

Mineral resources and mineral reserves cont.

Free State operations

Geology

Harmony's Free State operations are located on the south-western corner of the Witwatersrand Basin, between the towns of Allanridge, Welkom, Theunissen and Virginia. The basin, situated on the Kaapvaal Craton, has been filled by a 6-kilometre thick succession of sedimentary rocks, which extends laterally for hundreds of kilometres.

The Free State goldfield is divided into two sections, cut by the north-south striking De Bron Fault. This major structure has a vertical displacement of about 1 500 metres in the region of Bambanani, as well as a lateral shift of 4 kilometres. This lateral shift can allow a reconstruction of the orebodies of Unisel to the west of the De Bron Fault and Merriespruit to the east. A number of other major faults (Stuirmanspan, Dagbreek, Arrarat and Eureka) lie parallel to the De Bron Fault.

To the west of the De Bron, the mines and shafts currently in operation are Target, Tshepong, Phakisa, Nyala, Unisel, Bambanani and Joel. Dips are mostly towards the east, averaging 30 degrees but become steeper as they approach the De Bron Fault. To the east of the fault lie Merriespruit 1 and Masimong. These mostly dip towards the west at 20 degrees, although Masimong is structurally complex and dips of up to 40 degrees have been measured. Between these two blocks lies the uplifted horst block of West Rand Group sediments with no reef preserved.

The western margin area is bound by synclines and reverse thrust faults and is structurally complex. Towards the south and east, reefs sub-crop against overlying strata, eventually cutting out against the Karoo to the east of the lease area.

Most of the mineral resource tends to be concentrated in reef bands located on one or two distinct unconformities. A smaller portion of the mineral resource is located on other unconformities. Mining that has taken place is mostly deep-level underground mining, exploiting the narrow, generally shallow dipping tabular reefs.

The Basal Reef is the most common reef horizon and is mined at all shafts except Target and Joel. It varies from a single pebble lag to channels of more than 2 metres thick. It is commonly overlain by shale, which thickens northwards. Tshepong has resorted to undercutting of its mining panels to reduce the effect of shale dilution.

The second major reef is the Leader Reef, located 15-20 metres above the Basal Reef. This is mined mostly at shafts to the south – Unisel and Merriespruit 1. Further north, it becomes poorly developed with erratic grades. The reef consists of multiple conglomerate units, separated by thin quartzitic zones, often up to 4 metres thick. A selected mining cut on the most economic horizon is often undertaken.

The B Reef is a highly channelised orebody located 140 metres stratigraphically above the Basal Reef. Because of its erratic nature, it is only mined at Masimong and Tshepong. Within the channels, grades are excellent, but this reduces to nothing outside of the channels. Consequently, both shafts have undertaken extensive exploration to locate these pay channels.

The A Reef is also a highly channelised reef, located some 40 metres above the B Reef. This is currently only mined at Harmony 2 and Brand, although an extensive channel lies along the western margin from Nyala to Lorraine. It consists of multiple conglomerate bands of up to 4 metres thick and a selected mining cut is usually required to optimise the orebody.

Joel Mine, located 30 kilometres south of Welkom, is the only Harmony Free State operation to mine the Beatrix Reef. This varies from a single-pebble lag to a multiple conglomerate, often showing mixing of the reef with some of the overlying lower grade VS5 (mixed pebble conglomerate) material. None of the other reefs are present this far south, having sub-cropped against the Beatrix Reef.

The Target operations are located at the northern extent of the Free State goldfields, some 20 kilometres north of Welkom. The reefs currently exploited are the Elsburg-Dreyerskuil conglomerates, which form a wedge-shaped stacked package, comprising 35 separate reef horizons, often separated by quartzite beds. The Elsburg Reefs are truncated by an unconformity surface at the base of the overlying Dreyerskuil Member. Below the sub-crop, the Elsburg dips steeply to the east, with dips becoming progressively shallower down dip. Close to the sub-outcrop,

the thickness of the intervening quartzites reduces, resulting in the Elsburg Reefs coalescing to form composite reef packages that are exploited by massive mining techniques at the Target mine. The Dreyerskuil also consists of stacked reefs dipping shallowly to the east. These reefs tend to be less numerous, but more laterally extensive than the underlying Elsburg Reefs.

Gold – Mineral resources

Operations	Measured				Indicated				Inferred				Total			
	Tonnes		Gold	Gold	Tonnes		Gold	Gold	Tonnes		Gold	Gold	Tonnes		Gold	Gold
	(Mt)	g/t	(000 kg)	(000 oz)	(Mt)	g/t	(000 kg)	(000 oz)	(Mt)	g/t	(000 kg)	(000 oz)	(Mt)	g/t	(000 kg)	(000 oz)
Underground																
Bambanani																
Bambanani	11.7	11.47	134	4 318	3.2	9.75	31	1 009	1.0	10.67	11	356	15.9	11.07	176	5 683
Steyn 2	3.2	11.49	37	1 190	0.7	12.04	8	272	0.9	10.01	9	284	4.8	11.30	54	1 746
Total	14.9	11.47	171	5 508	3.9	10.16	39	1 281	1.9	10.37	20	640	20.7	11.12	230	7 429
Joel	5.0	6.85	34	1 096	5.5	7.27	40	1 276	12.5	6.06	76	2 439	23.0	6.52	149	4 811
Masimong 5	11.1	7.68	85	2 732	6.0	7.09	43	1 371	79.7	5.89	469	15 073	96.8	6.17	597	19 176
Phakisa	4.6	7.06	33	1 052	25.7	10.90	279	8 986	60.7	6.69	407	13 074	91.0	7.90	719	23 112
Target																
Target 1	5.4	10.11	55	1 770	14.4	7.37	106	3 411	5.1	6.32	32	1 038	24.9	7.75	193	6 219
Target 3	7.1	9.83	70	2 240	10.1	8.67	88	2 827	5.5	6.85	38	1 210	22.7	8.59	196	6 277
Total	12.5	9.95	125	4 010	24.5	7.91	194	6 238	10.6	6.59	70	2 248	47.6	8.15	389	12 496
Tshepong	12.8	11.00	141	4 527	12.5	10.90	136	4 371	11.3	9.55	108	3 473	36.6	10.52	385	12 371
Virginia																
Merriespruit 1	8.1	5.47	44	1 417	3.3	4.21	14	444	35.4	3.88	137	4 410	46.8	4.18	195	6 271
Unisel	9.8	5.82	57	1 828	9.4	5.29	50	1 604	17.3	5.39	93	3 001	36.5	5.48	200	6 433
Total	17.9	5.66	101	3 245	12.7	5.01	64	2 048	52.7	4.37	230	7 411	83.3	4.75	395	12 704
Total Free State																
Underground	78.8	8.75	690	22 170	90.8	8.76	795	25 571	229.4	6.01	1 380	44 358	399.0	7.18	2 864	92 099
Surface																
Free State Surface																
Phoenix	–	–	–	–	92.4	0.30	28	899	1.2	0.22	0	9	93.6	0.30	28	908
St Helena	–	–	–	–	288.5	0.25	72	2 319	–	–	–	–	288.5	0.25	72	2 319
Waste rock dumps	–	–	–	–	9.0	0.56	5	162	22.0	0.49	11	345	31.0	0.51	16	507
Slimes dams	–	–	–	–	582.0	0.22	129	4 135	183.6	0.21	38	1,220	765.6	0.22	167	5 355
Total Free State																
Surface	–	–	–	–	971.9	0.24	234	7 515	206.8	0.24	49	1 574	1 178.7	0.24	283	9 089
Grand total	78.8	–	690	22 170	1 062.7	–	1 029	33 086	436.2	–	1 429	45 932	1 577.7	–	3 147	101 188

Mineral resources and mineral reserves cont.

Free State operations cont.

Uranium – Mineral resources

Operations	Measured				Indicated				Inferred				Total			
	Tonnes (Mt)	U ₃ O ₈ (kg/t)	U ₃ O ₈ (Mkg)	U ₃ O ₈ (Mlb)	Tonnes (Mt)	U ₃ O ₈ (kg/t)	U ₃ O ₈ (Mkg)	U ₃ O ₈ (Mlb)	Tonnes (Mt)	U ₃ O ₈ (kg/t)	U ₃ O ₈ (Mkg)	U ₃ O ₈ (Mlb)	Tonnes (Mt)	U ₃ O ₈ (kg/t)	U ₃ O ₈ (Mkg)	U ₃ O ₈ (Mlb)
Underground																
Masimong 5	9.7	0.28	3	6	10.7	0.28	3	7	76.7	0.24	18	40	97.1	0.25	24	53
Phakisa	0.5	0.16	0	0	22.2	0.20	4	10	12.7	0.20	2	5	35.4	0.20	6	15
Tshepong	0.3	0.21	0	0	3.5	0.20	1	2	33.3	0.16	5	12	37.1	0.16	6	14
Total Free State Underground	10.5	0.28	3	6	36.4	0.22	8	19	122.7	0.21	25	57	169.6	0.22	36	82
Surface	0.0	0.00	–	0	159.9	0.11	17	38	13.5	0.34	5	10	173.4	0.12	22	48
Total Free State Surface	0.0	0.00	–	0	159.9	0.11	17	38	13.5	0.34	5	10	173.4	0.12	22	48
Grand total	10.5	0.28	3	6	196.3	0.13	25	56	136.2	0.22	30	67	343	0.17	58	130

Modifying factors

Operations	MCF (%)	SW (cm)	MW (cm)	PRF (%)
Bambanani	82	187	206	96
Steyn 2	81	142	173	96
Joel	88	150	176	95
Masimong 5	68	135	156	96
Phakisa	82	106	127	96
Target 3	76	100	119	96
Tshepong	66	105	130	96
Merriespruit 1	68	173	214	94
Unisel	76	186	203	95

MCF = Mine call factor

MW = Milling width

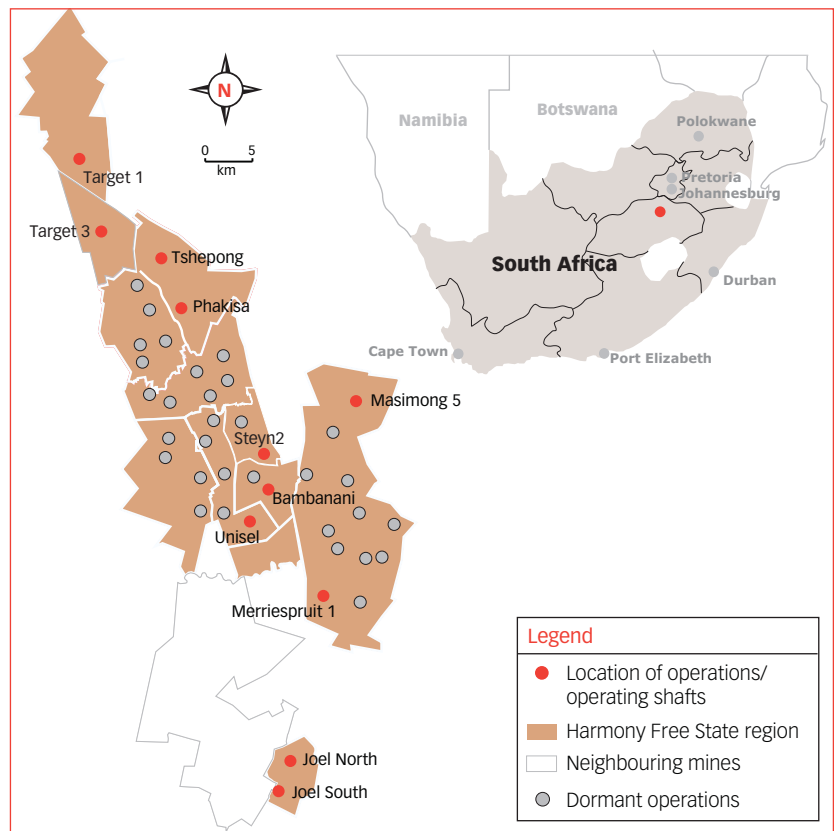
SW = Stopping width

PRF = Plant recovery factor

Operations	MCF (%)	PRF (%)
Target 1	100	96
Free State (Phoenix)	100	55
Free State (St Helena)	100	55
Free State (Other)	100	55

MCF = Mine call factor

PRF = Plant recovery factor



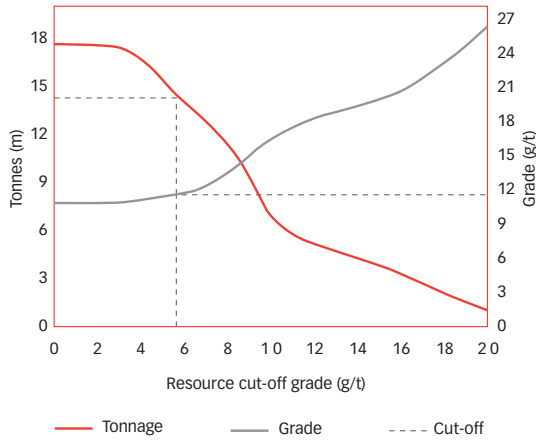
Gold – Mineral reserves

Operations	Proved				Probable				Total			
	Tonnes (Mt)	g/t	Gold (000 kg)	Gold (000 oz)	Tonnes (Mt)	g/t	Gold (000 kg)	Gold (000 oz)	Tonnes (Mt)	g/t	Gold (000 kg)	Gold (000 oz)
Underground												
Bambanani												
Bambanani	3.9	10.41	40	1 301	–	–	–	–	3.9	10.41	40	1 301
Steyn 2	0.5	7.26	3	105	0.1	6.95	1	25	0.6	7.20	4	130
Total	4.4	10.08	43	1 406	0.1	6.95	1	25	4.5	10.00	44	1 431
Joel	1.2	6.25	7	240	1.5	5.61	8	264	2.7	5.90	15	504
Masimong 5	5.4	5.11	28	894	1.9	5.09	10	306	7.3	5.10	38	1 200
Phakisa	0.6	4.65	3	94	19.4	8.13	158	5 065	20.0	8.02	161	5 159
Target												
Target 1	4.0	5.50	22	702	7.6	4.49	34	1 104	11.6	4.84	56	1 806
Target 3	1.0	7.59	8	252	3.6	6.33	23	743	4.6	6.61	31	995
Total	5.0	5.93	30	954	11.2	5.08	57	1 847	16.2	5.34	87	2 801
Tshepong	13.1	5.33	70	2 247	9.4	5.36	51	1 626	22.5	5.34	121	3 873
Virginia												
Merriespruit 1	0.4	4.01	2	58	0.1	3.55	0	9	0.5	3.94	2	67
Unisel	2.3	4.71	11	349	1.4	4.67	7	214	3.7	4.70	18	563
Total	2.7	4.60	13	407	1.5	4.62	7	223	4.2	4.60	20	630
Total Free State Underground	32.4	5.98	194	6 242	45	6.46	292	9 356	77.4	6.26	486	15 598
Surface												
Free State Surface												
Phoenix	–	–	–	–	92.4	0.30	28	899	92.4	0.30	28	899
St Helena	–	–	–	–	288.5	0.25	72	2 319	288.5	0.25	72	2 319
Waste rock dumps	–	–	–	–	5.1	0.61	3	99	5.1	0.61	3	99
Slimes dams	–	–	–	–	540.5	0.22	121	3 895	540.5	0.22	121	3 895
Total Free State Surface	–	–	–	–	926.5	0.24	224	7 212	926.5	0.24	224	7 212
Grand total	32.4	–	194	6 242	971.5	–	516	16 568	1 003.90	–	710	22 810

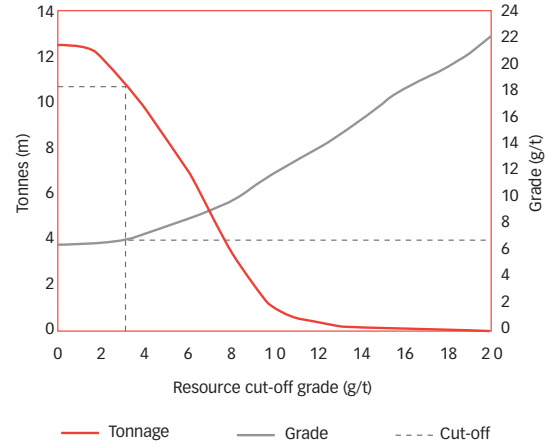
Mineral resources and mineral reserves cont.

Free State operations cont.

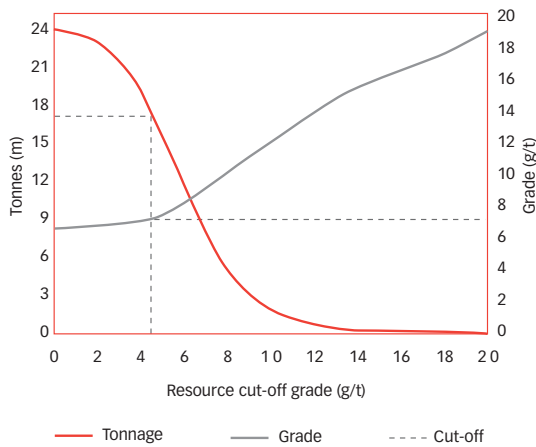
Bambanani: Grade tonnage curve (excl Steyn 2)
(measured and indicated resources)



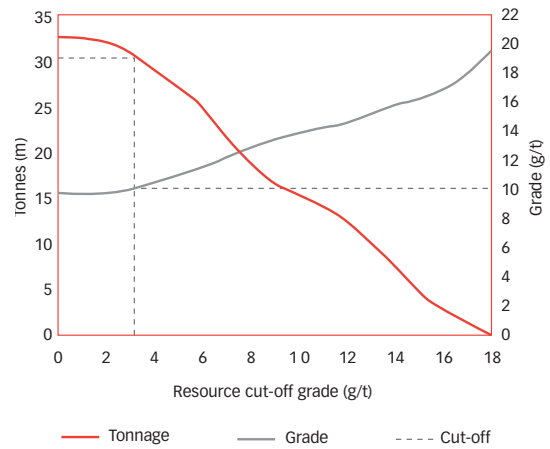
Joel: Grade tonnage curve
(measured and indicated resources)



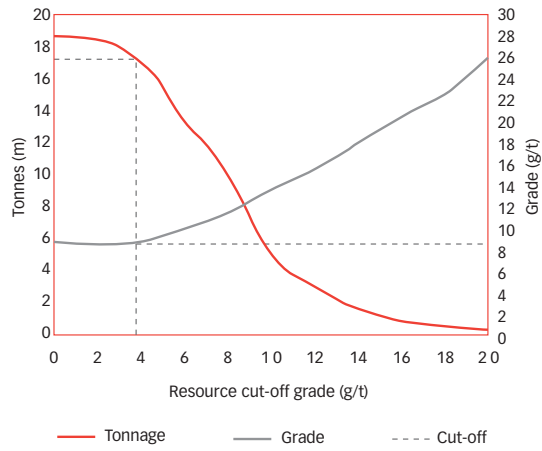
Masimong: Grade tonnage curve
(measured and indicated resources)



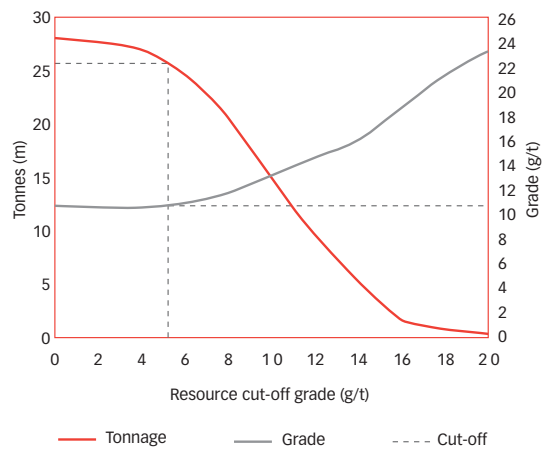
Phakisa: Grade tonnage curve
(measured and indicated resources)



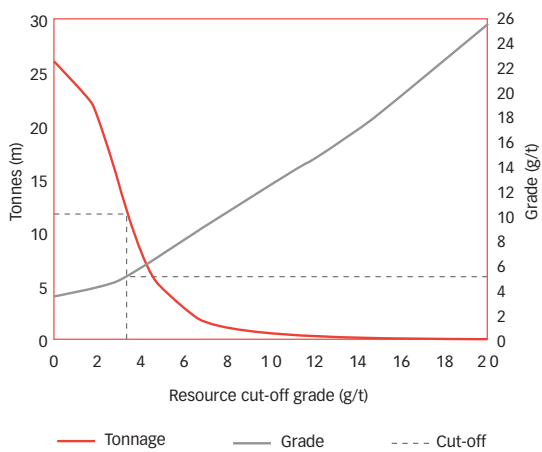
Target: Grade tonnage curve (excl Target 3)
(measured and indicated resources)



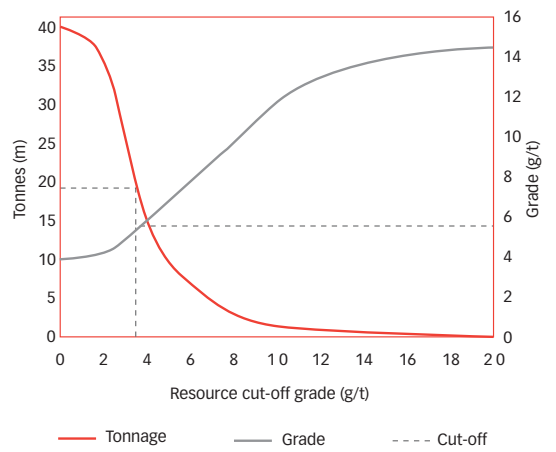
Tshepong: Grade tonnage curve
(measured and indicated resources)



Merriespruit: Grade tonnage curve
(measured and indicated resources)



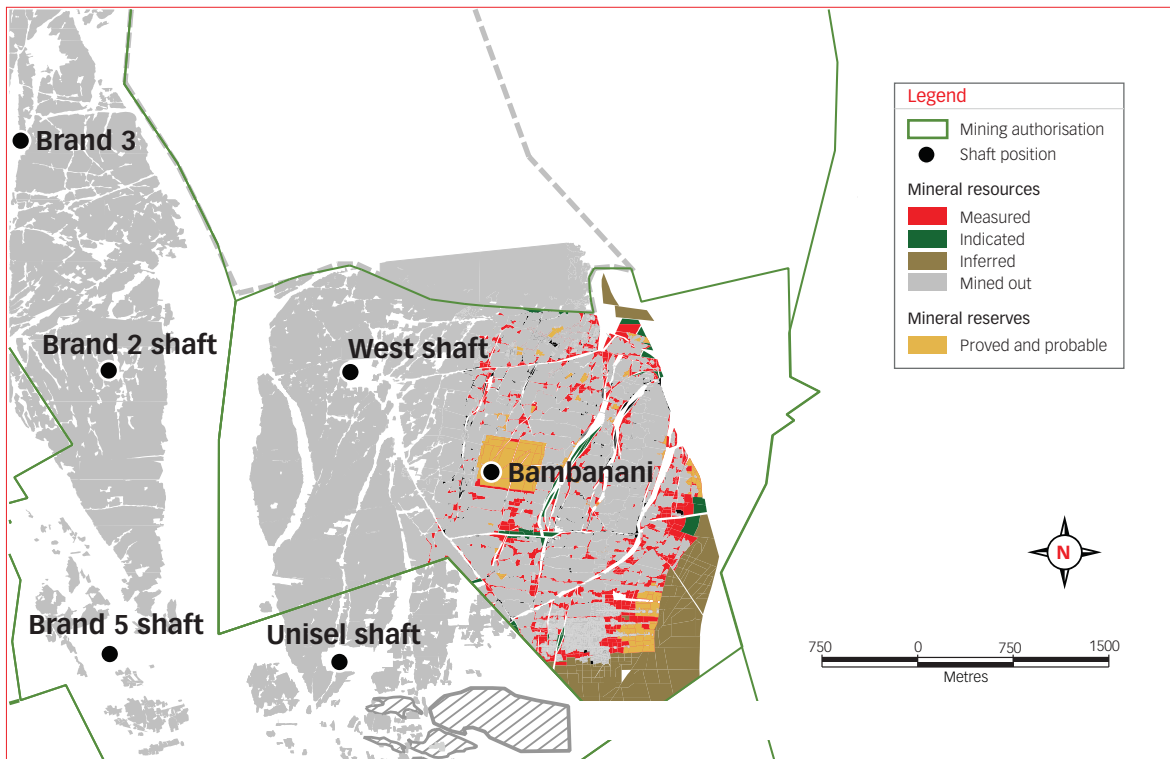
Unisel: Grade tonnage curve
(measured and indicated resources)



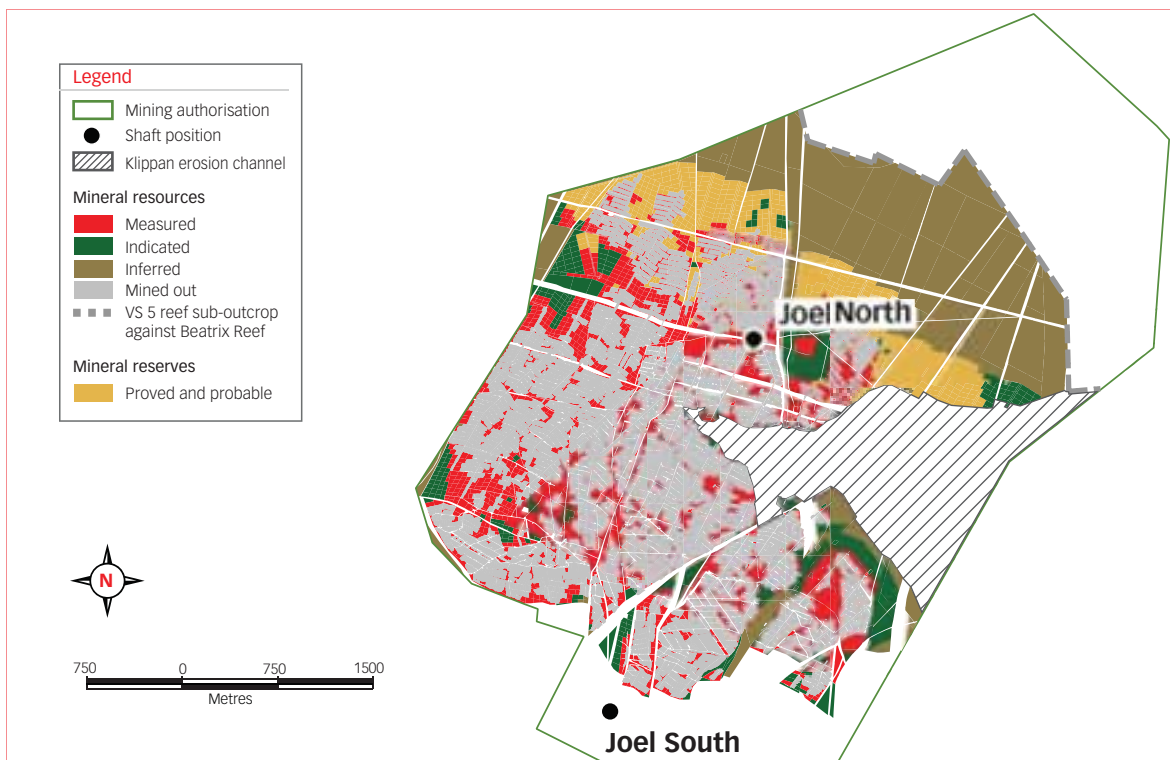
Mineral resources and mineral reserves cont.

Free State operations cont.

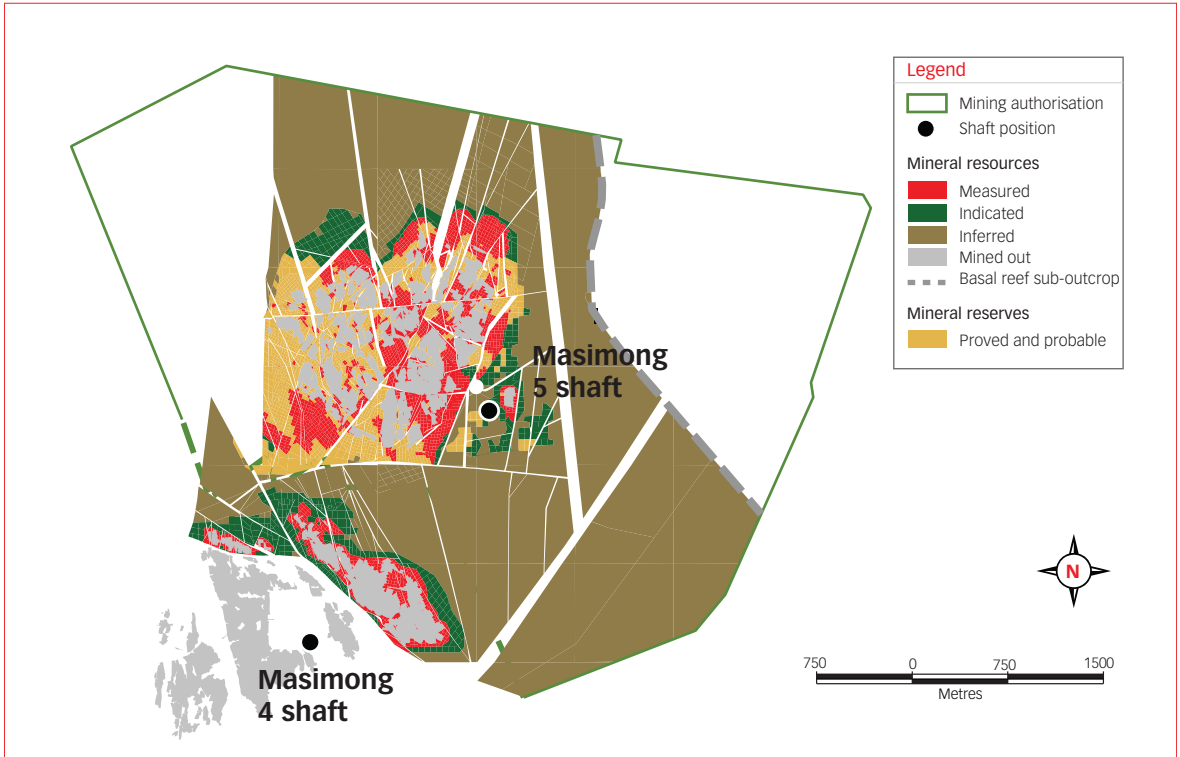
Bambanani – Basal reef



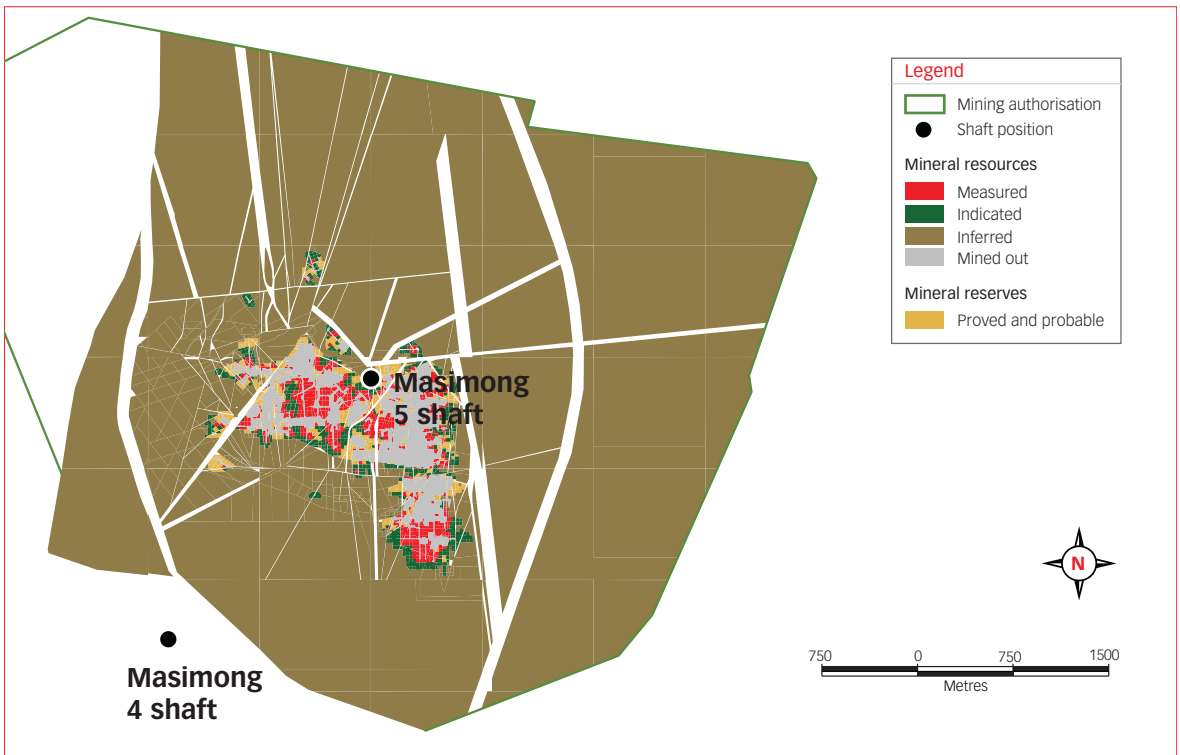
Joel mine – Beatrix reef



Masimong mine – Basal reef



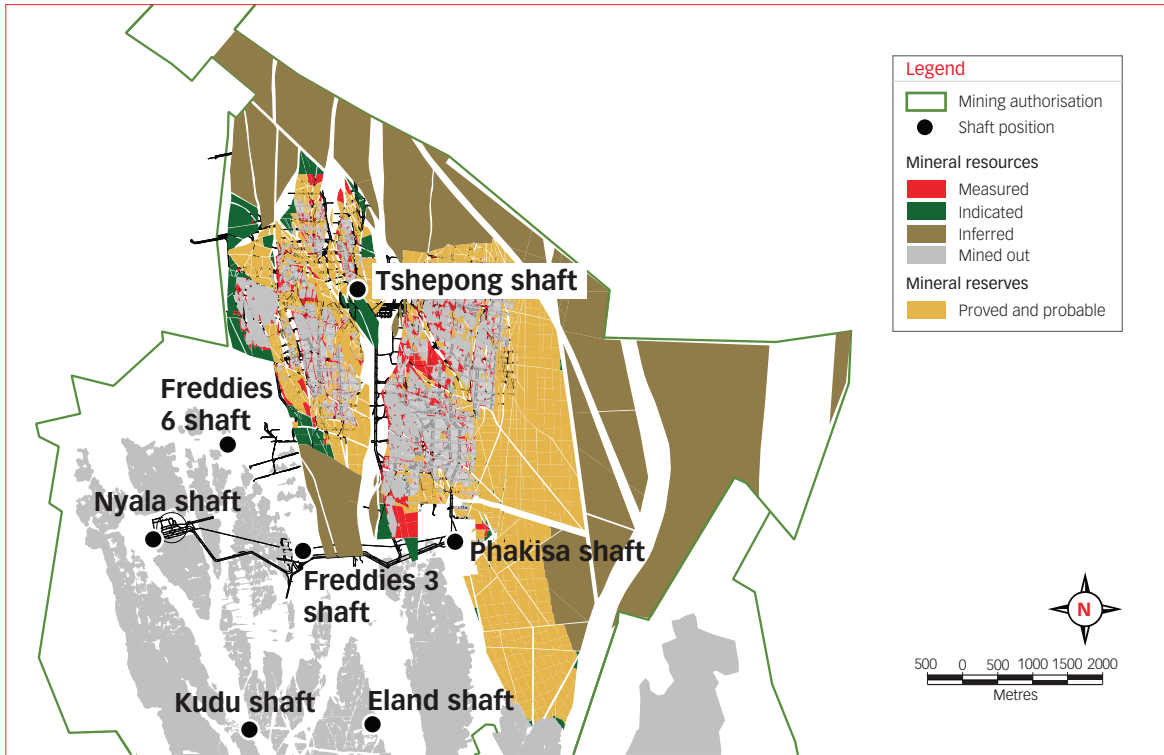
Masimong mine – B reef



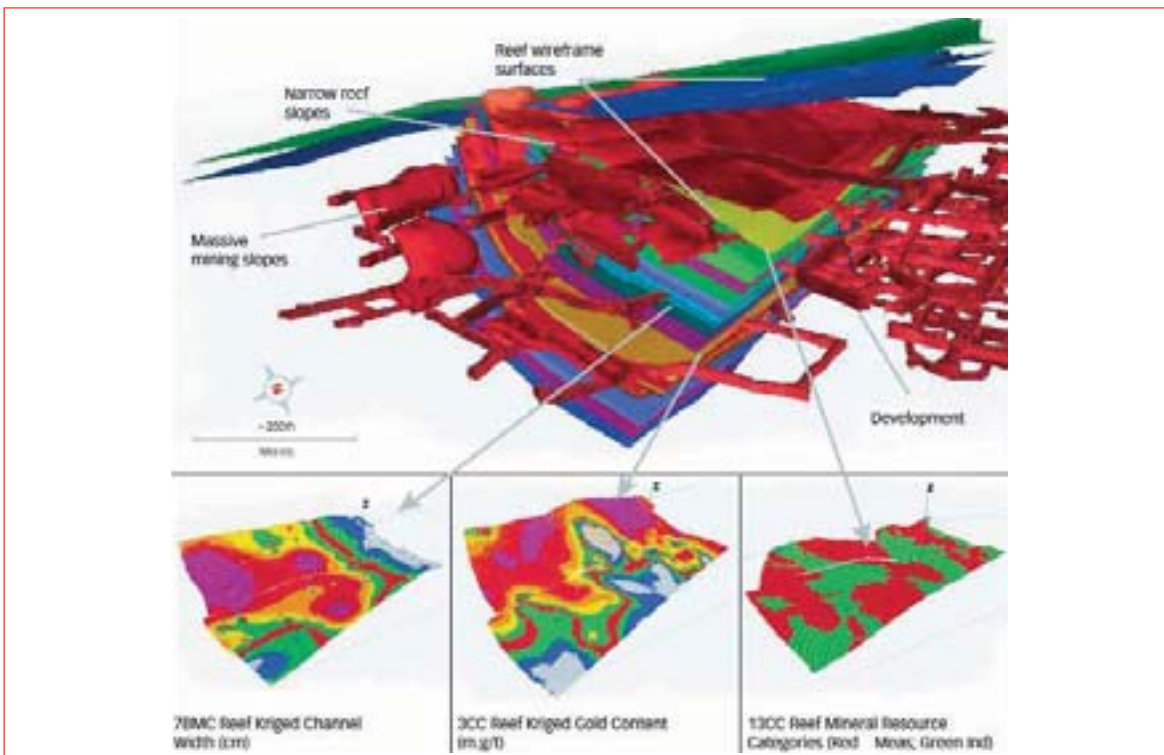
Mineral resources and mineral reserves cont.

Free State operations cont.

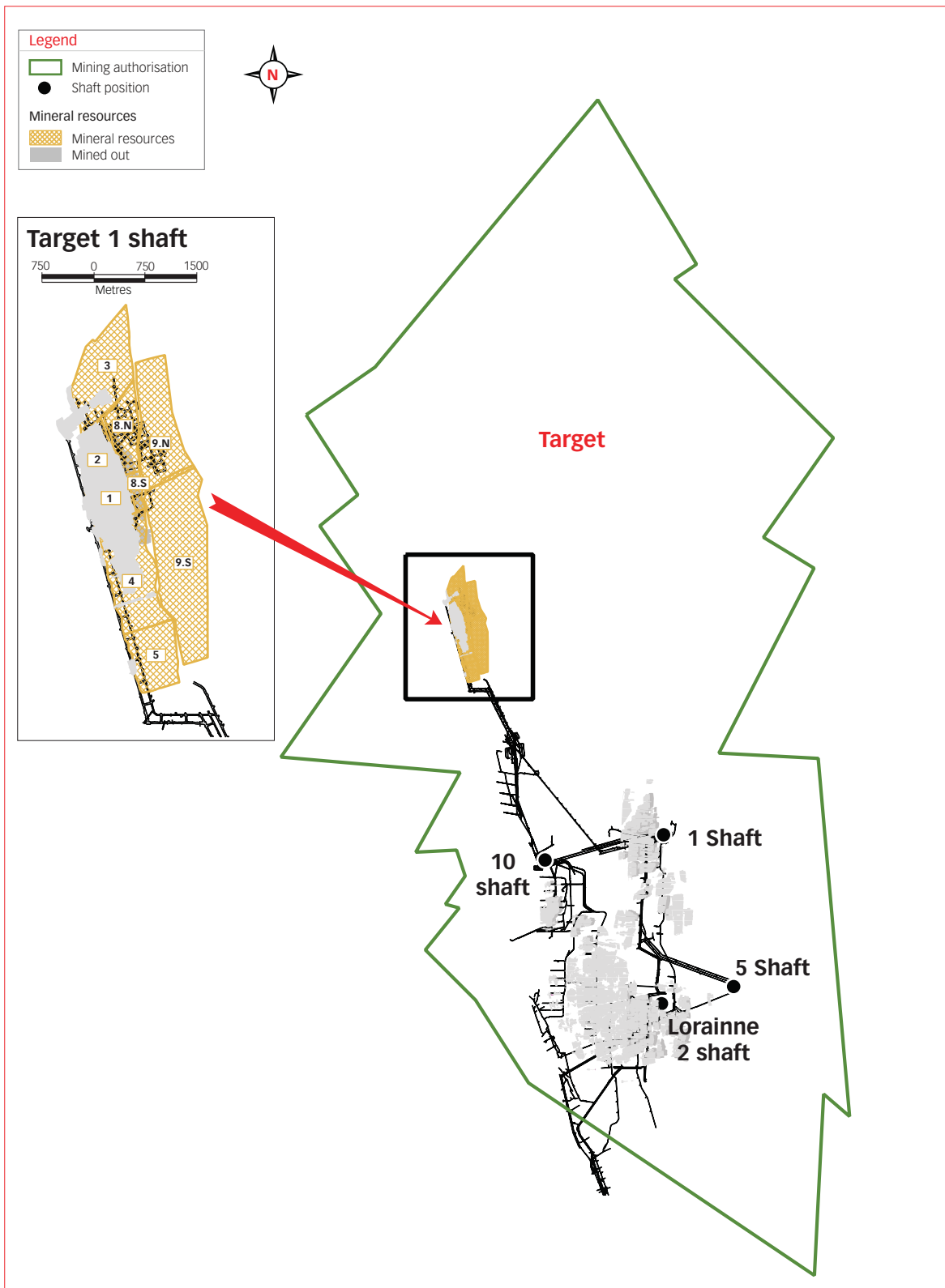
Phakisa mine, Tshepong mine – Basal reef



Target mine – Elsburg and Dreyerskuil reefs



Target mine



Mineral resources and mineral reserves cont.

Free State operations cont.

Unisel – Basal reef



Unisel – Leader reef

