identified three options for the future:

- Managed closure over a five-year period;
- Maintain *status quo* and continue to replenish Mineral Reserves; and
- Adopt the “Modified Focus” plan that increases development and exploration drilling for three years and generates sufficient reserves for at least a 10-year LoM.

The latter option would enable the mine to attract financing for renovating and upgrading the processing plant and providing housing for mine employees.

The Modified Focus plan has been approved by the Rosh Pinah Zinc Corporation Board subject to review by the Board depending on the viability of the exploration project. For the purpose of the valuation of the mine SRK have based their model on maintaining the *status quo*, that is a five-year plan (supplied by the mine) that replenishes Mineral Reserves on an ongoing basis with necessary capital for further exploration.

Mining has been conducted from eight principal orebodies (“orefields”) and future Mineral Reserves are contained in five orefields. The main focus is currently the Eastern Orefield that has a significantly higher grade (10.8% zinc). Production is currently limited by the capacity of the process plant which is ~780ktpa. Total tonnes mined are in the order of 1Mt/ya. Access to the underground workings is through three single declines with portals at 400m above the mean sea level (“AMSL”). The orefields are accessed via drives and ramps with the main levels developed at 30m vertical intervals. The deepest production level is currently 20 Level (20m AMSL). Ventilation is effected through surface exhaust fans. Several auxiliary fans are used to direct air to the working faces.

Inflow of water has increased slightly with the increase in depth. The mine has recently installed a cascade dam system in order to provide a more consistent supply of water to the production areas.

The mining method employed is sub-level open stoping which is locally referred to as “silling” and “benching”. The footwall and hangingwall contacts of the orebody are exposed at 30m intervals through development. The benches are then drilled with up-rings with 74mm holes to the footwall and hangingwall contacts on the level above.

The broken ore is loaded by LHDs into 20 – 40t trucks and hauled to the main tip on 370m level. The ore is then crushed and transported by conveyor to surface. Average haul distances are in the order of 3.5km. The mine has recently installed a service bay on 370 Level close to the tip where daily maintenance will be carried out. All maintenance has previously been carried out on surface which has reduced the availability of the machines. The daily servicing particularly of drill rigs on 370 Level is still not conducive to high levels of availability.

The mine has increased production by 65% over the last three years. Development in the current year is planned to increase by 4,000m and exploration drilling to 43,000m in order to increase confidence levels in Mineral Resources that will sustain a longer mine life. All development is being undertaken by the mine. Mineral Resource management is undertaken on the mine, mine design and scheduling is undertaken by an outside contractor who spends two weeks of a month at the mine. Monthly scheduling of the rings is done by utilising Minesite a 3D program to Xpac, an autoscheduler.

Only those mineral resources in the Measured and Indicated categories and contained within Mining Area No. 39 of the Republic of Namibia are converted into Mineral Reserves.

Mineral Reserves are estimated with reference to a 3D mining model drawn on the geological model. The design process utilises knowledge of the mining method, equipment constraints and geotechnical limitations in order to achieve optimum resource recovery. The model shows the stoping layout based on the chosen mining method, the development layout and the main infrastructure components required for access and ventilation. In-situ tonnage and grades are calculated for the main recoverable minerals, i.e. zinc, lead, silver and copper and reported as RoM quantities.

The mining model is designed with prior knowledge of the rock mass and ore body characteristics which influence the mining method. The rock mass ratings at Rosh Pinah enable ore extraction by open stoping methods without backfilling. Localised geotechnical problems are encountered and countered by installation of the relevant roof support. The planned reserve extraction ratio (including recovery from temporary support pillars) and waste dilution levels are audited by outside consultants.

The local geohydrological system has been modelled for environmental reasons but does not impose constraints on mining. There are no aquifers other than localised fault and joint systems which are de-watered as mining progresses. The Rosh Pinah ore bodies are generally suited to extraction by sub-level open stoping method. Where the dip of the orebody does not allow gravity flow the room and pillar method is applied. Reserves are blocked out with reference to the resource model without further reference to cut-off grades. The economic reserve is determined through cost/revenue estimates. Reserves are estimated on 3D models of detailed stope and development designs.

Grade control is in the form of accurate drillhole ring design and the accurate drilling of drill holes to the required length. Underground observations confirmed that this was taking place.

Planned dilution is estimated from the reserve models. No further dilution factors are applied. Mining recovery is assumed to be 100% on the basis of tonnage reconciliations. It is known that ore densities are undervalued and this may be accounting for the real mining losses (the reconciliation indicates that the ore density is slightly greater than what is currently being used in tonnage estimates and is balancing out real mining losses). Investigations into ore densities are currently being undertaken. All planned waste is included in the total reserve tonnage and grades.

New infrastructure is limited to underground tunnel extensions which are reported under the headings "Decline Development" and "Infrastructure Development" in the LoM schedule.

5.6 Industrial Minerals

5.6.1 Glen Douglas

Glen Douglas Mine is a mature open pit that has been in operation since 1957 and produces metallurgical quality dolomite construction aggregate and agricultural lime. RoM tonnes are in the order of 1.45Mtpa with a product yield of 94%. Of the total sales 50% is metallurgical dolomite supplied to Mittal Steel works at Vanderbijlpark in Gauteng and Newcastle in KwaZulu-Natal. A further 43% is supplied to construction aggregate producers and the balance of 7% supplied to farmers as agricultural lime. The major contract with Mittal Steel is currently being renegotiated. Transport of sales product is either contracted out or the responsibility of the buyer.

Production cost per RoMt was ZAR44.92 in 2004 and is planned at ZAR45.39 in 2005. The average price ZAR/t (FOR) was ZAR53.16 in 2004 and planned at ZAR54.0 for 2005. The mine has sufficient reserves of all products to sustain a mine life of 30 years.

Glen Douglas Mine is an open pit operation producing from a single excavation sub-divided by a 40m wide dyke zone into two pits, the B and C Pits. The C Pit is the main source of the low silica metallurgical dolomite and the B Pit supplies the high silica aggregate. Agricultural lime is produced as by-product from fines collected in settling ponds at the washing and screening plant.

The mining method comprises conventional drill, blast, load and haul using 7 x 50t Cat 773B diesel trucks and 2 x Cat 990 front-end loaders owned by Glen Douglas Mine. All ore and waste is drilled with 115mm blast holes and charged with bulk emulsion explosives. The strip ratio is 1.25 : 1 with bench heights of 14m. All ramp and haul roads are 25m wide at an inclination not exceeding 8.3%. The mine operates on a 3-shift basis over 5.5 days per week. There are community constraints on certain activities. Loading of waste must cease at 10pm and loading of dolomite at 23:00. These operations recommence at 06:00 the following morning. A significant amount of large rocks are evident in the bottom of the B Pit and the upper levels of both pits. These are a result of the low powder factor (0.18kg/t for six months to 30 June 2005) used, in an attempt to reduce the effects of blasting on the nearby community. Mining is affected by the presence of mud pockets that are exposed unexpectedly in the faces that contaminate the ore. The mud pockets also affect the blasting operation resulting in big rocks. All plant and equipment is maintained by mine personnel.