an **AMCOAL** company

APPROVED

DIRECTOR: MINERAL DEVELOPMENT
MPUMALANGA

DATE ....

LANDAU

C O L L I E R Y

SOUTH AFRICAN COAL ESTATES

aac

DEPARTMENT OF MINERALS AND ENERGY

Minerals and Energy for Development and Prosperity

MINERALS AND ENERGY

Privaatsak/Private Bag X7279, WITBANK, 1035
FAX No. 013-6903288

Enquiries: Sydney Ramovha
Tel No. 013-6561448/9

Date: 2001-11-19
Ref No. OT6/2/2/141

The Mine Manager
Landau Colliery
P O Box 78
CLEWER
1036

Sir/Madam

APPROVAL OF THE ENVIRONMENTAL MANAGEMENT PROGRAMME FOR LANDAU COLLIERY (ANGLO COAL) SITUATED ON THE FARM SCHOONGEZICH 308 JS : WITBANK DISTRICT : MPUMALANGA

In terms of Section 39(1) of the Minerals Act, 1991 (Act 50 of 1991) the Environmental Management Programme submitted by you, is hereby approved subject to the following conditions:

1. This approval does not purport to absolve Landau Colliery (Anglo Coal) from its common law obligations towards the holder of the surface rights.

2. This approval may be amended or withdrawn at any stage and provides no relief from the provisions of any other relevant statutory or contractual obligations whatsoever.

3. Environmental management must conform to the Environmental Management Programme as approved.

4. Mining activities must conform to all relevant legislations and such other conditions as may be imposed by the Director: Mineral Development or any other officer of this office, duly authorized thereto.

5. Rehabilitation of the disturbed surface caused by mining activities must comply with the provisions of this Programme.

cc MTB
H.L
H.N
ADMC
PG
BM
BVK

6. At least 60 (sixty) days before the end of each of its financial years thereafter, the company must, in consultation with the relevant statutory authorities, cause written estimates to be prepared of the probable cost of rehabilitation measures that will be required in order to comply with the aforementioned statutory obligations. Such written estimates must be prepared by a suitably qualified person and full particulars of which must be submitted to this office.

7. The financial provision must be adjusted annually to conform with the above-mentioned estimation.

8. A performance assessment, monitoring and evaluation report must be submitted annually to this office or as determined by the Director: Mineral Development.

9. Any alteration or deviation from the programme must be submitted to the Director: Mineral Development for his/her approval.

10. The approved environmental management programme that is being sent to you is for implementation and compliance to the conditions stipulated.

11. Your attention is also directed to the requirement of Section 54 of the Minerals Act, 1991. A copy of the Environmental Management Programme must always be available on mine premises for inspection by duly authorized officers.

Yours faithfully

DIRECTOR: MINERAL DEVELOPMENT
MPUMALANGA REGION

S:\tiksters/other/ot622141/ec

DME 6

DEPARTMENT OF MINERALS AND ENERGY

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Yours faithfully

J. Mahosana

DIRECTOR: MINERAL DEVELOPMENT
MPUMALANGA REGION

S:\tiksters/other/ot622141/ec

ANGLO OPERATIONS LIMITED
ANGLO COAL
SOUTH AFRICAN COAL ESTATES
LANDAU COLLIERY

APPROVED

DIRECTOR: MINERAL DEVELOPMENT
MPUMALANGA

DATE: 2001 -11- [illegible]

THE ENVIRONMENTAL MANAGEMENT PROGRAMME REPORT FOR LANDAU COLLIERY

ANGLO COAL

A DIVISION OF ANGLO OPERATIONS LIMITED

The Environmental Management Programme Report

For

Landau Colliery

A Section of South African Coal Estates

A. EXECUTIVE SUMMARY

The mine was established at a cost of R703, 5 million to produce some 90 million tons of steam coal over a period in excess of 25 years. This coal will be sold on the export market as well as on the inland South African market. Not only will it earn foreign currency but will also contribute to the country's economy and provide employment. The Navigation / Schoongezicht reserves are not part of the Kromdraai Opencast mining operation at present but if mining is envisaged in these areas then an amendment to the EMPR will be submitted.

This EMPR reports on work carried out up until April 1999. This Environmental Management Programme Report (EMPR) is Anglo Coal's commitment to integrated environmental management and shows how the negative impacts arising from mining operations will be ameliorated during operation and after closure.

Due to the size of mining machinery and plant employed, and the extent of the operations, the operations, the mine will have an impact on the environment during the operational phase. The negative impacts will be visual, noise and dust, which will be reduced by implementing environmental programmes as described in this report. Monitoring programmes for visual, noise and dust pollution have been established since the mining operation started.

The geological sequence up to the floor of the No. 1 seam will be disturbed in the area where opencast mining takes place. The impact this will have on the environment is to disturb the water tables and to expose the broken rock and coal to oxygen and water thus creating the potential to generate acidity and salinity in the water collected in the spoils. Any acid water that is generated in the pit area will be treated in the Kromdraai Liming Plant. Due to the mining operation the source of pollution (coal) will be removed and therefore after mining the operation has ceased the pollution potential will be greatly reduced.

Soil and land management will be implemented in the opencast mine's operating window which will cover some 240 hectares. Land management will be carried out on the rehabilitated mined out area as well as on areas ahead of and adjacent to the mining operations. A major positive undertaking will be to eradicate areas covered by invading species of trees such as wattle and gum. Known sinkholes that have resulted from old underground workings collapsing will be eliminated by the opencast mining method employed. The net effect will be to return the land to as close as is practicably possible to its pre – mining agricultural potential.

Natural vegetation, plant life and animal life will be disturbed during the mining operation. The natural vegetation and plant life will be reinstated through the rehabilitation programme as the mining operation progresses. The animals that inhabited the area before mining have been allocated to a game reserve area and will be released into the environment when the mining operation ceases.

Disposal and management of discards has been well planned ahead of mining operations commencing. The major impact from the Blaauwkrans dump will be visual and water pollution,

which will be softened by the environmental management programme, which includes vegetating the sides and top of the dump as well as planting a screen of trees.

The mine has been designed to make use of sources of polluted water in the opencast mine and plant. Two raw water treatment plants at Navigation and Kromdraai will neutralise acid water drawn from old underground mine workings before being used in the operations. Water will be managed such that, where practicable, rainwater runoff will be directed away from the operational areas and into streams. During the operational phase the net effect will be an improvement in salt loading on adjacent streams compared with what existed before implementation of the mine.

After mining operations cease all buildings and structures will be demolished, the areas rehabilitated and returned to agriculture with land potentials approximating pre – mining levels. There will be no post – mining residual impact arising from the mine's buildings and structures. However, if facilities can be used economically for other purposes after closure of the mine then the required buildings will be made available.

Post – mining impact on surface water will be negligible due to profiling the post – mining surface to facilitate controlled drainage and the standard of rehabilitation of vegetation being implemented. Ground water will be affected negatively after mining. Presently steps are being implemented to reduce the impact on ground water and if these measures are not sufficient the water will be collected where possible and treated. However, this EMPR has identified that research work will need to be carried out on treatment of acid mine drainage. Various water treatment systems will be investigated during the operational phase of the mine. The effect of rapidly draining accumulations of water in the opencast spoils to reduce residence time will also be undertaken in order to lower salt concentrations in the discharged water.

Interested and affected parties were consulted prior to the start of the mining operation and has continued through various different channels. The mine is active participant of the Saalklapspruit and Brugspruit forums. Regular meetings are held with neighbouring farmers, as well as, the Department of Water Affairs and Forestry, the Department of Mineral and Energy Affairs and the Department of Environmental Affairs and Tourism.

The mine has been working closely with the Department of Water Affairs on quality and quantity of water discharges from the operation. Work in this regard is ongoing and all necessary information gathered on monitoring will be made available. The mine is committed to continuing its' monitoring programmes and any agreed – to additional programmes required by authorities.

This EMPR is considered to be a "live" document, which will be added to as investigations yield more economically viable solutions to the mining and post – mining impacts identified. Anglo Coal is therefore committed to using Best (proven) Available Technology Not Entailing Excessive Cost (BATNEEC).

In conclusion, positive benefits the mine will achieve are: generator of foreign exchange and employment, improving the land capability of the opencast mining area and improving the water quality in surrounding streams.

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PART 1: BRIEF PROJECT DESCRIPTION

1.1 Name and Address of Mine, Mine Owner, Mine Manager and Responsible Head Office Person

All communications should in the first instance be directed to:

Postal:	The Mine Manager: Landau Colliery PO Box 78 Clewer 1036
Telefax:	(013) 656 9016
Telephone:	(013) 656 9000

Thereafter the Senior Vice President who may be contacted at:

Postal	Anglo Coal Anglo Operations Ltd. PO Box 61587 Marshalltown 2107
Telefax No.:	(011) 638 2645
Telegraph:	Anmercosa
Telephone:	(011) 638 9111

The company registration number of the mine is:

Reg. No. 01106730/06

The location of the opencast plant and mine is shown on Figure 1. 1.

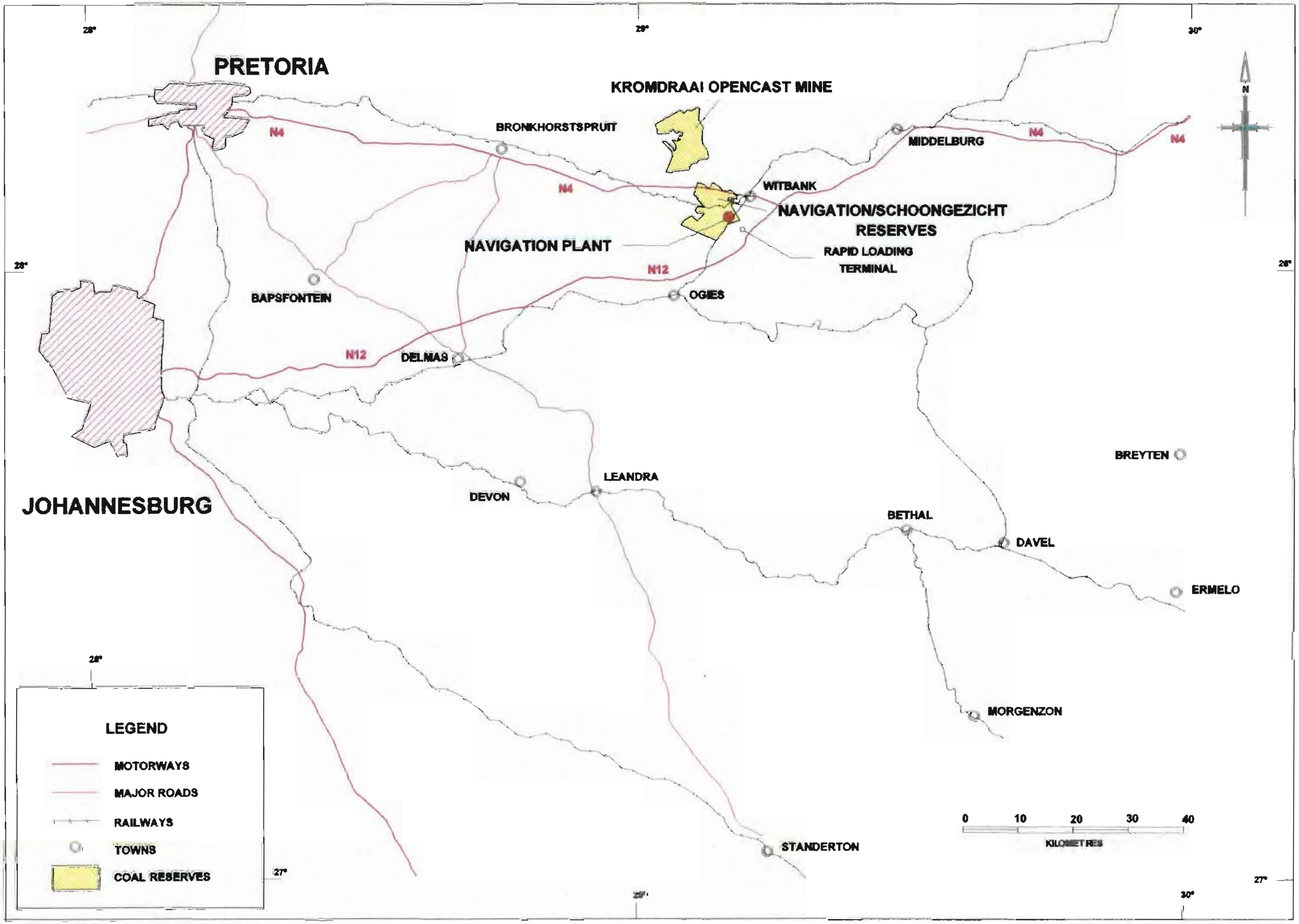

FIGURE 1.1 **LOCALITY PLAN**

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1.2 Name and Address of the Mineral Rights Holder

The Mineral Rights are held by:

Anglo Coal, a division of Anglo Operations Limited

Postal Address:	PO Box 61587 Marshalltown 2107
Physical Address:	55 Marshall Street Johannesburg 2000

In the application for mining authorisation dated 18th December 1992, plans and schedules detailing the areas over which coal rights are held for this project were submitted to the Regional Director – Eastern Transvaal Region.

A temporary mining authorisation has been granted until issuing of a Mining Authorisation in terms of letter dated 14th January 1993 reference OT 5/5/2/95.

Figure 1.2 shows the location of coal reserves held by this company whilst Figure 1.3 shows the coal reserves to be mined at the Kromdraai opencast mine.

1.3 Name and Address of the Holder of the Mining Authorisation

The Manager
Landau Colliery
PO Box 78
Clewer
1036

Landau Colliery forms part of South African Coal Estates company under Anglo Coal, a division of Anglo Operations Limited.

1.4 Name and Address of the Owner of the Land and the Title Deed Description

Anglo Coal, a division of Anglo Operations Limited

Postal Address:	PO Box 61587 Marshalltown 2107
Physical Address:	55 Marshall Street Johannesburg 2000

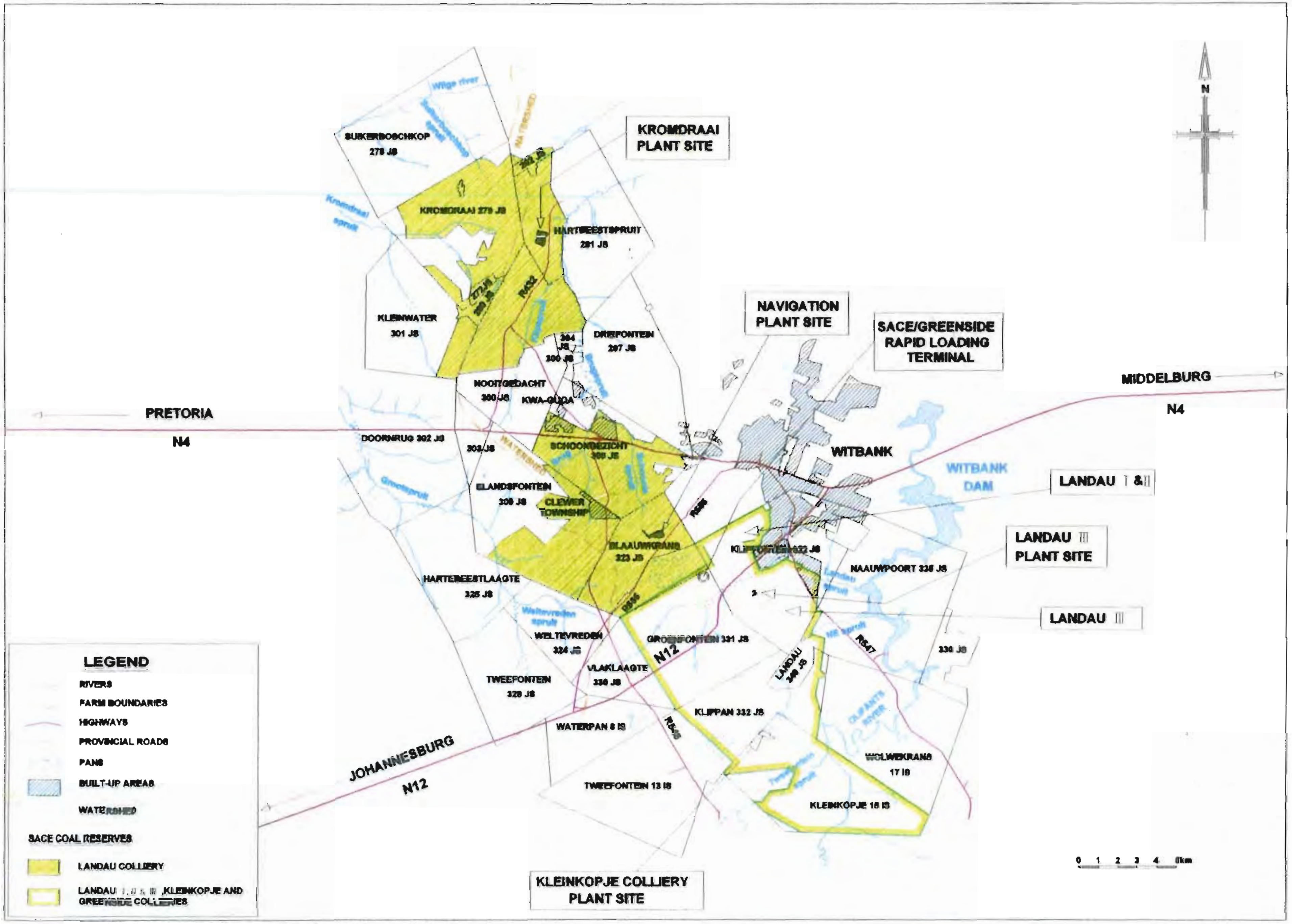

FIGURE 1.2 REGIONAL LOCATION PLAN AND COAL RESERVES

Figures 1.3 and 1.4 shows the extent of coal and surface rights owned by the company.

1.5 Regional Settings

1.5.1 The Kromdraai opencast mine, Navigation plant and railway line are situated in the Witbank magisterial district and are served by the Highveld Regional Services Council.

1.5.2 The Kromdraai opencast mine and Navigation plant are situated 15km Northwest and 6km Southwest of Witbank respectively.

1.5.3 Figure 1.5 shows the location of the Kromdraai opencast mine and Navigation plant in relation to Witbank, and also infrastructure serving the area.

1.5.4 Infrastructure services shown on Figure 1. 5 are covered by servitudes over properties they traverse. Details of these servitudes can be made available if required.

1.5.5 Table 1.5.1 lists the owners, addresses and farm names of land adjacent to land owned by the company. The locations of these properties are shown on Figures 1.3 and 1.4.

1.5.6 The Navigation plant and Kromdraai opencast mine are situated in the Olifants River Catchment number 210 and Wilge River Catchment number 220, respectively.

Table 1.5.1 - Owners of Land Adjacent to Mining Area (As at lst April 1998)

Portion	Owner	Title Deed	Share
SUIKERBOSCHKOP 278 J.S.			
9/4	Paul Lodewyk Zietsman	T54784/90	1/16
		T33157/71	15/16
RE/15/1/	Alberto Ceruti	T38091/58	1 / 2
	Tullie Ceruti	T38091/58	1 / 2
19/15/	Johannes Echard Kriel	T69692/92	
20/5/	Peter Donald Manson	T4020/57	
21/5/	Gerhardus Stephanus Pieterse	T6617/68	
KROMDRAAI 279 J.S.			
RE/5/3/	Gert Albertus van Kraayenburg	T37749/84	1 / 4
		T43050/76	3 / 4
6/1	Wallace Pieter Roux	T48906/85	

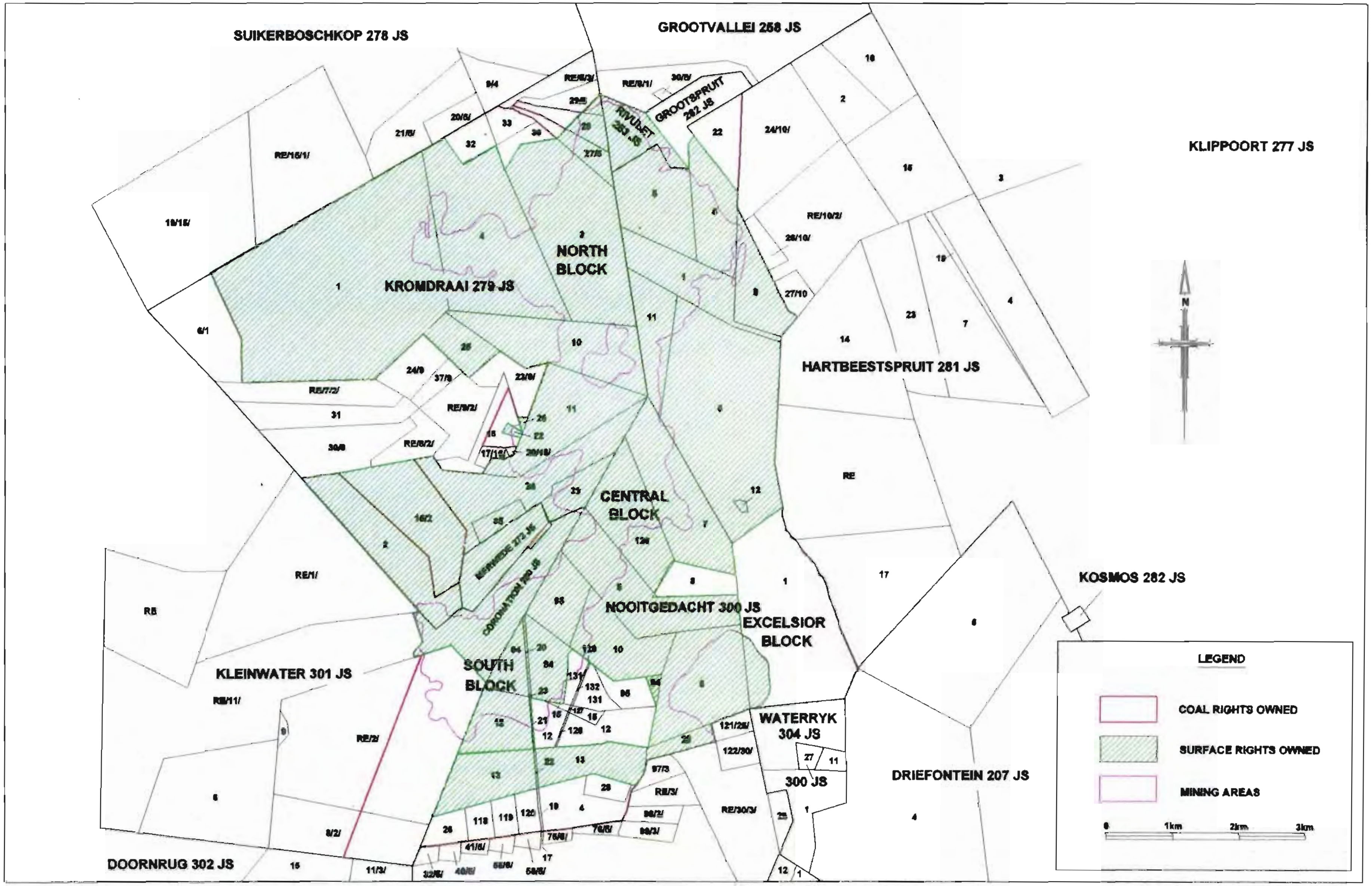

FIGURE 1.3 COAL AND SURFACE RIGHTS - KROMDRAAI OPENCAST

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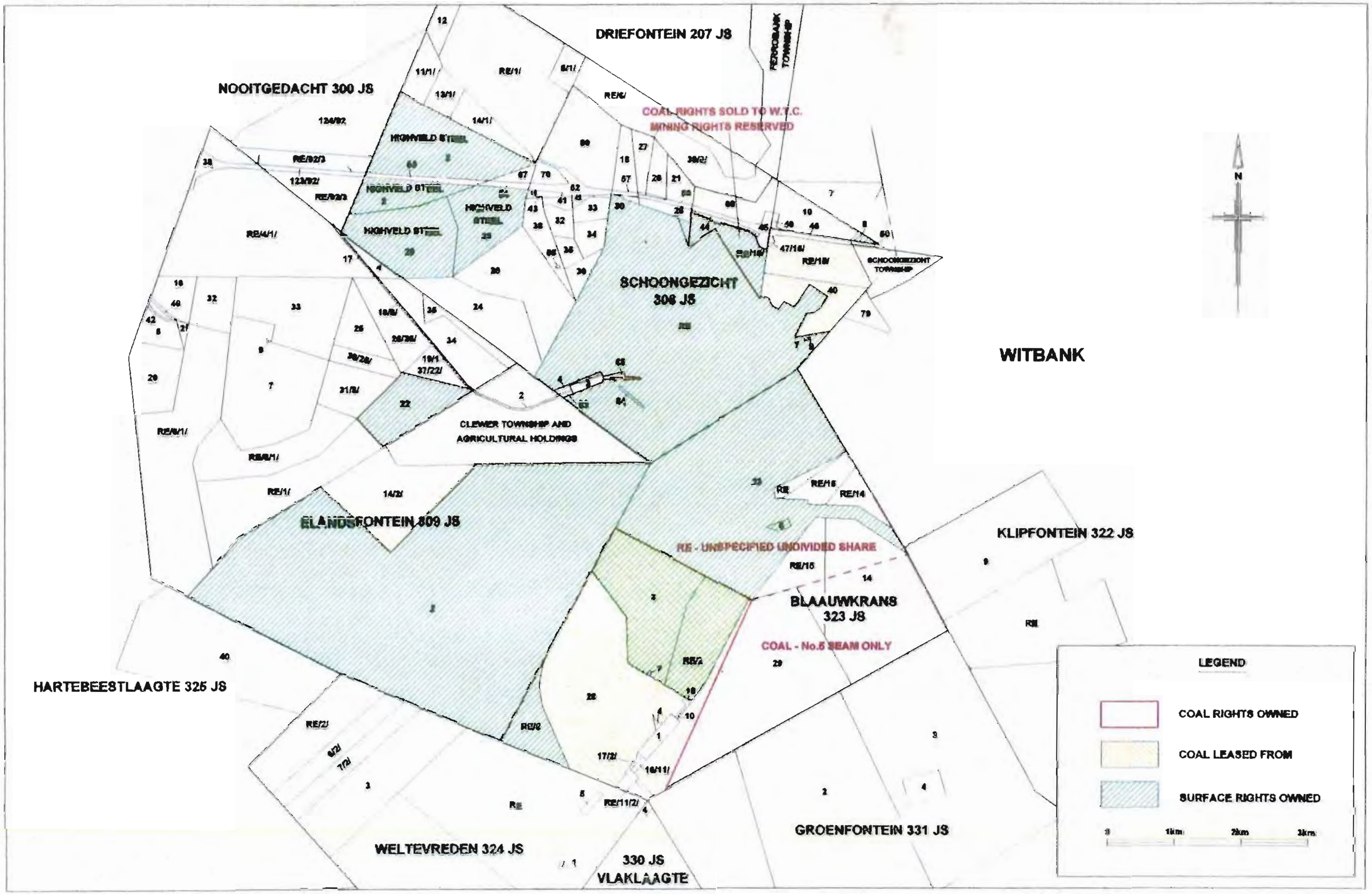

FIGURE 1.4 COAL AND SURFACE RIGHTS - SCHOONGEZICHT/NAVIGATION

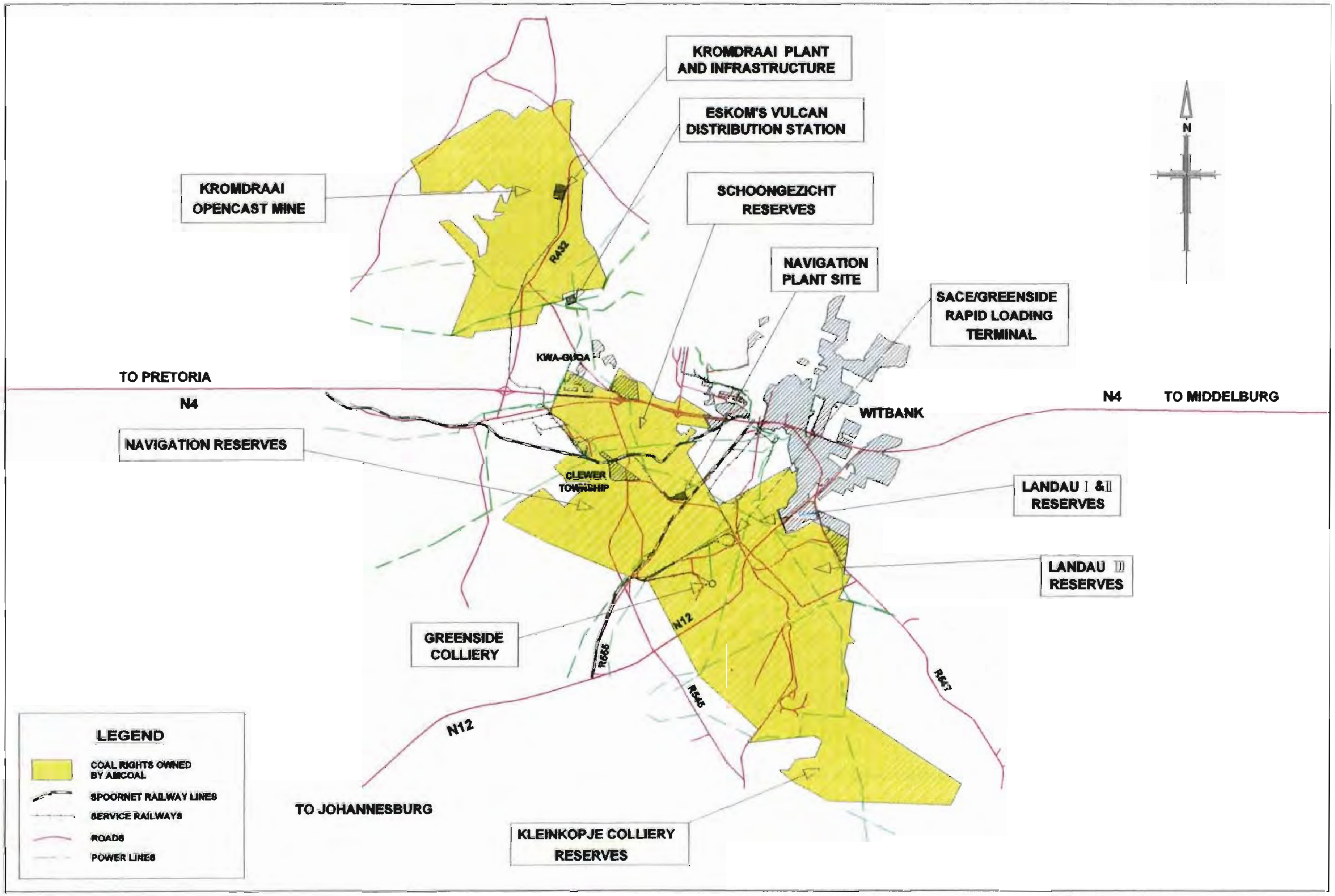

FIGURE 1.5 MAJOR INFRASTRUCTURE NETWORK

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Portion	Owner	Title Deed	Share
17	Sarovic Momir	T26560/91	
24/10/	Zacharias Marthinus Roux	T35131/87	
26/10/	Anna Johanna Susanna Scheepers Nortje	T47996/85	
27/10/	Cons 29- Jan Hendrik Terblanche	T82210/89	
Rem.Extent	Jan Harm Steenkamp	T75383/89	
GROOTVALLEI 258 J.S.			
RE/8/1/	Kenneth John Roy MacKenzie	T30297/67	1 /2
		T30298/67	1 /2
30/8/	Republic of South Africa	T12338/4	
SCHOONGEZICHT 308 J.S.			
Re/1/	Cons 73 – Municipality Kwa – Quqa	T43942/91	
3	Republic of South Africa	T7556/18	
4	Transnet Limited	T14044/29	
5/1/	Cons 73 – Municipality Kwa – Quqa	T43942/91	
RE/6/	Transvaal & Delagoa Bay Investment Co. Ltd.	T1963/35	
7	Acolls	T38306/92	
11/1/	Municipality Kwa – Quqa	T45253/87	
13/1/	Montferland (Pty) Ltd.	T3609/70	
14/1	Municipality Kwa – Quqa	T41802/88	
RE/15/	Municipality Witbank	T4257/71	
RE/19/	Acolls	T7687/89	
39/6/	Municipality Witbank	T8400/72	
40	Municipality Witbank	T28199/74	

Portion	Owner	Title Deed	Share
RE/7/2/	Christoffel Johannes Moolman	T26718/85	
RE/8/2/	Sarel Jacob du Plessis	T65381/92	
RE/9/2/	Christoffel Johannes Venter	T47869/85	
15/2/	Zacharias Marthinus Roux	T4628/86	
17/16/	Kromcor Beleggings (Pty) Ltd.	T22462/91	
20/16/	Kromcor Beleggings (Pty) Ltd.	T22462/91	
23/9/	Kromcor Beleggings (Pty) Ltd.	T22462/91	
24/9	Anna Maria Jansen	T41047/91	
27/5	Gert Albertus van Kraayenburg	T72943/88	
28/5	Acolls	T4487/90	
29/5	Gert Albertus van Kraayenburg	T3473/88	
30/8	Dudley James Antonie	T54809/83	
37/9	Nicholas Jacobus Johannes Krige	T20588/83	
KLIENWATER 301 J.S.			
RE/1/	H J D van der Walt & Seuns Boerdery (Pty) Ltd.	T12617/82	
RE/2/	Stephanus Johannes Schoeman	T25983/76	
8/2/	Anna Johanna Frederika Rautenbach	T37744/79	
RE/11/	Jan Daniel van Aardt	T11912/92	
DOORNRUG 302 J.S.			
11/3/	Elsie Johanna Dietrichsen	T37743/79	
NOOITGEDACHT 300 J.S.			
RE/3/	Municipality Kwa – Quqa	T49181/87	
RE/30/3	Municipality Kwa – Quqa	T33832/88	

Portion	Owner	Title Deed	Share
32/5/	Marius Nicolaas Johannes Booyse	T42163/84	1 /2
	Herculas Frederick Grobler	T42163/84	1 /2
40/5/	Church of Jesus Christ	T63978/92	
41/5/	Christiaan Johannes Naude	T42352/80	
53/5/	Raphael Taughum Cohen	T12029/73	
55/5/	Sybrand Gerhardus van Dyk	T42674/76	
56/5/	Richard Floor	T41314/90	
75/5/	Municipality Kwa – Quqa	T2017/90	
76/5/	Municipality Kwa – Quqa	T44149/87	
RE/92/3	Highveld Steel and Vanadium Corporation Limited	T12864/64	
97/3/	Municipality Kwa – Quqa	T39522/87	
98/3/	Municipality Kwa – Quqa	T58834/87	
99/3/	Municipality Kwa – Quqa	T58622/87	
121/25/	Eskom	T1754/74	
122/30/	Eskom	T14677/71	
123/92/	Suid – Afrikaanse Padraad	T31923/74	
124/92/	Municipality Kwa -Quqa	T35631/88	
WATERRYK 304 J.S.			
RE/	Republic of South Africa	T30774/88	
1/	Municipality of Kwa – Quqa	T30773/88	
HARTEBEESTSPRUIT 281 J.S.			
RE/10/2	Sarel Wessel Brits	T49711/88	
14	Smith Broers Trust	T33202/87	

Portion	Owner	Title Deed	Share
47/15/	Suid-Afrikaanse Padraad	T15559/73	
65	No owners/endorsements		
BLAAUWKRANS 323 J.S.			
1	Republic of South Africa	T2243/18	
RE/11/2/	Gold Fields Coal Limited	T112673/92	
16/11/	Transnet Limited	T14533/57	
17/2/	Transnet Limited	T21965/60	
KLIPFONTEIN 322 J.S.			
9	Acolls	T11915/1921	
Rem. Extent	Acolls	T16556/1938	
GROENFONTEIN 331 J.S.			
1	Uitspan Uitbreiding (Pty) Ltd.	T31086/75	
2	Gold Fields Coal Limited	T112673/92	
3	Gold Fields Coal Limited	T112673/92	
Rem. Extent	Gold Fields Coal Limited	T112673/92	
VLAKLAAGTE 220 J.S.			
4	Uitspan Uitbreidings (Pty) Ltd.	T31086/75	
WELTEVREDEN 324 J.S.			
RE/2/	Hercules Jacobus Scheffer	T2626/73	
3	Welvil cc	T2109/79	
6/2/	Christiaan Lodewyk Hoffman	T11946/73	
7/2/	Welvil cc	T2109/79	
Rem.Extent	Isabella Aletta Doyer	T14966/28	

Portion	Owner	Title Deed	Share
HARTEBEESLAAGTE 325 J.S.			
40	Maggel Margaritha Brown	T2777/78	
ELANDSFONTEIN 309 J.S.			
RE/1/	Naudven Boerdery Beleggings (Pty) Ltd.	T38718/86	
RE/4/1/	Highveld Steel & Vanadium Corporation Limited	T11898/63	1 /2
		T12318/64	1 /2
RE/6/1	Hester Petronella Muller Pretorius	T6797/75	1 /3
	Susanna Francina Maria Saayman	T6797/75	1 /3
	Pieter Johannes Vorster	T6797/75	1 /3
RE/8/1	Sophia Elizabeth Botha	T21962/82	
14/2	Jan Hendrik Smith	T7743/92	
18/8	Highveld Steel &Vanadium Corporation Ltd.	T41789/67	
19/1	Highveld Steel & Vanadium Corporation Ltd.	T41789/67	
26/25/	Highveld Steel & Vanadium Corporation Ltd.	T34313/65	
31/8	Savage & Lovemore Mining (Pty) Ltd.	T59844/86	
36/25/	Highveld Steel & Vanadium Corporation Ltd.	T4137/65	
37/22/	Highveld Steel & Vanadium Corporation Ltd.	T34313/65	

1. 6 Description of the Project

1.6.1 The mineral to be mined is a bituminous coal deposit.

1.6.2 The Kromdraai opencast mine will extract between 5,0 and 6,0 million tons per year of bituminous coal. The coal will be railed to the Navigation plant to produce a steam coal product at the rate of 3 - 3,3 million tons per year.

1.6.3. Economic reserves at Kromdraai Opencast total 137 million raw tons, which will yield some 90 million tons of, steam coal.

1.6.3 The coal reserves managed by the South African Coal Estates (SACE) run along a NW SE axis and border onto the town of Witbank (See Figure 1.2.). These reserves have been exploited by underground mining operations at Kromdraai, Schoongezicht / Navigation, and Landau I / II and the opencast mining operations at Kleinkopje, all of which form SACE. Coal is at present mined by the opencast methods from the Kleinkopje and Kromdraai Collieries. The underground mining operations at the Landau Colliery ceased during 1991. Production from this operation was replaced by expanding the Kromdraai minipit into a fully-fledged opencast mining operation extending the mine to recover the remaining coal from the reserves previously mined by underground bord and pillar methods.

On depletion of the Kromdraai reserves, consideration will be given to relocating the opencast mine to exploit the remaining reserves in the Schoongezicht and Navigation blocks if economically viable.

This EMPR covers only the Kromdraai opencast mine and the Navigation plant. Mining has been extended to include the Schoongezicht and Navigation reserves. Separate EMPR's for the Schoongezicht 2 Seam & Schoongezicht 4 Seam operations have been submitted.

Landau Colliery comprises of the following:

- A combined dragline and prestrip operation at Kromdraai opencast mine.
- A primary and secondary coal crushing and screening plant at Kromdraai.
- A railway link between Kromdraai and the Navigation plant.
- A coal processing plant at Navigation.
- A discard disposal site at Navigation (Blaauwkrans Co-Disposal Facility).
- An overland conveyor from Navigation to the existing Rapid Loading Terminal (RLT).

1.6.5 At full output the mine will produce approximately 3,3 million tons per year of steam coal from 5,0 to 6,0 million tons per year of raw coal.

1.6.6 The project's life is approximately 30 years including a three year build – up period which commenced in 1991and is now in the operational phase.

PART 2: DESCRIPTION OF THE PRE-MINING ENVIRONMENT

2.1 Geology

2.1.1 Geological Description

Throughout the Witbank area a thin succession of Vryheid Formation sediments is present. At their thickest these sediments attain some 120-140 metres and can contain a number of coal seams of which four are considered to have economic potential.

The deposition of the Vryheid Formation sediments is to a great extent controlled by the Pre-Karoo platform on which they were deposited. These Pre-Karoo rocks, consisting mainly of Waterberg quartzites or outliers of the Bushveld Igneous Complex, have been glacially sculptured giving rise to uneven basement topography. A thin veneer of Dwyka sediments overlies the Pre –Karoo but is generally not thick enough to ameliorate the irregularities in the placated surface, which therefore affected the deposition of the younger Karoo sediments.

Figure 2.1 shows the general geological sequence for the Witbank area and an exploded sequence for the Kromdraai mining area.

2.1.1.1 Kromdraai

Data from approximately 1 300 boreholes drilled within the Kromdraai area from 1925 to the present, allied to information derived from the old mine plans, have provided a detailed model of the geology of the proposed mining area.

Only the lower portion of the Vryheid Formation, containing the No. 1 and No. 2 seams of the Witbank Coalfield, is preserved within the Kromdraai Block (see Figure 2.2). These sediments overlie an uneven Dwyka Floor, which is controlled by the topography of the Pre-Karoo platform upon which these Karoo sediments were deposited. The most significant feature of this Pre-Karoo topography is the development of a north-south trending glacially sculptured trough within which the potentially mineable coal reserves have been preserved. Figure 2.3 is a cross section through the Kromdraai reserve block.

The structure of the mining block is relatively simple, with a few known occurrences of dolerite dykes and sills and some minor normal faulting. From the geological model it has been possible to prepare plots of physical features useful for mine planning.

Data on coal quality have been enhanced by the recently completed exploration programme and these have been extensively used in compiling plots of various quality parameters essential for the planning of the benefication facility and for the development of the marketing strategy for coal from Kromdraai Opencast.

APPROVED
DIRECTOR: MINERAL DEVELOPMENT
MPUMALANGA
DATE: 2001 -11- 19

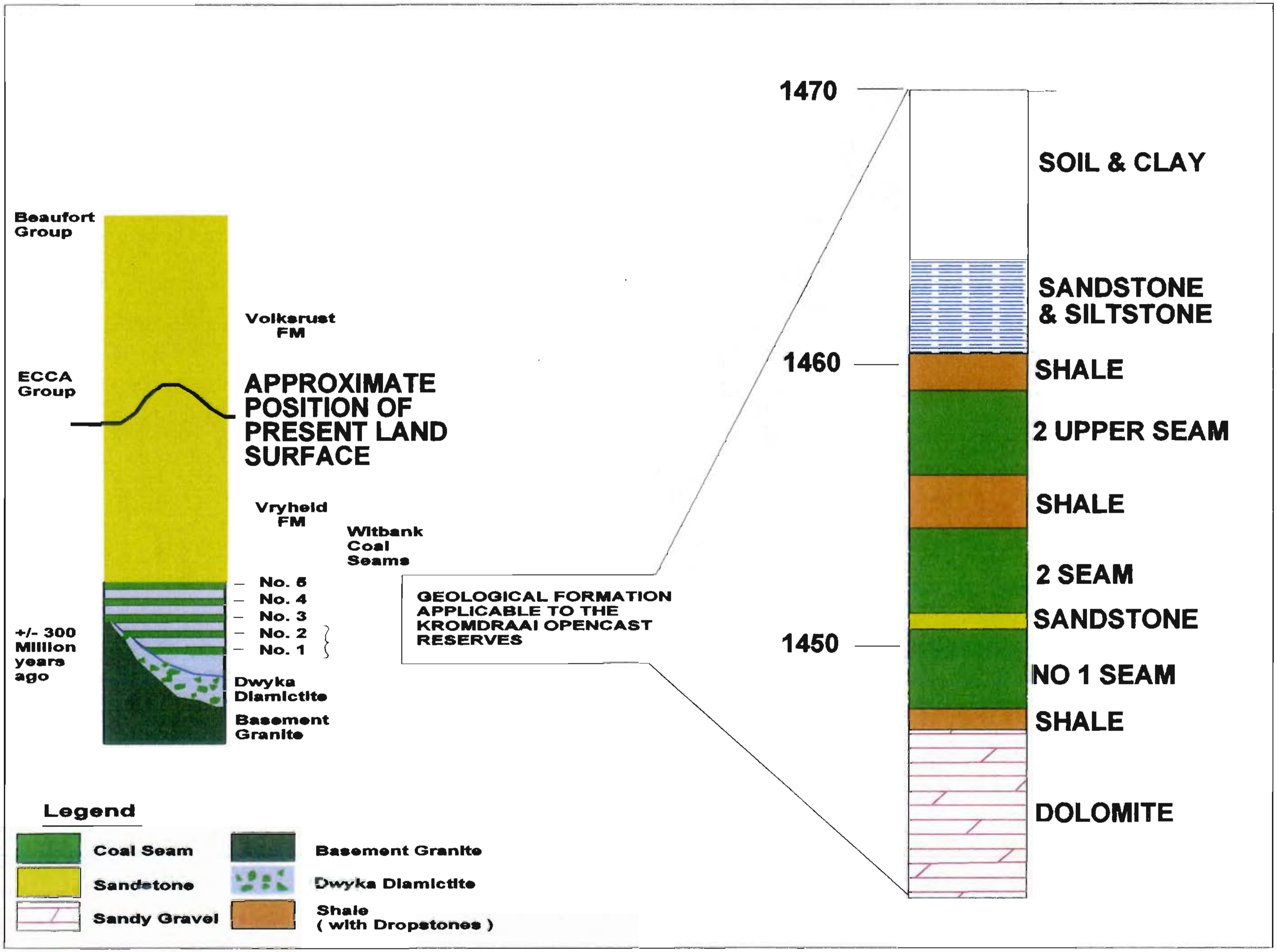

FIGURE 2.1 GENERAL GEOLOGICAL PROFILE IN THE WITBANK REGION DEPICTING THE FIVE COAL SEAMS

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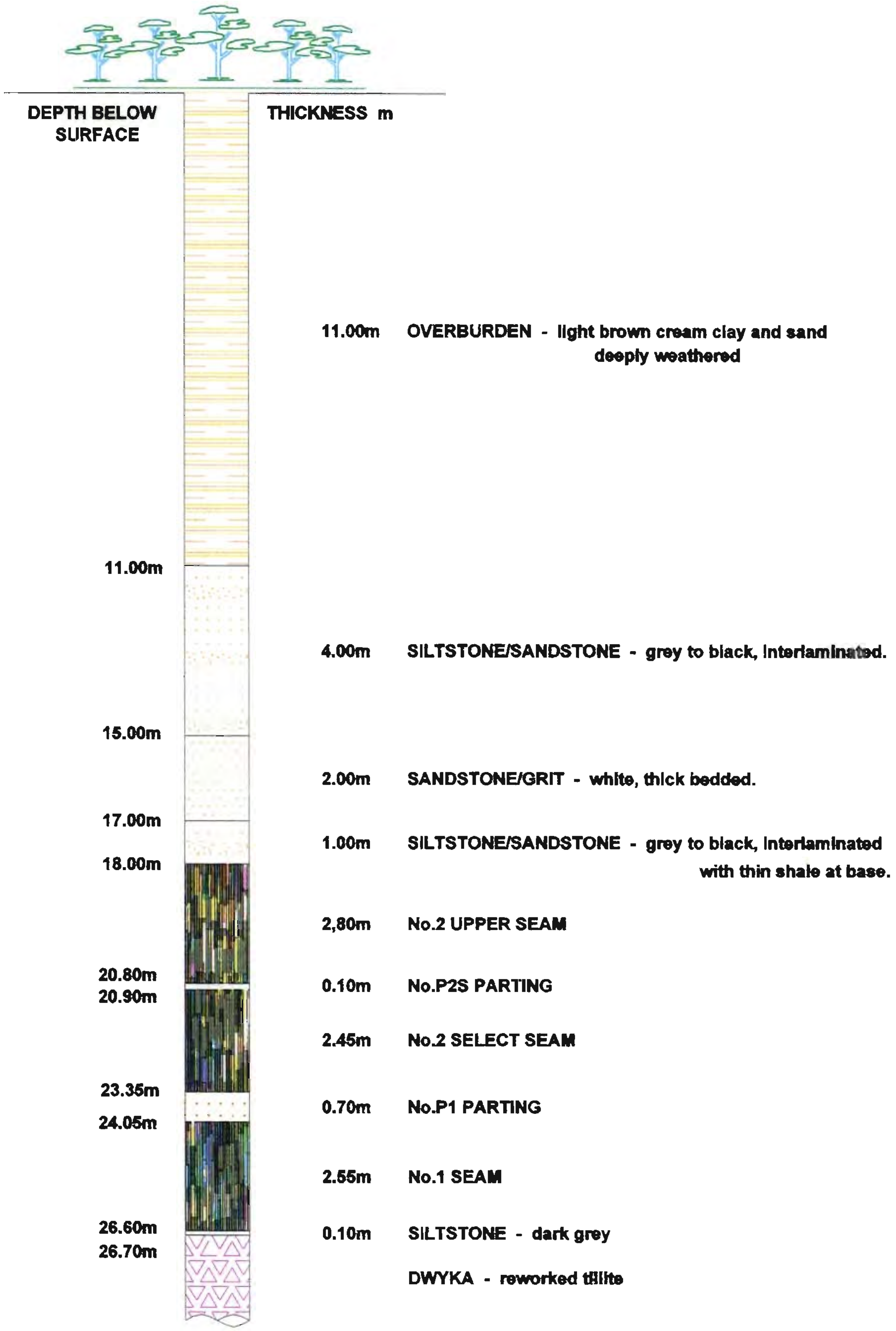

FIGURE 2.2 TYPICAL STRATIGRAPHIC COLUMN OF KROMDRAAI AREA

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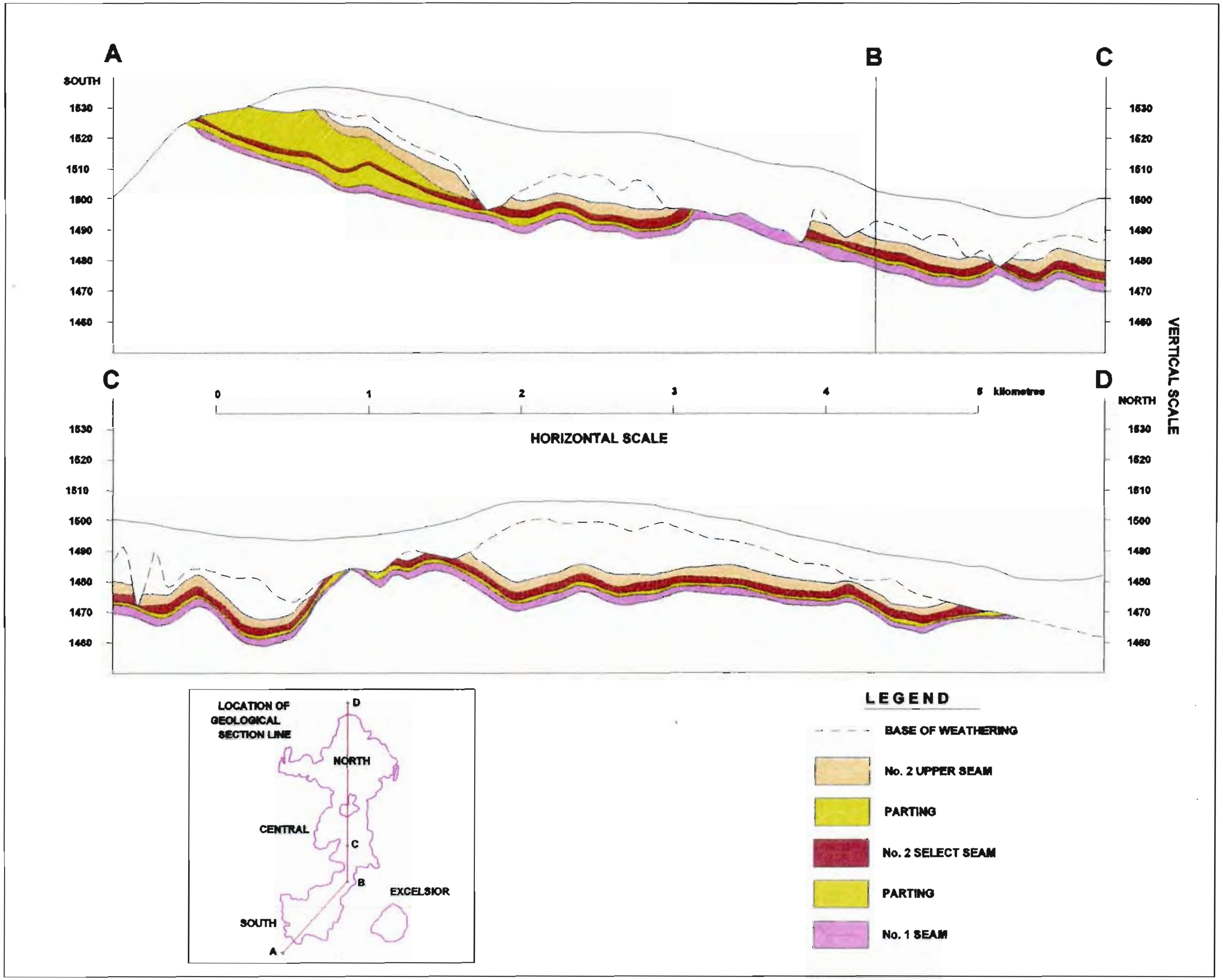

FIGURE 2.3 GEOLOGICAL CROSS-SECTION OF THE KROMDRAAI AREA

2.1.2 Presence of Dykes, Sills and Faults

2.1.2.1 Kromdraai

The regional geology of the Kromdraai coal deposit is shown on the 1:250 000 Geological Survey Series, Pretoria Sheet, No.2528. The coal occurs in the Vryheid Formation of the Ecca series, which overlies a thin layer of Dwyka shale's and tillites. The Ecca and Dwyka sediments are deposited in a glacial valley unconformably overlying Waterburg Group quartzites and sandtones. Rare diabase intrusions in the Waterburg have been regionally mapped, but no regional faulting has been detected.

The coal seams have been affected by the intrusion of a limited number of thin dolerite dykes and minor subordinate sills, which can have an effect on the mineability of the reserves.

In addition to the intrusion of dolerite, occasional minor small-scale normal faults occur. Strike lengths of faults encountered vary from a few metres to a maximum of a few hundred metres, and throws vary from a few centimetres to a maximum of six metres. There is no evidence that any of these Karoo faults penetrate through to the Waterburg sediments, or extend beyond the boundaries of the original Karoo glacial valley.

Figure 2.3(a) shows all known coal seam displacements, which are laterally discontinuous and of limited strike length. The maximum strike of any displacement exposed is approximately 700 metres.

The rare dolerite stringers exposed in the south-western section of the mini-pit have been highly weathered and are clayey in nature down to the floor of the coal horizon. Below this horizon they are expected to be solid and have a low capacity for ground water flow in the Dwyka and basement rocks. This is assumed for dykes encountered throughout the mining area. As yet no boreholes have intersected these dykes or adjacent zones particularly below the coal horizon and hence the associated water movement is difficult to quantify.

2.2 Climate

2.2.1 Regional climate

The climate of the area is one of summer rainfall with an average rainfall of about 690mm per annum. There is normally one fall annually of over 40mm. The average summer temperature range is from 12 degrees Celsius (°C) to 29 °C with an average temperature of 20 °C. The winter temperature varies from -3 °C to 20 °C with an average temperature of 9 °C, the first frost being experienced in May and the last in August. The prevailing winds are from the Northwest with an average wind speed of 2,9 metres per second.

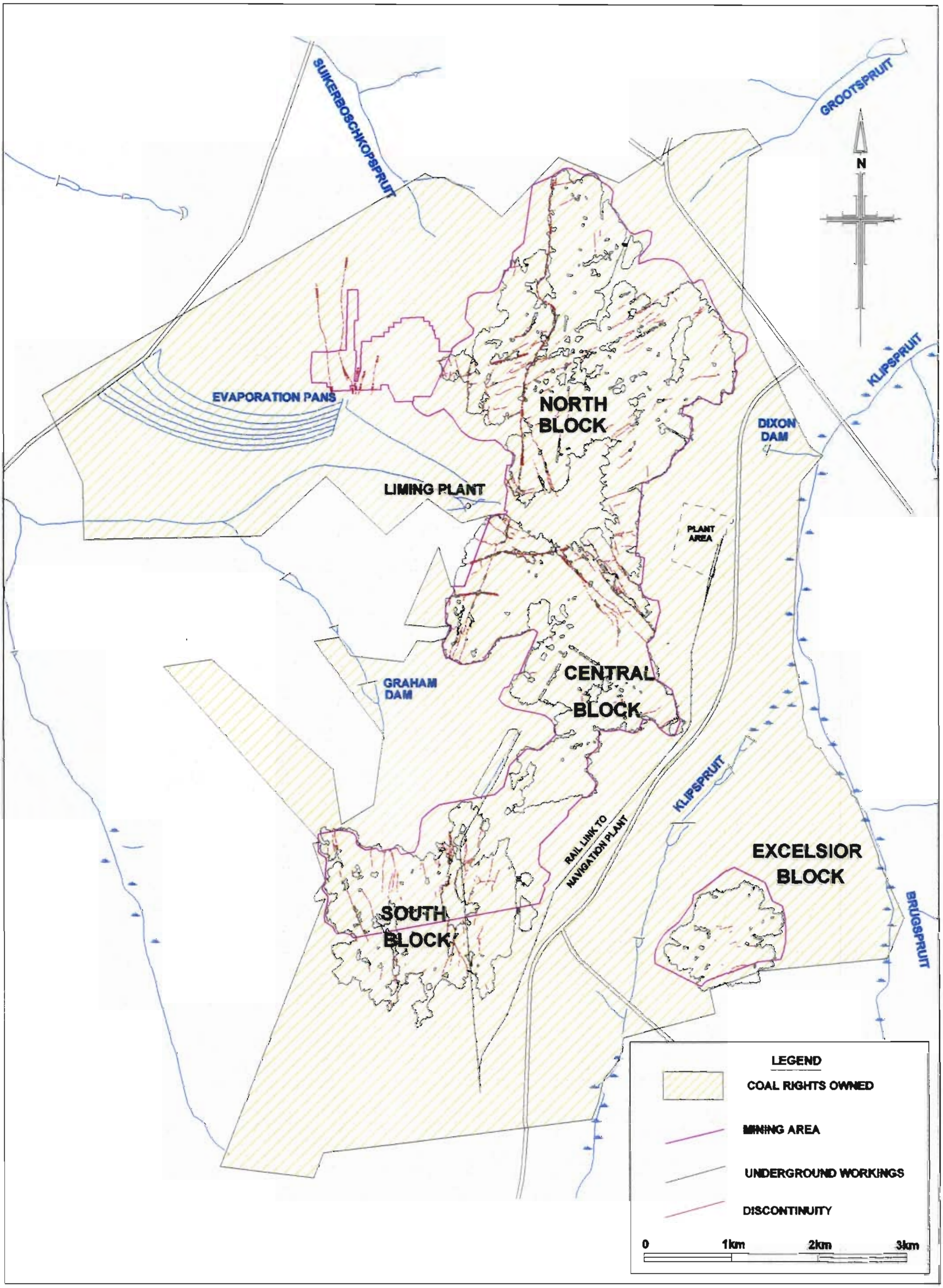

FIGURE 2.3(a) PLAN SHOWING LOCATION OF KNOWN COAL SEAM DISPLACEMENTS : KROMDRAAI

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2.2.2 Mean Monthly and Annual Rainfall

Table 2.2.1 shows the pre-mining monthly and annual rainfall recorded at the Kromdraai opencast mine from 1982 to 1992.

Table 2.2.1. - Monthly and Annual Rainfall at Kromdraai Liming Plant (mm/month and mm/year)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Total
1982	138	52	132	14	0	0	11	0	4	85	89	30	555
1983	186	36	90	31	15	21	23	38	3	83	251	89	866
1984	121	115	86	7	0	20	15	6	14	112	71	82	649
1985	78	171	89	0	17	0	0	0	49	83	65	94	646
1986	119	66	54	22	0	7	0	1	0	91	195	121	676
1987	144	36	187	17	3	0	0	41	86	65	217	123	918
1988	76	63	52	18	0	12	4	0	51	119	85	97	577
1989	76	151	95	29	11	49	0	5	2	52	189	124	783
1990	39	77	104	89	8	0	4	0	7	37	81	202	648
1991	179	150	194	4	2	28	0	0	6	69	47	97	776
1992	70	100	51	9	0	0	0	15	5	71	88	162	571
Average	**111**	**92**	**103**	**22**	**5**	**12**	**5**	**10**	**21**	**79**	**125**	**111**	**697**

Table 2.2.2 shows the monthly and annual rainfall recorded since mining commenced at the Kromdraai opencast mine from 1993.

Table 2.2.2. - Monthly and Annual Rainfall at Kromdraai Liming Plant (mm/month and mm/year)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Total
1993	73	171	122	45	2	0	0	0	60	172	150	117	912
1994	160	117	66	7	0	0	0	0	8	55	68	90	571
1995	120	49	128	114	8	0	0	6	3	76	183	197	884
1996	212	326	110	72	24	0	3	10	1	130	51	138	1077
1997	61	21	225	28	85	3	7	0	27	60	206	54	777
1998	99	51	33	0	0	0	0	0	66				249
Average	**121**	**123**	**114**	**44**	**20**	**1**	**2**	**3**	**28**	**99**	**132**	**119**	**745**

Table 2.2.3. shows pre-mining number of days in each month from 1986 to 1993 with measurable precipitation.

Table 2.2.3 – Monthly and Annual Days of Rainfall at Kromdraai Liming Plant (mm/month and mm/year)

Month	1986/87	1987/88	1988/91	1989/90	1990/91	1991/92	1992/93	Average
Mar	6	12	8	6	9	15	5	8.7
Apr	7	4	3	7	7	1	4	4.7
May	-	1	-	3	3	1	-	1.1
Jun	2	-	4	4	-	4	-	2.0
Jul	-	-	2	-	1	-	-	0.4
Aug	1	4	-	1	-	-	2	1.1
Sept	-	10	6	1	2	2	1	3.1
Oct	6	8	11	6	6	5	10	7.4
Nov	12	18	13	11	11	10	7	11.7
Dec	13	12	12	12	15	10	10	12.0
Jan	13	7	8	9	13	11	10	10.1
Feb	8	6	11	10	9	8	13	9.3
Total	68	82	78	70	76	67	62	71.9

Table 2.2.4. shows the number of days in each month since mining commenced at Kromdraai opencast mine in 1993.

Table 2.2.4 – Monthly and Annual Days of Rainfall at Kromdraai Liming Plant (mm/month and mm/year)

Month	1993/94	1994/95	1995/96	1996/97	Average
Mar	7	9	6	15	9
Apr	2	7	9	3	5
May	0	2	3	5	3
Jun	0	0	0	2	1
Jul	0	0	1	1	1
Aug	0	2	4	0	2
Sept	1	2	1	3	2
Oct	7	8	10	8	8
Nov	7	13	8	11	10
Dec	6	11	11	5	8
Jan	14	8	14	8	11
Feb	6	4	18	3	8
Total	50	66	85	64	66

2.2.3. Maximum Rainfall Intensities per Month

The storm event figures for both the Kromdraai and Navigation areas have not been recorded. Table 2.2.5. shows the rainfall records available from the Witbank Municipality.

Table 2.2.5. – Average Rainfall and 24 hour Storm Events Recorded by Witbank Municipality for the period May 1956 to January 1992

Month	Average (mm)	Max. In 24 hrs.	
		(mm)	Date
Jan	132	76	81.01.23
Feb	83	94	84.02.26
Mar	81	88	91.03.17
Apr	48	66	60.04.23
May	14	30	56.05.10
Jun	9	54	89.06.04
Jul	9	28	57.07.02
Aug	8	24	87.08.25
Sep	30	51	81.09.10
Oct	82	77	58.10.21
Nov	123	61	83.11.20
Dec	104	62	89.12.23

2.2.4 Mean Monthly Maximum and Minimum Temperatures

The nearest weather stations at which these data have been recorded are Carolina and Bethal. These figures are not believed to represent climatic conditions in the Witbank region and have therefore not been included, but will be made available on request.

2.2.5 Mean Monthly Wind Direction and Speed

The nearest weather stations at which these data have been recorded are Carolina and Bethal. These figures are not believed to represent climatic conditions in the Witbank region and have therefore not been included, but will be made available on request.

2.2.6 Mean Monthly Evaporation

The mean monthly evaporation for Witbank Dam is presented in table 2.2.6.

Table 2.2.6 – Mean Monthly Evaporation (mm/month) at Witbank Dam for the Period March 1963 to September 1998 (Symons Tank).

Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept
170	165	174	178	144	136	100	81	68	74	100	136

2.2.7 Incidence of Extreme Weather Conditions

There are no suitable records of extreme weather conditions, however if required these may be extracted from the records of the nearest weather station.

2.3 Topography

The topography of the area is illustrated on the Government topocadastral maps numbered 2529 CC and 2529 CA on a scale of 1:50 000. Also available are orthophoto plans to a scale of 1:10 000 with surface contour intervals of 5 metres. The most recent aerial survey of the area was carried out in 1991. In future the mining area will be flown as necessary for planning and control purposes.

2.3.1 Kromdraai

Figure 2.4 shows in more detail the topography of the Kromdraai opencast mine.

The north - south axis of the reserve area forms a topographic ridge that dips from 1 540m above MSL over the South Block to 1 480m at the extreme north of the North Block. The gently undulating surface dips to the west and east away from this ridge.

The unpolluted stormwater runoff is towards the Suikerboschkopspruit in the north, the Kromdraaispruit in the west and the Klipspruit in the east.

The following has disturbed the topography:

- Surface subsidence caused by collapsing of the old underground mine workings.

- The old Kromdraai mine village, coal treatment plant and discard disposal site.

- Recent minipit mining operations carried out by Anglo Coal.

- A South African Defence Force (SADF) ammunition depot, at South Shaft.

- Acid water is generated from the defunct underground workings and is treated in a High Density Sludge liming plant, which is located at the head of the Kromdraaispruit. The effluent from this flows into the Kromdraaispruit. The sludge, which is produced by the liming plant, is a mine waste and is deposited in a yellow buoy dam, which is situated above the evaporation ponds. This waste falls under the Environmental Conservation Act of 1989 which declares that it is not necessary to apply for a section 20 permit. Currently the disposal of yellow buoy is being investigated as to disposal methods and nature of the sludge.

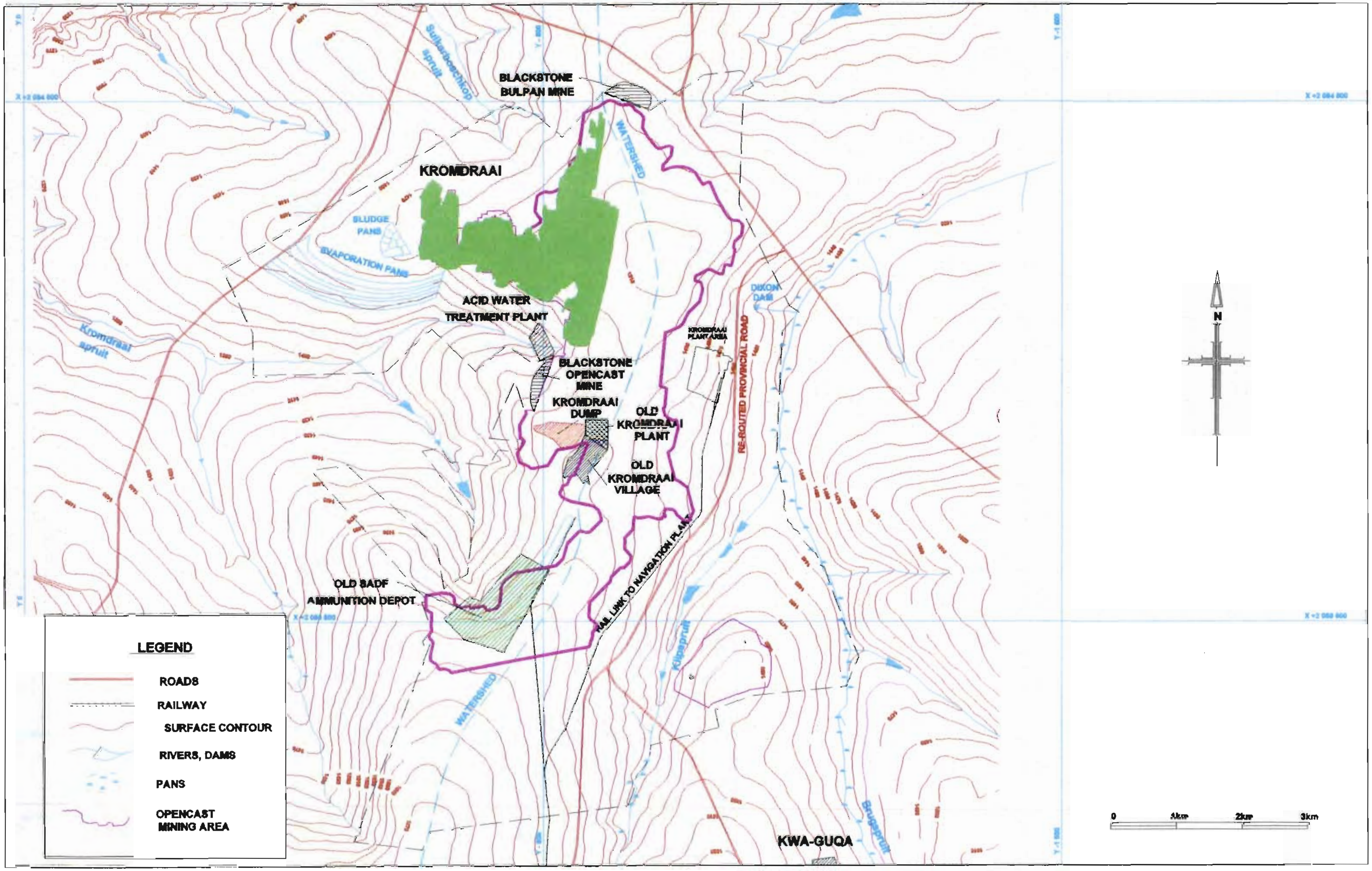

FIGURE 2.4 TOPOGRAPHY OF KROMDRAAI AREA

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- A number of minipit operations bordering the reserve area including the old Blackstone mining operations and the old Bulpan mine which are still evident to the south west of the liming plant and along the northern boundary.

- The R432 road which ran through the middle of the reserve area and which has been relocated to the east, adjacent to the coal reserves.

- The old Kromdraai/Clewer railway line.

2.3.2 Navigation

The following has disturbed the topography:

- The Kromdraai/Navigation railway line.

- The presence of old coal discard dumps (Schoongezicht I, II & III, Navigation and the Anglo-French dumps) and shafts, which form part of Landau Colliery. Redemption of these dumps is addressed in section 6.3.3.4.

- The old Navigation hostel and sewage works.

- The Hayford Colliery coal siding.

2.4 Soil

2.4.1 Soils of the Kromdraai Opencast Mining Area

Professor J.M. de Villiers was commissioned to report on the soil depth, soil classification and land capability of the area. (See Supplementary Reports 1 and 2).

The soil cover consists of an association that is typical of the Eastern Highveld but without a bottomland component. Essentially the pattern is made up of red and yellow soils of moderate depths plus interposed shallow grey-brown soils (See Figures 2.5 and 2.6)

2.4.2 Soils of the Navigation Plant and Discard Areas

After investigations the most suitable site for the discard dump was selected on the farm Blaauwkrans approximately one kilometre from the Navigation plant. The site is situated upon deep underground reserves, which have been partially mined. (Refer to section 3.2.6) The area that the dump occupies has been estimated at 114 hectares. A soil survey of the discard disposal site was carried out by Dr. H.V.H. van der Walt and Dr. A.S. Classes. The results are included as Supplementary Report No.3.

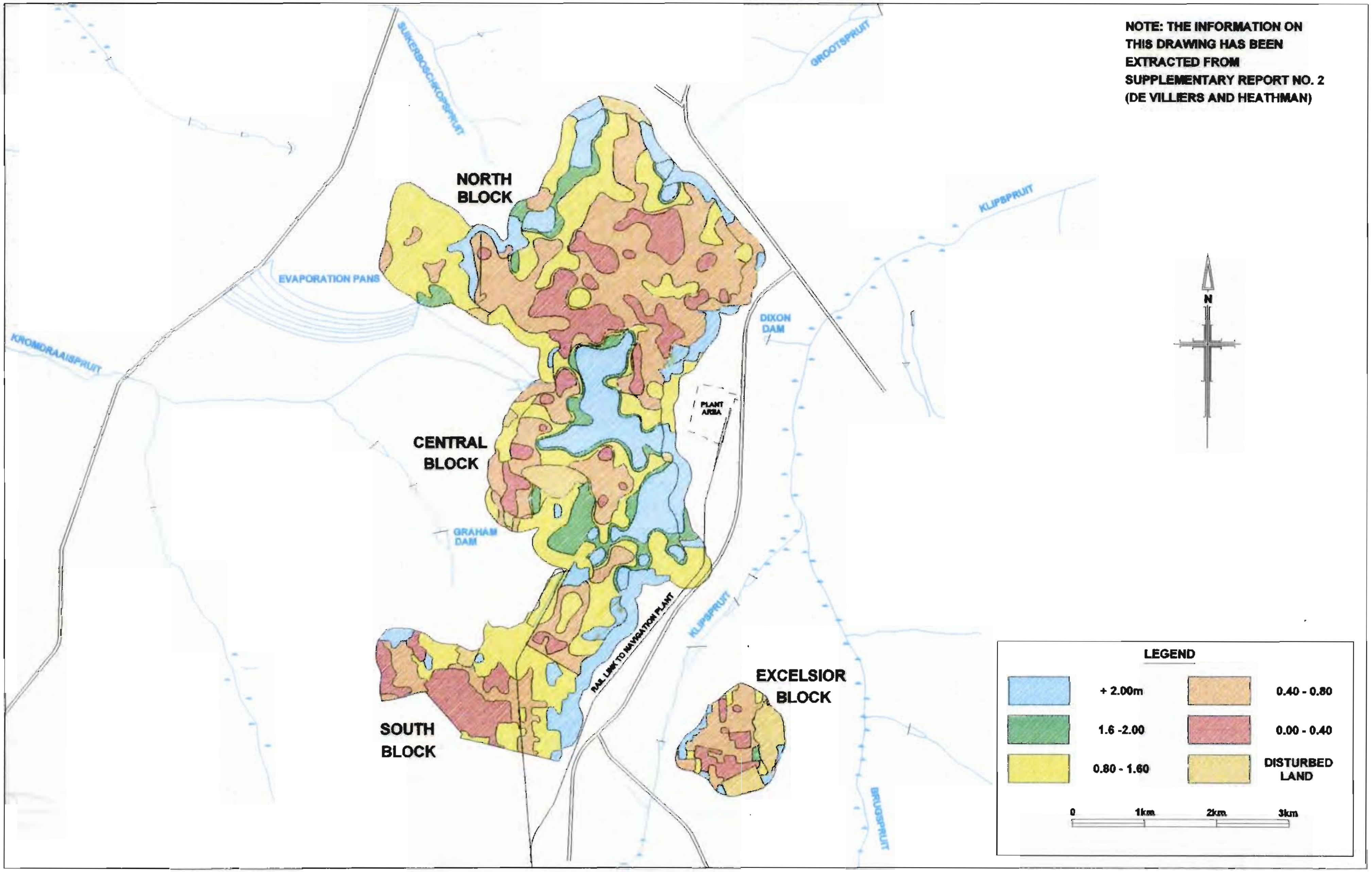

FIGURE 2.5 DEPTH OF USABLE SOIL

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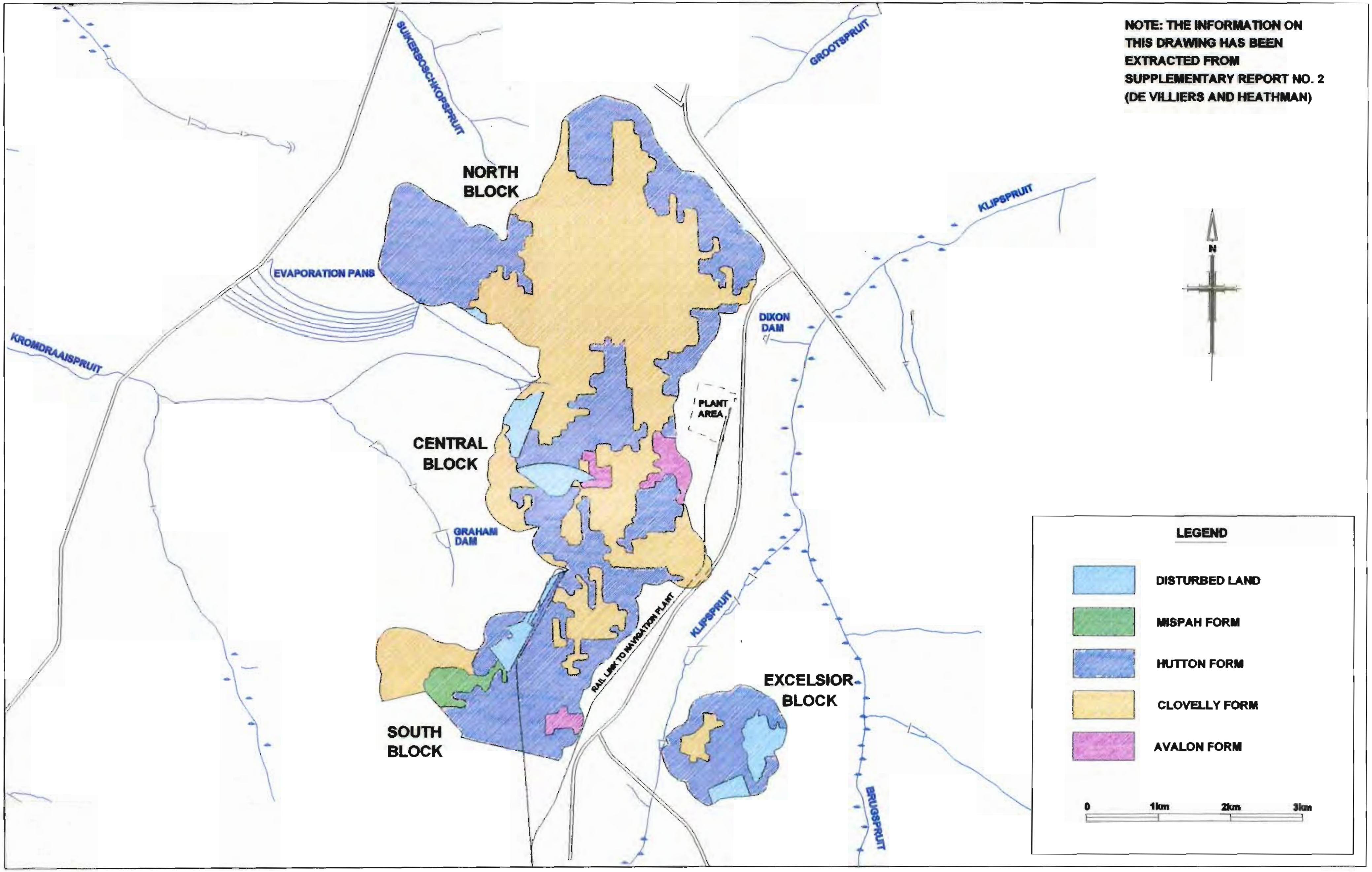

FIGURE 2.6 PRE-MINING SOIL TYPES

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2.5 Pre- Mining Land Capability

2.5.1 Kromdraai Opencast Mine

Supplementary Report No.1 is the rehabilitation report for the Kromdraai opencast mine submitted on the 21st December 1991 in terms of Regulation 5.12.1 of the Mines and Works Act, Act 27 of 1956. The results of the soil and land capability survey conducted by Professor J.M. de Villiers, which are contained in Supplementary Report No.2. are summarised in Table 2.5.1 and show that 64% of the area has arable potential and 24% has grazing potential, provided climatic and economic conditions are favourable. Figure 2.7 is a plan of the pre-mining land capability at Kromdraai.

It is significant to note that the instability of the surface over the previously mined underground area has prevented the utilisation of most of the mining area for agricultural or any other purpose.

Subsequent to submission of Supplementary Report No.1 further work has been carried out on the Kromdraai area, the results of which are contained in Supplementary Report No.2.

Table 2.5.1 - Pre-Mining Land Capability at Kromdraai
(Area to be disturbed by opencast mining)
(Information taken from Supplementary Report No.2)

Land Capability	Hectares	% of Total
Wetlands	0	0
Arable Land	1 670	64
Grazing	627	24
Wilderness	191	8
Disturbed Land	116	4
Total	**2 604**	**100**

2.5.2 Navigation Plant and Blaauwkrans Discard Site

The land on which the Navigation Plant is built has not been used for agricultural purposes due to the presence of buildings and foundations of an old plant and is therefore classed as disturbed land.

The area on which the Blaauwkrans discard dump is currently being built was previously utilised for agricultural purposes. Pre-mining land capability of the area is described in Supplementary Report No.3. Table 2.5.2 summarises the pre-mining land capability.

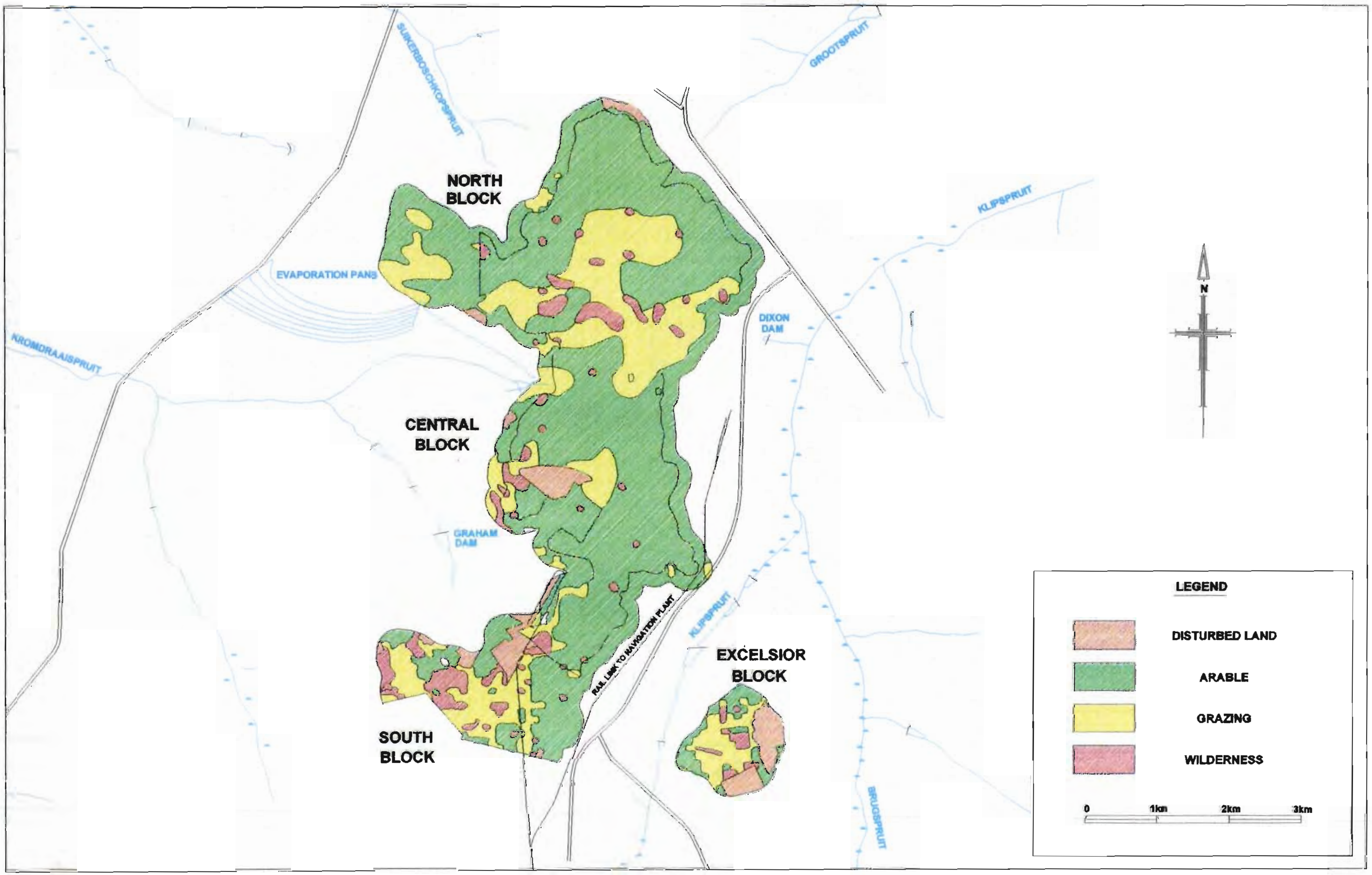

FIGURE 2.7 KROMDRAAI PRE-MINING LAND CAPABILITY

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Table 2.5.2 - Pre-Mining Land Capability at the Discard Dump
(Information taken from Supplementary Report No.3)

Land Capability	Hectares	% of Total
Arable	70	61
Grazing	25	22
Dwellings	15	13
Roads	4	4
TOTAL	**114**	**100**

2.6 Land Use

2.6.1. Pre-Mining Land Use

2.6.1.1 Kromdraai Opencast Mine

Numerous subsidences of the land surface have occurred in this area as a result of previous underground mining operations. More subsidence is likely to follow in the future. For this reason pre-mining landaus for the Kromdraai area is presented in Table 2.6.1

Table 2.6.1 - Pre-Mining Land Use at Kromdraai
(Source: AAC Civil Engineering Environmental Division, October 1992)

Land Use	Hectares	% of Total
Dumps	100	3.8
Roads	26	1.0
Dwellings	99	3.8
Opencast Mining	34	1.3
Evaporation Ponds	67	2.6
Dams	8	1.3
Fallow Land	2 270	87.2
Total	**2 604**	**100**

2.6.1.2 Run-of-Mine Railway Line

The railway line is shown in Figure 2.8. The route from Kromdraai runs parallel to the new road R432 through open farmlands. At point B it joins the existing siding 237 from Trans Alloys. Between points A and B a new track has been constructed. The soils and pre-mining land capability of this section are covered under Sections 2.4 and

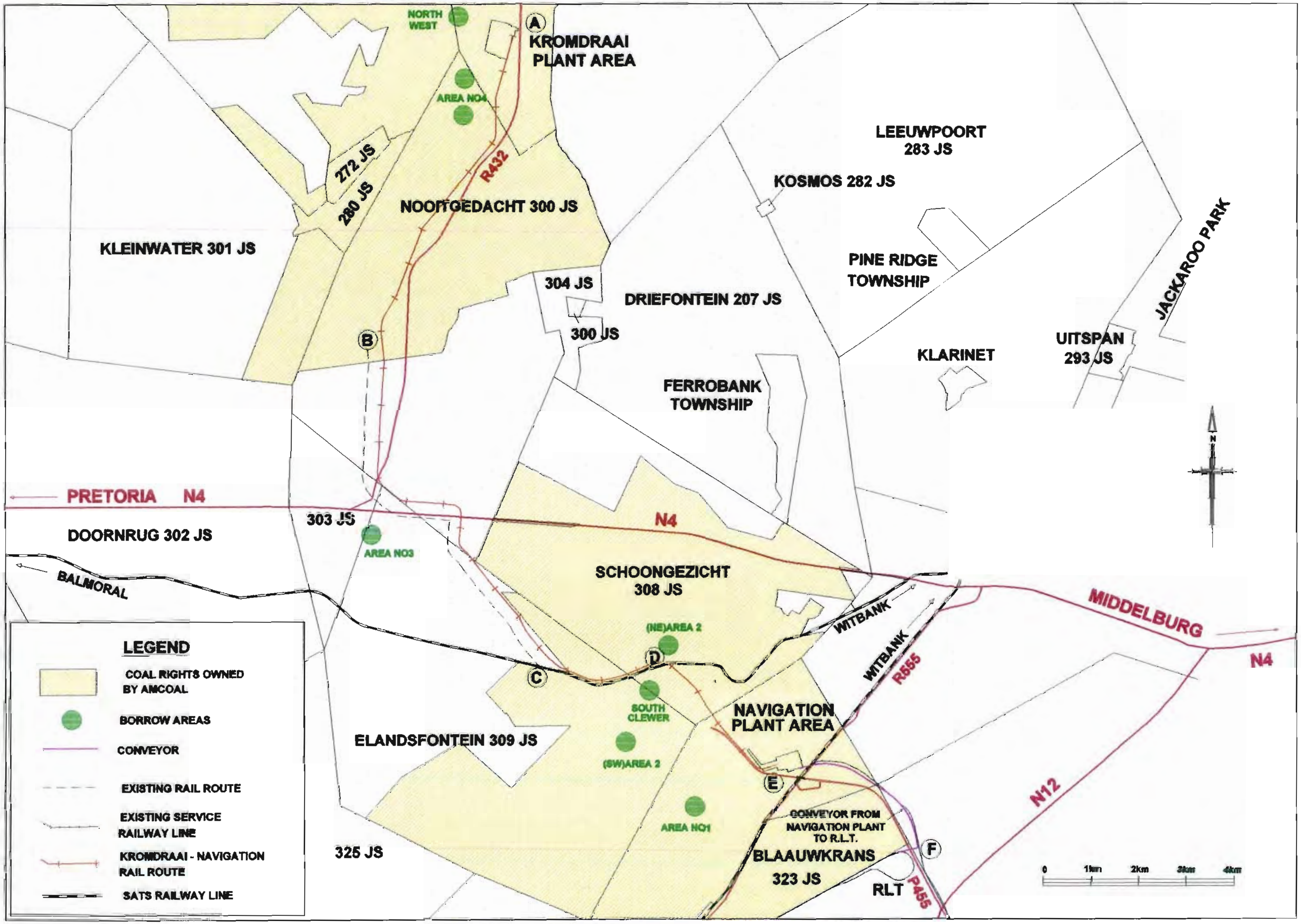

FIGURE 2.8 COAL TRANSPORT : KROMDRAAI TO RLT

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2.5. The pre-mining land use of this section is included in Table 2.6.1. From point B, the railway line is constructed on the existing railway line servitude through farmlands until it joins up with the Balmoral-Witbank line at point C. From point C the line runs parallel to the Spoornet line through Clewer until it crosses the Spoornet reserve and continues on the old Clewer/Navigation railway line servitude.

Land use between Kromdraai and point B has been affected by the construction of a new section of track. From point B to Navigation there has been no change in the pre-mining land use.

2.6.1.3 Navigation Plant Site

The Navigation plant site occupies 29,5 hectares and has the following structures sited on it, namely :

· The old Navigation dump
· The old Navigation office block
· The Navigation sewage works
· Foundations of the old Navigation plant

In close proximity to the site is the old Navigation hostel, married quarters and recruiting centre. The secondary road (P455) from Clewer to Landau passes along the western boundary of the plant.

Due to the above-mentioned infrastructure the land is not used for any agricultural purposes.

2.6.1.4 Product Overland Conveyor Route

The conveyor route from the plant to the RLT is shown on Figure 2.8, E to F. A conveyor route was designed to minimise disturbance to farmland and took into account the aspects mentioned below.

Due to extensive undermining in the area, which has caused surface subsidence, a safe route for the conveyor had to be sought. As a result, a curved conveyor was designed to follow as closely as possible the existing old Blackhill-Wolwekrans Colliery railway line servitude. Successful negotiations were concluded with Rand Mines to utilise the servitude, and this has been registered.

Only a very short section of the conveyor crosses an area where surface subsidence has occurred. It appears from routine surveys that the collapsing has stabilised. Over this area, the conveyor structure rests on concrete sleepers which are readily levelled should any ground movement occur.

The conveyor from the plant discharges into a 6 400 ton concrete silo from which coal is withdrawn onto a conveyor that crosses the P455 road. The conveyor is capable of discharging into either of the two export train loadout silos in the RLT. With the conveyor following the old railway line servitude as closely as possible the disturbance to farmland has been minimised.

2.6.1.5 Navigation Plant Discard Dump Site

The area on which the discard dump is being built was previously utilised for agricultural purposes and was largely cultivated for maize (See Table 2.5.2).

2.6.2 Historical Agricultural Production

2.6.2.1 Kromdraai Opencast Mine

There is evidence that the land was ploughed for agricultural purposes possibly prior to underground mining activities. With the occurrence of subsidence due to underground mining the land has recently been used for grazing purposes.

2.6.2.2 Run-of-Mine Railway Line

The section of track AB shown on Figure 2.8 has been used for grazing purposes. There is evidence of cultivation having taken place in this area.

2.6.2.3 Navigation Plant Site

Due to the presence of the old Navigation plant site there is no historical evidence of agricultural production.

2.6.2.4 Product Overland Conveyor

The overland conveyor route selected made use of an old railway line servitude thus minimising the impact on agricultural land used predominantly for cultivation of maize.

2.6.2.5 Navigation Plant Discard Dump Site

Prior to construction of the discard dump the area was cultivated mainly for maize production.

2.6.3 Evidence of Misuse

2.6.3.1 Kromdraai Opencast Mine

The only evidence of agricultural misuse has been the overgrazing of certain areas prior to opencast mining commencing. In addition areas have been allowed to be invaded by Acacia (wattle) and Eucalyptus (gum).

Misuse of the land due to previous underground mining operations is evident by the presence of sinkholes where collapses of the old underground workings have occurred.

2.6.3.2 Run-of-Mine Railway Line

No misuse of land is evident along the route of the old and new railway line sections.

2.6.3.3 Navigation Plant Site

The land has been used as a plant and discard dumpsite for many years. The presence of the old Navigation discard dump has resulted in acid mine drainage (AMD) which has polluted the Schoongezichtspruit Valley. Navigation dump still has some saleable coal in it and it is planned that during the life of mine the saleable coal will be mined and the revenue generated from the sale of the coal will be used to rehabilitate the dump.

2.6.3.4 Product Overland Conveyor

This route was previously used as a railway line servitude. The areas on either side of the route have been mined by underground bord and pillar methods with extensive collapsing having taken place in the area close to the RLT.

2.6.3.5 Navigation Plant Discard Dump Site

Situated on the site is the old Anglo-French discard dump and plant site as well as an old brickwork's quarry. The Anglo-French dump is owned by Landau Colliery and it will be encapsulated by the new Blaauwkrans dump during the operational phase.

A pollution plume in the sub-surface water to the south of the Anglo-French mine dump has been identified.

The old brickwork's quarry is currently being used as a source of water for stock watering purposes by a neighbouring farmer.

2.6.4 Existing Structures (Prior to development of the project)

2.6.4.1 Kromdraai Opencast Mining Area

Supplementary Report No.4 describes the buildings and structures on neighbouring properties. Buildings and structures occurring on the area to be disturbed by opencast mining are the following :

- Staff housing used by the old Kromdraai underground mine
- Concrete structures of the old underground mine plant
- The old Kromdraai mine hostel
- Various old shafts
- Various old farm dwellings
- An old trading store

2.6.4.2 Run-of-Mine Railway Line

No structures exist on this route.

2.6.4.3 Navigation Plant Site

Supplementary Report No.4 describes the buildings and structures on neighbouring properties.
Buildings and structures occurring on the area of the plant site are:

- The old Navigation mine office blocks, which have been renovated for use for the new plant.
- The Navigation sewage works
- The old Navigation hostel and adjoining trading store

2.6.4.4 Product Overland Conveyor

No existing structures occur on this route.

2.6.4.5 Navigation Plant Discard Dump Site

There was an informal settlement of farm labour on part of the dumpsite, which has been relocated by the farmer from whom the land was purchased. Negotiations with the farmer took place and a new site was found on land owned by him. All concerned were consulted and were in agreement with the arrangements for the relocation.

2.7 Natural Vegetation/Plant Life

2.7.1 Kromdraai Opencast Mine

A vegetation survey on and off the area to be disturbed by mining at Kromdraai was conducted by Mr. P.A. Pieterse of the University of Pretoria in December 1991 (Supplementary Report No.5) and commented on by Professor N.F.G Rethman in December 1991(Supplementary Report No.6). The vegetation of the area was investigated and reported on under the headings of Botanical Composition, Basal Cover, Vigour and Visible Erosion at each of 16 sites, 13 at Kromdraai and 3 at Excelsior (See Figure 2.9). The vegetation of the area falls into Acock's Veld Type 61c (Bankenveld).

The off mining area represents a range of grassland condition from 8% to 17% cover with vigour ranging from 1 to 3,5 (on a scale of 1 to 5) and composition varying from climax veld to old land. In terms of productivity the relative grazing capacity varies from 1,5 to 2,0 Ha/MLU to 4 to 5 Ha/MLU. (MLU = Mature Livestock Units). To place this in perspective, the potential of excellent veld under these ecological conditions would be in the region of 1,5 Ha/MLU. On the grassland area which is to be mined the grazing capacity, i.e. 3,0 to 3,5 Ha/MLU is very much lower than the potential of the veld in good condition, i.e. 1,5 Ha/MLU.

In terms of land capability, high potential arable soils are currently producing 2 000 kg of dry material per hectare. Under planted fertilised pastures these same soils have the potential to produce 10 000 to 12 000 kg dry material per hectare. The results of the vegetation survey are summarised in Table 2.7.1.

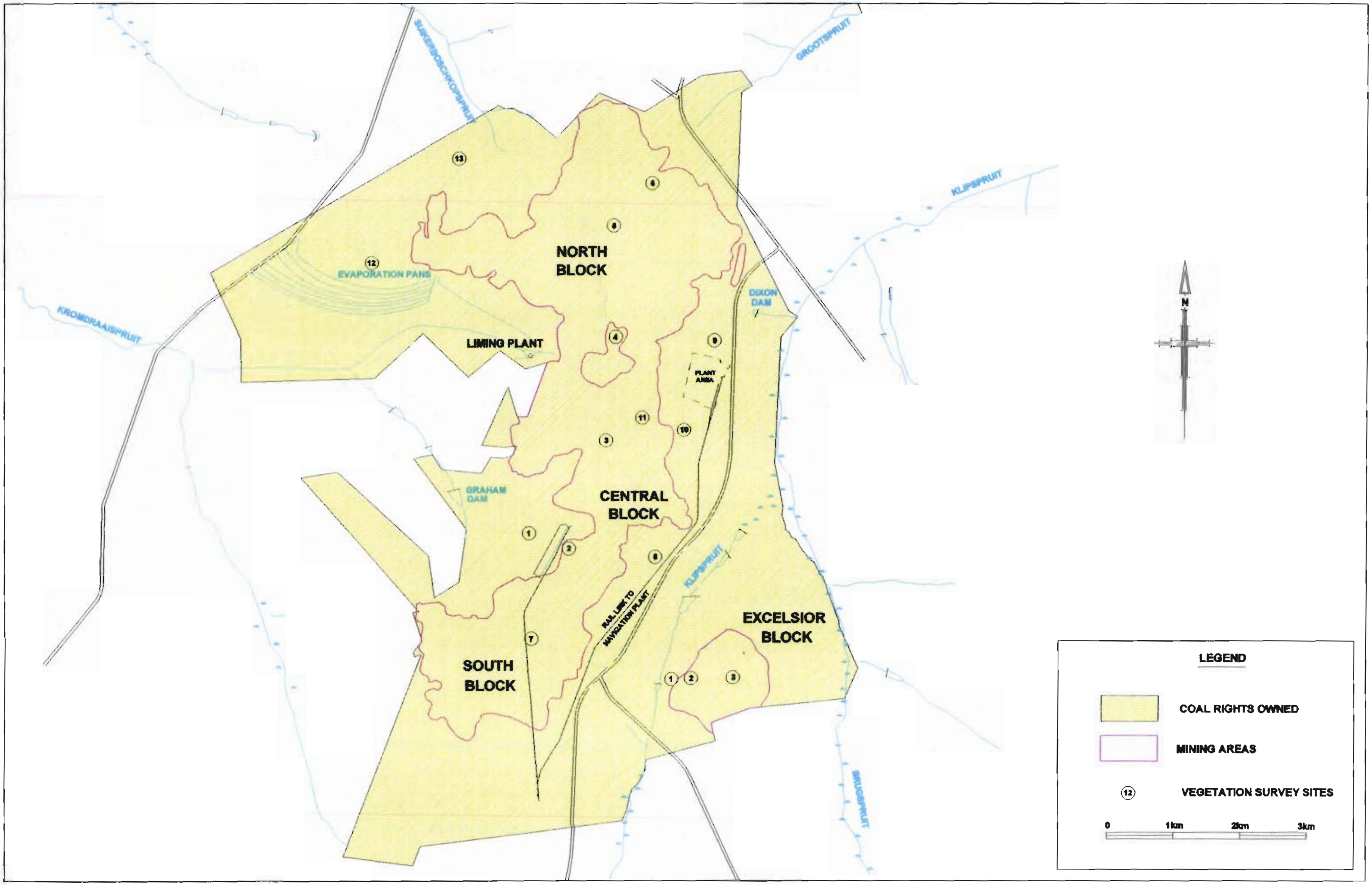

FIGURE 2.9 LOCATION OF VEGETATION SURVEY SITES - KROMDRAAI OPENCAST

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Table 2.7.1 – Vegetation Survey

SITE No	SLOPE	SHEET EROSION	VIGOUR	MAJOR SPECIES AND % COMPOSITION		% BASAL COVER
1 (CENTRAL)	<5degSE	3	1	*Themeda triandra*	*67%*	17%
				Eragrostis nindensis	*8%*	
				Heteropogon contortus	*8%*	
				Eragrostis curvula	*7%*	
2 (CENTRAL)	+/-Odeg	2	25	*Sedges*	*28%*	11%
				Eragrostis curvula	*21%*	
				Eragrostis nindensis	*18%*	
				Heteropogon contortus	*17%*	
				Digitaria agyrograpta	*14%*	
3 (CENTRAL)	<5degNE	1.5	2.5	*Digitaria agyrograpta*	*28%*	12%
				Heteropogon contortus	*15%*	
				Hyparrhenia hirta	*13%*	
				Sedges	*13%*	
				Eragrostis nindensis	*12%*	
4 (NORTH)	+/-Odeg	1.5	1.5	*Eragrostis curvula*	*32%*	18%
				Digitaria agyrograpta	*24%*	
				Sedges	*15%*	
				Eragrostis nindensis	*12%*	
				Heteropogon contortus	*7%*	
5 (NORTH)	<5degNE	2.5	3.5	*Themeda triandra*	*23%*	7%
				Eragrostis nindensis	*9%*	
				Herbs	*7%*	
				Brachiara serrata	*5%*	
				Sedges	*5%*	
				Tristachya rehmanni	*5%*	
6 (NORTH)	<5degN	2.5	3.5	*Eragrostis curvula*	*46%*	6%
				Melenis repens	*34%*	
				Aristida spp	*6%*	
				Eragrostis chloromela	*3%*	
				Perotis patens	*3%*	
7 (SOUTH)	+/-Odeg	2	3.5	*Eragrostis curvula*	*32%*	11%
				Digitaria agyrograpta	*31%*	
				Eragrostis nindensis	*15%*	
				Heteropogon contortus	*13%*	

Table 2.7.1 – Vegetation Survey continued :

SITE No	SLOPE	SHEET EROSION	VIGOUR	MAJOR SPECIES AND % COMPOSITION		% BASAL COVER
8 (CENTRAL)	<5degE	1.5	3.5	*Eragrostis curvula*	*40%*	15%
				Sedges	*18%*	
				Digitaria agyrograpta	*16%*	
				Heteropogon contortus	*14%*	
				Eragrostis nindensis	*5%*	
9 (NORTH)	<5degNE	2	3.5	*Eragrostis curvula*	*32%*	*14%*
				Digitaria agyrograpta	*24%*	
				Themeda triandra	*15%*	
				Heteropogon contortus	*5%*	
10 (CENTRAL)	<5degNE	1	1.5	*Eragrostis curvula*	*43%*	*15%*
				Digitaria agyrograpta	*27%*	
				Eragrostis nindensis	*11%*	
				Sedges	*6%*	
11 (CENTRAL)	<5degS	2.5	1.5	*Eragrostis curvula*	*65%*	*8%*
				Digitaria agyrograpta	*16%*	
				Sedges	*7%*	
				Eleohantorhiza spp	*3%*	
				Heteropogon contortus	*3%*	
12 (NORTH)	5-10degS	1.5	2.5	*Eragrostis curvula*	*30%*	*14%*
				Digitaria agyrograpta	*29%*	
				Eragrostis nindensis	*11%*	
				Hyparrhenia hirta	*10%*	
				Sedges	*10%*	
13 (NORTH)	<5degNW	2	2.5	*Cynodon dactylon*	*37%*	*8%*
				Eragrostis curvula	*17%*	
				Sedges	*15%*	
				Digitaria agyrograpta	*12%*	
				Melenis repens	*12%*	
1 (Excelsior)	5-10degW	3	2	*Eragrostis curvula*	*40%*	*18%*
				Digitaria agyrograpta	*11%*	
				Melenis repens	*11%*	
				Sedges	*9%*	
2 (Excelsior)	5-10degW	2	4	*Heteropogon contortus*	*29%*	*15%*
				Eragrostis nindensis	*24%*	
				Eragrostis curvula	*16%*	
				Sedges	*10%*	
3 (Excelsior)	<5degW	3	4	*Sedges*	*20%*	*13%*
				Digitaria agyrograpta	*18%*	
				Eragrostis nindensis	*10%*	
				Heteropogon contortus	*10%*	
				Hyparrhenia hirta	*6%*	

Rating Scale for Vigour:

1- Relatively Large Tufts
5- Relatively Small Tufts

Rating Scale for Sheet Erosion:

1- No Visible Erosion
5- Severe Erosion

2.7.2 Run-of-Mine Railway Line

The vegetation survey carried out by Mr. P.A. Pieterse (Supplementary Report No.5) covers the vegetation over which the new section of railway line was constructed. Survey points 7, 9 and 10 shown on Figure 2.9 are in close proximity to the railway line and are therefore representative of the vegetation along the new section track.

2.7.3 Navigation Plant Site

Due to the presence of foundations, etc. of the old Navigation plant no vegetation survey was carried out on this area.

2.7.4 Product Overland Conveyor

As the product overland conveyor was constructed on an old railway line servitude no vegetation survey was carried out.

2.7.5 Navigation Plant Discard Dump Site

As this area was extensively cultivated for maize no vegetation survey was carried out.

2.8 Animal Life

2.8.1 Kromdraai Opencast Mining Area

A wild life and habitat report was prepared by Professor W. Van Hoven and is included as Supplementary Report No.7.

The objectives of the survey were:

- To determine the pre-mining distribution and species diversity of wild life in and around the mining area. This information is required to define base-line targets for managing the wildlife.

- To provide guidelines for managing the wild life before, during and after closure of the mine.

2.8.1.1 Commonly Occuring Species

Kromdraai falls within the natural distribution range of a variety of wild life species which are not endangered and which would be affected only in the short term by the mining operation. It is estimated that in excess of 98 bird species occur in the Kromdraai region. Owls, swallows, doves and bee-eaters have nested in the walls of old shafts and sinkholes. Warthogs, a variety of rodents, rabbits, porcupine, badgers, jackal, duiker, steenbok and aardvark are known to live in this area.

2.8.1.2 Endangered or Rare Species

Several other mammal species could possibly occur in the study area of which the first two species are classified respectively as vulnerable and indeterminate; and five other species as rare. They are :

- *Mellivora capensis* – Honey badger
- *Dasymys incomtus* – Water rat
- *Hyaena brunnea* – Brown hyena
- *Proteles cristatus* – Aardwolf
- *Felis serval* – Serval
- *Poecilogale albanucha* – Striped weasel
- *Civettictis civetta* – African civet

Three bird species, which are classified respectively as, endangered, vulnerable and rare (Brook 1984) could possibly occur in the study area. They are :

- *Turnix hottentotta* – Blackriumped buttonquail
- *Neotis denhami* – Stanley's bustard
- *Falc perequinus* – Perequine falcon

2.8.2 Run-of-Mine Railway Line

No animal life survey was carried out.

2.8.3 Navigation Plant Site

The animal life survey is covered in Supplementary Report No.7.

2.8.4 Product Overland Conveyor

No animal life survey was carried out.

2.8.5 Navigation Plant Discard Dump Site

The animal life survey is covered in Supplementary Report No.7.

2.9 Surface Water

2.9.1 Surface Water Quantity

The major streams in the vicinity of Kromdraai and Navigation form part of the Olifants River catchment, which is depicted in Figure 2.10. The Loskop dam, Witbank dam, Klipspruit, Saalklapspruit and the Olifants River form the bulk of the water supply and river network of this region. The receiving water body is the Loskop dam.

The surface water runoff from the Kromdraai mining area drains into the Kromdraaispruit, Suikerboschkopspruit and the Klipspruit. The location of these streams is shown on Figure 2.11. The opencast mining area drains into catchments 220 and 210 as shown on Figure 2.10.

Messrs. Stewart and Scott Inc. prepared a hydrogeological study of the Kromdraai and Navigation areas. The study covers the pre-mining, mining and post-closure periods, and has been included as Supplementary Report No. 8.

2.9.1.1 Streams and Catchments

The catchment boundaries and affected streams at Kromdraai and Navigation are shown on Figure 2.10.

2.9.1.2 Mean annual runoff

The mean annual runoff for the Kromdraai catchment is 12.01 x 10^6 m^3, which equates to 46 mm over the 246.32 km^2 catchment.

The mean annual runoff for the Navigation catchment is 0.73 x 10^6 m^3, which equates to 45 mm over the 16.12 km^2 catchment.

2.9.1.3 Normal dry weather flow

The normal dry weather flows in the affected watercourses have been classified as follows:

- Kromdraaispruit – perennial - only flow in winter is from Kromdraai liming plant ~ max. flow = 14 Ml/day (average flow ~ 6-7 Ml/day)
- Klipspruit - non-perennial

Information from the Wates, Meiring and Barnard Survey for the Olifants River Catchment is not in a format, which can readily be used for determining flows for the Kromdraaispruit and Klipspruit.

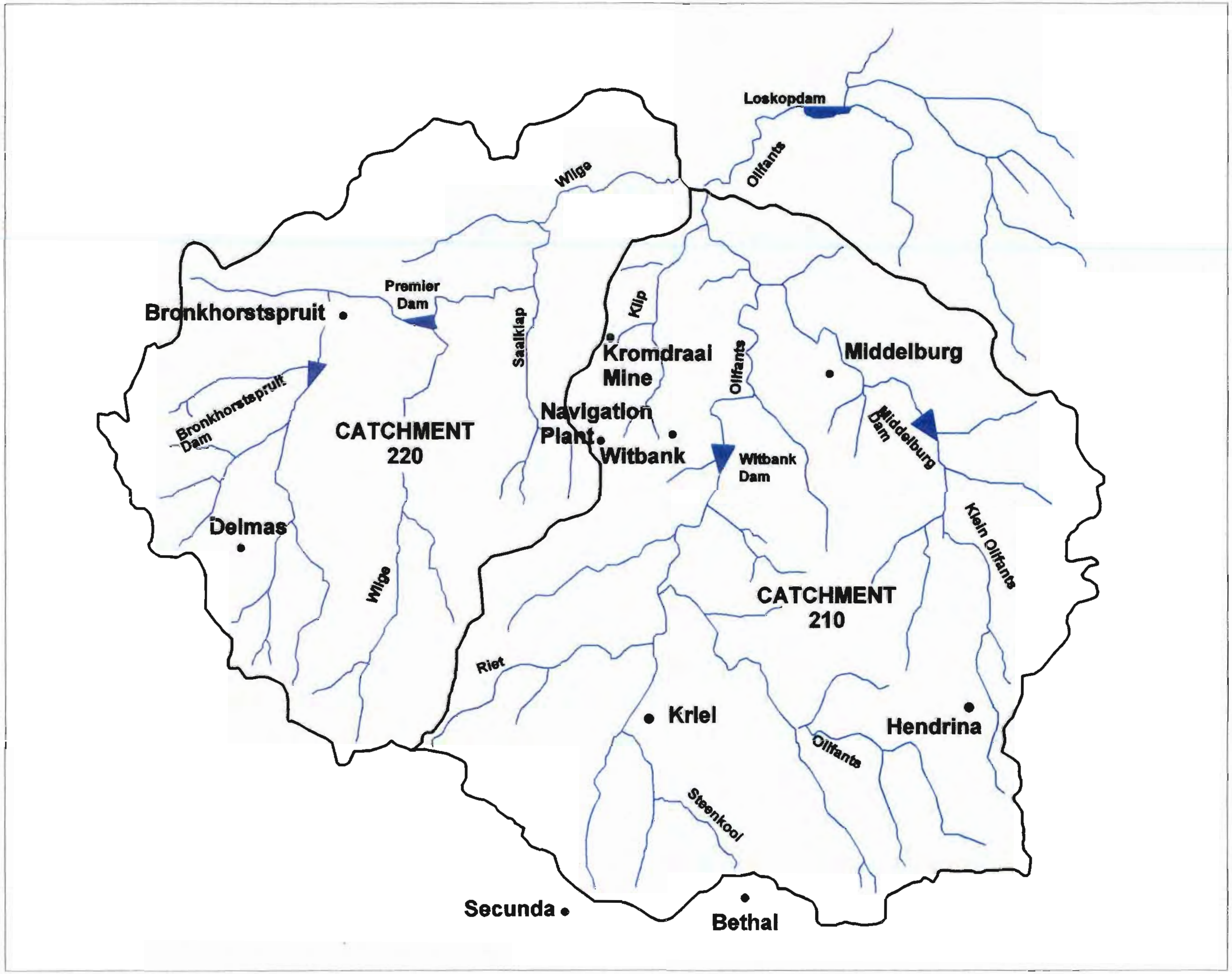

FIGURE 2.10 STREAMS AND CATCHMENTS OF THE UPPER OLIFANTS RIVER.

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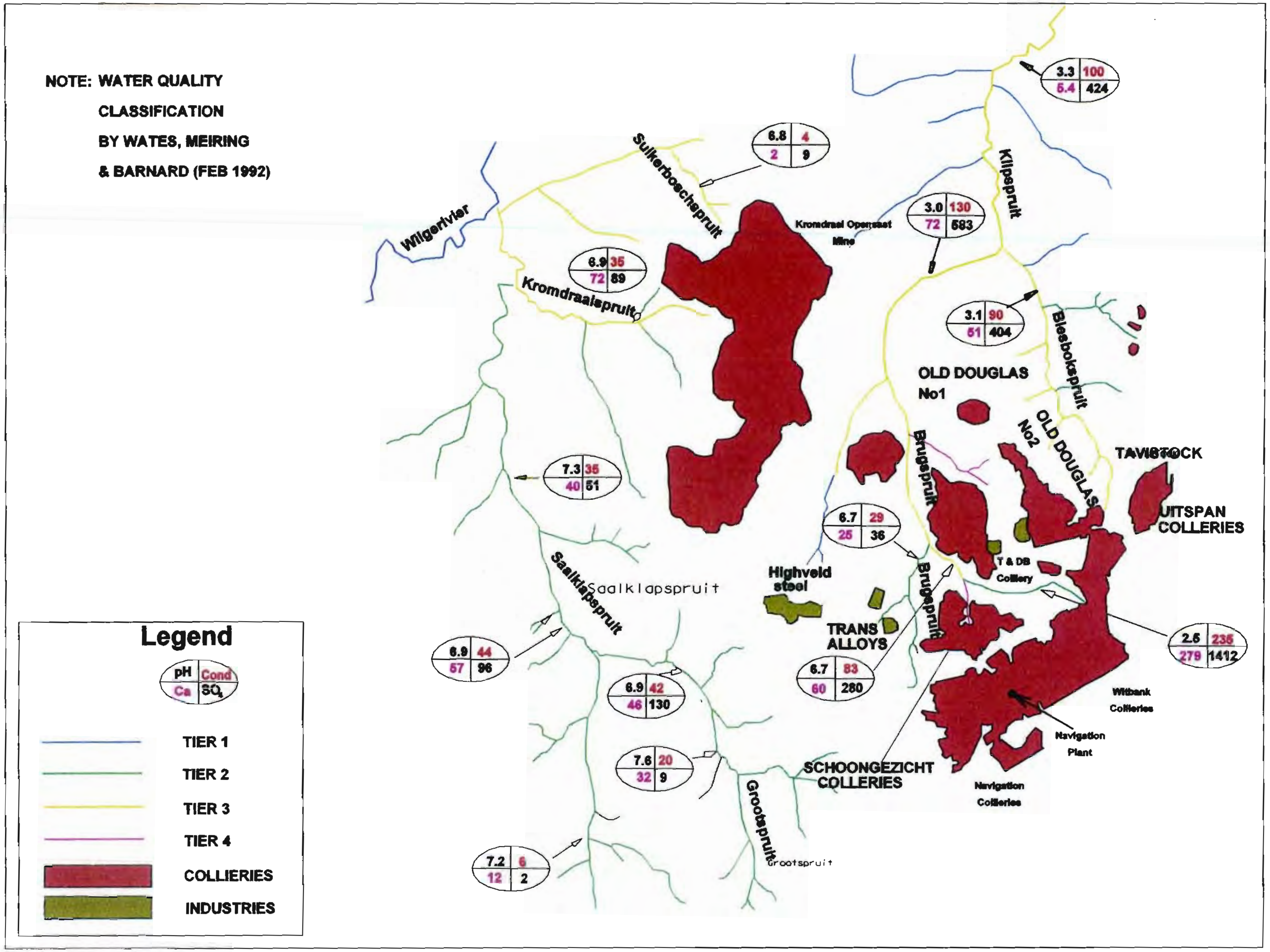

FIG 2.11 WATER QUALITY IN THE KROMDRAAI AREA

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2.9.1.4 Flood peaks

Flood flows have been estimated for the Kromdraaispruit at the point of discharge from the mining area and are presented in Table 2.9.1 below.

Table 2.9.1 - Estimated Flood Peaks for Kromdraaispruit

Return Period (yrs)	20	50	100
Flow (m^3/s)	153	223	298

2.9.2 Surface Water Quality

On account of mining, industrial and agricultural activity over the past 70 years the water quality of the Olifants River system has deteriorated. The conductivity of the water has increased from 60 mS/m in 1980 to 120 mS/m in 1987. This trend is equivalent to an increase of 111mg TDS/l/decade or 41 mg sulphate/l/decade entering the Loskop Dam. As a result the Department of Water Affairs and Forestry engaged a firm of consulting engineers, Wates, Meiring and Barnard, to develop a conceptual water quality management plan for the Witbank sub-region.

The chemical loads in the various streams in this region have been determined by (Wates, Meiring and Barnard, February 1992 - Supplementary Report No.9). These are summarised in Table 2.9.2 for the 95 percent pollution load reflecting the pollution flux during wet weather conditions and in Table 2.9.3 for the 50 percent pollution load reflecting the median pollutant flux.

Initial water quality estimates of the Klipspruit and Saalklapspruit, into which the mine ultimately drains are given in Figure 2.11. Low pH, high TDS and sulphate concentrations have been singled out as the most significant parameters.

Table 2.9.2 shows the 95 percentile pollution load reflecting the pollution flux during wet weather conditions (Wates, Meiring & Barnard, February 1992 - Supplementary Report No.9). Available base data is from the period January 1983 to July 1991. (See Figure 2.10 for localities of the streams).

2.9.2 – Chemical Loads on Streams Feeding the Loskop Dam –95 Percentile Pollution Load

	Olifants	**Klipspruit**
Catchment area (km2)	3 256	376
1.Total dissolved solids (TDS) -Kg/day -kg/km^2/day -percentage (kg/day)	 400 000 123 57	 80 000 213 2
2.Sulphate (as SO_4) -kg/day -kg/km^2/day -percentage (kg/day)	 110 000 34 42	 48 000 128 18
3.Alkalinity (as $CaCO_3$) -kg/day -kg/km^2/day -percentage (kg/day)	 110 000 34 68	 7 000 19 4
4.Ammonia (as N) -kg/day -percentage (kg/day)	 90 32	 140 50
5.Nitrate (as N) -kg/day -percentage (kg/day)	 750 61	 320 26
6. Orthophosphate (as P) -kg/day -percentage (kg/day)	 20 54	 5 12

Table 2.9.3 shows the 50 percentile pollution load reflecting a median pollutant flux after (Wates, Meiring &Barnard, February 1992 - Supplementary Report No.9). Available base data are from the period January 1983 to July 1991 (See Figure 2.10 for localities of streams).

Table 2.9.3 - Chemical Loads on Streams Feeding the Loskop Dam – 50 Percentile Pollution Load

	Olifants River	**Klipspruit**
Catchment area (km2)	3 256	376
1.Total dissolved solids (TDS)		
-kg/day	11 000	21 000
-kg/km^2/day	3,4	55,9
-percentage (kg/day)	29	56
2.Sulphate (as SO_4)		
-kg/day	4500	12000
-kg/km^2/day	1,4	31,9
-percentage (kg/day)	24,4	65,1
3.Alkalinity (as $COCO_3$)		
-kg/day	2300	100
-kg/km^2/day	0,71	0,27
-percentage (kg/day)	59	3
4.Ammonia (as N)		
-kg/day	1,3	7,5
-percentage (kg/day)	12,7	73,4
5.Nitrate (as N)		
-kg/day	4,5	90,0
-percentage (kg/day)	4,6	92,7
6.Orthophosphate (as P)		
-kg/day	0,30	0,60
-percentage (kg/day)	27	54

Wates, Meiring and Barnard proposed a framework to classify river water quality, which they divided into four tiers:

Tier 1 Stream in pristine natural condition and not impacted by human activity.

Tier 2 Stream quality in the acceptable range for all recognised downstream water users.

Tier 3 Stream water quality in the tolerable range are all recognised downstream users.

Tier 4 Stream water quality in the unacceptable range for one or more downstream water users

The status quo of the streams in this region has been classified into the above tier system and is depicted on Figure 2.11 for the Saalklapspruit and Klipspruit.

The Department of Water Affairs and Forestry tabled a water management strategy to prevent any further deterioration of water quality. The strategy is:

- Improve the water quality to a tolerable level (Tier 3) within five years
- Improve the water quality to an acceptable level (Tier 2) in the long term.

Figure 2.11 shows the water quality of the Kromdraaispruit to the west and Suikerboschkopspruit to the north and both tributaries of the Saalklapspruit, to be of an acceptable quality in terms of the DWA&F four-tier classification (as at August 1992).

The water from the Klipspruit to the east of the mining area, prior to the confluence with the Brugspruit, has been classified as a Tier 4 water quality (unacceptable for general use). This is mainly due to acid mine water seeping from disused mines upstream of Kromdraai. From the old workings at Excelsior water is piped into the Kromdraai Central Block for treatment in the liming plant.

Consideration is currently being given to installing pumps to dewater the old workings and prevent seepage along the sub-outcrop into the adjoining Klipspruit. After the confluence of the Brugspruit and the Klipspruit the water quality deteriorates marginally. This is largely due to the poor quality and higher flow in the Brugspruit. Table 2.9.4 shows indicative sulphate concentrations and pH of streams based on initial pilot sampling.

Professor F.D.I Hodgeson carried out further investigations on the Klipspruit and Brugspruit (report dated October 1992 and is attached as Supplementary Report No.10). The levels of contamination are quantified in this report. Pollution from the old Kromdraai underground workings has been identified as contributing to the pollution load.

Table 2.9.4 - Indicative Sulphate Concentrations and pH of Streams Entering and Leaving the Kromdraai Property
(Sampling carried out by SACE Environmental Officer)

Stream	Entry to Kromdraai		Exit from Kromdraai	
	pH	Sulphate (mg/l)	pH	Sulphate (mg/l)
Klipspruit	4,3	60	3,8	645
Brugspruit	5,9	287	-	-
Suikerboschspruit	-	-	5,0	18
Kromdraaispruit	-	-	5,0	161

A number of small dams in the Kromdraai area will not be detrimentally affected by the opencast operation. The water quality within the larger of these dams is presented in Table 2.9.5.

Table 2.9.5 - Water Quality of Dams within the Kromdraai Area
Sampling carried out during 1991 and 1992 by the SACE Environmental Officer. Samples were taken at discrete points around the dams at intervals of approximately 3 months.

	Graham Dam	Dixon Dam
Suspended Solids	<0,1	9,6
Conductivity (Ms/m)	31	174
pH	2,8	1,8
Sulphate (SO4)	84	1 035
Calcium (Ca)	9,6	16
Magnesium (Mg)	3,9	15
Iron as (Fe)	1,5	119

Some remedial work has been done to improve the quality of the water leaving Graham's dam and our weekly monitoring indicates that since November 1997 the pH has averaged at 6.9 and the sulphates at 580 mg/l. At Dixon dam a pump station was installed and pumps the acid water to the liming plant for treatment.

Figures 2.11 (a)(i) and 2.11 (a)(ii) show the locations of surface water monitoring points for the Colliery. Water quality results since 1990, when monitoring began, are summarised as whisker plots on Figure 2.11 (b) for Kromdraai and Navigation. Tables

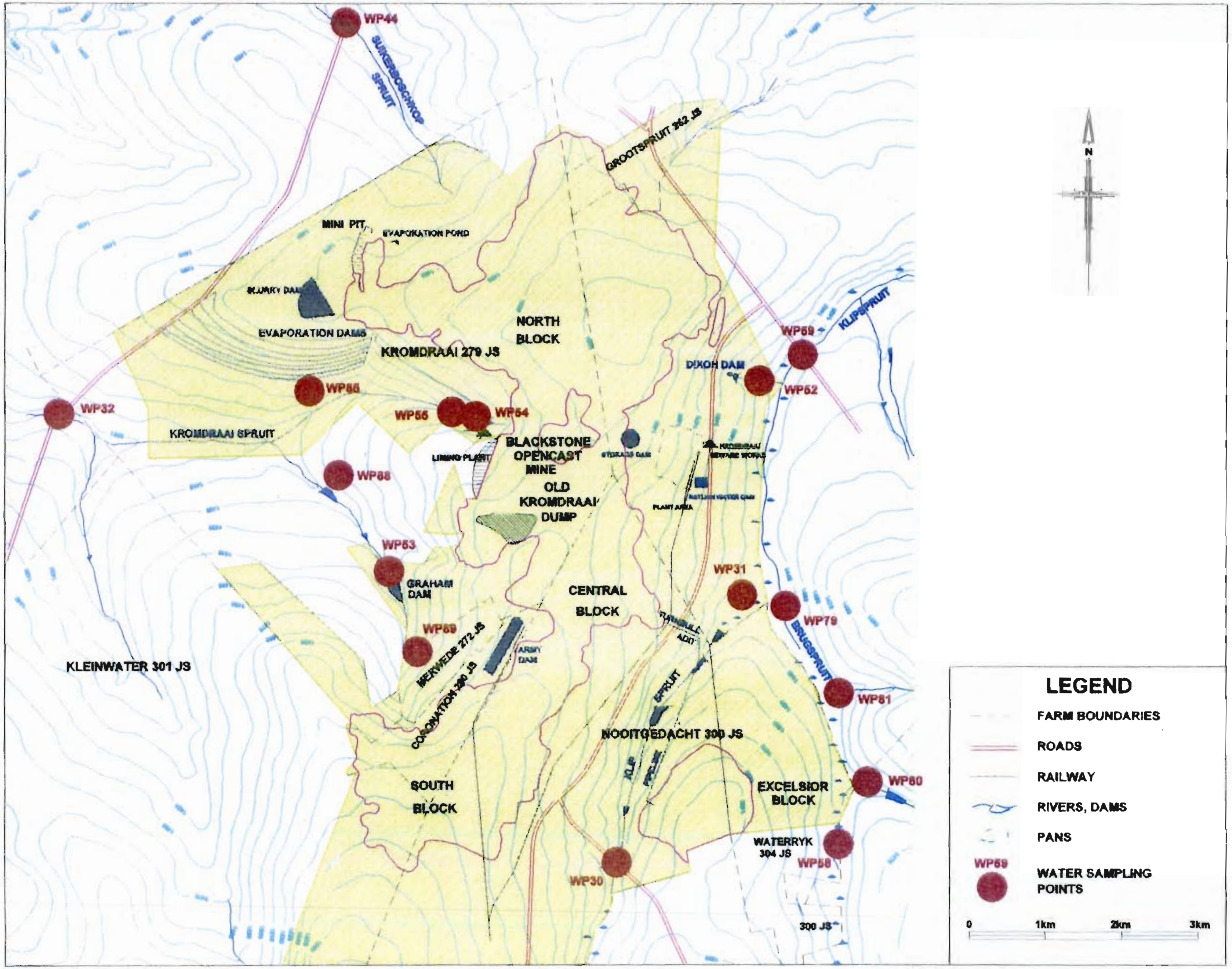

FIGURE 2.11(a)(i) LOCATIONS OF SURFACE WATER MONITORING POINTS : KROMDRAAI

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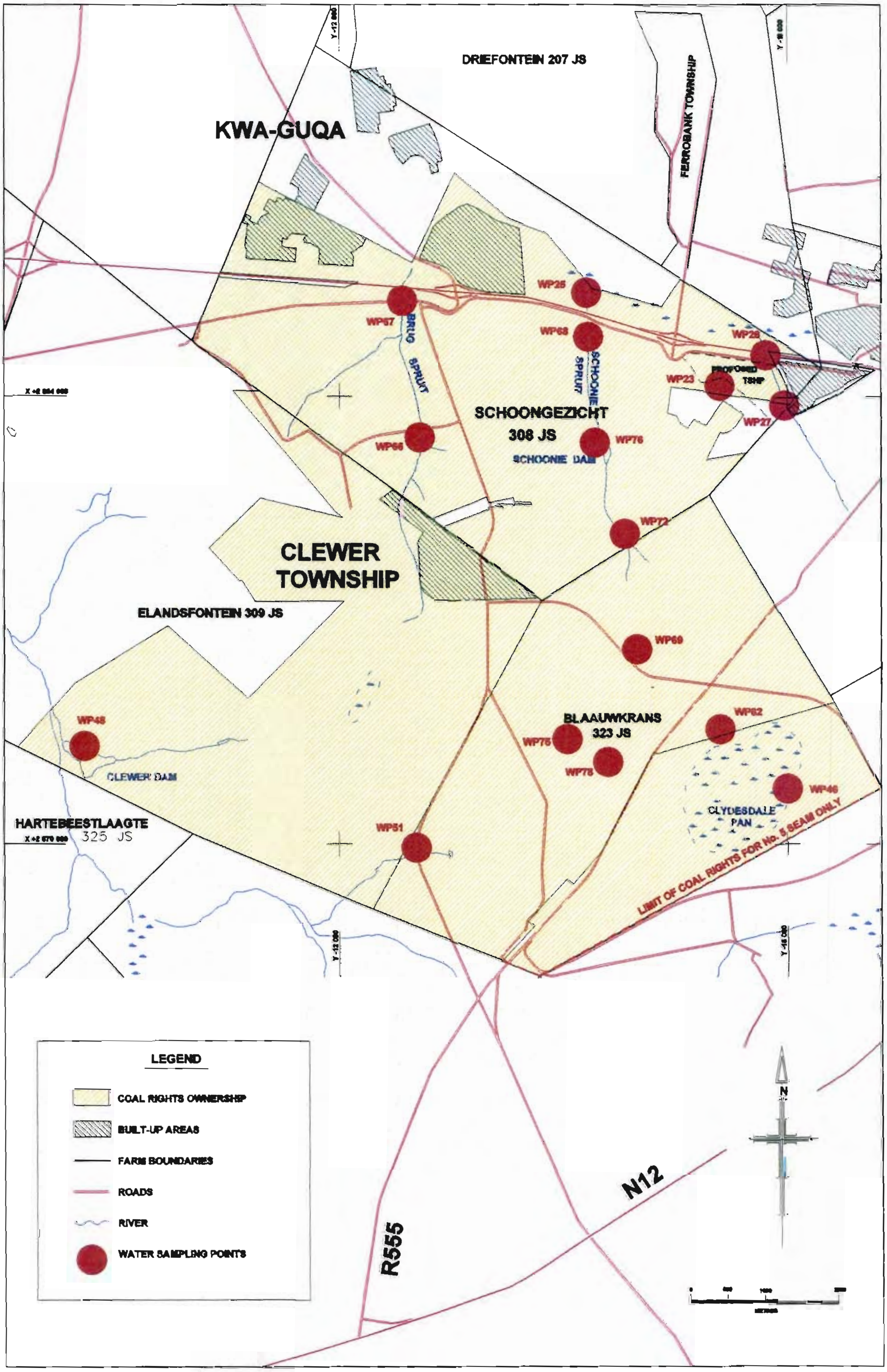

FIGURE 2.11(a)(ii) LOCATIONS OF SURFACE WATER MONITORING POINTS : NAVIGATION

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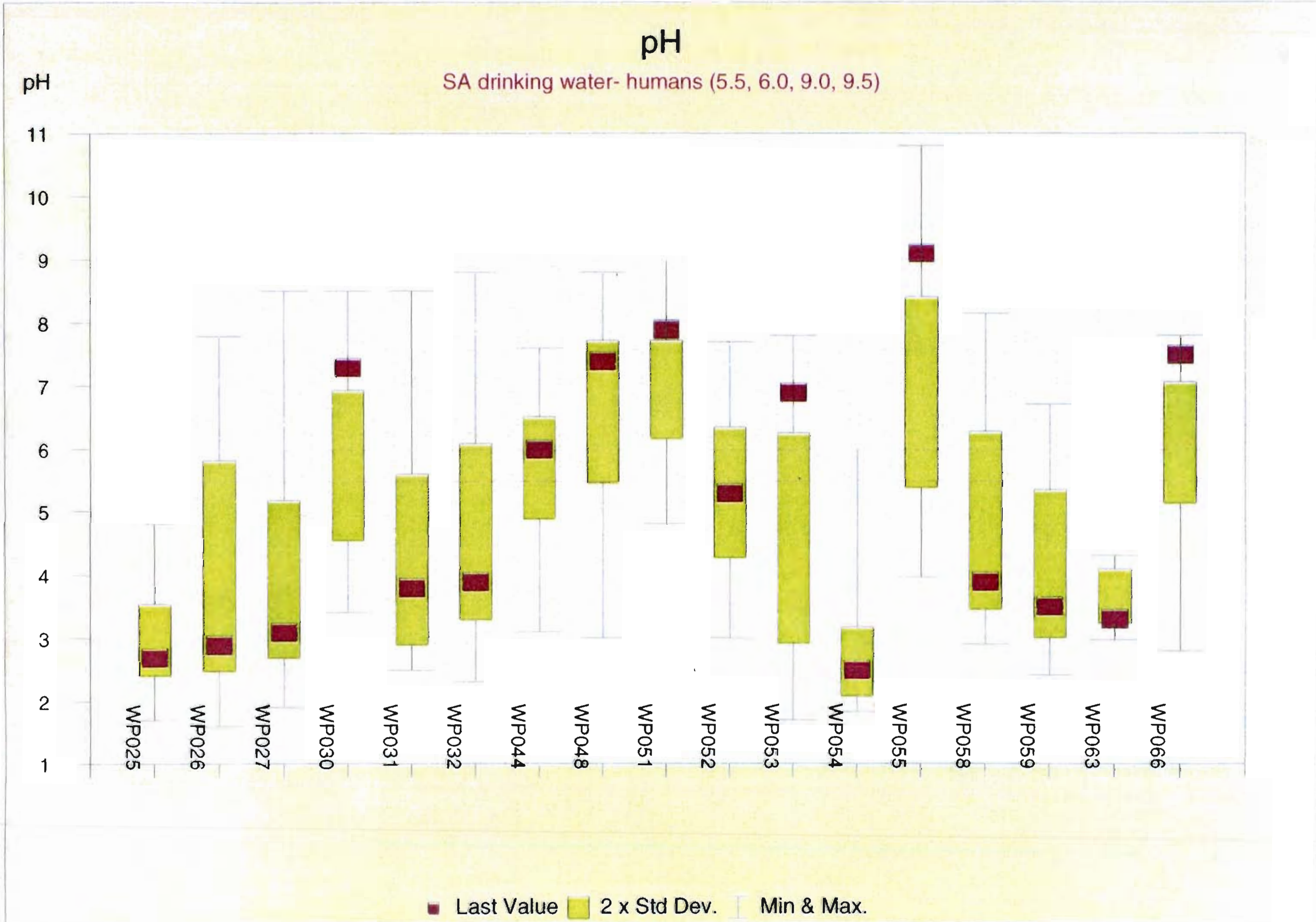

FIGURE 2.11(b) SURFACE WATER QUALITY WHISKER PLOT:SHEET 1OF6

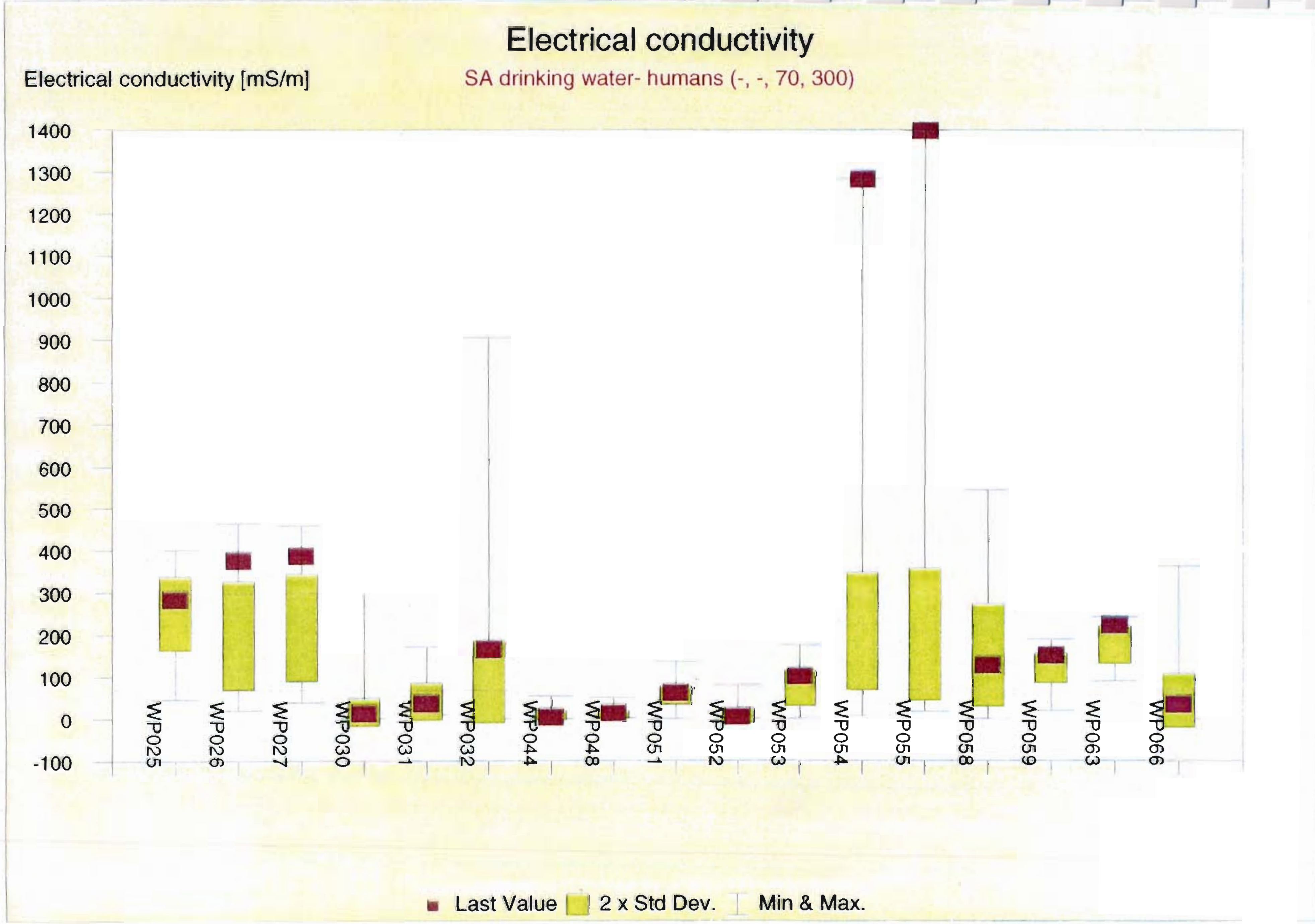

FIGURE 2.11(b) SURFACE WATER QUALITY WHISKER PLOT:SHEET 2 OF 6

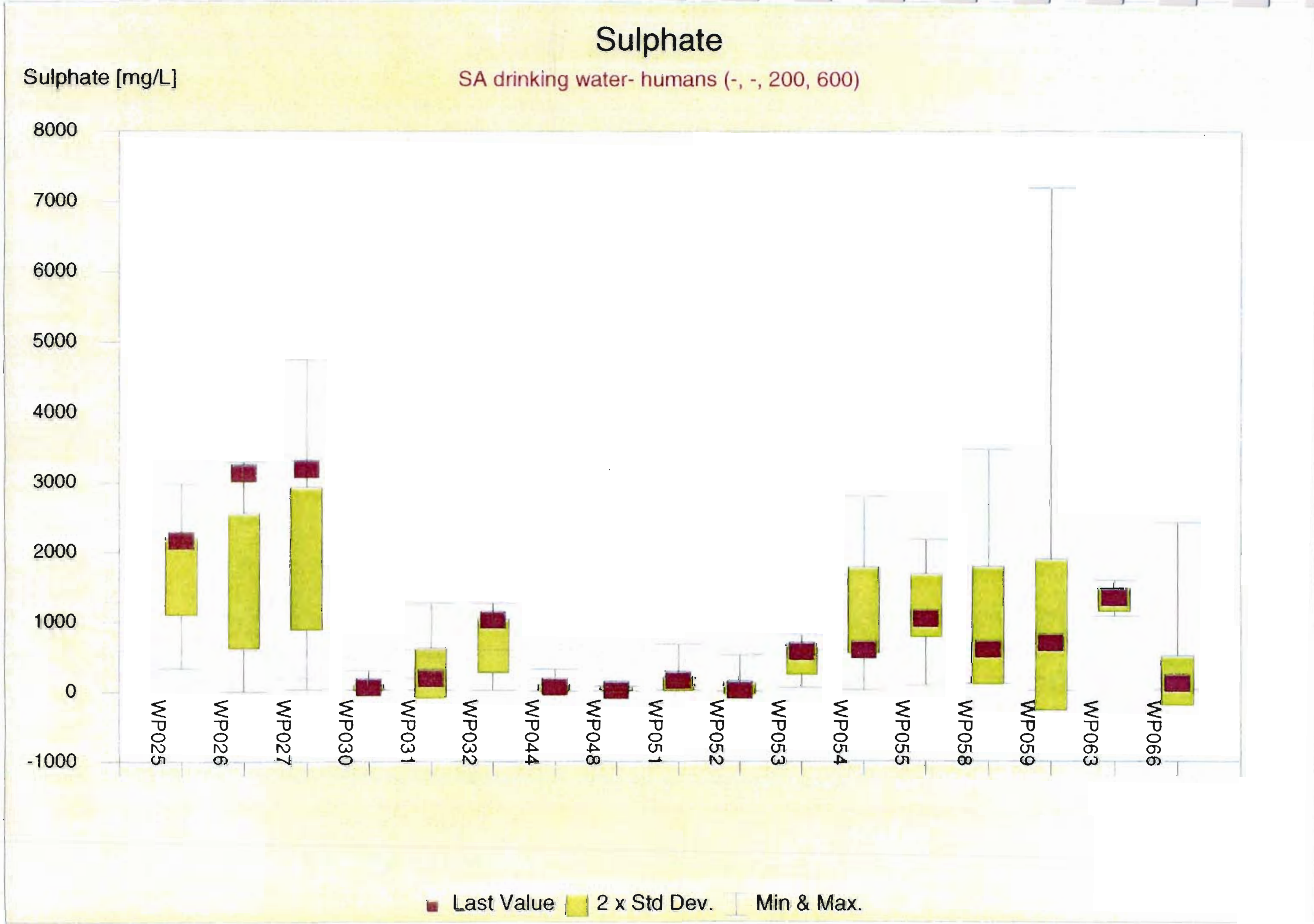

FIGURE 2.11(b) SURFACE WATER QUALITY WHISKER PLOT:SHEET 3 OF 6

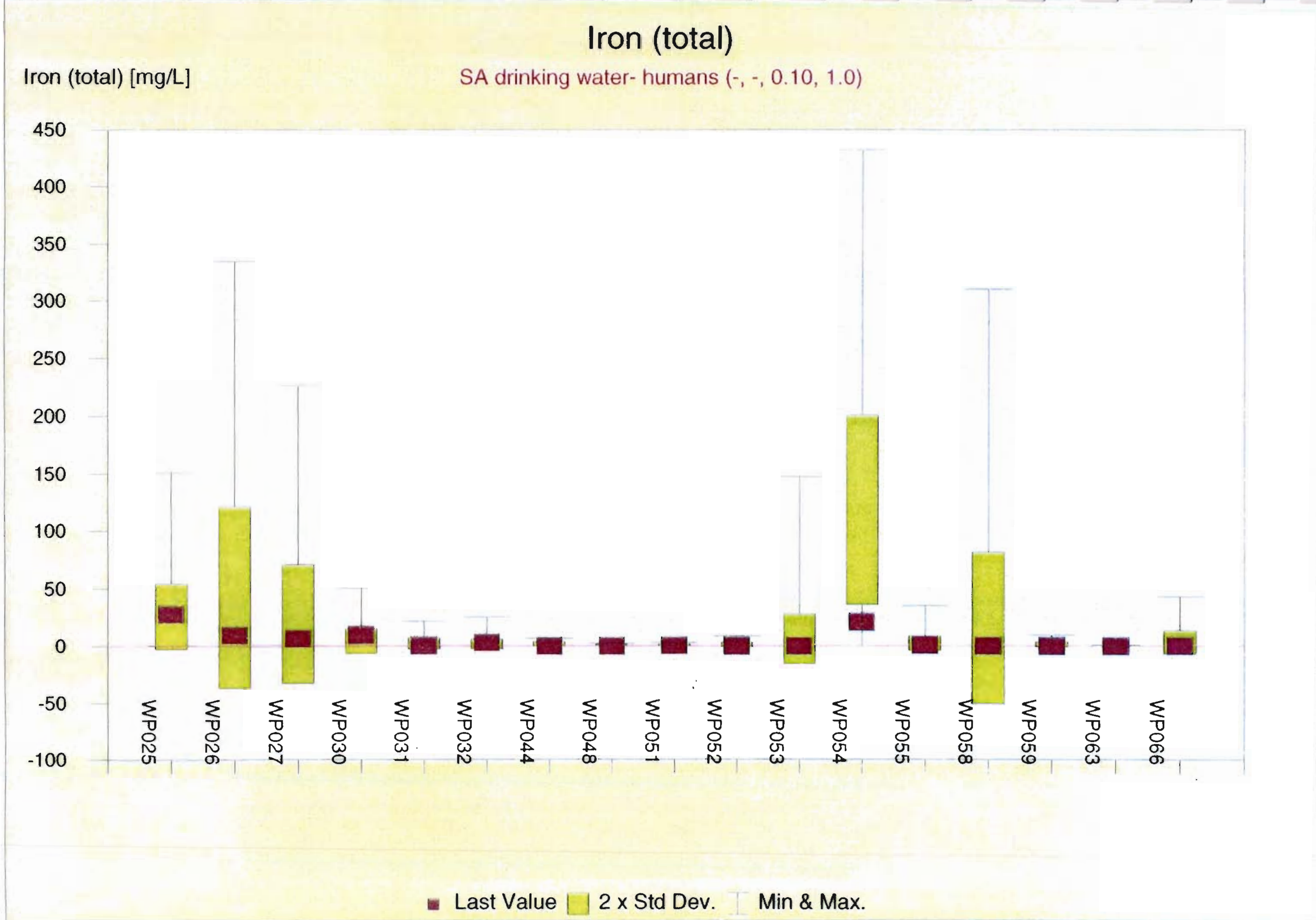

FIGURE 2.11(b) SURFACE WATER QUALITY WHISKER PLOT:SHEET 4 OF 6

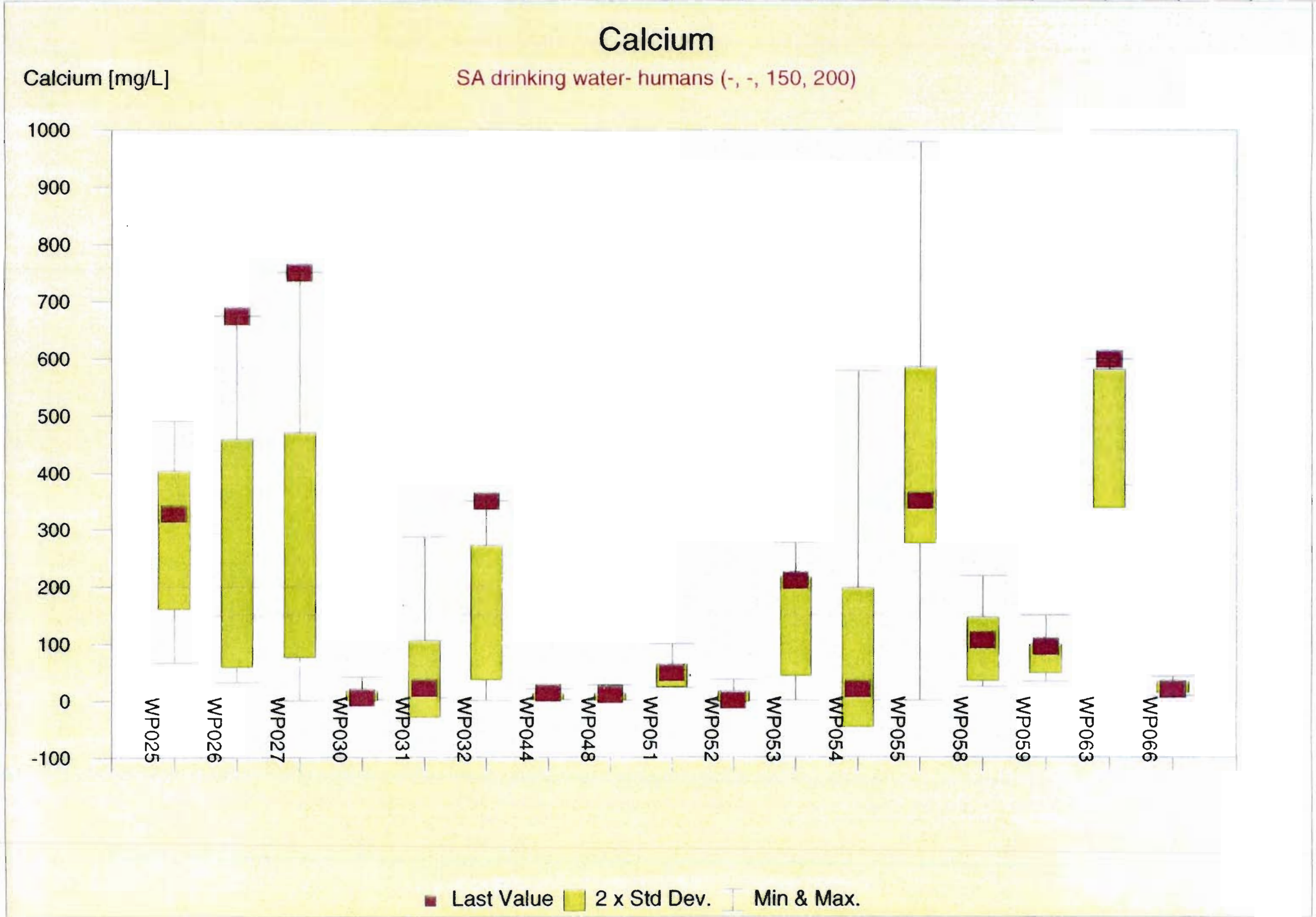

FIGURE 2.11(b) SURFACE WATER QUALITY WHISKER PLOT:SHEET 5 OF 6

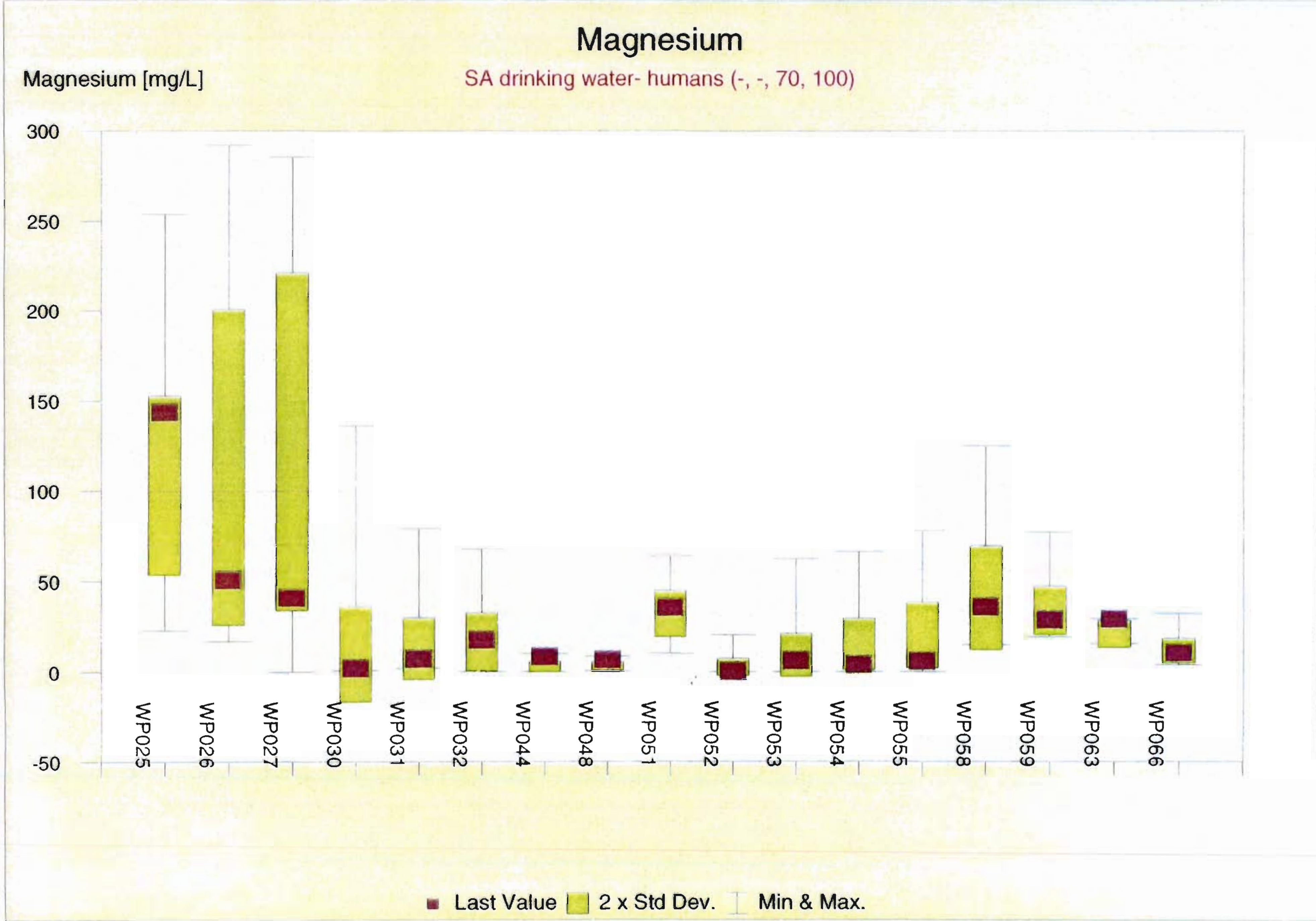

FIGURE 2.11(b) SURFACE WATER QUALITY WHISKER PLOT:SHEET 6 OF 6

of the results are attached as Supplementary Report No.10 (a). It must be noted that additional sampling points have been introduced since monitoring began in 1990.

2.9.3 Drainage Density of Areas to be Disturbed

The drainage density of disturbed areas is zero as no river streams will be disturbed by the mining operation.

2.9.4 Surface Water Use

A surface water user survey has been carried out on the downstream users from the mine area to the receiving water body – Loskop Dam. The information was compiled by F Bekker of Clean Stream Environmental Services and is recorded in Supplementary Report No.24.

2.9.5 Water Authority

A Water Permit application was submitted to the Department of Water Affairs in July 1991 (Supplementary Report No.11). This report sets out the actual and projected water usage by existing and planned expanded operations at SACE and was reviewed by (Wates, Meiring and Barnard, October 1991 - Supplementary Report No.12.).

2.9.6 Wetlands

A wetland occurs adjacent to the mining area. The Kromdraaispruit wetland has been thoroughly investigated by a postgraduate student from the University of the Witwatersrand (Supplementary Report No. 25). The wetland will not be disturbed by mining but has been impacted on by acid mine drainage from defunct underground workings. Remedial work is being done to reduce the impacts from acid mine drainage. Currently a further postgraduate study is underway to provide additional information about the Kromdraaispruit wetland.

No wetlands occur within the mining area.

2.10. Ground water

2.10.1 Depth of Water Tables and Qualities

The natural ground water in the region can be divided into two regimes within the Karoo series of the Kromdraai and Navigation areas.

Firstly, perched water aquifers occur at shallow depths at the base of residual or transported soils and flow above unweathered rock layers. Recharge occurs via surface infiltration and flow is generally in the direction of the surface topography.

Secondly, sandstone aquifers within the coal bearing horizons are considered to form part of a noncontinuous, multi-layered aquifer system. Infiltration and seepage along open joints and dyke contacts recharge these relatively shallow aquifers. The distribution and well cemented nature of the Dwyka diamictites at the base of the Karoo sequence has provided an extensive, impermeable lining to the coal bearing formations in this region. There is therefore a low probability of any major hydraulic connection between the coal bearing horizons and the underlying Waterberg sequence. The capacity of the Waterberg Formation to hold ground water is limited.

2.10.1.1 Kromdraai Opencast Mining Area

Water in aquifers surrounding the mining areas has been sampled and analysed from ground water monitoring boreholes established around the North, Central, South and Excelsior Blocks. Their locations are shown on Figure 2.11(c)

Table 2.10.1 shows the depths of water tables and water qualities recorded to date. Ground water has been affected by underground mining around the periphery of the mining blocks. Figure 2.11(d) is a section through monitoring points north of the North Block showing the soil and geological profile and water table elevations.
It should be noted that boreholes E, F and G in Table 2.10.1 contain 2 sample points per borehole. This has been done where it is thought that water tables may be layered in the boreholes, in which case one sample would not be representative of the ground water quality in the borehole.

2.10.1.2 Navigation Plant and Discard Disposal Site

Prior to construction commencing a series of boreholes were drilled to evaluate current ground water qualities, rock permeability and flow paths. The results of this work are contained in Supplementary Report No. 14. The locations of these boreholes are shown in Figure 2. 1 1 (e). These boreholes are monitored on a regular basis and results prior to mining are shown in Table 2.10.2. It must be noted that pollution from the Anglo-French discard dump is detected.

2.10.2 Water Boreholes, Springs and Underground Water Bodies

Loxton, Venn and Associates were commissioned to carry out a Building and Ground water Survey on properties adjacent to the mining areas and their report is included as Supplementary Report No. 4. Figures 2.12(a) and (b) show positions of homestead water sources assessed. Table 2.10.3 shows the water qualities of the points sampled. Table 2.10.4 shows the water levels, yields and usage of boreholes and springs examined.

2.10.2.1 Underground Water Bodies and Qualities

It is estimated that at present about 10 million cubic metres of water is stored in the Kromdraai workings, 20 million cubic metres in the Schoongezicht/Navigation workings and an 20 million cubic metres in the Landau/Kleinkopje workings. Where recycling or use of polluted surface water is not possible the mine will utilise water from these sources for process water and dust suppression.

Generally the stored water in the underground workings is acidic and saline.

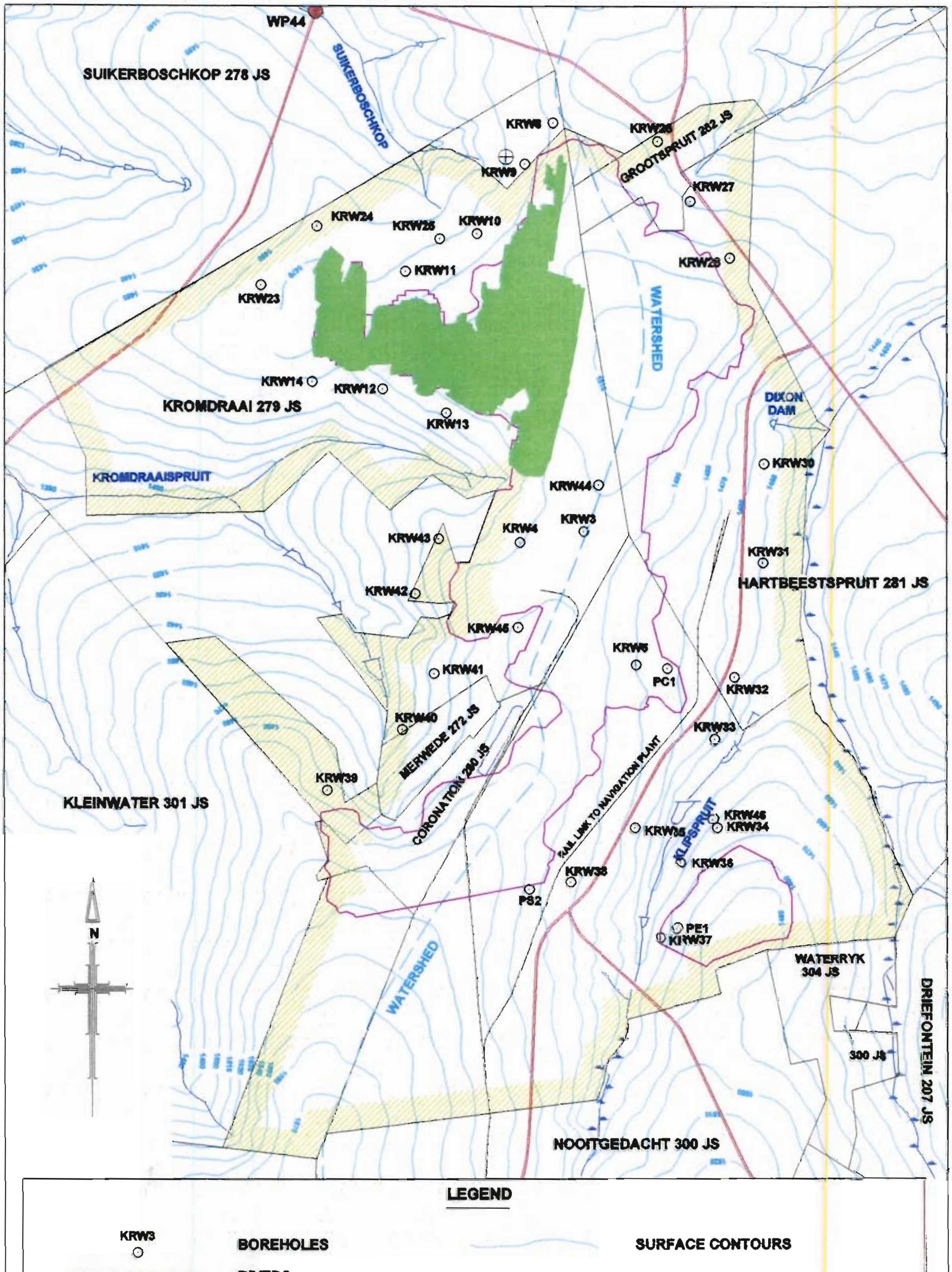

FIGURE 2.11(c) LOCATIONS OF GROUNDWATER MONITORING POINTS : KROMDRAAI

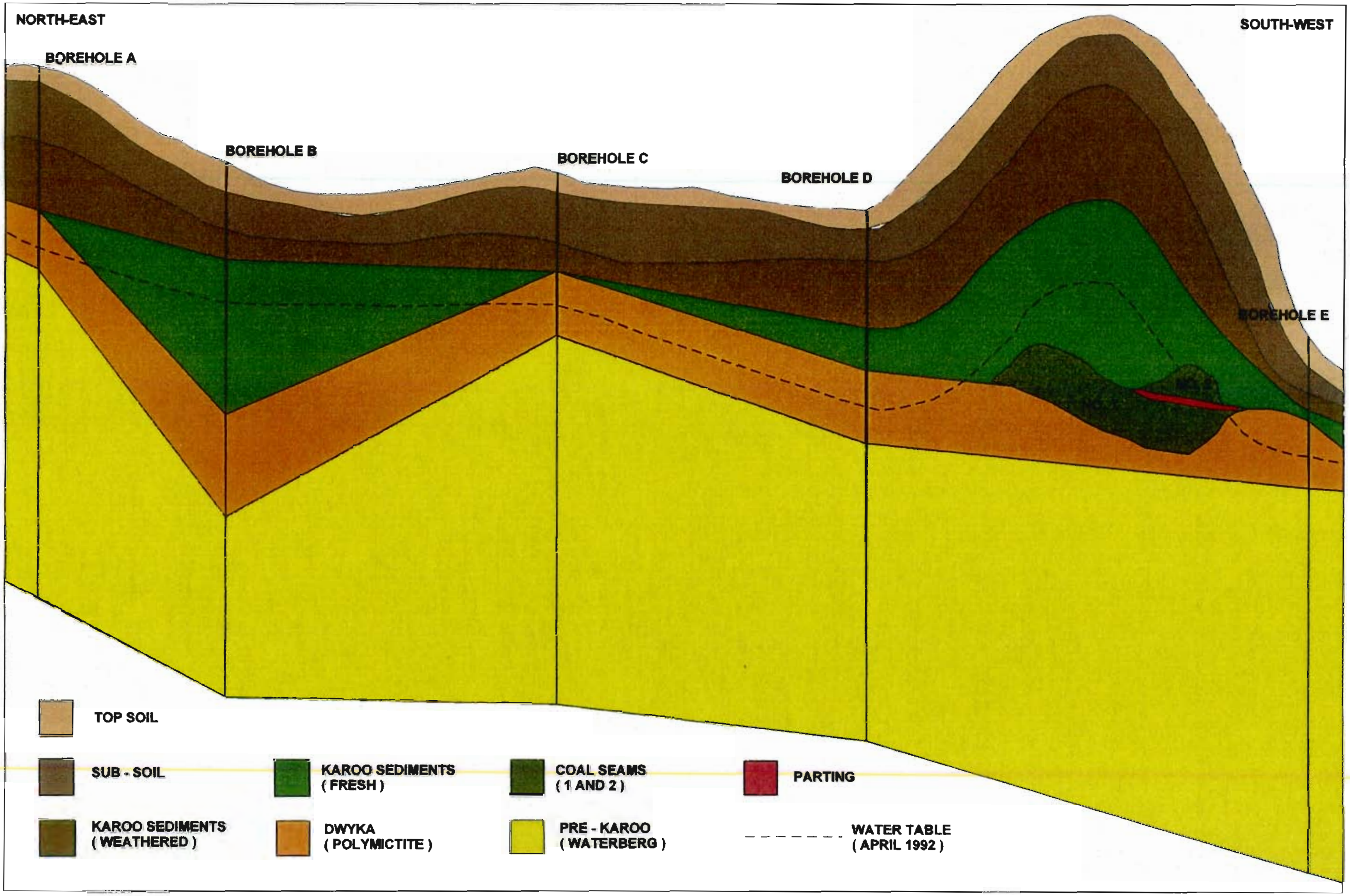

FIGURE 2.11 (D) WATER MONITORING BOREHOLES (WATER FLOW)

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Table 2.10.1 - Depths of Water tables and Ground water Qualities at Kromdraai

Borehole	A	B	C	D	E	E	F	F	G	G
Depth (m)	10	16	17	14	15	27	20	28	7	11
TDS	14	462	154	128	132	148	208	194	2016	1952
Conductivity	3	62	26	17	21	24	35	31,5	163	174
pH	6,4	6,1	6,4	6,4	6,4	6,4	6,4	6,3	3,0	3,0
Alkalinity 6,0	106	102	130	70	100	104	168	162	Nil	-
Turbidity	200	135	39	64	100	390	56	225	75	85
Sulphate	1,8	219	15,2	19,2	6,2	16	19,2	7,6	1480	1400
Nitrate	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1
Flouride	0,12	0,14	0,23	0,15	0,45	0,40	0,29	0,10	1,4	1,74
Sodium	1,7	15,4	9,0	6,3	5,0	5,5	18	17	11	21
Potassium	2,7	14,2	6,2	5,0	9,3	13,6	9,7	11	9,7	14
Calcium	1,6	69	28	47	24	25,6	38	38	104	176
Magnesium	0,5	31,1	9,2	4,4	5,4	6,3	12	13	88	102
Chloride	12	10	8	8	8	8	10	10	20	36
Boron	<0,1	<0,1	<0,01	<0,02	<0,01	<0,01	<0,01	<0,01	<0,01	<0,01
Cadmium	0,03	<0,01	<0,01	<0,01	<0,01	<0,01	<0,01	<0,01	>0.01	<0,01
Chromium	0,06	<0,01	<0,01	<0,01	<0,01	0,01	<0,01	<0,01	<0,01	<0,01
Copper	0,13	0,06	0,03	0,01	0,02	0,05	0,03	0,09	0,36	0.10
Iron	30	18,8	1,3	1,8	2,0	4,0	0,93	3	160	142
Manganese	0,06	3,98	0,76	0,64	0,07	0,81	0,71	0,72	47	42
Lead	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	0,33	0,16
Zinc	0,38	0,29	0,11	0,15	0,05	0,26	0,11	0,18	1,2	1,8
Silicon	91	9,1	6,9	6,3	14	123	9,1	22,2	`8,9	6,9
Nickel	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	1,8	1,1
Ortho P	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1
COD	47	73	100	42	42	108	38	69	102	30

Note: Results in mg/l where applicable.

Table 2.10.1 (Continued)

Site id	on map	Depth m	Date	EC mS/m	pH	SO4 mg/l	M.ALK mg/L	Ca mg/l	P.Acid mg/l	Mg mg/l	Fe mg/l	Na mg/l	Cl mg/l
*Hydrobase * Chemistry Report * Date printed : 15 December 1993 Generated for : South African Coal Estates Page 1													
2529CA6000	KRW8	0.000	19930420	8.0	6.90	18	36	13.300		0.900		6.800	6
2529CA60001	KRW8	10.000	19930514	5.0	6.90	10	14	0.500		0.600		3.500	8
529CA60001	KRW8	9.000	19930720	4.0	6.90	25	12	8.200		0.100		3.400	4
2529CA60001	KRW8	9.000	19930813	11.0	6.00	46	8	7.200		3.300		8.600	4
2529CA60002	KRW9	5.500	19930420	97.0	6.20	261	204	93.200		32.100		27.200	6
529CA60002	KRW9	12.000	19930	67.0	6.40	254	74	59.300		23.600		16.600	0
529CA60002	KRW9	8.000	19930514	82.0	6.60	353	170	95.400		37.200		35.900	4
2529CA60002	KRW9	20.000	19930514	104.0	6.50	559	148	117.400		48.600		38.800	4
529CA60002	KRW9	6.000	19930625	79.0	6.20	297	136	86.800		33.600		28.600	6
529CA60002	KRW9	11.000	19930625	93.0	6.00	317	176	101.100		37.100		33.200	6
2529CA60002	KRW9	5.500	19930813	91.0	6.40	309	150	92.400		33.700		30.800	6
529CA60002	KRW9	12.000	19930813	106.0	6.60	355	172	110.900		38.200		34.600	4
529CA60003	KRW10	7.800	19930420	31.0	6.80	28	128	25.600		8.000		13.400	4
2529CA60003	KRW10	8.000	19930514	34.0	7.00	62	118	32.300		12.400		15.500	2
2529CA60003	KRW10	11.000	19930625	35.0	6.50	40	134	33.300		13.300		15.900	4
529CA60003	KRW10	7.800	19930813	28.0	7.00	60	98	20.400		7.100		13.500	4
2529CA60004	KRW11	10.000	19930420	19.0	7.10	7	86	18.400		3.800		9.900	4
2529CA60004	KRW11	10.000	19930514	15.0	6.90	24	60	14.900		4.000		8.000	6
529CA60004	KRW11	15.000	19930625	22.0	6.10	21	110	25.500		8.400		12.400	4
529CA60004	KRW11	10.000	19930813	16.0	6.90	46	50	11.500		3.100		11.300	4
2529CA60005	KRW12	6.000	19930424	16.0	6.80	12	60	14.600		3.700		8.100	12
529CA60005	KRW12	10.000	19930529	13.0	6.50	42	60	17.500		3.200		8.600	4
529CA60005	KRW12	20.000	19930529	15.0	6.40	41	58	20.900		4.100		8.900	4
2529CA60005	KRW12	6.000	19930720	15.0	7.60	23	60	14.400		3.000		6.400	4
529CA60005	KRW12	8.000	19930826	16.0	7.40	26	6	15.100		3.000		5.400	4
529CC90066	KRW12	0.000	19930320	30.0	6.00								
2529CC90066	KRW12	0.000	19930725	4.1	6.50	129	54	31.100		15.400	0.001	26.700	24
2529CC90068	KRW14	0.000	19930320	340.0	3.40								
529CA60006	KRW13	9.000	19930420	21.0	7.50	29	92	26.700		3.900		9.900	4
2529CA60006	KRW13	10.000	19930529	19.0	6.60	50	42	29.300		3.500		8.800	8
2529CA60006	KRW13	20.000	19930529	23.0	6.20	60	40	29.400		6.000		10.500	10
529CA60006	KRW13	9.000	19930712	14.0	7.70	24	84	13.900	50	2.400		4.600	4
529CA60006	KRW13	9.000	19930826	19.0	7.10	18	76	25.300		2.600		4.000	6
2529CA60007	KRW14	5.000	19930424	193.0	3.10	1050	0	208.000		55.000		24.500	100
529CA60007	KRW14	7.000	19930514	188.0	2.60	1021	0	188.900	400	59.400	10.900	29.000	20
529CA60007	KRW14	20 .000	19930514	165.0	5.30	1032	12	238.600	64	78.500	18.400	48.200	20
2529CA60007	KRW14	5.000	19930720	200.0	2.90	1070	0	196.800	430	53.700	27.000	28.200	0
29CA60007	KRW14	20.000	19930720	180.0	5.70	1148	40	229.000	140	72.600	46.900	47.100	0
29CA60007	KRW14	5.000	19930813	210.0	3.00	928	0	191.600	280	51.900	16.400	29.900	0
2529CA60007	KRW14	20.000	19930813	203.0	5.90	960	90	249.500	80	73.400	65.400	50.300	0
2529CA60010	KRW17	0.000	19930730										
29CA60011	KRW18	0.000	19930730										

2529CA60012	KRW19	0.000	19930730										
2529CA60013	KRW20	0.000	19930730										
2529CA60014	KRW21	0.000	19930730										
2529CA60015	KRW22	0.000	19930730										
2529CA60016	KRW23	8.000	19930507	39.0	6.50	50	144	48.500		6.300		18.300	6
2529CA60016	KRW23	15.000	19930507	49.0	7.10	64	180	54.000		11.000		28.100	6
2529CA60016	KRW23	6.500	19930514	32.0	6.70	42	90	35.600		6.500		11.100	4
2529CA60016	KRW23	9.000	19930625	35.0	6.40	44	130	45.100		7.400		14.100	6
2529CA60016	KRW23	10.000	19930813	38.0	6.70	50	132	47.300		6.700		15.100	4
2529CA60017	KRW24	10.000	19930507	44.0	7.30	93	125	44.000		16.700		17.400	6
2529CA60017	KRW24	17.200	19930507	60.0	7.10	165	124	62.600		21.100		17.900	6
2529CA60017	KRW24	10.000	19930514	28.0	6.80	38	88	27.700		10.100		9.400	6
2529CA60017	KRW24	6.000	19930625	9.0	6.50	24	32	12.800		2.900		6.600	4
2529CA60017	KRW24	10.000	19930813	47.0	7.30	100	1126	36.400		20.900		14.900	4
2529CA60019	KRW26	6.000	19930420	17.0	6.90	25	70	21.500		2.000		7.300	4
2529CA60019	KRW26	9.000	19930712	12.0	6.80	43	68	27.200		0.900		4.700	4
2529CA60019	KRW26	8.000	19930813	12.0	7.20	38	43	18.500		1.500		8.400	6
2529CA60020	KRW27	9.000	19930420	4.0	5.70	26	16	5.800		0.500		6.600	2
2529CA60020	KRW27	10.000	19930813	3.0	6.00	18	8	1.100		0.600		7.100	6
2529CA60021	KRW28	9.000	19930420	5.0	7.00	15	18	4.200		0.400		6.300	2
2529CA60021	KRW28	14.000	19930720	97.0	7.90	427	80	118.200		31.400		23.900	8
2529CA60021	KRW28	14.000	19930813	62.0	6.70	217	72	72.700		15.800		17.000	6
2529CA60022	KRW29	8.000	19930420	16.0	6.80	29	44	16.800		2.000		6.900	4
2529CA60022	KRW29	9.000	19930712	18.0	7.40	49	44	21.600		2.100		4.100	6
2529CA60022	KRW29	9.000	19930823	11.0	6.20	46	12	8.000		1.900		7.400	4
2529CA60023	KRW30	0.000	19930424	8.0	5.80	27	10	5.000		1.100		7.300	4
2529CA60023	KRW30	11.000	19930521	5.0	6.00	23	18	4.400		0.900		7.000	6
2529CA60023	KRW30	11.000	19930712	5.0	7.40	20	18	4.000		0.001		2.400	6
2529CA60023	KRW30	11.000	19930823	4.0	6.50	28	10	4.400		0.001		6.100	4
2529CA60024	KRW31	5.000	19930424	3.0	5.30	8	8	0.001		0.900		7.200	4
2529CA60024	KRW31	15.000	19930521	11.0	6.40	33	50	9.600		4.100		9.500	6
2529CA60024	KRW31	15.000	19930712	14.0	7.30	1	6	2.600	50	3.200		7.300	28
2529CA60024	KRW31	15.000	19930823	13.0	6.60	39	52	12.000		2.300		7.000	2
2529CA60025	KRW32	0.000	19930427	116.0	5.40	482	22	161.800		34.400		27.000	52
2529CA60025	KRW32	8.000	19930521	106.0	5.10	519	14	140.400	20	46.300	0.001	26.900	42
2529CA60025	KRW32	16.000	19930521	108.0	5.20	508	20	140.600	22	44.500	0.600	27.200	48
2529CA60025	KRW32	16.000	19930712	103.0	6.10	532	14	152.400		42.400		23.900	44
2529CA60025	KRW32	16.000	19930823	91.0	5.50	495	10	125.400	36	37.800	3.000	24.700	46
2529CA60026	KRW33	6.000	19930424	85.0	4.40	400	0	113.800		19.500		13.000	40
2529CA60026	KRW33	10.000	19930521	78.0	4.30	375	0	109.900	50	23.500	0.600	15.300	8
2529CA60026	KRW33	10.000	19930712	76.0	5.20	440	8	108.700	68	18.600	2.100	11.400	8

Selected standard : nostd
= Exceeds max acceptable value **= Below min guideline value**
= Exceeds max guideline value **= Below min acceptable value**
< = Below detection limit

Table 2.10.1 (Continued)

Site Id	# on map	Depth Date		EC mS/m	pH	SO4 mg/l	M.ALK mg/L	Ca mg/l	P.Acid mg/l	Mg mg/l	Fe mg/l	Na mg/l	Cl mg/l
• Hydrobase *Chemistry Report * Date printed : 15 December 1993 • Generated for : South African Coal Estates Page 2													
2529CA60026	KRW33	10.000	19930823	72.0	4.80	417	0	99.100	78	16.200	2.800	12.400	4
2529CA60027	KRW34	6.000	19930427	16.0	6.30	15	48	19.900		2.000		9.200	10
2529CA60027	KRW34	14.000	19930611	17.0	5.80	90	12	13.100		8.700	0.100	12.100	4
2529CA60027	KRW34	10.000	19930712	30.0	7.00	1	26	2.900	40	28.500	0.001	7.700	61
2529CA60027	KRW34	10.000	19930823	18.0	6.00	83	12	13.200		6.000		10.100	4
2529CA60028	KRW35	13.000	19930427	24.0	6.70	26	78	33.000		4.900		7.800	8
2529CA60028	KRW35	13.000	19930521	30.0	6.50	72	80	32.200		9.100		9.500	4
2529CA60028	KRW35	13.000	19930712	20.0	7.80	36	82	24.400		5.300		2.500	8
2529CA60028	KRW35	13.000	19930823	20.0	6.80	49	74	22.900		5.400		9.300	4
2529CA60029	KRW36	8.000	19930427	45.0	5.90	156	26	38.000		16.300		16.200	20
2529CA60029	KRW36	10.000	19930611	37.0	5.80	173	36	25.000		19.100	1.100	22.300	6
2529CA60029	KRW36	10.000	19930712	34.0	6.50	153	14	17.800		14.100		14.500	4
2529CA60029	KRW36	10.000	19930823	30.0	6.00	150	10	19.200		11.400		19.600	4
2529CA60030	KRW37	12.000	19930427	21.0	6.10	53	36	18.100		3.900		33.800	30
2529CA60030	KRW37	12.000	19930611	30.0	6.30	79	40	14.200		5.600		34.500	26
2529CA60030	KRW37	18.000	19930611	27.0	6.30	83	40	12.700		4.200		41.000	24
2529CA60030	KRW37	12.000	19930712	18.0	6.90	70	15	12.300		5.500		4.200	8
2529CA60030	KRW37	12.000	19930823	27.0	6.30	69	36	13.000		3.600		31.200	30
2529CA60031	KRW38	6.000	19930424	10.0	6.30	14	30	7.500		1.200		6.500	6
2529CA60031	KRW38	10.000	19930521	19.0	5.80	77	24	14.000	6	5.800	4.600	10.800	4
2529CA60031	KRW38	20.000	19930521	15.0	5.90	44	28	12.100	4	4.600	0.300	9.000	4
2529CA60031	KRW38	10.000	19930712	19.0	6.10	73	8	9.900		4.200		5.100	4
2529CA60031	KRW38	10.000	19930823	21.0	5.00	105	8	12.600	34	6.500	0.400	13.400	8
2529CA60032	KRW39	10.000	19930427	4.0	5.10	9	8	3.200		0.500		6.800	6
2529CA60032	KRW39	19.000	19930529	3.0	5.30	30	10	5.600	8	0 .600	0.001	7.900	4
2529CA60032	KRW39	17.000	19930720	6.0	5.80	20	6	3.300	8	0.700	3.600	11.000	10
2529CA60032	KRW39	17.000	19930826	7.0	6.00	30	4	5.000		0.600		4.600	2
2529CA60033	KRW40	9.000	19930427	3.0	5.40	14	6	2.000		0.300		5.900	4
2529CA60033	KRW40	11.000	19930529	2.0	5.50	28	6	5.500	6	0.300	0.001	8.600	6
2529CA60033	KRW40	11.000	19930726	20.0	5.10	99	6	23.400		7.100	0.001	9.900	4
2529CA60033	KRW40	11.000	19930826	3.0	6.10	18	8	2.900		0.001		4.800	2
2529CA60034	KRW41	13.000	19930427	14.0	6.40	15	50	14.000		2.600		6.600	6
2529CA60034	KRW41	15.000	19930529	16.0	6.20	53	40	18.000		3.600		9.700	6
2529CA60034	KRW41	15.000	19930720	24.0	6.30	75	26	20.100		6.600		14.400	4
2529CA60034	KRW41	15.000	19930826	9.0	6.40	18	30	10.500		1.800		5.200	4
2529CA60035	KRW42	8.000	19930427	5.0	5.30	14	6	2.900		0.300		6.200	4
2529CA60035	KRW42	17.000	19930529	14.0	7.00	33	50	14.400		3.900		8.700	6
2529CA60035	KRW42	17.000	19930720			23	56	12.700		4.100		14.600	8
2529CA60035	KRW42	17.000	19930826	21.0	6.70	49	64	26.800		4.600		6.500	4
2529CA60036	KRW43	10.000	19930427	114.0	7.20	492	98	189.100		30.900		17.800	25
2529CA60036	KRW43	6.000	19930529	34.0	7.10	80	68	42.600		8.900		11.900	8

2529CA60036	KRW43	5.500	19930625	33.0	7.10	61	100	39.900		8.600		10.300	4
2529CA60036	KRW43	28.000	19930826	107.0	8.00	467	190	190.900		35.800		11.900	4
2529CA60037	KRW44	22.000	19930427	7.0	5.90	17	16	5.300		1.000		7.600	6
2529CA60037	KRW44	25.000	19930611	9.0	6.10	29	16	3.400		2.300		10.800	4
2529CA60037	KRW44	30.000	19930611	11.0	5.90	52	32	16.800		13.200	0.100	12.900	9
2529CA60037	KRW44	23.000	19930625	5.0	6.20	29	18	5.300		2.600		7.400	2
2529CA60037	KRW44	26.000	19930625	8.0	5.70	20	20	5.000	6	2.700	0.001	7.100	4
2529CA60037	KRW44	21.500	19930826	12.0	7.60	30	30	16.400		2.200		4.600	2
2529CA60037	KRW44	30.000	19930826	8.0	7.20	22	28	13.700		1.300		6.300	2
2529CA60038	KRW45	21.000	19930424	14.0	5.20	47	10	12.700		1.200		10.600	4
2529CA60038	KRW45	10.000	19930529	28.0	6.10	95	46	35.800		5.000		13.400	6
2529CA60038	KRW45	30.000	19930529	77.0	6.30	398	74	143.200		16.000		15.100	8
2529CA60038	KRW45	20.000	19930625	39.0	5.80	100	50	36.100	8	6.400	0.001	11.300	4
2529CA60039	KRW46	10.000	19930427	18.0	5.40	55	12	13.800		5.600		8.600	8

Selected standard : nostd

= Exceeds max acceptable value **= Below min guideline value**

= Exceeds max guideline value **= Below min acceptable value**

<= Below detection limit

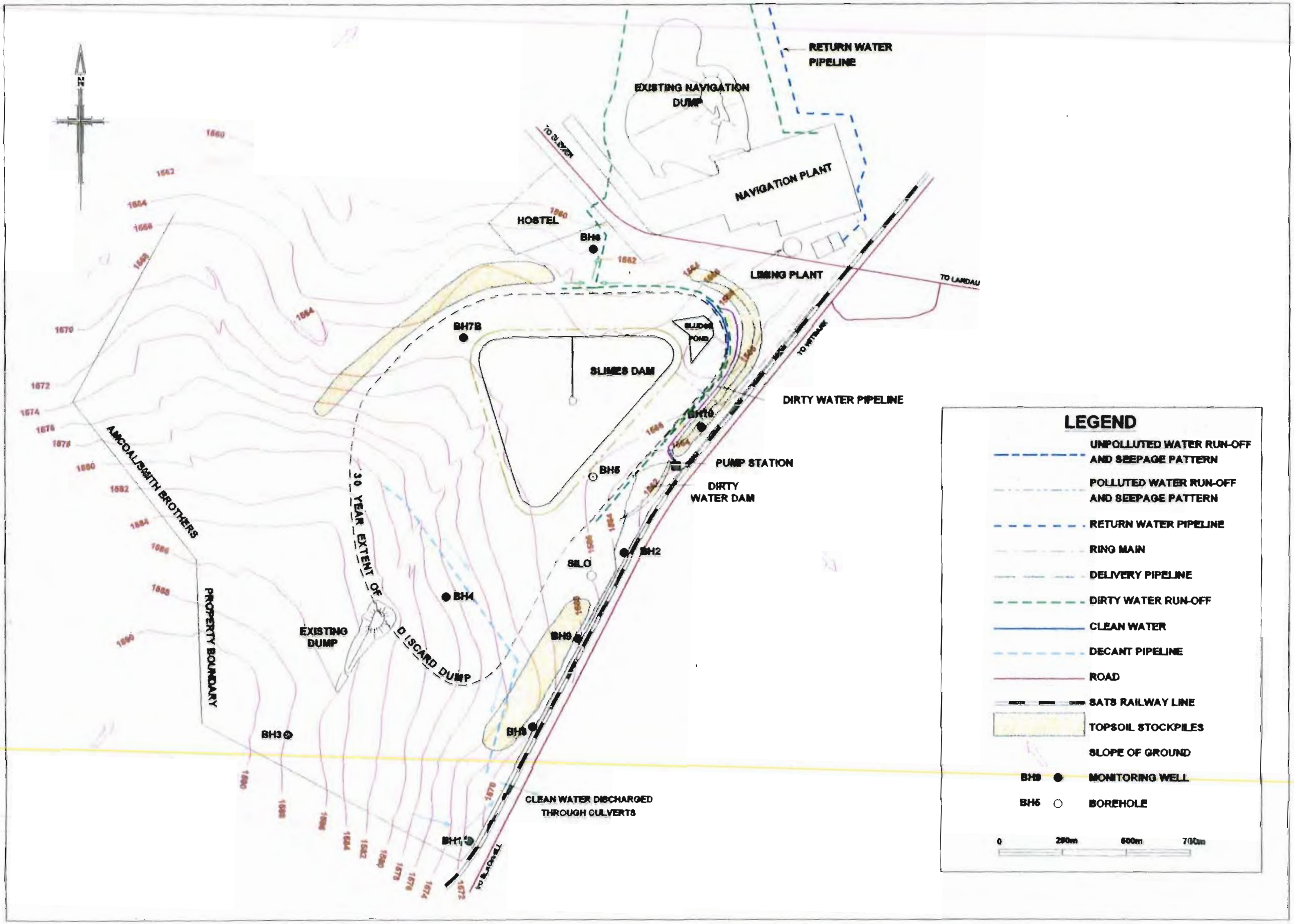

FIGURE 2.11(e) POSITIONS OF BOREHOLES AT BLAAUWKRANS DUMP

Table 2.10.2 - Ground water Qualities at Navigation: Sample Point BH1

Sample Date	Gen. Std.	24 May 91	24 Jun 92	24 Jul 91	21 Aug 91	9 Sep 91	10 Oct 91	15 Nov 91	12 Dec 91	16 Jan 92	13 Feb 92
Calcium (as Ca)	N/A	62.50	32.00	26.40	22.40	36.00	23	20.00	21.00	26	19.00
Chloride (as Cl)	N/A	*	*	12.00	49.00	14.00	9.00	10.00	5.00	13	11.00
Copper (as Cu)	1	0.40	0.02	<0.01	<0.01	0.01	0.01	0.01	0.01	0.01	0.02
Cyanide (as CN)	0.5	0.10	<0.01	<0.01	<0.01	*	0.01	0.01	0.01	0.10	0.01
E. Coli (/100 ml)	0	0	0	0	0	*	*	*	0	*	0
Elec. Cond. (mS/m)	250	51.20	33.00	30.20	42.90	34.50	32.90	27.10	21.10	26.9	25.10
Flouride (as F)	1	0.30	0.10	0.12	0.03	0.45	0.05	0.01	0.12	0.05	0.10
Iron (total) (as Fe)	N/A	2.10	0.06	0.04	0.03	0.01	0.01	0.01	0.01	0.01	0.01
Lead (as Pb)	0.1	0.40	0.02	<0.01	<0.01	0.01	0.01	0.01	0.04	0.01	0.10
Magnesium (as Mg)	N/A	16.00	12.20	11.70	8.70	7.00	10	14.00	4.00	13	10.00
Manganese (as Mn)	0.4	2.10	0.42	0.24	<0.01	0.40	0.17	0.06	0.14	0.02	0.02
Nitrate (as N)	N/A	10.00	10.41	7.74	9.17	0.70	13.8	8.60	0.10	5.6	10.20
pH	5.5-9.5	6.30	6.88	7.14	7.70	6.62	7.37	6.67	7.39	6.53	5.86
Potassium (as K)	N/A	3.30	2.30	1.50	4.00	2.80	1.9	1.40	3.80	1.6	1.80
Sodium (as Na)	N/A	12.00	14.00	12.00	51.00	21.00	16	13.00	16.00	14	14.00
Sulphate (as SO4)	N/A	162.00	20.00	20.00	7.00	84.00	13	18.00	5.00	16	16.00
Zinc (as Zn)	5	0.50	0.05	0.08	0.01	0.02	0.14	0.13	0.03	0.08	0.07

Sample Date	Gen. Std.	13Mar 92	9 Apr 92	15 May 92	11 Jun 92	9 Jul 92	14 Aug 92	10 Sep 92	Average	Sample Std. Deviation
Calcium (Ca)	N/A	22.00	21	18.00	18.40	18.40	20.00	22.40	21.09	14.692
Chloride (as Cl)	N/A	11.00	12	8.00	10.00	11.00	11.00	17.00	11.87	11.237
Copper (as Cu)	1	0.01	0.01	0.04	0.09	0.02	0.05	<0.01	0.04	0.095
Cyanide (as CN)	0.5	0.01	0.01	0.01	<0.1	<0.1	<0.1	<0.01	0.02	0.032
E. Coli (/100 ml)	0	0	*	0	0	0	0	0	0	0
Elect. Cond.(ms/m)	250	26.30	28.5	23.10	28.90	72.20	24.20	34.50	29.84	16.699
Flouride (as Fe)	1	0.03	0.23	0.09	<0.01	0.17	0.04	0.05	0.11	0.117
Iron (total) (as Fe)	N/A	0.06	0.01	0.01	<0.01	0.03	<0.01	<0.01	0.14	0.505
Lead (as Pb)	0.1	0.01	0.02	0.01	<0.01	<0.01	<0.01	0.01	0.04	0.096
Magnesium (as Mg)	N/A	11.00	13	10.00	10.20	9.70	8.30	13.60	8.61	4.941
Manganese (as Mn)	0.4	0.15	0.04	0.02	<0.5	0.06	0.03	0.01	0.23	0.5
Nitrate (as N)	N/A	7.20	0.60	5.30	19.69	18.49	13.47	11.22	7.81	6.178
pH	5.5-9.5	6.24	6.10	6.71	5.83	7.32	6.62	7.16	6.3	1.708
Potassium (as K)	N/A	3.00	1.6	1.30	1.51	1.30	1.20	2.10	1.84	1.244
Sodium (as Na)	N/A	14.00	14	13.00	10.40	13.00	9.00	6.00	12.85	11.457
Sulphate (as SO4)	N/A	27.00	35	11.00	19.00	12.80	16.20	19.00	25.71	39.937
Zinc (as Zn)	5	0.11	0.09	0.19	0.25	0.11	0.14	0.08	0.12	0.115

1. **Concentration not in General Standard specification** 2. **All results expressed as m/l where applicable** 3. **Results not received = ***

Table 2.10.2 – Ground water Qualities at Navigation: Sample Point BH2

Sample Date	Gen. Std.	24 May 91	24 Jun 92	24 Jul 91	21 Aug 91	9 Sep 91	10 Oct 91	15 Nov 91	12 Dec 91	16 Jan 92
Calcium (as Ca)	N/A	18.40	19.20	46.60	25.60	2.00	19.00	15.00	22.00	18.00
Chloride (as Cl)	N/A	*	*	78.00	11.00	12.00	7.00	7.00	10.00	7.00
Copper (as Cu)	1	0.10	0.02	0.05	<0.01	0.01	0.01	0.01	0.080	0.01
Cyanide (as CN)	0.5	<0.1	<0.01	<0.01	<0.01	*	0.01	0.01	0.010	0.10
E. Coli (/100 ml)	0	0.00	0.00	0.00	0.00	*	*	*	0	0.00
Elec. Cond. (mS/m)	250	48.10	57.80	70.20	32.40	30.00	22.30	18.70	28.50	18.20
Flouride (as F)	1	0.20	0.15	0.04	0.14	0.59	0.03	0.02	0.10	0.34
Iron (total) (as Fe)	N/A	0.30	0.01	0.02	0.05	0.01	0.01	0.01	0.01	0.02
Lead (as Pb)	0.1	0.20	0.03	<0.01	0.01	0.010	0.04	0.01	0.010	0.01
Magnesium (as Mg)	N/A	5.80	6.80	11.20	10.20	12.00	3.00	6.00	12.00	6.00
Manganese (as Mn)	0.4	0.10	0.05	0.95	0.14	0.070	0.03	0.03	0.110	0.02
Nitrate (as N)	N/A	11.10	8.11	6.99	14.53	11.1	0.70	0.10	5.4	0.10
pH	5.5-9.5	7.00	6.96	5.79	6.73	6.36	7.75	7.04	6.52	6.88
Potassium (as K)	N/A	5.20	5.60	4.20	1.80	1.7	2.80	2.40	1.8	3.00
Sodium (as Na)	N/A	60.00	90.00	64.00	14.00	11.00	20.00	16.00	10.00	15.00
Sulphate (as SO4)	N/A	20.00	20.00	138.00	14.00	12.00	2.00	3.00	22.00	2.00
Zinc (as Zn)	5	0.10	0.04	0.35	0.08	0.140	0.01	0.02	0.390	0.02

Sample Date	General Standard	13 Feb 92	13 Mar 92	9 Apr 92	15 May 92	11 Jun 92	9 Jul 92	14 Aug 92	Average	Sample Std. Deviation
Calcium (as Ca)	N/A	14.00	132.00	169.00	240.00	143.30	72.00	*	63.74	72.452
Chloride (as Cl)	N/A	7.00	23.00	24.00	19.00	20.00	10.00	*	18.08	18.764
Copper (as Cu)	1	0.01	0.02	0.04	0.02	0.04	0.13	*	0.032	0.037
Cyanide (as CN)	0.5	0.01	0.010	0.01	0.01	<.1	<0.1	*	0.01	0.025
E.Coli (/100 ml)	0	0.00	0.00	0.00	0.00	0.00	0.00	*	0	0
Elec. Cond. (Ms/M)	250	17.40	112.00	132.90	153.50	133.50	72.20	*	63.18	47.625
Flouride (as F)	1	0.10	0.42	0.29	0.09	0.12	0.17	*	0.113	0.105
Iron (total) (as Fe)	N/A	0.01	0.05	0.01	0.03	0.01	0.03	*	0.034	0.075
Lead (as Pb)	0.1	0.10	0.010	0.04	0.01	0.02	<0.01	*	0.033	0.054
Magnesium (as Mg)	N/A	4.00	75.00	107.00	111.00	98.20	40.80	*	33.933	41.512
Manganese (as Mn)	0.4	0.02	0.410	0.29	0.14	0.06	0.04	*	0.125	0.241
Nitrate (as N)	N/A	0.10	0.1	0.10	0.10	<.1	0.71	*	2.489	4.846
pH	5.5-9.5	6.38	6.58	6.18	6.79	6.11	8.05	*	6.471	0.593
Potassium (as K)	N/A	2.90	14.4	6.70	6.20	5.20	3.70	*	3.313	2.231
Sodium (as Na)	N/A	15.00	43.00	50.00	42.00	35.20	24.00	*	33.947	23.847
Sulphate (as SO4)	N/A	3.00	760	872.00	1040.00	602.00	260.00	*	200.667	347.303
Zinc (as Zn)	5	0.01	0.110	0.24	0.07	0.08	0.33	*	0.09	

2. Concentration not in General Standard specification 2. All results expressed as m/l where applicable 3. Results not received = *

Table 2 10.2- Ground water Qualities at Navigation: Sample Point BH3

Sample Date	Gen. Std.	24 May 91	24 Jun 92	24 Jul 91	21 Aug 91	9 Sep 91	10 Oct 91	15 Nov 91	12 Dec 91	16 Jan 92
Calcium (as Ca)	N/A	30.40	89.70	29.60	96.90	30.00	27.00	51.00	55.00	53.00
Chloride (as Cl)	N/A	*	*	29.00	26.00	24.00	23.00	23.00	22.00	24.00
Copper (as Cu)	1	0.80	0.14	<0.01	0.27	0.01	0.01	0.04	0.16	0.02
Cyanide (as CN)	0.5	<0.01	<0.01	<0.01	<0.01	*	0.01	0.01	0.01	0.10
E. Coli (/100 ml)	0	0.00	0.00	0.00	0.00	*	*	0.00	0.00	0.00
Elec. Cond. (mS/m)	250	36.50	70.10	35.50	157.00	35.50	35.70	*	*	*
Flouride (as F)	1	0.00	0.34	2.68	0.56	0.10	0.01	0.04	0.32	0.34
Iron (total) (as Fe)	N/A	0.40	0.04	0.03	0.05	0.01	0.01	0.05	0.01	0.02
Lead (as Pb)	0.1	0.40	0.06	<0.01	0.15	0.06	0.01	0.010	0.01	0.03
Magnesium (as Mg)	N/A	19.40	26.20	17.50	23.80	19.00	17.00	20	23.00	29.00
Manganese (as Mn)	0.4	0.20	1.72	0.02	2.97	0.06	0.03	0.820	1.01	0.65
Nitrate (as N)	N/A	2.00	1.86	2.68	1.19	1.20	1.90	3.2	2.70	3.40
pH	5.5-9.5	7.40	4.96	6.70	3.67	6.61	6.96	6.46	5.77	6.25
Potassium (as K)	N/A	3.40	3.60	2.80	5.00	3.00	3.10	28	3.30	3.30
Sodium (as Na)	N/A	10.00	12.00	9.00	11.00	9.00	11.00	10	9.00	11.00
Sulphate (as SO4)	N/A	32.00	320.00	30.00	680.00	36.00	22.00	120	198.00	148.00
Zinc (as Zn)	5	0.50	0.35	0.05	0.68	0.04	0.02	0.440	0.89	0.22

Sample Date	General Standard	13 Feb 90	13 Mar 92	9 Apr 92	15 May 92	11 Jun 92	9 Jul 92	14 Aug 92	10 Sep 92	Average	Sample Std. Deviation
Calcium (as Ca)	N/A	51.00	53.00	37.00	28.00	48.80	52.80	56.00	28.80	48.118	20.368
Chloride (as Cl)	N/A	25.00	24.00	24.00	21.00	22.00	21.00	22.00	22.00	25.14	2.041
Copper (as Cu)	1	0.20	0.01	0.06	0.06	0.06	0.04	0.02	<0.01	0.12	0.194
Cyanide (as CN)	0.5	0.01	0.01	0.10	0.01	<.1	<0.1	<0.1	<0.1	0.02	0.032
E Coli (/100 ml)	0	0.00	0.00	0.00	0.00	0.00	0.00	0	0	0	0
Elec. Cond.(Ms/m)	250	40.30	44.00	45.80	30.10	50.60	5.60	99.40	41.30	55.95	33.239
Flouride (as F)	1	0.21	0.27	0.21	0.12	0.02	0.37	0.12	0.03	0.36	0.625
Iron (total) (as Fe)	N/A	0.10	0.06	0.13	0.03	<0.01	<0.01	0.01	0.01	0.05	0.096
Lead (as Pb)	0.1	0.100	0.01	0.03	0.010	<0.01	<0.01	0.02	0.03	0.05	0.098
Magnesium (as Mg)	N/A	18	19.00	22.00	14	21.90	18.50	36.00	13.60	19.12	9.997
Manganese (as Mn)	0.4	0.660	1.19	0.92	0.020	1.03	1.05	2.06	0.01	0.81	0.87
Nitrate (as N)	N/A	1.4	2.60	2.40	1.6	3.65	8.96	6.28	7.39	3.01	2.542
pH	5.5-9.5	5.63	5.68	6.61	6.93	5.36	7.41	6.49	7.26	6.63	0.977
Potassium (as K)	N/A	3.3	3.60	3.10	2.5	2.56	3.00	3.60	3.00	2.9	1.401
Sodium (as Na)	N/A	10	10.00	10.00	10	7.50	10.00	9.00	9.50	8.63	4.01
Sulphate (as SO4)	N/A	13	134.00	236.00	25	158.00	146.00	272.00	34.80	152.93	171.86
Zinc (as Zn)	5	0.250	0.23	0.37	0.310	0.26	0.33	0.15	0.06	0.244	0.257

1. Concentration not in General Standard specification 2. All results expressed as m/l where applicable 3. Results not received = *

Table 2.10.2- Ground water Qualities at Navigation: Sample Point BH4

Sample Date	Gen. Std.	24 May 92	24 Jun 92	24 Jul 92	21 Aug 92	9 Sep 91	10 Oct 91	15 Nov 91	12 Dec 91	16 Jan 92
Calcium (as Ca)	N/A	348.30	388.40	388.00	360.40	347.00	364	388.00	356.00	557
Chloride (as Cl)	N/A	*	*	45.00	75.00	11.00	44	75.00	70.00	58
Copper (as Cu)	1	0.50	0.40	0.30	0.88	0.28	0.45	0.66	0.33	1.19
Cyanide (as CN)	0.5	<0.1	<0.01	<0.01	<0.01	*	0.01	0.01	0.01	0.10
E. Coli (/100 ml)	0	0.00	0.00	0.00	0.00	*	*	0.00	*	0.00
Elec. Cond. (Ms/m)	250	197.90	213.00	228.00	216.00	205.00	204.00	222.00	221.00	199.90
Flouride (as F)	1	0.60	3.20	0.80	0.34	1.06	0.34	0.25	0.89	0.89
Iron (total) (as Fe)	N/A	0.70	0.40	0.30	0.28	0.34	0.32	0.25	0.47	0.34
Lead (as Pb)	0.1	0.70	0.40	0.10	0.39	0.94	1.16	0.28	0.23	0.29
Magnesium (as Mg)	N/A	38.90	24.30	58.30	65.60	38.00	44.00	54.00	54.00	73.00
Manganese (as Mn)	0.4	7.90	8.70	10.70	10.40	9.88	8.490	9.90	9.78	9.56
Nitrate (as N)	N/A	<0.1	<0.1	0.70	0.58	0.90	0.1	0.60	0.10	0.1
pH	5.5-9.5	4.00	3.50	3.10	3.17	2.98	3.18	2.92	3.01	2.87
Potassium (as K)	N/A	5.40	6.00	5.00	6.00	4.20	4.7	5.00	7.30	6.9
Sodium (as Na)	N/A	9.00	13.00	10.00	13.00	10.00	13	13.00	13.00	14
Sulphate (as SO4)	N/A	1440.00	1740.00	1360.00	1840.00	1640.00	1640	1780.00	1645.00	1840
Zinc (as Zn)	5	0.90	0.90	0.80	0.32	0.57	0.660	1.11	0.85	1.510

Sample Date	General Standard	13 Feb 90	13 Mar 92	9 APR 92	15 May 92	11 Jun 92	9 Jul 92	14 Aug 92	10 Sep 92	Average	Sample Std. Deviation
Calcium (as Ca)	N/A	368.00	372.00	368	408.00	368.40	396.30	380.30	416.40	310.912	149.588
Chloride(as Cl)	N/A	40.00	68.00	14	31.00	16.00	16.00	20.00	19.00	324	26.229
Copper (as Cu)	1	0.13	0.18	0.700	0.55	0.51	0.82	0.22	0.18	0.446	0.306
Cyanide (as CN)	0.5	0.01	0.01	0.01	0.01	<.11	<0.1	<0.1	<0.1	0.001	0.024
E. Coli (/100 ml)	0	0.00	0.00	0.00	0.00	0.00	0.00	0	0	0	0
Elec. Cond. (mS/m)	250	179.90	192.00	192.30	183.60	230.00	223.00	263.00	412.00	222.506	52.86
Flouride (as F)	1	0.89	1.22	0.78	0.84	0.75	0.45	0.81	0.69	0.871	0.654
Iron (total) (as Fe)	N/A	0.27	1.12	0.43	0.29	0.25	0.25	0.19	0.21	0.377	0.226
Lead (as Pb)	0.1	0.42	0.25	0.30	0.10	0.19	0.20	0.41	0.41	398	0.286
Magnesium (as Mg)	N/A	78.00	51.00	224.00	61.00	77.80	70.50	158.00	194.40	80.282	56.534
Manganese (as Mn)	0.4	8.88	13.70	9.78	12.60	17.10	14.90	19.20	22.80	11.516	5.078
Nitrate (as N)	N/A	0.70	0.10	0.1	0.10	1.47	1.67	1.55	1.94	0.612	0.674
pH	5.5-9.5	2.60	2.71	3.38	3.32	3.18	3.55	3.95	3.77	2.891	1.157
Potassium (as K)	N/A	6.40	7.00	6.8	6.70	8.20	7.00	14.40	12.60	5.953	3.848
Sodium (as Na)	N/A	14.00	11.00	18	14.00	11.40	15.00	13.00	8.00	9.847	5.059
Sulphate (as SO4)	N/A	1595.00	1440.00	2040	1800.00	1980.00	1740.00	2300.00	2580.00	1463.529	759.928
Zinc (as Zn)	5	0.58	0.61	0.910	0.95	0.81	1.02	0.43	0.49	0.608	0.361

1. Concentration not in General Standard specification 2. All results expressed as m/l where applicable 3. Results not received = *

Table 2.10.2 – Ground water Qualities at Navigation: Sample Point BH6

Sample Date	Gen. Std.	24 May 92	24 Jun 92	24 Jul 92	21 Aug 92	9 Sep 91	10 Oct 91	15 Nov 91	12 Dec 91	16 Jan 92
Calcium(as Ca)	N/A	146.50	184.20	175.40	62.50	175	148.00	224.00	311	428.00
Chloride (as Cl)	N/A	*	*	9.00	39.00	4.00	6.00	50.00	50	60.00
Copper (as Cu)	1	0.10	0.02	0.23	0.01	0.340	.09	0.07	0.530	0.18
Cyanide (as CN)	0.5	<0.1	<0.01	<0.01	<0.01	*	0.01	0.01	0.010	0.10
E. Coli (/100 ml)	0	0.00	0.00	0.00	0.00	*	*	*	0.00	0.00
Elec. Cond.(mS/m)	250	110.20	130.90	133.70	66.40	133.80	163.40	158.80	205.0	217.00
Flouride (as F)	1	0.30	3.16	0.97	0.42	1.81	1.43	1.81	2.30	8.30
Iron (total) (as Fe)	N/A	1.70	0.16	0.07	0.05	0.03	0.06	0.07	0.23	0.32
Lead (as Pb)	0.1	0.30	0.07	<0.01	0.01	0.32	0.14	0.32	0.23	0.24
Magnesium (as Mg)	N/A	41.30	56.90	53.90	21.40	53.00	49.00	80.00	84.00	136.00
Manganese (as Mn)	0.4	0.90	4.12	4.47	1.26	4.98	2.85	7.90	15.74	16.04
Nitrate (as N)	N/A	0.90	0.64	0.49	2.31	0.50	0.10	0.10	0.10	0.10
PH	5.5-9.5	6.40	4.86	4.26	6.40	3.92	4.84	3.80	3.54	3.44
Potassium (as K)	N/A	11.60	9.00	8.60	2.50	7.2	8.80	7.70	10.0	11.20
Sodium (as Na)	N/A	29.00	35.00	27.00	12.00	23	31.00	24.00	13	14.00
Sulphate (as SO4)	N/A	576.00	856.00	720.00	220.00	912	728.00	1065.00	1590	2040.00
Zinc (as Zn)	5	0.30	0.27	0.48	0.22	0.570	0.31	0.59	2.230	1.05

Sample Date	Gen. Std.	13Feb 90	13 Mar 92	9 Apr 92	15 May 92	11 Jun 92	9 Jul 92	14 Aug 92	10 Sep 92	Average	Std. Dev.
Calcium (as Ca)	N/A	320.00	308	170.00	96.00	109.00	106.50	127.30	120.10	142.206	110.655
Chloride (as Cl)	N/A	22.00	60	23.00	3.00	7.00	5.00	3.00	4.00	15.667	18.016
Copper (as Cu)	1	0.16	0.040	0.12	0.03	0.01	0.01	0.01	<0.01	0.061	0.073
Cyanide (as CN)	0.5	0.01	0.010	0.01	0.01	<0.1	<0.1	<0.1	<0.1	0.009	0.024
E. Coli (/100ml)	0	0.00	0.00	0.00	0.00	0.00	0.00	0	0	0	0
Elec. Cond. (mS/m)	250	178.60	178.0	111.00	73.50	82.80	864.00	96.40	96.40	153.935	191.572
Flouride (as F)	1	2.34	2.10	0.84	0.21	<0.01	0.21	0.23	0.06	1.435	2.02
Iron (total) (as Fe)	N/A	0.45	0.29	0.03	0.01	0.08	<0.01	0.04	0.04	0.214	0.404
Lead (as Pb)	0.1	0.15	0.25	0.04	0.01	0.02	<0.01	0.08	0.05	0.131	0.121
Magnesium(as Mg)	N/A	131.00	95.00	59.00	34.00	34.00	32.60	41.80	49.60	61.912	33.124
Manganese (as Mn)	0.4	12.36	18.34	3.39	0.51	0.35	0.33	0.23	0.31	5.534	6.227
Nitrate (as N)	N/A	0.70	0.40	0.50	0.10	0.75	0.46	0.46	0.99	0.565	0.533
pH	5.5-9.5	3.15	3.17	4.18	5.48	6.72	7.07	6.74	7.13	5.006	1.461
Potassium (as K)	N/A	10.80	10.00	8.60	6.80	6.80	7.00	7.40	7.80	7.329	3.467
Sodium (as Na)	N/A	16.00	14	28.00	30.00	24.50	33.00	31.00	20.00	20.853	11.911
Sulphate (as SO4)	N/A	1640.00	1345	868.00	396.00	368.00	460.00	520.00	536.00	646.647	550.743
Zinc (as Zn)	5	0.97	1.670	0.29	0.19	0.01	0.13	0.15	0.08	0.296	0.316

1. Concentration not in General Standard specification 2. All results expressed as m/l where applicable 3. Results not received = *

Table 2.10.2 – Ground water Qualities at Navigation: Sample Point BH7

Sample Date	General Standard	15 Nov 91	12 Dec 91	16 Jan 92	13 Feb 92	13 Mar 92	9 Apr 92	15 May 92	11 Jun 92	9 Jul 92	14 Aug 92	10 Sep 90	Average	Sample Std. Deviation
Calcium (as Ca)	N/A	31.00	51.00	36.00	38.00	34.00	36.00	34.00	37.60	28.80	62.40	56.80	40.509	11.056
Chloride (as Cl)	N/A	18.00	12.00	40.00	17.00	10.00	12.00	8.00	8.00	8.00	3.00	6.00	12.909	10.025
Copper (as Cu)	1	0.01	0.02	0.01	0.01	0.01	0.03	0.03	0.02	0.01	0.01	0.01	0.015	0.008
Cyanide (as CN)	0.5	0.01	0.01	0.01	0.01	0.01	0.01	0.01	<0.1	<0.1	<0.1	<0.1	0.006	0.005
E. Coli (/100 ml)	0	0.00	0.00	0.00	0.00	10.00	0.00	0.00	0.00	0.00	0	0	0.909	3.015
Elec. Cond. (mS/m)	250	44.30	56.10	50.20	39.20	39.70	26.40	30.50	35.30	28.20	55.40	50.60	41.445	10.703
Flouride (as F)	1	0.03	0.03	*	*	0.69	0.22		<0.01	0.30	0.18	0.05	0.19	0.192
Iron (total) (as Fe)	N/A	1.16	0.72	0.62	1.35	0.58	2.65	1.17	0.70	0.18	0.20	0.41	0.885	0.7
Lead (as Pb)	0.1	0.01	0.17	0.07	0.10	0.10	0.12	0.04	0.05	<0.01	0.11	0.05	0.075	0.051
Magnesium (as Mg)	N/A	13.00	16.00	14.00	12.00	20.00	8.00	10.00	12.60	8.70	22.40	18.00	14.064	4.621
Manganese (as Mn)	0.4	0.14	0.72	0.13	0.39	1.19	0.26	0.27	0.29	0.23	0.27	1.78	0.515	0.521
Nitrate (as N)	N/A	0.10	0.10	0.10	0.10	0.10	0.10	0.10	<0.1	<0.1	<0.1	1.13	0.166	0.323
pH	5.5-9.5	6.73	6.59	6.38	6.47	6.25	5.93	6.24	7.28	8.30	7.26	7.09	6.775	0.669
Potassium (as K)	N/A	6.50	9.70	8.60	7.50	8.60	5.80	5.30	5.20	4.70	5.20	5.70	6.618	1.706
Sodium (as Na)	N/A	25.00	23.00	20.00	20.00	18.00	14.00	14.00	11.40	13.00	15.00	7.00	16.4	5.333
Sulphate (as SO4)	N/A	82.00	50.00	91.00	118.00	136.00	27.00	64.00	96.00	51.60	230.00	208.00	104.873	64.622
Zinc (as Zn)	5	0.12	0.13	0.02	0.15	0.10	0.08	0.11	<0.01	0.08	0.24	0.11	0.104	0.064

1. **Concentration not in General Standard specification**
2. **All results exposed as mg/l where applicable**
3. **Results not received =***

Table 2.10.2 – Ground water Qualities at Navigation: Sample Point BH8

Sample Date	General Standard	15 Nov 91	12 Dec 91	16 Jan 92	13 Feb 92	13 Mar 92	9 Apr 92	15 May 92	11 Jun 92	9 Jul 92	14 Aug 92	10 Sep 90	Average	Sample Std. Deviation
Calcium (as Ca)	N/A	21.00	21.00	28.00	18.00	18.00	17.00	19.00	17.60	18.40	18.40	16.00	19.309	3.25
Chloride (as Cl)	N/A	7.00	6.00	8.00	7.00	9.00	10.00	6.00	6.80	6.00	6.00	87.00	143436	24.103
Copper (as Cu)	1	0.01	0.01	0.01	0.01	0.01	0.03	0.04	0.01	0.01	0.01	<0.01	0.014	0.011
Cyanide (as CN)	0.5	0.01	0.01	0.10	0.01	0.01	0.01	0.01	<0.1	<0.1	<0.1	<0.1	0.014	0.029
E Coli (/100 ml)	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	0	0	0
Elec. Cond. (mS/m)	250	21.80	24.80	27.10	20.50	23.40	24.30	19.20	20.70	20.20	22.30	25.40	22.7	2.498
Flouride (as F)	1	0.01	0.03	0.05	0.23	0.67	0.09	0.09	0.05	0.06	0.06	0.03	0.125	0.19
Iron (total) (as Fe)	N/A	0.04	0.03	0.19	0.03	0.07	0.01	0.01	<0.01	<0.01	0.02	<0.01	0.036	0.055
Lead (as PBX)	0.1	0.18	0.02	0.01	0.10	0.01	0.01	0.01	<0.01	<0.01	0.03	0.02	0.035	0.055
Magnesium (as Mg)	N/A	11.00	9.00	12.00	10.00	9.00	15.00	7.00	8.70	7.80	7.30	12.10	9.9	2.431
Manganese (as Mn)	0.4	0.03	0.06	0.01	0.01	0.06	0.04	0.02	0.05	0.03	0.02	0.01	0.031	0.019
Nitrate (as N)	N/A	1.00	1.40	3.20	2.00	2.40	1.10	1.50	2.97	4.26	3.05	3.64	2.411	1.096
pH	5.5-9.5	6.02	7.17	5.95	6.43	6.44	6.01	6.31	7.33	7.97	7.52	7.46	6.783	0.721
Potassium (as K)	N/A	1.70	1.80	3.30	1.90	2.40	1.80	1.50	1.60	1.40	1.10	1.50	1.818	0.591
Sodium (as Na)	N/A	10.00	9.00	10.00	12.00	9.00	8.00	8.00	5.70	8.00	6.40	6.60	8.427	1.839
Sulphate (as SO4)	N/A	8.00	13.00	16.00	12.00	18.00	22.00	9.00	10.00	5.20	11.20	6.60	11.909	5.079
Zinc (as Zn)	5	0.02	0.06	0.01	0.07	0.13	0.06	0.15	<0.01	0.08	0.18	0.03	0.072	0.059

1. **Concentration not in General Standard**
2. **All results expressed as mg/l where applicable**
3. **Results not received =***

Table 2.10.2 – Ground water Qualities at Navigation: Sample Point BH 9

Sample Date	General Standard	15 Nov 91	12 Dec 91	16 Jan 92	13 Feb 92	13 Mar 92	9 Apr 92	15 May 92	11 Jun 92	9 Jul 92	14 Aug 92	10 Sep 90	Average	Sample Std Deviation
Calcium (as Ca)	N/A	11.00	10.00	9.00	6.00	12.00	5.00	22.00	5.60	40.00	7.20	5.60	12.127	10.429
Chloride (as Cl)	N/A	11.00	6.00	7.00	7.00	7.00	9.00	5.00	6.00	6.00	5.00	6.00	6.818	1.779
Copper (as Cu)	1	0.01	0.01	0.01	0.03	0.01	0.02	0.01	0.06	0.01	<0.01	<0.01	0.015	0.017
Cyanide (as CN)	0.5	0.01	0.01	0.10	0.01	0.01	0.01	0.01	<0.1	<0.1	<0.1	<0.1	0.015	0.029
E. Coli (/100 ml)	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	0	0	0
Elec. Cond. (mS/m)	250	15.00	14.70	16.90	12.40	15.90	12.70	26.60	11.80	10.81	12.90	11.90	14.699	4.375
Flouride (as F)	1	0.01	0.29	0.15	0.14	0.17	0.17	0.12	0.09	0.04	0.04	0.05	0.115	0.081
Iron (total) (as Fe)	N/A	0.04	0.01	0.04	0.01	0.08	0.01	0.01	<0.01	<0.01	0.03	<0.01	0.021	0.025
Lead (as Pb)	0.1	0.15	0.01	0.01	0.01	0.01	0.02	1.03	<0.01	<0.01	<0.01	0.03	-0.07	0.315
Magnesium (as Mg)	N/A	5.00	2.00	5.00	3.00	4.00	9.00	9.00	1.90	2.40	1.50	0.97	3.979	2.818
Manganese (as Mn)	0.4	0.13	0.12	0.07	0.02	0.09	0.05	0.03	0.04	0.03	0.04	0.01	0.057	0.046
Nitrate (as N)	N/A	2.90	3.80	5.90	4.00	2.80	2.40	2.00	3.89	6.78	3.77	4.78	3.911	1.455
pH	5.5-9.5	6.08	6.91	5.45	6.52	6.43	6.06	6.16	6.99	7.47	7.08	6.68	6.53	0.575
Potassium (as K)	N/A	2.20	2.10	2.30	2.20	2.60	2.80	2.30	2.10	1.70	1.40	1.70	2.127	0.405
Sodium (as Na)	N/A	13.00	11.00	13.00	13.00	10.00	14.00	14.00	9.50	12.00	10.00	10.80	11.845	1.656
Sulphate (as SO4)	N/A	2.00	3.00	2.00	3.00	19.00	2.00	90.00	6.00	1.80	2.80	1.10	12.064	26.341
Zinc (as Zn)	5	0.01	0.07	0.01	0.04	0.03	0.02	0.06	0.03	0.07	0.09	0.01	0.04	0.028

1. **Concentration not in General Standard specification**
2. **All results expressed as mg/l where applicable**
3. **Results not received = ***

Table 2.10.2 – Ground water Qualities at Navigation: Sample Point BH10

Sample Date	General Standard	15 Nov 91	12 Dec 91	16 Jan 92	13 Feb 92	Average	Sample Standard Deviation
Calcium (as Ca)	N/A	11.00	13.00	14.00	10.00	12	1.83
Chloride (as Cl)	N/A	6.00	6.00	8.00	6.00	6.5	1
Copper (as Cu)	1	0.01	0.02	0.01	0.02	0.02	0.01
Cyanide (as CN)	0.5	0.01	0.01	0.10	0.01	0.03	0.05
E. Coli (/100 ml)	0	0.00	0.00	0.00	0.00	0	0
Elec. Cond. (mS/m)	250	15.60	16.20	16.50	13.50	15.45	1.35
Flouride (as F)	1	0.10	0.25	0.48	0.25	0.27	0.16
Iron (total) (as Fe)	N/A	0.03	0.01	0.04	0.04	0.03	0.01
Lead (as Pb)	0.1	0.13	0.06	0.01	0.10	0.07	0.05
Magnesium (as Mg)	N/A	7.00	5.00	6.00	4.00	5.5	1.29
Manganese (as Mn)	0.4	0.06	0.07	0.03	0.01	0.04	0.03
Nitrate (as N)	N/A	0.10	0.40	0.90	0.70	0.53	0.35
pH	5.5-9.5	6.19	6.95	6.18	6.51	6.46	0.36
Potassium (as K)	N/A	3.80	4.10	4.30	4.00	4.05	0.21
Sodium (as Na)	N/A	11.00	9.00	10.00	9.00	9.75	0.96
Sulphate (as SO4)	N/A	5.00	3.00	3.00	2.00	3.25	1.26
Zinc (as Zn)	5	0.01	0.09	0.03	0.06	0.05	0.04

1. **Concentration not in General Standard specification**
2. **All results expressed as mg/l where applicable**
3. **Results not received = ***

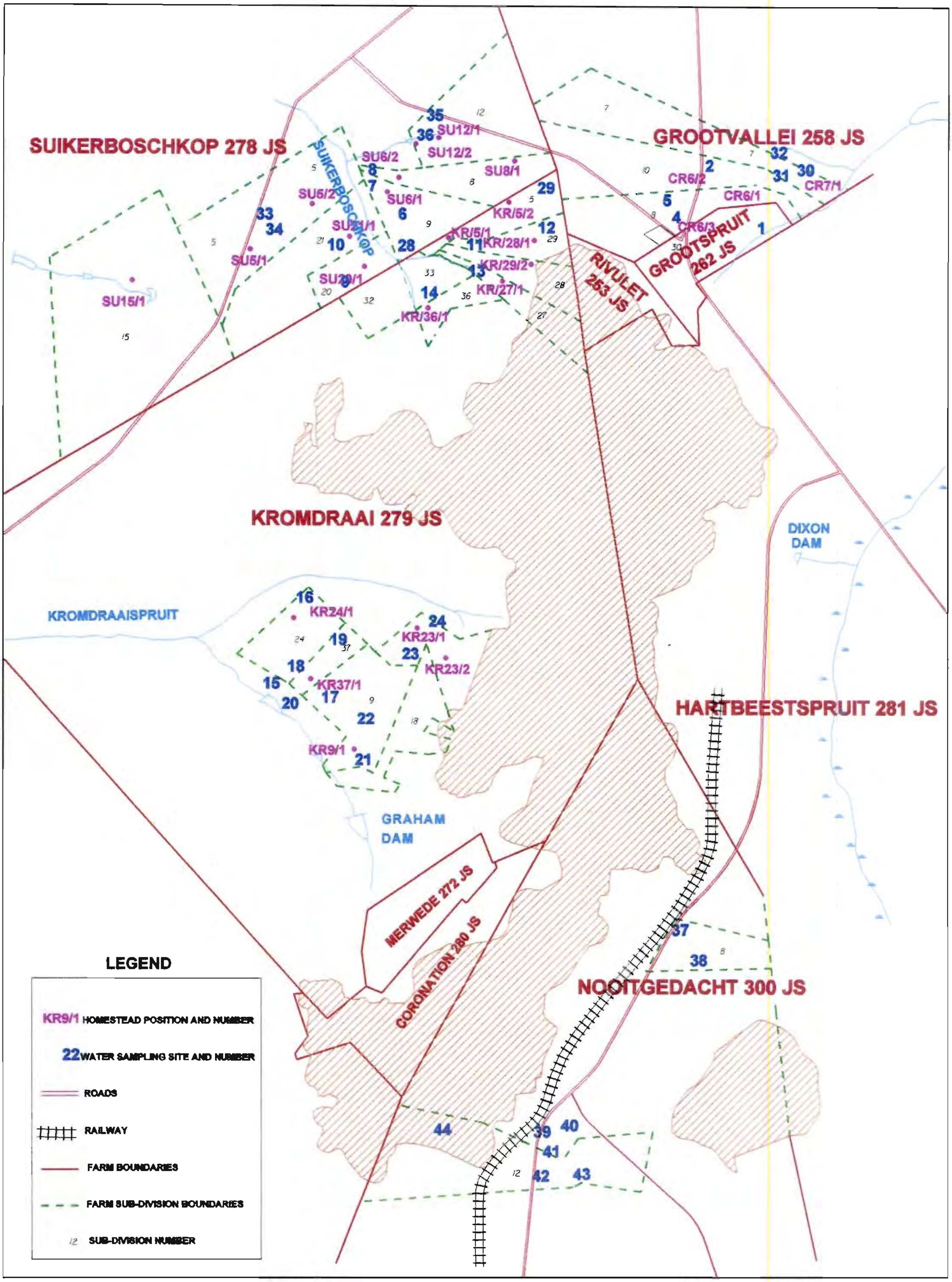

FIGURE 2.12(a) LOCATIONS OF HOMESTEAD WATER SOURCES : KROMDRAAI

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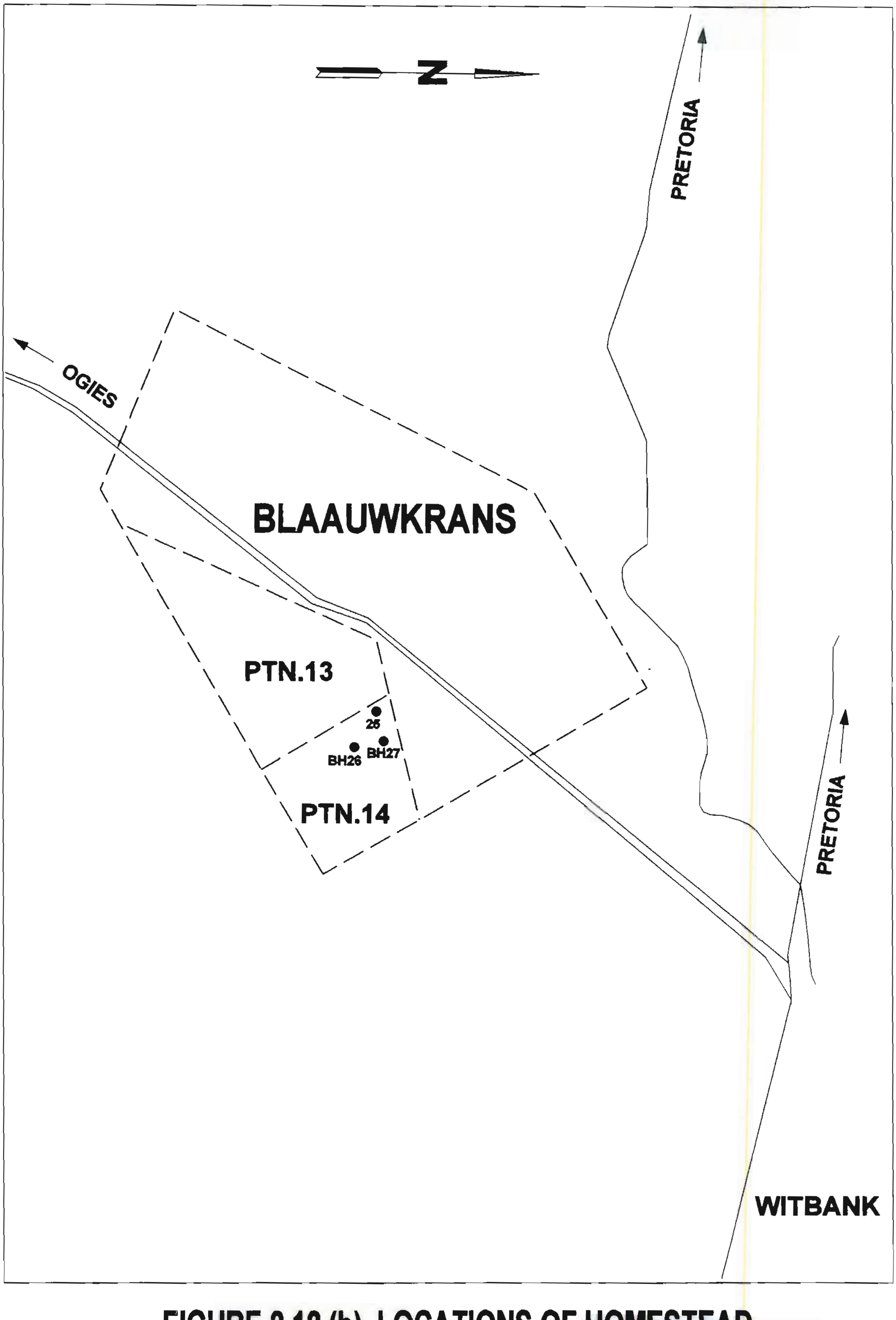

FIGURE 2.12 (b) LOCATIONS OF HOMESTEAD WATER SOURCES : NAVIGATION

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Table 2.10.3 – Homestead Ground water Qualities – Sheet 1 of 2

Sample No.	pH	Cond (mS/m)	TDS	ALK	Ca	Mg	Na	K	HCO_3	CO_3	Cl	SO_4	NO_3	F	Fe
1	4.71	3.92	56	2.0	0.9	0.7	3.1	1.2	2.4	Nil	2.1	8	<0.1	0.2	<0.01
2	6.40	8.63	82	22	4.8	0.7	10.3	3.9	27	Nil	6.2	11	0.3	0.2	<0.01
3	6.07	3.86	60	6.0	1.5	0.2	4.0	3.5	7.3	Nil	5.2	<1	4.7	0.1	<0.01
5	6.97	21.4	204	44	6.6	2.8	24	13.2	54	Nil	35	3	0.6	0.4	0.17
7	5.54	2.90	40	4.0	1.0	0.3	2.5	3.8	4.9	Nil	6.2	<1	0.7	0.1	<0.01
8	5.64	3.39	92	6.0	2.0	0.5	3.5	2.3	7.3	Nil	7.2	<1	0.7	0.1	<0.01
9	6.77	5.93	60	26	3.5	1.5	4.9	4.2	32	Nil	2.1	2	<0.1	0.1	<0.01
10	6.58	4.34	104	20	2.5	1.0	5.0	1.7	24	Nil	2.1	1	<0.1	0.1	<0.01
11	6.85	2.31	40	4.0	0.9	<0.1	2.7	<0.1	4.9	Nil	2.1	<1	1.5	0.1	<0.01
12	5.07	4.62	88	4.0	0.3	0.5	5.3	2.2	4.9	Nil	6.2	1	3.3	0.1	<0.01
13	5.39	3.16	80	8.0	1.0	<0.1	4.8	1.7	9.8	Nil	4.1	1	<0.1	0.1	<0.01
14	5.36	1.13	32	6.0	1.8	<0.1	2.3	1.1	7.3	Nil	3.1	<1	<0.1	0.1	<0.01
15	6.66	17.38	148	40	18.3	4.9	5.3	4.0	49	Nil	3.1	35	<0.1	0.1	<0.01
18	6.63	12.47	120	38	9.9	1.8	7.9	8.4	46	Nil	11.4	2	1.1	0.4	<0.01
21	7.71	23.0	208	104	15.3	7.9	21	6.3	127	Nil	4.1	9	0.5	0.3	<0.01
24	3.50	13.3	120	Nil	3.0	0.5	4.5	4.5	Nil	Nil	4.1	34	1.9	0.2	<0.01
25	4.96	29.1	252	60	20	7.0	16.0	7.5	7.3	Nil	10.4	103	0.7	0.3	<0.01
*Recommended limit For potable water Quality	6-9	70	* 1000	* 300	* 150	70	100	* 200	-	-	250	200	6.0	1.0	0.1

 # All units are mg/l unless otherwise specified.

*** Recommended limits SABS 241 standard (1984)**

Samples exceeding the recommended limit for potable water

Table 2.10.3 – Homestead Ground water Qualities – Sheet 2 of 2

Sample No	pH	Cond (ms/m)	TDS	ALK	Ca	Mg	Na	K	HCO_3	CO_3	Cl	SO_4	NO_3	F	Fe
26	7.12	97.4	944	3104	85	35	35	11.0	127	Nil	179	70	34	0.2	<0.01
27	6.14	40.4	396	34	30	22	11.2	3.6	41	Nil	10.4	144	4.0	0.1	<0.01
28	5.13	4.01	68	6.0	2.5	0.5	3.9	1.0	7.3	Nil	2.1	8	<0.1	0.2	<0.01
29	3.82	147.4	1876	Nil	220	62	11.7	25	Nil	Nil	6.3	1007	0.6	0.5	<0.01
30	5.76	2.15	28	4.0	2.9	0.5	0.3	0.	4.9	Nil	3.2	1	1.8	0.1	<0.01
31	6.22	1.32	24	8.0	3.5	0.5	1.5	<0.1	9.8	Nil	2.1	3	<0.1	0.1	0.83
32	7.07	15.8	172	74	15.0	4.9	9.8	6.3	90	Nil	3.2	6	<0.1	0.2	<0.01
33	5.65	2.35	48	6.0	3.1	0.4	0.4	2.0	7.3	Nil	2.1	1	2.8	0.1	<0.01
34	6.56	5.86	76	24	5.5	1.4	1.9	5.1	29	Nil	3.2	1	0.8	0.1	<0.01
35	5.62	1.08	20	4.0	0.5	0.2	1.5	1.2	4.9	Nil	1.1	1	<0.1	0.2	<0.01
36	5.92	2.90	68	4.0	1.3	0.7	3.7	0.8	4.9	Nil	3.2	6	<0.1	0.2	0.12
37	6.49	7.30	104	24	3.5	1.5	7.2	4.1	29	Nil	3.2	4	0.9	0.3	<0.01
38	4.50	17.6	160	6.0	10.0	5.0	2.4	2.8	7.3	Nil	3.2	39	<0.1	0.7	<0.01
39	5.31	2.99	100	6.0	1.3	0.5	4.0	0.8	7.3	Nil	3.2	1	3.0	0.2	<0.01
40	5.57	1.34	56	6.0	1.0	0.3	2.0	<0.1	4.9	Nil	1.1	1	1.0	0.2	<0.01
41	6.12	1.45	40	4.0	0.5	0.1	4.0	<0.1	4.9	Nil	1.1	4	<0.1	0.2	<0.01
• Recommended limit For potable water quality	6-9	70	* 1000	* 300	* 150	70	100	* 200	–	–	250	200	6.0	1.0	0.1

 # All units are mg/l unless otherwise specified

*** Recommended limits SABS 241 standard (1984)**

Samples exceeding the recommended limit for potable water

Table 2.10.4 - Homestead Ground water Levels, Yield and Usage – Sheet 1 of 3

Farm	Position No.	Ground water Source (depth driller)	Present Water Level m.b.g.l.	Present Usage	Approx. Daily Extraction L/day	Estimated Borehole Yield L/hr	Sample No.	Remarks
GROOTVALLEI Portion 7	30	Borehole (35m)	No access	Potable	2000	5000	30	Electric Pump
	31	Borehole (60m)	No access	Domestic/Limited Irrigation	5000	2500	31	Electric Pump
	32	Spring	-	None	5000	5000	32	-
Portion 8	1	Spring	-	Potable/Irrigation	2000	7500	1	Diesel pump
	2	Borehole (30m)	6.5m	Potable	1000	500	2	Windmill
	3	Borehole (35m)	4.4m	Potable	1000	1000	3	Electric pump
	4	Borehole (30m)	-	None	-	2000	-	No access due to Beehive
	5	Bulpan pan	-	Livestock Watering	2000	-	5	No Boreholes/Springs
Portion 30	-	-	-	-	-	-	-	No boreholes/Springs
SUIKERBOSCHKOP Portion 5	33	Borehole (30m)	10m	Potable	2000	500	33	Electric pump
	34	Borehole (90m)	no access	Potable	2000	500	34	Electric pump
Portion 8	-	-	-	-	-	-	-	No boreholes/springs
Portion 9	6	Borehole	No access	Livestock watering	500	1000	-	Windmill
	7	Spring	-	Irrigation	2000	2000	7	Diesel pump
	8	Borehole (30m)	1.9m	Potable	1000	1800	8	Electric pump
	28	Spring	-	Livestock	2000	10000	28	Pits in drainage course
Portion 12	35	Borehole (50m)	20m	Potable	1000	<500	35	Electric pump
	36	Spring	-	Irrigation	10000	10000	36	Trench drainage
Portion 20	9	Borehole (25m)	16.4m	Potable	1000	500	9	Diesel pump

Table 2.10.4 – Homestead Ground water Levels, Yield and Usage – Sheet 2 of 3

Farm	Position No.	Ground water Source (depth driller)	Present Water Level m.b.g.l	Present Usage	Approx. Daily Extraction L/day	Estimated Borehole Yield l/hr	Sample No.	Remarks
SUIKERBOSCKOP Portion 21	10	Borehole (20m)	No access	Potable	1000	500	10	Windmill – no access
Portion 15	-	Well (4m)	Dry	-	-	-	-	Farm abandoned
KROMDRAAI Portion 5	11 29	Spring Old Quarry	- 10	Potable/Industrial -	5000 -	8500 -	11 29	Electric pump Water contaminated
Portion 29	12	Borehole (30m)	6.5m	Potable	1000	3000	12	Electric pump
Portion 27	13	Spring		Potable	200	1000	13	Hand extraction
Portion 36	14	Spring	-	Potable	3000	500	14	Diesel pump
Portion 33	-	-	-	None	-	-	-	No development
Portion 32	-	-	-	None	-	-	-	No development
Portion 24	15 16	Well Borehole	- infilled	Potable -	1000 -	10000 -	15 -	Diesel pump broken Farm abandoned
Portion 37	17 18 19 20	Borehole Well Borehole Well	8.4 7.1 No access 7.5	Potable Potable None None	500 200 - -	2000 2000 - -	- 18 - -	Pump broken Extraction by hand Windmill broken Disused

Table 2.10.4 – Homestead Ground water Levels, Yield and Usage – Sheet 3 of 3

Farm	Position No.	Ground water Source (depth drilled)	Present Water Level m.b.g.l	Present Usage	Approximate Daily Extraction L/day	Estimated Borehole Yield L/hr	Sample No.	Remarks
KROMDRAAI Portion 9	21	Borehole	12.10 (35m)	Potable	1000	3600	21	Electric pump
	22	Borehole	6.1	None	-	-	-	Not equipped
Portion 23	23	Borehole	Collapsed	None	-	-	-	Abandoned
	24	Well	5.0 (7.5)	Domestic	200	500	-	Water contaminated
BLAAUWKRANS Portion 13	-	-	-	-	-	-	-	No Borehole
Portion 14	25	Dam	-	Irrigation	5000	-	-	
	26	Borehole	-	Potable/Domestic	1000	3600	26	Electric pump
	27	Borehole	11.3 (20m)	Potable/Domestic	3000	3600	27	Electric pump
NOOITGEDACHT Portion 8	37	Borehole (30m)	16.0m	Potable	2000	1000	37	Electric pump
	38	Dam	-	Irrigation/ cattle	5000	-	38	-
Portion 12	39	Borehole (30m)	9.0m	Not used	500	500	-	Windmill broken
	40	Borehole (35m)	no access	Cattle watering	1000	1000	-	Windmill broken
	41	Borehole (20m)	3.4	Potable	2000	5000	39	Electric pump
	42	Borehole (30m)	>40m	Cattle watering	500	<500	40	Electric pump
	43	Spring	-	Cattle watering	1000	5000	41	-
	44	Borehole	collapsed	-	1000	500	-	-

Due to the fact that underground water has remained in the old workings for long periods it has had time to react with the pyrite in the pillars and become acidic. This in turn has increased the salinity levels in the water due to the presence of neutralising agents such as calcium and magnesium carbonates.

2.10.2.2 Kromdraai Opencast Mining Area

At present the ground water at Kromdraai is confined to water which accumulated in the old workings, water within a perched aquifer above unweathered impervious coal seams and within the weathered coal seams.

A geohydrological survey (Supplementary Report No. 13) has been conducted in conjunction with Professor F.D.I. Hodgson to:

- Identify seepage zones associated with the ground water, which has accumulated in underground workings, and become polluted by the oxidation of pyrite present in the overburden and coal horizons.
- Define the ground water regime above, below and around the mining area.
- Evaluate the impact mining will have on the ground water.

The locations of the water bodies in the old workings are presented in Figure 2.13. In general this water is acidic and ranges from pH 2,7 to 6,3 and contains between 70 and 4 000mg/l of sulphates. This water is being treated in a 14 Ml/day liming neutralisation plant to raise the pH from 2,7 to 7,5. The metals (iron and aluminium) are precipitated in a settler and removed to dams.

In order to reduce seepage of acid mine water the level of water in the old mine workings is, where practical, maintained below the level where seepage will occur. Water that accumulates in the Central and North Blocks drains via two adits to the liming plant where it is treated. Water from the Excelsior Block is gravitated by pipeline to the Turnbull Adit from where it is discharged via the Central Block workings for treatment. Similarly, water from the South Block is piped to the liming plant for treatment. Due to security problems water cannot be pumped at all times and manual liming of the water entering Graham's dam is required. Water from the North Block is also discharged to this liming plant via an adit. The quality before and after treatment is presented in Table 2.10.5.

Flooded underground areas will have to be dewatered ahead of opencast mining. As a result the average rate of dewatering required, assuming normal weather conditions, has increased considerably. Dewatering operations may have to be accelerated and the liming plant may have to be upgraded. Initially the sulphate load is expected to increase and, as the water bodies are depleted, the retention time of water entering the mine will reduce. The acidity is expected to improve and the sulphate load to decrease. A permit was obtained when the Kromdraai liming plant was first built (1972) to release treated water into the evaporation ponds. However, due to acid seeping from the evaporation ponds into the Kromdraaispruit the water was released into the Kromdraaispruit from 1997 onwards. Permission was

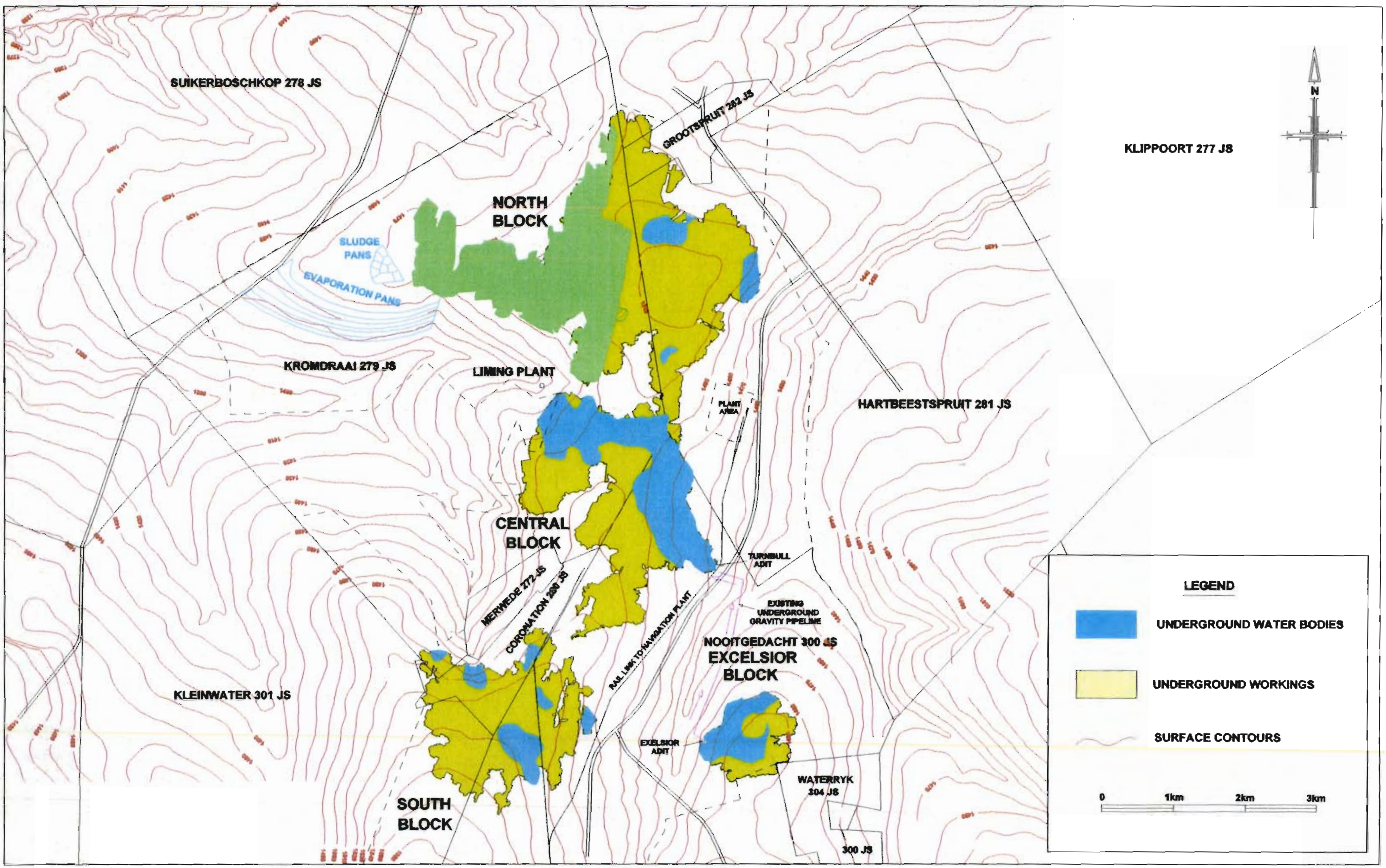

FIGURE 2.13 UNDERGROUND WATER BODIES AT KROMDRAAI

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granted by the DWAF Regional Director in February 1997 to release the treated water into the Kromdraaispruit (DWAF Reference no. 16/2/7/B100/C12).

Table 2.10.5 - Typical Water Quality Entering and Leaving the Liming Plant (pre 1993)

TEST	BEFORE TREATMENT	AFTER TREATMENT
Suspended Solids	9,6	21,2
Conductivity (mS/m)	174	164
pH	1,8	7,3
Sulphate (SO4)	1 035	1 035
Total hardness ($CaCO_3$)	100	1 100
Calcium hardness	40	1 050
Magnesium hardness	60	50
Calcium (Ca)	16	420
Magnesium (Mg)	14	12
Iron (Fe)	119	2

Average qualities of treated water leaving the liming plant indicate that the pH was about 8.3.

Figures 2.14 shows diagrammatically the operation of the liming plant. During the pre-mining period effluent from the liming plant flowed into a series of evaporation ponds located on the banks of the Kromdraaispruit downstream from the liming plant (Figure 2.13). During peak flow periods the final evaporation pond overflows into the Kromdraaispruit. A considerable proportion of the water drained into the evaporation ponds was lost through seepage and evaporation. A significant fraction of the seepage water ends up in the Kromdraaispruit. An application has been submitted to the Department of Water Affairs and Forestry to obtain permission to discharge neutralised water directly into the Kromdraaispruit and not into the evaporation dams. This application was approved by the Regional Director of the Department of Water Affairs in 1997 (Reference no 16/2/7/B100/C12). Currently the evaporation dams are empty and no seepage is evident from the evaporation dams.

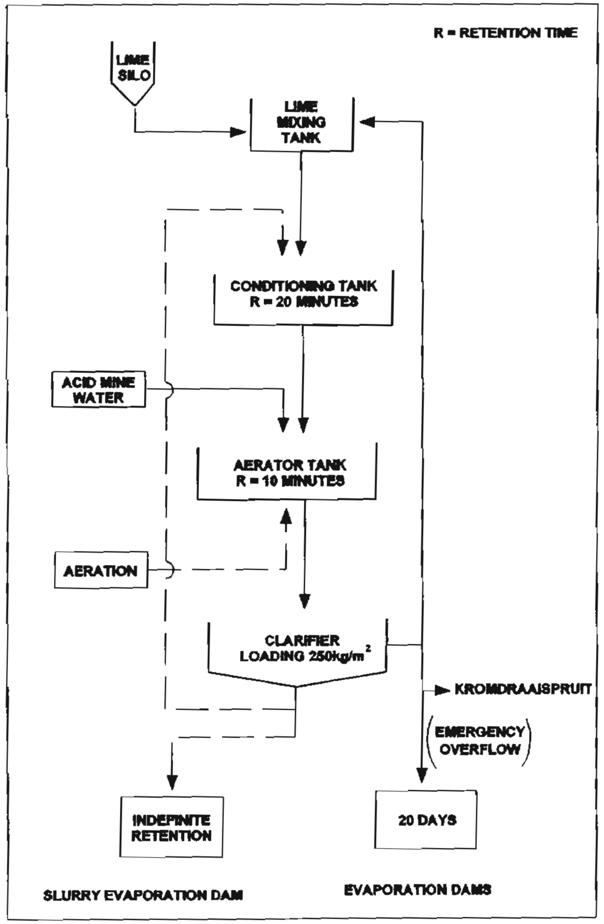
The thickener underflow sludge generated by the liming plant is a mine waste and is pumped into a sludge pan located to the north of the evaporation ponds. (See Figure 2.13). The estimated volume of sludge pumped each month is $200m^3$. This sludge takes the form of an iron rich slurry, yellow/brown in colour and of neutral pH.

The exact impact of the long-term storage of thickener underflow sludge from the liming plant on ground water qualities is difficult to determine due to the location of a coal stockpile adjacent to the slurry dams.

In view of this, samples of the sludge will be analysed and subjected to leaching tests to determine the long-term impact of the sludge pans on the ground water regime. Investigations are underway into the ground water qualities, suitability of the site, disposal methods, whether the heavy metals in the sludge can be

OBJECTIVE

1. INCREASE pH TO 7.5
2. REMOVE HEAVY METALS
3. REDUCE TDS



PLANT LAYOUT
CAPACITY 14 000m³/ d

PROBLEM

IRON OXIDE PRECIPITATION HAS LOW DENSITY

LIME SLURRY $Ca(OH)_2$

LIME CONTENT	20%
pH	12.0

CONDITIONING OF RETURNED SLUDGE

RETURN SLUDGE AGED
FERROUS IRON HIGH (Fe^{2+})
FERRIC IRON LOW (Fe^{3+})
MIXING SLOW TO PREVENT FLOC DISINTEGRATION
pH 10.0

ACID MINE WATER

REACTIONS IN MINE

$2FeS_2 + H_2O + 7O_2 \longrightarrow 2FeSO_4 + 2H_2SO_4$ - BACTERIA

$FeS_2 + 14Fe^{3+} + 8H_2O \longrightarrow 15Fe^{+2} + 2SO_4 + 16H^+$

pH	2.5
FERROUS	0 - 140 mg/l
FERRIC	30 - 200 mg/l
TDS	1750 mg/l
SO_4	1150 mg/l
TOTAL IRON	170mg / 1

NEUTRALISATION & PRECIPITATION

REACTIONS IN LIME PLANT

$Ca(OH)_2 + H_2SO_4 \longrightarrow CaSO_4 + 2H_2O$

$Ca(OH)_2 + FeSO_4 \longrightarrow Fe(OH)_2 + CaSO_4$

$4Ca(OH)_2 + 4FeSO_4 + 2H_2O + O_2 \longrightarrow 4Fe(OH)_3\downarrow + CaSO_4$

IRON HYDROXIDE PRECIPITATES
SLOW TO SETTLE BECAUSE :
IRON MOLECULES SURROUNDED BY H_2O MOLECULES

THICKINING POOR BECAUSE :
HYDRATED IRON MOLECULES NEGATIVELY CHARGED &
REPEL EACH OTHER THEREFORE REQUIRES RECIRCULATION

CLARIFICATION

SLUDGE

Fe	400 mg/l	
pH	7.5	
FERROUS	5.6%	
FERRIC	20.2%	DRY BASIS

LIQUID

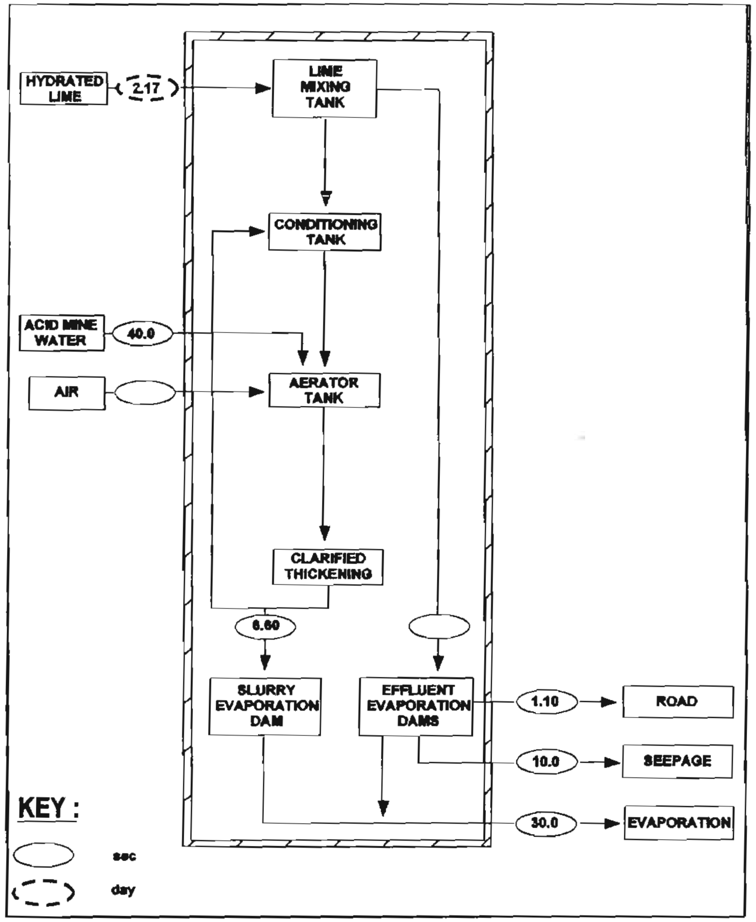
pH	7.5
FERROUS	1 mg/l
FERRIC	30 mg/l
TDS	1800 mg/l
SO	1150 mg/l
TOTAL IRON	0.18

DENSITY OF SLUDGE

WITHOUT RECYCLE	10 g/l
WITH RECYCLE	350 g/l

SOLUTION

1. RECYCLE PRECIPITATE
2. AGE RETURNED SLUDGE
3. IRON SHOULD BE IN FERROUS FORM IN CONDITIONING TANK



CURRENT FLOW NETWORK

FIGURE 2.14 DIAGRAMMATIC OPERATION OF KROMDRAAI LIMING PLANT

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immobilised and the sludge rendered inert. This would declassify the sludge as a general waste.

2.10.3 Ground water Quality

Ground water qualities are described in Sections 2.10.1 and 2.10.2

2.10.4 Ground water Use

Figure 2.12 shows the locations of adjacent ground and spring water users. Table 2.10.5 gives the estimated yields of these points.

2.10.5 Ground water Zone

Two naturally occurring ground water regimes have been identified, namely the perched shallow aquifer associated with the depth of weathering and the sandstone aquifer.

2.10.5.1Kromdraai Opencast

Opencast mining will disturb both aquifers. Only the aquifer associated with weathering will remain intact around the perimeter of the opencast workings. Accumulations of water in the opencast spoils could move into both aquifers.

2.10.5.2 Navigation Plant Area

Similarly, at Navigation, the two aquifers described above occur. As no mining is planned to take place the upper weathered aquifer will be affected under the Blaauwkrans discard dump. The aquifer under the old Navigation and Anglo French dumps has already been affected.

2.11 Air Quality

CJ. Els, in his 1990 report titled "Strategies for dealing with the Eastern Transvaal Highveld Acidic Deposition situation has prepared an estimate of the sulphur dioxide emissions in the Eastern Transvaal Highveld which is summarised in Table 2.11.1

Table 2.11.1 – Major Sources of Air Pollution in the Eastern Transvaal Highveld

SOURCE	SULPHUR DIOXIDE MASS (TON/YR)	EMISSIONS PERCENTAGE (%)
Power Stations	1 110 585	91,20
Brickwork's	2 634	0,22
Ferro-alloy Works	1 557	0,13
Steelworks/Foundaries	78	<0,01
Saw Mills	499	0,04
Paper &Pulp Mills	79	<0,01
Petrochemical Plants	7 019	0,58
Domestic/Municipal Combustion	36 984	3,04
Coal Dumps	54 390	4,47
Other	3 903	0,32
TOTAL	1 217 728	100,00

(Results derived from data made available by the Department of National Health and Population Development based on an air pollution survey carried out in 1985. Where no samples for a particular industry were available, the pollution results given in the table are estimates using emission factors from American industries).

From Table 2.11.1 it is noted that burning coal dumps contribute some 4,5% of sulphur dioxide to the atmospheric pollution, i.e. very little compared to power generation plants which contribute 91%. Coal discard recovery and disposal techniques now applied in the region have improved to the extent that a reduction in sulphur dioxide pollution from dumps can be expected in future years.

Annegarn Environmental Research (AER) conducted a survey of particulate air pollution at the Kromdraai Opencast mine area and the Navigation Plant and discard sites and issued a report on a proposed monitoring programme which is attached as Supplementary Report No.15. AER continues to monitor air pollution monthly.

The settelable or fallout dust settles out exponentially with distance from the source. Except during exceptional thunderstorm activity, fallout dust will not have measurable impacts beyond 3km from source, based on long-term measurements on gold mine tailings. The assessment of air quality for a particular mining operation therefore needs to be site specific, taking into account the land use in a 3km band around the boundaries of the operation. Residential quarters for mineworkers are considered as public areas for air quality purposes, when situated within mine boundaries.

Historically, the Witbank district was predominantly a maize cultivation area. Soil cultivation itself has led to exposed areas of soil on a seasonal basis, and both ploughing and harvesting, and burning of agricultural residues are dust-producing activities. Over the past two decades, numerous surface and underground mines have operated in the region.

Surface mining and coal benefication activities at Kromdraai Colliery are located at a number of distinct sites well separated from each other. For impact assessment, each needs to be considered separately:

- Kromdraai mining Area
- Excelsior mining Area
- Schoongezicht mining area
- Navigation plant
- Blaauwkrans Co-Disposal facility

Supplementary Report No. 15(a) contains the results of the dust-monitoring programme at the Colliery. To date no major impact on surrounding neighbours has been identified.

2.12 Noise

A preliminary class 3 sound impact study for the Kromdraai and Navigation areas has been carried out and is attached as Supplementary Report No. 16. It is the Colliery's view that a further sound impact assessment is not necessary at this stage. However, should the need arise a class 2 assessment will be carried out for specific areas.

2.13 Sites of Archaeological and Cultural Interest

Mr. A.C van Vollenhoven of the National Cultural History Museum in Pretoria, presented the findings of his investigation of the Kromdraai area in his report of April 1992 (Supplementary Report No.17).

Mr. van Vollenhoven identified one Stone Age site, which yielded two artefacts, during the course of his investigation. In his report it was concluded that, due to the nature of the terrain, the Kromdraai area would not have been suitable for stone age inhabitants; the artefacts were most likely left by travelling hunters and were therefore not of significance.

Graves dating to 1928, and possibly earlier, were identified. The gravesites that will be affected by mining will be relocated. Relocation of graves are currently under investigation and will done according to the proper legal procedure as stated in the Development and Facilitation Act of 1995, as well as, any other legislation.

2.14 Sensitive Landscapes

No sensitive landscapes have been identified within the area to be mined by the various consultants employed on the project.

For the purposes of this report sensitive landscapes have been defined as follows:

1. Landscapes contain a habitat of endangered or rare species.
2. Landscapes which are especially sensitive to erosion.

3. Landscapes containing wetlands.

Wetlands are found adjacent to the mining area along the Klipspruit and Kromdraaispruit rivers. Both wetlands are subjected to a degree of acid mine drainage resulting from seepage from the old underground workings (along the Klipspruit) and from beneath the evaporation pans below the liming plant (in the case of the Kromdraaispruit). This situation has been going on for a number of years and appears to have had little impact on the functioning of the wetlands, which have served to improve the quality of the water leaving the property.

2.15 Visual Aspects

The areas in which the mine, plant and discard dump are situated do not lie on recognised tourist routes.

Dust generated from the Kromdraal opencast mine will be kept to a minimum with controlled blasting practices and dust suppression methods.

The Navigation plant and discard dumpsites are situated in the vicinity of the residential areas of Clewer and Schoongezicht Township, which are shown on the attached 1:50 000 topocadastral maps. With the environmental steps taken in the plant and on the discard dump, visible dust and gases will be kept to a minimum.

Due to the size of plant and machinery employed these are visible from the various public roads that pass in the vicinity of the operations.

2.16 Regional Socio-Economic Structure

2.16.1 Witbank is the largest city in the region with an estimated population of 250 000. The town is surrounded by smallholdings, working and abandoned coal mines and the Kwa-guqa township to the West of Witbank The population of Kwa-guqa is estimated to be between 70 000 and 90 000 and approximately 40% of this population is economically active.

2.16.2 The main employers in the greater Witbank area are Anglo Coal, Ingwe, Highveld Steel and Vanadium Corporation, Rand Carbide, Vantra, Ferrometals and Eskom.

2.16.3 As a result of the closure of the underground mining operation at Landau, Approximately 1 500 jobs were lost. With the present recession there is a shortage of employment opportunities and it is estimated that there is more than 25 % unemployment in the area. Also as a result of the recession there has been a significant influx of people from rural areas to the towns seeking employment. This has resulted in an acceleration of the informal settlement area of Kwa-guqa

2.16.4 Due to the closure of the Landau III Colliery, S.A. Coal Estates has a surplus of accommodation units and will therefore not place a burden on the existing housing demand.

2.16.5 Witbank is the commercial and industrial centre of this region and is well represented by most of the major banking institutions, retail stores and engineering facilities. The town has well established community facilities, some of which are listed below:

a provincial hospital
a private hospital
churches (44)
two cinemas with four theatres each
a drive-in cinema
a civic theatre

2.16.6 Water is abstracted from the Witbank Dam and then purified in the 100 Ml/d Ferrobank plant, the 5 Ml/d River View plant which is to be extended to 11 Ml/ d and the 4,5 Ml /d Naauwpoort Plant. A new plant is in the planning stage, the capacity and location of which is still to be decided.

2.16.7 Power supply is from the Eskom grid.

2.17 Interested and Affected Parties

During the planning and development stage of the project the following bodies were Briefed:

1. Department of Mineral and Energy Affairs - Regional Director : Witbank.
2. Department of Water Affairs.
3. Witbank Town Council.
4. Transvaal Provincial Administration ~ Roads Branch.
5. Spoornet
6. Eskom.
7. Neighbouring farmers

The following parties are in consultation with Landau Colliery:

1. The Department of Nature Conservation.
2. The Department of Agriculture
3. The Department of Environmental Affairs.
4. The Department of water Affairs and Forestry

5. Local farmers (Smith Brothers, Havalaar, etc.) through direct contact and through the Brugspruit and Saalklapspruit Forums, of which Landau Colliery is an active participant.

A surface water user survey was conducted by Clean Stream Environmental Services along the Brugspruit, Klipspruit, Kromdraaispruit and Saalboomspruit. Findings of this report appear in Supplementary Report no. 24

PART 3: MOTIVATION FOR THE PROPOSED PROJECT

3.1 Benefits of the Project

3.1.1 The products from the project will be sold on the South African market and also exported through the Richards Bay Coal Terminal (RBCT) to be sold internationally.

3.1.2 The estimated cost to completion of the project is R703, 5 million escalated.

3.1.3 The total annual expenditure at full output is estimated at R90 million in December 1992 money values.

3.1.4 S.A. Coal Estates on the project will employ a total of 337 people.

Use will be made of contract labour for certain aspects of the operation such as discard disposal and when emergencies occur.

During the construction phase approximately 1 500 people were employed on site on the project.

Applying the general multiplier effect of 4: 1 it is anticipated that a further 1 000 people will gain employment in South Africa as a result of this project.

It must be noted that the above figures are a net decrease from the numbers employed directly and indirectly prior to the closure of the Landau III Colliery.

3.2 Consideration of Project Alternatives

3.2.1 Mining Method

Anglo Coal decided to maintain it's position as a major supplier and exporter of coal to the world market when with other mining houses it embarked on the expansion of the Richards Bay Coal Terminal from 44 million tons per annum to 53 million tons per annum. By investing R703, 5 million in the development of Landau Colliery, Anglo Coal has demonstrated its ongoing commitment to the growth and stability of the coal mining industry in South Africa. The benefits arising from this major investment will be widespread both to the country as a whole and the region in particular. In the late seventies coal became a significant earner of foreign exchange and today is second only to the gold mining industry.

During 1989 and 1990 a comprehensive feasibility study was undertaken to identify coal reserves to support a 3 million sales tons per annum mine suitable for the export market.

The coal reserve blocks investigated were the Kromdraai and Schoongezicht/Navigation blocks.

APPROVED
DIRECTOR: MINERAL DEVELOPMENT

An expansion at Kromdraai, using existing facilities where possible, was selected ahead of the Schoongezicht/Navigation field as it proved to be the most cost-effective option and offered opportunities to stabilise a significant area of land for agricultural or other use after mining.

The Kromdraai coal reserves have been divided into four blocks, namely North, Central, South and Excelsior.

These reserves are contained in the Number 1 and 2 seams, which are separated by a stone parting with an average thickness of 0,7 metres. Some 50% of the gross insitu tons of the No. 1 seam were extracted by previous underground bord and pillar methods. The Number 2 seam is largely still intact. The average thickness of the Number 2 coal seam is 5,5 metres, and in the central part the thickness is as much as 7,0 metres. The total mineable coal reserve is estimated at 137 million tons of which 67% is saleable.

The Kromdraai opencast mine is an Anglo Coal Colliery operated by South African Coal Estates and is situated some 15km Northwest of Witbank. Previous underground mining operations took place between the years 1926 and 1966. There is an existing minipit operation in the north west corner of the North Block from where the new opencast mining operation will commence. The planned development of the mine is depicted in Figure 3. 1.

Since cessation of the underground mining operations, water has accumulated in these workings. Furthermore, subsidence has occurred in the area due to failure of the roof of the old underground workings.

Anglo Coal Research and Development Department have evaluated the stability of the old workings and categorised the area into different hazard zones. This report is enclosed as Supplementary Report No. 18.

There is also a risk of spontaneous combustion as a result of the previous mining operations. Testing of the various carbonaceous strata for self-heating risk, using the University of the Witwatersrand-EHAC test, was carried out as part of the pre-production technical investigations. This report is enclosed as Supplementary Report No.19. Due to the risk of spontaneous combustion, gas monitoring equipment is installed in all machines that operate at the coal face.

Access will be gained to the coal seam by a network of high-wall ramps. This method of access has been chosen in preference to the more commonly used low-wall ramp system, which leaves depressions between the blocks of rehabilitated mining land. These two methods of access are illustrated in Figure 3.2. The highwall ramps are mined out by the dragline and pre-strip shovel and truck operation as mining progresses.

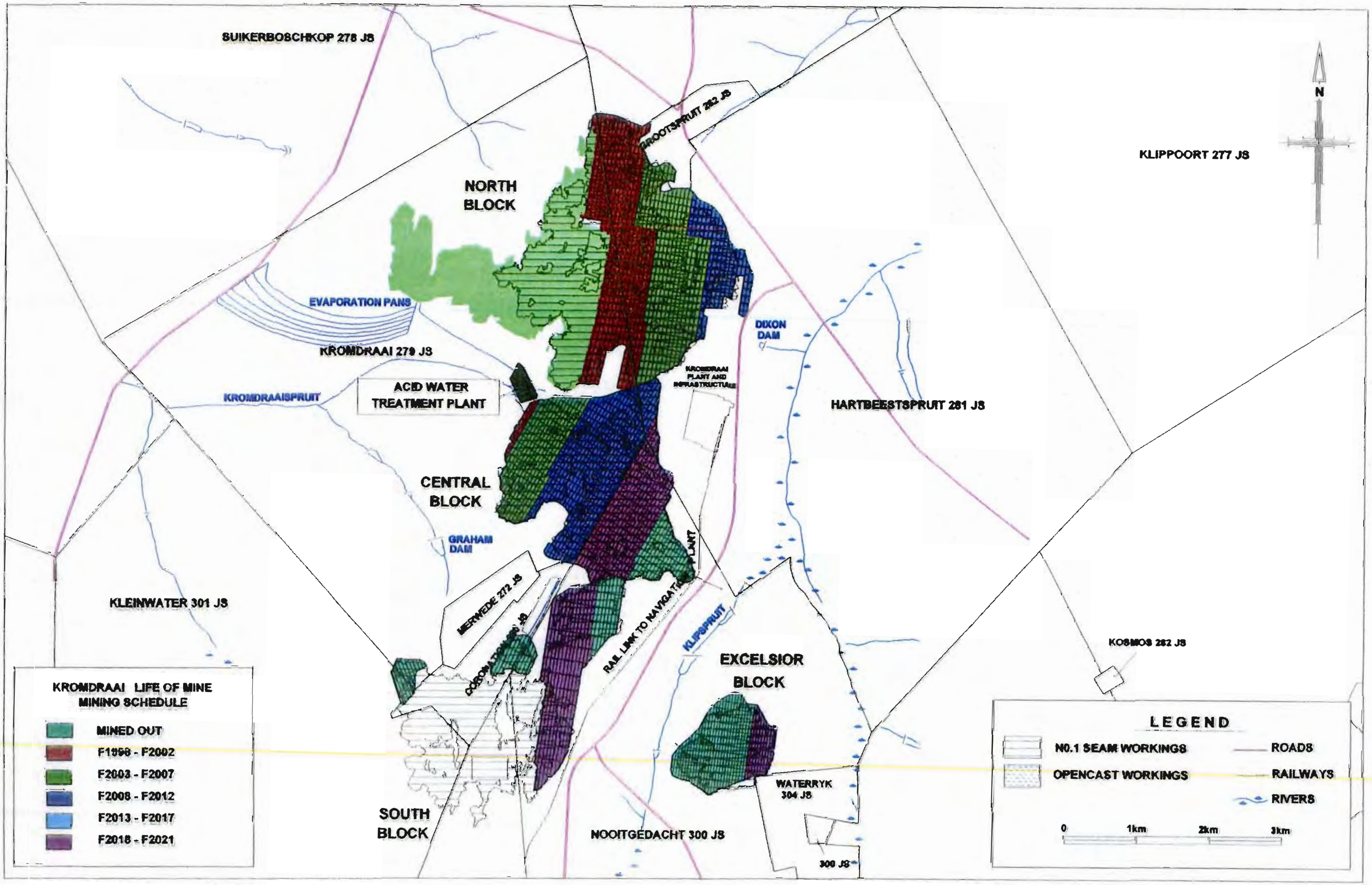

FIGURE 3.1 INDICATIVE LIFE OF MINE PLAN

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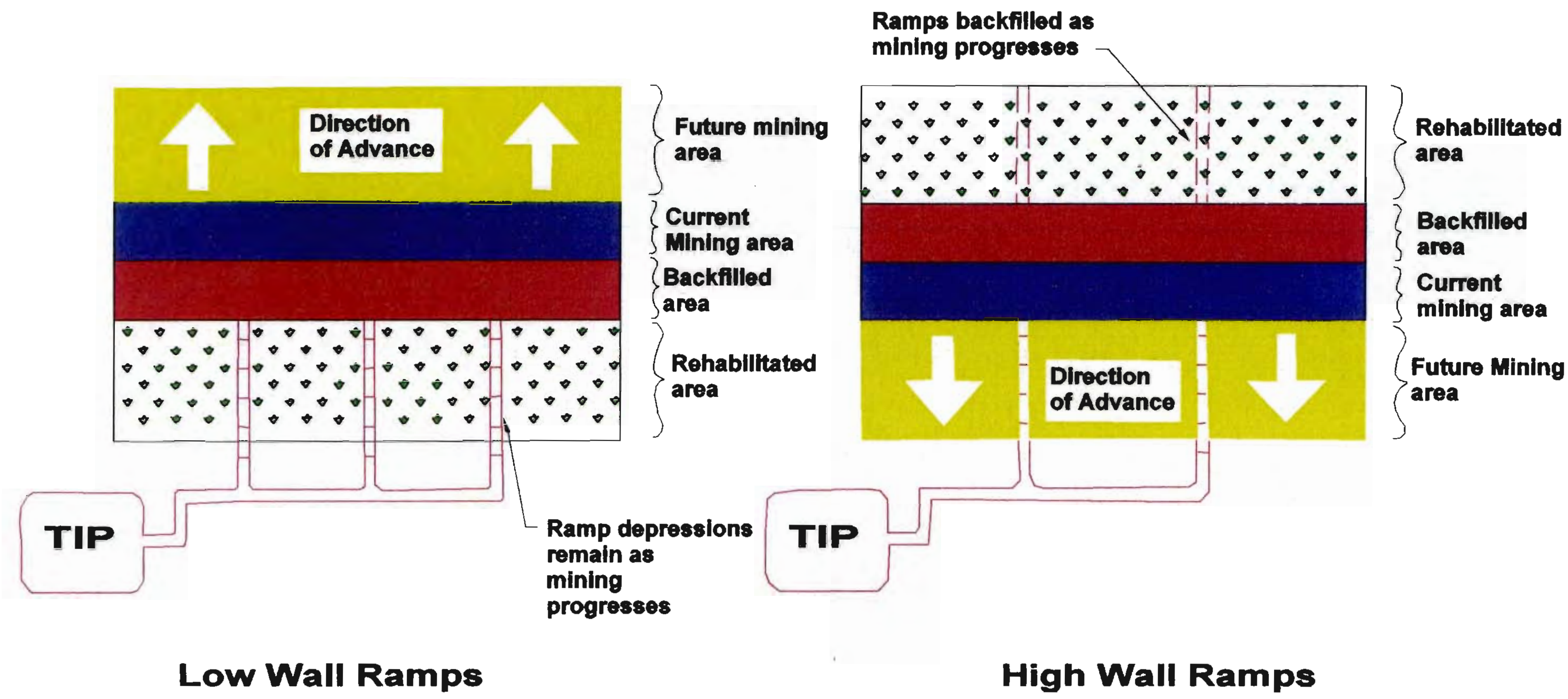

FIGURE 3.2 COMPARISON OF LOW AND HIGH WALL RAMPS

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The mining method to be employed will be a combination of shovel and truck and dragline operations shown in cross section in Figure 3.3. The operational steps are as follows:

1. Usable soil will be removed and either stockpiled separately for later use during rehabilitation, or placed directly over graded spoils.

2. Where necessary, overburden will then be removed by shovel and truck and selectively dumped over dragline spoils to profile the post-mining topography.

3 The remaining overburden to top of coal will be sidecast by the dragline into the void left after removal of the coal.

4 Strips of exposed coal of approximately 60 metres wide will be removed by shovel and truck and hauled to the run of mine (ROM) tip for processing.

5. The dragline spoils will be roughly graded prior to placement of overburden by shovel and truck followed by replacement of useable soil.

6. Soil placement will be carefully controlled to achieve the. pre-planned soil distribution. After replacement, all profiled surfaces will be thoroughly ripped to overcome the compaction of the soil induced by heavy mining equipment. Final tillage will produce a bed suitable for planting pasture seed. The land rehabilitation section of Anglo Coal Environmental Services will monitor the pasture performance, fertiliser requirements, success of seed mixes and any other factors, which affect growth.

Final voids along the eastern limit of the North, Central, and Excelsior blocks will be filled and re-vegetated on completion of mining in these blocks. (Refer to Supplementary Report No. 1). The indicative timing of completion of these blocks is shown in Figure 3.1.

The Geological formations above the coal seams, which are to be removed and mining, will disturb the topography. Once the coal is removed from a mining cut, the overburden spoil from the next cut, which typically consists of a shale, siltstone and sandstone mixture interspersed with limited amounts of clay and sand overburden, will be returned to the mined out cut by the dragline. On account of this disturbance up to 30% bulking of the overburden will occur, depending on the characteristics of the different strata, which will partly compensate for the coal removed from the area. Figure 3.4 compares the pre- and post-mining contours anticipated whilst Figure 3.5 shows in cross section the pre- and post-mining surfaces.

Apart from the effects on the surface, mining will destroy the perched water table and alter the geohydrology and geochemical behaviour of the spoil. Overall the overburden spoil will be more permeable than the original strata with greater voids and exposed rock surface areas. Pyrite exposed on the rock surfaces will be

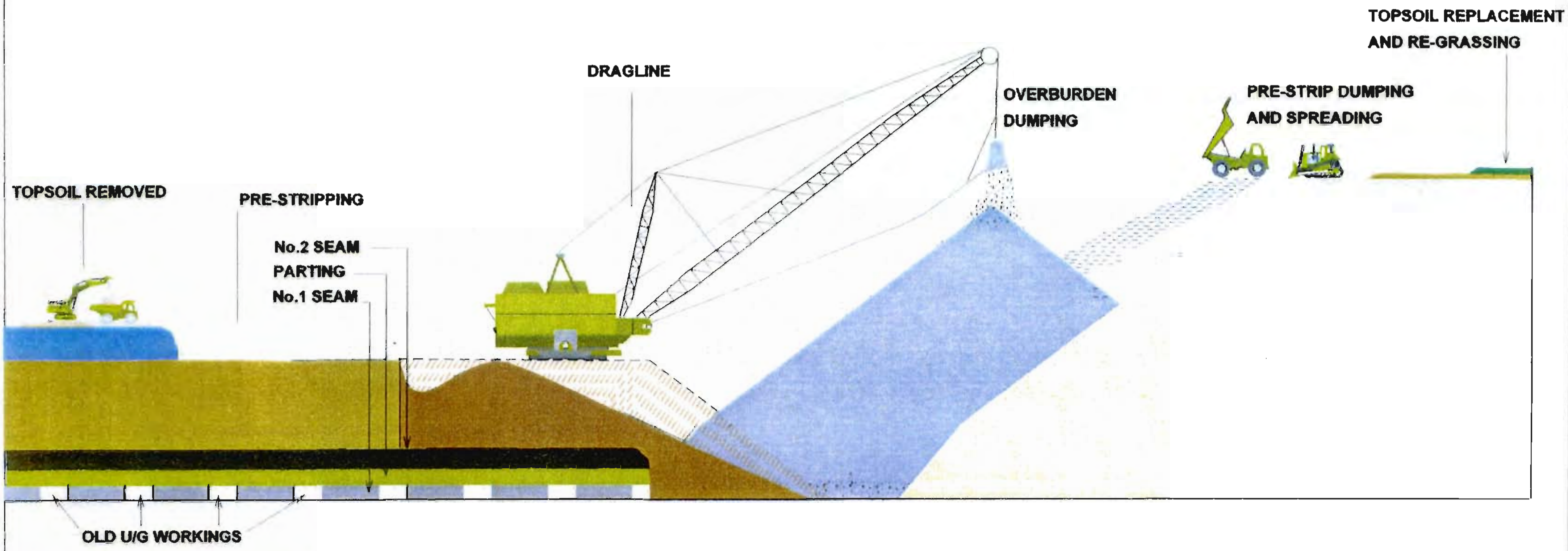

FIGURE 3.3 DIAGRAMMATIC REPRESENTATION OF THE OPENCAST MINING OPERATION

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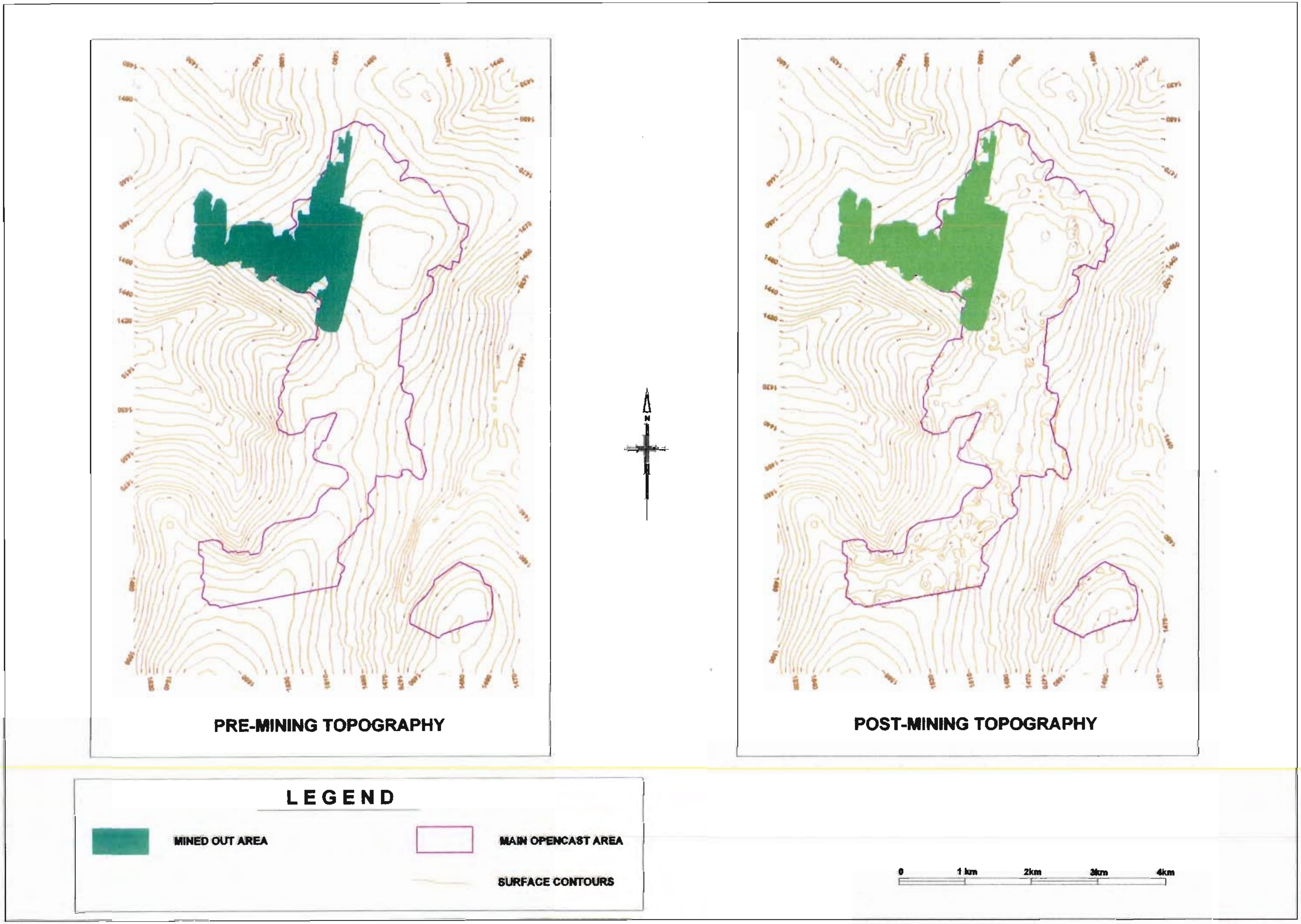

FIGURE 3.4 PRE- AND POST-MINING TOPOGRAPHY

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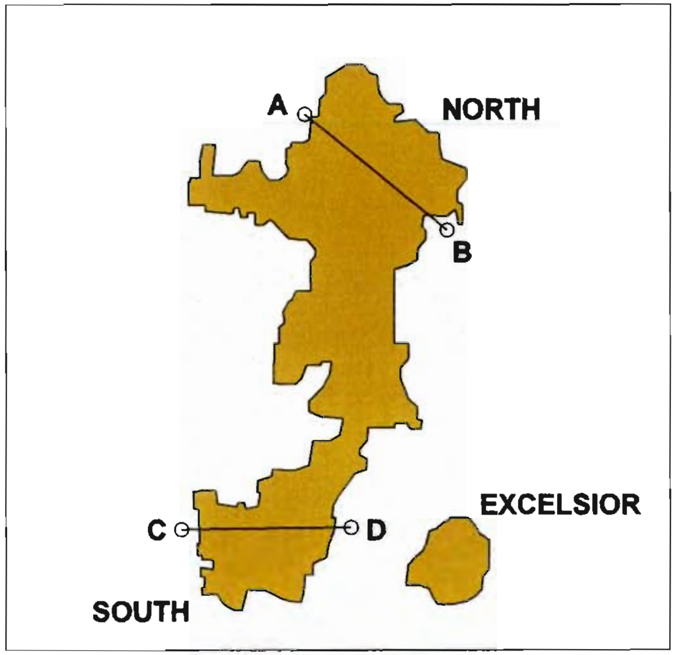
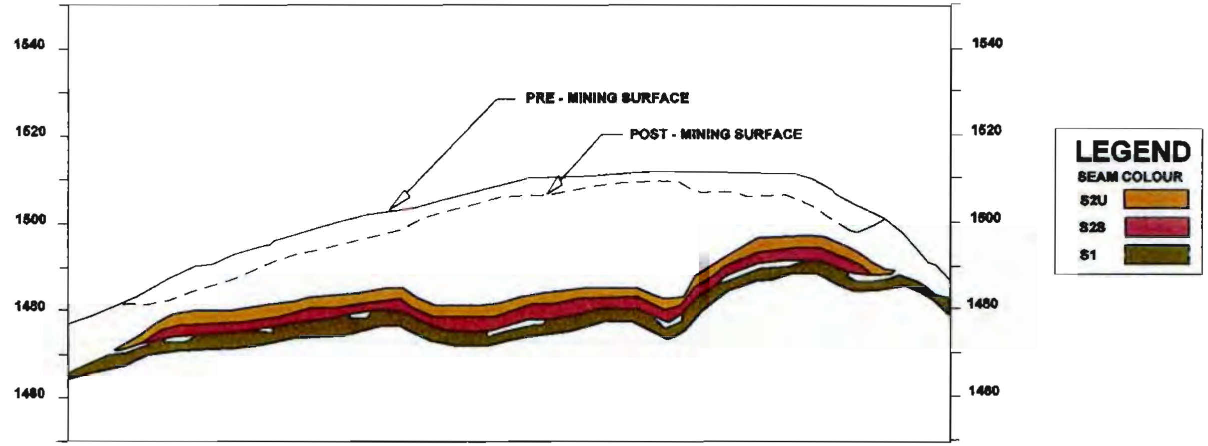
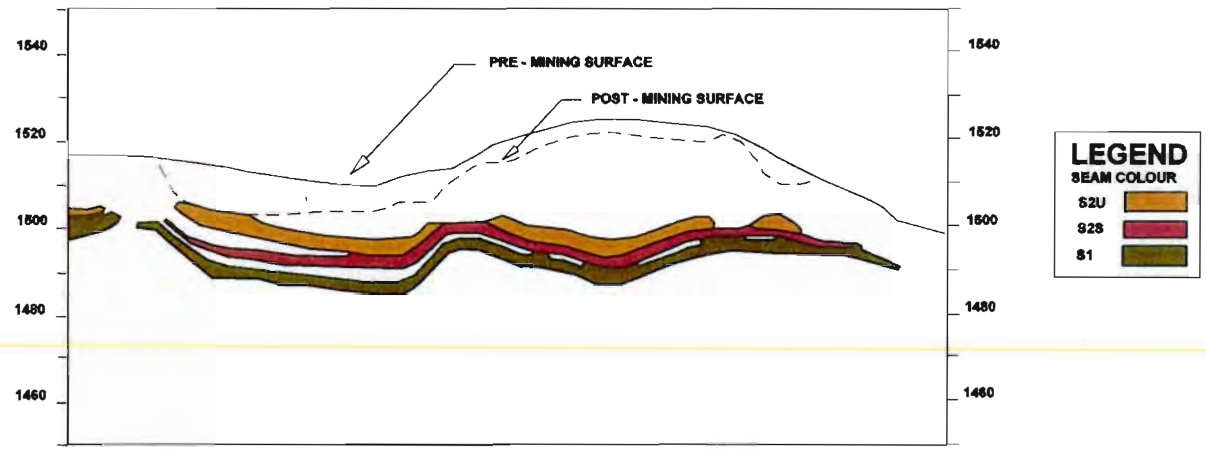


LOCATION OF REHABILITATION SECTION LINES



SECTION A-B VERTICAL EXAGGERATION OF 15.00



SECTION C-D VERTICAL EXAGGERATION OF 15.00

FIGURE 3.5 PRE AND POST-MINING TOPOGRAPHY

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oxidised by the oxygen found in the voids. Therefore a potential increase in bacterial/chemical leaching and acid mine drainage can be expected.

3.2.2 Mineral Processing Method

The mineral processing methods selected are those generally used in the coal mining industry. These are described in detail in Section 4.3.3.

3.2.3 Transport, Power and Water Supply Routes

3.2.3.1 Transport

During the design phase of the project, various alternatives were investigated for the transport of ROM coal from the mine to the plant. Alternatives considered were overland conveying, aerial ropeway and rail. Due to the presence of infrastructure between the mine and plant, the most feasible option was to utilise the existing railway servitude initially used to serve the old Kromdraai mine. The route of the railway line is shown on Figure 2.8 and is described in Section 2.6.1 B.

The route for the overland product conveyor was selected to follow as closely as possible the route of existing railway servitude. Selecting this route did not sterilise additional coal reserves or disturb agricultural land. The conveyor route is shown on Figure 2.8 and is described in Section 2.6.1 D

3.2.3.2 Power Supply

The nearest source of Eskom power for the Kromdraai opencast mine is the Vulcan distribution station situated south of the Excelsior reserve block. Eskom agreed to provide a consumer substation adjacent to the distribution station and two overhead power lines were built to the plant on land owned by Anglo Coal and did not sterilise coal reserves. The route of these power lines is shown on the attached 1:50 000 topocadastral plan.

For the Navigation plant Eskom tapped off the 132 kV line which runs north of the RLT. The route of the overhead line followed the product overland conveyor route to a consumer sub station built adjacent to the Navigation plant. This route did not sterilise further coal reserves or disturb agricultural land. The route of the power line is shown on the attached 1:50 000 topocadastral plan.

3.2.3.3 Water Supply Routes

At Kromdraai, neutralised acid mine drainage water is used in the tip, crushing and screening operation. The pipeline routes have been kept on land for mining. Thus no coal reserves are sterilised or agricultural land disturbed. A ground water spring is treated in a small water treatment plant (chlorination, flocculation and filtration) to produce potable water for domestic use at Kromdraai. This ground water spring has been a source of water since the mining operation started in 1991 and therefore as stipulated by section 32 (1)(a) of the National Water Act of 1998 does not require a licence.

Potable water for the Navigation plant is drawn from the existing pipeline from the Witbank Municipality, installed to serve the old Navigation plant and hostel in past. Consumption levels of 30 litres of potable water per Run of Mine Ton are adhered to.

Raw water for the Navigation plant is drawn from old underground workings at Kleinkopje and the pipeline follows the overland conveyor routes to the RLT and from the RLT to the Navigation plant. Navigation Plant also neutralises acid mine from the flooded Schoongezicht/Navigation underground workings.

3.2.4 Sources of Water

Detailed investigations were carried out to source water for the mine and plant from resources of polluted water rather than draw water from the Olifants River.

Water for the Kromdraai mine and plant is drawn from the old Kromdraai mine workings. Details of this source of water are described in Supplementary Report No. 11

Water for the Navigation plant is being drawn from old underground workings at Landau III Colliery from polluted water collected in the Schoongezichtspruit and from return water from the discard dump. These sources are described in Supplementary Report No. 11. The only water, which is sourced externally, is potable water for the Navigation plant, which is supplied from the Witbank Town Council.

3.2.5 Mine Infrastructure Sites

Infrastructure at Kromdraai is located at the centre of gravity of the reserve and on the eastern flanks where the topography is suitable for construction of the plant and workshops.

The coal beneficiation plant site was located at Navigation, as it would then treat coal from the Kromdraai reserves and at a later stage from the Navigation/Schoongezicht reserves. Siting the plant at Navigation would also enable facilities at the RLT to be used for exporting the coal.

3.2.6 Mine Residue Disposal (Blaauwkrans Dump)

The site selected for discard disposal lies over deep coal reserves, which have been partially mined by underground bord and pillar methods. These reserves are too deep to be mined by opencast methods. The Blaauwkrans dump was designed and constructed according to best practices in 1992 and does not contradict the SABS 0286 guidelines, which were issued after the construction of the dump.

Supplementary Report No.20 details the investigations carried out by the Anglo American Corporation Civil Engineering Department into aspects of locating the dump.

3.2.7 Domestic and Industrial Waste Disposal Sites

Industrial and domestic waste is disposed from Kromdraai by Wastetech.

Industrial and domestic waste is disposed from Navigation to the Clewer Municipal Waste Site.

3.2.8 Housing Sites

No new houses were built for this project.

3.2.9 Land Use Options After Rehabilitation

All land will be returned to the pre-mining agricultural potential and present thoughts are that it will be used for grazing purposes.

3.2.10 Alternatives to River Diversions

No river diversions were planned for.

3.2.11 The "No Project" Option

This option was not considered.

PART 4: DETAILED DESCRIPTION OF THE PROJECT

4.1 Surface Infrastructure

Figures 4.1 and 4.2 show the layout of the Kromdraai and Navigation infrastructure respectively.

4.1.1 Roads, Railways and Power Lines

The existing roads, railways and power lines are shown on the 1:50 000 topocadastral plan.

Roads, railways and power lines constructed for the mine and plant are shown on the overlay accompanying the topocadastral plan.

4.1.2 Solid Waste Management Facilities

4.1.2.1 Industrial and Domestic Waste Disposal Sites

Industrial and domestic waste is disposed from Kromdraai and Navigation at approved disposal sites. Refer to section 3.2.7.

4.1.2.2 Mine Residue Disposal Site

The site of the Navigation plant discard dump (Blaauwkrans Co-Disposal facility) is shown on the attached 1:50 000 topocadastral plan. Details of this site are described in Section 4.3.4.

4.1.3 Water Pollution Management Facilities

The locations of the Kromdraai and Navigation sewage treatment plants are shown on Figures 4.1 and 4.2. Figures 4.3 and 4.4 show the layouts of the Kromdraai and Navigation sewage treatment plants.

4.1.3.1 Sewage Plants

Figure 4.5 (a) and 4.5 (b) gives the most recent final effluent qualities for the Kromdraai and Navigation sewage plants. Table 4.1 shows the most recent final effluent qualities for the Kromdraai sewage plant. Table 4.2 shows the pre-mining final effluent qualities for the Navigation sewage plant, while Table 4.3 shows the most recent final effluent qualities. The estimated quantities of effluent produced at the plants are 0.5 kl/day at Kromdraai and 1.2 kl/day at Navigation. With the opening of the married accommodation at Navigation, the effluent quantity released is expected to increase to 3.6 kl/day.

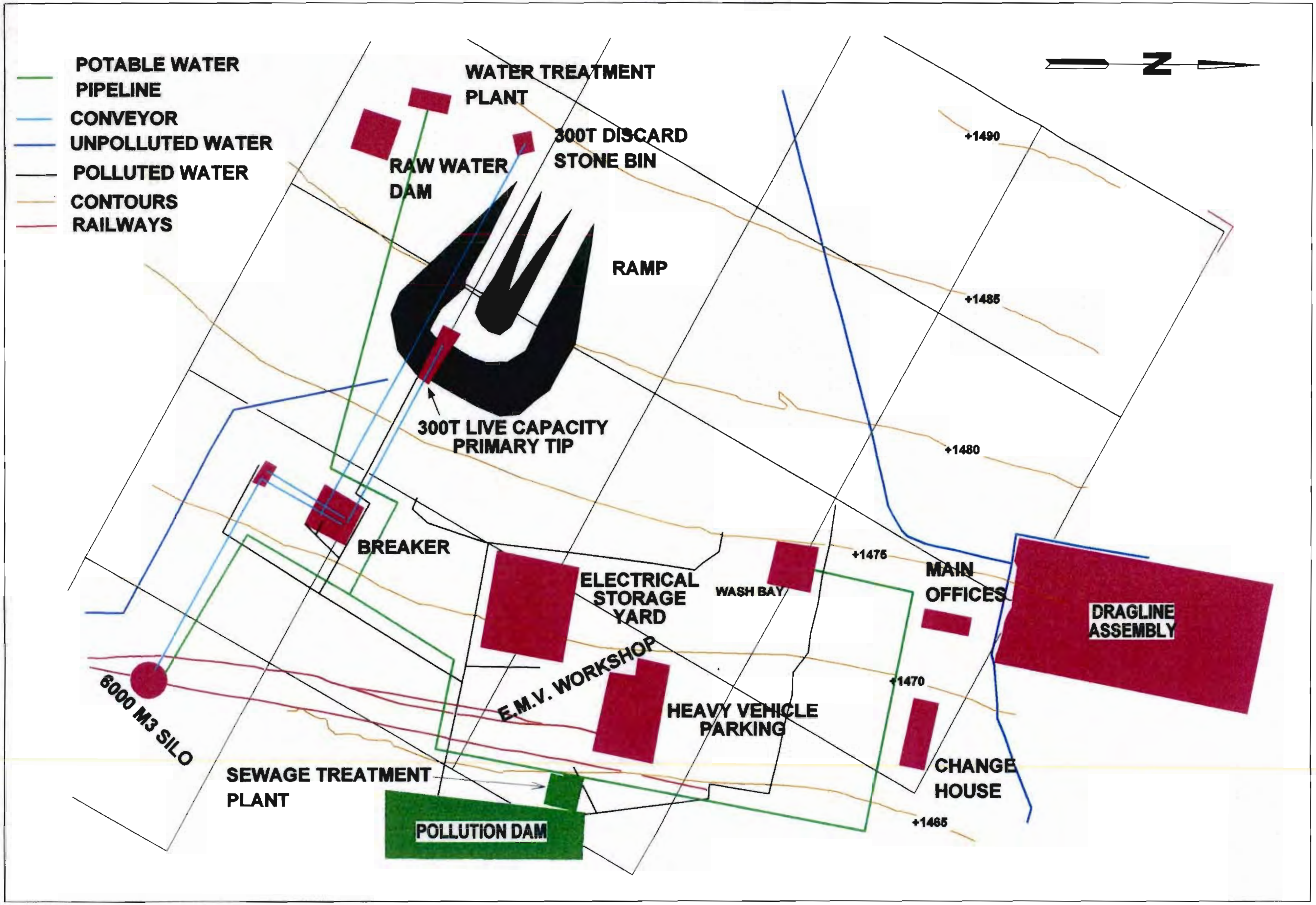

FIGURE 4.1 KROMDRAAI INFRASTRUCTURE AND POLLUTION CONTROL

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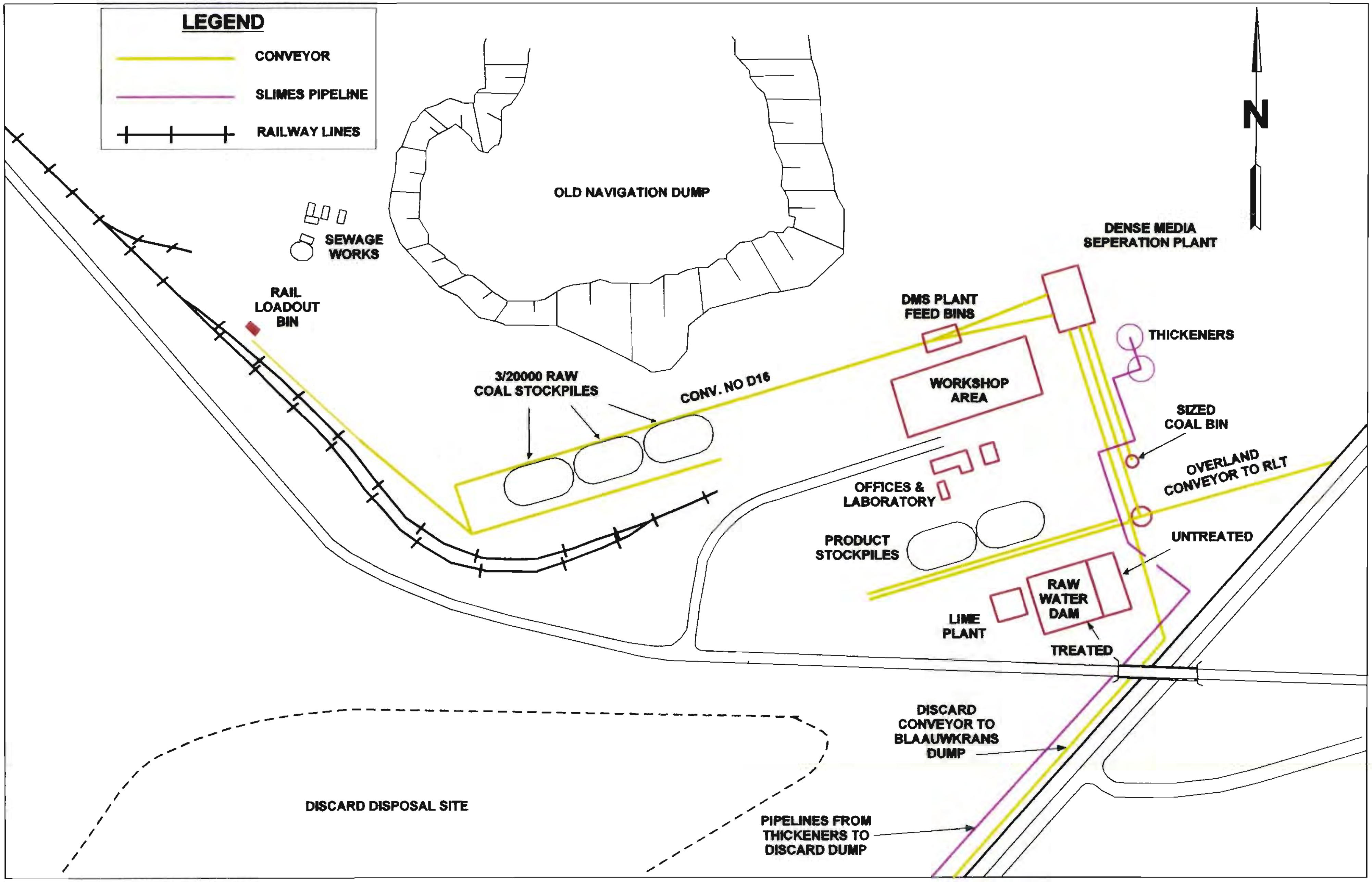

FIGURE 4.2 - NAVIGATION PLANT

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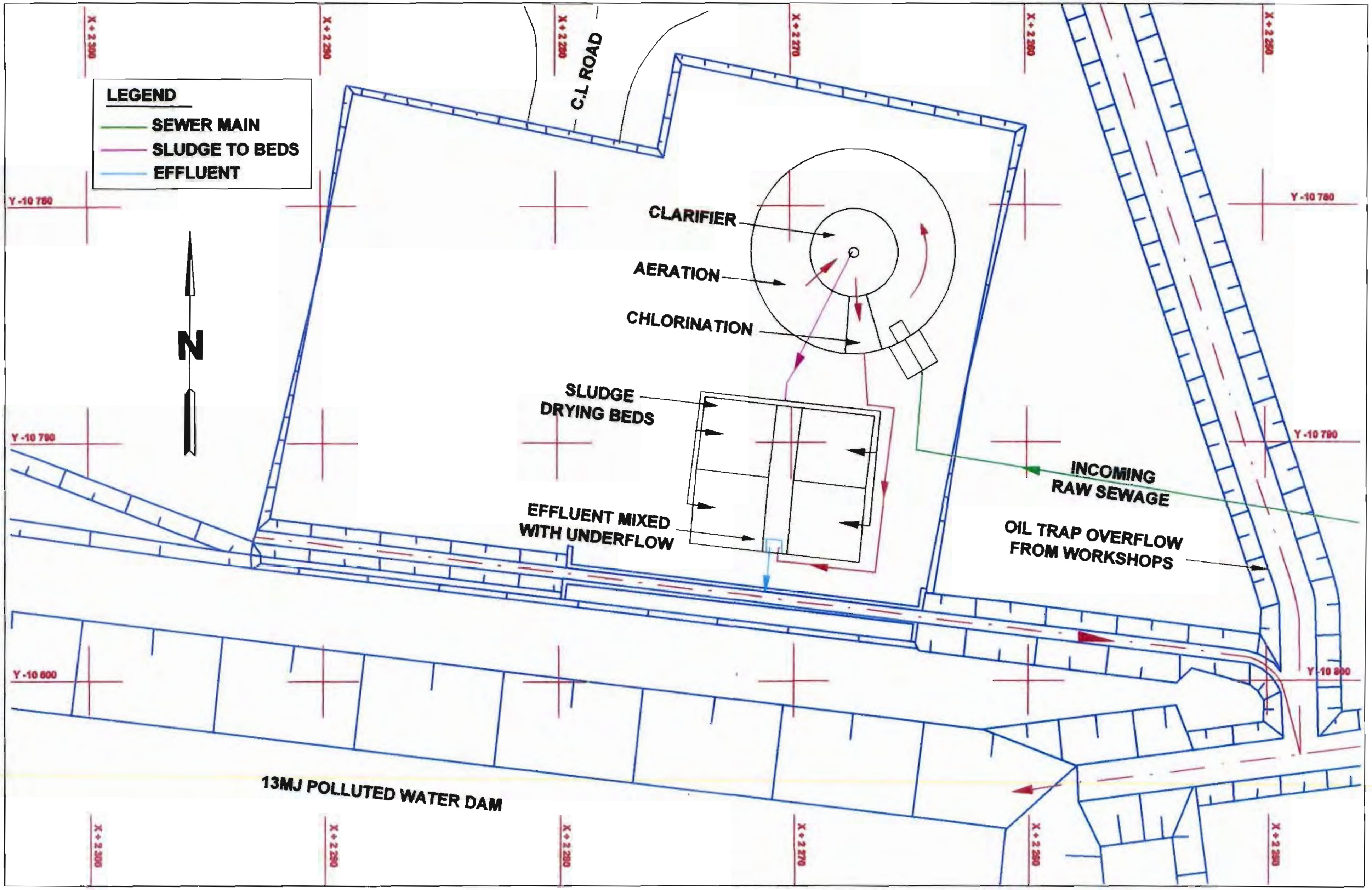

FIGURE 4.3 LAYOUT OF SEWAGE TREATMENT PLANT

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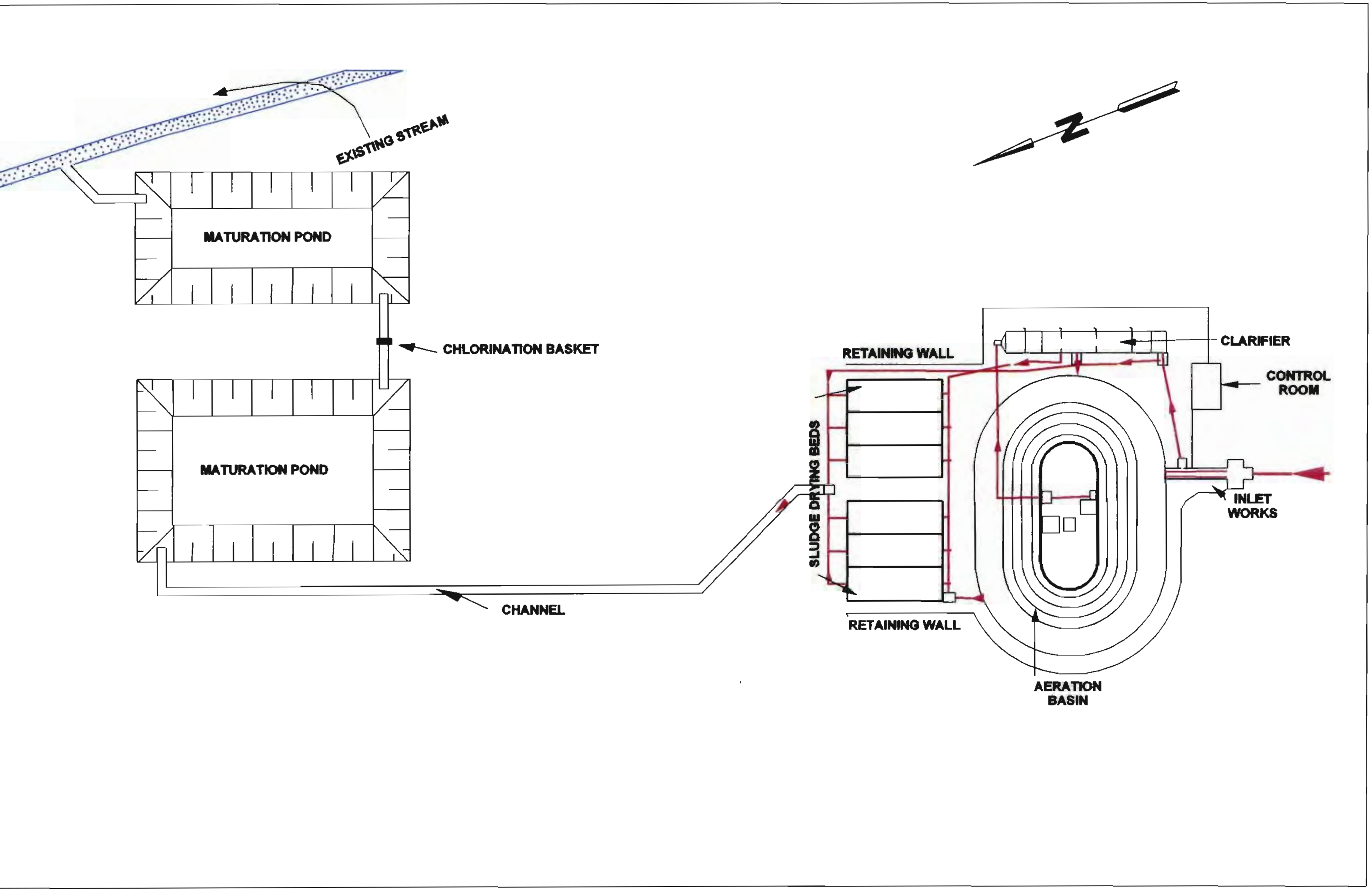

FIGURE 4.4 LAYOUT OF NAVIGATION SEWAGE TREATMENT PLANT

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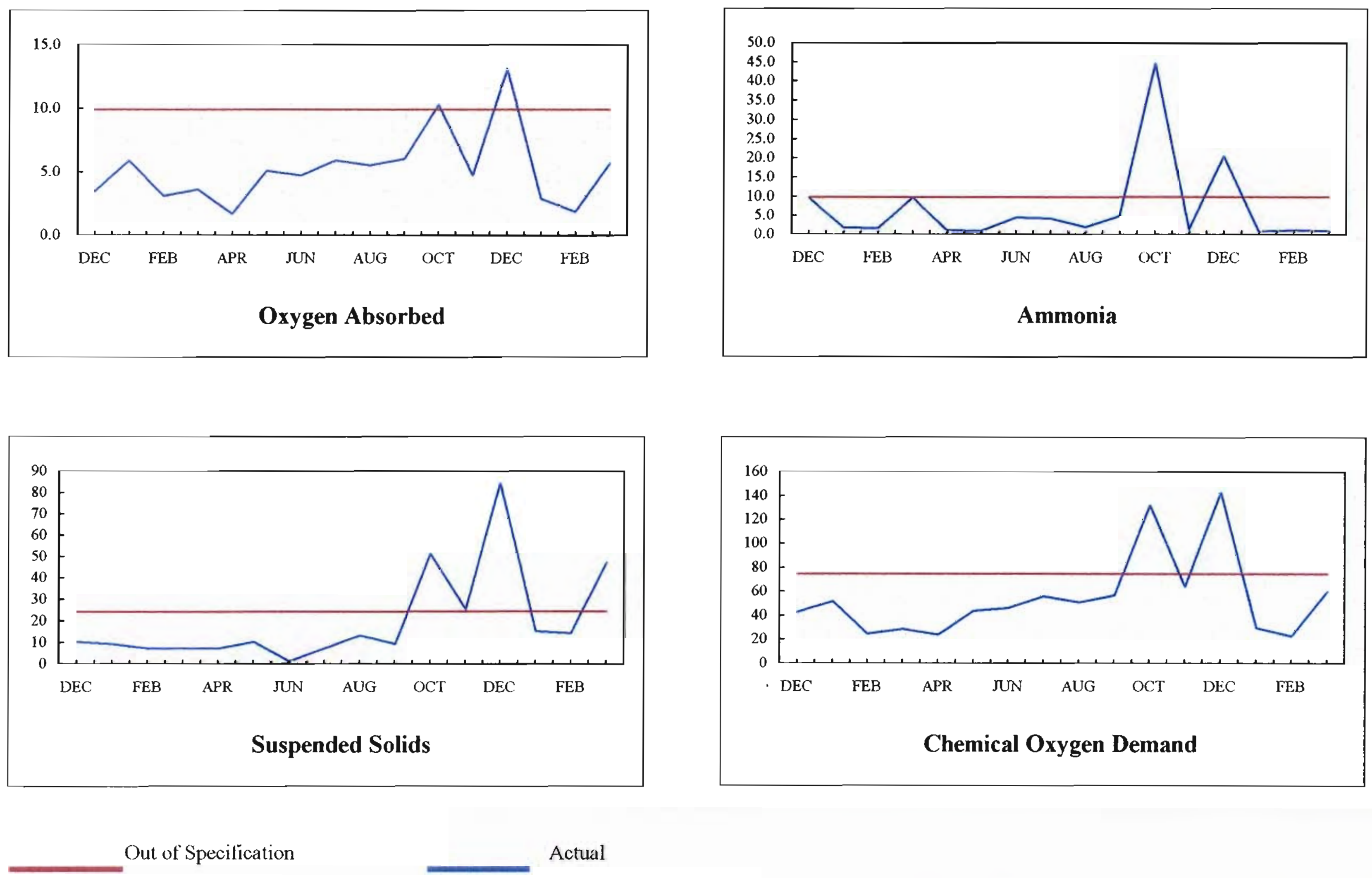


FIGURE 4.5 (a) FINAL EFFLUENT QUALITY FOR KROMDRAAI SEWAGE PLANT

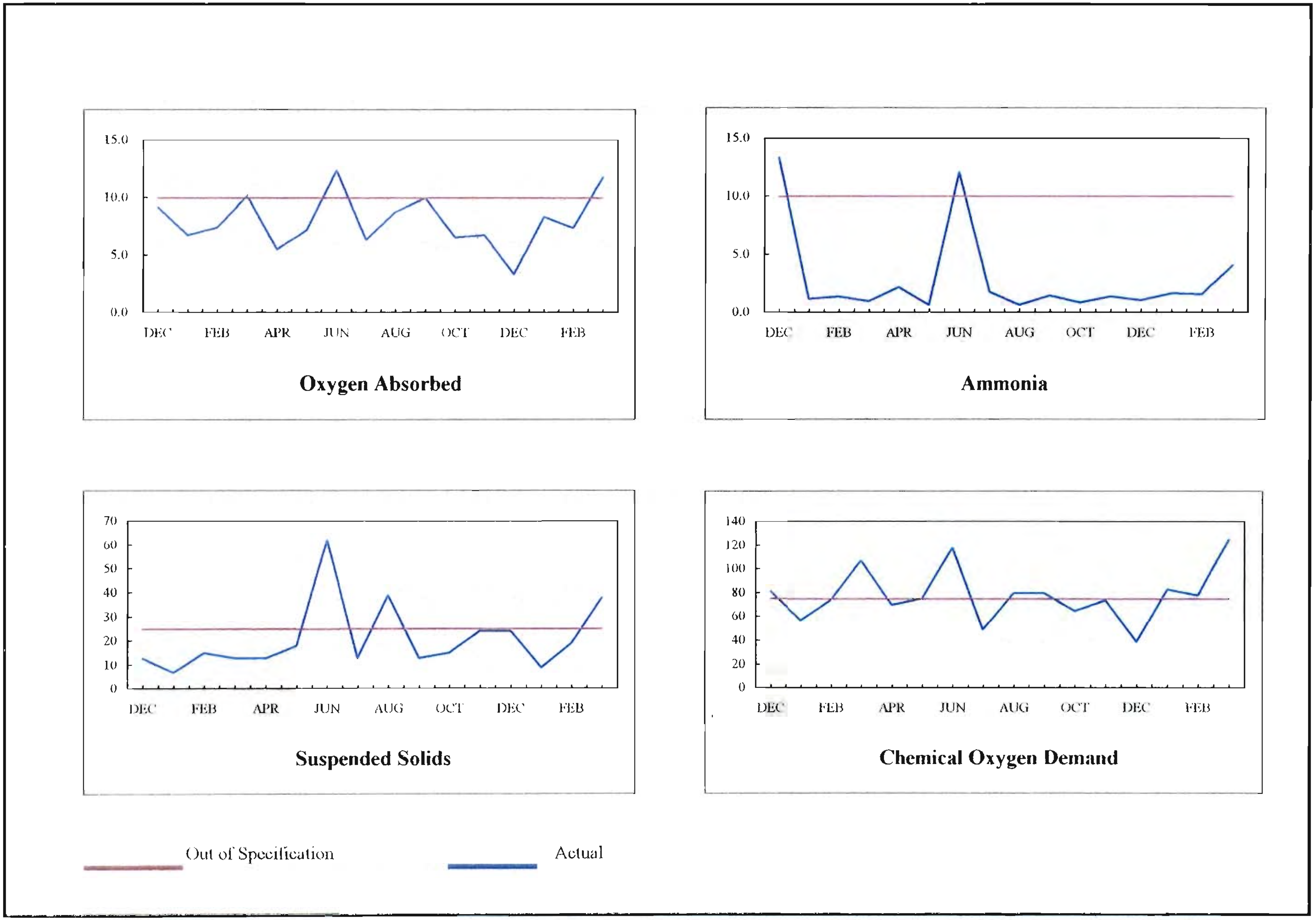


FIGURE 4.5 (b) FINAL EFFLUENT QUALITY FOR NAVIGATION SEWAGE PLANT

A. Kromdraai Sewage Plant

A new sewage purification plant has been constructed at Kromdraai to the East of the workshops. See Figures 4.1 and 4.3.

The plant is an activated sludge plant with a treatment capacity of 42 kl /day and is designed to produce an effluent which complies with the general standard laid down by the Department of Water Affairs & Forestry (DWAF).

Table 4.1 represents the final effluent quality of the Kromdraai sewage plant for the period December 1997 to March 1999.

The effluent from this plant will flow to the polluted water dam from where it will be pumped to the raw water reservoir for use in the plant.

Table 4.1 - Final Effluent Qualities at Kromdraai Sewage Plant (December 1997 – March 1999)

Analysis Results (mg/l Where applicable)	Raw Sewage	Reactor	Final Effluent	General Standard
Total dissolved solids			428.8	
Suspended Solids		28.5	20.8	25
Settable solids ml/l		2538		
Conductivity Ms/m	71.8		63.1	Supply +75
4 hours oxygen absorbed		6.8	5.3	<10
Chemical oxygen demand	530.3	73.5	54.9	<75
Free and saline ammonia (N)	39.8	8.8	7.0	<10
Nitrate – NO_3 as N		8.9	7.5	
Nitrate – NO_2 as N				
Ortho-phosphate-PO_4 as P			8.1	* < 1,0
Chlorides as Cl			49.1	
Total alkalinity as $CaCO_3$			127.6	
pH	7.3		7.3	5,5 – 9,5
Sodium as Na			62.2	Supply + 90
Potassium as K			7.6	
Sulphate as SO_4			143.6	
Residual Chlorine as Cl_2			0.3	
Sludge Volume Index		180.9		
Typical faecal coliform (E.Coli)			Nil	Nil/100ml

* Applicable only to certain catchment areas

B. Navigation Sewage Plant

See Figures 4.2 and 4.4 for the location and layout of the plant.

The existing Navigation sewage works is an extended aeration activated sludge plant with a treatment capacity of 160kl/day. The plant was upgraded from 160 kl/day to 335 kl/day to cater for the housing of staff in the Navigation Hostel. The effluent from this plant will comply with the general standards laid down by DWAF and is channelled into the clean water trench, which diverts water around the Navigation pollution dam.

Table 4.2 represents the pre-mining final effluent quality of the Navigation sewage plant for the period January 1993 to November 1993. Table 4.3 represents the most recent final effluent quality of the Navigation sewage plant for the period December 1997 to March 1999.

Table 4.2 - Final Effluent Qualities at Navigation Sewage Plant (January 1993 - November 1993)

Analysis Results (mg/l Where applicable)	Raw Sewage	Reactor	Final Effluent	General Standard
Total dissolved solids	612		464	
Suspended Solids	70.0	1869	21.2	25
Settable solids ml/l	0.2	140	< 0.1	
Conductivity Ms/m	96.5		75.9	Supply +75
4 hours oxygen absorbed	22.2		5.2	<10
Chemical oxygen demand	292.0		53.2	<75
Free and saline ammonia (N)	21.4	3.6	0.8	<10
Nitrate – NO_3 as N	< 0.1	21.99	21.23	
Nitrate – NO_2 as N	< 0.01	.04	0.01	
Ortho-phosphate-PO_4 as P	4.62		3.99	* < 1,0
Chlorides as Cl	45		41	
Total alkalinity as $CaCO_3$	188	44	28	
pH	7.77	7.23	7.35	5,5 – 9,5
Sodium as Na	59.5		54.5	Supply + 90
Potassium as K	13.4		11.2	
Sulphate as SO_4	193		220	
Residual Chlorine as Cl_2			0.8	
Sludge Volume Index		74		
Typical faecal coliform (E.Coli)			Nil	Nil/100ml

* Applicable only to certain catchment areas

Table 4.3 - Final Effluent Qualities at Navigation Sewage Plant (December 1997 – March 1999)

Analysis Results (mg/l Where applicable)	Raw Sewage	Reactor	Final Effluent	General Standard
Total dissolved solids			462.9	
Suspended Solids		24.9	20.9	25
Settable solids ml/l		790.9		
Conductivity Ms/m	78.2		68.4	Supply +75
4 hours oxygen absorbed		9.0	8.0	<10
Chemical oxygen demand	409.0	83.1	78.4	<75
Free and saline ammonia (N)	31.7	3.4	2.9	<10
Nitrate – NO_3 as N		12.1	10.5	
Nitrate – NO_2 as N				
Ortho-phosphate-PO_4 as P			4.8	* < 1,0
Chlorides as Cl			51.5	
Total alkalinity as $CaCO_3$			81.5	
pH	7.4		7.4	5,5 – 9,5
Sodium as Na			52.7	Supply + 90
Potassium as K			9.3	
Sulphate as SO_4			190.7	
Residual Chlorine as Cl_2			0.4	
Sludge Volume Index		135.7		
Typical faecal coliform (E.Coli)			Nil	Nil/100ml

* Applicable only to certain catchment areas

4.1.3.2 Pollution Control Dams

A. Kromdraai

Raw water is abstracted from a ground water source, which is situated outside of the mining area about 1 km to the northeast of Kromdraai offices. The raw water is treated in a new water treatment plant located south west of the ROM tip (See Figure 4.1). The capacity of this plant is 14 cubic metres per hour and is designed to produce potable water, which conforms to the requirements of the South African Bureau of Standards (SABS). This will satisfy the potable water needs of this complex. The use of water for industrial water use is covered in the section 12 permit that was submitted in December 1997. A layout of the plant is shown in Figure 4.6.

A raw water dam situated adjacent to the potable water plant will be fed with neutralised water from the liming plant. Water from this dam together with water from the pollution control dam will be used for dust suppression and process water.

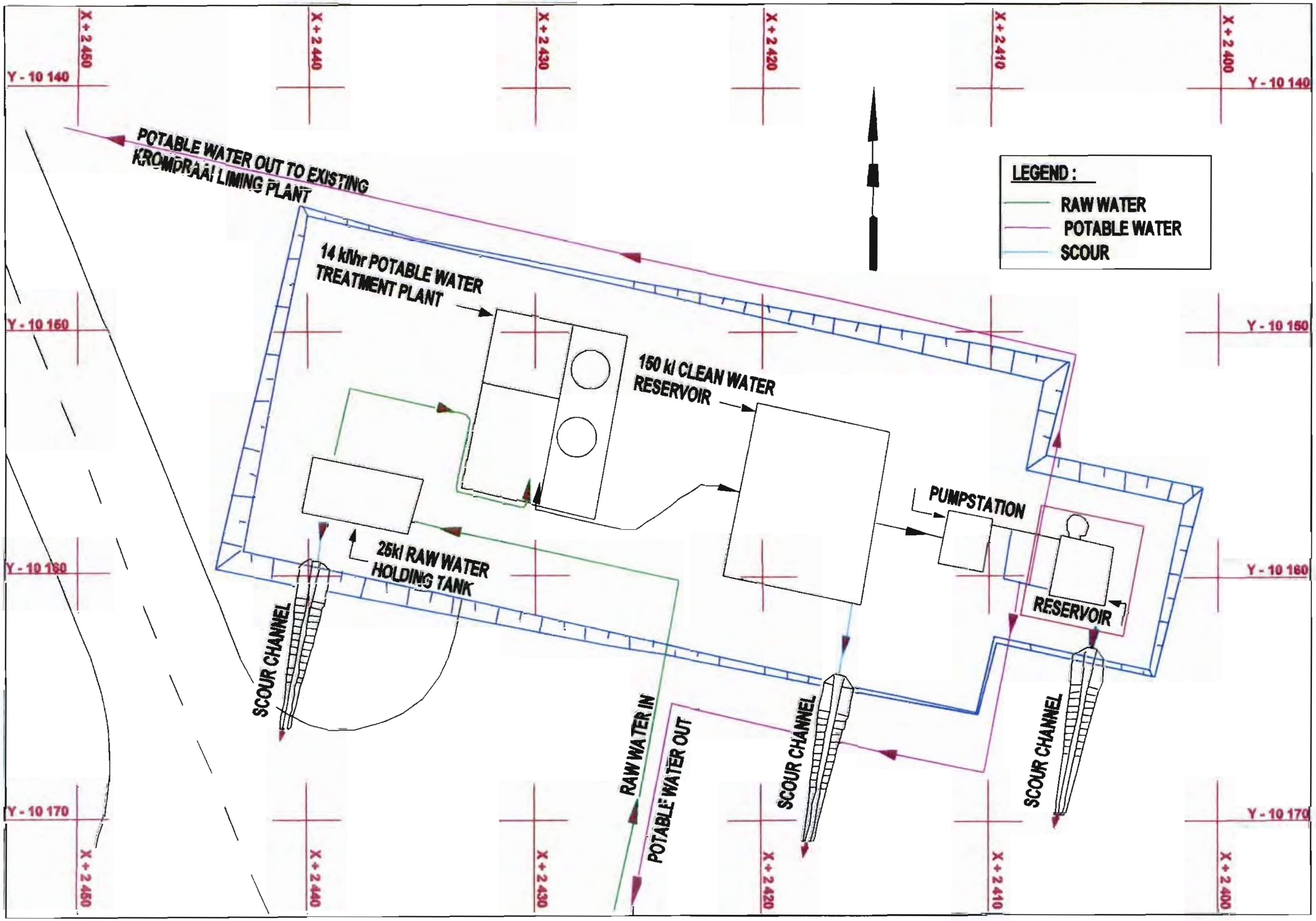


FIGURE 4.6 LAYOUT OF KROMDRAAI WATER TREAMENT PLANT

A pollution control dam sited at the lowest side of the complex east of the workshops (Figure 4.1) is designed to collect contaminated stormwater runoff from within the plant area as well as wash-down water from the plant and workshop areas. Cut-off drains up-slope of the plant and workshop areas will divert stormwater runoff into the Klipspruit. The separation of clean and dirty water is designed and operated as stated in the draft regulation 1499 of the National Water Act of 1998. In a large storm, the excess water will bypass the pollution control dam and flow directly into the Klipspruit. The level of water in this pollution control dam will be kept low in order to impound the maximum amount of runoff from within the plant area. Water from this dam will be pumped to the raw water reservoir and be used in the plant for dust suppression and for dust control on the haul roads.

Figure 4.7 shows the overall utilisation of water at the Kromdraai opencast mine.

B. Navigation

There is only one stream in the plant area, the Schoongezichtspruit, which flows northwards. Due to the seepage of acid mine water from the No. 1 and 2 Seams which outcrop south of the N4 motorway, as well as runoff from the old Navigation dump, this stream has become polluted.

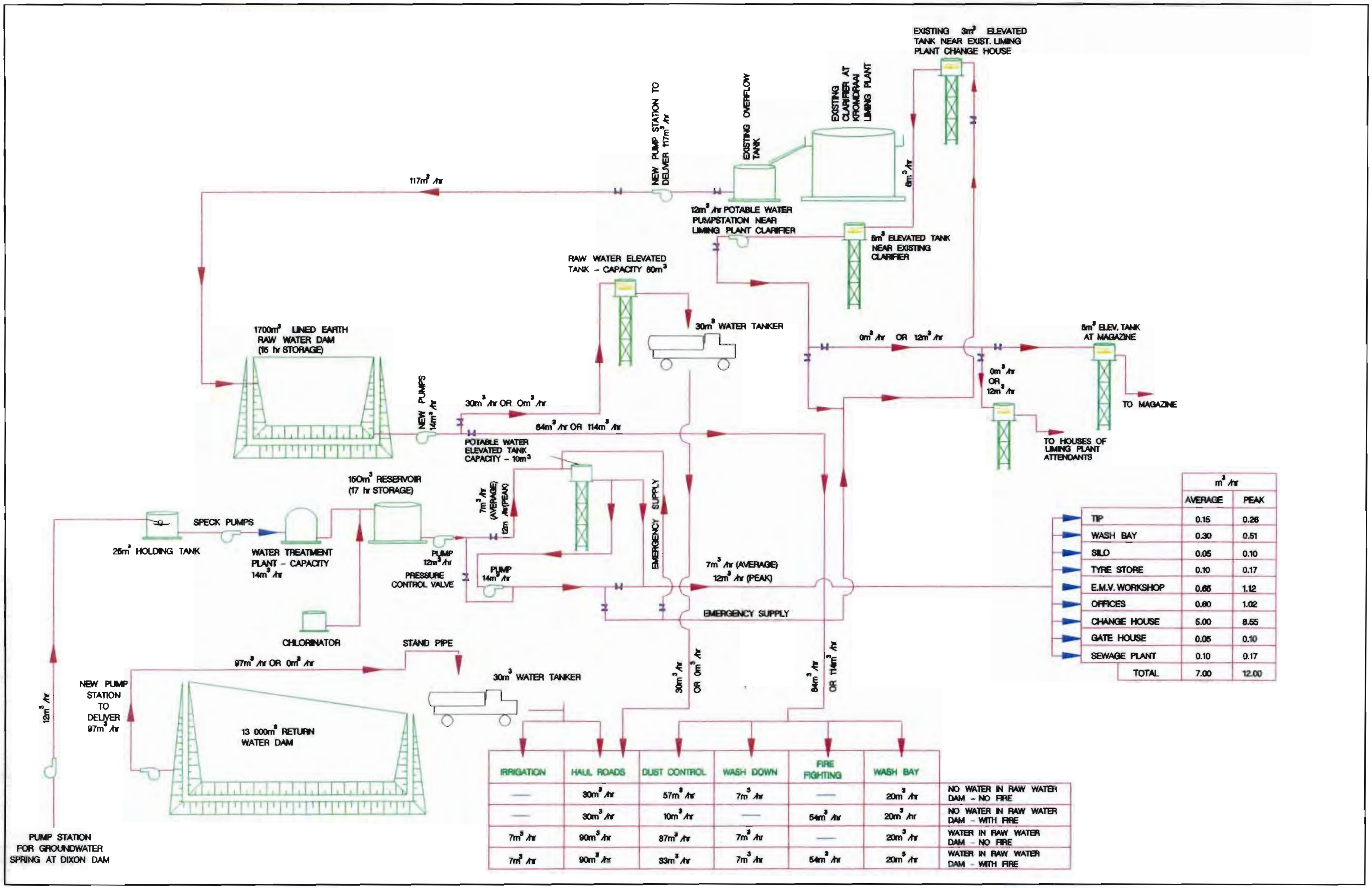
In order to improve this situation Anglo Coal decided, as part of the Landau Project, to improve the water quality of this stream by constructing two pollution control dams and linking the overflow from the Middle dam (old Schoongezicht clean water dam) with the stream below the pollution control dam by means of cut-off drains as shown in Figure 4.8.

Below the Navigation pollution control dam is the Middle dam (old Schoongezicht clean water dam), which is designed to collect stormwater runoff from non-polluted areas. It overflows into a diversion channel, which bypasses the Schoongezicht polluted water dam and discharges into the Schoongezichtspruit.

All the stormwater runoff from the plant area including the Navigation dump will be collected in the Navigation pollution control dam. During normal rainfall events this dam will not overflow, as this water will be pumped to the acid water reservoir adjacent to the liming plant where it will be neutralised and reused. This dam has been constructed to cater for a 1 in 100 year rainfall event (only 1:50 year rainfall control is required by the Department of Water Affairs and Forestry).

Downstream from this dam is the Schoongezicht pollution control dam, which will collect all the seepage from the underground workings and other polluted areas. Under "normal" circumstances this dam will not overflow as the water will be pumped back to the Navigation pollution control dam or directly to the acid water reservoir adjacent to the liming plant.

The water requirements for the Navigation complex are shown in Figure 4.9 as a flow network.



	m³/hr	
	AVERAGE	PEAK
TIP	0.15	0.26
WASH BAY	0.30	0.51
SILO	0.05	0.10
TYRE STORE	0.10	0.17
E.M.V. WORKSHOP	0.65	1.12
OFFICES	0.60	1.02
CHANGE HOUSE	5.00	8.55
GATE HOUSE	0.05	0.10
SEWAGE PLANT	0.10	0.17
TOTAL	7.00	12.00

IRRIGATION	HAUL ROADS	DUST CONTROL	WASH DOWN	FIRE FIGHTING	WASH BAY	
—	30m³/hr	57m³/hr	7m³/hr	—	20m³/hr	NO WATER IN RAW WATER DAM - NO FIRE
—	30m³/hr	10m³/hr	—	54m³/hr	20m³/hr	NO WATER IN RAW WATER DAM - WITH FIRE
7m³/hr	90m³/hr	87m³/hr	7m³/hr	—	20m³/hr	WATER IN RAW WATER DAM - NO FIRE
7m³/hr	90m³/hr	33m³/hr	7m³/hr	54m³/hr	20m³/hr	WATER IN RAW WATER DAM - WITH FIRE

FIGURE 4.7 KROMDRAAI WATER FLOW NETWORK

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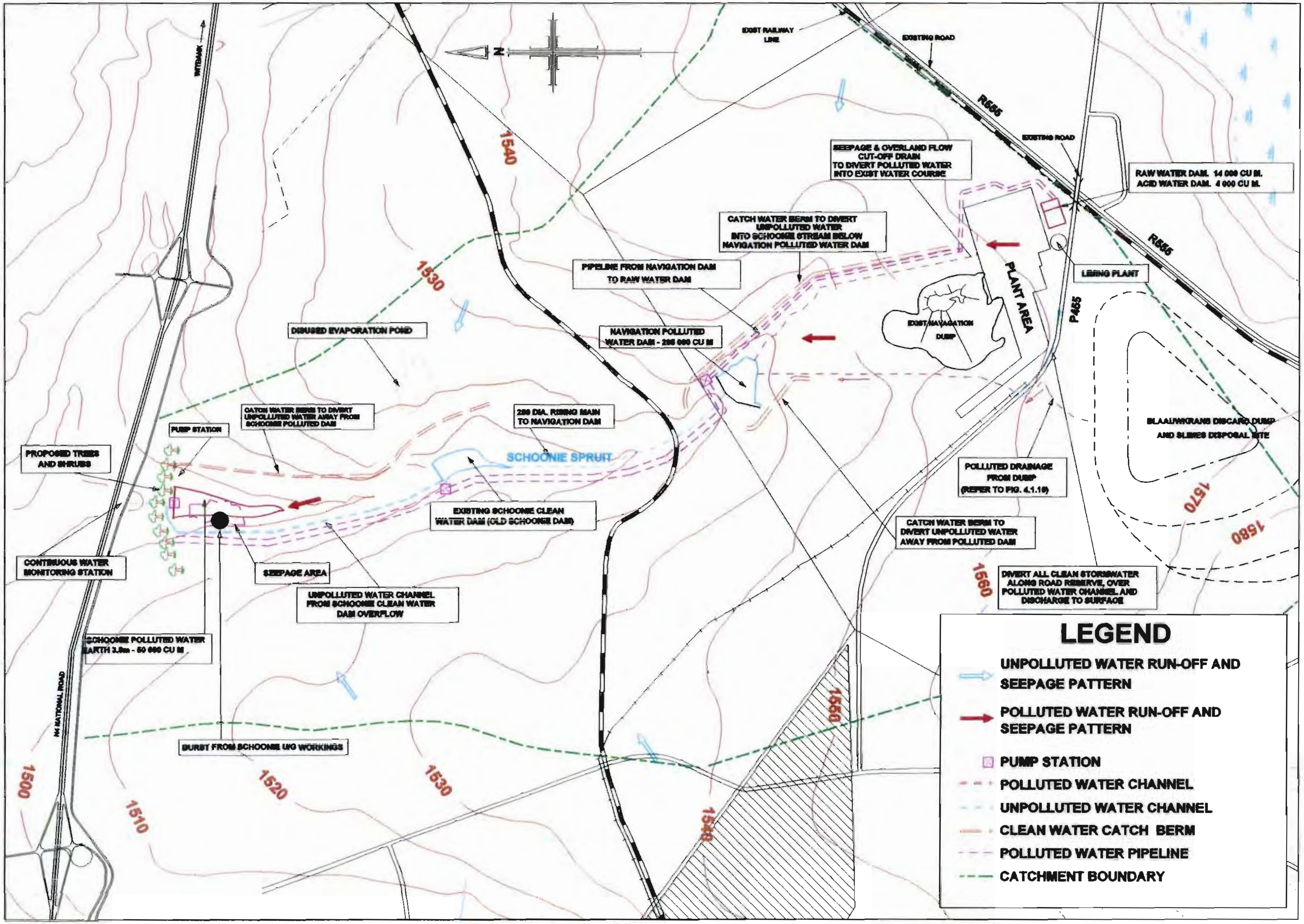

FIGURE 4.8 LAYOUT OF POLLUTION CONTROL SYSTEM IN SCHOONGEZICHT VALLEY

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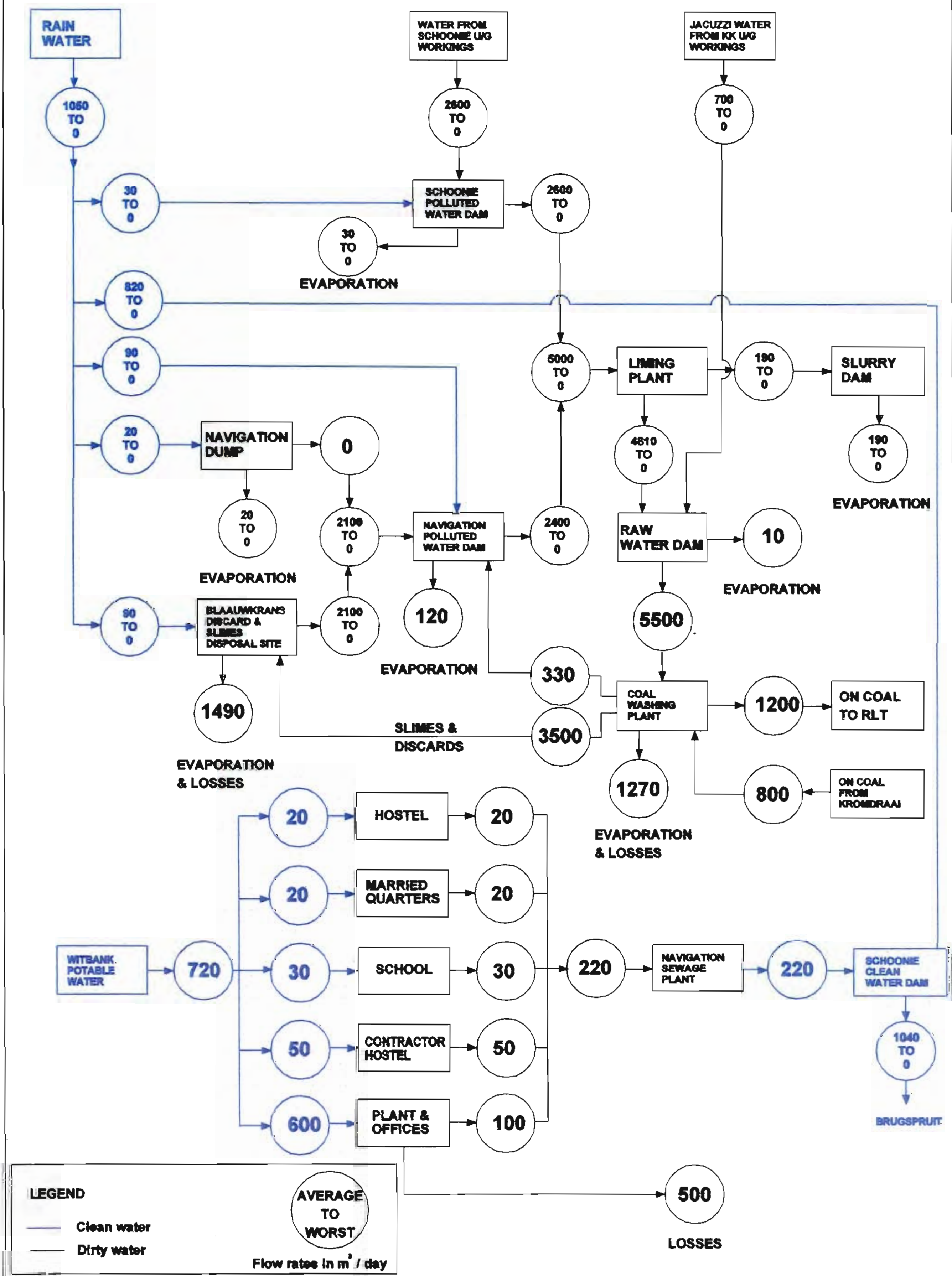

FIGURE 4.9 SCHOONGEZICHT / NAVIGATION SURFACE WATER NETWORK

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4.1.3.3 Polluted Water Treatment Facilities

A. Kromdraai

An existing lime treatment plant for neutralising AMD from the old workings of the Kromdraai mine has been in operation since 1973. The operation of the plant is described in Supplementary Report No.11. The plant is designed to treat 14 Ml/day.

Currently the lime treatment plant effluent flows (See the attached 1:50 000 topocadastral plans) directly into the Kromdraaispruit (permission granted by DWAF Regional Director on 12 February 1997). A portion of the effluent may be used for irrigation purposes on rehabilitated land. A trial under the control of the Water Research Commission was implemented in 1993/94 using treated water from the liming plant. A further trial under the guidance of the University of Pretoria, with partial sponsorship from the Water Research Commission, is currently in operation at Kleinkopje Colliery to determine the suitability of polluted water for the irrigation of crops using centre pivots.

After closure, pumping from the pit will cease and the water table in the mined out area will rise until decant onto surface at a number of points occur. To treat this water it is proposed that operation of the lime treatment plant (with a network of pipes and pumps to collect water from a number of points in the mining area) be continued. The most likely post-mining scenario is that between 2000 and 4000 m3/day of water at a pH of 4.0 to 5.5 will require treatment for after mining ceases. See Supplementary Report Number 22. However, a model (generated by Anglo American Technical Services) predicts the required dewatering rate of the mine over the life of mine. The model predicts that the final volume of water to be treated could be in the order of 6000 – 8000 m3/day.

B. Navigation

The polluted water treatment facilities have been described under Section 4.1.3.2. A new liming plant has been constructed adjacent to the Navigation plant to treat all acid water from the Schoongezicht catchment dam and the old navigation and Schoongezicht Colliery workings. The plant was originally designed to treat 3.5 Ml/day. The plant was upgraded to 6 Ml/day (max capacity 8 M/day in 1998) so as to treat an increased volume of acid water. The flow sheet of the plant is shown on Figure 4.10.

4.1.4 Potable Water Treatment Plant

A. Kromdraai

Potable water, to SABS standards, will be supplied to the Kromdraai infrastructure from a 14 kl/h water treatment plant (chlorination, flocculation and filtration) situated adjacent to the ROM tip. Plant feed water is pumped from a ground water source from outside the mining area. Figure 4.6 shows a layout of the plant.

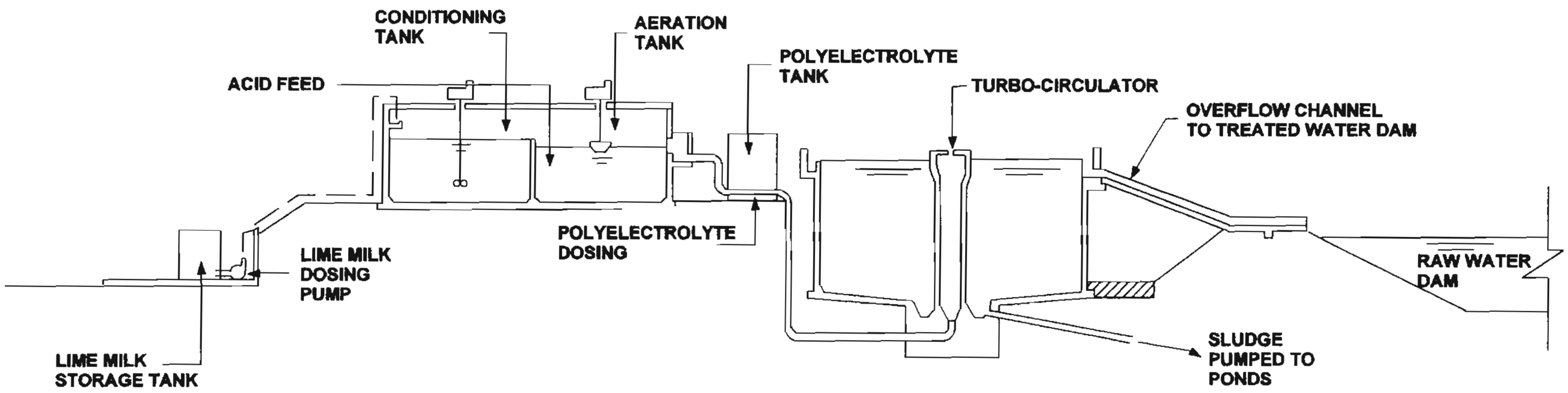

FIGURE 4.10 FLOW SHEET OF THE NAVIGATION POLLUTED WATER TREATMENT PLANT

B. **Navigation**

Potable water for this area is supplied from the Witbank Town Council.

4.1.5 Process Water Supply System

A. **Kromdraai**

The process water supply network is shown in Figure 4.7. The Kromdraai liming plant (capacity of 14 Ml/day) will supply process water for the pre-screening and crushing plant.

B. **Navigation**

The process water supply network is shown in Figure 4.9. The Navigation liming plant (capacity of 8.0 Ml/day) will supply process water for the coal plant.

4.1.6 Mineral Processing Plant

A. **Kromdraai**

The location of the plant is shown on the attached 1:50 000 topocadastral plan. The pre-screening and crushing plant is described in section 4.3.3.

B. **Navigation**

The location of the plant is shown on the attached 1:50 000 topocadastral plan. The coal beneficiation plant is described in section 4.3.3.

4.1.7 Workshops, Offices, Change Houses

A. **Kromdraai**

Figure 4.1 shows the locations of the infrastructure facilities for this area.

B. **Navigation**

Figure 4.2 shows the locations of the infrastructure facilities for this area.

4.1.8 Housing, Recreation and Other Employee Facilities

Employees are housed in Witbank, Clewer, Kwa-Gqua and in the Landau mine villages, the locations of which are shown on the attached 1:50 000 topocadastral plan.

Recreation facilities are situated in the Landau mine village. (See attached 1:50 000 topocadastral plan).

4.1.9 Transport

Three coal transport systems have been constructed:

- A rail link between Kromdraai and Navigation to carry ROM coal.
- An overland conveyor between Navigation and the RLT to carry the export product.
- A discard conveyor belt to the Blaauwkrans Co-Disposal facility.

A. Description of the Railway System

The railway system is designed to haul 6 million tons per annum of coal 23 km from the mine to the plant. At full output, two trains will be used, each employing three Class 38E electric locomotives and hauling up to 32x50-ton payload wagons. A round trip of some three hours per train is normal for, giving on average a total of 10 to 12 trains per day.

The route of the railway line is shown in Figure 2.8 and is described in Section 2.6. 1 B.

B. Overland Product Conveyor

The conveyor route between Navigation and the Rapid Loading Terminal is shown in Figure 2.8 and is described in Section 2.6.1 D. It is designed to handle 4,0 million tons per year.

4.1.10 Water Balance Diagram

A. Kromdraai

Figure 4.7 shows the water balance for this area.

B. Navigation

Figure 4.9 shows the water balance for this area.

4.1.11 Disturbance of Water Courses

No watercourses will be disturbed in terms of the planning carried out for the mine.

4.1.12 Stormwater

A. Kromdraai

Stormwater run-off is directed away from the mining area into public streams by a series of cut-off drains, which are constructed one to five years ahead of the mining window. Any affected stormwater which does find its way into the pit is pumped via a pipeline to a settling dam after which it joins AMD water before entering the lime treatment plant. Should cut-off drains or dams be breached under flood conditions, sufficient capacity exists in the mining area to contain any contaminated water until it can be processed through the lime treatment plant.

Figure 4.1 shows the separation of storm and contaminated waters around the Kromdraai infrastructure site. Cut-off drains prevent unpolluted water mixing with contaminated water, which is directed towards settling dams and prevented from flowing into the Klipspruit.

B. Navigation

Figure 4.8 shows the drainage system in place at Navigation. Polluted water arising from either the Navigation Plant or the Blaauwkrans Dump is contained in a closed system, consisting of two interlinked dams and a pump network to take water back up the valley for use in the Navigation Plant.

Cut-off berms and a clean water dam prevent mixing of unpolluted water and contaminated water up to a 1:50 year rainfall event as stipulated in the draft regulation 1499 of the National Water Act of 1998. If the 1:50 year flood level designs are exceeded, stormwater will find its way into the polluted water dams. Should these overflow, polluted water will enter the Schoongezichtspruit over a short period of time.

C. Navigation Plant Discard Dump - Blaauwkrans Co-Disposal Facility

Figure 4.13 shows the separation of storm and contaminated waters. Cut-off drains surround the discard dump to prevent clean water entering the area, while polluted water flowing directly off the discard dump is pumped directly to the liming plant for treatment. A series of silt traps were constructed to desilt the toe seepage water from the dump before the clarified acid water is pumped back to the liming plant. A dam was constructed to collect the additional toe seepage from the discard dump for flows (up to 1:100 rainfall events) that exceed the pumping system back to the liming plant.

4.2 Construction Phase

The construction phase was spread over some 18 months and employed approximately 1500 people directly on site.

Construction was broken down into the following elements:

1. Site clearing - Bush and scrub was cleared and topsoil removed. All topsoil was stockpiled for use after construction to fill-in areas on which plant was not constructed and for landscaping.

2. Civil construction - This involved preparing the terraces for the various areas, excavating foundations, piling and casting of concrete foundations.

3. Mechanical erection - This involved erecting buildings and machinery onto concrete foundations

4. Electrical installation - Running of power and instrumentation cables to all equipment.

5. Commissioning - Mechanical commissioning of machines followed by electrical and instrumentation

4.3 Operational Phase

4.3.1 Soil Utilisation Guide

Based on current technology and economic circumstances the overall aim of the project is to restore at least 90% of the pre-mining arable and grazing capability.

Wherever possible stripped topsoil will be transported to the nearest available area of levelled spoil and deposited in its final position. Stockpiling of topsoil will be kept to a minimum. Soil will be replaced on a planned system so as to achieve the best practical land use. At present, a total land management strategy and plan is being developed in conjunction with Professor N.F.G. Rethman of the University of Pretoria.

Depths of topsoil have been described in Section 2.4.

4.3.2 Mine Surface Layout

4.3.2.1 Access to Workings

Access to the opencast workings will be via a network of haul roads and ramps from the Kromdraai infrastructure. These roads will traverse the areas where previous underground mining has taken place and will be mined through as the openpit highwall faces advance. No haul roads will remain in the rehabilitated areas.

4.3.2.2 Structures Affected by Blasting Vibrations

A system of recording blast vibrations has been established both for mine-owned structures and privately-owned neighbouring structures. A blasting consultant is employed to advise on these matters.

4.3.2.3 Surface Subsidence

Numerous subsidences from the old underground workings are evident. After opencast mining no subsidences will remain.

4.3.2.4 Structures and Drainage Paths Affected by Surface Subsidences

No structures and drainage paths will be affected by surface subsidences.

4.3.2.5 The Mining Plan

Figure 3.1 shows the indicative mining plan. Box cuts will be established along the western sub –outcrop with faces advancing to the East. There will be no final voids left after mining. As described in Section 3.2.1, the final voids will be filled in.

4.3.3 Mineral processing

A. Introduction

The run of mine (ROM) coal will be loaded into rear dump trucks in the pit by face shovels and hauled to a tip at the coal processing plant at Kromdraai. At full production, up to 6.0 million tons per annum of ROM coal will be crushed in this plant after which it will be transported by rail to Navigation where it will be processed to produce 3 - 3.3 million sales tons per annum of 27.6 MJ/kg steam coal.

B. Kromdraai Coal Crushing Plant

A plan of the coal crushing plant and Kromdraai infrastructure is shown on Figure 4.1. Figure 4.11 shows the flow of coal through the Kromdraai plant. The ROM coal is tipped from 165 ton rear dump trucks into a 750 ton bin from where it is withdrawn by apron feeder into a jaw crusher and crushed to -250 mm. Secondary crushing by rotary breaker reduces the coal to -75 mm. Some of the stone contamination is removed in these breakers and will be returned to the pit by truck. The -75 mm raw coal is then transported by rail to the Navigation plant. No chemicals are used in this process and the only waste product is rock which, as mentioned above, is returned to the pit.

Supplementary Report No. 21 is a report by Professor F. D. I. Hodgson on the chemical composition of the stone discards from the rotary breakers. This stone will be returned to the pit as spoils or for in-pit roads building material and no detrimental effects are anticipated. An application to the Regional Director, Eastern Transvaal, for permission to return the stone discards to the pit has been approved.

C. Navigation Coal Processing Plant

The processing plant at Navigation is designed to treat from 45% to 70% coal yielding material at a rate of 6 million tons per annum. Figures 4.2 and 4.12 show respectively the layout of the Navigation plant and associated infrastructure on plan and the flow of coal through the coal processing plant. The plant is designed to handle a wide range of yields to cope with the higher levels of contamination arising from mining previously mined coal seams and also to allow for retreating of old discard dumps in the area.

Raw coal from Kromdraai is delivered to Navigation by train, where the coal is discharged into a bin. Coal is withdrawn from the bin and stockpiled to provide a surge capacity ahead of the plant. From the stockpile the coal is fed to the Dense

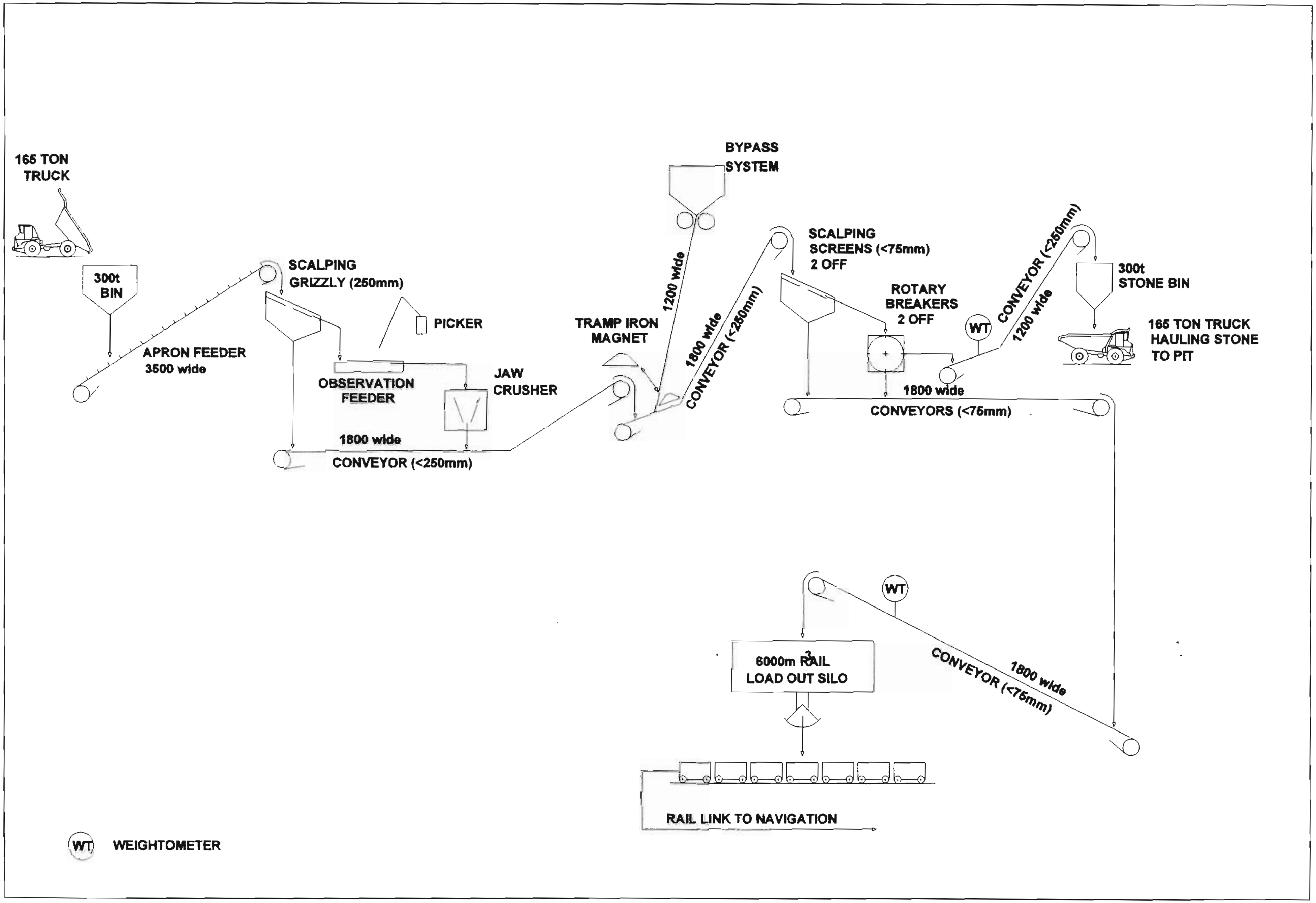

FIGURE 4.11 KROMDRAAI COAL FLOW DIAGRAM

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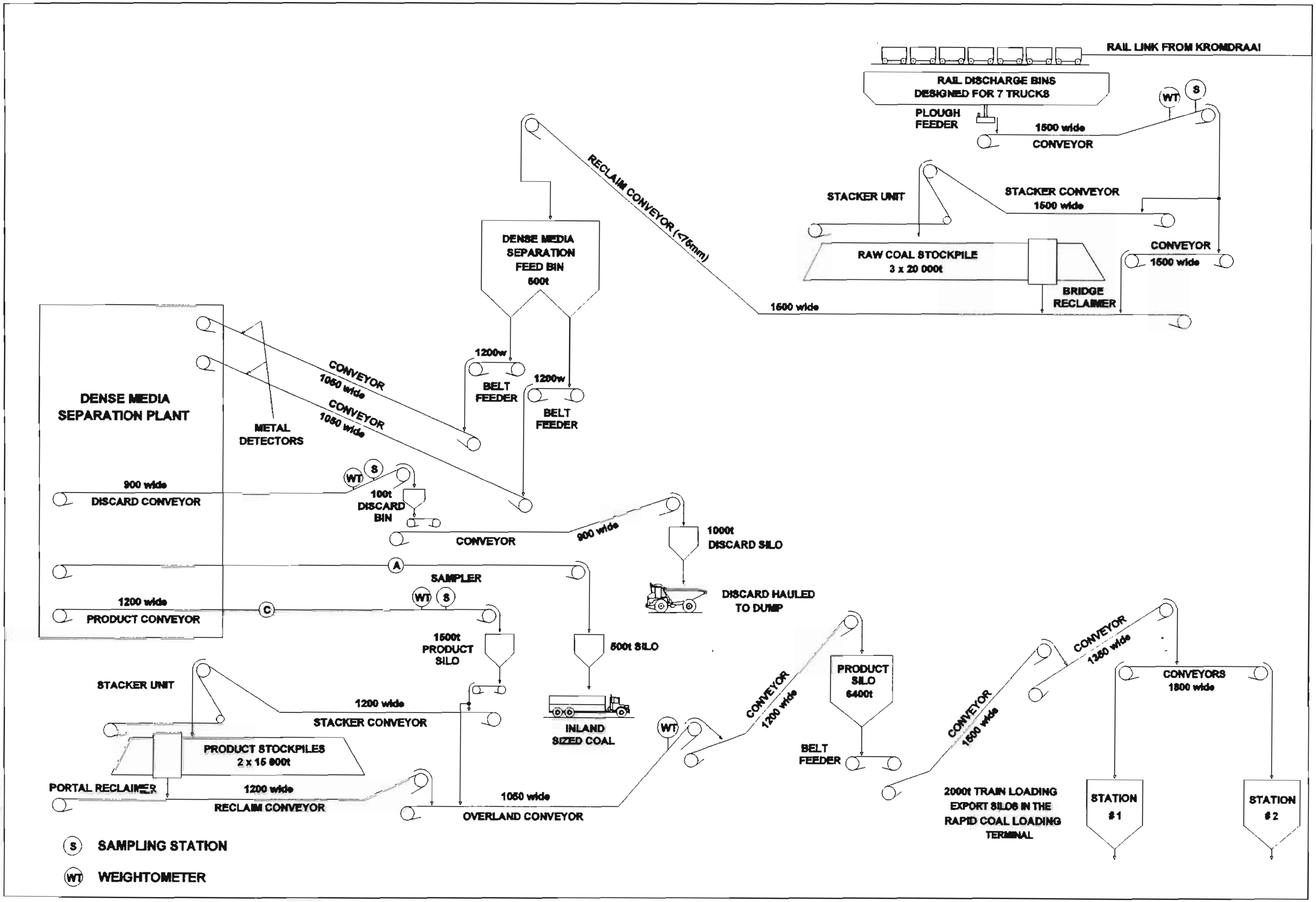

FIGURE 4.12 NAVIGATION PLANT COAL FLOW DIAGRAM

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Media Separation (DMS) plant where it is washed and graded. The plant consists of two modules, each having a Drewboy bath treating 75x10 mm, a cyclone section treating 10x0.5 mm and a spiral section treating 0.5x0.15 mm coal. The plant will have a centralised control room, which will control the raw coal stockpile, processing plant, as well as, the product stockpiles. Two saleable products are produced: sized coal for sale within South Africa and steam coal for the export market.

Discards from the plant will be conveyed to the Blaauwkrans Co-Disposal site adjacent to the plant for stockpiling. Details of the disposal system are described under Section 4.3.4. Discards, made up of 75x0.15 mm material, will be conveyed to the discard site and slimes (-0.15 mm material) will be pumped into the slimes dam. The fine coal (0.15 mm material) can be beneficiated via the forth flotation process. Currently froth flotation has been tested at Navigation and yielded promising results. Froth flotation is on trial at Kleinkopje Colliery and if the plant there proves successful, plans will be made to investigate fine coal beneficiation at Navigation. Fine coal beneficiation, if implemented, could reduce the quantity of slimes disposed of by at least 50 % and the quality of the discards by 9-10%.

4.3.4 Plant Residue Disposal

Introduction

The choice of the site for the Blaauwkrans discard dump and slimes dam was governed by the following considerations:

- distance from Navigation plant
- impact with regard to water pollution
- future opencastable coal reserves

Ground water Monitoring

Prior to deposition commencing on the dump a series of boreholes was put down for the purpose of monitoring showed the ground water to be polluted to varying extents. Table 2.10.2 summarises the pre-dumping ground water qualities. The source of pollution is from the Anglo-French discard dump situated to the south of the dumping site.

Supplementary Report No. 14 gives details of the water-monitoring programme.

During construction of the discard facility two monitoring holes were destroyed. These holes were re-drilled during 1994 and the monitoring programme re-commenced after completion of laying of the Gascor pipeline.

Description of Discard Dump and Slimes Dam

Supplementary report No. 23 is the operating manual for the discards disposal facility.

Coarse discards in the size range 75x0.15 mm will be conveyed to the dumpsite on two conveyors. The first conveyor will feed a 100 ton surge bin at the first transfer point which will allow for an orderly plant shutdown in the event of the second conveyor stopping. The second conveyor feeds a 1000-ton silo located at the discard dump site. From here contractors' vehicles will be used to distribute the discards onto the dump.

At the same time as the discard dump is being built a slimes dam will be constructed so that the discard dump and slimes dam will form an integral unit. Slimes of minus 0.15 mm will be pumped as thickener underflow to the slimes dam and deposited inside a dam wall. Initially, the dam wall will be constructed of earth, followed by compacted discards. Water from the slimes dam will be pumped back to the coal plant for use as process water.

A general layout of the dump, slimes dam and return water system is presented in Figure 4.13.

Prior to deposition of discards topsoil will be removed from the site and stockpiled for later use to cover and rehabilitate the dump. Rehabilitation of the dump will commence within four years of the dump starting and will continue throughout the life of the plant.

4.3.5 Transport

The methods of transporting the ROM coal and product are described in Section 2.6.1 of this report.

4.3.6 River Diversions

No river diversions are planned for.

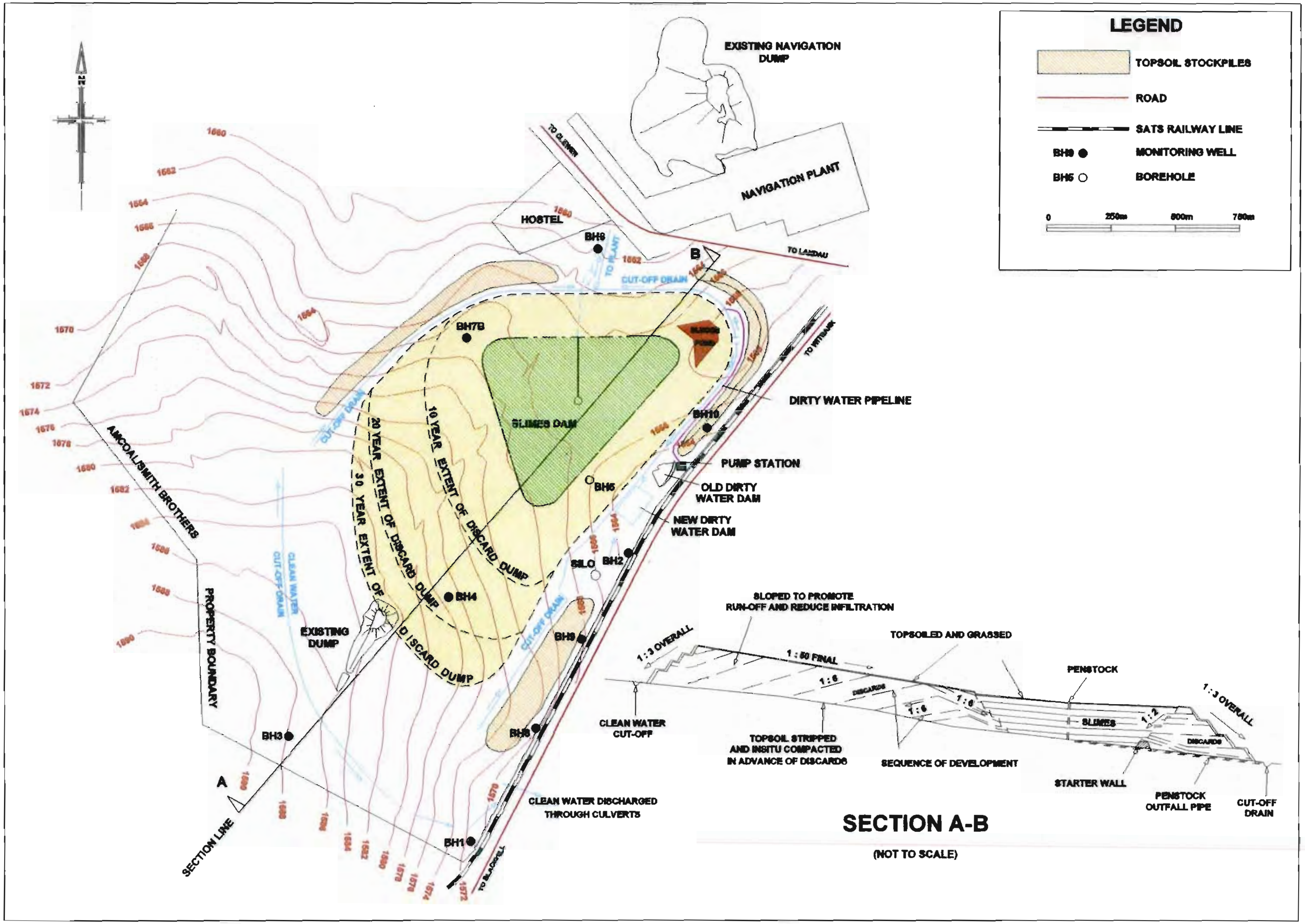

FIGURE 4.13 LAYOUT OF BLAAUWKRANS DUMP AND SLIMES DAM

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PART 5: ENVIRONMENTAL IMPACT ASSESSMENT

5.1 Construction phase

The construction phase impacted on the environment in two areas:

- Borrow pits were excavated for the railway line embankment and for plant terraces at Kromdraai and Navigation.

- Natural surface water drainage was affected by construction of the railway line embankment and associated culverts.

5.2 Operational Phase

5.2.1 Geology at Kromdraai

The geological sequence up to the floor of the No. 1 seam will be disturbed in the area where opencast mining takes place. The impact this will have on the environment is to disturb the water tables and to expose the broken rock and coal to oxygen and water thus creating the potential to generate acidity and salinity in the water collected in the spoils

Work carried out by Professor Hodgson in January 1992 (Supplementary Report No.22) concluded that the in-pit water after mining will have a pH of 4,0 to 5,5 due to the overburden spoils not having the potential to neutralise long-term acid water generation. However, as described in previous sections, any polluted water decanted from the pit areas will be pumped to the liming plant for treatment.

5.2.2 Topography

The topography will be disturbed as follows:

- In the opencast mining area some 240 ha, representing the operating window, will be disturbed as the pit advances through the coalfield. This operating window will consist of haul roads, topsoil stripping, pre-stripping, dragline overburden removal, coaling, levelling and profiling of spoils, pre-strip dumping, topsoil replacement, fertilising, seeding and vegetation management operations.

- The ROM railway line will disturb the topography for the duration of the mine's life.

- The Kromdraai and Navigation plants and infrastructure will disturb the topography for the duration of the mine's life.

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5.2.3 Soils

Soils will be disturbed in the operating window of approximately 240 hectares as well as on the areas occupied by the railway line, Blaauwkrans dump, Kromdraai and Navigation plant and infrastructure sites.

5.2.4 Land Capability

Approximately 240 hectares in the opencast mining area will be disturbed during the mining operation, which will reduce the land capability.

A reduction in land capability of the area occupied by the Kromdraai plant and infrastructure and the new section of the railway line has occurred.

At Navigation the plant and infrastructure occupies an area that had been disturbed by previous mining operations.

Building of the Blaauwkrans dump will reduce the land capability.

5.2.5 Land Use

During the operational phase the land utilised by the Kromdraai and Navigation plants, discard dump, railway line and the 240 hectares opencast mining window will be withdrawn from agricultural use for mining purposes.

The operations do not impact on existing structures.

5.2.6 Natural Vegetation/Plant Life

All of the natural vegetation occurring on the areas required for the mine and associated infrastructure has been or will be disturbed.

No stream diversions are planned for.

5.2.7 Animal Life

All animal life in the areas required for the mine and associated infrastructure will be disturbed over the life of the mine. Disturbance of animal life in the opencast area will be restricted to the 240 hectares operating window and should be considered temporary.

5.2.8 Surface Water

The impact on the yield of the catchment will be insignificant. Disturbance to the natural flow of surface water will occur as follows :

- Kromdraai and the Navigation plant and Blaauwkrans discard dump areas will disturb the flow of surface water throughout the life of the mine.

- The railway line will disturb the natural flow of water for the life of the mine.
- In the opencast area the 240 hectares operating window will disrupt the flow of the natural surface water.
- The Blaauwkrans Co-Disposal facility will disturb the natural flow of water permanently.

Kromdraai mine and Navigation plant and their surroundings are closed loop systems in that all polluted water should be collected and treated in the respective liming plants, while the clean stormwater runoff is separated and discharged off the property into the respective catchments.

5.2.8.1 Impact of Polluted Water Discharges on Loskop Dam (receiving water body)

There should be little or no impact of the water quality of the water in the catchments due to the mining and processing operations. The impacts will come from areas of acid seeps and decants. These areas have not arisen due to the recent mining of Landau Colliery but due to the mining that took place in previous years. Theses acid water seeps and decants have affected the Kromdraaispruit wetland in the past. A past investigation into the functionality of the wetland indicated that, treated water from the Kromdraai liming plant which was discharged into the evaporation ponds generated acid seeps along the Kromdraaispruit. This was altered by the DWAF Regional Director in 1997 who gave permission to the mine to discharge the treated water directly into the Kromdraaispruit.

The management of surface water arising on the operational areas has been described in Part 4.

5.2.8.2 Impact of Floods

In the event of flood conditions the following situations are anticipated :

A. Kromdraai Opencast

The pit will become flooded with surface water runoff entering the opencast strip. The water will push back into the old underground workings, which will in effect become a reservoir to contain the excess water. This accumulated water will be pumped and/or gravitated to the liming plant for treatment. An effort will be made to utilise this water in the operations to minimise the impact on the environment.

B. Kromdraai Plant and Infrastructure

Cut-off drains have been constructed to divert clean surface run-off into the Brugspruit. All water falling within the operational area is channelled to a polluted water dam from where it is pumped back into the plant for re-use.

C. ROM Railway Line

The culverts constructed for the railway line are designed for a 1:50 year flood. Floods of greater magnitude may result in parts of the embankment washing away.

D. Navigation Plant Site and Blaauwkrans Dump

Cut-off drains have been constructed to divert clean water into the Schoongezichtspruit. All polluted water is collected in dams from which it is pumped to the water treatment plant for use in the operations. The water management system is described in Part 4.

5.2.9 Ground water

A. Kromdraai

The mining operation will impact on the present ground water system. Ground water is impacted at Kromdraai through the flooded previously mined underground workings.

The existing liming plant will continue to be operated to neutralise acid mine water pumped from both the old underground workings and the opencast operation.

B. Navigation

The ground water is not expected to be disturbed significantly, however pollution-monitoring wells have been installed around the Navigation discard dump to monitor whether or not any pollution arises. Ground water is impacted through the seeps from the Blaauwkrans Co-Disposal facility and from the flooded previous mined Navigation and Schoongezicht underground workings. The burst from the old Schoongezicht 1 Seam underground workings decants into the Schoongezicht pollution control dam where the water is pumped back to the Navigation liming plant.

5.2.10 Air Quality

The mining and processing plants are expected to impact on the air quality. Air quality monitoring stations have been set up to quantify the extent of impact. The majority of these stations are not directional, and can only qualify total loads i.e. one cannot differentiate between mine made dust and imported dust.

To minimise the effects on air quality arising from the mining and coal processing operations dust suppression will be practised by wetting down haul roads and spraying of coal at the transfer points in the plant.

5.2.11 Noise

A preliminary noise survey (Supplementary Report No. 16) has been carried out and may need to be followed up by a further survey to assess the impact the mine and plant has on selected neighbouring farms and residential areas. No significant impacts are expected or have been recorded.

5.2.12 Sites of Archaeological and Cultural Interest

No sites of archaeological and cultural interest have been identified.

5.2.13 Sensitive Landscapes

No sensitive landscapes have been identified.

5.2.14 Visual Aspects

A. Kromdraai

The opencast mine, plant and infrastructure are visible from roads in the area. These roads are not on the tourist routes. The operations are also visible from neighbouring farms.

B. Navigation

The plant and discard dump are visible from roads in the area as well as from the Clewer township and parts of Witbank. The plant and dump is also visible from the Pretoria-Witbank and Johannesburg-Witbank motorways.

5.2.15 Regional Socio-economic Structures

The mine, as described in Section 3. 1 will generate employment opportunities directly and indirectly mainly in the Witbank and Middelburg areas. Taking into account the multiplier effect the mine provides employment for some 1000 people in the country.

5.2.16 Interested and Affected Parties

The mine and associated infrastructure has an effect on neighbouring farms, a brickwork's and residents of Clewer township. The potential effects on these parties are noise, dust and to a lesser extent impacts on underground water.

It is anticipated that the mine will improve the quality of water being released into public streams compared with what was being released from the old underground workings. This will be achieved by utilising polluted water in the mine and processing plants and through lime neutralisation. Refer to section 2.17.

5.3 Decommissioning Phase

During the decommissioning phase the environmental impacts identified in Section 5.2 will still be evident but will gradually reduce as the environmental management programme is implemented as described in Part6.

Impacts present during the decommissioning phase will be:

Noise: Noise will be generated by machinery involved in dismantling the plant and rehabilitating the mining areas. The noise levels will not be greater than during the operational phase.

Dust: Dust will be generated at levels lower than during the operational phase.

Water: The extent of water pollution will be similar to that during the operational phase.

Visual: Visual impacts from mining and plant sites will still be evident.

Socio-Economic: This will be negatively affected by the reduction in the workforce.

No application for partial closure is anticipated in this report

5.4 Residual Impacts After Closure

The main residual impact identified after closure is the effect on ground water and the generation of acid mine drainage with poor leachates.

5.4.1 Potential for Acid Mine Drainage or Poor Quality Leachates

A. Kromdraai Opencast Mine

When examining the records kept of the Kromdraai liming plant (1981 to 1992), the sulphate loading emanating from the old underground workings has averaged 1910 tons per annum. Professor F. D. I. Hodgson (Supplementary Report No. 13) has estimated that after closure of the opencast mine a sulphate loading of from 2 to 10 kg/ha/day could be generated. This for an area of 2600 hectares equates to between 1900 to 9500 tons per annum. With good surface rehabilitation and construction of the post-mining topography the ingress of surface water will be minimised and the generation of salt from the opencast area will tend towards the lower end of the range estimated by Professor Hodgson. It is therefore estimated that the post-mining sulphate load will not be greater than that experienced before opencast mining commenced.

Adjacent to the Kromdraai Opencast mine is the old Blackstone and Bulpan mining areas. Both areas were mined by Blackstone Mining. Currently the areas are pollution sources and through rehabilitation this will lessen the impact from these areas on Landau Colliery.

Blackstone Workings to be Rehabilitated

The Blackstone mining area is owned by Mr Z Mohammed. Landau requires the Blackstone area for spoiling depending on mining conditions. The Blackstone 1 Seam floor dips away from the Kromdraai Opencast workings but in the direction of the Kromdraaispruit. Monitoring wells will be erected and any seepage will be captured and treated in the Kromdraai Liming Plant. However, it is expected that only ground water will be seeping out of the Blackstone area. Due to the slope of the final rehabilitated ground the area will be terraced to prevent erosion. The Blackstone area will be rehabilitated at no cost to the state. The Blackstone rehabilitation is shown in Figure 5.1.

Bulpan workings to be Rehabilitated

In the Bulpan area there are a number of open pits, which remained after mining ceased in the area. The land is currently owned by Mr K McKenzie. Landau requires the Bulpan area for a servitude and possibly spoiling purposes when the Kromdraai Opencast mining area is close to the Bulpan area, depending on mining conditions. The Bulpan area will be rehabilitated as per Figure 5.2 with no cost to the state. The area will be rehabilitated with the same mix of grass as used in the other rehabilitated areas on Landau. The 1 Seam floor of Bulpan dips away from the Kromdraai Opencast workings but monitoring will still be performed once rehabilitation of the Bulpan area has been completed.

These areas are not owned by Landau Colliery and are not in operation anymore. Landau Colliery would like to rehabilitate these areas when the current mining is adjacent to these areas.

B. Navigation Plant and Discard Dump

Leachates with high salt concentrations will emanate from the remains of the rehabilitated old Navigation dump as well as from the new dump constructed on the farm Blaauwkrans.

5.4.2 Long-term Impacts on Ground water

A. Kromdraai Opencast Mine

Due to the elevation of the floor of the No. 1 Seam ground water could be impacted by leachates generated from within the opencast spoils which could migrate into the surrounding water regime.

B. Navigation Plant and Discard Dump

Ground water tables in the area could be affected by leachates emanating from the old Navigation dump and the new Blaauwkrans dump.

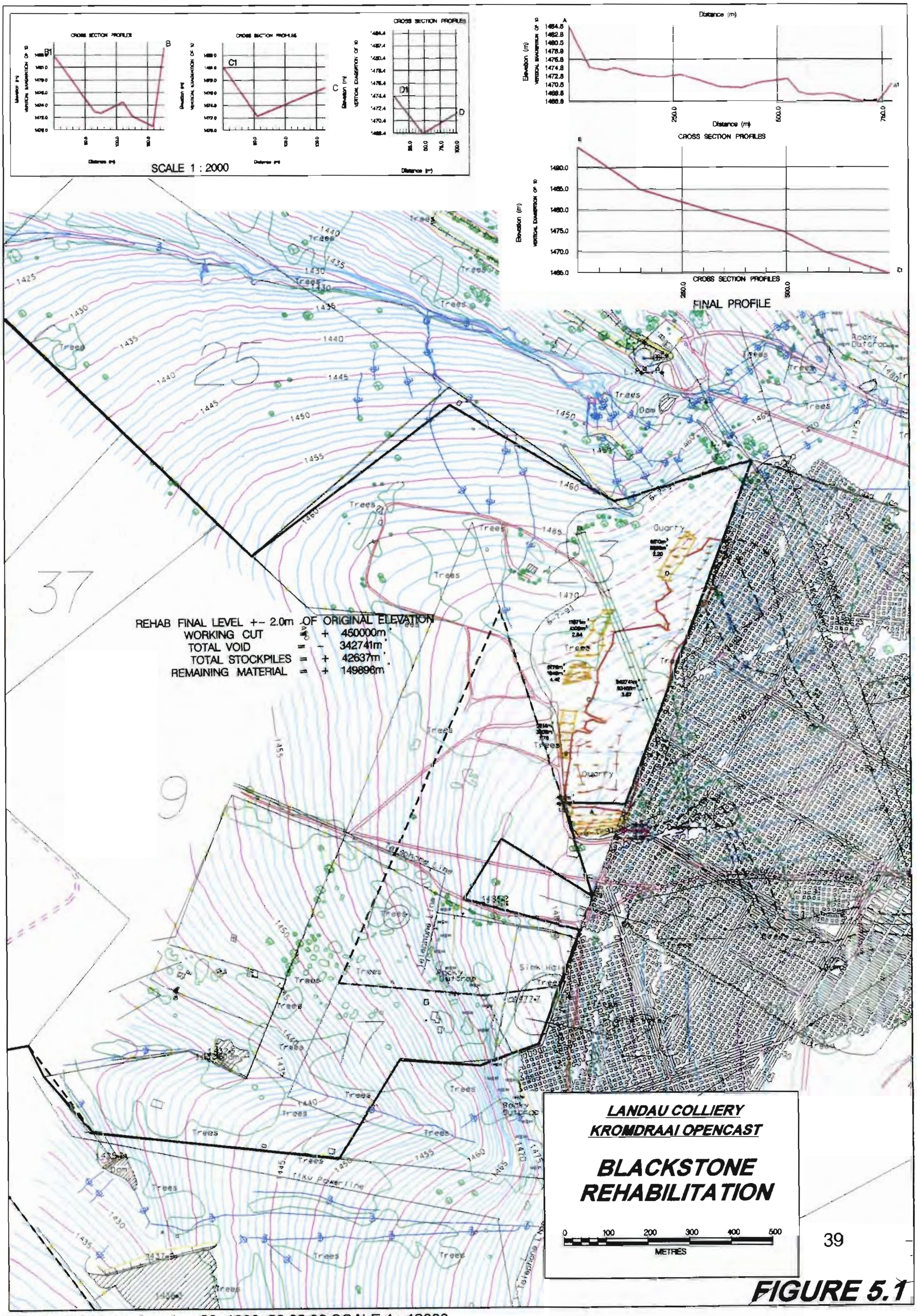

FIGURE 5.1

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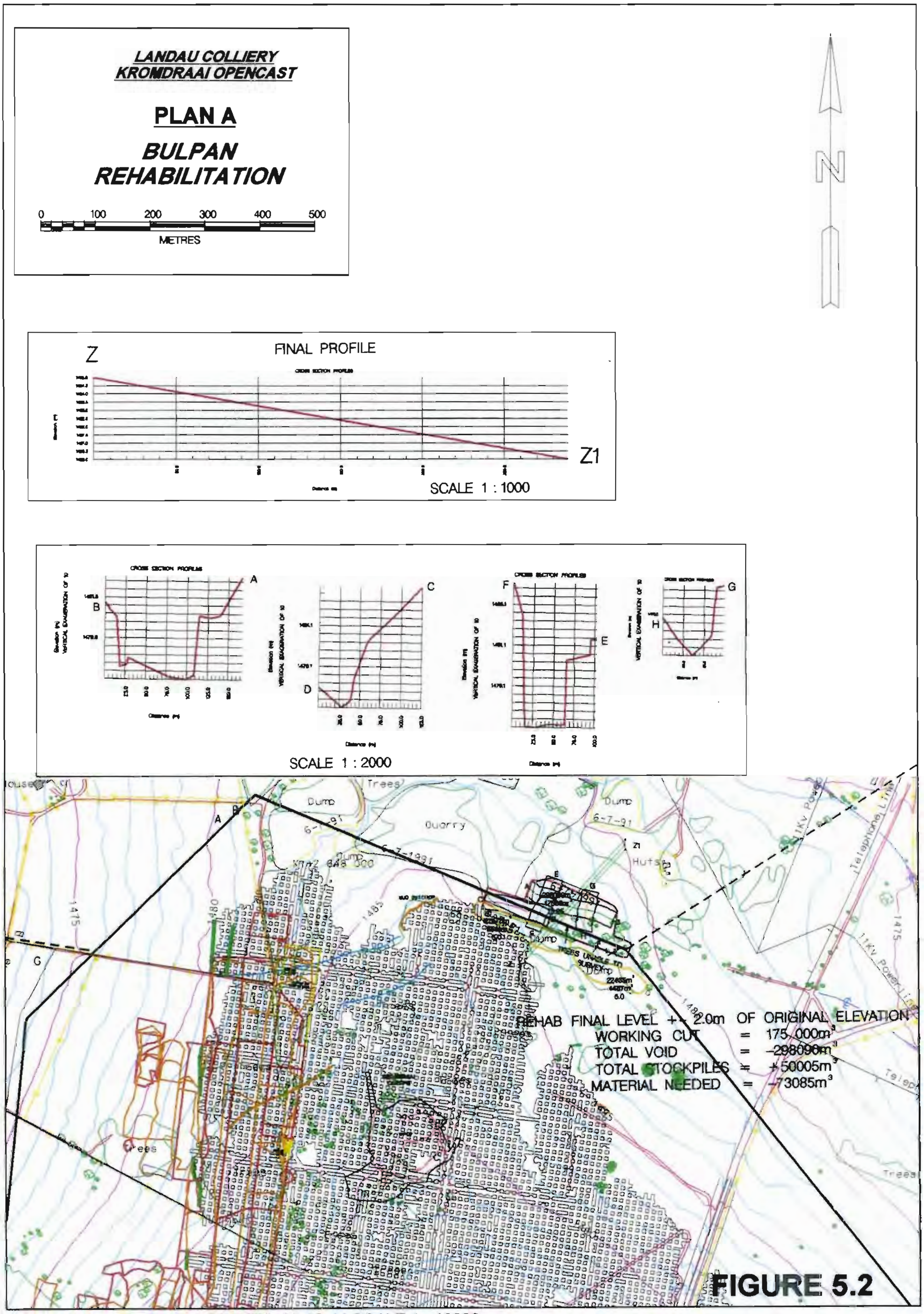

FIGURE 5.2

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5.4.3 Long-term Stability of Rehabilitated Ground and Residue Dumps

A. Kromdraai Opencast Mine

Past opencast mining experience has shown that in time rehabilitated land is sufficiently stable for normal agricultural purposes. In the longer term and with using special construction techniques light residential buildings could be erected on the rehabilitated land.

It must be noted that after opencast mining has taken place the risk from collapses due to the underground workings will have been eliminated.

B. Navigation Plant and Discard Dump

The two dumps described earlier are constructed over old underground workings. Geotechnical evaluations have shown that the pillars are sufficiently stable to carry these dumps.

The construction of the dumps is such that the slopes will not fail. However, there is a risk of local failures occurring in periods of high rainfall when erosion of the berms could occur. When local failures occur they are rectified immediately.

As the dumps will be topsoiled and grassed the vegetation on the slopes and berms will need to be managed.

5.4.4 Long-term Impacts Arising from River Diversions

Not applicable.

PART 6: ENVIRONMENTAL MANAGEMENT PROGRAMME

6.1 Construction Phase

Prior to excavating borrow material for construction requirements the topsoil was removed and stockpiled. On cessation of borrowing operations the pits were sloped to facilitate drainage and the topsoil replaced. The areas have been fertilised, re-seeded and are being managed.

After closure of the mine the railway line and embankments will be sloped, stabilised and revegetated. This will return the natural surface drainage to the approximate pre-mining regime.

6.2 Operational Phase

Introduction

Access will be gained to the coal seams by a network of highwall ramps. This method of access has been chosen in preference to the more commonly used lowwall ramp system, which leaves depressions between the blocks of rehabilitated mining land. These two methods of access are illustrated in Figure 6.1. The highwall ramps are established by the dragline and pre-strip shovel and truck fleet ahead of the coaling faces.

Operational Phase

The mining method to be employed will be a combination of shovel and truck and dragline operations shown in cross section in Figure 6.2. The operational steps leading to surface rehabilitation are as follows:

1. Usable soil will be removed and either stockpiled separately for later use during rehabilitation, or placed directly over graded spoils.

2. Where necessary, overburden will then be removed by shovel and truck and selectively dumped over dragline spoils to profile the post-mining topography.

3. The remaining overburden to top of coal will be sidecast by the dragline into the void left after removal of the coal.

4. Strips of exposed coal of approximately 60 metres wide will be removed by shovel and truck and hauled to the run of mine (ROM) tip for processing.

5. The dragline spoils will be roughly graded prior to placement of overburden by shovel and truck followed by replacement of useable land.

6. Soil placement will be carefully controlled to achieve the pre-planned soil

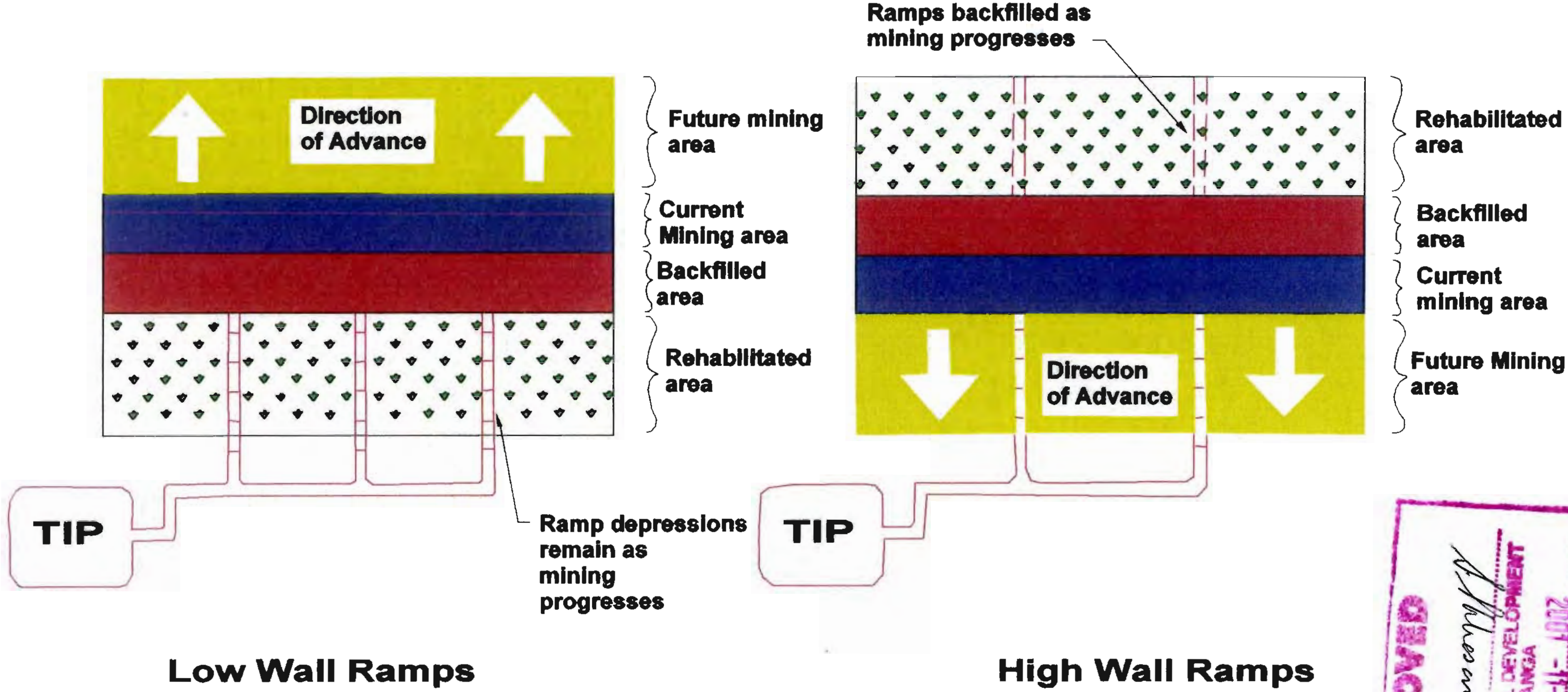

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FIGURE 6.1 COMPARISON OF LOW AND HIGH WALL RAMPS

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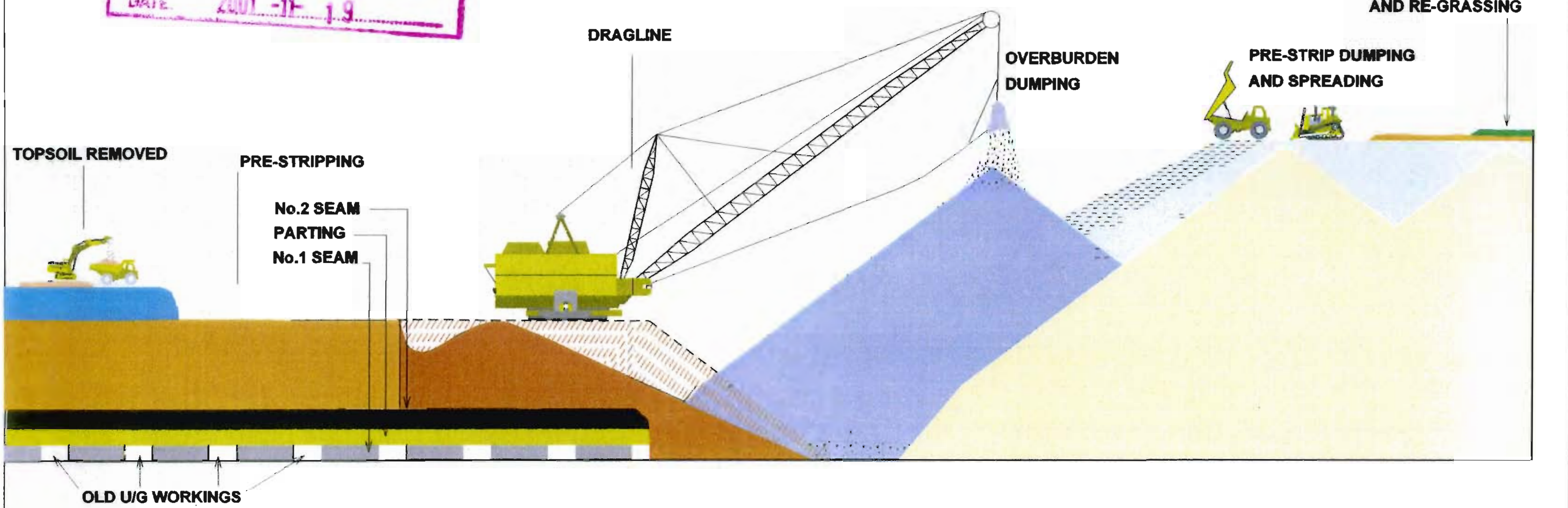

FIGURE 6.2 DIAGRAMMATIC REPRESENTATION OF THE OPENCAST MINING OPERATION

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distribution. After replacement, all profiled surfaces will be thoroughly ripped to overcome the compaction of the soil induced by heavy mining equipment. Final tillage will produce a bed suitable for planting pasture seed. The pasture performance, fertiliser requirements, success of seed mixes and any other factors, which affect growth, will be monitored by the land rehabilitation section of Anglo Coal Environmental Services. Anglo Coal Environmental Services have environmental audits on Landau every three years.

Final voids along the eastern limit of the North, Central, and Excelsior blocks will be filled with spoils from the original box cuts and re-vegetated on completion of mining in these blocks. The indicative timing of completion of these blocks is shown in Figure 6.3.

The geological formations above the coal seams, which are to be blasted and removed, will disturb the topography. Once the coal is removed from a mining cut, the overburden spoil from the next cut, which typically consists of a shale, siltstone and sandstone mixture interspersed with limited amounts of clay and sand overburden, will be returned to the mined out cut by the dragline. On account of this disturbance up to 30% bulking of the overburden will occur, depending on the characteristics of the different strata, which will partly compensate for the coal removed from the area. Figure 6.4 compares the pre- and post-mining topography anticipated whilst Figure 6.5 shows in cross section the pre- and post-mining surfaces.

Apart from the effects on the surface, mining will destroy the shallow perched water table and alter the geohydrology and geochemical behaviour of the spoil. Overall the overburden spoil will be more permeable than the original strata with greater voids and exposed rock surface areas. Pyrite exposed on the rock surfaces will be oxidised by the oxygen found in the voids. Therefore a potential increase in bacterial/chemical leaching and acid mine drainage can be expected.

The advantages of this mining method are:

Advantages. Total removal of coal seam and therefore high potential acid mine generator

Removal of sinkholes and old underground workings, thus stabilising the surface.

Elimination of spontaneous combustion in old underground workings.

Removals of long standing accumulations of acid mine water.

Reprofiling post – mining surfaces to reduce ingress of water into spoils to become acid.

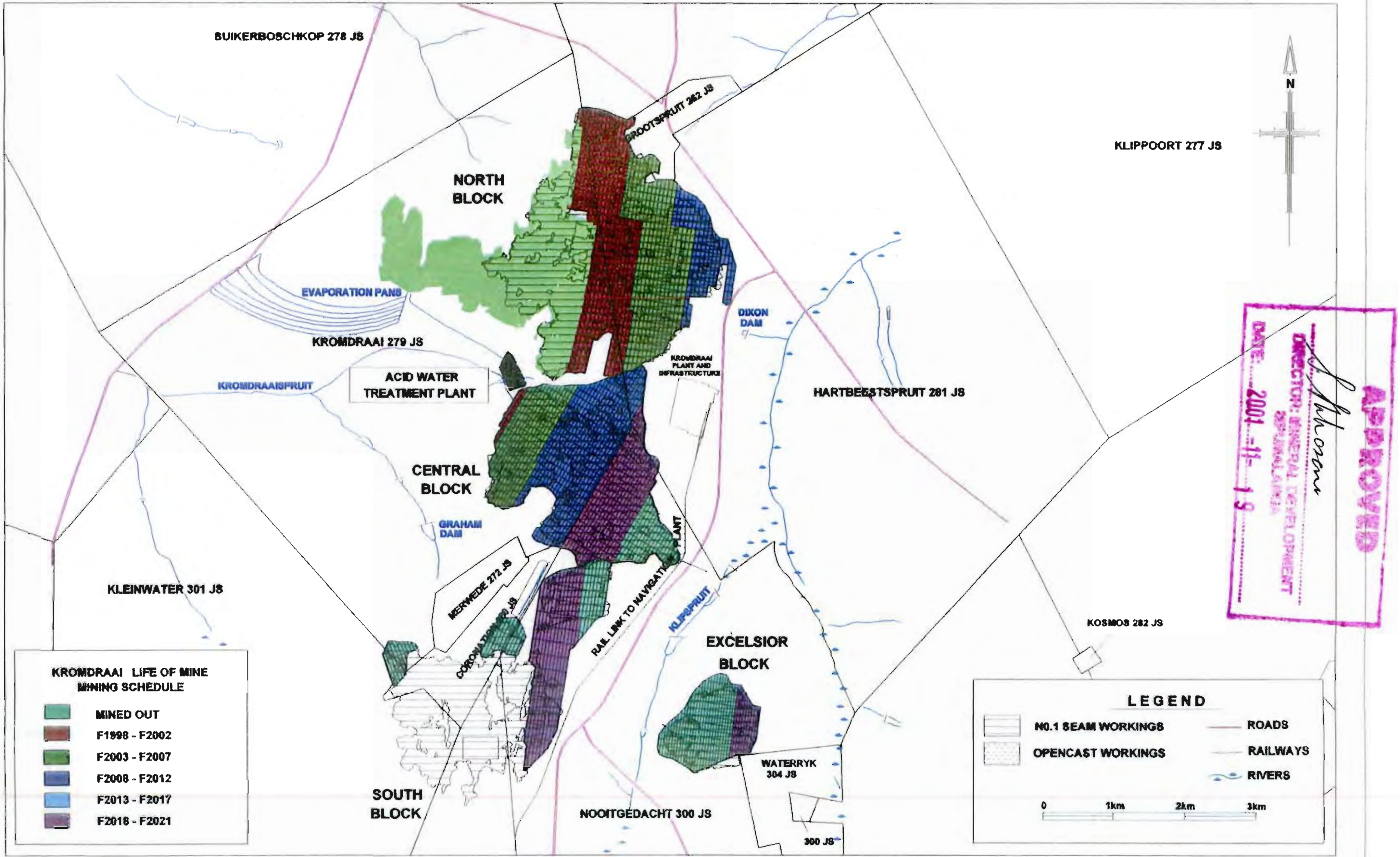

FIGURE 6.3 INDICATIVE LIFE OF MINE PLAN

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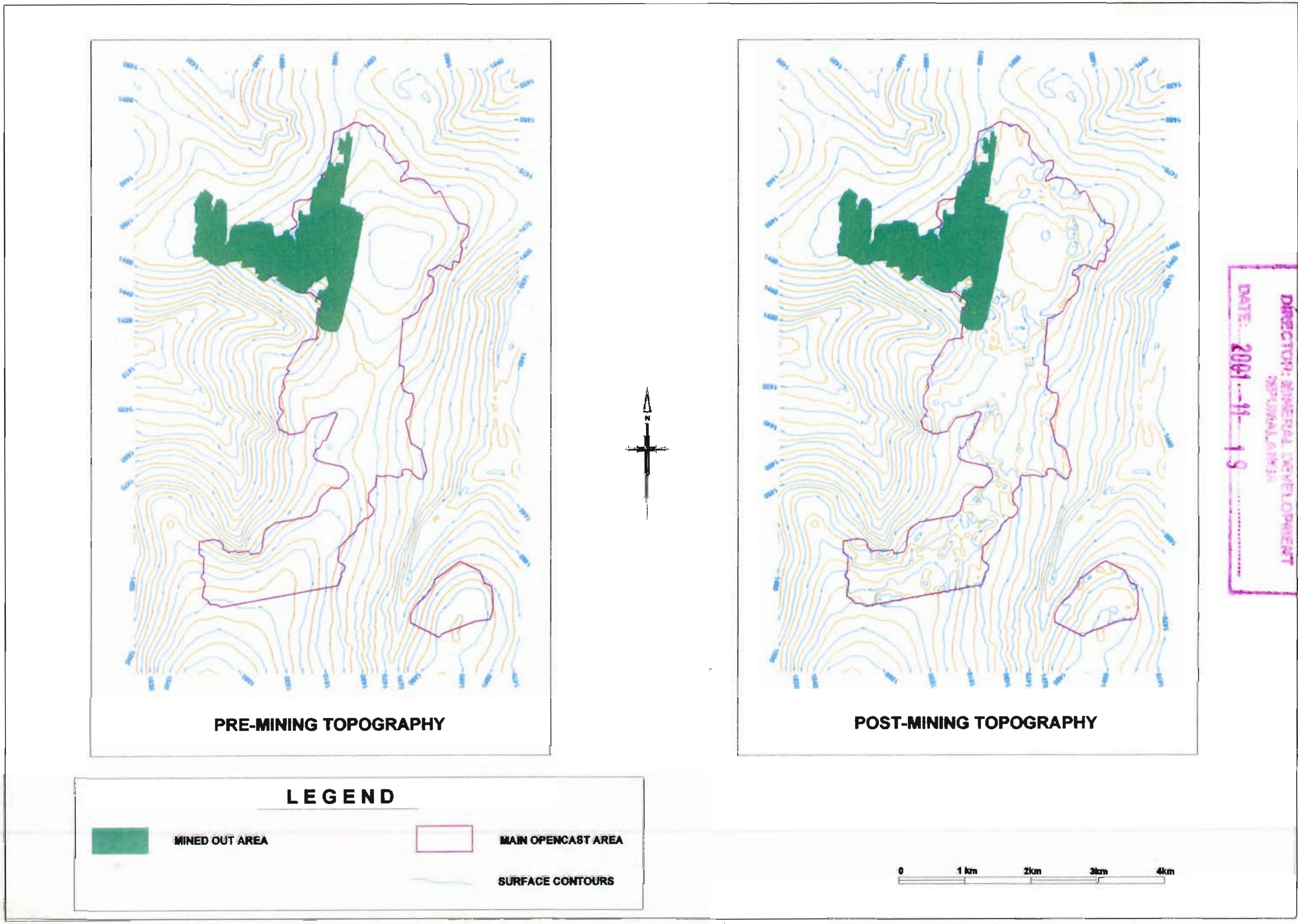

FIGURE 6.4 PRE- AND POST-MINING TOPOGRAPHY

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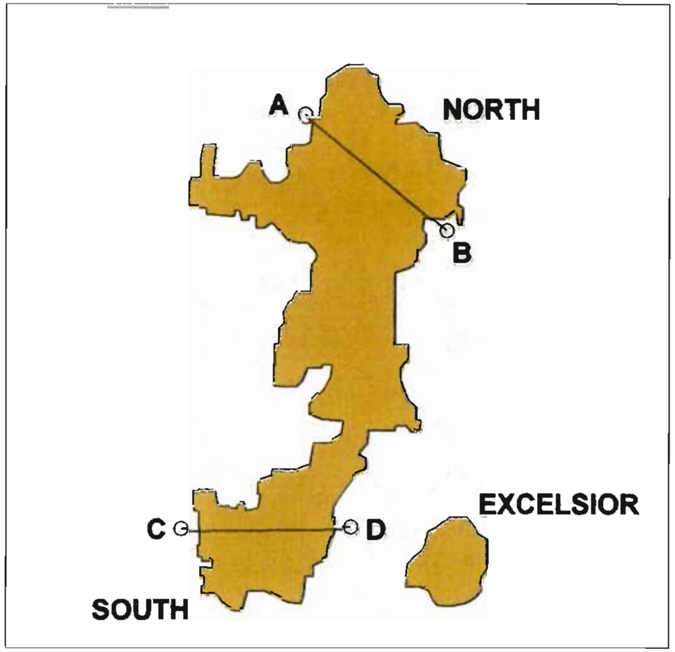
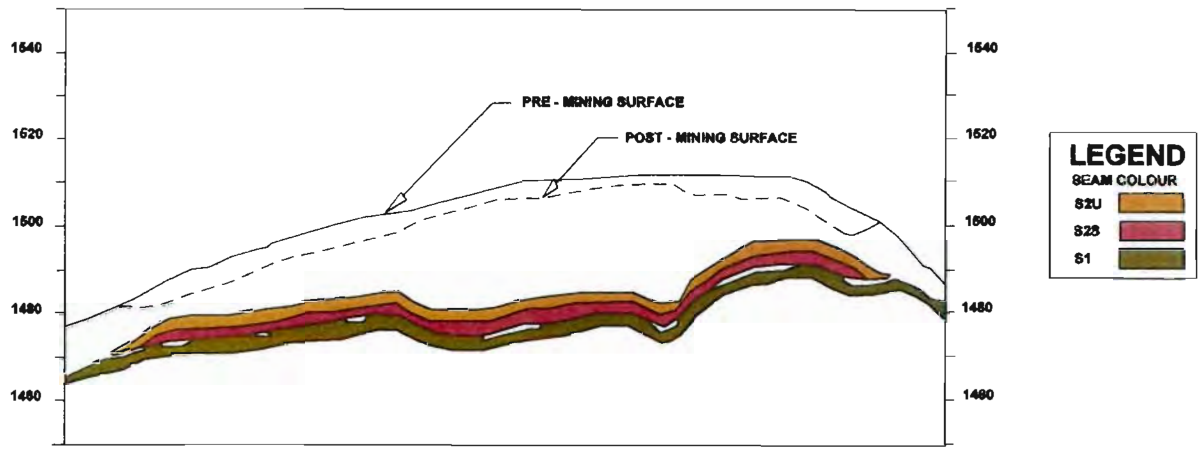
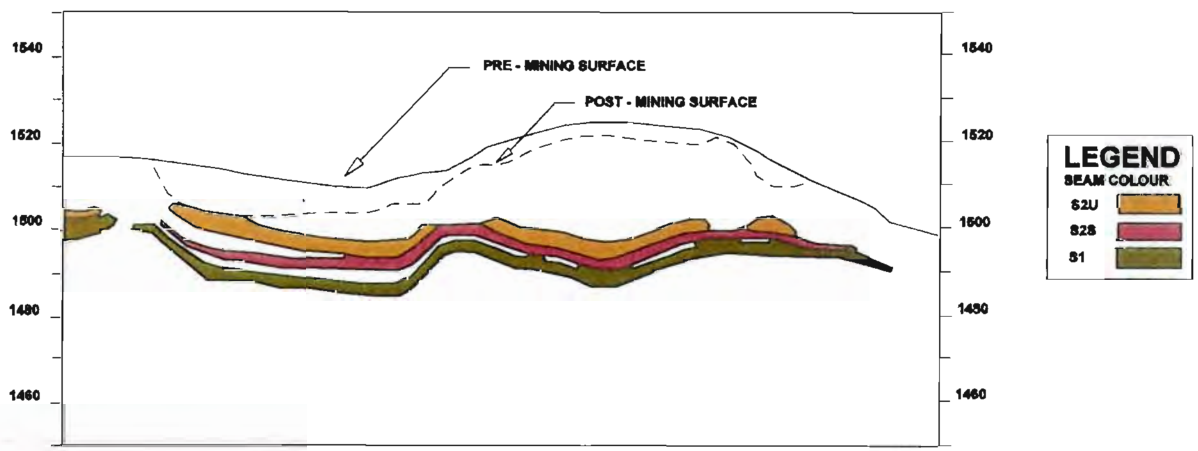


LOCATION OF REHABILITATION SECTION LINES



SECTION A-B VERTICAL EXAGGERATION OF 15.00



SECTION C-D VERTICAL EXAGGERATION OF 15.00

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FIGURE 6.5 PRE AND POST-MINING TOPOGRAPHY

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Removal of old discard dumps and reprofiling to reduce generation of acid water.

Overall, an area whose agricultural potential has been greatly reduced by previous underground mining, will be restored to some 90% of its pre-underground mining potential.

Disadvantages: Destruction of natural ground water aquifers and generation of acid mine drainage.

Establishment of a discard dump which reduces the pre-mining agricultural potential

Noise, dust and visual impacts.

6.2.1 Geology at Kromdraai

It will not be possible to reinstate the pre-mining geological sequence due to the fact that the stratigraphy will be destroyed. However, the opencast mining method described removes and replaces the topsoil and weathered materials/subsoil's where applicable, up to four metres in depth in separate operations. This allows the post mining surfaces to be profiled and facilitate surface water drainage, as well as, limit ingress of water into the spoils.

6.2.2 Topography at Kromdraai

The final topography for the pit has been planned using computer techniques. A program has been developed to predict the post-mining surface, taking cognisance of an increase or swell in overburden volume as a result of disturbance of overburden material.

The pre-mining and proposed post-mining topographies are shown in Figure 6.4. Figure 6.5 gives two typical sections across the mining area, which show the pre-mining topography (black line) and the post-mining topography (red line). Note that the vertical scale has been exaggerated by a factor of fifteen times for clarity. The final profiled surface has been planned to permit maximum slope angles of 7% (1:14) for arable land and 17% (1:6) for grazing land, as defined by the Chamber Guidelines. Spoils, will be levelled to ensure that slopes are continuous so that minor undulations, where surface run-off water may accumulate, are avoided.

The pre-mining and post-mining profiles are summarised as follows:

Slope Angle	**Pre-Mining**	**Post Mining**
Less than 3%	65,3%	68,3%
3 – 5%	21,7%	22,3%
5 – 7%	13,0%	9,4%
Greater than 7%	0%	0%

As indicated in the table, there are no areas with slopes greater than 7%.

It is important to note that at present much of the area is affected by deep sinkholes, which make the property difficult to farm. As such, opencast mining and subsequent rehabilitation will improve the agricultural potential of the area. Important goals during re-shaping the topography will be:

- To recreate a pre-planned stable surface with a fully integrated erosion minimising drainage pattern as indicated in Figure 6.4. During mining, surface runoff will be channelled away from working areas of the mine into the natural river network.

- To establish economic units of land by consolidating un-mined and rehabilitated land portions.

- To fill in post rehabilitated subsidence areas where non-draining hollows are formed so as to promote surface runoff

The topography before and that anticipated after mining are presented in Figure 6.4 with cross sections shown in Figure 6.5

6.2.3 Soils

A. Kromdraai

It is planned for all soil removal and replacement to be carried out by the truck and shovel fleet and sufficient soil will be stripped to rehabilitate the land as closely as possible to its original potential. However there may be times when due to low machine availability contractors with scraper fleets may be employed.

With normal soil stripping methods, approximately 85 % of the insitu soil are replaced. The remaining 15 % are lost in the recovery and placement. As a result of the existing sinkholes and the possibility of further sinkholes developing, it is envisaged that soil losses could be greater than the 15 % norm and an estimate of a 25 % loss has been predicted. This indicated loss takes cognisance of the fact that in areas of instability, it is not planned to strip soil prior to drilling and blasting of overburden.

Wherever possible, stripped soil will be transported to the nearest available areas of prepared spoil and deposited. Soil will be stripped ahead of mining operations so far as the stability of the underground workings will permit.

Soil replacement will be carefully controlled in the field by means of depth markers to ensure an even distribution. After replacement, all profiled surfaces will be thoroughly ripped to ensure disturbance of the soil/spoil interface. Final tillage will produce a seedbed suitable for planting pasture seed.

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The depth of pre-mining usable soils and soil types in the Kromdraai area is shown on Figures 6.6 and 6.7.

The average thickness of usable soil over the area to be mined is 1,03m and assuming a loss of soil of 25 % as detailed above this would indicate that in excess of 600mm of usable soil depth would be placed over the area.

The soil cover consists of an association that is very typical of the eastern Highveld. Essentially, the profile is made up of red and yellow soils of moderate to great depth plus interspersed shallow grey-brown soils (Mispah form).

The typical soil formations are described below:

Hutton form Generally deep to very deep soils which have, under the orthic A-horizon (darkened by organic matter), a red apedal B-horizon of variable depth. Below this, it is common to find a substantial thickness of well-weathered rock before reaching hard rock.

Bainsvlei form The upper part of the profile of soils belonging to the Bainsvlei soil form has the same range of properties as soils of the Hutton form. The two are defined in identical terms as consisting of an orthic A-horizon followed by the red apedal B-horizon. The Bainsvlei is underlain by a soft plinthite, which is not suitable for rehabilitation.

Clovelly form Soils of this form consist of an orthic A-horizon followed by a yellow-brown apedal B-horizon. The latter lies on hard rock or more commonly, grades into hard rock via saprolite (weathered rock). Except for colour, the soil materials are similar to those found in Hutton form soils: they have favourable physical properties due to the micro-aggregate structure. They are porous, very friable when moist and soft when dry. In the Kromdraai area, Clovelly soils have acid reaction, are under-saturated with bases and have low phosphate potentials.

Avalon form these are yellow-brown analogues of the Bainsvlei soil. The horizon sequence is orthic A-horizon over yellow-brown apedal B-horizon over soft plinthic B-horizon. The latter reflects a degree of drainage impedance.

As with Bainsvlei, the soft plinthic material is unsuitable for rehabilitation purposes and must be strictly avoided.

Longlands form Longlands form also has a soft plinthic horizon. The overlying horizons comprise of orthic A followed by an alluvial horizon. The latter is recognised by light grey or grey coloration, which is due to periodic saturation with water. The soft plinthic horizon below tends to be very wet and this is reflected in paler mottling (yellow and orange) than is the case with the plinthite in Avalon and Bainsvlei.

This horizon makes a poor rehabilitation material because it is subject to hardening and crusting when brought to the surface.

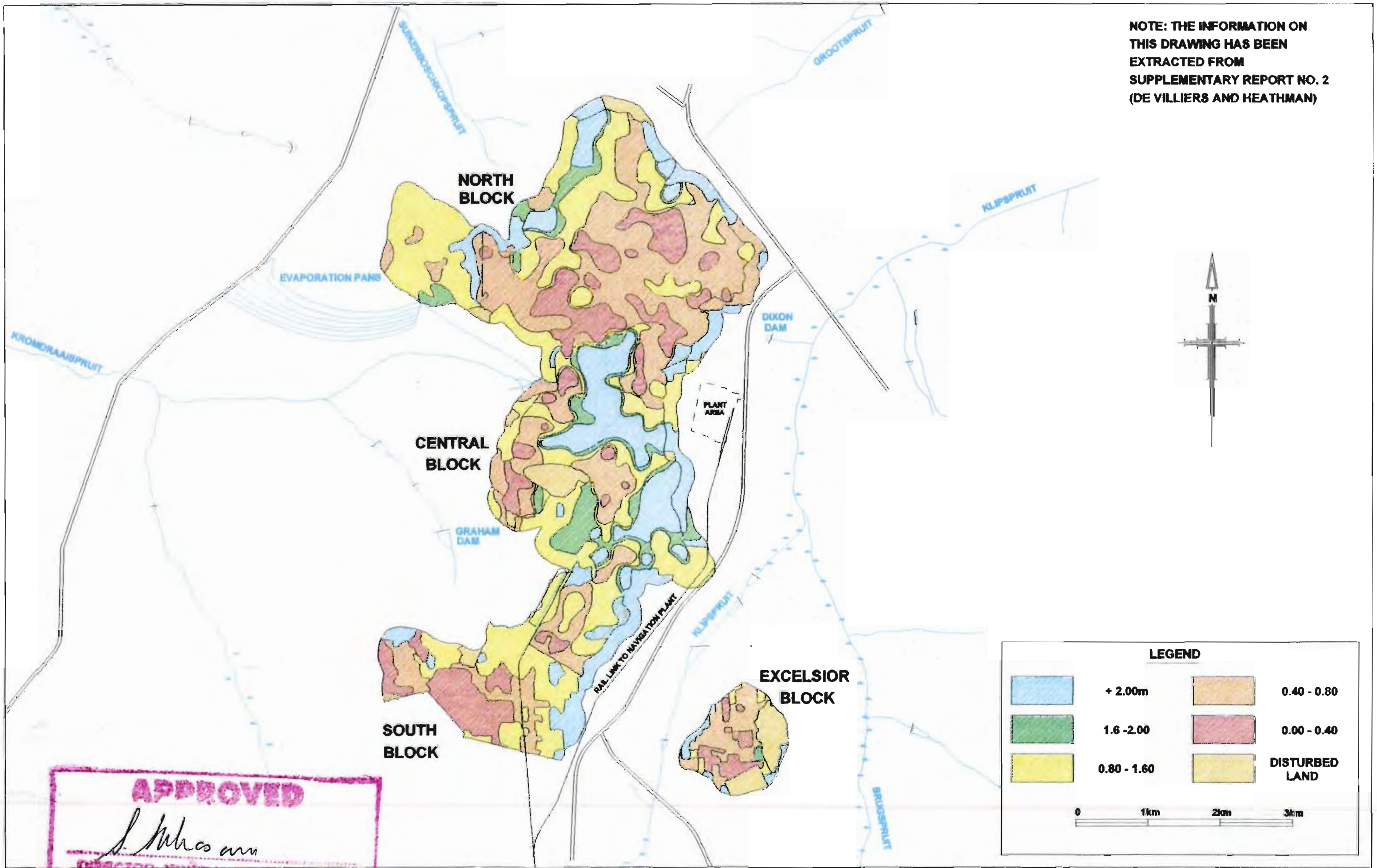

FIGURE 6.6 DEPTH OF USABLE SOIL

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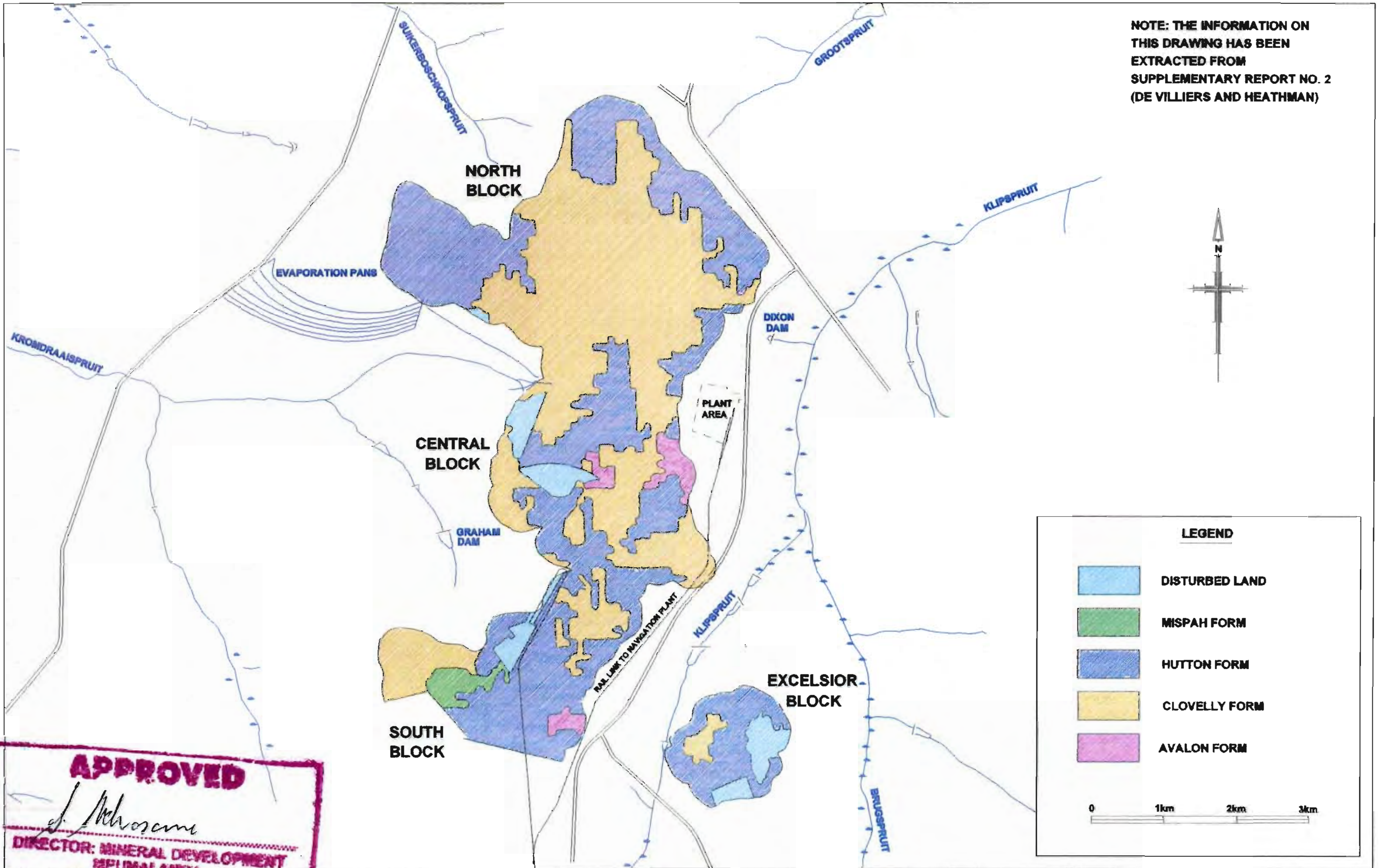

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FIGURE 6.7 PRE-MINING SOIL TYPES

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Glencoeform The horizon sequence defining this form is orthic A-horizon overlying yellow-brown apedal onto a hard plinthic horizon.

Hence it is like the Avalon form except that the plinthite has become hardened. The latter is obviously not suitable for rehabilitation purposes, but the overlying soft material is.

Mispah form these are shallow soils with a simple profile form comprising only an orthic A -horizon, which overlies fresh or partly weathered rock or occasionally hard plinthite. The material of the A-horizon is suitable as cover soil.

It is not normal practice to irrigate rehabilitated areas as planting of seed is carried out in the rainy season.

The fertiliser requirements will be determined by periodic routine analysis.

B. Navigation

Discard (consisting of stone and slimes) from the Navigation plant will be disposed of on a newly constructed dump on the Blaauwkrans property. Figure 6.8 shows the dump design.

Compaction will be carried out regularly and to specification to reduce permeability and to prevent spontaneous combustion. A topsoil bank to reduce visual impact in the short term and prevent run-off of contaminated water will surround the dump. Topsoil is currently being placed over the dump and the area revegetated. This will continue as the dump continues to grow. Trees have been planted around the base of the dump.

6.2.4 Land Capability

A. Kromdraai

The objectives of rehabilitation are to restore the land to close to its present potential by means of applying appropriate measures to the restoration of topography and the rehabilitation of topsoil, vegetation, habitat and wild life. These objectives will be complemented by positive impacts such as the reduction in the number of subsidences and the programmes to remove invading wattle and gum.

The aim will be to re-establish environmental systems, which will as far, as is practicable, be self-sustaining.

After grading of the topsoil, lime and fertiliser will be applied and seed sown by normal mechanised methods. In this regard suitable seed mixes normally in use on Anglo Coal collieries and which will be used in this instance are the result of numerous trials, experience and advice from specialist consultants. The fertiliser requirements will be determined by periodic routine analyses of the soil. An investigation has been in operation at Kleinkopje to irrigate rehabilitated ground

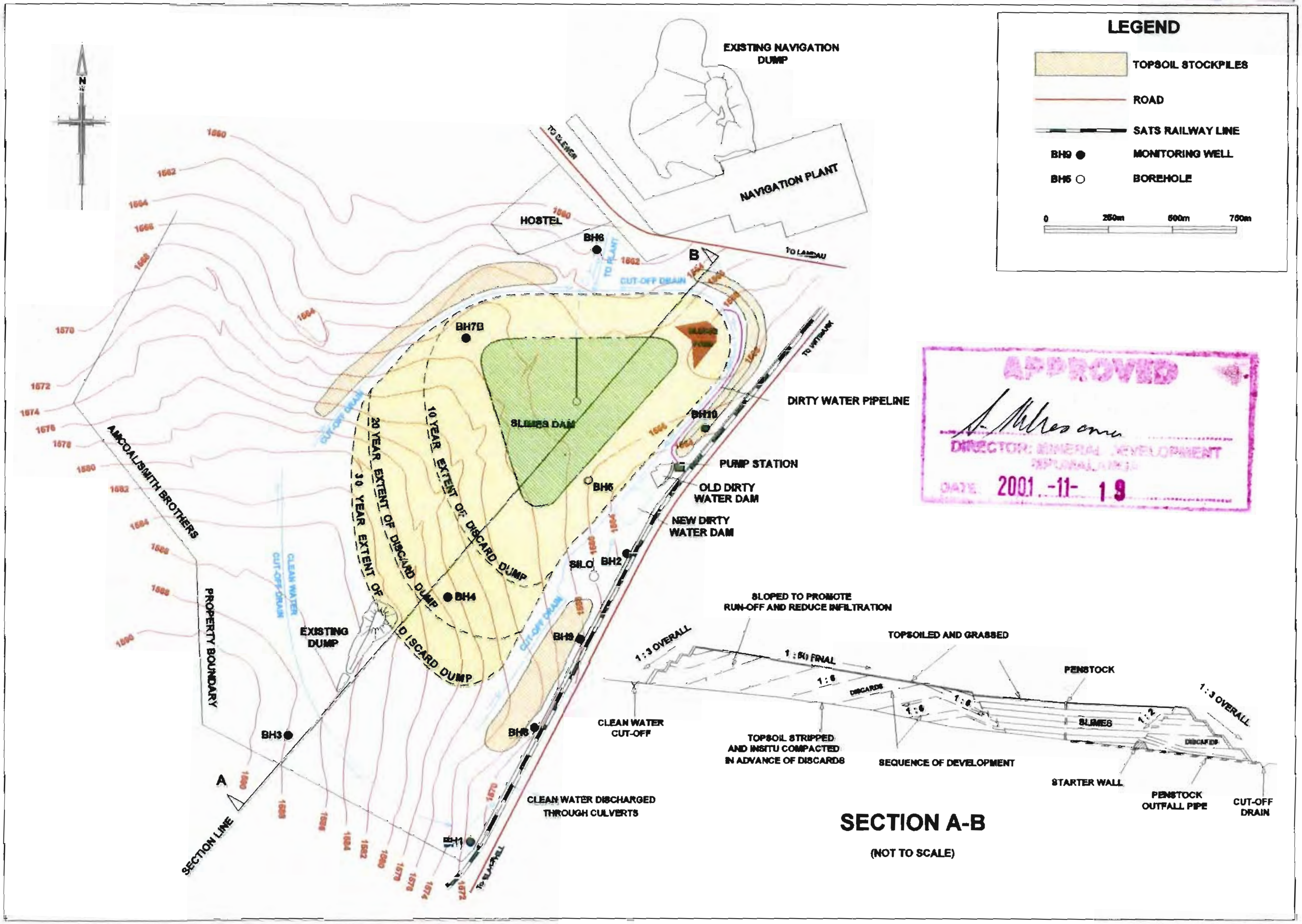

FIGURE 6.8 LAYOUT OF BLAAUWKRANS DUMP AND SLIMES DAM

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with polluted water. Findings from this investigation and from earlier trials at Kromdraai will be considered.

In summary, the aims of revegetation as stated in the Chamber of Mines guidelines and to which the mine commits itself are:

- to stabilise the soil and minimise erosion
- to prevent pollution of streams and air by particulate matter
- to re-establish nutrient recycling
- to ameliorate the effects of stockpiling the soils
- to maximise runoff into public water courses

Rehabilitation and farming techniques have been developed at all of Anglo Coal's operations to cope with a large variety of soil types, depths and vegetation. Anglo Coal is therefore well placed to guarantee a high standard of rehabilitation.

In his comments on the vegetation survey by Pieterse (Supplementary Report No.5), Professor Rethman (Supplementary Report No.6) stated :

- Off-mining sites have a basal cover of between 8% and 17%, with vigour ranging from 1,0 to 3,5 and composition varying from climax to both old and recent old land.

- Current productivity levels in terms of ha/MLU (hectare per mature live stock unit) would range from 1,5 to 5,0. The potential of excellent veld under these ecological conditions would be in the region of 1,5 ha/MLU.

In terms of pastoral product the rehabilitated areas will have the ability to produce at least as much excellent veld as existed before mining to maintain ecological stability even after the application of fertiliser has been terminated. The purpose of rehabilitation is not to improve the land capability beyond current levels, but rather to create stable, productive grazing land with minimum maintenance requirements

B. Navigation

The land occupied by the discard dump could be used to provide cattle fodder or mulch through regular mowing. Due to the slope angles it is considered inadvisable to allow grazing as animal hooves could damage the surface and promote erosion.

6.2.5 Land use

The land occupied by the Kromdraai and Navigation plants and railway line will be sterilised for agricultural and other purposes during the operational phase.

Some 240 hectares will be sterilised for agricultural and other purposes by the opencast mine. The areas ahead of and behind the mining operations will be utilised for grazing purposes.

The land use capability (as defined in the Chamber Guidelines) will be returned, as far as possible, to its present potential, which has been determined as:

	Present potential due to the presence of wattle and sinkholes	Future potential after removal of wattle and sinkholes
Arable	54,3	65,6
Grazing	20,1	24,8
Wilderness	25,6	10,6

During and after the mining operation the land will be put under pasture and utilised for grazing.

6.2.6 Natural Vegetation/Plant Life

After the soil has been prepared for planting, seed will be sown by normal mechanised methods (hand planting will be used occasionally for waterways and other specific sites).

The mix of seeds to be sown will be selected to suit the conditions prevailing at the site and on the season in which the pasture is planted. A number of standard seed mixes are used by Anglo Coal, which have been made up as the result of experience and advice from consultants.

The present mix is 2kg of Teff, 6kg of Smuts, 6kg of Rhodes and 2kg of Lucerne per hectare of rehabilitated land. Kikuyu/cynodon will be used in combination with the above on steeply sloping ground such as the Blaauwkrans discard dump.

Pasture performance, fertiliser requirements, the success of the seed mixes and other factors, which can affect growth, are monitored by the Land Rehabilitation Section of Anglo Coal Environmental Services. Soil sampling of the rehabilitated land is carried out prior to the application of fertiliser but the normal amount of fertiliser initially placed is 1 ton of 232 (3) + Zn, 3 tons of lime and 0,5 tons of super phosphate per hectare.

6.2.7 Animal Life

During the mining operation it is anticipated that a natural migration of animal and bird life onto the rehabilitated opencast areas will take place from adjoining areas.

6.2.8 Surface Water

Landau Colliery has adopted a five-point water management policy to ensure that surface water is effectively managed. The policy is as follows, and is applied sequentially :

- create an effective water balance

- maximise clean and dirty water separation
- minimise the import of raw/potable water
- maximise the reuse of polluted water, and
- treat polluted water

A series of cut-off trenches have been installed at Navigation and Kromdraai to ensure separation of clean and dirty water. Silt traps have been installed around the Blaauwkrans Co-Disposal Facility to ensure separation of clean and dirty water runoff from the dump. A new dam has been constructed at Blaauwkrans and the Navigation dam wall raised to cater for 1:50 year rainfall event on the Blaauwkrans dump.

Dams and collection points are used to collect acid water and treat the water in the respective liming plants. A capital application is currently in hand which addresses the collection of acid seeps and decants, as well as, decreasing the volume of water stored in the Kromdraai underground workings.

6.2.8.1 Managing the Water Balance

The following management practices have been implemented:

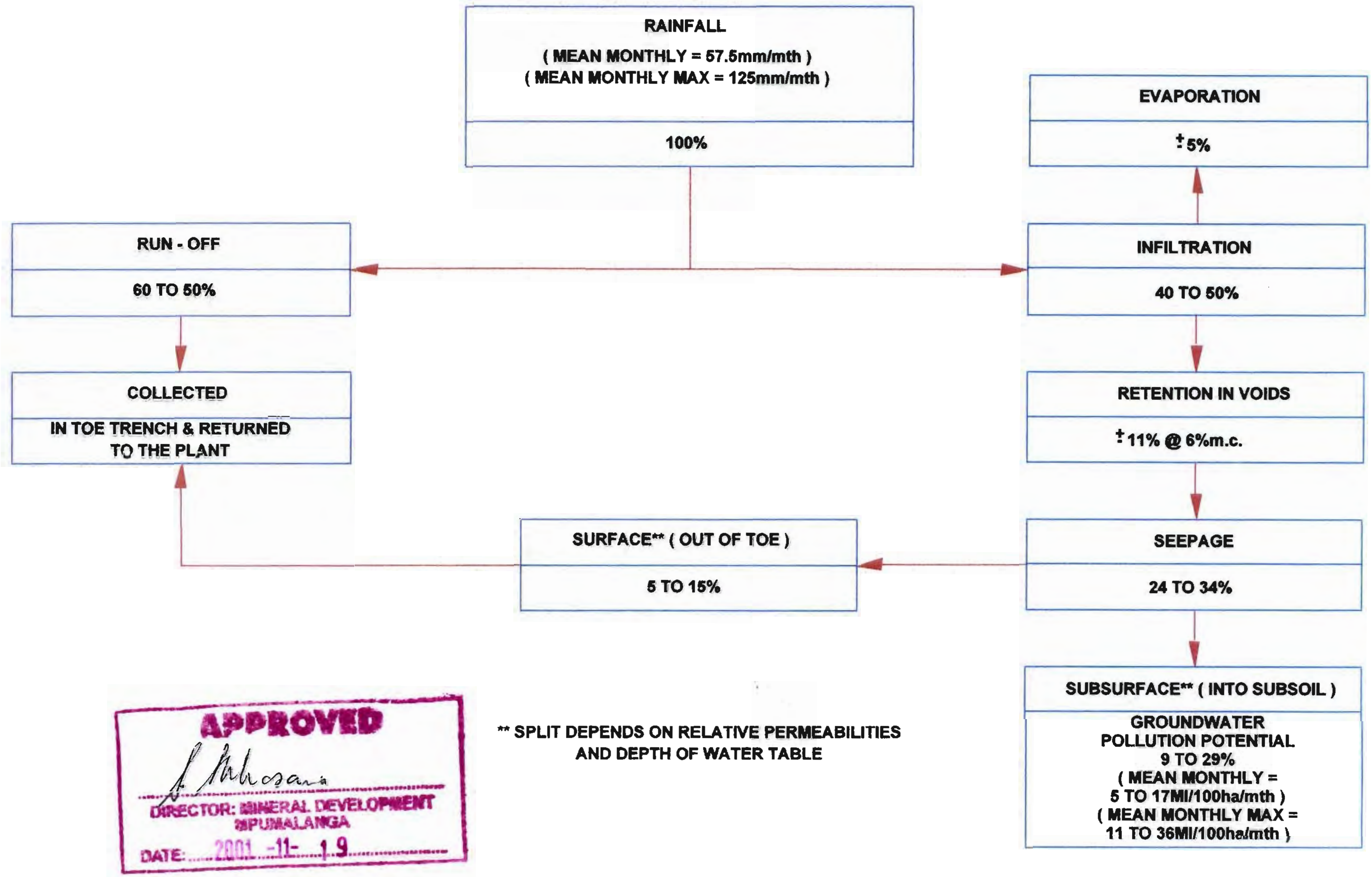
- Surface water monitoring is conducted at 52 sites on a daily, weekly or monthly basis. Analytical data is recorded on a Hydrocom database for management purposes. Various reports are issued daily, weekly, monthly and quarterly for control and monitoring of the water balance.

- Clean surface water is being directed away from the operational areas.

- Polluted water in the mining and plant areas is being contained and pumped to processing plants for use in the coal processing circuit. Figure 6.9 shows the Blaauwkrans dump water balance for the operational phase whilst Figure 6.10 is the anticipated water balance for the post-mining operational phase.

- At Kromdraai, excess neutralised water is discharged directly into the Kromdraaispruit (permission granted by Regional Director of DWAF in 1997).

- Studies on the role of wetlands to improve AMD quality have produced an initial report by D. Limpetlaw of Wits University (Supplementary Report No.25). A further investigation is currently underway by a further student from the University of the Witwatersrand and will be completed by the end of 1999.



** SPLIT DEPENDS ON RELATIVE PERMEABILITIES AND DEPTH OF WATER TABLE

FIGURE 6.9 - BLAAUWKRANS DUMP : WATER FLOW DIAGRAM FOR THE OPERATIONAL PHASE

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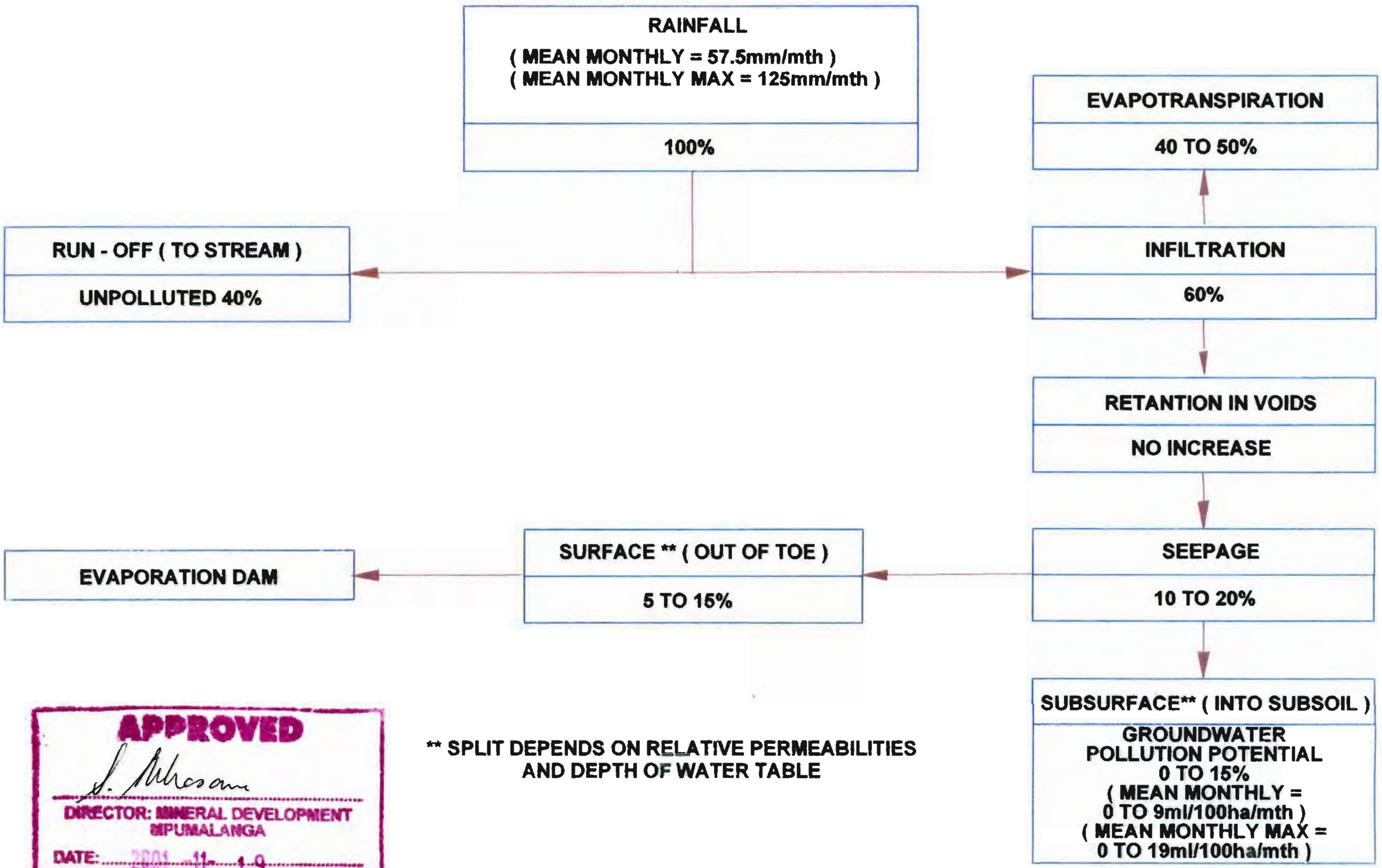

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FIGURE 6.10 - BLAAUWKRANS DUMP : WATER FLOW DIAGRAM FOR THE POST OPERATIONAL PHASE

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- The growing of trees around the mining area where seepage is a problem has been implemented. This promotes evapotranspiration. Figure 6.11 shows where the trees have been planted.

6.2.8.2 Stormwater

- The operational areas are protected by cut-off drains diverting unpolluted stormwater into the Klipspruit, Kromdraaispruit and Schoongezichtspruit.

- Unpolluted stormwater runoff from rehabilitated opencast mining areas will be directed into the Klipspruit, Kromdraaispruit and Schoongezichtspruit.

- Stormwater runoff from polluted areas has been minimised to collect the smallest volume of stormwater possible. This water will be collected and directed to the respective liming plants at Navigation and Kromdraai for treatment and reuse.

6.2.8.3 Surface rehabilitation

The rehabilitation standards will promote surface runoff with minimum or no erosion, enhance evapotranspiration and minimise infiltration.

6.2.8.4 Surface Water Users

Surface water users have been identified downstream as far as Loskop Dam (see Supplementary Report no.24). To ensure that surface water users are not affected by pollution generated by the mining operation both the Kromdraai and Navigation water networks are closed loop systems, i.e. pollution generated by the mining operations is contained within the mining area.

6.2.9 Ground water

A. Kromdraai Opencast

All ground water emanating from the underground workings and opencast operations will be collected and used as process water and for wetting down of haul roads. All excess water from the old underground workings not required for the above processes will be treated in the liming plant and released directly into the Kromdraaispruit in consultation with the Department of Water Affairs and Forestry. This will be an ongoing operation over the life of mine.

B. Navigation Plant and Blaauwkrans Discard Dump

All water from within the plant area is channelled to a pollution control dam from where it is pumped into the plant raw water dam, treated in the liming plant and used in the beneficiation process as shown on Figure 6.12.

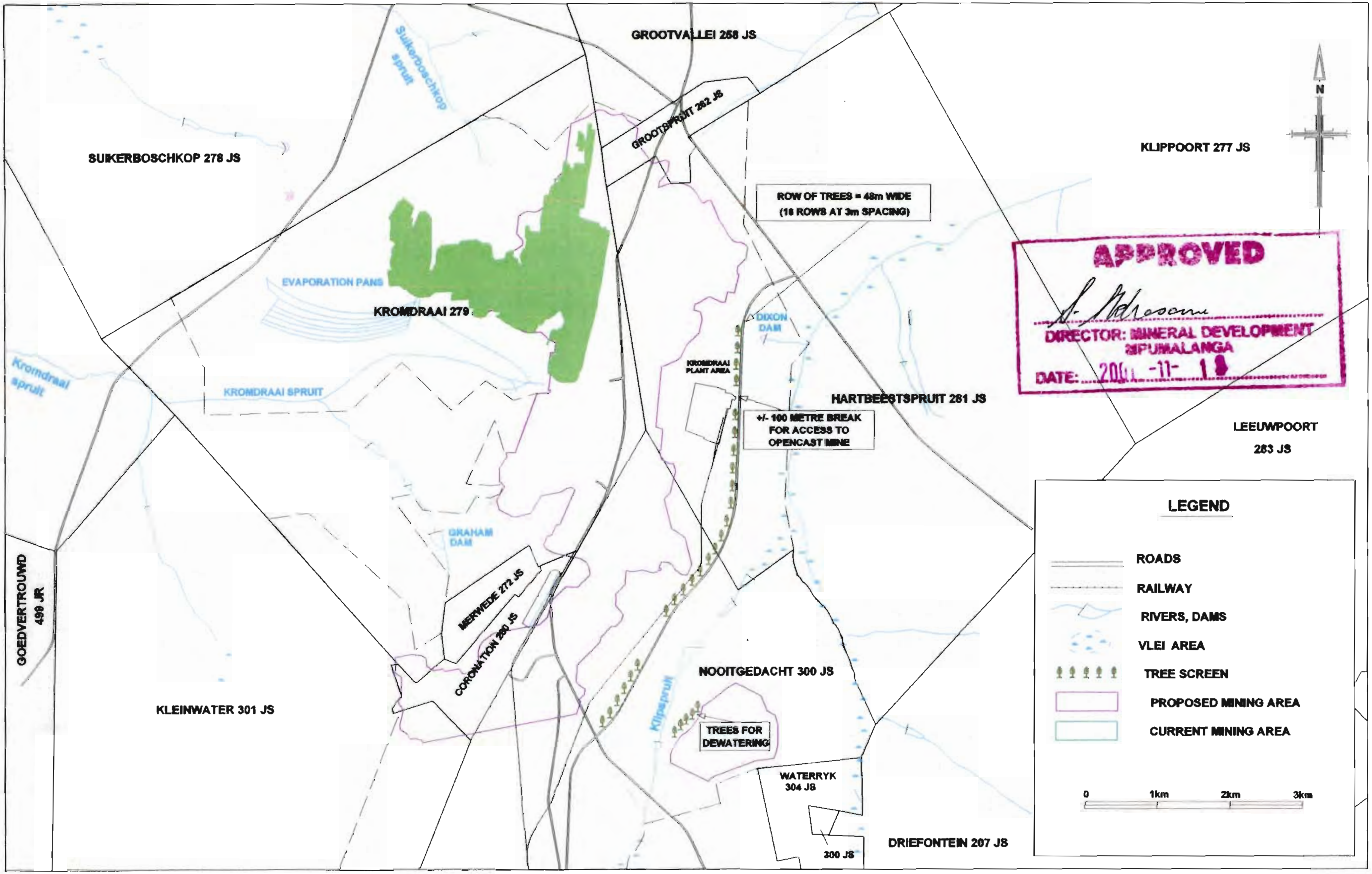

FIGURE 6.11 AFFORESTATION AT KROMDRAAI

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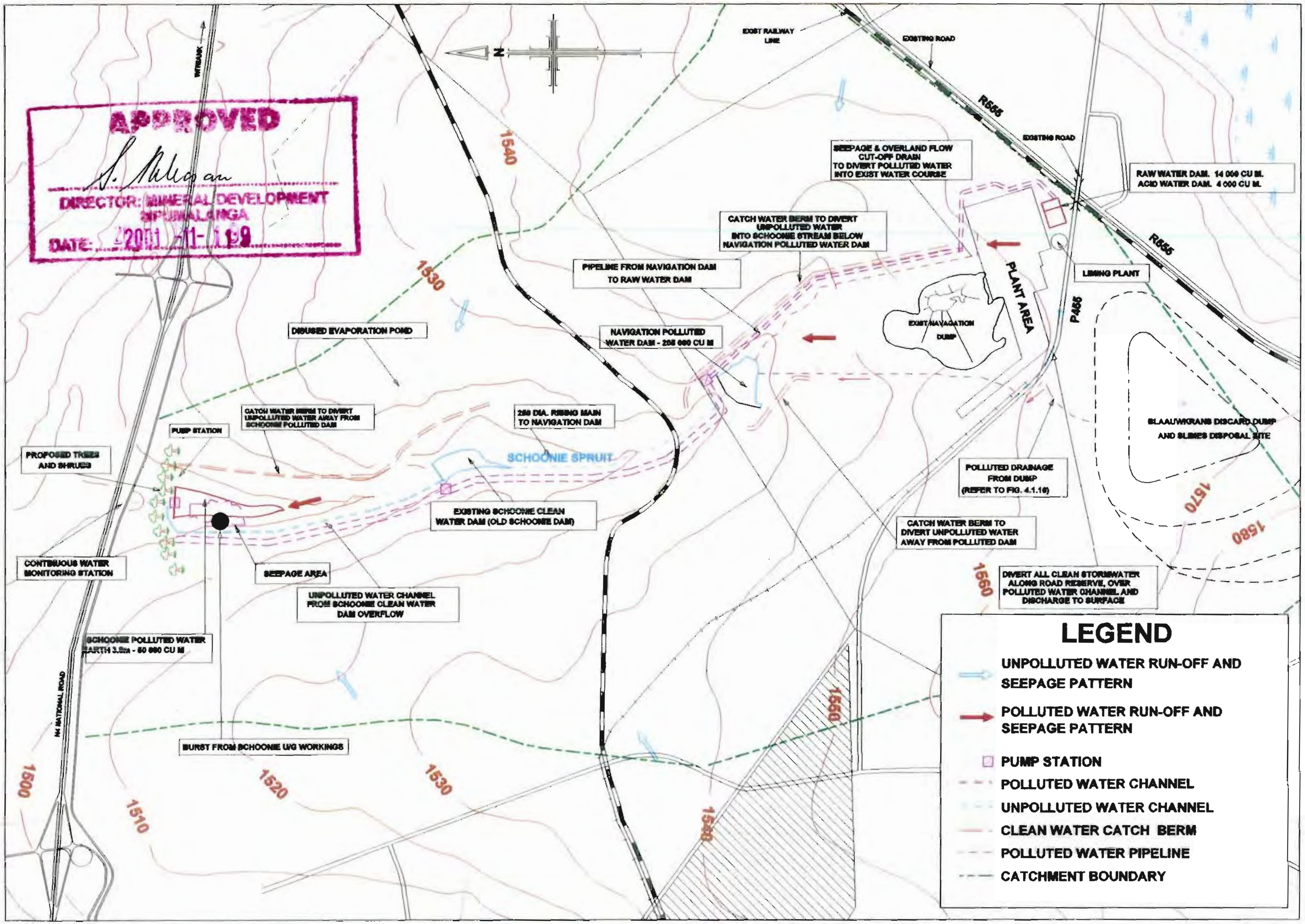

FIGURE 6.12 LAYOUT OF POLLUTION CONTROL SYSTEM IN SCHOONGEZICHT VALLEY

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Boreholes have been drilled around the Blaauwkrans dump to monitor ground water pollution emanating from the dump. Cut-off toe drains have been dug to catch the shallow ground water seep, which is pumped to the raw water dams. This water is treated in the liming plant and used in the process plant and for dust suppression purposes.

Polluted ground water arising from the dump will ultimately seep via the underground workings into the Schoongezichtspruit where it is contained in a pollution control dam and pumped to the liming plant for operational use.

6.2.9.1 Surface Rehabilitation

The planned standards for surface rehabilitation will reduce ingress of water into the spoils. The laying down, where applicable, of weathered overburden and subsoil's prior to the topsoil will reduce the ingress of rainwater.

6.2.9.2 Ground water users

The ground water monitoring programme has shown that ground water has been polluted and AMD is emanating from the old underground workings at Kromdraai and Navigation/Schoongezicht.

The effects of rehabilitation and water management referred to earlier in this section will be monitored by the ground water sampling programme. Currently about 80 boreholes are sampled for ground water and water in the underground workings on a monthly and quarterly basis.

The only ground water users are the Smith Brothers adjacent to Navigation. Seven boreholes are monitored on a monthly basis and the water quality is acceptable for irrigation and livestock drinking.

6.2.10 Air Quality

The air quality monitoring programme for Kromdraai and Navigation commenced in 1993 and the first and latest results are included with this report as Supplementary Report No.15(a).

Professor Annergarn of AER has made the following comments on air quality control during the operational phase.

Gaseous pollutants

Standard mining practice in the construction and maintenance of coal stockpiles and discard dumps will be adhered to for the life of the mine. These practices are designed to prevent spontaneous combustion both during operation and after closure. This will prevent emission of gaseous and particulate emissions from smouldering combustion.

Other than vehicle operations, normal processes on the mine do not generate gaseous emissions, so no specific further measures are deemed necessary.

Dust pollutants

Control of air pollution emissions from Landau Colliery will be based on the following objectives:

- to minimise emissions of suspended dust which may impact on residential areas adjacent to the mine;
- to minimise emissions of suspended dust contributing to the regional pollution load;
- to minimise emissions of settleable coal dust which may adversely affect crop quality;
- to minimise emissions of settleable coal dust which may contaminate runoff into streams and dams;
- to minimise fugitive emissions within plant areas which detract from the well being and efficiency of the work force.

The air pollution control plan for the mine will consist of the following steps:

a) Compilation of a qualitative inventory of major dust sources on the mine, including wind blown dust from stockpiles, dust generated by blasting, draglining, vehicle movements, spillage's, material handling and transport, and coal processing.

b) Documentation of all measures for control of air pollution emissions, and estimates of their efficiency.

c) Prioritisation of further control measures to control significant emissions identified in step a above.

d) A complaint register to record complaints from the public or staff concerning dust emissions and impacts has been implemented.

e) Implementation of a recording system to document, control and audit purposes, that the dust control plan is operating and being adhered to.

f) Meteorological Station

A continuous recording anemometer has been installed at the Kromdraai Opencast Mine. Wind data will be processed on a routine basis to produce wind roses and/or dust generation potential plots to assess potential impact areas of wind borne dust. Meteorological data will be stored for dispersion modelling purposes, should this be required at a later date. It is not considered necessary to perform detailed dispersion model calculations at this stage, as the active mining area for the first five-year plan is remote from residential areas.

g) Fallout Dust Monitoring

Routine monitoring of dust fallout was implemented in October 1992. A network of thirteen single bucket dust fallout monitors has been established. Siting took into account planned mining and benefication activities, and potential impact sites. Documentation of the sites and results will be recorded as part of the environmental records. Results are evaluated against the Department of National Health and Population Development Guideline values for dust fallout.

Twin bucket directional dustfall; monitors have been established at two sites, namely between the Navigation plant and Clewer Village, and at a local farmer, Smith residence opposite the Blaauwkrans discards dump. The directional samplers will assist in establishing any excessive dustfall exported from the mine sectors, and allow prompt remedial action to be taken.

Samplers within the network will be moved or supplemented as necessary with the further development of the mine.

Results measured to date have been included as Supplementary Report No. 15 (a).

6.2.11 Noise

Generally there is no problem with noise from the operational areas, but there have been isolated incidences of complaints due to noise form the mine. These incidences are taken seriously and reaction measures are implemented.

At both Navigation and Kromdraai there are Pollution Control Registers which record any complaints from interested and affected parties. The register records the date of the incident, the nature, which filed the incident and the action taken regarding that incident. Furthermore a weather station is used to monitor wind direction, wind speed, rainfall, etc. which will help to prevent any incidences that are likely to occur.

6.2.12 Sensitive Landscapes

No sensitive landscapes are affected by the mine's operations.

6.2.13 Visual Aspects

The tree planting programme shown in Figures 6.8 and 6. 11 have been implemented. To date some 75 000 trees have been planted; the visual impact identified will be reduced as these trees grow.

6.2.14 Regional Socio-economic Structure

The mine is in operation and the benefits to the region, as described in Section 3. 1, are apparent.

6.2.15 Interested and Affected Parties

Liaison has been established with statutory bodies as well as with neighbours to handle any problems that may occur. To date this form of communication has proved successful and it remains Anglo Coal's policy to continue with this approach.

Meetings have been held with the following:

- Bulpan Brickwork's on blast vibrations and ground water.

- Mr. Manson on ground water, dust and blast vibrations.

- Smith Brothers on water, dust and noise.

- Mr. van Heerden on ground water.

- Open days for farmers have been held at the mine to expose farmers to opencast mining operations, rehabilitation of mined out areas, noise, dust and water monitoring.

- Zaalklapspruit and Brugspruit Forums meetings are held regularly and Landau Colliery is an active participant in these meetings.

6.2.16 Submission of Information

Information on measurements, taken to comply with statutory requirements, will be submitted as requested by the Department of Mineral and Energy.

Details of the measurements to be taken and submitted will be finalised following discussions held with the relevant departments.

An environmental audit report will be generated every three years by Anglo Coal Environmental Services and will be submitted to the Department of Mineral and Energy for onward transmission to the other affected government departments.

The mine undertakes to submit results (with time related trends based on pre-mining data) of the following monitoring programmes in the environmental audit reports.

- Dust
  - Single bucket sampling
  - Twin bucket directional sampling
  - Personnel gravimetric sampling

- Surface Water - Kromdraai

- Navigation
- Downstream water users

- Ground water
  - Kromdraai
  - Navigation

- Continuous surface water monitoring
  - Kromdraaispruit
  - Schoongezichtspruit

- Spontaneous combustion monitoring
  - Kromdraai
  - Navigation
  - RLT Silo

- Blaauwkrans dump discard disposal management and revegetation
- Tree planting programme
- Rehabilitation of mined out opencast areas.
- Land utilisation pre- and post-mining
- Air and ground vibrations from blasting.
- Subsidence monitoring along railway line, overland conveyor routes and haul roads.
- Weather monitoring at Kromdraai and Navigation

6.2.17 Maintenance

Anglo Coal undertakes to maintain the monitoring equipment during the operational period if the readings remain useful to the relevant authorities and contribute towards the environmental management programme.

The following monitoring programmes will be maintained:

Impact	Frequency of Monitoring
Dust	Continuous
Water	Three-monthly in 80 boreholes and 52 surface points.
Spontaneous Combustion	Continuously through use of CO gas monitors on machinery working in the coal face, as well as, visual inspections.
Blast vibration and Noise	when blasts take place which could impact on neighbours
Rehabilitation	Regular field audits culminating in bi-annual audits

Subsidence	Annual
Weather	Continuously

Anglo Coal undertakes to maintain infrastructure established for environmental protection listed below :

Dust	Watering of haul roads, dust suppression in the tip area and coal processing plant and blast control
Stormwater	Flood protection dams and levees.
Polluted surface water	Kromdraai – evaporation pans and Navigation-Schoongezicht valley pollution control shown in Figure 6.12.
Rehabilitation	Monitoring practices as described in Section 6.2

6.3 Decommissioning Phase and Closure

6.3.1 Closure Objectives

The objective on closure is to demolish all structures that cannot be usefully employed and to rehabilitate the land and return it to at least 90% of its pre-mining land capability. The objective for water treatment is to implement a water treatment system for seepage from mined out areas which will introduce treated water into public streams at an acceptable quality for use of downstream consumers.

Objective details are:

- *Surface Water:*	All unpolluted surface water will be directed into public streams. All polluted surface water will be treated in the respective liming plants at Navigation and Kromdraai.
- *Ground water:*	Affected ground water will be collected, treated and released into public streams.
- *Land use:*	The land will be returned to agriculture and used for grazing purposes.
-*Noise:*	Noise from mining operations will be minimised
-*Dust:*	Dust from mining operations will be minimised
-*Visual:*	Visual impacts will be reduced by land rehabilitation, tree planting and dismantling of surface structures.

6.3.2 Closure Planning for Kromdraai Opencast

6.3.2.1 Overview

Provision will be made to achieve the following objectives:

- The closure of final voids and levelling including topsoiling and revegetation.
- The demolition of concrete structures, transportation of rubble and levelling of the ROM tip area, workshops areas and haulroads.
- Removal of the Kromdraai-Navigation railway line and stabilising of the affected area.
- Rehabilitation and seeding of all plant areas referred to above.
- Maintenance of rehabilitated lands until they can be released for agricultural use.

Closure costs to achieve the above objectives are discussed in more detail below.

6.3.2.2 Closure of Final Voids and Levelling of Spoil Piles Backlog

The area of final voids is estimated to be 19 hectares.

The final spoil piles are estimated to be 40 hectares and the filling and levelling will be carried out by dragline and shovel and trucks.

6.3.2.3 Demolition of Concrete Structures, Transportation of Rubble and Levelling of the ROM Tip Area and Workshop Areas

The only major concrete structures, which will need to be demolished prior to levelling, are the silos and tip structures. The volume of concrete involved is 13 500 m^3 which will be transported to the final void and be covered over with spoils.

The volume of recoverable steel is estimated at 2 000 tons.

The total area occupied by the tip, plant, offices and workshops amounts to 60 hectares. It is planned to use a track dozer to demolish the smaller buildings, break up concrete structures and level the area. This area amounts to 25 hectares.

6.3.2.4 Removal of the Railway Line from Kromdraai to Navigation and Levelling of the Affected Area

The railway line from Kromdraai to Navigation is 28,0 km long and the following materials are recoverable:

- 2 688 tons of rail, 33 600 m^3 of ballast and 37 000 sleepers.

6.3.2.5 Rehabilitation and Seeding

A summary of the areas is provided in Table 6.3. 1.

TABLE 6.3.1 – Areas to be Rehabilitated and Seeded : Kromdraai

DESCRIPTION	AREA (ha)
Final Voids	19.0
Spoil pile backlog	40.0
ROM tip/offices/workshops area	60.0
Haul roads (7km @ 30 m width)	21.0
Railway line (23,5km @ 10m width)	28.0
TOTAL	**148.0**

6.3.2.6 Maintenance of Rehabilitated Lands Prior to Release for Agricultural Use

It is planned to release all rehabilitated lands within 3 years of the closure of the mine. However, during the three year post-closure period these areas will be maintained by way of controlled grazing, fertilising or other appropriate and necessary means.

Provision is made in the Pollution Control Fund (see Section 6.5) to cover the cost of this maintenance.

During mining operations topsoiling and seeding will take place within 3 to 5 spoil pile lines of the mining cut. Under normal rainfall conditions the revegetated areas may be released for grazing two years after planting.

6.3.2.7 Water Management

It is assumed that acid water will decant from the mining area for a considerable period after mining operations cease.

In order to provide sufficient money in the Pollution Control Fund for water care works after closure, the equivalent capital and working costs have been calculated for a 14 Ml /day lime treatment plant operating to treat acid water which may occur. (See Table 6.3.2).

Presently, no definitive solutions have been formulated for the long-term treatment of acid mine drainage after closure. Anglo Coal has embarked on investigations into various methods for the neutralisation and desalination of acid mine drainage such as the use of crushed dolomite, activated sewage sludge treatment, ion exchange resins, lime neutralisation, biological sulphate removal treatment processes and the use of wetlands. Based on the outcome of these investigations and applying the BATNEEC principle, a water treatment programme will be formulated in conjunction with the Department of Water Affairs and Forestry.

A summary of provisions showing present-day costs per unit is presented in Table 6.3.2.

TABLE 6.3.2 – Cost of Closure – Kromdraai (December 1997 values)

Paragraph	Description	Unit	Quantity	Cost per Unit	Cost (R)	Total Cost
6.3.2.2	Levelling of Final Voids Levelling of Spoil Pile Backlog	Ha Ha	19 40	99 173 88 996	1 884 288 3 559 846	**5 444 135**
6.3.2.3	Demolition Work – ROM Tip Area Scrap Value of Steel Rubble Transportation Dozing of Foundations	M^3 Tonne M^3 Ha	13 500 2 000 13 500 25	29 (90) 15 61 269	391 500 (180 000) 202 500 1 531 731	**1 945 731**
6.3.2.4	Removal of Railway Line Scrap Value of Material	Km Km	28 28	8 140 (42 722)	227 920 (1 196 219)	**(968 299)**
6.3.2.5	Topsoiling Seeding	Ha Ha	148 148	45 277 539	6 700 985 671 772	**7 372 757**
6.3.2.6	Maintenance of Rehabilitated Lands Labour for Maintenance	Ha Years	825 5	1 267 151 615	1 045 275 758 077	**1 803 352**
6.3.2.7	Operation of Liming Plant Establishment of 45 Hectares of Wetland Maintenance of Wetland Construction of Evaporation Pan Maintenance of Pipeline Power Cost for Pump System	Years Ha Ha Ha Metres Years	20 45 45 1.25 12 000 20	748 938 36 969 6 854 11 423 37 123 015	14 978 769 1 663 615 308 423 14 279 438 462 2 460 308	**19 863 856**
KROMDRAAI TOTAL						**35 461 530**

6.3.3 Closure Planning for Navigation

6.3.3.1 <u>Overview</u>

Provision will be required to achieve the following objectives:

- Demolition of all plant structures, levelling and rehabilitation of the sites.
- Rehabilitating old coal dumps in the vicinity of Navigation.
- Seeding of all areas referred to above.
- Water management.
- Maintenance of rehabilitated lands until they can be released for agricultural or other use.

The rehabilitation of the following dumps from previous operations which have not been rehabilitated have been considered in this provision.

Schoongezicht I, II and III (included in the mining of Schoongezicht 2 and 4 Seam)
Anglo French (incorporated in the Blaauwkrans Dump)
Navigation

It has been assumed that dumps containing coal of economic value (i.e. those which can be beneficiated to produce a saleable coal) will have been reprocessed and the areas on which they stand rehabilitated. Dumps of no economic value will be profiled, topsoiled and vegetated. Ground water emanating from the dumps will be collected and pumped to a water treatment plant.

The Anglo French dump has not been included in this provision as it will form part of the new discard dump at Navigation.

6.3.3.2 Demolition of Plant Structures

The only major concrete structures which will need to be demolished prior to levelling are the DMS feed bins, discard silo and RLT silo. The volume of concrete involved is approximately 26 500m^3. Rubble from these structures will be transported to the final voids of the Schoongezicht mine.

The volume of recoverable steel is estimated at 5 000 tons.

6.3.3.3 Rehabilitation of Land Occupied by Discard and RLT Conveyors

The total length of the conveyors is 7.2 km and the recoverable steel content is 20 kg per metre i.e. 144 tons of steel. The areas over which the, conveyors run will be levelled and rehabilitated.

6.3.3.4 Rehabilitation of Uneconomic Coal Dumps in the Vicinity of Navigation

As a result of their poor economic value, the following Schoongezicht III dump (7.0 Ha) will not be processed through the Navigation Plant but will be dealt with in a manner agreed to by the authorities.

6.3.3.5 General Rehabilitation and Seeding of Dumps

The area of uneconomic dumps and re-processed dumps is as follows:

	Area
Schoongezicht I	10.5
Schoongezicht II	9.0
Schoongezicht III	7.0
Anglo French	6.0
Navigation	18.4
Schoongezicht 2 Upper	16.3
TOTAL	67.2 ha

A summary of the total areas to be rehabilitated and seeded is presented in Table 6.3.3.

Table 6.3.3 - Areas to be Rehabilitated and Seeded : Navigation

Description	Area (Ha)
Plant Area	30.0
Conveyor Routes	7.2
Dumps	67.2
TOTAL	**104.4**

6.3.3.6 <u>Maintenance of Rehabilitated Lands Prior to Release for Agricultural Use</u>

The maintenance programme to be followed at Navigation will be similar to that for Kromdraai.

6.3.3.7 <u>Water Management</u>

It is assumed that acid water will drain out of the Schoongezicht underground workings adjacent to the Schoongezicht pollution control dam for a considerable period after mining operations cease.

In order to provide sufficient money in the Pollution Control Fund for water care works after closure, the equivalent capital and working costs of a lime treatment plant operating for 20 years have been calculated.

Presently, no definitive solutions have been formulated for the long-term treatment of acid mine drainage after closure. Anglo Coal has embarked on investigations into various methods for the neutralisation and desalination of acid mine drainage such as the use of crushed dolomite, activated sewage sludge treatment, ion exchange resins, lime neutralisation, biological sulphate removal treatment processes and the use of wetlands. Based on the outcome of these investigations and applying the BATNEEC principle, a water treatment programme will be formulated in conjunction with the Department of Water Affairs and Forestry.

A summary of provisions showing current costs per unit is shown in Table 6.3.4.

TABLE 6.3.4 – Cost of Closure – Navigation (December 1997 values)

Paragraph	Description	Unit	Quantity	Cost Per Unit	Cost (R)	Total Cost
6.3.3.2	Demolition – Plant Area Scrap Value of Steel Rubble Transportation Dozing of Foundations	M^3 ton M^3 Ha	26 500 5 000 26 500 30	26 (90) 15 60 854	689 000 (450 000) 397 500 1 825 615	2 462 115
6.3.3.3	Levelling of Conveyor Routes Scrap Value of Steel	Km Ton	7.20 144	5 409 (76)	55 440 (12 960)	42 480
6.3.3.4	Rehabilitation of Non-Economic Coal Dumps	Ha CU.M	67.20 2 480 779	38 500 1.15	2 587 200 2 852 896	5 440 096
6.3.3.5	Topsoiling Seeding	Ha Ha	37.20 37.20	16 669 2 164	1 099 967 168 851	1 268 818
6.3.3.6	Maintenance of Rehabilitated Lands Labour for Maintenance	Ha Years	235 5	1 267 24 051	297 745 120 255	418 000
6.3.3.7	Operation of Liming Plant Power Cost for Pump System Maintenance of Pipeline	Years Years Metres	20 20 4 000	1 002 115 74 458 37.08	20 042 308 1 489 154 148 308	21 679 769
NAVIGATION TOTAL						**66 772 808**

6.4 Proposed Timetable, Duration and Sequence

6.4.1 Prospecting Project

Not Applicable.

6.4.2 Mining Project

6.4.2.1 <u>Submission of EMPR and Application for Mining Authorisation</u>

A temporary mining authorisation has been granted.

6.4.2.2 <u>Construction Period</u>

Not applicable.

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6.4.2.3 Duration of Mining Activities

A. Kromdraai

Mining commenced in 1989 as a mini-pit operation, which was upgraded to a dragline opencast operation in 1992. The opencast mine reached full output in 1995. It is forecast that the economic coal reserves at Kromdraai will be depleted by approximately 2020 when mining operations could relocate to the Schoongezicht/Navigation reserve area.

B. Navigation

The Navigation plant commenced operation in 1992. Closure of the plant will depend upon the economic climate and whether or not the mining operation relocates to the Schoongezicht/Navigation reserve area.

Should the Navigation reserves be utilised it is estimated that some 20 years of reserves remain based on present day economics.

6.4.2.4 Rehabilitation Programme

A. Kromdraai

After cessation of mining the rehabilitation programme will take some 3 years. The first two years will involve demolishing buildings, structures, filling and profiling of the final void, clean up, and topsoiling and seeding of disturbed areas.

The last year will entail maintenance of the areas to ensure that the vegetation is established.

B. Navigation

After cessation of processing coal a similar 3-year programme will be followed as for Kromdraai.

The discard dump will be shaped into its final profile, topsoiled and seeded. A three-year maintenance programme will be carried out on the dump to ensure that adequate vegetation cover is in place and that all watercourses are properly constructed.

6.4.2.5 Dates for Closure

A. Kromdraai

Based on the above programme closure of Kromdraai is anticipated in 2023.

A. Navigation

No closure date can be forecast for the plant and dump due to the possibility of relocating the mining operations to the Schoongezicht/Navigation reserves.

6.4.2.6 Decommissioning and After-care Programme

The after-care programme for water management has still to be defined and will depend upon results of test work being carried out on treatment of acid mine drainage as well as passive water treatment systems. The after-care water management programme will run through to approximately the year 2040.

Rehabilitated surfaces will be cared for by regular cropping of grasses and fertilisation until these have become established to the point of being self-sustaining. Areas of localised subsidence in the opencast mining area will be filled and sloped to conform to the required drainage pattern.

6.4.2.7 Date for Closure Application

The anticipated date for closure application will be 2023.

6.5 Financial Provision

The particulars for Anglo Coal's provision to implement the measures described in Part 6 have been lodged with the Regional Director – Mpumalanga and form part of the application for Mining Authorisation.

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PART 7: CONCLUSION

The management of Anglo Coal is committed to an integrated environmental management programme. Responsibility is delegated to mine management, which is involved in the evaluation of environmental impacts and the implementation of the management programmes. Adequate funds are provided over the life of the mine to ameliorate negative impacts both during operation and after closure.

Key aspects of the management approach of Anglo Coal as defined in this report include:

- Effective communication with government agencies and affected parties.
- Professionally designed environmental control measures, which may involve the services of specialists.
- Compliance with legal requirements based on BATNEEC as defined in this report.
- Compliance audits conducted on a regular basis.
- Monitoring of the implementation of the environmental programme.

A constituted pollution control fund was established in August 1977 by Anglo Coal, for each of its operations. The fund will ensure that adequate funds are available in terms of Section 9(5) e of the Minerals Act for closure. The contributions made to this fund are reviewed annually to ensure that sufficient funds are provided to meet the standards agreed to in the EMPR.

The mine will impact on the environment during the operational phase. This must be weighed up against the socio-economic benefits to the area and the country as a whole.

After closure the impact will be eliminated with the buildings and structures removed, the land rehabilitated and returned to agriculture. Sinkholes associated with the previous underground mining, as well as invasive trees, will have been removed and the land stabilised over previously underground mined areas.

Ground water emanating from the opencast discard and mine dump will have a long-term impact on the downstream users. The results of research work being conducted on AMD and various water treatment systems will provide guidance on how these waters should be handled to reduce the impact on downstream users.

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PART 8: STATUTORY REQUIREMENTS

The contents and commitments of the EMPR have been linked to the legislative requirements of the following Acts :

- National Water Act of 1998
- National Water Act of 1956 (where still applicable)
- Water Services Act
- National Environmental Management Act of 1998
- Environment Conservation Act of 1989
- Minerals Act of 1991
- as well as, relevant current and draft regulations under these statutes.

The following lists the permissions granted concerning the environment.

- Notification of expansion of operations
- Temporary mining authorisation permits
- Building of Blaauwkrans discard dump

The following are a list of permits that have been granted or applied for :

- Section 12	- Water use for industrial purposes
- Section 12 A	- Water care works
- Section 12 B	- Water use
- Section 21	- Sewage works

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PART 9: AMENDMENTS TO THE EMPR

9.1 Hayford Siding

Due to changes in the market for Landau Colliery coal, construction work was completed during 1994 to upgrade the Hayford Railway Siding at Clewer. This enables Landau to distribute inland coal via rail to the South African local market (limited amounts of coal will still be transported by road to local customers).

9.2 Navigation Liming Plant

Since writing this EMPR the mine has identified the need to increase the buffering potential of the raw water feed to the Navigation Plant. The Navigation liming plant was recently upgraded from 3.5 Ml/day to a maximum capacity of 8.0 Ml/day. This was done to cater for the increased volume of acid water that requires neutralisation before being used as raw water for the Navigation Plant.

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PART 10: REFERENCES AND SUPPORTING DOCUMENTATION

The following supplementary reports are provided under separate cover.

LIST OF SUPPLEMENTARY REPORTS

1. Rehabilitation Report for Kromdraai and Navigation. (December 1991)

2. de Villiers, Professor JM and Heathman, WZ (November 1991): Pre-Mining Soil Inventory and Land Capability Assessment of Kromdraai Surface Mining Rights in the Witbank Area of Transvaal.

3. van der Watt, Dr HVH and Claassens, Dr AS (November 1991): Soil Survey and Land Capability Assessment of Area for Coal Discards: Blaauwkrans Extension, Landau Project.

4. Loxton, Venn and Associates (September 1992): Building and Ground water Survey.

5. Pieterse, PA (December 1991): Report on Pre-Mining (Vegetation) Survey - Kromdraai and Excelsior

6. Rethman, Professor NFG (December 1991): Comment on Pre-Mining Vegetation Survey Conducted by Mr PA Pieterse at Kromdraai and Excelsior in December 1991.

7. van Hoven, Professor W (September 1991): The Fauna of Kromdraai and Navigation Mining Areas.

8. Stewart & Scott Incorporated (September 1992): (a) Modelling the Surface Water Balance of Kromdraai Opencast Mining Area, and (b) Modelling the Surface Water Balance of Navigation Plant and Discard Area.

9. Wates, Meiring & Barnard (February 1992): Conceptual Water Management Plan for the Olifants River Catchment.

10. Hodgson, Professor FDI (October 1992): Report on Surface Water Quality at Kromdraai Colliery.

10(a) Water Analyses at Kromdraai and Navigation. (Sampling by SACE Environmental Officer)

11. Application for Rationalisation of SACE Water Permits (January 1991), including Report CED 013/91 and correspondence.

12. Wates, Meiring & Barnard (October 1991): Review of Proposed Water Management and Water Balances.

13. Hodgson, Professor FDI (June 1992): Preliminary Investigations into the Impact on Ground water by Mining and Associated Activities of the Landau Replacement Project.

14. Blaauwkrans Dump - Borehole Monitoring Report.

15. Annegarn Environmental Research (Pty) Ltd (March 1992): Notes on a Dust Monitoring Report and Control Programme for the Landau Replacement Project.

15(a) Annegarn Environmental Research (Pty) Ltd. (December 1998): Results of Dust Monitoring Programme at Landau Colliery.

16. Meij, GV (April 1992): Sound Impact, Preliminary Class 3 Study - Landau Replacement Project.

17. van Vollenhoven, AC (April 1992): Identification Survey of Historical Sites.

18. Akermann, KA (November 199 l): Hazard Rating for Dragline Operations - Kromdraai Opencast.

19. University of the Witwatersrand (March 1991): EHAC Test Report.

20. Permit application for Blaauwkrans Dump and Design Report - AAC Civil Engineering Dept. (November 1991) (Revised January 1992): Conceptual Design Report for Proposed Blaauwkrans Discards and Slimes Disposal Facility.

21. Hodgson, Professor FDI (April 1992): Placement of Rotary Breaker Discards into the Pit at Kromdraai Colliery.

22. Hodgson, Professor FDI (January 1992): Acid-Base Potential and Associated long-term Water Quality for Kromdraai Colliery.

23. Blaauwkrans Slimes and Discards Disposal Facility Operating Manual.

24. Clean Stream Environmental Services (April 1999): Surface Water User Survey on the Brugspruit, Klipspruit, Kromdraaispruit and Saalboomspruit

25. Limpetlaw (1995): The Assimilative Capacity of the Kromdraaispruit Wetland

26. Preliminary EMPR for the Schoongezicht No.2 Seam Minipit

27. Preliminary EMPR for the Schoongezicht No.4 Seam Minipit

PART 11 : CONFIDENTIAL MATERIAL

No confidential material is submitted with this report.

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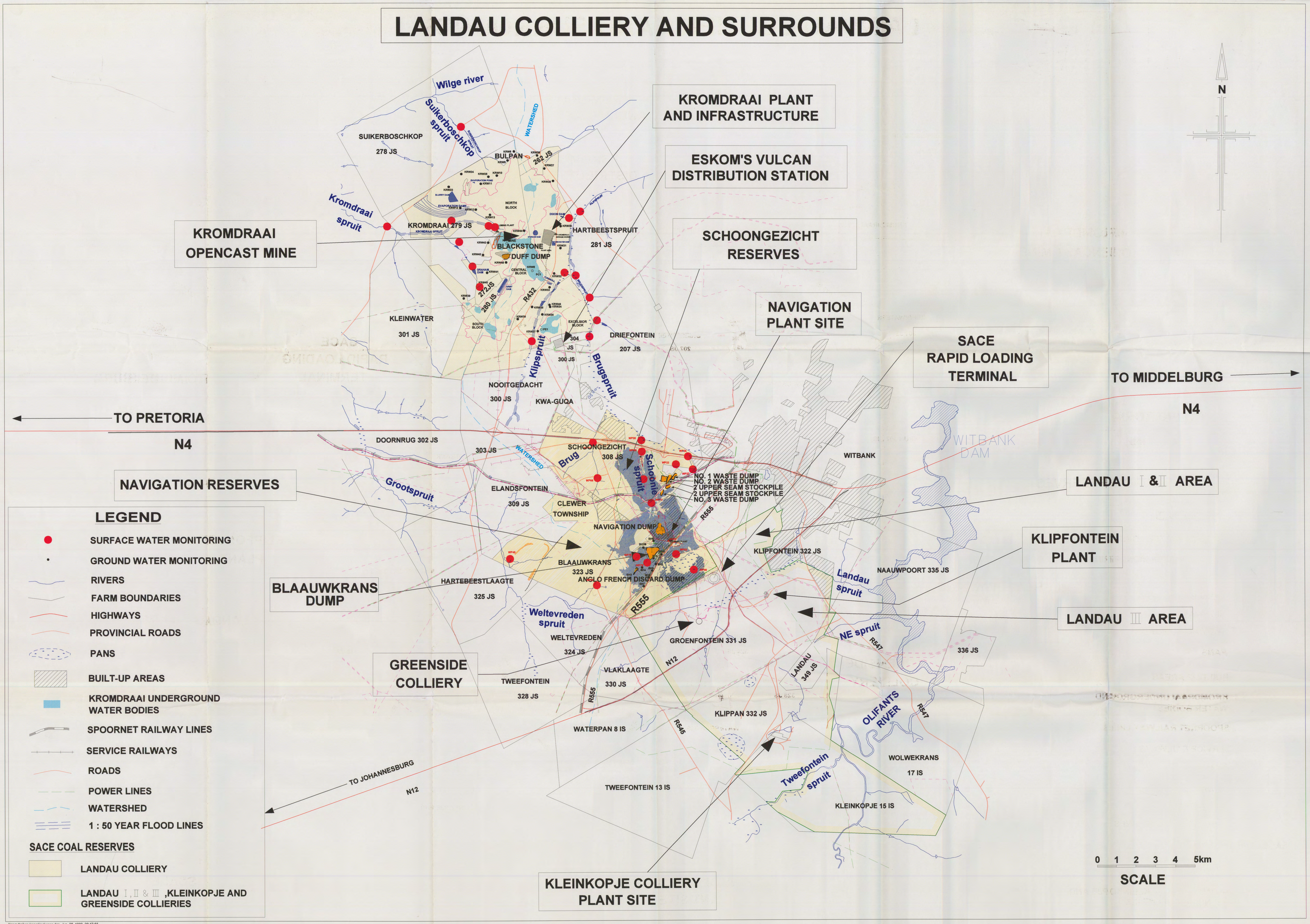
LANDAU COLLIERY AND SURROUNDS
KROMDRAAI PLANT AND INFRASTRUCTURE
ESKOM'S VULCAN DISTRIBUTION STATION
SCHOONGEZICHT RESERVES
NAVIGATION PLANT SITE
SACE RAPID LOADING TERMINAL
KROMDRAAI OPENCAST MINE
NAVIGATION RESERVES
LANDAU I & II AREA
KLIPFONTEIN PLANT
LANDAU III AREA
BLAAUWKRANS DUMP
GREENSIDE COLLIERY
KLEINKOPJE COLLIERY PLANT SITE
TO PRETORIA
N4
TO MIDDELBURG
N4
TO JOHANNESBURG
N12
Wilge river
Suikerboschkop spruit
Kromdraai spruit
Klipspruit
Brugspruit
Grootspruit
Schoonspruit
Weltevreden spruit
Landau spruit
NE spruit
Tweefontein spruit
OLIFANTS RIVER
WITBANK DAM
WATERSHED
SUIKERBOSCHKOP 278 JS
BULPAN
262 JS
KROMDRAAI 279 JS
BLACKSTONE
DUFF DUMP
HARTBEESTSPRUIT 281 JS
KLEINWATER 301 JS
DRIEFONTEIN 207 JS
304 JS
300 JS
NOOITGEDACHT 300 JS
KWA-GUQA
R432
DOORNRUG 302 JS
303 JS
SCHOONGEZICHT 308 JS
ELANDSFONTEIN 309 JS
CLEWER TOWNSHIP
NO. 1 WASTE DUMP
NO. 2 WASTE DUMP
2 UPPER SEAM STOCKPILE
2 UPPER SEAM STOCKPILE
NO. 3 WASTE DUMP
NAVIGATION DUMP
BLAAUWKRANS 323 JS
ANGLO FRENCH DISCARD DUMP
HARTEBEESTLAAGTE 325 JS
WITBANK
KLIPFONTEIN 322 JS
NAAUWPOORT 335 JS
R555
WELTEVREDEN 324 JS
GROENFONTEIN 331 JS
VLAKLAAGTE 330 JS
TWEEFONTEIN 328 JS
LANDAU 349 JS
336 JS
R547
R545
WATERPAN 8 IS
KLIPPAN 332 JS
WOLWEKRANS 17 IS
TWEEFONTEIN 13 IS
KLEINKOPJE 15 IS
LEGEND
SURFACE WATER MONITORING
GROUND WATER MONITORING
RIVERS
FARM BOUNDARIES
HIGHWAYS
PROVINCIAL ROADS
PANS
BUILT-UP AREAS
KROMDRAAI UNDERGROUND WATER BODIES
SPOORNET RAILWAY LINES
SERVICE RAILWAYS
ROADS
POWER LINES
WATERSHED
1 : 50 YEAR FLOOD LINES
SACE COAL RESERVES
LANDAU COLLIERY
LANDAU I, II & III, KLEINKOPJE AND GREENSIDE COLLIERIES
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