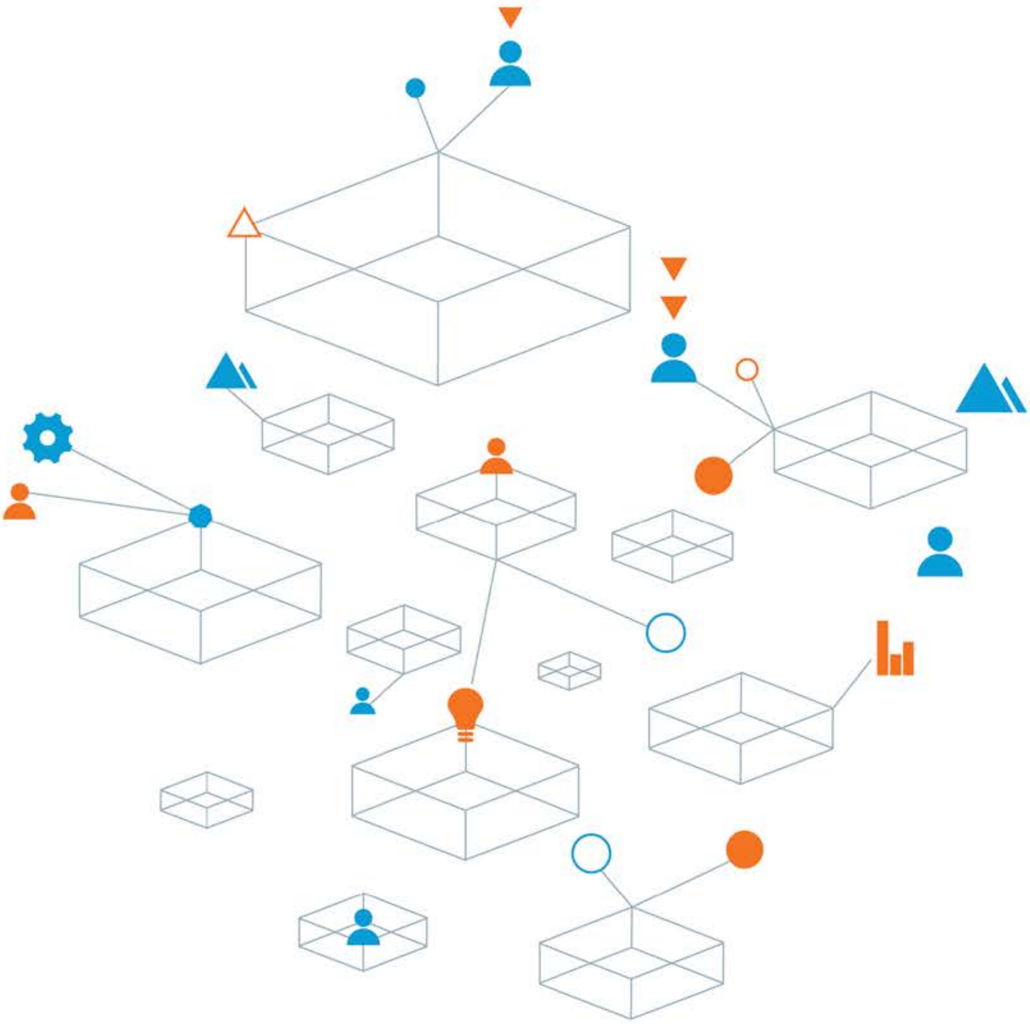
Tharisa plc

Tharisa Chrome and PGM Mine, South Africa

Mineral Expert Report

(Effective Date 31 December 2015)

Lead Competent Person: Ken Lomberg (Pr.Sci.Nat.)



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Date: 31 December 2015

Project Number: JTHA011

Copies:	Tharisa plc	(2)
	Coffey – Johannesburg	(1)

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EXECUTIVE SUMMARY

Coffey Mining (South Africa) (Proprietary) Limited (Coffey) was requested by Tharisa plc, formerly Tharisa Limited (Tharisa or the Company), to complete a Mineral Expert Report (MER) on the Tharisa Mine located in the North West Province of South Africa.

This report complies with the Listing Requirements of the London Stock Exchange (LSE). The Mineral Resources and Reserves are reported in accordance with the guidelines of "The South African Code for Reporting of Exploration Results, Mineral Resources and Reserves (prepared by the South African Mineral Resource Committee (SAMREC) Working Group) (2007 and as amended in 2009)" (SAMREC Code) and "The South African Code for the Reporting of Mineral Asset Valuation (2008)(as amended in July 2009)" Prepared by The South African Mineral Asset Valuation Committee (SAMVAL) Working Group (SAMVAL Code).

This report is dated 31 December 2015 and Tharisa has advised Coffey that no material change has occurred to the Tharisa Mine since this date.

Participants

The participants consist of a number of technical experts brought together by Coffey to complete the MER and are all Competent Person's as defined in (SAMREC Code). The compilation of the MER in accordance with the reporting requirements of the LSE was supervised by Mr Lomberg. The participants in the compilation of the MER and their individual areas of responsibility are listed as follows:-

Ken Lomberg, Senior Principal Consultant, Coffey
Project management, mineral resources, geological interpretations, site visits, report preparation.

Alan Goldschmidt, Senior Consultant, Coffey
Mineral resources, geological interpretations, report preparation.

Jaco Lotheringen, Associate Consultant – Ukwazi Mining Solutions
Mining engineering, mineral reserve estimation, infrastructure, economic valuation, site visits, report preparation.

Jacques van Wyngaard, Associate Consultant – MDM Engineering
Process engineering, infrastructure, site visits, report preparation.

Alistar James, Associate Consultant – SLR Consulting (previously Metago)
Environmental and Social, site visits, report preparation.

Alex Pheiffer, Associate Consultant – SLR Consulting (previously Metago)
Environmental and Social, site visits, report preparation.

John James, Associate Consultant – Celtis Geotechnical
Geotechnical Engineering, site visits, report preparation.

Hannes Bornman, Manager Mining, Coffey
Economic valuation, site visit, report preparation.

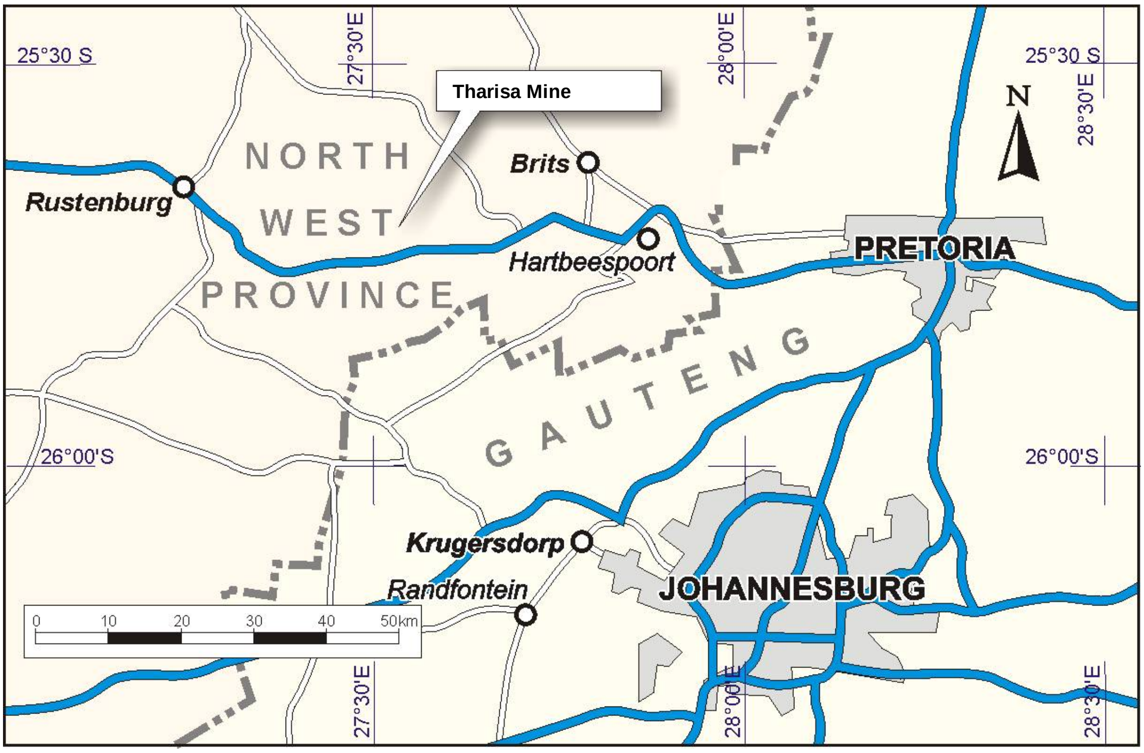
Independence

Coffey is an independent technical consulting group, with no direct or indirect interests in Tharisa. Neither Coffey, nor the key personnel responsible for the work, has any material interest in Tharisa, the companies associated with this project, their subsidiaries or their mineral properties. All work done by Coffey for Tharisa, is strictly in return for professional fees. Payment for the work is not in any way dependent on the outcome of the work or on the success or otherwise of Tharisa's own business dealings. There is no conflict of interest in Coffey undertaking this work as contained in this document.

Ownership and Property Description

The Tharisa Mine a PGM and Chrome Mining Operation exploiting the Middle Group (MG) Chromitite Layers on two properties, being portions of the property Farm 342JQ and the whole of the property Rooikoppies 297JQ, located in the North West Province some 35km east of the city of Rustenburg and 95km from Johannesburg (Figure 1). The Tharisa Mine was developed by Tharisa Minerals (Pty) Ltd (Tharisa Minerals) which holds a mining right, granted by the Department of Mineral Resources (DMR) on 19 September 2008 and registered on 13 August 2009, to various portions of Farm 342JQ (in respect of PGMs (Platinum Group Metals), gold, silver, nickel, copper and chrome ore) and Rooikoppies 297JQ (PGMs, gold, silver, nickel, copper and chrome ore contained within the MG Chromitite Layers only).

Figure 1
Location of the Tharisa Mine



A main road bisects the property in a north-south direction. The road provides access to the town of Marikana. The nearest major road, the N4 National Road links Pretoria with Rustenburg and crosses the south-eastern corner of the Farm 342JQ property immediately south of the outcrop of the Middle Group (MG) Chromitite Layers. The east west Rustenburg-Brits railway line bisects the Rooikoppies property with a station located in the town of Marikana on the Rooikoppies property.

History of the Tharisa Mine Ownership

Thari Resources (Pty) Ltd (Thari) which was incorporated in January 2005, acquired prospecting rights for chrome and PGMs over various portions of the property Farm 342JQ and to the property Rooikoppies 297JQ in March 2006. Thari is a Historically Disadvantaged South African (HDSA) and woman controlled company focused on the minerals and energy sectors.

In March 2006 Thari established Tharisa Minerals as a wholly owned subsidiary. During September 2008, February 2009 and March 2009 the prospecting rights held by Thari were transferred to Tharisa Minerals after obtaining the necessary Ministerial approval in terms of Section 11 of the Mineral and Petroleum Resources Development Act, 2002 (MPRDA).

In March 2008, the mining rights for chrome ore, over portions 96 and 183 of Farm 342JQ were purchased from South African Producers and Beneficiators of Chrome Ore (Pty) Ltd. On 19 September 2008, the prospecting rights, including those for PGM and chrome ore, over various portions of Farm 342JQ and the whole of Rooikoppies held by Tharisa Minerals, were converted into mining rights in terms of Section 16 of the MPRDA.

Tharisa plc was incorporated in February 2008 and after obtaining the necessary Ministerial approval acquired 74% of Tharisa Minerals on 9 February 2009. The remaining 26% is currently held by Thari (20%) and the Tharisa Community Trust (6%). In July 2011 the Tharisa Minerals mining right 49/2009 (MR) was amended in terms of Section 102 of the MPRDA to include portions 96 and 183 of Farm 342JQ in respect of PGM, and to include PGM and chrome ore in respect of portion 286 of Farm 342JQ.

The Tharisa Mine started trial mining in October 2008 and commenced production of ore on a small scale from March 2009, achieving an average throughput rate of 38,000 tpm Run of Mine (RoM) with a small chrome concentrator. From 2010 to 2012 the mine undertook a number of process facility expansions to increase processing capacity to 400,000 tpm RoM).

Tharisa plc was listed on the Johannesburg Stock Exchange and commenced trading on 10 April 2014.

Current Mining Operations

The mining operation is divided into the east pit and west pit, located on either side of the Sterkstroom River that runs north-south through the Tharisa Mine (Tharisa) property. The pits are designed to protect the water course and the local infrastructure running parallel to the river (Figure 5). The east pit extends to the eastern boundary of the mining right while the west pit extends to where the Mineral Resource is defined on the far western portion of the mine. MCC Contracts (Pty) Ltd is the appointed mining contractor and has extensive open pit contract mining experience in Africa.

Tharisa produces largely fresh material from four groups of the MG Chromitite Layers, namely, MG4 (MG4A and MG4), MG3, MG2 and MG1. Some mining occurred on the UG1 Chromitite Layer in the past.

The shallow MG1 was mined underground, by the previous mining right holder, to a limited extent on the eastern boundary of the property. Currently, no mining is conducted on MG0.

The mining schedule is co-ordinated to match the capacity of the processing facility. At steady state Tharisa will mine and process 5.0Mtpa of run of mine (RoM) ore.

The open pit operations maintain planned production levels until 2030, then transitions to underground bord and pillar mining. The last open pit tonnage is mined in 2036.

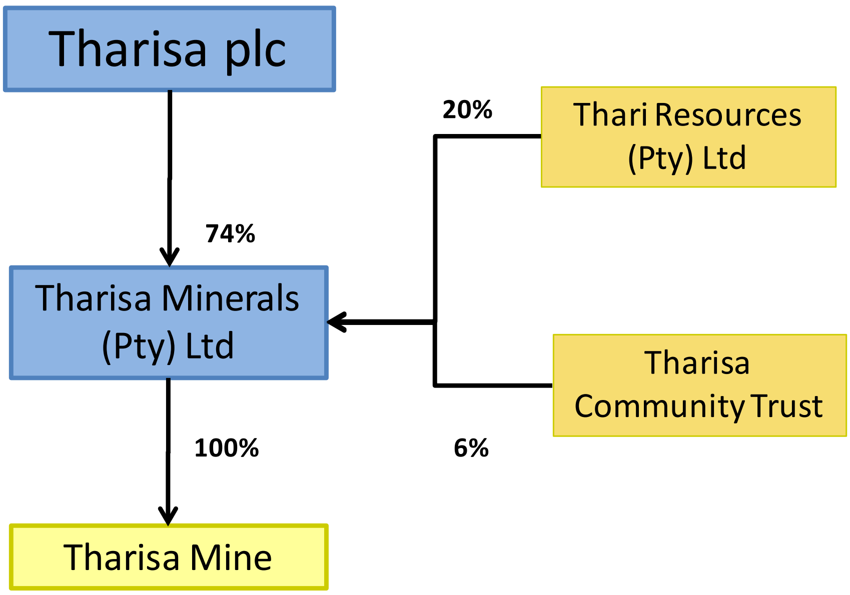
The open pit design and schedule including the mine design and scheduling of the future underground operation, was undertaken by Ukwazi Mining Solutions (Pty) Ltd (Ukwazi). The two schedules were combined into a joint production schedule.

Legal Aspects and Legal Tenure

The Tharisa Mine was developed by Tharisa Minerals which holds a mining right, granted by the DMR on 19 September 2008, to various portions of the property Farm 342JQ and to the property Rooikoppies 297JQ.

The corporate holding structure of the Tharisa Mine is represented in Figure 2.

Figure 2
Corporate Holdings Structure for the Tharisa Mine



Geology and Mineralisation

The Tharisa Mine is situated on the south-western limb of the Bushveld Complex and is underlain by the Middle Group (MG) Chromitite Layers.

The MG Chromitite Layers outcrop on Farm 342JQ striking roughly east - west and dipping at 12 -15° to the north. Towards the western extent of the outcrop, the dip is steeper, with a gentle change in strike to NW-SE. The stratigraphy typically narrows to the west and the dip steepens. The dip typically shallows out at depth across the extent of the mine area.

The MG Chromitite Layer package consists of five groups of chromitite layers being the MG0 Chromitite Layer, MG1 Chromitite Layer, the MG2 Chromitite Layer (subdivided into C, B and A chromitite layers), the MG3 Chromitite Layer and the MG4 Chromitite Layer (subdivided into MG4(0), MG4 and MG4A Chromitite Layers) (Figure 3). The layers between the chromitite layers frequently include stringers or disseminations of chromite. The MG0 Chromitite Layer may be defined but the formation of these chromitites is erratic and thin, and is generally considered uneconomical in the mine area. Where exposed in the open pit, the MG0 Chromitite Layer is expected to be mined. The structural interpretation of the Tharisa Mine is based on the aeromagnetic data and the drilling data. The MG Chromitite Layers at the Tharisa Mine are a typical stack of tabular deposits (Figure 3 and Figure 4).

The Upper Group (UG) 1 Chromitite Layer ranges between 165m to 18m stratigraphically above the MG4A Chromitite Layer on the Farm 342JQ property and 163m (downdip) to 18m (near surface) on the Rooikoppies property. The UG1 Chromitite Layer outcrops on the Farm 342JQ property. Both the UG2 Chromitite Layer (which ranges between 300m to 150m above the MG4A Chromitite Layer) and Merensky Reef (which ranges between 400m (east) to 290m (west) above the MG4A Chromitite Layer) outcrop on the Rooikoppies property. Poorly developed chromitite layers below the MG Chromitite Layer were intersected in boreholes and are interpreted as the Lower Group (LG) Chromitite Layers.

The structural interpretation of the Tharisa Mine was previously based on the aeromagnetic data and the drilling data. The only significant fault is a steeply dipping NW-SE trending normal fault with a downthrow of less than 30m to the east. This fault occurs only on the far north-eastern corner of the property and will have little effect on mining of the MG Chromitite Layers on Farm 342JQ. This fault was confirmed in both Lonmin plc (Lonmin) underground operations and Samancor stopes located immediately east of the mine. A NE-SW sub-vertical dyke of some 10m thickness was interpreted on the aeromagnetic survey. This dyke was not fully intersected in any of the boreholes but has been intersected in the East Mine box-cut and is 11m wide. The dyke is not expected to have a major impact on mining. The only other major feature of interest is the Spruitfontein upfold or pothole which is located on the properties immediately west of the mine. It affects the UG2 Chromitite Layer as well as the rest of the Critical Zone below. The area around the pothole is on the adjacent property and was not accessible for further investigation.

Figure 3

Summary of Stratigraphic Units modelled

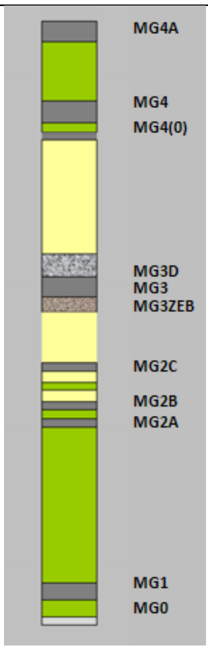
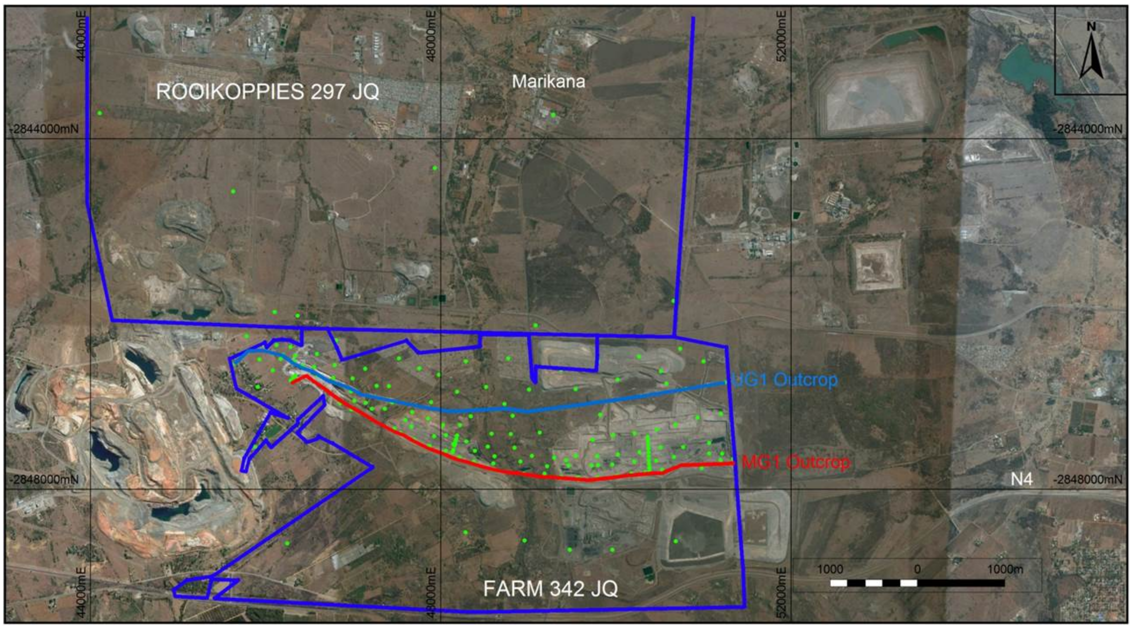
Stratigraphic Column	Unit	
	MG4A Chromitite Layer	
	MG4 Chromitite Layer	MG4 Chromitite
		MG4 – MG4 (0) Parting
		MG4(0) Chromitite
	MG3 Chromitite Layer	MG3 Disseminated
		MG3 Chromitite
		MG3 Zebra
	MG2 Chromitite Layer	MG2C Chromitite
		PGEM+ Parting
		PEGM
		PEGM- Parting
		MG2B Chromitite
		MG2A – MG2B Parting
		MG2A Chromitite
	MG1 Chromitite Layer	
	MG0 Chromitite Layer	

Figure 4

Google Image of the Tharisa Mine plan showing borehole locations and outcrop positions of UG1 and MG1 Chromitite Layers



The UG1 Chromitite Layer is stratigraphically situated in the Upper Critical Zone and is well developed in the Bushveld Complex. It comprises of massive chromitite, chromitiferous pyroxenite, bands of anorthosite, chromitite, norites and stringers of chromitites. The UG1 Chromitite Layer has an east-west strike and dips to the north. The dip angle varies from 10º in the east to 25º in the west. The thickness of the UG1 Chromitite Layer ranges from a few centimetres up to 3m in places. The lenses of anorthosite and pyroxenite are seen impregnated with numerous chromite grains in places. The hanging wall changes from pyroxenite to anorthositic norites. The footwall is formed by bifurcated bands of anorthosite and chromite lenses.

Exploration and Geology

The Tharisa Mine has been explored for its mineral potential since the early 1900s. Initially this was in the form of erratic exploration activities which included trenching and small open pits.

Various trenches were excavated on both the UG1 and the MG Chromitite Layers. The MG Chromitite Layers were previously exploited from three known pits, excavated by previous tenement holders and which remain unrehabilitated.

Six diamond boreholes were drilled during January 1997 by an entrepreneur, Mr Hennie Botha in the northwest part of Farm 342JQ property and on the adjacent property, Spruitfontein 341JQ. Five NQ size, vertical diamond boreholes were drilled along strike on Farm 342JQ during 2006 by Thari Resources under the supervision of Coffey. A total of 121 vertical boreholes and 23 deflections, representing some 22,500m were drilled from March 2007 to October 2007. The drilling programme was designed so that boreholes would intersect the base of the MG1 Chromitite Layer at approximately 30m, 60m, 120m, 180m, 300m, 500m and 1000m below surface. A line of boreholes that intersected at 220m below surface was later added for greater coverage of the deposit. The drilling programme was designed to drill the deposit closest to the outcrop at higher density than further downdip so that the subsequent mineral resource estimate close to the outcrop could confidently be declared as an indicated and/or measured mineral resource in preparation for a feasibility study and the consideration of open pit mining. The programme for the deeper boreholes on the Rooikoppies property, where Lonmin is mining the Merensky Reef and UG2 Chromitite Layer, was revised due to various difficulties relating to the siting of boreholes to prevent holing into existing underground infrastructure. Fewer, more widely spaced boreholes were therefore drilled.

Two fence lines (down dip) were drilled with TNW core size for metallurgical test purposes, intersecting the chromitite layers at 10m depth increments down to 60m below surface on the MG4 Chromitite Layer. Two NQ boreholes were drilled for geotechnical logging, sampling and to conduct rock strength tests. Six boreholes were drilled around the proposed civil engineering sites which coincide with the LG6 Chromitite Layer outcrop to ensure that a possible economical deposit was not being sterilised. A total of 10 boreholes were drilled on the Rooikoppies property to test the extension of the MG Chromitite Layer package down dip.

The collars of all the boreholes were surveyed. Downhole surveys were completed for all the boreholes drilled to a depth greater than 120m. All geological and sampling protocols used are to international standards. The precious metal analyses (Pt, Pd, Rh, Au, Ru, Ir, Os) were undertaken using NiS/MS analytical method and base metals analysis using the ICP Fusion D/OES analytical method, at Genalysis (Johannesburg).

A comprehensive quality assurance and quality control (QA/QC) programme was carried out concurrent with drilling. This included three certified reference standards, blanks and field duplicates. Each quality control aspect used was introduced in a ratio of 1:20. All assay issues were resolved and the assay data confirmed to be reliable and acceptable for a mineral resource estimate.

The geological modelling confirmed the tabular nature of the deposit and identified the major structural features (dykes and faults). The models were validated to ensure that the stratigraphic integrity was maintained. The result is five planar surfaces stacked on top of each other demonstrating the tabular nature of the deposit. The geological modelling utilised the other structural information gained from the aeromagnetic survey, trenching etc. It was noted that the dip flattens with depth.

Mineral Resource

The mineral resource estimate was completed over the mining right of Tharisa Minerals to a depth of 750m for the MG Chromitite Layers and UG1Chromitite Layer:-

- MG4A Chromitite Layer
- MG4 Chromitite Layer consisting of the MG4(0) and MG4 Chromitite Layer with the parting between them
- MG3 Chromitite Layer with the disseminated material above and the disseminated chromitite below (“zebra”)
- MG2 Chromitite Layer including the MG2A, MG2B, MG2C Chromitite Layers, the parting between the MG2A and MG2B Chromitite Layers as well as the PGM layer between the MG2B and MG2C Chromitite Layers and the associated partings
- MG1 Chromitite Layer
- MG0 Chromitite Layer
- UG1 Chromitite Layer

<u>MG Chromitite Layer</u>

The data was coded for the different units within the MG and UG1 Chromitite Layer packages. Statistical analysis was then completed on both the raw and composite data grouped by unit type after examination of the data indicated that the units defined different geological populations and are statistically distinct.

Each intersection was composited after coding for all stratigraphic layers. The Pt, Pd, Rh, Au, Ru, Ir, Os, Cu, Ni, Al, Ca, Cr, Cr_2O_3, Fe, Mg and Si concentrations were composited utilising the weighting by densities. An analysis of the unit thickness showed that there is little correlation between the concentration and thickness confirming that the use of concentration was appropriate in the mineral resource estimate.

An assessment of the high-grade composites was completed to determine whether high-grade cutting was required. Based on the above assessment, no high grade cutting or capping was undertaken.

Omni-directional/isotropic grade variograms were developed for all the components and all variables after it had been established that the anisotropy was weak. A block size of 100m x 100m was selected. The search criteria included an isotropic search volume of 500m that expanded to 1000m then 8000m if the criteria of a minimum of four and a maximum of 12 composite data for each block estimate were not met.

A series of two-dimensional grade estimates were generated based on geologically and geochemically defined units within the MG Chromitite Layer cycle. The mineral resource estimation was completed using either an inverse distance (power 2) or Ordinary Kriging methodology, depending if a suitable variogram for each variable within each unit could be modelled. The concentration of Pt (g/t), Pd (g/t), Rh (g/t), Au (g/t), Ru (g/t), Ir (g/t), Os (g/t), Cu (ppm), Ni (ppm), Al (%), Ca (%), Cr (%), Cr_2O_3 (%), Fe(%), Mg (%) and Si (%) for each of the units identified within the MG Chromitite Layers utilising the composite grade over the thickness of that unit (seam model approach). In addition the bulk density was estimated for each unit.

A geological loss of 15% over most of the mine was applied for areas where the MG Chromitite Layers are not developed viz. dykes, faults, potholes, mafic pegmatites. A geological loss of 7.5% has been applied for areas around the current open pit mining as only a few geological features have been intersected in the current pits.

The classification of the mineral resources was undertaken in accordance with the guidelines of the SAMREC Code. The Competent Persons responsible for the mineral resource estimation and classification is Mr Ken Lomberg Pr.Sci.Nat. and Mr Alan Goldschmidt Pr.Sci.Nat..

<u>UG1Chromitite Layer</u>

The UG1 Chromitite Layer comprises a top chromitite layer, a middling (pyroxenite/anorthosite) and a bottom chromitite layer. It was necessary to model these individual layers separately due to their different geochemical characteristics.

The East and West Mine areas were modelled independently as it was noted that they are of different populations. The boundary between east and west mines was put at the Sterkstroom River bisecting the property. The East Mine was further divided into two domains due to geology and grade considerations in the far eastern side. In total seven datasets were distinguished and modeled independently i.e. West (top, middling, and bottom), East (top, middling and bottom) and Far East (one model).

As a result of the confidence in the geological model, each of the stratigraphic units was estimated independently as a layer and a hard boundary was used. Each of the (Al_2O_3 (%), CaO (%), MgO (%), Fe_2O_3(%), K_2O(%), MnO (%), Na_2O(%), P_2O_5(%), Cr_2O_3(%), Pt (g/t), Pd (g/t), Rh (g/t), Ru (g/t), Ir (g/t), Au (g/t), width(m) and density values were estimated independently using inverse power of distance (power of 2) .

The classification of the mineral resources was undertaken in accordance with the guidelines of the SAMREC Code. The Competent Person responsible for the mineral resource estimation and classification is Mr Ken Lomberg Pr.Sci.Nat.

The classification was based on the robustness of the various data sources available, confidence of the geological interpretation, variography and various estimation service variables (e.g. distance to data, number of data, maximum search radii etc.).

In classification of the mineral resource estimate for the UG1 Chromitite Layer, consideration was given to the reasonable and realistic prospects for eventual economic extraction. As a result the declaration was made only for the areas where MG Chromitite Layer mining is anticipated to occur in open pit. The expansion of the declaration will require a financial assessment incorporating the potential movement of dumps and other surface infrastructure.

The mineral resource estimates for the MG and UG1 Chromitite Layers were estimated with an effective date 31 December 2015.

For the 2014 Annual Report the Mineral Resource estimate was derived by depleting the 2013 estimate. The depletion was completed using production data. All relevant MG Chromitite Layers were depleted to account for the period to the end of September 2014.

Both the mineral resource tonnages and grade within each resource category were depleted.

The depletion of the Mineral Resource tonnage for each layer is the sum of the monthly production information. These were reduced by 8% to account for material previously reported as part of the mineral resource, but not extracted.

Table 1 is the estimated mineral resource estimate dated 31 December 2015.

Table 1

Mineral Resource Statement for the Tharisa Mine (31 December 2015)

MG4A CHROMITITE LAYER

	Tonnage (Mt)	True Thick (m)	Bulk Density (t/m^3)	Cr_2O_3 (%)	Pt (g/t)	Pd (g/t)	Rh (g/t)	Au (g/t)	Ru (g/t)	Os (g/t)	Ir (g/t)	3PGE+ Au (g/t)	Pt:Pd:Rh:Au	6PGE+Au (g/t)	Pt:Pd:Rh:Au:Ru:Os:Ir	Cr:Fe	6PGE+Au (koz)	Ni (ppm)
Measured	6.234	1.43	3.69	24.82	0.40	0.15	0.12	0.003	0.26	0.04	0.05	0.67	59:22:18:0	1.02	39:15:12:0:25:4:5	1.12	204	760
Indicated	15.885	1.59	3.70	24.29	0.40	0.15	0.13	0.003	0.25	0.04	0.05	0.68	59:23:18:1	1.03	39:15:12:0:25:4:5	1.10	525	762
Inferred	68.476	1.43	3.70	25.18	0.39	0.14	0.13	0.004	0.26	0.05	0.05	0.67	59:21:19:1	1.03	38:14:12:0:26:4:5	1.11	2,263	763

MG4 and MG4(0) CHROMITITE LAYER Package

	Tonnage (Mt)	True Thick (m)	Bulk Density (t/m^3)	Cr_2O_3 (%)	Pt (g/t)	Pd (g/t)	Rh (g/t)	Au (g/t)	Ru (g/t)	Os (g/t)	Ir (g/t)	3PGE+ Au (g/t)	Pt:Pd:Rh:Au	6PGE+Au (g/t)	Pt:Pd:Rh:Au:Ru:Os:Ir	Cr:Fe	6PGE+Au (koz)	Ni (ppm)
Measured	17.920	4.09	3.74	26.39	0.69	0.19	0.17	0.003	0.32	0.06	0.08	1.06	66:18:16:0	1.51	46:13:11:0:21:4:5	1.17	872	781
Indicated	29.790	2.99	3.65	24.75	1.08	0.22	0.21	0.003	0.36	0.08	0.11	1.51	71:15:14:0	2.06	52:11:10:0:18:4:6	1.20	1,972	730
Inferred	170.678	3.70	3.62	22.60	0.99	0.19	0.19	0.003	0.34	0.07	0.10	1.36	72:14:14:0	1.88	53:10:10:0:18:4:6	1.15	10,313	697

MG3 CHROMITITE LAYER

	Tonnage (Mt)	True Thick (m)	Bulk Density (t/m^3)	Cr_2O_3 (%)	Pt (g/t)	Pd (g/t)	Rh (g/t)	Au (g/t)	Ru (g/t)	Os (g/t)	Ir (g/t)	3PGE+ Au (g/t)	Pt:Pd:Rh:Au	6PGE+Au (g/t)	Pt:Pd:Rh:Au:Ru:Os:Ir	Cr:Fe	6PGE+Au (koz)	Ni (ppm))
Measured	10.417	3.73	3.26	13.22	0.60	0.35	0.15	0.005	0.22	0.04	0.06	1.11	54:32:14:0	1.43	42:25:11:0:15:3:4	0.99	479	482
Indicated	23.412	4.28	3.22	17.99	0.75	0.44	0.19	0.005	0.27	0.05	0.08	1.39	54:32:14:0	1.79	42:25:11:0:15:3:4	1.08	1,347	603
Inferred	67.415	3.21	3.20	25.65	1.01	0.58	0.26	0.005	0.38	0.08	0.10	1.86	54:31:14:0	2.42	42:24:11:0:16:3:4	1.13	5,245	785

MG2 CHROMITITE LAYER

	Tonnage (Mt)	True Thick (m)	Bulk Density (t/m^3)	Cr_2O_3 (%)	Pt (g/t)	Pd (g/t)	Rh (g/t)	Au (g/t)	Ru (g/t)	Os (g/t)	Ir (g/t)	3PGE+ Au (g/t)	Pt:Pd:Rh:Au	6PGE+Au (g/t)	Pt:Pd:Rh:Au:Ru:Os:Ir	Cr:Fe	6PGE+Au (koz)	Ni (ppm)
Measured	13.092	3.96	3.62	19.33	1.07	0.28	0.15	0.004	0.26	0.05	0.08	1.50	71:18:10:0	1.89	56:15:8:0:14:3:4	0.97	796	730
Indicated	42.716	4.37	3.67	17.80	0.98	0.28	0.15	0.004	0.24	0.05	0.07	1.42	69:20:10:0	1.78	55:16:8:0:14:3:4	0.92	2,388	733
Inferred	286.164	6.68	3.62	13.26	0.70	0.21	0.11	0.004	0.19	0.04	0.05	1.02	69:20:11:0	1.30	54:16:8:0:15:3:4	0.75	11,975	674

MG1 CHROMITITE LAYER

	Tonnage (Mt)	True Thick (m)	Bulk Density (t/m^3)	Cr_2O_3 (%)	Pt (g/t)	Pd (g/t)	Rh (g/t)	Au (g/t)	Ru (g/t)	Os (g/t)	Ir (g/t)	3PGE+Au (g/t)	Pt:Pd:Rh:Au	6PGE+Au (g/t)	Pt:Pd:Rh:Au:Ru:Os:Ir	Cr:Fe	6PGE+Au (koz)	Ni (ppm)
Measured																	-	
Indicated	14.041	1.24	3.91	33.44	0.34	0.22	0.11	0.004	0.48	0.08	0.08	0.67	50:32:17:1	1.30	26:17:9:0:37:6:6	1.34	589	811
Inferred	57.245	1.23	3.89	32.26	0.33	0.20	0.11	0.003	0.45	0.08	0.07	0.64	51:31:17:1	1.24	26:16:9:0:36:6:6	1.29	2,276	803

MG0 CHROMITITE LAYER

	Tonnage (Mt)	True Thick (m)	Bulk Density (t/m^3)	Cr_2O_3 (%)	Pt (g/t)	Pd (g/t)	Rh (g/t)	Au (g/t)	Ru (g/t)	Os (g/t)	Ir (g/t)	3PGE+Au (g/t)	Pt:Pd:Rh:Au	6PGE+Au (g/t)	Pt:Pd:Rh:Au:Ru:Os:Ir	Cr:Fe	6PGE+Au (koz)	Ni (ppm)
Measured	1.801	0.50	3.74	26.07	0.57	0.18	0.16	0.004	0.30	0.05	0.07	0.92	62:19:18:0	1.33	43:13:12:0:22:4:5	1.19	77	747
Indicated	3.188	0.71	3.75	27.08	0.61	0.19	0.17	0.004	0.32	0.06	0.07	0.98	62:20:17:0	1.44	43:14:12:0:22:4:5	1.22	147	752
Inferred	0.011	0.17	3.73	23.76	0.45	0.17	0.15	0.006	0.24	0.04	0.05	0.77	58:22:19:1	1.11	41:15:13:1:22:4:5	1.11	0.40	711

UG1 CHROMITITE LAYER

	Tonnage (Mt)	True Thick (m)	Bulk Density (t/m^3)	Cr_2O_3 (%)	Pt (g/t)	Pd (g/t)	Rh (g/t)	Au (g/t)	Ru (g/t)	Os (g/t)	Ir (g/t)	3PGE+Au (g/t)	Pt:Pd:Rh:Au	6PGE+Au (g/t)	Pt:Pd:Rh:Au:Ru:Os:Ir	Cr:Fe	6PGE+Au (koz)	Ni (ppm)
Measured																		
Indicated	1.500	2.17	3.75	23.68	0.36	0.28	0.14	0.030	0.21			0.82	44:35:17:4			1.12	39	
Inferred																		

TOTAL MINERAL RESOURCE

	Tonnage (Mt)	True Thick (m)	Bulk Density (t/m^3)	Cr_2O_3 (%)	Pt (g/t)	Pd (g/t)	Rh (g/t)	Au (g/t)	Ru (g/t)	Os (g/t)	Ir (g/t)	3PGE+Au (g/t)	Pt:Pd:Rh:Au	6PGE+Au (g/t)	Pt:Pd:Rh:Au:Ru:Os:Ir	Cr:Fe	6PGE+Au (koz)	Ni (ppm)
Measured	49.464	2.68	3.73	21.51	0.73	0.24	0.16	0.004	0.28	0.05	0.07	1.13	64:21:14:0	1.53	48:16:10:0:18:3:5	1.09	2,428	699
Indicated	128.033	2.45	3.67	22.22	0.80	0.27	0.16	0.004	0.31	0.06	0.08	1.24	65:22:13:0	1.69	48:16:10:0:18:3:5	1.10	7,007	713
Inferred	651.488	3.11	3.74	19.88	0.74	0.23	0.15	0.004	0.28	0.05	0.07	1.13	66:21:13:0	1.53	49:15:10:0:18:4:5	1.00	32,072	712
Total	**828.984**	**2.95**	**3.73**	**20.38**	**0.75**	**0.24**	**0.15**	**0.004**	**0.28**	**0.05**	**0.07**	**1.15**	**66:21:13:0**	**1.56**	**48:15:10:0:18:4:5**	**1.02**	**41,507**	**712**

Note: The mineral resource is declared to a depth of 750m below surface.

The consideration of realistic eventual extraction necessitates that the mineral resource considers the MG Chromitite Layer to be a geological unit and that all platiniferous and chromiferous horizons will be mined and all PGM, Cu, Ni and Cr_2O_3 recovered.

The UG1 Chromitite Layer is declared for the part that falls within the current proposed open pit

The mineral resource is reported inclusive of the mineral reserve

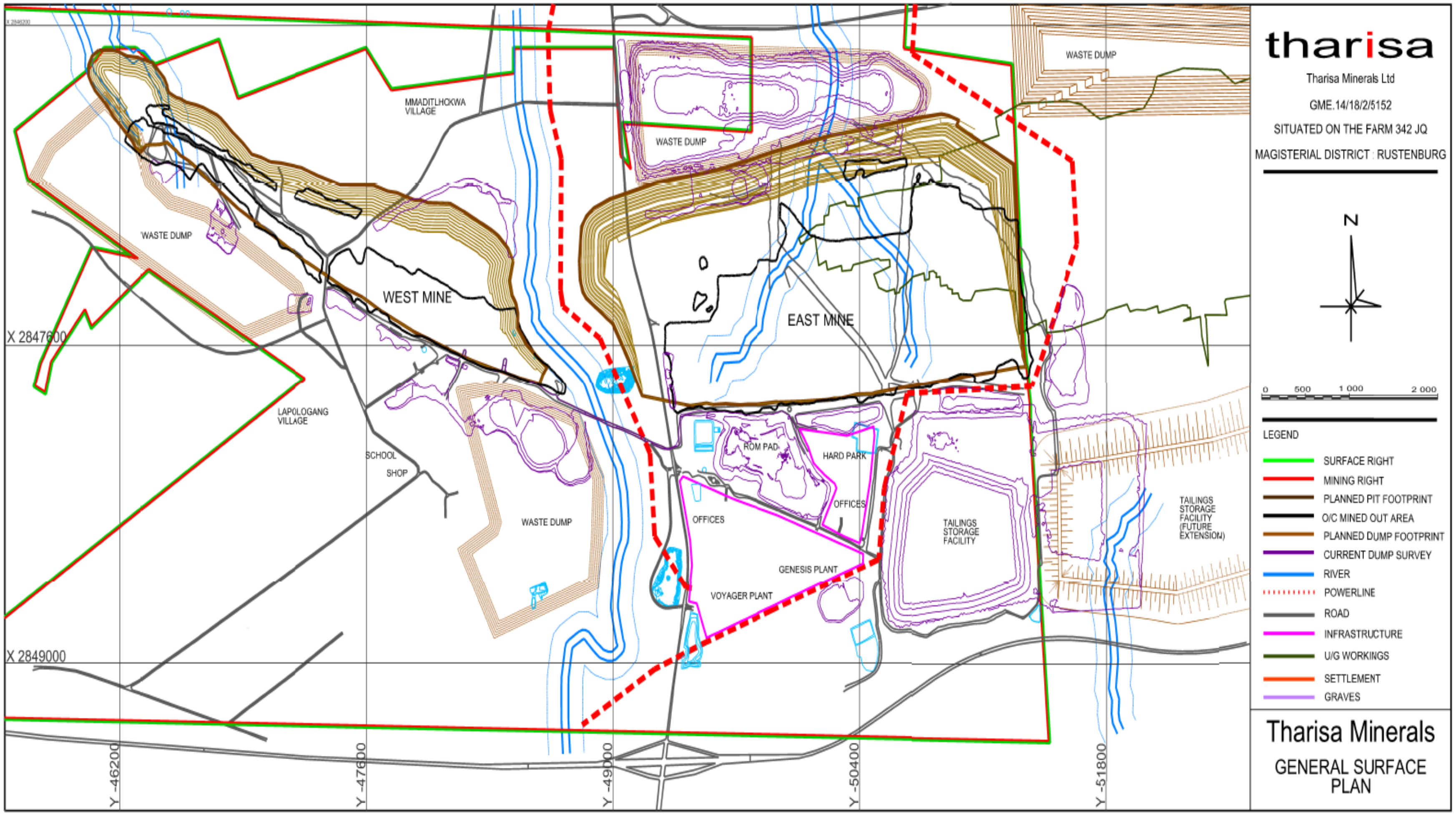
Mining Engineering

A feasibility study was concluded in October 2008. Various revisions to the mine plan were undertaken to match the requirements of the processing facilities, including both open pit and underground mine design and scheduling.

The open pit operation targets MG1, MG2, MG3, MG4 and MG4A in an operation split into a west pit and an east pit. The mine is planned for two phases, an initial open pit mine followed by an underground mining operation. The open pit plan is based on fixed contract rates and volumes as determined through a detailed planning process. Based on a maximum of a 200m high wall, the life of pit and a 420ktpm production profile, the open pit operation maintains planned production levels until 2030 before mining underground. The last open pit tonnage is mined in 2036. The underground mining of targeted layers starts towards the end of the open pit operations.

Figure 5

Map showing the Mining Layout



Open Pit

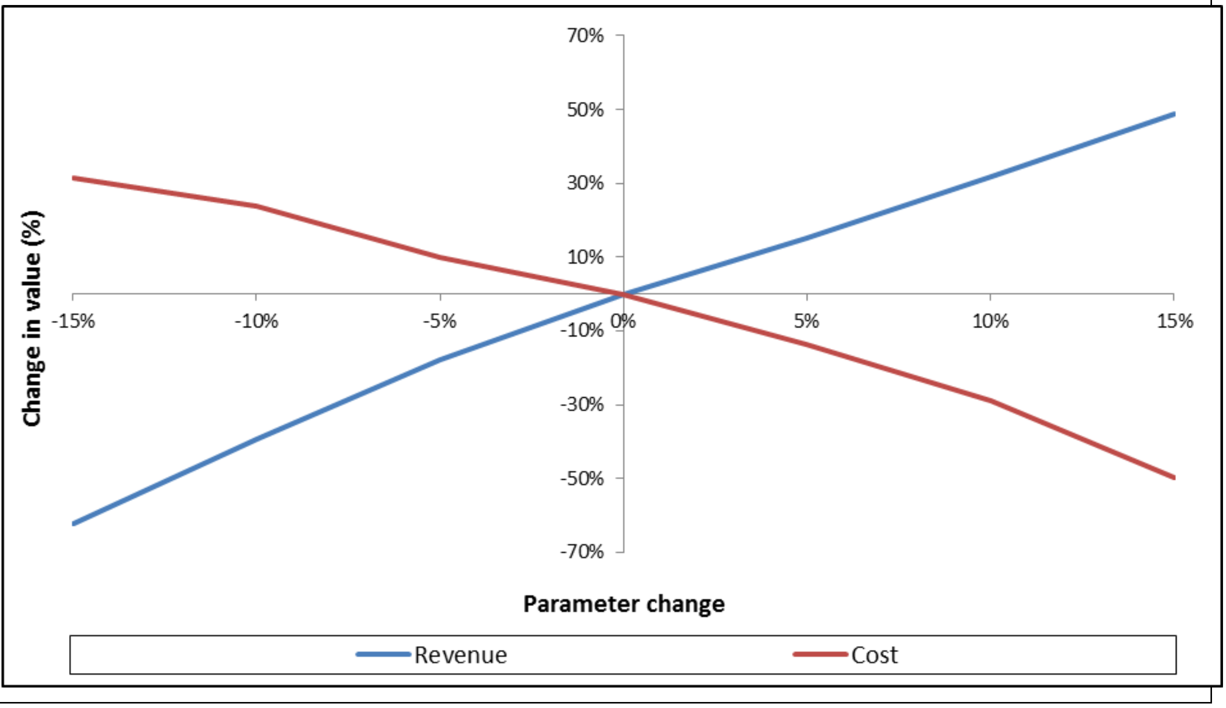
The pit optimisation was undertaken in 2013 using GEMCOM Whittle® pit optimisation software. No further optimisation work was completed as stated in the 2013 CPR. A comprehensive sensitivity analysis was completed taking into consideration the previously completed pit optimisation with updated mining, cost, revenue and financial parameters.

A sensitivity analysis was conducted on a revenue and cost basis to determine the impact on the current selected pit shell. This entailed adjustment of the revenue (basket and chrome prices) by ±15% in 5% increments. The value stated in the optimisation/ sensitivity analysis process is a relative value based on the Whittle® schedule including fixed and variable operational cost. A 15% reduction in revenue impacts on the relative value of the project with a value reduction, excluding capital, of 62% while a 15% increase in revenue with a relative value gain of 49%. It is evident that the mine value is most sensitive to revenue. Although a lower basket revenue has a material impact on the value of the project, it does not have a material impact on the pit selection strategy up to ±15% in basket and chrome prices.

It is evident that a relative value from the selected pit is sensitive to both reduction and increase in cost. A 15% reduction on cost has a 32% increase in relative value while a 15% increase shows a 50% reduction in relative value on the selected pit. Figure 6 shows a graphical representation of the sensitivity analysis conducted for the selected pit. The sensitivity analysis indicates that the pit is sensitive to both revenue and cost.

Figure 6

Sensitivity Analysis Graph



Mining is undertaken by an established mining contractor with a track record on similar operations. Mine planning is conducted in conjunction with the mining contractor to ensure that operational plans are achieved.

The mining related modifying factors applied were based on study work, testwork, observation and measurement. A geotechnical slope angle of 45º, with a 10m safety berm at an overall slope angle of 35º was used for the top 20m of topsoil and soft overburden while an average overall 53º slope angle was applied at depth. Geological losses were applied at 7.5% in the less steeply dipping eastern section where more information existed whilst a 15% geological loss was applied towards the west. The geological loss accounted for unknown and known geological features that resulted in a loss of available Mineral Resources. The total of 6% mining losses was based on the available Mineral Resource mined, with losses allowed for drilling, blasting and loading activities. External dilution was applied based on the mining methodology employed per ore layer. MG4A, MG4 and MG2 were not mined selectively and thus attracted a higher dilution percentage. The selectively mined ore layers included MG3 and MG1 as these layers attracted lower dilution levels. The average dilution applied amounted to 9.1% measured on a tonnage basis. Excessive losses and dilution pose a material risk and have a material negative effect on the profitability of the operation.

Excavators (65t to 90t class) are used to load 40t to 80t class articulated dump trucks in the chromitite layer and waste parting zones. The RoM ore is hauled directly from the pit to the RoM pad or placed on a designated stockpile or fed directly through the mobile primary crusher and sized to 200mm. Mining operations in the west pit is restricted to day-light hours compared to 24 hour operation in the east pit. The east pit is equipped with appropriate lighting plants on each production face with quality control enforced by grade control technicians.

Bulk waste above the MG4A is excavated using 360t excavators and hauled with 150t dump trucks. Haul roads were designed at a maximum inclination of 10% and with a width of 30m, taking into consideration the 150t truck dimensions for safe two-way traffic.

Mining costs used in the optimisation process and subsequent sensitivity analysis were based on the plant and infrastructure operational budget, overheads and contractual mining rates. PGM metal prices were adjusted to incorporate the offtake terms and the government royalty.

Plant recoveries were based on actual performance while capacities were based on design capacity. The PGM recoveries on oxidised and fresh ore are shown in Figure 7. The mass yield applied was based on the supplied yield curves as indicated in Figure 8.

Bulk waste is blasted in 20m benches. Depending on the dump location, waste is hauled to either the dump located on the outcrop side or hauled through temporary ramps on the interim high wall to a dump located on the high wall side of the pit. Backfilling will commence once the pit reaches a depth of approximately 100m. Close to 35% of the waste is backfilled over the life of the operation. It must be noted that, due to the low wall ramps and a minimum 100m down dip lag between the backfill and the working faces, the 35% backfill is reasonable and in line with similar operations.

Figure 7

PGM Recovery

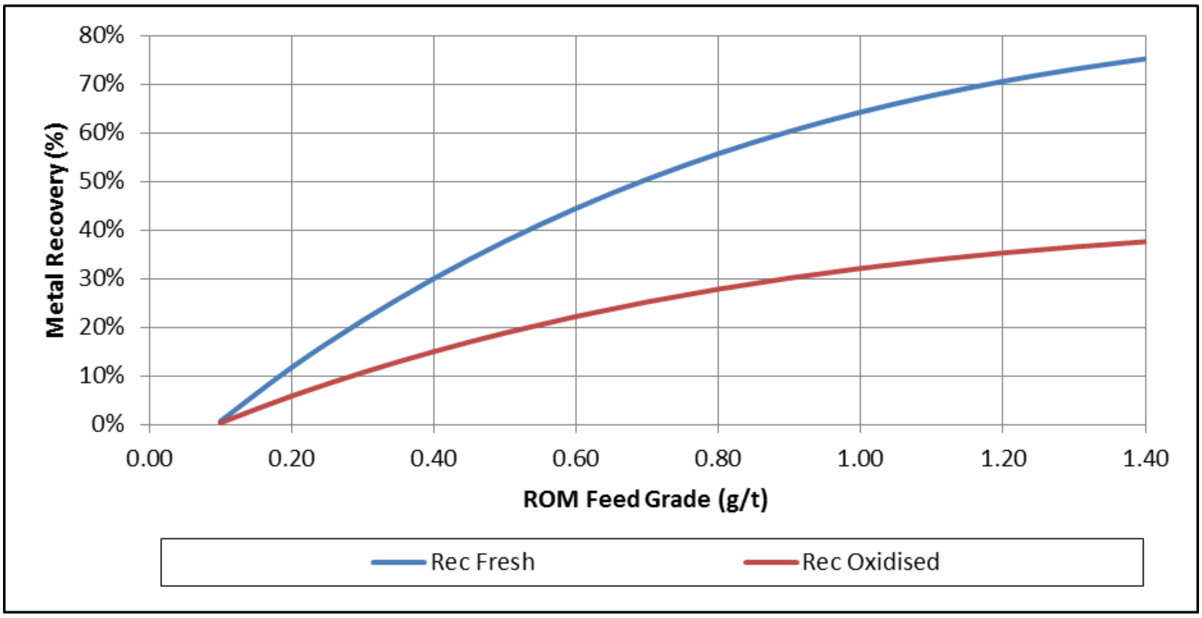
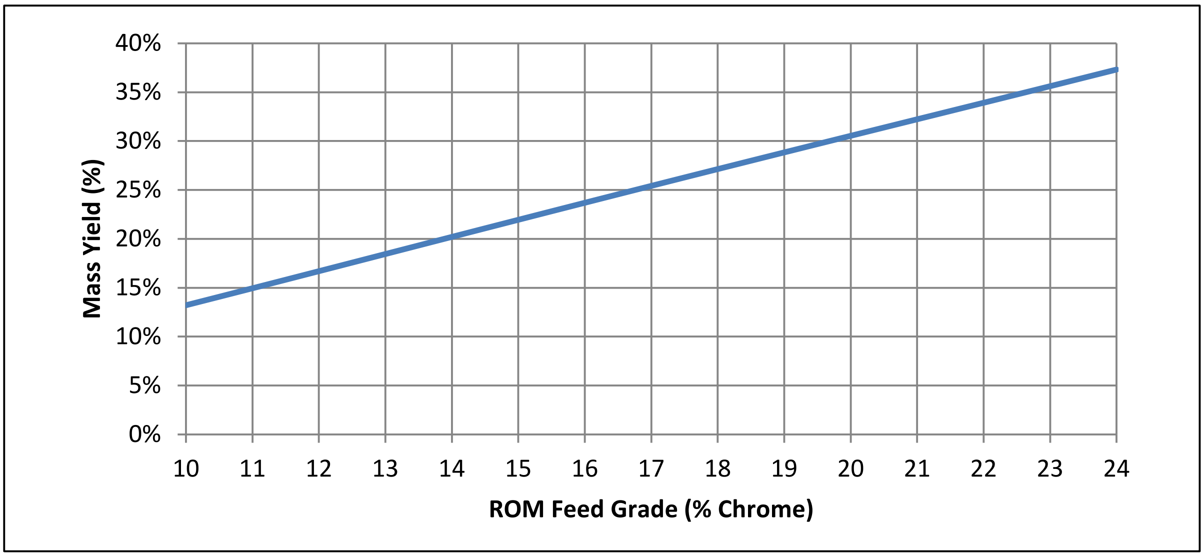


Figure 8

Mass Yield – Chrome Concentrate



Steady state waste stripping requirements are set at approximately 1.3 million BCM per month from the two pits. A total of 420ktpm of RoM ore is produced from the two pits. Steady state production levels are maintained from the open pits up to 2030 when there is a gradual ramp up of production from underground sources. The last open pit tonnage is mined in 2036.

A total of 41.4Mt of Proved Mineral Reserve and 46.4Mt of Probable Mineral Reserve is declared for the open pits (Table 2).

Table 2
Open Pit: Mineral Reserve Estimation Summary
(31 December 2015)

Reserve category	Tonnes (Mt)	Pt (g/t)	Pd (g/t)	Rh (g/t)	Au (g/t)	3PGE+Au (g/t)	5PGE+Au (g/t)	Cr_2O_3 (%)
Proved	41.4	0.74	0.25	0.15	0.004	1.14	1.45	17.8
Probable	46.4	0.67	0.27	0.14	0.004	1.08	1.42	19.1
Total	**87.8**	**0.70**	**0.26**	**0.14**	**0.004**	**1.11**	**1.43**	**18.5**

Note: The Mineral Reserve is declared in terms of the guidelines of the SAMREC Code
The reserve does not report Os as it typically not included in the revenue generated from the sale of PGEs.

Underground Mine Design

An underground mining study was conducted as part of the 2013 CPR. No subsequent study work was completed. The sections contained in this document describing the underground mining and design methodologies are an extract of the 2013 report.

Small portions exist within the mine design for which Tharisa does not currently hold the mining right and/ or where the surface rights have yet to be acquired. These areas were not excluded from the mine design based on the reasonable expectation that exists that the necessary permitting and ownership could be in place by the time mining is undertaken in these areas.

The minimum strategic design requirements for the underground section was a RoM production of 400ktpm as a continuation of the open pit production profile with sustained production levels during the transition period. The health and safety aspects considered must provide for a low safety risk and profitable underground mining.

To successfully define a single go-forward case for the mining exploitation strategy, the mining method, access selection, mine design, scheduling, mining equipment selection, and the preparation of an operational and capital cost schedule up to steady state production was considered. The footprint area for underground mining was constrained by the open pit perimeter and crown pillar to the south, the 750m depth cut-off to the north and the mining right boundaries to the east and west. The overall exploitation strategy applied was to maximise the economic open pit limits followed by underground mining from the pit high walls.

A mining method selection study was undertaken to evaluate the productivity, equipment suitability, capital costs, operating costs, environmental aspects, and health and safety risks associated with various methods. A trackless bord and pillar was selected as the preferred mining method. Bord and pillar mining is widely employed for the extraction of similar flat dipping deposits with the advantages that:

- Development rates are faster compared to conventional systems
- The mining method offers good flexibility in terms of dealing with geological and quality anomalies
- Safety is enhanced as fewer people are involved and most of the work is conducted from the protection of machinery
- Personnel, equipment and consumables are moved efficiently and almost directly to the working faces
- Shift change-over times are reduced
- Supervision is improved and working places can be visited with less effort compared to conventional methods.

An analysis was undertaken to select the appropriate mining horizons. From this analysis, MG2 and MG4 were selected. After further scrutiny, it was concluded that MG2C must be excluded from the mining cut to reduce internal dilution and only MG2A, MG2B and the waste parting will be mined. The combined thickness of MG2A, waste parting and MG2B in the greater part of the underground design area is well over 1.8m and meets the minimum requirements of the equipment selected. A further constraint was applied that the maximum mining width must not exceed 4m. The mining cut was re-stated for MG2A only, taking the minimum width into consideration.

MG4 at an average in situ thickness of 3.0m, was selected as the second mining horizon as it was wide enough for trackless bord and pillar mining. The parting between MG2 and MG4 vary between 15m to 20m thick. The selected mining cut includes MG4, the pyroxenite parting and MG4(0) below. The same maximum and minimum width criteria were used. Where the MG4 package thickness exceeded 4m, only MG4 was selected for the mining cut.

Mining extraction in the bord and pillar mining method was achieved by developing a series of roadways (rooms or bords) on the chromitite layer and connecting them by holings or cut-throughs to form pillars that provide support for the overlying strata. Mining extraction in this method is a function of the pillar sizes which is a function of the depth below surface.

To accommodate the equipment sizes, production requirements and geotechnical considerations, minimum and maximum mining cuts were set at 1.8m and 4.5m respectively. Layers thinner than 1.8m were diluted up to a minimum height of 1.8m in the production sections and 4.5m in the declines.

Access to the underground mine is gained through three sets of on reef declines. The advantages of this system are that all development is undertaken on the reef horizon, more information on the geology is obtained during development and waste development is required to access the chromitite layers. The main disadvantage of this option is the lack of surge capacity. Two decline systems with a capacity of 150ktpm each were planned from the high wall of the east pit for MG2 and MG4 respectively. Another set of declines must be developed on MG2 from the west pit high wall which services both MG2 and MG4 at a capacity of 50ktpm from each chromitite layer.

The geotechnical parameters considered for this study were based on the work conducted as part of the feasibility study concluded in 2008 and additional work completed in 2012. Initial pillar designs were modified in line with best practices employed at similar mines in the area. Consequently, pillar sizes of 6m x 6m on 8m bord spans and 6m holings were used in the stoping designs. The pillars were designed to increase with depth from 6m x 6m in the upper levels to 8m x 8m in the bottom stopes. Additional geotechnical modelling is required to refine these parameters in due course. This modelling must include a study of the waste partings between the layers to form the basis of possible future inclusion of portions of MG1 and MG3.

The mining dilution factors were estimated from first principles assuming an over break of 10cm waste from both the hanging and footwall horizons of the mined Layer. Depending on dip of the chromitite layer, some waste will be mined to maintain safe and horizontal underfoot conditions. The dilution factors decrease with depth from 16% to 13% for MG2 and from 15% to 12% for MG4. This is in direct proportion to the pillar sizes which increase with depth. Mining recovery for both horizons was set at the historical mining average for similar operations at 98%. The extraction is a function of the pillar sizes and was estimated from first principles. A decreasing trend with depth is shown from 79% in the upper levels to 71% in the lower levels for both chromitite layers.

Ten production sections are required to meet the planned 200ktpm RoM production for MG2 based on the LHD requirement estimate. A total of 12 production sections are required to meet the planned 200ktpm RoM production from MG4. Based on a production profile of 400ktpm, the scheduled underground production commences with the production ramp up during FY 2030 and continues up to FY 2075, with an underground mine life of 24 years at steady state production.

The scheduling strategy, which is a key driver to the overall project costs and economic value, was set to establish the eastern decline system initially before moving to the western decline system. This strategy was chosen to minimise project risk by starting off with areas of higher geological confidence and chromitite layer thicknesses. The sinking of the MG2 east triple declines is set to start five years before the depletion of open pit operations. At the planned advance rates, the mining of the triple MG2 declines to Level 4, including the ledging and ventilation provisions, will be completed within 24 months with the ramp up to steady state within 48 months. Sinking and production ramp up for the MG4 declines will be executed over the next three years and steady state production of 400ktpm is expected in year five from project inception. This ramp up is timed to maintain production rates with the depletion of the open pit Mineral Reserves.

The underground operations will make use of some of the existing infrastructure established for open pit operations such as electricity, water, the plant, houses, offices and transport and communications networks as this would be operational when the underground operations are conducted. Additional infrastructure provided in the capital cost estimate includes:

- The ventilation network
- Underground workshops and fuelling facilities
- Pumping arrangements
- Washrooms and lamp room facilities
- Emergency facilities.

The mining operating costs were sourced mainly from an internal cost database and from relevant service providers.

A total of 18.6Mt of underground RoM was declared as a Probable Mineral Reserve (Table 3).

Table 3
Underground Mine: Mineral Reserve Statement
(31 December 2015)

Reserve category	Tonnes (Mt)	Pt (g/t)	Pd (g/t)	Rh (g/t)	Au (g/t)	3PGE+Au (g/t)	5PGE+Au (g/t)	Cr_2O_3 (%)
Proved	-	-	-	-	-	-	-	-
Probable	18.6	0.82	0.19	0.15	0.002	1.17	1.52	19.3
Total Reserve	**18.6**	**0.82**	**0.19**	**0.15**	**0.002**	**1.17**	**1.52**	**19.3**

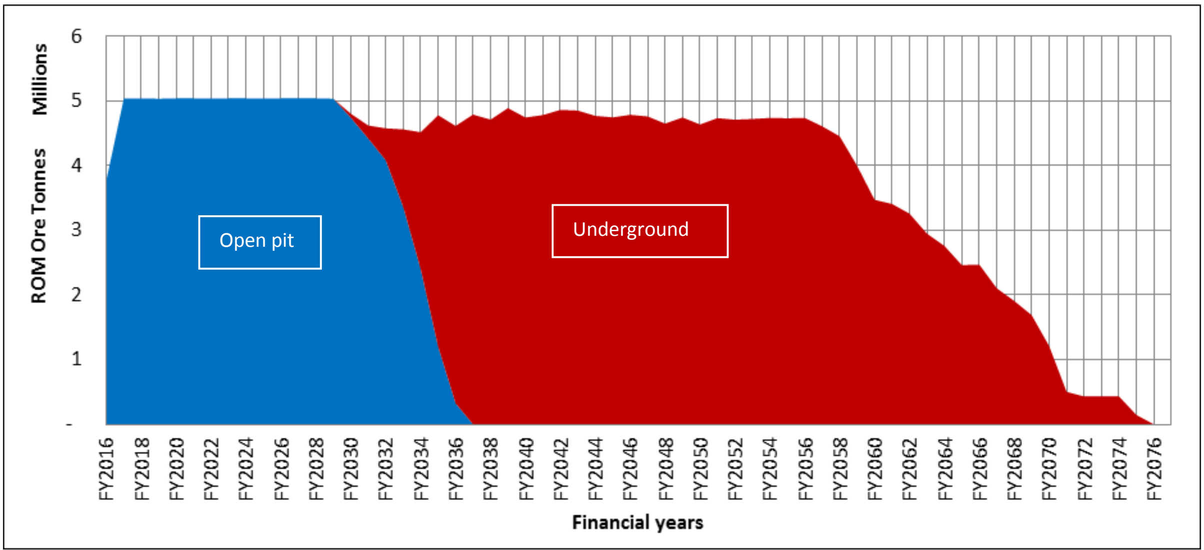
Note: The Mineral Reserve is declared in terms of the guidelines of the SAMREC Code.
The reserve does not report Os as it typically not included in the revenue generated from the sale of PGEs.

Production Schedule

The combined LoM schedule for the current open pit and planned underground operations is presented in Figure 9.

Figure 9

Integrated Mining Production Schedule



Mineral Reserves

Modifying factors were applied to the Mineral Resource to convert it to a Mineral Reserve. The modifying factors applied were geological losses (7.5% in the less steeply dipping eastern section and 15% in the steeper dipping western section of the west pit), mining recovery (mining loss of 6%) and mining dilution (9.1% tonnage basis on average). Metallurgical recoveries were applied according to metal recovery curves for oxidised and fresh ore respectively and Cr_2O_3 recovery was based on the process recovery curve.

The combined open pit and underground Mineral Reserve estimate is presented in Table 4.

Table 4
Total Mine: Mineral Reserve Statement
(31 December 2015)

Reserve Category	Tonnes (Mt)	Pt (g/t)	Pd (g/t)	Rh (g/t)	Au (g/t)	3PGE+Au (g/t)	5PGE+Au (g/t)	Cr_2O_3 (%)
Proved	41.4	0.74	0.25	0.15	0.004	1.14	1.45	17.8
Probable	65.0	0.71	0.25	0.14	0.003	1.11	1.45	19.2
Total Reserve	**106.4**	**0.72**	**0.25**	**0.15**	**0.004**	**1.12**	**1.45**	**18.6**

The reserve does not report Os as it typically not included in the revenue generated from the sale of PGMs.
5PGE = Pt+Ir+Ru+Rh+Pd

Geotechnical Engineering

On the most recent visit to the mine it was observed that the working pit slopes are stable and the benches and slopes conform to the design. The stripping ratio is low and will need to be increased. No major risks were observed.

In the 2013 design study, data was collected from geotechnical logging in the then current east and central pits of Tharisa Mine to determine stable slope angles. Acceptable design methodologies were used to quantify the appropriate slope angles that will allow for safe and effective extraction of the resource. Slope angles of 45° in saprolitic material and 53° overall slope angles in fresh rock up to an overall slope height of 210m were shown to be stable. Kinematic analysis suggests a possibility for toppling failure. Instability is expected to be on a bench scale and therefore catch berms must be maintained. Beside this potential minor mode of failure the safety factors are high.

An earlier geotechnical investigation was carried out by logging eight boreholes and sampling the lithological units prior to strength testing the samples. The pillar strengths and N' values for underground mining were calculated and from this pillar sizes and stope spans designed. Mining aspects require that the bord spans be limited to 6m. The planned support for the stoping and development has also been designed incorporating these design parameters.

Metallurgy and Processing

<u>Introduction</u>

The processing facilities at the Tharisa Mine are designed to treat the (Middle Group) MG Chromitite Layers of the Bushveld Complex. These layers vary in thickness, competence and chromite and Platinum Group Metals (PGM) grades. Historically some of the MG Chromitite Layers have been mined for the recovery of chromite but not for PGM's. Tharisa Minerals has undertaken metallurgical tests on samples from these layers and confirmed the economic viability of mining and processing these ores for the recovery of both the chromite and PGM concentrates and confirmed this with the subsequent operating results.

The Tharisa Mine has been developed in a phased manner as described below.

- The **<u>first phase</u>** of the mine development involved the production of a chromite concentrate only from a pilot plant. Trial production commenced in March 2009. This pilot plant was later adapted to provide early revenue and from November 2009 the plant treated RoM ore at a throughput rate of 38,000 tpm.
- The **<u>second phase</u>** of the mine development involved the expansion of the mining operation and first phase processing facility to mine and treat 100,000 tpm of RoM ore. In addition the processing facility was expanded to incorporate both a 65,000 tpm PGM recovery circuit and a secondary chromite recovery section. This combined complex is currently known as the Genesis plant. Commissioning of the Genesis plant commenced in August 2011 and was completed in February 2012.

- The **third phase** of mine development increased the mining and processing rate by a further 300,000 tpm. This was achieved through the construction of a new standalone concentrator which operates in parallel to the existing 100,000 tpm processing facility. The new 300,000 tpm concentrator, known as the Voyager plant, recovers a primary chromite concentrate, a PGM concentrate from the primary chromite tailings and a secondary chromite concentrate from the PGM tailings.

After the construction and commissioning of the Voyager plant the total mining and processing throughput capacity of the Tharisa Mine was 400,000 tpm (4.8Mtpa) of RoM ore.

The original process design was based on test work undertaken by Mintek. In addition, the Tharisa Minerals processing facility was developed on a phased basis. The different phases were structured to provide additional design information for the 300,000 tpm plant while generating an income stream through recovering chromite concentrate.

The current operational processing facilities consist of two distinct and separately operated facilities. The two facilities are described below.

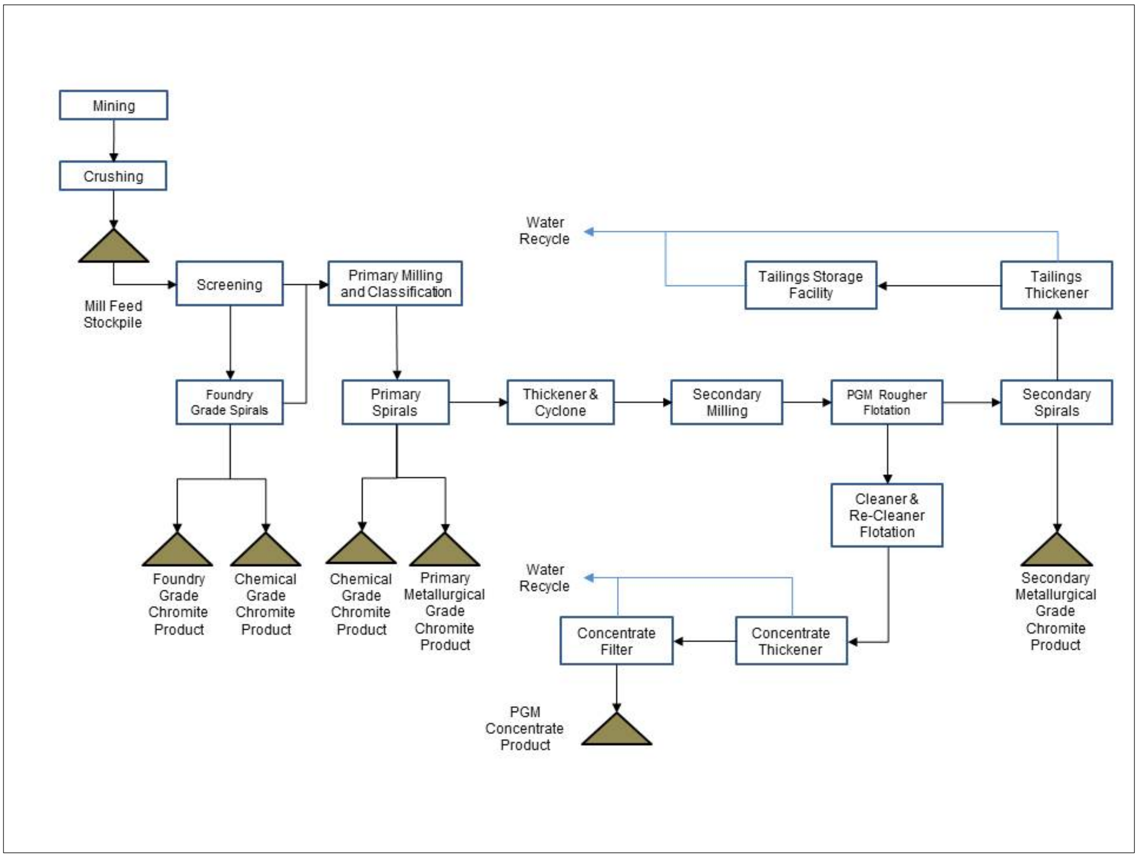
Genesis Plant

The second phase of mine development established the Genesis processing plant with a design plant throughput of 100,000 tpm RoM. The Genesis plant processes predominantly the MG1 and MG4A Chromitite layers which contain the higher grade chromite and lower grade PGM's. The main focus of the Genesis plant is therefore to recover and produce higher value chromite products.

The current Genesis process flow is indicated in Figure 10 and described below.

Figure 10

Genesis Plant Simplified Flow Diagram



RoM material from the open pit mining operation is received and stored on a RoM pad. The RoM material is fed either directly by truck or by front end loader into the crushing circuit. The ore is crushed to less than 12mm by a three stage crushing circuit. The crushed ore is screened at 0.6mm to remove the crushed fines. The fine material is pumped to the foundry grade spiral plant for recovery of a foundry grade and chemical grade chromite concentrate from the higher grade feed material. The chemical grade concentrate and foundry grade concentrate are dewatered separately by dewatering cyclones and stored on separate drying pads from where it is despatched by truck.

The natural fines screen coarse fraction is milled in a single stage ball mill operated in closed circuit with a vibrating screen with a 0.6mm deck size. The milled ore that passes through the screen combines with the tailings from the foundry grade spiral concentrator plant and is then pumped to the primary spiral concentrator circuit. The primary spiral circuit further recovers chromite to produce metallurgical and chemical grade chromite concentrates. The metallurgical grade chromite concentrate is dewatered by separate dewatering cyclones and stored on separate drying pads from where the concentrate is despatched by truck. The chemical grade concentrate joins the chemical grade concentrate from the foundry plant for dewatering and storage.

The primary spiral circuit tailings stream is dewatered by a cluster of cyclones from where the coarse solids gravitate to three open circuit secondary ball mills operated in parallel. The fine solids (cyclone overflow) feeds a thickener from which the thickened fine solids are also pumped to the ball mills. The milled slurry discharging from the mills is collected in a common pump tank and pumped to a flotation plant for PGM recovery. The concentrate from the initial rougher flotation stage is subjected to three stages of cleaner flotation to produce a final PGM concentrate. The PGM concentrate is dewatered by a combination of a thickener and a filter before despatch by truck.

The PGM flotation section tailings stream is pumped to a secondary spiral concentrator section where the chromite, liberated by the secondary mill, is separated from the gangue minerals to produce a second fine metallurgical grade chromite concentrate. This fine chromite concentrate is dewatered by cyclone and stored on a separate dedicated drying pad from where it is despatched by truck.

The water in the tailings from the secondary spirals section is recovered in a thickener and re-circulated as process water. The solid tailings (thickener underflow) are pumped to the final Tailings Storage Facility (TSF). Water is also recovered from the TSF and circulated back to the processing facility.

<u>Voyager Plant</u>

The third phase of mine development increased the throughput rate to 400,000 tpm by establishing a new processing facility rated at 300,000 tpm, known as the Voyager plant. The Voyager plant operates in parallel with the 100,000 tpm Genesis plant. The Voyager plant processes predominantly the MG2, MG3 and MG4 Chromitite layers which contain the higher PGM grades and lower chromite grades.

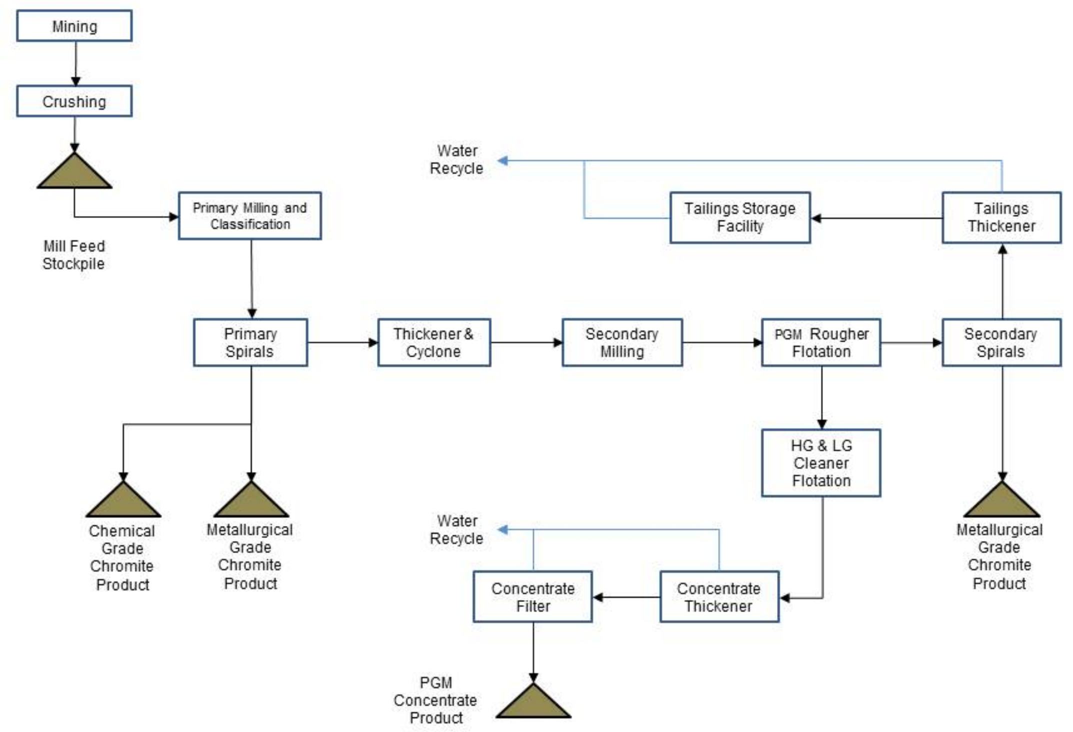
The current Voyager process flow is indicated in Figure 11 and described below.

The Voyager plant receives RoM ore from the open pit mining operation which is then crushed to 80% passing 22mm in a three stage crushing circuit. RoM material from the open pit mining operation is received and stored on a RoM pad. The RoM material is fed either directly by truck or by front end loader into the crushing circuit. The RoM handling allows for blending of material as required to maintain stable feed into the plant.

The crushed ore is stored on an open stockpile from where it is fed to two ball mills operating in parallel. Each 3.35 MW ball mill is in closed circuit with dedicated mill screens sizing at 0.6mm. Material coarser than 0.6mm is returned to the mills whilst the solids finer than 0.6mm pass through the screens and are pumped to the primary spiral concentrator for recovery of the coarse chromite. The bulk of the chromite concentrate recovered is metallurgical grade concentrate, but a chemical grade concentrate is also produced from the primary spiral concentrator circuit. The bulk of the chromite concentrate recovered in the Voyager plant is from the primary spiral circuit.

Figure 11

Voyager Plant Simplified Flow Diagram



The metallurgical grade chromite concentrate from the secondary spirals joins the metallurgical grade concentrate from the primary spirals for dewatering. The combined metallurgical grade concentrate is dewatered by cyclone and stored on drying pads. Two drying pads are used, each equipped with two dewatering cyclones, allowing for four placement options for the metallurgical grade chromite concentrate. The chemical grade concentrate is dewatered by cyclone and stored on a separate drying pad. The drying pad is equipped with two dewatering cyclones, allowing for two placement options for the chemical grade chromite concentrate. The concentrates are loaded from the drying pads by front end loader and dispatched by truck.

The tailings from the primary spiral concentrator plant is pumped to a classifying cyclone cluster where coarse solids discharge via the underflow to a single 5.5 MW ball mill that operates in open circuit. The overflow from the primary cyclone cluster feeds a thickener where the contained water is recovered and returned to the process water tank. The underflow from this thickener is then pumped to the PGM recovery section flotation plant where it is combined with the mill discharge for PGM recovery and subjected to rougher flotation. The concentrate from the initial rougher flotation stage is subjected to various stages of cleaner flotation in a High grade / Low grade cleaner circuit to produce a final PGM concentrate. The PGM concentrate is dewatered by a combination of a thickener and a filter before despatch by truck.

The PGM recovery section tailings stream is pumped to a secondary spiral concentrator section where the chromite, liberated by the secondary mill, is separated from the gangue minerals to produce a second fine metallurgical grade chromite concentrate. The fine metallurgical grade chromite concentrate joins the primary spiral metallurgical grade product for dewatering and dispatch.

The water in the tailings from the secondary spiral concentrator is recovered in a thickener and re-circulated to the processing facility whilst the solid tailings (thickener underflow) are pumped by a tailings pumping system, to the final TSF. The TSF is a shared facility with the Genesis processing facility

Construction of the Voyager plant commenced in July 2011 and was completed in September 2012. Commissioning of this plant commenced during August 2012, first ore was introduced to the plant during September 2012 and commissioning was completed in December 2012.

The Tharisa Minerals combined Genesis and Voyager process plants have been operated as production units since December 2012. From the actual 2015 production results it can be concluded that the Tharisa Minerals operation can achieve 400,000 tpm throughput.

The PGM recovery and grade improved from 2013 to 2015. The total recovery for 2015 was 65.8% at a concentrate grade of 131 6E g/t. The recovery and grade is better than originally predicted and with the expected increase in the ratio of fresh (non-oxidised) ore in the plant feed, it is expected that the improving trend will continue into future.

The average chromite feed grade declined from 2013 to 2015 from 20.7% Cr_2O_3 to 18.3% Cr_2O_3. The decline was associated with a decline in the chromite concentrate grade and the chromite recovery. The chromite feed grade is expected to increase over the next three year period with corresponding increase in chromite recovery and concentrate grade. In addition current spiral plant upgrades and quality improvements will impact positively on the chromite production from 2016.

The process plant is in good operational and running condition with the operational areas clean and neat indicating good housekeeping. There is a large process improvement drive visible with various pilot scale units installed and operational in the plant. These include WHIMS, column flotation, shaking tables and replacement spirals. It is expected that the WHIMS circuit will be operational from 2016 with expected chromite recovery improvement.

Good capital cost and operating cost management is in place. The increase of operating cost from 2015 to the 2016 budget is of concern but is seen as a medium risk factor.

The overall process and metallurgy section risk is viewed as a medium risk with the main concerns the decreasing trend in chromite feed grade associated with lower recovery, the variability in chromite feed grade and an increase in operating cost.

Tailings Storage Facilities and Waste Rock Dumps

The Tailings Storage Facilities (TSFs) design process was dominated by the need to create sufficient tailings storage capacity to serve the design life of the mine in the limited space available within the mining right area. The location of the orebody, and hence the open pit mining operations, within the mining right area necessitated that the TSFs would be constructed in close proximity to the open pit.

The proximity of the TSFs to the mining operations meant that one of the design priorities would be to minimise risks in terms of loss of life and future earnings and this in turn meant that the design of a robust impoundment would have to be adopted. A decision was thus made to use waste rock, from the open cast mining operations, to construct a tailings impoundment.

The construction of TSF 1 has been completed successfully with the construction of the next TSF (TSF 2 Phase 1) in progress. Table 5 summarises the operational life and capital costs associated with the construction of Tharisa Mine TSFs. These costs exclude rehabilitation and other life cycle costs.

Table 5

Tailings Storage Facilities: Operational Life and Estimated Capital Costs

Description	Operational Life	Cost
TSF 1 Phase 1	2011 - 2013	R12.2 mil
TSF 1 Expansion	2012 - 2016	R43.1 mil
TSF 2 Phase 1	2016 - 2019	R50.6 mil
TSF 2 Phase 2	2019 - 2024	R49.1 mil
Future TSF	2024 - 2044	R240.0 mil
Total (excluding rehabilitation and closure costs)		**R395.0 mil**

It is estimated that the tailings storage requirements for the next 20 years following 2024, i.e. after TSF 2 Phase 2 has reached full capacity, will have a capital cost implication of approximately R240 million. This estimate includes the cost of a liner system, a requirement included due to new environmental legislation, and excludes rehabilitation and closure costs.

The Waste Rock Dumps (WRDs) will serve as storage facilities to accommodate all the excess waste rock generated by the open cast mining operations not being absorbed by the construction of the TSFs as well as other construction activities. It is the mine's intention to backfill the open pits with the waste rock generated on an advancing basis once the pits have been sufficiently developed.

The WRDs were designed in such a manner to enable their on-going rehabilitation and the control of surface water runoff, as it is probable that they will become permanent features of the post mining landscape.

Tharisa Mine currently makes use of two operational WRDs for waste rock disposal namely the East Mine WRD 1 and the West Mine WRD 1 with the TSF 2 Division wall to be commissioned in December 2015. The total approximate waste rock capacity in the facilities is 81.13Mm³, which excludes the volume of the

TSF 2 Division Wall, accounted for in the TSF section of this report. Table 6 summarises the capital costs, the waste rock capacity and operational life of all WRDs.

Table 6
Waste Rock Dumps: Capacity, Operational Life and Estimated Capital Costs

Waste Rock Dump	Waste Rock Capacity (m^3)	Operation Life	Capital Cost
East Mine WRD 1	21,700,000	September 2013 - May 2016	R3.31 mil
East Mine WRD 2	19,980,000	June 2016 - February 2019	R5.47 mil
TSF 2 Division Wall	15,340,000	December 2015 – September 2017	R0.41 mil
West Mine WRD 1	21,800,000	August 2013 - July 2020	R3.27 mil
West Mine WRD 2	15,430,000	August 2020 - October 2025	R3.75 mil
Total (excluding rehabilitation and closure costs)			**R16.22 mil**

Infrastructure

Logistics

Logistics management and procurement was identified as an important aspect of the Tharisa Mine. Arxo Logistics (Pty) Ltd (Arxo), a Tharisa plc group company, was mandated to manage the logistics chain for the chrome concentrate from the mine to final offtake - which is mainly in China. This includes the activities of sourcing third party services, capacity planning, technology solution, distribution planning, warehouse management and shipping.

Arxo makes use of both rail and road distribution channels to move the mine's product to the Richards Bay and Durban ports for shipment abroad. A dedicated rail siding has been allocated to Tharisa Minerals which is located 6km from the mine site. Arxo has secured adequate trucking and warehousing facilities to cater for the full requirement of 160,000 tpm of chromite concentrate at steady state production.

Roads

The mining right area is traversed east/west by local un-surfaced roads originally constructed to service the local farming community. In a north/south direction the mine is split by a local tarred road connecting Buffelspoort with Marikana. This in turn is linked to the N4 Bakwena Highway locally linking Rustenburg to Brits, and internationally linking Mozambique to Botswana and Namibia.

Rail

A rail siding was secured 6km from the mine at Marikana to facilitate the railing of the chrome product to the port at Richards Bay.

Electricity

Electrical power supply for the mine's requirements at full production has been secured from Eskom's Selene-Middlekraaal and Bighorn-Middlekraal sub stations as a dedicated ring supply.

Water

Tharisa Mine has established a groundwater well field on the property which in addition to pit dewatering, supplies sufficient water as 'make up water' for the processing facilities. These two sources will be sufficient to supply the mine's water requirements at the planned steady state and for the anticipated LoM. This is supplemented by Rand Water as well as excess water from nearby mining companies.

Environmental Baseline

In 2008, baseline environmental studies were undertaken to determine the state of the pre-mine environment and to assess potential environmental impacts relating to the mining activities at the mine. These were updated, where relevant, in 2014 to cater for changes to the mine's operations and infrastructure.

Geology: Other than the potential for mineral sterilisation (which can be avoided) no impacts relating to the geology underlying the mine were identified.

Climate: No impacts relating to climate were identified, but climate data was used to assess air quality and surface water related impacts.

Topography: Potential impacts that were identified were safety issues relating to hazardous excavations and visual impacts.

Soil and Land Capability: Potential impacts that were identified related to soil contamination, compaction and erosion.

Land Use: Potential Impacts on and around the mine such as impacts from blasting and traffic/public road disturbance were identified.

Biodiversity: Potential impacts relating to destruction of sensitive habitats were identified.

Surface Water: Potential impacts relating to pollution of surface water and destruction of non-perennial water courses were identified.

Groundwater: Potential groundwater impacts relating to contamination and depletion of third parties groundwater and effects on baseflow were identified.

Air Quality: Potential air quality impacts relating to the generation of both small inhalable dust particulates and larger fallout dust were identified.

Noise: A potential impact relating to high noise levels to third parties was identified.

Sites of Archaeological and Cultural Interest: Potential impacts relating to the discovery of resources such as stone walled settlements, graveyards, a historical village and homestead, mining heritage remains, isolated and randomly scattered stone tools, historical houses and outdated and discarded agricultural implements, were identified.

Socio-economic: Potential impacts relating to positive economic benefits such as capital investment, employment, support services, and foreign exchange income were identified. In addition, a number of potential negative impacts were also identified. These included issues associated with involuntary relocation, informal settlements and associated problems of crime, disease and security concerns, pressure on housing infrastructure and services, and issues around land sales and impacts on land values.

Environmental Approvals, Reporting and Management

Environmental Assessment Process

As the mine incorporates several listed environmental activities, the 2008 environmental assessment process was undertaken in terms of the National Environmental Management Act, 107 of 1998 (NEMA) and the regulations under Regulation 385 of 21/04/2006. In addition, the mine environmental assessment process was also undertaken in accordance with the requirements of the MPRDA and the regulations there under (Regulation 527 of 23/04/2004). To cater for changes in the mine's operations and infrastructure, an environmental assessment process was completed in 2014. The process was undertaken in terms of Section 102 of the MPRDA and the NEMA and the regulations under Regulation 543 of 18/06/2010.

The Tharisa Mine has an approved Environmental Management Plan (EMP) by the DMR and the Provincial Department of Rural, Environment and Agricultural Development (DREAD). The EMP makes provision for the rehabilitation of the mining footprint and associated infrastructure.

Water License

In order to conduct all water use and waste disposal activities lawfully an integrated license is required from the Department of Water Affairs (DWA) in terms of the National Water Act, 36 of 1998. The water use license was granted in July 2012. An amendment to the Tharisa water use license in terms of the National Water Act (NWA), 36 of 1998, is required as changes to the mine's operations and infrastructure incorporate water uses changes.

Additional Licences and Authorisations required by the Tharisa Mine

Tharisa Minerals management is cognizant of the various permits and authorisations required as per the 2008 and 2014 EIA/EMP reports namely:

- Amendment of the mine's water use license to cater for water uses associated with changes addressed in the 2014 EIA/EMP report and if required, updating of the existing dam safety risk registrations;

- An air emission license (AEL) for the drying of mineral solids at the chrome sand drying plant;
- Permit for the removing or damaging of any protected plant species as needed;
- Any changes to the approved deviation as a result of the east pit extension will need to be discussed and agreed to with the North West Department of Transport Roads and Community Safety; and
- Permit for damaging or removing heritage resources such as graves and historical houses/complexes within the central waste rock dump footprint;

Ongoing Environmental Management, Monitoring and Reporting

An assessment of compliance was carried out in July 2013 (for the EMP and WUL) and in December 2014 (for the WUL) at which time some deviations from the EMP and water licence requirements were found. The required management interventions and/or authorisation processes are underway or imminent. More recent compliance assessments (for the EMP and WUL) were conducted in December 2015 with a final report due in February 2016. The findings will be presented to management and recommendations considered, budgeted and actioned where necessary.

Environmental Rehabilitation: Financial Closure Liability

Current legislation requires that mining operations make financial provision for environmental rehabilitation and closure prior to commencement of any operations under the MPRDA. The calculations of the current financial closure liability associated with the Tharisa Mine were completed in accordance with the Guideline Document for the Evaluation of the Quantum of Closure-Related Financial Provision Provided by a Mine as published by the DMR, previously the Department of Minerals and Energy (DME), dated January 2005. The EMP requirement is for the financial closure liability to be updated and submitted to the DMR annually. The most recent calculation values the closure liability at R143.8million (as at 31 December 2015).

This calculation allows for making any remaining open pit voids safe but excludes the cost of backfilling the open pit voids, which is in accordance with the amended closure objective to only partially backfill the open pits based on a revised mine plan. This amended closure objective to only partially backfill the open pit voids has been approved by the DMR.

The September 2015 closure liability calculation is only planned to be submitted to the DMR for feedback and approval in December 2015. Tharisa Minerals currently provide a financial guarantee to the value of R117.4 million through a Guardrisk Insurance Company Limited policy.

On 20 November 2015, new financial provision regulations in terms of the National Environmental Management Act, for prospecting, exploration, mining and production operations came into effect. These regulations require mining companies to develop detailed closure plans that support a financial provision calculation to varying degrees of accuracy (depending on the predicted life of mine) and based on actual rates. Existing operations have a period of 15 months from the 20 November 2015 to comply.

Valuation/Mine Economics

A Technical Economic Model (TEM) for the Tharisa Mine has been constructed by Coffey in order to confirm the feasibility of the mine and to substantiate the declaration of mineral reserves.

Tharisa is contemplating capital expenditures to improve the effieciencies on the mine. Coffey thus did TEM's for two scenarios:

- TEM Excluding Optimisation Projects
- TEM Inclucing Optimisation Projects

Most of the planned underground production would mine inferred mineral resources. The TEM was initially constructed for mining opencast and then start moving underground in year 2030 for a 53 years LoM. Rather than to look at a TEM model that excludes the inferred mineral resources from the production profile, consideration was given to rather exclude the underground mining component. This assessment considers that the ZAR2bn necessary to establish the underground mine will not be recouped by the 18,649Mt Probable Reserves available for underground mine production.

Table 7 presents aspects of the TEM in which the underground mine has been excluded as a close proxy for exclusion of the inferred mineral resources form the production profile.

Table 7
Tharisa Mine Technical Economic Model
Effect of Underground Production/Inferred Resources on DCF Valuation

Parameter	Unit	Excluding Optimisation		Including Optimisation	
		Including Underground	Excluding Underground	Including Underground	Excluding Underground
Life of Mine	Years	53	21	53	21
ROM over LOM	Mt	235.44	90.60	235.44	90.60
LOM C_2O_3	Mt	65.33	24.6	82,221	29.44
LOM PGM's	Moz	7.35	2.60	7.93	2.892
Capital	ZAR Million	5,089	1,871	5,964	2,437
Discount Rate	%	8.5%	8.5%	8.5%	8.5%
High NPV	ZAR Million	15,947	13,178	21,355	12,655
Low NPV	ZAR Million	6,049	6,018	7,001	5,546
Preferred NPV	**ZAR Million**	**11.474**	**10,655**	**14,703**	**9,923**

The underground mine has been excluded as a close proxy for exclusion of the inferred mineral resources form the production profile.

Coffey prefers the results of the Discounted Cash Flow (DCF) model that excludes the underground production as a close proxy for exclusion of inferred mineral resources.

The model confirmed that the mine is feasible with a positive Net Present Value (NPV). The model further confirmed that the mine is most sensitive to changes in revenue and least sensitive to changes in capital.

This is because relatively little capital is spent on mining equipment as this is a contract open pit mining operation.

As a second valuation methodology, the Market Approach was applied. Recent transactions involving PGM producers as well as opencast chrome projects were used to attribute PGM and chrome market values to Tharisa mine.

Coffey prefers the Cash Flow Approach to valuating the Tharisa mine as it is a producing mine with known production and cost parameters.

The Market Approach valuation is based on a combination of transactions for properties that are somewhat dissimilar to the Tharisa Mine. Coffey considers it is not a true reflection of the market price of Tharisa Mine. Coffey thus values the Tharisa Mine on 31 December 2015 as shown in Table 8.

Table 8
Tharisa Mine
Valuations of the Tharisa Mine on 31 December 2015 (ZAR Million)

Valuation Methodology	DCF Excluding Optimisation		DCF Including Optimisation		Comparative Transaction
	Including Underground	Excluding Underground	Including Underground	Excluding Underground	
High NPV	15,947	13,178	21,355	12,655	17,229
Low NPV	6,049	6,018	7,001	5,546	14,404
Preferred NPV	**11.474**	**10,655**	**14,703**	**9,923**	**15,817**

The value of the Tharisa Mine as at 31 December 2015 is considered to lie in the range of ZAR 6.302 billion to ZAR 15.792 billion with a preferred value of **ZAR 12.923 billion**.

Risk Summary

A summary of the perceived risks associated with the mine is presented in Table 9.

Table 9
Tharisa Minerals Technical Risk Summary

Item	Relative Risk
Geology and Mineral Resources	Low
Mining Engineering and Mineral Reserves	Low to Medium
Geotechnical Engineering	Low
Metallurgy and Processing	Medium
Infrastructural	Low to Medium
Environmental	Medium
Manpower and Management	Low to Medium

Based on the above risk summary, Coffey considers the Tharisa Mine to have an overall **Low to Medium Risk.**

1 INTRODUCTION AND TERMS OF REFERENCE

1.1 Scope of the Report

Coffey Mining (South Africa) (Proprietary) Limited (Coffey) was requested by Tharisa plc, formerly Tharisa Limited (Tharisa or the Company), to complete a Mineral Expert Report (MER) on the Tharisa Mine located in the North West Province, South Africa. The MER is required to support a listing on the London Stock Exchange (LSE) and has been compiled in accordance with the requirements of the LSE.

1.2 Site Visits

Messrs Lomberg, Lotheringen, van Wyngaard, Stobart, Bornman and Dr James have visited the property on a regular basis over a period of approximately seven years since 2007.

1.3 Mineral Expert Report

This report complies with the Listing Requirements of the LSE; specifically the particular requirements applicable to Mineral Companies (Section 12) and is prepared in accordance with the guidelines of "The South African Code for Reporting of Exploration Results, Mineral Resources and Reserves (prepared by the South African Mineral Resource Committee (SAMREC) Working Group) (2007 and as amended in 2009)" (SAMREC Code) and "The South African Code for the Reporting of Mineral Asset Valuation (2008)(as amended in July 2009)" Prepared by The South African Mineral Asset Valuation Committee (SAMVAL) Working Group (SAMVAL Code).

1.4 Qualifications and Experience

Coffey is part of Coffey International Limited, a specialist professional services consultancy with expertise in geosciences, international development (foreign aid programme assistance), and project management. Coffey is an integrated Australian-based consulting firm, which has been providing services and advice to the international mineral industry and financial institutions since 1987. Coffey, previously RSG Global, has maintained a fully operational office at in Johannesburg, South Africa, since 1999 to support expanding activities within southern and eastern portions of the continent.

Coffey has over 50 years of experience supplying specialist services to the mining industry and has completed projects in more than 70 countries, across most commodity types. Coffey provides 'turn-key' consulting, operational support and optimisation services, independent reports and a range of technical audits and studies. Coffey is professionally accredited in all mining jurisdictions globally and supported by a network of mining offices throughout the Americas, Africa and Australia.

The participants consist of a number of technical experts brought together by Coffey to complete the MER and are all "Competent Persons" as defined in the SAMREC code. The compilation of the MER in accordance with the reporting requirements of the LSE was supervised by

Mr Lomberg. The participants in the MER and their individual areas of responsibility are listed as follows:-

Ken Lomberg, Senior Principal Consultant, Coffey

B.Sc. (Hons) Geology, B.Com., M.Eng., FGSSA, Pr.Sci.Nat.

Project management, mineral resources, geological interpretations, site visits, report preparation.

Mr Lomberg has some 25 years experience in the minerals industry (especially platinum and gold). He has been involved in exploration and mine geology and has had the privilege of assisting in bringing a mine to full production. His expertise is especially in project management, mineral reserve and resource estimation.

Mr Lomberg has undertaken mineral resource and reserve estimations and reviews for platinum, chromite, gold, copper, uranium and fluorite projects. He has assisted with the reviews or estimation of diamond and coal projects. He has assisted with or compiled Mineral Expert Reports/NI 43-101 for various companies that have been listed on the TSX, JSE and AIM.

Alan Goldschmidt, Senior Principal Consultant, Coffey

B.Sc. (Honours), GDE, Pr.Sci.Nat.

Mineral resources, geological interpretations, report preparation.

Mr Goldschmidt has some 29 years' experience in the minerals industry. He has been involved in exploration and mine geology. His expertise is project management, reserve, and resource estimation. Primarily he has been involved with geological block models and geostatistical resource estimation. He is registered with the South African Council for Natural Scientific Professions.

Jaco Lotheringen, Associate Consultant – Ukwazi Mining Solutions

B.Eng., MSAIMM, Pr.Eng.

Mining engineering, mineral reserve estimation, infrastructure, site visits, report preparation.

Mr. Lotheringen is a member in good standing of the Southern African Institute of Mining and Metallurgy (SAIMM) and is a registered Professional Mining Engineer with the Engineering Council of South Africa (ECSA). He has more than 14 years' experience in the Mining and Minerals industries with the last nine years focussed primarily on the estimation and audit of mineral reserve estimates. Mr. Lotheringen has more than five years relevant experience in the planning and reserve estimation of similar platinum and chrome open cast operations.

Mr Lotheringen has undertaken mineral reserve estimations and reviews for platinum, gold, copper, chrome, manganese and iron ore projects. He has assisted on Mineral Expert Reports/NI 43-101 for various projects that have been listed on the TSX, JSE and AIM.

Jacques van Wyngaard, Associate Consultant – MDM Engineering

B.Eng. (Hons) Metallurgical Engineering, FSAIMM, Professional Engineer (ECSA 20090177)
Process engineering, infrastructure, site visits, report preparation.

Mr Van Wyngaard has over 18 years' experience in the metallurgical industry of which the last 8 years have been specifically in the metallurgical project development field. He has been involved in the execution of numerous feasibility studies and implementation projects covering a wide range of minerals including platinum and chromite. These studies and projects have included establishment and management of metallurgical test campaigns, process development, detailed plant design, construction and commissioning of the constructed metallurgical plants. Mr Van Wyngaard has undertaken studies and projects for the extraction of base metals, precious metals, energy minerals and industrial minerals and has been involved in the operation and management of base metals, coal processing and metallurgical research facilities.

Alex Pheiffer, Associate Consultant – SLR Consulting (previously Metago)

B.Sc. (Honours), M.Sc., Pr.Sci.Nat.
Environmental and social, report review.

Mrs Pheiffer has some 11 years experience in the minerals industry in the field of mine permitting and environmental and social assessment. Mrs Pheiffer has undertaken permitting, environmental and social reviews for platinum, chrome, uranium, coal, and gold projects. She has assisted with or compiled feasibility contributions for various listed projects. She is registered with the South African Council for Natural Scientific Professions.

Guy Wiid, Associate Consultant – Epoch Resources

B.Sc.(Eng) (Civil), M.Sc. (Eng) (Civil), Pr.Eng.
Tailings facility design, site visits, report preparation.

Mr Wiid has been involved in the mining waste and environmental management field for 19 years during which time he has worked in the fields of power station and mining waste management, rehabilitation and closure design, implementation of environmental management systems, surface water management, due diligence investigations and project management of construction and rehabilitation contracts.

Dr John James, Associate Consultant – Celtis Geotechnical

B.Sc. (Hons) (Geology), PhD, FSAIMM, FSANIR, MGSSA
Geotechnical Engineering, site visits, report preparation.

Dr James is the principal consultant for Celtis Geotechnical CC, consulting to various mining companies on projects in South Africa, Zambia, Botswana and Australia. While with Rodio SA, he managed exploration drilling, grouting, surface and underground geotechnical contracts in Turkey and South Africa.

He has experience in open pit mining, involved with supervising slope stability consultants at the then JCI's Platinum Mines and while with Rand Mines on outcrop mining. He has a total of 20 years experience in practical rock mechanics and design on gold mines, with Anglo-American, Rand Mines and JCI; this includes considerable experience in wide orebody mining, geology and all aspects of support design and backfill behaviour and placement; the Technology, Rock Mechanics and Design of hard rock, coal and base metal mines as well as tunnelling, and has also directed projects and research into mine design, technology transfer and auditing and assessment systems.

He was jointly awarded the M D G Salamon prize for the most important contribution to Rock Mechanics in 1997. He has published numerous publications on rock support and other relevant rock engineering topics.

Hannes Bornman, Manager Mining, Coffey
B.Eng. (Mining), MBA, Pr.Eng., FSAIMM
Economic valuation, site visit, report preparation.

Mr Bornman has 10 years production experience of hard rock mining in South African gold and platinum mines. He has broad experience in feasibility and due diligence studies both in South African and International contexts. He has travelled extensively within Central Asia and Russia. He has undertaken project risk assessment studies on mining projects in South Africa as well as in Mozambique and Mali.

1.5 Independence

Neither Coffey, nor the key personnel nominated for the completed and reviewed work, has any interest (present or contingent) in Tharisa plc and its subsidiaries, its directors, senior management, advisers or the mineral properties reported on in this report. The proposed work, and any other work done by Coffey for Tharisa plc, is strictly in return for professional fees. Payment for the work is not in any way dependent on the outcome of the work, nor on the success or otherwise of Tharisa plc's own business dealings. As such there is no conflict of interest in Coffey undertaking the MER as contained in this document.

1.6 Legal Proceedings

Coffey is not aware of any legal proceedings against the Company that could adversely affect its ability or right to exploit the Tharisa Mine's mineral resource and reserve.

2 DISCLAIMER

This report was prepared as a Mineral Expert Report, in accordance with both the SAMREC and SAMVAL Codes for Tharisa plc, by Coffey. The quality of information, conclusions and estimates contained herein is consistent with the level of effort involved in Coffey's services and based on:

i) information available at the time of preparation by Tharisa plc and its subsidiaries,

ii) third party technical reports prepared by Government agencies and previous tenement holders, along with other relevant published and unpublished third party information, and

iii) the assumptions, conditions and qualifications set forth in this report.

This report is intended to be used by Tharisa plc, subject to the terms and conditions of its contract with Coffey.

The sole purpose of this report is for the use of the Directors of Tharisa plc and its Sponsor and advisors in connection with Tharisa plc's listing prospectus and the report should not be used or relied upon for any other purpose.

Neither the whole nor any part of this report nor any reference thereto may be included in or with or attached to any document or used for any other purpose, without Coffey's written consent to the form and context in which it appears.

A final draft of this report was provided to Tharisa plc, along with a written request to identify any material errors or omissions, prior to lodgement.

Neither Coffey, nor the authors of this report, are qualified to provide extensive comment on legal facets associated with ownership and other rights pertaining to Tharisa Minerals', mineral properties. Coffey did not see or carry out any legal due diligence confirming the legal title of Tharisa Minerals, to the mineral properties.

3 PROPERTY DESCRIPTION AND LOCATION

3.1 Mine Description and Location

Tharisa Minerals, a 74% held subsidiary of Tharisa plc, operates the Tharisa Mine. Tharisa Minerals holds a mining right, granted by the Department of Mineral Resources (DMR) on 19 September 2008 and registered on 13 August 2009, to various portions of the property of Farm 342JQ (in respect of PGMs (Platinum Group Metals), nickel, copper, silver and chrome) and to the whole property of Rooikoppies 297JQ (in respect of the PGMs, nickel, copper, silver and chrome contained within the MG Chromitite Layers only). The Tharisa Mine is located in the North West Province some 35km east of the city of Rustenburg (Figure 3.1_1) in the Marikana section of the south-western limb of the Bushveld Complex (Figure 3.1_2). The Marikana section is separated from the Brits section to the east by Wolhulterskop and from the Rustenburg section to the west by the Spruitfontein upfold.

The Tharisa Mine is located approximately 5km north of the Magaliesberg Mountains. These mountains are formed by quartzites (Transvaal Sequence), which are common as floor or basement rocks to the Bushveld Complex.

The nearest major road is the N4 National Road which links Pretoria with Rustenburg and crosses the south-eastern corner of the Farm 342JQ property immediately south of the outcrop of the Middle Group (MG) Chromitite Layers. A secondary road bisects the property in a north-south direction providing access to the town of Marikana. The east west Rustenburg-Brits railway line bisects the Rooikoppies property with a station located in the town of Marikana on the Rooikoppies property.

Figure 3.1_1
Map Showing the Geographic Location of the Tharisa Mine

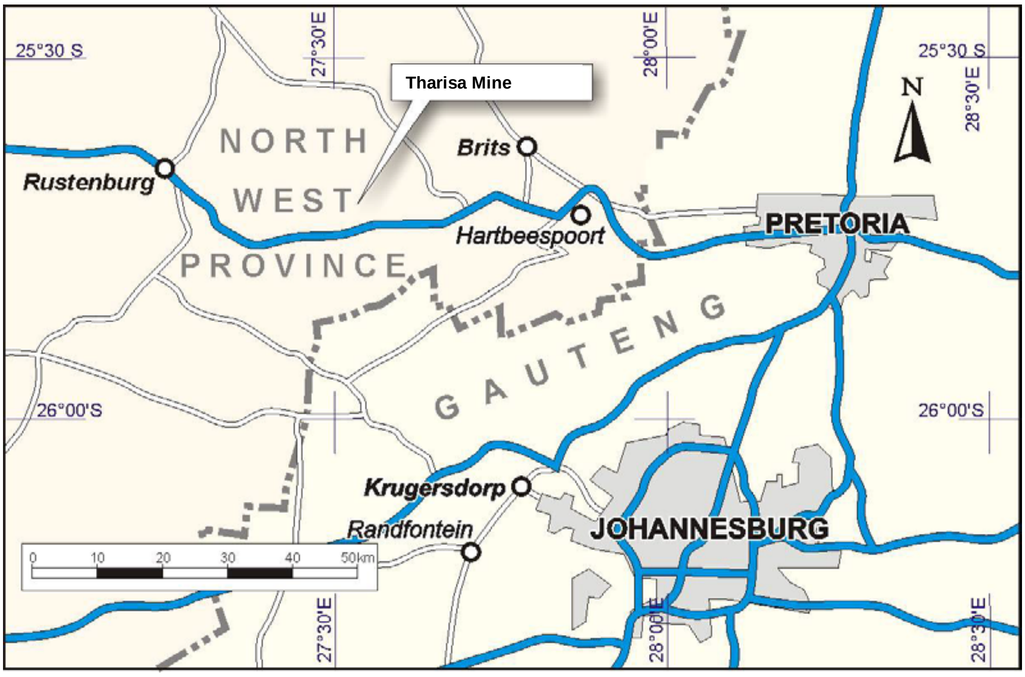
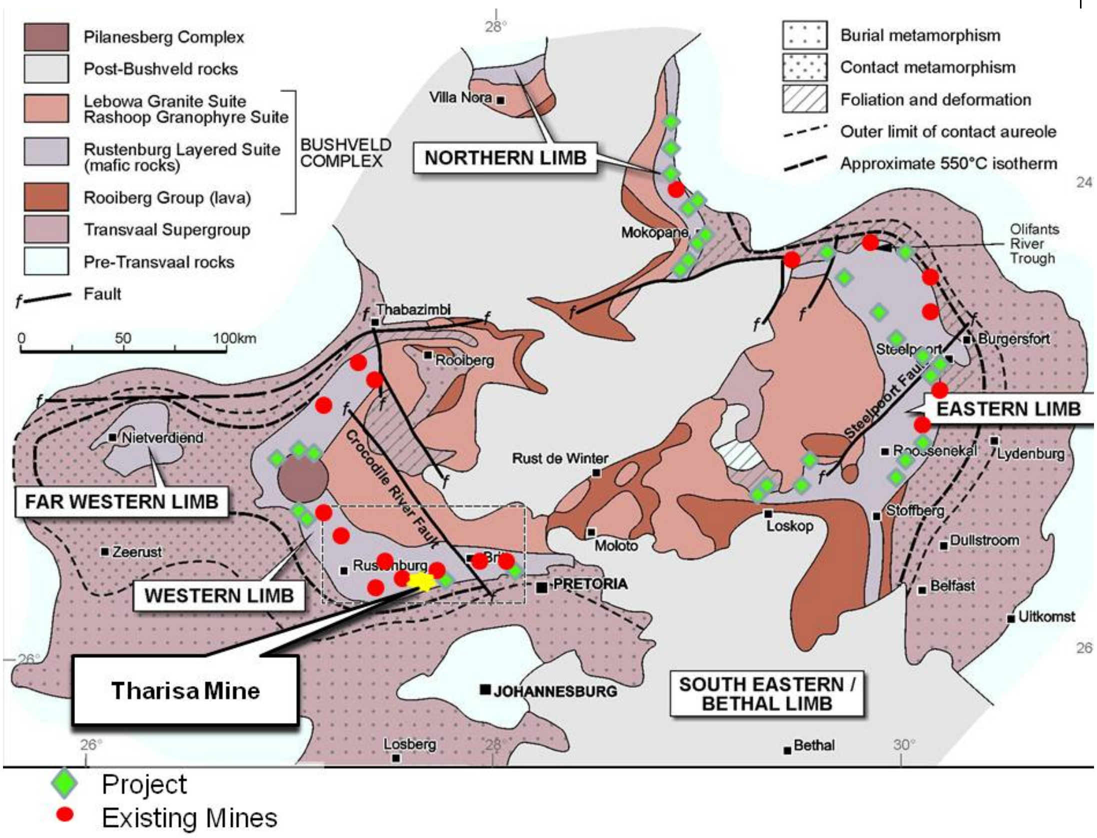


Figure 3.1_2
Generalised Geological Map of Bushveld Complex Showing the Location of the Tharisa Mine



3.2 Mining Industry of South Africa

Background

The mining industry in South Africa was traditionally controlled by six large mining conglomerates: Anglo American - De Beers, Gencor - Billiton, Gold Fields, JCI, Anglovaal and Rand Mines, which dominated gold, platinum, chrome, coal and base metal production. Sweeping changes in the industry have taken place as a result of a rising cost structure due to ageing mines and the impact of a new democratic constitution. This has led, in part, to the establishment of a growing mid-tier and junior developer and producer sector.

Historical Perspective - Legislative Development

Since about 1860, mining regulation in South Africa has evolved to keep pace with changing technological, economic, and socio-political needs to grow and sustain the country’s world-class mining industry.

Enactment of the Minerals Act, 50 of 1991 (Minerals Act) marked the consolidation of a substantial legislative modernisation that began in the 1960s. After the first democratic elections in 1994, all government policies and legislation were subject to fundamental review. A White Paper (government discussion document) on minerals and mining policy was published in October 1998. Mine health and safety was given first priority with the enactment of the Mine Health and Safety Act, (Act No 29 of 1996). The South African Parliament passed the Mineral and Petroleum Resources Development Act, Act 28 of 2002 (MPRDA) in August 2002, which was subsequently promulgated by the State President (Government Gazette, 1 May 2004).

Mineral and Petroleum Resources Development Act, 2002

The concept of state custodianship of mineral rights (now embodied in the MPRDA) has replaced the common law principles previously embodied in the Minerals Act. Enactment of the MPRDA places South Africa in line with global mineral ownership principles.

The mechanics for converting mineral rights previously held under the Minerals Act to mineral rights recognised under the MPRDA, were set out.

The Mineral and Petroleum Royalty Act, 2008

The Government has imposed the payment of royalties through the Mineral and Petroleum Royalty Act 28 of 2008 (Royalty Act) which gives effect to the MPRDA and which came into effect during the first half of 2010, but uncertainties surrounding it’s interpretation and implementation still exist. The Royalty Act requires that compensation be given to the State (as custodian) of the country’s Mineral and Petroleum Resources for the country’s “permanent loss of non-renewable resource”. The Royalty Act distinguishes between refined and unrefined mineral resources, where refined minerals have been refined beyond a condition specified by the Royalty Act, and unrefined minerals have undergone limited beneficiation as specified by the Royalty Act.

The royalty rate structure is based on a formula that takes into account the profitability of Tharisa Minerals as follows:-

Unrefined: $$\boldsymbol{RoyaltyRate}\ (\%) = \mathbf{0.5} + \frac{\boldsymbol{EBIT}}{\boldsymbol{Gross\ Sales}\ (\boldsymbol{unrefined}) * \mathbf{9}} * \mathbf{100}$$

Refined: $$\boldsymbol{RoyaltyRate}\ (\%) = \mathbf{0.5} + \frac{\boldsymbol{EBIT}}{\boldsymbol{Gross\ Sales}\ (\boldsymbol{refined}) * \mathbf{12.5}} * \mathbf{100}$$

The maximum percentage royalty for refined mineral resources is 5%, whereas the maximum percentage royalty for unrefined mineral resources is 7%. The royalty is determined by multiplying the Gross sales value of the operation in respect of that mineral resource in a specified year by the percentage determined in accordance with the royalty formula. Both operating and capital expenditure incurred is deductable for the determination of earnings before interest and tax (EBIT).

In the case of the Tharisa Mine, the chromite concentrate and Platinum Group Metal (PGM) concentrate produced both classify as an 'unrefined mineral resource'.

Electronic copies of the MPRDA and other regulations can be found on the DMR website: **www.dmr.gov.za**.

3.3 South African Taxes

Mining companies in South Africa are taxed at the standard corporate tax rate of 28%. In addition, a witholding tax on dividends is payable at the rate of 15% by the company. No other tax or withholding tax is payable in respect of dividends paid to shareholders.

Corporate tax is paid on all income, plus 50% of capital gains, less deductible operating expenditure and a capital expenditure allowance. Deductible expenditure includes rehabilitation expenditure actually incurred and annual contributions to an approved rehabilitation trust. Prospecting and capital development expenditure is treated as follows:

all prospecting and capital development expenditure is carried forward to the year of commencement of production;

thereafter the accumulated prospecting expenditure and all future prospecting expenditure is allowed as a deduction either in full or in annual instalments as determined by the South African Revenue Service;

in the year of commencement of production and thereafter the accumulated and future annual capital expenditure on shaft-sinking, mine equipment and mine development is deductible in full up to the amount of taxable income from mining before allowing for this capital expenditure allowance. Any excess of capital expenditure over such taxable income is carried forward for deduction from future taxable income from mining;

capital expenditure in respect of employees' housing, hospitals, schools, shops, recreational buildings and facilities and railway lines is deductible in 10 equal annual instalments. Capital expenditure in respect of motor vehicles intended for the private use of employees is deductible in five equal annual instalments. Each annual instalment is included in the above capital expenditure which is subject to the annual limit of taxable income from mining;

no deduction is allowed in respect of the cost of land and mineral rights; and

proceeds on the disposal of any asset previously included in the capital expenditure allowance are first deducted from any excess capital expenditure not already deducted and thereafter are included in full in taxable income. Such proceeds do not give rise to capital gains.

Value Added Tax (VAT) at 14% is payable on most goods and services in South Africa, however as it is claimable against any VAT charged on sales of product, it does not represent a cost to the Tharisa Mine.

3.4 Mining Tenure

A summary of the pertinent aspects of the mineral exploration and mining rights for South Africa are provided in Table 3.2_1.

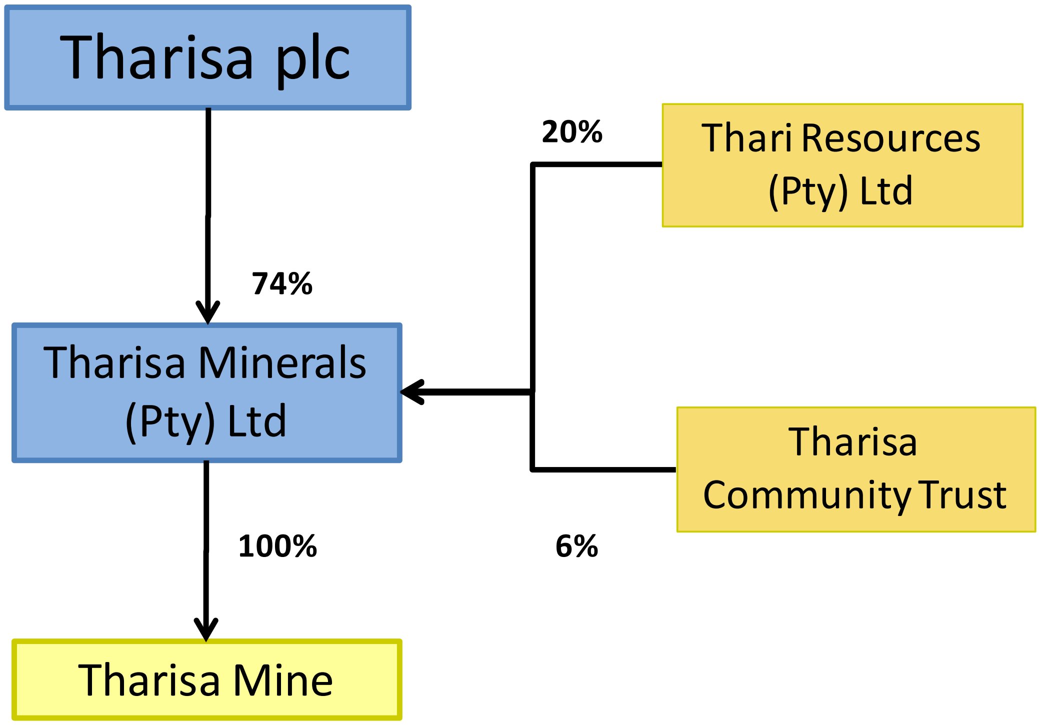
Table 3.2_1
Summary of Pertinent Aspects of the Mineral Exploration and Mining Rights
(South Africa)

South Africa		***Mineral Exploration And Mining Rights***
Mining Act	:	Mineral and Petroleum Resources Development Act, No. 28 of 2002 (Implemented 1 May 2004)
State Ownership of Minerals	:	State custodianship
Negotiated Agreement	:	In part, related to work programmes and expenditure commitments.
Mining Title/Licence Types		
Reconnaissance Permission	:	Yes
Prospecting Right	:	Yes,
Mining Right	:	Yes
Retention Permit	:	Yes
Special Purpose Permit/Right	:	Yes
Small Scale Mining Rights	:	Yes.
Prospecting Right		
Name	:	Prospecting Right
Purpose	:	All exploration activities including bulk sampling.
Maximum Area	:	No limit, Ministerial discretion
Duration	:	Up to 5 years.
Renewals	:	Once for 3 years
Area Reduction	:	No
Procedure	:	Apply to Regional Department of Mineral Resources.
Granted by	:	Minister
Mining Right		
Name	:	Mining Right
Purpose	:	Mining and processing of minerals
Maximum Area	:	No limit, Ministerial discretion
Duration	:	Up to 30 years, Ministerial discretion
Renewals	:	Yes, with justification, Ministerial discretion
Procedure	:	Apply to Regional Department of Mineral Resources
Granted by	:	Minister

3.5 Company Structure

The corporate holdings structure of the Tharisa Mine with the various Historically Disadvantaged South African (HDSA) shareholders is presented in Figure 3.5_1

Figure 3.5_1
Corporate Holdings Structure for Tharisa Mine



Tharisa plc was listed on the Johannesburg Stock Exchange and commenced trading on 10 April 2014.

3.6 License Status

3.6.1 Mining Right

Tharisa Minerals holds a mining right, granted by the DMR (then the DME) in terms of the MPRDA on 19 September 2008, for a period of 30 years, to various portions of the property Farm 342JQ (in respect of PGMs, gold, nickel, copper, silver and chrome) and the whole of the property Rooikoppies 297JQ (in respect of PGMs, gold, nickel, copper, silver and chrome contained within the MG Chromitite Layers only) (Figure 3.6.1_1). On 13 August 2009, the mining right was registered in the Mining and Petroleum Titles Registration Office, under Reference No 49/2009(MR).

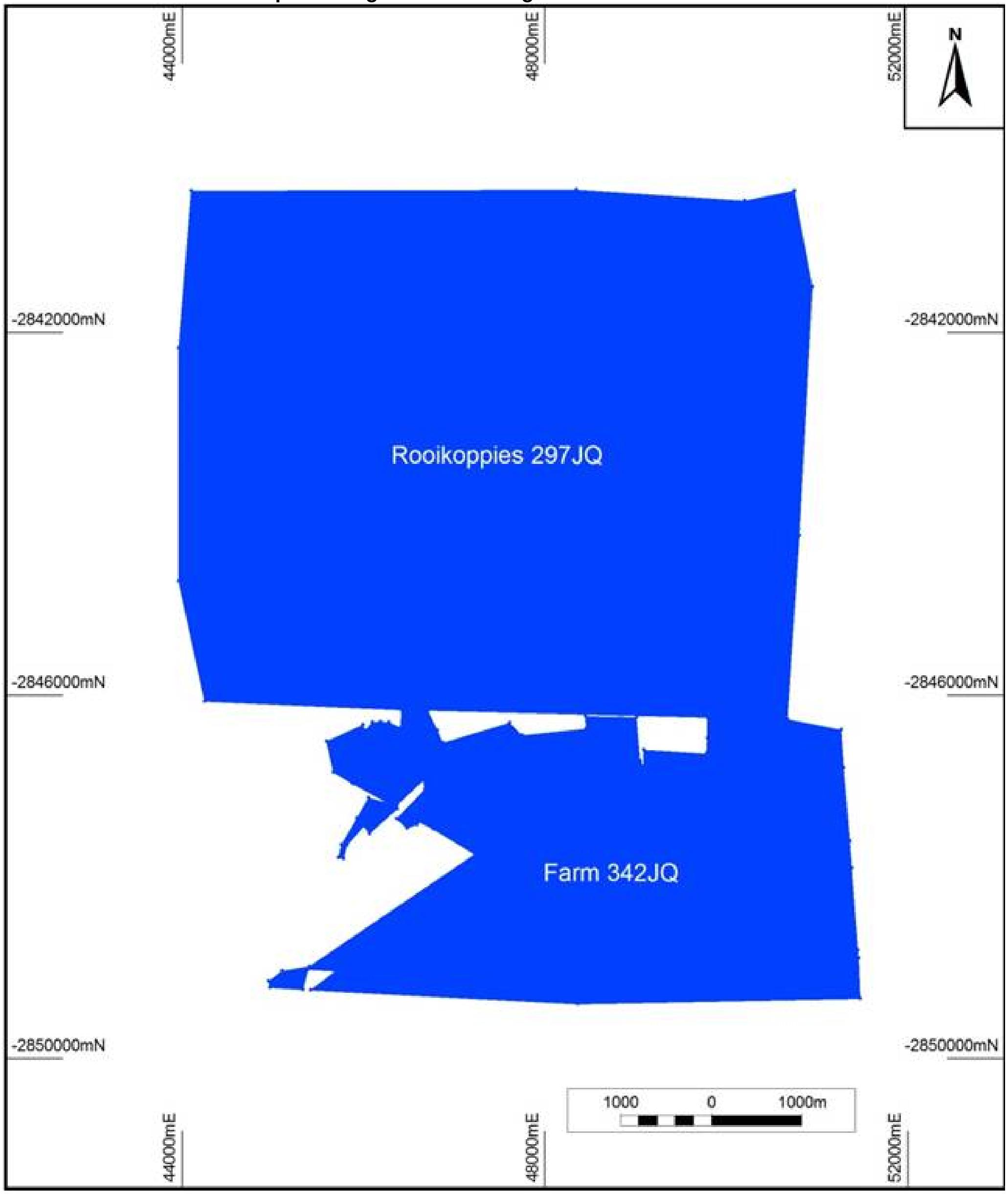
On 7 March 2008 a mining right in respect of chrome was granted over Portions 96 and 183 of the property Farm 342JQ to South African Producers and Beneficiators of Chrome Ore (Pty)

Ltd and registered on 27 July 2009. These rights were purchased by Tharisa Minerals on 18 March 2008.

In July 2011, an application was granted in terms of Section 102 of the MPRDA, to amend the existing mining right by the addition of Portions 96 (46.38ha), 183 (15.18ha) and 286 (13.29ha) of the property Farm 342JQ to the mining right 49/2009(MR).

Figure 3.6.1_1

Map showing the Mineral Rights of the Tharisa Mine

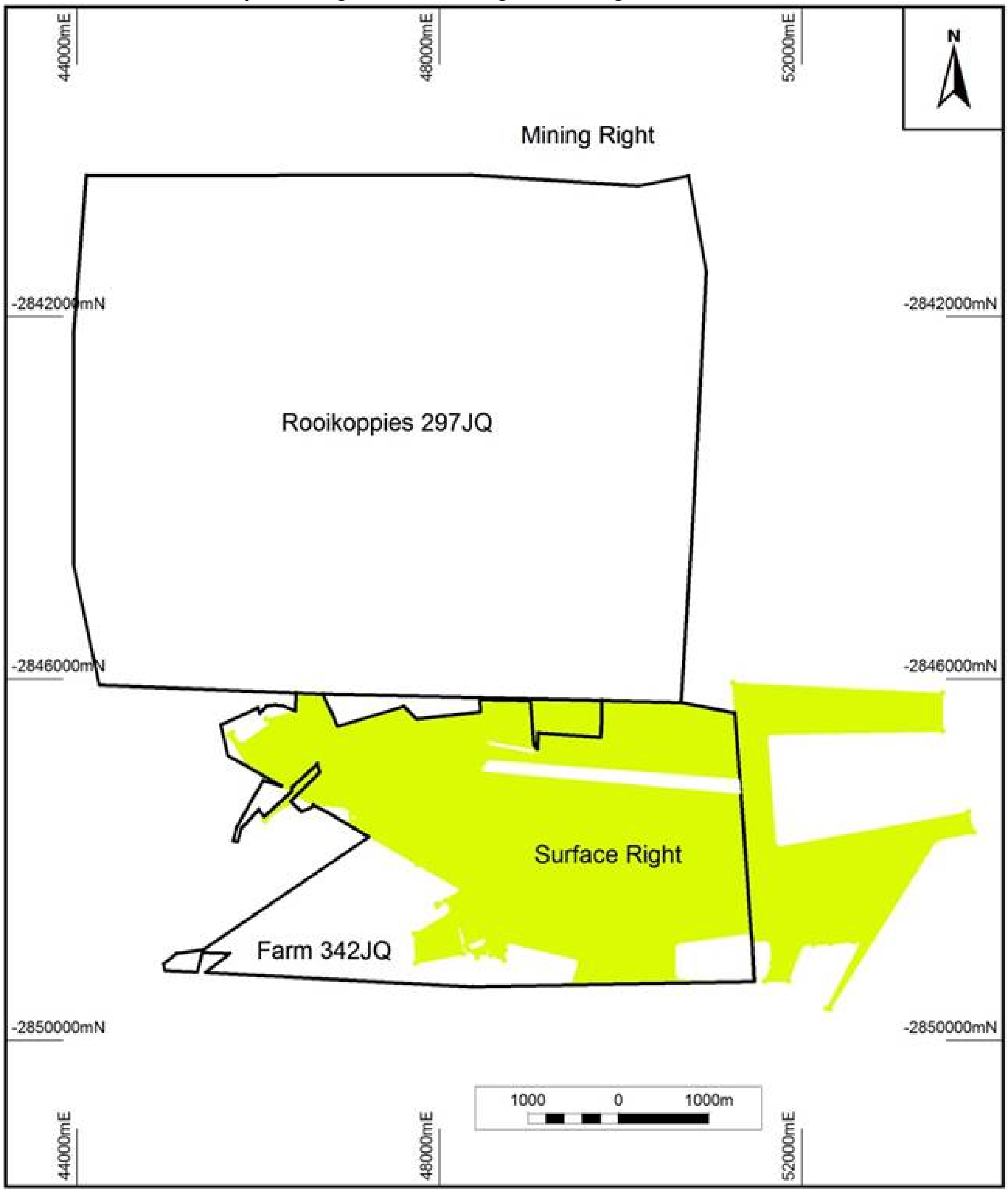


3.7 Surface Rights

The surface rights of several of the portions of Farm 342JQ have been purchased by Tharisa Minerals with the stated intent of obtaining other surface rights (Figure 3.7_1). It should be noted that should Tharisa Minerals not acquire all the surface rights of the area defined in the mining right, it will not be precluded from mining there.

Figure 3.7_1

Map showing the Surface Rights Holdings of Tharisa Mine



4 ACCESSIBILITY, CLIMATE, LOCAL RESOURCES, INFRASTRUCTURE AND PHYSIOGRAPHY

4.1 Mine Access

The nearest major road is the N4 National Road which links Pretoria with Rustenburg and crosses the south-eastern corner of the Farm 342JQ property immediately south of the outcrop of the MG Chromitite Layers. A secondary road bisects the property in a north-south direction providing access to the town of Marikana. The east west Rustenburg-Brits railway line bisects the Rooikoppies property with a station located in the town of Marikana on the Rooikoppies property.

The mine is located approximately 35km from the mining city of Rustenburg and 95km from Johannesburg.

4.2 Climate

A typical summer rainfall climate prevails in the area. Summer rain occurs mainly in the form of thunderstorms with a mean annual precipitation of approximately 680mm, and evaporation is about 1,800mm per year. Winds are generally light and blow predominantly from the north-west. Winters are cool and dry. Extreme weather conditions occur in the form of frost (2 to 20 occurrences per annum) and the occasional hail storm.

The average annual temperature for the year is approximately 19°C, with average maximum temperatures ranging between 22°C and 32°C and average minimum temperatures ranging between 2°C and 18°C. The hottest months are December to February. During April and May there is a noticeable drop in temperature, which signals the commencement of winter. The coldest months are June and July.

The area generally has a high S-Pan evaporation rate in the summer months from November to January. This gives rise to a high relative humidity. Evaporation is greater in summer than in winter, due to higher ambient temperatures.

4.3 Physiography

The topography on the Tharisa Mine property is gently undulating. The elevation ranges from 1,140m in the south-west to approximately 1,320m in the north. Immediately north of the project are a number of gabbro-norite hills. Approximately 5km to the south of the mine is the Magaliesberg Mountain range where the peaks rise to approximately 1400m above mean sea level (amsl). The perennial Sterkstroom and various non-perennial tributaries run through the mine area.

This area is located within the savannah biome, and consists typically of scattered trees and shrubs with continuous grass ground cover. Shrub and tree density increases along rivers and in the gabbro-norite hills. Land use is predominantly agricultural in the south with the Marikana operations of Lonmin plc (Lonmin) being situated on the northern part of the Rooikoppies property and the chrome operations of Samancor situated to the east of the mine.

4.4 Soils

Soils in and around the mine area include those of the orthic phase (Mispah, Glerosa and Hutton), structured forms (Milkwood, Mayo, Shortlands, Sterkspruit, Swartland and Valsrivier), and hydromorphic forms (Sepane, Rensburg and Bonheim). The heavy structured black and dark brown clay soils (Sterkspruit, Mayo and Swartland soil forms) are commonly referred to as “black-turf” or “Cotton Soils”.

4.5 Land Use

Land use around the Tharisa Mine consists of a mixture of farming, mining, residential, small business and general community activities. It is expected that agricultural production took place in the area for both subsistence farming by informal settlers and commercial farming, including crop production (maize, sunflowers, wheat, livestock feed) and livestock grazing. Due to overgrazing and subsistence farming practices by informal dwellers as well as the collection of vegetation mainly for firewood, parts of the general area were transformed. River systems within the area also show evidence of disturbance by agricultural activities.

A 275KV power line associated Eskom servitude, crosses through the eastern boundary of the mine area in a north-south direction. Smaller rural power lines and telephone lines currently service the residential areas within the western and eastern sections of the mine area. Infrastructure (pipes and canals) associated with the Buffelspoort Irrigation Board traverse various sections of the mine area in a south-north direction. There is also a network of tarred and gravel roads which exists in the area.

4.6 Flora and Fauna

The Tharisa Mine is located within the savannah biome, characterised by open Acacia karoo woodlands, which occur in valleys and slightly undulating plains, and some lowland hills. This vegetation unit is of significance because it is listed as endangered mainly due to severe impacts from transformation through cultivation and urbanisation. The following vegetation/habitat zones) exist within the Tharisa Mine area:

- scattered open woodland (338 ha);
- transformed cultivated land and built up areas (1276 ha);
- rocky outcrops (23 ha);
- wetland: river system and associated riparian vegetation (26 ha); and
- azonal vegetation units.

Mammal species identified on site, through actual observation or capture, and through evidence of presence include Lepus saxatilis (scrub hare), Sylricapra grimmia (common duiker), Raphicerus campestris (steenbok), Helogale parvula (dwarf mongoose) and Hystrix africaeaustralis (porcupine). Bird species identified on site, through actual observation or capture, and through evidence of presence include Ardea melanocephala (Black - headed Heron), Plectropterus gambensis (Spur- winged Goose), Streptopelia senegalensis (Laughing Dove), Streptopelia capicola (Cape Turtle Dove) and Ploceus velatus (Southern Masked Weaver). Reptile and amphibian species identified on site, through actual observation or capture, and through evidence of presence include Kassina senegalensis (Bubbling Kassina), Phrynomantis bifasciatus (Banded Rubber Frog), Afrana angolensis (Common River Frog), Schismaderma carens (Red Toad), Bitis arietans (Puff Adder), Pachydactylis affinis (Transvaal Gecko) and Trachylepis striata (Eastern Striped Skink).

Invertebrate species that were identified on site, through actual observation or capture, and through evidence of presence include Astylus atromaculatus (Spotted Maise Beetle), Musca domestica (Robber Flies), Anoplolepis custodiens (Pugnacious Ant), Junonia hierta cebrene (Yellow Pansy), Gryllus bimaculatus (Common Garden Cricket) and Olorunia spp (Grass Funnel-web Spiders).

4.7 Groundwater

Ground water in and around the Tharisa Mine is typically between 10m and 30m below ground level. Ground water flow is generally influenced by the topography in the mine area. In general, the flow is from the higher ground in the south to lower lying areas in the north and towards water courses which occur in lower lying areas. The Tharisa Mine is underlain by a shallow upper weathered aquifer and a deeper fractured aquifer. The interface between these features is relatively impermeable. In the vicinity of the water courses, alluvium replaces the weathered overburden and the water courses do lose and gain water to the alluvium aquifer. Ground water is generally of good quality and can either be classified as ideal or good. Most of the boreholes in the vicinity of the mine are used for domestic and agricultural (livestock and irrigation) purposes.

4.8 Surface Water

The Tharisa Mine is located within the upper reaches of the A21K quaternary catchment, which falls within the Lower Crocodile Secondary catchment and the Crocodile West and Marico Water Management Area. The mine area is drained by the perennial Sterkstroom, which flows from the Buffelspoort Dam, south of the N4, in a northerly direction through the centre of the mine area and two unnamed non-perennial tributaries of the Brakspruit, an unnamed non-perennial tributary of the Maretlwane and an unnamed non-perennial tributary of the Elandsdriftspruit. Non-perennial tributaries of the Brakspruit traverse the western edge of the proposed mining area, the Maretlwane tributary originates in the eastern open pit, and the Elandsdriftspruit tributary traverses through the preferred tailings dam site and will need to be diverted for the project (Figure 4.8_1). Apart from the Sterkstroom, drainage lines within the mine area are not well defined and do not have distinct channels.

The run-off for the catchments associated with the mine area is not gauged. The mean annual runoff (MAR) was therefore simulated using rainfall-runoff response parameters from WR90.

The rainfall-runoff response of the catchment was assumed to be the same as the regional rainfall-runoff response as determined for quaternary catchment A21K and set out in WR90. According to Midgley et al (1994) the MAR for quaternary catchment A21K is 31.9Mm3/year. The normal dry weather flow for the non-perennial Elandsdriftspruit, Brakspruit and Maretlwane tributaries in the mine area is zero. The normal dry weather flow of the Sterkstroom is dependent on the rate of release from the Buffelspoort Dam situated about 3.25km upstream of the mine.

The regional maximum flood (RMF) peak flow rate was determined using Kovács method (1980). The peak flow rates and flood volumes calculated using the calculated flood peaks and the time of concentration for each catchment are also summarised in Table 4.8_1.

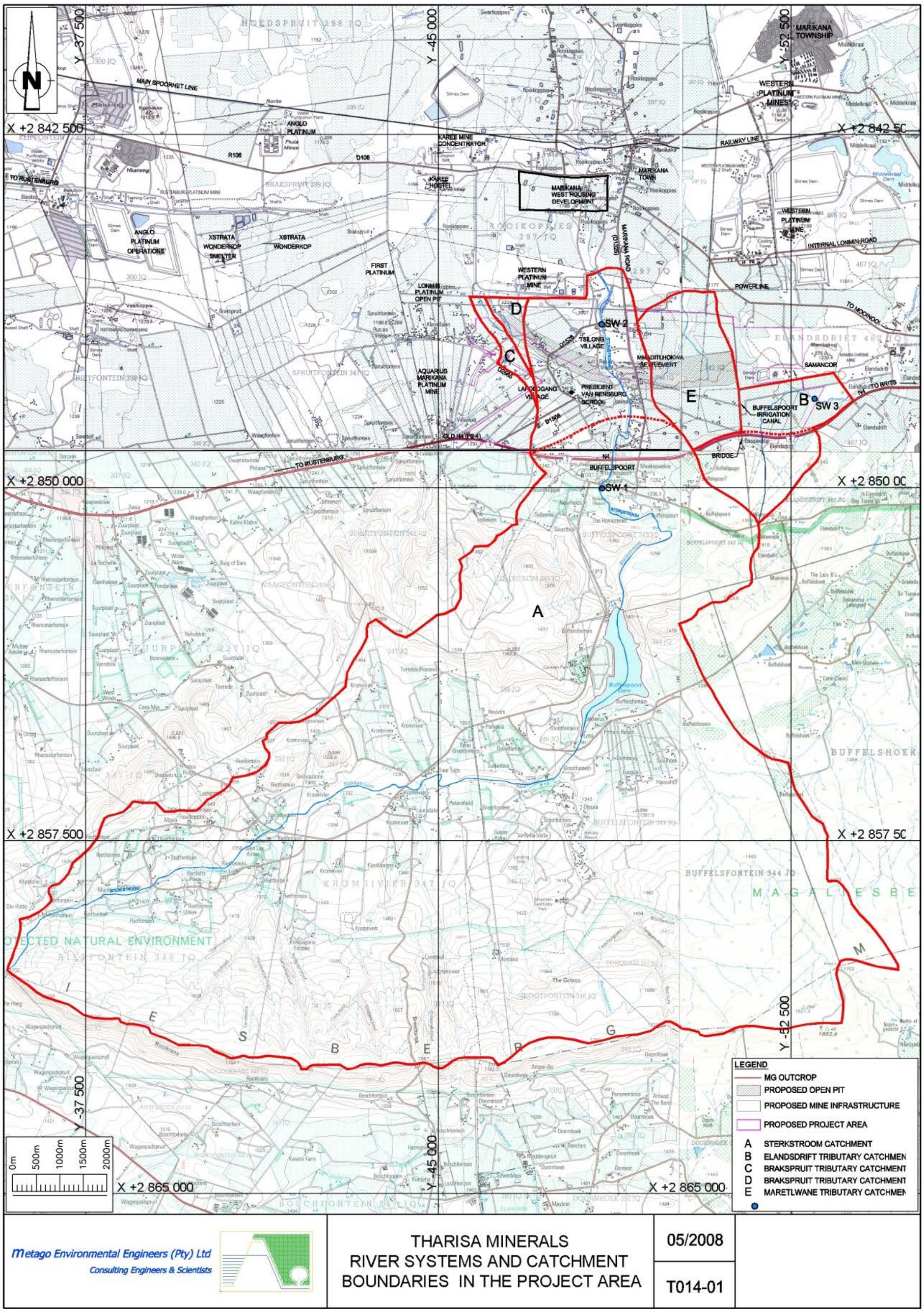
Table 4.8_1
Tharisa Mine
Calculated Peak Flow Rates and Flood Volumes

Catchment	Area (km^2)	Return period			
		1:20	1:50	1:100	Regional Maximum Flood RMF
Peak Flow Rate (m^3/s)					
Sterkstroom	140.3	314	444	544	1185
Elandsdriftspruit	3.3	25	35	43	181
Flood Volume ($x10^6$ m^3)					
Sterkstroom	140.3	7.36	10.39	12.73	-
Elandsdriftspruit	3.3	0.14	0.19	0.24	-

Flood lines for the Sterkstroom River were determined using the software package HEC-RAS River Analysis System version 3.1.3 (2005). Preliminary observations for the Sterkstroom indicate that the water quality is of a good quality. Water from the Sterkstroom is used for domestic purposes such as washing and bathing, livestock watering and for agricultural purposes. There are features that exhibit wetlands components within the mining area because of the associated biodiversity present. No pans or other wetlands occur in the mine area.

Figure 4.8_1

River Systems and Catchment Boundaries in the Mine Area



4.9 Local Resources and Infrastructure

The Tharisa Mine is located 95km from Johannesburg and 35km east of the city of Rustenburg, which is a major centre for the platinum and chrome mining industries in the surrounding area. Rustenburg is located within the Rustenburg Local Municipality and Madibeng Local Municipalities and is part of the Bojanala Platinum District Municipality of the North West Province of South Africa. The city of Rustenburg serves as a base for providing a full range of urban amenities, including world class medical, educational, financial, retail and commercial services. Basic facilities and services are present within the immediate surrounding rural areas.

5 HISTORY

5.1 Ownership History

Thari Resources (Pty) Ltd (Thari) which was incorporated in January 2005, acquired prospecting rights for chrome and PGMs over various portions of the property Farm 342JQ and to the property Rooikoppies 297JQ in March 2006. Thari is a HDSA and woman controlled company focused on the minerals and energy sectors.

In March 2006 Thari established Tharisa Minerals as a wholly owned subsidiary. In September 2008, the prospecting rights were transferred from Thari to Tharisa Minerals after obtaining the necessary Ministerial approval in terms of Section 11 of the MPRDA.

Tharisa plc was incorporated in February 2008 and after obtaining the necessary Ministerial approval acquired 74% of Tharisa Minerals on 9 February 2009. The remaining 26% is held by Thari (20%) and The Tharisa Community Trust (6%).

On 19 September 2008, the prospecting rights, for PGM and chrome, over various portions of Farm 342JQ and the whole of Rooikoppies, held by Tharisa Minerals, were converted into a mining right with the approval of the DMR. This mining right was registered to Tharisa Minerals on 13 August 2009. Subsequently, the mining right for chrome over portions 96 and 183 of the Farm 342 JQ was purchased from South African Producers and Beneficiators of Chrome Ore (Pty) Limited.

In July 2011, an application was granted in terms of Section 102 of the MPRDA, to amend the existing mining right by the addition of Portions 96, 183 and 286 of the property Farm 342JQ to the mining right 49/2009(MR).

5.2 Work undertaken by the Previous License Holders

Prior to Thari obtaining the prospecting rights, the only known exploration activities undertaken on the properties had been the regional mapping undertaken by the Geological Survey (now Council of Geoscience) and the drilling of six cored boreholes by an entrepreneur Mr Hennie Botha on Farm 342JQ and the adjacent property Spruitfontein 341JQ.

5.3 Historical Mineral Resources and Mineral Reserves

The mineral resource was initially estimated in 2008 and depleted based on the tonnage mined. The mineral resource reported as at December 2013 is presented in Table 5.3_1. The mineral reserve has been re-estimated a number of times utilising revised mining approaches and revised revenue and cost projections. The mineral reserves of December 2013 are reported in Tables 5.3_2 and 5.3_3.

Table 5.3_1

Mineral Resource Statement for the Tharisa Mine (31 December 2013)

MG4A CHROMITITE LAYER

	Tonnage (Mt)	True Thick (m)	Bulk Density (t/m^3)	Cr_2O_3 (%)	Pt (g/t)	Pd (g/t)	Rh (g/t)	Au (g/t)	Ru (g/t)	Os (g/t)	Ir (g/t)	3PGE+ Au (g/t)	Pt:Pd:Rh:Au	6PGE+Au (g/t)	Pt:Pd:Rh:Au:Ru:Os:Ir	Cr:Fe	6PGE+Au (koz)	Ni (ppm)
Measured	6.709	1.43	3.69	24.89	0.40	0.15	0.12	0.00	0.25	0.04	0.05	0.67	59:22:18:0	1.01	39:15:12:0:25:4:5	1.12	219	761
Indicated	15.927	1.59	3.70	24.29	0.40	0.15	0.13	0.00	0.25	0.04	0.05	0.68	59:23:18:1	1.03	39:15:12:0:25:4:5	1.10	526	762
Inferred	68.516	1.44	3.70	25.18	0.39	0.14	0.13	0.00	0.26	0.05	0.05	0.67	59:21:19:1	1.03	38:14:12:0:26:4:5	1.11	2,265	763

MG4 and MG4(0) CHROMITITE LAYER Package

	Tonnage (Mt)	True Thick (m)	Bulk Density (t/m^3)	Cr_2O_3 (%)	Pt (g/t)	Pd (g/t)	Rh (g/t)	Au (g/t)	Ru (g/t)	Os (g/t)	Ir (g/t)	3PGE+ Au (g/t)	Pt:Pd:Rh:Au	6PGE+Au (g/t)	Pt:Pd:Rh:Au:Ru:Os:Ir	Cr:Fe	6PGE+Au (koz)	Ni (ppm)
Measured	19.645	4.14	3.75	26.52	0.70	0.19	0.17	0.003	0.33	0.06	0.08	1.07	66:18:16:0	1.53	46:13:11:0:21:4:5	1.18	966	784
Indicated	29.785	3.00	3.65	24.76	1.08	0.22	0.21	0.003	0.36	0.08	0.11	1.51	71:15:14:0	2.06	52:11:10:0:18:4:6	1.20	1,972	730
Inferred	170.733	3.72	3.62	22.60	0.99	0.19	0.19	0.003	0.34	0.07	0.10	1.36	72:14:14:0	1.88	53:10:10:0:18:4:6	1.15	10,319	697

MG3 CHROMITITE LAYER

	Tonnage (Mt)	True Thick (m)	Bulk Density (t/m^3)	Cr_2O_3 (%)	Pt (g/t)	Pd (g/t)	Rh (g/t)	Au (g/t)	Ru (g/t)	Os (g/t)	Ir (g/t)	3PGE+ Au (g/t)	Pt:Pd:Rh:Au	6PGE+Au (g/t)	Pt:Pd:Rh:Au:Ru:Os:Ir	Cr:Fe	6PGE+Au (koz)	Ni (ppm))
Measured	12.369	3.74	3.25	13.07	0.60	0.35	0.15	0.006	0.22	0.04	0.06	1.10	54:32:14:1	1.42	42:25:11:0:15:3:4	0.99	563	486
Indicated	23.451	4.13	3.22	18.01	0.75	0.44	0.19	0.005	0.27	0.05	0.08	1.39	54:32:14:0	1.80	42:25:11:0:15:3:4	1.08	1,354	603
Inferred	67.376	3.10	3.20	25.65	1.01	0.58	0.26	0.005	0.38	0.08	0.10	1.86	54:31:14:0	2.42	42:24:11:0:16:3:4	1.13	5,247	784

MG2 CHROMITITE LAYER

	Tonnage (Mt)	True Thick (m)	Bulk Density (t/m^3)	Cr_2O_3 (%)	Pt (g/t)	Pd (g/t)	Rh (g/t)	Au (g/t)	Ru (g/t)	Os (g/t)	Ir (g/t)	3PGE+ Au (g/t)	Pt:Pd:Rh:Au	6PGE+Au (g/t)	Pt:Pd:Rh:Au:Ru:Os:Ir	Cr:Fe	6PGE+Au (koz)	Ni (ppm)
Measured	14.555	3.30	3.62	19.33	1.07	0.28	0.15	0.004	0.27	0.05	0.08	1.51	71:18:10:0	1.90	56:15:8:0:14:3:4	0.98	891	732
Indicated	41.692	3.59	3.67	17.79	0.98	0.28	0.15	0.004	0.24	0.05	0.07	1.42	69:20:10:0	1.78	55:16:8:0:14:3:4	0.92	2,386	733
Inferred	286.164	5.72	3.62	13.26	0.70	0.21	0.11	0.004	0.19	0.04	0.05	1.02	69:20:11:0	1.30	54:16:8:0:15:3:4	0.75	11,975	674

MG1 CHROMITITE LAYER																		
	Tonnage (Mt)	True Thick (m)	Bulk Density (t/m^3)	Cr_2O_3 (%)	Pt (g/t)	Pd (g/t)	Rh (g/t)	Au (g/t)	Ru (g/t)	Os (g/t)	Ir (g/t)	3PGE+Au (g/t)	Pt:Pd:Rh:Au	6PGE+Au (g/t)	Pt:Pd:Rh:Au:Ru:Os:Ir	Cr:Fe	6PGE+Au (koz)	Ni (ppm)
Measured												0.00	#DIV/0!	0.00	#DIV/0!		-	
Indicated	14.322	1.23	3.89	33.38	0.34	0.22	0.11	0.004	0.48	0.08	0.08	0.67	50:32:17:1	1.30	26:17:9:0:37:6:6	1.34	599	810
Inferred	57.245	1.23	3.89	32.26	0.33	0.20	0.11	0.003	0.45	0.08	0.07	0.64	51:31:17:1	1.24	26:16:9:0:36:6:6	1.29	2,277	803
MG0 CHROMITITE LAYER																		
	Tonnage (Mt)	True Thick (m)	Bulk Density (t/m^3)	Cr_2O_3 (%)	Pt (g/t)	Pd (g/t)	Rh (g/t)	Au (g/t)	Ru (g/t)	Os (g/t)	Ir (g/t)	3PGE+Au (g/t)	Pt:Pd:Rh:Au	6PGE+Au (g/t)	Pt:Pd:Rh:Au:Ru:Os:Ir	Cr:Fe	6PGE+Au (koz)	Ni (ppm)
Measured	1.801	0.50	3.74	26.07	0.57	0.18	0.16	0.004	0.30	0.05	0.07	0.92	62:19:18:0	1.33	43:13:12:0:22:4:5	1.09	77	747
Indicated	3.188	0.72	3.75	27.08	0.61	0.19	0.17	0.004	0.32	0.06	0.07	0.98	62:20:17:0	1.44	43:14:12:0:22:4:5	1.10	147	752
Inferred	0.011	0.17	3.73	23.76	0.45	0.17	0.15	0.006	0.24	0.04	0.05	0.77	58:22:19:1	1.11	41:15:13:1:22:4:5	1.00	0.40	711
UG1 CHROMITITE LAYER																		
	Tonnage (Mt)	True Thick (m)	Bulk Density (t/m^3)	Cr_2O_3 (%)	Pt (g/t)	Pd (g/t)	Rh (g/t)	Au (g/t)	Ru (g/t)	Os (g/t)	Ir (g/t)	3PGE+Au (g/t)	Pt:Pd:Rh:Au	6PGE+Au (g/t)	Pt:Pd:Rh:Au:Ru:Os:Ir	Cr:Fe	6PGE+Au (koz)	Ni (ppm)
Measured																		
Indicated	1.500	2.17	3.75	23.68	0.36	0.28	0.14	0.030	0.21			0.82	44:35:17:4			1.12	39	
Inferred																		
TOTAL MINERAL RESOURCE																		
	Tonnage (Mt)	True Thick (m)	Bulk Density (t/m^3)	Cr_2O_3 (%)	Pt (g/t)	Pd (g/t)	Rh (g/t)	Au (g/t)	Ru (g/t)	Os (g/t)	Ir (g/t)	3PGE+Au (g/t)	Pt:Pd:Rh:Au	6PGE+Au (g/t)	Pt:Pd:Rh:Au:Ru:Os:Ir	Cr:Fe	6PGE+Au (koz)	Ni (ppm)
Measured	55.079	2.68	3.71	21.39	0.73	0.24	0.16	0.004	0.28	0.05	0.07	1.14	64:21:14:0	1.53	48:16:10:0:18:3:5	1.07	2,717	699
Indicated	129.864	2.45	3.73	22.24	0.80	0.27	0.16	0.004	0.31	0.06	0.08	1.24	65:22:13:0	1.68	48:16:10:0:18:3:5	1.09	7,034	713
Inferred	650.045	3.11	3.73	19.93	0.74	0.23	0.15	0.004	0.28	0.05	0.07	1.13	66:21:13:0	1.54	49:15:10:0:18:4:5	0.98	32,083	712
Total	**834.989**	**2.95**	**3.73**	**20.38**	**0.75**	**0.24**	**0.15**	**0.004**	**0.28**	**0.05**	**0.07**	**1.15**	**66:21:13:0**	**1.56**	**48:15:10:0:18:4:5**	**1.00**	**41,834**	**712**

Note: The mineral resource is declared to a depth of 750m below surface.
The consideration of realistic eventual extraction necessitates that the mineral resource considers the MG Chromitite Layer to be a geological unit and that all platiniferous and chromiferous horizons will be mined and all PGM, Cu, Ni and Cr_2O_3 recovered.
The UG1 Chromitite Layer is declared for the part that falls within the current proposed open pit
The mineral resource is reported inclusive of the mineral reserve

Table 5.3_2

Tharisa Mine: Open Pit Mineral Reserve (December 2013) (SAMREC Code)

Chromitite Layer	Tonnes ('000)	Pt (g/t)	Pd(g/t)	Rh(g/t)	Au (g/t)	3PGE+Au (g/t)	Ru(g/t)	Ir(g/t)	5PGE+Au (g/t)	Cr_2O_3 (%)	Cu (%)	Ni (%)	Cr (%)
Proved Mineral Reserve													
MG0													
MG1													
MG2	11,817	1.03	0.26	0.15	0.004	1.45	0.25	0.07	1.77	18.31	0.002	0.070	12.53
MG3	10,412	0.56	0.32	0.14	0.005	1.03	0.20	0.06	1.29	12.23	0.003	0.046	8.37
MG4	11,010	1.06	0.22	0.21	0.003	1.49	0.35	0.11	1.95	25.72	0.003	0.075	17.60
MG4A	5,234	0.34	0.13	0.11	0.003	0.58	0.22	0.04	0.85	21.44	0.002	0.066	14.67
Total	**38,474**	**0.79**	**0.25**	**0.15**	**0.004**	**1.19**	**0.27**	**0.08**	**1.53**	**19.21**	**0.002**	**0.064**	**13.14**
Probable Mineral Reserve													
Chromitite Layer	**Tonnes ('000)**	**Pt(g/t)**	**Pd(g/t)**	**Rh(g/t)**	**Au (g/t)**	**3PGE+Au (g/t)**	**Ru(g/t)**	**Ir(g/t)**	**5PGE+Au (g/t)**	**Cr_2O_3 (%)**	**Cu (%)**	**Ni (%)**	**Cr (%)**
MG0	4,473	0.40	0.13	0.12	0.003	0.665	0.23	0.05	0.93	19.16	0.002	0.060	13.11
MG1	8,005	0.29	0.18	0.10	0.003	0.57	0.41	0.07	1.05	28.89	0.003	0.069	19.77
MG2	21,454	1.02	0.28	0.15	0.004	1.45	0.25	0.07	1.77	18.11	0.002	0.070	12.39
MG3	18,825	0.59	0.34	0.15	0.005	1.06	0.21	0.06	1.33	12.81	0.001	0.047	8.76
MG4	9,960	1.08	0.24	0.21	0.003	1.52	0.36	0.11	1.99	25.30	0.003	0.073	17.31
MG4A	6,043	0.35	0.14	0.11	0.004	0.59	0.22	0.04	0.85	20.83	0.002	0.066	14.25
Total	**68,761**	**0.74**	**0.26**	**0.15**	**0.004**	**1.15**	**0.27**	**0.07**	**1.49**	**19.26**	**0.002**	**0.064**	**13.18**
Total Mineral Reserve													
Chromitite Layer	**Tonnes ('000)**	**Pt(g/t)**	**Pd(g/t)**	**Rh(g/t)**	**Au (g/t)**	**3PGE+Au (g/t)**	**Ru(g/t)**	**Ir(g/t)**	**5PGE+Au (g/t)**	**Cr_2O_3 (%)**	**Cu (%)**	**Ni (%)**	**Cr (%)**
MG0	4,473	0.40	0.13	0.12	0.003	0.66	0.23	0.05	0.93	19.16	0.002	0.060	13.11
MG1	8,005	0.29	0.18	0.10	0.003	0.57	0.41	0.07	1.05	28.89	0.003	0.069	19.77
MG2	33,272	1.03	0.27	0.15	0.004	1.45	0.25	0.07	1.77	18.18	0.002	0.070	12.44
MG3	29,237	0.58	0.34	0.15	0.005	1.06	0.21	0.06	1.33	12.78	0.001	0.048	13.68
MG4	20,970	1.07	0.23	0.21	0.003	1.50	0.36	0.11	1.97	25.52	0.003	0.074	17.46
MG4A	11,277	0.34	0.13	0.11	0.003	0.59	0.22	0.04	0.85	21.11	0.002	0.066	14.44
Total	**107,235**	**0.76**	**0.25**	**0.15**	**0.004**	**1.17**	**0.27**	**0.07**	**1.51**	**19.29**	**0.002**	**0.064**	**13.20**

Table 5.3_3

Tharisa Mine: Underground Mine Mineral Reserve (December 2013)
Reported in terms of the guidelines of the SAMREC Code

Proved Mineral Reserve

Chromitite Layer	Tonnes ('000)	Pt (g/t)	Pd(g/t)	Rh(g/t)	Au (g/t)	3PGE+Au (g/t)	Ru(g/t)	Ir(g/t)	5PGE+Au (g/t)	Cr_2O_3 (%)	Ni (%)	Cu (%)	Cr (%)
MG2AB	-	-	-	-	-	-	-	-	-	-	-	-	-
MG4	-	-	-	-	-	-	-	-	-	-	-	-	-
Total	-	-	-	-	-	-	-	-	-	-	-	-	-

Probable Mineral Reserve

Chromitite Layer	Tonnes ('000)	Pt(g/t)	Pd(g/t)	Rh(g/t)	Au (g/t)	3PGE+Au (g/t)	Ru(g/t)	Ir(g/t)	5PGE+Au (g/t)	Cr_2O_3 (%)	Ni (%)	Cu (%)	Cr (%)
MG2AB	6,646	0.70	0.21	0.10	0.002	1.02	0.20	0.05	1.27	17.37	0.060	0.002	11.88
MG4	12,002	0.89	0.18	0.17	0.002	1.25	0.31	0.10	1.66	20.39	0.061	0.002	14.10
Total	**18,649**	**0.82**	**0.19**	**0.15**	**0.002**	**1.17**	**0.27**	**0.08**	**1.52**	19.31	0.060	0.002	**13.31**

Total Mineral Reserve

Chromitite Layer	Tonnes ('000)	Pt(g/t)	Pd(g/t)	Rh(g/t)	Au (g/t)	3PGE+Au (g/t)	Ru(g/t)	Ir(g/t)	5PGE+Au (g/t)	Cr_2O_3 (%)	Ni (%)	Cu (%)	Cr (%)
MG2AB	6,646	0.70	0.21	0.10	0.002	1.02	0.20	0.05	1.27	17.37	0.060	0.002	11.88
MG4	12,002	0.89	0.18	0.17	0.002	1.25	0.31	0.10	1.66	20.39	0.061	0.002	14.10
Total	**18,649**	**0.82**	**0.19**	**0.15**	**0.002**	**1.17**	**0.27**	**0.08**	**1.52**	19.31	0.060	0.002	13.31

5.4 Occupational Health and Safety

A summary of the Tharisa Mine safety statistics are presented in Table 5.4_1.

Table 5.4_1 Tharisa Mine Progressive Safety Statistics to September 2015						
	2010	**2011**	**2012**	**2013**	**2014**	**2015**
Fatalities	0	0	0	1	1	1
Fatality Free shifts	129,268	349,907	945,926	347,705	95,054	115,375
Injury Free Shifts	129,268	4,654	72,967	139,011	95,054	25,212
Lost Time Injuries (LTI)	0	3	5	3	3	4
Lost Time Injury Rate per 200,000hrs	0	0.3	0,19	0.13	0.1	0.13

5.5 Production History

Other than various small scale chrome mining operations, no significant production is known to have occurred within the Tharisa Mine area prior to the obtaining of the prospecting rights by Thari.

The Tharisa Mine started conducting trial mining in October 2008, with the objective of testing the viability of the mining method and the veracity of the assumptions of the feasibility study, then being undertaken.

RoM ore was first produced on a small scale in March 2009 with the focus at the time being to build and operate a small chrome concentrator, with a capacity of some 38,000 tpm. The mine was able to generate early revenue which was used to secure surface infrastructure and fund moderate expansion.

5.5.1 Current Mining Operations

In Phase 2 of the mine's development, the mining rate was increased to 100,000 tpm, in order to feed the Phase 2 processing facility expansion. This consisted of an increase in the pilot plant throughput capacity to 100,000 tpm as well as the incorporation of a PGM recovery circuit and additional chrome scavenging circuit. The Phase 2 processing facility was commissioned in February 2012. A 300,000 tpm concentrator was commissioned to treat the increased RoM production in parallel to the existing 100,000 tpm Phase 2 plant. The current mine capacity is 4.8Mtpa.

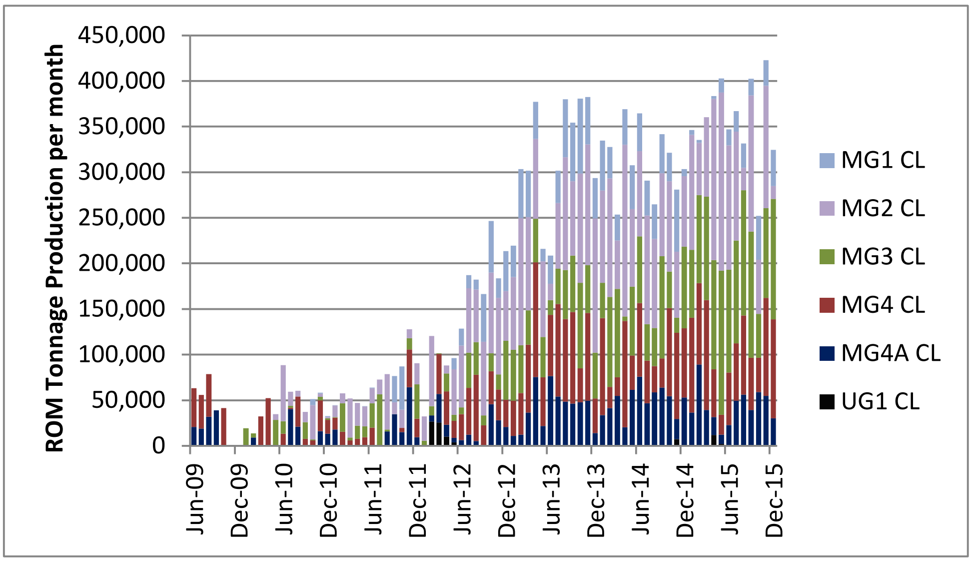
The historical mine production is presented in Figure 5.5.1_1:

- As at 31 December 2015. the Tharisa Mine has produced 2,095,000t of 42% Cr_2O_3 chromite concentrate
- The mining cost is currently R205 per Run of Mine (RoM) tonne

Tharisa Mine has secured sufficient supply of water and electricity to meet its requirements for steady state production for the LoM.

Figure 5.5.1_1

Graph showing the Historical Mining Production from the UG1 and MG Chromitite Layers



Mining is being undertaken by the Tharisa Mine's appointed mining contractor – MCC.

While the Phase 2 and 3 process facility expansions were underway, mine production was limited to 38,000 tpm of RoM ore throughput. With the commissioning of the 100,000t plant in February 2012, and the 300,000 tpm plant in December 2012, RoM production has increased to 380,000 tpm.

The depth of mining is currently up to 29m and the mine is producing fresh material from the six MG Chromitite Layers, namely the MG4A, MG4, MG3, MG2, MG1 and MG0. The shallow MG1 Chromitite Layer was mined underground to a limited extent on the eastern boundary of the property by the previous mining right holder.

The current mine plan is based on two open pit operations east and west of the Sterkstroom river which runs north south through the Tharisa Mine area. The pits are designed to protect the water course and the local infrastructure running parallel to the river. Currently RoM production is 380,000 tpm.

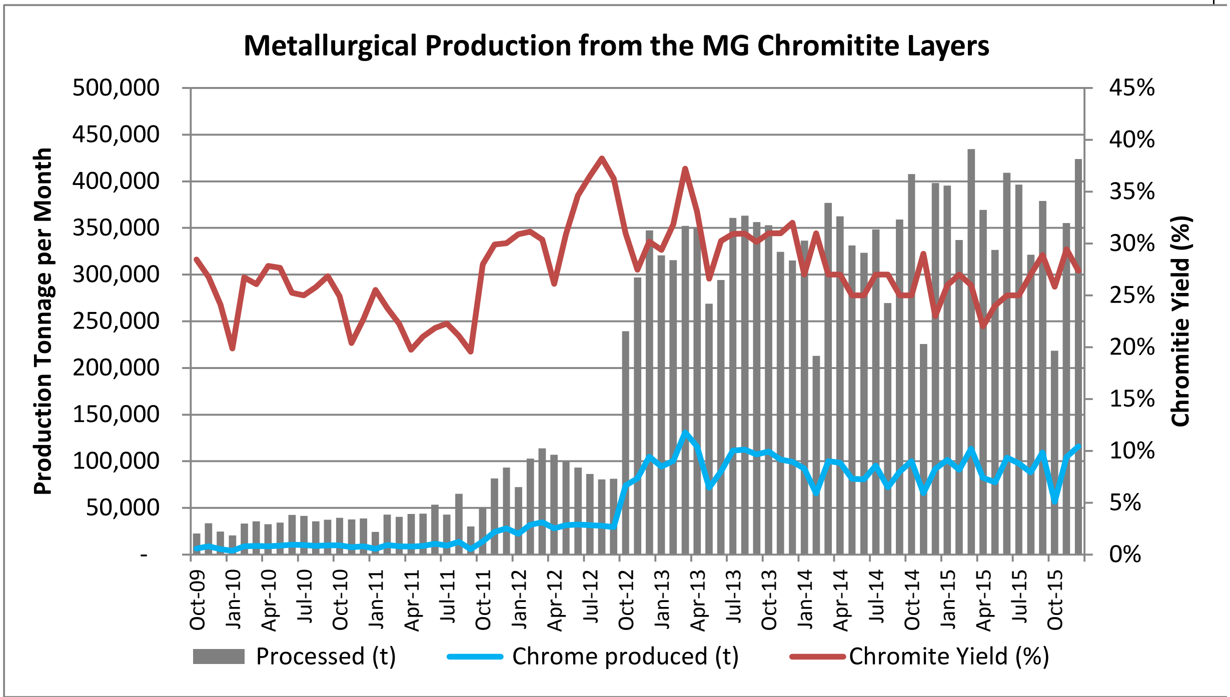
The open pits will fulfil the production requirements until 2032, after which time production will transition to underground bord and pillar mining. The last open pit tonnage will be mined in 2038.

The mine design and schedule was completed by Ukwazi Mining Solutions (Proprietary) Limited (Ukwazi). The production profile has been designed to ensure steady ore to the processing facility.

5.5.2 Current Metallurgical Production

The historical production from the Tharisa processing facilities is presented in Figure 5.5.2_1.

Figure 5.5.2_1
Graph of the Historical Metallurgical Production



As at 31 December 2015 a RoM stockpile of 67,500t existed with an additional stockpile of crushed material of 20,600t. The historical tailings from the chrome plant (arising prior to the commissioning of the Phase 2 plant, and therefore containing recoverable PGMs and chrome) have been stockpiled separately for future treatment through the PGM recovery section. As at 31 December 2015 the PGM stockpile tonnage is estimated to be some 58,000t. This stockpile will eventaully be processed for chromite and PGM's.

5.5.3 Mine Personnel

The Tharisa Mine's current staffing levels are summarised in Table 5.5.3_1.

Table 5.5.3_1
Tharisa Mine
Summary of Current Mine Staffing Levels (December 2015)

Category	In Service	Planned	Category	In Service	Planned
General Management	15	17	Process	80	84
Technical Management	19	31	Operations	178	188
Safety	9	9	Engineering	94	100
Human Resources	41	59	IT	5	5
Finance	29	29	Security	1	3
Total Tharisa Minerals				**471**	**518**

6 GEOLOGICAL SETTING

6.1 Regional Setting

The stable Kaapvaal and Zimbabwe Cratons in southern Africa are characterised by the presence of large mafic to ultramafic layered complexes, the best known of which are the Great Dyke in the Zimbabwe Craton and the Bushveld and Molopo Complexes in the Kaapvaal Craton. By far the largest, best-known and economically most important of these is the Bushveld Complex, which was intruded about 2,060 million years ago into rocks of the Transvaal Supergroup, largely along an unconformity between the Magaliesberg quartzite of the Pretoria Group and the overlying Rooiberg felsites. The total estimated extent of the Bushveld Complex is some 66,000 km^2, of which about 55% is covered by younger formations. The mafic rocks of the Bushveld Complex host layers rich in PGM, chromium and vanadium, and constitute the world's largest known resource of these metals.

6.1.1 Bushveld Complex Stratigraphy

The mafic rocks (collectively termed the Rustenburg Layered Suite) can be divided into five zones known as the Marginal, Lower, Critical, Main and Upper Zones from the base upwards (Figure 6.1.1_1).

The **Marginal Zone** is comprised of generally finer grained rocks than those of the interior of the Bushveld Complex and contains abundant xenoliths of country rock. It is highly variable in thickness and may be completely absent in some areas and contains no known economic mineralisation.

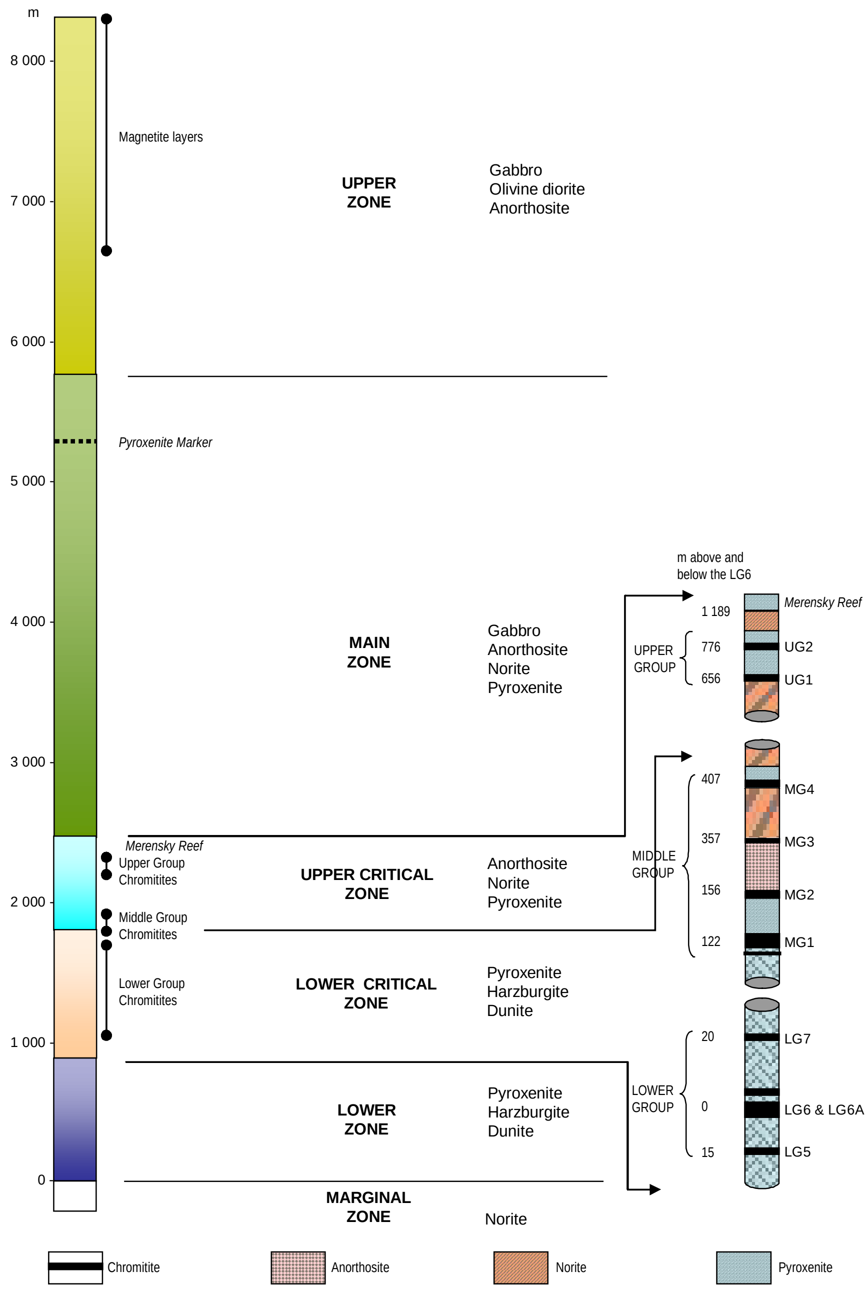
The **Lower Zone** is dominated by orthopyroxenite with associated olivine-rich cumulates in the form of harzburgites and dunites. The Lower Zone may be completely absent in some areas.

The **Critical Zone** is characterised by regular and often fine-scale rhythmic, or cyclic, layering of well-defined layers of cumulus chromite within pyroxenites, olivine-rich rocks and plagioclase-rich rocks (norites, anorthosites etc). The economically important PGM deposits are part of the Critical Zone.

The Critical Zone hosts all the chromitite layers of the Bushveld Complex, of which up to 14 have been identified. The first important cycle is the lower of the two Upper Group (UG) Chromitite Layers (the UG1 Chromitite Layer). This unit consists of a chromitite layer and underlying footwall chromitite layers that are interlayered with anorthosite. The most important of the chromite cycles for PGM mineralisation is the upper of the two UG Chromitite Layers (the UG2 Chromitite Layer) which averages some 1m in thickness and is mined throughout the Bushveld Complex.

Underlying the UG Chromitite Layers are the MG Chromitite Layers which consists of five groups of chromitite layers over an overall thickness of 50 – 80m. These chromitite layers are important as they contain significant concentrations of chromite and PGMs.

Figure 6.1.1_1
Generalised Stratigraphic Column of Rustenburg Layered Suite, Bushveld Complex
(after Viljoen and Schürmann, 1998)



The two uppermost units of the Critical Zone are the Merensky and Bastard units. The former is also of great economic importance as it contains at its base the PGM-bearing Merensky Reef, a feldspathic pyroxenitic assemblage with associated thin chromitite layers that rarely exceeds 1m in thickness. The top of the Critical Zone is generally defined as the top of the robust anorthosite (the Giant Mottled Anorthosite) that forms the top of the Bastard cyclic unit.

The Critical Zone may be subdivided into the Upper and Lower Critical Zones based on the last appearance of cumulus feldspar. This boundary is considered to be between the UG and MG Chromitite Layers.

The economically viable chromite reserves of the Bushveld Complex, most of which are hosted in the Critical Zone, are estimated at 68% of the world's total, whilst the Bushveld Complex also contains 56% of all known platinum group metals. The Merensky Reef, which developed near the top of the Critical Zone, can be traced along strike for 280km and is estimated to contain 60,000t of PGM to a depth of 1 200m below surface. The pyroxenitic Platreef mineralisation, north of Mokopane (formerly Potgietersrus), contains a wide zone of more disseminated style platinum mineralisation, along with higher grades of nickel and copper than occur in the rest of the Bushveld Complex.

The well-developed **Main Zone** consists of norites grading upwards into gabbronorites. It includes several mottled anorthosite layers in its lower sector and a distinctive pyroxenite layer two thirds of the way up, termed the Pyroxenite Marker.

The base of the overlying **Upper Zone** is defined by the first appearance of cumulus magnetite above the Pyroxenite Marker. In all, 25 layers of cumulus magnetite punctuate the Upper Zone, the fourth (Main Magnetite layer) being the most prominent. This is a significant marker, some 2m thick, resting upon anorthosite, and is exploited for its vanadium content in the eastern and western limbs of the Bushveld Complex.

6.1.2 Platinum Mineralisation

The Merensky Reef has traditionally been the most important platinum producing layer in the Bushveld Complex. Seismic surveys undertaken by the Council for Geoscience indicate that reflectors associated with the Merensky Reef can be traced as far as 50km down dip, to depths of 6,000m below surface. The Merensky Reef varies considerably in its nature, but can be broadly defined as a mineralised zone within, or closely associated with the ultramafic cumulate at the base of the Merensky cyclic unit.

In addition to the PGM mineralisation associated with the Merensky Reef, all chromitites in the Critical Zone at times contain elevated concentrations of PGMs. The UG2 Chromitite Layer is the only chromitite layer that is significantly exploited for PGMs at present.

The major geological features that affect the UG2 Chromitite Layer are faults, dykes, potholes and mafic/ultramafic pegmatites. Potholes are features of subsidence or erosion where the igneous layer is absent or occurs at a lower elevation in a modified form. Typically the PGM concentration and the thickness of the layer are modified. Potholes typically approach a circular shape. Potholes occur within all stratigraphic units of the Bushveld Complex including the MG Chromitite Layer. Poor ground conditions may be associated with potholes and pothole edges. On some mines, such as Bokoni (formerly known as Atok) and Northam, potholes may cause a geological loss of ground of up to 25%.

Another unique feature of the geology of the Bushveld Complex is the mafic/ultramafic pegmatites sometimes referred to as iron rich ultramafic pegmatites (IRUP's) or replacement pegmatites. While these often destroy the structure of the chromitite layer, the PGMs may be unaffected. However, it can result in a mining problem, especially underground, as it becomes difficult to identify the mineralised horizons.

6.1.3 Chromite Mineralisation

The first record of chrome in the Bushveld Complex is noted as an outcrop in the Hex River near Rustenburg in 1865. By the 1920s the various chromitite layers had been identified and traced over the known extent of the Bushveld Complex. Chromite mining started in earnest at about that time but it was not until the 1960s that South Africa became a major producer.

The Bushveld Complex hosts stratiform chromite deposits that are present as layers of massive chromitite. These layers are present in the Critical Zone and have been designated as the Lower Group (LG), MG and UG Chromitite Layers. The lower Critical Zone is host to the LG Chromitite Layers that consists of seven chromitite layers. The thickest and most significant being the LG6 Chromitite Layer. The MG Chromitite Layers consist of five individual chromite packages of which three are in the lower Critical Zone and two are in the upper Critical Zone. There are two UG Chromitite Layers with the UG2 Chromitite Layer being the most significant as a major source of PGM mineralisation.

Although remarkably consistent and continuous across the Bushveld Complex, the variations along strike have allowed the definition of 14 sections each with a unique character. The Tharisa Mine is located in the Marikana Section.

The LG6, MG1 and UG2 Chromitite Layers are the most exploited because of their mineralogical composition and because they can be mined by mechanised equipment both in open pit and underground. The LG6 Chromitite Layer is typically up to 1.05m thick and has a Cr_2O_3 grade of 46% to 48% and a Cr:Fe ratio of 1.56 – 1.60. Locally the LG Chromitite Layers may have much higher Cr:Fe ratios such as at Grasvaley (2.13 – 2.83) and Nietverdeind (1.88 – 2.06). The grade at Nietverdiend ranges from 48% to 51% Cr_2O_3.

The UG2 Chromitite Layer is typically up to 1m thick and has a Cr_2O_3 grade of 43.6% and a Cr:Fe ratio of 1.26 to 1.40. It has a significant PGM grade and so has been mined extensively to recover the PGMs.

The MG1 Chromitite Layer has been sporadically mined with the largest underground mining section being immediately east of the Tharisa Mine and mined by Samancor.

6.2 Local Geology

6.2.1 Tharisa Mine Area

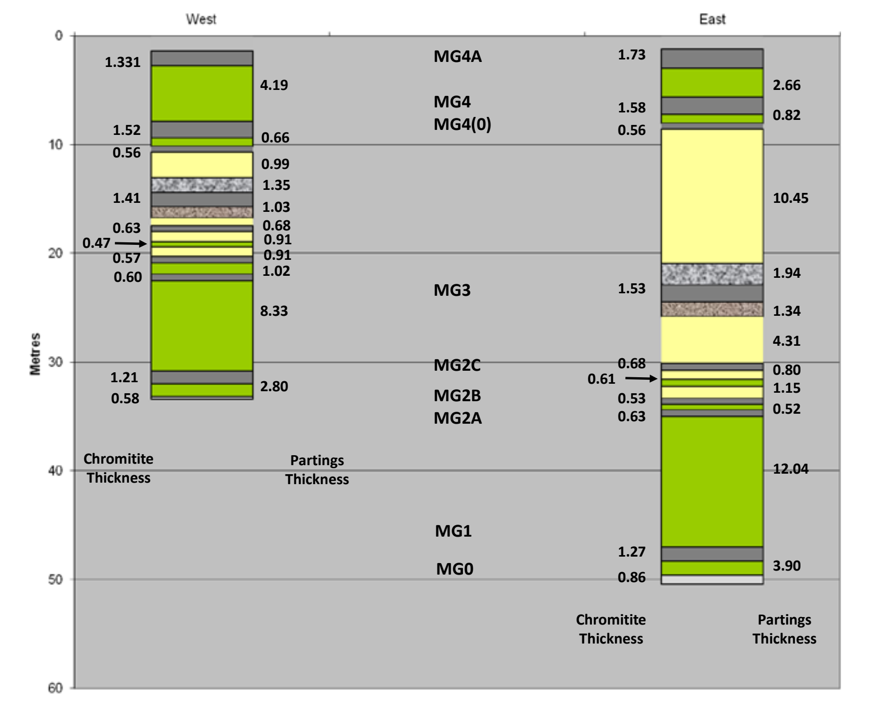
The Tharisa Mine is located on the south-western limb of the Bushveld Complex in the Marikana section, on the properties Farm 342JQ and Rooikoppies 297JQ. The Marikana section is separated from the Brits section to the east by Wolhulterskop and the Rustenburg section to the west by the Spruitfontein upfold (Figure 6.2.1_1).

The MG Chromitite Layers outcrop on Farm 342JQ striking roughly east - west and dipping at 12-15° to the north to a depth estimated at over 1,000m. The total strike length is some 5,400m but only the first 3,900m has been declared in the mineral resource statement as the most westerly part is considered too narrow to be considered to have a **"**reasonable and realistic prospects for eventual economic extraction" (SAMREC, 2009). Towards the western extent of the outcrop, the dip is steeper with a gentle change in strike to NW-SE (Figure 6.2.1_2). The stratigraphy typically narrows to the west and steepens (Figure 6.2.1_3). The dip typically shallows out at depth across the extent of the mine area. The UG1 Chromitite Layer which occurs between 165m to 18m stratigraphically above the MG4A Chromitite Layer on the Farm 342JQ property and 163m (downdip) to 18m (near surface) on the Rooikoppies property also outcrops on the Farm 342JQ property. Both the UG2 Chromitite Layer (between 300m to 150m above MG4A Chromitite Layer) and the Merensky Reef (between 400m (east) to 290m (west) above MG4A Chromitite Layer) outcrop on the Rooikoppies property. Poorly developed chromitite layers below the MG Chromitite Layer were intersected in boreholes and are interpreted as the LG Chromitite Layers.

Figure 6.2.1_1

Tharisa Mine

Summary of Stratigraphic Unit across Tharisa Mine



Unit
MG4A Chromitite Layer
MG4 Chromitite Layer
MG3 Chromitite Layer
MG2 Chromitite Layer
MG1 Chromitite Layer
MG0 Chromitite Layer

Figure 6.2.1_2

Map of the Western Bushveld Complex showing the location of the Tharisa Mine

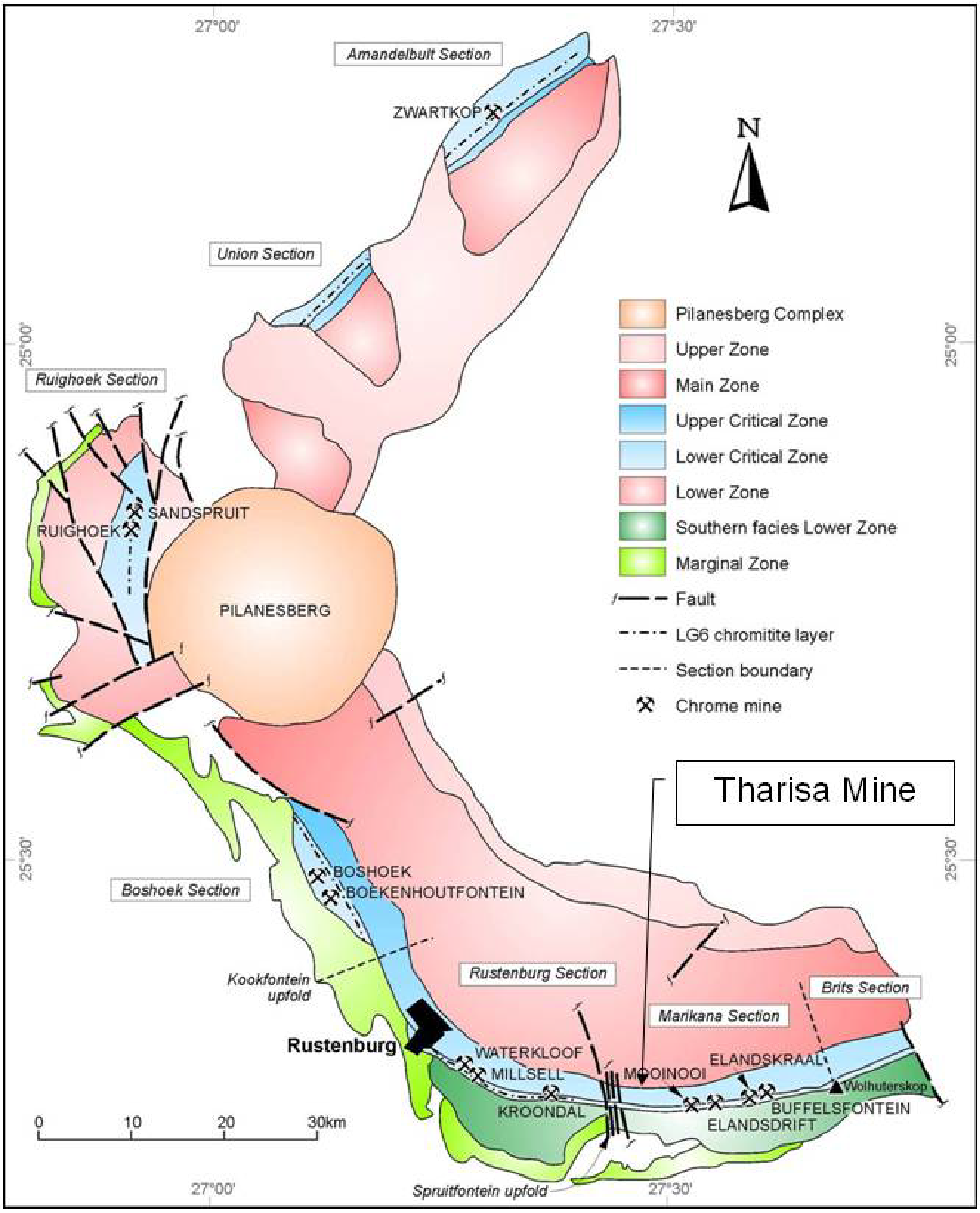
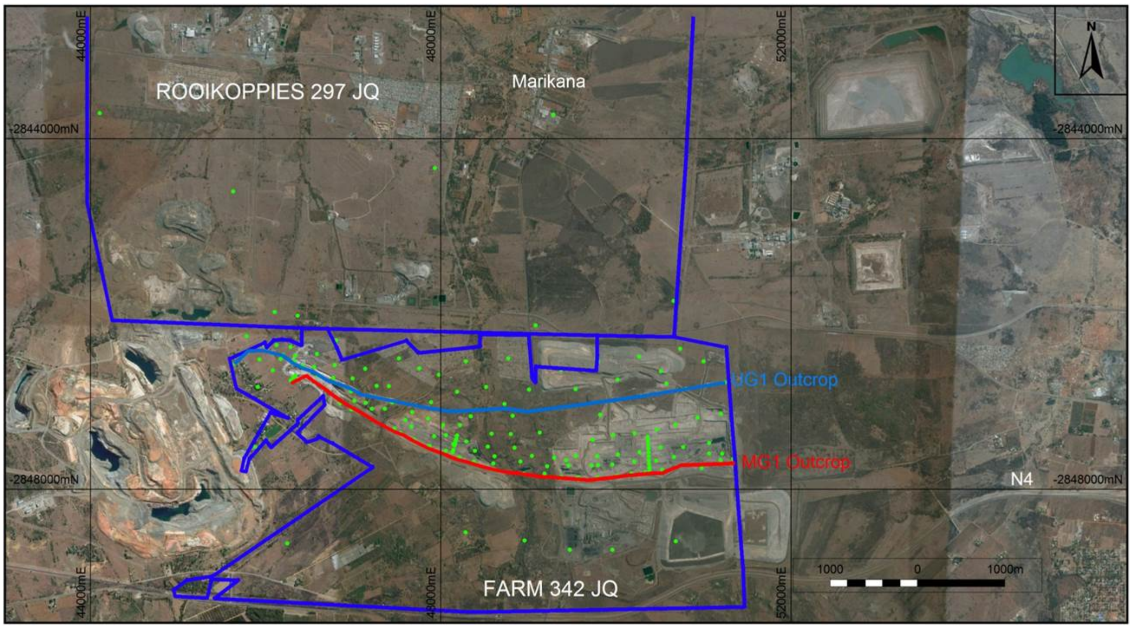


Figure 6.2.1_3

Borehole locations and outcrop positions of UG1 and MG1 Chromitite Layers represented on a Google Image of the Tharisa Mine



6.2.2 Middle Group Chromitite Layers

The MG Chromitite Layer package consists of five groups of chromitite layers (the MG0 Chromitite Layer, MG1 Chromitite Layer, the MG2 Chromitite Layer (subdivided into C, B and A Chromitite Layers), the MG3 Chromitite Layer and the MG4 Chromitite Layer (subdivided into the MG4(0), MG4 and MG4A Chromitite Layers) (Figure 6.2.2_1). The MG0 Chromitite Layer may be defined but formation of these chromitites is very erratic, thin and generally considered uneconomical in the mine area. However, where the MG1 Chromitite Layer immediately above is mined, there is merit in mining the MG0 Chromitite Layer as well. The MG0 Chromitite Layer Mineral Resource is declared for the area of the planned open pit.

The MG Chromitite Layer package (MG1 Chromitite Layer to MG4A Chromitite Layer) is developed over an average thickness of 74m in the East but thins to 50m in the West. The average thickness of the various units and subunits and a summary of the composite statistics are presented in Table 6.2.2_1. Down dip all partings thickness increase except for the MG4A – MG4 Chromitite Layer parting that decreases downdip. Figure 6.2.2_2 and Figure 6.2.2_3 are schematic representations of the variation within the MG Chromitite Layer packages and the parting thicknesses along strike and down dip respectively.

The entire MG and LG Chromitite Layers are truncated by the UG2 Chromitite Layer in the west at the neighbouring Spruitfontein upfold. The UG2 Chromitite Layer is reported to have a pothole morphology where it overlies the Transvaal Sequence rocks and truncates the MG and LG Chromitite Layers.

Figure 6.2.2_1

Generalised Stratigraphic Column of the MG Chromitite Layer at the Tharisa Mine

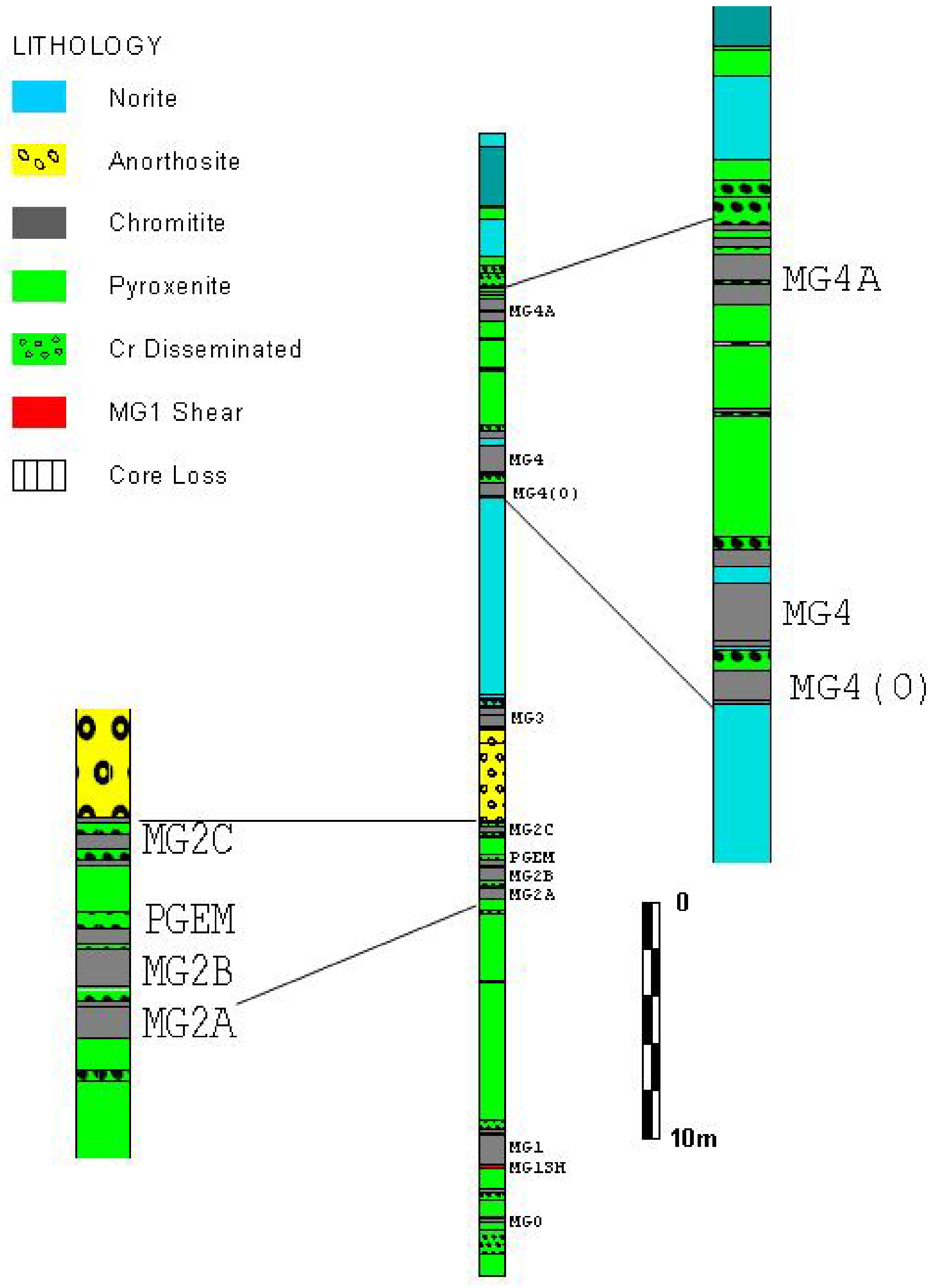


Table 6.2.2_1

Average Intersection Thicknesses of the MG Chromitite Layers and Partings

Unit or sub unit	Mine Average (m)	3PGE+Au (g/t)	Pt:Pd:Rh:Au	Cr_2O_3 (%)	Cr:Fe
MG4 Chromitite Layer					
MG4A Chromitite Layer	1.49	0.68	59:22:18:1	25.07	1.11
Parting MG4A-MG4	4.19	0.14	56:23:19:2	4.98	0.35
MG4 Chromitite Layer	1.55	1.76	70:15:15:0	28.28	1.22
Parting MG4-MG4(0)	0.79	1.04	77:12:`0:0	15.18	0.99
MG4(0) Chromitite Layer	0.56	1.31	69:17:13:0	29.00	1.21
MG4 to MG4(0)	2.90	1.39	71:15:13:0	24.69	1.17
MG3 Chromitite Layer					
Parting MG4(0)-MG3	9.68				
MG3 Disseminated	1.61	0.75	47:38:14:1	5.43	0.59
MG3 Chromitite Layer	1.41	1.84	54:32:14:0	25.66	1.16
MG3 - Zebra	1.17	0.54	66:21:13:1	5.14	0.65
MG2 Chromitite Layer					
Parting MG3-MG2C	3.84				
MG2C Chromitite Layer	0.63	2.07	69:19:11:0	28.89	1.20
PEGM+	0.86	0.96	74:16:9:0	5.02	0.37
PEGM	0.53	2.66	73:17:10:0	16.21	0.87
PEGM-	1.03	0.69	68:21:11:1	6.96	0.48
Parting MG2C-MG2B	2.42	1.12	72:18:10:0	9.97	0.63
MG2B Chromitite Layer	0.57	1.27	68:17:14:0	31.49	1.24
Parting MG2B-MG2A	0.82	0.64	68:19:12:1	11.95	0.71
MG2A Chromitite Layer	0.60	2.01	71:21:8:0	29.09	1.20
MG2 package	5.04	1.56	71:19:10:0	19.74	0.98
MG1 Chromitite Layer					
Parting MG2A-MG1	11.03	0.21	49:38:11:2	4.53	0.33
MG1 Chromitite Layer	1.21	0.64	51:32:17:1	31.92	1.30
MG0 Chromitite Layer					
Parting MG1 - MG0	3.70				
MG0 Chromitite Layer	0.58	0.87	61:19:19:1	26.31	1.19

Figure 6.2.2_2

Along strike section showing the variations in MG Chromitite Layer partings

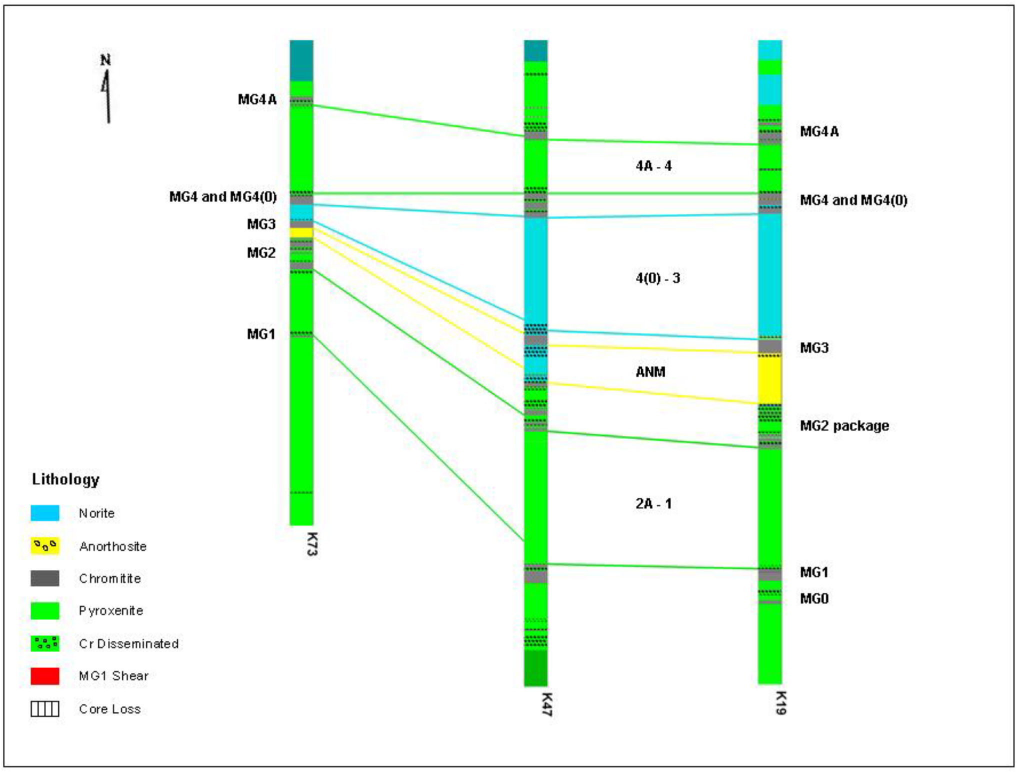
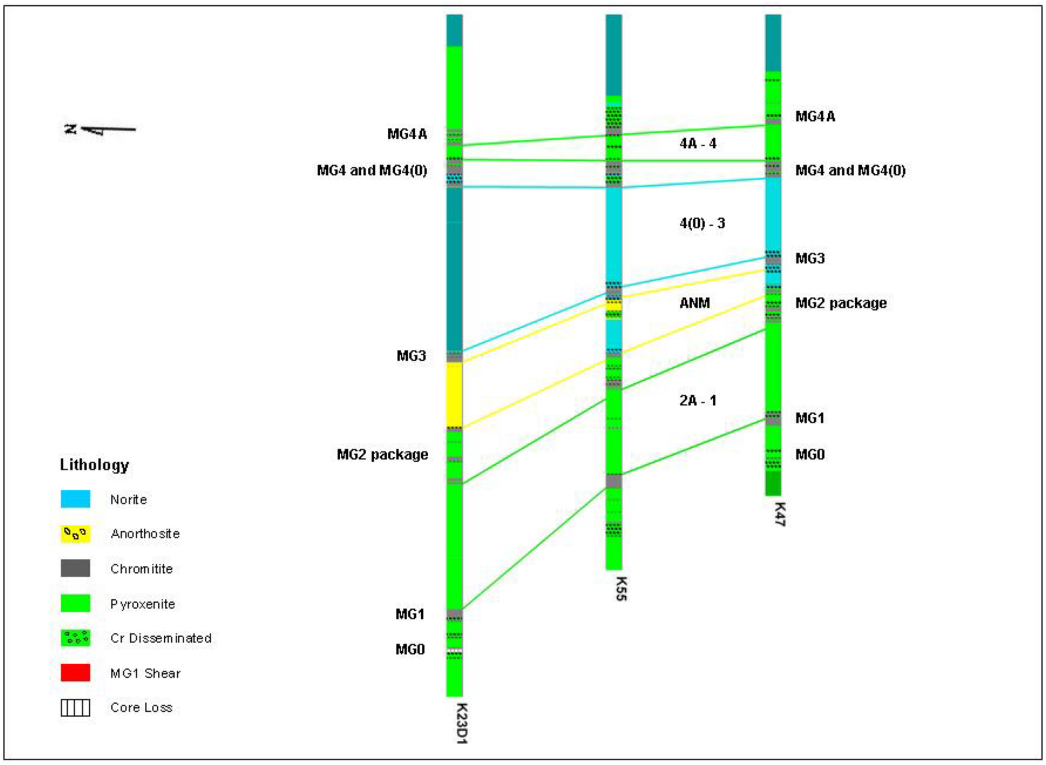


Figure 6.2.2_3

Downdip section showing the variations in MG Chromitite Layer partings



Description of the MG0 Chromitite Layer

Some dissemination and more chromitite layers and stringers are developed in the footwall pyroxenite of the MG1 Chromitite Layer. These are termed the MG0 Chromitite Layer. The number of stringers and layers vary and little consistency was noticed within the MG0 Chromitite Layer.

Description of the MG1 Chromitite Layer

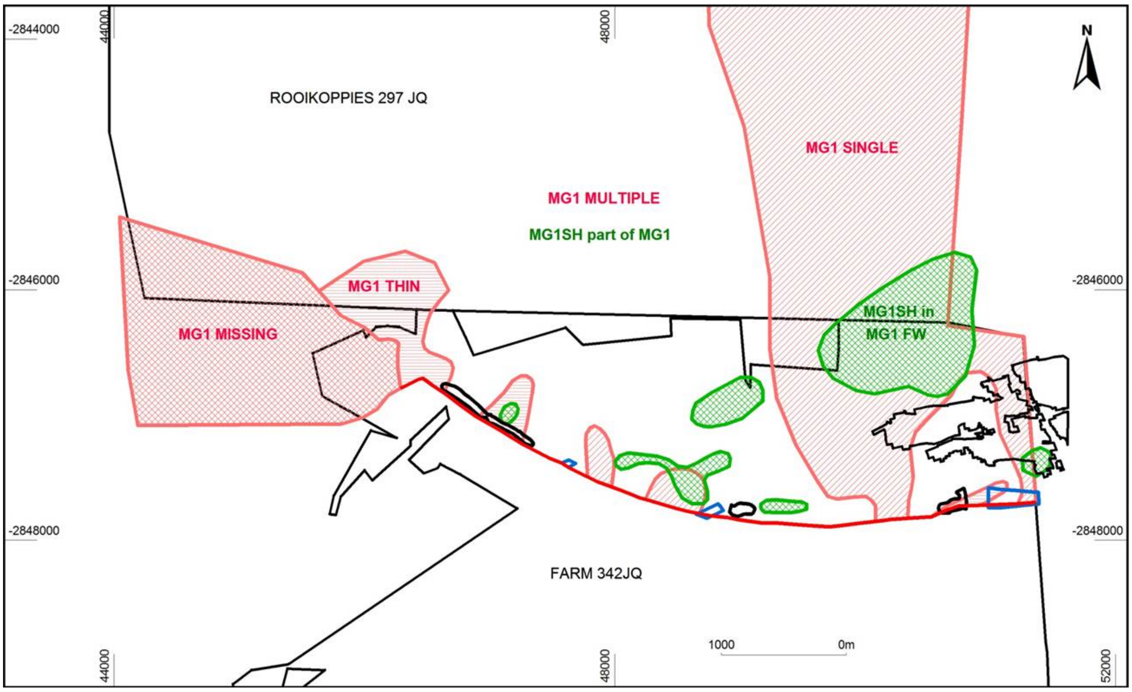
At the base of the MG Chromitite Layer Package is the MG1 Chromitite Layer (1.3m thick) with a feldspathic pyroxenite developed above for some 12m and which underlies the MG2 Chromitite Layer. The MG1 Chromitite Layer is typically a massive chromitite with minor feldspathic pyroxenite partings or layering. In some areas the MG1 Chromitite Layer has developed into two chromitite layers separated by a feldspathic pyroxenite. A textural feature called mottling is common in both the MG1 Chromitite Layer and MG2B Chromitite Layer. The mottles reflect large rounded individual silicate crystals (5mm in diameter), called oikocrysts (Schurmann, 1998). The MG1 Chromitite Layer becomes thinner to the west with a transition from 1.3m thick in the east to an average of 0.75m thick in the west. The MG1 Chromitite Layer has a relatively simple structure.

Borehole intersections and trench exposures clearly demonstrate that the MG1 Chromitite Layer thins towards the NW near surface and eventually disappears. Although outcrop of the MG1 Chromitite Layer disappears, it was intersected again downdip below 50m depth. It is not uncommon for the MG1 Chromitite Layer to split into more than one layer. The facies outlines defined are single, multiple (where the MG1 Chromitite Layer splits into various bands), thinning and missing (Figure 6.2.2_4). Shearing in and around the MG1 Chromitite Layer is common and can occasionally be present in the hanging wall but is more common within the MG1 Chromitite Layer or its immediate footwall.

Figure 6.2.2_4

MG1 Chromitite Layer and MG1 Shear facies outlines

Mined out areas indicated with rehabilitated pits shown in blue



The MG1 Chromitite Layer carries the highest Cr content of all the MG Chromitite Layers with an average Cr_2O_3 grade of 33.9% and a Cr:Fe ratio of 1.34. The PGM concentration is low (0.6g/t 3PGM+Au). A definite geochemical signature is recognised where the top contact of the MG1 Chromitite Layer has the highest PGM concentrations grading down linearly to its bottom contact (Figure 6.2.2_5).

Midway between the MG1 Chromitite Layer and the overlaying MG2A Chromitite Layer, a thin chromitite stringer or some chromite dissemination is typically present within the felspathic pyroxenite. Figure 6.2.2_6 shows the parting/middling thickness between the MG1 and the MG2 Chromitite Layers.

Figure6.2.2_5

Typical MG1 Chromitite Layer Cr_2O_3 and 3PGE+Au geochemical signature

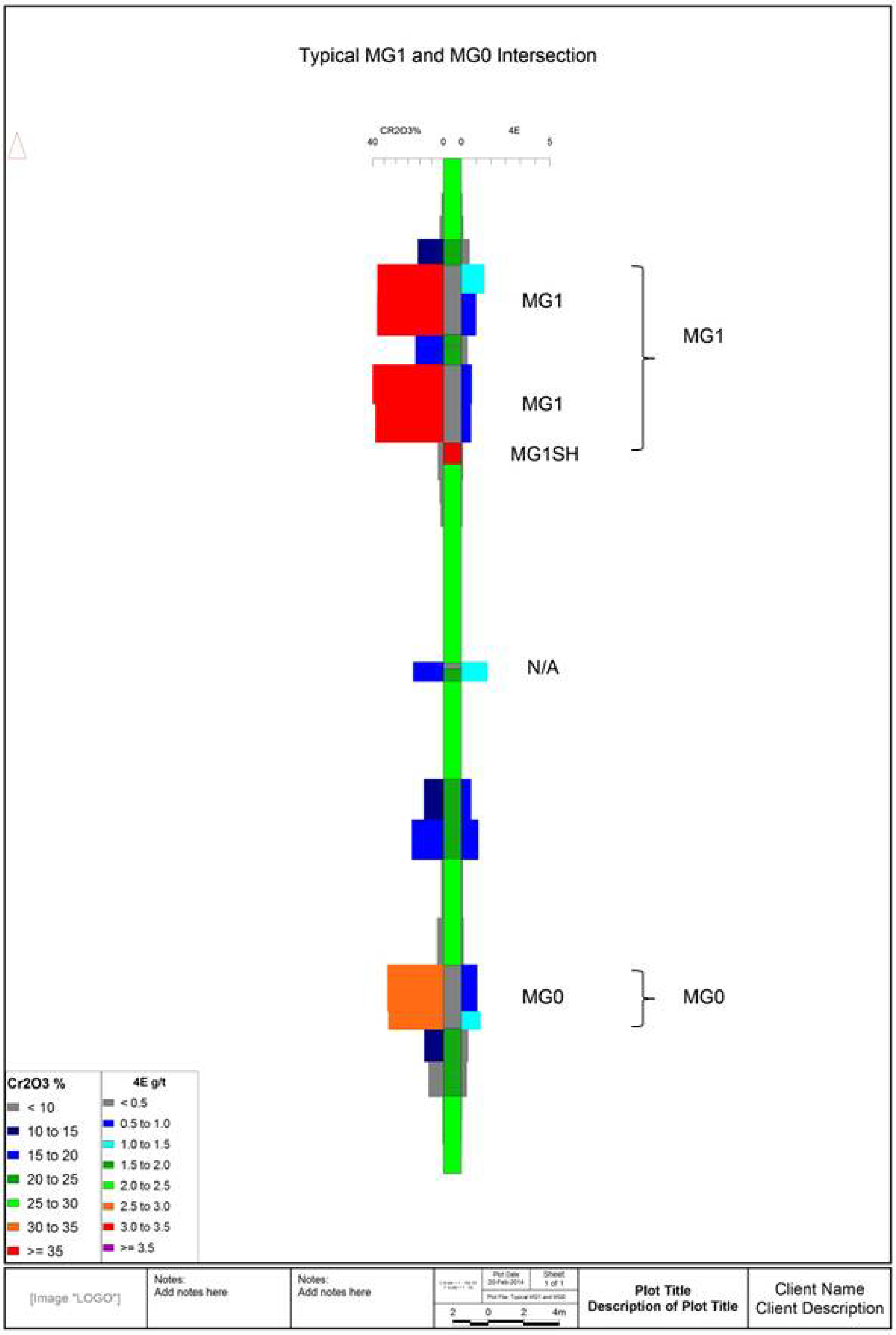
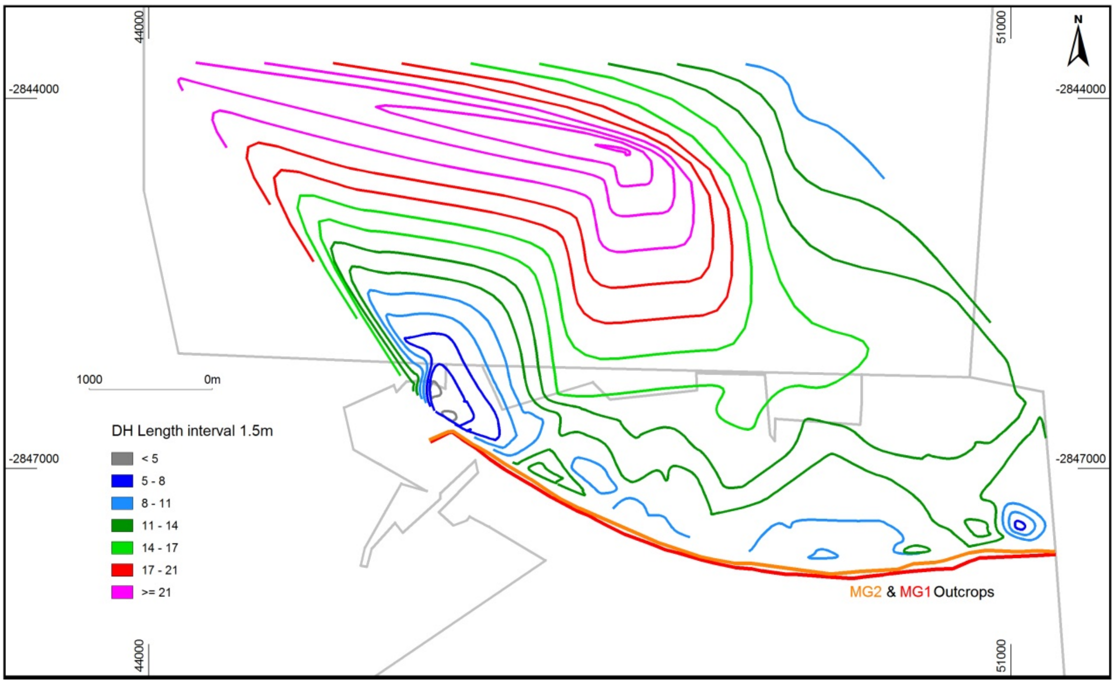


Figure 6.2.2_6

Thickness isopachs for the parting between MG2A and MG1 Chromitite Layers



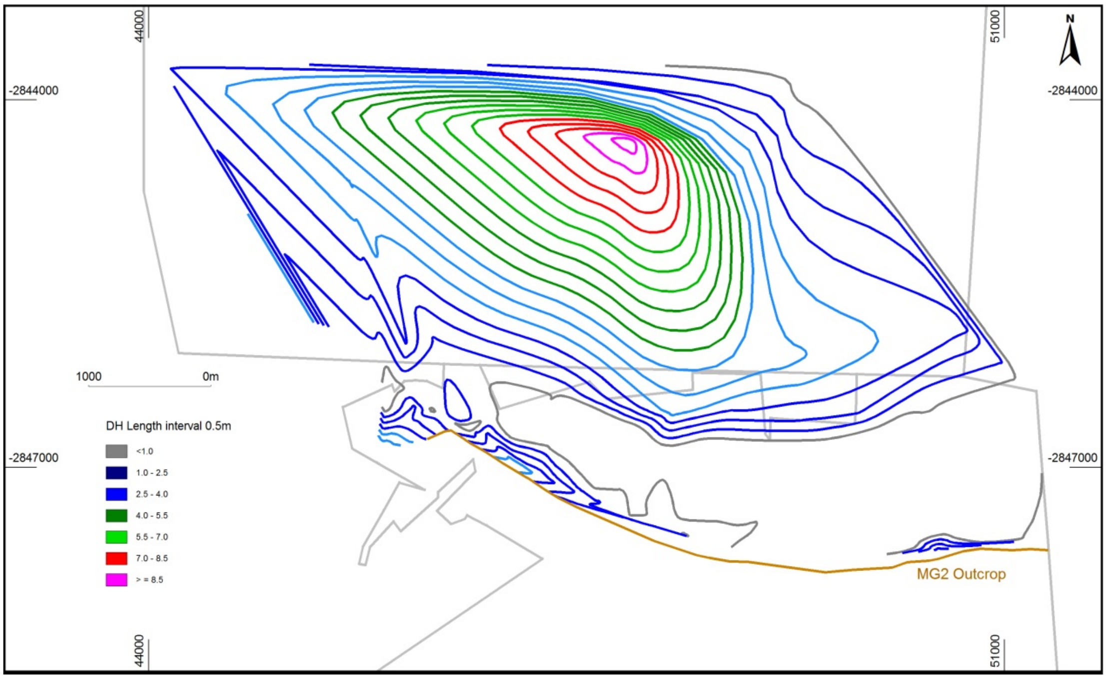
<u>Description of the MG2 Chromitite Layer</u>

The MG2 Chromitite Layer (some 4.6m thick) consists of three groupings of chromitite layers which from the base are the MG2A Chromitite Layer (0.6m thick), MG2B Chromitite Layer (0.6m thick) and the MG2C Chromitite Layer (0.6m thick). The partings are typically feldspathic pyroxenite with the parting between the MG2A Chromitite Layer and MG2B Chromitite Layer being on average 0.5m thick. The parting between the MG2B Chromitite Layer and MG2C Chromitite Layer is typically 2.4m thick and includes a platiniferous chromitite stringer (PGEM). Some 5.6m above the MG2C Chromitite Layer is the MG3 Chromitite Layer. The parting is generally an anorthosite or norite which forms the overlaying Anorthosite Marker.

The MG2A Chromitite Layer separates from the MG2B Chromitite Layer towards the NW along strike and downdip, with more than a metre separation closer to surface and up to 9m further downdip. Figure 6.2.2_7 presents the parting thickness between the MG2B and MG2A Chromitite Layers.

Figure 6.2.2_7

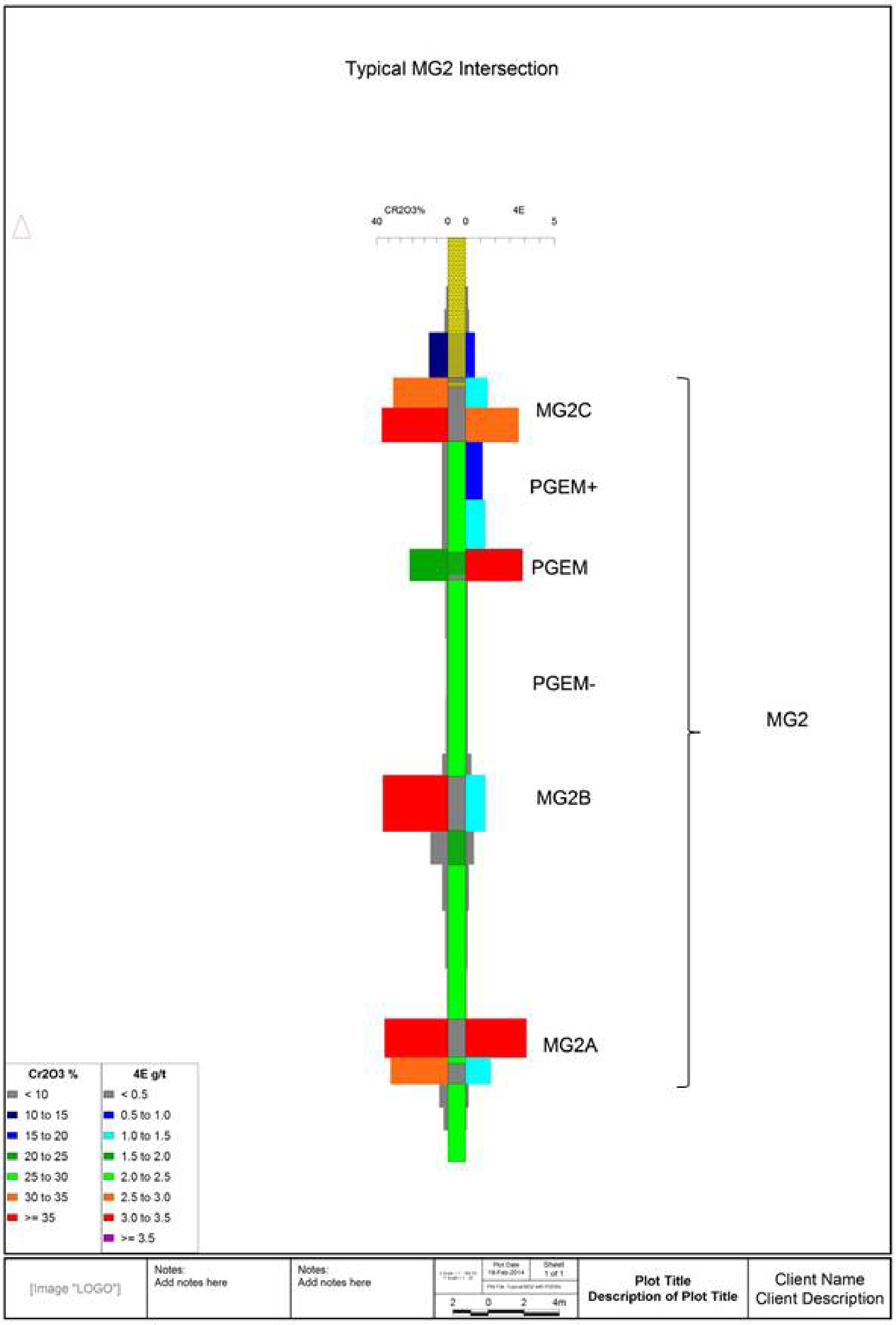
Thickness (Down Hole Intersection Length) isopachs for the parting between MG2B and MG2A Chromitite Layers



The MG2A and MG2B Chromitite Layers occasionally form a single chromitite layer but can be distinguished by a definite analytical signature. PGM concentrations are much higher in the MG2C and MG2A Chromitite Layers (±2g/t (3PGE+Au)) with a much lower concentration in the MG2B Chromitite Layer (±1g/t (3PGE+Au)). A few chromitite stringers, disseminated chromite within the middling pyroxenite and sometimes a chromitite layer at the base of these stringers, appear between the MG2C and MG2B Chromitite Layers. These have been coded PGEM and carry the highest concentration of PGMs within the MG2 Chromitite Layer at approximately 4g/t (3PGE+Au). A typical geochemical signature is presented in Figure 6.2.2_8. Typically an increase in PGM concentration from the MG2C Chromitite Layer top contact to the MG2C Chromitite Layer bottom contact can be noted. The MG2A Chromitite Layer displays the opposite signature.

Figure 6.2.2_8

Typical MG2 Chromitite Layer Cr_2O_3 and 3PGE+Au geochemical signature



The Anorthosite Marker (ANM), a prominent anorthosite, norite or a combination of the two, separates the MG2 Chromitite Layer from the overlying MG3 Chromitite Layer. Chromitite stringers are often present within the marker close to the top and bottom contacts and they may have high PGM concentration.

Description of the MG3 Chromitite Layer

The MG3 Chromitite Layer is occasionally a massive chromitite layer but more often a very irregular, assemblage of chromitite layers and stringers within a norite and/or anorthosite, which is difficult to correlate. The top of the package typically consists of thin chromitite stringers and dissemination of chromite in norite which develops into a more massive layer at the base. Due to numerous chromitite layers and stringers comprising the MG3 Chromitite Layer, it is not easy to define the core of the MG3 Chromitite Layer package or the most appropriate mining unit. The mining unit is defined largely by the presence of massive chromitite. The upper or lower limits of the mining cut was defined where the immediate hanging or footwall becomes largely noritic or anorthositic with disseminations of chromite. This typically correlates with the reduction in PGM concentration. The chromitite is mineralised with PGM bearing minerals with the disseminated chromite bearing lithologies being much less mineralised or barren. The top contact of the MG3 Chromitite Layer is not always very clearly defined and hence the use of the bottom contact as the reference contact.

The mining cut of the MG3 Chromitite Layer (1.5m thick) consists of a chromitite with disseminated chromite in a norite or anorthosite immediately above and below the chromitite (Figure 6.2.2_9). The PGM concentrations are very erratic and no definite geochemical signature is defined (Figure 6.2.2_9).

Above the massive MG3 Chromitite Layer, a layer containing disseminated chromitite with an average thickness of 1.6m has been identified. This unit has sufficient lateral continuity that it has been possible to identify it in within the open pit and within exploration boreholes. The unit is referred to as the MG3 Disseminated or Hangingwall and coded as MG3D.

Immediately below the massive MG3 Chromitite Layer a zone in which chromitite layers are developed between layer of anorthosite and norite or disseminated within these lithologies, is developed. This zone is also of sufficient lateral continuity such that it has been possible to identify and was considered of economic significance. The zone is referred to as the MG3 Zebra because of the stripey appearance.

Based on geological and geochemical features, various facies of the MG3 Chromitite Layer can be defined (Figure 6.2.2_10). The MG4(0) Chromitite Layer is some 12m above the MG3 Chromitite Layer.

Figure 6.2.2_9

Typical MG3 Chromitite Layer Cr_2O_3 and 3PGE+Au geochemical signature

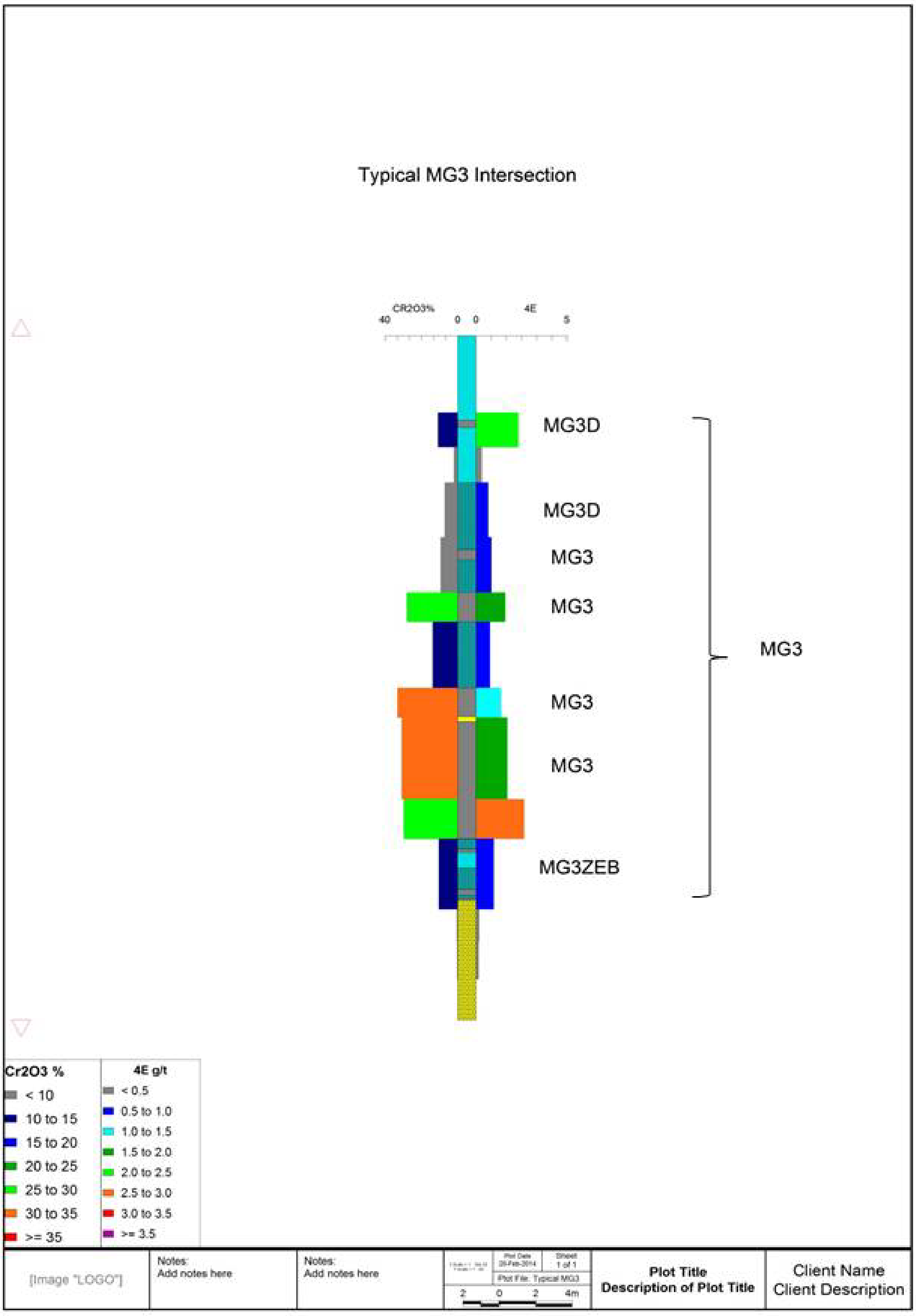
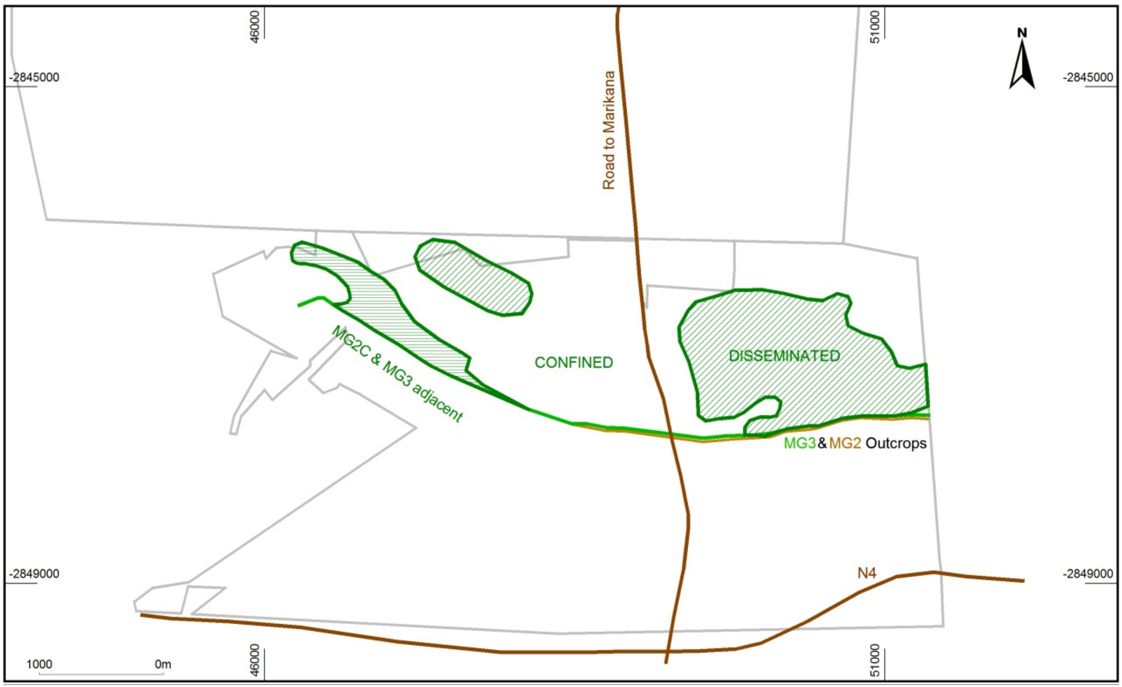


Figure 6.2.2_10

Facies defined for the MG3 Chromitite Layer



Description of the MG4 Chromitite Layer and MG4(0) Chromitite Layer

The MG4 Chromitite Layer consists of a lower chromitite (MG4(0) Chromitite Layer) (approximately 0.6m thick) immediately overlain by a norite (approximately 0.85m thick) followed by the chromitite layer of the MG4 Chromitite Layer (approximately 1.8m thick), overlain by another parting, of feldspathic pyroxenite composition, some 3.2m thick and finally overlain by the chromitite of the MG4A Chromitite Layer (approximately 1.5m thick).

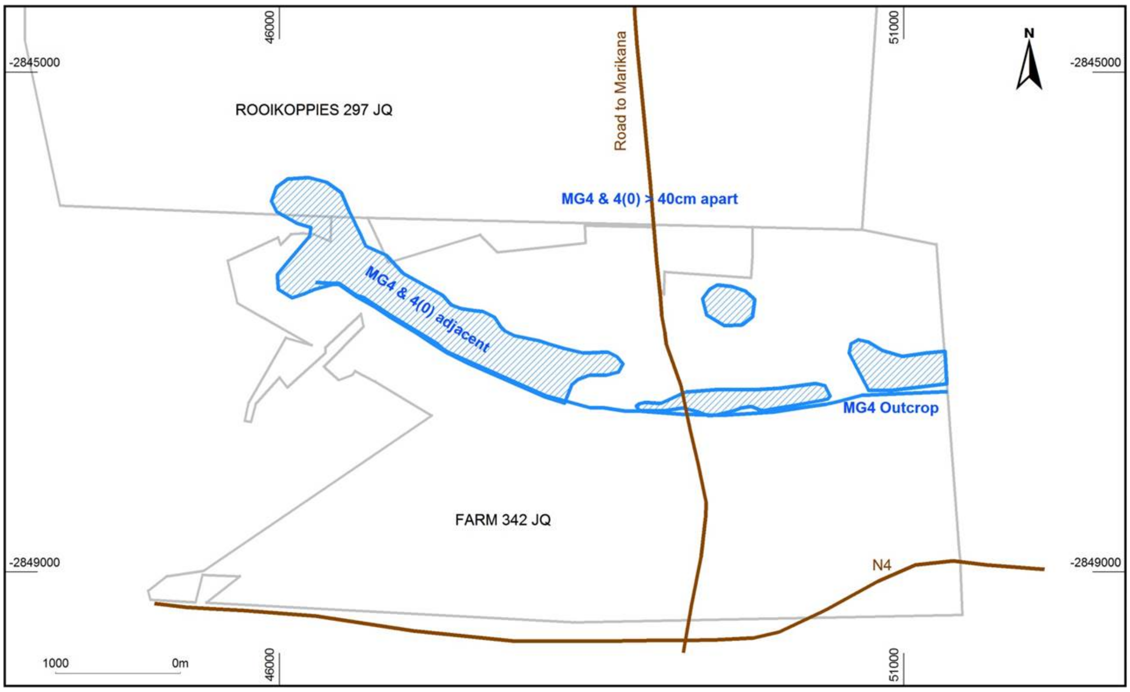
The MG4 Chromitite Layer is consistent throughout the property in that it has a pyroxenite hangingwall and a norite footwall. At its base a chromitite layer (or layers) - the MG4(0) Chromitite Layer. This subdivision is based on a geochemical signature which does not necessarily correspond to an obvious parting above the last chromitite layer.

The MG4 Chromitite Layer has a relatively simple structure similar to the MG1, MG2 and MG3 Chromitite Layers.

Both the MG4 and MG4(0) Chromitite Layers may comprise more than one chromitite layer. The parting between MG4 and MG4(0) Chromitite Layers is mostly a norite with disseminated chromite or disseminated chromite in pyroxenite. The parting is up to 2m thick at its thickest but can also be entirely absent. Based on the geology of the MG4 and MG4(0) Chromitite Layers, various facies are defined (Figure 6.2.2_11).

Figure 6.2.2_11

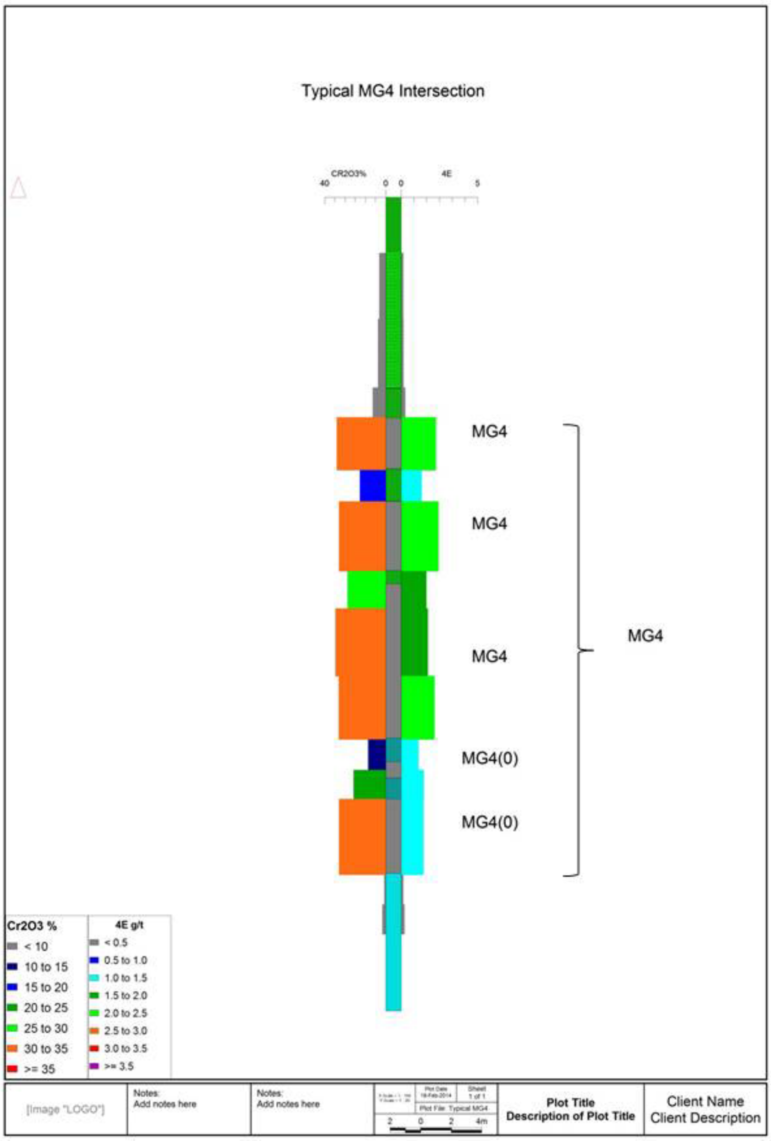
Facies defined for the MG4(0) and MG4 Chromitite Layers



The typical geochemical signatures of MG4 and MG4(0) Chromitite Layers are presented in Figure 6.2.2_12. The PGM concentration of the MG4(0) Chromitite Layer is approximately 1.3g/t (3PGE+Au) lower than the grade of the MG4 Chromitite Layer which has a PGM concentration of approximately 1.7g/t (3PGE+Au).

Figure 6.2.2_12

Typical MG4(0) and MG4 Chromitite Layer Cr_2O_3 and 3PGE+Au geochemical signature



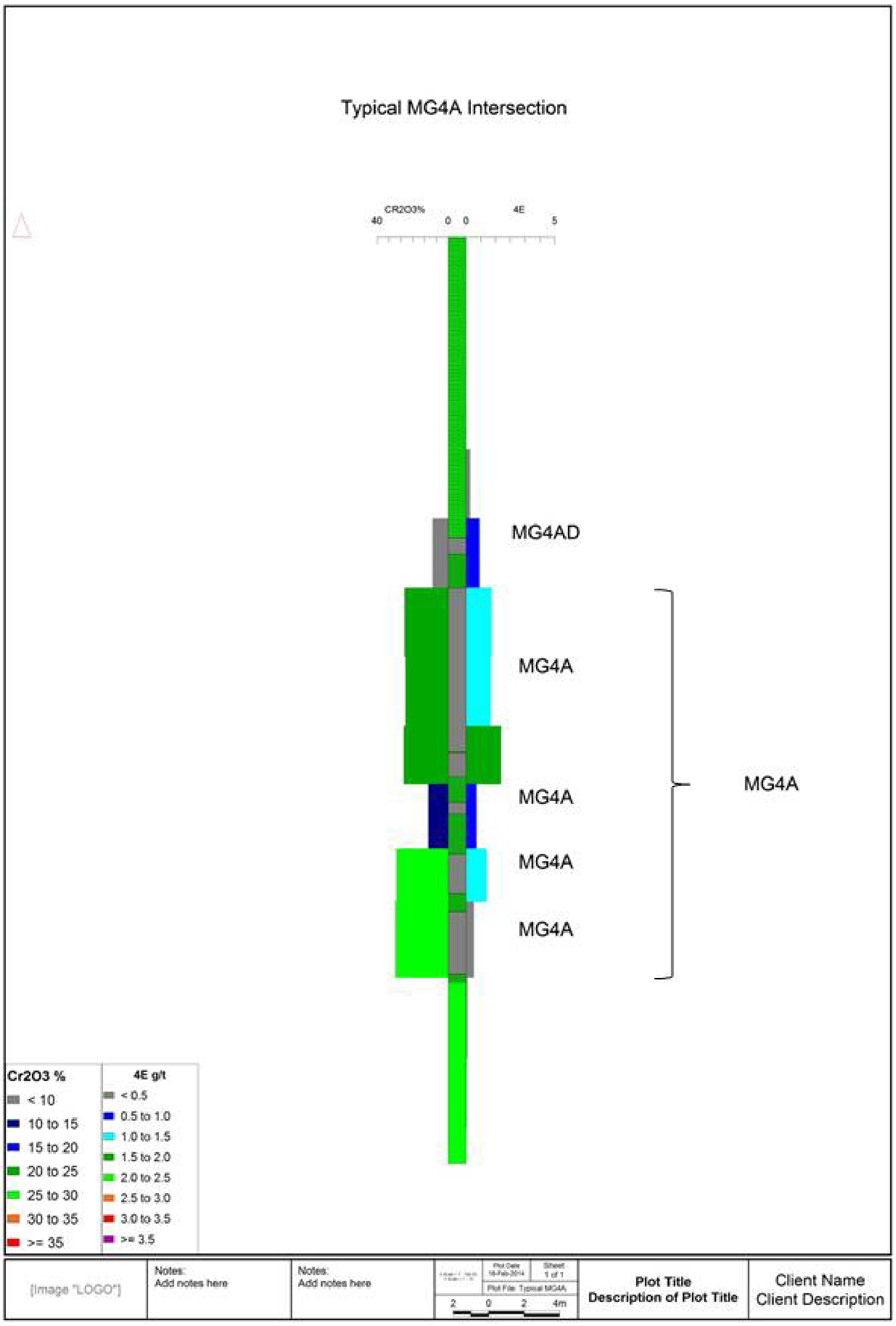
<u>Description of the MG4A Chromitite Layer</u>

Above the MG4 Chromitite Layer is a 3.2m thick feldspathic pyroxenite parting overlain by the chromitite of the MG4A Chromitite Layer (1.5m thick). The MG4A Chromitite Layer consists of a number of chromitite layers within a pyroxenite host rock. Midway between the MG4A and MG4 Chromitite Layers, chromitite stringers and disseminated chromite may be present. The MG4A Chromitite Layer, as with the MG3 Chromitite Layer, has a less well defined top contact and hence the bottom contact was contoured. A norite/melanorite is consistent prelude to the pyroxenite in the hanging wall of the MG4A Chromitite Layer.

The concentrations of Cr_2O_3 and PGM in the MG4A Chromitite Layer are low at 25% and 0.7g/t (3PGE+Au) respectively. The typical geochemical profile is presented as Figure 6.2.2_13.

Figure 6.2.2_13

Typical MG4A Chromitite Layer Cr_2O_3 and 3PGE+Au geochemical signature



6.3 Geology of the UG1 Chromitite Layer

The UG1 Chromitite Layer is stratigraphically situated in the Upper Critical Zone and is well developed in the Bushveld Complex. It comprises the massive chromitite, chromitiferous pyroxenite, bands of anorthosite, chromitite and norites and stringers of chromitites. The UG1 Chromitite Layer has a strike direction of east-west and dips to the north with the dip varying from 10º in the east to 25º in the west.

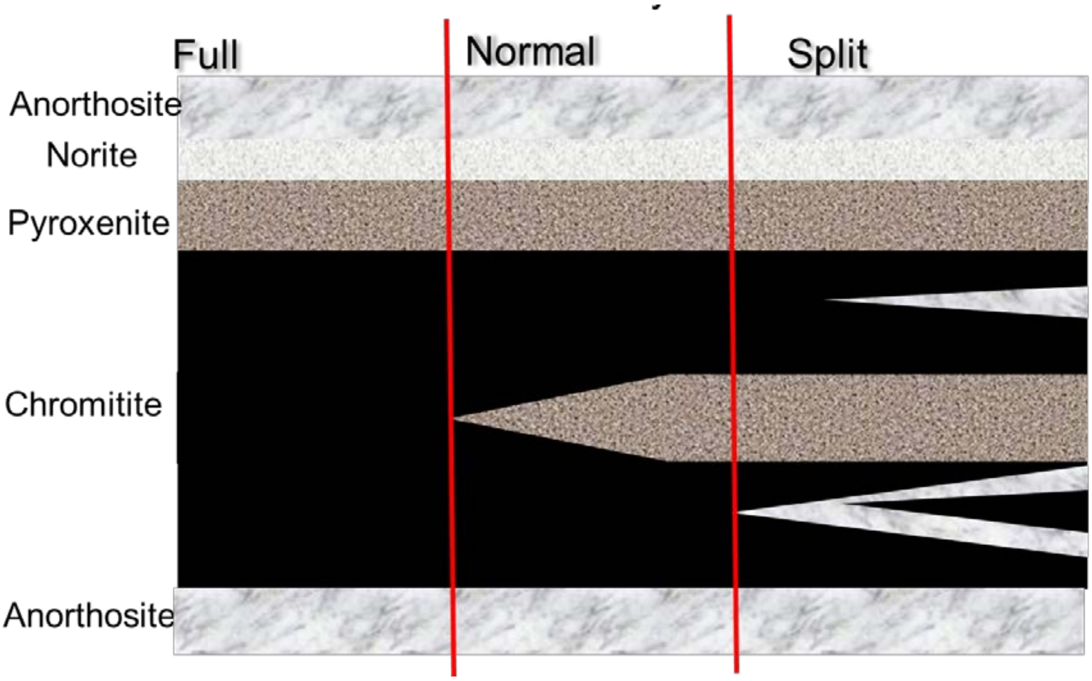
The thickness of the UG1 Chromitite Layer ranges from few centimetres up to 3m in places. The lenses of anorthosite and pyroxenite are seen impregnated with numerous chromite grains in places. The hanging wall changes from pyroxenite to anorthositic norites. The footwall is formed by bifurcated bands of anorthosite and chromite lenses.

At Tharisa Mine, the UG1 Chromitite Layer has three distinguishable facies (Figure 6.3_1):

- Full UG1 Chromitite Layer
- Normal Reef
- Split Reef Facies

Figure 6.3_1

Schematic Diagram of the UG1 Chromitite Layer Model



6.3.1 Full UG1 Chromitite Layer

This facies contributes 1% of the UG1 Chromitite Layer at Tharisa Mine. It is more prevalent to the west. It comprises a single massive chromitite layer with an average thickness of 2.5m.

6.3.2 Normal Reef

The Normal Reef facies of the UG1 Chromitite Layer comprises the massive chromitite with 10 to 100cm internal waste. The top and bottom chromitite layers have different geochemistry signatures suggesting that they were formed under different conditions and from different sources. The thicknesses of top and bottom layers differ considerably throughout the property. The thickness varies from 0.5m to 1.50m per layer.

This facies contribute 95% of the UG1 Chromitite Layer in the property.

6.3.3 Split Reef Facies

The Split Reef facies contributes 4% of the UG1 Chromitite Layer at Tharisa. It comprises of numerous layers of chromitite, anorthosite and pyroxenite as shown in Figure 6.3.3_1.

The UG1 Chromitite Layer is affected by geological structures such as reef rolls, faults, potholing, intrusives such as iron-rich ultramafic pegmatites and dykes.

Figure 6.3.3_1

Structures in the UG1 Chromitite Layer

6.4 Structure

The structural interpretation of the Tharisa Mine area is based on the aeromagnetic data and the drilling data. The MG Chromitite Layers at the Tharisa Mine are a stack of tabular deposits.

An Air Tractor 402A aircraft was used to conduct a high resolution aeromagnetic survey over the Tharisa Mine area during August 2007 (Figure 6.4_1). Total field magnetics were calculated with the use of 2 Cesium Vapour magnetometers. A DTM was constructed using real time differential GPS and a laser altimeter. A total of 900 line-km were covered. The survey lines were 0 degrees (true north) with 100m spacing. Tie lines perpendicular to the survey lines were spaced at 500m. Sample spacing was at 6.5m along the flight lines and ground clearance was 40m.

The only significant fault in the mine area is a steeply dipping NW-SE trending normal fault (Figure 6.4_1) with a downthrow of less than 30m to the east. This fault occurs only on the far north-eastern corner of the property and will have little effect on mining of the MG Chromitite Layers on Farm 342JQ. This fault was confirmed in both Lonmin underground operations and Samancor stopes.

A low angled WNW-ESE trending thrust fault (Lonmin interpretation) is a prominent lineation on the aeromagnetic image. The fault is expected to have little impact on the mining of the MG Chromitite Layers.

A NE-SW striking sub-vertical dyke of approximately 10m thickness was interpreted from the aeromagnetic survey. This dyke was not fully intersected in any of the boreholes but was intersected in the East Mine box-cut and is 11m wide.

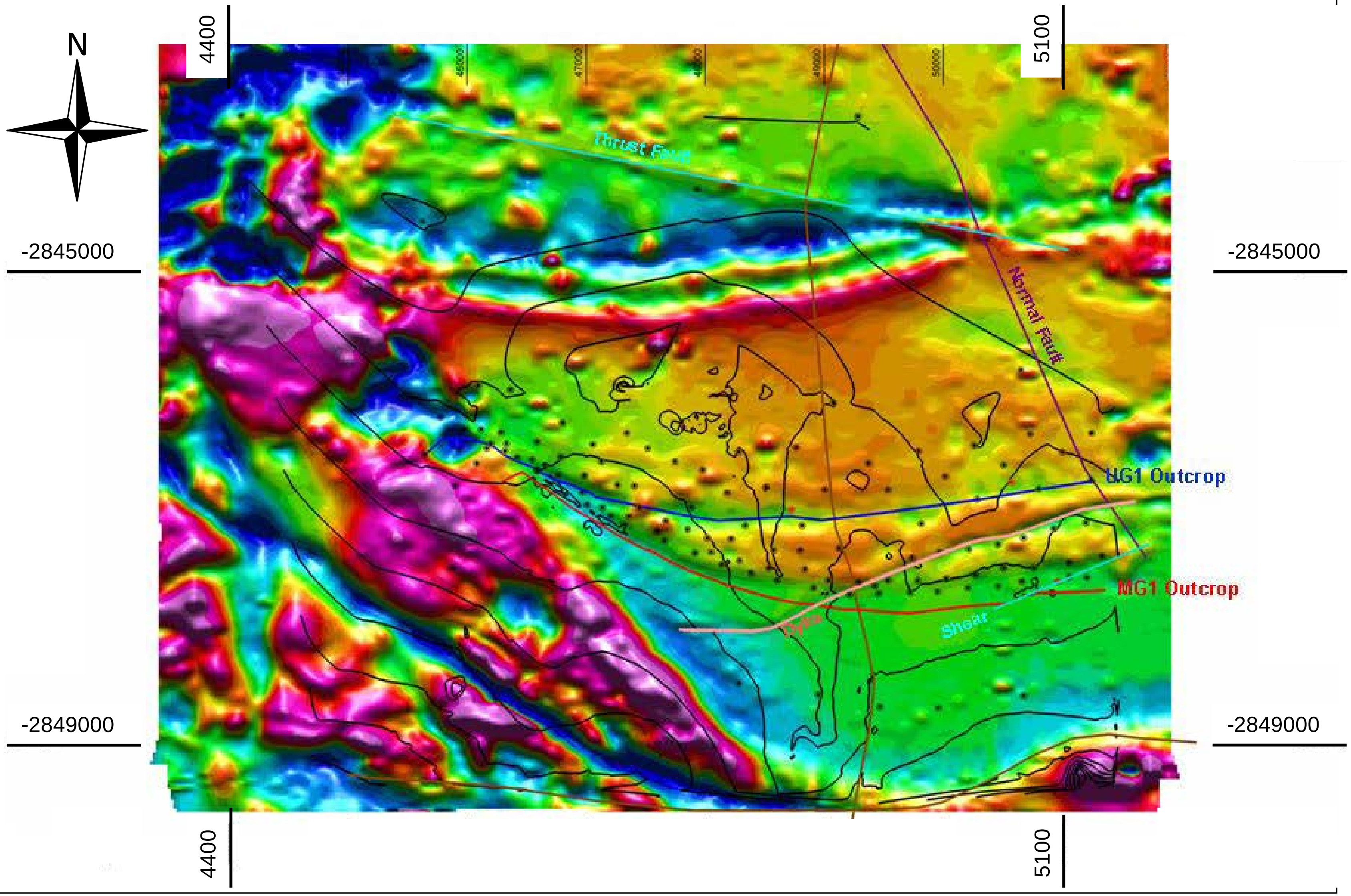
A NE-SW trending sub-vertical shear is exposed in the far eastern pit on Farm 342JQ. Evidence of this shear was seen in boreholes K94, K6A and K20. It is evident as a lineation on the aeromagnetic survey. The MG1 Chromitite Layer thickness is reduced around the shear. Future open pit activities are not affected as the thinned MG1 Chromitite Layer has already been exploited in the area around the shear.

An aeromagnetic anomaly north of the MG Chromitite outcrops, following the north-westerly curve along strike is interpreted as the anorthosite and norite in the UG1 Chromitite Layer footwall.

The only other major structural feature of interest is the Spruitfontein upfold or pothole to the west of the Tharisa Mine. It affects the UG2 Chromitite Layer as well as the rest of the Critical Zone below. The area around the pothole which is on the adjacent property was not accessible to further investigation.

Figure 6.4_1

Map Showing High Resolution Aeromagnetic Survey Interpretation



7 EXPLORATION AND DRILLING

7.1 Previous Exploration

The Tharisa Mine area has been explored for its mineral potential since the early 1900s. Initially this was in the form of erratic exploration activities which included trenching and small open pits.

7.2 Exploration by Thari

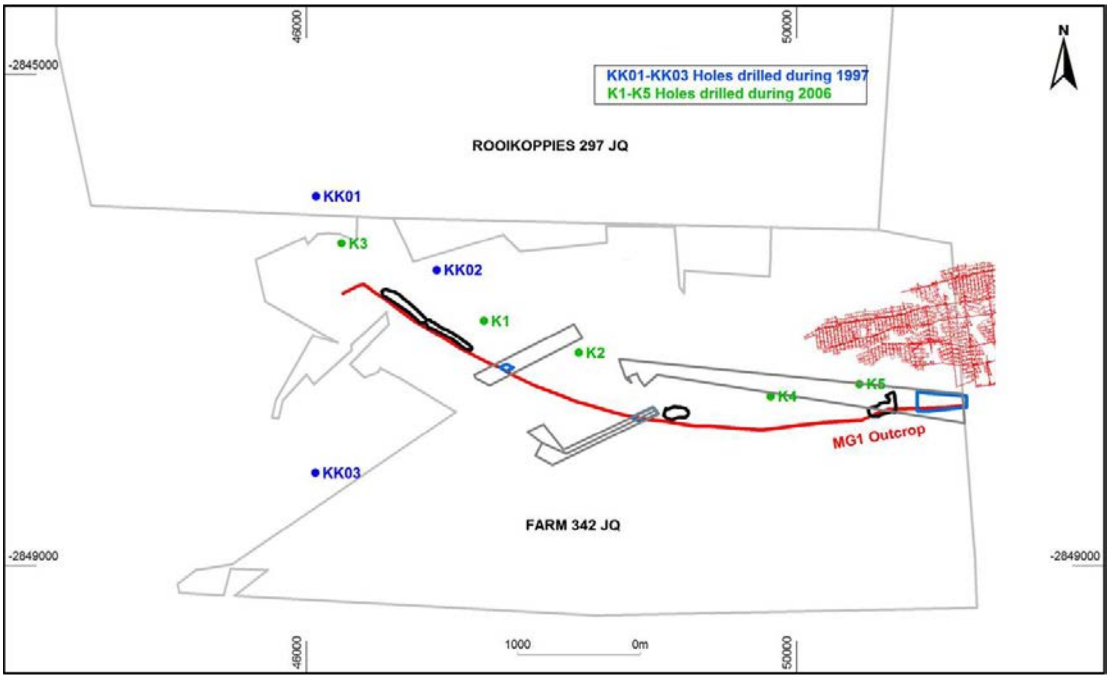
The mineral resource estimate is based predominately on a diamond drilling exploration programme managed by Coffey in 2007. Trenching was undertaken and utilised for geological understanding and geological modelling. Drilling for metallurgical sampling purposes was also undertaken but the associated assay data was not included in this modelling.

7.3 Trenching and Pit Excavations

Various trenches were historically excavated on both the UG1 and the MG Chromitite Layers. During the 2007 exploration programme additional trenching was undertaken on the MG Chromitite Layers. The MG Chromitite Layers were previously exploited from three known pits, excavated by previous tenement holders and which remain unrehabilitated. An additional two pits, one on portion 96 (Farm 342JQ) and another on portions 361/362 (Farm 342JQ), were excavated and exposed the lower half of the MG Chromitite Layer package and were subsequently rehabilitated (backfilled). A sixth pit was opened and backfilled during 2007 on portion 286 of Farm 342JQ. The details of these excavations are presented in Figure 7.3_1. A photograph taken in 2006 of the pit on portion 286 (Farm 342JQ) is presented in Figure 7.3_2. The MG1 Chromitite Layer was mined out underground by Samancor on the eastern side of the Farm 342JQ property.

Figure 7.3_1

Map Showing Distribution of the Historic Boreholes, Various Pits and the Stoped Out MG1 Chromitite Layer on the Eastern Side of Farm 342JQ.



Pits shown in blue have been rehabilitated

Figure 7.3_2

Photograph of Pit Sidewall showing the relationship of the various MG Chromitite Layers (Pit on Portion 286)

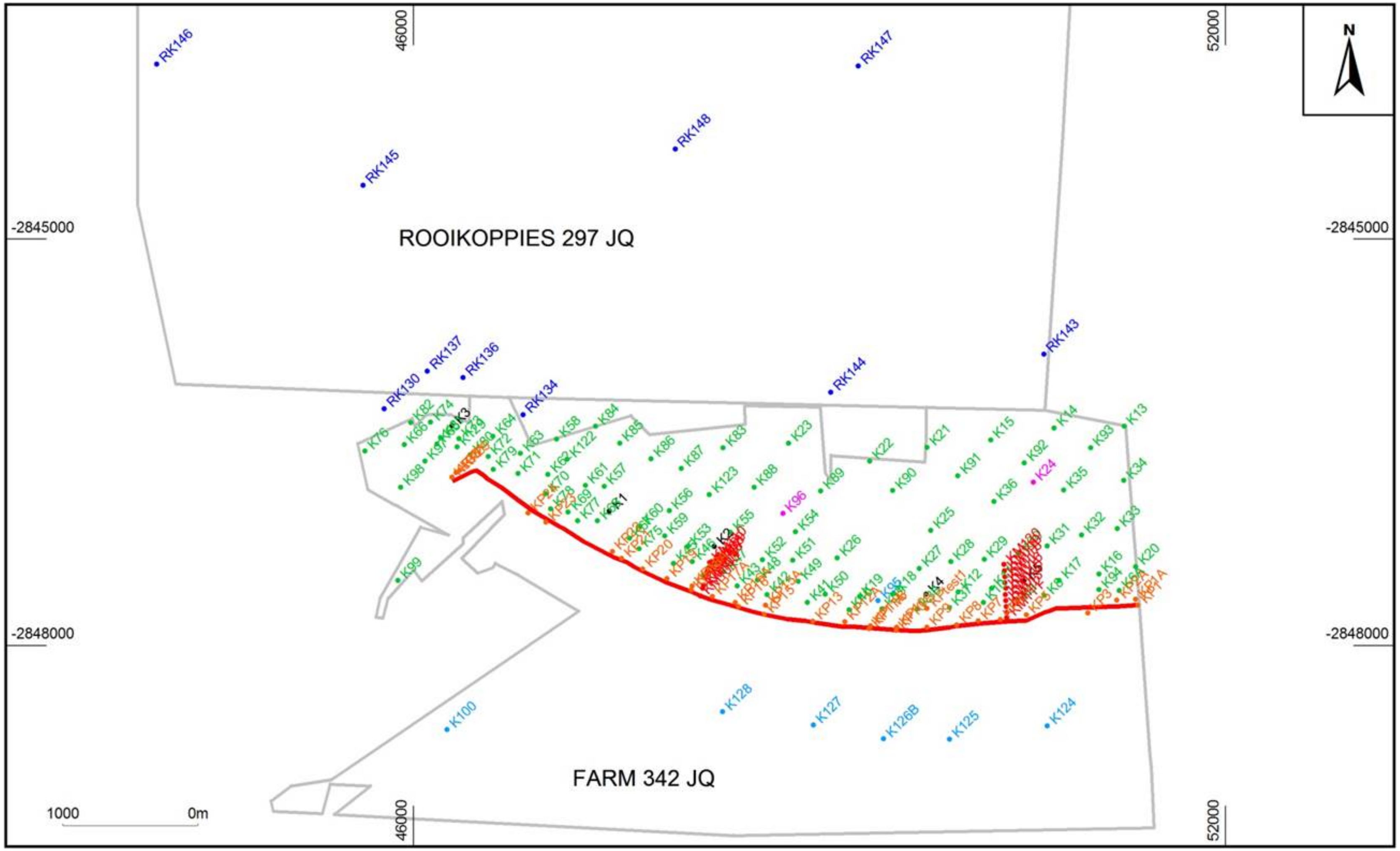
7.4 Drilling

Six diamond boreholes were drilled during January 1997 by a local entrepreneur, Mr Hennie Botha, in the northwest part of Farm 342JQ property (K01, K02 and K03) and on the adjacent property, Spruitfontein 341JQ (BSB01, BSB02 and BSB03). A report was subsequently compiled by LW Schurmann. The only data available from this exploration programme are five of the logs included in the report. The core was not made available to Coffey. The original logs provide insufficient and inaccurate detail compared to geology of diamond boreholes drilled nearby during the 2007 Thari drilling programme. The collar positions could also not be verified. The data is therefore considered unreliable and was not included in the mineral resource estimate.

Five NQ diameter, vertical diamond boreholes totalling 654m were drilled along strike on Farm 342JQ during 2006 by Thari under the supervision of Coffey. One TNW diameter diamond borehole (K4M1) was drilled 5m away from K4 for metallurgical testwork. The collar positions of these boreholes were surveyed by Clive Macintosh Surveys.

Figure 7.4_1

Location Plan for Drilling Programme on the Tharisa Mine



A total of 121 vertical boreholes and 23 deflections, representing 22,500m of drilling were completed in the period from March 2007 to October 2007 (Figure 7.4_1). Drilling was mainly of NQ (47.50mm) diameter except for 18 boreholes of TNW (60.4mm) diameter completed for metallurgical testwork. Four deep boreholes drilled on Rooikoppies were drilled BQ (36.27mm) diameter. A total of 13 NQ diameter deflections were drilled off some mother boreholes for lithological comparison. Ten TNW diameter deflections were drilled to contribute bulk material for the metallurgical testwork. Shallow percussion boreholes were drilled along the full strike extent on the MG1 Chromitite Layer, on the Farm 342JQ property, to accurately demarcate it. A total of 31 boreholes were drilled (see orange coloured collars in Figure 7.4_1); the boreholes averaged 15m in depth. All borehole locations were clearly marked with cement beacons and a PVC rod. However, where the land has since been cultivated or illegally occupied, the beacons have been either displaced or destroyed.

The drilling programme was designed so that boreholes would intersect the base of the MG1 Chromitite Layer at approximately 30m, 60m, 120m, 180m, 300m, 500m and 1000m below surface. A line of boreholes that intersected at 220m below surface later added for greater coverage of the deposit. The drilling programme was designed to drill the deposit closest to the outcrop at higher density than further downdip so that the subsequent mineral resource estimate close to the outcrop could confidently be declared as an indicated and/or measured mineral resource in preparation for a feasibility study and the consideration of open pit mining. The programme for the deeper boreholes on the Rooikoppies property where Lonmin was then mining the Merensky Reef and UG2 Chromitite Layer, was revised due to various difficulties relating to siting the boreholes to avoid holing into existing underground infrastructure. Fewer, more widely spaced boreholes were therefore drilled.

Two fence lines (oriented in the down dip direction) were drilled with TNW diameter core for metallurgical test purposes, intersecting the chromitite layers at 10m depth increments down to 60m below surface on the MG4 Chromitite Layer. These boreholes are shown in red on Figure 7.4_1 as KM101 to KM120.

Two NQ boreholes, K96 and K24, were drilled at the request of Coffey for geotechnical logging, sampling and to conduct rock strength tests.

Six sterilisation boreholes (K100 and K124 to K128 indicated in cyan, Figure 7.4_1) were drilled around the proposed civil engineering sites which coincide with the LG6 Chromitite Layer outcrop. One borehole, K95, was drilled to intersect both the MG Chromitite Layer package and the LG Chromitite Layer package.

A total of 10 boreholes (in dark blue Figure 7.4_1) were drilled on the Rooikoppies property to test the extension of the MG Chromitite Layer package down dip.

The X, Y and Z coordinates of all drill collars have been accurately determined by a qualified surveyor of Trevor Cufflin Surveys cc. Downhole surveys were undertaken on all the boreholes drilled deeper than 120m by Reflex Africa.

The surface topography data was generated from an airborne survey.

All diamond drilling was undertaken by reputable drilling contractors to industry standard. Core recoveries were estimated to average >95%. Intersections of mineralisation with lower than 95% core recovery were redrilled. Core recovery over the MG1 Chromitite Layer averaged 80% due to the presence of a fault gouge commonly present or adjacent to the MG1 Chromitite Layer. The fault gouge within the more competent rock rendered core loss inevitable.

7.5 Logging of Boreholes

A detailed geological log of each borehole was undertaken. A geotechnician marked 1m intervals on the core with a black paint marker prior to logging by a geologist. Core was logged in detail, coding the various lithologies, dip angles, grain size, rock texture, alteration, weathering, mineralisation and structures. Chromitite layers were assigned friability (friable, semi-friable or hard) and were coded in a separate stratigraphic column on the logsheets.

Data from these hardcopy logsheets were captured into a SABLE database and validated.

For all chromitite layer intersections below 60m depth a rock quality designation (RQD) was calculated starting 20m above the reef top contact. A RQD for each drill run length was calculated. Intersections within the run length with joints/fractures less than 10cm apart were measured with a clinorule and all these lengths were added together and the total then subtracted from the total drill run length. A percentage of intact core (>10cm pieces) was then recorded as the RQD for that run length.

7.6 Sampling and Data Verification

After logging, representative samples over various chromitite layer intersections were marked out on the core with a paint marker. Unique sample numbers were assigned and information for each sample recorded in a sample ticket book. Core with samples marked out was photographed with a digital camera both dry and wet. Subsequently the core was cut in half vertically along its length and across to obtain the marked out samples. Only half core was submitted for analyses. The other half was retained in the core tray for future reference.

The focus during sampling was to choose sample intervals according to lithologies in order to separate the chromitite from the host rock. Each designated unit (MG1, MG2, MG3, MG4(0) and MG4 Chromitite Layer) was sampled such that the geochemistry of the unit could be investigated.

The units were sampled as indicated below:

- The MG4 Chromitite Layer was sampled continuously from the top of MG4A Chromitite Layer to the base of MG4(0) Chromitite Layer separating the chromitite within into different samples.
- The MG3 Chromitite Layer was sampled continuously from the bottom to the top contact.
- The MG2 Chromitite Layer was sampled continuously from the base of the MG2A Chromitite Layer to the top of the MG2C Chromitite Layer. The sampling was also undertaken so as to obtain the geochemical signatures of the chromitite layers separately from the partings.
- The MG1 Chromitite Layer and MG0 Chromitite Layer were sampled continuously from the bottom contact to the top contact.
- Two non-mineralised footwall and hangingwall samples were taken.

Sample intervals varied from an absolute minimum of 15cm for NQ core (20cm for BQ) to a maximum of 50cm. Chromitite samples included a 0.5 to 2cm host rock margin to avoid PGM and chrome loss during the core cutting process. This is the recognised standard for sampling of PGM deposits in the industry

Quality control monitoring protocols involved submission of sample blanks, duplicates and certified standards with the core sample batches. AMIS0010 and SARM8 were originally alternated as standards but AMIS0010 was later replaced with AMIS0006 due to lack of availability of AMIS0010.

Each sample was bagged separately with a numbered ticket inside the bag and the sample number also written on the outside of the sample bag. A dispatch form was submitted along with samples to ensure the total number of samples and correct sample numbers were recorded.

The sampling methodology is appropriate and supports the mineral resource estimate and classification made.

7.6.1 Analytical Procedures

Analyses were undertaken by Genalysis, a certified laboratory. Genalysis is an accredited Laboratory with the South African National Analytical Standards (SANAS) with reference number T0464-11-2013.

Sample preparation was undertaken in the Genalysis facility in Johannesburg prior to a pulp being air freighted to Genalysis Perth for analysis. The sample preparation was undertaken using a jaw crusher to crush samples to minus 10mm in size. Pulverising of the samples was undertaken to achieve 85% minus 75µm in size. All samples were assayed for PGM by 7E NiS/MS and for base metals by ICP Fusion D/OES.

Detection limits are presented in Table 7.6.1_1.

Table 7.6.1_1

Detection Limits Applicable to Tharisa Mine Data

Element	Detection Limit (ppb)	Element	Detection Limit (ppm)
Pt	2	Cu	20
Pd	2	Ni	20
Rh	1	Cr	50
Ru	2		
Os	2		
Ir	2		
Au	5		

The assay techniques used are considered appropriate for the PGM and base metal analyses and the mineral resource estimate.

7.6.2 Analytical Quality Control Data

A comprehensive QA/QC programme was undertaken. The QA/QC programme identifies various aspects of the results that could have negatively influenced the subsequent resource estimate. It was possible to identify samples that had been swapped, missing samples, incorrect labelling amongst other aspects. Further, the QA/QC aims to confirm both the precision and accuracy of the laboratory and thereby confirm that the data used in the mineral resource estimate is of sufficient quality.

The control samples used comprised of two different certified standards, a blank and a duplicate for every 20 samples submitted. The intended aim was 5% coverage for each of the control sample types. Further control on data integrity was achieved through re-submittal of not less than 5% of the total samples to a referee laboratory (SGS Lakefield, Johannesburg). The quality control data was analysed on an on-going basis and generated numerous queries with the laboratory. All queries were satisfactorily resolved.

SGS Lakefield is an accredited Laboratory with the South African National Analytical Standards (SANAS) with reference number T0107-10-2013.

Definition of terms related to the QA/QC protocols applied and subsequent evaluations are provided below:

A **standard** is a reference sample with a known (statistically) element abundance and standard deviation. Reference standards are used to gauge the accuracy of analytical reporting by comparing the pre-determined values to those reported by the laboratory used during an exploration project.

A **blank** is a standard with abundance of the element of interest below the level of detection of the analytical technique.

A **duplicate** is the split of a sample taken at a particular stage of the sampling process; e.g. Field Duplicate.

The precision and accuracy will be discussed in terms of the following statistical measures routinely applied by Coffey:-

Thompson and Howarth Plot showing the mean relative percentage error of grouped assay pairs across the entire grade range, used to visualise precision levels by comparing against given control lines.

Rank HARD Plot, which ranks all assay pairs in terms of precision levels measured as half of the absolute relative difference from the mean of the assay pairs (HARD), used to visualise relative precision levels and to determine the percentage of the assay pairs population occurring at a certain precision level.

Mean vs HARD Plot, used as another way of illustrating relative precision levels by showing the range of HARD over the grade range.

Mean vs HRD Plot is similar to the above, but the sign is retained, thus allowing negative or positive differences to be computed. This plot gives an overall impression of precision and also shows whether or not there is significant bias between the assay pairs by illustrating the mean percent half relative difference between the assay pairs (mean HRD).

Correlation Plot is a simple plot of the value of assay 1 against assay 2. This plot allows an overall visualisation of precision and bias over selected grade ranges. Correlation coefficients are also used.

Quantile-Quantile (Q-Q) Plot is a means where the marginal distributions of two datasets can be compared. Similar distributions should be noted if the data is unbiased.

7.6.3 Assay Quality Control Data Assessment

The quality control protocol required the use of two different certified standards, a blank and a coarse reject duplicate for every 20 samples. The intended aim was 5% coverage of each control. In addition some 5% of the samples were analysed by a referee laboratory (SGS Lakefield) (Table 7.6.3_1)

Table 7.6.3_1
Summary of the Number of Control Samples

	Submitted	Samples	Proportion
Standard SARM8	567	11,344	4.9%
Standard AMIS0006	240	11,344	2.1%
Standard AMIS0010	324	11,344	2.9%
Coarse Reject Duplicates	563	11,344	4.9%
Blanks	571	11,344	5.0%
Referee samples (pulps)	483	9,079 (actual samples)	5.3%
Referee control samples (pulps)	119	2,265 (control samples)	5.3%

Blanks

Blanks (washed silica sand) were introduced with each batch submitted to the laboratory to monitor contamination in the crushing process and pulverisation stages. Some 100g of blank material was supplied for each blank sample included in the sample batch.

The blanks were introduced at a frequency of **1 in 20 (5%)**.

Standards

The precision of laboratory results during the drilling/sampling programme were monitored with the use of two commercial standards supplied by Mintek in Johannesburg (SARM 8) and African Mineral Standards in Johannesburg (AMIS0006 and AMIS0010). Some 50g of standard material was supplied for each standard sample included in the sample batch. The standards were not crushed or milled as they were sufficiently fine grained (pulps). In addition the laboratory introduced their own standards for internal quality control purposes.

The standards were selected for the anticipated average PGM grade and a suitable matrix. Both selected standards are derived from UG2 Chromitite Layer in the Bushveld Complex.

Standards were introduced at a frequency of **1 in 20 (5%)** or greater.

Duplicates

Duplicates were generated from the coarse rejects by the sample preparation laboratory. A designated sample was crushed and riffle split to provide a duplicate rather than resubmitting duplicates from previous sample batches. This was deemed to be the most practical method of providing duplicates due to the volume of samples being submitted and the remote location of the mine area.

Duplicates were introduced at a frequency of **1 in 20 (5%)** or greater.

Inter-Laboratory Analyses (Referee checks)

Pulps were submitted to an independent laboratory (SGS Lakefield) for comparative analysis.

7.6.4 Chain of custody – Responsibility and accountability

The full chain of custody was implemented for the sample submission by the geologists to the analytical laboratory.

The details of the samples to be submitted were recorded on standard documentation on site. The samples were checked by sampling personnel and the geologists prior to shipment. All details were provided on the despatch notes.

The assay certificates were e-mailed to the Project Geologist as csv files. Cross checking of the assay certificates with the results was possible as these included details of each batch including the shipment codes.

7.6.5 Relative Density Determinations

Bulk density data determinations were derived via the Archimedean 'weight in air/weight in water' technique, using an appropriate procedure and an accurate balance. The core is essentially impermeable and contains no vugs or voids. These density determinations are therefore considered appropriate for bulk density. In total, 8,814 bulk density measurements were taken, representing samples submitted for chemical analysis and representing the various lithologies of the MG Chromitite Layers. The data was collected from all diamond drill boreholes in the latest drilling campaign.

7.7 UG1 Chromitite Layer

The UG1 Chromitite Layer was not logged in detail in the previous drilling campaigns as it was not deemed economic. In 2012, the core was relogged and sampled to determine the nature of the UG1 Chromitite Layer and allow the estimation of a mineral resource. An outcrop position of the UG1 Chromitite Layer was projected based on the present mining of the UG1 Chromitite Layer and the borehole intersections.

The layers have a north-south dip direction. All drilled boreholes on the northern side of the outcrop intersected the Layer at the anticipated depths; an indication of continuity of mineralization and consistency in dip angle. All boreholes that intersected the UG1 Chromitite Layer were logged and sampled. The logging was done 1m above and below the UG1 Chromitite Layer.

7.7.1 Sampling Methodology

Representative samples over various UG1 Chromitite Layer intersections were marked out on the core with a paint marker. Unique sample numbers were assigned and information for each sample recorded in a sample ticket book. Core with samples marked out was photographed with a digital camera both dry and wet. Subsequently the core was cut in half vertically along its length and across to obtain the marked out samples. Only half core was submitted for analyses. The other half remained in the core tray for future reference.

The focus during sampling was to choose sample intervals according to lithologies in order to separate the mineralized layer from the host rock.

Sample intervals varied from an absolute minimum of 15cm for NQ core (20cm for BQ) to a maximum of 35cm. Chromitite samples included a 0.5 to 2cm host rock margin to avoid PGM and chrome loss during the core cutting process. This is the recognised standard for sampling of chromitite and PGM deposits in the industry

Quality control monitoring protocols involved submission of sample blanks, duplicates and certified standards with the core sample batches.

Each sample was bagged separately with the ticket number inside and the sample number also written on the outside of the sample bag. A dispatch form was submitted along with samples to ensure the total number of samples and correct sample numbers were recorded.

The sampling methodology is appropriate and supports the mineral resource estimate and classification made.

7.7.2 Analytical Procedures

Sample preparation was undertaken in the SGS Lakefield laboratory in Johannesburg. The sample preparation was undertaken using a jaw crusher to crush samples to minus 10mm in size. Pulverising of the samples is undertaken to achieve 85% minus 75µm in size.

Analyses were undertaken by SGS Lakefield, a certified laboratory. All samples were assayed for major oxides by XRF fusion and PGM by 6E NiS/MS. Selected samples were analysed for base metals by ICP Fusion D/OES.

The assay techniques used are considered appropriate for the major elements, PGM and base metal analyses and suitable for use in a mineral resource estimate.

7.7.3 Chain of Custody – Responsibility and accountability

The full chain of custody was implemented for the sample submission by the geologists to the analytical laboratory. The details of the samples to be submitted were recorded on standard documentation on site. The samples were checked by sampling personnel and the geologists prior to shipment. All details were provided on the despatch notes. The assay certificates were e-mailed to the Geologist as csv and pdf files. Cross checking of the assay certificates with the results was possible as these included details of each batch.

7.7.4 Bulk Density Measurements

Bulk density data determinations were derived via the Archimedean ‘weight in air/weight in water’ technique, using an appropriate procedure and an accurate balance. The core is essentially impermeable and contains no vugs or voids. These density determinations are therefore considered appropriate for bulk density. In total, 534 bulk density measurements were taken representing samples submitted for chemical analysis and representing the various lithologies of the UG1 Chromitite Layers. The density measurements were not taken from sheared and fractured cores as they are permeable.

7.8 Summary

The geological, collar and downhole survey data is considered to conform to international standards and to be suitable for use in a mineral resource estimation. The assay data are considered acceptable in terms of both assay precision and accuracy.

Coffey is not aware of any sample technique and data audits and reviews other than reported above.

8 MINERAL RESOURCE ESTIMATION

8.1 Database

8.1.1 Borehole Database Development

Coffey was commissioned to manage the drill programme in 2007. The following key digital data relevant to the resource estimation study was compiled by Coffey:

- A borehole database that included collar location, downhole survey, assay, and geology data was compiled.
- Bulk density data and documentation.
- Assay quality control data.

In November 2013, Coffey updated the borehole database utilising the knowledge gained during the exploration phase in 2008 and the subsequent knowledge gained during the open pit mining operation. The update consisted of the coding and re-coding of the various stratigraphic layers that constitute the MG Chromitite Layer packages and adding additional codes for units for which a better understanding had been gained. The following are new units that were not present in the initial database.

- The MG4AD Layer which consists of disseminated mineralisation identified above the MG4A Chromitite Layer.
- The MG3D Layer which consists of disseminated mineralisation has been defined. It is located directly above the primary MG3 Chromitite Layer.
- The MG3 Zebra Layer has been defined. It consists of an accumulation of thinly laminated chromitite layers located directly below the MG3 Chromitite Layer.
- Sub units within the parting between the MG2C and MG2B Chromitite Layers have been identified. These are as follows:
  - A layer named the PGEM Layer has been identified as within the parting.
  - Between this layer and the MG2C Chromitite Layer above is the PGEM+ Layer.
  - Between the PGEM Layer and the MG2B Chromitite Layer below is the PGEM- Layer.

8.1.2 Borehole Database Validation

The drilling data was reviewed and validated prior to the resource evaluation studies.

The following general activities were undertaken during database validation:-

- Ensuring compatibility of total borehole depth data in each of the collar, survey, assay and geology database files.
- During the drilling programme the geological model was continuously updated and the boreholes validated on an individual basis.
- Inspections of the borehole core and consideration of the assay data to ensure understanding of the mineralisation and eliminate problems with the correlation of assay results and geology.
- Checking of borehole survey data for unusual or suspect downhole deviations.
- Ensuring sequential downhole depth and interval data in the survey, assay and geology files.

- Replacements of “less than detection limit” character entries with nominal low-grade values (half detection limit).
- Coding and re-coding of the various stratigraphic layers of the borehole database utilising the knowledge gained during the exploration phase in 2008 and the subsequent knowledge gained during the open pit mining operation.

8.1.3 Assay Quality Control Data Assessment

The quality control protocol implemented during the exploration drilling required the use of two different certified standards, a blank and a coarse reject duplicate for every 20 samples. The intended aim was 5% coverage of each control. In addition some 5% of the samples were analysed by a referee laboratory (SGS Lakefield) (Table 7.6.3_1)

8.1.4 Conclusion

The conclusion drawn is that the precision and accuracy of the assay data is acceptable for use in a mineral resource estimate.

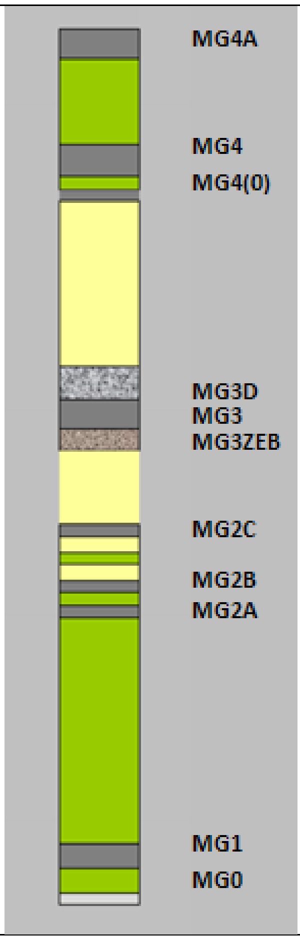
8.2 Bulk Density Database

Bulk density data was collected routinely. In total, 8,814 bulk density measurements were taken, representing samples submitted for chemical analysis and representing the various lithologies of the MG Chromitite Layer. The data was collected from all diamond drill boreholes in the latest drilling campaign. Examination of the data confirmed internal constancy with the ranges and averages typical of the lithologies represented.

8.3 Geological Modelling

The Tharisa Mine deposit was modelled using the 3D software packages Datamine™Studio Version 3.21.6774.0 and Micromine™ Version 11. The geological modelling consisted of defining and then modelling the most appropriate contact in each Chromitite Layer across the property (Table 8.3_1).

Table 8.3_1
Summary of Stratigraphic Unit modeled



Unit	Contact Modeled
MG4A Chromitite Layer	Base
MG4 Chromitite Layer	Top
MG3 Chromitite Layer	Base
MG2 Chromitite Layer	Top MG2C Chromitite Layer
MG1 Chromitite Layer	Top
MG0 Chromitite Layer	Base

Wireframe surfaces for each of the five Chromitite Layer were modelled based on the borehole intersections. The models were validated to ensure that they did not cross and that the stratigraphic sequence was maintained. It was noted that the dip flattens with depth and the deepest borehole provided unusual data.

For the open pit area, more detail was required. Wireframe surfaces for each of the eighteen units were modelled based on the borehole intersections. The thickness of some of the units i.e. the vertical distance between some of the surfaces was small. The models were validated to ensure that they represented the geometry of the units and that the stratigraphic sequence was maintained. The resulting surfaces are stacked on top of each other demonstrating the tabular nature of the deposit. The modelling utilised the other structural information gained from the aeromagnetic survey, in pit observations, surface mapping, trenching etc.

An examination of the geology revealed that it changes from east to west. In the east the stratigraphy was typically well defined with all the layers being recognisable. Towards the west, the geology becomes more complex. The identification and delineation of all stratigraphic units become more difficult as the separation of the units became narrower with some units overlying other units directly. Based on these observations a cut off was defined separating the eastern side of the property which is more constant geologically from the western part where the geology is significantly more complicated. This boundary also represents the extent where the mineral resource can be declared due to the uncertainties in the geology to the west.

8.4 Statistics

The data was coded for the different units within the MG Chromitite Layer package. Statistical analysis was then completed on both the raw and composite data grouped by unit type after examination of the data indicated that the units defined different geologically distinct populations and are well defined statistically (Table 8.4_1). Summary descriptive statistical analysis was completed based on the various geological units of the MG Chromitite Layer package

Table 8.4_1

Coding for the various units of the MG Chromitite Layer Package

DESCRIPTION	LAYER	STATIGRAPHY
4A Disseminated Hangingwall	4AD	MG4
MG4A	4A	
Parting MG4A-MG4	4A4	
MG4	4CR	
Parting MG4-MG0	44Z	
MG4(0)	4Z	
Parting MG4-MG3	4Z3	
3CR Disseminated Hangingwall	3D	MG3
MG3	3CR	
Zebra 3CR Footwall	3ZEB	
Parting MG3-MG2	2CHW	
MG2C	2C	MG2
PGEM Hangingwall	PGEM+	
PGEM Layer	PGEM	
PGEM Footwall	PGEM-	
MG2B	2B	
Parting MG2B-MG2A	BA	
MG2A	2A	
Parting MG2-MG1	2A1	
MG1	1CR	MG1
MG0	MG0	MG0

8.5 Compositing

Each intersection was composited across the full thickness of each unit as defined in the coding in Table 8.4_1. The Pt, Pd, Rh, Au, Ru, Ir, Os, Cu, Ni, Al, Ca, Cr, Cr_2O_3, Fe, Mg and Si concentrations were composited utilising the weighting by density and thickness. This is considered necessary as the lithologies have significantly different densities. An analysis of the unit thickness showed that there is little correlation between the concentration and thickness confirming that the use of concentration was appropriate for use in grade estimation.

8.6 Data Cutting

An assessment of the high-grade composites was completed to determine whether high-grade cutting was required. The approach taken to the assessment of the high-grade composites and outliers is summarised as:-

- Detailed review of histograms and probability plots with significant breaks in populations interpreted as possible outliers.
- Investigation of clustering of the higher grade data. High-grade data which clustered were considered to be real while high grade composites not clustered with other high grade data were considered to be a possible outlier and requiring further consideration either through cutting and/or search restriction.
- The ranking of the composite data and the investigation of the influence of individual composites on the mean and standard deviation plots.

Where possible outliers were identified, an examination of the data was undertaken to confirm whether this was indeed an outlier. The potential influence on the mineral resource estimate was also considered. After this examination and assessment, no high grade cutting or capping was undertaken.

8.7 Variography

Variography is used to describe the spatial variability or correlation of an attribute (Pt, Pd, Rh, Au, Cu, Ni etc). The spatial variability is traditionally measured by means of a variogram, which is generated by determining the averaged squared difference of data points at a nominated distance (h), or lag (Srivastava and Isaacs, 1989). The averaged squared difference (variogram or $\gamma(h)$) for each lag distance is plotted on a bivariate plot, where the X-axis is the lag distance and the Y-axis represents the average squared differences ($\gamma(h)$) for the nominated lag distance.

The variography was calculated and modelled in the geostatistical software, Datamine. As only weak anisotropsy was determined, all experimental variograms were generated as an omnidirectional isotropic variogram. The nugget effects were considered after examination of the closely spaced boreholes and deflections as well as consideration for other chromitite layers in the Bushveld Complex. The nugget effects are generally moderate to high, typical of the platiniferous horizons of the Bushveld Complex. Where appropriate, variograms were developed for the estimations (Table 8.7_1).

Table 8.7_1

Summary of parameters for which variograms were modelled

	MG4AD Chromitite Layer	MG4A Chromitite Layer	PARTING MG4 – MG4())	MG3D Chromitite Layer	MG3 Chromitite Layer	MG4ZEB Chromitite Layer	MG2C Chromitite Layer	MG2 PGEM+	MG2 PGEM	MG2 PGEM-	MG2B Chromitite Layer	MG2A Chromitite Layer	MG1 Chromitite Layer	MG1 Chromitite Layer
Thickness	*	m	*	m	m	*	m	m	*	m	m	m	m	m
3PGE+Au	g/t	g/t	*	g/t	g/t	*	*	g/t	*	g/t	g/t	g/t	g/t	g/t
Cr_2O_3	%	%	*	%	%	*	%	%	*	%	%	%	*	%
Density	*	t/m^3	*	t/m^3	t/m^3	*	t/m^3	t/m^3	t/m^3	t/m^3	t/m^3	t/m^3	*	t/m^3
Cu	*	ppm	*			*	*	ppm	*	ppm	*	*	*	ppm
Ni	ppm	ppm	*	ppm	ppm	*	ppm	Ppm	ppm	ppm	ppm	ppm	ppm	ppm
Cr	%	%	*	%	%	*	*	%	*	%	%	%	*	%
Pt	*	*	*	g/t	g/t	*	*	g/t	g/t	g/t	g/t	g/t	g/t	g/t
Pd	g/t	*	*	*	*	*	*	g/t	g/t	g/t	g/t	g/t	g/t	g/t
Au	*	g/t	*	g/t	*	*	*	*	g/t	*	*	*	*	g/t
Rh	g/t	*	*	g/t	g/t	*	g/t	g/t	g/t	g/t		g/t	g/t	g/t
Ru	g/t	*	*	g/t	g/t	*	g/t	g/t	g/t	g/t	g/t	g/t	g/t	g/t
Os	g/t	*	*	g/t	g/t	*	g/t	g/t	g/t	g/t	g/t	g/t	g/t	g/t
Ir	g/t	g/t	*	g/t	g/t	g/t	g/t	g/t	*	g/t	*	g/t	g/t	g/t
Al	*	%	%		%	*	%	%	%	%	*	*	%	%
Ca	*	*	%	%	%	%	%	%	%	%	%	%	%	%
Si	%	%	*		%	%	%	%	%	%	%	%	*	%
Fe	*	%	*	%		%	%	%	%	%	%	%	*	%
Mg	*	%	*	%	%	%	%	%	%	%	%	%	*	%

*- no variogram modeled and estimate undertaken using inverse distance squared

8.8 Block Model Development

A series of two-dimensional seam model-type estimates based on geologically and geochemically defined units within the MG Chromitite Layer cycle, was undertaken (Table 8.4_1). Based on the average spacing of surface boreholes and the requirements of the mine design, a parent block size of 100m x 100 was used. No rotation of the model was undertaken.

In to this model, for each unit, grade variables and layer thicknesses were interpolated.

- The MG0 Chromitite Layer was estimated as a single unit.
- The MG1 Chromitite Layer was estimated as a single unit.
- The MG2 Chromitite Layer was estimated as five units – three chromitite layers (MG2A Chromitite Layer, MG2B Chromitite Layer and MG2C Chromitite Layer) with the two partings being estimated independently due to the different geological and geochemical characteristics. The upper parting is further subdivided by a platiniferous layer (PEGM) into a lower parting (PEGM-) and an upper parting (PEGM+). Seven units – MG2C, PGEM+, PGEM, PGEM-, MG2B, MG2B-MG2A parting and MG2A Chromitite Layer.
- The MG3 Chromitite Layer was estimated three separate units - MG3D, MG3 Chromitite Layer and MG3 Zebra.
- The MG4 and MG4A Chromitite Layers were estimated as five units – three chromitite layers (MG4(0) Chromitite Layer, MG4 Chromitite Layer and MG4A Chromitite Layer) with the two partings being estimated independently due to the different geological and geochemical characteristics.

The data supplied included the 'collar' coordinates and survey data for both the mother holes and deflections. The data from the deflections thus formed part of the database as if it were an independent borehole. Each deflection within the borehole database was retained as separate data. These deflections have been offset from the surveyed chromitite layer intersection location of the mother hole by a nominal 1° at the top of wedge position. Where multiple deflections are developed, the deflections have been distributed around the borehole. The choice of displacement is arbitrary, given the scale of the borehole spacing. Maintaining the individual deflections as separate data rather than compositing the deflections to a single intersection composite is preferred.

In addition to the mineral resource estimate, the block model was utilised for subsequent mining studies. The precision of a block estimate is a function of the block size, related to the distribution of local data and the variogram structure. Although the MG Chromitite Layers have lateral variations, based on the distribution of data it is not considered possible to identify and hence it is considered impractical to selectively mine the higher grade blocks. Most of the selectivity is based on geological and geochemical characteristics of the different chromitite layers within the MG Chromitite Layer package i.e. selectivity dependent on the vertical stratigraphy.

8.9 Grade Estimation

The mineral resource estimation for the Tharisa Mine was completed using Ordinary Kriging and inverse distance weighting of borehole data. The intersected width, the density and the concentration of Pt (g/t), Pd (g/t), Rh (g/t), Au (g/t), Ru (g/t), Ir (g/t), Os (g/t), Cu (ppm), Ni (ppm), Al (%), Ca (%), Cr (%), Cr_2O_3 (%), Fe (%), Mg (%) and Si (%) of each of the units identified within the MG Chromitite Layers where the concentration or grade is for the composite over the thickness of that unit. The mineral resource estimate was completed for the area of the mining right of Tharisa Minerals.

The relationship between grade and thickness was examined for the most economically important elements namely 3PGE+Au (g/t) and Cr_2O_3 (%). Based on this analysis, the concentration of each element was estimated independently from the thickness (LENGTH) of the units. The grade estimation was carried out using the Datamine software.

8.9.1 Search Criteria

Based on the understanding of spatial variation of the data and of the geology, a spherical search was adopted. A number of search radii were tested for the different elements. The final selection of the search criteria was made after the various options were tested on the various units. The selection was based on an examination of the global grades as well as consideration for the geological variability and the observed east – west grade trends. The grade estimation utilised the search parameters presented in Table 8.9.1_1.

8.9.2 Model Validation

A visual and statistical review was completed on the estimates prior to accepting the model. Acceptable levels of mean reproduction are noted between the block model and input composite data.

Table 8.9.1_1
Sample Search Parameters

	First Search Volume			Second Search Volume			Third Search Volume		
	Search radius (m)	Min. No of Samples	Max. No of Samples	Search radius (m)	Min. No of Samples	Max. No of Samples	Search radius (m)	Min. No of Samples	Max. No of Samples
MG4AD	500	3	20	1000	3	20	8000	3	20
MG4A	500	3	20	1000	3	20	8000	3	20
MG4A-MG4 Parting	500	3	20	1000	3	20	8000	3	20
MG4	500	3	20	1000	3	20	8000	3	20
Parting MG4 – MG4(0)	500	3	20	1000	3	20	8000	3	20
MG4(0)	500	3	20	1000	3	20	8000	3	20
MG3D	500	3	20	1000	3	20	8000	3	20
MG3CR	500	3	20	1000	3	20	8000	3	20
MG3-Zebra	500	3	20	1000	3	20	8000	3	20
MG2C	500	3	20	1000	3	20	8000	3	20
PGEM+	500	3	20	1000	3	20	8000	3	20
PGEM	500	3	20	1000	3	20	8000	3	20
PGEM-	500	3	20	1000	4	20	8000	3	20
MG2B	500	3	20	1000	3	20	8000	3	20
Parting MG2B – MG2A	500	3	20	1000	3	20	8000	3	20
MG2A	500	3	20	1000	3	20	8000	3	20
MG1	500	3	20	1000	3	20	8000	3	20
MG0	500	3	20	1000	3	20	8000	3	20

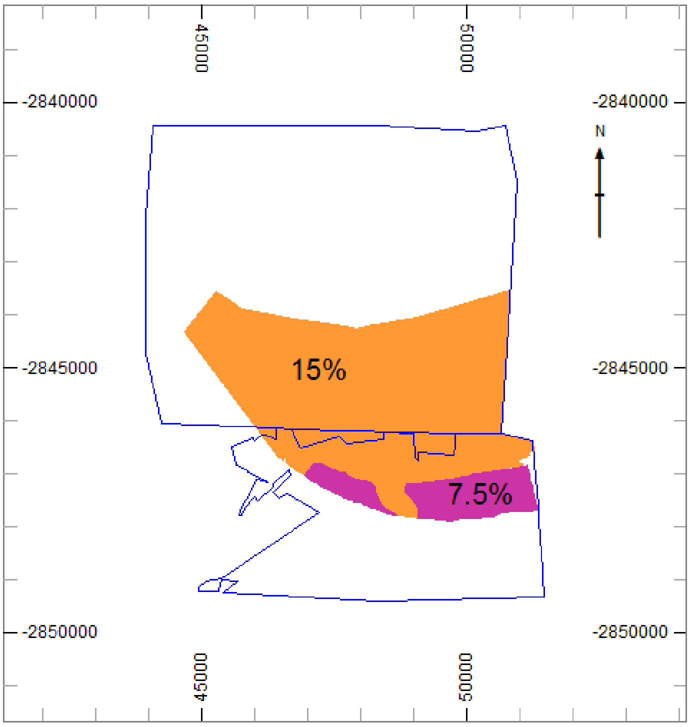
8.10 Geological Loss

The major geological features that affect the Middle Group Chromitite Layer are faults, dykes, potholes and mafic/ultramafic pegmatites. The geological model developed presents a tabular deposit with some dykes and large displacement faults crossing the property. In addition larger potholes have been delineated. However the smaller scale faulting (<10m throw) and the presence of smaller potholes must be considered. The application of a geological loss is made based on a prior knowledge of the deposit and is intended to represent these areas where the Middle Group Chromitite Layer is replaced by mafic pegmatites, intersected by faults or dykes or disrupted by potholes.

The information gained from the current mining activities has served to inform the declaration of the geological loss in the areas that are anticipated to be mined by open pit. As a result the geological loss for the East Mine and the eastern side of the West Mine has been set at 7.5%. The geological loss for the remaining pit area has been set at 15% as has the area beyond the anticipated highwall where underground mining is planned to be undertaken. The details are depicted din Figure 8.10_1.

Figure 8.10_1

Map showing the Applied Geological Loss



8.11 MG Chromitite Layers Mineral Resource Reporting

The classification of the mineral resources was undertaken in accordance with the guidelines of the SAMREC Code. The Competent Persons responsible for the mineral resource estimation and classification are Mr. Ken Lomberg Pr.Sci.Nat. and Mr Alan Goldschmidt Pr.Sci.Nat..

The classification of the mineral resource was based on the robustness of the various data sources available, confidence in the geological interpretation, variography and various estimation service variables (e.g.: distance to data, number of data, maximum search radii etc).

8.11.1 Criteria for Mineral Resource Categorisation

The resource estimate was classified as a combination of Measured, Indicated and Inferred Resource based on the criteria set out in Table 8.11.1_1.

Table 8.11.1_1

Confidence Levels of Key Criteria for Classification of MG Chromitite Layers of the Tharisa Mine

Items	Discussion	Confidence				
		MG0	MG1	MG2	MG3	MG4/MG4A
Drilling Techniques	Diamond drilling to International Standard.	High	High	High	High	High
Logging	Standard nomenclature and procedures to international standards.	High	High	High	High	High
Drill Sample Recovery	The core recovery is estimated as >95% and is considered acceptable for mineral resource estimation.	High	High/Moderate (Core very friable with generally <90% recovery)	High	High	High
Sub-sampling Techniques and Sample Preparation	International standard for Diamond Drilling.	High	High	High	High	High
Quality of Assay Data	Available data is of international quality.	High	High	High	High	High
Verification of Sampling and Assaying	Complete QA/QC programme employed.	High	High	High	High	High
Location of Sampling Points	Survey of all collars with downhole survey.	High	High	High	High	High
Data Density and Distribution	Drilled with a spacing of 250m to 2000m.	Classification based on borehole density and understanding of the underlying geology and geochemistry				
Audits or Reviews		None	None	None	None	None
Database Integrity	Errors identified and rectified.	High	High	High	High	High
Geological Interpretation	Geological interpretation of each chromitite layer. Continuity of geology adequately demonstrated. Major structures identified.	High	High	High	High	High
Mineralisation Type	Able to correlate Chromitite Layers across the project.	High	High	High	High	High
Estimation and Modelling Techniques	Ordinary Kriging.	High	High	High	High	High
Cut-off Grades	Geological interpretation of the mineralised horizon for grade composting	High	High	High	High	High
Mining Factors or Assumptions	None.	High	High	High	High	High

It should be noted that the core recovery on the MG1 Chromitite Layer was considerably more difficult due to the very friable nature of the chromitite layer. This resulted in a lower confidence in the assays and hence the lower classification of the mineral resource.

8.11.2 Mineral Resource Classification

The resource classification considers the above assessment and confidence in exploration data, geological understanding and grade estimation. The classification is presented in Figure 8.11.2_1 for MG1 Chromitite Layer and Figure 8.11.2_2 for the other Chromitite Layers.

Figure 8.11.2_1

Plan showing the location of the various classified mineral resources for the MG0 and MG1 Chromitite Layers of the Tharisa Mine

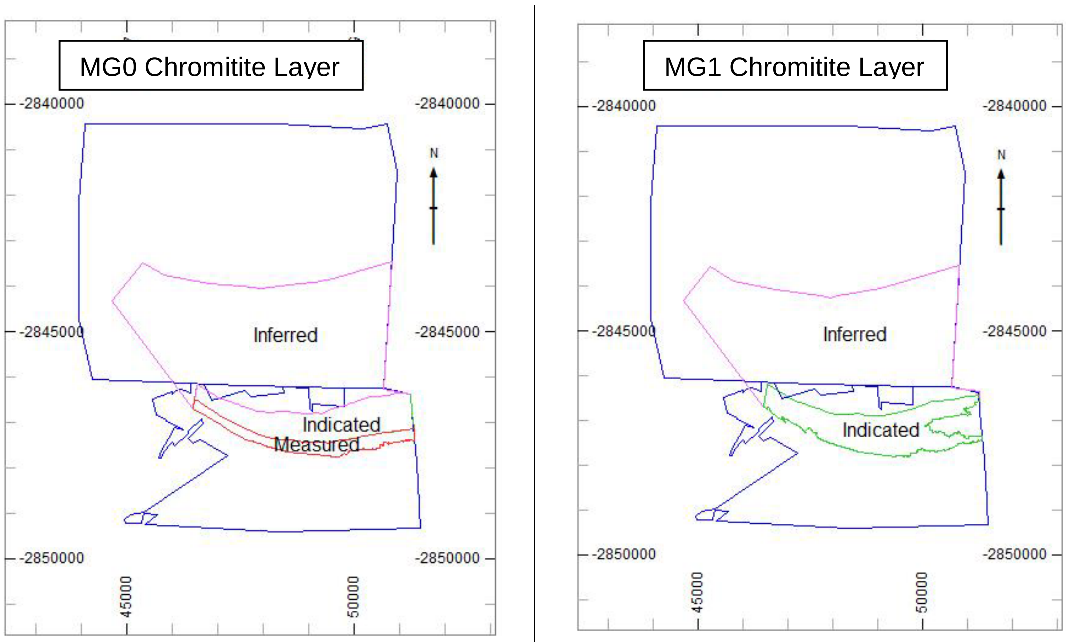
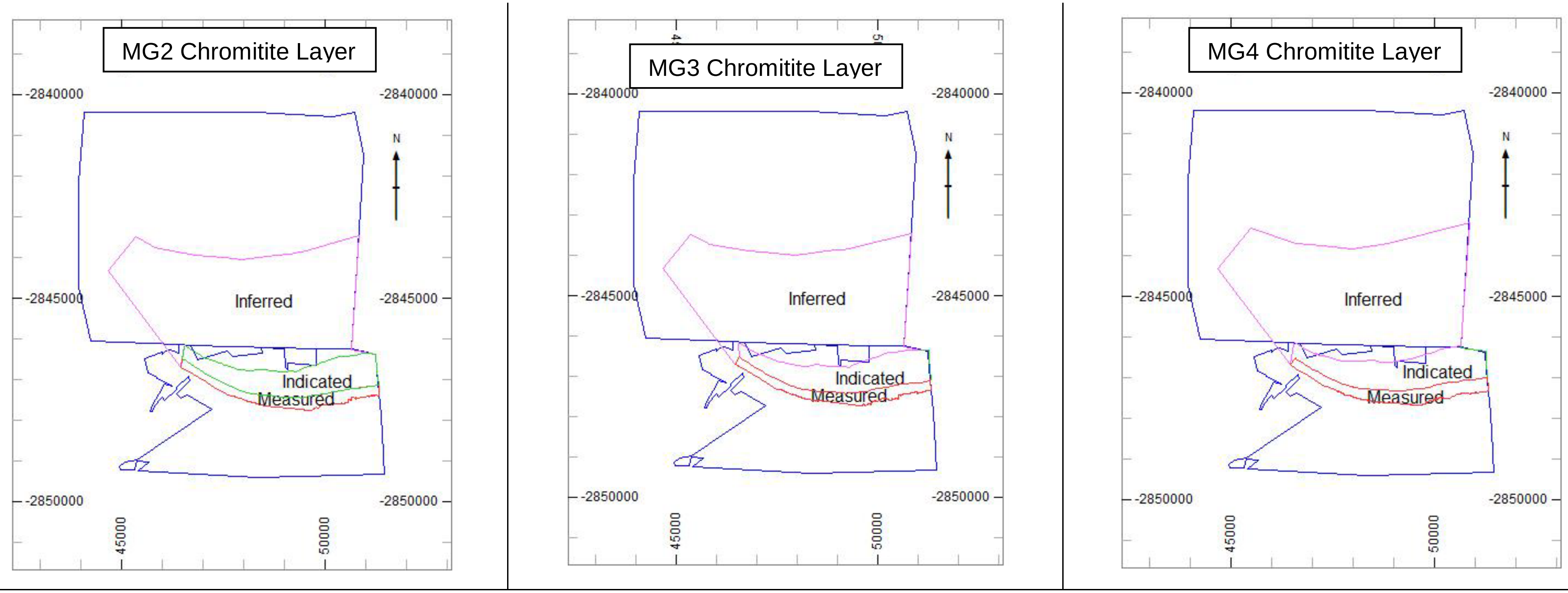


Figure 8.11.2_2

Plan showing the Location of the Various Classified Mineral Resources for the MG2, MG3 and MG4 Chromitite Layers of the Tharisa Mine



8.12 Estimate of the Mineral Resources – 31 December 2015

The September 2013 mineral resource statement was based on the interpretation of the structure and assay values available at that time. The mineral resource statement dated September 2014 was derived by depleting this estimate based on production figures of both tonnage and grade.

The Datamine block model that formed the basis for the September 2013 estimate has formed the basis of the present estimate of the mineral resources. No further exploration drilling has been completed thus primarily the structure and grade values interpolated into the 2013 block model remain valid.

Previously the location of the outcrop of each unit was projected to surface using the data from the borehole database. The present outcrop positions have now been surveyed and this new information has made it possible for the 2013 model to be updated. No new estimate of grade values has been completed.

8.12.1 Update of Geology Block Model

Mining is generally advancing down dip from south to north. The geological block models have been updated by removing those parts of the models south of the newly surveyed outcrop positions.

8.12.2 Geological Loss

No further information is available that makes it necessary to update the geological loss areas. As the outcrop positions move further north the volume of material within the 7.5% geological loss area close to the current mining operations has decreased more than the 15% geological loss area.

8.12.3 Classification of Mineral Resources

As with the geological loss areas, there is no further information is available that makes it necessary to modify these perimeters. The Measured Resources have proportionally been ‘depleted’ more than the Indicated and Inferred Resources.

8.12.4 Mineral Resource Statement

The Mineral Resource Statement for the Tharisa Mine with an effective date of 31 December 2015 is presented in Table 8.12.4_1.

Table 18.12.4_1

Mineral Resource Statement for the Tharisa Mine (31 December 2015)

	Tonnage (Mt)	True Thick (m)	Bulk Density (t/m^3)	Cr_2O_3 (%)	Pt (g/t)	Pd (g/t)	Rh (g/t)	Au (g/t)	Ru (g/t)	Os (g/t)	Ir (g/t)	3PGE+ Au (g/t)	Pt:Pd:Rh:Au	6PGE+Au (g/t)	Pt:Pd:Rh:Au:Ru:Os:Ir	Cr:Fe	6PGE+Au (koz)	Ni (ppm)
MG4A CHROMITITE LAYER																		
Measured	6.234	1.43	3.69	24.82	0.40	0.15	0.12	0.003	0.26	0.04	0.05	0.67	59:22:18:0	1.02	39:15:12:0:25:4:5	1.12	204	760
Indicated	15.885	1.59	3.70	24.29	0.40	0.15	0.13	0.003	0.25	0.04	0.05	0.68	59:23:18:1	1.03	39:15:12:0:25:4:5	1.10	525	762
Inferred	68.476	1.43	3.70	25.18	0.39	0.14	0.13	0.004	0.26	0.05	0.05	0.67	59:21:19:1	1.03	38:14:12:0:26:4:5	1.11	2,263	763
MG4 and MG4(0) CHROMITITE LAYER Package																		
	Tonnage (Mt)	True Thick (m)	Bulk Density (t/m^3)	Cr_2O_3 (%)	Pt (g/t)	Pd (g/t)	Rh (g/t)	Au (g/t)	Ru (g/t)	Os (g/t)	Ir (g/t)	3PGE+ Au (g/t)	Pt:Pd:Rh:Au	6PGE+Au (g/t)	Pt:Pd:Rh:Au:Ru:Os:Ir	Cr:Fe	6PGE+Au (koz)	Ni (ppm)
Measured	17.920	4.09	3.74	26.39	0.69	0.19	0.17	0.003	0.32	0.06	0.08	1.06	66:18:16:0	1.51	46:13:11:0:21:4:5	1.17	872	781
Indicated	29.790	2.99	3.65	24.75	1.08	0.22	0.21	0.003	0.36	0.08	0.11	1.51	71:15:14:0	2.06	52:11:10:0:18:4:6	1.20	1,972	730
Inferred	170.678	3.70	3.62	22.60	0.99	0.19	0.19	0.003	0.34	0.07	0.10	1.36	72:14:14:0	1.88	53:10:10:0:18:4:6	1.15	10,313	697
MG3 CHROMITITE LAYER																		
	Tonnage (Mt)	True Thick (m)	Bulk Density (t/m^3)	Cr_2O_3 (%)	Pt (g/t)	Pd (g/t)	Rh (g/t)	Au (g/t)	Ru (g/t)	Os (g/t)	Ir (g/t)	3PGE+ Au (g/t)	Pt:Pd:Rh:Au	6PGE+Au (g/t)	Pt:Pd:Rh:Au:Ru:Os:Ir	Cr:Fe	6PGE+Au (koz)	Ni (ppm))
Measured	10.417	3.73	3.26	13.22	0.60	0.35	0.15	0.005	0.22	0.04	0.06	1.11	54:32:14:0	1.43	42:25:11:0:15:3:4	0.99	479	482
Indicated	23.412	4.28	3.22	17.99	0.75	0.44	0.19	0.005	0.27	0.05	0.08	1.39	54:32:14:0	1.79	42:25:11:0:15:3:4	1.08	1,347	603
Inferred	67.415	3.21	3.20	25.65	1.01	0.58	0.26	0.005	0.38	0.08	0.10	1.86	54:31:14:0	2.42	42:24:11:0:16:3:4	1.13	5,245	785
MG2 CHROMITITE LAYER																		
	Tonnage (Mt)	True Thick (m)	Bulk Density (t/m^3)	Cr_2O_3 (%)	Pt (g/t)	Pd (g/t)	Rh (g/t)	Au (g/t)	Ru (g/t)	Os (g/t)	Ir (g/t)	3PGE+ Au (g/t)	Pt:Pd:Rh:Au	6PGE+Au (g/t)	Pt:Pd:Rh:Au:Ru:Os:Ir	Cr:Fe	6PGE+Au (koz)	Ni (ppm)
Measured	13.092	3.96	3.62	19.33	1.07	0.28	0.15	0.004	0.26	0.05	0.08	1.50	71:18:10:0	1.89	56:15:8:0:14:3:4	0.97	796	730
Indicated	42.716	4.37	3.67	17.80	0.98	0.28	0.15	0.004	0.24	0.05	0.07	1.42	69:20:10:0	1.78	55:16:8:0:14:3:4	0.92	2,388	733
Inferred	286.164	6.68	3.62	13.26	0.70	0.21	0.11	0.004	0.19	0.04	0.05	1.02	69:20:11:0	1.30	54:16:8:0:15:3:4	0.75	11,975	674

MG1 CHROMITITE LAYER																	
	Tonnage (Mt)	True Thick (m)	Bulk Density (t/m^3)	Cr_2O_3 (%)	Pt (g/t)	Pd (g/t)	Rh (g/t)	Au (g/t)	Ru (g/t)	Os (g/t)	Ir (g/t)	3PGE+Au (g/t)	Pt:Pd:Rh:Au	6PGE+Au (g/t)	Pt:Pd:Rh:Au:Ru:Os:Ir	Cr:Fe	6PGE+Au (koz)	Ni (ppm)
Measured												0.00	#DIV/0!	0.00	#DIV/0!		-	
Indicated	14.322	1.23	3.89	33.38	0.34	0.22	0.11	0.004	0.48	0.08	0.08	0.67	50:32:17:1	1.30	26:17:9:0:37:6:6	1.34	599	810
Inferred	57.245	1.23	3.89	32.26	0.33	0.20	0.11	0.003	0.45	0.08	0.07	0.64	51:31:17:1	1.24	26:16:9:0:36:6:6	1.29	2,277	803
MG0 CHROMITITE LAYER																	
	Tonnage (Mt)	True Thick (m)	Bulk Density (t/m^3)	Cr_2O_3 (%)	Pt (g/t)	Pd (g/t)	Rh (g/t)	Au (g/t)	Ru (g/t)	Os (g/t)	Ir (g/t)	3PGE+Au (g/t)	Pt:Pd:Rh:Au	6PGE+Au (g/t)	Pt:Pd:Rh:Au:Ru:Os:Ir	Cr:Fe	6PGE+Au (koz)	Ni (ppm)
Measured	1.801	0.50	3.74	26.07	0.57	0.18	0.16	0.004	0.30	0.05	0.07	0.92	62:19:18:0	1.33	43:13:12:0:22:4:5	1.09	77	747
Indicated	3.188	0.72	3.75	27.08	0.61	0.19	0.17	0.004	0.32	0.06	0.07	0.98	62:20:17:0	1.44	43:14:12:0:22:4:5	1.10	147	752
Inferred	0.011	0.17	3.73	23.76	0.45	0.17	0.15	0.006	0.24	0.04	0.05	0.77	58:22:19:1	1.11	41:15:13:1:22:4:5	1.00	0.40	711
UG1 CHROMITITE LAYER																	
	Tonnage (Mt)	True Thick (m)	Bulk Density (t/m^3)	Cr_2O_3 (%)	Pt (g/t)	Pd (g/t)	Rh (g/t)	Au (g/t)	Ru (g/t)	Os (g/t)	Ir (g/t)	3PGE+Au (g/t)	Pt:Pd:Rh:Au	6PGE+Au (g/t)	Pt:Pd:Rh:Au:Ru:Os:Ir	Cr:Fe	6PGE+Au (koz)	Ni (ppm)
Measured																		
Indicated	1.500	2.17	3.75	23.68	0.36	0.28	0.14	0.030	0.21			0.82	44:35:17:4			1.12	39	
Inferred																		
TOTAL MINERAL RESOURCE																	
	Tonnage (Mt)	True Thick (m)	Bulk Density (t/m^3)	Cr_2O_3 (%)	Pt (g/t)	Pd (g/t)	Rh (g/t)	Au (g/t)	Ru (g/t)	Os (g/t)	Ir (g/t)	3PGE+Au (g/t)	Pt:Pd:Rh:Au	6PGE+Au (g/t)	Pt:Pd:Rh:Au:Ru:Os:Ir	Cr:Fe	6PGE+Au (koz)	Ni (ppm)
Measured	49.464	2.68	3.73	21.51	0.73	0.24	0.16	0.004	0.28	0.05	0.07	1.14	64:21:14:0	1.53	48:16:10:0:18:3:5	1.07	2,428	699
Indicated	128.033	2.45	3.67	22.22	0.80	0.27	0.16	0.004	0.31	0.06	0.08	1.24	65:22:13:0	1.68	48:16:10:0:18:3:5	1.09	7,007	713
Inferred	651.488	3.11	3.74	19.88	0.74	0.23	0.15	0.004	0.28	0.05	0.07	1.13	66:21:13:0	1.54	49:15:10:0:18:4:5	0.98	32,072	712
Total	**828.984**	**2.95**	**3.73**	**20.38**	**0.75**	**0.24**	**0.15**	**0.004**	**0.28**	**0.05**	**0.07**	**1.15**	**66:21:13:0**	**1.56**	**48:15:10:0:18:4:5**	**1.00**	**41,507**	**712**

Note: The mineral resource is declared to a depth of 750m below surface.
The consideration of realistic eventual extraction necessitates that the mineral resource considers the MG Chromitite Layer to be a geological unit and that all platiniferous and chromiferous horizons will be mined and all PGM, Cu, Ni and Cr_2O_3 recovered.
The UG1 Chromitite Layer is declared for the part that falls within the current proposed open pit
The mineral resource is reported inclusive of the mineral reserve

8.13 UG1 Chromitite Layer

8.13.1 Methodology

The UG1 Chromitite Layer was modelled using the 3D software package Datamine™. The UG1 Chromitite Layer comprises the top chromitite layer, middling (pyroxenite/anorthosite) and bottom chromitite layers. It was necessary to further model individual layers because of the independent geochemical characteristics. Therefore three layers were modelled independently.

A plan showing the UG1 Chromitite Layer is presented in Figure 8.13.1_1. East and West Mines were modelled independently as it was noted that they are of different populations. The boundary between east and west mines was put at the river. East Mine was further divided into two domains due to geology and grade considerations in the far eastern side.

In total seven databases were distinguished and modeled independently i.e West (top, middling, and bottom), East (top, middling and bottom) and Far East (one model).

As a result of the confidence in the geological model, each of the stratigraphic units was estimated independently as a layer and hard boundary was used. Each of the (Al_2O_3(%), CaO(%), MgO(%), Fe_2O_3(%), K_2O(%), MnO(%), Na_2O(%), P_2O_5(%), Cr_2O_3(%), (Pt (g/t), Pd(g/t), Rh(g/t), Ru(g/t), Ir(g/t), Au(g/t), width(m) and density) values were estimated independently using inverse power of distance (power of 2).

Mean densities for each domain were used in tonnage calculations as the variability was low.

8.13.2 Compositing

The data was composited by stratigraphic unit (UG1 Chromitite Layer) to produce a "reef only" grade as well as composited to sub-stratigraphic zones (i.e Top, Middling and Bottom Chromitite Layers) and domains within UG1 Chromitite Layer (i.e West and East's Top, Middling and Bottom Chromitite Layers and Far East).

8.13.3 Statistical Analysis

A detailed statistical analysis was undertaken according to the geological model developed for each mineralised domain and for each metal element per composite. The composited data shows more or less normal distributions.

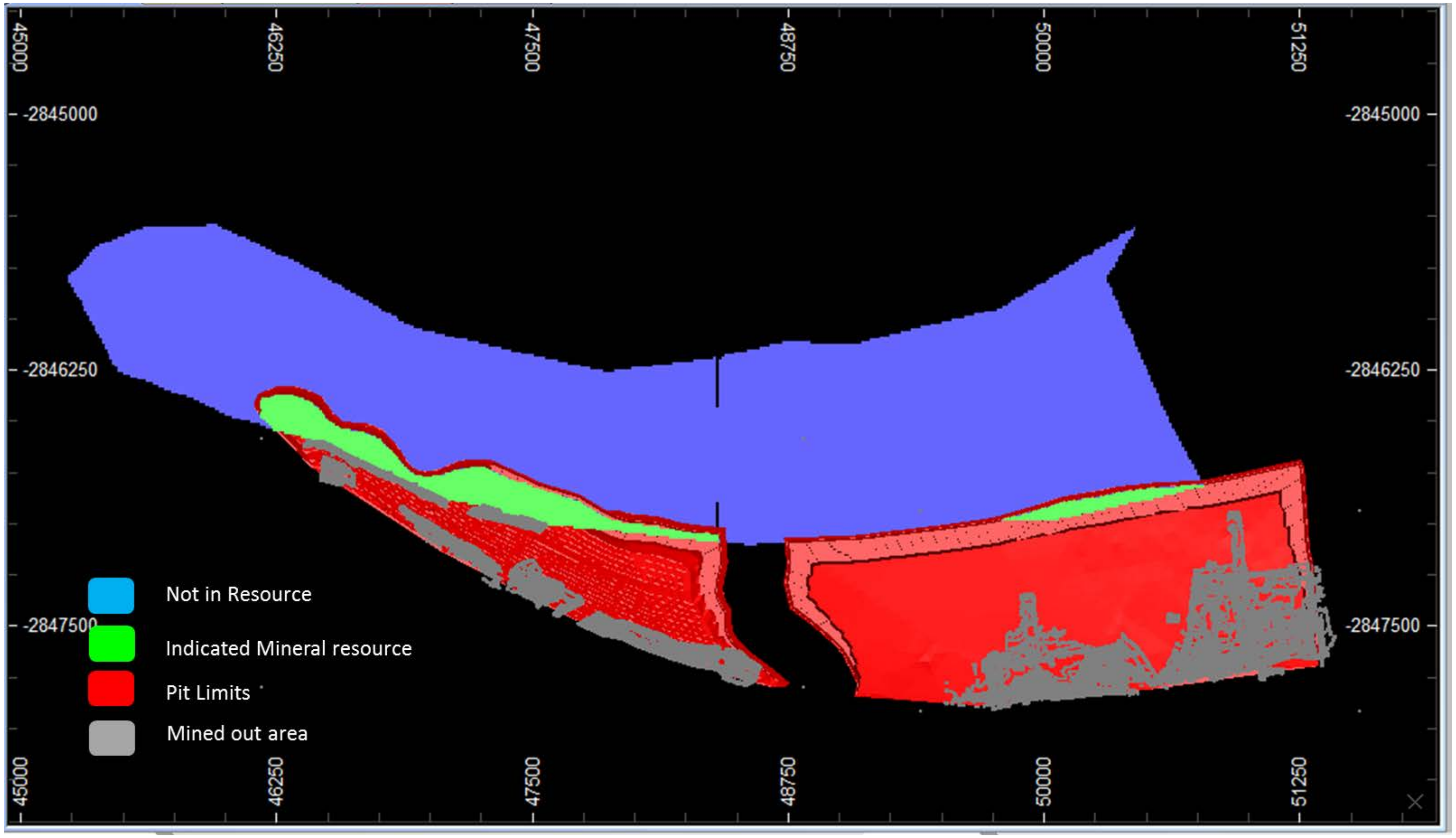
8.13.4 Geological Losses

The deposit is known to be intersected by few faults, barren mafic and ultramafic dykes as well as potholes and replacement pegmatites which both have an effect on stratigraphic and grade continuity. A geological loss of 15% was applied.

Figure 8.13.1_1

Plan view of the UG1 Chromitite Layer's Mineral Resource.

With grey colour showing the position of final pit limits, green indicates present mining status on the Middle Group in the east and to the west both Middle Group (MG) and Upper Group (UG1) chromitites are being mined.



8.14 UG1 Chromitite Layer Mineral Resource Reporting

The mineral resource in respect of the UG1 Chromitite Layer is reported in Table 8.14_1. The classification of the mineral resources was undertaken in accordance with the guidelines of the SAMREC Code. The Competent Person responsible for the mineral resource estimation and classification is Mr. Ken Lomberg Pr.Sci.Nat.

The classification of the mineral resource was based on the robustness of the various data sources available, confidence in the geological interpretation, variography and various estimation service variables (e.g.: distance to data, number of data, maximum search radii etc).

Additional consideration has been given to the stand alone potential based on reasonable expectation of eventual economic extraction. It is therefore assumed that the UG1 Chromitite Layer is mined together with the Middle Group (MG) Chromitite Layers in the same open pit.

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Table 8.14_1
Tharisa Minerals
UG1 Chromitite Mineral Resource Estimation
30 August 2012

	Layer	Thickness (m)	Tonnage (Mt)	Cr_2O_3 (%)	Pt (g/t)	Pd (g/t)	Rh (g/t)	Au (g/t)	3PGE+Au (g/t)
INDICATED MINERAL RESOURCE									
West Mine	Top Layer	1.34	0.8	24.05	0.27	0.28	0.12	0.04	0.71
	Bottom Layer	0.92	0.6	23.13	0.48	0.29	0.17	0.03	0.97
TOTAL		2.26	1.4	23.70	0.36	0.29	0.14	0.03	0.82
INFERRED MINERAL RESOURCE									
East Mine	Top Layer	1.07	0.03	24.02	0.24	0.20	0.12	0.04	0.60
	Bottom Layer	1.00	0.02	19.10	0.28	0.10	0.12	0.04	0.55
TOTAL		2.07	0.05	23.01	0.26	0.17	0.13	0.04	0.60
TOTAL RESOURCE		**2.17**	**1.50**	**23.68**	**0.36**	**0.28**	**0.14**	**0.03**	**0.82**
***Assuming UG1 Chromitite Layer is mined together with the Middle Group (MG) Chromitite Layers**									

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9 MINING ENGINEERING

9.1 Background

A feasibility study was concluded in October 2008. Various revisions to the mine plan were undertaken to match the requirements of the processing facilities, including both open pit and underground mine design and scheduling. The last revision was undertaken using the 2013 Mineral Resource update.

The selected exploitation strategy is the combined mining of MG1, MG2, MG3, MG4, MG4(0) and MG4A which extend from the surface to a depth of 750mbs at dips varying from 13° in the east to 16° in the west.

9.2 Geotechnical Assessment

The mine is being excavated following the slope designs undertaken by Celtis Geotechnical and Open House Management Services. The current slopes are much shallower than the designed slope angles of 53º for sound rock and 45º for weathered rock and soil. .This is due to the low stripping ratio, pursued for economic reasons. .This will lead to a reduction in the final pit depth unless stripping is undertaken more rapidly.

The slope assessment was based on the on fracture logging and rockmass classification of 10 boreholes (eight geological boreholes and two additional boreholes to collect samples for rock strength testing) (James, 2008) and geotechnical data collected by Open House Management Solutions (Pty) Ltd (OHMS) in the current east and central pits of Tharisa Mine to determine stable slope angles (Cilliers and Bosman, 2013).

Further data collection and reassessment of the slope design will be undertaken as mining continues. However as the pit is still very shallow this has not yet begun.

9.2.1 Geotechnical Environment

During the visit to the mine for this review the following observations were made:

- There are no slopes which have been cut to the maximum design slope of 53º so all slopes which stable.
- The benches and berms are being mined to design standards.
- In the Far West Pit the initial vertical benches in highly weathered pyroxenite and soil are being cut over 10 m high. The rock engineering consultant has recommended that these benches be pushed back with 3 m benches.
- The stripping ratio is low and will have to be increased to achieve the planned final depth.
- The deepest part of the pits is about 50 m below surface.

No critical risks were observed.

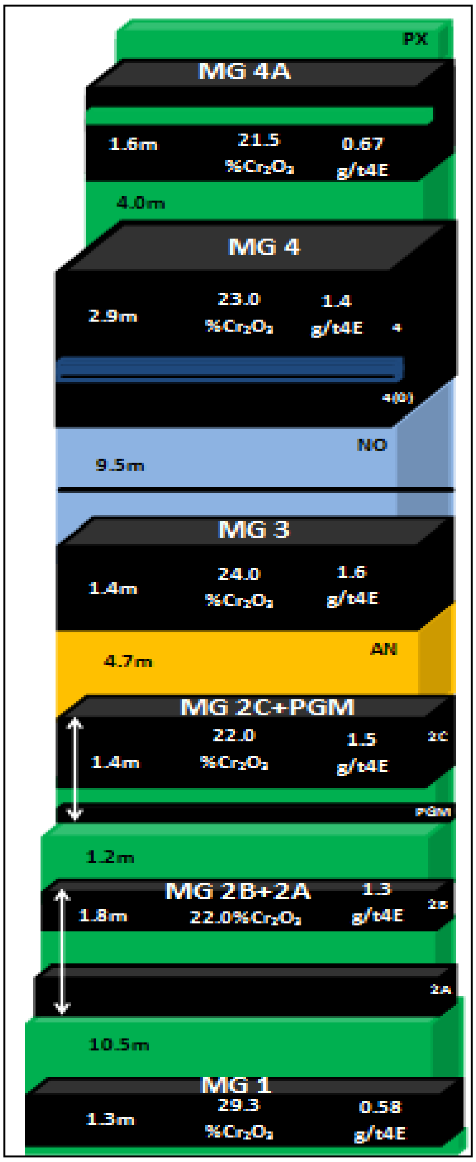
In 2013 a detailed geotechnical study was undertaken by OHMS at the mine consisting of face mapping in the existing east and central pits. Samples were collected from existing exploration boreholes for rock strength testing. The major lithological units in the ore body were tested for Uniaxial Compressive Strength (UCS), Density, Elastic Modulus and Poisson's Ratio.

These boreholes were selected to be at the location of the final pit walls.

There was also a previous geotechnical investigation in 2008 which included fracture logging and rock mass ratings of eight geological boreholes before splitting. The boreholes were selected to sample the area of the ore body and two additional geotechnical boreholes were drilled for sampling and strength testing.

It is planned to mine all the MG Chromitite Layers from the MG0 to the MG4A Chromitite Layers in the open pit (Figure 9.2.1_1). The MG Chromitite Layers sub outcrop beneath black turf soil and are separated by middlings of pyroxenite, anorthosite and norite. The footwall of the MG0 Chromitite Layer consists of pyroxenite.

Figure 9.2.1_1
Generalised Stratigraphy of the MG Chromitite Layers



Structure and rock fabric

In order to quantify the predominant orientation of geological structures in the various rock types, OHMS took measurements of exposed discontinuity surfaces in the east and central pits.

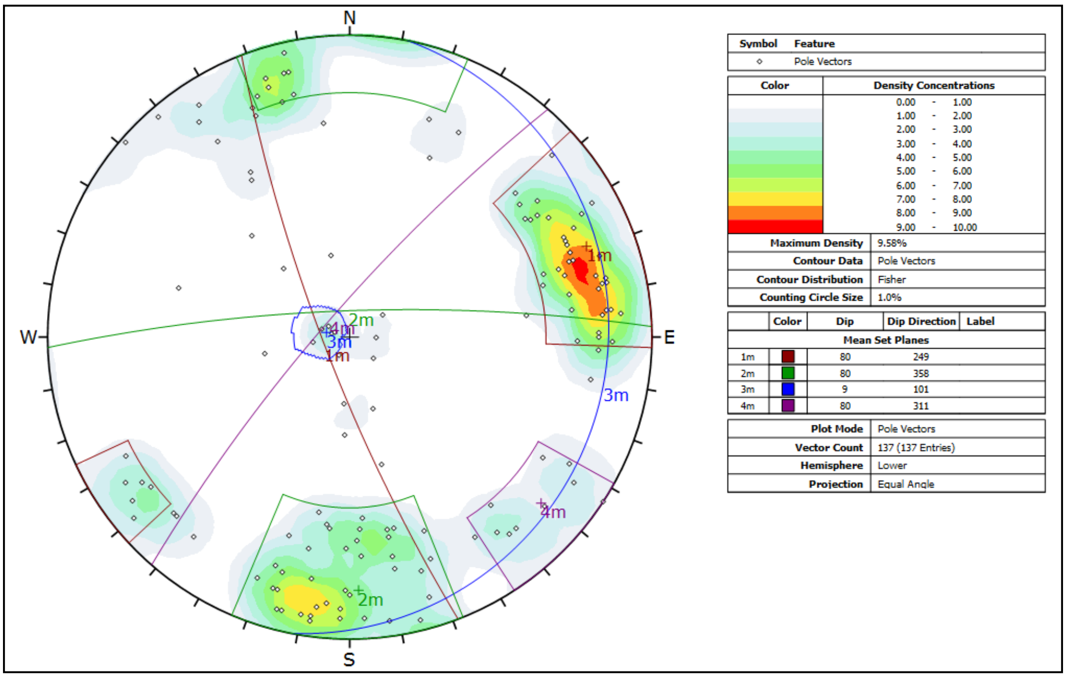
The measurements were analysed using lower hemispherical stereonet projections (Figure 9.2.1_2). Distinct joint sets were defined from Fischer concentration contours of poles. A total of 137 observations were mapped at various locations in the current pits. Four distinct clusters were identified and grouped in sets (Table 9.2.1_1). A number of randomly orientated joints, not conforming to the identified sets, were identified. Only two of these joint sets were identified as prominent, the flat dipping joints were identified as related to the igneous layering.

Table 9.2.1_1 Tharisa Minerals Summary of Joint Sets Identified in the Open Pit		
Joint set	**Dip (degree)**	**Dip Direction**
J1	8000000	249
J2	80	358
J3	9	101
J4	80	311

.

The exposed rock surfaces in the open pits were also limited as most of the areas were affected by blasting damage. Unfortunately the mapping could therefore not be performed in each lithology. No regional structures were mapped or logged.

Figure 9.2.1_2
Stereonet of Joints Mapped from In Pit Observations



Structure and rock fabric

The only geological structures of note are a major fault which strikes approximately east west and is near vertical. It should have no major effect on the open pit mining. Although faulting is limited in the area, the majority of minor faults are anticipated to be of the high angle-normal or reverse faults.

A thin shear zone which is often altered is located below or in the MG1 Chromitite Layer. Due to its position it should have no effect on the design of the open pit. However in localised areas it may mean additional support or larger pillars needed in the underground mine.

From the site visits the following observations were made:

The drill core from the geological drilling campaign is in a good state and is stored in the core shed on the property.

Some of the RoM production has been affected by poor fragmentation. An accurate geotechnical model would provide information to optimise the blasting and reduce fragmentation issues.

Rock mass quality

The rock mass quality was quantified by OHMS using the RMR methodology proposed by Bieniawski and for the purpose of comparison the Bartons Q rating was also determined. The rock mass classification was done from exposures in the current east and central pit. Figure 9.2.1_3 illustrates the methodology for rating. The results are presented in Table 9.2.1_2.

Figure 9.2.1_3
Photograph Demonstrating the Method of Rock Mass Rating Determination

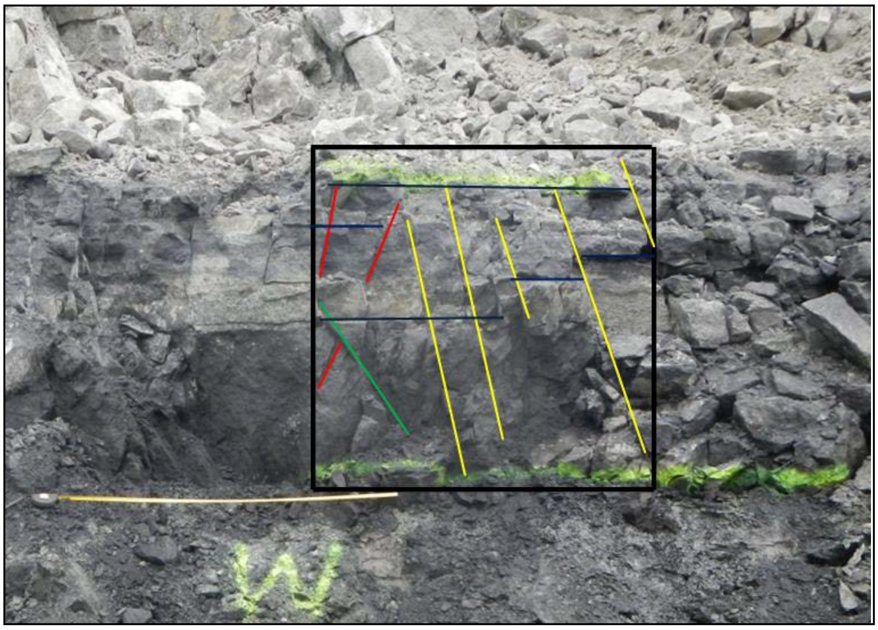


Table 9.2.1_2 Tharisa Minerals Summary of Rock Mass Ratings						
Area	**MG1 Chromitite Layer**	**MG2 Chromitite Layer**	**MG3 Chromitite Layer**	**MG4 Chromitite Layer**	**MG1- MG2 Chromitite Layers Parting**	**MG2- MG3 Chromitite Layers Parting**
RMR	68	69	65	71	74	73
Q Rating	6.01	13.4	10.05	13.4	13.99	13.4

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An adjusted MRMR value is used to take into account weathering. The rock mass ratings used for design purposes also allowed for existing blast damage. An MRMR average value of 53 was derived for the rock mass.

Rock strength testing

Samples were selected for a series of uniaxial and triaxial strength tests. All tests were conducted strictly according to the prescribed ISRM procedures.

The uniaxial compressive strength tests, of core samples collected from fresh rock, were performed to also quantify the Young's modulus and Poisson's ratio of the rocktypes. The UCS values obtained from the laboratory tests were evaluated using the Modulus ratio method: In addition Brazilian indirect tensile strength (UTB) testing was carried out which also confirmed the accuracy of the UCS values obtained as it is generally assumed that the UTB value approximates 10% of the UCS.

Table 9.2.1_3 Tharisa Minerals Summary of Rock Strengths		
Lithology	**UTB method**	**Modulus Ratio method**
Anorthosite	270.5MPa	229.08MPa
Pyroxenite	197.0MPa	186MPa

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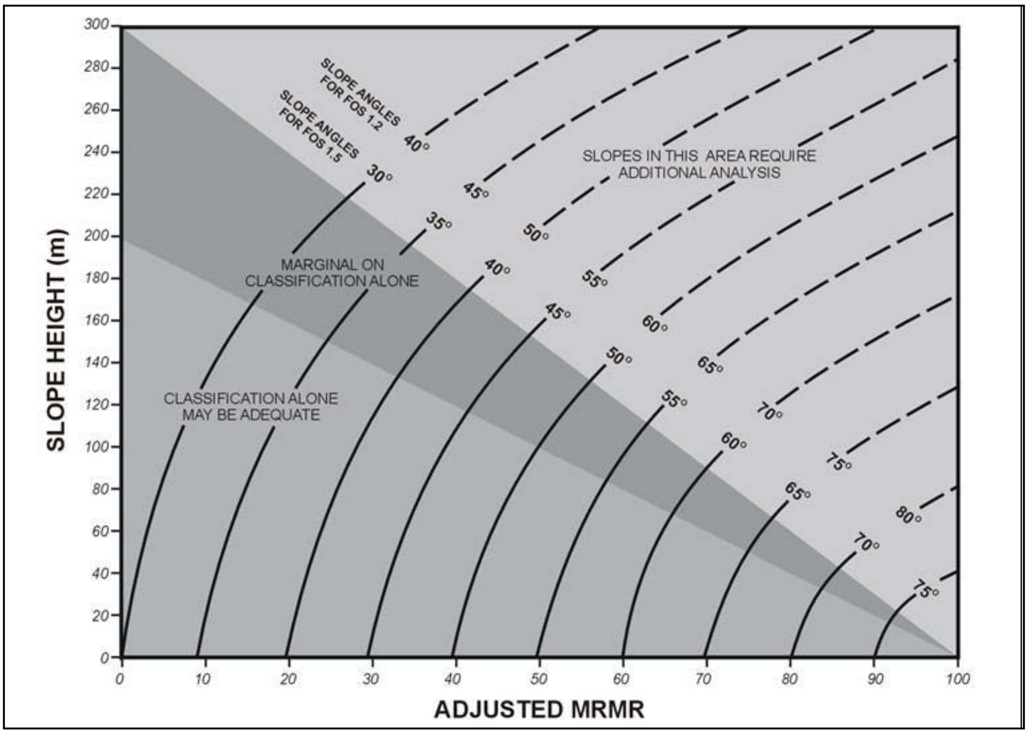
Hydrogeology

During the visits there was evidence of groundwater seepage from the exposed highwalls. Pit dewatering is conducted from toe drains at the advancing highwall. The hydrogeology is being monitored for environmental reasons as the mine deepens, this data should be incorporated in the geotechnical data base. The OHMS slope design is based on a dry slope as the pit will be dewatered.

9.2.2 Open Pit Slope Design

For indicative purposes the Haines and Terbrugge empirical design chart was used to assess the probable safe slope angles (Figure 9.2.2_1). The adjusted MRMR value of 51 for fresh rock was used in the assessment.

Figure9.2.2_1
Haines and Terbrugge Empirical Design Chart used to Assess Safe Pit Slope Angles



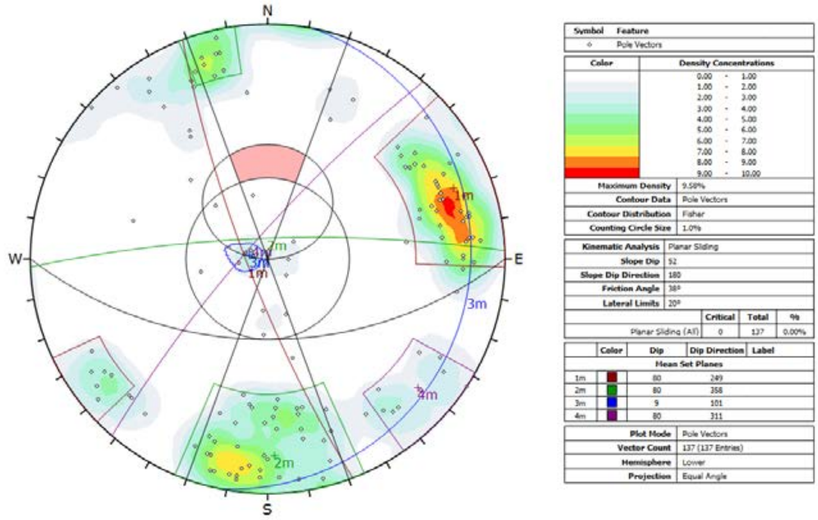
The Haines and Terbrugge design chart suggests that an overall slope angle of 52° in fresh rock will have a factor of safety of 1.2. This was taken as a guideline for further investigation using numerical modelling and kinematic analysis.

Kinematic analysis

The potential for structurally controlled failure modes of the northern highwall was investigated. The discontinuities measured on the outcrops were used for a kinematic analysis. A slope angle of 52° was assessed. For planar sliding to occur, a discontinuity must daylight in the slope and the dip of the discontinuity must be lower than the friction angle. The analysis is presented in Figure 9.2.2__2.

Figure 9.2.2_2

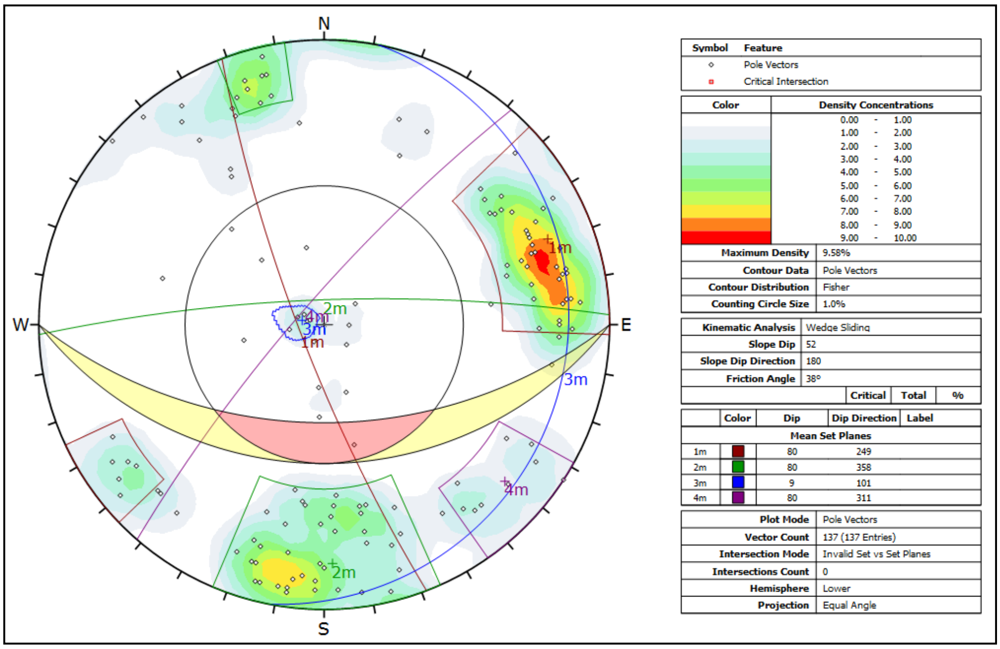
Stereonet and Analysis of Planar sliding in the Northern Slope



The wedge sliding kinematic analysis is based on the analysis of intersections of joint sets (Figure 9.2.2__3).

Figure 9.2.2_3

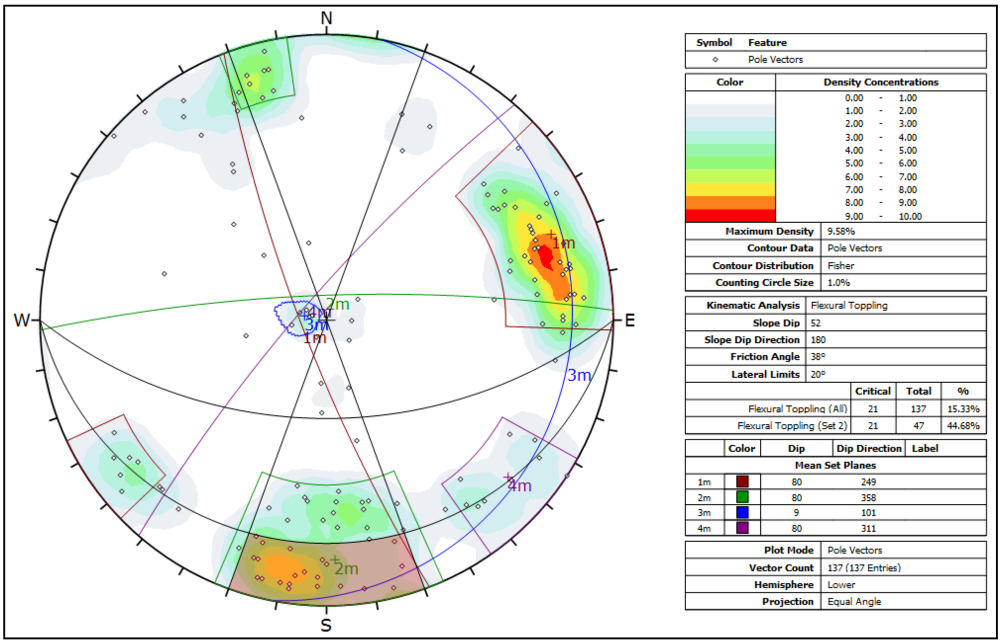
Stereonet and Analysis of Wedge Failure in the Northern Slope



The critical zone for flexural toppling is the highlighted region between the slip limit plane, stereonet perimeter and the 20° lateral limits. Any poles plotting in this region represent a potential risk of flexural toppling (Figure 9.2.2__4).

Figure 9.2.2_4

Stereonet and Analysis of Flexural Toppling Failure in the Northern Slope



From the stereonets it was concluded that no planar or wedge type failures are anticipated in the final highwall slope. The orientation of Joint Set 2 indicates that toppling failure is possible. The scale of this was not assessed and the potential would depend on joint continuity and cohesion.

It was concluded that in the fresh rock, overall slope angles of 52° should be stable with catch berms of 9.4m wide.

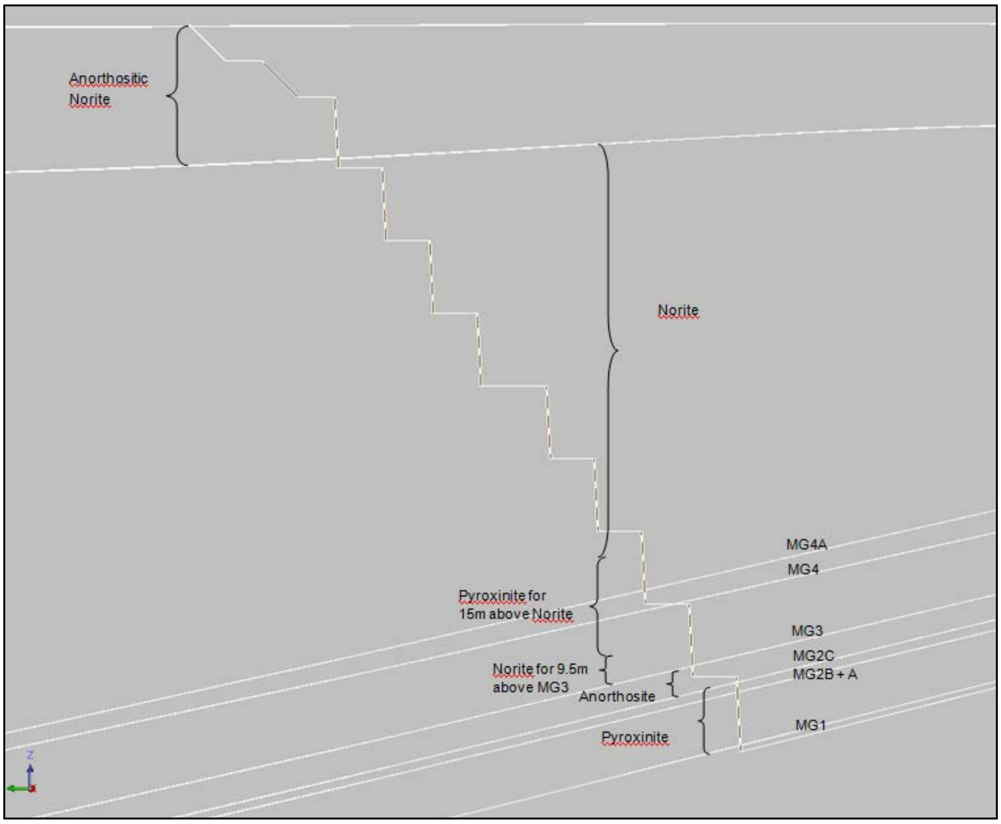
Numerical Modelling

The slope stability was assessed using the Phase 2D, two dimensional, finite element software. The sections modelled for East Mine are shown in Figure 9.2.2_5. Models of 3 sections through the pit were constructed using the material properties as defined from laboratory tests and rock mass properties quantified using the RocData software program.

Figure 9.2.2_5
Schematic Plan of East Mine showing the positions of the Sections Modelled

Only saprolitic and fresh rock material properties were used for the Highwall slope (Figure 9.2.2_6). An overall angle of 53° was used to investigate the stability of the slope. The angle modelled for saprolitic rock was 45°.

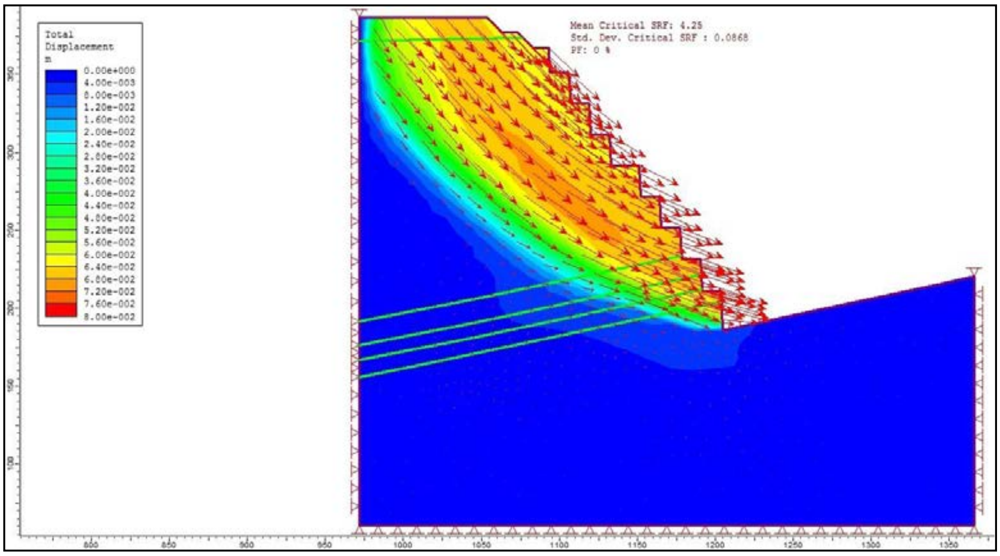
Figure 9.2.2_6
Diagram of the Proposed Highwall configuration showing Geology



The models simulated completely dry slopes, as it was assumed that an effective dewatering program will be implemented. An example of the numerical modelling is presented in Figure 9.2.2_7.

Figure 9.2.2_7

Graphic Example of the Hydrological Numerical Modelling Results



The Finite Element models calculated contours of displacement for the highwall. The Factor of Safety (FoS) and the Probability of Failure (PoF) were determined from these models and presented in Table 9.2.2_1. The likelihood of failure occurring was shown to be remote given the high Factor of Safety and low Probability of Failure.

Table 9.2.2_1
Tharisa Minerals
Summary of Rock Fall Hazard Analysis

Northern slope	Slope angle (fresh rock)	Slope angle (saprolitic rock)	FoS	PoF
Section 1	53°	45°	4.27	0
Section 2	53°	45°	4.25	0
Section 3	53°	45°	4.6	0

.

<u>Rock fall hazard analysis</u>

OHMS used The Trajec3D rigid body dynamics software to simulate the trajectory of probable fall bodies. This software simulated the fall paths for three dimensional bodies, over a three dimensional surface, representing a pit geometry. The aim is to determine fall body velocity and kinetic energy at impact with road ways or catch berms. Three fall body geometries were selected for comparison, with two masses. The fall body geometries were selected to effectively simulate the most likely rock fall shape.

None of the falling bodies roll down the pit slopes and therefore it was concluded that the width of the catch berms will be sufficient to catch possible falls.

Seismic Hazard

Using the seismic hazard map for South Africa produced by the South African Council for Geoscience it was concluded that Tharisa Mine does not fall within any of the zones of known seismic activity, whether natural or mining induced. The historic peak ground acceleration values are of the lowest in the subcontinent and therefore it was concluded that the potential influence of seismic activity on the stability of the mine is negligible and was not a consideration in the design of the slopes.

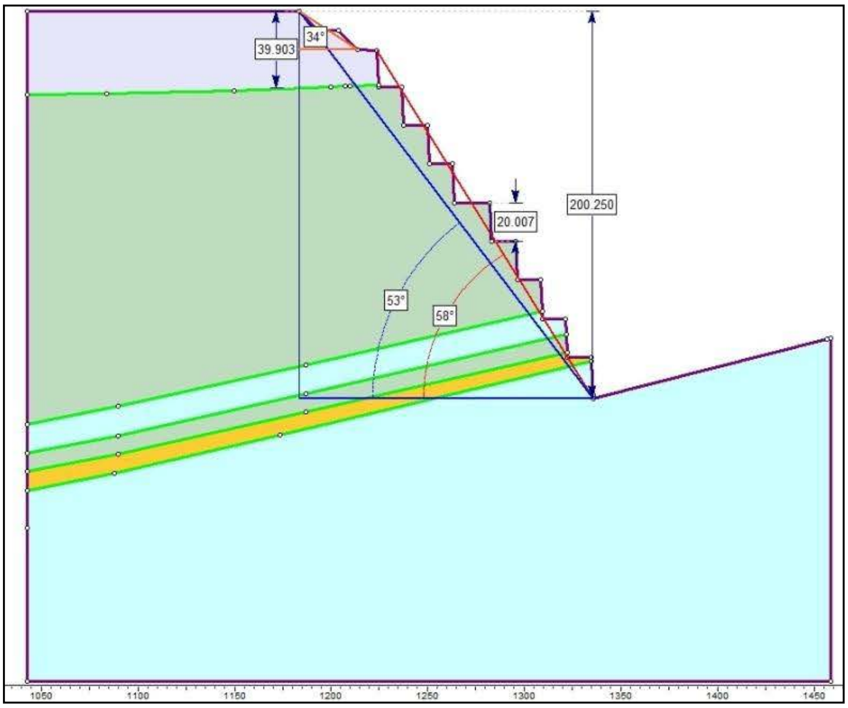
Conclusions

During the OHMS investigation, analyses and design, the following was carried out:

The geotechnical conditions have been comprehensively assessed and the results found to be similar those of the previous investigation.

Slope angles were determined from the Haines and Terbrugge design chart suggest overall slope angles of approximately 52° with a Factor of Safety of 1.2 in fresh rock. The proposed final design is presented in Figure 9.2.2_8.

Figure 9.2.2_8
The Proposed Final Pit Slope Design



Transitional surfaces between residual soil and saprolite, and between saprolite and fresh rock, were constructed from borehole information.

Slope stability was assessed using Phase2D Finite Element Model. Factor of Safety and Probability of Failure suggested that overall slope angles of 45° in saprolitic rock and 53° in fresh rock, will yield very stable slopes.

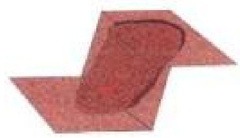
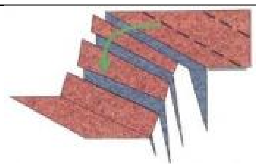
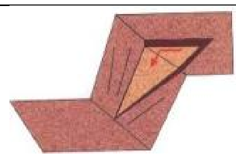
Kinematic failure was investigated and it was found that the Highwall may have some probability of toppling type failure related to Joint Set 2. Adequate catch berms are required.

Rock fall hazard analysis was performed and it was concluded that catch berms with 9.4m widths were determined to be sufficient.

No seismic activity is anticipated during the mining process.

The quantification of critical input parameters and level of detail considered in the design is sufficient for Life of Mine design. Various modes of failure were considered. These are illustrated in Figure 9.2.2_9.

Figure 9.2.2_9
Illustration of the Types of Slope Failure Considered

Modes of failure	Parameter	Modes of failure	Parameter
Circular		**Circular**	
			
Very unlikely, as shown by the Numerical Modelling	Most likely shown by Kinetic Analysis. However depends on the continuity of the jointing and will be halted by catch berms	Very unlikely as shown by Kinetic Analysis	Very unlikely as shown by Kinetic Analysis

The overall slope angle derived in the OHMS study may be conservative as the kinetic analysis indicated that toppling failure was a potential problem but all the other assessments indicated high factors of safety.

The toppling may be limited to small failures depending on joint continuity, and can be controlled with catch berms. Toppling failure is sensitive to bench slope and not to the overall slope. Further studies could steepen the overall slope of the final highwalls with attendant economic advantages.

No major geotechnical risks are anticipated.

9.2.3 Underground Mining

With regard to the future underground mining operation, the middlings between the various chromitite layers are a factor to consider in geotechnical design as with middlings of less than 12m it is usually necessary to superimpose the pillars. However the middlings between the MG1 and MG2A Chromitite Layers in most of the proposed underground mining areas are typically 12m to 15m or greater. The MG2C to MG4(0) Chromitite Layer middling is mainly 12m to 20m or greater. Thus interaction between the chromitite layers is not considered to be a concern. However this must be reassessed in localised areas once underground mining commences.

The mechanised trackless bord and pillar was deemed to be the best mining method for the mining resource under consideration.

The MG2 and MG4 Chromitite Layers were selected for underground mining. The combined thickness of the MG2A Chromitite Layer, parting and MG2B Chromitite Layer, in the greater part of the underground area, will be in excess of 1.8m. The MG4 Chromitite Layer is on average 3.0m thick and is wide enough for trackless Bord and Pillar mining and selected as the second mining horizon. Minimum and maximum mining cuts were set at 1.8m and 4.5m respectively.

The Potvin stability graph method was used to design stable panel spans for each chromitite layer. This method is widely used in South African platinum mines and incorporates the relevant geotechnical information based on a modification of Q, the Modified Stability Number N'. The maximum spans were calculated for used in a hybrid mining system. However recent findings indicate that in the MG1 Chromitite Layer, spans in conventional mining with mine poles and a middling to the MG2 Chromitite Layer of less than 15m, should be restricted to 15m.

Celtis Geotechnical investigated the maximum stable spans and pillar sizes for the underground mining as shown in Table 9.2.3_1.

Table 9.2.3_1
Tharisa Minerals
Summary of the Relevant Geotechnical Data for Underground Mine Design

Lithological Unit	Average N'	Average N"	Minimum N'	Minimum N"	Hydraulic Radius Minimum N' Unsupported
MG4 hangingwall	38.86	15.55	7.30	2.92	4.75
MG4A hangingwall	55.61	22.25	5.72	2.29	4.00
MG4- 4A middling	53.59	21.43	6.57	2.63	4.50
MG2 hangingwall	56.09	22.43	4.65	1.86	4.25
MG2 footwall MG1 hangingwall	39.45	15.78	5.92	2.37	4.50

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However, for the planned trackless bord and pillar mining, a bord width of 6m will be used throughout.

The DRMS or rock mass strength for each chromitite layer to be mined was calculated taking into account the effects of weathering, joint orientation and method of excavation. This was used to calculate the size of the in-panel pillars. A range of pillar sizes for the various depths and mining widths were calculated. Rigid pillars will be left to prevent plug failure and back-break problems. Down to a depth of 600m, the pillars were designed as non-yielding pillars which can support the whole over burden load from surface. The stress was calculated using tributary areas theory, and the pillar strengths were calculated by the Hedley and Grant (H&G) formula. As the mining will all be below 200m below surface where tributary areas theory over-estimates the pillar loading, Factors of Safety in excess of 1.3 were considered stable. Below 350 m, crush pillars can be considered, sized to suit the mining width of each chromitite layer.

The primary support in Bord and Pillar mining is the in situ pillars. A pattern of 2.4m grouted roofbolts, or equivalent splitsets, spaced at 2m apart in the hanging wall should be sufficient under normal conditions. Long anchor tendon support will be installed if faulted areas are encountered.

Access to the underground workings will be through a triple decline shaft system on reef from portals in the highwall of the opencast mining to the MG2 Chromitite Layer. This decline set will also be used as the main intake airways for the mine. Initial access will be on apparent dip. The decline support will depend on local geotechnical conditions and excavation dimensions. Below 350m it is anticipated that the geological losses in the area may provide sufficient regional support. In some areas, specific regional pillars may need to be designed on the stoping horizon.

In order to proceed with the study for the future underground expansion of the mine, additional work will be required to verify the geotechnical conditions at the selected portal positions.

9.2.4 Rock Engineering

The mine has appointed a competent rock engineering consultant to undertake regular visits and inspections to the mine including the collection of geotechnical data required to ratify the slope designs. The mine is visited monthly and reports are made on the vists and any salient issues.

Mines in South Africa are required to have a Code of Practice (CoP) to combat rockfalls drawn up according to the guidelines of the Department of Mineral Resources. There is a CoP in place in the mine, which complies with the guidelines. The CoP was revised in September 2015.

9.2.5 Conclusions

The current mining has reached a depth of about 50 m. Current slopes are shallower than the design slopes. Designed bench geometry is being followed. The stripping ratio is low and will have to be increased to achieve the planned final pit depths.

The planned surface mining method has been devised with consideration of the geotechnical conditions anticipated in the ore body. The slope design is based on the study undertaken by

OHMS. This is based on structural and geotechnical information obtained from in-pit joint mapping and the establishment of a geotechnical database.

The study ratified the design of the highwalls by dynamic analysis and numerical modelling.

Regular monitoring of the pit wall conditions and rock conditions is being carried out and reports on conditions and stability are being produced.

Groundwater level measurement and monitoring is being conducted for environmental management purposes. This data should be included in the geotechnical database.

The underground mining design has been conducted using modified stability number studies for stope spans and the Hedley and Grant methodology to calculate stable pillar sizes.

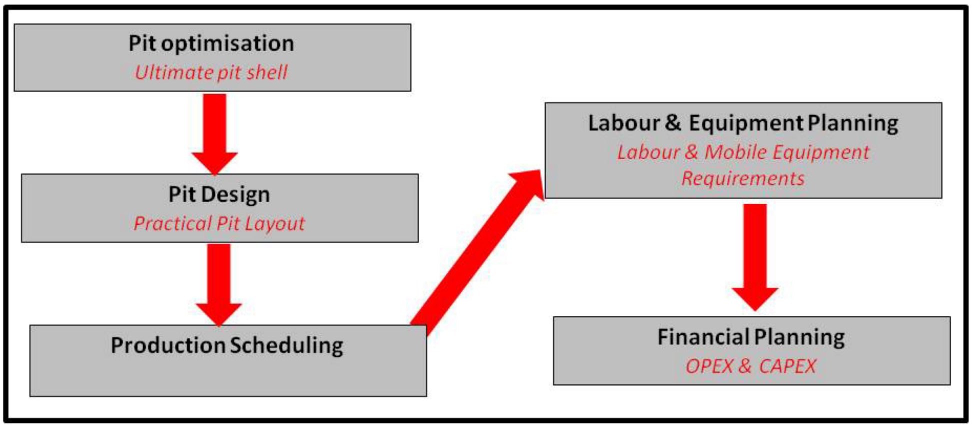
No major geotechnical risks are anticipated.

9.3 Open Pit Mine Design Study

A LoM planning process was followed to declare a Mineral Reserve for the open pits and the transition into underground mining. Practical limitations were considered to balance pit life and economic value. The final pit dimensions were selected to maximise value, considering factors such as modifying factors, scheduling constraints, unit costs and potential revenue. Mining contractor costs, transport costs, overhead costs, product selling price, and infrastructure costs were the major drivers in the cost model. The mining engineering process followed during the 2013 open pit mine design study is depicted in Figure 9.3_1. No pit optimisation or pit re-design was conducted for the 2015 Mineral Reserve estimation process.

Figure 9.3_1

Open Pit Mining Engineering Process Flow



9.3.1 Design Criteria

The design criteria were applied throughout the planning process to ensure that the work was undertaken in line with the guidelines of the SAMREC Code with a transparent reporting process and an executable plan.

<u>Safety berm</u>

The dimensions of the safety berm were calculated using global standards of good mining practice.

- Berm height = 1.7m
- Width of berm = 4.9m.

<u>Haul roads</u>

All mining equipment operate within the mining industry standard gradient of 1:10 (10% or 6°). The width of the haul road was based on the design criteria of a 3.5 multiple of the equipment width, plus the width of the safety berm with provision for a drainage channel to a minimum haul road width of 30m.

<u>Haul road width: Two way traffic</u>

- Width of equipment = 7m
- Width of haul road surface for two way traffic =23m
- Safety berm = 5m
- Drainage channel = 0.8m
- Design width = 30m.

Minimum operating width

The minimum operating width for the pit is limited by the equipment selection. For a 360t class hydraulic shovel, a minimum width of 40m is required for double sided loading. The 150t class haul trucks have a minimum turning diameter of 27.5m. A minimum mining operating width of 50m is sufficient for the bulk waste mining operations for a double side loading configuration.

Bench height

A bench height of 20m for bulk waste was selected to accommodate the large sized equipment. The first bench in the weathered zone must be battered at an overall slope angle of 35°. The ore is loaded in flitches depending on the MG Chromitite Layer thickness, using 65t excavators.

Waste Backfill

Waste backfill into the final void was considered during the haul road placement to optimise the available floor area available for dumping. Approximately 35% of all waste mined is dumped in-pit on the exposed pit floor. This has a material cost advantage relative to dozing or loading and hauling of the waste material from out-of-pit waste rock dumps (WRDs) during making safe process of the final void.

Initial waste material from the bulk waste above MG4A and the internal waste partings between the chromitite layers is used for the construction of tailings storage facility (TSF) walls. Further waste material is dumped on the permanent WRDs that are constructed to a maximum height of 60m, in 15m lifts, with an overall slope angle of 16°. A WRD is constructed at a safe distance north of the east pit high wall (WRD 1). Waste from the west pit is hauled to the south of the outcrop (WRD 2). Existing dwellings to the south of the west pit were relocated to the north of the west pit. An additional WRD is required for the east pit to accommodate the balance of the waste material.

Other Considerations

Various infrastructure constraints were considered during the detailed and operational planning processes. One road, an overhead power line and a water canal must be diverted for pit development and infrastructure placement.

9.3.2 Equipment Selection

MCC is required to supply the required mining equipment. MCC has similar contracts at adjacent mines with similar equipment and has extensive experience in hard-rock open pit mining.

Excavators (65t to 90t class) are used to load 40t to 80t class articulated dump trucks in the chromitite layer and waste parting zones. RoM ore is hauled directly from the pit to the RoM pad or placed on a designated stockpile or fed directly through the mobile primary crusher and sized to 200mm. Mining operations in the west pit is restricted to day-light hours compared to

24 hour operation in the east pit. The east pit is equipped with appropriate lighting plants on each production face with quality control enforced by grade control technicians.

Bulk waste above MG4A is loaded with 360t excavators and hauled with 150t dump trucks. Haul roads were designed at a maximum inclination of 10% and with a width of 30m, taking into consideration the 150t truck dimensions for safe two-way traffic.

9.3.3 Pit Optimisation and sensitivity analysis

The pit optimisation process was undertaken in 2013 using GEMCOM Whittle® pit optimisation software. No further optimisation work was completed as described in the 2013 CPR. A comprehensive sensitivity analysis was completed taking into consideration the previously completed pit optimisation with updated mining, cost, revenue and financial parameters.

<u>Input parameters</u>

The variances in the input parameters as used in 2015 sensitivity analysis relative to the 2013 pit optimisation are shown in Table 9.3.3_1.

The 30% increase in ore mining cost was as a result of revised contractual mining rates currently used on site. The time cost increased by 68% due to the increase in processing fixed cost, contractor fixed cost and overhead costs.

PGM recovery for fresh material decreased by an average of 7% due to the recovery curve employed. Chrome recoveries decreased on average by 6% for fresh material. The majority of the current production is from the fresh ore zone.

The 6E basket price increased by 10% measured on a rand basis. The dollar to rand exchange rate increased by 27%.

A sensitivity analysis carried out on the base case scenario established the sensitivity in the selected pit towards:

- Revenue
- Cost.

Table 9.3.3_1 Open pit: Sensitivity Analysis Input Parameters		
Description		**Variance relative to 2013 Pit optimisation (%)**
Revenue	Platinum	+4
	Palladium	+49
	Rhodium	+31
	Gold	+26
	Iridium	-35
	Ruthenium	-34
	Cr_2O_3 @ 42%	+1
	Nickel	-2
	Copper	+30
	6E	+10
Cost	Waste mining cost	+3
	Ore mining cost	+30
	Processing cost	+20
	Time cost	+68
	Chrome transport cost	+15
Recoveries	PGM oxide	-21
	PGM Fresh	-7
	Chrome oxide	-9
	Chrome fresh	-6
	Nickel	0
	Copper	0

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Revenue

A sensitivity analysis was conducted on a revenue basis to determine the impact on the current selected pit shell. This entailed adjustment of the revenue (basket and chrome prices) by ±15% in 5% increments.

The value stated in the optimisation/ sensitivity analysis process is a relative value based on the Whittle® schedule including fixed and variable operational cost. A 15% reduction in revenue impacts on the relative value of the project with a value reduction, excluding capital, of 62% while a 15% increase in revenue with a relative value gain of 49%. It is evident that the relative value from the optimisation process is sensitive to revenue. Although a lower basket revenue has a material impact on the value of the project, it does not have a material impact on the pit selection strategy up to ±15% in basket and chrome prices. The revenue sensitivity is represented on the sensitivity analysis graph as shown in Figure 9.3.3_2

Cost

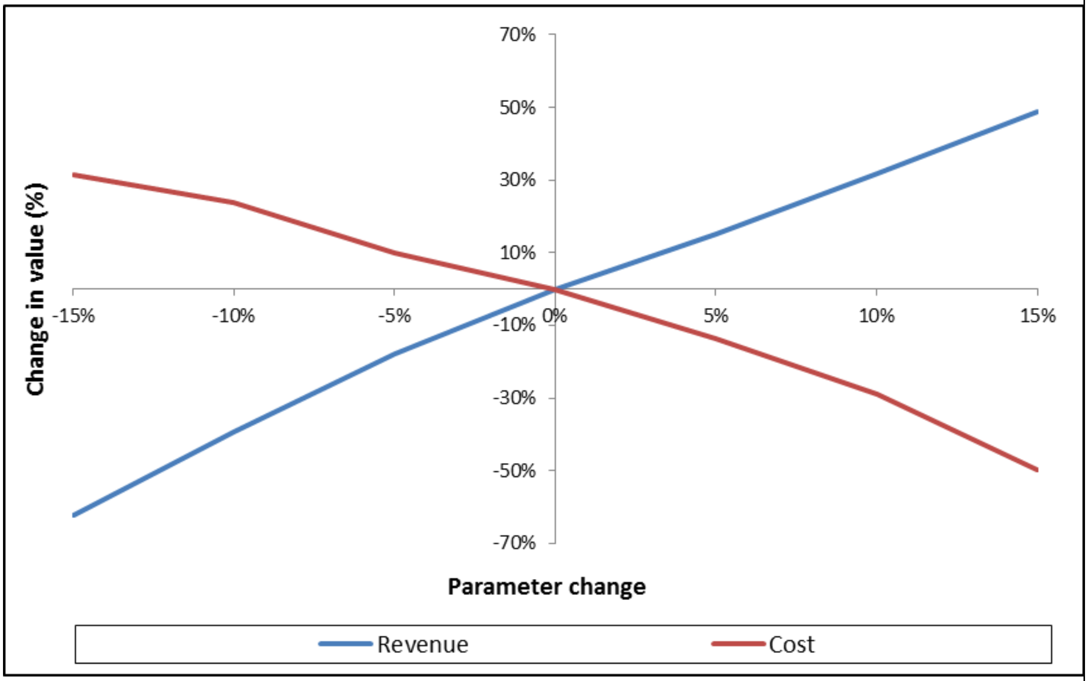
The cost was adjusted by ±15% in 5% increments. The cost component consists of:

- Mining cost
- Processing cost
- Time cost
- Selling cost.

A relative value index from the selected pit is sensitive to both reduction and increase in cost. A 15% reduction on cost has a 32% increase in relative value while a 15% increase shows 50% reduction in relative value on the selected pit. Figure 9.3.3_1 shows a graphical representation of the sensitivity analyses conducted for the selected pit. The sensitivity analysis indicates that the pit is sensitive to both revenue and cost.

Figure 9.3.3_1

Sensitivity Analysis Graph

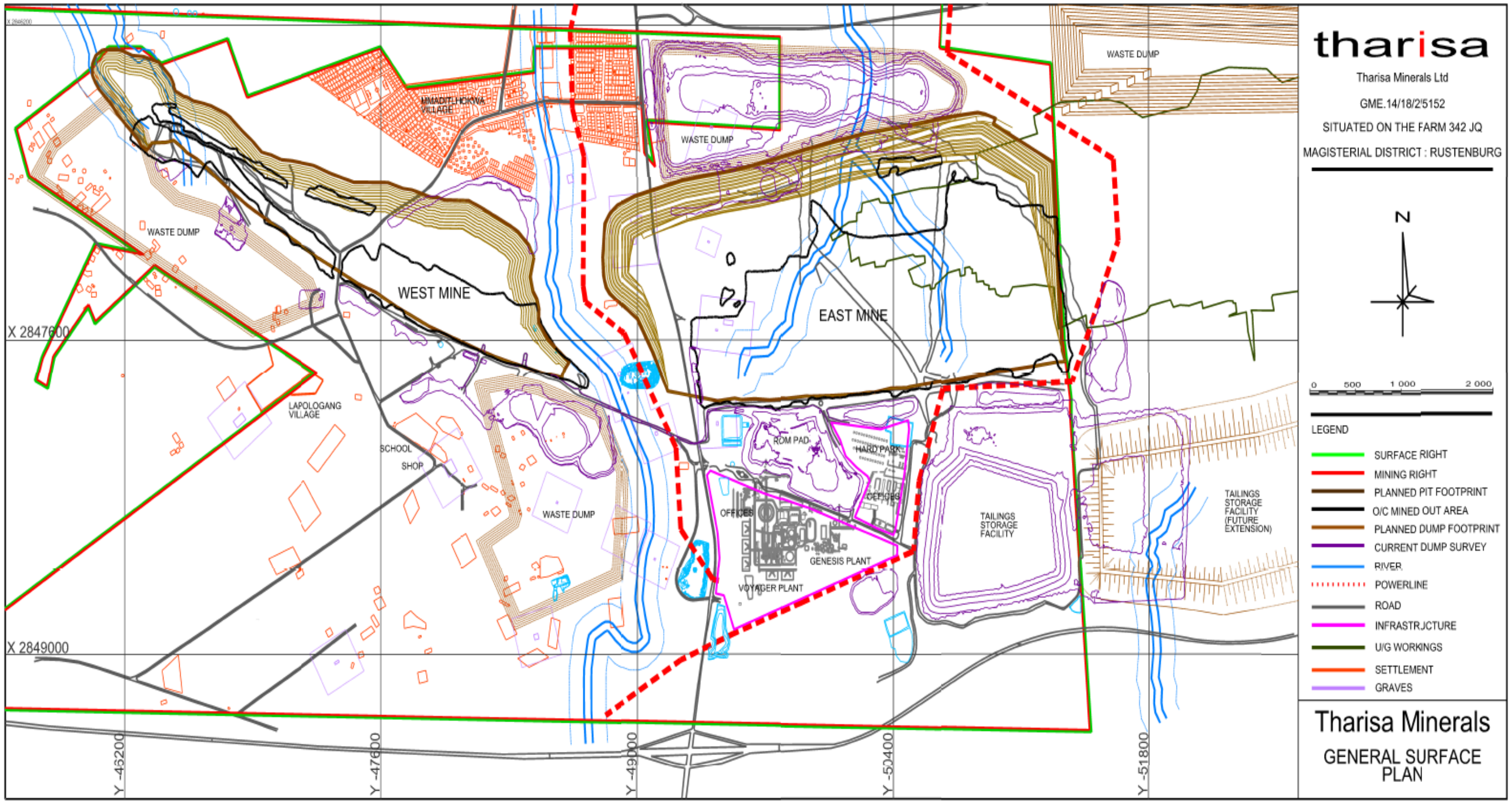


9.3.4 Pit Design

Permanent ramps were designed on the high-wall of the east pit, thus reducing the overall high-wall slope angle from the previously accepted 53° to 50° on the latest east pit design. For the purposes of the strategic plan and Mineral Reserve estimate, the pit shell was modified in areas along faults where impractical 'waste islands' were placed and in areas where slumps in the pit floor were planned. The position of low wall access ramps were considered and are critical to the sustainability of RoM production. The surface layout is presented in Figure 9.3.4_1.

Figure 9.3.4_1

Open Pit Surface Layout



9.3.5 Mining Methodology

Waste is blasted in 20m benches. Depending on the dump location, waste is hauled to the dump located on the outcrop side or hauled through temporary ramps on the interim high wall to a dump located on the high wall side of the pit. Once the pit reaches a depth of approximately 100m, backfill commences. An estimated 35% of the waste is backfilled over the life of the operation. The backfill percentage is a reasonable due to the low wall ramps, envisaged underground infrastructure and a minimum 100m down dip lag between the backfill and the working faces. The underground portals are established from the highwall.

The current reef mining methodology requires that MG1 and MG3 are blasted selectively with MG2, MG4 and MG4a blasted with their respective surrounding waste. All the materials are loaded in 5m flitches with 65t to 90t class hydraulic excavators. In-pit grade control 'spotters' do all ore and waste classifications to control losses and dilutions based on the selected mining cuts.

9.3.6 Destination Scheduling

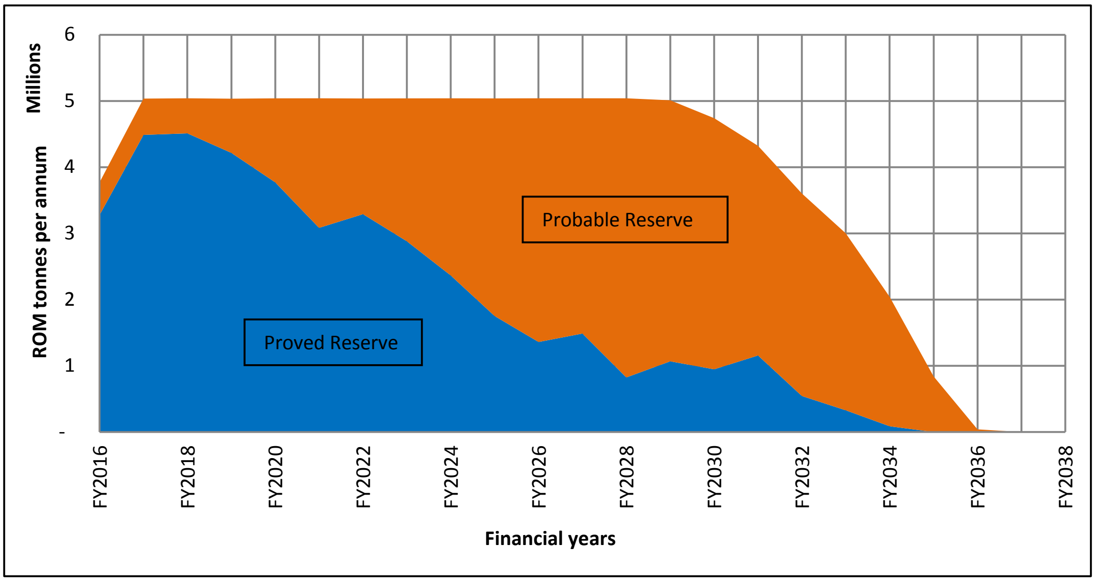
Hauling distances per period are calculated from the schedule based on the specific blast block mined, the dump destination and the haul route. Distances from the mined block to the closest ramp on each level are determined and added to the ramp and surface hauling distances. An appropriate cost model based on the contractual hauling rates and scheduled hauling distances were compiled.

9.3.7 Life of Mine Plan

Most of the material mined from the first ten years of the schedule is from the Measured Mineral Resource category which was converted into Proved Reserves (Figure 9.3.7_1). Indicated Mineral Resources were converted to Probable Reserves.

Figure 9.3.7_1

Open Pit Mine Schedule with Mineral Reserve Classification



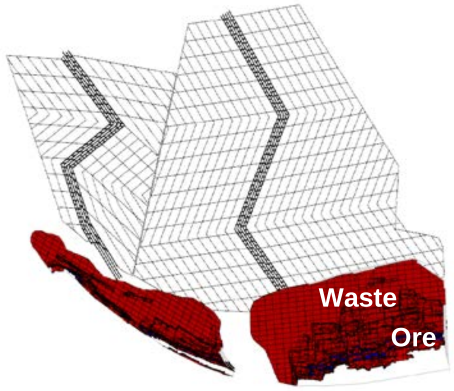
A depiction of the mining schedule is provided in Figure 9.3.7_2.

The schedule delivers an average 3PGE+Au grade of 1.12g/t over the life of the operation and 1.45g/t on a 5PGE+Au basis and RoM Chromite grade delivered at an average of 18.6% Cr_2O_3. During the previous financial year (October 2014 to September 2015) the combined plant feed grades excluding tailings treated in the Genesis plant averaged 18.8% for chrome with a lower than expected feed quantity of high chrome grade MG1 material, the PGM feed grade for the same period averaged 1.03g/t (4E). The production schedule indicates medium term plant feed grades of 18.6% and 19.1% (chrome) for FY2016 and FY2017 respectively. The medium term 4E PGM plant feed grades for FY2016 and FY2017 is 1.10g/t and 1.11g/t (4E). The schedule is based on a steady state RoM production of 420k tpm from the two pits with the data for FY2016 displayed in Figure 9.3.7_1 only representing nine production months. No physical mining or processing constraints was identified that would inhibit planned production rates. It must be noted that during the 2014 financial year the average reef tonnes achieved from the open pits was 348.6 ktpm. Steady state waste stripping requirements are set at 1.3 million BCM per month in total from the two pits. Steady state production from the open pit is maintained to 2030 when the underground production ramp up is planned.

Figure 9.3.7_2

Open Pit Mine Schedule

The figures below is a graphic representation of the mining sequence with the red indicated as the bulk waste and blue showing mining blocks that contain chromitite layers or selective waste.



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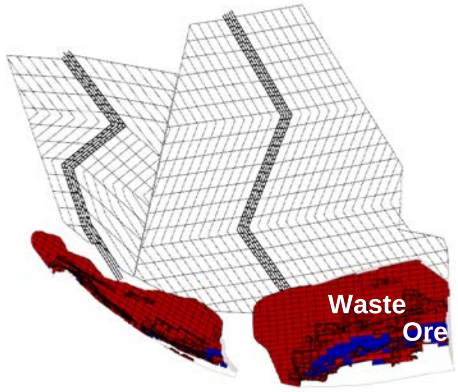
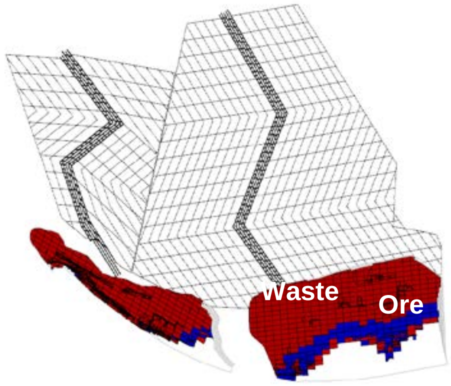
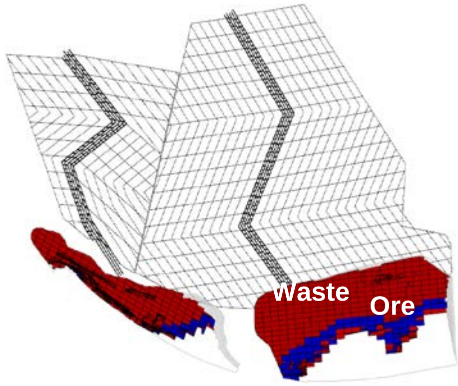


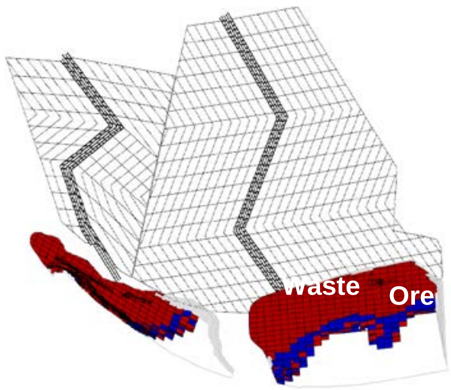
January 2016



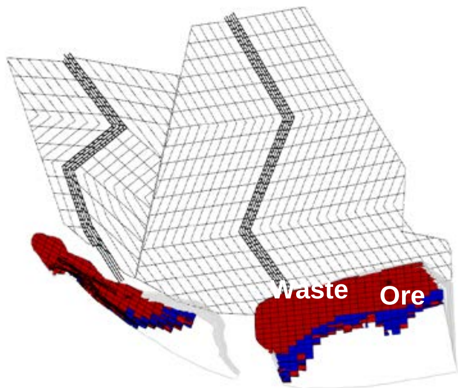
January 2018



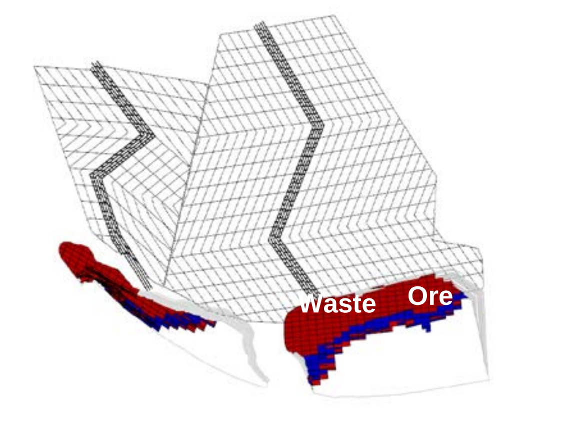
January 2020



January 2022



January 2024



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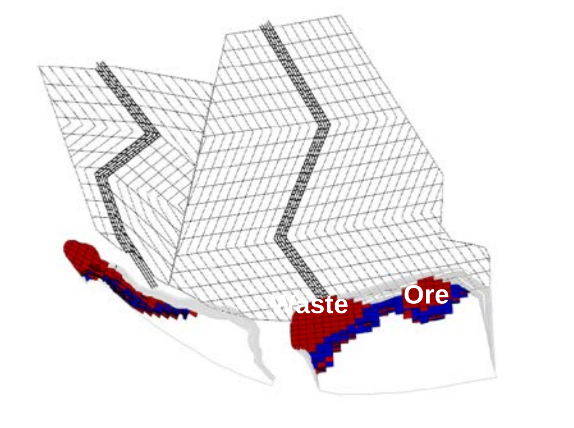
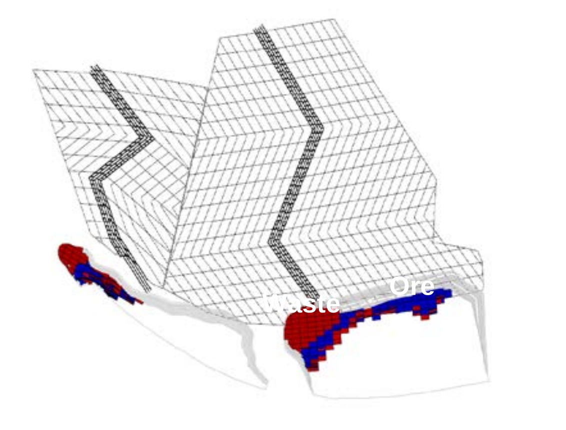
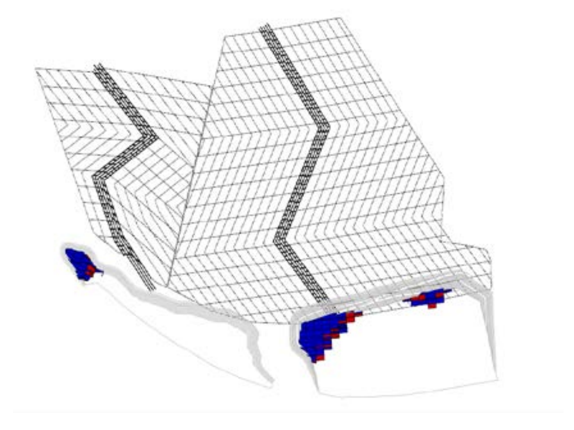


January 2028



January 2030



January 2032

9.4 Underground Mining

9.4.1 Introduction

The design requirements identified for the underground section included:

- An underground RoM production of 400ktpm as a continuation of the open pit production profile. Underground mining is planned to commence in 2030
- Health and safety aspects were considered to deliver a relatively low risk operation
- Maintain profitability.

9.4.2 Mining Method Selection

The critical aspects considered during the mining method selection included safety, the Chromitite Layer widths, dip, the required volume of RoM ore, minimised waste development and mining cost. Four mining methods were considered:

- Conventional breast stoping;
- Hybrid mining;
- Mechanised dip mining;
- Trackless Bord and Pillar.

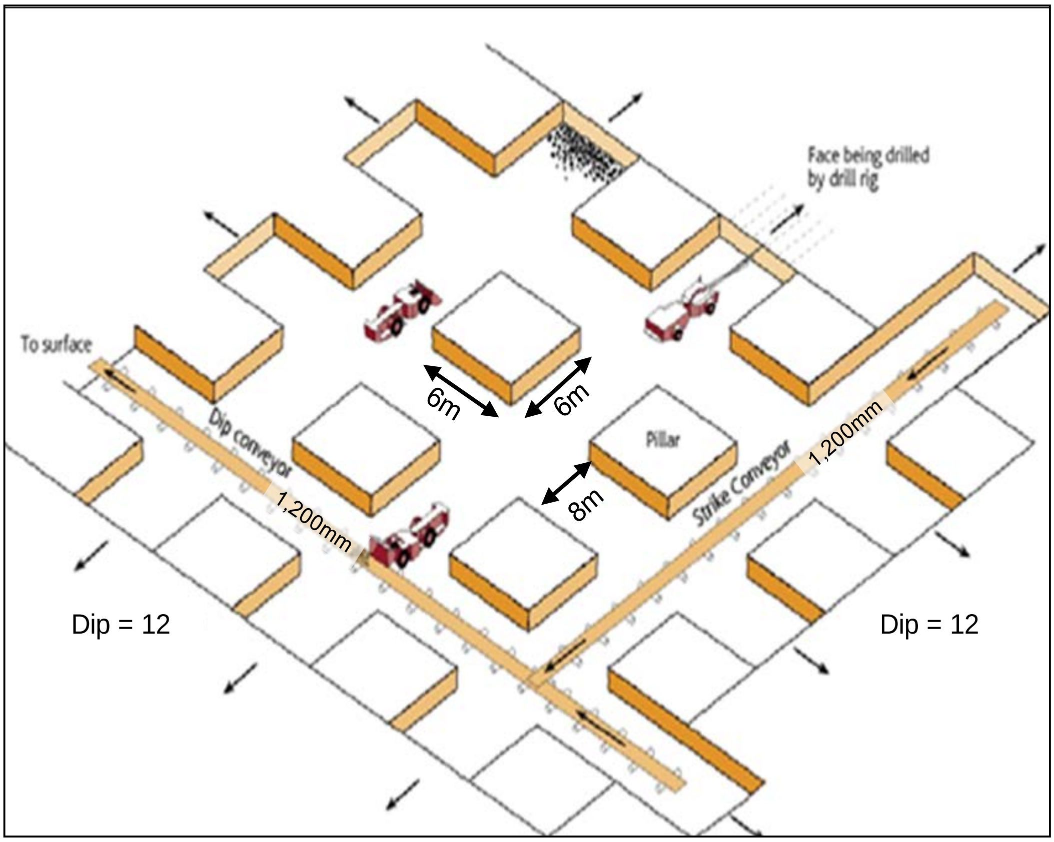
Trackless Bord and Pillar mining was selected as the preferred mining method. Compared to the other systems, it offers the following advantages:

- Development rates are faster.
- Flexibility in dealing with geological structures.
- Safety is enhanced as people are removed from high energy contact sources. Supervision is improved through mobile access to the workings.
- Mining extraction is achieved by developing a series of bords on reef and connecting them via holings to form pillars that provide support for the overlying strata (Figure 9.4.2_1).

Three active faces are allowed in each section for drilling, three for support, three for cleaning operations and a further three as production contingency.

Figure 9.4.2_1

Typical Bord and Pillar Layout



Each section with a dip width of 168m is equipped with a 1 200mm advancing strike conveyor which is maintained not more than 80m from the active stoping faces to minimise LHD hauling distance. Each conveyor is equipped with a grizzly feeder to screen out boulders that is either crushed or scalped as waste. The main conveyor capacity was set at 400t/h and tips directly onto the 1 200mm main surface stockpile feed conveyor.

9.4.3 Chromitite Layer Selection

MG2 and MG4 were selected for underground mining. The combined thickness of MG2A, parting and MG2B in the greater part of the underground area, will be in excess of 1.8m. This matches the minimum stoping width requirements for the selected trackless equipment.

MG1 has an average in situ thickness of 1.3m which is not ideally suitable for mechanised bord and pillar mining. Excessive dilution would result in the application of mining related modifying factors. This chromitite layer was mined using conventional mining methods on the adjacent property. The mined-out workings exist within the current open pit perimeter and within the planned underground footprint area. Due to the low, 10m average, inter burden parting between MG1 and MG2, only one reef was selected.

MG3 is relatively thin at an average in situ thickness of 1.4m and is midway between the MG2 and MG4 horizons. This layer was excluded from the underground investigation on the same principle as MG1 due to the low in situ thickness.

MG4 is on average 3.0m thick and is of sufficient thickness for trackless bord and pillar mining and was selected as the second mining horizon.

9.4.4 Mining Cut

MG4 Chromitite Layer

MG4 was selected as the second mining horizon with an average in situ thickness of 3.0m which is wide enough for trackless bord and pillar mining. The selected mining cut includes MG4, the pyroxenite parting and MG4(0) below. A maximum mining cut of 4m, with a minimum of 1.8m, was used as criteria for the mining cut selection. However where the thickness exceeded 4m, only MG4 was selected for the mining cut.

MG2 Chromitite Layer

The mining cut is taken as MG2A to MG2B. MG2C was not considered as part of the mining cut due to the width of the parting. The mining cut was optimised to allow for a minimum of 1.8m and a maximum 4.0m mining height. Where the chromitite layer exceeds 4.0m, MG2A Chromitite Layer was targeted.

9.4.5 Underground Access Options

Various options to access the targeted reef horizons were considered and after a systematic analysis the top three options were:

- Option I: A vertical shaft at the centre of gravity of the resource.
- Option II: A footwall decline 20m below the targeted chromitite layers.
- Option III: Declines on reef.

The on-reef declines, Option III, was considered to be the most suitable access system for the underground project. Plans showing the underground mining layout are presented in Figure 9.4.5_1 (MG2 Chromitite Layer) and Figure 9.4.5_2 (MG4 Chromitite Layer).

The advantages of this system are:

- All development is on reef.
- More information on the geology is obtained during development.
- No cross cut development in waste to reef horizons.

The main disadvantage of this option is the lack of surge capacity. A breakdown on the strike conveyor has a direct impact on production as operations can only proceed once the ore handling system is functional.

The triple on-reef decline system is used as the main ventilation intake airways for the mine and consists of:

- **Services Decline** for access by trackless mobile equipment.
- **Main Conveyor Decline** for ore handling. This decline accommodates other services such as pumping columns, potable water pipes, fuel lines, compressed air lines, power lines and a walkway. From investigations carried out, a 1 200mm size trough conveyor at a speed of 4m/s in this decline has the capacity to handle the planned tonnage including allowances for maintenance and unplanned disruptions.
- **Chairlift Decline** primarily for the transportation of men to and from the working faces.

The dimensions of the three declines have been set at 6.0m wide by 4.5m high. All the declines will be developed at an apparent dip of 9^0 to facilitate access with mobile machinery. A crown pillar of 50m on dip separating the surface and underground operations was allowed for in the design. The RoM production capacity for each set of declines is presented in Table 9.4.5_1.

Table 9.4.5_1
Decline System Design Capacities

Decline system	Capacity per month [RoM tpm]
MG2 East Decline	150,000
MG4 East Decline	150,000
MG2 West Decline	50,000
MG4 West Decline	50,000

Figure 9.4.5_1

Underground Layout for theMG2 Chromitite Layer

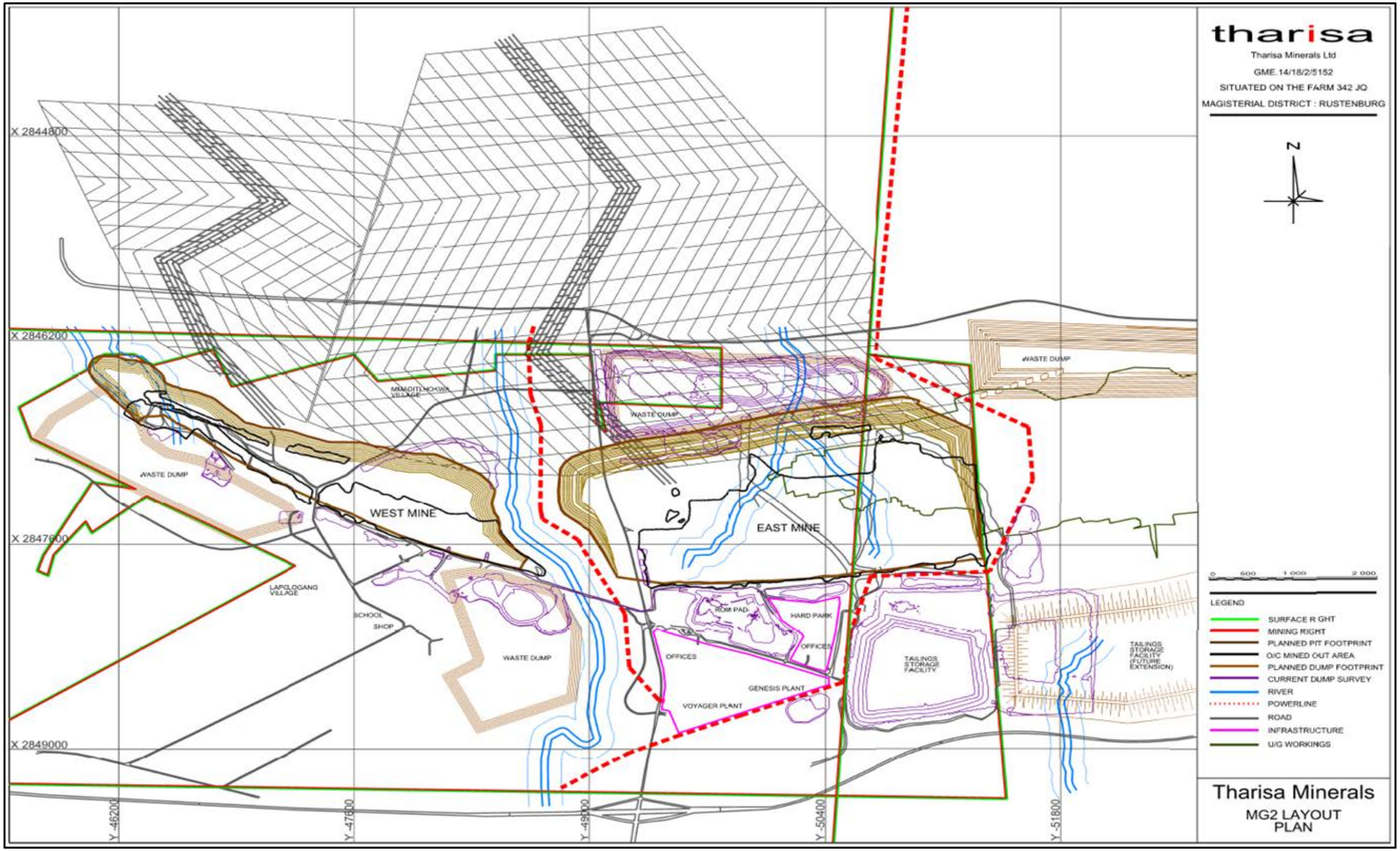
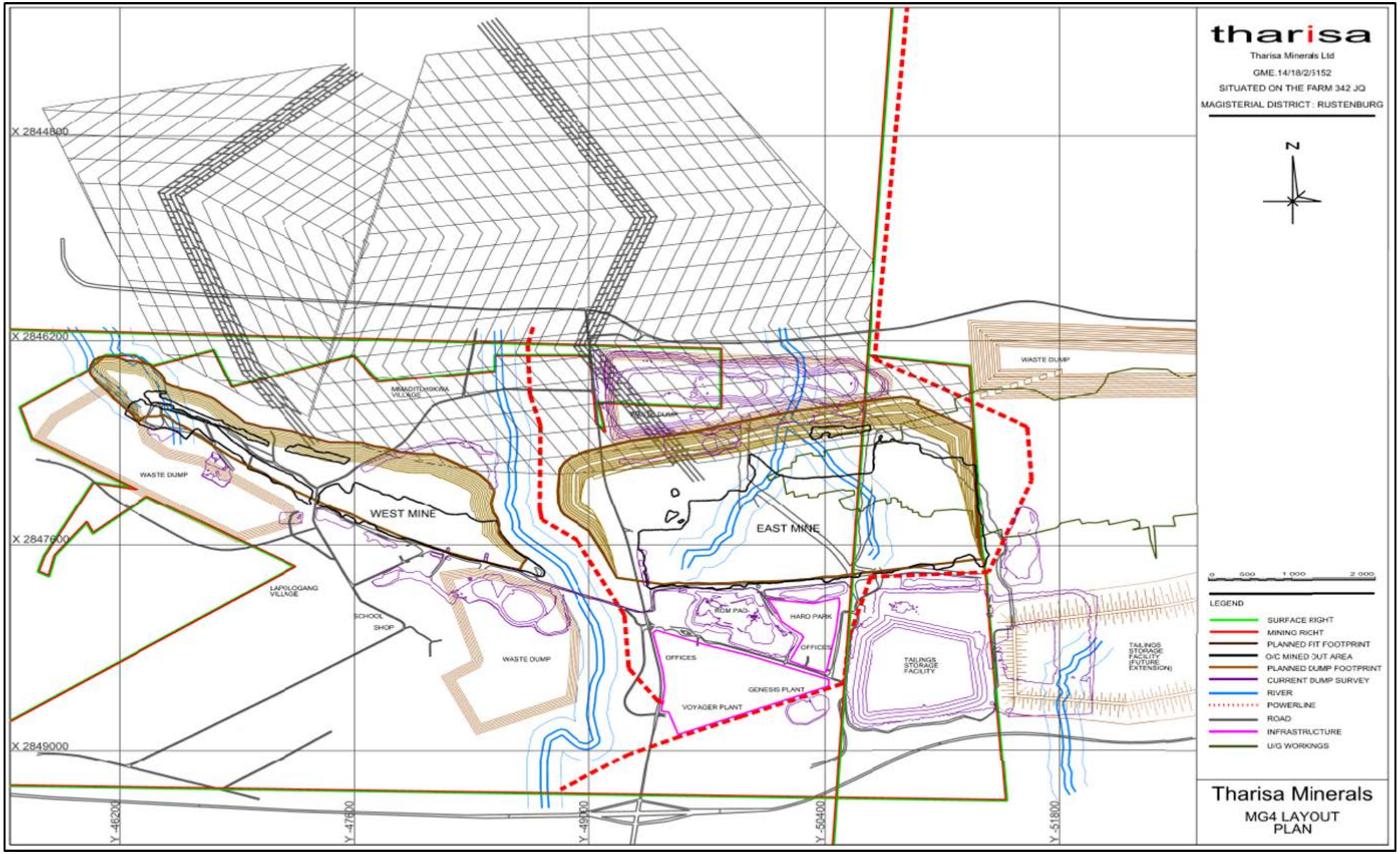


Figure 9.4.5_2

Underground Layout for theMG4 Chromitite Layer



9.4.6 Geotechnical/ Hydrological Considerations

The geotechnical parameters and pillar designs were recommended by Dr J James, Geotechnical Engineer. The recommendation is for 6m x 6m pillars on 8m bord spans and 6m holings for the stoping designs. The pillars are designed to increase with depth from 6m x 6m in the upper levels to 8m x 8m in the lower areas.

MG2A, MG2B and MG4 hanging walls are competent. A support pattern of 2.4m grouted roof bolts, or equivalent split sets, spaced on a 2m x 2m grid in the hanging wall was considered sufficient under normal conditions. Additional spot bolts are required if faulted areas are encountered as mining progresses.

The general hydrological conditions for the area were described as wet and the shallow open pit being mined at the time of compiling this report is being pumped almost continuously to maintain workable underfoot conditions.

Excessive water is not expected to cause any material risk to the planned underground operations. An appropriate water reticulation system was provided for in the capital cost. To minimize the inflow of water into underground workings, diversion trenches or embankments are installed around all the decline portals. Surface ventilation holings are protected from surface run-off water.

9.4.7 Equipment Selection

Equipment units were selected based on the planned production rates, chromitite layer geometry, excavation sizes and available technology. The minimum height that is traversed safely and efficiently by low profile machines is currently 1.8m.

A LH209L or equivalent LHD is suitable based on the above criteria. This LHD is 1.69m high and has a bucket reach of almost 5m making it an appropriate match for the planned mining cuts.

The Sandvik DL230L or equivalent drill rig, with a tramming height of 1.4m isthe best fit.

9.4.8 Shift Cycle

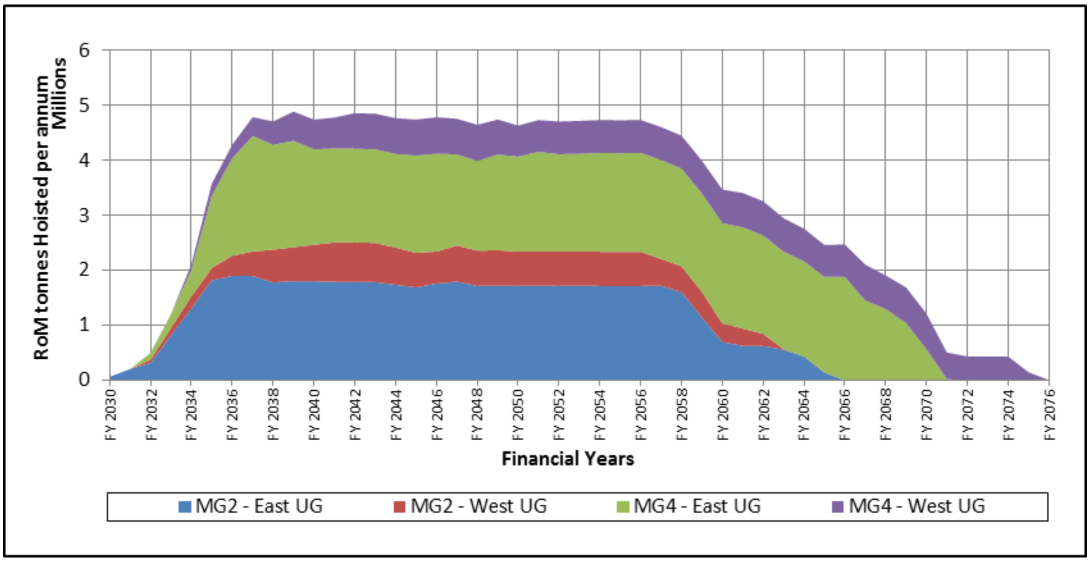
Mining production for the underground operations was planned for twoby 10 hour shifts, five days per week. Drilling, blasting, lashing and supporting are the main activities on the morning shift while the back shift is mainly for lashing. Blasting is carried out once per day at the end of the morning shift while blasting during the sinking of the declines was set at twice per day during the first 18 months. A period of at least three hours was allowed for before re-entry after blasting.

9.4.9 Production Scheduling

Based on a production profile of 400ktpm, the scheduled underground production commences during financial year 2030 with initial development and continues to 2075 resulting in a mine life of 24 years at steady state production (Figure 9.4.9_1). The mine plans for MG2 and MG4 underground mining are presented in Figure 9.4.9_2 and Figure 9.4.9_3.

Figure 9.4.9_1

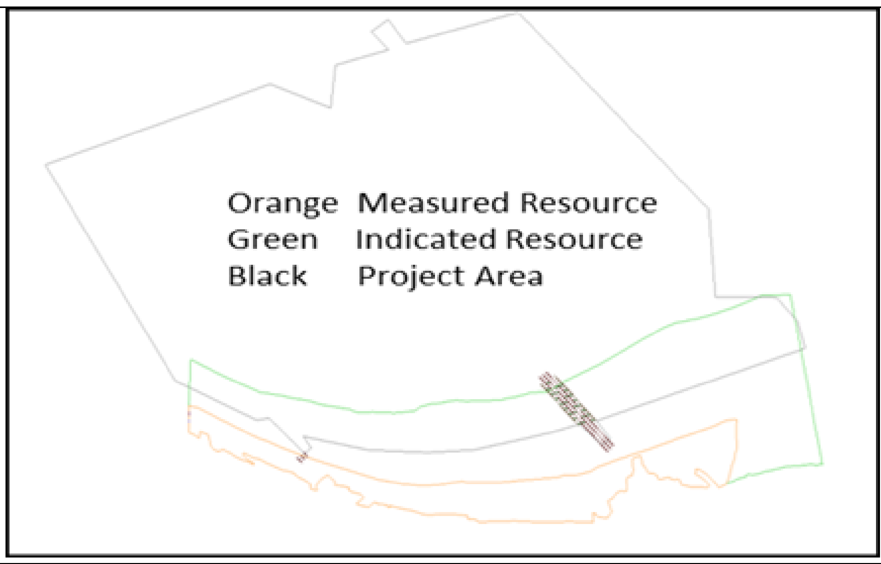
Underground Mine Production Schedule



The scheduling strategy, which is a key driver to the overall project costs and economic value, was to establish the eastern decline system initially before moving to the western decline system. This strategy was chosen to minimise the project risk by starting off with areas of higher geological confidence and layer thicknesses. The sinking of the MG2 east triple declines system, starts five years before the projected winding down of open pit operations. At the planned advance rate, the mining of the triple MG2 declines and ledging to the Level 3, will be completed within 24 months with the ramp up to steady state within 48 months.

Figure 9.4.9_2

Underground Period Progress Plots: MG2 Chromitite Layer



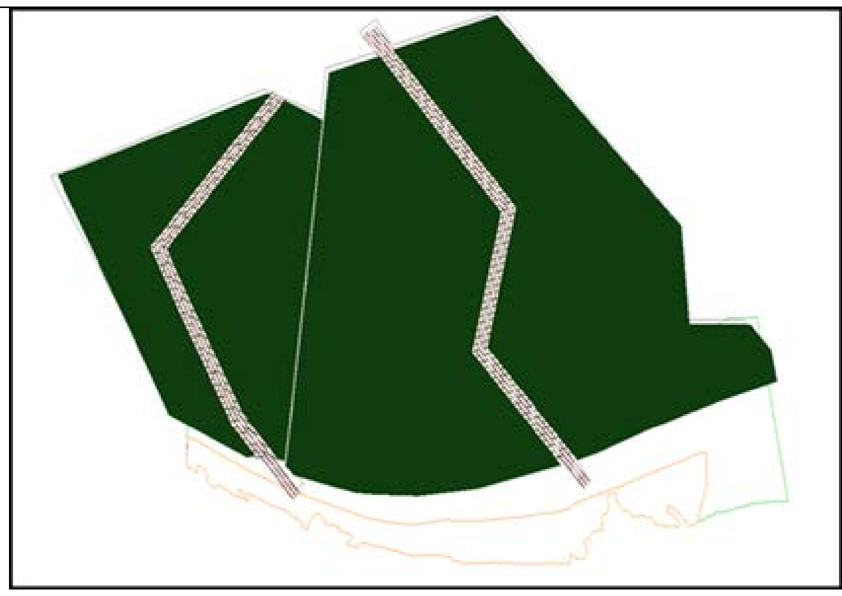
January 2030

January 2032

January 2042

January 2052

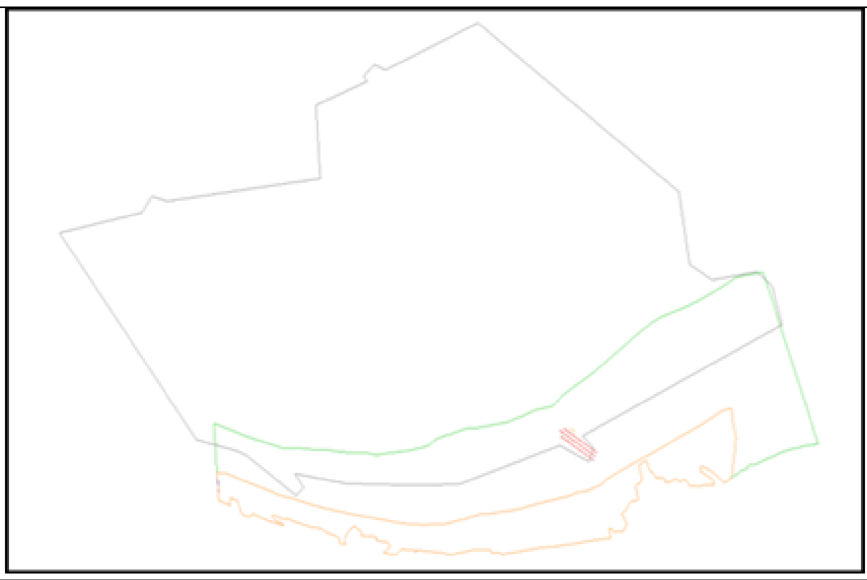
January 2062



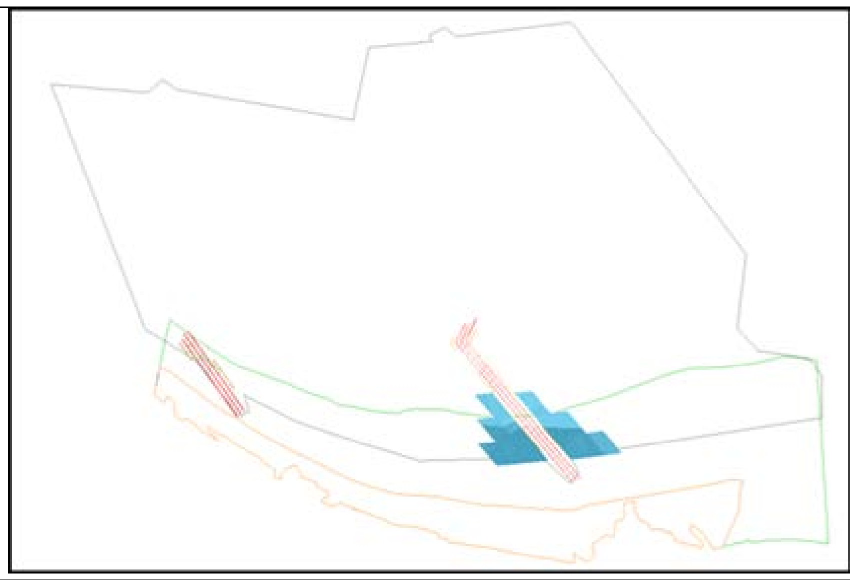
January 2066

Figure 9.4.9_3

Underground Period Progress Plots: MG4 Chromitite Layer



January 2032



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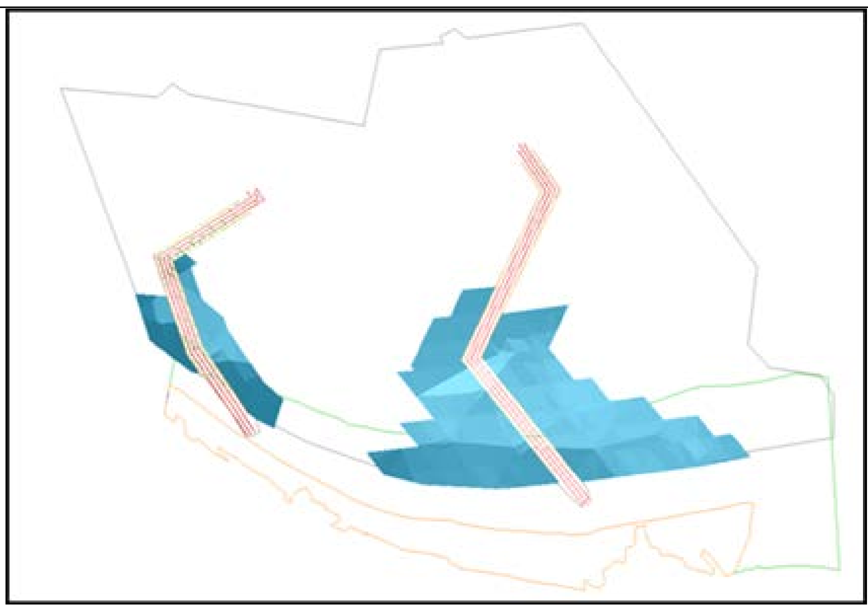

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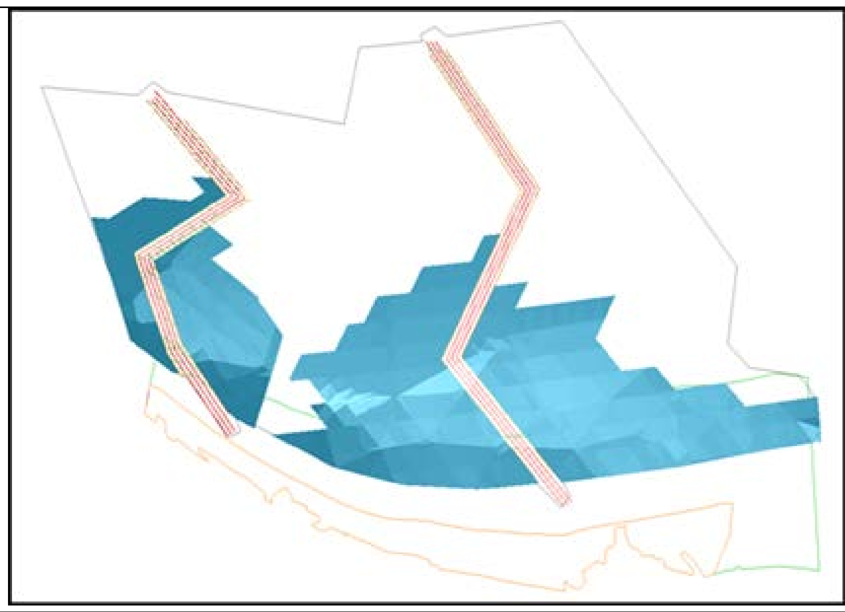

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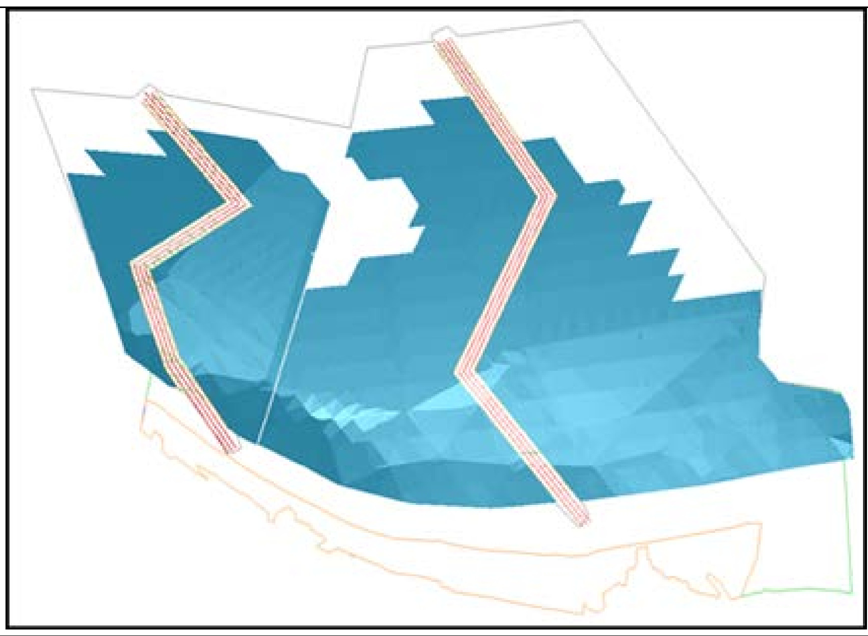

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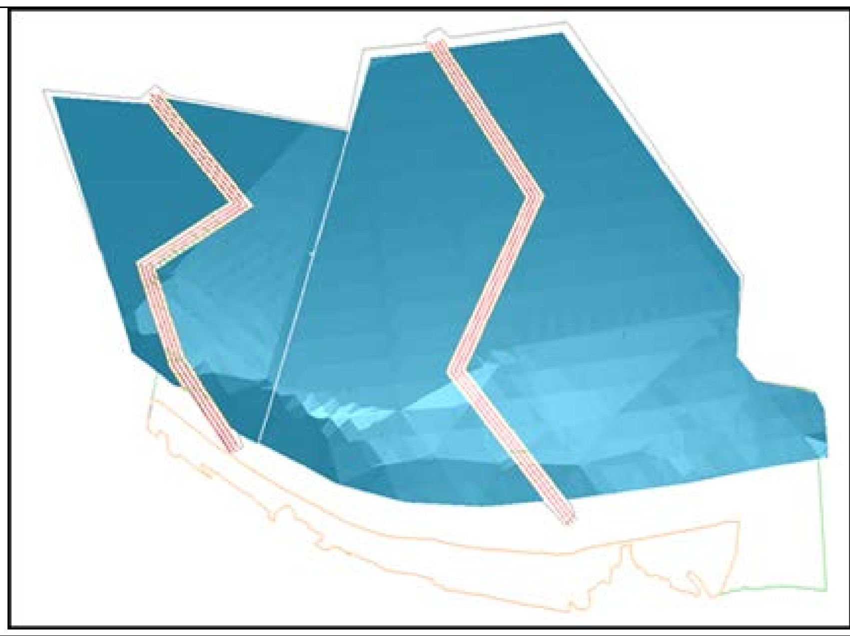


January 2068

9.4.10 Infrastructure Requirements

The underground operations will leverage off existing infrastructure for open pit operations such as electricity, water, the plant, houses, offices, transport and communications networks that are in place when the underground operations commence. Additional infrastructure provided for in the capital cost estimate includes:

- The ventilation network
- Underground workshops and fuelling facilities
- Pumping arrangements
- Washrooms and lamp room facilities
- Emergency Facilities.

9.4.11 Labour

Except for a core owner's team, the majority of the labour force is contracted labour. Tharisa is located in a prime mining area with an experienced pool of labour to choose from. The owner's team, including the supervisory and management staff are retained from the open pit operations. Appropriate induction and training is required to ensure a smooth transition to underground operations.

9.4.12 The Underground Cost Model

An underground cost model was compiled from first principles and based on a 2013 schedule of rates. A contract mining site establishment fee of R20m per decline was assumed.

Capital Costs

A capital cost outlay of R2.23 billion including a 10% contingency is required to move the project to steady state production at a rate of 400ktpm over a period of 5 years. A summary of the initial major capital costs include:-

- R1,516m for decline development, equipping and conveyor installations
- R140m for site establishment, Preliminary and general and electricity costs
- R175m for portal establishment and support
- A 10% contingency.

Mining Operating Costs

The mining operating costs were sourced from the Ukwazi database and from relevant service providers. The operating expenditure estimate of R508/t (including a 10% contingency) compares favourably with other similar operations in the country employing the same mining method.

10 MINERAL RESERVES

10.1 Open Pit Mineral Reserve Estimation

A LoM planning process was followed to declare a Mineral Reserve for the open pits and the transition into underground mining. Various technical aspects were considered in the mine design and schedule including the determination of the economic pit limits, geotechnical parameters, mining methodology and sequence, pit access, ramp placement, equipment capability, production rates and practical mining considerations. The mining related modifying factors applied included geological losses, mining loss and mining dilution.

10.1.1 Geological Losses

Geological losses were applied at 7.5% for the east pit and 15% for the west pit in accordance with the recommendation of the competent person.

10.1.2 Mining Recovery (Mining Loss)

Mining losses was based on 6%, estimated on previous performance and determined by observation and measurement in the existing operation. The sources of mining losses included mining activities close to geological features, misalignment of reef excavator bucket size with the chromitite layer thickness, incorrect loading on the roof and floor of the chromitite layers and losses due to blasting activities.

10.1.3 Mining Dilution

Appropriate dilution was applied in the LoM plan and Mineral Reserve estimate. A mining dilution of 9.1% (calculated on a tonnage basis) was applied based on a reconciliation conducted between actual grades achieved and modelled grades with calculated dilution for the corresponding periods. The reconciliation consisted of production data for the preceding nine months, based on actual plant feed grades achieved in both the Genesis and Voyager plants for the period excluding milled and residual tailings treated in the Genesis plant. Dilution was planned for every chromitite layer based on the mining methodology employed for that specific chromitite layer. The chromitite layers that were mined with the surrounding waste rock were classified as non-selective mining and thus attracted a higher percentage dilution. Non selective mining units included MG2, MG4 and MG4A layers. The chromitite layers mined as selective was allocated a lower relative percentage dilution. The only chromitite layers that were deemed to mine selectively were MG1 and MG3.

10.1.4 Metallurgical Recoveries

Plant recoveries were based on actual performance while capacities were based on design capacity. The PGM recoveries are shown in Figure 10.1.4_1. The mass yield applied for a metallurgical grade chromite product based on the supplied yield curves as indicated in Figure 10.1.4_2.

Figure 10.1.4_1

PGM Recovery

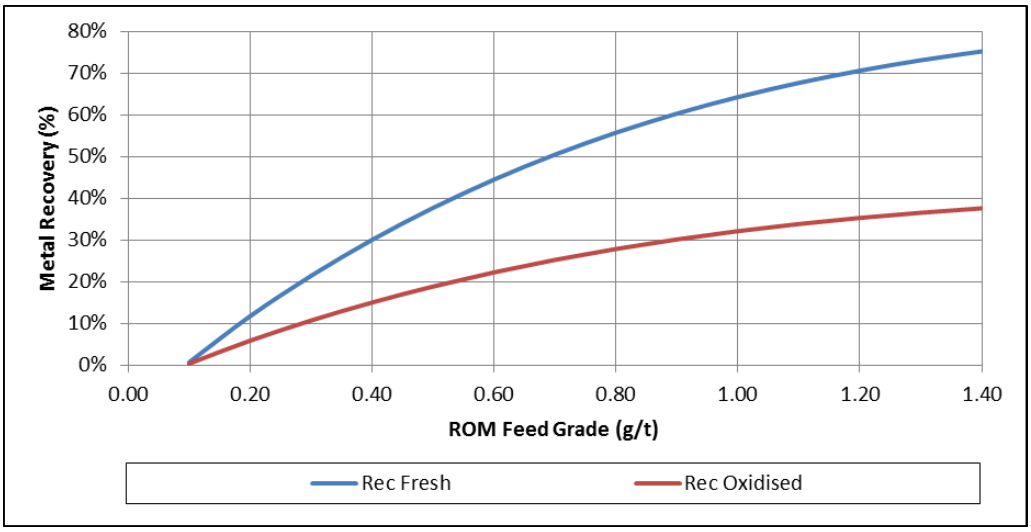
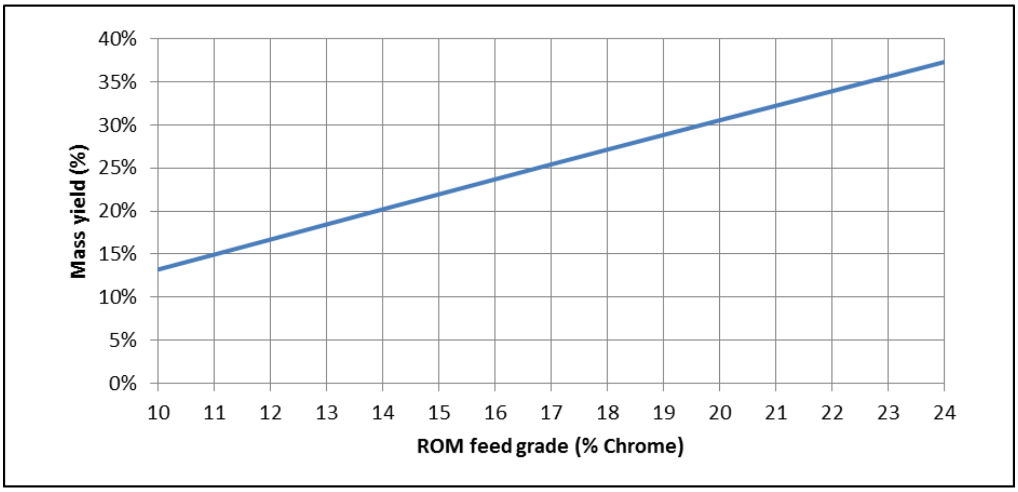


Figure 10.1.4_2

Mass Yield – Chrome Concentrate



10.1.5 Financial and Revenue Parameters

The revenue parameters used in the financial assessment to allow declaration of a Mineral Reserve are presented in Table 10.1.5_1. The PGM prices were reduced as the metals are sold as a concentrate, and only attract a percentage of the metal value. No selling cost was assigned to the PGM's and a royalty of 4.7% was included. A Cost, Insurance and Freight (CIF) cost was allowed for transport and associated costs of the chrome concentrate to the ultimate destination in China.

Table 10.1.5_1
Open Pit: Financial and Revenue Parameters

Parameter	Unit	Value
Revenue		
Pt	US$/oz.	1,184
Pd	US$/oz.	753
Rh	US$/oz.	1,401
Au	US$/oz.	995
42% Cr_2O_3	R/t	2,132
Financial		
Discount rate	%	9.2
Royalty fee (% of revenue)	%	4.7
Chrome transport cost	R/t	750

Note: the economic parameters used to optimise the mining operation and determine the viability of the mining operation in order to declare a mineral reserve, may be different from those used in the valuation of the mine as a whole.

The commodity prices and foreign exchange rates used in the model were supplied based on a range of broker forecasts.

10.1.6 Capital and Operating Costs

The mining cost was based on the approved contract rates of the current mining contractor. The rate included drilling, blasting, loading and hauling on a semi selective mining basis.

Minimal capital is required for the mining operation as MCC supplies all the mining equipment. The capital is in effect incorporated into the mining rate which is captured in the mine operating cost estimate.

10.1.7 Mineral Reserve Tabulation

With the applicable modifying factors identified and evaluated as being reasonable, and the financial model yielding positive economic returns, the Mineral Resource within the mining footprint was converted to a Mineral Reserve. The Mineral Reserve was declared exclusive of UG1 and MG(0).

The Mineral Reserve Estimate for the open pit section for Tharisa Mine is presented in Table 10.1.7_1 in accordance with the SAMREC guidelines.

Table 10.1.7_1

Tharisa Open Pit Mineral Reserve Estimation (31 December 2015)

Chromitite Layer	Tonnes (Mt)	Pt (g/t)	Pd(g/t)	Rh(g/t)	Au (g/t)	3PGE+Au (g/t)	Ru(g/t)	Ir(g/t)	5PGE+Au (g/t)	Cr_2O_3 (%)	Cu (%)	Ni (%)	Cr (%)
Proved Mineral Reserve													
MG0													
MG1													
MG2	13.2	0.85	0.27	0.13	0.004	1.27	0.23	0.07	1.57	15.9	0.003	0.060	10.8
MG3	11.1	0.55	0.32	0.14	0.005	1.01	0.20	0.05	1.26	11.9	0.003	0.045	8.1
MG4	11.0	1.00	0.22	0.20	0.003	1.43	0.34	0.10	1.87	24.2	0.002	0.071	16.6
MG4A	6.1	0.35	0.13	0.11	0.003	0.59	0.22	0.04	0.85	21.3	0.003	0.066	14.6
Total	**41.4**	**0.74**	**0.25**	**0.15**	**0.004**	**1.14**	**0.25**	**0.07**	**1.46**	**17.8**	**0.003**	**0.060**	**12.2**
Probable Mineral Reserve													
Chromitite Layer	**Tonnes (Mt)**	**Pt(g/t)**	**Pd(g/t)**	**Rh(g/t)**	**Au (g/t)**	**3PGE+Au (g/t)**	**Ru(g/t)**	**Ir(g/t)**	**5PGE+Au (g/t)**	**Cr_2O_3 (%)**	**Cu (%)**	**Ni (%)**	**Cr (%)**
MG0													
MG1	6.8	0.32	0.20	0.11	0.004	0.63	0.45	0.07	1.15	32.1	0.002	0.077	22.0
MG2	14.6	0.85	0.30	0.14	0.004	1.29	0.23	0.06	1.58	15.9	0.002	0.061	10.9
MG3	13.2	0.58	0.33	0.15	0.004	1.05	0.21	0.06	1.32	12.8	0.003	0.047	8.7
MG4	6.8	1.04	0.24	0.20	0.003	1.48	0.35	0.11	1.94	24.0	0.002	0.070	16.4
MG4A	5.0	0.34	0.14	0.11	0.004	0.59	0.22	0.04	0.85	20.7	0.003	0.066	14.2
Total	**46.4**	**0.67**	**0.27**	**0.14**	**0.004**	**1.08**	**0.27**	**0.07**	**1.42**	**19.1**	**0.002**	**0.061**	**13.1**
Total Mineral Reserve													
Chromitite Layer	**Tonnes (Mt)**	**Pt(g/t)**	**Pd(g/t)**	**Rh(g/t)**	**Au (g/t)**	**3PGE+Au (g/t)**	**Ru(g/t)**	**Ir(g/t)**	**5PGE+Au (g/t)**	**Cr_2O_3 (%)**	**Cu (%)**	**Ni (%)**	**Cr (%)**
MG0													
MG1	6.8	0.32	0.20	0.11	0.004	0.63	0.45	0.07	1.15	32.1	0.002	0.077	22.0
MG2	27.8	0.85	0.28	0.14	0.004	1.28	0.23	0.07	1.58	15.9	0.003	0.061	10.9
MG3	24.4	0.56	0.32	0.14	0.005	1.03	0.20	0.06	1.29	12.4	0.003	0.046	8.5
MG4	17.7	1.02	0.23	0.20	0.003	1.45	0.34	0.11	1.90	24.2	0.002	0.071	16.5
MG4A	11.1	0.34	0.13	0.11	0.003	0.59	0.22	0.04	0.85	21.0	0.003	0.066	14.4
Total	**87.8**	**0.70**	**0.26**	**0.14**	**0.004**	**1.11**	**0.26**	**0.07**	**1.44**	**18.5**	**0.002**	**0.061**	**12.7**

10.2 Underground Mineral Reserve Estimation

Mining related modifying factors applicable to the underground design were applied to convert the Mineral Resources to Mineral Reserves.

10.2.1 Geological Losses

A geological loss of 15% was applied based on the recommendations of the competent person.

10.2.2 Mining External Dilution

The mining dilution factors were calculated from first principles with the following assumptions:

- A 10cm layer of waste from the hanging and footwall horizons of the mined chromitite layer will be mined and conveyed as RoM ore.
- Depending on dip of the chromitite layer, some waste is mined to maintain safe and horizontal underfoot conditions as per design.

The dilution factors decrease with depth from 16.1% to 13.2% for MG2 Chromitite Layer and from 15.0% to 11.7% for MG4 Chromitite Layer. This is in direct proportion to the pillars sizes that increase with depth.

10.2.3 Mining Recovery

Mining recovery for both chromitite layers was set at the historical mining average for similar operations at 98%.

10.2.4 Mining Extraction before Geological Losses

This is mainly a function of the pillar size and was estimated from first principles. A decreasing trend with depth is indciated from 78.6% in the upper levels to 71.4% in the lower levels for both Chromitite Layers.

10.2.5 Mineral Reserve Tabulation

Indicated Resources included in the mine plan were converted to Probable Mineral Reserves.

This project includes Probable Mineral Reserves and material from Inferred Mineral Resources. The Mineral Reserve estimate for Tharisa is presented in Table 10.2.5_1 in accordance with the SAMREC guidelines.

The Mineral Reserve declaration is in respect of tonnage and grade delivered to the processing facility.

Table 10.2.5_1

Tharisa Underground Mineral Reserve Estimate (31 December 2015)

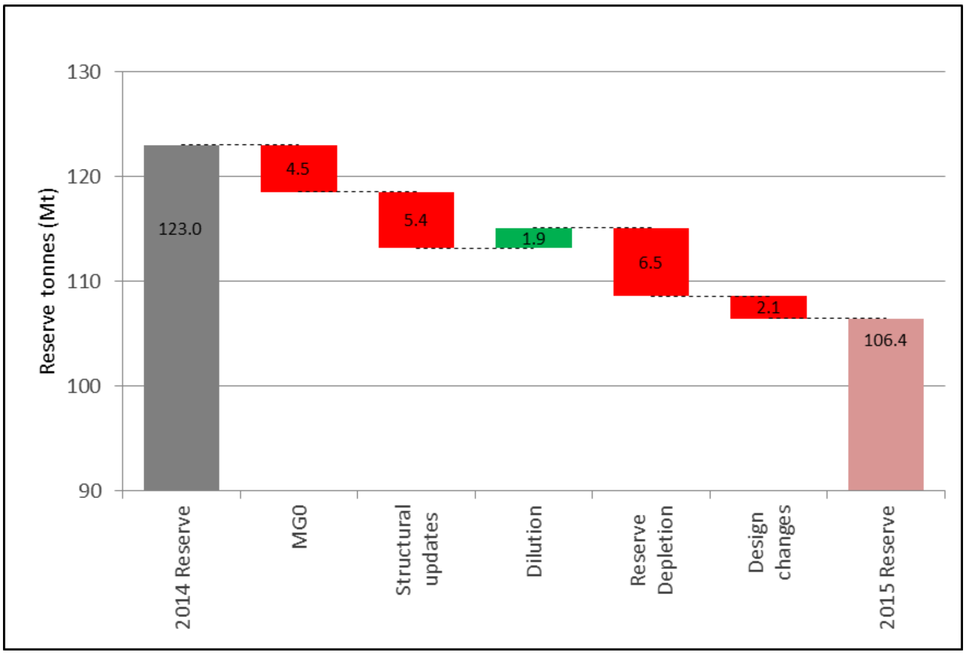
Chromitite Layer	Tonnes (Mt)	Pt (g/t)	Pd(g/t)	Rh(g/t)	Au (g/t)	3PGE+Au (g/t)	Ru(g/t)	Ir(g/t)	5PGE+Au (g/t)	Cr_2O_3 (%)	Ni (%)	Cu (%)	Cr (%)
Proved Mineral Reserve													
MG2AB	-	-	-	-	-	-	-	-	-	-	-	-	-
MG4	-	-	-	-	-	-	-	-	-	-	-	-	-
Total	-	-	-	-	-	-	-	-	-	-	-	-	-
Probable Mineral Reserve													
Chromitite Layer	**Tonnes (Mt)**	**Pt(g/t)**	**Pd(g/t)**	**Rh(g/t)**	**Au (g/t)**	**3PGE+Au (g/t)**	**Ru(g/t)**	**Ir(g/t)**	**5PGE+Au (g/t)**	**Cr_2O_3 (%)**	**Ni (%)**	**Cu (%)**	**Cr (%)**
MG2AB	6.6	0.70	0.21	0.10	0.002	1.02	0.20	0.05	1.27	17.4	0.060	0.002	11.9
MG4	12.0	0.89	0.18	0.17	0.002	1.25	0.31	0.10	1.66	20.4	0.061	0.002	14.1
Total	**18.6**	**0.82**	**0.19**	**0.15**	**0.002**	**1.17**	**0.27**	**0.08**	**1.52**	**19.3**	**0.060**	**0.002**	**13.3**
Total Mineral Reserve													
Chromitite Layer	**Tonnes (‘000)**	**Pt(g/t)**	**Pd(g/t)**	**Rh(g/t)**	**Au (g/t)**	**3PGE+Au (g/t)**	**Ru(g/t)**	**Ir(g/t)**	**5PGE+Au (g/t)**	**Cr_2O_3 (%)**	**Ni (%)**	**Cu (%)**	**Cr (%)**
MG2AB	6.6	0.70	0.21	0.10	0.002	1.02	0.20	0.05	1.27	17.4	0.060	0.002	11.9
MG4	12.0	0.89	0.18	0.17	0.002	1.25	0.31	0.10	1.66	20.4	0.061	0.002	14.1
Total	**18.6**	**0.82**	**0.19**	**0.15**	**0.002**	**1.17**	**0.27**	**0.08**	**1.52**	**19.3**	**0.060**	**0.002**	**13.3**

10.3 Mineral Reserve reconciliation

A Mineral Reserve reconciliation was conducted between the 30 September 2014 and 31 December 2015 reported Mineral Reserve. Figure 10.3_1 shows the variance in the 2014 and 2015 Mineral Reserve estimate.

Figure 10.3_1

Mineral Reserve Reconciliation



The MG0 chromite layer did not form part of the 2015 Mineral Reserve estimate due the practical and economic considerations. A volume variance occurred due to structural updates, mainly due to wireframe thickness variations between the estimated Mineral Resource wireframes and updated survey information as measured during the preceding 12 months. Planned dilution increased due to the change in mining methodology regarding the mining selectivity of chromitite layers that resulted in an increase in Mineral Reserves of approximately 1.9Mt. Reserve depletions for the period were estimated at 6.5Mt. Local design changes accounted for 2.1Mt based on the addition of a highwall ramp and the exclusion of steeper dipping areas in the far west.

11 MINERAL PROCESSING AND METALLURGICAL TESTING

11.1 Introduction

The processing facilities at the Tharisa Mine are designed to treat the (Middle Group) MG Chromitite Layers of the Bushveld Complex. These layers vary in thickness, competence and chromite and Platinum Group Metals (PGM) grades. Historically some of the MG Chromitite Layers have been mined for the recovery of chromite but not for PGM's. Tharisa Minerals has undertaken metallurgical tests on samples from these layers and confirmed the economic viability of mining and processing these ores for the recovery of both the chromite and PGM concentrates and confirmed this with the subsequent operating results.

The Tharisa Mine has been developed in a phased manner as described below.

- The **first phase** of the mine development involved the production of a chromite concentrate only from a pilot plant. Trial production commenced in March 2009. This pilot plant was later adapted to provide early revenue and from November 2009 the plant treated RoM ore at a throughput rate of 38,000 tpm.
- The **second phase** of the mine development involved the expansion of the mining operation and first phase processing facility to mine and treat 100,000 tpm of RoM ore. In addition the processing facility was expanded to incorporate both a 65,000 tpm PGM recovery circuit and a secondary chromite recovery section. This combined complex is currently known as the Genesis plant. Commissioning of the Genesis plant commenced in August 2011 and was completed in February 2012.
- The **third phase** of mine development increased the mining and processing rate by a further 300,000 tpm. This was achieved through the construction of a new standalone concentrator which operates in parallel to the existing 100,000 tpm processing facility. The new 300,000 tpm concentrator, known as the Voyager plant, recovers a primary chromite concentrate, a PGM concentrate from the primary chromite tailings and a secondary chromite concentrate from the PGM tailings.

After the construction and commissioning of the Voyager plant the total mining and processing throughput capacity of the Tharisa Mine was 400,000 tpm (4.8Mtpa) of RoM ore.

11.2 Processing Facilities and Flow Sheets

The original process design was based on test work undertaken by Mintek. In addition, the Tharisa Minerals processing facility was developed on a phased basis as discussed in Section 11.1. The different phases were structured to provide additional design information for the 300,000 tpm plant while generating an income stream through recovering chromite concentrate.

The Tharisa minerals operation produces the following products:

- Metallurgical Chromite Concentrate

  The typical metallurgical chromite product chrome grade from Tharisa is 41% to 42% Chrome (As Cr_2O_3) with the silica (SiO_2) lower than 5%.

- Chemical Grade Chromite Concentrate

  The typical chemical grade chromite product chrome grade from Tharisa is 44% to 46% Cr_2O_3 with the SiO_2 lower than 1.0%. This is a higher value chromite product than the metallurgical grade chromite concentrate.

- Foundry Grade Chromite Concentrate

  The typical foundry grade chromite product chrome grade from Tharisa is 44% to 46% Cr_2O_3 with the SiO_2 lower than 1.0%. The American Foundryman Society Grain Fineness Number (AFS Number) is managed between 45 and 50. As with the Chemical Grade Chromite, this is a higher value chromite concentrate than the metallurgical grade chromite concentrate.

- PGM Concentrate

  PGM concentrate is produced from both the processing facilities. The concentrate produced from the Voyager plant is higher grade than the concentrate from the Genesis plant due to the different chromitite reefs treated. The concentrate grade of the Genesis plant varies from 40 g/t 6E (Six Elements) PGM's to 100 g/t 6E PGM's with the average product grade increasing from 56 g/t 6E in 2014 to 78 g/t 6E in 2015. The concentrate grade of the Voyager plant varies from 104 g/t 6E PGM's to 167 g/t 6E PGM's with the average product grade increasing from 129 g/t 6E in 2014 to 139 g/t 6E in 2015. The major component of the PGM's is Platinum, followed by Palladium and Ruthenium. The concentrates are blended if required to ensure a consistent final concentrate product leaving the mine.

The Tharisa production drive is to optimise the recovery of chromite to higher value products (Chemical and Foundry Grade Concentrates) without compromising the sales of the metallurgical grade chromite concentrate. In the case of the PGM flotation circuit the main drive is to optimise PGM recovery while maintaining an acceptable PGM concentrate grade and maintain penalty elements (mainly Cr_2O_3) within limits.

The current operational processing facilities consist of two distinct and separately operated plants which are described below.

<u>Genesis Plant</u>

The second phase of mine development established the Genesis processing plant with a design plant throughput of 100,000 tpm RoM. The Genesis plant processes predominantly the MG1 and MG4A Chromitite layers which contain the higher grade chromite and lower grade PGM's.

The main focus of the Genesis plant is therefore to recover and produce higher value chromite products.

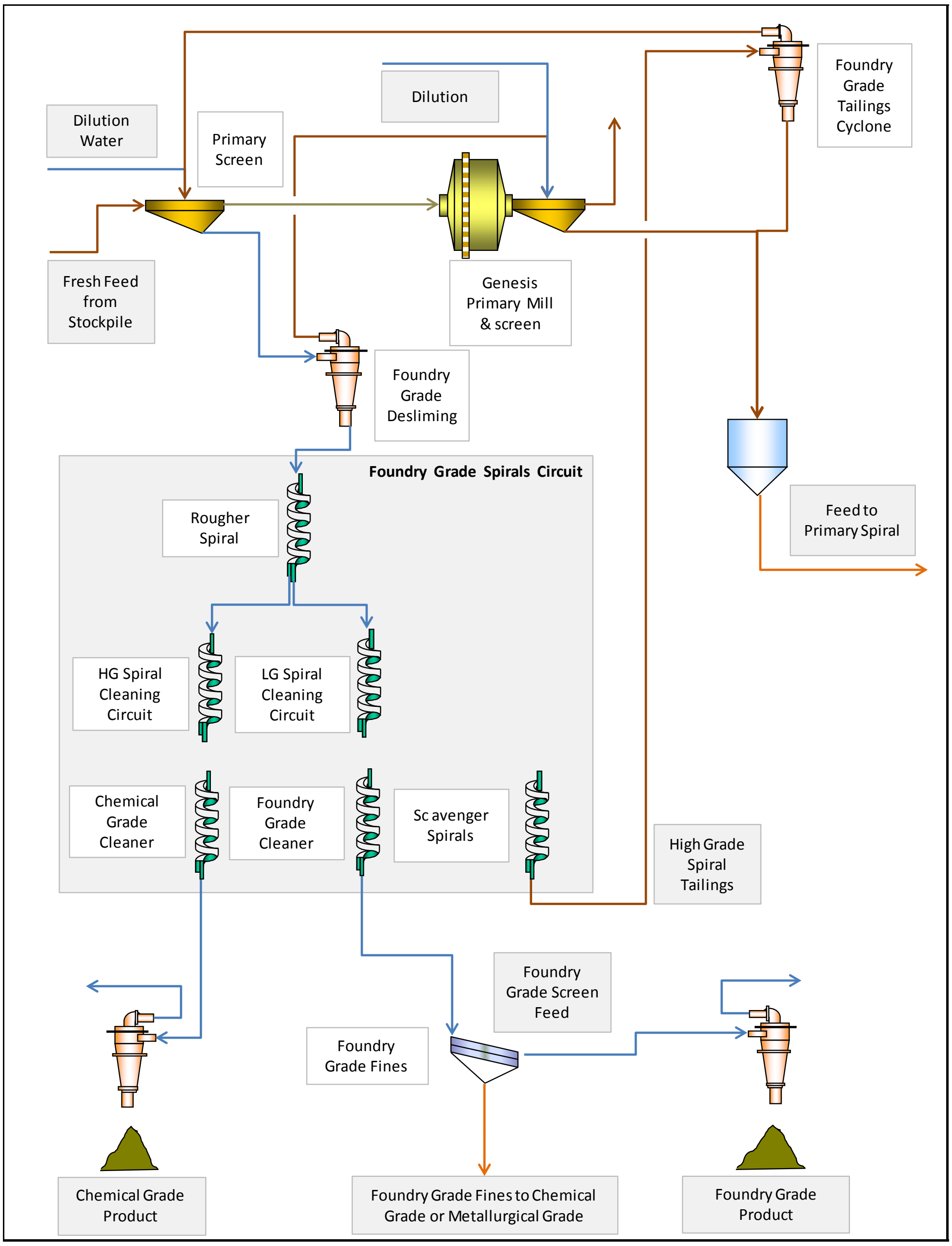
Since the original design of the Genesis plant the following projects have been implemented to optimise the production and product value.

- Foundry Grade Project

  The Foundry Grade Project is an additional spiral plant that was added to the Genesis plant to treat natural fines from the crushing circuit to produce up to 2,250 tpm of foundry grade and up to 1,500 tpm of chemical grade chromite. The production of higher grade final products is associated with a minor reduction in the total metallurgical grade chromite production (but higher total value) from this plant. The simplified process flow diagram of the foundry grade circuit is presented in Figure 11.2_1.

Figure 11.2_1

Phase 1 Foundry Grade Project Simplified Flow Diagram



- Additional Stages to Primary and Secondary Spiral Section

  Two additional middlings cleaning spiral stages and a re-cleaner spiral stage have been added to the original primary spiral circuit. Also a re-wash circuit consisting of two additional cleaning stages has been added to clean middlings from the cleaner circuit.

Two cleaning spiral stages have been added to the Secondary spiral circuit. These additions gives additional cleaning capacity to ensure flexibility and to increase recovery on the roughers and scavengers while still maintaining the final concentrate grade.

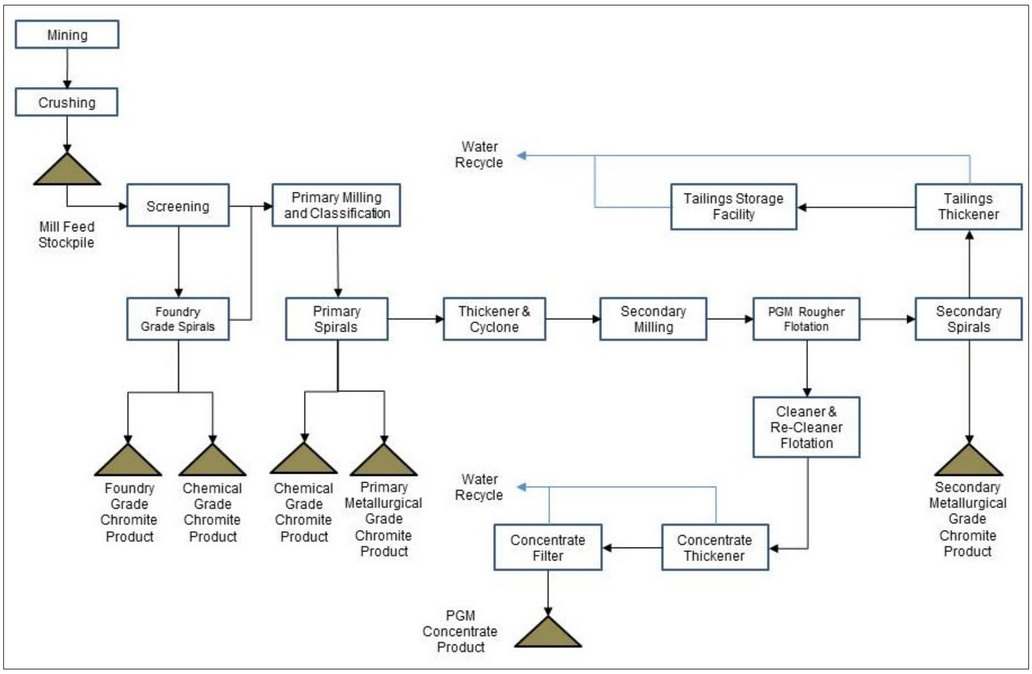
- Production of Chemical Grade Concentrate from the Primary Spiral Section

  The concentrate from the primary re-cleaner spirals is re-directed to two additional spiral cleaning stages producing a chemical grade chromite concentrate from the primary spiral circuit. The combined chemical grade chromite concentrate for the Genesis plant, from the Foundry Plant and Primary Spirals section, varies up to a maximum of 5,500 tpm dependent on the feed chromite grade.

The Genesis process flow is indicated in Figure 11.2.2 and described below.

Figure 11.2_2

Genesis Plant (Phase 2):Simplified Block Flow Diagram



RoM material from the open pit mining operation is received and stored on a RoM pad. The RoM material is fed either directly by truck or by front end loader into the crushing circuit. The ore is crushed to less than 12mm by a three stage crushing circuit. The crushed ore is screened at 0.6mm to remove the crushed fines. This minus 0.6mm fine material is pumped to the foundry grade spiral plant for recovery of foundry and chemical grade chromite concentrates. These concentrates are dewatered separately by dewatering cyclones and stored on separate drying pads from where it is despatched by covered road truck.

The plus 0.6mm coarse fraction from the screen is milled in a single stage ball mill operated in closed circuit with a vibrating screen with a 0.6mm cut size. The milled ore that passes through the screen combines with the tailings from the foundry grade spiral concentrator plant and is pumped to the primary spiral concentrator circuit. The primary spiral circuit further recovers chromite to produce metallurgical and chemical grade chromite concentrates. The metallurgical grade chromite concentrate is dewatered by separate dewatering cyclones and stored on separate drying pads from where the concentrate is despatched. The chemical grade concentrate joins the chemical grade concentrate from the foundry plant for dewatering and storage.

The primary spiral circuit tailings stream is dewatered by a cluster of cyclones from where the coarse solids gravitate to three open circuit secondary ball mills operated in parallel. The fine solids, cyclone overflow, feeds a thickener where the thickened fine solids are also pumped to the ball mills. The slurry discharging from the secondary mills is collected in a common tank and pumped to the flotation plant for PGM recovery. The concentrate from the first rougher flotation stage is subjected to three stages of cleaner flotation to produce a final PGM concentrate. The PGM concentrate is dewatered first through a thickener and the thickener underflow reduced to a cake in a filter press..

The PGM flotation section tailings stream is pumped to a secondary spiral concentrator section where the finer chromite, liberated by the secondary mills, is separated from the gangue material to produce a second fine metallurgical grade chromite concentrate. This fine chromite concentrate is dewatered by cyclone and stored on a separate dedicated drying pad..

The water in the tailings from the secondary spirals section is recovered in a thickener and re-circulated as process water. The thickened tailings are pumped to the final Tailings Storage Facility (TSF). Water is also recovered from the TSF and circulated back to the processing facility.

Voyager Plant

The third phase of mine development increased the total throughput rate to 400,000 tpm by establishing a new processing facility rated at 300,000 tpm, known as the Voyager plant. The Voyager plant operates in parallel with the 100,000 tpm Genesis plant. The Voyager plant processes predominantly the MG2, MG3 and MG4 Chromitite layers which contain the higher PGM grades and lower chromite grades.

Since the original design of the Voyager plant the following projects have been implemented to optimise the production and product value.

- PGM Rougher Flotation Concentrate Regrinding Circuit:

  The original feasibility study process flow included a regrinding circuit. Subsequent to the final Mintek test work results, the regrinding circuit was removed from the design as the PGM recovery improvement, indicated by laboratory test work, did not justify the additional capital cost required for the regrinding circuit.

- PGM Cleaner Flotation Circuit:

The original feasibility study process flow was based on a cleaner, re-cleaner and final cleaner (three stage cleaner circuit). During detail design the circuit was changed to a high grade / low grade cleaner circuit to produce a high grade and low grade PGM concentrate. (The concentrates are combined as final product). The design improvement provided additional process flexibility resulting in better flotation efficiencies.

- Three Stage Crushing Circuit:

  The initialplant design was based on a single stage primary jaw crushing and Semi-Autogeneous Grinding (SAG) mill circuit. As the ore hardness was not adequately defined for the fresh ore, the mitigation factor in the original design was to include a pebble crusher in the circuit. From final test work results, the fresh ore has proven to be more competentthan the original design. The consequence of this was that the final crushing circuit was changed to a three stage crushing with the primary millsingoperating as grate discharge ball mills.

- Production of Higher Value Chromite Products (Voyager Plant)

  Tharisa has proven with plant test work that the recovery of a small fraction of higher value chemical grade chromite is possible from the Voyager plant primary spiral circuit. This required the installation of two additional cleaning spiral stages to produce a chemical grade product from the existing re-cleaner spiral concentrate. The required circuit changes to achieve the production of chemical grade chromite have been completed. In addition to spiral circuit changes, one of the chromite dewatering and stacking cyclone sections will be used to dewater and stack the chemical grade product separatly from the metallurgical grade product.

- Primary Chromite Circuit Improvements to Increase Flexibility

  The original 6 stage spiral circuit had single stage cleaning and middling's treatment circuits. circuit. Subsequent to the original commissioned circuit, two stages of cleaning, a dewatering cyclone cluster and a scavenger circuit have been added to the primary spiral operation. The additional spiral steps allow for more flexibility that ensures optimum chromite concentrate grade and yield; even with variable chromite feed grades. In addition, the originally installed primary spirals are being replaced with better quality, and slightly modified, spirals to improve the flow and separation characteristics.

- Secondary Chromite Circuit Improvements to Improve Yield

  The original installed spiral plant included a 6 stage spiral circuit with single stage cleaning and middling's treatment circuit. Subsequent to the original implemented circuit, three stages of high grade cleaning spirals and one stage of low grade cleaning spirals were added to the circuit. As with the primary circuit, a dewatering cyclone cluster and a scavenger spiral stage were added to the spiral circuit. The additional spiral steps improved the secondary spiral yield while maintaining an acceptable concentrate grade.

- The Implementation of High Energy Flotation

Due to the small grain size of the PGM minerals in the Tharisa ore, liberated fines are lost to tails in conventional flotation cells as they do not have enough energy to penetrate bubble surfaces. By combining high energy mechanisms with conventional mechanisms, and dedicating a cleaner circuit to each of the different recovered size fractions, the ultra-fine PGM minerals lost to tails can be recovered.

After a pilot tests program, high energy flotation mechanisms were installed in the Tharisa Voyager flotation circuit. These mechanisms have been installed in selected flotation cells in the rougher circuit and in selected flotation cells in the low grade cleaning circuit.

The current Voyager process flow is indicated in Figure 11.2.3 and described below.

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The Voyager plant requires a stable and mixed feed from the different ores from the open pit mining operations. The Run of Mine ore is delivered to the area ahead of the crushing section. It is either stockpiled or fed directly in to the plant. The required blend in to the plant is made up from stockpiled material and direct feed depending on the seams being mined in the pit.

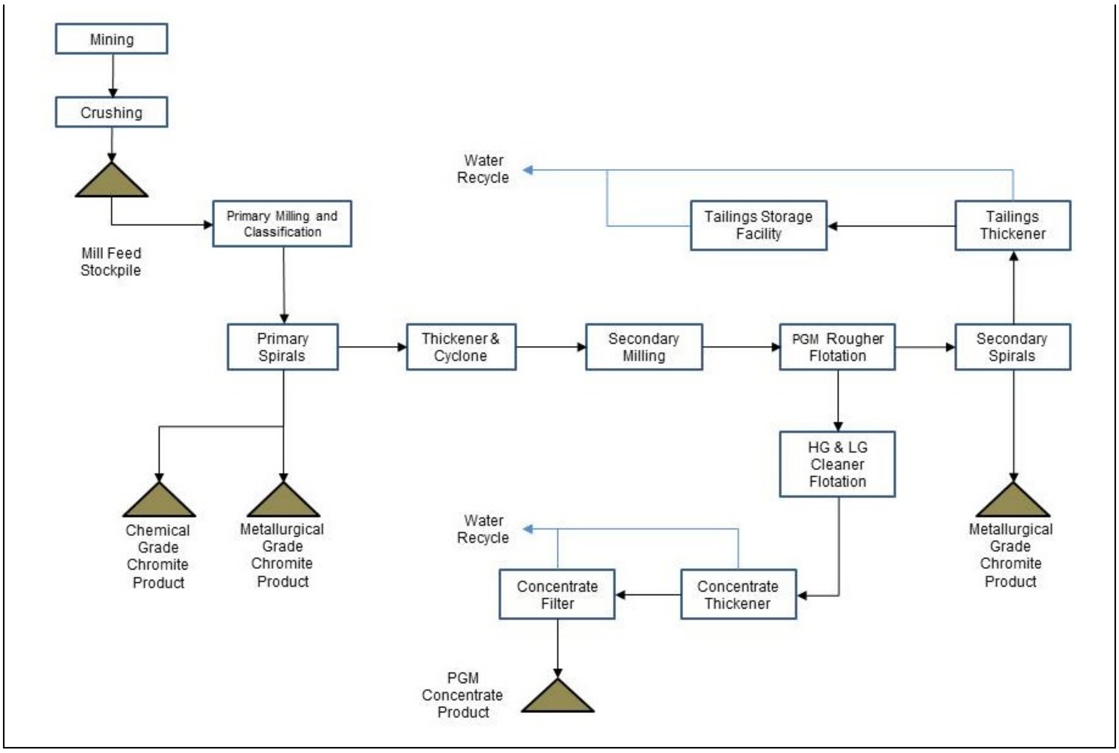
The ore is fed to the primary jaw crusher from a vibrating grizzly feeder that removes the fine material ahead of the crusher. These fines and crushed ore is further educed through the secondary and tertiary cone crushers to a nominal particle size of 22mm, from 500mm in to the primary crusher.

The crushed ore is stored on an open stockpile from where it is fed to two ball mills operating in parallel. Each 3.35 MW ball mill is in closed circuit with dedicated mill screens sizing at 0.6mm. Material coarser than 0.6mm is returned to the mills whilst the solids finer than 0.6mm pass through the screens and are pumped to the primary spiral concentrator section for recovery of the coarse chromite. Most of the chromite concentrate recovered is metallurgical grade concentrate, but recent modifications to the circuit produce a chemical grade concentrate.

The metallurgical grade chromite concentrate from the secondary spirals joins the metallurgical grade concentrate from the primary spirals for dewatering. The combined metallurgical grade concentrate is dewatered by cyclone and stored on drying pads. Two drying pads are used, each equipped with two dewatering cyclones, allowing for four placement options for the metallurgical grade chromite concentrate. The chemical grade concentrate is dewatered by cyclone and stored on a separate drying pad. The drying pad is equipped with two dewatering cyclones, allowing for two placement options for the chemical grade chromite concentrate. The concentrates are loaded from the drying pads by front end loader and dispatched by truck.

Figure 11.2_3

Voyager Plant (Phase 3):Simplified Block Flow Diagram



The tailings from the primary spiral concentrator plant is pumped to a classifying cyclone cluster where coarse solids discharge via the underflow to a single 5.5 MW ball mill that operates in open circuit. The overflow from these cyclones are fed to a thickener where the contained water is recovered and returned to the process water tank. The underflow from this thickener is then pumped to the PGM recovery section together with the secondary mill discharge in to the rougher flotation circuit. The concentrate from the rougher flotation circuit is subjected to various stages of cleaner flotation in a High grade / Low grade cleaner circuits to produce a final PGM concentrate. The PGM concentrate is dewatered by a combination of a thickener and a filter before despatch by truck.

The PGM recovery section tailings stream is pumped to a secondary spiral concentrator section where the fine chromite, liberated by the secondary mill, is separated from the gangue material to produce a second fine metallurgical grade chromite concentrate.

The water in the tailings from the secondary spiral concentrator is recovered in a thickener and re-circulated to the processing facility whilst the solid tailings (thickener underflow) are pumped by a tailings pumping system, to the final TSF. The TSF is a shared facility with the Genesis processing facility.

Construction of the Voyager plant commenced in July 2011 and was completed in September 2012. Commissioning of this plant commenced during August 2012, first ore was introduced to the plant during September 2012 and commissioning was completed in December 2012.

The Tharisa metallurgical and engineering team has undertaken a number of plant performance evaluation studies subsequent to the 400,000 tpm processing facility being put into production. These studies have resulted in various plant upgrades (as discussed) to improve the process plant performance in terms of both recovery and concentrate grade for both chromite and PGM's.

Furtherimprovement projects currently under investigation are described below. These projects are in various phases of testing and the final decision of which will be implementation has not being made.

- Wet High Intensity Magnetic Separation (WHIMS)

  During the operation of the plants it has been found that there is chromite content in the final tailings. These losses were found to be in the fines fraction where spiral efficiencies are low. Chromite is paramagnetic and laboratory and pilot scale tests have shown that this material can be recovered with high intensity magnets.. A two stage production scale WHIMS circuit has been installed at the Voyager plant to evaluate this technology and likely plant performance.

- Column Flotation

  Pilot tests are in progress to evaluate the application of column flotation to the PGM circuit to improve final PGM concentrate grade and the recovery of fine PGM particles.

- Shaking Tables

  Pilot tests are in progress to evaluate the application of shaking tables in the chromite circuit to improve spiral chromite product grade and yield.

- Application of Regrind Milling

  The PGM flotation circuit has undergone significant optimising to improve recovery and grade. The application of regrinding is currently under review for further PGM recovery improvement in future.

11.3 Genesis and Voyager Plant Metallurgical Performance

The Tharisa combined Genesis and Voyager process plants have been operated as production units since December 2012. The ore that has been processed to date is from near surface and can be described as mixed rather than fresh ore. This means that the ore is partially oxidised which has a negative impact on the flotation recovery of the PGM's. As the open pit deepens the RoM ore will increasingly become "fresh" (non-oxidised) with a resultant improvement in PGM recovery.

The chemical and foundry grade chromite recovery circuits were commissioned in July 2013 and production of these higher grade concentrates has continued since.

The actual production data for 2013 to 2015, together with the planned metallurgical performance is presented in Table 11.3_1.

Table 11.3_1
Tharisa Mine
Key Achieved and Planned Metallurgical Performance Statistics

Description	Year	2013*	2014*	2015*	2016	2017	2018
Tonnes Milled	'000t	3,866	3,913	4,400	4,659	5,086	5,035
RoM Chromite Grade	$\%Cr_2O_3$	20.7	19.4	18.3	19.5	19.6	19.3
Foundry Grade Chromite Concentrate							
Concentrate Tonnes	'000t	4.0	13.4	5.0	16.6	24.3	23.4
Concentrate Grade	$\%Cr_2O_3$	45.0	45.4	44.4	45.0	45.0	45.0
Chemical Grade Chromite Concentrate							
Genesis Plant – Tonnes	'000t	11.4	46.4	18.9	51.4	64.7	62.2
Genesis Plant – Grade	$\%Cr_2O_3$	45.0	45.3	44.4	45.0	45.0	45.0
Voyager Plant – Tonnes	'000t	47	81.0	88.9	79.2	200.1	199.0
Voyager Plant – Grade	$\%Cr_2O_3$	44.0	43.7.0	43.7	44.0	44.0	44.0
Metallurgical Grade Chromite Concentrate							
Concentrate Tonnes	'000t	1,130	937	1,009	1,061	1,099	1,079
Concentrate Grade	$\%Cr_2O_3$	42.0	41.2	41.3	42.0	42.0	42.0
Total Chromite Concentrate							
Concentrate Tonnes	'000t	1,193	1,078	1,122	1,341	1,439	1,415
Chromite Yield	%	30.9	27.6	25.5	29	29	28
Chromite Recovery	%	59.3	59.4	58.1	66	74	73
PGM Concentrator Section							
PGM Concentrator Feed	'000t	2,894	3,060	3,446	3,454	3,626	3,625
PGM Feed Grade	g/t	1.41	1.64	1.62	1.68	1.75	1.76
PGM's in Concentrate	ounces	57,421	78,226	118,041	123,052	151,043	164,429
PGM Concentrate Grade	g/t	60	116	131	116.25	128.37	139.79
PGM Recovery	%	43.7	48.5	65.8	66	74	80
*Actual Production							

The following needs to be noted on the historical production information:

- Production Capacity

  The average production for the Genesis plant was 80,615 tpm and the Voyager plant was 284,098 tpm during 2015. This is an average total production of 366,704 tpm. The Genesis plant did achieve 100,000 tpm for one month and the Voyager plant achieved 300,000 tpm for six months during the 2015 12 month period. The average production of the Voyager plant during these six months was 319,000 tpm.

  From 2015 production results it can be concluded that the Tharisa Minerals operation can achieve 400,000 tpm if operated optimally and if RoM feed is readily available.

- PGM Recovery and Grade

  Both the PGM recovery and grade improved greatly from 2013 to 2015. The total recovery for 2015 was 65.8% at a concentrate grade of 131 6E g/t. The recovery and grade is better than expected and with the expected increase in the ratio of fresh (non-oxidised) ore in the plant feed, it is expected that the improving trend will continue into future.

- Chromite Recovery and Grade

  The average chromite feed grade declined from 2013 to 2015 from 20.7% Cr_2O_3 to 18.3% Cr_2O_3. The decline corresponded with a decline in the chromite concentrate grade and the chromite recovery in line with predicted plant performance.

The planned metallurgical production is based upon the following:

- The tonnage and head grade from the mining schedule for this period. The feed ore supply to the Genesis and Voyager plant will be stabilised to ensure the 400,000 tpm throughput target is met.
- PGM recoveries are based upon the fresh (non-oxidised) ore and oxidised ore mix in the mining schedule for this period. Higher recoveries are achieved with fresh ore. The fresh ore ratio in the plant feed will increase over the next three years.
- A programme of chromite spiral upgrading is currently under way. The combination of spiral circuit changes and spiral quality improvement is expected to provide an improvement in chromite recovery over the next three years.
- Pilot testing of WHIMS has shown a 2% (up to 10%) increase in chromite recovery as fine chromite from tailings. Two WHIMS units have been installed and final test work is currently underway to finalise the position of the WHIMS. The expected final implementation is 2016.
- Higher grade PGM concentrates can be readily produced without loss of PGM recovery as indicated by the 2015 PGM concentrator section performance. During 2015 an average concentrate grade of 131 g/t at 65.8% recovery were achieved.

- The ratio of foundry grade chromite concentrate to total chromite concentrate production averaged 0.67% from 2013 to 2015. The peak was in 2014 at 1.24%. The current budget, based on the spiral plant improvements currently underway, is 1.38% from 2016.
- The ratio of chemical grade chromite concentrate to total chromite concentrate production averaged 8.6% from 2013 to 2015. The peak was in 2014 at 11.8% and during 2015 9.6% was achieved. The current budget is to maintain the ration at 11.0% from 2016.

11.4 Combined Genesis and Voyager Plant Operating Cost

The operating costs for the combined Genesis and Voyager process plants are presented in the following categories for both the historical costs and the forecast costs:

Labour

The labour cost includes: salaries, employee benefits, training, travel, accommodation and expense claims. The planned and actual labour component for 2015 and 2016 is indicated in Table 11.4_1. The actual labour component for 2015 indicates that the mine is currently understaffed according to plan with 469 employees against 518 planned. The budget plan for 2016 indicates that the staffing requirements will increase with 15 people from the 2015 budget. The labour component excludes the mining contractor employees.

Table 11.4_1
Tharisa Mine
Planned and Actual Labour Component for 2015 and 2016

Description	2015 Planned	2015 Actual	2016 Planned
On Mine Support Staff	129	121	146
Plant Operation and Engineering	374	348	370
Engineering	100	92	100
Lab	29	29	29
Plant Overheads – Genesis	20	21	21
Plant Overheads – Voyager	20	20	20
Plant Overheads – Common Plant	14	12	14
Logistics	15	15	15
Operations Tailings Dam	13	14	14
Operations Genesis	48	43	44
Operations Challenger	13	10	13
Operations Voyager	57	56	57
Operations – Crusher	45	36	45
Total on mine	**503**	**469**	**518**

Stores

The stores cost includes: mill media, reagents, mill liners, mechanical spares, tools, laboratory consumables, lubricants, electrical spares, control and instrumentation spares, piping and valves, crane hire, engineering consumables, fuel, surveying and personnel protection equipment. The stores cost forms a large portion of the overall plant operational cost and accounts for most of the process consumables as well as the maintenance consumables.

The typical reagent and mill steel consumption are provided in Table 11.4_2. The table indicates the budget against the actual for 2014 and 2015. The reagent and mill media consumption was historically fairly accurate.

Table 11.4_2
Tharisa Mine
Planned and Actual Reagent and Mill Media Consumption 2014 and 2015

Plant			Voyager		Genesis	
Description			2014	2015	2014	2015
Primary Mill Media	Planned	kg/tonne	1.00	1.00	0.47	0.65
	Actual	kg/tonne	1.34	1.02	0.45	0.31
Secondary Mill Media	Planned	kg/tonne	0.65	0.65	0.66	0.45
	Actual	kg/tonne	0.42	0.32	0.39	0.28
Senfloc 2660	Planned	g/tonne	25	30	25	40
	Actual	g/tonne	27	16	46	58
SNPX Minibulk	Planned	g/tonne	200	220	200	220
	Actual	g/tonne	222	210	287	234
Senfroth 200	Planned	g/tonne	35	23	43	50
	Actual	g/tonne	20	15	47	51
Sendep 30D	Planned	g/tonne	160	180	230	180
	Actual	g/tonne	169	159	237	105
Copper Sulphate	Planned	g/tonne	145	165	130	130
	Actual	g/tonne	157	141	117	101

Sundries

The sundries cost includes: sampling and analysis, tailings management, consultants, (Information Technology) IT, legal costs, office costs, plant security, outsourced services, insurances, medical costs and equipment hire.

Materials Handling Cost

The materials handling cost is the cost related to the movement of the raw materials and product in the process plant. This include for blending of products to ensure the correct quality product is loaded and transported to customers.

Utilities

The utilities cost entails the power and water supply cost.

Total Operating Cost

The operating cost data for 2013, 2014 and 2015 together with the budget operating cost for 2016 is presented in Table 11.4_4 below.

The operating cost provided in Table 11.4_4 is the direct operating cost relevant to the plant operation and maintenance.

The operating cost is indicated to increase by 10.0% from 2015 actual cost to the 2016 budget cost.

The major components impacting on the increased operating cost is increased labour cost, mill media cost, mill liner cost, general stores cost and materials handling cost. The cost increase is in line with what is expected within the current South African operating environment.

Table 11.4_4
Tharisa Mine
Achieved and Planned Metallurgical Operating Cost – Excluding Overheads (ZAR/t)

Operating Cost (ZAR/t)	Year	2013	2014	2015	2016**
Labour		20.33	25.29	26.94	30.92
Stores		44.98	55.95	55.86	60.12
Sundries		3.16	4.43	7.09	5.89
Materials Handling		3.82	8.65	4.74	6.89
Utilities		18.06	23.61	23.38	25.97
TOTAL		**90.34**	**117.93**	**118.00**	**129.79**

**** Budget for 2016**

11.5 General Process Facility Observations

The process plant was found to be in good operational and running condition with the operational areas clean and neat indicating good housekeeping.

A large drive to improve the process efficiency was evident. This was clear from the amount of pilot scale test facilities installed (WHIMS, Column Flotation, Shaking Tables, Smelting Facility etc.).

In addition the active replacement of faulty spirals and installation of new spiral clusters was observed in both the Genesis and Voyager plant.

Normal maintenance activities in the form of a mill screen replacement, workshop activities and delivery of primary mill liners made it evident that the plant is considered a long term asset and that active maintenance and improvement projects are in progress on a regular basis.

A review of the capital budget indicated the following:

- A prioritising system is in place to schedule capital projects dependant on plant income with the focus on high priority and high value creation projects.
- The capital budget includes for strategic spares replacement with the total value for 2016 ZAR 17.36 million.
- The total capital budget for 2016 is ZAR 156.22 million.

The conclusions from the plant observations and capital budget review is that the Tharisa Minerals operations are actively maintaining and improving the production plant to ensure long term viable operations.

11.6 Tailings Storage Facilities and Waste Rock Dumps

The Tailings Storage Facilities (TSFs) design process was dominated by the need to create sufficient tailings storage capacity to serve the design life of the mine in the limited space available within the mining right area. The location of the orebody, and hence the open pit mining operations, within the mining right area necessitated that the TSFs would be constructed in close proximity to the open pit.

The proximity of the tailings storage facilities to the mining operations meant that one of the design priorities would be to minimise risks in terms of loss of life and future earnings and this in turn meant that the design of a robust impoundment would have to be adopted.

A decision was thus made to use waste rock, from the open cast mining operations, to construct a tailings impoundment. This would ultimately achieve the following:

- The efficient use of the limited space available for mining infrastructure;
- The construction of a robust structure with high factors of safety necessary due to their proximity to mining operations and the process plant;
- Ease and ability to rehabilitate the side slopes of the TSFs as soon as possible;
- The reduction of the overall footprint of the waste storage areas (tailings and waste rock);
- The reduction of closure costs.

The proximity of the TSFs to the open cast operations meant that the short waste rock haul distances lent themselves to constructing stable rockfill walls without incurring exorbitant construction costs. This results in a solution that addresses the risks to the mine and at the same time disposes of the waste rock and tailings stream efficiently.

The Waste Rock Dumps (WRDs) will serve as storage facilities to accommodate all the excess waste rock generated by the open cast mining operations not being absorbed by the construction of the TSFs as well as other construction activities. It is the mine’s intention to backfill the open pits with the waste rock generated on an advancing basis once the pits have been sufficiently developed. Roll over mining is envisaged to begin in the third quarter of 2017.

The design of each of the WRDs was governed by the following:

- Maximise the storage capacity of the WRDs within the footprint designated for their development;
- Ensure that their final geometry is such that it facilitates on-going rehabilitation and closure and also minimises the works required at the end of the life of mine to complete the closure process; and
- Ensure that surface water runoff and seepage emanating from the WRDs are contained.

11.6.1 Design and Construction of the Tailings Storage Facilities

The construction of TSF 1 has been completed successfully with the construction of the next TSF (TSF 2 Phase 1) in progress. Figure 11.6.1_1 shows the layout of TSF 1 and TSF 2. The construction of the rockfill walls will absorb approximately 38.28Mm^3 of waste rock (Including the volume of waste rock allocated to the TSF 2 Division Wall) which would otherwise have been disposed of in dedicated WRDs, adding to the overall mine footprint and rehabilitation costs. The combined tailings storage capacity for TSF 1 and TSF 2 is 25.12Mm^3. The construction of TSF 1 and TSF 2 has been phased as shown in Figure 11.6.1_2 and Figure 11.6.1_3 respectively.

Figure 11.6.1_1
Layout of Tharisa Mine's TSF 1 and TSF 2 (Combined Facility)

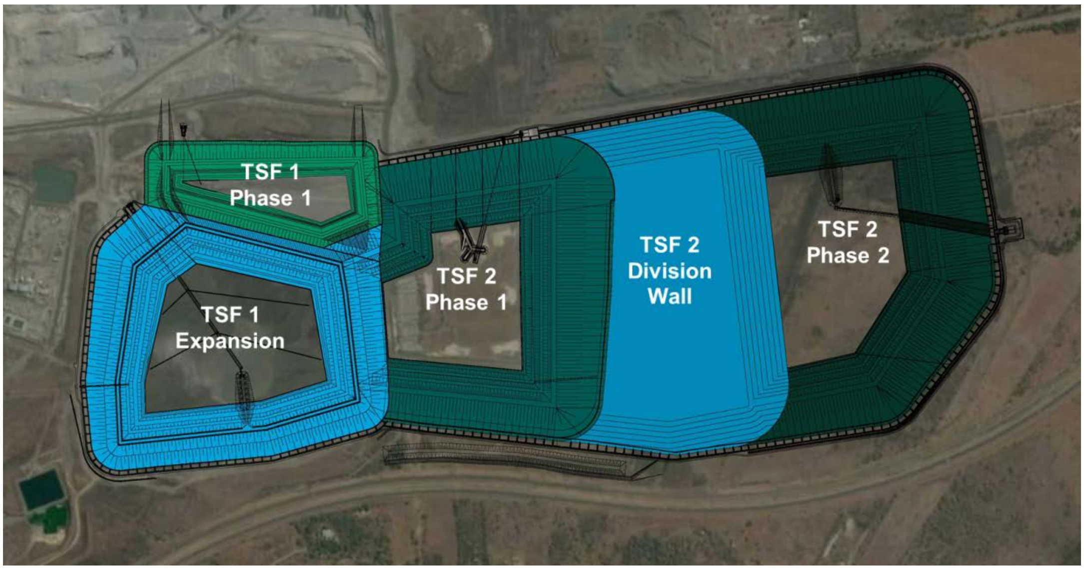
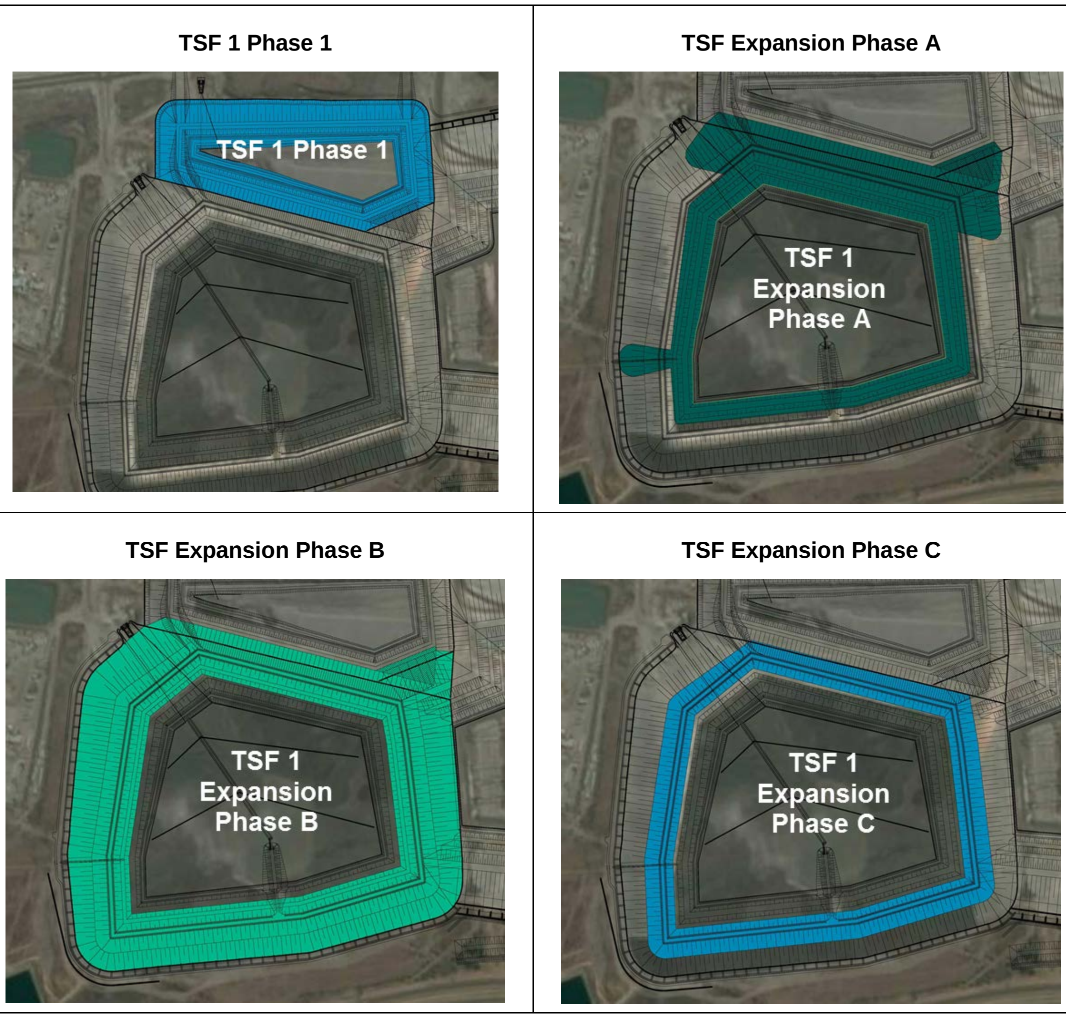


Figure 11.6.1_2

Construction Phasing of TSF 1



The phasing of the construction of TSF 1 was executed as follows:

TSF 1 Phase 1 is a small paddock whose construction was prioritised to provide a tailings storage facility for the early deployment of the 100,000 tpm Genesis plant:

- Construction completed and paddock commissioned in August 2011.
- This phase provided 640,000m3 tailings storage capacity for a period of 20 months of tailings produced by the 100,000 tpm Genesis plant.
- Approximately 860,000m3 of waste rock was used for the construction of the impoundment walls.

TSF 1 Expansion Phases A, B and C will provide tailings storage capacity for tailings produced from both the 100,000 tpm (Genesis plant) and the 300,000 tpm (Voyager plant) for a total period of approximately four years. More specifically:

TSF 1 Expansion Phase A:

- Construction completed in July 2012 in time for the commissioning of the 300,000 tpm Voyager plant.
- Containment walls constructed to an elevation of 1,223mamsl which provided a storage capacity for about 18 months or 2.3Mm3 of tailings.
- Approximately 3.3Mm3 of waste rock was used for the construction of the impoundment walls, with an additional 0.61Mm^3 of waste rock placed in the key below the containment wall footprint.

TSF 1 Expansion Phase B:

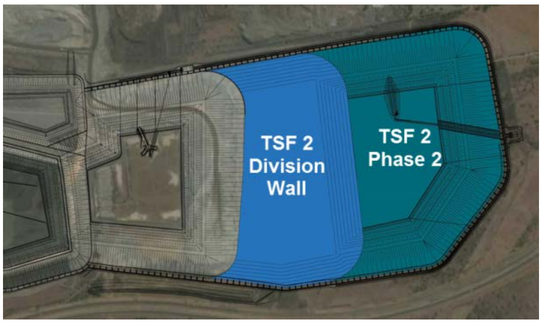
- Completion of construction of Phase B occurred in mid December 2013.
- The containment walls were constructed to an elevation of 1,230mamsl which provides a storage capacity for about 11 months or 1.69Mm3 of tailings.
- Approximately 1.4Mm3 of waste rock placed in the impoundment walls.

TSF 1 Expansion Phase C:

- Completion of the containment wall to its final design elevation of 1,242mamsl was achieved in July 2015.
- Final wall provides tailings storage for a further 18 months or 3.25Mm3 of tailings and is expected to reach full capacity in September 2016.
- A further 980,000m3 of waste rock was used to construct the impoundment wall to its final height.

Figure 11.6.1_3

Construction Phasing of TSF 2

TSF 2 Phase 1 – 1218 Bench	**TSF 2 Phase 1 – 1227 Bench**
	
TSF 2 Phase 1 – 1242 Bench	**TSF 2 Phase 2 and TSF 2 Division Wall**
	

TSF 2 Phase 1 consists of three phased benches namely 1218 bench, 1227 bench and 1242 bench at final elevation and will provide tailings storage capacity for tailings produced from both the 100,000 tpm (Genesis plant) and the 300,000 tpm (Voyager plant) for a total period of approximately three years and four months. The phased benches are as follows:

TSF 2 Phase 1 – 1218 Bench:

- Construction commenced in August 2014.
- At an elevation of 1,218mamsl this phase will provide 9 months of tailings storage capacity or 1.59Mm3 of tailings.
- Approximately 3.48Mm3 of waste rock will be used for the construction of the impoundment walls with an additional 0.35Mm³ of waste rock placed in the key below the containment wall footprint.

TSF 2 Phase 1 – 1227 Bench:

- Construction to commence after completion of the 1,218 bench.
- At an elevation of 1,227mamsl this phase will provide 10 months of tailings storage capacity or 1.76Mm3 of tailings.
- Approximately 1.97Mm3 of waste rock will be used for the construction of the impoundment walls.

TSF 2 Phase 1 – 1242 Bench:

- Construction to commence after completion of the 1,227 bench and is expected to be completed around October 2017.
- At a final design elevation of 1,242mamsl this phase will provide 20 months of tailings storage capacity or 3.68Mm3 of tailings.
- Approximately 1.54Mm3 of waste rock will be used for the construction of the impoundment walls.

TSF 2 Phase 2 footprint will incorporate a widened division wall between TSF 2 Phase 1 and Phase 2. The division wall will be phased towards the East and will serve as an additional waste rock disposal facility for waste production from the Eastern and Central Pits if required. TSF 2 Phase 2 will provide tailings storage capacity for tailings produced from both the 100,000 tpm (Genesis plant) and the 300,000 tpm (Voyager plant) for a total period of approximately four years and nine months. The detailed design for TSF 2 Phase 2 has not yet been completed. The preliminary design comprises the following:

- Construction to commence when the waste rock deposition rate is reduced due to width restrictions on TSF 2 Phase 1 when reaching 1,237mamsl and is expected to be completed around September 2019.
- At a final elevation of 1,236mamsl the facility will provide 4 years and 9 months of tailings storage capacity or 10.17Mm3 of tailings.
- Approximately 8.04Mm3 of waste rock will be used for the construction of the impoundment walls with an estimated additional 0.36Mm^3 of waste rock to be placed in the key below the containment wall footprint.
- 15.34Mm^3 of waste rock to be used for the construction of the division/co-disposal wall.

Table 11.6.1_1 summarises the capacities and operation life of TSF 1 and TSF 2.

Table 11.6.1_1

Waste Rock Capacity, Tailings Storage Capacity and Operational Life associated with the TSFs

Tailings Storage Facility	Waste Rock Capacity (m^3)	Tailings Storage Capacity (m^3)	Operation Life
TSF 1 Phase 1	884,000	640,000 (Genesis Plant)	September 2011 – March 2013
TSF 1 Expansion	6,290,000	560,000 (Voyager Plant)	October 2012 – March 2013
		6,700,000 (Genesis and Voyager)	April 2013 – September 2016
TSF 2 Phase 1	7,340,000	7,030,000	October 2016 – December 2019
TSF 2 Phase 2	8,400,000	10,170,000	January 2019 – September 2024
TSF 2 Division Wall	15,340,000	N/A	

11.6.2 Capital Costs for the TSFs

Table 11.6.2_1 summarises the capital expense costs associated with the construction of TSF 1, TSF 2 and the Future TSF. These costs exclude rehabilitation and other life cycle costs.

Table 11.6.2_1

Summary of Capital Costs for the TSFs

Description	Cost
TSF 1 Phase 1 (2011 – 2013)	R12.2 mil
TSF 1 Expansion (2012 – 2016)	R43.1 mil
TSF 2 Phase 1 (2016 – 2019)	R50.6 mil
TSF 2 Phase 2 (2019 – 2024)	R49.1 mil
Future TSF (As at 2015 rates – 2024 -2044)	R240.0 mil
Total (excluding rehabilitation and closure costs)	**R395.0 mil**

It is estimated that the tailings storage requirements for the next 20 years following 2024, i.e. after TSF 2 Phase 2 has reached full capacity, will have a capital cost implication of approximately R240 million. This estimate includes the cost of a liner system, a requirement included due to new environmental legislation, and excludes rehabilitation and closure costs.

11.6.3 Environmental Protection Measures for the TSF

The key design features and environmental protection measures for the TSFs are summarised in Table 11.6.3_1.

Table 11.6.3_1
Tailings Complex Key Features and Environmental Protection Measures

Feature	Detail
Physical Dimensions	**TSF No.1 Phase 1** – Footprint = 16ha; Max height = 17m; Tailings Capacity = 0.64Mm³; Wall Waste Rock Volume = 0.79Mm³; Clay Key Cut Waste Rock Volume = 0.09Mm³ **TSF No.1 Expansion** – Footprint = 52ha; Max height = 38m; Tailings Capacity = 7.28Mm³; Wall Waste Rock Volume = 5.68Mm³; Clay Key Cut Waste Rock Volume = 0.61Mm³ **TSF No.2 Phase 1** – Footprint = 50 ha; Max height = 40m; Tailings Capacity = 7.03Mm³; Wall Waste Rock Volume = 7.0Mm³; Clay Key Cut Waste Rock Volume = 0.35Mm³ **TSF No.2 Phase 2** – Footprint = 96.83ha; Max height = 45m; Tailings Capacity = 10.17Mm³; Wall Waste Rock Volume = 8.04Mm³; Division Wall Waste Rock Volume = 15.34Mm³; Clay Key Cut Waste Rock Volume = 0.36Mm³
Tailings Delivery and Deposition	Two slurry delivery pipelines per processing facility (i.e. Genesis and Voyager plants) for pumping tailings in slurry form to the TSFs. HDPE pipes are used for the delivery pipelines. Each TSF will have delivery pipe uptakes situated on the side of the dam closest to the plants. These uptakes will be connected to a pipeline positioned around the inside crest of each TSF with flanged T pieces (allowing for open end deposition) positioned every 75m. Deposition will cycle around each TSF by continually opening and closing a number of the T Pieces. Deposition in TSF 2 will only commence once TSF 1 has reached full capacity.
Diversion	Storm water diversion trenches or swales around the upstream sides of both TSFs to direct clean surface water run-off around and away from the TSFs.
Topsoil Stripping	Topsoil within the TSF containment wall footprint areas will be stripped and stockpiled in accordance with the topsoil conservation guide in close proximity to the final toe on the upstream side of each TSF. A stripping depth of 200mm was recommended by the soils study. Stripping and stockpiling of topsoil will be done as part of the initial TSF construction works.
Lining	In-situ low permeability black clays will reduce infiltration of leachate from the TSFs to ground water. The black clays vary between 1.0m to 2.0m in the basin of TSF 1 and between 4.5m to 6m in the basin of TSF 2. Seepage cut off trenches around the perimeter of the TSFs excavated into the insitu norites will assist to collect any water seeping through the basin of the TSFs. These trenches will be dewatered and the water pumped back for processing.
Embankments	Compacted clay toe walls and elevated compacted clay platforms will be constructed along the inner toe of the TSFs to enable the construction and efficient operation of inner toe drains which will assist with the lowering of the elevation of the phreatic surface within the facilities as well as the consolidation of tailings.

Table 11.6.3_1
Tailings Complex Key Features and Environmental Protection Measures

Feature	Detail
	Each TSF waste rock containment wall will be developed at an overall outside slope of 1V:3H. The waste rock will be spread in maximum 2m thick layers and compaction will be carried out by 19t vibratory rollers and as well as traffic compaction. The clay keys requiring to be removed beneath the waste rock walls for stability issues will be removed allowing the walls to be founded on competent norite thus improving the overall stability of the TSF. Ramps at gradients of 1V:10H (6º) will be provided at various locations around each TSF to allow for access by both mine haul trucks and TSF operators onto the containment walls and into each TSF.
Under Drains & Decanting system	A 750mm high by 6.5m wide wall toe drains constructed using filter sand and stone material will be installed along the upstream toe of the clay starter wall on a slightly elevated compacted clay platform. Water collected from the drain will be removed via a number of 160mm diameter HDPE pipes running beneath the rockfill wall. Supernatant water will be decanted from each TSF via a central decant (penstock) and report to a concrete lined return water sump, from which water will be pumped back to the plant. Each sump has a capacity of 1000m³. Surface run-off from the TSF side slopes and ramps will be retained by a series of nominally compacted catchment paddocks (constructed using local clays) around the perimeter of each TSF. Water will then either evaporate or seep into the basin from these catchment paddocks. Water from the Western Wall of TSF No.1 Expansion will be channelled into a v-drain and discharged into the sump.
Access and Access Control	Mining haul roads for construction of the TSF containment walls will have a minimum width of 25m and will be constructed using waste rock along the northern sides of the TSFs. A 6m wide waste rock road will be constructed around the perimeter of each TSF for access during operations, routine inspections and maintenance. A perimeter fence around each TSF is not planned. Rather a perimeter fence around the whole of the mine site will be installed.
Waste Minimisation	A portion of TSF 1 Phase 1's Platinum Group Metals (PGMs) tailings has been re-processed. No opportunities for the reduction of the tailings production rate are envisaged.
Rehabilitation	A 300mm topsoil cover to be applied over the outer slopes of the TSF. Topsoil rehabilitation and vegetation establishment to commence on completion of containment wall construction to final height.
Monitoring	The monitoring of the TSFs will include: Safety aspects e.g. monthly review of freeboard during operational phase, presence of seepage, functioning of toe drains etc, quarterly inspections (operational phase) and annual audits. Groundwater pollution aspects including monitoring of at least 3 boreholes located on the perimeter of each TSF to ascertain upstream and downstream groundwater levels and quality including pH, EC, TDS, NO3, Ca, Mg, Fe, Mn, Na, Cl, K, SO4, HCO3, PO4, Cr (VI) and piezometric level. Monitoring frequency of major cations and anions quarterly, minor constituents annually after 2 years of quarterly monitoring – quarterly report.

Table 11.6.3_1 Tailings Complex Key Features and Environmental Protection Measures	
Feature	**Detail**
	Vegetation cover and success rate. The rehabilitation and vegetation of the outer slope of each TSF will be done during the operational phase – quarterly report. Erosion damage and general condition of catchment paddocks, drainage outlet pipes, solution trench and sumps – quarterly report. Dust generation – annual report.
Dust Control	The height of the TSF waste rock containment walls being a minimum of 1m above the tailings beach gives both TSFs a low dust generation potential due to the coarse particle size of the waste rock. In addition, rehabilitation and vegetation of the TSF outside slopes further reduces the risk of dust generation. During the construction of the TSF containment walls, dust suppression will be undertaken by wetting both the haul roads as well as the crest of the TSF walls.
Closure	Ensure final level of tailings is at least 2m below the level of the waste rock containment wall crest to provide freeboard for storm water intercepted on the top surface. The top surface will serve as a store and evaporate facility for rainfall. Adjust the topography of the top surface of the TSFs to create a low area near the centre of the facility. This will be developed as a wetland and will receive run-off from the entire top surface of the facility. Remove all pipelines, pumps, barges, catwalks, electrical cables etc. from the TSF surfaces and surrounds. Within a period of between 5 and 10 years after deposition ceases grout up the under drainage outlet pipes. Construct the final cover to the top surface of the TSFs by importing topsoil from the topsoil stockpiles and covering the top surface with a minimum depth of topsoil of 0.3m. Establish vegetation on the top surface of the TSFs using a selection of indigenous trees, shrubs, grasses, aloes etc. The TSF catchment paddocks are rehabilitated in the same manner as for the waste rock dumps.

11.6.4 Design and Construction of the Waste Rock Dumps

The WRDs were designed in such a manner to enable their on-going rehabilitation and the control of surface water runoff, as it is probable that they will become permanent features of the post mining landscape.

The East Mine WRD 1 (EMWRD 1) is currently receiving waste rock produced from over and interburden removal from the Eastern as well as the Central Pits. The facility's original design slopes were not maintained during construction, however this will be rehabilitated, as per the EIA commitment, before Mine Closure. The development of the proposed East Mine WRD 2 (EMWRD 2) has been delayed and is pending approval from the Department of Mineral Resources (DMR) with an estimated approval period of up to six months.

As there is currently an uncertainty regarding the commencement date for the development of the EMWRD 2, a short term alternative has been identified. An extended division wall between TSF 2 Phase 1 and TSF 2 Phase 2 has been identified as an area to provide for additional waste rock capacity and extend the life of the EMWRD 1.

The TSF 2 Division Wall can accept waste rock during the 13 hours of day shift excluding Sundays (due to noise restrictions in this area) and will accommodate approximately 63 percent of the total waste production per day. Approximately 27 percent of the total waste production from the Eastern and Central Pits will be used for the construction of TSF 2 Phase 1. EMWRD 1 will accommodate the balance (10 percent) of the waste during night shifts and Sundays. The mining plan is to be adjusted to ensure that mainly reef (and not waste) is mined during the night shift and Sundays.

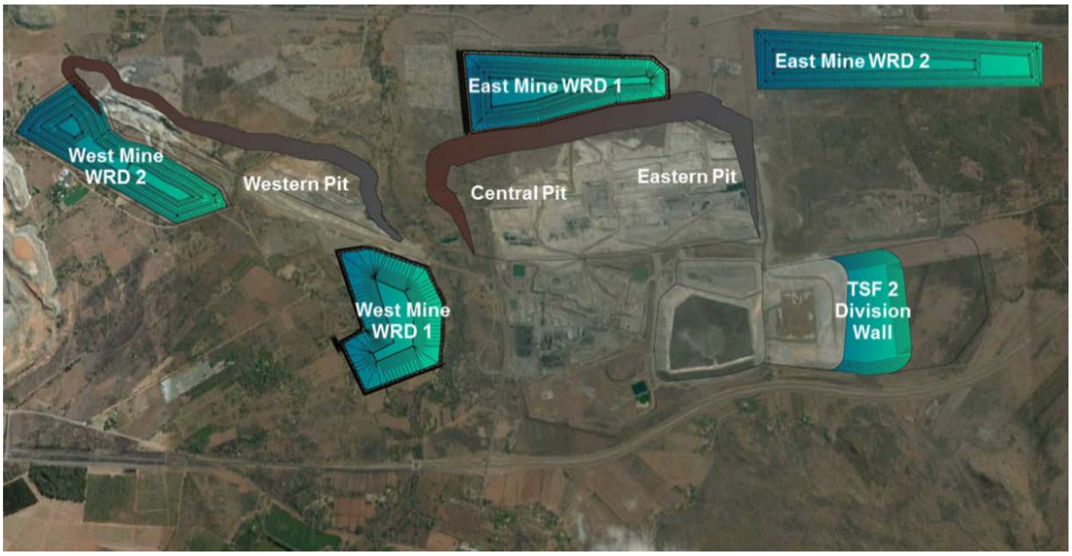
The West Mine WRD 1 (WMWRD 1) is currently receiving waste rock produced by over and interburden removal from the Western Pit. The Marikana Road, between the Central and West Pits, is to be rerouted to the west to maximise the Central Pit footprint. The new road design incorporates underpasses which will allow the safe tramming of waste rock from the Central Pit to the WMWRD 1.

Based on current information it is envisaged that roll-over mining on the East Mine will commence in approximately two years or September 2017. Waste rock generated on the East Mine will be disposed of by backfilling the Eastern and Central open pits on an advancing basis from South to North.

The West Mine WRD 2 (WMWRD 2) is still in the preliminary design phase and its development is expected to commence in the second half of 2020. Figure 11.6.4_1 shows the layout of all available WRD facilities as well as the pits from where the waste rock is sourced. The total approximate waste rock capacity in the facilities is 81.13Mm^3, which excludes the volume of the TSF 2 Division Wall, accounted for in the TSF section of this report.

Figure 11.6.4_1

Layout of Tharisa Mine's WRDs



11.6.5 Design Life of the Waste Rock Dumps

The **East Mine WRD 1** accommodates waste rock produced from the Eastern and Central Pits.

- This facility provides storage capacity for a period of approximately 32 months of waste rock produced from both the Eastern and the Central Pits.
- Full capacity is forecast to be reached in May 2016 (Provided that the proposed waste destination plan is followed from December 2015 – i.e. only 10% of waste reporting to the facility).

The **East Mine WRD 2** will accommodate waste rock from the Eastern and Central Pits as soon as approval from the DMR is received.

- Start date for deposition of waste rock on this facility is forecast to be in June 2016.
- This facility provides storage capacity for a period of approximately 32 months of waste rock produced from the Eastern and Central Pits.
- Capacity is forecast to be reached in February 2019.

The **TSF 2 Division Wall** providing waste rock capacity for the 13 hours of day shift excluding Sundays.

- Start date for deposition of waste rock on this facility to be in December 2015.

- This facility provides storage capacity for a period of approximately 21 months of waste rock produced from the Eastern and Central Pits during day shift, with 63 percent of the total waste allocated to it.
- Capacity is forecast to be reached in September 2017.
- The facility footprint and capacity can be reduced when the approval of the EMWRD 2 from the DMR is received and/or the construction of the route from the East Mine to the West Mine has been completed.

The **West Mine WRD 1** accommodates waste rock produced from the Western and Central Pits.

- This facility provides storage capacity for a period of approximately 84 months of waste rock produced from the Western Pit as well as waste rock from the Central Pit from May 2016 to August 2017.
- Capacity is forecast to be reached in July 2020.

The **West Mine WRD 2** will accommodate waste rock produced from the Western Pit as soon as the WMWRD 1 has reached full capacity.

- Start date for deposition of waste rock on this facility is expected to be August 2020.
- This facility provides storage capacity for a period of approximately 62 months of waste rock produced from the Western Pit.
- Capacity is forecast to be reached in October 2025.

Table 11.6.5_1 summarises the waste rock capacity and operational life of all four WRDs.

Table 11.6.5_1

Waste Rock Capacity and Operational Life associated with the WRDs

Waste Rock Dump	Waste Rock Capacity (m^3)	Operation Life
East Mine WRD 1	21,700,000	September 2013 – May 2016
East Mine WRD 2	22,210,000	June 2016 – February 2019
TSF 2 Division Wall	15,340,000	December 2015 – September 2017
West Mine WRD 1	21,800,000	August 2013 – July 2020
West Mine WRD 2	15,430,000	August 2020 – October 2025

11.6.6 Capital costs for the construction of the Waste Rock Dumps

Table 11.6.6_1 summarises the capital costs for Tharisa Mine's East mine and West Mine's WRDs. These costs exclude rehabilitation and other life cycle costs.

Table 11.6.6_1

Summary of Capital Costs for the WRDs

Description	Cost
Eastern WRD	R2.48 mil
Central WRD	R2.21 mil
North Eastern Waste Rock Dump	R3.00 mil
Western Waste Rock Dump	R2.10 mil
Total (excluding rehabilitation and closure costs)	**R9.79 mil**

11.6.7 Environmental Protection Measures of the Waste Rock Dumps

The key design features and environmental protection measures for the Tharisa Mine WRDs are summarised in Table 11.6.7_1.

Table 11.6.7_1

Waste Rock Dumps Key Features and Environmental Protection Measures

Feature	Detail
Physical Dimensions	**East Mine WRD 1** – Footprint = 73.8ha; Max height = 75m; Waste Rock Capacity = 21.7Mm³. **East Mine WRD 2** – Footprint = 102.6ha; Max height = 60m; Waste Rock Capacity = 22.2Mm³. **TSF 2 Division Wall** – Footprint = 43.5ha; Max height = 45m; Waste Rock Capacity = 15.34Mm³. **West Mine WRD 1** – Footprint = 69.8ha; Max height = 75m; Waste Rock Capacity = 21.79Mm³. **West Mine WRD 2** – Footprint = 79.03ha; Max height = 50m; Waste Rock Capacity = 15.43Mm³.
Waste Rock Transport and Deposition	Open pit waste rock is loaded onto mine dump trucks and transported to waste rock dumps. Waste rock dump access ramps constructed with a maximum gradient of 1V:10H (6º) for mine dump trucks. Waste rock is dumped and spread/flattened with a bulldozer.
Diversion	Storm water diversion trenches or swales around the upstream boundaries of the WRDs to direct clean surface water run-off around and away from the WRDs.
Topsoil Stripping	Topsoil within the WRD footprint areas will be stripped and stockpiled in accordance with the topsoil conservation guide in close proximity to the final toe on the upstream side of each

Table 11.6.7_1

Waste Rock Dumps Key Features and Environmental Protection Measures

Feature	Detail
	WRD. A stripping depth of 200mm was recommended by the soils study. Stripping and stockpiling of topsoil will be done immediately in advance of dumping.
Lining	No lining will be provided in addition to the in-situ black clays or turf found at surface. The low permeability clays will reduce infiltration of leachate from the waste rock to the ground water.
WRD Configuration and Development	The WRDs are configured to enable their on-going rehabilitation and the control of surface water runoff. The configuration of the dumps may be summarised as follows: The side slopes of each dump will be constructed to a final slope of 1V:3H. The toe line of each consecutive lift will continue where the previous lift' crest line ends. A 1.5m high levelled wall will be constructed to the edge of the storm water control bench to collect surface water runoff from the slope above. The wall is expected to comprise a 1.5m high berm with an inside slope of 1V:1.5H placed, levelled and compacted during the placement of waste rock to also serve as a safety berm for traffic on the dump. On commencement of the next lift of the dump the storm water control bench will be subdivided into paddocks by secondary storm water control berms to prevent the concentration of runoff at low points on the bench. Benches will be top soiled and vegetated to enhance evapotranspiration. Infiltration of runoff into the dump will be encouraged by loosening the surface of the waste on the bench prior to the placement of soil.
Under Drains & Surface Run-Off Control	No under drains will be provided. A 5m key is installed around the perimeter underneath the toe of each facility to prevent creep. Surface run-off and toe seepage will be retained by a series of catchment paddocks (constructed using local clays) around the perimeter of each WRD and allowed to evaporate.
Access and Access Control	Mining haul roads will have a minimum width of 25m and will be constructed using waste rock. A 6m wide waste rock road will be constructed around the perimeter of each WRD for access during operations, routine inspections and maintenance of the catchment paddocks. A perimeter fence around each WRD is not planned. A perimeter fence around the whole of the mine site has been installed.
Monitoring	Monitoring of seepage water retained in the perimeter catchment paddocks and of boreholes around the perimeter of each WRD to determine pH, EC, TDS, NO3, Ca, Mg, Fe, Mn, Na, Cl, K, SO4, HCO3, PO4, and Cr (VI).
Dust Control	Operational Phase: Watering of haul roads for dust suppression. Post Operational Phase: No measures necessary due to the coarse particle size distribution.
Rehabilitation and Closure	WRDs will be re-vegetated using a combination of indigenous trees, shrubs, and grasses etc. with the topsoil and clay removed from the footprint of each WRD serving as a growth medium. The vegetation will be irrigated initially until it is no longer dependant on artificial irrigation for survival. Final catchment paddocks constructed of durable waste rock materials covered with a clay layer to be provided. The catchment paddocks will be vegetated in a manner similar to that stated above to blend in to the natural Bushveld. The catchment paddocks will be sized to contain run-off from a 1:50 year 7 day duration storm event.

Table 11.6.7_1 Waste Rock Dumps Key Features and Environmental Protection Measures	
Feature	**Detail**
	On closure of the WRDs, access ramps and berms will be eliminated prior to rehabilitation to reduce erosion risks. No active groundwater protection measures are envisaged given the relatively low pollution potential of waste rock. In the event that surface water quality monitoring around the WRDs indicates that Class 4 (SANS 241:2005) water is likely to emanate as surface run-off from the dumps, soak-aways will be provided within the catchment paddocks to minimise the risk of exposure of Class 4 water to wildlife, livestock and humans. The crest of the WRDs will be provided with a durable waste rock berm to prevent drainage from the top surface from eroding the side slopes.

11.7 Smelting and Beneficiation

Tharisa has secured a long term off take agreement with Impala Refining Services (IRS) for its PGM concentrates.

12 INFRASTRUCTURE AND LOGISTICS

12.1 Roads

The Tharisa Mine is traversed east/west by local un-surfaced roads originally constructed to service the local farming community. In a north/south direction the mine is split by a local tarred road connecting Buffelspoort with Marikana. This in turn is linked to the N4 Bakwena Highway locally linking Rustenburg to Brits, and internationally linking Mozambique to Botswana and Namibia.

12.2 Water Supply

The primary sources of water to the site are:

- Borehole water from onsite wellfields;
- Water from open pit dewatering including additional dewatering boreholes situated around the mining area to ensure safe operation;
- Storm water or run-off contaminated water collected and recycled back to the plant;
- Rand Water Board water allocation;
- Excess water from nearby mining companies (Samancor) under supply agreement.

The water allocation to the Tharisa Mine site is given in Table 12.2_1. The table indicates the water volumes allocated under the current water licence and existing agreements. The table also indicates additional water allocations applied for by the mine. The application to amend the water licence was submitted during 2013. In addition the mine is busy with a submission to convert certain water licences for agricultural use into water for industrial use to be available in emergency situations, for instance extended periods of drought.

Table 12.2_1

Summary of Water Sources

Source	Sources under Current Licence and Agreements	Sources under Amendments
	Capacity (m^3/Annum)	Capacity (m^3/Annum)
Borehole Water - Wellfield	114,000	419,000
Open Pit Dewatering	322,613	322,613
Mine Dewatering - Quarry	439,927	439,927
Storm Water	785,352	785,352
Rand Water Board and Agreements	266,000	266,000
Emergency Water – Agricultural Licence	0	900,000
Total Water Sources	**1,927,892**	**3,132,892**

As indicated the existing water licence and agreements allows Tharisa mine the use of 1,927,892m^{3}pa. The total water licence will amount to 3,132,892m^{3}pa if the proposed amendments are approved.

12.3 Potable Water

Potable water is obtained from either Rand Water or appropriate borehole water. The abstracted groundwater is treated in order to make it suitable for potable supply.

12.4 Process Water

The main water supply is obtained from dewatering of the open pits and borehole water from the onsite wellfield, supplemented by Rand Water as well as excess water from nearby mining companies (Section 12.2).

The monthly average water consumption required to feed the process plants is approximately 394,400m^3 for a throughput of 400,000 tpm. This amounts to 0.99m^{3}pt feed.

Between 54% and 75% the water utilised within the plant is recycled from the tailings dams and from other sources reducing the total required make-up water. The amount of water recycled is dependent on the season. The recycle portion is greater in the rainy season and lower in the dry season.

The average required make-up water from water sources external to the recycle systems ranges between 0.35m^{3}pt and 0.45 m^{3}pt RoM feed..

12.5 Water Balance and Priority for Water Use

A site wide climatic water balance was modelled for the entire operation as part of the EIA/EMP report, which took cognisance of environmental conditions (such as seasonal changes, rainfall and evaporative loss). The water balance was modelled based on monthly climatic data and predicted mine usage requirements.

A water usage protocol has been adopted. The protocol ensures that dirty water is re-used as far as possible and that the water level in key storage dams is kept as low as possible to maximise storage capacity in the event of an extreme storm event (complying with the Regulation 704 requirement to not overflow more than once in 50 years).

The protocol for water use is ranked as follows:

- TSF/process water dam;
- Storm water/pollution control dams;
- Seepage/rainwater ingress to the open pits; and
- Rand Water supply/groundwater abstraction boreholes/agricultural water.

The water use protocol is strictly applied in order to ensure compliance with Regulation 704 as well as to minimise water treatment and operating costs.

12.6 Stormwater Management Plan

A storm water management strategy for the mine was developed as part of the approved EIA/EMP and has been updated to cater for changes in mine infrastructure. A summary of the key design features is presented below:

- Clean storm water will be diverted around mine infrastructure and, where possible, routed towards existing watercourse(s) or conveyed into the veld;
- Wherever possible, the footprint of dirty storm water catchment areas will be minimised by isolating these areas from clean water run off using bunds and/or channels;
- Storm water from the surface of the TSF is pumped to the process water dam for re-use;
- Storm water from the side slopes of the TSF drains towards the eastern pit for further re-use;
- Storm water from the plant area, will drain via channels to the plant Storm Water Dam. Any excess flow will be conveyed from the Storm Water Dam to the Hernic Quarry;
- Storm water from the East mining area will drain to the existing MCC dam; excess flow will be conveyed to the Storm Water Dam;
- Storm water from the plant Storm Water Dam, MCC Dam and Hernic Quarry will be transferred to the process water dam for re-use in the plants;
- Storm water and groundwater collected within the open pits will be pumped to the process water dam for re-use in the plants;
- Storm water from the waste rock dumps will be collected by perimeter drainage ditches and passed through a settlement dam prior to usage within the plants.

12.7 Containment Dams

The operation features several containment and transfer dams which form part of the operational water management strategy for the mine; a summary of these dams is presented in the Table 12.7_1.

Table 12.7_1

Summary of Containment Dam Capacities

Dam	Capacity (m^3)
Raw Water Dam	45,000
Hernic Quarry	200,000
Plant Storm Water Dam	30,000
Process Water Dam	15,000
MCC Dam	40,000
Borehole water	12,000

The above mentioned dams as well as six (6) boreholes are authorised water usages as per Tharisa Minerals' water usage license which was issued in July 2012 by the Department of Water Affairs.

12.8 Power

During May 2010 Tharisa Minerals submitted an application to Eskom for a 40 MVA premium electrical power supply. A premium supply is a ring main supply from two different Eskom distribution substations.

In order to meet the commissioning date of the concentrator, the power supply project was split into three phases.

Phase 1 was commissioned in June 2012 ahead of the scheduled concentrator commissioning date of July 2012. This phase secured a non-premium power supply of 30 MVA.form a single Eskom substation This supply exceeds the mine's current power requirement of 23.5 MVA.

Phase 2 was commissioned and provided a premium power supply to the Tharisa site.

Phase 3 provided for the construction of an overhead line between the Eskom's Middlekraal and Bighorn substations. This was completed in September 2015 and increases the available power supply to the mine from the current 30MVA to 40MVA, as per the original Eskom application. The current Eskom NMD (notified maximum demand) is 30 MVA.

Based on the current Eskom notified maximum demand of 30 MVA, the electrical spare capacity is 21.6%.

Once Eskom approves the increased NMD, the electrical spare capacity will be approximately 41.25%, which can be utilised to accommodate future expansions in the short and medium term.

12.9 Communications

Tharisa Minerals uses up to date information, communication and telecommunications systems, including an enterprise resource planning (ERP) system, virtual servers and various high speed, point to point networks between its various sites. The networks that have been established allow for the use of virtual-private networks, the replication of servers, dedicated and high speed connections between the ERP system components, zero cost telephone calls between Tharisa's various sites, as well as video conferencing facilities. Tharisa Minerals has also implemented a 'unified e-mail management system' which is hosted off-site, thereby providing continuity and back-up through the archiving of all inbound, outbound and internal e-mails.

12.10 Logistics of Chromite Concentrate Distribution

Chrome concentrate logistics management and procurement has been outsourced to a Tharisa plc group company, Arxo Logistics (Pty) Ltd (Arxo), which is responsible for the cost-effective management of the entire logistics chain from the mine to Tharisa Minerals final customers, most of whom are in China. Arxo's responsibilities include the activities of sourcing third party services, capacity planning, technology solutions, distribution planning, warehouse management and shipping.

12.10.1 Current Logistics

Arxo makes use of various distribution channels to move the mine's product to Richards Bay and Durban Ports for shipment abroad. A dedicated rail siding has been allocated to Tharisa and is located 6km from the mine site. Arxo has also secured adequate trucking and warehousing facilities to cater for the full requirement of 160,000 tpm of final chrome product.

12.10.2 Planned Logistics

<u>Rail transport</u> – a long term maxirail contract has been entered into with Transnet.

<u>Road transport:-</u> Agreements have been entered into with a number of transporter contractors who have sufficient capacity to transport the balance of chromite concentrate not railed.

<u>Storage Facilities</u> Sufficient warehousing facilities have been secured and contracted to handle volumes in bulk or containers from the Tharisa Mine to FOB Durban. The following facilities have been secured at Richards Bay

- 45,000t at any given time through the dry bulk terminal. The dry bulk terminal is currently the most cost effective terminal to be used in conjunction with rail;
- 15,000t at any given time through the multipurpose terminal.

Shipping Facilities Shipping is not considered to be a risk due to the availability of bulk vessels and container shipping capacity.

On Mine Rapid Load-out Facility The mine is currently in a feasibility phase for establishing a rapid load out facility on the mine, together with a deicated new rail siding. The focus of the project is to reduce materials handling at the mine and thereby reducing the total logistic cost of the final product.

12.11 Occupational Health and Safety

12.11.1 Key Areas of Legislation

The Mine Health and Safety Act No 29 of 1996 (MHSA) was developed under the auspices of a tripartite relationship between State, Employer and Employee organisations. The result is a large emphasis on employee participation regarding the Health and Safety matters.

Section 26 of the MHSA requires consultation between the employer (Tharisa Minerals) and employee representatives or organised labour in the form of Trade Unions. From this consultation a Health and Safety agreement must be concluded which spells out the management of the relationship between employer and employee regarding Health and Safety issues. Tharisa Mine has a Safety and Health agreement in place.

Health and safety representatives have been appointed for the various designated working places as described in the Health and Safety Agreement, in compliance with the MHSA. Regular interactions between management and representatives take place to ensure good communication between management and safety representatives.

Other important sections of the MHSA deal with the Inspector of Mines' powers when encountering unsafe or unhealthy occurrences, practices or conditions at a Mine, including the power to halt an operation should he consider the workplace to be unsafe or unhealthy (Section 50). The inspector also has the option of imposing an administrative penalty in place of an instruction to halt operations at the mine (Section 54).

Sections 60 and 65 of the MHSA deal with the requirement to conduct investigations or inquiries into any accident or occurrence at a mine. These sections are fairly extensive, allowing an inspector access to safety and health documentation kept by a mine

Other important sections of the MHSA deal with:-

- Health and Safety Policy (Section 8)
- Health and Safety Training (Section10)
- Employer to access and respond to risk (Section 11)
- Medical surveillance (Section 13)
- Manufacturing and suppliers' duty for the Health and Safety (Section 21)

From the above it can be seen that it is a fundamental requirement to have systems and resources in place to ensure compliance with the requirements of the MHSA and its associated regulations. Not meeting these obligations can result in severe penalties and consequences for the mine as well as its employers (including owners and managers) who fail to comply with the MHSA.

12.11.2 Mine Health and Safety

Tharisa Minerals is subject to the MHSA. The objectives of this Act are:

i) To protect the health and safety of the persons at the mine

ii) To require the employer and the employees to identify hazards and eliminate, control and minimise the risks relating to health and safety at the mine

iii) To give effect to the public international law obligations of South Africa that concern health and safety at mines

iv) To provide for employees participation in matters of health and safety through health and safety representatives and the health and safety committees at mines

v) To provide for the effective monitoring of health and safety conditions

vi) To provide for the enforcement of health and safety measures

vii) To provide for the investigations and inquiries to improve health and safety at the mines

viii) To promote :

A culture of health and safety in the mining industry

Training in health and safety in the mining industry

Co-operation and consultation on health and safety between the State, employers, employees and their representatives.

The MHSA is administrated by the DMR and the Inspector of Mines conducts site inspections on a regular basis to ensure compliance with the requirements of the MHSA.

Wellness Programs which include policies dealing with HIV/AIDS and tuberculosis are being requested by the DMR to ensure that the mining industry caters not only for the occupational health of employees whilst at work, but also instil a program in which they promote awareness and provide treatment programmes for employees as well as surrounding communities regarding primary health issues such as HIV/AIDS, tuberculosis, cancer, hypertension etc."

12.11.3 Processing Facilities Health and Safety.

The processing facility is considered to be part of the Tharisa Mine and the same requirements in terms of the legislation are applicable.

12.11.4 Contractors Health and Safety

All employees, including contractors, have to undergo a medical examination to ensure their fitness to work. This examination is conducted by a Tharisa Minerals appointed Occupational

Health Practitioner. This examination is reviewed on an annual basis to ensure that persons are fit to perform their duties in a healthy and safe manner.

Tharisa Minerals makes use of a Contractors Compliance Pack (CCP) and all contractors are required to demonstrate their safety performance as well as compliance with the mine's own Health and Safety requirements. This CCP is investigated on a regular basis for each contractor to ensure compliance with the mine's system.

12.11.5 Legal Appointments

In terms of the requirements of the MHSA, all the legal appointments have been reviewed and suitable and experienced people have been appointed, and the DMR notified accordingly. These appointments have also been divided between the two appointed General Managers (Mining and Process) respectively.

13 ENVIRONMENTAL AND SOCIAL

In 2008, an Environmental Impact Assessment and Environmental Management Programme (EIA/EMP) report was compiled for Tharisa Mine by Metago Environmental Engineers (Pty) Ltd (Metago), now SLR Consulting (Africa) (Pty) Ltd (SLR), an independent environmental consulting company. This EIA/EMP was submitted in support of the mining right application and the environmental authorisation applications in terms of the MPRDA and NEMA. Similarly, in 2012 Tharisa Mine received a water use licence which sets out permitted water and waste activities and the required mitigation measures for managing potential water related impacts. In 2014, environmental authorisation was sought to address a number of operational and infrastructure changes at the mine. An EIA/EMP report was compiled by SLR, the independent environmental consulting company, to support the application process. The 2014 EIA/EMP report was submitted in support of environmental authorisations in terms of the MPRDA and NEMA. An application to update the mine's water use license to cater for the relevant changes is still required. This chapter identifies the related compliance issues and the potential environmental impacts (both biophysical and social) of the Tharisa Mine based on the outcomes of the EIA processes. These impacts were assessed and management measures proposed with input from various specialists. The outcome of both the 2008 and 2014 EIA/EMP processes determined that all potential impacts of the mine can be managed to a satisfactory level, provided that the mitigation measures detailed in the EIA/EMP are adhered to.

13.1 Existing Environment

The details relating to the physiography, soils, land use, flora and fauna, groundwater, surface water and climate are presented in Section 4.

13.2 Interested and Affected Parties (IAPs) Consultation Process

The scope of environmental issues that were considered in both the 2008 and 2014 EIA were given specific context and focus through consultation with authorities and IAPs. Included below is a summary of the process that was followed, the people that were consulted and the issues that were identified.

13.2.1 Authorities and interested and affected parties (IAPs)

The following authorities and IAPs were involved in the 2008 and 2014 EIA/EMP processes:

Regulatory authorities:

- Department of Mineral Resources (DMR) (previously the DME)
- Department of Rural, Environment and Agricultural Development (DREAD) (previously known as Department of Economic Development, Environment, Conservation and Tourism (DEDECT) and Department of Agriculture, Conservation and Environment (DACE))
- Department of Water and Sanitation (DWS) (previously Department of Water Affairs (DWA) and Department of Water Affairs and Forestry (DWAF))

- Department of Environmental Affairs and Tourism: Air Pollution Management (DEAT:APM)
- National Department of Agriculture (NDA)
- South African Heritage Resources Agency (SAHRA)
- Department of Transport, Roads and Community Safety (NWDTRCS) (previously Department of Public Works and Roads)
- North West Parks and Tourism Board and
- Department of Rural Development and Land Reform (DRDLR) (previously Department of Land Affairs (DLA))

Interested and Affected Parties (IAPs☺

- landowners in and surrounding the mine area
- land occupiers and communities in and surrounding the mine area (various villages, farm labourers, squatters and informal settlers)
- surrounding mines and industries
- non-government organisations
- local authorities (Bojanala Platinum District Municipality, Rustenburg Local Municipality and Madibeng Local Municipality) and
- any other people/entities that choose to register as IAPs

13.2.2 Summary of issues raised

A summary of issues raised by authorities and IAPs in 2008 is given below. These include:

- clarity on the environmental assessment process and procedural issues
- understanding of the mine and alternatives
- sterilisation of minerals
- recognition of communities
- topography
- soils
- land capability
- blasting
- land use – disruption to current activities
- biodiversity
- sensitive areas
- air quality
- noise
- heritage resources
- visual aspects

- traffic/road use/transport
- water supply
- rehabilitation
- disturbance of ground and surface water (quality and quantity) and
- socio-economic aspects (land values, relocation, crime, social investment, services/housing).

Similar issues and concerns were raised in the 2014 process with the addition of:

- understanding of Tharisa's stakeholder communication process
- land use: tourism, economic losses and compensation
- employment and SLP related aspects
- resettlement related issues.

13.3 Environmental Impact Assessment and Management

The following section provides a summary of the findings of the 2008 and 2014 EIA/EMP processes and the associated environmental management measures.

13.3.1 Specialist input

In 2008, specialist information was used both to determine the state of the pre-mine environment and to assess potential environmental impacts relating to the mining activities at the Tharisa Mine. This information was obtained from work done by the appointed specialists, Metago's (now SLR) existing knowledge of both the region and the specific site and information provided by the technical project team. These specialist investigations are listed below and the findings have been incorporated in the impacts description in the section below:

- Design of waste facilities, floodlines, water balance, design of water management facilities and closure calculations
- Land and aquatic biodiversity study
- Groundwater study
- Air quality study
- Traffic study
- Heritage study
- Socio-economic impact assessment
- Soils and land capability studies
- Blast impact study and
- Visual impact study.

In 2014, relevant specialist studies were updated to cater for the changes at the mine. Where relevant, design information was provided by the technical project team. The specialist investigations are listed below and the findings have been incorporated in the impacts description to follow:

- Updated design of waste facilities, water balance, storm water management strategy and closure calculations
- Land and aquatic biodiversity study
- Groundwater study
- Air quality study
- Heritage study
- Economic impact assessment
- Soils and land capability studies
- Noise study
- Blast impact study and
- Visual impact study.

13.3.2 Risk Analysis and Environmental Management

Potential impacts were identified by Metago/SLR in consultation with IAPs and regulatory authorities, specialist consultants and mine management. Where relevant, cumulative on and off-site impacts were considered. As indicated in the EIA/EMP reports, the discussion and impact assessment for each sub-section covered the construction, operational, decommissioning and closure phases where relevant.

The criteria used to assess the impacts and the method of determining the significance of the impacts was based on Metago/SLR's method of determination of the significance of impacts. This method also complies with the method provided in the EIA guideline document.

Management measures to address the identified impacts were given in the corresponding section of Chapter 6 in the 2008 EIA/EMP report and in Chapter 19 in the 2014 EIA/EMP report. These management measures were taken into account in the assessment of the significance of the mitigated impacts.

A discussion of the more significant project related issues is provided below:

Hazardous excavations: All excavations into which, or off which, people and animals could fall, were considered hazardous. If unmanaged, these could result in high impacts because the excavations could cause injury or death to people and animals. With the security, fencing and warning measures, as included in the 2008 and 2014 EIA/EMP reports, this impact will be managed to an acceptable level.

Impact on soil resources and land capability: The majority of the pre-mining soils on site are considered to be of moderate agricultural potential. With the changes in infrastructure and operations at the mine catered for in the 2014 EIA/EMP report, the disturbance footprint has increased to approximately 1026ha. In the unmanaged scenario this impact could be of high significance, however implementation of the topsoil management plan included in the 2008 and 2014 EIA/EMP reports mitigate this impact to an acceptable level. At closure approximately 50% of the disturbed land (excluding the TSF and waste rock dumps) will be rehabilitated to a functional land use. The EIA/EMP commitment is to restore the majority of the land back to agricultural potential with grazing and wilderness capabilities

Road disturbance and traffic safety: Changing the configuration of the road network, and increased traffic on existing public road networks could result in an inconvenience to current road users, greater accidents (to people and animals) and increased road damage. In the managed scenario, the largest component of mine related traffic (product carrying trucks) will be directed to the Marikana siding or will use the N4. Tharisa has approached Transnet to establish a private siding on the mine site. It is understood by SLR that the EIA process for the siding has been initiated by Transnet. Other safety related measures included in the 2008 EIA/EMP report, mitigates related impacts to an acceptable level.

Infrastructure and blast related impacts: Damage (to people, animals and structures) from open pit blasting could potentially be caused by fly-rock, air blast and vibrations. In the unmanaged scenario this impact could be high, but with the appropriate infrastructure diversions/relocations, land acquisitions, blast designs, warning requirements and monitoring requirements (as included in both the 2008 and 2014 EIA/EMP reports) these impacts will be reduced to acceptable levels.

Loss of biodiversity: Although large parts of the mine area were already disturbed by agricultural, community and mining related activities, the mine hosts some sensitive habitats with associated flora and fauna species. In the unmanaged scenario, the mine could damage this biodiversity and cause impacts of high significance. The 2008 infrastructure site selection process attempted to limit the disturbance of the more sensitive areas and the biodiversity action plan included in the EIA/EMP report was designed to further reduce the impacts to an acceptable level. In the 2014 EIA/EMP report disturbance of some of the more sensitive areas was unavoidable due to space constraints. Emphasis was however placed on minimising further disturbance and protecting the Sterkstroom and its floodplain.

Impact on surface water: The mine infrastructure will impact a number of non-perennial water courses. In the unmanaged scenario, the impact on water flows and surface hydrology will be high. With the implementation of the management measures, as included in the 2008 and 2014 EIA/EMP reports, this impact can be mitigated to an acceptable level. Notwithstanding the above, if Tharisa Mine's surface water systems are not managed, along with implementing appropriate management of pollution sources, significant pollution could be released into the environment. The updated surface water management system design, as included in the 2014 EIA/EMP report, is therefore aimed at compliance with Regulation 704 of 4 June 1999 and is sufficient to manage both clean and dirty surface water provided the recommendations of the specialist study are adhered to.

Impact on ground water: The specialist investigations conservatively predicted that the tailings dam complex and waste rock dumps could have a negative impact on water quality in surrounding ground and surface water resources. This could include some third party boreholes. Mine dewatering could also result in decreased yields at these boreholes. To cater for the event that these users experience negative impacts on their ground water supply, Tharisa Mine has committed to monitoring the boreholes of these landowners, implementing quality related remediation measures, and where required, compensating affected third parties with water of equivalent quality and quantity to what they enjoy at present. Tharisa is also in the process of updating the geochemistry sample data of tailings and waste rock material and tailings return water. This study is expected to be completed in early 2016. Long term closure planning of the tailings dam and waste rock dumps is important in mitigating potential pollution impacts.

The specialist investigations identified that the use of the Hernic Quarry as a water storage dam has the potential to negatively impact the water quality of the Sterkstroom; however additional investigation and monitoring is needed to verify this. The 2014 EIA/EMP report provides for this monitoring and related seepage management measures.

It has been indicated by the mine that an emergency discharge into the Sterkstroom has taken place. Although SLR has not had sight of the relevant paperwork, it was indicated by the mine that the necessary reporting to DWS had taken place and that water quality analyses had been conducted. The mine reported that there were no abnormalities detected in the sampled water.

Impact on air quality: In the unmanaged scenario, it was predicted that there could be unacceptable off-site impacts from dust generating activities. To mitigate this, dust controls are required to mitigate impacts from the main emission sources, air quality will be monitored to check whether the controls are effective, and land has been purchased by Tharisa Minerals to keep unacceptable impacts within mine property as far as possible. Additional mitigation included in the 2014 EIA/EMP report provides for the relocation of sensitive receptors within the mining right boundary where health related risks have been identified.

Visual impact: In the unmanaged scenario, it was predicted that there could be a high impact on sensitive views from the south of the mine, in particular. The measures included in the 2008 and 2014 EIA/EMP reports mitigate this impact to an acceptable level. Key management components include rehabilitation of the pre-built tailings dam walls from the outset, visual screening berms, and control of colours and lighting within the mine area and are in place

Noise impact: In the unmanaged scenario, it was predicted that there would be a potential for high noise impacts on surrounding residents particularly at night. In the case of the President van Rensburg /Retief School there is the potential for high impacts during the day. The measures included in the 2008 and 2014 EIA/EMP reports mitigate this impact to an acceptable level. Key components include noise control berms of sufficient height, guidance on waste rock handling activities and restrictions on operating times for certain noise generating activities are in place.

Impact on heritage resources: The Tharisa Mine hosts significant heritage resources. Despite the avoidance of many of these through the 2008 site selection process, in the unmanaged scenario, the impact on some of these resources could be high. The 2014 EIA/EMP report which catered for changes to the mine layout identified additional resources of high significance that would be disturbed. To mitigate this, the necessary assessments and applications have been made for the grave sites that will be affected by the mine. It is assumed that this also applies to historical structures although this could not be confirmed at the time of completing this report. All graves that were located inside the mining footprint area have been relocated.

Socio-economic impacts: The mine will have a number of positive economic benefits for the local communities in the area, the greater region and South Africa. These benefits will be in the form of capital investment, employment, support services, and foreign exchange income. In addition, a number of potential negative impacts were identified. These include: issues associated with involuntary relocation, informal settlements and associated problems of crime, disease and security concerns, pressure on housing infrastructure and services, and issues around land sales and impacts on land values. It has been indicated by the mine that a clear strategy supported by policies and action plans to address the issues are being developed and implemented by the mine.

13.3.3 Summary of Potential Environmental Impacts

A summary of the significance of identified impacts in the 2008 and 2014 EIA/EMP is provided in the Table 13.3.3_1.

Table 13.3.3_1
Summary of Potential Environmental Impacts

Environmental component	Potential impact	Significance of the impact			
		Rating from 2008 EIA/EMP		Updated rating from 2014 EIA/EMP	
		Unmitigated	Mitigated	Unmitigated	Mitigated
Geology	Loss and sterilization of mineral resources	No impact expected		No impact expected	
Topography	Hazardous excavations and infrastructure	High	Medium	High	Medium
	Surface subsidence	Medium	Low	Medium	Low
Soils and land capability	Loss of soil resources and land capability	High	Medium	Assessed separately as outlined below	
	Loss of soil resources and land capability through physical disturbance	Not assessed separately in the approved EIA and EMediumP		High	Medium-High
	Loss of soil resources and land capability through pollution			High	Low
Biodiversity	Physical destruction of biodiversity	High	Medium	High	Medium
	General disturbance of biodiversity	High	Medium	High	Medium

Table 13.3.3_1
Summary of Potential Environmental Impacts

Environmental component	Potential impact	Significance of the impact			
		Rating from 2008 EIA/EMP		Updated rating from 2014 EIA/EMP	
		Unmitigated	Mitigated	Unmitigated	Mitigated
Surface water	Alteration of surface drainage lines	High	Medium	High	Medium
	Contamination ofsurface water resources	High	Low	High	Low
Groundwater	Groundwater contamination	High	Medium	High	Medium
	Reduction in groundwater levels / availability – impacts on third party users	High	Low	High	Low
	Reduction in groundwater levels / availability – impacts on baseflow	High	Medium	High	Medium
Air quality	Air pollution through dust generation (including PM_{10} and $PM_{2.5}$)	High	Medium	High	High-Medium
Noise	Noise pollution	High	Medium	High-Medium	Medium-Low
Visual	Negative visual impacts	High	Medium	High	Medium
Heritage, palaeontological and cultural resources	Loss of heritage, palaeontological and cultural resources	High	Low	High	Low
Land use	Loss of or changes to existing land uses	Not assessed in the approved EIA and EMediumP		High	Medium-Low Low (at closure)
Socio-economic	Blasting impacts	High	Medium	High	Medium
	Road disturbance and traffic safety	High	Medium	Remains unchanged	
	Economic impact (negative)	Medium+	Medium+	Medium+	Medium+
	Economic impact (positive)	Medium	Medium-Low		
	Inward migration and associated social issues	High-Medium	Medium-Low	High	Medium-Low

Interpretation of the significance		
Significance		**Decision guideline**
H	High	It would influence the decision regardless of any possible mitigation.
M	Medium	It should have an influence on the decision unless it is mitigated.
L	Low	It will not have an influence on the decision.
	+	Denotes a positive impact.

The outcome of both the 2008 and 2014 EIA process determined that there was no environmental reason for Tharisa Mine's application not to be approved provided the mitigation outlined in the EMP is implemented.

13.4 Permitting

The Tharisa Mine currently operates with the following environmental authorisations:

- An environmental decision from the North West DMR in terms of the MPRDA for the mining operation;
- An environmental decision from the North West DMR in terms of the MPRDA for changes to the mine operations and infrastructure;
- Environmental authorisation from the North West DREAD in terms of the National Environmental Management Act, 107 of 1998 (NEMA) for the activities that were triggered by the mining operation as presented in the 2008 EIA/EMP report; and
- Environmental authorisation from the North West DREAD in terms of the NEMA for the activities that were triggered by the changes to the mining operation as presented in the 2014 EIA/EMP report.
- Waste and Water Management: Tharisa Minerals was granted an integrated water use license from the North West Province DWS in terms of the National Water Act, 36 of 1998 (NWA) in July 2012. Included in the license are relevant exemptions from Regulation 704 of 4 June 1999 as well as registration for all dams with a safety risk (i.e. with both a wall greater than 5m and a capacity of 50,000m^3).
- Approval for the construction of the road intersections, diverting roads and closing roads: Tharisa has confirmed that the D1325 road deviation approval has been obtained from the North West Department of Roads and Transport in terms of the relevant Provincial Road Ordinance. Any changes to the approved deviation as a result of the east pit extension will need to be discussed and agreed to with the North West Department of Transport Roads and Community Safety
- Permits for damaging or removing heritage resources such as graves: Tharisa Minerals has obtained a permit in terms of the National Heritage Act, 25 of 1999 for the exhumation and relocation of graves to be disturbed by the mining of the east pit. For the 2014 changes, prior to damaging or removing heritage resources within the central waste rock dump footprint, additional permissions will need to be sought.

Additional environmental authorisations/permits required are listed below:

- Waste and Water Management: Amendment of the mine's water use license to cater for water uses associated with changes addressed in the 2014 EIA/EMP report and if required, updating of the existing dam safety risk registrations
- As from the 2 September 2014, a waste management license in terms of the National Environmental Management: Waste Act, 59 of 2008, is required for mineralised waste disposal facilities. At the time of compiling the 2014 EIA/EMP report, there was a lack of transitional arrangements and clarity on the required license and therefore provision was included for Tharisa to consult with the relevant competent authority to obtain input on

the way forward. From more recent changes to the legislation, it is SLR's understanding that existing residue deposits and/or stockpiles that were approved in terms of the MPRDA prior to 24 July 2015 must continue to be managed in accordance with the EMP, approved in terms of the MPRDA, which is regarded as having been approved in terms of NEM:WA. (Regulation 4 of GN R 633 refers.). The establishment of deposits and/or stockpiles that are not approved in existing EMPs now require a waste management license and supporting environmental assessment process. What is uncertain is under which provision facilities approved under the MPRDA but not yet constructed fall.

- Air quality: an air emission license (AEL) from the North West DREAD in terms of the National Environmental Management: Air Quality Act (NEM:AQA), 39 of 2004, for an activity listed in Government Notice 248 of 31 March 2010. The activity relates to the drying of mineral solids at the chrome sand drying plant (activity sub-category 4.1: Drying and Calcining).
- <u>Registering the sewage plant in addition to the water licence that has been obtained</u>: Tharisa Minerals has applied for the registration of both the sewage plant and the required personnel to the DWA in terms of Regulation 2834 of 27 December 1965.
- <u>Permit to removing or damaging any protected plant species</u>: Tharisa Minerals will compile and submit the necessary documents when required. When needed the permits will be obtained from the Department of Agriculture, Fisheries and Forestry (DAFF) and DEDECT in terms of the National Forests Act, 84 of 1998 and the Nature Conservation ordinance of Transvaal (12 of 1983), respectively.

In addition to the above it is important to note that since the start of the 2014 EIA process (commenced in 2011), the eastern waste rock dump has subsequently been built and therefore this component is excluded from the NEMA process but still remains part of the MPRDA process. A Section 24G application would likely need to be submitted to address this non-compliance. This requires confirmation and input from the decision-making authorities.

13.5 Environmental Protection and Monitoring

As indicated in the 2008 and 2014 EIA/EMP reports, Tharisa Minerals is committed to and has implemented the monitoring programmes detailed below. Table 13.5_1 sets out the monitoring costs as per the EMP commitments.

Table 13.5_1
Environmental Monitoring Costs

Item	EMP Monitoring Commitment	2016 Budget	Period
1	Water quality – monthly for surface and quarterly for groundwater	R 420,000	October 2015 to September 2016
2	Air quality – monthly	R 375,000	October 2015 to September 2016
3	Noise monitoring – annually	R 60,000	October 2015 to September 2016
4	Biomonitoring – biannually	R80,000	October 2015 to September 2016
5	EMP performance assessment – every 2 years and WUL audit annually	R 175,000	October 2015 to September 2016
TOTAL		R 1,200,000	

Note: Expenditure has occurred as per budget

In general, the approach to each monitoring programme will include:

- a formal procedure and appropriately calibrated equipment;
- where samples require analysis they will be preserved according to laboratory specifications;
- an accredited, independent, commercial laboratory will undertake sample analyses;
- parameters to be monitored will be identified in consultation with a specialist in the field and/or the relevant authority;
- if necessary, following the initial monitoring results, certain parameters may be removed from the monitoring programme in consultation with a specialist and/or the relevant authority;
- monitoring data will be stored in a structured database;
- data will be interpreted and reports on trends in the data will be compiled by an appropriately qualified person on a quarterly basis; and
- both the data and the reports will be kept on record for the life of mine.

13.5.1 Groundwater and Surface Water

A set of monitoring points (33 for ground water and 13 for surface water), a programme and the parameters for both ground and surface water on and off the site have been set out. These parameters may be modified on the basis of input from an appropriate specialist and the DWS. It is also possible that the programme will be modified as part of the amended integrated water license process.

13.5.2 Air

Dust monitoring comprising a network of 12 dust buckets (directional and single) has been set out. The dust buckets will be placed immediately downwind of potentially significant dust generating sources. The target off-site dust fallout reading is less than 600mg/m^2/day. A PM10 monitor for ambient concentrations has been set up in the middle of the mining right area adjacent to security control office. The 2014 EIA/EMP report makes provision to revisit the location of this station to support management of impacts. The buckets and PM10 monitor will be measured daily and reported on a monthly basis.

13.5.3 Blasting

Monitoring is done for each blast to verify that fly rock is being contained within 500m from the blast, that the ground vibration is less than or equal to a peak particle velocity of 12mm/s at a distance of 500m from the blast, and that the airblast is less than or equal to 130dB. Specific locations of the monitoring seismographs have been identified by an appropriate specialist during the pre-blast survey. These points may move as the open pit mining progresses.

13.5.4 Noise

Noise monitoring is done on an annual basis to confirm that implemented noise management measures are effective. Monitoring will be done by an appropriately qualified environmental noise specialist. The noise measurement points may be modified on the basis of input from an appropriate specialist.

13.5.5 Bio monitoring

The Tharisa Mine monitors the aquatic ecology integrity of water courses in the vicinity of the mining operations as per the water license conditions. Monitoring points exist up and downstream in the Sterkstroom.

13.5.6 Tailings and Other Dams

In addition to the abovementioned environmental monitoring programmes, the following issues will, as a minimum and where applicable, be monitored by a professional engineer on a quarterly basis:

- phreatic surface, slope stability, adequacy of freeboard, integrity of walls, the position of the pools, silt trap sediment, presence of seepage, and functioning of drains;
- the success of vegetation establishment on the outer side walls; and
- erosion damage.

13.5.7 Additional monitoring

In addition to the prescribed monitoring network as discussed above, the mine in the past has done ad hoc additional monitoring on request from neighbours to the south and west of the operations.

13.5.8 General

The mine's environmental manager will conduct internal management audits against the commitments in the EIA/EMP reports. During the construction of changes to the mine catered for in the 2014 EIA/EMP report, these audits will be conducted bi-monthly. In the operational phase, these audits will be conducted on an annual basis. The audit findings will be documented for both record keeping purposes and for informing continual improvement.

In addition, and in accordance with the MPRDA and the NWA, an independent environmental professional will conduct an EMP performance assessment every 2 years and a water use licence audit every year. The mine's compliance with the provisions of the EMP and conditions of the water use licence will be assessed and reported in the relevant reports.

13.5.9 Reporting

As a minimum, the following documents will be submitted to the relevant authorities on an ongoing basis:

- EMP performance assessment, submitted every two years to DMR;
- closure cost update, submitted annually to the DMR;
- tailings, waste rock and DMS waste management and risk report, submitted annually to the DMR;
- dust and noise monitoring reports, submitted annually to the DMR and DREAD; and
- water licence audit and water monitoring reports, submitted annually to DWS.

13.6 Rehabilitation and Mine Closure

Tharisa's philosophy towards rehabilitation is to do this concurrently with the operational phase, where possible, to limit the financial, environmental and social impact of the decommissioning and closure stages.

Tharisa have not finalised a formal and detailed closure plan yet. Conceptual planning has taken place for the purposes of the environmental assessment processes undertaken. Nonetheless, the calculations of the current financial closure liability associated with the mine were completed in accordance with the Guideline Document for the Evaluation of the Quantum of Closure-Related Financial Provision Provided by a Mine as published by the DMR, previously the Department of Minerals and Energy (DME), dated January 2005. The MPRDA requirement is for the financial closure liability to be updated and submitted to the DMR annually. The most recent calculation values the closure liability at R143,796,799 (as at 31 December 2015). This calculation allows for making any remaining open pit voids safe (by sloping the pit walls and putting perimeter berms in place) but excludes the cost of backfilling the open pit voids with waste rock and restoring agricultural land potential. This is in accordance with the amended closure objective to only partially backfill the open pits based on a revised mine plan, and it has been approved by the DMR.

The September 2015 closure liability calculation is only planned to be submitted to the DMR for feedback and approval in December 2015. Tharisa Minerals currently provide a financial guarantee to the value of R117.4 million through a Guardrisk Insurance Company Limited policy.

On 20 November 2015, new financial provision regulations in terms of the National Environmental Management Act, for prospecting, exploration, mining and production operations came into effect. These regulations require mining companies to develop detailed closure plans that support a financial provision calculation to varying degrees of accuracy (depending on the predicted life of mine) and based on actual rates. Existing operations have a period of 15 months from the 20 November 2015 to comply.

13.7 EMPR Performance Assessment and Water Licence Audit

An EMP performance assessment was completed in 2013. Based on the EMP and water licence performance assessments undertaken by the Ethical Exchange in July 2013 and a follow up site visit by SLR in November 2013 in support of the 2013 CPR update, Tharisa Mine was found to be in compliance with the majority of its environmental and water management obligations. Of the observed non-compliances, some are listed below:

- deviations from the approved infrastructure layout plan;
- incorrect storage and handling of non-mineralised waste and hydrocarbons. It must be noted that most of these issues were addressed in 2013;
- abstraction of water in excess of the authorised limits;
- various surface water management aspects including the incomplete provision of clean and dirty water separation infrastructure around all stockpiles/dumps and the incorrect use of the unlined Hernic Quarry for dirty water storage;
- unauthorised disposal of waste rock on a non-perennial watercourse;
- temporary storage of tailings during the early development stage of the plant in an unauthorised facility; and
- Incomplete implementation of the biodiversity and soil management plans.

Some of these issues are being addressed through management interventions. Where relevant, some of these issues have been addressed through the 2014 MPRDA and NEMA environmental authorisation processes. Verification of the mine's compliance with the 2014 EIA/EMP report will be done as part of the 2015 EMP performance assessment. The assessment was conducted in December 2015 with a final report due in February 2016. The findings will be presented to management and recommendations considered, budgeted and actioned where necessary. The 2014 water license audit conducted by MSA in November 2014 identified similar issues to those listed above. The audit also identified the potential need for a waste management license for the old processing plant/scrap yard area. In addition the following authorisation application processes are either in progress or imminent:

- A water use licence amendment to address the various water and waste management issues.
- A potential NEMA rectification application to address the unauthorised disposal of waste rock on a non-perennial watercourse. Although SLR has not had sight of the relevant paperwork, it is indicated by the mine that this was investigated and determined not to be required as it is catered for in a WUL amendment application.

13.8 Social and Labour Plan

In compliance with its obligations under the MPRDA, whereby each mining company is required to adopt a new Social and Labour Plan each 5 years, in November 2013 Tharisa Minerals adopted a new Social and Labour Plan, the salient features of which are listed below.

13.8.1 Objectives

The objects of the Social and Labour Plan are to promote employment and advance social and economic welfare of the local communities, contribute towards transformation in the mining sector and contribute towards socio-economic development in the area in which the Tharisa Mine is situated. In order to achieve the objectives, the following specific undertakings and commitments were given by Tharisa Minerals:

<u>Local Recruitment</u>

Tharisa Minerals agreed that all new, novice and entry level appointments would be taken from the local community, unless such positions could not be filled from applicants within the local community.

<u>Skills Development</u>

Tharisa Minerals undertook and committed itself towards skills development of its workforce. This would be achieved through bursaries, internships, learnership and apprenticeship programmes, portable skills programmes, career progression programmes, mentorship programmes and community adult basic education, all of which are detailed on the Social and Labour Plan.

13.8.2 Employment Equity Plan

Tharisa Minerals bound itself to an employment equity plan whereby there would be focus on HDSAs in management and participation of women in mining.

13.8.3 Local Economic Development Programme

The aim of this programme is to eradicate poverty and create community upliftment. A number of projects have been included in the SLP. It is understood by SLR that these are at various stages of development. An update on projects as provided by Tharisa is outlined below. No details were available on the planned scheduling and budget allocation at the time of completing this report:

- Housing project: The provision of land, development of a formal township (in co-operation with the Rustenburg Local Municipality which would be required to provide bulk services) and construction of brick house units for people who do not qualify for RDP houses. Discussions with relevant stakeholders are ongoing.
- Gardening service: still in progress with all Tharisa gardens being serviced.

- Sewing Project: with particular focus on aspects of the PPE clothing to be used by the Tharisa Mine workforce. This project is able to provide services on small orders from Tharisa and other clients. Plans are at an advance stage to ensure that this project is self sustaining.
- Brick Making project: to provide bricks suitable for the housing project, is now on hold until the proposed relocation of Madithlokwa is finalised.
- Construction projects: A number of construction projects which were requested by Tharisa have been completed. The last project was the paving of the walk way to the training centre. Orders have been placed by Tharisa for additional paving projects.
- Cleaning services: Rocasize is in discussion with Tharisa to provide all the cleaning service requirements in and around the administration blocks.
- Stemming material: It has been identified that once the crusher plant has been relocated, it will be able to crush and provide stemming materials for use by MCC. This will generate a huge income for Rocasize.
- Courier services: It has been identified that there is a need for a courier service for Tharisa (Mine).
- Scats and scrap metal: There is an opportunity for Rocasize to collect scats and scrap metal for sale. This will be another income generating project for Rocasize. Discussions are ongoing with Tharisa to determine how this could be implemented.
- Waste management project: with focus initially on waste produced at the Tharisa Mine. The type of waste that this project would address has not yet been specified.

14 TECHNICAL-ECONOMIC MODEL

14.1 Introduction

A Technical Economic Model (TEM) for the Tharisa Mine has been constructed by Coffey in order to confirm the feasibility of the mine and to substantiate the declaration of mineral reserves. Tharisa is contemplating capital expenditures to improve the effieciencies on the mine. Coffey thus did TEM's for two scenarios:

- TEM Excluding Optimisation Projects
- TEM Inclucing Optimisation Projects

This valuation has been prepared in accordance with "The South African Code for the Reporting of Mineral Asset Valuation (The SAMVAL Code) 2008 Edition (as amended in July 2009)" prepared by The South African Mineral Asset Valuation Committee (SAMVAL) Working Group under the Joint Auspices of the Southern African Institute of Mining and Metallurgy and the Geological Society of South Africa (www.samcode.co.za).

14.1.1 Competent Valuator and Effective Date

The Competent Valuator for the purposes of this report is Hannes Bornman. He is a registered Professional Engineer (Pr.Eng.) in terms of the Engineering Profession Act, 46 of 2000 (:the EPA") and is a "Competent Person" as defined in the SAMREC Code. He has 30 years' experience in hard and soft rock mining with more than 9 years experience in the valuation of platinum, chrome, gold, copper, coal, diamond, bauxite and uranium mines.

All the facts presented in this report are correct to the best knowledge of the Competent Valuator. This is a forward looking document and the analyses and conclusions are limited only by the reported forecasts and conditions. Neither Coffey, nor the Competent Valuator, has any material interest in Tharisa Mine, its Parent Companies, subsidiaries or projects. The work, and any other work done by Coffey for Tharisa, is strictly in return for professional fees. Payment for the work is not in any way dependent on the outcome of the work or on the success or otherwise of Tharisa's own business dealings. There is no conflict of interest in Coffey undertaking the independent mine valuation as contained in this document.

Hannes Bornman is a full-time employee of Coffey and has sufficient experience which is relevant to the style of mineralization and type of mining under consideration and to the valuation which he is undertaking to qualify as a Competent Valuator as defined in "The South African Code for the Reporting of Mineral Asset Valuation (2008) (as amended in July 2009)" Prepared by The South African Mineral Asset Valuation Committee (SAMVAL) Working Group (SAMVAL Code). Hannes Bornman has visited the property under valuation and consents to the inclusion in the report of the matters based on his information in the form and context in which it appears.

The effective date of the valuation is 31 December 2015.

14.1.2 Methodology

There are numerous recognised methods used in valuing "mineral assets". The most appropriate application of these various methods depends on several factors, including the level of maturity of the mineral asset, and the quantity and type of information available in relation to any particular asset.

The SAMVAL Code, sets out minimum standards and guidelines for Public Reporting of Mineral Asset Valuation for all styles of solid mineralization or mineral asset in South Africa which is binding upon the Competent Valuator involved in the valuation.

The mineral property can be defined in accordance with the level of asset maturity under the various categories as summarised in Table 14.1.2_1.

Table 14.1.2_1
Glossary of Valuation Terms (SAMVAL Code, 2008)

Exploration Property	A Mineral Asset that is being actively explored for mineral deposits but for which economic viability has not been demonstrated. Exploration Properties have asset values derived from their potential for the discovery of economically viable mineral deposits. Exploration property interests are bought and sold in the market. Many of these transactions involve partial-interest arrangements, such as farm-in, option or joint-venture arrangements.
Development Property	A Mineral Asset that is being prepared for mineral production and for which economic viability has been demonstrated by a Feasibility Study or Pre-feasibility Study and includes a Mineral Asset which may not be financed or under construction.
Production Mines	A Mineral Asset that is in production
Dormant Properties	A Mineral Asset that is not being actively explored or exploited, in which the Mineral Resources and Mineral Reserves have not been exhausted, and that may or may not be economically viable.
Defunct Properties	A Mineral Asset on which the Mineral Resources and Mineral Reserves have been exhausted and exploitation has ceased, and that may or may not have residual assets and liabilities.

The SAMVAL Code recognises three generally accepted approaches to Mineral Asset Valuation: -

Cash Flow Approach: The Cash Flow Approach relies on the 'value-in-use' principle and requires determination of the present value of future cash flows over the useful life of the Mineral Asset.

Market Approach: The Market Approach relies on the principle of 'willing buyer, willing seller' and requires that the amount obtainable from the sale of the Mineral Asset is determined as if in an arm's-length transaction.

Cost Approach: The Cost Approach relies on historical and/or future amounts spent on the Mineral Asset.

The Competent Valuator is required to apply at least two Valuation approaches.

The relationship between the maturity of the property and the approach to the valuation as presented in the SAMVAL Code are reproduced in Table 14.1.2_2.

Table 14.1.2_2
Relationship between Stages of Development and Valuation approaches for Mineral Properties (SAMVAL Code)

Valuation Approach	Exploration Properties	Development Properties	Production Properties	Dormant Properties		Defunct Properties
				Economically Viable	Not Viable	
Cash Flow	Not generally used	Widely used	Widely used	Widely used	Not generally used	Not generally used
Market	Widely used	Less widely used	Quite widely used	Quite widely used	Widely used	Widely used
Cost	Quite widely used	Not generally used	Not generally used	Not generally used	Less widely used	Quite widely used

In the case of Tharisa Mine, which is a producing mine, the primary valuation was undertaken using a discounted cashflow (DCF) approach utilising the planned production profile together with the costing relating to the LoM.

Discounted Cash Flow

In generating the financial model and deriving the valuations, the following approach was adopted:

- The DCF valuation was set up in financial years ending September (the Company's financial year end).
- A discount rate of 8.5% per annum (in real terms) was assumed for the base case discount factor, but the NPV was also calculated for a range of discount rates.
- The impact of the Mineral Royalties Act using the formula for unrefined metals was included.
- Sensitivity analyses were performed to ascertain the impact of discount rates, commodity prices, exchange rates, total working costs and capital expenditures.
- Valuation of the tax entity was performed on a stand-alone basis.
- The full value of the operation was reported – no attributable value was calculated

The approach to the second valuation selected was that of looking at comparative transactions.

Comparative Transactions

Recent work was undertaken to determine market values for listed companies active in the Southern African region and these values were plotted against the respective stages of exploration (including resource definition) in order to create value benchmarks for comparison.

Analysis of the transaction data where transactions involved the acquisition of classified Mineral Resources can be used to investigate the value ascribed to contained metal in these resources. This is based on the reasonable assumption that effectively all the value was ascribed to those resources and their upside.

14.2 Sources of information

The information has been supplied by Tharisa and various independent technical advisors to Tharisa. It is based on this information that the cash flow model was constructed.

The following sources were used as inputs:

- Commodity prices – Average of Macquarie, Investec, HSBC and ABSA – January 2015 real term view. (Published prices from Industrial Minerals for foundry sand and 45% chemical grade products); (For the purposes of the financial evaluation, foundry grade and 45% chemical grade chromite concentrate is sold to Arxo Metals at the price of 42% metallurgical grade chromite plus 10%).
- Exchange rate forecasts – Average of Macquarie, Investec, HSBC and ABSA – January 2016 real term view.
- Operating costs and capital expenditures – Tharisa Minerals.
- RoM tonnage, chrome and PGM grade forecast – Ukwazi.
- Grades, metal splits, recovery/yields and other process parameters – MDM Engineering and Tharisa Minerals actual plant performance data.
- Royalties and taxes were calculated as per South African legislation.
- No financing or other instruments were considered in the model and the NPV and IRR were calculated on the free cash flow of the project, both before and after tax and royalties. Depreciation and other non-cash items were ignored.

14.3 Capital Budgets

Table 14.3_1 is the summary of the capital budgets utilised in the TEM Excluding Optimisation Projects.

Table 14.3_1
Tharisa Mine
Total Capital Budget Excluding Optimisaton Projects (ZAR millions)

Description	2016	2017	2018
Ongoing Capital	62.84	33.52	23.85
Strategic Spares	17.36	14.42	3.21
Tailings Storage Facility	43.22	7.37	27.93
Infrastructure	42.8	20.69	21.79
Magnetic Separation			
High Energy Floatation			
Ultra-Fine Grind			
Rail Siding		100.0	85.0
Silos			
Provision to fill final void			20.41
TOTAL CAPITAL	**166.22**	**176.00**	**182.19**

Table 14.3_2 is the summary of the capital budgets utilised in the TEM Including Optimisation Projects.

Table 14.3_1
Tharisa Mine
Total Capital Budget Including Optimisaton Projects (ZAR millions)

Description	2016	2017	2018
Ongoing Capital	62.84	33.52	23.85
Strategic Spares	17.36	14.42	3.21
Tailings Storage Facility	43.22	7.37	27.93
Infrastructure	42.8	20.69	21.79
Magnetic Separation		125.0	125.0
High Energy Floatation			
Ultra-Fine Grind		180.0	
Rail Siding		100.0	85.0
Silos			
Provision to fill final void			20.41
TOTAL CAPITAL	**166.22**	**481.0**	**307.19**

14.4 Operating Costs

Table 14.4_1 is the summary of the plant recovery parameters utilised in the TEM Excluding Optimisation Projects.

Table 14.4_1
Tharisa Mine
Plant Recovery Parameters Excluding Optimisaton Projects

Parameter	2016	2017	2018	2019	Value (Long Term avg)
Chrome Mass Yield	29%	29%	28%	27%	28%
PGM Concentrator recovery	66%	74%	73%	73%	75%
PGM Concentrate grade	116.25	128.37	126.77	125.67	128.24

The following Optimisation Projects are planned to increase the chrome yield and PGM recoveries as shown in Table 14.4_2.

- Magnetic Separation and Shaking Tables
  - From FY2019
  - Capital of R250 million (R125 million in FY2017 & R125 million in FY2018)
  - Additional R5 per tonne milled on total tonnes milled
  - 37.5% yield for Genesis and Voyager
- Ultra Fine Grind
  - From FY2018
  - Capital of R180 million during FY2017
  - Additional R30 per tonne milled on Voyager portion only
  - Recovery at Voyager up from 75% to 80%

Table 14.4_2
Tharisa Mine
Plant Recovery Parameters Including Optimisaton Projects

Parameter	2016	2017	2018	2019	Value (Long Term avg)
Chrome Mass Yield	29%	29%	28%	33%	36%
PGM Concentrator recovery	66%	74%	80%	80%	80%
PGM Concentrate grade	116.25	128.37	139.79	137.39	138.76

14.5 Revenue Factors

Table 14.5_1 is the summary of the revenue factors utilised in the technical-economic model.

Table 14.5_1
Tharisa Mine
Revenue Factors

Parameter	Unit	Value
Exchange rate long term (real)	ZAR/US$	13.23
PGM Basket price (Real) long term	US$/ troy oz (5PGE+Au)	966
Met Grade chrome concentrate CIF long term (42% Cr_2O_3)	US$ / conc t	155
Chemical-grade chromite 44% Cr_2O_3, wet bulk, CIF to China	US$ / conc t	203
Foundry-grade chromite 45% Cr_2O_3, wet bulk, (Arxo Metals) FOT	US$ / conc t	144
Chemical-grade chromite 45% Cr_2O_3, wet bulk, (Arxo Metals) FOT	US$ / conc t	98
Nickel Price	US$/tonne	13,485
Copper Price	US$/tonne	5,713
PGM payment factor (5PGE+Au)	%	80%
Nickel payment factor	%	72.5%
Copper payment factor	%	67.5%

14.6 Cost Factors

Table 14.6_1 summarises the cost factors utilised in the TEM by Coffey Mining.

Table 14.6_1
Tharisa Mine
Cost Factors (Excluding Optimisation)

Parameter	Unit	Value
Opencast Mining costs long term	ZAR/RoM t	246.73
Underground Mining costs long term	ZAR/RoM t	482.45
Chrome plant processing costs long term	ZAR/feed t	53.80
CIF transportation cost (Mine to China) long term	ZAR/t concentrate	567
PGM plant processing costs	R/t PGM feed	74.72
On Mine overhead cash cost	ZAR/ feed t	27.95
Tharisa Minerals SA Head Office Cost	ZAR/ feed t	15.29
Arxo Logistics Commission	%	3%

The following fiscal parameters were utilised by Coffey Mining in its technical economic model:

Company tax rate of 28%

Capital expenditures written off in the year incurred

Royalty percentage = 0.5 + [earnings before interest and taxes/(gross sales in respect of unrefined mineral resources x 9)] x 100. The percentage so determined must not exceed 7%.

14.7 Steady State Production

Table 14.7_1 provides a summary of the steady state production profile.

Table 14.7_1
Tharisa Mine Technical Economic Model
Steady State Production

Product	Unit	Excluding Optimisation	Including Optimisation
Metallurgical grade Chromite Concentrate 42% Cr_2O_3	tpa	1,014000	1,492,000
Chemical Grade Chromite Concentrate 44% Cr_2O_3	tpa	256,800	154,000
Foundry grade Chromite Concentrate (Arxo Metals)	tpa	15,000	8,900
Chemical Grade Chromite Concentrate 45% Cr_2O_3 (Arxo Metals)	tpa	40,013	34,000
Total Chrome Concentrate	**tpa**	**1,330,000**	**1,689,000**
PGMs in PGM Concentrate	5PGE+Au oz pa	147,399	159,000

14.8 Summary of the Technical Financial Model Inputs

Table 14.8_1 and Table 14.8_2 summarises the inputs and outputs of the TEM Excluding Optimisation Projects and the TEM Including Optimisation Projects constructed by Coffey.

The TEM's confirmed that the mine is viable with a positive Net Present Value (NPV). The TEM's further confirmed that the mine is most sensitive to changes in revenue and least sensitive to changes in capital. This is because relatively little capital is spent on mining equipment as this is a contract mining operation.

Table 14.8_1

Tharisa Mine

Summary of the Technical Financial Model Excluding Optimisation Projects

		Opencast Mining			Opencast & Underground Mining							U/G Steady State	Declining Underground										
	Unit	**2016**	**2017**	**2018 - 2029**	**2030**	**2031**	**2032**	**2033**	**2034**	**2035**	**2036**	**2037 - 2057**	**2058**	**2059**	**2060**	**2061**	**2062**	**2063**	**2064**	**2065**	**2066**	**2067**	**2068**
ROM tonnage	*Mtpa*	4.989	5.036	5.037	4.801	4.619	4.576	4.560	4.515	4.503	4.471	4.747	4.452	3.996	3.471	3.407	3.257	2.949	2.758	2.462	2.469	2.103	1.907
Grade to PGM circuit																							
5PGE+Au	*g/t*	1.68	1.75	1.73	1.77	1.60	1.56	1.58	1.66	1.64	1.68	1.88	1.94	1.96	2.03	1.96	1.93	1.98	2.01	2.04	2.04	2.04	2.11
Cr_2O_3	%	19.48%	19.59%	18.63%	18.46%	17.72%	17.53%	17.68%	19.48%	18.92%	19.22%	19.34%	19.24%	19.13%	19.61%	18.83%	18.93%	19.39%	19.70%	19.68%	19.58%	19.48%	19.63%
Metal to PGM Circuit																							
5PGE+Au	*Kg*	5,805	6,361	6,272	6,120	5,310	5,146	5,173	5,398	5,325	5,417	6,425	6,207	5,631	5,069	4,796	4,524	4,198	3,989	3,611	3,627	3,090	2,893
Chrome Plant																							
Chrome plant feed	*Mtpa*	4.659	5.036	5.037	4.801	4.619	4.576	4.560	4.515	4.503	4.471	4.747	4.452	3.996	3.471	3.407	3.257	2.949	2.758	2.462	2.469	2.103	1.907
Yield	%	28.8%	28.6%	27.2%	26.9%	25.8%	25.6%	25.8%	28.4%	27.6%	28.0%	28.2%	28.1%	27.9%	28.6%	27.5%	27.6%	28.3%	28.7%	28.7%	28.6%	28.4%	28.6%
Metallurgical Grade (42%)	*Mtpa*	1.061	1.099	1.042	0.989	0.915	0.898	0.903	0.990	0.959	0.968	1.027	0.966	0.876	0.784	0.739	0.711	0.659	0.626	0.558	0.557	0.472	0.431
Chemical Grade - (44%)	*Mtpa*	0.212	0.251	0.248	0.241	0.242	0.238	0.239	0.258	0.251	0.253	0.266	0.252	0.232	0.208	0.197	0.189	0.175	0.166	0.148	0.148	0.126	0.115
Foundry grade - Arxo Metals	*Mtpa*	0.017	0.024	0.022	0.017	0.010	0.009	0.009	0.010	0.009	0.009	0.013	0.009	0.002	-	-	-	-	-	-	-	-	-
Chemical Grade - (45%) Arxo Metlas	*Mtpa*	0.051	0.065	0.057	0.045	0.027	0.025	0.025	0.026	0.024	0.024	0.034	0.023	0.006	-	-	-	-	-	-	-	-	-
Chrome concentrate produced	*Mtpa*	1.341	1.439	1.369	1.293	1.194	1.170	1.176	1.283	1.243	1.254	1.340	1.250	1.115	0.993	0.936	0.899	0.834	0.793	0.707	0.705	0.598	0.546
PGM Plant																							
Flotation plant feed	*Mtpa*	3.453	3.626	3.627	3.457	3.325	3.295	3.283	3.251	3.242	3.219	3.418	3.205	2.877	2.499	2.453	2.345	2.123	1.986	1.772	1.778	1.514	1.373
PGEs in Plant feed	*Kg*	5,805	6,361	6,272	6,120	5,310	5,146	5,173	5,398	5,325	5,417	6,425	6,207	5,631	5,069	4,796	4,524	4,198	3,989	3,611	3,627	3,090	2,893
6E PGM rougher feed grade	*g/t*	1.68	1.75	1.73	1.77	1.60	1.56	1.58	1.66	1.64	1.68	1.88	1.94	1.96	2.03	1.96	1.93	1.98	2.01	2.04	2.04	2.04	2.11
Concentrator recovery	%	66%	74%	72%	72%	69%	68%	69%	72%	71%	73%	76%	77%	77%	78%	77%	77%	77%	78%	78%	78%	78%	80%
PGM's in concentrate	6E Kg	3,827	4,698	4,521	4,417	3,651	3,520	3,591	3,864	3,792	3,933	4,861	4,761	4,340	3,968	3,695	3,464	3,250	3,110	2,832	2,846	2,425	2,301
PGM's in concentrate	6E oz	123,052	151,043	145,349	142,018	117,389	113,183	115,442	124,227	121,918	126,435	156,280	153,059	139,548	127,582	118,801	111,366	104,488	99,975	91,045	91,513	77,976	73,975
Concentrate grade	6E g/t	116	128	128	128	128	128	128	128	128	128	128	128	128	128	128	128	128	128	128	128	128	128
Tonnes of concentrate	tonnes	32,925	36,597	36,610	35,946	35,420	35,298	35,252	35,121	35,087	34,994	35,790	34,940	33,628	29,986	29,435	28,142	25,476	23,833	21,269	21,334	18,173	16,476
Exchange rate	ZAR/USD	15.78	15.00	13.84	13.23	13.23	13.23	13.23	13.23	13.23	13.23	13.23	13.23	13.23	13.23	13.23	13.23	13.23	13.23	13.23	13.23	13.23	13.23
PGM Basket price (Real)	USD/oz	809.16	916.33	974.00	965.79	965.79	965.79	965.79	965.79	965.79	965.79	965.79	965.79	965.79	965.79	965.79	965.79	965.79	965.79	965.79	965.79	965.79	965.79
PGM Basket price (Real)	R/g	397.02	427.52	431.92	397.42	397.42	397.42	397.42	397.42	397.42	397.42	397.42	397.42	397.42	397.42	397.42	397.42	397.42	397.42	397.42	397.42	397.42	397.42
42% met grade chrome CIF price to TFI including discount	US$/t conc	107.00	120.00	135.00	155.00	155.00	155.00	155.00	155.00	155.00	155.00	155.00	155.00	155.00	155.00	155.00	155.00	155.00	155.00	155.00	155.00	155.00	155.00
SOC Agreement IRS	Payment %	80.0%	80.0%	80.0%	80.0%	80.0%	80.0%	80.0%	80.0%	80.0%	80.0%	80.0%	80.0%	80.0%	80.0%	80.0%	80.0%	80.0%	80.0%	80.0%	80.0%	80.0%	80.0%
Arxo Logisrtis Commission	%	3.0%	3.0%	3.0%	3.0%	3.0%	3.0%	3.0%	3.0%	3.0%	3.0%	3.0%	3.0%	3.0%	3.0%	3.0%	3.0%	3.0%	3.0%	3.0%	3.0%	3.0%	3.0%
Effective 42% Met grade price (CIF to China)	ZAR/tonne	1,637	1,746	1,813	1,989	1,989	1,989	1,989	1,989	1,989	1,989	1,989	1,989	1,989	1,989	1,989	1,989	1,989	1,989	1,989	1,989	1,989	1,989
Effective 44% Chem grade price (CIF to China)	ZAR/tonne	1,989	2,099	2,215	2,600	2,600	2,600	2,600	2,600	2,600	2,600	2,600	2,600	2,600	2,600	2,600	2,600	2,600	2,600	2,600	2,600	2,600	2,600
Effective 45% Chem grade price (to Arxo metals)	ZAR/tonne	1,261	1,261	1,261	1,261	1,261	1,261	1,261	1,261	1,261	1,261	1,261	1,261	1,261	1,261	1,261	1,261	1,261	1,261	1,261	1,261	1,261	1,261
Effective Foundry grade price (to Arxo metals)	ZAR/tonne	1,843	1,843	1,843	1,843	1,843	1,843	1,843	1,843	1,843	1,843	1,843	1,843	1,843	1,843	1,843	1,843	1,843	1,843	1,843	1,843	1,843	1,843
Effective PGM Price	ZAR/6E ounce	10,212	10,996	11,109	10,222	10,222	10,222	10,222	10,222	10,222	10,222	10,222	10,222	10,222	10,222	10,222	10,222	10,222	10,222	10,222	10,222	10,222	10,222
Chrome Revenue - Export Chrome concentrate	ZAR mil	2,278	2,600	2,572	2,703	2,513	2,464	2,476	2,701	2,617	2,640	2,815	2,632	2,358	2,102	1,982	1,904	1,766	1,678	1,496	1,494	1,266	1,156
Chrome Revenue - Sales to Arxo Metals	ZAR mil																						
PGM Revenue (Incl Base Metals)	ZAR mil	1,268	1,674	1,519	1,466	1,214	1,171	1,194	1,284	1,261	1,307	1,612	1,579	1,440	1,316	1,226	1,150	1,079	1,032	939	944	805	763
TOTAL REVENUE	**ZAR mil**	**3,546**	**4,275**	**4,092**	**4,170**	**3,727**	**3,635**	**3,671**	**3,985**	**3,878**	**3,947**	**4,427**	**4,211**	**3,798**	**3,418**	**3,208**	**3,054**	**2,845**	**2,710**	**2,436**	**2,438**	**2,070**	**1,919**
Operating Cost																							
Mining costs	ZAR mil	1,263.4	1,288.7	1,238.8	829.3	513.8	399.5	696.9	981.5	1,675.6	2,108.1	2,317.9	2,106.0	1,887.0	1,635.8	1,603.4	1,533.0	1,384.2	1,295.8	1,156.3	1,158.9	992.4	907.8
Chrome plant processing costs	ZAR mil	250.6	270.9	271.0	258.3	248.5	246.2	245.3	242.9	242.3	240.5	255.4	239.5	215.0	186.7	183.3	175.2	158.6	148.4	132.4	132.8	113.2	102.6
Chrome Transport cost (CIF to China)	ZAR mil	763.8	810.1	676.1	636.4	598.2	587.2	590.4	645.2	625.4	631.4	668.3	629.9	572.5	513.2	483.9	465.0	431.2	409.8	365.4	364.7	309.1	282.3
PGM plant processing costs	**ZAR mil**	250.6	270.9	271.0	258.3	248.5	246.2	245.3	242.9	242.3	240.5	255.4	239.5	215.0	186.7	183.3	175.2	158.6	148.4	132.4	132.8	113.2	102.6
Laboratory cost	ZAR mil	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
On mine overhead cost	ZAR mil	130.2	140.7	140.8	134.2	129.1	127.9	127.5	126.2	125.9	125.0	132.7	124.4	111.7	97.0	95.2	91.0	82.4	77.1	68.8	69.0	58.8	53.3
Total Tharisa On Mine Cash Cost (including chrome transport)	**ZAR mil**	**2,658.7**	**2,781.4**	**2,597.7**	**2,116.6**	**1,738.0**	**1,607.0**	**1,905.4**	**2,238.7**	**2,911.3**	**3,345.5**	**3,629.7**	**3,339.3**	**3,001.1**	**2,619.5**	**2,549.1**	**2,439.5**	**2,215.1**	**2,079.5**	**1,855.3**	**1,858.3**	**1,586.6**	**1,448.6**
Tharisa Minerals SA Head Office	**ZAR mil**	73.5	73.5	73.5	73.5	73.5	73.5	73.5	73.5	73.5	73.5	73.5	68.4	61.4	53.3	52.4	50.1	45.3	42.4	37.8	37.9	32.3	29.3
Total Cash Cost Tharisa Minerals South Africa	ZAR mil	**2,732.2**	**2,854.9**	**2,671.2**	**2,190.0**	**1,811.5**	**1,680.5**	**1,978.9**	**2,312.1**	**2,984.8**	**3,419.0**	**3,703.2**	**3,407.7**	**3,062.6**	**2,672.8**	**2,601.5**	**2,489.6**	**2,260.4**	**2,121.9**	**1,893.2**	**1,896.2**	**1,618.9**	**1,477.9**
Total chrome + PGM cost (excluding mining, HO & overheads)	**ZAR mil**	**1,265.1**	**1,352.0**	**1,218.1**	**1,153.0**	**1,095.2**	**1,079.6**	**1,081.1**	**1,131.0**	**1,109.9**	**1,112.4**	**1,179.1**	**1,108.9**	**1,002.5**	**886.7**	**850.5**	**815.5**	**748.5**	**706.6**	**630.3**	**630.4**	**535.4**	**487.4**
Copper head grade	%	0.1919%	0.1919%	0.1919%	0.1919%	0.1919%	0.1919%	0.1919%	0.1919%	0.1919%	0.1919%	0.1919%	0.1919%	0.1919%	0.1919%	0.1919%	0.1919%	0.1919%	0.1919%	0.1919%	0.1919%	0.1919%	0.1919%
Contained copper in concentrate	t	63.2	70.2	70.3	69.0	68.0	67.8	67.7	67.4	67.3	67.2	68.7	67.1	64.5	57.6	56.5	54.0	48.9	45.7	40.8	40.9	34.9	31.6
Copper Payment factor (IRS)	%	67.5%	67.5%	67.5%	67.5%	67.5%	67.5%	67.5%	67.5%	67.5%	67.5%	67.5%	67.5%	67.5%	67.5%	67.5%	67.5%	67.5%	67.5%	67.5%	67.5%	67.5%	67.5%

		Opencast Mining			Opencast & Underground Mining							U/G Steady State	Declining Underground										
	Unit	**2016**	**2017**	**2018 - 2029**	**2030**	**2031**	**2032**	**2033**	**2034**	**2035**	**2036**	**2037 - 2057**	**2058**	**2059**	**2060**	**2061**	**2062**	**2063**	**2064**	**2065**	**2066**	**2067**	**2068**
Nickel Head Grade	%	0.2413%	0.2413%	0.2413%	0.2413%	0.2413%	0.2413%	0.2413%	0.2413%	0.2413%	0.2413%	0.2413%	0.2413%	0.2413%	0.2413%	0.2413%	0.2413%	0.2413%	0.2413%	0.2413%	0.2413%	0.2413%	0.2413%
Contained Nickel in concentrate	t	79.5	88.3	88.3	86.7	85.5	85.2	85.1	84.8	84.7	84.4	86.4	84.3	81.1	72.4	71.0	67.9	61.5	57.5	51.3	51.5	43.9	39.8
Nickel Payment factor (IRS)	%	72.5%	72.5%	72.5%	72.5%	72.5%	72.5%	72.5%	72.5%	72.5%	72.5%	72.5%	72.5%	72.5%	72.5%	72.5%	72.5%	72.5%	72.5%	72.5%	72.5%	72.5%	72.5%
Copper price	US$/t	4,941	5,276	5,700	5,639	5,713	5,713	5,713	5,713	5,713	5,713	5,713	5,713	5,713	5,713	5,713	5,713	5,713	5,713	5,713	5,713	5,713	5,713
Nickel price	US$/t	8,940	10,147	13,157	12,117	13,485	13,485	13,485	13,485	13,485	13,485	13,485	13,485	13,485	13,485	13,485	13,485	13,485	13,485	13,485	13,485	13,485	13,485
Capital Expenditure	ZAR mil																						
Ongoing Capital	ZAR mil	63	34	29	30	30	30	30	30	30	30	30	30	30	30	25	20	20	20	15	15	15	-
Strategic Spares	ZAR mil	17	14	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Tailings Storage Facility	ZAR mil	43	7	29	5	5	5	5	5	5	5	5	5	5	-	-	-	-	-	-	-	-	-
Infrastructure	ZAR mil	43	21	22	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Magnetic Separation	ZAR mil	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
High Energy Floatation	ZAR mil	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ultra Fine Grind	ZAR mil	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Rail Siding	ZAR mil	-	100	85	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Silos	ZAR mil	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Underground Mining Project	ZAR mil	-	-	-	258	294	471	499	363	230	116	-	-	-	-	-	-	-	-	-	-	-	-
Provision to fill final void	ZAR mil	-	-	20	20	20	20	20	20	20	20	1	-	-	-	-	-	-	-	-	-	-	-
Closing Environmental Rehab	ZAR mil	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	144
TOTAL CAPITAL	ZAR mil	**166**	**176**	**189**	**314**	**349**	**527**	**554**	**419**	**285**	**172**	**36**	**35**	**35**	**30**	**25**	**20**	**20**	**20**	**15**	**15**	**15**	**144**
TOTAL REVENUE	ZAR mil	3,546	4,275	4,092	4,170	3,727	3,635	3,671	3,985	3,878	3,947	4,427	4,211	3,798	3,418	3,208	3,054	2,845	2,710	2,436	2,438	2,070	1,919
TOTAL COSTS	ZAR mil	2,732	2,855	2,671	2,190	1,811	1,680	1,979	2,312	2,985	3,419	3,703	3,408	3,063	2,673	2,601	2,490	2,260	2,122	1,893	1,896	1,619	1,478
CAPITAL EXPENDITURE	ZAR mil	166	176	189	314	349	527	554	419	285	172	36	35	35	30	25	20	20	20	15	15	15	144
Net Cash before Royalties & Tax	ZAR mil	**648**	**1,244**	**1,232**	**1,666**	**1,567**	**1,428**	**1,137**	**1,254**	**608**	**356**	**688**	**768**	**701**	**716**	**582**	**545**	**564**	**568**	**528**	**526**	**436**	**297**
Net Cash after Royalties & Tax	ZAR mil	**634**	**1,189**	**1,073**	**1,141**	**1,089**	**1,051**	**872**	**908**	**457**	**264**	**437**	**489**	**447**	**456**	**370**	**345**	**358**	**361**	**334**	**334**	**277**	**225**
Discount Rate	**%**	**8.5%**																					
NPV (Before tax and royalties)	**R mil**	**15,832**																					
NPV (After tax and royalties)	**R mil**	**11,474**																					

- All costs are expressed in quarter four 2015 real terms.
- The table reflects cash cost excluding depreciation, royalties, interest payments and any other non-cash cost.
- Real term adjustments, to mining cost was included taking cognisance of the increase in mining stripping ratios and underground mining (for the life of mine).

Table 14.8_2

Tharisa Mine

Summary of the Technical Financial Model Including Optimisation Projects

		Opencast Mining			Opencast & Underground Mining							U/G Steady State	Declining Underground										
	Unit	2016	2017	2018 - 2029	2030	2031	2032	2033	2034	2035	2036	2037 - 2057	2058	2059	2060	2061	2062	2063	2064	2065	2066	2067	2068
ROM tonnage	*Mtpa*	4.989	5.036	5.037	4.801	4.619	4.576	4.560	4.515	4.503	4.471	4.747	4.452	3.996	3.471	3.407	3.257	2.949	2.758	2.462	2.469	2.103	1.907
Grade to PGM circuit																							
5PGE+Au	*g/t*	1.68	1.75	1.73	1.77	1.72	1.68	1.69	1.79	1.77	1.84	1.88	1.94	1.96	2.03	1.96	1.93	1.98	2.01	2.04	2.04	2.04	2.11
Cr_2O_3	%	19.48%	19.59%	18.63%	18.46%	17.72%	17.53%	17.68%	19.48%	18.92%	19.22%	19.34%	19.24%	19.13%	19.61%	18.83%	18.93%	19.39%	19.70%	19.68%	19.58%	19.48%	19.63%
Metal to PGM Circuit																							
5PGE+Au	*Kg*	5,805	6,361	6,272	6,120	5,725	5,528	5,541	5,811	5,742	5,925	6,425	6,207	5,631	5,069	4,796	4,524	4,198	3,989	3,611	3,627	3,090	2,893
Chrome Plant																							
Chrome plant feed	*Mtpa*	4.659	5.036	5.037	4.801	4.619	4.576	4.560	4.515	4.503	4.471	4.747	4.452	3.996	3.471	3.407	3.257	2.949	2.758	2.462	2.469	2.103	1.907
Yield	%	28.8%	28.6%	32.5%	33.2%	34.1%	33.7%	33.9%	36.8%	35.9%	36.4%	36.6%	36.4%	36.1%	36.9%	35.4%	35.6%	36.5%	37.1%	37.0%	36.9%	36.7%	36.9%
Metallurgical Grade (42%)	*Mtpa*	1.061	1.099	1.300	1.274	1.255	1.231	1.234	1.323	1.288	1.295	1.388	1.290	1.141	1.012	0.954	0.917	0.850	0.808	0.720	0.719	0.609	0.557
Chemical Grade - (44%)	*Mtpa*	0.212	0.251	0.280	0.278	0.284	0.281	0.283	0.309	0.300	0.304	0.312	0.304	0.294	0.269	0.254	0.244	0.226	0.215	0.192	0.191	0.162	0.148
Foundry grade - Arxo Metals	*Mtpa*	0.017	0.024	0.013	0.008	0.007	0.006	0.006	0.006	0.006	0.005	0.008	0.005	0.001	-	-	-	-	-	-	-	-	-
Chemical Grade - (45%) Arxo Metlas	*Mtpa*	0.051	0.065	0.046	0.033	0.026	0.025	0.024	0.023	0.023	0.021	0.031	0.021	0.005	-	-	-	-	-	-	-	-	-
Chrome concentrate produced	*Mtpa*	1.341	1.439	1.639	1.592	1.573	1.543	1.548	1.661	1.616	1.626	1.738	1.620	1.441	1.281	1.208	1.161	1.076	1.023	0.912	0.910	0.771	0.704
PGM Plant																							
Flotation plant feed	*Mtpa*	3.453	3.626	3.627	3.457	3.325	3.295	3.283	3.251	3.242	3.219	3.418	3.205	2.877	2.499	2.453	2.345	2.123	1.986	1.772	1.778	1.514	1.373
PGEs in Plant feed	*Kg*	5,805	6,361	6,272	6,120	5,725	5,528	5,541	5,811	5,742	5,925	6,425	6,207	5,631	5,069	4,796	4,524	4,198	3,989	3,611	3,627	3,090	2,893
6E PGM rougher feed grade	*g/t*	1.68	1.75	1.73	1.77	1.72	1.68	1.69	1.79	1.77	1.84	1.88	1.94	1.96	2.03	1.96	1.93	1.98	2.01	2.04	2.04	2.04	2.11
Concentrator recovery	%	66%	74%	80%	81%	79%	79%	79%	80%	80%	80%	78%	80%	84%	85%	85%	85%	85%	85%	85%	85%	85%	85%
PGM's in concentrate	6E Kg	3,827	4,698	5,018	4,954	4,528	4,387	4,404	4,635	4,585	4,743	5,032	4,977	4,710	4,309	4,077	3,845	3,568	3,391	3,069	3,083	2,627	2,459
PGM's in concentrate	6E oz	123,052	151,043	161,325	159,280	145,592	141,055	141,588	149,027	147,415	152,505	161,768	160,016	151,420	138,524	131,074	123,626	114,713	109,011	98,675	99,121	84,451	79,066
Concentrate grade	6E g/t	116	128	128	128	128	128	128	128	128	128	128	128	128	128	128	128	128	128	128	128	128	128
Tonnes of concentrate	tonnes	32,925	36,597	36,610	35,946	35,420	35,298	35,252	35,121	35,087	34,994	35,790	34,940	33,628	29,986	29,435	28,142	25,476	23,833	21,269	21,334	18,173	16,476
Exchange rate	ZAR/USD	15.78	15.00	13.84	13.23	13.23	13.23	13.23	13.23	13.23	13.23	13.23	13.23	13.23	13.23	13.23	13.23	13.23	13.23	13.23	13.23	13.23	13.23
PGM Basket price (Real)	USD/oz	809.16	916.33	974.00	965.79	965.79	965.79	965.79	965.79	965.79	965.79	965.79	965.79	965.79	965.79	965.79	965.79	965.79	965.79	965.79	965.79	965.79	965.79
PGM Basket price (Real)	R/g	397.02	427.52	431.92	397.42	397.42	397.42	397.42	397.42	397.42	397.42	397.42	397.42	397.42	397.42	397.42	397.42	397.42	397.42	397.42	397.42	397.42	397.42
42% met grade chrome CIF price to TFI including discount	US$/t conc	107.00	120.00	135.00	155.00	155.00	155.00	155.00	155.00	155.00	155.00	155.00	155.00	155.00	155.00	155.00	155.00	155.00	155.00	155.00	155.00	155.00	155.00
SOC Agreement IRS	Payment %	80.0%	80.0%	80.0%	80.0%	80.0%	80.0%	80.0%	80.0%	80.0%	80.0%	80.0%	80.0%	80.0%	80.0%	80.0%	80.0%	80.0%	80.0%	80.0%	80.0%	80.0%	80.0%
Arxo Logisrtis Commission	%	3.0%	3.0%	3.0%	3.0%	3.0%	3.0%	3.0%	3.0%	3.0%	3.0%	3.0%	3.0%	3.0%	3.0%	3.0%	3.0%	3.0%	3.0%	3.0%	3.0%	3.0%	3.0%
Effective 42% Met grade price (CIF to China)	ZAR/tonne	1,637	1,746	1,813	1,989	1,989	1,989	1,989	1,989	1,989	1,989	1,989	1,989	1,989	1,989	1,989	1,989	1,989	1,989	1,989	1,989	1,989	1,989
Effective 44% Chem grade price (CIF to China)	ZAR/tonne	1,989	2,099	2,215	2,600	2,600	2,600	2,600	2,600	2,600	2,600	2,600	2,600	2,600	2,600	2,600	2,600	2,600	2,600	2,600	2,600	2,600	2,600
Effective 45% Chem grade price (to Arxo metals)	ZAR/tonne	1,261	1,261	1,261	1,261	1,261	1,261	1,261	1,261	1,261	1,261	1,261	1,261	1,261	1,261	1,261	1,261	1,261	1,261	1,261	1,261	1,261	1,261
Effective Foundry grade price (to Arxo metals)	ZAR/tonne	1,843	1,843	1,843	1,843	1,843	1,843	1,843	1,843	1,843	1,843	1,843	1,843	1,843	1,843	1,843	1,843	1,843	1,843	1,843	1,843	1,843	1,843
Effective PGM Price	ZAR/6E ounce	10,212	10,996	11,109	10,222	10,222	10,222	10,222	10,222	10,222	10,222	10,222	10,222	10,222	10,222	10,222	10,222	10,222	10,222	10,222	10,222	10,222	10,222
Chrome Revenue - Export Chrome concentrate	ZAR mil	2,278	2,600	3,080	3,329	3,295	3,234	3,245	3,487	3,393	3,414	3,638	3,404	3,045	2,712	2,557	2,457	2,279	2,166	1,931	1,927	1,633	1,492
Chrome Revenue - Sales to Arxo Metals	ZAR mil	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PGM Revenue (Incl Base Metals)	ZAR mil	1,268	1,674	1,684	1,643	1,503	1,456	1,462	1,538	1,521	1,573	1,668	1,650	1,562	1,428	1,352	1,275	1,183	1,124	1,017	1,022	871	815
TOTAL REVENUE	**ZAR mil**	**3,546**	**4,275**	**4,764**	**4,972**	**4,798**	**4,691**	**4,707**	**5,025**	**4,914**	**4,988**	**5,306**	**5,054**	**4,607**	**4,141**	**3,909**	**3,733**	**3,462**	**3,290**	**2,948**	**2,949**	**2,504**	**2,307**
Operating Cost																							
Mining costs	ZAR mil	1,263.4	1,288.7	1,238.8	829.3	513.8	399.5	696.9	981.5	1,675.6	2,108.1	2,317.9	2,106.0	1,887.0	1,635.8	1,603.4	1,533.0	1,384.2	1,295.8	1,156.3	1,158.9	992.4	907.8
Chrome plant processing costs	ZAR mil	250.6	270.9	324.0	312.2	301.5	299.0	298.0	295.4	294.7	292.8	309.0	291.7	264.9	234.0	230.2	221.4	203.3	192.1	174.6	175.1	153.6	142.0
Chrome Transport cost (CIF to China)	ZAR mil	763.8	810.1	826.0	802.1	796.0	781.6	784.4	843.9	821.1	826.7	878.8	824.3	741.8	662.3	624.4	600.0	556.4	528.8	471.5	470.5	398.8	364.2
PGM plant processing costs	**ZAR mil**	250.6	270.9	326.0	311.3	301.2	298.9	297.8	295.3	294.5	294.3	308.9	289.4	262.2	233.6	229.5	219.9	202.3	190.6	174.7	173.2	152.6	132.5
Laboratory cost	ZAR mil	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
On mine overhead cost	ZAR mil	130.2	140.7	140.8	134.2	129.1	127.9	127.5	126.2	125.9	125.0	132.7	124.4	111.7	97.0	95.2	91.0	82.4	77.1	68.8	69.0	58.8	53.3
Total Tharisa On Mine Cash Cost (including chrome transport)	**ZAR mil**	**2,658.7**	**2,781.4**	**2,855.5**	**2,389.2**	**2,041.6**	**1,906.9**	**2,204.6**	**2,542.3**	**3,211.7**	**3,646.9**	**3,947.3**	**3,635.8**	**3,267.5**	**2,862.6**	**2,782.7**	**2,665.3**	**2,428.6**	**2,284.3**	**2,045.8**	**2,046.8**	**1,756.2**	**1,599.8**
Tharisa Minerals SA Head Office	**ZAR mil**	73.5	73.5	73.5	73.5	73.5	73.5	73.5	73.5	73.5	73.5	73.5	68.4	61.4	53.3	52.4	50.1	45.3	42.4	37.8	37.9	32.3	29.3
Total Cash Cost Tharisa Minerals South Africa	ZAR mil	**2,732.2**	**2,854.9**	**2,929.0**	**2,462.6**	**2,115.0**	**1,980.3**	**2,278.0**	**2,615.8**	**3,285.2**	**3,720.4**	**4,020.8**	**3,704.2**	**3,328.9**	**2,916.0**	**2,835.1**	**2,715.4**	**2,473.9**	**2,326.7**	**2,083.7**	**2,084.7**	**1,788.5**	**1,629.1**
Total chrome + PGM cost (excluding mining, HO & overheads)	**ZAR mil**	**1,265.1**	**1,352.0**	**1,475.9**	**1,425.6**	**1,398.7**	**1,379.5**	**1,380.2**	**1,434.6**	**1,410.3**	**1,413.8**	**1,496.7**	**1,405.3**	**1,268.9**	**1,129.8**	**1,084.1**	**1,041.3**	**962.0**	**911.5**	**820.8**	**818.9**	**704.9**	**638.7**
Copper head grade	%	0.1919%	0.1919%	0.1919%	0.1919%	0.1919%	0.1919%	0.1919%	0.1919%	0.1919%	0.1919%	0.1919%	0.1919%	0.1919%	0.1919%	0.1919%	0.1919%	0.1919%	0.1919%	0.1919%	0.1919%	0.1919%	0.1919%
Contained copper in concentrate	t	63.2	70.2	70.3	69.0	68.0	67.8	67.7	67.4	67.3	67.2	68.7	67.1	64.5	57.6	56.5	54.0	48.9	45.7	40.8	40.9	34.9	31.6
Copper Payment factor (IRS)	%	67.5%	67.5%	67.5%	67.5%	67.5%	67.5%	67.5%	67.5%	67.5%	67.5%	67.5%	67.5%	67.5%	67.5%	67.5%	67.5%	67.5%	67.5%	67.5%	67.5%	67.5%	67.5%
Nickel Head Grade	%	0.2413%	0.2413%	0.2413%	0.2413%	0.2413%	0.2413%	0.2413%	0.2413%	0.2413%	0.2413%	0.2413%	0.2413%	0.2413%	0.2413%	0.2413%	0.2413%	0.2413%	0.2413%	0.2413%	0.2413%	0.2413%	0.2413%
Contained Nickel in concentrate	t	79.5	88.3	88.3	86.7	85.5	85.2	85.1	84.8	84.7	84.4	86.4	84.3	81.1	72.4	71.0	67.9	61.5	57.5	51.3	51.5	43.9	39.8

		Opencast Mining			Opencast & Underground Mining							U/G Steady State	Declining Underground										
	Unit	**2016**	**2017**	**2018 - 2029**	**2030**	**2031**	**2032**	**2033**	**2034**	**2035**	**2036**	**2037 - 2057**	**2058**	**2059**	**2060**	**2061**	**2062**	**2063**	**2064**	**2065**	**2066**	**2067**	**2068**
Nickel Payment factor (IRS)	%	72.5%	72.5%	72.5%	72.5%	72.5%	72.5%	72.5%	72.5%	72.5%	72.5%	72.5%	72.5%	72.5%	72.5%	72.5%	72.5%	72.5%	72.5%	72.5%	72.5%	72.5%	72.5%
Copper price	US$/t	4,941	5,276	5,700	5,639	5,713	5,713	5,713	5,713	5,713	5,713	5,713	5,713	5,713	5,713	5,713	5,713	5,713	5,713	5,713	5,713	5,713	5,713
Nickel price	US$/t	8,940	10,147	13,157	12,117	13,485	13,485	13,485	13,485	13,485	13,485	13,485	13,485	13,485	13,485	13,485	13,485	13,485	13,485	13,485	13,485	13,485	13,485
Capital Expenditure	ZAR mil																						
Ongoing Capital	ZAR mil	63	34	39	40	40	40	40	40	40	40	40	40	40	40	35	30	25	20	15	15	15	-
Strategic Spares	ZAR mil	17	14	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Tailings Storage Facility	ZAR mil	43	7	24	5	5	5	5	5	5	5	5	5	5	-	-	-	-	-	-	-	-	-
Infrastructure	ZAR mil	43	21	22	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Magnetic Separation	ZAR mil	-	125	125	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
High Energy Floatation	ZAR mil	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ultra Fine Grind	ZAR mil	-	180	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Rail Siding	ZAR mil	-	100	85	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Silos	ZAR mil	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Underground Mining Project	ZAR mil	-	-	-	258	294	471	499	363	230	116	-	-	-	-	-	-	-	-	-	-	-	-
Provision to fill final void	ZAR mil	-	-	20	20	20	20	20	20	20	20	1	-	-	-	-	-	-	-	-	-	-	-
Closing Environmental Rehab	ZAR mil	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	144
TOTAL CAPITAL	ZAR mil	**166**	**481**	**318**	**324**	**359**	**537**	**564**	**429**	**295**	**182**	**46**	**45**	**45**	**40**	**35**	**30**	**25**	**20**	**15**	**15**	**15**	**144**
TOTAL REVENUE	ZAR mil	3,546	4,275	4,764	4,972	4,798	4,691	4,707	5,025	4,914	4,988	5,306	5,054	4,607	4,141	3,909	3,733	3,462	3,290	2,948	2,949	2,504	2,307
TOTAL COSTS	ZAR mil	2,732	2,855	2,929	2,463	2,115	1,980	2,278	2,616	3,285	3,720	4,021	3,704	3,329	2,916	2,835	2,715	2,474	2,327	2,084	2,085	1,788	1,629
CAPITAL EXPENDITURE	ZAR mil	166	481	318	324	359	537	564	429	295	182	46	45	45	40	35	30	25	20	15	15	15	144
Net Cash before Royalties & Tax	ZAR mil	**648**	**939**	**1,517**	**2,185**	**2,324**	**2,174**	**1,864**	**1,980**	**1,334**	**1,086**	**1,240**	**1,304**	**1,233**	**1,185**	**1,039**	**987**	**963**	**943**	**850**	**849**	**700**	**534**
Net Cash after Royalties & Tax	ZAR mil	**634**	**918**	**1,376**	**1,474**	**1,573**	**1,527**	**1,337**	**1,372**	**922**	**731**	**792**	**832**	**788**	**757**	**663**	**629**	**613**	**599**	**539**	**539**	**445**	**375**
Discount Rate	**%**	**8.5%**																					
NPV (Before tax and royalties)	**R mil**	**20,751**																					
NPV (After tax and royalties)	**R mil**	**14,703**																					

- All costs are expressed in quarter four 2015 real terms.

- The table reflects cash cost excluding depreciation, royalties, interest payments and any other non-cash cost.

- Real term adjustments, to mining cost was included taking cognisance of the increase in mining stripping ratios and underground mining (for the life of mine).

14.9 Cash Flow Approach – Excluding Inferred Resources

14.9.1 Opencast Mine

The tail of the opencast mine was shortened in this scenario due to the fixed costs on the mine that will have to be covered with diminished production in the last year or two.

14.9.2 Underground Mine

In the valuation of the Tharisa Mine excluding the inferred mineral resources, it was decided to exclude the underground production profile as a close proxy for the exclusion of inferred mineral resources. This assessment considers that the ZAR2bn necessary to establish the underground mine will not be recouped by the 18,649Mt Probable Reserves available for underground mine production. The bulk of the underground operations would obtain their production from areas declared as an inferred mineral resource.

14.9.3 Modifying Factors

All modifying factors in this valuation are the same as in the valuation where the underground production, a proxy for the inferred mineral resources, were included.

14.9.4 Effect of Underground Production/Inferred Mineral Resources on DCF Valuation

Table 14.9.4_1 presents aspects of the TEM in which the underground mine have been excluded as a close proxy for exclusion of the inferred mineral resources from the production profile.

Table14.9.4_1
Tharisa Mine Technical Economic Model
Effect of Underground Production/Inferred Resources on DCF Valuation

Parameter	Unit	Excluding Optimisation		Including Optimisation	
		Including Underground	Excluding Underground	Including Underground	Excluding Underground
Life of Mine	Years	53	21	53	21
ROM over LOM	Mt	235.44	90.60	235.44	90.60
LOM C_2O_3	Mt	65.33	24.6	82,221	29.44
LOM PGM's	Moz	7.35	2.60	7.93	2.892
Capital	ZAR Million	5,089	1,871	5,964	2,437
Discount Rate	%	8.5%	8.5%	8.5%	8.5%
High NPV	ZAR Million	15,947	13,178	21,355	12,655
Low NPV	ZAR Million	6,049	6,018	7,001	5,546
Preferred NPV	**ZAR Million**	**11.474**	**10,655**	**14,703**	**9,923**

Coffey prefers the DCF valuation where the underground production has been excluded.

14.10 Market Approach

Tharisa is unique in the sense that there are no other opencast chrome mines with PGM's as co-products in South Africa. There are therefore no similar mine transactions that can be used to value Tharisa according to the Market Approach. Since it is an operating mine the Cost Approach is not generally used (Figure 1 in the SAMVAL Code).

Coffey approached the problem by first valuing the PGM content of Tharisa Mine, and then the chrome content, using publicly available transactions.

14.11 PGM Comparative Transactions

Table 14.11_1 shows the transactions relied upon as well as the resultant value attributable to Tharisa PGM's, based on a Market Approach.

14.12 Chrome Comparative Transactions

Chromex sold its 74% interest in the Chromex mine to the Ruukki Group (Mogale Alloys) in 2010 for £37.0 million. The full consideration plus debt, less cash of this transaction was US$59.17 million as at the date of acquisition.

In 2009 AMCOL International Corporation bought Chrome Corporation's 74% of the Ruighoek chromite mine for US$26.4 million. Using these two transactions, Coffey placed a value on the chromite content of Tharisa Mine, using the Market approach. Table 14.12_1 indicates the implied value of Tharisa Mine's 828 Mt chromitite resource based on the transactions described above.

Table 14.11_1
Tharisa Mine
PGM Valuation using Market Approach

Target*	Acquirer	Date announced	% of shares acquired	EV (US$m)	Deal value (US$m)	4PGM Resources purchased (Moz)	Deal Value (US$/4PGM oz)
Northam	ENRC	26-Apr-10	12.20%	2297	300	137.1	17.94
Anooraq Resources	Anglo Platinum	2-Feb-12	100.00%	418	213	20.9	10.19
Zimbabwe Platinum Mines	Zimplats Mhondoro – Ngexi, ESOT, NIEEF	11-Jan-13	51.00%	1904	971	107.4	17.73
Mean of all							**15.28**

Tharisa Implied Valuation

Tonnes resources	4PGMg/t	Grams per Oz	Oz contained 4PGM	Multiple	Transaction value/resources valuation	
					US$m	ZARm**
835,000,000	1.15	31.1035	30,872,731	15.82	471.89	7,321.73
			Discount factor			**100%**
			Enterprise value		**471.89**	**7,322**

***Operating PGM mine sales in last 5 years**
****ZAR:US$ at spot on 31/12/2015 – 15.52**

Table 14.12_1
Tharisa Mine
Chrome Valuation using Market Approach

Target*	Acquirer	Date announced	% of shares acquired	Deal value (US$m)	Chrome resource Mt	Transaction US$/t	Target Cr_2O_3%	Tharisa Cr_2O_3%	Tharisa US$/t based on grade	Tharisa implied valuation US$M
Chromex	Ruukki Group	30-Sep-10	74.00%	59	31.7238	1.87	38.22%	20.38%	0.99	830.5
Ruighoek Chrome Project	AMCOL International Corporation	23-Feb-09	74.00%	26.4	9.47792	2.79	43.65%	20.38%	1.30	1085.9
Mean value										**958.2**

***Chrome project sales in last 5 years**

14.13 Value according to Market Approach

Based on the Market Approach the following value can thus be attributed to Tharisa as shown in Table 14.13_1.

Table 14.13_1
Tharisa Mine
Market Approach Valuation of 100% of Tharisa Mine

Transaction type	US$	ZARm
PGM comparable transaction valuation (Resources)	**472**	**7,322**
Chrome Corporation transaction valuation (Resources)	830	16,849
Chromex transaction valuation (Resources)	1086	12,885
Chrome comparable transaction valuation (Resources)	**958**	**14,867**
Low valuation	1,302	20,207
High valuation	1,558	24,170
Average	**1,430**	**22,189**

14.14 Summary

In the Valuation, a Comparative Transaction Valuation and a DCF Valuation were compared. Table 14.14_1 summarises the results of the valuations.

Table 14.14_1
Tharisa Mine
Valuations of the Tharisa Mine on 31 December 2015 (ZAR Million)

Valuation Methodology	DCF Excluding Optimisation		DCF Including Optimisation		Comparative Transaction
	Including Underground	Excluding Underground	Including Underground	Excluding Underground	
High NPV	15,947	13,178	21,355	12,655	17,229
Low NPV	6,049	6,018	7,001	5,546	14,404
Preferred NPV	**11.474**	**10,655**	**14,703**	**9,923**	**15,817**

14.15 Conclusion

Coffey prefers the Cash Flow Approach to valuating the Tharisa Mine as it is a producing mine with known production and cost parameters. Coffey prefers the DCF valuation excluding the underground production as a close proxy for exclusion of inferred mineral resources, as the inferred mineral resources have a lower level of confidence.

The Market Approach valuation is based on a combination of transactions for properties that is not very similar to the Tharisa Mine. Coffey considers that it is not a true reflection of the market price of Tharisa Mine. Table 14.15_1 are thus the values Coffey attributes to Tharisa Mine.

Table 14.15_1 Tharisa Mine Preferred Valuation of the Tharisa Mine on 31 December 2015			
Valuation Methodology	**Preferred Value ZAR million**	**High Value ZAR million**	**Low Value ZAR million**
Discounted Cashflow excluding underground production	10,655	13,547	6,018

15 RISK ANALYSIS

15.1 Introduction

The risk analysis presented here is not a formal risk assessment. Coffey prefers to highlight areas of risk and the potential impacts of that risk that would normally be expected in similar operations. The focus is on highlighting areas of risk that are of relevance to project financiers or to potential project purchasers or investors.

In this report the risk analysis determines the level of risk which is classified from minor to major, as presented in Table 15.1_1.

Table 15.1_1
Definitions of the Levels of Risk

Level of Risk	Explanation
Major Risk	The factor poses an immediate danger of a failure, which if uncorrected, will have a material effect (>15% to 20%) on the project cash flow and performance and could potentially lead to project failure.
Moderate Risk	The factor, if uncorrected, could have a significant effect (10% to 15% or 20%) on the project cash flow and performance unless mitigated by some corrective action.
Minor Risk	the factor, if uncorrected, will have little or no effect (<10%) on project cash flow and performance.

The likelihood of a risk must also be considered as is the likelihood that within a seven year period, the event may occur ans is classified as likely (will probably occur), possible (may occur) or unlikely (unlikely to occur).

The impact of a risk and its likelihood are combined into an overall risk assessment as presented in Table 15.1_2.

Table 15.1_2
Overall Risk Assessment Matrix

Likelihood of Risk (within a 7 year period)	Level of Risk		
	Minor	**Moderate**	**Major**
Likely	Medium	High	High
Possible	Low	Medium	High
Unlikely	Low	Low	Medium

15.2 Risk Summary

Based on the sections above, a summary of the perceived risks to the Tharisa Mine are presented in Table 15.2_1.

Table 15.2_1
Overall Risk Assessment Analysis

Hazard/Risk Issue	Likelihood	Consequence Rating	Overall Risk Assessment
Geology and Mineral Resources			
Significant Variance in Resource Tonnage	Unlikely	Moderate	Low
Resource Grade Variation	Unlikely	Moderate	Low
Significant Variance in Geological losses	Unlikely	Minor	Low
Western Extend of Mineral Resource	Possible	Minor	Low
Mining Engineering			
Tonnage variation	Possible	Moderate	Medium
Grade Variation	Possible	Moderate	Medium
Open Pit Mining Method	Unlikely	Minor	Low
Production Schedule	Unlikely	Moderate	Low
Highwall Collapse	Possible	Moderate	Medium
Underground Mining Method	Unlikely	Minor	Low
Negative change in Opex	Possible	Moderate	Medium
Negative change in Capex	Possible	Moderate	Medium
Metallurgy and Processing			
RoM Grade Variation – Feed to Plant	Possible	Moderate	Medium
Recoveries	Possible	Moderate	Low
Negative change in Opex	Possible	Moderate	Low
Process Technology / Complexity	Unlikely	Moderate	Low
Negative change in Capex	Unlikely	Moderate	Low
Ore response to processing	Unlikely	Minor	Low
Infrastructural			
Water Supply	Possible	Moderate to Minor	Medium to Low
Power Supply	Unlikely	Moderate	Low
Environmental*			
Potential for ground and surface water contamination	Possible	Moderate to Minor	Medium to Low
Relocation of informal settlement and related social issues	Possible	Moderate to Minor	Medium to Low
Potential for air pollution	Possible	Moderate to Minor	Medium to Low
Blasting and noise disturbance of surrounding land users	Possible	Minor	Low
Soil and biodiversity management	Possible	Minor	Low
Traffic impacts	Possible	Minor	Low
Disturbance of archaeological resources	Possible	Minor	Low
Rehabilitation and closure planning	Possible	Moderate to Minor	Medium to Low
Ongoing permitting	Unlikely	Minor	Low
TSF and waste rock dump rehabilitation	Unlikely	Low	Low
Manpower and Management			
Lack of Skills availability	Possible	Moderate	Medium
Inability to retain skills	Unlikely	Moderate	Medium
HIV	Possible	Minor	Low
Labour costs	Possible	Moderate	Medium
Disruptions to business	Possible	Moderate	Medium
Industrial action	Possible	Moderate	Medium
Safety/DMR	Possible	Moderate	Medium
Infrastructure			
Water Supply	Possible	Moderate	Medium
Power Supply	Unlikely	Moderate	Medium

* Environmental risks shown above reflects the managed scenario which assumes successful implementation of the EMP commitments

Based on the above risk summary, Coffey considers the Tharisa Mine to have an overall ***Low to Medium Risk***.

15.3 Geology and Mineral Resources

The level of technical risk is defined as the likelihood of variation of resource tonnage and/or grade from the stated values.

The geological model developed by Coffey and the application to the mineral resource estimate.

- The geological model developed presents a tabular deposit with some dykes and faults crossing the property. However smaller scale faulting (<10m throw) must be considered. No potholes have been delineated although it is considered likely that some potholing of the MG Chromitite Layers has occurred. As these Chromitite Layers are not mined extensively elsewhere, it is difficult to assess the degree of potholing or the presence of small scale faulting. The application of a 7.5% - 15% geological loss is made based on knowledge of the Bushveld Complex and is intended to represent those areas where the MG Chromitite Layer is replaced by mafic pegmatites, intersected by faults or dykes, or disrupted by potholes.

The interpretation of the position of the most westerly point where a mineral resource can be declared is subjective.

- The interpreted position is considered to represent the likely extent of the deposit that can realistically be exploited based on the current data available, the current understanding of the geology and the macro economic understanding. It is possible that this boundary could move. It is considered more likely to move westward, effectively increasing the mineral resource base.

The overall geological risk is therefore considered ***Low***.

15.4 Mining

Coffey Mining associates a ***medium risk*** rating for the mining operation due to a concern relating to the amount of dilution which may report to the RoM ore and into the processing facility. Tharisa must place special emphasis on grade control and mining the width of the ore zone with limited dilution.

Any delay in the relocation of the roads, overhead power lines and water canals in the east pit area poses a scheduling risk. Reasonable time allocations were made in the LoM schedule for these relocations. Sufficient flexibility exists in the mining plan to reschedule activities to maintain the planned build-up profile.

The planned construction of a dam from the pit void at the end of the economic life of the operation poses a risk since the required regulatory approval must still be obtained. This application is in process and it is reasonable to assume that it will be approved.

15.5 Geotechnical Engineering

Geotechnical open pit slope and underground bord and pillar designs have been carried out using a probability based design, numerical modelling and dynamic wedge analysis, developed from detailed rock mass and rock material data coupled with structural data collected, which provide for greater certainty in the geotechnical design that is at an acceptable level of confidence for a mine of this size.

Coffey associates a **Low Risk** with the geotechnical engineering.

15.6 Metallurgy and Processing

The process utilised at Tharisa Minerals are conventional crushing, milling, spiral gravity concentration and flotation. The auxiliary processes used like thickening, reagent make-up, concentrate dewatering and concentrate filtration are well known processes and poses a low operational risk.

The processing plant have been in operation as a 400,000 tpm unit since December 2012 and the process has been proven to be successful in recovering Chromite concentrate and PGM concentrate from the Middle Group (MG) Chromitite layers of the Bushveld Complex.

The main risks associated with the metallurgy and processing are the following:

- RoM feed variation

  The chromite feed grade has a significant impact on the chromite recovery and yield. Similarly the PGM recovery and concentrate grade is influenced by the PGM feed grade into the plant. From the available production data the chromite feed grade seems to be variable day to day and has been declining since the plant commissioning. This variable and possible lower than design chromite feed grade can impact negatively on the production performance of the processing facility. The variable feed grade has been identified as a medium risk due to the possible influence on the production performance.

- Chromite and PGM recovery

  From the production data the PGM recovery has been following an upward trend since the plant commissioning. This is due to projects implemented in the process plant to improve recovery as well as an increase of fresh non-oxidised ore ratio in the plant feed. The chromite recovery was fairly stable with a slight decrease from 2014 to 2015. The budget for the chromite recovery going forward indicates a steep increase of chromite recovery from 58-59% to 73-74% from 2015 to 2016. This is with similar chromite feed grade. Although a large process improvement drive is currently underway the realization of the high recoveries at a similar feed grade is identified as a medium risk.

- Opex cost increase

The Tharisa Minerals operating unit cost per feed tonne has been maintained stable between 2014 and 2015. The budget for 2016 indicates a significant increase in the total operating cost (cost including overheads). Increased operating cost can have a negative impact on the long term viability of the operation and has therefor being indicated as a medium risk.

- Other process risks

  Less significant or low process risks includes the increasing complexity of the spiral circuits as the primary recovery method used for chromite recovery. This increased circuit complexity requires detailed knowledge of the circuit and can trigger a skill shortage of operators to ensure good production performance if adequate training is not supplied.

  The process technology employed has been identified as a low risk as the process has been proven to be successfully able to treat the MG ore.

  The plant capital cost has been identified as a low risk as this is managed well and a system is in place to prioritise the capital spent to ensure the capital cost does not increase above normal requirements.

The risk review of the processing facility indicates that the risk associated with metallurgy and processing is deemed to be ***Medium Risk.***

15.7 Infrastructure

Tharisa Minerals has obtained commitments to water and power that are suitable for the operations of the mine. According to the mine water consultant, there is adequate water to take the mine up to 400,000 tpm and maintain it at steady state production. This is in agreement with the water licence and water balance, however there may be a risk of water shortages during extreme dry times. If the amendment of the water licence is approved, allowing use of agricultural water, in the risk during extreme dry seasons will be reduced and allow the mine to function as required. Tharisa Minerals has finalised the arrangements with Eskom for provision of power as required, ensuring sufficient power for steady production.

Coffey associates a **Medium to Low Risk** rating for infrastructure.

15.8 Environmental

There are a number of environmental issues material to the future of the Tharisa Mine. The more significant issues are:

- Potential for ground and surface water contamination and reduction of water resources available to surrounding users;
- Potential for air pollution;
- Blasting and noise disturbance of surrounding land users;
- Soil and biodiversity management;
- Traffic impacts;
- Disturbance of archaeological resources;
- Rehabilitation and closure planning; and
- On going permitting.

The outcome of both the 2008 and 2014 EIA/EMP processes determined that all potential impacts of the mine can be managed to a satisfactory level, provided that the management measures detailed in the EIA/EMP reports are adhered to.

Coffey is of the opinion that a ***Medium Risk*** is associated with the environmental issues based on the managed scenario which assumes successful implementation of the EMP commitments.

15.9 Manpower and Management

The mining industry has a wealth of experienced workers immediately available. However, the population of skilled professionals/workers is aging and so suitable individuals will need to be identified and recruited and where there are skills or experience gaps, suitable training programmes implemented to provide the necessary skilling.

Coffey considers that there is **Low to *Medium Risk*** in terms of the available skills and experience and of the projected productivity on the mine.

15.10 Risk Summary

Based on the sections above, a summary of the perceived risks to the Tharisa Mine are presented in Table 15.10_1.

Table 15.10_1
Tharisa Mine Technical Risk Summary

Item	Relative Risk
Geology and Mineral Resources	Low
Mining Engineering and Mineral Reserves	Low to Medium
Geotechnical Engineering	Low
Metallurgy and Processing	Medium
Infrastructure	Low to Medium
Environmental	Medium
Manpower and Management	Low to Medium

Based on the above risk summary, Coffey considers the Tharisa Mine to have an overall ***Low to Medium Risk*****.**

16 GLOSSARY OF DEFINITIONS AND TECHNICAL TERMS

Term	Description
Au	Chemical symbol for Gold
Ir	Chemical symbol for Iridium
Os	Chemical symbol for Osmium
Pd	Chemical symbol for Palladium
Pt	Chemical symbol for Platinum
Rh	Chemical symbol for Rhodium
Ru	Chemical symbol for Ruthenium
3PGE+Au	Pt, Pd, Rh and Au
4E	Pt, Pd, Rh and Au
5PGE+Au	Pt, Pd, Rh, Ru, Ir and Au
6PGE+Au	Pt, Pd, Rh, Ru, Ir, Os and Au
7E	Pt, Pd, Rh, Ru, Ir, Os and Au
aeromagnetic survey	A geophysical survey method to measure the strength of the earth magnetic field using a magnetometer aboard or towed behind an aircraft.
AIDS	Acquired immune deficiency syndrome or acquired immunodeficiency syndrome (AIDS) is a disease of the human immune system caused by the human immunodeficiency virus (HIV)
anorthosite	A rock comprised of largely feldspar minerals and minor mafic iron-magnesium minerals
Arxo	Arxo Logistics (Pty) Ltd, a company registered and incorporated in South Africa. Arxo is the appointed logistics contractor for the Tharisa Mine.
Bushveld Complex	A major intrusive igneous body in the northern part of South Africa, that has undergone remarkable magmatic differentiation. It is by far the largest layered intrusion known. The Bushveld Complex is a leading source of chromium and PGMs.
Chromitite	A rock composed essentially of chromite, that typically occurs as layers or irregular masses exclusively associated with magmatic complexes. The bulk of the world's exploitable chromitite occurs almost exclusively in layered complexes.
Chromitite layers	Thick accumulations of chromite grains to form almost monomineralic bands or layers. Chromitite Layers are typically greater than 30cm thick..
chromium	The element chromium (Cr) is classified as a metal and is situated between other metals such as vanadium (V), manganese (Mn) and molybdenum (Mo) in the Periodic Chart of Elements.
Chromite	a hard, black, refractory chromium-spinel mineral consisting of varying proportions of the oxides of iron chromium, aluminium and magnesium.
Chrome mass yield	Chrome mass yield is calculated by dividing the chrome concentrate tonnes by the total feed tonnes and expressed as a percentage
Coffey	Coffey Mining SA (Pty) Ltd, a company registered and incorporated in South Africa.
Composite	A weighted accumulation of the intersection value to a specific length or over a specific stratigraphic unit
CPI	Consumer Price Index
MER	Mineral Expert Report
Critical Zone	A stratigraphic zone within the Bushveld Complex where a wide variety of different igneous rock types occur which host the bulk of the significant PGM and chrome mineralization i.e. Merensky Reef and UG2 Chromitite Layer.
DME	Department of Minerals and Energy – in 2009 the DME was split into the Department of Mineral Resources (DMR) and the Department of Energy (DoE)
DMR	Department of Mineral Resources
DTM	Digital Terrain Model
dyke	A wall-like body of igneous rock that is intruded (usually vertically) into the surrounding rock in such a way that it cuts across the stratification (layering) of this rock.

Term	Description
DWA	Department of Water Affairs
Eskom	South African electrical utility company
fault	A fractured surface in the earth's crust along which rocks have moved relative to each other.
Feasibility Study	The original feasibility study conducted by Coffey on the Tharisa Mine, which was concluded in October 2008
EIA	Environmental Impact Assessment
EMP	Environmental Management Programme
EPCM	Engineering, Procurement and Construction Management
FOB	Free on board
GATT	General Agreement on Tariffs and Trade
GDP	Gross Domestic Product
geostatistics	A branch of statistics focusing on the understanding of spatial data
GPS	Global Positioning system
HDSA	Historically Disadvantaged South Africans
highwall	The unexcavated face of exposed overburden of an opencast mine
HIV	Human immunodeficiency virus
IAPs	Interested and Affected Parties
ICP Fusion D/OES	Analytical technique to measure the concentration of trace elements
Indicated Mineral Resource (SAMREC)	An 'Indicated Mineral Resource' is that part of a Mineral Resource for which tonnage, densities, shape, physical characteristics, grade and mineral content can be estimated with a reasonable level of confidence. It is based on information from exploration, sampling and testing of material gathered from locations such as outcrops, trenches, pits, workings and drill holes. The locations are too widely or inappropriately spaced to confirm geological or grade continuity but are spaced closely enough for continuity to be assumed.
Inferred Mineral Resource (SAMREC)	An 'Inferred Mineral Resource' is that part of a Mineral Resource for which volume or tonnage, grade and mineral content can be estimated with only a low level of confidence. It is inferred from geological evidence and sampling and assumed but not verified geologically or through analysis of grade continuity. It is based on information gathered through appropriate techniques from locations such as outcrops, trenches, pits, workings and drill holes that may be limited in scope or of uncertain quality and reliability.
IRUP	Iron-Rich Ultramafic Pegmatite – a type of rock which typically intruded into the Rustenburg Layered Suite of the Bushveld Complex, generally after the main mineralized layers were formed. IRUPs can replace the normal stratigraphic sequence over extensive areas, and can have a greater or lesser effect on the mineralized layers. They occur as pipes, dykes and sheets.
JSE	Johannesburg Stock Exchange South Africa. JSE Limited, a licensed exchange under the Securities Services Act, 2004
Farm 342JQ	The Farm 342JQ, registration division JQ, located in the Bojanala Municipal District in the North West Province, South Africa.
LG Chromitite Layer	Lower Group Chromitite Layer
LSE	London Stock Exchange
Lower Zone	Stratigraphic unit of the Bushveld Complex
mafic pegmatites	a suite of coarse-grained rocks that form discordant bodies within the layered sequence of the Bushveld Complex.
mamsl	metres above mean sea level
MCC	MCC (Pty) Ltd, a company registered and incorporated in South Africa. MCC is the appointed open pit mining contractor at the Tharisa Mine.
MDM Engineering	MDM Engineering (Pty) Ltd, a company registered and incorporated in South Africa. MDM is the appointed engineering contractor responsible for the construction of the new 300,000 tonne per month concentrator at the Tharisa Mine.

Term	Description
Measured Mineral Resource (SAMREC)	A 'Measured Mineral Resource' is that part of a Mineral Resource for which tonnage, densities, shape, physical characteristics, grade and mineral content can be estimated with a high level of confidence. It is based on detailed and reliable information from exploration, sampling and testing of material from locations such as outcrops, trenches, pits, workings and drill holes. The locations are spaced closely enough to confirm geological and grade continuity.
Metago	Metago Environmental Engineers (Pty) Ltd (now trading as SLR Consulting (Africa) (Proprietary) Limited), a company registered and incorporated in South Africa.
Merensky Reef	A pyroxenitic tabular layer or band within the Bushveld Complex containing economic concentrations of PGMs. The Merensky Reef is one of the principle PGM ore bodies within the Bushveld Complex and is mined extensively.
MG	Middle Group with reference to MG Chromitite Layers
MG Chromitite Layers	Group of five chromitite layers that are known in the lower and upper Critical Zone of the Bushveld Complex
MG0 Chromitite Layer	Specific chromitite layer contained within the MG Chromitite Layer package
MG1 Chromitite Layer	Specific chromitite layer contained within the MG Chromitite Layer package
MG2 Chromitite Layer	Specific chromitite layer contained within the MG Chromitite Layer package
MG3 Chromitite Layer	Specific chromitite layer contained within the MG Chromitite Layer package
MG4 Chromitite Layer	Specific chromitite layer contained within the MG Chromitite Layer package
MG4A Chromitite Layer	Specific chromitite layer contained within the MG Chromitite Layer package
MHSA	Mine Health and Safety Act, Act 29 of 1996
Mineral Expert Report	A Mineral Expert Report (MER) is a Techno-Economic Report. It represents the opinions on a deposit of a registered professional, independent of the client and its subsidiaries. By reason of his/her education, professional associations and past relevant work experience, the person is deemed as qualified to form an opinion of the deposit.
Mineral Reserve (SAMREC)	A 'Mineral Reserve' is the economically mineable material derived from a Measured or Indicated Mineral Resource or both. It includes diluting and contaminating materials and allows for losses that are expected to occur when the material is mined. Appropriate assessments to a minimum of a Pre-Feasibility Study for a project and a Life of Mine Plan for an operation must have been completed, including consideration of, and modification by, realistically assumed mining, metallurgical, economic, marketing, legal, environmental, social and governmental factors (the modifying factors). Such modifying factors must be disclosed.
Mineral Resources (SAMREC)	A 'Mineral Resource' is a concentration or occurrence of material of economic interest in or on the earth's crust in such form, quality and quantity that there are reasonable and realistic prospects for eventual economic extraction. The location, quantity, grade, continuity and other geological characteristics of a Mineral Resource are known, or estimated from specific geological evidence, sampling and knowledge interpreted from an appropriately constrained and portrayed geological model. Mineral Resources are subdivided, and must be so reported, in order of increasing confidence in respect of geoscientific evidence, into Inferred, Indicated or Measured categories
Mining Right	A mining right is the permission granted by the State through the Department of Mineral Resources which gives you the authority to mine minerals within a certain area. A mining right may not exceed a period of 30 years.
MPRDA	The Mineral and Petroleum Resources Development Act 28 of 2002 of South Africa
MRMR	mining rock mass rating system
Mt	million tonnes
MVA	megavolt – ampere – a measure of required electrical power
NiS/MS	Specialist analytical technique used to determine the concentration of PGMs
norite	A coarse-grained, basic igneous rock consisting of essential plagioclase feldspar, orthopyroxene (hypersthene or bronzite), and clinopyroxene (augite), often with accessory ilmenite.
oz	fine ounce or troy ounce (31.1035g), used as a measure for the mass of precious metals
PGM	Platinum Group Metals, being platinum, palladium, rhodium, ruthenium, iridium, osmium, and, for the purposes of this report and in accordance with industry practice, gold.
pillar	Natural underground support system using unmined parts of the ore body

Term	Description
potholes	A geological feature frequently occurring in the Bushveld Complex in which one layer of the Bushveld Complex transgresses its footwall and forms a basin-shaped depression.
Pr.Sci.Nat.	Professional Natural Scientist in accordance with the rules of the South African Council for Natural Scientific Professionals which identifies him/her as a highly skilled professional with technical knowledge and competence.
Probable Mineral Reserve (SAMREC)	A 'Probable Mineral Reserve' is the economically mineable material derived from a Measured or Indicated Mineral Resource or both. It is estimated with a lower level of confidence than a Proved Mineral Reserve. It includes diluting and contaminating materials and allows for losses that are expected to occur when the material is mined. Appropriate assessments to a minimum of a Pre-Feasibility Study for a project or a Life of Mine Plan for an operation must have been carried out, including consideration of, and modification by, realistically assumed mining, metallurgical, economic, marketing, legal, environmental, social and governmental factors. Such modifying factors must be disclosed.
Prospecting Right	A prospecting right is a permit which allows a company or an individual to survey or investigate an area of land for the purpose of identifying an actual or probable mineral deposit.
Proved Mineral Reserve (SAMREC)	A 'Proved Mineral Reserve' is the economically mineable material derived from a Measured Mineral Resource. It is estimated with a high level of confidence. It includes diluting and contaminating materials and allows for losses that are expected to occur when the material is mined. Appropriate assessments to a minimum of a Pre-Feasibility Study for a project or a Life of Mine Plan for an operation must have been carried out, including consideration of, and modification by, realistically assumed mining, metallurgical, economic, marketing, legal, environmental, social and governmental factors. Such modifying factors must be disclosed.
Pyroxenite	refers to a relatively uncommon dark-coloured rock consisting chiefly of pyroxene; pyroxene is a type of rock containing sodium, calcium, magnesium, iron, titanium and 215luminium combined with oxygen.
QA/QC programme	A programme of testing, used particularly for assays, to assist to confirm that the data used in a mineral resource estimation is reliable and comparable
RMR	The rock mass rating (RMR) system is a geomechanical classification system for rocks, developed by Z. T. Bieniawski between 1972 and 1973.[1]
RoM	Run of Mine
Rooikoppies 297JQ	The farm Rooikoppies 297, registration division JQ, located in the Bojanala Municipal District in the North West Province, South Africa.
Royalty Act	Mineral and Petroleum Resources Royalty Act, Act 28 of 2008.
RQD	Rock quality designation which is a description using geotechnical engineering principles which that determines the quality of rock that was recovered when taking a core sample.
SAG mill	Semi autogenous grinding mill
SAMREC	The South African Code for the Reporting of Exploration Results, Mineral Resources And Mineral Reserves (The SAMREC Code) (2007 Edition as amended July 2009) (prepared by The South African Mineral Resource Committee (SAMREC) Working Group)
Sponsor	Macquarie Capital Securities Limited
tailings	that portion of the ore from which most of the valuable material has been removed by concentration and which is therefore low in value and rejected.
Tharisa	Tharisa plc formerly Tharisa Limited, a company registered and incorporated in the Republic of Cyprus.
Tharisa Mine	The existing chrome and PGM mine and processing operations, owned by Tharisa Minerals, located in the Bushveld Complex, which is situated in the Magisterial District of Rustenburg, North West Province, South Africa
Tharisa Minerals	Tharisa Minerals (Pty) Ltd, a company registered and incorporated in the Republic of South Africa, the developer and operator of the Tharisa Mine, held 74% by Tharisa.
The Company	Tharisa plc, formerly Tharisa Limited, a company registered and incorporated in the Republic of Cyprus.
tpa	tonnes per annum
tph	tonnes per hour
tpm	tonnes per month
TSF	Tailings Storage Facility

Term	Description
UCS	Uniaxial Compressive strength
UG2 Chromitite Layer	Upper Group 2 Chromitite Layer of the Bushveld Complex that is well known and typically contains PGMs in a concentration that is sufficient for economic extraction
Uniaxial Compressive Strength	Measure of the capacity of a material to withstand pushing forces
Ukwazi	Ukwazi Mining Solutions (Pty) Ltd, a company registered and incorporated in South Africa.Ukwazi is the appointed mine design and scheduling contractor at the Tharisa Mine.
US$	United States Dollar (currency)
variogram	The variogram is the key mathematical and graphical function in geostatistics as it is used to describe or fit a model of the spatial correlation of the observed phenomenon.
VAT	Value added tax
WTO	World Trade Organisation
ZAR	South African Rand (currency)

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18 DATE AND SIGNATURE PAGE

This report titled Independent Mineral Expert Report entitled "**Tharisa Chrome and PGM Mine, South Africa Mineral Expert Report"** with an effective date of 31 December 2015 was prepared on behalf of Tharisa plc by Kenneth Lomberg, who takes overall responsibility for this report.

I have some 28 years experience in the minerals industry (especially platinum and gold). I have been involved in exploration and mine geology and have had the privilege of assisting in bringing a mine to full production. My expertise is especially in project management, mineral reserve and resource estimation.

I have undertaken mineral resource and reserve estimations and reviews for platinum, gold, copper, uranium and fluorite projects. I have assisted with the reviews or estimation of diamond and coal projects and assisted or compiled Competent Persons Reports/NI 43-101 for various projects that have been listed on the TSX, JSE and AIM stock exchanges

I am also Chairman of the SAMREC Working Group which is responsible for the SAMREC Code and I represent SAMREC on the CRIRSCO Executive.

I have practiced my profession continuously since 1985. I have over 5 years of relevant experience having completed mineral resource estimations on various properties located on the Bushveld Complex hosting Magmatic Layered Intrusive style mineralization.

I consider the Executive Summary to be a true reflection of this Competent Persons Report.

Dated at Johannesburg, this 31 December 2015

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Mr Kenneth Lomberg
Senior Principal
B.Sc. (Hons) Geology, B.Com., M.Eng.
(Pr.Sci.Nat. Membership No (400038/1))
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The Competent Valuator for the purposes of this report is Johannes Jurgens Bornman. He is a registered Professional Engineer (Pr.Eng.) in terms of the Engineering Profession Act, 46 of 2000 (:the EPA") and is a “Competent Valuator” as defined in the SAMVAL Code 2008 as amended July 2009. He is also a Fellow of the SAIMM. He has 30 years’ experience in hard and soft rock mining with more than 9 years experience in the valuation of platinum, chrome, gold, copper, coal, diamond, bauxite and uranium mines.

All the facts presented in this report are correct to the best knowledge of the Competent Valuator. This is a forward looking document and the analyses and conclusions are limited only by the reported forecasts and conditions. Neither Coffey, nor the Competent Valuator, has any material interest in Tharisa Mine, its Parent Companies, subsidiaries or projects. The work, and any other work done by the Competent Valuator for Tharisa, is strictly in return for professional fees. Payment for the work is not in any way dependent on the outcome of the work or on the success or otherwise of Tharisa’s own business dealings. As such there is no conflict of interest in the Competent Valuator undertaking the independent mine valuation as contained in this document.

Johannes Jurgens Bornman is a full-time employee of Coffey and has sufficient experience which is relevant to the style of mineralization and type of mining under consideration and to the valuation which he is undertaking to qualify as a Competent Valuator as defined in the South African Code for the Reporting of Mineral Asset Valuation (The SAMVAL Code) of 2008 as amended July 2009. Hannes Bornman has visited the property under valuation and consents to the inclusion in the report of the matters based on his information in the form and context in which it appears.

I consider the Executive Summary to be a true reflection of this Competent Valuator’s Report.

Dated at Johannesburg, this 31 December 2015.

____

Mr Johannes Jurgens Bornman

Principal Mining Engineer

B.Eng., MBA

(Pr.Eng. Membership No 20090201)

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