Camberwell Coal Project

Glennies Creek, NSW.

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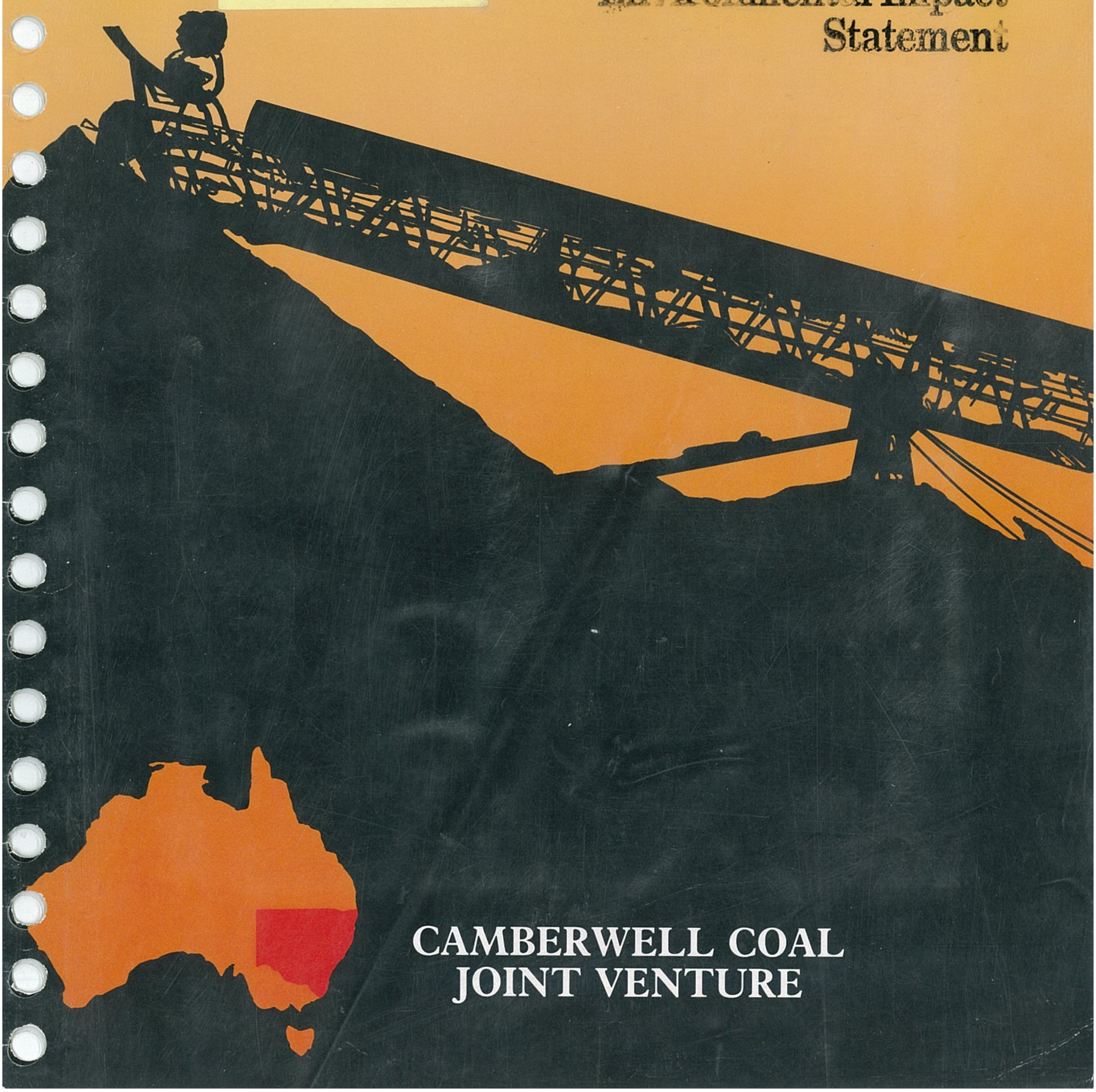
Environmental Impact Statement



CAMBERWELL COAL JOINT VENTURE

Environmental Impact Statement

Camberwell Coal Project

Glennies Creek, NSW

CAMBERWELL COAL JOINT VENTURE

October, 1989

EPPS & ASSOCIATES Pty. Ltd.

FORM 4

ENVIRONMENTAL PLANNING AND ASSESSMENT ACT, 1979 (SECTION 77(3)(D))

ENVIRONMENTAL IMPACT STATEMENT

This Statement has been prepared by or on behalf of the Camberwell Coal Joint Venture, being the applicant making the development application referred to below.

The Statement accompanies the development application made in respect of the development described as follows: Development of an Open Cut Coal Mine and Surface Facilities near Camberwell in Singleton Shire, NSW.

The development application relates to the land described as: Camberwell Surface Lease Application Area, part of Authorisations 81 and 308, Shire of Singleton, N.S.W.

Real Property description: Shire of Singleton, Parishes of Auckland, Broughton and Darlington, County of Durham, N.S.W.

The contents of this Statement as required by Clause 34 of the Environmental Planning and Assessment Regulation, 1980, are set forth in the accompanying pages.

Name, Qualification and address of person who prepared the Environmental Impact Statement	Janet M. Epps BSc M. Environmental Studies 3 Julian Street, MOSMAN, N.S.W. 2088

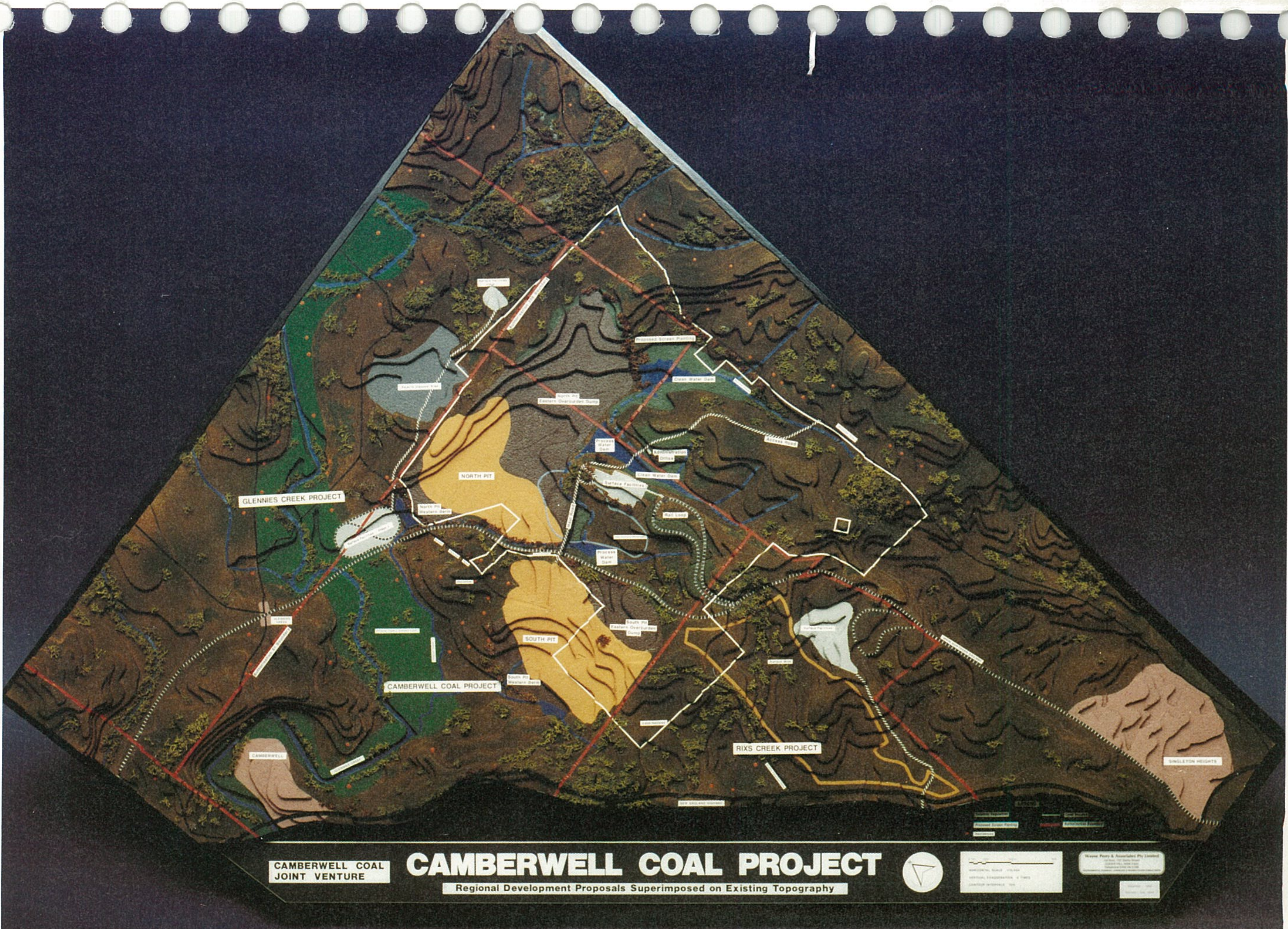
CERTIFICATE: I, Janet Epps of Epps & Associates Pty Ltd hereby certify that I have prepared the contents of this Statement in accordance with Clauses 34 and 35 of the Environmental Planning and Assessment Regulation, 1980.

J M Epps.

Signature

30 | 10 | 1989

Date



GLENNIES CREEK PROJECT
North Pit Eastern Overburden Dump
Proposed Screen Planting
Clean Water Dam
Process Water Dam
Administration Office
NORTH PIT
Surface Facilities
North Pit Western Dam
Rail Loop
SOUTH PIT
South Pit Eastern Overburden Dump
South Pit Western Dam
CAMBERWELL COAL PROJECT
RIXS CREEK PROJECT
CAMBERWELL
SINGLETON HEIGHTS
CAMBERWELL COAL JOINT VENTURE
CAMBERWELL COAL PROJECT
Regional Development Proposals Superimposed on Existing Topography

CAMBERWELL COAL PROJECT

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ABBREVIATIONS

\$M/annum	Millions of dollars per year
10^6m^3	million cubic metres
ABS	Australian Bureau of Census and Statistics
AHD	Australian Height Datum
bm^3/t	bank cubic metres per tonne
cal/kg	Calorie per kilogram
CCJV	Camberwell Coal Joint Venture
CEC	Cation Exchange Capacities
CES	Commonwealth Employment Service
CSN	Crucible Swelling Number
dB	decibel
dB(A)	A weighted decibel
DM&E	NSW Department of Minerals & Energy
DWT	Dead Weight Tonnes
EIS	Environmental Impact Statement
FR	Filterable residue
$g/m^2/month$	grammes per square metre per month
g/s/ha	grammes per second per hectare
GSG	Great Soil Group
ha	hectares
HGI	Hardgrove Grindability Index
hpa	hours per annum
Hz	hertz
J	Joule
JCB	Joint Coal Board
kcal/kg	kilocalorie per kilogram
kg	Kilogram
kg/ha/h	kilograms per hectare per hour
kg/t	Kilogram per tonne
km	kilometre
km/h	kilometres per hour
km^2	square kilometre
kV	kilovolt
kW	kilowatt
l	litre
l/s	litres per second
LA1	Maximum noise level
LA10	The A weighted sound level exceeded 10% of the time
LA90	The A weighted sound level exceeded 90% of the time
$LAeq^{24}$	Equivalent continuous 24 hour noise level
m	metre
m/s	metres per second
m^3	cubic metre
m^3/s	cubic metre per second
m^3/t	cubic metres per tonne
max	Maximum
mbm^3	million bank cubic metres
mEq/l	milliequivalents per litre
mg/l	milligrams per litre
min	minimum
MJ/kg	Megajoules per kilogram

Ml	megalitre
Ml/a	megalitres per annum
Ml/day	megalitres per day
mm	millimetre
mm/s	millimetres per second
MMCC	Mitsubishi Mining & Cement Co Limited
Mt	million tonnes
Mtpa	million tonnes per annum
MVA	million volt amps
Mw	megawatts
NFR	non filterable residue
NH&MRC	National Health & Medical Research Council of Australia
ppm	parts per million
ppv	peak particle velocity
ROM	run of mine
SC	Southland Coal Pty Limited
SCS	Soil Conservation Service of NSW
SLA	Surface Lease Application
SPCC	State Pollution Control Commission
SRA	State Rail Authority
t	tonne
TDS	Total Dissolved Solids
temp	temperature
TJ	tera joule
tpa	tonnes per annum
tpd	tonnes per day
tph	tonnes per hour
TSP	Total Suspended Particulate
TTC	Toyota Tsusho Corporation
USBM	United States Bureau of Mines
US EPA	United States Environment Protection Authority
v	volts
$\mu g/m^3$	microgrammes per cubic metre
μm	micrometres
$\mu S/cm$	microSiemens per centimetre

Note: Bridgman Road also known as Bridgeman Road.
Glennies Creek also known as Fal Brook.

SUMMARY

The Camberwell Coal Joint Venture (CCJV) proposes to develop the Camberwell Coal Project approximately 10km north-west of Singleton in the Hunter Valley of NSW. The proposed mine is located in a district that has a long tradition of both coal mining and rural activities. The village of Camberwell is located to the west of the Project while small rural settlements and dwellings are scattered around the countryside.

It is proposed to develop an open cut mine in the eastern part of Authorisation 81, defined as the Surface Lease Application (SLA) area recovering approximately 40 million tonnes (Mt) run of mine (ROM) coal to produce about 26Mt of saleable coal over a 20 year period.

The mine will produce 1.35 million tonnes per annum (Mtpa) of a mixed product of soft coking, semi-soft coking and steaming coal. The coal products will be of good quality being of low to medium ash, medium to high volatiles, low sulphur, high specific energy and with good caking properties.

A truck and shovel mining plan is proposed to exploit the multi-seam coal resource.

The geological sequence is complex containing nine coal seams (Arties to Lower Hebden), which occur as 28 separate characteristically thin splits of the major seams. Coalescence of some of these splits creates 8 additional local coal beds within parts of the area. Most of the resultant 36 coal beds have some economic potential.

A coal preparation plant will be constructed on site and washed coal will be transported to Newcastle via rail for shipment. A balloon loop and a Level 5 Category train loading facility will be constructed at the mine site.

A joint user train loading facility is proposed to be constructed and operated by a separate Joint Venture Company comprising several entities including user companies and the Joint Coal Board. The site would be similar to Camberwell's proposed train loading site. This facility is proposed to be used jointly by the Rix's Creek, Camberwell and possibly Glennies Creek Mines. To date no EIS has been prepared, nor approval given for this joint-user facility. Consequently this Development Application includes train loading facilities for the Camberwell Project only, as a measure ensuring all necessary components of the Project will be available for use as soon as coal is able to be mined.

The Main Northern Railway, which cuts across the Project area, will not be affected by the open cut pits as there are no resources at economic overburden strip ratios anywhere along its route.

A small resource with underground mining potential exists east of the South Pit and a larger resource to the west of the proposed open cuts, beyond the boundary of the SLA. Future investigation of this western resource may lead to further mine development. A Coal Lease covering these underground resources has been applied for in conjunction with this SLA. This lease will replace the existing Authorisations 81 and 308.

The proposed open cut mine is set in open grazing land with soils of poor to moderate fertility that have suffered considerably from erosion. The mine site itself is well shielded on most sides from public viewing points by a combination of ridge lines and distance. The South Pit will not be visible from Camberwell Village residences, although it will be visible from the Camberwell access road.

Noise, vibration and dust impacts will be managed to minimise nuisance to surrounding residents. While every practical means will be adopted to minimise noise, vibration and dust generation in conjunction with the mining operation, land purchase of potentially affected properties is the policy of the CCJV. Where owners of properties located within the predicted Zone of Affectation prefer not to move but to tolerate the temporary effect of mining nearby, compensation arrangements will be negotiated.

It is not intended that water will be discharged from the site, instead the Project will be a net water user drawing water from Glennies Creek. All water on the site will be captured and recycling practised wherever possible.

In the course of developing the Project some sites containing aboriginal artefacts will need to be disturbed. No disturbance can occur, however without first obtaining a permit from the National Parks and Wildlife Service.

Rehabilitation of the site will be governed by a strategy comprising a combination of land uses. These uses will include grazing as a predominant use, natural timbered areas along ridges, watercourses, gullies and slopes exceeding 10° and limited recreational use related to the larger water storage dams. The strategy will ensure an optimal post-mining land use incorporating re-establishment of the current landscape character, surface stability of land with a higher erosion potential and enhancement of the natural timbered areas.

1. BACKGROUND INFORMATION AND PROJECT OBJECTIVES

1.1. INTRODUCTION

The Camberwell Coal Project is contained within the Surface Lease Application (SLA) area within Authorisation Nos 81 and 308, located about 10km northwest of Singleton, NSW (Figure 1.1.1). Singleton (population 17,500) services Hunter Valley coal mining and power industries, as well as traditional agricultural activities such as dairying and grazing.

Infrastructure support for the Project is already well established, for example:

- Rail access via the Main Northern Railway to the major export harbour of Newcastle, about 85km to the south-east.
- Road access via the New England Highway to Newcastle.
- A short travel distance for mine workers from the residential areas of Singleton Shire. The north-south Bridgman Road provides a well constructed access route passing along the eastern edge of the Project area.
- A new water pipeline from Glennies Creek Dam, adjacent to Bridgman Road, as a contingency water supply facility (make up water is however to be pumped from Glennies Creek to meet intermittent requirements).
- A 66kV power line located near the eastern boundary of the SLA.
- The useable base of a dismantled railway in the eastern part of the Project area that can be reused for construction of part of the train loading loop.

Authorisation Nos 81 and 308 cover about 23.2km^2 and 2.9km^2 respectively. The SLA covers some 11.5km^2. There are no producing neighbourhood mines, however some adjacent Authorisations (shown on Figure 1.1.1) are subject to project development proposals.

In 1987 the mines within Singleton Shire produced approximately 27.6Mt, representing some 33% of the total NSW raw coal production. Of this production about 25% (or some 7Mt) was consumed locally for power generation and the remainder exported.

1.2 STATUS OF THE PROJECT SITE

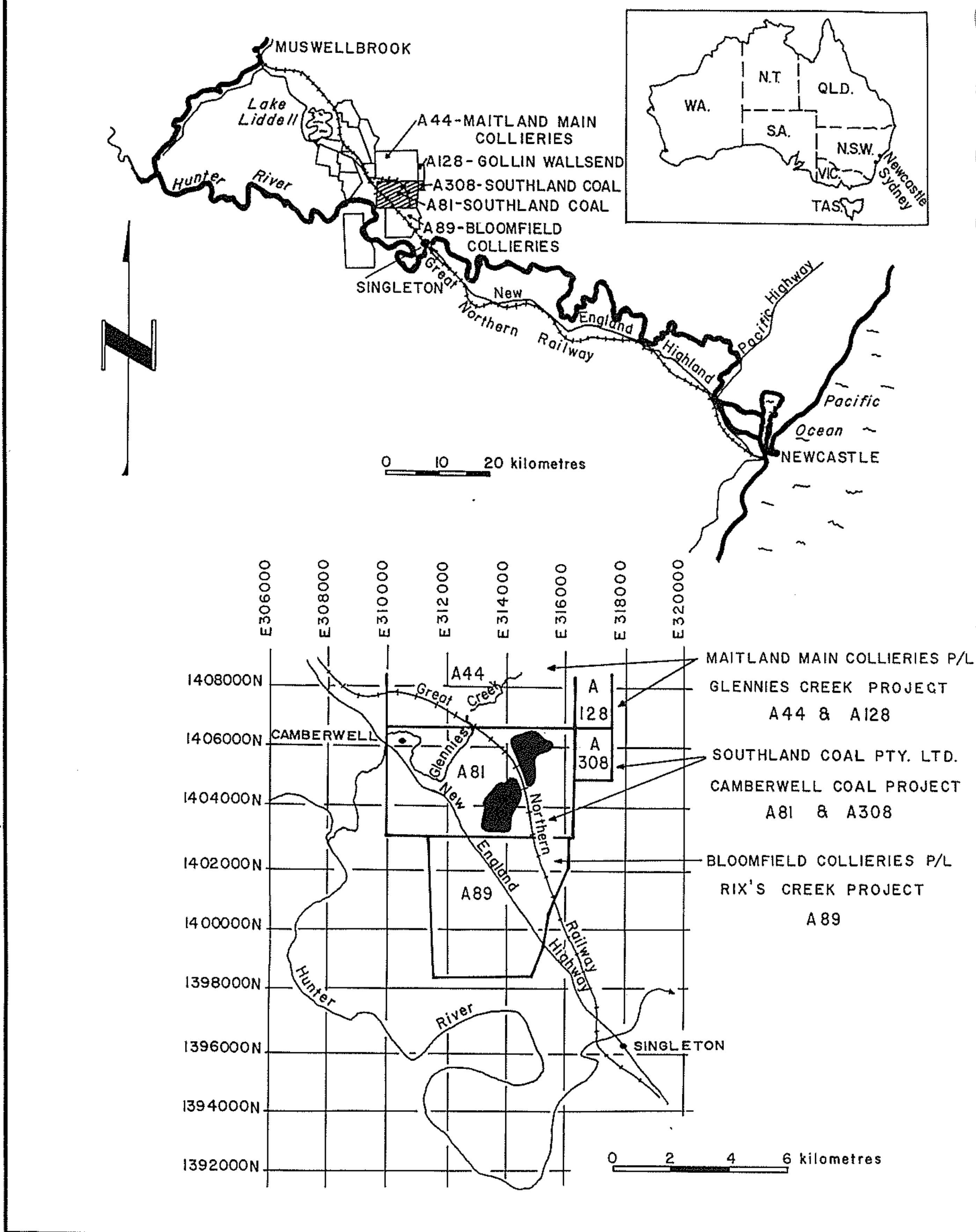
In 1977 the New South Wales Government granted Eric Newham (Wallerawang) Pty Ltd, now Southland Coal Pty Limited (Southland), rights to prospect for coal in the Camberwell area of the Hunter Valley as a potential replacement area for the old Bellbird Colliery near Cessnock. Southland has since undertaken geological, mining and developmental investigations of the coal measures which, between the 1870s and 1940s, supported the Rosedale, Nundah and other smaller adjacent collieries (Figure 2.1.1).

1.3. OWNERSHIP STRUCTURE

Equity in the Camberwell Coal Joint Venture is held by three parties. Devex Limited is a Stock Exchange listed Australian company with interests in a range of minerals held by its wholly-owned subsidiary companies. The subsidiary holding equity in the Camberwell Project is Southland Coal Pty Limited.

In 1988 Toyota Tsusho Corporation of Japan entered into a 50% joint venture arrangement with Southland to develop the Camberwell Coal Project. It then transferred the whole of its equity to Toyota Tsusho Mining (Australia) Pty Limited which in turn transferred 20% of its equity to Dia Coal Mining (Australia) Pty Limited, a wholly owned subsidiary of Mitsubishi Mining & Cement Co Limited.

The joint venture ownership, as finalised, is depicted in Figure 1.3.1.

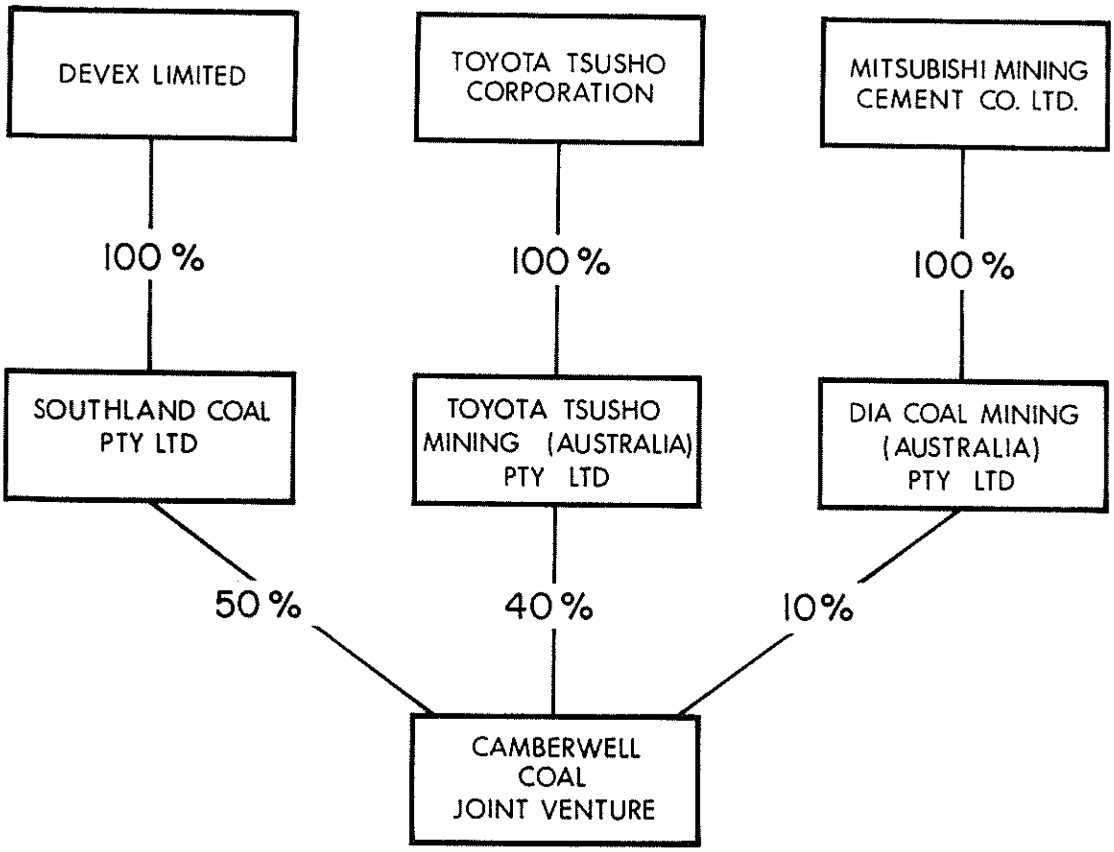


CAMBERWELL COAL PROJECT

LOCATION OF STUDY AREA

Date SEPT 88

Figure 1.1.1



CAMBERWELL COAL PROJECT

JOINT VENTURE OWNERSHIP STRUCTURE

Date

Figure 1.3.1

1.4 PROJECT OBJECTIVE

The Camberwell Coal Joint Venture (CCJV)'s objective for the Camberwell Coal Project is to develop a profitable, technically sound and environmentally acceptable coal mining operation.

The operation will produce high quality coal products targeted at domestic and export markets and suitable for many applications including:

- soft-coking coal;
- semi-coking coal; and
- steaming coal.

The Project described in this Environmental Impact Statement (EIS) is an open cut coal mining development. The acquisition of a coal lease will provide coal reserves supplying 40Mt ROM coal to produce 26Mt of saleable coal over a 20 year period, which is desirable for a commercially viable open cut operation.

1.5 ENVIRONMENTAL IMPACT STATEMENT OBJECTIVES

The objectives of the EIS are to:

- describe the design and operation of a commercially and environmentally sound open cut coal mining operation north of Singleton, NSW;
- outline alternatives considered;
- describe the existing environment of the Project area;
- identify the environmental effects of the proposed Project and describe suitable means of mitigating and managing these effects; and
- comply with requirements to obtain development consent for the Project.

1.6 LEGISLATIVE REQUIREMENTS

This EIS was prepared and submitted to satisfy the requirements of the NSW legislation.

1.6.1 Development Consent

The *Environmental Planning and Assessment Act* (1979) and associated Regulation (1980) provide the basis for development control in NSW. The activities associated with the proposed Project require development consent under the legislation. As this Project is classified as Designated Development, the development application must be accompanied by an EIS.

The Development Application was submitted to Singleton Shire Council, which is the relevant Local Government Authority.

1.6.2 Coal Lease

The Department of Minerals and Energy (DM&E) administers the *Coal Mining Act* (1973), under which coal leases are granted.

Coal leases are granted for 21 years and provision for renewal is contained in the *Coal Mining Act* (1973).

Exploration has been carried out under Authorisations 81 and 308. As the Minister for Minerals and Energy granted the Authorisations under Section 20 of the *Coal Mining Act*, so the Coal Lease will also be granted by the Minister. The Minister's intention to invite the CCJV to apply for the Coal Lease in respect of Authorisations 81 and 308 has been published in the NSW Government Gazette.

1.6.3 Joint Coal Board Approval

The CCJV will need to obtain Joint Coal Board (JCB) approval under Order No. 27 to open a coal mine.

1.6.4 State Pollution Control Commission Approvals and Licences

The CCJV will need to submit applications to the State Pollution Control Commission (SPCC) for approvals to construct and licences to operate the Project. Approvals to construct and annual licences to operate are required under the *Clean Air Act*, 1961, *Clean Waters Act*, 1970 and *Noise Control Act*, 1975.

1.7 ANALYSIS OF NEED FOR THE PROJECT

1.7.1 Corporate Need

Southland Coal Pty Limited is a subsidiary of Devex Limited. Devex's prime objective is to evolve into a significant Australian mining company with interests in a diversified portfolio of minerals. At present it has interests in gold, magnesite, coal and fluorspar deposits which are at various stages of exploration and development. For the long-term, Devex is committed to growth through further acquisitions in the mining industry.

The CCJV has a proven management team with both the technical and financial expertise to develop the Camberwell Project. Toyota Tsusho Corporation and Mitsubishi Mining & Cement Co Limited will draw on their considerable marketing and technical expertise to ensure viability of the Project.

1.7.2 Export Prospects

The Japanese joint venture parties have already carried out preliminary marketing in Japan of the proposed production from the Project. These studies provide confidence that all production will be sold on the Japanese market to power utilities and steel mills.

Market indicators point to significant medium term growth in the Japanese demand for steaming and soft coking coals.

1.7.3 National Benefit

Coal exports are a major contributor to Australia's trade balance and current account. A trade balance which continues to be unfavourable will jeopardise national growth, by eroding the power to import goods required to maintain living standards.

A new export oriented Project will assist in offsetting the level of national foreign debt and will help foster the trade base for international relations. The latter is particularly important for Australia's future involvement in the Pacific Region.

The Federal Government will benefit from export taxes, while State and Local revenue will be generated by State taxes, royalties, up-front payments and charges for services. Similarly, diversification of local industries, decentralisation of NSW industry and improved utilisation of State rail and port facilities has long-term economic benefits for the tax paying community.

The CCJV believe the Camberwell Project is strategically beneficial in achieving its corporate objectives. At the same time, it provides benefits at international, national, state and local levels. The Project represents a significant capital investment occurring in Australia. This investment will benefit both Australian industry and the community by providing additional employment, expendable income and government revenue.

2. GEOLOGY

A comprehensive report on the geology overburden ratios, reserves and coal quality of Authorisation 81 and the SLA area has been presented to the DM&E as part of the normal reporting procedures of the CCJV and to the JCB to progress their Order 27 evaluation.

2.1 PREVIOUS EXPLORATION AND MINING

Records indicate that a number of small collieries were worked between 1873 and 1948 down dip from the outcrops of the Upper Hebden and the overlying Lower Barrett Seams (see Figure 2.1.1.). It is estimated that the largest of these mines, the Rosedale Colliery, produced about 600,000t at an average recovery rate of 60% from the 1.75m Upper Hebden Seam. The other mines were much smaller. Records suggest that much of the district's coal production was either sold locally or turned into coke for use at the Cobar Copper Smelters.

Prior to Southland obtaining exploration rights, exploratory boreholes were drilled by the Joint Coal Board in 1953, and Clutha Development Pty Ltd in 1970.

2.2 GEOLOGICAL SETTING

The Camberwell Project area overlies part of the north plunging Glennies Creek Syncline, which is flanked in the western portion of Authorisation 81 by the eroded Camberwell Anticline, and in the eastern portion into Authorisation 308 by the Darlington Anticline. The core of each of the anticlinal structures contains outcrops of Maitland Group marine sediments. The overlying coal measures are preserved within the syncline and on the western flank of the Camberwell Anticline (Figure 2.2.1).

A typical stratigraphic column representation is shown in Figure 2.2.2. The strata are identified as the lower portion of the Upper Permian Wittingham Coal Measures, Vane Subgroup, Foybrook Formation which here attain a thickness of up to 350m. Nine formally named geological seams are recognised. Due to the development of significant non-coal intervals within these formal seam units, there are considerably more defined workable "coal beds" in the eventual mining operation. Figure 2.2.3 delineates the coal bed loxlines within the SLA area.

2.3 COAL BED NOMENCLATURE

The seam nomenclature used in this study is presented in Table 2.3.1. To facilitate correlation of the individually discrete coal beds within the recognised geological seams, a numerical coal unit labelling system was developed. To aid in the evaluation of the coal resources' potential, "workable" intervals were further identified by the suffix W, these intervals generally being defined as at least 0.3m in thickness and being predominantly made up of coal. Figure 2.3.1 shows diagramatically the definition of coal beds, interburden and intraburden.

Some beds coalesce over significant areas. Where these coal beds have a separation of less than 0.3m they are renamed using the following convention – bed 180 combined with bed 170 creates bed 175.

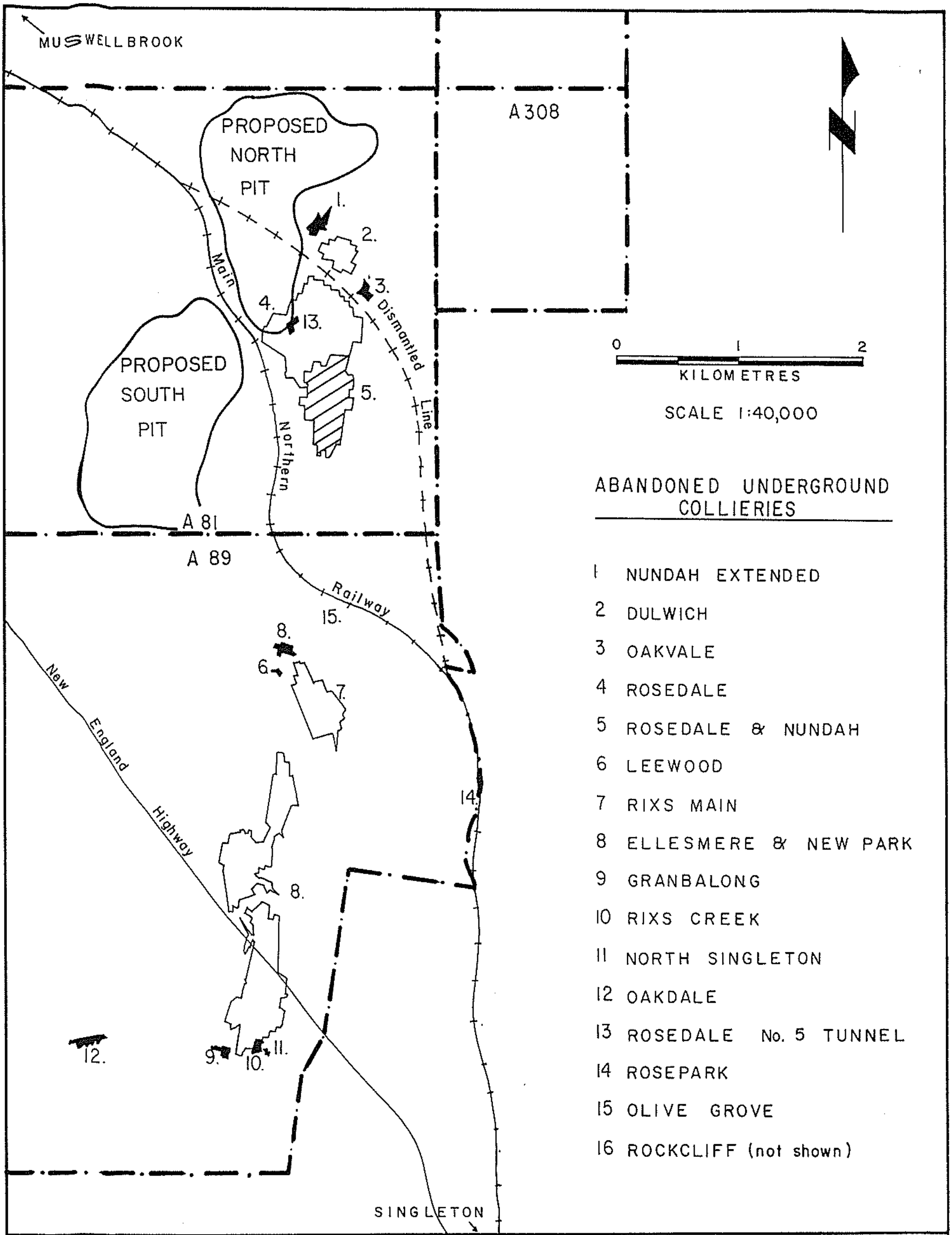
2.4 COAL BED THICKNESS

Coal bed working sections within Authorisation 81 are typically thin in their occurrence and may contain many bands of non-coal material.

A quarter of the coal bed intersections defined as "workable" are less than 0.5m thick, another 50% range up to one metre in thickness. The maximum bed thickness intersected was 3.6m. The average range of thicknesses for each of the primary coal beds varies from 0.36m to 1.44m and for the coalesced beds from 0.77m to 2.31m across the Authorisations. Only six coal horizons have average thicknesses in excess of 1m (250W/255W, 205W, 190W, 120W, 105W and 70W/75W).

Some coal beds contain minor isolated areas of intraseam stone development (in excess of 0.3m). The thicknesses reported here exclude such stone material and the splits were added to calculate bed thickness.

Table 2.4.1 shows the coal bed thickness variations for each of the two proposed pits which are located geographically on Plate 2.8.1 and Figure 2.2.1.

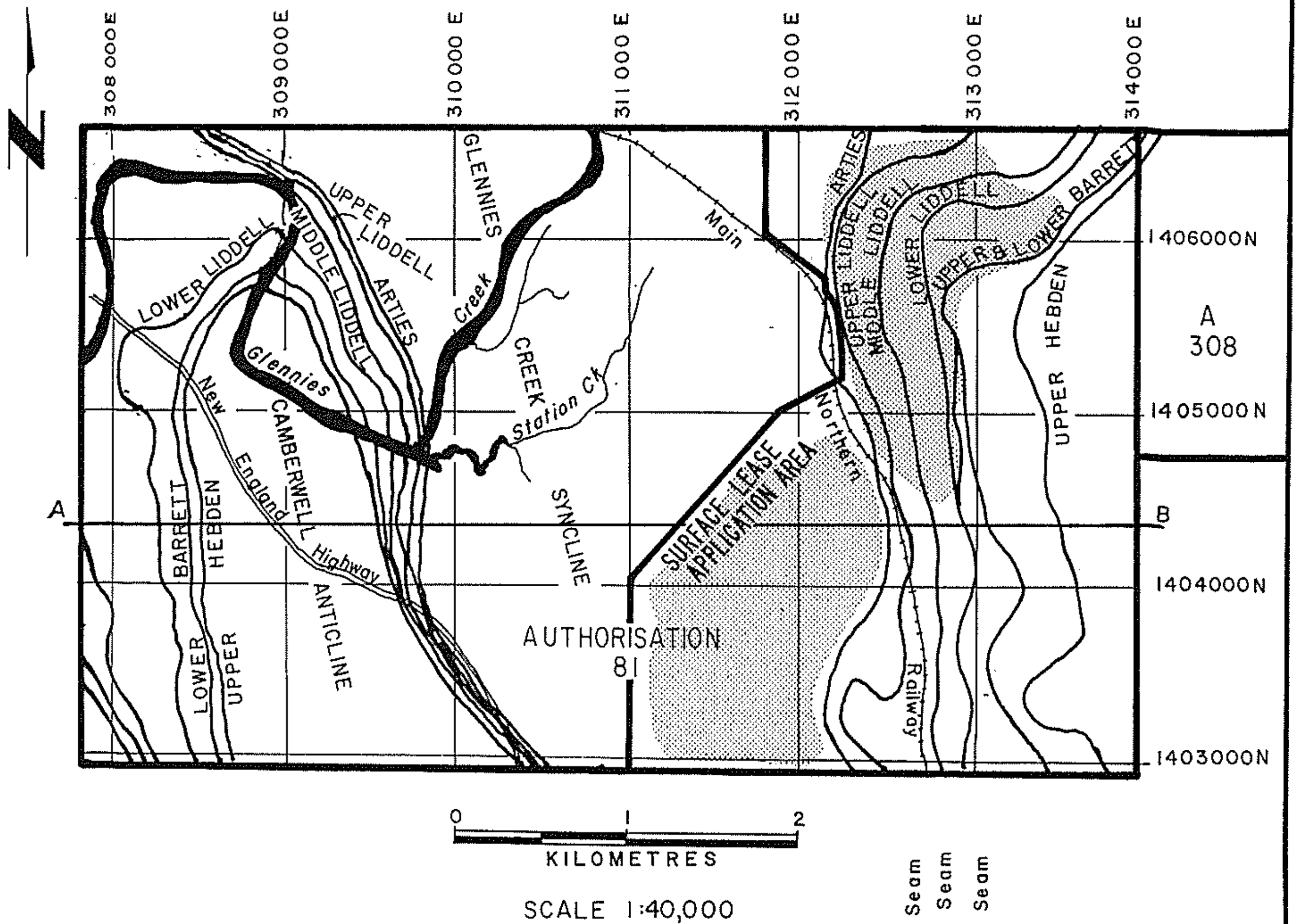


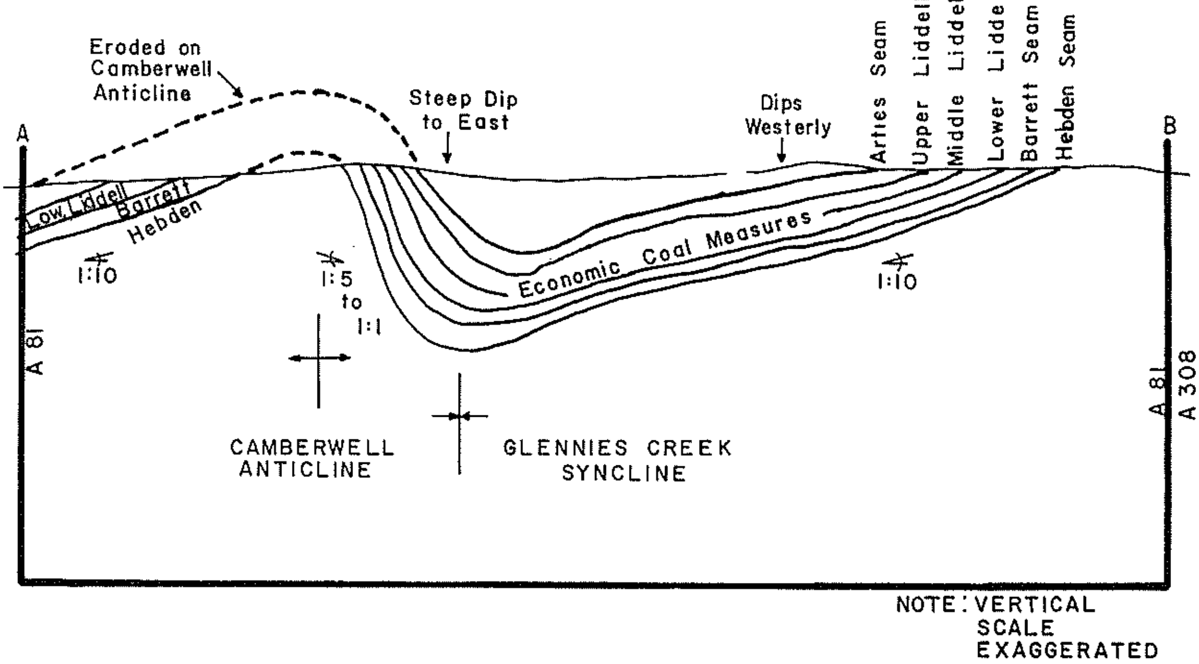
CAMBERWELL COAL PROJECT

PREVIOUS MINING ACTIVITY IN THE CAMBERWELL AREA

Date SEPT 88

Figure 2.1.1



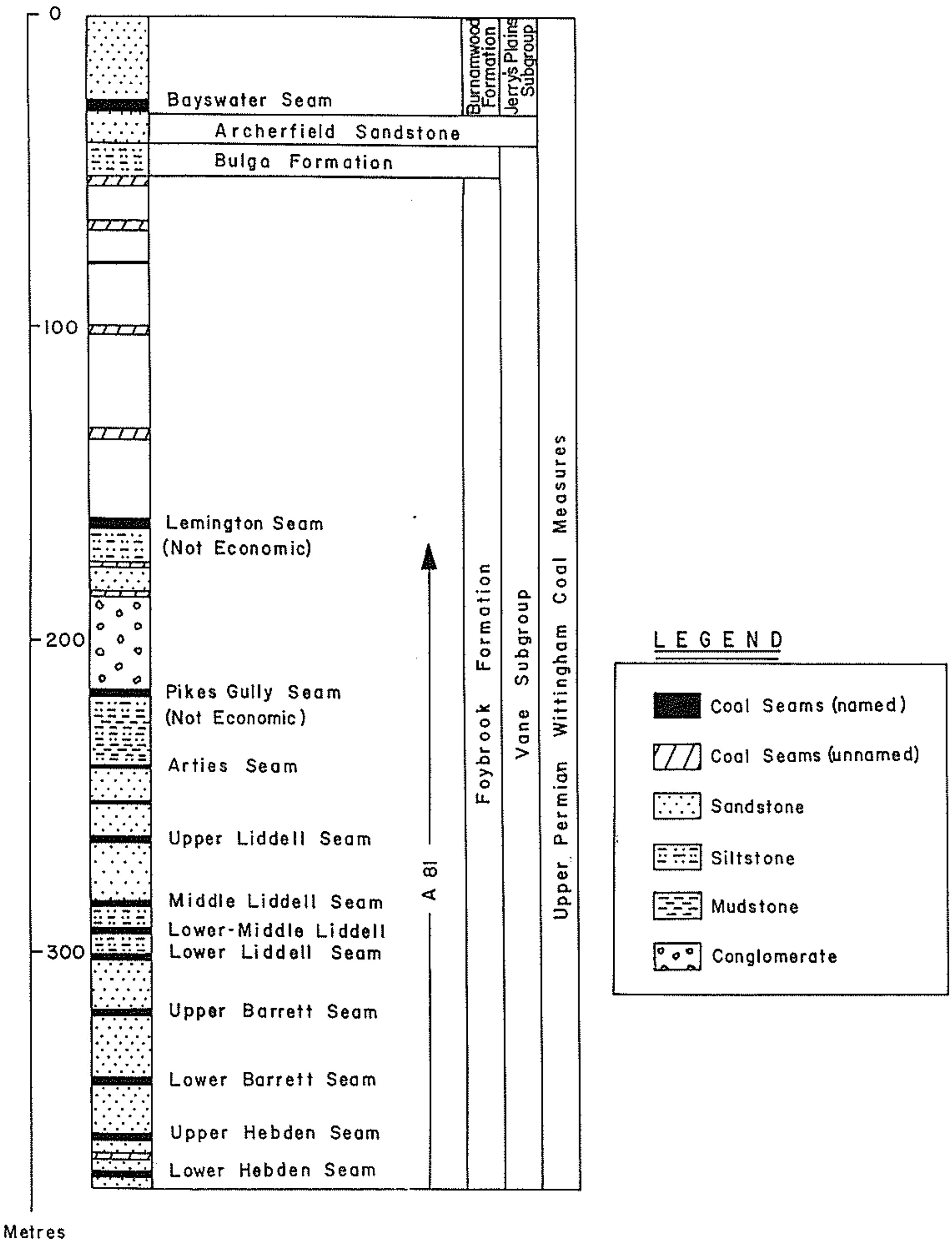


CAMBERWELL COAL PROJECT

COAL SEAM OUTCROPS & CROSS SECTION

Date SEPT 88

Figure 2.2.1

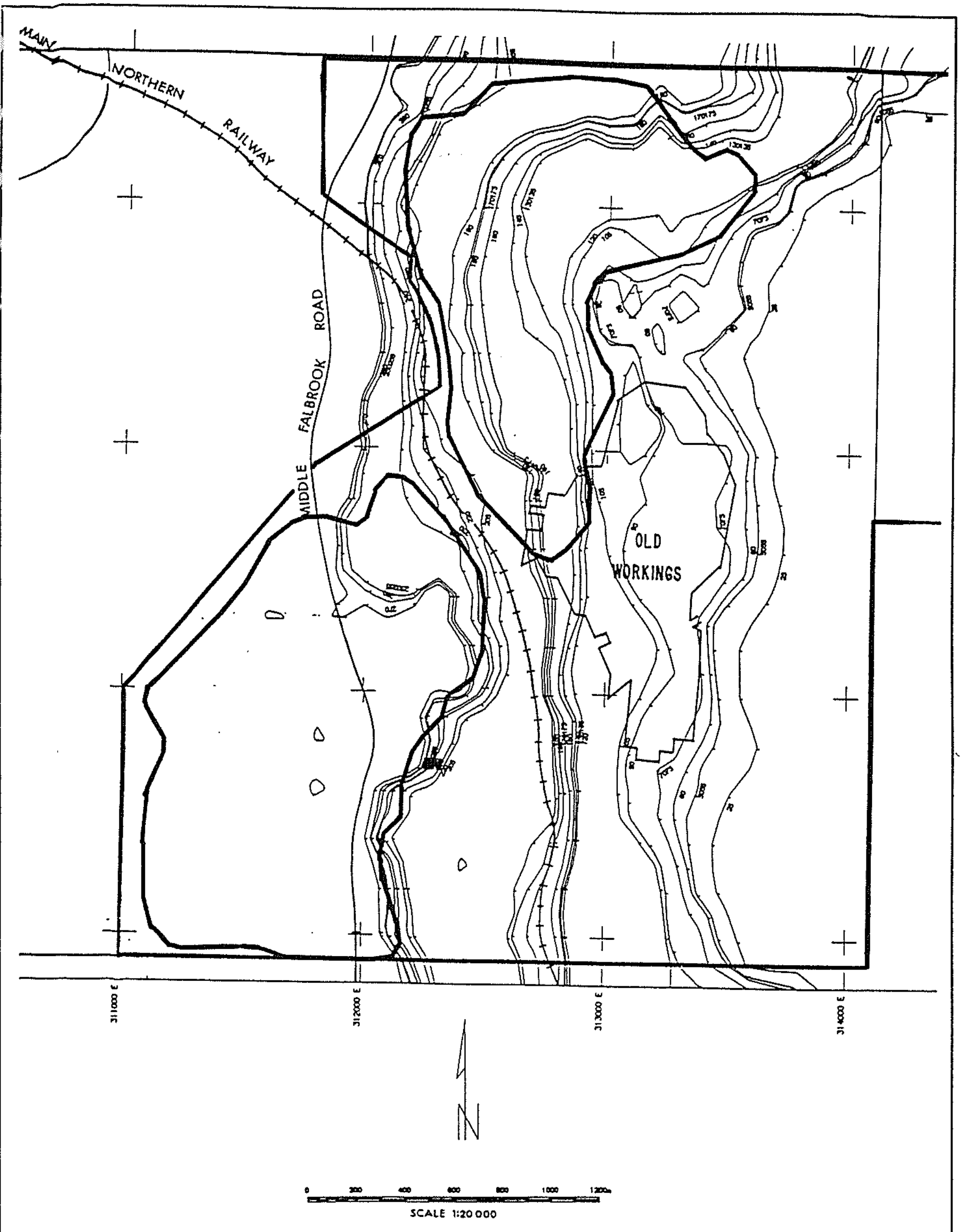


CAMBERWELL COAL PROJECT

TYPICAL STRATIGRAPHIC COLUMN

Date SEPT 88

Figure 2.2.2



CAMBERWELL COAL PROJECT

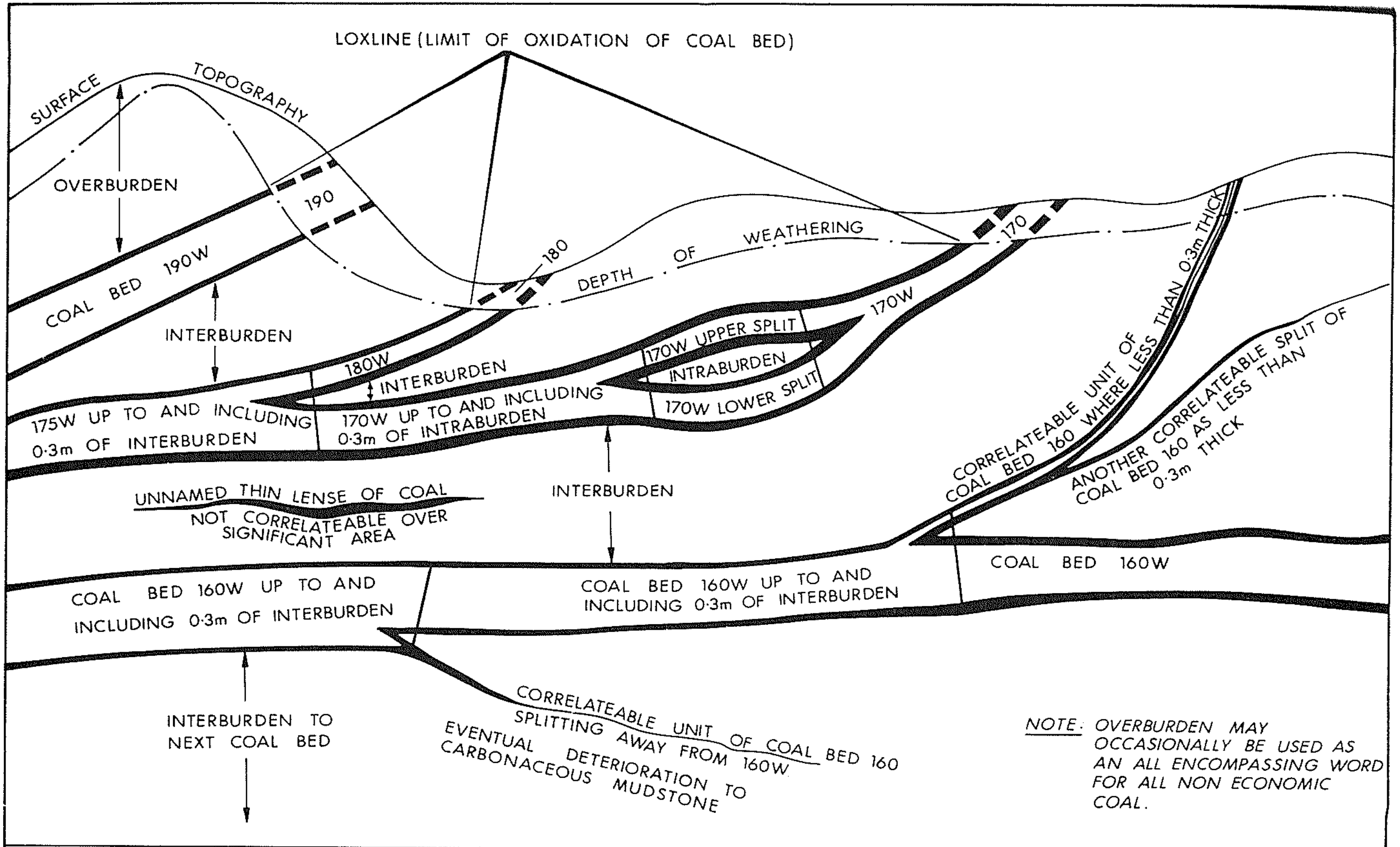
COAL BED LOXLINES WITHIN THE SURFACE LEASE APPLICATION AREA

Date	
Figure 2.2.3	

TABLE 2.3.1

SEAM DEFINITION AUTHORISATION 81

Primary COAL BED		Coalesced COAL BED	Formal Geological Seam
270			Arties
260W	}		
250W	}	255W	
249W	}		
240W			
230W			
220W			Upper Liddell
210W	}		
200	}	205W	
190W			Middle Liddell
180W	}		
170W	}	175W	
160W			Lower Middle Liddell
150W			Lower Liddell
140W	}		
130W	}	135W	
120W			Upper Barrett
110W	}		Lower Barrett
100W	}	105W	
90W			Upper Hebden
80W	}		
70W	}	75W	
60W	}		Lower Hebden
50W	}	55W	
40			
30W	}		
20W	}	25W	
10			



CAMBERWELL COAL PROJECT	Date July 89	Figure 2.3.1

DIAGRAMATIC DEFINITION OF COAL BEDS

TABLE 2.4.1

COAL BED THICKNESSES TO BE MINED IN THE PROPOSED SURFACE PITS

	North Pit				South Pit			
	Coal Bed Thickness (m)				Coal Bed Thickness (m)			
Coal Bed	Range			Average	Range			Average
260W		–		–	0.8	–	1.2	0.9
255W		–		–	1.1	–	2.9	2.5
250W		1.5§		–	1.1	–	1.8	1.4
249W		0.5§		–		–		–
240W		0.5§		–	0.6	–	1.4	1.1
230W		–		–	0.4	–	0.6	0.5
220W		0.7§		–	0.4	–	0.8	0.6
210W	0.4	–	0.9	0.7	0.7	–	1.0	0.8
205W		–		–	1.0	–	1.2	1.1
190W	0.7	–	1.4	1.3	0.6	–	1.8	1.4
180W	0.3	–	0.4	0.4	0.3	–	0.5	0.4
175W	1.0	–	1.1	1.0		–		–
170W	0.3	–	0.4	0.4	0.3	–	0.4	0.3
160W	0.3	–	1.5*	0.6	1.0	–	1.4	1.3
150W	0.3	–	0.5	0.4		–		–
140W	0.3	–	0.7	0.45	0.4	–	0.6	0.5
135W		–		–		–		–
130W	0.5	–	1.0	0.7	0.5	–	0.6	0.55
120W	1.0#	–	2.0	1.4	1.1	–	1.5	1.25
105W	1.6#	–	3.6	2.6	1.8	–	2.2	2.1
75W	2.0	–	2.9	2.3		–		–
70W	1.0	–	1.6	1.3		–		–
60W	0.4	–	0.5	0.45		–		–
55W	1.0	–	1.3	1.1		–		–
50W	0.5	–	0.7	0.6		–		–

§ Limited seam area and data
# Variation due to weathering
* Variation due to working one or more splits

2.5 OVERBURDEN/INTERBURDEN

Overburden and interburden is diagramatically defined in Figure 2.3.1. This material consists of interbedded sandstone, conglomerate, mudstone, siltstone and lesser amounts of shale, claystone, carbonaceous mudstone, siderite and thin irregular coal. Interburden thicknesses show considerable variation from 0.3 to 39m in various directions across the Authorisation.Table 2.5.1 shows the ranges of interburden thicknesses between coal beds for each of the North and South Pits (Figure 2.8.1).

TABLE 2.5.1

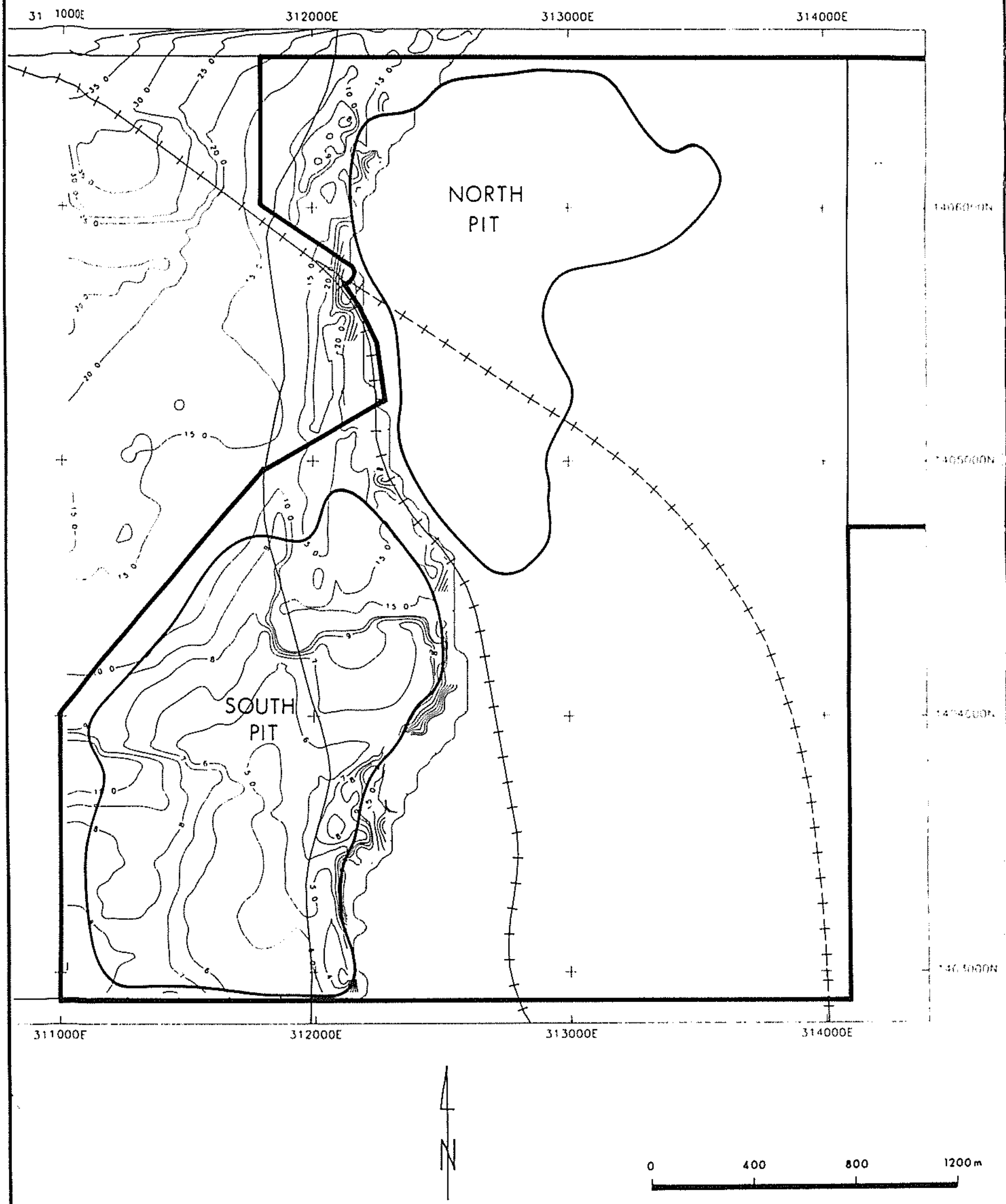
VARIATION OF INTERBURDEN THICKNESS WITHIN PROPOSED SURFACE PITS

Coal Bed	North Pit Range (m)	South Pit Range (m)
260W–250W	4.3	0.30 – 1.0
250W–249W	2.2	–
249W–240W	3.3	–
240W–230W	–	0.4 – 2.1
230W–220W	–	2.7 – 4.9
240W–220W	13.8	(4.1 – 6.7)*
220W–210/205W	1.2 – 2.3	0.6 – 5.5
210/205W–190W	21.9 – 27.1	14.3 – 29.4
190W–180/175W	1.0 – 4.1	1.3 – 3.0
180W–170W	0.3 – 1.5	2.0 – 3.6
175/170W–160W	2.7 – 6.9	1.0 – 1.8
160W–150W	0.3 – 2.2	–
150W–140W	0.6 – 1.3	–
160W–140W	1.8 – 27.9	1.9 – 23.1
140W–130W	0.7 – 6.4	1.9 – 4.8
130W–120W	1.3 – 31.7	0.6 – 1.6
120W–105W	0.2 – 3.2	1.5 – 20.0
105W–70/75W	1.5 – 22.1	–
70/75W–60/55W	0.8 – 9.6	–
60W–50W	0.3 – 0.8	–

* includes coal bed 230W thickness

Figures 2.5.1 to 2.5.5 present cumulative volume of overburden to tonnes of clean coal float 1.6 ratio to each of the major coal benches in the proposed mine (205/210W, 120W, 105W and 70/75W) as well as for coal bed 190W.

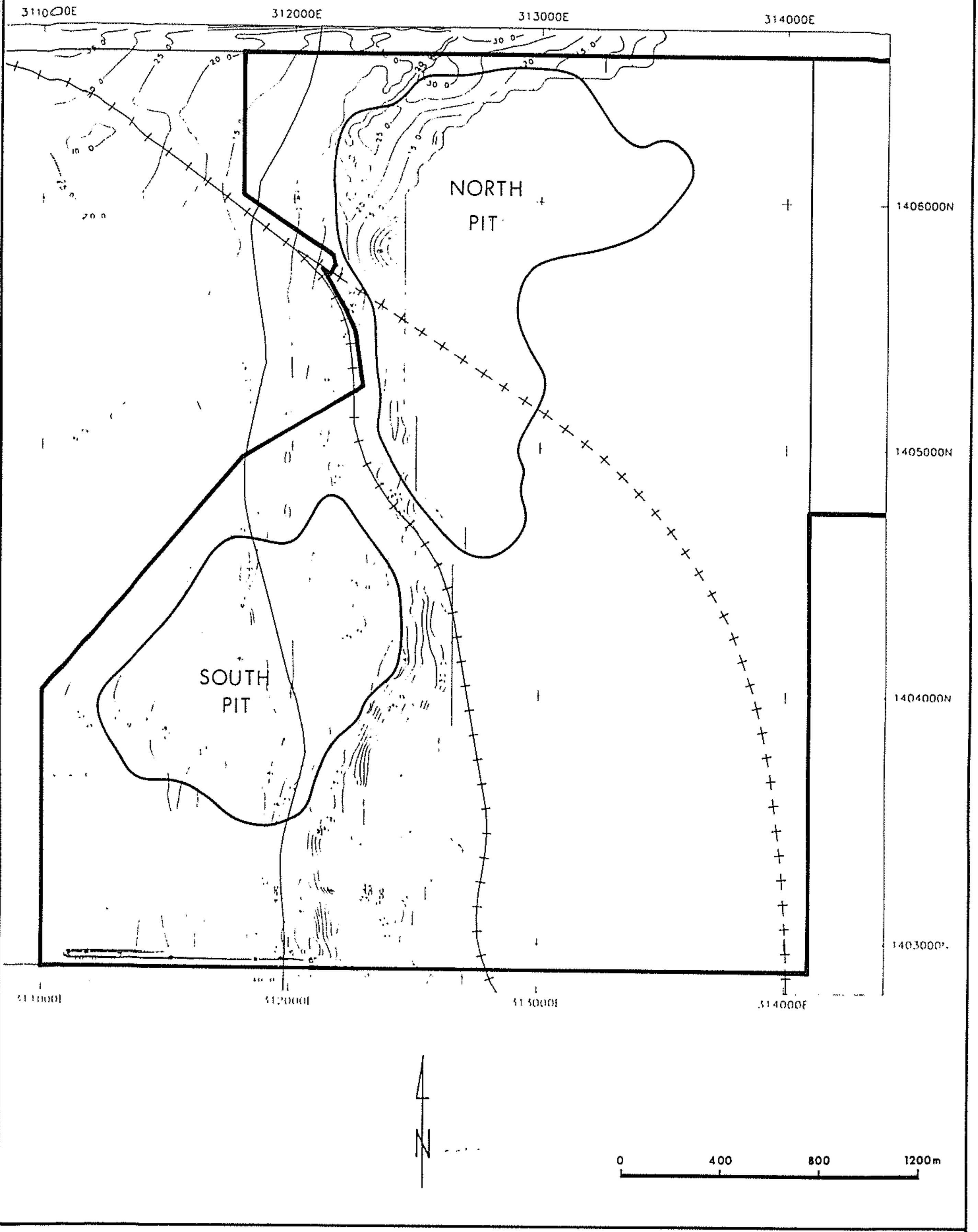
Incremental stripping ratios on the same basis are presented in Figures 2.5.6 to 2.5.8 for coal beds 205/210W to 190W, 120W to 105W and 105W to 70/75W as these increments were of considerable influence in determining the ultimate plan of the proposed mine.



CAMBERWELL COAL PROJECT

CUMULATIVE OVERBURDEN RATIO
SEAM 210205 (BCM/TONNE CLEAN COAL)

Date	
Figure 2.5.1	

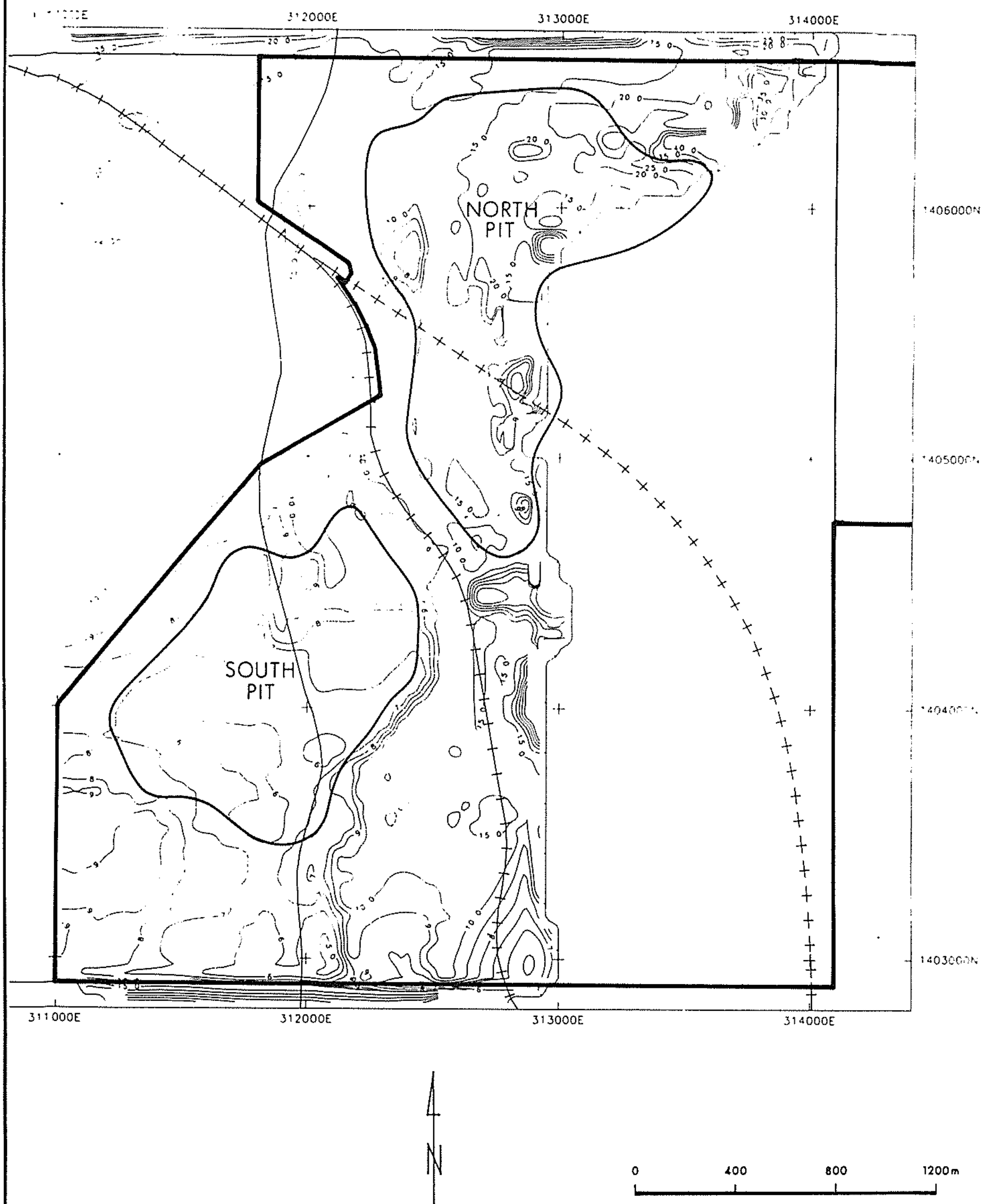


CAMBERWELL COAL PROJECT

CUMULATIVE OVERBURDEN RATIO SEAM 190 (BCM/TONNE CLEAN COAL)

Date

Figure 2.5.2

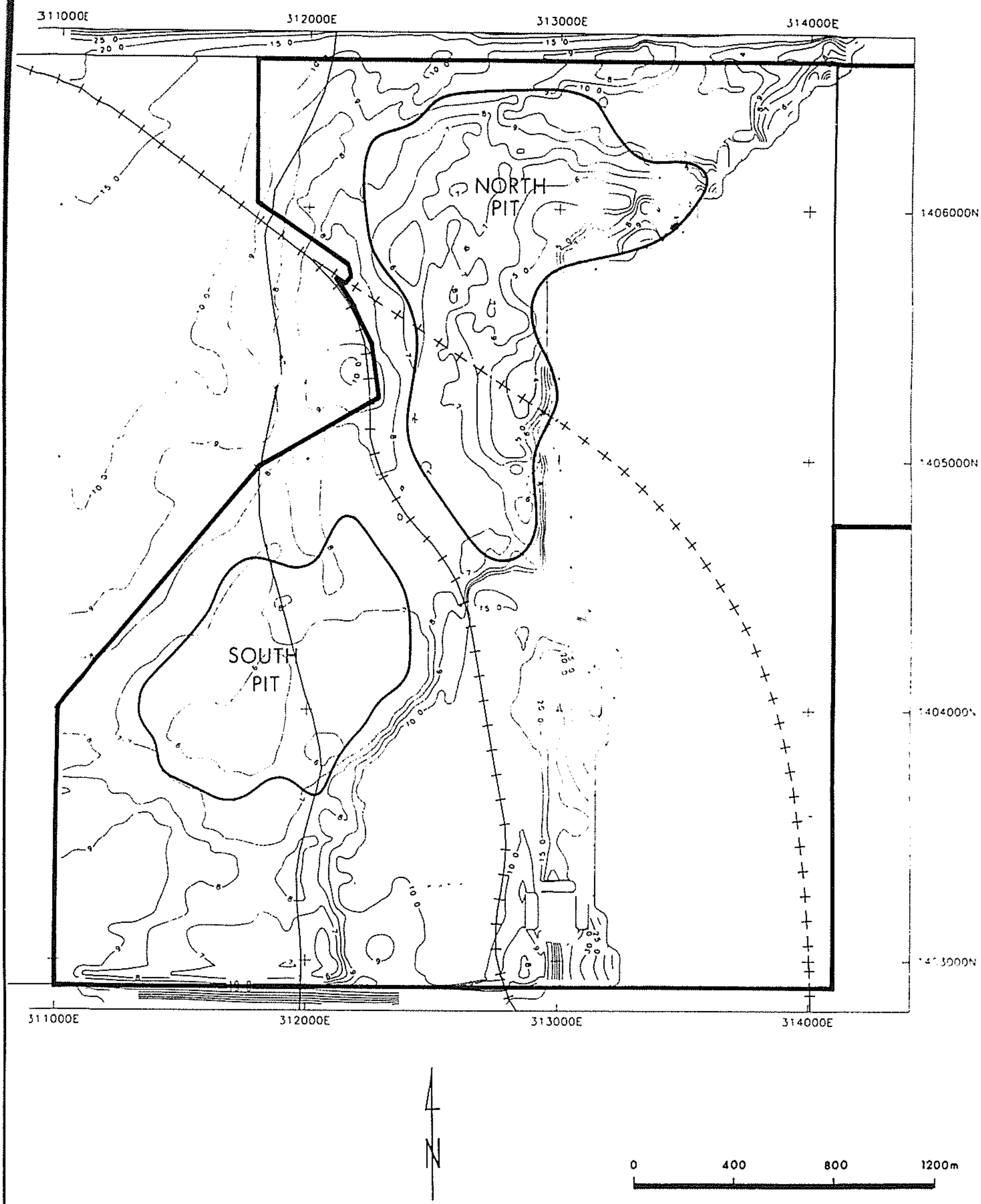


CAMBERWELL COAL PROJECT

CUMULATIVE OVERBURDEN RATIO SEAM 120 (BCM/TONNE CLEAN COAL)

Date

Figure 2.5.3

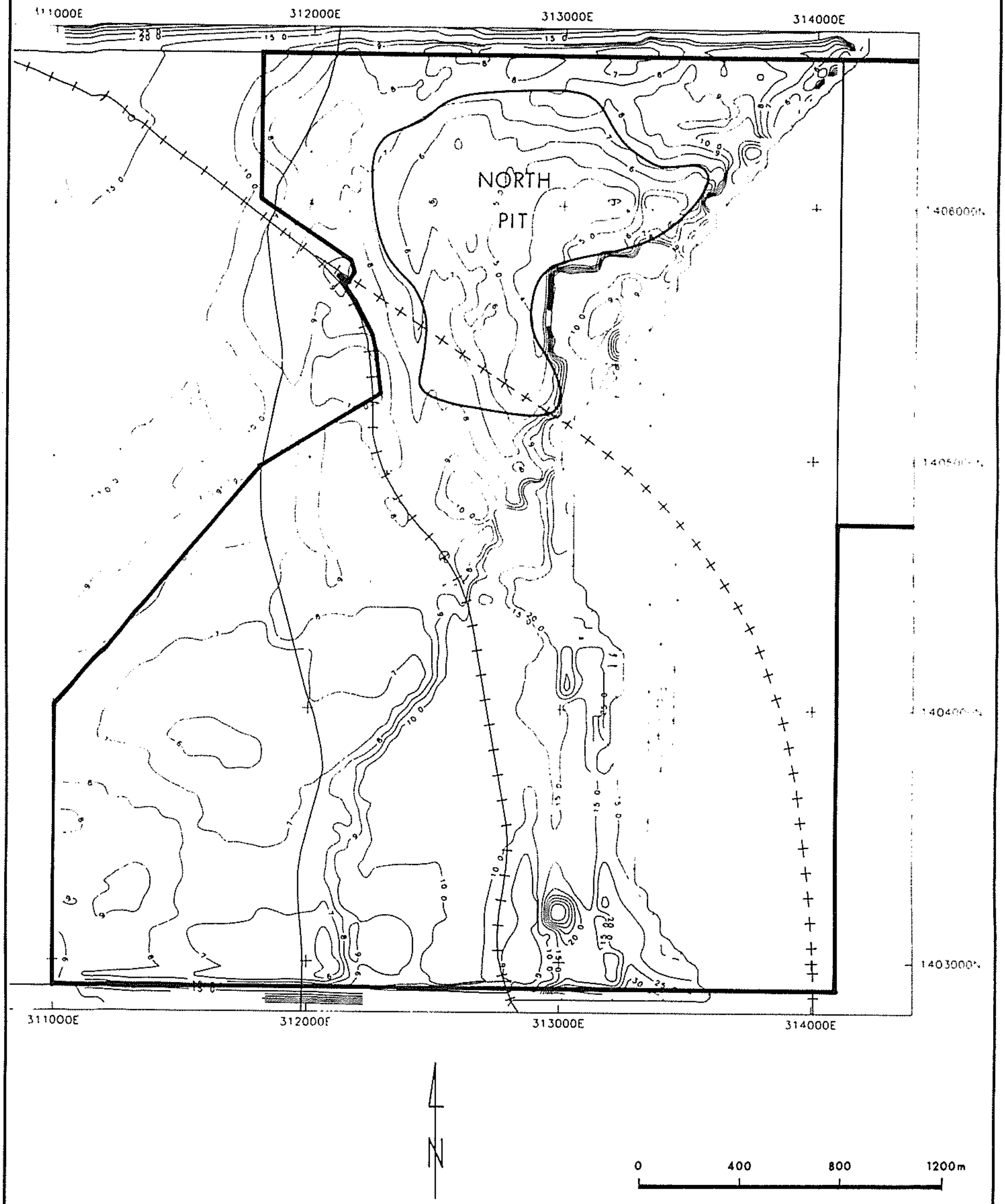


CAMBERWELL COAL PROJECT

CUMULATIVE OVERBURDEN RATIO
SEAM 105 (BCM/TONNE CLEAN COAL)

Date

Figure 2.5.4

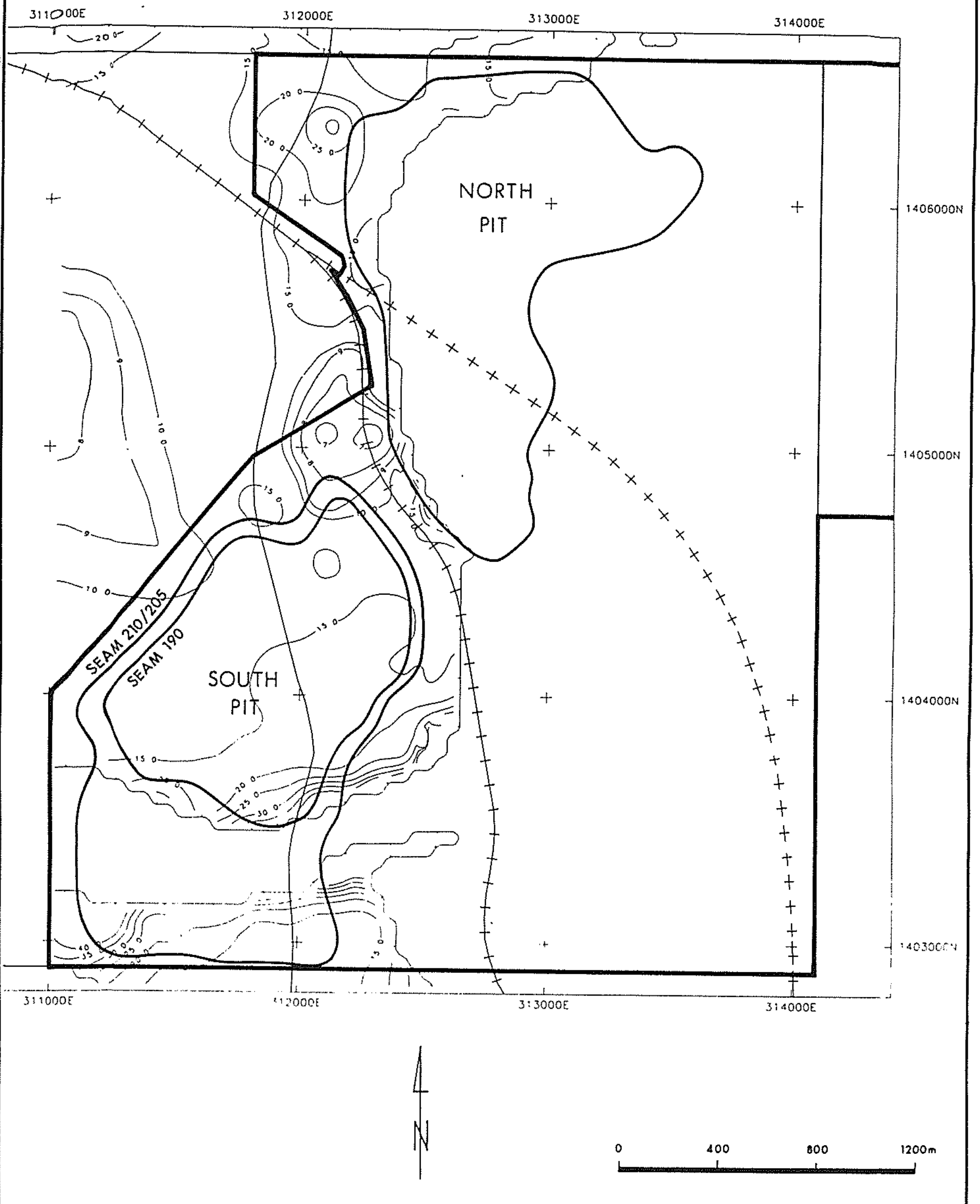


CAMBERWELL COAL PROJECT

CUMULATIVE OVERBURDEN RATIO
SEAM 7075 (BCM/TONNE CLEAN COAL)

Date

Figure 2.5.5

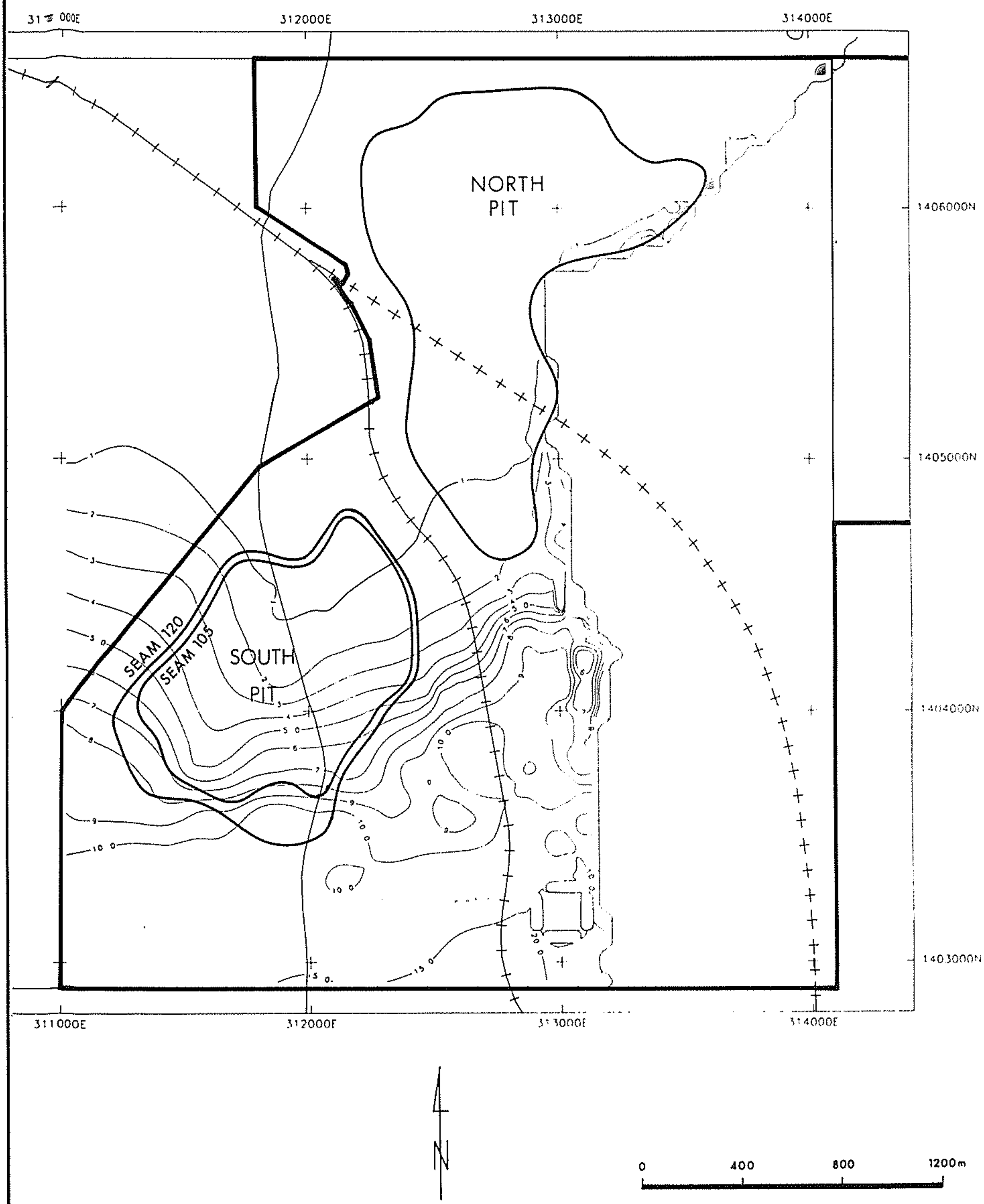


CAMBERWELL COAL PROJECT

INCREMENTAL STRIP RATIO BASE 210205 TO BASE 190 (BCM/TONNE CLEAN COAL)

Date

Figure 2.5.6

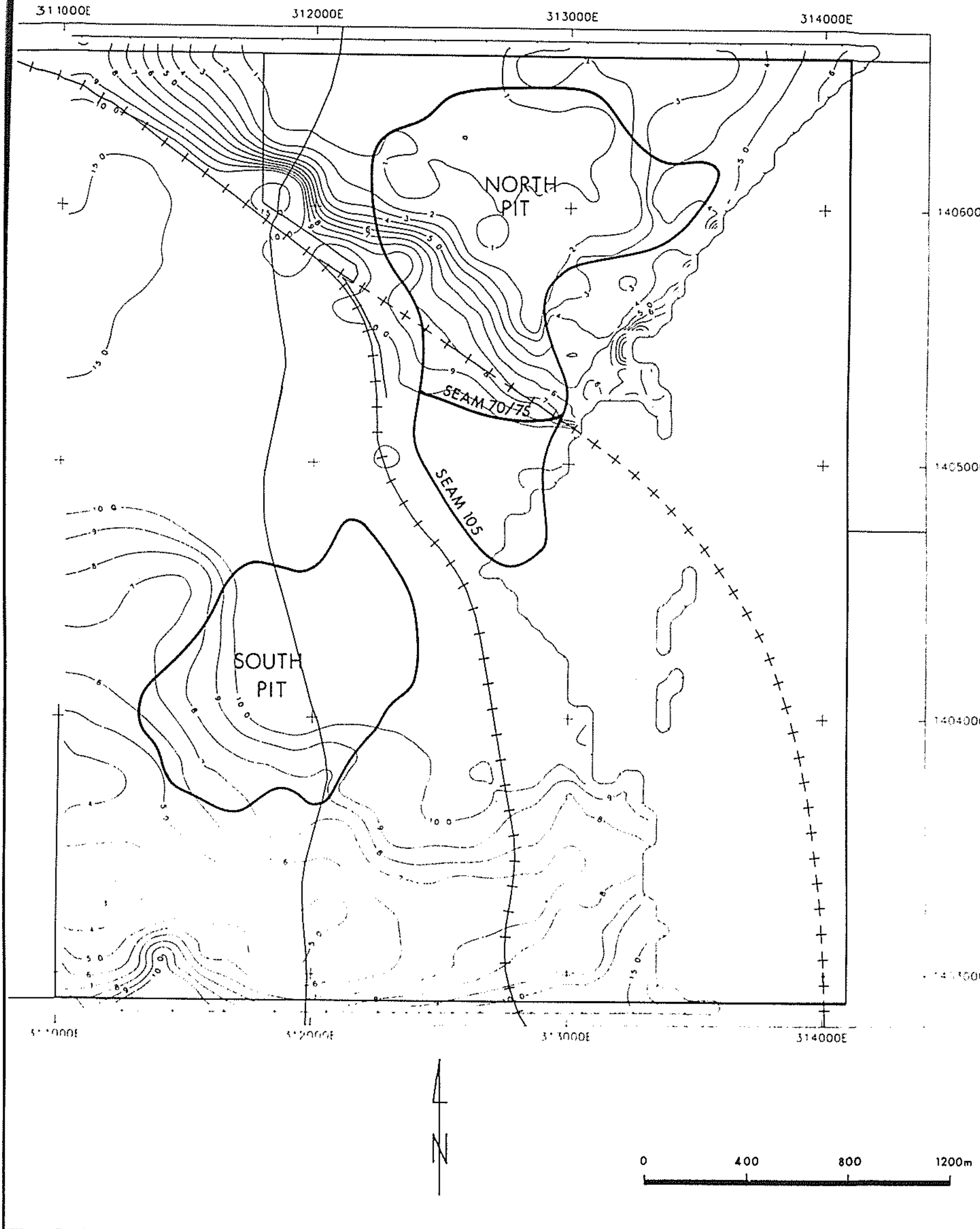


CAMBERWELL COAL PROJECT

INCREMENTAL STRIP RATIO
120 TO 105 (BCM/TONNE CLEAN COAL)

Date

Figure 2.5.7



CAMBERWELL COAL PROJECT

INCREMENTAL STRIP RATIO
105 TO 7075 (BCM/TONNE CLEAN COAL)

Date	
Figure 2.5.8	

2.6 STRUCTURE

The strata are generally conformable. The coal measures dip gently westward at an average gradient of 1 in 10 (2° to 8°) from their subcrops on the eastern side of Authorisation 81. After passing the Glennies Creek (Rixs Creek) synclinal axis, they rise steeply on the eastern flank of the Camberwell Anticline (20° to 40°) before passing over its eroded crest (Figure 2.2.1).

Drilling has identified some faulting and an igneous intrusion, however these do not appear to cause any problems in the proposed pits.

The surface weathering profile varies with geological structure in association with the topography. Weathering is generally deeper on ridges compared to valleys and deeper on sides of ridges which transect rather than parallel the dip of the strata. The proposed North Pit is weathered to 8-10m and the South Pit 12-18m in depth.

2.7 COAL RESOURCE

The coal resources within Authorisation 81 have been calculated as per the Australian Code for Reporting Identified Coal Resources and Reserves, March 1986.

The geological computer model has principally been based on a minimum "workable" defined thickness of 0.3m primarily for correlation purposes, as thicknesses less than this generally involved increased seam splitting, but also as a practical minimum unit mineable by proved surface mining methods. Other primary factors involved in this definition were at least 50% linear coal for working interval and a maximum 0.3m thickness for individual non-coal bands within any workable interval.

In addition any of the defined coal beds which typically had a raw coal ash content in excess of 35% adb, or patchy restricted areas of development, were eliminated from the resource evaluation. This removed beds 270, 150, 90, 80, 40, 30, 20 and 10 from consideration. Some of these beds had only been defined as an aid to correlation.

As shown in Table 2.3.1 the nine coal seams (Arties to Lower Hebden) are represented by 27 coal beds and eight coalescences of these within Authorisation 81. Within the SLA area it is planned to recover coal from 18 of these 35 coal units by truck and shovel methods.

Underground mining has not been planned at this time. However coal seams which could have application to this form of recovery (defined as to a minimum coal bed thickness of 1.5m and non patchy occurrence, calculated to minimum depth of cover of 30m, and occurring at least 10m or more apart) are situated in the Lower Barrett and Upper Hebden Seams (coal beds 105W and 70/75W). These potential reserves extend over a small area east of the South Pit and westward from both Pits across the SLA boundary, around the barren Camberwell Anticline to the western limit of Authorisation 81.

As the limited drilling information available indicates that the Lower Barrett and Upper Hebden Seams are situated less than 30m below the Village of Camberwell, underground mining is not envisaged in that area.

Resources within the SLA area have been drilled to measured status. West of the SLA area they could only be considered at indicated status because of the increase in borehole spacing from 250m to 750m centres considering the variation in coal bed thickness shown in the better drilled SLA area and the need for additional coal bed structural definition west of that area. On the eastern flank of the Camberwell Anticline there is a zone of steep dip (up to 40°) of ill-defined extent.

Partial or total restrictions on underground mining beneath the Main Northern Railway (and as a consequence some small areas east of the Railway) and under Glennies Creek could be significant in reducing the amount of saleable coal.

Resources within the Surface Lease Application Area are presented in Table 2.7.1

TABLE 2.7.1

MEASURED INSITU COAL RESOURCES (Mt) WITHIN SURFACE LEASE APPLICATION AREA

Coal Seam (Mt)		Coal Bed (Mt)	
Arties	13.4	260W	1.6
		255W	3.7
		250W	3.0
		249W	0.1
		240W	3.8
		230W	1.2
Upper Liddell	6.4	220W	2.4
		210W	2.2
		205W	1.8
Middle Liddell	10.5	190W	5.6
		180W	2.2
		175W	0.8
		170W	1.9
Lower Middle Liddell	8.4	160W	8.4
Lower Liddell	7.3	140W	3.3
		130W	4.0
Upper Barrett	10.9	120W	10.9
Lower Barrett	20.8	105W	20.8
Upper Hebden	16.6	75W	16.6
Lower Hebden	10.8	60W	1.3
		55W	2.7
		50W	2.0
		25W	4.8
Total (Mt)	105.1		105.1

As an indication of the potential insitu underground resources discussed above we present Table 2.7.2.

TABLE 2.7.2

AUTHORISATION 81 POTENTIAL INSITU UNDERGROUND RESOURCES (Mt) + 1.5 METRES in THICKNESS*

Coal Seam	Surface Lease Application Area (Mt)		West of Surface Lease Application Area (Mt)	
Lower Barrett	7.6	(1.8*)	20.6	(4.4*, 2.9#)
Upper Hebden	7.1	(1.6)	24.5	(1.7, 2.2)
Total (Mt)	14.7	(3.4)	45.1	(6.1, 5.1)

* underground resources beneath Main Northern Railway estimated zone of possible mining prohibitions at depth

underground resources beneath Glennies Creek estimated zone of possible mining prohibitions at depth

To further exemplify the distribution of the coal resources by depth increments in the eastern half of Authorisation 81 Table 2.7.3 is presented.

TABLE 2.7.3

AUTHORISATION 81 MEASURED RESOURCE (Mt) BY DEPTH INSITU
EAST OF 311,000mE

Coal Bed	Raw Density	Total less than 60m Average thickness & Tonnage m	Mt	Total Less than 80m Average thickness & Tonnage m	Mt	Total less than 100m Average thickness & Tonnage m	Mt	Total less than 120m Average thickness & Tonnage m	Mt
260W	1.42	0.89	2.4	0.91	3.0	0.91	3.5	0.93	3.8
255W	1.49	2.57	3.2	2.51	3.7	2.51	3.7	2.51	3.7
250W*	1.56	1.47	4.6	1.45	5.6	1.43	6.6	1.44	6.4
249W	1.56	0.50	0.1	0.50	0.1	0.50	0.2	0.50	0.2
240W*	1.43	0.91	3.6	0.88	4.4	0.87	5.0	0.86	5.4
230W	1.35	0.50	1.1	0.49	1.2	0.49	1.2	0.49	1.2
220W	1.37	0.62	2.3	0.64	2.9	0.62	3.3	0.63	3.8
210W*	1.53	0.77	2.3	0.77	3.0	0.78	3.5	0.77	4.1
205W*	1.50	1.09	1.3	1.09	1.6	1.07	1.8	1.07	1.8
190W	1.43	1.06	2.9	1.29	5.3	1.26	7.2	1.32	8.5
180W*	1.55	0.39	1.0	0.41	1.9	0.41	2.4	0.41	2.7
175W*	1.55	0.88	0.4	0.88	0.6	0.87	0.8	0.90	1.0
170W*	1.41	0.39	0.8	0.39	1.5	0.37	1.8	0.38	2.0
160W*	1.58	0.89	3.3	0.98	5.7	1.02	7.7	1.03	8.8
150W	1.55	0.37	0.3	0.36	0.6	0.40	0.9	0.39	1.0
140W	1.34	0.43	1.2	0.43	1.9	0.44	2.6	0.44	3.1
130W	1.35	0.56	1.7	0.56	2.5	0.56	3.5	0.57	4.2
120W*	1.52	1.20	4.4	1.23	6.6	1.22	9.1	1.23	10.8
105W*	1.47	2.29	8.2	2.31	12.4	2.31	16.4	2.28	20.3
75W*	1.49	1.99	3.2	1.96	5.5	1.94	7.5	1.85	10.2
70W	1.46	1.39	1.5	1.34	2.0	1.31	2.8	1.30	3.0
60W*	1.52	0.46	0.7	0.46	0.8	0.46	1.0	0.43	1.9
55W*	1.56	1.01	1.0	1.04	1.5	1.03	1.9	1.03	2.1
50W*	1.65	0.53	0.6	0.52	0.9	0.54	1.2	0.53	1.5
25W*	1.54	0.83	1.8	0.82	2.6	0.80	3.4	0.78	4.0
TOTAL			53.9		77.6		98.4		115.5

NOTES:
1. No allowance made for sterilization beneath railway lines, batter slopes, offset from lease boundary, or proximity to old colliery workings. However the old workings on 75W are excluded.
2. Resource contains some coal with raw ash greater than 35% adb (*)
3. Figures may not add due to rounding.
4. 311,000mE is a convenient geographic line west of all potential surface mineable coal.

2.8 COAL RESERVES

The mining plan features two pits (Plate 2.8.1) which were designed to produce from 41.4Mt of insitu coal about 25.8Mt of product coal and to have total overburden stripping ratios of less than 4.9bm^3 of overburden per tonne of raw coal. Pit boundaries were offset 50m to 100m from Authorisation and railway boundaries and conservative batter slopes of 53° were adopted. Maximum Pit depth is 120m.

The geometry of the deposit:

- the excessive number of individual coal beds;
- the predominance of thin coal beds throughout most of the sequence;
- the presence of thicker coal beds (plus 1.5m) at the base of the sequence such that these beds must generally be recovered if acceptable mining ratios for the whole stratigraphic sequence are to be achieved;
- the distribution of high ash coal (greater than 35% raw adb) throughout the sequence but especially where it occurs in the three thicker lower seams which results in lower product yield reducing the advantage of the thicker coal bed;
- the rate of change of overburden ratios from coal bed to coal bed as a result of variation of interburden thickness and/or thinning of the lower coal bed in some areas, not to forget the cumulative impact of this on the upper coal beds;
- the maximum depth deemed mineable by truck and shovel;
- the structure of coal beds;
- the position of the Main Northern Railway through the centre of the most obvious open cut target area and as a consequence the method of excavation of the deposit required and an imposed physical limit on east-west extent of mining with batter slopes off the railway easement; and
- the position of old workings in the most likely lowest economic coal bed (75W) with generally renders that area and what coal is located above at uneconomic overburden ratios of up to 15 to 1 on a raw coal basis;

causes constraints to be imposed on the approach to successful development of the Project. As such it is not considered practical to determine reserves for this operation by selecting a limiting line ratio outlining the pit areas (10 to 1 linear overburden to coal, 7 to 1 volume of overburden to tonnes of raw coal, 10.3 to 1 volume of overburden to tonnes of clean coal F1.6 at the 67% yield of this coal to encompass the reserves to be recovered at some total pit ratio.

In selecting the pit areas iterative studies of several mine configurations were undertaken based on the assumption that the Project could support an overall operation handling a cumulative overburden to tonnes of raw coal ratio of up to 4.9 to 1. This equated to a 7.3 to 1m^3 of overburden to tonnes of clean coal based on F1.6 analytical data.

At various points around the pit boundaries the cumulative limiting line ratio of overburden to tonnes of clean float 1.6 on the basal coal bed mined varies from 4 to 1 to 10 to 1bm^3/t.

The selection of the 4.9 to 1 ratio was based on studies by CMPS and MMCC on the cost of mining (arising from the equipment deemed necessary as a result of the geometry of the deposit and a minimum production rate) and the likely projections of future coal prices. These inputs were computed together with production rates based on maximising the equipment selected and downstream smoothing of tonnages to be processed from the variable individual coal bed tonnages and quality comprising the scheduled ROM material. The final saleable product was targeted as 1.35Mtpa after scale up.

Mining to an overburden pit ratio limit allows the North Pit to be mined from interval 210W to 55W and the South Pit from 260W to 105W.

Table 2.8.1 summarises the insitu surface pit mineable reserves by coal bed on a including/excluding 35% adb ash basis. The DM&E does not consider coal in excess of 35% ash to constitute a reserve. However for practical mining reasons such coal must be recovered to yield some saleable product. Royalties are paid on saleable production tonnages.

Table 2.8.2 further represents these figures specifically for each Pit plus presenting average Pit data for float 1.60 saleable coal product tonnage and calculated ash content.

TABLE 2.8.1

INSITU SURFACE PIT MINEABLE RESERVES (Mt) BY COAL BED

Coal Bed	North Pit (Mt) Including 35% Raw Ash Material	North Pit (Mt) Excluding 35% Raw Ash Material	South Pit (Mt) Including 35% Raw Ash Material	South Pit (Mt) Excluding 35% Raw Ash Material
260W	–	–	1.03	1.02
250W	–	–	4.56	4.45
249W	#	#	–	–
240W	#	#	2.77	2.77
230W	–	–	0.98	0.98
220W	0.02	0.02	1.38	1.38
210/205W	0.04	–	2.48	1.83
190W	0.68	0.63	2.19	2.19
180W	0.15	0.15	0.68	0.63
170/175W	0.36	0.19	0.48	0.48
160W	0.55	0.47	2.19	0.32
150W	0.06	0.02	–	–
140W	0.45	0.45	0.70	0.70
130W	0.81	0.81	0.79	0.79
120W	2.73	1.85	2.01	1.72
105W	5.31	5.31	2.60	2.60
70/75W	3.78	1.24	–	–
60W	0.29	0.29	–	–
50/55W	1.41	0.35	–	–
25W	–	–	–	–
Total‡	16.6	11.8	24.8	21.8

‡ Figures may not add due to rounding

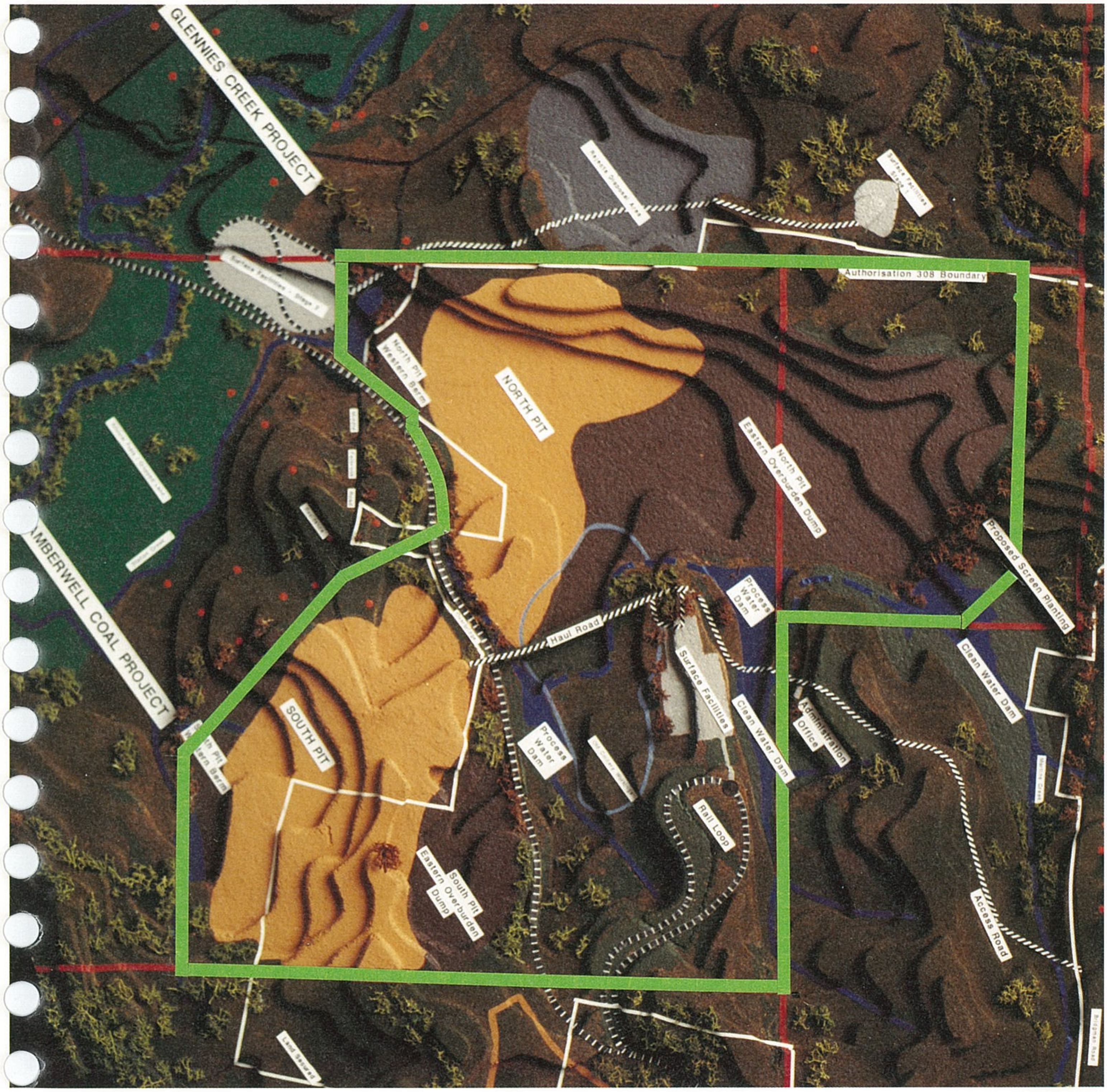
\# Very minor tonnage

Note Saleable reserves identified within this insitu reserve amount to 24.2Mt (8.5 Mt North Pit, 15.7 Mt South Pit)

TABLE 2.8.2

MINE RESERVES CAMBERWELL COAL PROJECT*

	Measured In Situ (Mt) Including +35% ash	Measured In Situ (Mt) Excluding +35% ash	Float 1.60 Clean Saleable (Mt)	Float 1.60 Ash % adb
North Pit	16.6	11.8	8.5	8.9
South Pit	24.8	21.8	15.7	9.2
TOTAL	41.4	33.6	24.2	9.1



Surface Lease Application area featuring position and extent of North and South Pits

PLATE 2.8.1

The float 1.60 clean saleable reserve figure of 24.2Mt in the above tables is based on slim core analytical yield data applied to the interpreted geology and insitu reserves defined by recorded coal bed thicknesses and analytical density. The 24.2Mt figure has been modified to 25.8Mt with more detailed large diameter sizing/mass/ash/studies by BMCH from four large diameter bores specifically sunk to assist BMCH in designing a coal preparation plant with more accurate predictions of the final handling characteristics of the coal including mass and ash likely to be produced from the selected equipment. The prinicpal aim of this work was to allow flexible design of the plant to cater for variation in plant feed.

Three of these bores were located in the North Pit and one in the South Pit. They are generally provided only one or two intersections of each coal bed to be mined but over 14 size ranges and 11 floats. Due to the thin nature of some coal beds insufficient material was available in several instances to produce full washability and size profiles for all core.

The nature of these studies does not readily allow comparison to the more numerous slim core data used to calculate the insitu resources and reserves. The preparation plant work not uncommonly shows that an increase in final product can be expected (in this case up to 7% more product). This increase occurs through the recovery of additional material of variable mass at different sizes and ashes through the various plant processes to produce up to three final coal products, compared to the single size yield and ash result as is commonly requested for a typical evaluation of slim borecore exploration seam samples at one or two nominated floats (in this case F1.60) for essentially one product.

The material sourcing the three final products cannot be simply reallocated to particular insitu coal beds or ROM reserve tabulations in this report. Instead the overall predicted increase in yield has been multiplied against the calculated insitu and ROM reserve values to raise that saleable figure to 25.8Mt. The quality characteristics of these final market products are presented in Section 2.9 and their projected sales volumes in Section 3.3.

Tables 2.8.3 and 2.8.4 present ROM coal tonnage, seam thickness, stripping ratios and product tonnage, yield and ash based on exploration borehole data as formulated in the Project Feasibility Study for both the North and South Pits.

To the northeast of the North Pit there is some potential for economic mining of limited additional coal tonnage but this possibility needs to be confirmed by further drilling. This area is separated from the North Pit by a zone of deep weathering.

The CCJV also recognises a potential for a limited strike length stripping operation (of some 1.5km length by 0.3km width) adjacent to and east of the Main Northern Railway and south of the North Pit to the southern boundary of Authorisation on coal bed 105W and perhaps 120W. However this also needs additional loxline drilling to confirm.

Should this additional southern reserve be proved, the South Pit out-of-pit spoil area could be repositioned over this strike length area after it is worked out, prior to working the South Pit. The CCJV is still considering the transfer of the South Pit spoil area to a portion east of the railway.

Drilling in this eastern railway zone may also prove that the overburden is suitable for construction material for the nearby proposed rail balloon loop and ROM and product coal stockpile earthworks. Winning such construction material from this area could enhance the potential for coal production.

Both these drilling programmes are scheduled for early commencement to ensure that potential resources are not sterilised before spoiling operations commence. The extension of mining operations and subsequent spoiling in these additional areas would have no significant adverse impacts or significant changes on impacts currently assessed for the Project concept due to CCJV land ownership of the area potentially affected by this additional mining.

TABLE 2.8.3

CAMBERWELL COAL PROJECT
NORTH PIT RESERVES – FEASIBILITY STUDY

	ROM Coal Strip Ratios		Overburden Volume Waste Mbcm			ROM Coal				Product Coal		
Coal Bed	INC	CUM	+5m	2-5m	–2m	Thick (m) *	ARD ‡	Tonnage (Mt)	Ash % §	Tonnage (Mt)	Ash % CF1.6	Yield % CF1.6
210/205	39.2	39.2	0.2	–	–	0.4	1.50	#	40.1	#	15.0	70.0
190	16.1	16.3	10.5	–	–	1.2	1.45	0.65	27.5	0.46	9.3	77.8
180	1.0	16.3	–	–	#	0.4	1.60	#	38.0	#	9.6	74.4
170/175	0.9	14.5	#	#	#	1.0	1.61	0.09	42.1	0.05	9.1	57.1
160	21.6	14.6	0.3	–	–	1.3	1.39	0.01	29.7	#	15.0	70.0
(150)								( )		( )		
140	29.9	14.9	0.5	–	–	0.5	1.44	0.02	26.0	0.01	6.5	94.1
130/135	23.4	15.7	2.0	#	–	0.6	1.47	0.09	29.0	0.06	7.5	81.6
120	14.8	15.1	41.4	0.1	0.1	1.5	1.58	2.80	38.3	1.55	9.1	58.6
105	0.4	6.6	0.5	0.5	1.1	2.7	1.47	5.06	27.8	3.41	9.1	70.0
70/75	1.7	5.1	4.4	1.4	0.4	2.3	1.58	3.68	38.1	2.02	7.5	57.4
60	2.0	5.0	–	0.6	0.4	0.8	1.65	0.50	45.0	0.26	10.8	60.9
50/55	2.6	4.8	1.9	1.2	0.2	0.9	1.65	1.25	44.4	0.63	10.6	56.4
Total**								14.2	34.7	8.5	8.9	63.3

Notes:
* Weighted average thickness over mine area after 6.5cm coal (roof) loss and 7cm stone (floor) dilution gain.
‡ Weighted average ROM density. Floor stone allocated density of 2.2.
§ Weighted average raw ash after floor contamination. Floor stone allocated 82% ash.
\# Minor amount.
** Figures may not add to rounding.
MRSRSR MINEX program reserves composited, combined, wasted, cleaned and diluted.

TABLE 2.8.4

CAMBERWELL COAL PROJECT
SOUTH PIT RESERVES – FEASIBILITY STUDY

Coal Bed	ROM Coal Strip Ratios INC	ROM Coal Strip Ratios CUM	Overburden Volume Waste Mbcm +5m	2-5m	–2m	ROM Coal Thick (m) *	ARD ‡	Tonnage (Mt)	Ash % §	Product Coal Tonnage (Mt)	Ash % CF1.6	Yield % CF1.6
260	25.3	25.3	26.5	–	–	1.0	1.46	1.05	24.5	0.79	8.2	84.4
250/255	4.1	8.0	18.3	–	0.6	2.1	1.53	4.62	34.2	2.83	10.6	64.5
249	–	–	–	–	–	–	–	–	–	–	–	–
240	2.3	6.3	3.6	1.3	0.6	1.2	1.46	2.44	27.6	1.69	8.8	75.9
230	1.0	5.6	–	0.1	1.0	0.6	1.51	1.11	32.3	0.70	7.9	78.4
220	4.9	5.6	1.0	5.1	–	0.6	1.42	1.22	23.4	0.92	7.2	90.7
210/205	5.3	5.5	10.1	2.3	0.9	1.0	1.57	2.51	36.6	1.47	8.0	65.6
190	12.0	6.5	26.2	–	–	1.5	1.45	2.18	24.0	1.67	11.0	82.0
180	2.9	6.3	–	1.3	0.7	0.4	1.62	0.69	40.2	0.38	9.2	70.6
170/175	3.8	6.2	–	1.3	0.5	0.4	1.52	0.48	32.7	0.31	7.1	88.8
160	0.8	5.6	–	0.5	1.2	1.3	1.65	2.07	42.0	1.06	11.5	55.2
150	–	–	–	–	–	–	–	–	–	–	–	–
140	10.4	5.8	6.1	1.4	#	0.5	1.45	0.73	24.6	0.52	6.4	89.7
130/135	3.9	5.7	–	3.0	0.1	0.6	1.48	0.80	25.8	0.59	7.8	89.9
120	0.5	5.2	–	–	0.8	1.3	1.60	1.93	37.3	1.07	8.4	60.3
105	2.4	5.0	4.9	0.9	#	2.1	1.49	2.46	27.4	1.70	8.7	72.5
Total**								24.3	31.6	15.7	9.2	72.1

Notes:
- * Weighted average thickness over mine area after 6.5cm coal (roof) loss and 7cm stone (floor) dilution gain.
- ‡ Weighted average ROM density. Floor stone allocated density of 2.2.
- § Weighted average raw ash after floor contamination. Floor stone allocated 82% ash.
- # Minor amount.
- ** Figures may not add to rounding.

MRSRSR MINEX program reserves composited, combined, wasted, cleaned and diluted.

TABLE 2.8.5

SUMMARY OF RESOURCES AND RESERVES – AUTHORISATION 81

RESOURCE AUTHORISATION 81

- Underground Insitu (indicated status) 59.8Mt
- Surface Insitu (measured status) 41.4Mt

RESOURCES IN PROPOSED SURFACE COAL LEASE APPLICATION AREA

- Underground Insitu 14.7Mt
- Surface Insitu 41.4Mt

RESERVES

Excluding >35% ash[§] material	Including >35% ash material, coal roof loss, stone floor gain
MINEABLE 33.6Mt (Table 2.8.2)	MINEABLE 41.4Mt (Table 2.8.2)
RECOVERABLE[*] 31.9Mt	RECOVERABLE[*] 36.9Mt
MARKETABLE[‡] 23.5Mt	MARKETABLE[‡#] 24.2Mt (Table 2.8.1)

§ >35% ash material not considered coal by DM&E for reserve calculations

* assumes 95% mining recovery factor, does not include floor dilution gain

‡ calculated from exploration CF1.60 yield assuming 100% washery recovery

\# **this marketable figure alternatively calculated by BMCH under a different set of basic data for their anticipated coal preparation plant operation design predictions as 25.8Mt.**

2.9 COAL QUALITY

Generally the product coal is of a good quality (low to medium ash, medium to high volatiles, low sulphur, high specific energy, high CSN) suitable for soft coking and/or steaming markets. Product coal from the same seams is already being sold by other Hunter Valley producers as soft coking, semi-soft coking and steaming coals.

Table 2.9.1 presents anticipated indicative specifications for each coal product. Tables 2.9.2 and 2.9.3 provide detailed descriptions of typical coal qualities for each product.

TABLE 2.9.1

INDICATIVE PRODUCT SPECIFICATIONS

	Soft Coking Coal	Semi-Soft Coking Coal	Steaming Coal
Size (mm)	–50	–50	–50
% Total Moisture	9.0 max	9.0 max	9.0 max
Air Dried Analysis :			
• % Moisture	3.0	3.0	3.0
• % Ash	6.5 (0.5 tolerance)	9.0 (0.5 tolerance)	15.0 max
• % Volatile Matter	36.5	35.5	34.0
• % Fixed Carbon	54.0	52.5	49.0
• % Sulphur	0.7 max	0.7 max	0.7 max
Gross Specific Energy (kcal/kg)	–	–	6700
(MJ/kg)			28.05
CSN	4-5	3-4	–
HGI	–	–	46
Ash Fusion Temps (°C) – oxidising atmosphere :			
• Initial Deformation	–	–	1320
• Spherical Deformation	–	–	1460
• Hemispherical Deformation	–	–	1480
• Flow Deformation	–	–	1530

The indicative product specifications are a balance between quality and an acceptable yield from the coal preparation plant.

A maximum ash content at 6.5% for soft coking coal is achievable. At such a level this coal would be superior to most coking coals currently marketed.

The ash content for semi-soft coking coals, at 9.0%, compares favourably with other semi-soft coking coals. The CSN for the semi-soft coking coal is higher than many coals being sold in this market, giving the Camberwell product a definite advantage.

The steaming coal at 15% ash and 6,700 kcal/kg gross specific energy is fairly typical of Hunter Valley steaming coal.

The design of the preparation plant will facilitate production of 6.5% plus 15.0% ash products, or 9% ash product, or 15% ash product at any given time.

Tables 2.9.4 and 2.9.5 show the range of a number of analytical tests for each coal bed within the confines of each of the North and South Pits.

TABLE 2.9.2

TYPICAL COKING COAL PRODUCT QUALITY

	Soft Coking Coal	Semi-Soft Coking Coal
Size (mm)	-50 + 0.5	-50 + 0.07
Proximate Analysis (Air Dried Basis)		
• % Moisture	2.9	2.9
• % Ash	6.5	9.0
• % Volatile Matter	36.5	35.5
• % Fixed Carbon	54.1	52.6
• % Sulphur	0.52	0.53
Ultimate Analysis (Dry Ash Free Basis)		
• % Carbon	82.5	82.5
• % Hydrogen	5.8	5.8
• % Nitrogen	1.9	1.9
• % Sulphur	0.6	0.6
• % Oxygen	9.2	9.2
CSN	4-6	4
Gieseler Plastometer Values		
• Initial Softening Temp (°C)	398	402
• Max Fluidity Temp (°C)	435	432
• Max Fluidity (ddpm)	75	70
• Solidification Temp (°C)	460	452
• Plastic Range Temp (°C)	62	50
Audibert Arnu Dilatometer Values		
• Initial Softening Temp (°C)	376	382
• Max Contraction Temp (°C)	425	433
• Max Dilation Temp (°C)	446	450
• % Max Contraction	27	26
• % Max Dilatation	8	–3
• % Total Dilatation	35	23
% Phosphorous	0.03	0.03
% Chlorine	0.01	0.01
Petrographic Paramaters		
• Mean Max Reflectance of Vitrinite	0.77–0.80	0.77–0.80
• % Vitrinite	74–80	74–80
• % Exinite	6–10	6–10
• % Inertinite	10–15	10–15
• % Mineral Matter	4–5	4–5

TABLE 2.9.3

TYPICAL STEAMING COAL PRODUCT QUALITY

	Steaming Coal
Size (mm)	-50 + 0.07
Proximate Analysis (Air Dried Basis)	
• % Moisture	2.9
• % Ash	14.6
• % Volatile Matter	33.5
• % Fixed Carbon	49.0
• % Sulphur	0.57
Ultimate Analysis (Dry Basis)	
• % Carbon	70.4
• % Hydrogen	4.9
• % Nitrogen	1.6
• % Sulphur	0.5
• % Oxygen	8.0
• % Ash	14.6
• % Chlorine	0.01
Gross Specific Energy (kcal/kg)	6750
(MJ/kg)	28.26
HGI	48
Abrasion Index	22
Ash Fusion Temp. (°C) – oxidising atmosphere	
• Initial Deformation	1320
• Spherical Deformation	1460
• Hemispherical Deformation	1480
• Flow Deformation	1530
% Phosphorus	0.03
% Chlorine	0.01
Forms of Sulphur	
• % Pyritic	0.21
• % Sulphate	0.03
• % Organic	0.33
Analysis of Ash Constituents	
• % SiO_2	55.10
• % Al_2O_3	25.70
• % Fe_2O_3	5.33
• % CaO	4.61
• % MgO	1.61
• % Na_2O	0.54
• % K_2O	1.33
• % TiO_2	1.44
• % Mn_3O_4	0.04
• % SO_3	3.12
• % P_2O_5	0.46

TABLE 2.9.4

COAL QUALITY VARIATION FOR COAL BEDS PROPOSED FOR MINING WITHIN THE NORTH PIT

Coal Bed	Raw Density Range	Raw Density Average	Raw Ash % adb Range	Raw Ash % adb Average	Yield % CF1.6 Range	Yield % CF1.6 Average	Ash % adb CF1.6 Range	Ash % adb CF1.6 Average	SE MJ/kg adb CF1.6 Range	SE MJ/kg adb CF1.6 Average	CSN CF1.45 Range
260W	–	–	–	–	–	–	–	–	–	–	–
255W	–	–	–	–	–	–	–	–	–	–	–
250W	1.62‡		42.3‡		64‡		12.7‡		NA		4.5‡
249W	1.40‡		25.0‡		70‡		11.5‡		NA		1.5‡
240W	1.35‡		12.8‡		94‡		8.9‡		30.2‡		3‡
230W	–	–	–	–	–	–	–	–	–	–	–
220W	1.39 – 1.48	1.43	21.5 – 29.3	24.5	75		8.0‡		30.4‡		5‡
210W	1.62 – 1.67	1.65	42.0 – 47.6	44.8	50 – 56	53	6.7 – 7.2	7.0	30.7 – 31.0	31.8	6‡
205W	–	–	–	–	–	–	–	–	–	–	–
190W	1.33 – 1.56	1.43	14.0 – 38.0	24.3	63 – 91	75	7.9 – 10.7	9.0	29.6 – 31.1	30.4	4 – 6.5
180W	1.44 – 1.51	1.48	27.5 – 32.9	30.0	66 – 77	73	8.3 – 9.6	9.1	29.8 – 30.5	30.0	4 – 5.5
175W	1.58 – 1.62	1.60	40.2 – 44.9	42.4	53 – 57	55	8.4 – 9.6	8.8	30.0 – 30.5	30.2	5 – 6
170W	1.29 – 1.33	1.31	8.2 – 13.3	10.1	66 – 77	71	6.1 – 7.1	6.4	30.5 – 31.0	30.7	2.5 – 7
160W	1.36 – 1.81	1.41	13.4 – 41.5	26.0	47 – 90	54	9.4 – 13.0	11.0	28.8 – 29.8	29.3	2 – 5.5
150W	1.39 – 1.69	1.53	20.5 – 37.5	31.1	48 – 81	62	10.4 – 12.0	11.0	–	29.4	1.5 – 4
140W	1.27 – 1.35	1.31	6.5 – 14.7	10.0	88 – 99	95	5.9 – 8.6	7.0	30.2 – 31.3	31.0	2.5 – 6
135W	–	–	–	–	–	–	–	–	–	–	–
130W	1.28 – 1.74	1.36	7.0 – 26.8	12.8	78 – 96	91	4.9 – 8.1	6.9	30.2 – 31.7	31.0	3 – 6.5
120W	1.45 – 1.74	1.46	28.2 – 40.2	32.1	54 – 71	63	7.9 – 10.3	9.0	30.0 – 31.0	30.4	4.5 – 6.5
105W	1.40 – 1.61	1.44	21.0 – 31.8	25.6	65 – 77	72	8.2 – 11.3	9.2	29.8 – 31.0	30.6	2 – 6
90W	–	–	–	–	–	–	–	–	–	–	–
80W	–	–	–	–	–	–	–	–	–	–	–
75W	1.47 – 1.63	1.52	31.3 – 45.1	37.5	49 – 62	59	6.4 – 8.8	7.7	30.8 – 31.4	31.0	5 – 6.5
70W	1.35‡		7.8‡		93‡		6.1‡		31.2‡		NA
60W	1.41 – 1.50	1.45	21.6 – 27.7	25.4	70 – 80	77	9.9 – 12.4	10.5	29.7 – 30.3	29.8	2.5 – 4.5
55W	1.42 – 1.75	1.59	20.9 – 54.8	38.3	48 – 84	56	9.4 – 11.4	10.6	29.4 – 30.5	29.8	3 – 5.5
50W	1.63 – 1.75	1.70	43.1 – 47.5	45.4	43 – 51	48	9.6 – 10.6	10.3	29.5 – 30.0	29.8	4 – 4.5

NA not available
‡ Limited coal bed area and/or data.
The specific energy range of values tabulated here (28.8-31.7MJ/kg) equates to 6,880-7,570 kcal/kg

TABLE 2.9.5

COAL QUALITY VARIATION FOR COAL BEDS PROPOSED FOR MINING WITHIN THE SOUTH PIT

Coal Bed	Raw Density Range	Raw Density Average	Raw Ash % adb Range	Raw Ash % adb Average	Yield % CF1.6 Range	Yield % CF1.6 Average	Ash % adb CF1.6 #Range	Ash % adb CF1.6 Average	SE MJ/kg adb CF1.6 Range	SE MJ/kg adb CF1.6 Average	CSN CF1.45 Range
260W	1.36 – 1.62	1.40	11.0 – 37.1	19.7	73 – 94	83	7.4 – 10.0	7.7	29.5	guess	1 – 3.5
255W	1.45 – 1.55	1.50	28.2 – 36.2	31.6	60 – 69	66	9.6 – 10.4	10.0	29.4 – 30.1	29.8	2.5 – 4.5
250W	–	–	–	28.5	59 – 77	69	9.6 – 12.5	11.2	30.3 – 30.9	30.6	2 – 3.5
249W	–	–	–	–	–	–	–	–	–	–	–
240W	1.36 – 1.49	1.42	16.9 – 31.8	20.5	67 – 81	75	8.0 – 10.6	8.0	29.8 – 31.2	30.5	2.5 – 6
230W	1.26 – 1.55	1.33	9.6 – 27.2	14.5	67 – 98	88	6.1 – 8.6	6.9	30.0 – 31.5	31.0	1.5 – 6
220W	1.29 – 1.45	1.33	7.9 – 26.0	10.9	74 – 97	92	6.2 – 8.2	6.8	30.2 – 30.5	30.4	4 – 6
210W	1.48 – 1.60	1.49	21.5 – 35.6	31.0	63 – 80	70	7.6 – 9.0	8.2	30.1 – 31.0	30.5	4.5 – 6
205W	1.42 – 1.64	1.45	23.4 – 42.9	31.1	55 – 76	67	7.3 – 8.8	8.2	29.0 – 30.4	29.5	5.5 – 7
190W	1.35 – 1.48	1.42	14.8 – 33.6	20.3	65 – 86	82	8.9 – 13.1	10.6	29.5 – 30.6	30.2	3 – 6.5
180W	1.46 – 1.62	1.49	14.8 – 37.1	29.0	61 – 81	70	8.1 – 10.1	9.0	29.8 – 30.6	30.3	3 – 5.5
175W	–	–	–	–	–	–	–	–	–	–	–
170W	1.33 – 1.64	1.36	8.4 – 32.7	14.0	61 – 81	71	6.5 – 7.7	7.0	30.7 – 31.5	31.2	2.5 – 6
160W	1.49 – 1.71	1.61	29.1 – 44.9	36.6	49 – 66	55	10.2 – 13.3	11.2	29.5 – 29.9	29.7	4 – 5.5
150W	–	–	–	–	–	–	–	–	–	–	–
140W	1.28 – 1.43	1.35	6.0 – 23.2	9.6	78 – 96	92	5.7 – 7.3	6.3	30.5 – 31.7	31.3	5 – 6.5
135W	–	–	–	–	–	–	–	–	–	–	–
130W	1.33 – 1.44	1.36	8.2 – 19.1	13.3	81 – 97	90	6.7 – 8.6	7.8	30.3 – 31.7	30.8	5 – 6.5
120W	1.32 – 1.67	1.54	12.8 – 40.8	23.5	60 – 90	68	6.9 – 9.0	7.8	30.5‡		5.5
105W	1.42 – 1.52	1.45	22.4 – 28.5	23.0	70 – 77	73	8.0 – 9.3	8.7	30.6 – 31.1	30.7	5 – 6
90W	–	–	–	–	–	–	–	–	–	–	–
80W	–	–	–	–	–	–	–	–	–	–	–
75W	–	–	–	–	–	–	–	–	–	–	–
70W	–	–	–	–	–	–	–	–	–	–	–
60W	–	–	–	–	–	–	–	–	–	–	–
55W	–	–	–	–	–	–	–	–	–	–	–
50W	–	–	–	–	–	–	–	–	–	–	–

‡ Limited coal bed area and/or data.

The specific energy range of values tabulated here (29.0-31.7MJ/kg) equates to 6,920-7,570 kcal/kg

3. PROJECT DESCRIPTION

3.1 PROJECT CONCEPT

3.1.1 Outline

The Project concept provides for the production of 25.83Mt of clean coal from 38.47Mt ROM coal over a 20 year period.

The proposed mining concept[1] features two separate pits – a North Pit and a South Pit on opposite sides of the Main Northern Railway.[2] (Figure 3.1.1.) Summary details of the Project concept are detailed in Table 3.1.1.

An optimised mining concept has been designed utilising truck and shovel down to a maximum 120m depth. A typical mining block operational layout is shown in Figure 3.1.2.

Some of the principal mining assumptions are to:

- maximise economic extraction of coal reserves,
- apply a 60m barrier from the centre of the main Northern Railway under which coal resources are at stripping ratios too high for an economically viable operation,
- impose a maximum overall pit batter angle of 53° with 15m berms at appropriate locations,
- avoid rehandling of overburden and interburden wastes by disposing directly in final landforms,
- conduct in pit dumping whenever feasible to minimise haulage requirements and to minimise environmental impacts,
- adopt a minimum mining thickness of 0.3m for workable coal beds,
- include interburden or seam split material of thickness less than 0.3m between coals as ROM,
- use conventional mining equipment, and
- maximise the use of key equipment by adopting recent potential work practice changes which permit more operating days per annum and more effective shift arrangements.

Table 3.1.2 summarises the waste, ROM and product quantities for the North and South Pits.

The main equipment comprises a large shovel, a large and two smaller front end loaders (FELs) and compatible heavy haulage trucks. This equipment may operate up to 363 days/annum on overburden. Coal mining operations may operate up to 258 days/annum.

Operations commence in the North Pit with some prestrip operations in Year -1. Full scale operations are underway at peak waste production levels in Year 1.

In Year 6 the shovel will be transferred to the South Pit to commence prestrip operations on the thicker overburden. To facilitate this, the haul road and bridge over the main Northern Railway will be constructed in Year 5.

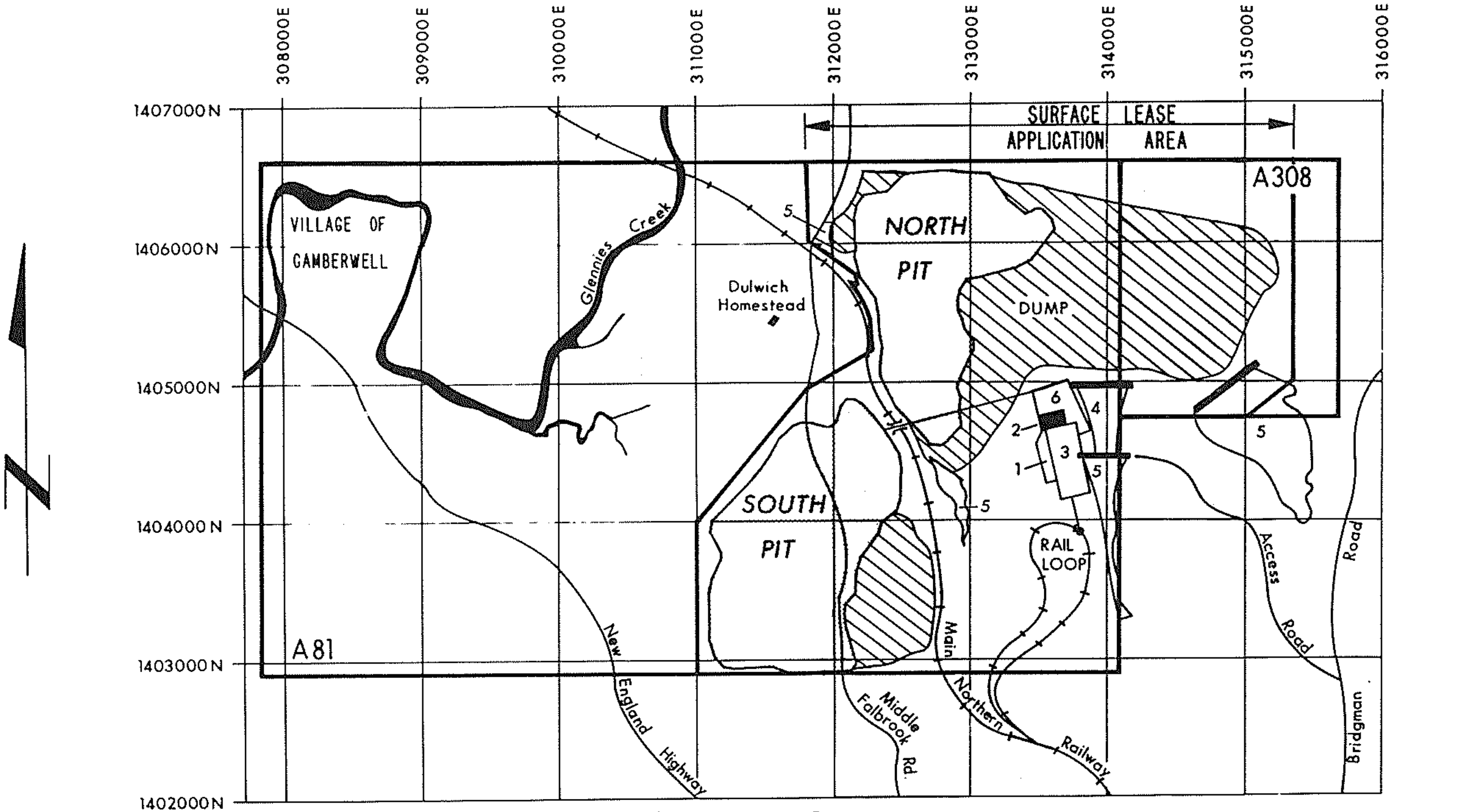
Coal extraction will be completed in the North Pit in Year 9 and commence in Year 6 in the South Pit, increasing annually to balance the gradually depleting production from the North Pit. After Year 10 coal extraction will only occur in the South Pit by which time much of the thicker overburden will have been removed.

Dumping and rehabilitation operations will initially be conducted in out-of-pit emplacements because it is not possible to commence significant in-pit disposal until towards the end of Year 3. The North Pit dump, which will generally follow mining progress where practicable, will remain operational until about Year 12 to provide disposal capacity for waste from the South Pit.

Details of mine and dump status in Years 1, 2, 5, 10, 13, 17 and 20 are presented in Figures 3.1.3 to 3.1.9.

1 The mine concept was the result of a planning process which employed various Engineering Computer Services (ECS) MINEX computer programs.

2 The North Pit exploits seams 210/205 to 50/55 with main benches at seams 105 and 50/55. The South Pit exploits seams 260 to 105 with main benches at seams 210/205, 120 and 105.



1. Raw Coal Stockpiles
2. Coal Preparation Plant
3. Product Coal Stockpile
4. Process Water Dams
5. Clean Water Dam
6. Site Facilities

CAMBERWELL COAL PROJECT	Date Aug.1989	Figure 3.1.1

PROJECT LAYOUT

TABLE 3.1.1
SUMMARY DETAILS OF THE PROJECT

Project Objective	To develop an environmentally sound open cut coal mine that will produce 25.8Mt of product coal over a 20 year life.
Area of Coal Mining Titles	Authorisation 81 23.3km² Authorisation 308 2.9km² Surface Mining Lease Application 11.5km²
Type of Operation	Open Cut – North and South Pits
Coal Reserves	25.8Mt saleable coal from 38.5Mt ROM coal
Mine Life	20 years
Mining Method	Truck and Shovel
Projected ROM Coal Output	38.5Mt
Projected Product Coal Output	25.8Mt
Range Max Annual ROM Production	1.72-2.17Mtpa
Range Max Annual Product	1.34-1.36Mtpa
Range Max Annual Waste Production	5.2-11.5Mbm³
Max Pit Depth	120m
Overall Pit Slope	53°
Buffer from Railway (centre line) to Pit	60m
Overburden Stripping Ratios	Raw Coal < 4.9bm³/t Clean Coal < 7.3bm³/t
Commencement of South Pit	Year 6
Railway Bridge Construction	Year 5
Raw Coal Transport	85t dump truck delivery to dump hopper
Overburden Transport	170t dump trucks to Year 4. 240t trucks From Year 5.
Coal Preparation Plant	Capacity 2.3Mtpa. Jig – two stage dense medium cyclones, two stage spirals.
Stockpiling Capacity	80,000t ROM. 120,000t Product (4 stockpiles) Emergency ROM and Product stockpiles
Tailings & Rejects Disposal	Dewatered coarse and fine rejects mixed together transported by 85t truck to waste dumps for disposal.
Coal Handling	Belt conveyors will transport coal from dump hopper to train load out facility.
Product Tonnages (averaged over mine life)	0.135Mtpa Soft Coking Coal 0.405Mtpa Semi-soft Coking Coal 0.810Mtpa Steaming Coal Total 1.35Mtpa
Transport to Port	Rail. 4.3km of new track will link the Mine with the Main Northern Railway.
Distance to Port	85km by rail.
Rail Loading	New Level 5 Balloon Loop facility
Train Unit	84 CHS wagons with net capacity of 6,400t.
Power	Existing 66Kv County Council line adjacent to Bridgman Road.
Water Supply	Site water sources – surface and ground waters; recycled site water. Make-up water periodically pumped from Glennies Creek.
Road Access	1.5km of new, sealed road to connect mine with Bridgman Road, 8km north of Singleton.
Personnel	Peak – 93 operators/shift: 188 operators/day Years 3-8 Total workforce 299.
Production Hours	3 x 8.5 hour shifts/day: 7 days/week. Coal extraction 6 days/week (up to 258 days/annum) Shovels, trucks, FELs up to 363 days/annum
Area of Disturbance	10km²
Blasting	Blasting up to 7 days/week Community will be advised of programmed time.
Topsoil Removal	Dozers and trucks for topsoil removal and distribution.

Initial waste material from both the North and South Pits will be used to create mounds for early establishment of visual and acoustic screening to the west of both operations where this is possible in the context of land ownership arrangements.

Except for early waste disposal in areas adjacent to the South Pit in Year 6, most waste generated to Year 13 will be disposed of in the North Pit dump because it is not possible to commence significant in-pit disposal until this stage.[3] From Year 13 all waste will be disposed of in the South Pit in-pit dumps. These dumps will be separated by the haul road, which remains operational until the end of the Project. A final void will remain when operations cease in Year 20 (Figure 3.1.9).

The main access ramp is positioned along the eastern side of each pit to take advantage of both seam structure and local topography, thus minimising ramp material excavation requirements. This position also minimises out-of-pit dumping and optimises coal haulage distances to any point on the northern end of the pit.

Bench widths in both pits will be about 80 to 100m due to the comparatively small pit areas and the need to provide sufficient coal inventory for blending purposes.

The key to the economic success of the mine is the full utilisation of the largest conventional equipment that can be deployed. While the Project has been designed around a truck and shovel operation, new technologies are still being appraised. Technologies such as the use of surface continuous miners, instead of truck and shovel, would be more desirable environmentally particularly concerning noise and dust generation. Their viability, however, is still being proved.

Suitable auxiliary equipment in the form of dozers, FELs and scrapers will excavate topsoil and thinner sections of overburden and interburden.

The economic stripping ratio which could carry the Project was determined as 4.9:1bm^3 of overburden to raw coal or 7.3:1 overburden to clean coal. Economies also dictate a three 8$^1/_2$-hour shift operation.

It is possible that future open cut mining or possibly underground mining could be conducted from the South Pit using Seam 105 coal bed as the base from which such operations could be staged. Further exploration may define additional coal, enhancing the economic prospects of a future shift to underground mining or may allow open cut areas to be extended.

3.1.2 Site Constraints

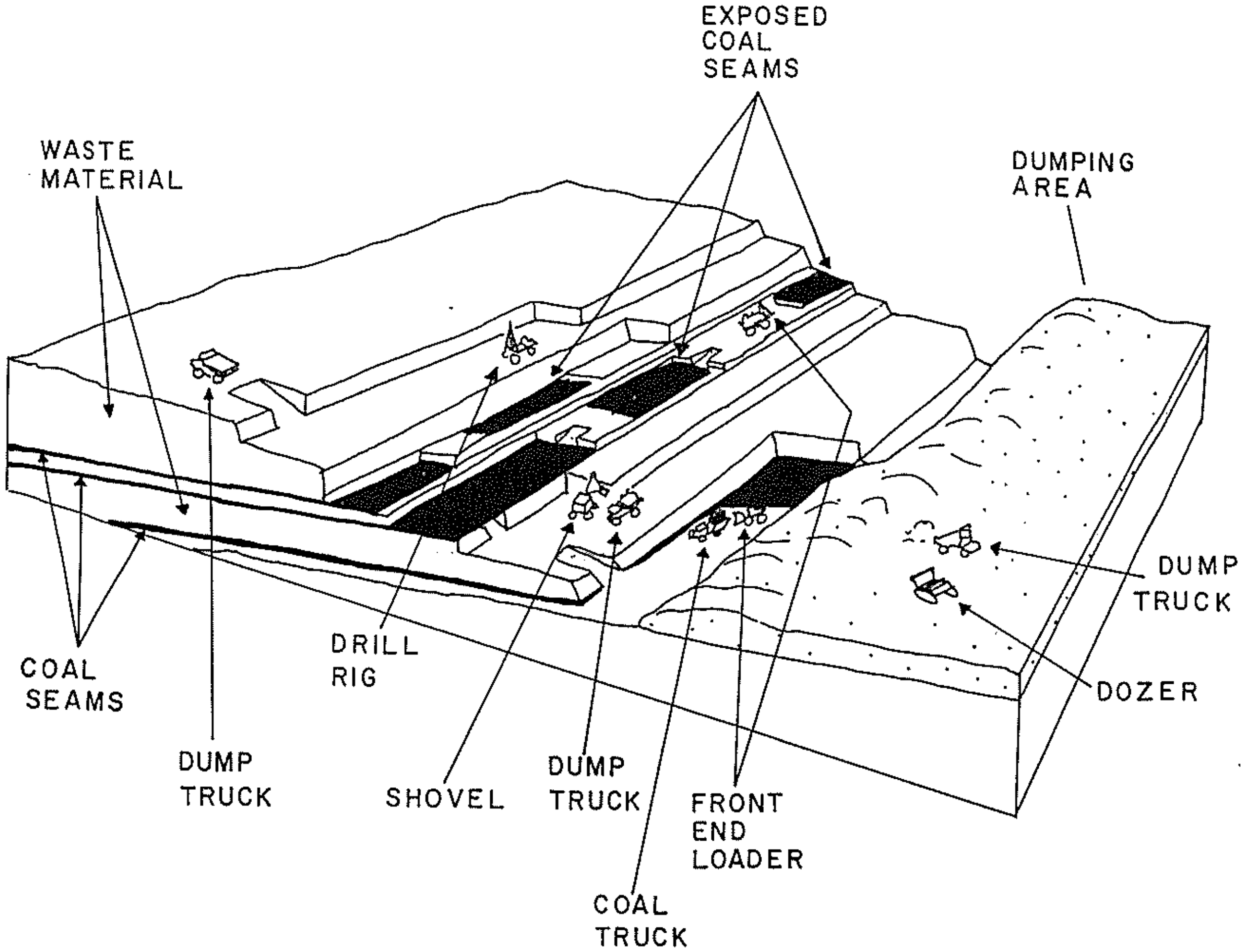
As identified in Section 2.1.1, a number of small collieries were operated down dip from the outcrops of the Upper Hebden (70/75) and the overlying Lower Barrett Seams (105). The areas are shown on Figure 2.1.1. The old workings have been taken into account in mine planning with only limited North Pit development of seam 105 in an area below which partial extraction took place in seam 70/75. Generally the mine plan avoids any former workings.

There will be no need to move the Main Northern Railway as an examination of the computed strip ratio maps indicate the absence of resource at favourable overburden ratios anywhere along the railway's route. In general, for all seams, raw and clean coal overburden stripping ratios are respectively greater than 4.9 and 7.3bm^3/t.

The North Pit is located mainly on lower topography within the Station Creek catchment, and accordingly, appropriate water management measures have been planned to cater for natural storm runoff and flooding and to prevent water pollution (see Section 5).

No mining will occur over any alluvial flats.

3 It is possible (indeed it is the CCJV's intention) to be able to dump up to 15Mt additional waste material within the South Pit. At this stage the Mining Plan is not sufficiently detailed to be able to verify this, hence this situation is defined as the "Target" and the removal of this material to the North Pit as the "worst case".



CAMBERWELL COAL PROJECT

TYPICAL MINING BLOCK DIAGRAM

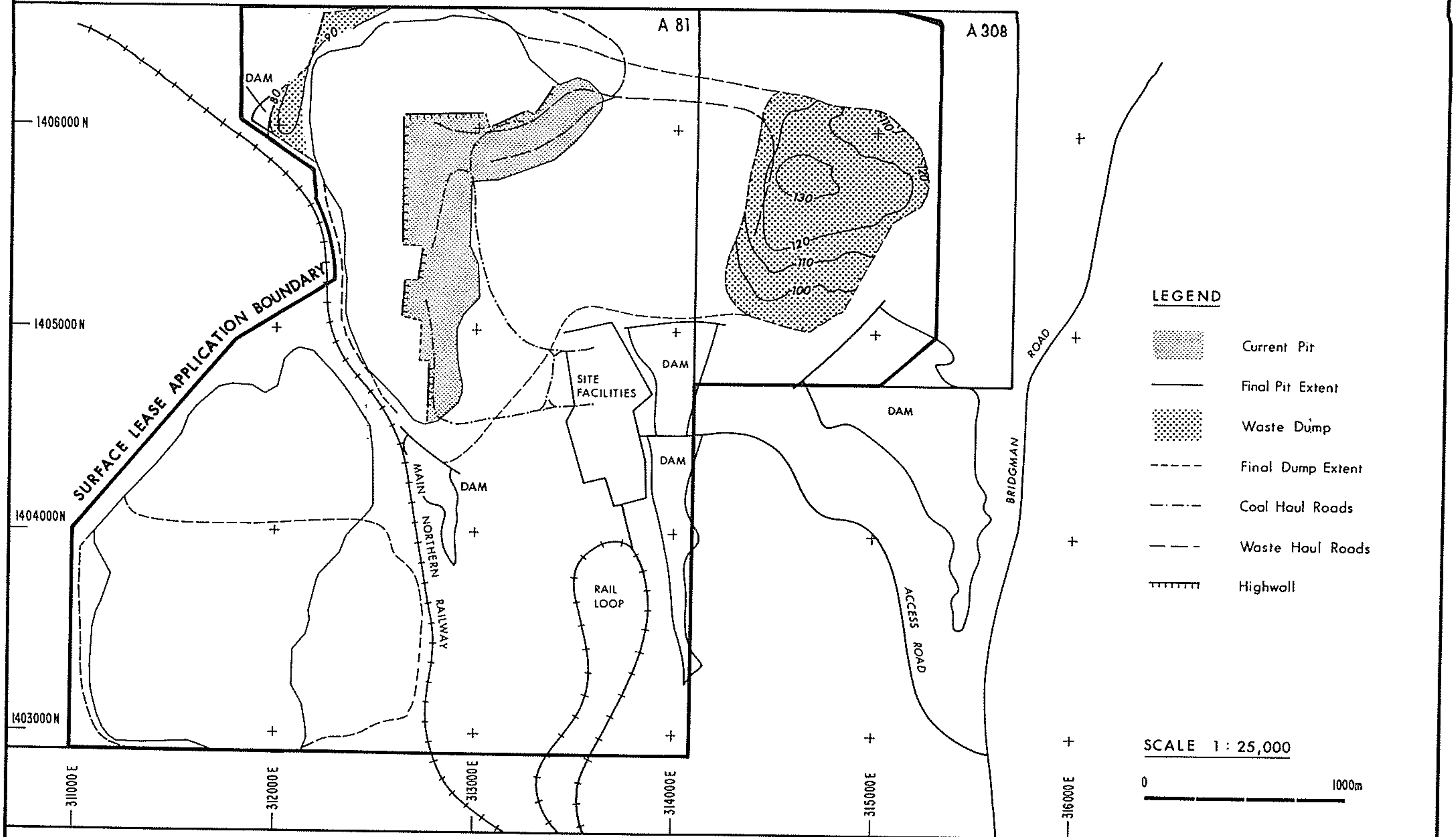
Date SEPT 88

Figure 3.1.2

TABLE 3.1.2

ANNUAL QUANTITY SCHEDULES

Pit	Year	Waste (kbm³) ≥5m	Waste (kbm³) 2-5m	Waste (kbm³) ≤2m	Total	ROM Feed (kt)	Product (kt)
North	-1	1,231.9	5.4	0.0	1,273.3	28.1	22.0
North	1	10,118.7	47.8	342.8	10,509.3	1,322.1	913.7
North	2	10,237.6	1,018.3	190.5	11,446.4	1,718.5	1,177.2
North	3	10,063.9	890.7	334.2	11,288.8	2,007.2	1,360.9
North	4	10,622.1	307.6	378.9	11,348.6	1,880.0	1,347.9
North	5	10,598.9	529.0	267.6	11,395.6	1,922.9	1,349.9
North	6	6,984.0	490.0	410.0	7,884.1	2,163.2	1,226.5
South	6	3,426.0	–	–	3,426.0	50.2	34.0
		10,410.0	490.0	410.0	11,310.1	2,061.6	1,346.2
North	7	449.7	44.9	235.6	730.2	1,224.2	749.6
South	7	9,602.3	807.8	231.1	10,641.2	784.8	509.3
		10,052.0	852.7	466.7	11,371.4	1,920.8	1,350.3
North	8	1,347.9	365.0	78.9	1,791.8	1,109.7	611.8
South	8	8,666.0	534.0	262.6	9,482.0	1,093.2	658.2
		10,013.9	918.4	341.5	11,273.8	2,078.2	1,350.8
North	9	–	116.8	–	116.8	199.9	100.5
South	9	8,960.2	1,111.8	383.3	10,455.3	1,884.8	1,160.2
		8,960.2	1,228.6	383.3	10,572.1	2,001.8	1,345.2
South	10	8,333.4	2,008.7	325.0	10,667.0	1,946.9	1,353.1
South	11	8,707.6	1,188.7	698.8	10,595.1	2,023.0	1,351.4
South	12	9,346.0	969.8	329.0	10,644.8	1,921.3	1,352.6
South	13	9,060.0	1,078.7	525.8	10,644.5	1,985.1	1,347.9
South	14	8,797.4	1,267.3	632.6	10,697.3	2,125.9	1,352.1
South	15	5,525.6	2,031.5	507.6	8,064.7	2,010.4	1,351.0
South	16	6,074.6	1,984.6	418.0	8,477.2	2,171.6	1,346.4
South	17	5,662.6	2,034.3	592.2	8,289.0	2,091.4	1,342.7
South	18	2,568.2	1,645.1	1,072.3	5,285.6	2,029.4	1,339.4
South	19	1,370.3	643.4	548.4	2,562.2	2,116.2	1,343.8
South	20	542.0	74.5	0.0	616.5	1,104.3	788.4
Total		158,337.0	21,215.1	8,765.2	188,317.1	38,466.6	25,832.9

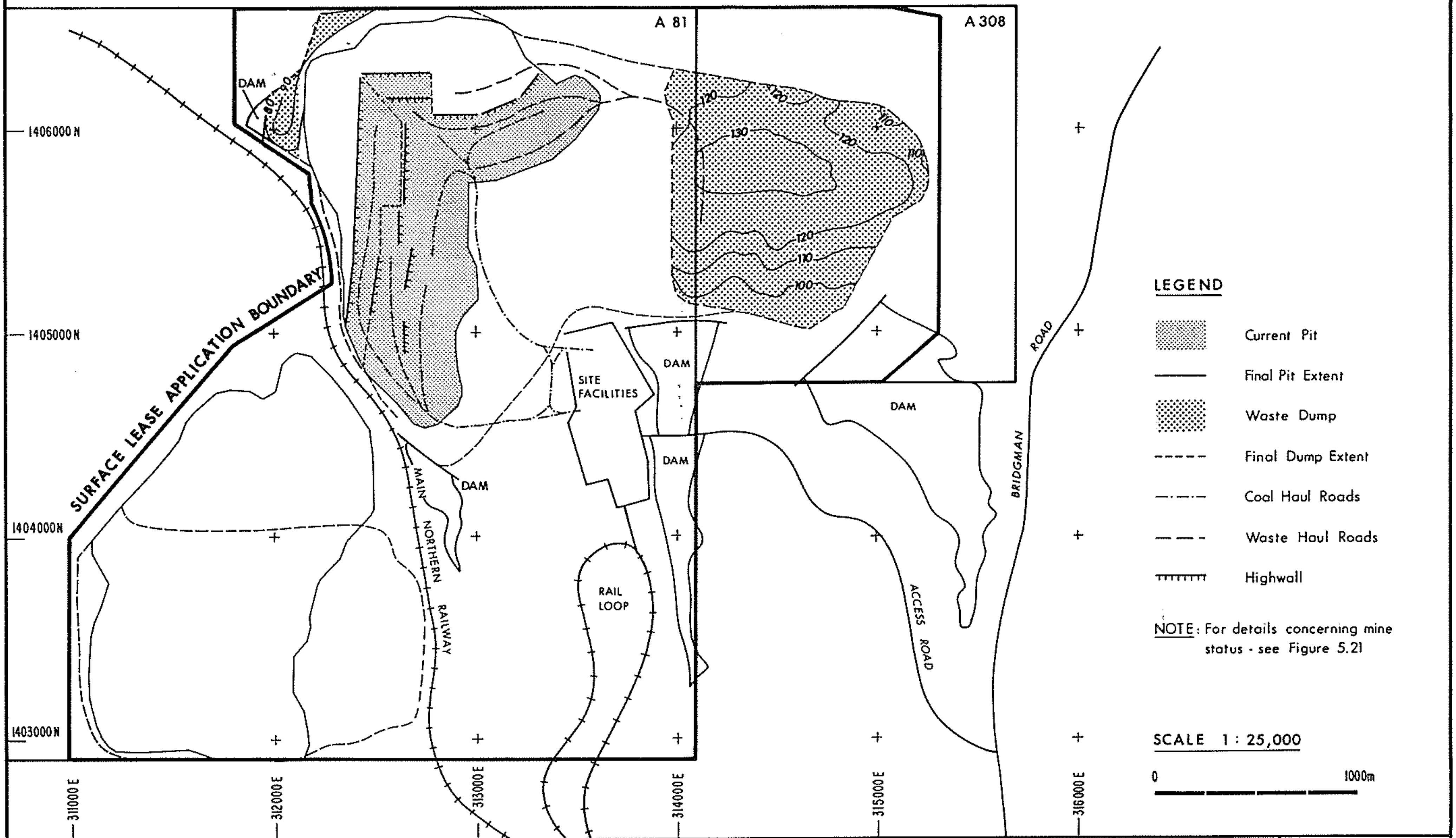


CAMBERWELL COAL PROJECT

Date

Figure 3.1.3

MINE AND DUMP STATUS (YEAR 1)

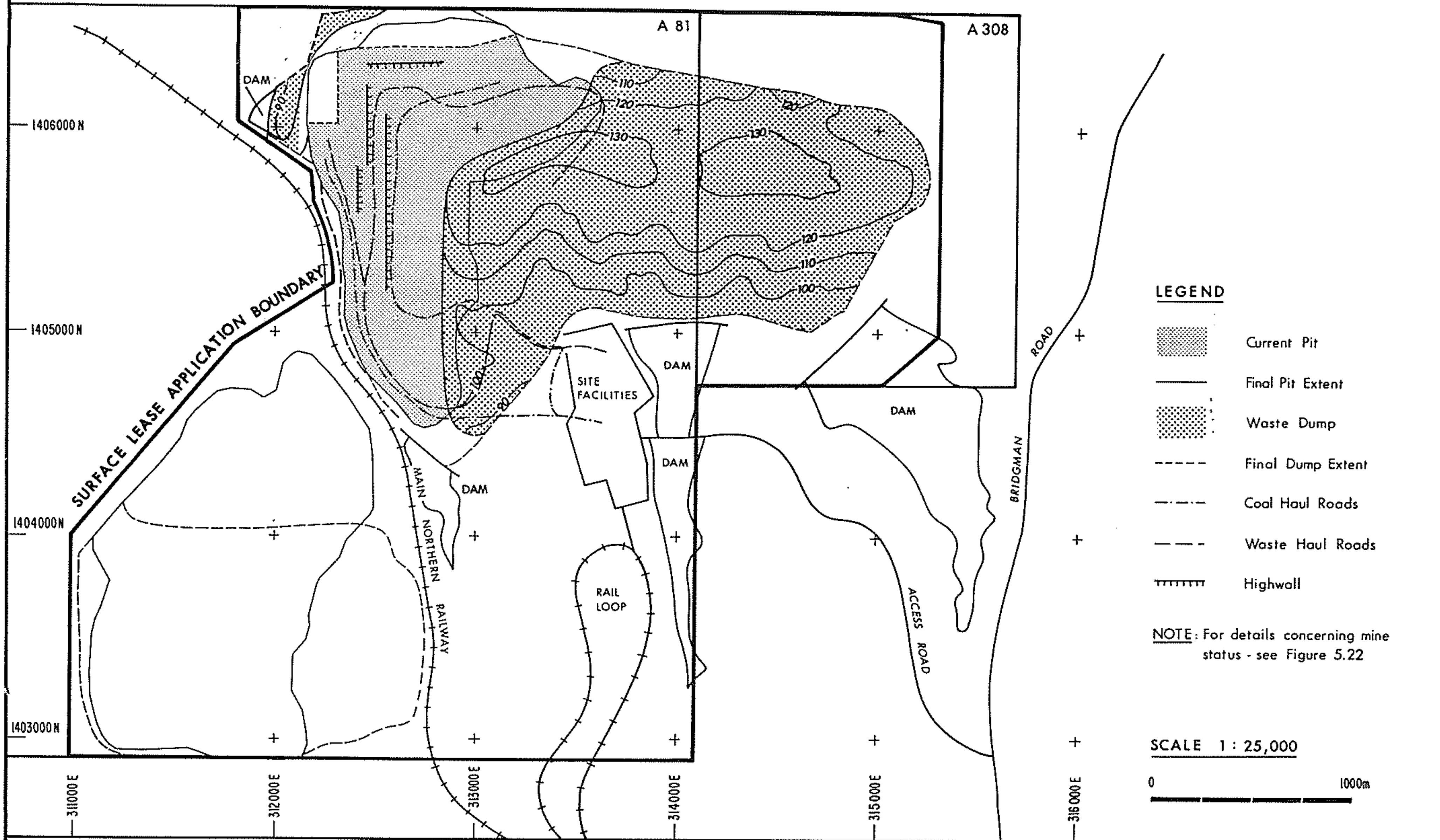


CAMBERWELL COAL PROJECT

Date

Figure 3.1.4

MINE AND DUMP STATUS (YEAR 2)

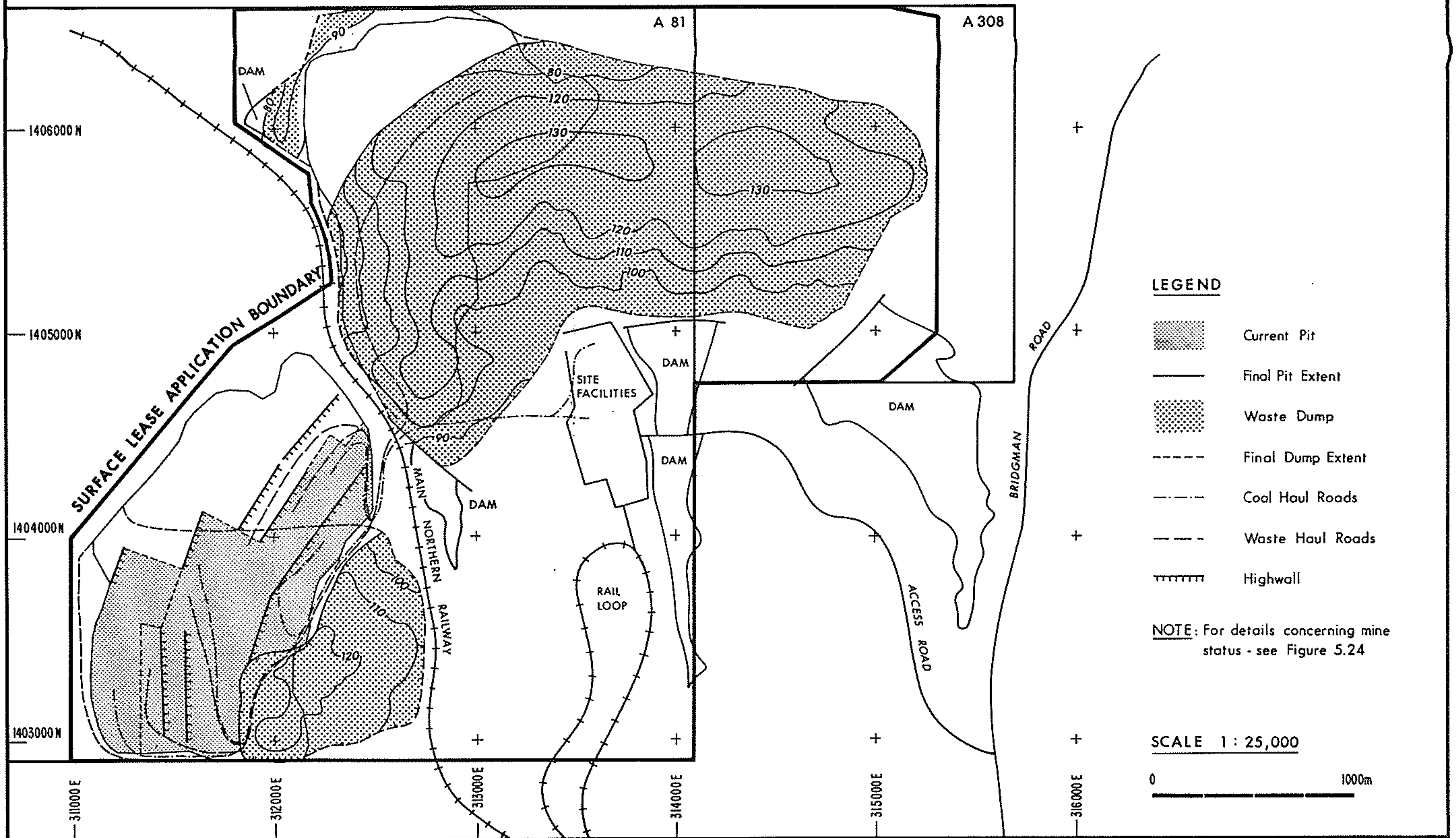


CAMBERWELL COAL PROJECT

Date

Figure 3.1.5

MINE AND DUMP STATUS (YEAR 5)

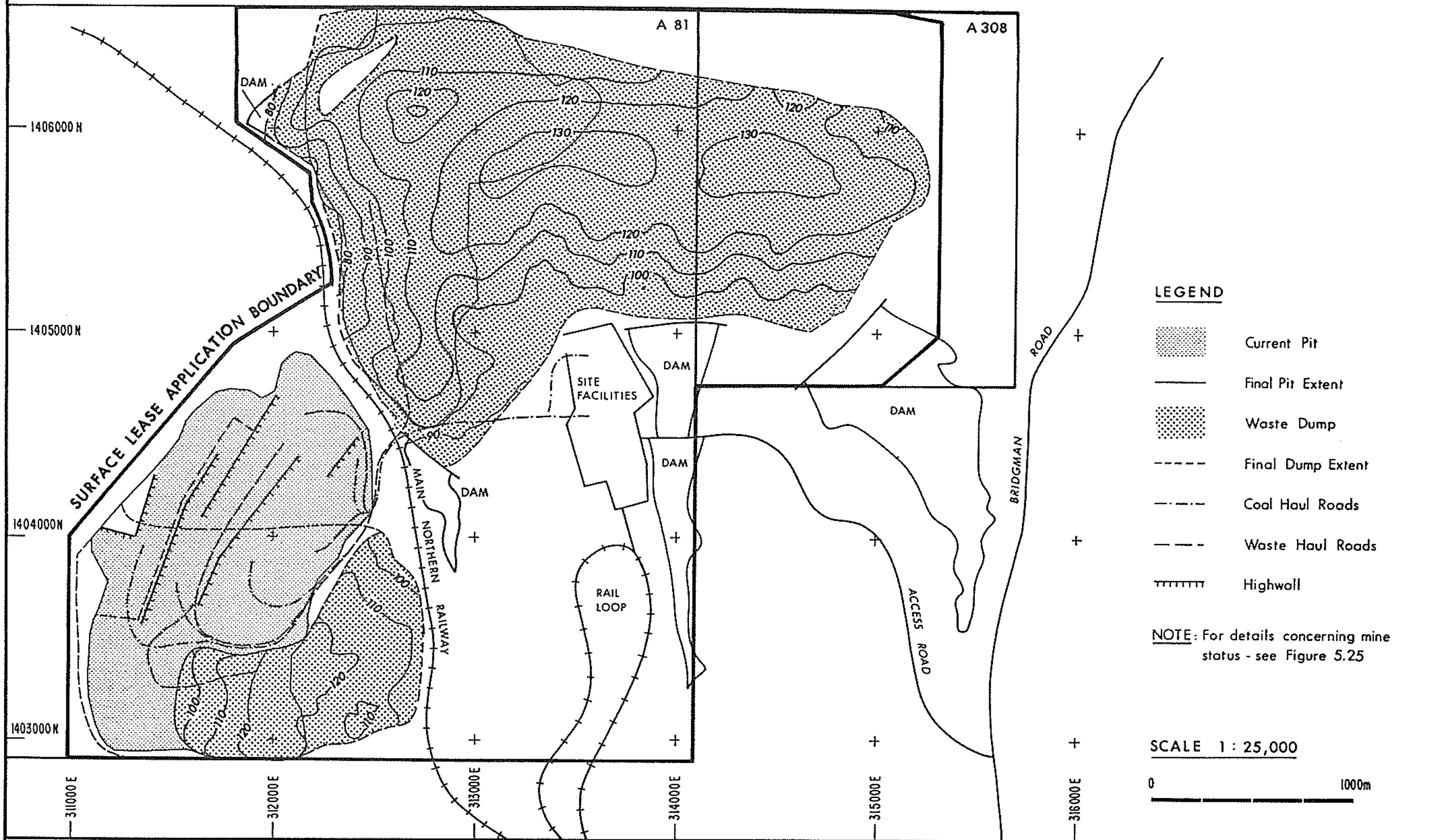


CAMBERWELL COAL PROJECT

Date

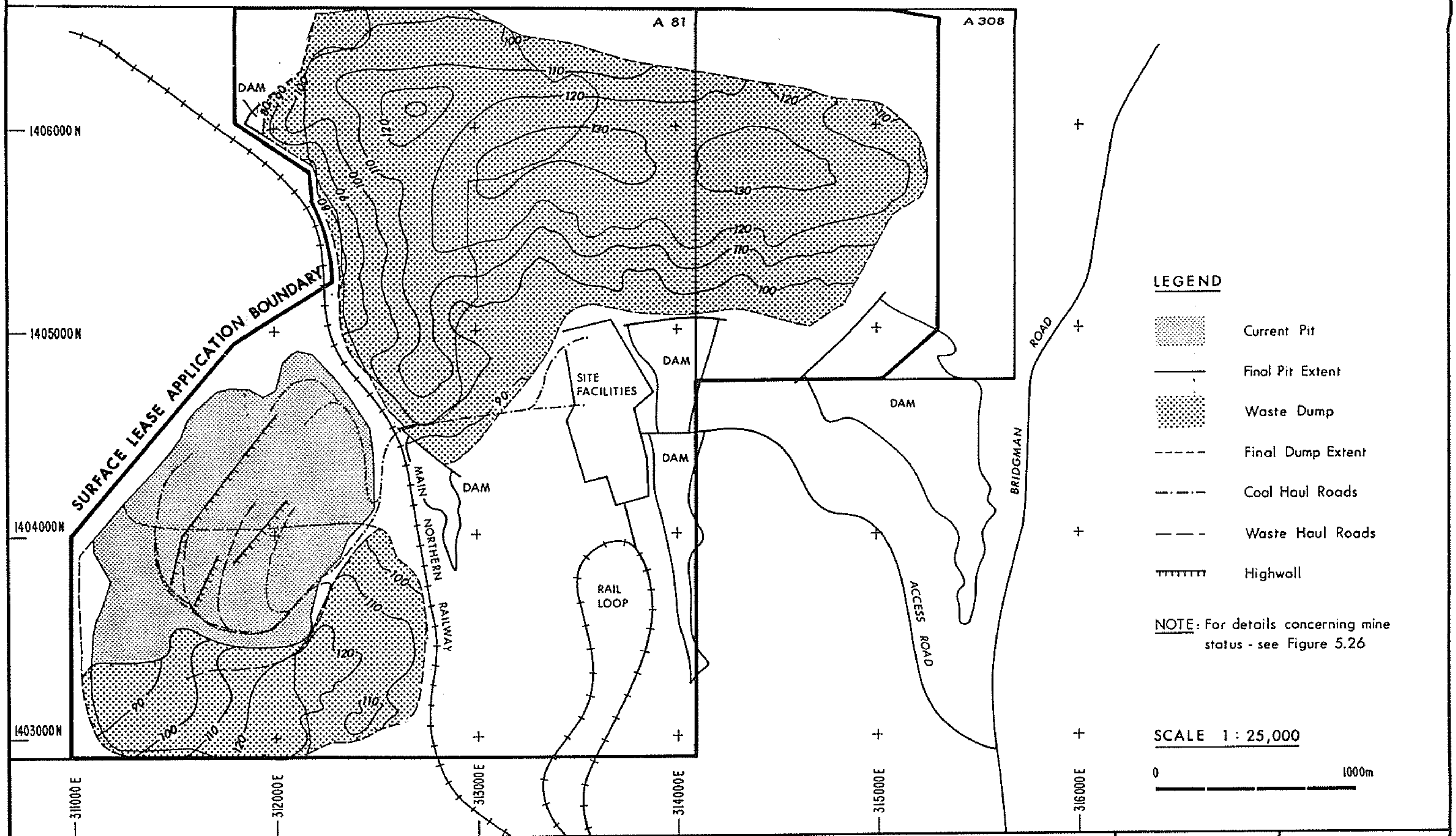
Figure 3.1.6

MINE AND DUMP STATUS (YEAR 10)



CAMBERWELL COAL PROJECT	Date	Figure 3.1.7

MINE AND DUMP STATUS (YEAR 13)

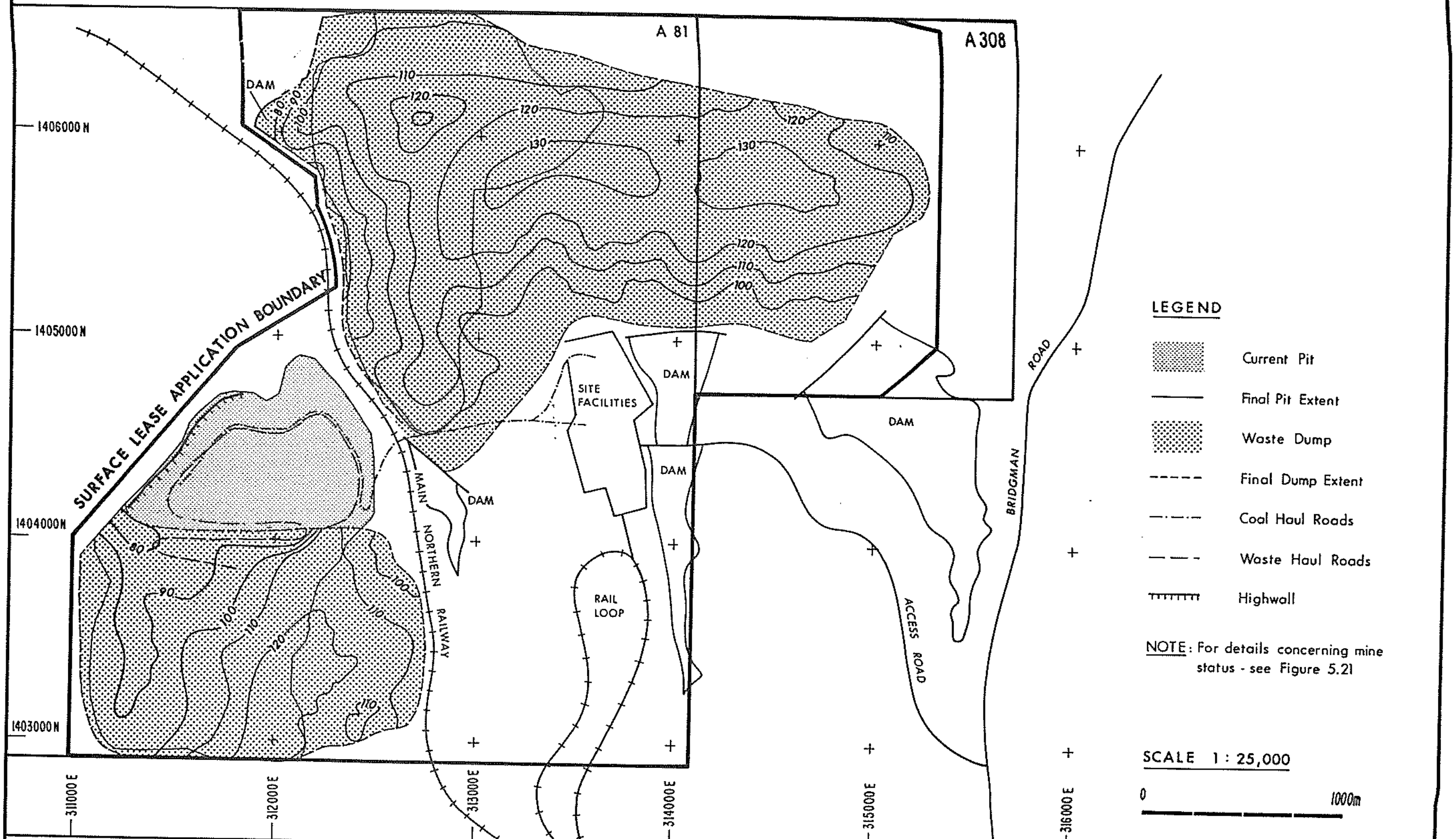


CAMBERWELL COAL PROJECT

Date

Figure 3.1.8

MINE AND DUMP STATUS (YEAR 17)



CAMBERWELL COAL PROJECT

Date

Figure 3.1.9

MINE AND DUMP STATUS (YEAR 20)

Wherever possible dust and noise generating activities associated with mining or materials handling have been located away from nearby residences. Appropriate pollution control measures have been adopted where practical. However, all directly affected properties and those with residences closer than 500m to mining activities have been acquired, are currently negotiating acquisition arrangements or have been approached by the CCJV to seek agreement for compensation or deferred payment with such owners who wish to remain on their properties.

3.1.3 Work Practice Implications

In September and October 1988, the Coal Industry Tribunal (CIT) varied the 1982 NSW Coal Industry (Miners) Award, to provide much greater flexibility in coal mine working arrangements.

Accordingly, project planning can now take advantage of the recent work practice changes which permit the following:

- overburden operations for 7 days/week with 2 compulsory public holidays (ie 363 days/annum),
- coal preparation and materials handling operations for 7 days/week with 2 compulsory public holidays (ie 363 days/annum),
- coal recovery at the mine and associated transport activity for 5 days/week with 2 compulsory public holidays and with a provision for make-up time for lost production on Saturdays (ie 258 days/annum).

If allowances are made for practical operational considerations (wet weather, strikes etc) it is realistic to adopt the following criteria for maximum effective production:

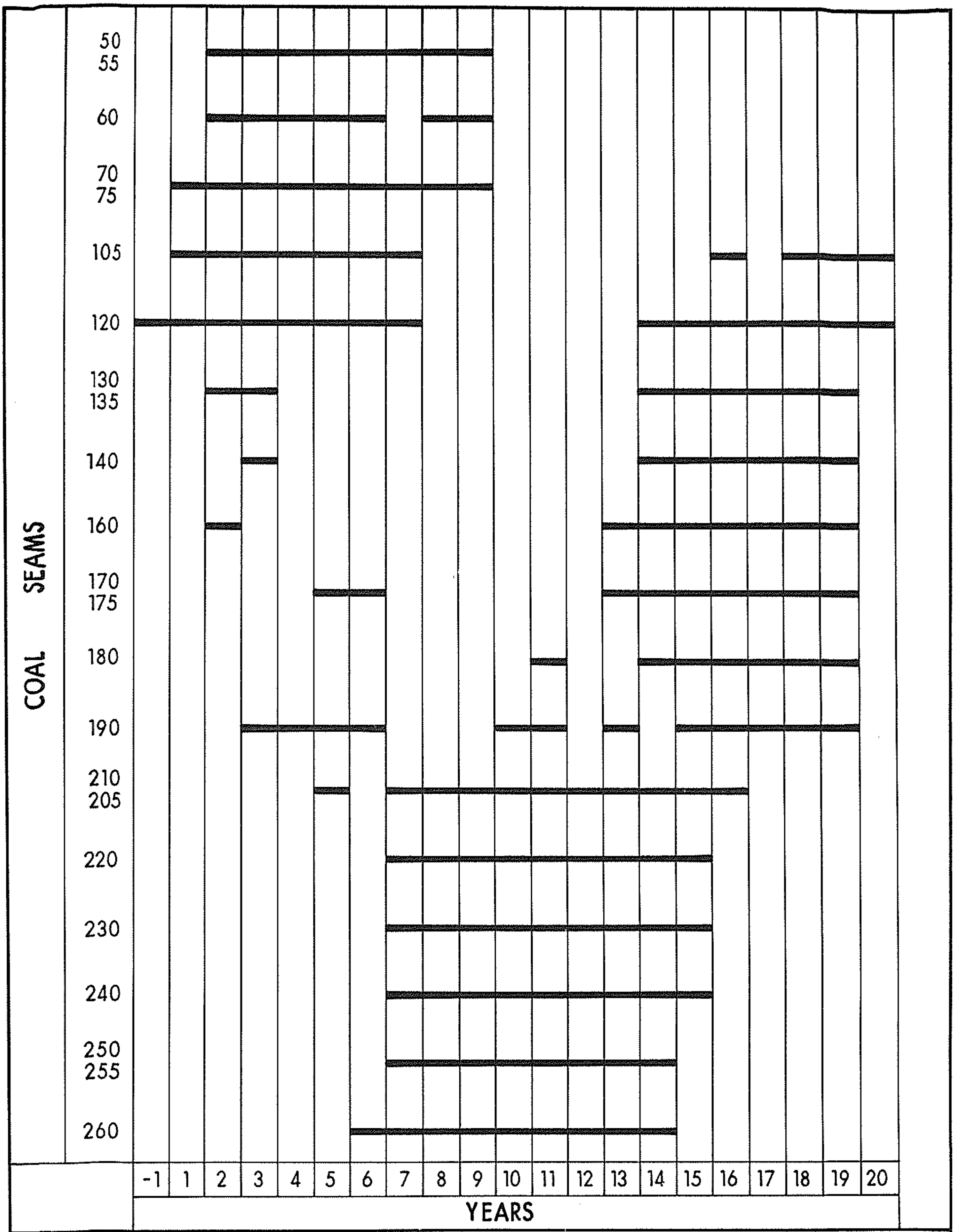
- overburden operations – 345 days/annum.
- coal preparation and associated coal handling operations – 353 days/annum.
- coal production and transport operations – 258 days/annum.

3.2 PRODUCTION RATES

Mining production rates with waste volume and clean coal tonnages are documented in Table 3.1.2. This coal seam development schedule is represented by Figure 3.2.1 and the coal production schedule by Figure 3.2.2.

To achieve production rates detailed in Table 3.1.2, loading equipment requirements are as listed in Table 3.2.1. This list uses brand and model names to illustrate plant able to perform the tasks specified. Equivalent machines from other manufacturers may be selected as being equally suitable. The electric shovel is not required to operate after Year 18. The Hough 580 type FEL and the two Cat 992C type FELs will be employed on overburden and coal. Table 3.1.2 shows that waste volumes vary between 10.51 and 11.45Mbm^3/year up to Year 14, with subsequent significant reductions down to 5.29Mbm^3/year in Year 18. Much lower volumes will be produced in the last two years.

Highly mobile coal mining equipment is required because in most years relatively small tonnages will be produced from individual coal beds. The range of annual maximum ROM coal outputs is 1.72 to 2.17Mtpa which can be catered for by one FEL. The proposed preparation plant, which has a design throughput of 2.3Mtpa has adequate capacity to handle this variability.

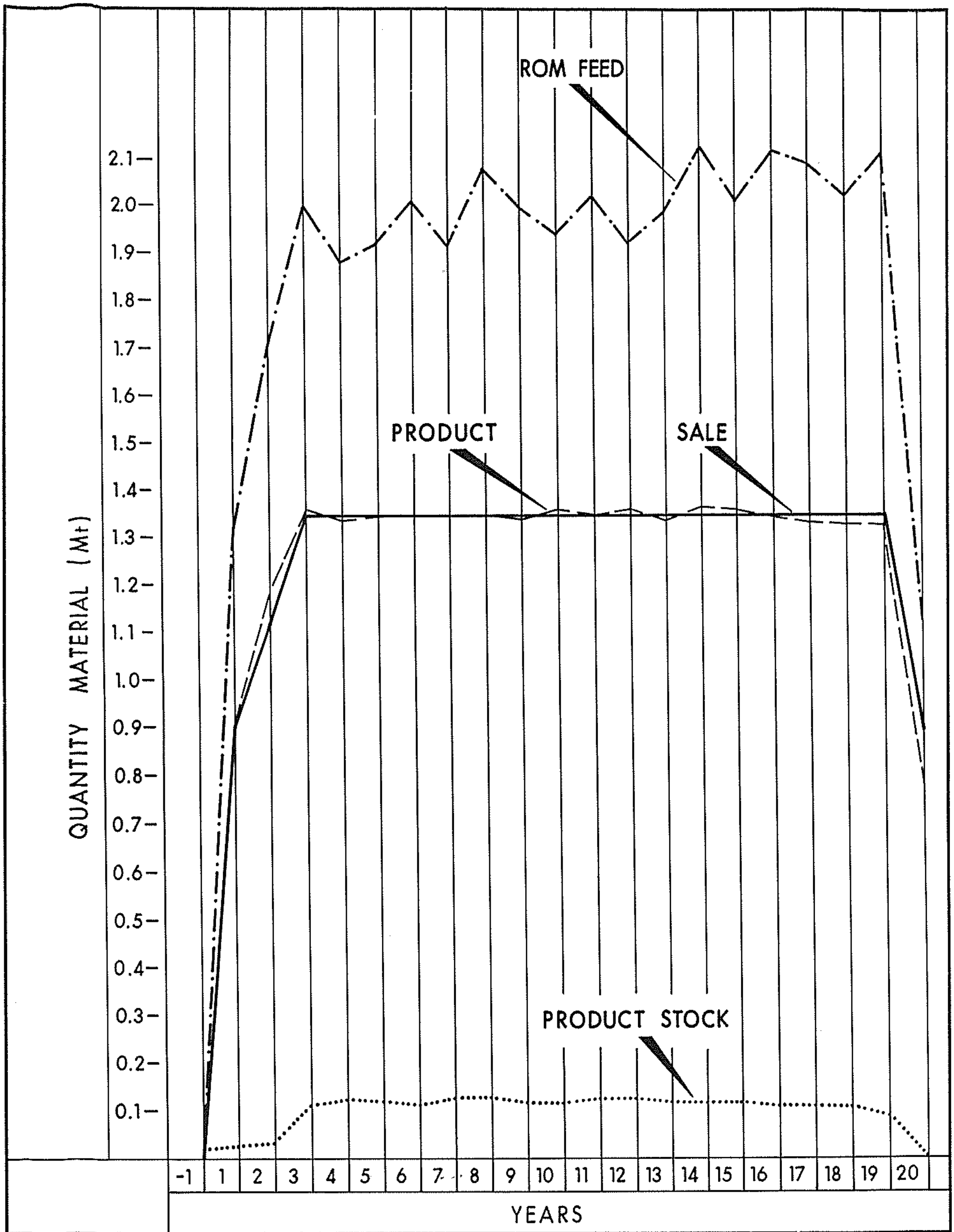


CAMBERWELL COAL PROJECT

COAL SEAM DEVELOPMENT SCHEMATIC

Date

Figure 3.2.1



CAMBERWELL COAL PROJECT

COAL PRODUCTION SCHEDULE

Date

Figure 3.2.2

TABLE 3.2.1.

OPEN CUT EQUIPMENT LIST*

Operation	Typical Machine	Number	Years of Operation	Shifts/Day
Thick Overburden Removal	Shovel P&H2800XP/A	1	-1 to 18	3
	Dozer 843B	1	-1 to 18	3
	Truck Cat 789**	8	-1 to 18	3
		2	19 to 20	3
	Dozer D11N	1	-1 to 18	3
Topsoil, Rehabilitation & Construction	Scraper Cat 637E	1	-1 to 20	3
	Dozer D11N	1	-1 to 20	3
Thin Overburden & Coal Mining	FEL Cat 992C	1	-1 to 20	3
	High Lift	1	2 to 17	3
	FEL Hough 580	1	-1 to 20	3
	Truck Cat 777B	3	-1 to 20	3
		3	1 to 20	3
	Dozer D10N	1	-1 to 20	3
Blast Hole Drilling & Shotfiring	Drill BE49R	1	-1 to 18	3
	Drill D45K	1	-1 to 20	3
Coal Preparation Stockpiles & Rejects	Dozer D10N	1	1 to 20	3
	Truck Cat 777B	1	1 to 20	3
Road Maintenance	Water Cart Cat 773	1	-1 to 20	3
	Spare Water Cart	1	-1 to 20	
	Grader Cat 16G	1	-1 to 20	3
	Spare Grader	1	-1 to 20	
General	Truck 10t	1	-1 to 20	2
	Fuel & Lube Truck	1	-1 to 20	2
	Light Vehicles	16	-1 to 20	3
	Transformers &Cables	1	-1 to 20	3

* Equivalent machines from other manufacturers may be selected

** Up to 240 tonne class truck

3.3 PROJECTED COAL SALES

Although Camberwell coal could be sold solely as a steaming product, it also has the capability of producing considerable quantities of soft and semi-soft coking coal products from both the coal preparation process as well as from specific coal beds.

The mining plan envisages saleable coal production as detailed in Table 3.3.1.

TABLE 3.3.1

SALEABLE COAL PRODUCTION

Year	1 (Mt)	2 (Mt)	3-19 (Mt)	20 (Mt)	Saleable Total (Mt)
Soft coking	–	–	0.135	–	2.295
Semi-soft coking	0.600	0.600	0.405	–	8.985
Steaming	0.300	0.500	0.810	0.883	15.453
Saleable Total	0.900	1.100	1.350	0.912*	25.833

* difference due to inventory stocks

The ratio of coking to steaming coal tonnage will show variation throughout the mine life because mining of the complex multiple seam Camberwell Project will result in variable ROM feed rates, reflecting the specific stage of development.

Over the Project life, total sales of about 26Mt are projected. Ignoring the first two years of capacity build-up this then averages 1.35Mtpa over 18 years of production.

It should be noted that stockpile inventory allowance accounts for any difference between production and sales rates.

3.4 OVERBURDEN AND INTERBURDEN REMOVAL

Table 2.5.1 presents average thicknesses of interburden material for each pit. It is estimated that 188Mbm^3 of waste overburden will be generated over the 20 year life of the mine. Figure 3.4.1 depicts the removal schedule over the 20 year period. Overburden/interburden in excess of 5m thickness will be removed by an electric shovel, of between 27.5 and 32m^3 capacity.

Sections less than 5m thick will be loaded out by a Hough 580 type FEL with 20.6m^3 bucket and Cat 992C type high lift FEL with 13.5m^3 bucket. Generally these thin sections will be ripped by bulldozers including a Cat D10N type dozer with a smaller drill being provided for occasional blasting[4]. Cat 777B type rear dump trucks are scheduled for use with the loaders.

The production rate requires a fleet of up to seven Cat 789 type trucks and up to seven Cat 777B type rear dump trucks. From Year 9, Cat 789 type trucks may be replaced by 240t dump trucks.

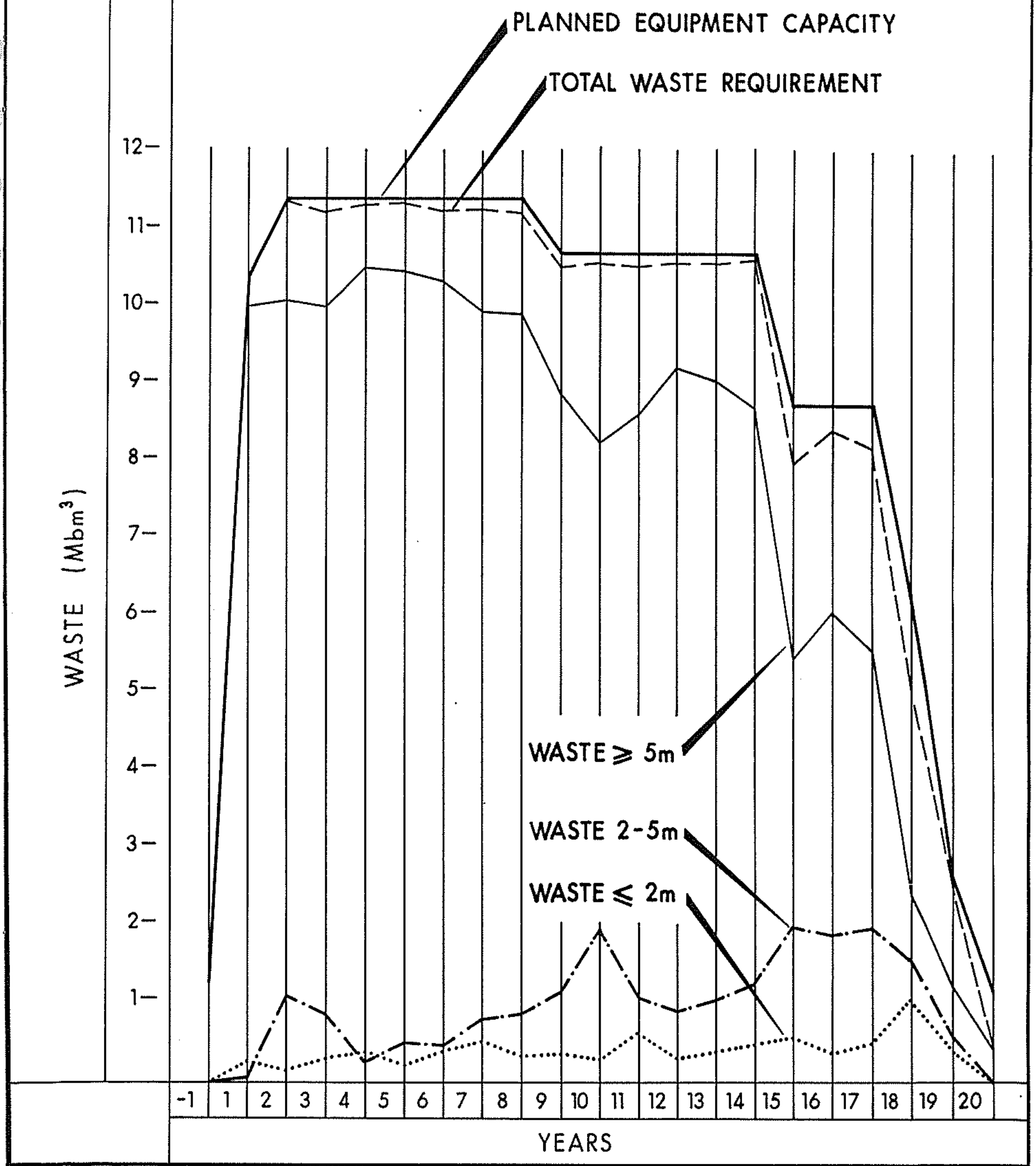
A Cat 637E type scraper will be used for topsoil removal and rehabilitation works.

3.5 COAL MINING

Coal mining will be undertaken using the same equipment as used for thin overburden removal. The system thus has the mobility and flexibility to maximise utilisation.

The thicker coal seams will be ripped while thinner seams will be pushed up by bulldozers, prior to loading. Coal recovery will be maximised and dilution minimised in this way. There will be no blasting of coal.

4 It is being assumed that all overburden less than 2m will be ripped, 50% of overburden 2 to 5m thick will be blasted and all overburden greater than 5m in thickness will be blasted.



CAMBERWELL COAL PROJECT

OVERBURDEN/INTERBURDEN REMOVAL SCHEDULE

Date

Figure 3.4.1

Rear dump trucks will deliver directly to the raw coal hopper located next to the preparation plant or to the adjacent stockpile.

These coal mining techniques are already well established at many mines in the Hunter Valley.

3.6 GEOTECHNICAL CONSIDERATIONS

Geotechnical and surface mining conditions assessed by ACIRL highlight the following:

- Rock joint spacing is reasonably close at the surface, and is expected to be wider with depth.
- Overburden is of average strength between 50MPa and 83MPa for coarse unweathered sandstone and fine sandstone respectively.
- Bulk overburden could be dug by rope shovel after blasting with powder factors of 0.3 to 0.6kg/m^3 ANFO equivalent explosive.
- Material less than 10MPa strength and more than 40 x 10^{-6} sec/m sonic interval is rippable, which may also be the case for thinly bedded or blast-loosened stronger rock.
- Working sections thinner than 2m will be ripped.
- Spoil pile stability should not present a major problem due to the high proportion of non-slaking sandstone in the overburden, and relatively flat floor dip of around 5°.

Significant inpit dumping can commence in Year 3 in the North Pit and in Year 13 in the South Pit. The dumped overburden will consist of typical Hunter Valley rudities, arenites and lutites.

Normal care will be taken to ensure that the low wall is not based on layers of clay or other unsuitable strata. Presplitting techniques will be used to ensure that there are smooth high walls without overhang due to underlying layers of lutite that are softer than the predominant arenites. A 70° high wall slope, with final 5m wide berms giving an overall slope of 53°, has been adopted.

3.7 INFRASTRUCTURE

3.7.1 Service Areas

The service area houses the site facilities complex. It will be situated to the east of the mine operations, approximately 1.5km from Bridgman Road and a further 8km from Singleton (Figure 1.1.1). Facilities include mobile plant repair, servicing, fuelling and standing areas, stores, bath house, offices and employee parking.

3.7.2 Site Access

Access to the Project site will be via a new sealed road connecting with Bridgman Road. The access road is approximately 1.5km long and terminates at the service area.

The Singleton Shire Council has advised that the width and pavement construction of Bridgman Road is considered to be satisfactory for construction and workforce traffic, and will not require upgrading, provided that the road is not used for coal haulage.

A 15m wide link road would connect the service area to a series of site roads which service the coal preparation plant, the stockyard/stockpile area, the train loader and the North and South Pits (Figure 4.1.1).

Middle Falbrook Road will not be used as access to the Mine Site. It will however need to be diverted to accommodate mine development. The deviation details will be determined in conjunction with Singleton Shire Council at the time relevant approvals need to be obtained. The CCJV is committed to maintaining suitable access arrangements for all current users of Middle Falbrook Road. Where existing arrangements are interrupted as a result of the Camberwell Mine development, an alternative deviation route will be provided as required.

3.7.3 Site Development and Earthworks

Earthworks for site development will be balanced without significant use of overburden from the mining operations. The construction of the balloon loop railway will result in an excess of cut material which will be disposed of in the construction of the dam embankments and site facilities bench. Any deficiency of fill will be obtained from mine overburden removal. Clay required for the cores of the dams is expected to be obtained from the site.

Landscaping proposals feature visual improvement of the coal preparation plant area and the service area, together with selected plantings along the site access road. Further clump planting will be undertaken as necessary to screen prominent features of the Project from sensitive locations.

The whole of the mine site will be fenced with cattleproof fencing, whilst the service area will be secured with manproof security fencing and appropriate security gates.

3.7.4 Site Facilities

Site facilities will comprise the following:

- Administration building, air conditioned.
- Mine bath house, including training rooms, crib rooms, mine office, pay office and first aid.
- Mobile plant workshop equipped with overhead travelling crane and associated offices for workshop and stores administration.
- Stores building and stores compound.
- Bulk fuel storage tanks in bunded compound.
- Vehicle fuelling and servicing building.
- Truck wash bay, including grit and oil separators.
- Waste oil storage.
- Computer and communications equipment.
- Service areas, roads, parking, site drainage and lighting.

Office space, stores yard and ablutions will also be required at the coal preparation plant.

For maintenance purposes, mobile cranes will be provided. Where heavy lifts are necessary, larger cranes will be hired. Other maintenance plant will include a light backhoe/loader and ride-on mower/slasher.

3.7.5 Power

Power will be supplied from an existing 66kV Shortland County Council transmission line adjacent to Bridgman Road and metered at that voltage. Transmission at 66kV will supply a 66/11kV substation at the coal preparation plant, and 66/6.6kV transportable substations supplying the overburden shovels and based on a transmission route parallel to the Main Northern Railway. Distribution to the service area and coal handling plant will be at 11kV. Provision has been made for power factor correction capacities on the medium voltage systems.

3.7.6 Construction Facilities

Construction facilities will be provided to meet requirements for access, electric power, water and hardstanding. Earthworks, sub-base and some water mains will continue to be used as part of the permanent works. A site office and first-aid room will be required.

3.8 MANNING

The peak manpower period occurs between Year 3 and Year 8 when 93 opencut operators per shift (188 per day) are required in a total workforce of 299. Thereafter the numbers gradually decrease because there would be less requirement for overburden removal. It should also be noted that some operators and equipment are required in Year-1 to assist in pre-development construction.

The workforce requirements for the first 6-15 months during construction will peak at 250 personnel (Table 3.8.1). The construction workforce is expected to average 150 over this 15 month period.

TABLE 3.8.1

CONSTRUCTION WORKFORCE SUMMARY

Months from start of construction	3	6	9	12	15
Mean Employment	100	125	150	150	180
Peak Employment	120	140	250	250	250

Operational workforce requirements for the Project are summarised in Table 3.8.2. An overall absenteeism allowance of 10% has been made to cover sick leave, long service leave and absence without pay, and balance of annual leave. Costs for absenteeism labour have been included in each operational cost category.

TABLE 3.8.2

OPERATIONAL WORKFORCE SUMMARY

	Project Year									
Category	**-1**	**1**	**2**	**3-8**	**9-12**	**13-14**	**15-17**	**18**	**19**	**20**
Head Office	5	5	5	5	5	5	5	5	5	5
Site Staff	54	54	54	54	54	54	54	47	47	47
Mine Operations	122	144	153	157	155	149	115	117	74	66
Preparation Plant & Materials Handling	9	42	42	42	42	42	42	42	42	30
Maintenance	22	44	45	46	45	44	40	39	31	23
TOTAL (at Mine)	212	284	294	299	297	289	253	239	194	166

3.9 WORKFORCE TRANSPORT

Construction Phase

It is anticipated that most of the workforce (over 90%) will be based in Singleton, travelling to and from the site daily with an assumed vehicle occupancy rate of 1.3. During the peak construction phase a maximum of 173 vehicles would drive along Bridgman Road to the Mine Site in the morning and leave in the afternoon. It has been further assumed that up to 20 additional trips would be carried out daily by heavy vehicles associated with construction activities, most of which would not coincide with peak hours.

Operational Phase

Peak staffing levels are expected within one year of operations commencing (see Table 3.8.2).

A similar vehicle occupancy ratio as that for the construction phase has been assumed, indicating that at peak production 51 vehicles will leave the site each morning and 68 vehicles will arrive. In the afternoon, this situation will be reversed.

As for construction workers, the majority of the workforce is expected to travel to and from Singleton along Bridgman Road.

3.10 ENERGY STATEMENT

Energy Gain

The energy output from the proposed development will be considerably in excess of the energy consumed.

The coal produced will be marketed at a constant 1.35Mtpa for most of the Project life . The specific energy production is documented in Table 3.10.1.

TABLE 3.10.1

SPECIFIC ENERGY OF ANNUAL COAL PRODUCTION

Product Coal	Ash Content (%)	Unit Specific Energy (MJ/kg)	(kcal/kg)	Typical Annual Production (%)	Mtpa	Specific Energy TJ/a*
Soft coking	6.5	31.9	7,620	10	0.135	4,307
Semi-soft coking	9.0	29.9	7,150	30	0.405	12,110
Steaming	14.6	28.3	6,750	60	0.810	22,923
Total				100	1.350	39,340

*TJ/a - 10^{12}J

Energy Loss

Energy consumed will be chiefly in the form of electricity, diesel fuel and lubrication fluids.

Consumption figures for the various sources are not yet available as detailed engineering studies are required before this information can be determined.

Electricity is the principal energy source and will be used wherever feasible. Power will be supplied from an adjacent 66kV transmission line adjacent to Bridgman Road. This will be transformed to 6.6kV via a 7.5MVA main substation transformer. Power factor correction, computerised load shedding will be practised to improve electrical efficiency .

The preliminary average electrical power demand is estimated as follows:

Coal preparation, stockpiling and rail loading	3.0Mw
Mine shovel, drill, general	1.0Mw
Support services	0.5Mw

which would equate to about 28.4 x 10^6kWh/a. This power represents 102 TJ electrical energy consumption or 340TJ of thermal energy, assuming 30% of energy in coal burnt at the power stations is delivered as electrical energy to the Project site.

Use of petroleum products will vary according to the stage of development. A preliminary estimate for a typical year is about 90 TJ.

The annual explosives usage also is subject to considerable variation with dry ammonium nitrate fuel oil (ANFO) for dry holes and emulsion type explosives for wet holes being employed. Typical annual consumption could be about 160TJ but further investigation is likely to result in lower levels of energy.

The average project washing yield is 67.6%. At 1.35Mtpa coal production this implies 0.65Mtpa rejects, but this is subject to variation. At an average specific energy of 16.8MJ/kg of reject, this represents a loss of 10,900TJ/a. As the Project progresses, the CCJV will investigate the feasibility of using rejects from the coal preparation plant for fluidised bed consumption for power generation. This measure, if adopted, would further improve energy conservation.

It is expected that open cut operations will recover 95% of the mineable coal. At an average specific energy of 29.1MJ/kg, this equates to 2,070TJ.

All product will be transported by rail to Newcastle which requires about 80TJ/a.

The surface pit mining concept excludes but does not sterilise the potential exploitation of 14.7Mt underground insitu coal. At 26.0MJ/kg this equates to 20,580TJ. West of the SLA area there is 45.1Mt of insitu underground coal representing 63,140TJ.

Energy Balance

Although further studies will refine energy demands, it appears that the typical energy production represents more than 72% of the assumed annual total available energy, as shown in Tables 3.10.2 and 3.10.3.

TABLE 3.10.2

ENERGY GAIN SUMMARY

Energy Gain Summary		TJ
0.135Mt	Soft coking coal	4,307
0.405Mt	Semi-soft coking coal	12,110
0.810Mt	Steaming coal	22,923
	Total	34,340

TABLE 3.10.3

ENERGY LOSS SUMMARY

Energy Loss Summary	TJ
Open cut pit loss	2,070
Coal preparation rejects	10,900
Electrical energy, thermal equivalent	340
Petroleum products	90
Explosives	160
External transport	80
Total	13,640

3.11 ALTERNATIVES

Development of the Project Concept has involved appraisal of many alternatives concerning pit size and dimensions, method of working the pits, coal and waste haulage, access, placement of waste materials and environmental controls.

The mine development has had to be designed to ensure that the operation will remain viable for the 20 year mine life. The proposed configuration is one of a limited range of possibilities that could ensure this viability. It is possible that there may be some future opportunity to rationalise coal extraction in the vicinity of the SLA boundary with the consents of all appropriate authorities. This is not possible in the short term or under current economic circumstances.

Landownership aspects have been a significant factor in defining the Project. Should the land ownership of surrounding properties change markedly, for example allowing significant CCJV purchase of land to the west of the Pits, some addition to the environmental mitigating measures proposed could be realised.

"No Development" Option

The alternative of not proceeding with the Camberwell Project development at the present time would give rise to the following consequences:

- The quality of the coal resource is such that development will inevitably occur at some time. The constraints on landowners regarding subdivisions and house extensions in the vicinity of the coal resource will remain until such time as the coal is extracted. Early development will bring forward the release of these constraints.
- The environmental impact of developing the Camberwell coal resource will be greatest in the initial years as the open cut reserves are developed. In later years, as mining shifts to underground development, the effects on neighbouring properties will diminish. The sooner this phase is completed the sooner the potential for environmental impact that is associated with mining areas, will be reduced. An increase in residential density will then be permitted without the concern for potential land use conflict.
- The joint user train loading facilities proposed for the Rixs Creek and Camberwell Projects and perhaps the Glennies Creek Project also, will only be viable if all Projects are developed within the same time frame. This option is more environmentally acceptable than individual development at different times that meet the requirements of only one Project.
- The economic considerations of increased generation of wealth for the region, the State, the nation and the corporate sector as a result of the development of the Camberwell Project will not occur. Generation of wealth and foreign reserves is increasingly critical to the maintenance of Australian living standards which are only sustained by a strong export sector.

4. COAL HANDLING, PREPARATION AND TRANSPORTATION

4.1 COAL HANDLING

Coal transportation has been planned to provide simple, environmentally acceptable and cost effective facilities. The systems employed will be capable of:

- Supporting optimal productive use of mine equipment,
- Ensuring that coal production is transferred either directly to the coal preparation plant or stockpiles, where blending can assist in catering for the wide variations in coal quality between working sections,
- Supporting maximum recoveries in the coal preparation plant,
- Disposing of rejects,
- Servicing market needs by having adequately sized product coal stockpiles and associated handling facilities, which can blend coals to several market specifications and transfer to off-site transportation for subsequent delivery to markets.

Stockpiles of ROM feed and clean coal at the mine and at the ship loader will be provided in the early years when production is increasing. Thus a provision of about one month's production has been allowed in the various stockpiles in the coal chain.

Various means of transporting and handling material between the coal face and shiploader will be employed.

Cat 777B type rear dump trucks will be used to transport both ROM feed directly to the dump hopper and occassionally to the ROM hardstand and to transport coal preparation plant rejects. A fleet of up to eight trucks will operate on a three shift basis.

The proposed washery and the materials handling concept is illustrated in Figure 4.1.1. The short rail spur and balloon loop adjoining the Main Northern Railway is shown in Figure 3.1.1. Most ROM and product material will be automatically transported by belt conveyor, stacked, reclaimed and loaded out by purposely designed equipment.

All stockpile, crushing, conveying and transfer stations will incorporate water sprays to control dust.

Mobile plant is required for occassional loading of emergency ROM hardstand material into the ROM hopper, controlling the product stockpiles, loading into the product reclaim hopper and loading refuse into the dump truck. A dedicated bulldozer will be available to assist in the control of product stockpiles if they require expansion. An FEL would be occassionally borrowed from the mining equipment to assist in loading emergency ROM hardstand material.

Belt conveyors will be used to transport coal between the dump hopper and breaker, the ROM blending stockpile, the coal preparation plant, the product stockpiles and the rail load out facilities. The conveyor loading will be assisted by FEL's. The coal handling and preparation plant will operate on a three shift basis.

4.2 COAL PREPARATION

4.2.1 Plant Capacity

Annual Capacity Requirements

Overall project economics dictate the development of a mine which attempts to:

- minimise material movement;
- optimise equipment use; and
- exploit a deposit which is both complex in structure and variable in quality.

Accordingly the mine's material production rates are variable.

The project economics are also based on at least three saleable products being produced from the preparation plant:

- a 6.5% ash coking coal product (or Special Product coal);
- a 9% ash semi coking coal product; and
- a 15% ash maximum steaming coal product.

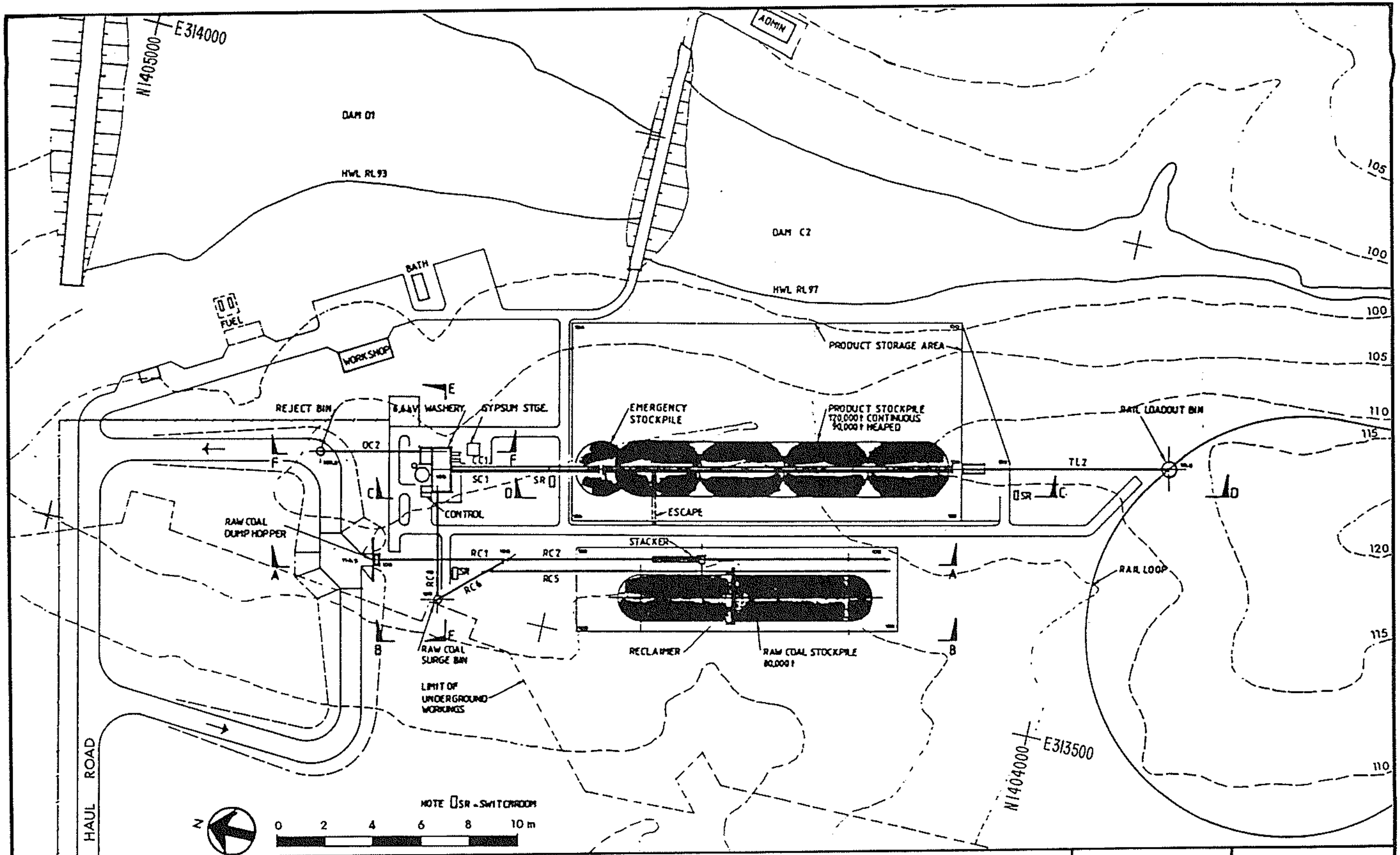


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Figure 4.1.1

PROPOSED WASHERY & MATERIALS HANDLING SITE PLAN

The different product specifications cannot be produced from all seams, indicating the need for selective mining and a materials handling facility capable of isolating different raw coals for washing.

Overall plant capacity required is based on annual mine production rates as detailed in Table 4.1.1. Clean coal production rates also given in Table 4.1.1 are based on predicted yields at an average 1.6 S.G. cut-point. Actual production of the three product types will require a sophisticated plant operating over a wide range of cut points.

TABLE 4.1.1

ANNUAL KEY PRODUCTION AND SALES QUANTITIES
(Thousand Tonnes)

Year	ROM Feed	Plant Product
-1	28.1	22.0
1	1,322.1	913.7
2	1,718.5	1,177.2
3	2,007.2	1,360.9
4	1,880.0	1,347.9
5	1,922.9	1,349.9
6	2,061.6	1,346.2
7	1,920.8	1,350.3
8	2,078.2	1,350.8
9	2,001.8	1,345.2
10	1,946.9	1,353.1
11	2,023.0	1,351.4
12	1,921.3	1,352.6
13	1,985.1	1,347.9
14	2,125.9	1,352.1
15	2,010.4	1,351.0
16	2,171.6	1,346.4
17	2,091.4	1,342.7
18	2,029.4	1,339.4
19	2,116.2	1,343.8
20	1,104.3	788.4
TOTAL	38,466.6	25,832.9

Based on Table 4.1.1, project economics have been calculated on an average clean coal production rate of 1.35Mtpa over Years 2 to 20 of the Project life, with annual production varying between 1.3 and 1.35Mtpa. Annual ROM production rates are relatively more variable because yields and dilutions reflect the specific working sections being exploited. In designing the coal handling and preparation plant, an average ROM feed quantity of 2.3Mtpa has been used.

Raw Coal Handling Storage and Blending Plant Capacity

In designing the raw coal handling and storage plant, allowance is made for ROM coal deliveries ex the mine 5 days per week, 24h/day for 50 weeks per annum – equivalent to 6,000h/a.

Average handling capacity required is $= \frac{2{,}300{,}000t}{6{,}000h}$

$= 383tph$

However, to allow for plant availability, variations in continuity of supply from the trucking fleet and variations in supply from the mine due to normal mine output fluctuations, a nominal handling plant capacity of 1,000tph is allowed.

Coal Preparation Plant Capacity

In designing the coal preparation plant, the average ROM feed quantity of 2.3Mtpa (65% clean coal yield) has been used.

Nominal capacity allowed for design is 350tph.[5]

Products Handling Capacity

In designing the products handling plants, allowance is made for simultaneous production of two saleable products for some coals, while a single product will be produced from other coals. Because of the expected variability between seams, coking coal and steaming coal product streams are designed to handle maximum product rates of approximately 300tph each.

Rejects Handling Capacity

In designing the rejects handling plant, allowance is made for removal of total rejects – including fines – via trucks. To allow for short term peaks resulting from potential adverse mining conditions, a rejects capacity of 210tph (60% of feed) is allowed.

Train Loading Capacity

To meet the State Rail Authority (SRA's) Level 5 Category standards a total train loading rate of 3500tph is required. The total facility comprising stockpiles reclaim/train loading bin feed conveyor and train loading bin is designed to accommodate these requirements.

4.2.2 Coal Handling and Preparation Plant Design Philosophy

Design Basis

Coal will be mined from a variety of seams. Quality is variable across each coal seam and from seam to seam. As some feed will contain non-coal bands (mudstone, claystone, siltstone, shale, carbonaceous, sandstone, siderite, etc) it will be crushed to a marketable size of -50mm prior to washing to maximise shale liberation and hence saleable product ex the preparation plant. Other coals will be washed at a nominal 150mm top size to minimise fines generation.

In selecting the optimum process design, the following factors are relevant:

- A 6.5% ash product cannot be produced from all seams mined. When produced, it will be at a very low relative density separation requiring dense medium processing.
- It is a characteristic of the coal seams of the Wittingham Coal Measures, Foybrook Formation that the natural coarser fractions are higher in ash and poorer in plastimetric properties than the natural smalls. As a result, the 6.5% ash product is obtainable only from a limited finer size fraction of the total raw coal feed.
- The inclusion of non-coal bands as described above could result in difficult operating conditions in a dense medium circuit.
- Production of a 15% ash product from some seams will not be possible – product ash at maximum dense medium cut-points will be lower than required.
- All test results available indicate that the fine coal (-0.5mm) is not amenable to froth flotation for benefication.

5 Plant operates 3 shifts/day – 8h/shift
7 days/week
50 weeks/annum

Potential operating time	=	8400hpa
Plant availability	=	85% (allows for scheduled maintenance, breakdowns, etc).
Plant utilisation	=	90% (allows for time when plant is capable of receiving feed but is not due to plant start-up or shut-down time requirements, no feed available, or plant less than nominal capacity for various reason etc).
Therefore actual operating hours	=	0.85 x 0.9 x 8400h
	=	6426hpa
Nominal hours allowed for design	=	6500hpa
Required Plant Capacity	=	$\frac{2,300,000t}{6500h}$
	=	354 tph

Overall Concept

Taking the factors outlined above into account, the following design concepts have been adopted for the coal handling and preparation plant.

- The coal handling and preparation facilities including products stockpiling and reject bin loading is fully computer/PLC controlled from the central control room in the main control room.
- Products reclaim to the train loading facility is fully computer/PLC controlled from the central control room, except that equipment is required to assist in the presentation of coal to the reclaim feeders.
- Train loading is controlled from a local control room adjacent to the train loading bin.
- Total ROM coal is reduced to a top size suitable for washing prior to stockpiling. No ROM sized reject is produced.
- The raw coal storage facility allows for independent stockpiling of different raw coal grades as required for washing. For each stockpile formed, the total feed is fully blended, resulting in stockpiles of uniform and known composition.
- The coal preparation plant allows for scalping of total raw coal feed in a jig, with washing as required of 50mm x 20mm, 20mm x 0.5mm and 0.5mm x 0.075mm size fractions in dense medium cyclones and spirals to produce different product grades.
- The products handling facility provides for four similar stockpiles formed by overhead travelling tripper conveyors. The dual preparation plant product conveyors can each discharge to any point on the common product stockpile pad.
- The products reclaim facilities provides four independent high capacity coal reclaim feeders. As a result, there is provision of stockpiling four different quality products at any time.
- The preparation plant design includes dewatering filters for the fine tailings product – *thus closing the process plant water circuit and eliminating the need for tailings dams.*

4.2.3 Plant Description

Plate 4.2.1 shows a similar plant to that envisaged for the Camberwell Project (courtesy of Coal & Allied Operations Pty Ltd).

Raw Coal Handling and Storage

The ROM materials handling concept and processing steps are shown in Figure 4.2.1. 600 cubic millimetres

ROM coal ex the mine is delivered to the ROM dump hopper at a maximum size of ~~600m³~~. The ROM coal is then fed through a ROM Sizer which reduces total raw coal to 100% minus 150mm and the coal is then conveyed to either:

- the 80,000t raw coal stockpile via an automatic slewing and luffing stacker, or (effectively 50000t with 3 campaign stacks)
- direct to the preparation plant surge bin feed conveyor.[6]

6 Raw coal ex the plant feed surge bin feeds the single module preparation plant at a controlled feed rate. The coal preparation plant comprises the following major processing sections.

- Jig Circuit treating total raw coal feed.
  +20mm product reports to coal product
  or secondary dense medium rewash circuit.
  -20mm + 0.5mm product reports to steaming coal product
  or primary dense medium rewash circuit.
  -0.5mm product reports to spirals circuit.
- Primary Dense Medium Cyclone Circuit to rewash -20mm + 0.5mm jig product. For low ash coking coal product (6.5% Ash), cyclone underflow product reports to secondary dense medium cyclone circuit.
  For semi coking coal product (9% Ash), cyclone underflow typically reports to rejects.
- Secondary Dense Medium Cyclone Circuit either to rewash primary dense medium cyclone underflow to produce steaming coal product *or* to rewash +20mm Jig product typically to produce semi coking coal product.
- Primary Spirals Circuit to wash total -0.5mm + 0.075mm jig products.
  Product reports to coking coal or steaming coal. Middlings report to secondary spirals circuit.
- Secondary Spirals Circuit to rewash -0.5mm + 0.075mm primary spirals middlings. Product is recirculated to primary spirals *or* reports to steaming coal.
- Tailings Thickener to thicken the -0.075mm fines tailings and clarify the process water for recirculation through the plant.
- Tailings Filter Circuit for dewatering tailings thickener underflow to a condition suitable for disposal with the coarse rejects.

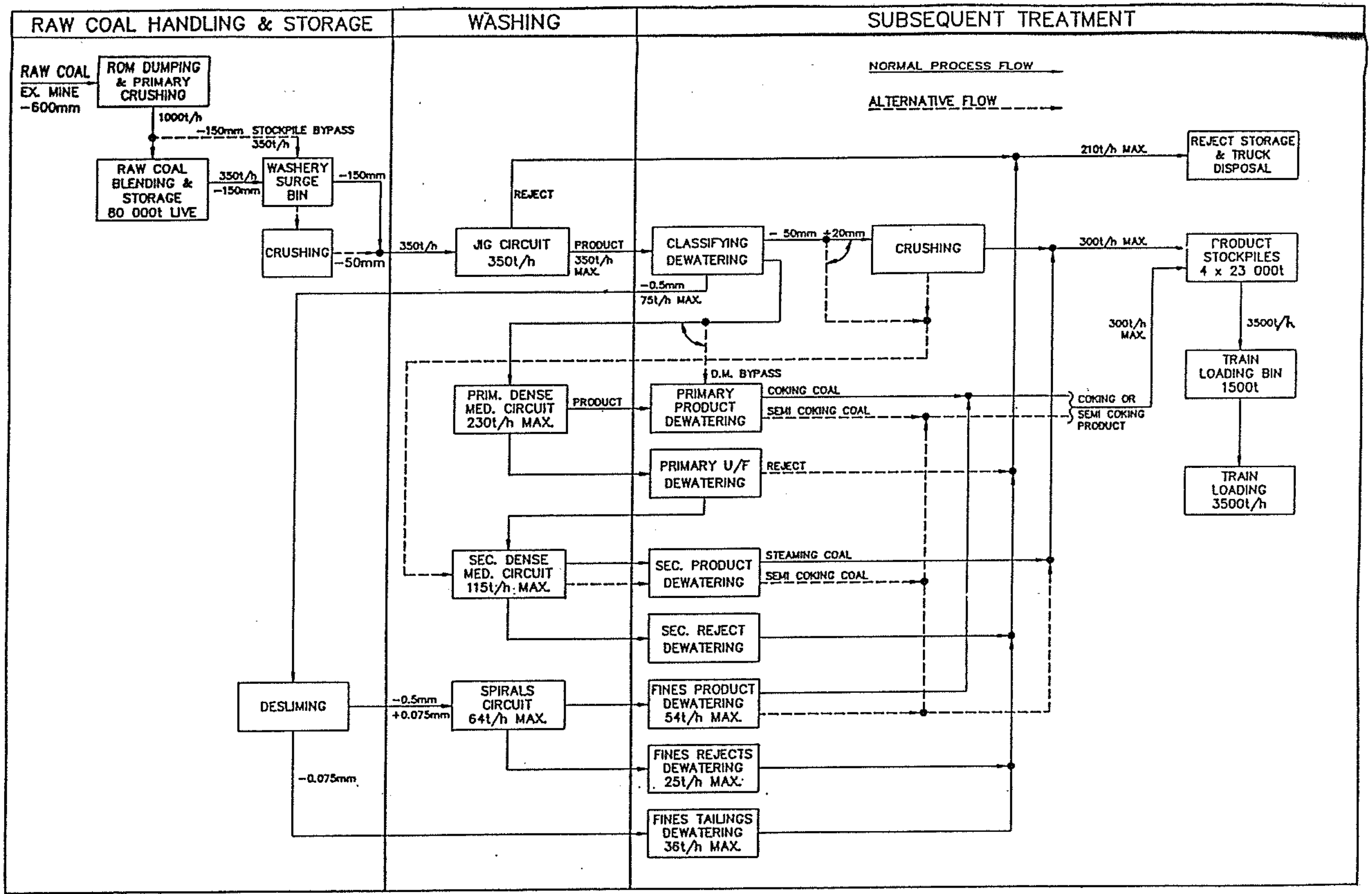

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Figure 4.2.1

COAL HANDLING & PREPARATION FACILITIES - PROCESS BLOCK DIAGRAM

Hunter Valley Coal Preparation Plant
Designed and constructed by BMCH
A similar plant is envisaged for
the Camberwell Project

PLATE
4.2.1

Raw coal management is aided by the provision of an automatic ash monitor, an automatic sampler and weighers as required.

The raw coal stockpile is of sufficient capacity to allow formation of three to four fully blended independent stockpiles as required. To aid plant flexibility, a fully automatic travelling bridge reclaimer is utilised to reclaim raw coal and feed the preparation plant feed surge bin. This reclaimer permits reclaim from any pile, reclaims from the full face to eliminate segregation normally associated with travelling reclaimers, and being a bridge reclaimer, clears the stockpile base for further storage as it reclaims.

Preparation plant operating modes are selected depending on raw coal feed quality and on plant product requirements. All operating modes are operator selected from the plant control room.

Products Handling and Storage

The two plant product conveyors, nominally coking coal and steaming coal, each feed skyline conveyors with travelling trippers. Maximum stockpile capacity – based on four stockpiles – without pushing by mobile equipment is 120,000t. Four sets of high capacity reclaim feeders are provided, one per stockpile. These independent reclaim facilities allow for storage of up to four products of varying specification. Mobile equipment is required to effect continuous coal supply to the reclaim feeders.

Each preparation plant product conveyor is provided with weigher, automatic ash monitor and automatic sampler to provide full plant control and management.

Rejects Handling

Tailings will be passed through a Belt Press Filter and mixed with the coarse reject to form a single reject product. This technology has been in use at at two NSW collieries for some years and has proved most successful.

Dewatered coarse and fine coal preparation plant rejects will be mixed to result in a total moisture of about 20%, and then loaded into a 150t rejects bin.

Belt Press Filters have been selected to dewater plant tailings to provide a relatively dry tailings product for disposal by truck. The alternative equipment choice could have been Screen Bowl Centifuges. The selection of Belt Press Filters was based on experience in designing and observing the operation of both types of machines in plants where tailings are disposed of by truck. Experience has shown use of Screenbowl Centrifuges has resulted in tailings being considerably wetter than that obtained from the Belt Press Filter and hence more difficult to handle by conveyor, through bins/discharge gates and trucks. Disposal by this means is relatively messy when compared with Belt Press Filters.

The Camberwell Plant will have a fully integrated and automated flocculation control system to ensure optimal performance and automatic control of the Belt Press Filters.

The Plant will have two Belt Press Filters with each unit rated to handle near to full plant capacity. If one Belt Press Filter was to fail, then the plant could still operate at near to full rated capacity with only the second operating Belt Press Filter.

Pre-treatment by centrifuging may be required for coarse rejects so as to reduce free water content and provide stable fill material when mixed with the tailings cake. This material will be loaded into a dedicated 85t truck for transport to the open cut dumps for disposal. The approximate dry weight totals vary between 0.15Mtpa and 0.60Mtpa.

A third alternative considered was conventional tailings ponds. Use of ponds involves a greater degree of on-going maintenance, requires additional land area and is an inferior technology on environmental grounds.

4.3 COAL TRANSPORTATION

4.3.1 Reclaim and Train Loading

Product coal will be reclaimed from any one of the four reclaim feeders at 3,500tph onto a common reclaim conveyor. This conveyor feeds a 1,500t train loading bin which is supplied complete with an Anderson Rea Rapid Train Loading System.

The total train loading system is capable of loading trains as required for the State Rail Authority (SRA) Level 5 Rating.

To meet this standard, trains are required to keep moving through the facility whilst being loaded under a loading bin fitted with a special chute. The chute discharges coal into the wagons at a rate compatible with the speed of the train and automatically adjusts the contents of the wagon to a predetermined height above the wagon top.

All facilities will comply with SRA specifications in regard to design, structure clearances etc, be equipped with electric lighting for night loading and have signalling to assist the driver in controlling the train speed. Separate amenities will be provided for SRA staff.

4.3.2 Rail Haulage

The return balloon loop and loading facilities will be located near the former Rosedale Mine surface facilities. This will involve laying about 4.3km of track using the former railway formation wherever possible. From the point at which the single track spurline joins the Main Northern Railway (whose route is shown on Figure 1.1.1) it is about 80km to Newcastle.

A standard unit train (84 CHS wagons) has a net capacity of about 6,400t. Trains can be expected to collect coal at any hour on any day of the week, depending on SRA scheduling requirements. In typical practice, it might be expected that up to seven trains a day could arrive at the loading facility. This would mean that a 35,000DWT ship could be loaded within two days. Averaged over a year's operation, approximately one train a day would use the facility. For the medium term there is considerable surplus capacity in the rail system.

A walkway for one train length will be provided with lighting to the standards set by the SRA, to facilitate the guard walking along the train prior to commencement of loading.

4.3.3 Ship Loading

The export coal facilities at Newcastle are the Kooragang Island and Port Waratah loaders, handling a total capacity of 46Mt. In 1987 and 1988 a total of 31.5Mt and 28.5Mt were loaded, hence there is ample capacity to handle additional tonnages. There is also provision for further expansion at the Kooragang Island loader to increase its annual throughput from 15Mt to 45Mt.

The Port can handle ships up to 180,000DWT. At present both the Port Waratah and the Kooragang Island loaders can take trains of up to 84 CHS wagons.

4.4 ALTERNATIVES

4.4.1 Siting of Preparation Plant

The preparation plant has been sited to avoid sterilisation of coal resources, to take advantage of the topography, and to minimise visual and noise effects on surrounding residences and public vantage points. It is the most preferable site with regard to environmental considerations.

4.4.2 Coal Handling Technology

Latest technologies have been assessed in conjunction with developing the design concept for this Project. While certain technologies, particularly surface continuous miners and other mobile equipment, look promising at this stage and could provide an improved environmental operation, they are not yet functioning viably. This situation will be kept under regular review.

The materials handling system adopted for this Project represents the most efficient, effective modern technology available.

4.4.3 Train Loading

As a recommendation put forward by the Commissioners of the Rixs Creek Inquiry, a joint-user train loading facility is proposed for the Rixs Creek, Camberwell and possibly the Glennies Creek Mines. The site of this facility would be similar to that proposed for the Camberwell facility, however in this instance the site would be excised from the Camberwell SLA and be an independent land holding.

The joint-user facility would be managed by a separate Joint Venture company comprising several entities including the user companies and the Joint Coal Board (JCB).

No EIS has yet been prepared for the development nor any approvals granted. The JCB has advised however, that once approvals are in place the facility would be in operation within 18 months. Prior to any construction occurring, a proper process of EIS preparation, display and assessment would have to occur.

The Joint Venture is supportive of the JCB's concept and views this alternative as an environmentally desirable option.

An independent train loading facility has been included as part of this Development Application as it is imperative that a suitable train loading facility is available to the CCJV as soon as coal is able to be mined. It is expected, however, that approval for the JCB's facility will ultimately coincide with that of the Camberwell Project.

5. WATER MANAGEMENT

5.1 WATER MANAGEMENT STRATEGY

Water Management is of major importance to the successful implementation and operation of the Camberwell Coal Project.

The objectives of a management programme for the mine are twofold:

- to obtain water supplies to operate the mine under a range of weather conditions; and
- to safeguard the environmental integrity of downstream water bodies through the control of potential sources of pollution.

To achieve these objectives the following water management strategy was adopted:

- development of a system to collect, store, treat and re-use waste waters wherever possible;
- harvesting of runoff from local catchments to reduce the need for external sources of water;
- use of groundwater resource supply opportunities available;
- segregation of different classes of water to reduce and manage the quantity of polluted waters;
- detailed assessment of the Project's water consumption requirements (a maximum demand of 877ml/a is envisaged) and allocation of priorities in water consumption so that the poorer quality waters are used first;
- the provision of water collection and treatment facilities sufficient to ensure any releases from the site can be safely assimilated in receiving waters;
- how the management concept can cater for extreme storm, normal and drought conditions; and
- some possible alternatives to elements of the water management concept including water supply make-up from Singleton Council's pipeline.

5.2 AVAILABLE WATER RESOURCES

The Project has a variety of natural and Project associated site water resources as well as offsite supply sources. This range of resources will provide considerable flexibility in water management and security of supply at all stages of project development and operation.

Site generated water includes surface runoff from the mining areas, flows in Station Creek and its tributaries which cross the site, groundwaters and also water in old mine workings located within the SLA area.

Suitable off site water sources are Glennies Creek west of the Project area and the Singleton water supply pipeline from Glennies Creek Dam, passing to the east of the site along Bridgman Road.

5.2.1 Surface Waters

The surface waters in the region which could be drawn upon to provide a supply for mining purposes lie within the catchment of Glennies Creek, a major tributary of the Hunter River. A large water supply dam was built on the upper reaches of Glennies Creek in 1983 by the Water Resources Commission, having a capacity of 284,000Ml. This Dam is the source of supply for Singleton and the surrounding district (see Section 7.3.2).

It is understood that releases of water from the Dam by Water Resources personnel are currently sufficient to meet the needs of downstream users, and despite utilisation of Glennies Creek as a source of water for the Camberwell Project, an adequate supply would be assured, as is the Government's policy for all industrial enterprises.

As shown on Figure 5.2.1 the Mine Site is located within the catchment of Station Creek, which has two main tributaries, Blackwall Creek and Martins Creek and several smaller un-named watercourses. Station Creek passes through the area to be occupied by the North Pit, passes under both Middle Falbrook Road and the Main Northern Railway, and joins Glennies Creek near the village of Camberwell, about 2.5km downstream of the railway bridge.

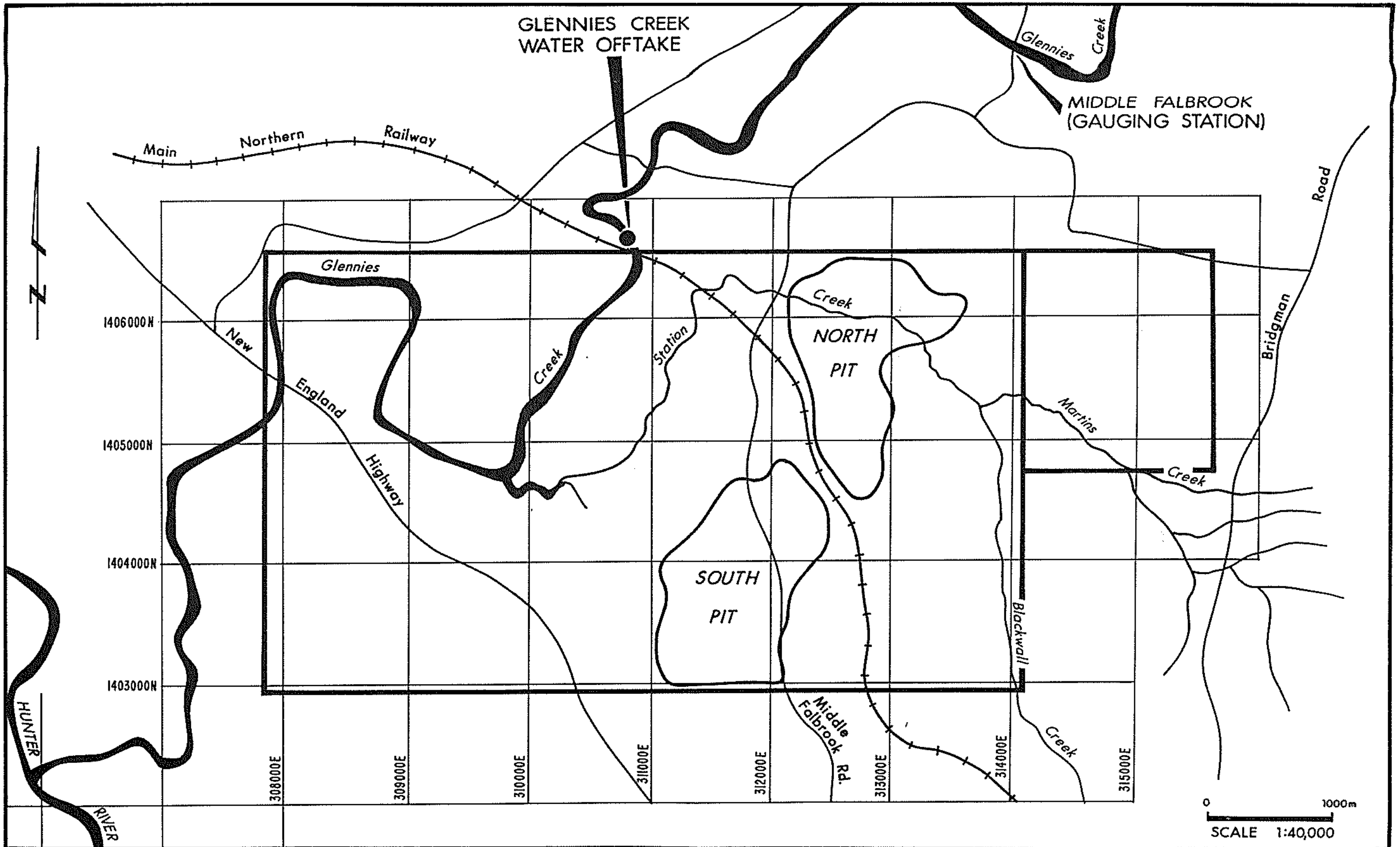

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Figure 5.2.1

LOCAL HYDROLOGY AND ITS RELATIONSHIP TO PROJECT WATER SUPPLY

In order to accurately determine flood levels between this point and Middle Falbrook a backwater analysis[7] was undertaken based on surveyed cross sections of the Creek and its flood plain. This exercise was necessary to determine the height of levee bank required to protect the mine from floods in Glennies Creek. It was also required for detailed design of improvements to Noble's Crossing and the proposed water supply intake. The analysis indicates a flood level at the Station Creek junction of RL 65.7 for the 1 in a 100 year event.

It is noted however that a restriction of Station Creek under the Main Northern Railway downstream of Dam C4 creates flooding in this region. Local information indicates that Middle Falbrook Road is impassable two to three times per year. The proposed upgrading of the road would remove this problem for the local community, and at the same time provide an extra storage for site provisions.

Calculations for the Station Creek catchment reveal a peak discharge at the railway culvert of $46m^3$ for the 100 year event. The total catchment draining to this point is approximately $18km^2$, and a collection and diversion system is necessary to prevent runoff entering the North Pit and Dump area.

Significant natural annual runoff occurs from this creek system and collection of this water would substantially reduce the need for external water supplies.

The 1987 edition of *"Australian Rainfall and Runoff"* indicates a large difference in rainfall patterns between the Station Creek catchment and the Glennies Creek catchment above Middle Falbrook. The steeper countryside in the upper catchment of Glennies Creek produces peak discharges which are two to three times greater per hectare than for Station Creek. Long term average runoff figures are also higher, although not to the same extent. Over the 30 years of records, the average runoff recorded at the Middle Falbrook gauging station was equivalent to 164mm per year for the upstream catchment of $466km^2$. This represents a mean runoff of more than 200Ml/day.

In undertaking subsequent analysis a runoff figure of 100mm per year has been adopted for Station Creek, which is an ungauged catchment. This compares with figures of similar magnitude for other mine sites in the area. A conservative figure of 70mm was used recently for a water balance study at Howick. This mean runoff figure is considered a realistic estimate from available data.

Mean annual rainfall for the area is about 700mm based on 70 years of records at Singleton. The mean evaporation figure for the same period was approximately 1,700mm. Monthly rainfall figures are contained in Table 7.4.2.

Various measurements have been taken of the quality of surface waters, and typical results are contained in Section 7.3. Some samples recorded relatively high sediment levels, but otherwise water quality was good. The surface waters are suitable for all mining purposes except for potable water, which will require pre-treatment.

Measures to be taken to minimise sediment in collected surface waters include rehabilitation of disturbed areas and settlement of waters containing sediment in settlement pits and storage dams on the site.

5.2.2 Groundwater

The results of tests on groundwater obtained from bores on the site and surrounding areas are shown in Section 7.3.

The old underground workings in the SLA area are flooded with groundwater estimated at about 1,000Ml. This water is a potential source of supply for the mine. Access to the water is possible either through the old workings drift entries or via boreholes into the deeper sections of the workings. Further investigations will be necessary to determine the best method, with safety issues related to the

7 The HEC 2 computer program, developed by the US Army Corps, used for this analysis, predicts no flooding problems at the site of Dam C4. The 1 in a 100 year flood level of Glennies Creek adjacent to this area is predicted to be RL 70.09. Therefore the reduced level used for preliminary design at the existing Middle Falbrook Road crossing of Station Creek, appears conservative and allowance will be made of this parameter during final design. The level of the reconstructed Middle Falbrook Road may change as a consequence of the above.

stability of roof and walls under drawdown conditions being an important factor. The present planning preference is to establish boreholes.

Water quality in the old workings was checked using samples obtained from two sections, one from the workings in the Barrett Seam (coal bed 105) and the other from the Hebden seam (coal bed 75). Results of the analyses are given in Table 5.2.1.

Waters in the underground workings are of high quality and are dissimilar to groundwaters. This indicates that water in the underground workings originated from surface waters rather than groundwater.

TABLE 5.2.1

CHARACTERISTICS OF WATER CONTAINED IN UNDERGROUND MINE WORKINGS

Test Parameter*	Barrett Seam*	Hebden Seam*
pH	7.1	6.4
Total Dissolved Solids	400	130
Specific Conductance (microsiemens/cm)	650	200
Chloride	100	30
Sulphate	70	10
Alkalinity due toHCO3 (as CaCO3)	140	50
Sodium	95	19
Potassium	5.9	7
Calcium	11	8.8
Magnesium	21	8.1
Iron (filterable)	2.5	3.9

Source: Australian Coal Industry Research Laboratories Ltd, 1989.

* All results are reported in mg/l unless noted otherwise.

Inflows to the open pit areas are estimated to be minimal and less than 600m^3/day (equivalent to 220Ml/a). Modelling in the hydrological report was based on relatively limited data and the inflow rates presented were therefore only approximate. To consider a broader range of possible flow volumes, reference was made to published estimates in adjoining mines.

Environmental impact statements have been published for mines to the south (Rixs Creek) and north (Glendell) of the Camberwell project. These contained estimates of groundwater flows to the open cut areas of up to 300Ml/a for Rixs Creek (Croft, undated) and a range of up to 510Ml/a for Glendell (Croft, 1982). Although these cannot be taken to be directly representative of groundwater flows likely to be encountered at Camberwell, they provide comparative data for adjacent areas. Run of mine production rates were proposed to be 1.5Mtpa at Rixs Creek and 3.6Mtpa at Glendell.

The high salinity of groundwater is typical of groundwater encountered in other mines in the valley (Section 7.3). The quantities of groundwater however, are small compared to surface water resources.

It is intended to store all groundwater that can be collected in storage dams on the site for re-use.

5.2.3 Site Water Sources

The main sources of water which will be available on the site (see Figure 5.4.1) are:

- Clean surface runoff from undisturbed areas in the catchment of Station Creek and its tributaries.
- Runoff containing sediments from areas under construction, spoil dumps and other disturbed areas including pit waters – runoff and groundwater seepage.

- Treated wastewater, including contaminated runoff from site facilities areas which has passed through oil separators and heavy sediment traps.
- Groundwater obtained from the old underground workings via boreholes or from bores within the open cut areas established for dewatering ahead of the advancing high wall.

Sewage effluent is not included in this list as after primary and secondary treatment, the treated effluent will be disposed of by spray irrigation on areas undergoing rehabilitation.

Off site sources of water include the two alternatives of Glennies Creek and the pipeline from Glennies Creek Dam to Singleton.

As shown on Figure 5.2.1 the most convenient location for an intake structure on Glennies Creek is adjacent to the railway bridge. This point is about 1km beyond the level crossing on Middle Falbrook Road. If necessary all site water requirements can be provided from this location, the water being pumped to on-site storages. At present this is the preferred planning option when supplementary water is required.

Discussions with Singleton Council reveal that there is also surplus capacity available in the pipeline which supplies the town of Singleton. The pipeline passes close to the SLA along Bridgman Road and it would be a simple matter to tap into this pipe for the mine supply with a scour valve arrangement. It should be possible to extract water at times suitable to Council, thus making compatible use of established facilities for which Council operating costs could be expected to decrease. One possible problem is the availability of supply in future years as the development expected in the Singleton area makes increasing demands on the available supply. However within the next few years this is not perceived as a constraint.

5.3 WATER CONSUMPTION REQUIREMENTS

5.3.1 Nature of Water Requirements

Different categories of waters will be suited for use in various areas of the mine. Two broad categories are required and are classed as potable and non-potable water. Potable water is needed for employee amenities while other mine demands, such as dust suppression and make-up water to the coal preparation plant could be met using non-potable supplies. The various types of water requirement are detailed below.

- **employee use**

  An average figure of 200 lpd per person has been adopted for water management estimates. Most will be used for showers and the balance in sinks, basins and toilet areas.

- **mine vehicle washdown**

  A washdown bay will be provided to clean surface mining vehicles. Mud, coal, dust and grease will be dislodged with a series of fixed high pressure water spray jets.

- **dust suppression on haul roads**

  Water will be required for dust suppression on active haul roads. The annual volume of water required will vary according to the stage of mine development and the prevailing weather conditions.

- **dust suppression in the coal handling plant**

  Water will be required for dust suppression within the coal handling plant on stockpiles, receival bins, conveyors and loadout bins. The annual quantities required will vary with both weather conditions and also the levels of coal inventory maintained.

- **coal preparation plant**

  Water will be used in the coal beneficiation process and will be "lost" due to moisture content increases in the product coal and rejects materials. Water consumption will vary according to the production of coal. An average demand figure of 211 l/t of product coal has been used for a typical 1.35Mtpa production.

- **miscellaneous uses**
  Minor volumes of water will be required in other areas of the mine. These are washdown waters for service buildings and workshops and maintenance of landscaped areas around the surface facilities.

Estimates of annual water consumption for three stages of mine development are given in Table 5.3.1. Three stages assessed are Years 5, 10 and 17. Year 5 is representative of extraction from the North Pit; Year 10 the changeover from mining in the North Pit to the South Pit; and Year 17 extraction from the South Pit. A range of consumption is given for dust suppression.

TABLE 5.3.1

ANNUAL WATER CONSUMPTION (Ml)

	Water Use	Year 5	Year 10	Year 17
1.	Potable water for domestic use	21	21	21
2.	Washdown of service buildings and workshops	2	2	2
3.	Mine vehicle washdown	8	8	8
4.	Dust suppression on haul roads	299-416	331-460	204-284
5.	Dust suppression in coal handling plant, including stockpiles	72-101	72-101	72-101
6.	Coal preparation plant make up water	285	285	283
	TOTAL	687-833	719-877	590-699

5.3.2 Coal Preparation Plant

The proposed coal preparation plant will not require a tailings dam, but will use mechanical dewatering for fine tailings. This will reduce the water content so that when mixed with coarse reject materials, the tailings can be transported by truck to the spoil dumps and spread using conventional earthmoving equipment.

Estimates obtained from Bulk Materials Handling Pty Ltd (BMCH) of water contents of various materials for each 1.0Mtpa production rate are typically as follows:

Feed	1.5 Mtpa at 5% moisture	=	79Ml water IN
Product	1.0 Mtpa at 8.5% moisture	=	93Ml water OUT
Coarse Reject	0.39 Mtpa at 15% moisture	=	69Ml water OUT
Tailings	0.11 Mtpa at 40% moisture	=	73Ml water OUT

The nett water demand will be 211Ml/a for 1.35Mtpa production.

5.3.3 Dust Suppression

Water is required for dust suppression within the pit areas, on haul roads and for stockpile sprays. It is also required on spoil dumps.

The total quantity of water required in an average year for these purposes is difficult to assess, as it will vary with weather conditions, and the length of haul roads to be watered will vary from year to year.

Haul road watering represents a major proportion of the water used for dust suppression. Guidelines of the State Pollution Control Commission (SPCC) require that the water supply system for road tankers be capable of supplying water for the roads at the rate of 0.5 $l/m^2/h$ for 24 hours a day on operating days.

This requirement will vary according to evaporation levels but on average would represent an annual demand of 66Ml/a for a kilometre of haul road 25m wide. It is estimated that the maximum length of haul roads in use at any one time will be 6km. The total water demand for haul road watering wil range from 200 to 460Ml/a (see Table 5.3.1).

In addition to this requirement the SPCC specify that the water trucks must be capable of applying water to the roads at three times the above rate or 1.5 $l/m^2/h$ on roads in use.

The figure of 460Ml/a is considered to be an upper limit as the anticipated hours of operation of water tankers will be much fewer than those specified by the SPCC. All dust suppression requirements, including stockpile sprays, watering in pit areas, spoil dumps and haul roads will require a maximum of 561Ml/a in Year 10.

5.3.4 Bathhouse and Industrial Uses

Water for these purposes is required to be of a higher standard than that used for washery make-up or dust suppression purposes. Highly saline mine water is not desirable in the bathhouse where it could cause industrial disputes nor is it desirable in the workshop where corrosion and electrical problems could occur.

Water for these uses should be drawn from the major storages on the site which have collected clean runoff, such as Dam C2.

The quantities required for these purposes are small compared with other uses. A total demand of 31Ml/a has been adopted to cover all water uses other than dust suppression and washery make-up.

Total demands for water for all purposes will depend upon the stage of mine development and weather conditions among other factors. An assessment of these demands for certain typical years is shown in Table 5.3.1.

5.4 THE WATER CONTROL SYSTEM

5.4.1 Water Management Controls

Strategy

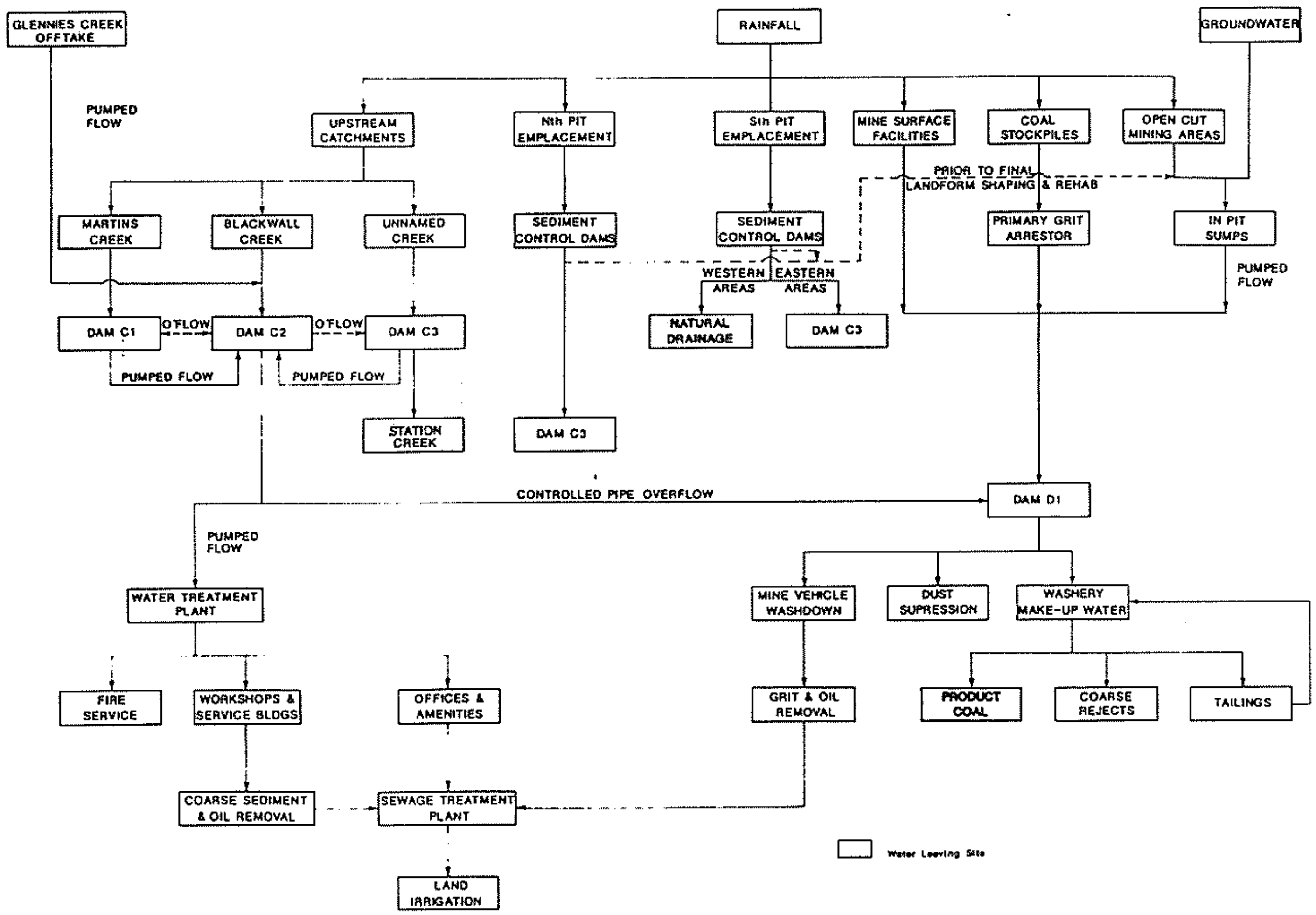
The strategy adopted for water management was described in Section 5.1. To achieve the aims of the strategy, water sources were categorised according to origin and pollution potential. Where possible site generated waters will be harvested and used to satisfy mine demands. Main water demands are for dust suppression and washery make-up which can use a wide range of potential water sources.

As a basis for the water management system a preferential order of water consumption was established, utilising poorest quality waters first. The order of use is :

- groundwater inflows into the pits and rainwater runoff from open cut mining areas, including unrehabilitated emplacements;
- rainfall runoff from the mine's facilities area;
- collection of local streamflows (Martins, Blackwall and an unnamed creek); and
- abstraction from Glennies Creek.

Figure 5.4.1 presents a water management flowsheet for the Project. It shows all water inputs, their use and final disposal. Management controls are discussed in detail in the following sections.

Four major dams will be constructed as part of the mine's water management. Their function and capacity are given on Table 5.4.1 and location shown on Figure 5.4.2.



CAMBERWELL COAL PROJECT

Date

Figure 5.4.1

WATER MANAGEMENT FLOW SHEET

TABLE 5.4.1

SUMMARY OF DAM CAPACITY AND FUNCTION

Dam	Capacity (Ml)	Function
C1	238	Storage dam located on Martins Creek
C2	173	Storage dam located on Blackwall Creek. Water from this dam will be used for mine supplies. Potable supplies always sourced from here.
C3	72	Storage dam on unnamed creek. Acts as a back up storage for Dam C2.
C4	4	Flood mitigation levee and sedimentation pond located west of the North Pit.
D1	228	Storage dam for rainfall and groundwaters collected in the open cut pits. Runoff control dam from coal stockpiles and facilities area. Main supply dam for process waters.
Open Cut and emplacement rehabilitation areas	Various	Sediment Control

Rainfall Runoff

The Mine has been divided into five areas for the control of rainfall runoff. These areas are shown on Figures 5.4.2, 5.4.3 and 5.4.4 at three stages of mine development and comprise :

- open cut and spoil emplacement working areas;
- areas undergoing rehabilitation;
- rehabilitated areas;
- site facilities (stockpiles, workshops etc.); and
- upstream catchments.

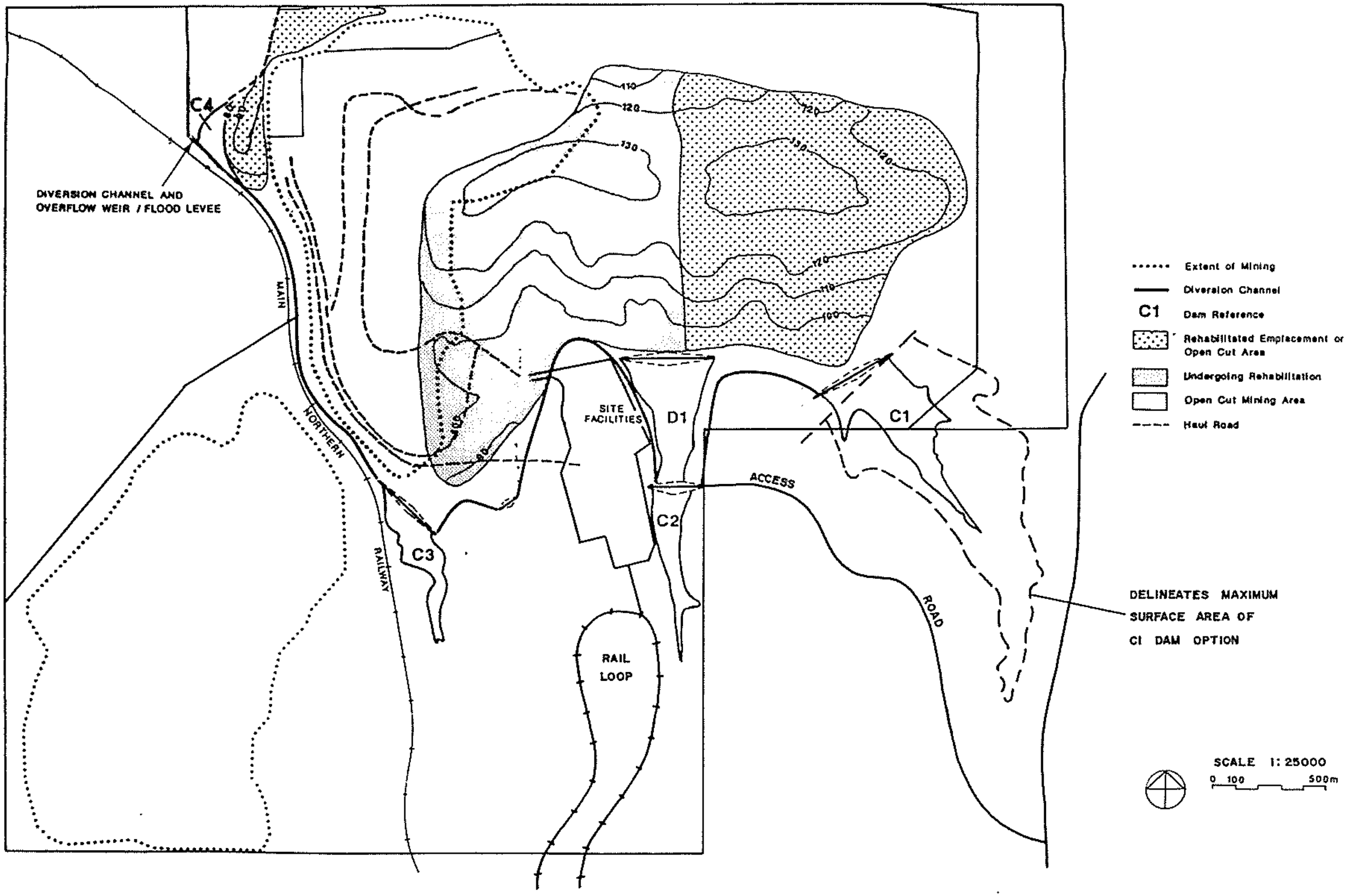
The means of controlling each is different, as shown on Figure 5.4.1 and described below.

Open Cut and Spoil Emplacement: All rainfall runoff from working or disturbed areas of the open cut and spoil emplacement will be directed to sumps contained within the open cut. Temporary diversion banks and channels will be used to direct all runoff to the sumps. From the sumps water will be pumped to Dam D1 for eventual use in meeting the Mine's requirements. During extended wet periods, when Dam D1 is full, water would be allowed to pond in the open cut. This aspect is further discussed in conjunction with the Water Balance Model.

Areas Undergoing Rehabilitation: This category refers to areas where mining and/or spoil emplacement has ceased and the surface is being shaped to the final landform and undergoing rehabilitation. These areas will drain to a series of temporary sedimentation dams prior to discharge from the site or to the mine's storage dams. These dams will be incorporated into the final landform. Sedimentation ponds will be designed to provide a minimum one hour's detention for peak flows from all storms with average recurrence intervals of up to 10 years.

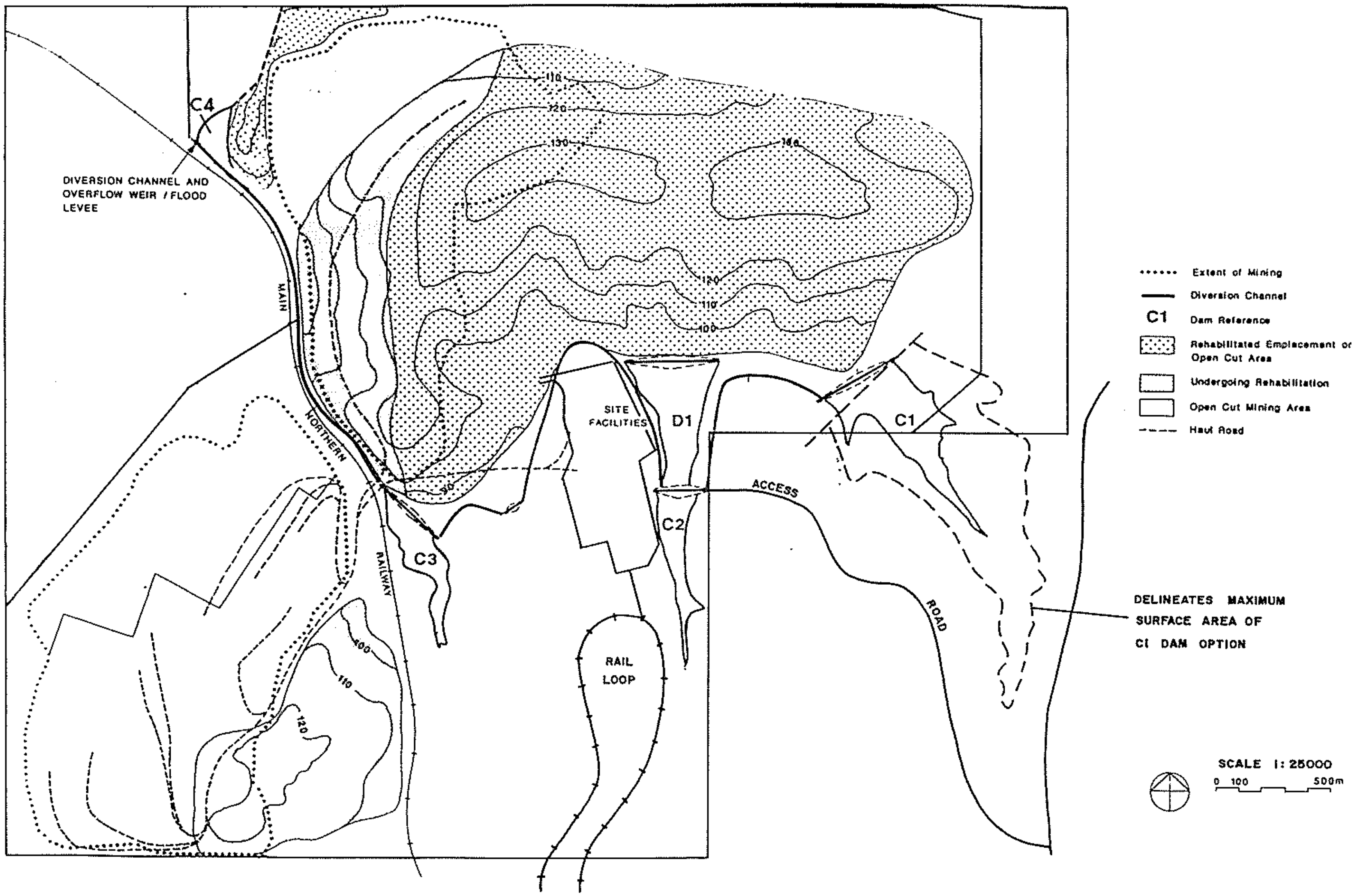
Figures 5.4.2, 5.4.3 and 5.4.4 show the extent of areas being rehabilitated at three stages of mine development. After passing through sedimentation dams, runoff from the southern catchment of the North Pit and Dump will flow to Dam C3. The diversion channel will be necessary to divert water flows from Dam D1. Similarly runoff from the eastern catchment of the South Pit and Dump will flow to Dam C3.

Rehabilitated Areas: Rainfall runoff from rehabilitated areas will gravitate to adjacent natural drainage or to Dam C3 as previously described.



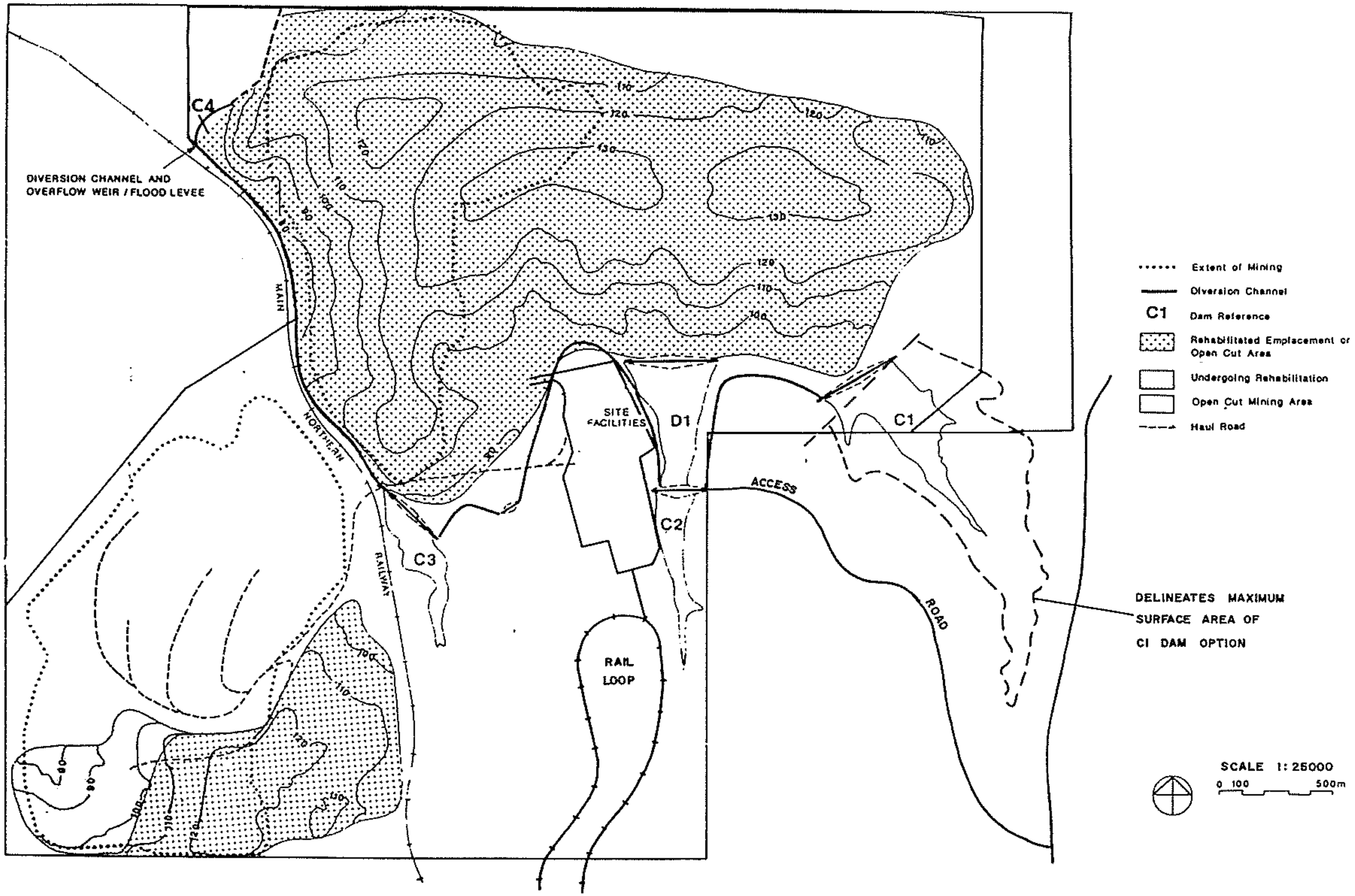
CAMBERWELL COAL PROJECT	Date	Figure 5.4.2

WATER MANAGEMENT (YEAR 5)



CAMBERWELL COAL PROJECT	Date	Figure 5.4.3

WATER MANAGEMENT (YEAR 10)



CAMBERWELL COAL PROJECT

Date

Figure 5.4.4

WATER MANAGEMENT (YEAR 17)

Site Facilities: Rainfall runoff from the site facilities will be directed to Dam D1. Diversion banks and channels will direct all flows to a culvert passing beneath the diversion channel before entering the dam.

Rainfall runoff from stockpiles will pass through a primary grit arrestor before entering the general stormwater drainage. The grit arrestor will remove coarse sized coal particles.

Upstream Catchments: Runoff from catchments upstream of the Mine will be controlled by a series of dams and diversion channels as previously described.

Groundwater

Groundwaters entering the pit will be collected with rainfall runoff in sumps at the base of the open cut. From here groundwater will be pumped to Dam D1 for use in the coal preparation plant and dust suppression system.

Potable Water Supply

Potable water supplies for use in staff amenities, offices and workshops will be drawn from Dam C2. A water treatment plant will treat the dam water prior to storage in a small tank reservoir from which supply will be drawn.

Domestic and Process Wastewaters

Two sources of wastewater will be domestic wastes from office and staff amenities and trade wastes from industrial areas. Domestic wastes will be collected and reticulated directly to a sewage treatment plant.

Trade wastes will be washdown waters from workshops, service buildings and the mine vehicle washdown bay. These waters will be collected and passed through grit and oil arrestors to remove gross sediments and hydrocarbons. The water will then be directed to the mine sewerage system. Sediments collected in the grit trap will be disposed of in the open cut and reclaimed hydrocarbons will be supplied to an oil recycling contractor.

A sewage treatment plant will be provided to achieve an effluent quality suitable for land disposal as defined by the requirements of the SPCC. Final effluent will be disposed of by land irrigation on a designated area of the Mine. Spare capacity will be provided in the sewage treatment plant maturation ponds to store effluent during wet periods when land disposal is not possible.

Rainfall runoff from fuel storage and refuelling areas will be directed to the trade waste system. To avoid surcharging the system during prolonged rainfall, provision will be made for a bypass system to divert excess flows to the stormwater system. These stormwater flows will then be collected in Dam D1.

5.4.2 Water Control Network

The water balance network for the Project consists of a number of storage dams, with gravity diversion channels and various pumps and pipelines. The adopted scheme is recommended as the most cost-effective way of meeting all the objectives of the Project especially the retention on site under all conditions of contaminated waters. Dams were designed to take into consideration the requirements of the authorities. No dams are classified as being prescribed. The conceptual operation is depicted in Figure 5.2.2 and the proposed layout in Figure 5.4.2.

Three main branches of Station Creek converge within the North Pit area. Dams are to be built on each of these branches to intercept water which would otherwise flow into the North Pit.

Dam C1 is located on Martins Creek which is the eastern-most branch, close to Bridgman Road. This dam has a predominantly clean catchment and water stored in it will be suitable for all mine uses except potable water.

Dam C2 is located on Blackwall Creek, the central branch of Station Creek, and the storage will also contain water suitable for all uses except potable water. Dam C2 is located close to the site facilities and coal preparation plant, and the main access road from Bridgman Road will pass along the crest of the dam. This dam is the supplementary storage from which water will be drawn for washery make-up, bathhouse, industrial uses and fire service.

A diversion channel connects Dams C1 and C2 which have the same top water level. When both of these dams are full surplus water will then discharge to Dam C3.

Dam D1 is located immediately downstream of Dam C2 at a lower level.

This Dam will provide water for washery make-up, truck washing and dust suppression purposes. It will contain contaminated water out of the Pits and their adjacent temporary dams. A provision will be made to supplement this dam with water from Dam C2 via a controlled pipe outflow. Contaminated site facility runoff will be collected in a perimeter drain and directed to the dirty water Dam D1. A spillway provision has been made from Dam C2, to a second diversion channel which follows the contours and skirts the site facilities area to Dam C3. It is expected this facility will only be required during periods of prolonged rainfall.

Dam C3 is to be constructed on the western branch of Station Creek which is un-named, adjacent to the Main Northern Railway. This dam is located so that no part of the wall or the stored water is above the old underground workings or encroaches on the Railway easement. The catchment for this dam is clean. Overflow from this dam will travel via a third channel constructed adjacent to the existing railway into Dam C4.

Dam C4 is a storage of small capacity adjacent to the north western edge of the North Pit and Middle Falbrook Road (which must be reconstructed to avoid local flooding problems). The reconstructed road will form the DamC4 wall which will act as a flood levee bank against Glennies Creek. An outlet structure will allow discharge from the Station Creek diversion system westwards to Glennies Creek.

In the early stages of the Mine, water will be allowed to pond behind the dam wall. This will provide an initial storage which must be reduced as development of the pit necessitates.

In later years, when the North Pit is backfilled with spoil from the South Pit, the dam wall pondage incorporated in the final landform will be adequate to fulfil the function of Dam C4.

This dam will thus have three separate stages of development, but there will always be some capacity for retention of storm flows and for sediment control.

The source of external water supply to the site will be from an intake in Glennies Creek adjacent to the railway bridge. A small weir and pumping station will be constructed with a rising main following the railway line to Dam C3. This system will operate only when storages C1, C2 and C3 are below pre-determined levels. In addition a pump will be provided in Dam C4 connecting to the Glennies Creek/C3 pipeline.

A temporary dam adjacent to the west of the South Pit is located on a watercourse which drains to Station Creek downstream of the railway culvert. Its purpose is to trap sediment from areas disturbed by mining operations. The water level in this dam will be kept low by pumping into Dam D1. Minewater collected in the South Pit will be transported to Dam D1 via the same pipeline.

A temporary dam immediately east of the North Pit is to collect runoff which is not intercepted by the upstream storages and so reduce flow into the Pit. It will also act as a sediment control dam for water from the initial waste dumps. This major temporary dam will cease to exist during the life of the mine when the spoil dumps advance towards the North Pit over the site of the dam.

A number of pumps and pipelines are required to effect the transfer of waters. The main pumps and pipelines are:

- Glennies Creek offtake to Dam C3
- Dam C4 to Glennies Creek/C3 line
- Dam C3 to Dam C2
- Dam C1 to diversion channel between C1 and C2
- Mines to temporary dams
- Temporary dams to Dam D1
- Dams D1 and C2 to Storage Tanks.

The inventory of pumps (some of which would be located on pontoons) would include:

- Horizontal Back Pull Out (BPO)
- Vertical Sump
- Submersible borehole
- Standard Submersible
- Pit dewatering, diesel
- Pressure system
- Fire.

All pipeline will be Class 6 polyetheylene (HDPE), either butt welded (buried pipe) or joined with victaulic joints (above ground). The pumping system will be controlled by both automatic and manual means.

All major fixed pumps will be controlled by Programmable Logic Controllers (PLC), programmed to respond to a set of instructions dependent on specific inputs from various system monitors (eg water levels, flow meters). The PLC will assign priorities for the pumping methodology.

Other pumps will be actuated manually when and where required as is standard practice. Included in this set will be truck mounted pumps for extraction of water for dust suppression needs, from pit areas and from associated temporary dam structures.

With a combination of gravity feed and pumps the water requirements of the site will be fulfilled at minimum cost and maximum productivity.

Final land forms for the North and South Pits are shown in Figure 3.1.9. Many small dams and controlled streams will be established on the rehabilitated dumps to control erosion and establish local water supplies to support the long term success of rehabilitation efforts.

The water management system will not only minimise the chances of pollution of Station Creek by discharge of contaminated waters from the Mine Site, but will also make maximum use of available water resources for mining uses and ensure that the water supply intake in Glennies Creek is only used when site storage dams are depleted.

It would be possible, by providing large enough storage dams on site, to make the Mine self-sufficient in water. It will be necessary to have an external supply however, in the early years before the storages are sufficiently full. The subsequent savings in operating costs of such large structures are insufficient to justify the construction of larger storages than planned.

5.5 PERFORMANCE UNDER VARYING CONDITIONS

5.5.1 Extreme Flow Rates

A peak discharge of 1,700m^3/s has been estimated for the 100 year event in Glennies Creek at Middle Falbrook.

The backwater analysis indicates water levels at various strategic locations for a range of floods as follows:

	1 Year	10 Year	100 Year
Noble's Crossing	68.7	70.9	72.4
Railway Bridge	66.8	68.7	70.1

For the Station Creek catchment of 18km^2, a peak discharge of 46m^3/s has been calculated for the 100 year event for this stream, at the site of the reconstructed Middle Falbrook Road. The water control network will divert water which would otherwise flow into the North Pit, and will provide on site storage for clean and contaminated waters. The management concept does not provide sufficient storage to prevent all discharges from the site in wet weather, as this is not practical. All contaminated waters will be retained on site for use in dust suppression operations and/or coal washery make-up waters.

The peak flow rates at all points in the proposed system have been calculated using a computer program which routes runoff through the system of dams and channels, calculates discharges and flow times and plots inflow and outflow hydrographs at critical locations.

The outlet structures and channels from these dams have been designed for the 1 in a 100 year event because the consequences of inadequate spillway capacity could be dam failure.

Water control structures will be properly designed to ensure that no damage occurs to the railway embankment as a result of extreme flow conditions. Equally the design will ensure that no backwater flooding will enter the North Pit.

5.5.2 Normal Flow Rates

Long term average runoff rates have been assessed at 100mm per year. On this basis the average inflow to the Station Creek catchment at the levee bank is 1,800Ml per year of surface runoff.

During periods of heavy rain when the dams are full some of this inflow will be lost to the downstream creek system and evaporation and seepage losses will account for another portion of the natural inflow. In order to assess the quantity of water to be obtained from external sources to meet the water demand of the Mine, a water balance calculation has been carried out to cover a range of weather patterns, taking into account the varying demands over the life of the Mine.

Mean rainfall is 700mm per year and mean evaporation is 1,700mm (see Section 7.4). This means that nett evaporation is about 1,000mm per year. Seepage losses are very dependent on soil type, however a figure of 300mm per year has been adopted.[8] Using this figure the combined losses from evaporation and seepage are 1,300mm per year.

Under average conditions it is estimated that total water surface areas of all dams will be about 20ha. On this basis evaporation and seepage losses will amount to about 260Ml in an average year, out of a mean runoff of 1,800Ml per year.

It is clear from the above figures that runoff in an average year is considerably more than the sum of demands and losses. *It is anticipated that water from Glennies Creek will only be required in prolonged spells of dry weather.*

The water management structures have been designed to cater for storm events ranging from those normally encountered to extreme situations.

In extreme storm events (eg a 1 in 100 year event) the principal dams, diversion structures, spillways and weirs have been designed to cater for large flows (up to $46m^3$/sec). These measures will prevent any inundation of pit and dump areas from external sources. This is important from both environmental and operational perspectives. Water collected within the Pits will take time to be pumped to surface dams. The retention period will permit settlement of sediment.

By contrast, for normal storm events, the dams will be operated to provide some retention capacity by maintaining them in a purposely partially depleted state. This ensures that all normal wastewaters are retained and reused on site and that there is always the capacity to retain both contaminated and natural storm runoff. This assists in minimising external water supply requirements whilst protecting the environment.

To assess typical performance assume that Dams C1 and C2 are full and D1 and C3 are depleted 2m lower than their top water levels, as normally planned by controlled pumping. The system will then have about 253Ml storage capacity. This exceeds the quantity of water expected to runoff (principally from clean catchment areas) in the annual one hour duration storm (estimate 187Ml).

In practice it might also be expected that Dams C1 and C2 might be partially full providing further retention capacity.

Excess waters falling on rehabilitated and active dump and mine areas will be retained and directed to Dam D1 for subsequent reuse.

8 This figure is recommended by Burton in his text on dam design: JR Burton (1965) *Water Storage on the Farm*

5.6 WATER BALANCE MODELLING

5.6.1 Methodology

A water balance model was used which compared mine water demands with the volume of water generated on the site. The objective of the model was to determine the magnitude of either water surplus or deficit at various stages of mine development under varying climatic conditions and rates of groundwater inflows.

A computer program was developed to simulate the water cycle of the Mine. It used actual rainfall and evaporation data combined with estimates of mine water requirements at several stages of development. The mine has a proposed life of 20 years. Rainfall data over the period 1945-1983 was used to assess the water balance over 18 separate "mine lives". For example mine life one extended from 1945-1964, mine life two from 1946-1965 and so on.

The computer model utilized an algorithm to determine mine water demands and supply sources at three representative stages of mine development, Years 5, 10 and 17. The algorithm determined water demands based on factors such as haul road length combined with evaporation data, and run of mine production combined with washery requirements. Water supply was determined from factors including catchment area and dam storage capacity. The three representative years were extended to cover the mine life. Year 5 is representative of Years 1 to 7, Year 10, Years 8 to 15 and Year 17, Years 16 to 20. Variability in mine water demands is principally affected by climate. The other main components such as length of active haul road, production rate and stockpile sizing remain relatively constant over the life of the Mine.

This computer modelling approach using historic rainfall and evaporation data was adopted because it provided a more realistic assessment of the water balance than looking at "wet', "dry" or average years in isolation. Modelling a "real" mine life enabled the cumulative effect of several years of below or above average rainfalls to be assessed.

The model was also able to isolate separate components of the management system. In particular the flow of water through Dam D1 was isolated to determine if there were a surplus of waters supplied to the dam from the open cut sumps.

The model assesses both yearly and monthly water balances as well as determining monthly storage characteristics.

5.6.2 Model Inputs

Principal inputs into the water management model were demand, supply and climatic data. Fixed demands are discussed in Section 5.3.1. Variable demands, supply inputs and climate are discussed below:

i Demands

In estimating water demands, the following employment and working day data were used (Camberwell Coal, 1989):

- average number employees 293;
- overburden operations 345 days per year;
- coal preparation and coal handing operations 353 days per year;
- coal production and transport operations 258 days per year;
- stockpile dust suppression equals active stockpile surface area x 2 [Evaporation Rate];
- haul road dust suppression equals active haul road surface area x 1.5 [Evaporation Rate];
- dam evaporation volume equals Dam Surface Area x 0.7 [Evaporation Rate]; and
- dam seepage losses equal to 300mm per year.

ii Supply

- Groundwater inflow varies from 0 to 400 Ml/a
- average annual rainfall runoffs equals [catchment area] x [rainfall] x [coefficient]. The coefficient of runoff has been taken to be 0.1 for natural and rehabilitated areas, 0.5 for pit areas and 1.0 for the site facilities.

5.6.2 Rainfall and Evaporation

Rainfall data are available for Singleton post office from 1902 to 1969 (Station 061070) and Singleton Army Base from 1965 to 1988 (Station 061275). Evaporation data were obtained for Paterson (Station 061250) for the period 1967 to 1986.

A statistical analysis of rainfall and evaporation data was completed. This indicated that for modelling purposes the post office and army base rainfall data could be treated as one record. The analysis further determined the probability of annual rainfall events. This was calculated to provide a basis for assessment of the water balance results. The following results with a 90% confidence range are given in Table 5.6.1

TABLE 5.6.1
RAINFALL AND EVAPORATION (mm)

	Dry	Average	Wet
Rainfall	450-560	650-760	810-1010
Evaporation	1820-2200	1530-1750	1310-1580

Dry, average and wet years have been defined as:

- dry year, with annual rainfall having a probability of exceedance of 90%;
- average year, with annual rainfall having a probability of exceedance of 50%; and
- wet year, with annual rainfall having a probability of exceedance of 10%.

Evaporation data are only available from 1967. It was found that there was a reasonable correlation between evaporation and rainfall with higher rainfall years generally having lower evaporation rates and vice versa. Actual evaporation rates from the available years of records were therefore assigned to the period 1945 to 1966 on the basis of this correlation.

5.6.3 Results

Results of the water balance modelling are summarised in Tables 5.6.2 and 5.6.3.

Table 5.6.2 shows the period over which the mine has a nett water deficit. During these times water will be required to be supplied from an external source such as Glennies Creek. Over each 20 year mine life the period of deficit varies from a minimum 18 months up to a maximum 39 months. Also given in Table 5.6.2 are estimates of the maximum monthly and annual volumes required to be supplied from external sources. Maximum monthly deficit is 166Ml and the maximum annual deficit 663Ml. In all mine lives modelled, the maximum deficits occurred in either year 1957 or 1966 which had annual rainfalls of 351mm and 476mm respectively. An annual rainfall of 351mm is estimated to have a probability of occurrence of about 1% and 476mm approximately 10%. 1965 was also a dry year with an annual rainfall of 421mm.

TABLE 5.6.2

WATER BALANCE MODEL RESULTS

Simulation Period	Number months with deficit	Maximum monthly deficit (Ml)	Maximum Annual deficit (Ml)	Year of occurrence
1945-1964	18	164	674	1957
1946-1965	22	164	674	1957
1947-1966	31	164	674	1957
1948-1967	29	164	631	1957
1949-1968	28	157	544	1957
1950-1969	29	157	544	1957
1951-1970	31	166	663	1966
1952-1971	31	166	663	1966
1953-1972	32	166	663	1966
1954-1973	33	166	663	1966
1955-1974	37	166	663	1966
1956-1975	37	166	663	1966
1957-1976	39	166	663	1966
1958-1977	30	157	663	1966
1959-1978	26	157	567	1966
1960-1979	34	157	567	1966
1961-1980	36	157	567	1966
1962-1981	27	157	567	1966
1963-1982	27	157	567	1966
1964-1983	32	157	567	1966

The results in Table 5.6.2 assumed zero groundwater inflows. The effects of groundwater inflows were examined by recalculating the model assuming annual groundwater inflows of 200Ml and 400Ml respectively. For the mine life 1957-1976 (the "driest" modelled) the results were:

- groundwater inflow 200Ml/a
  - number months with deficit 22,
  - maximum monthly deficit 149Ml,
  - maximum annual deficit 617Ml.
- groundwater inflow 400Ml/a
  - number months with deficit 9 (eight of these in the initial year of mining)
  - maximum monthly deficit 90Ml,
  - maximum annual deficit 371Ml.

Both simulations give maximum annual deficits during Year 1 of mine operations when storages are empty. After Year 1 the maximum annual deficits from groundwater inflows of 200Ml/a and 400ml/a are 463Ml and 37Ml respectively.

The mine's water balance is therefore sensitive to groundwater inflows, although in the driest life modelled deficits still occurred even at an annual groundwater inflow of 400Ml/a.

TABLE 5.6.3

COMPARISON OF INFLOWS - VS - OUTFLOWS, DAM D1

Simulation Period	Number months With Flow Excess	Maximum Monthly Excess (Ml)	Maximum Annual Excess (Ml)
a) Zero Groundwater Inflow			
1945-1964	2	25	33
1952-1971	0	0	0
1958-1977	2	20	24
1964-1983	0	0	0
b) Groundwater inflow = 400 Ml/a			
1945-1964	29	101	238
1952-1971	12	48	130
1958-1977	4	71	125
1964 -1983	3	49	61

Dam D1 is the main storage for polluted water on site, receiving flows from the pits, groundwater and rainfall runoff, as well as rainfall runoff from the site facilities. It was therefore modelled separately to determine the potential for an excess of polluted waters. Table 5.6.3 summarises the water balance for Dam D1 for four separate mine lives and groundwater inflows of 0 and 400 Ml/a. For zero groundwater inflows the dam has a deficit 99% of the time and water would be drawn from Dams C1, C2 and C3 or Glennies Creek. For groundwater inflows of 400Ml/a there were a total of 29 months (12%) with an excess during mine life 1945-1969. The probability of occurrence of a surplus of water directed to Dam D1 from the Pits is low. At times of surplus these could be temporarily stored in the Pit. Mining activities would be constrained by this requirement but could continue on higher benches.

5.7 ALTERNATIVES

Calculations involving water levels in Dams C1 and C2 have shown that it is possible to provide sufficient on site storage to meet normal water demands throughout a two year drought and thus obviate the need for an external source of water supply. In order to achieve this it would be necessary to raise the top water level of these two dams from RL97 to RL101.

The storage capacities of dams at the alternative higher level are substantial and such dam walls would be major structures requiring registration with the Dam Safety Committee as Prescribed Dams. It would require three average years runoff to fill these storages so if drought conditions prevailed in the early years of the mine an external source of water would be necessary until the dams were full. Even under normal conditions an external source would be required unless dam construction preceded coal production by at least two years.

Since the initial capital expenditure on such an intake is unavoidable, it is proposed to eliminate the high capital costs and greater environmental impact of larger than necessary storage volumes in Dams C1 and C2.

The proposed water control system provides considerable scope for flexibility, particularly in regard to water level maintenance in the water storages. Operational control will be refined with experience.

The preferred option for an external source of water as discussed above is an intake in Glennies Creek near the railway bridge. The alternative of connecting to the Singleton Council pipeline from Glennies Creek Dam has a lower initial capital cost but the operating costs are dependent on ongoing negotiations with Council. It is quite possible that an acceptable arrangement could be negotiated giving access to sufficient water at a reasonable price, however long-term costs cannot be assured.

5.8 HYDROLOGICAL AND GEOCHEMICAL CONSIDERATIONS

5.8.1 Hydrological Considerations

In the Wittingham Coal Measures, the coal seams are normally the principal ground water aquifers. Even when there are extensive alluvial deposits near major water courses, it is believed that ground water being pumped from the Pits will not have any significant impact on alluvial aquifers. There is likewise no evidence of ground water pressure causing instability in high walls. No special provision has been made therefore in the mine plan for groundwater.

Hydrogeological investigation indicates that:

- Groundwater is continuous throughout the coal measures infiltrating through the weathered zone and alluvium, particularly along Station Creek and Glennies Creek. Weathered rock aquifers are apparently also recharged by infiltration updip along the eastern and western subcrops.
- Within the coal measure strata, water quality is typically saline with total dissolved salts of about 6,000mg/l.
- Low permeabilities suggest limited potential inflows to mining areas. Highly permeable strata adjacent to water courses will require control by cut-off trenches.
- The abandoned Rosedale Colliery workings will have to be dewatered prior to mining.

5.8.2 Geochemical Considerations

Generally, the geology at the Camberwell site consists of interbedded sandstones, conglomerate, siltstone, mudstone, claystone, siderite, carbonaceous mudstone and coal. The weathering profile varies over the site but generally the overburden is weathered to 8-10m in the North Pit and to 12-18m in the South Pit area. The strata occur within the Foybrook Formation of the lower portion of the Upper Permian Wittingham Coal Measures.

For details of the study approach and testing method see Appendix 1.

Acid Producing Potential

Table 5.8.1 gives the results of the acid-base analysis for the individual profile samples. This Table presents the total sulphur content (% S), acid neutralising capacity (ANC), net acid producing potential (NAPP), saturation extract pH and electrical conductivity (EC) for each sample.

The net acid producing potential (NAPP), presented in Table 5.8.1 is calculated from the total sulphur content less the inherent acid neutralising capacity and is expressed in terms of $CaCO_3$ equivalents. A negative NAPP indicates there is an excess of neutralising capacity and the material is unlikely to generate acid (Non-Acid Forming). A positive value suggests that the material is acid (Acid Forming) or may become acid in the long term (Potentially Acid Forming).

A pH less than 4 indicates that the material is naturally acid. An electrical conductivity (EC) value greater than 2 dS/m suggests that the material is geochemically reactive or contains a high level of soluble salts.

The results in Table 5.8.1 show that all individual samples had a pH greater than 4 and negative NAPP value. These results suggest that the overburden and interburden units represented by the samples tested are classified as Non- Acid Forming.

Electrical conductivity values greater than 2 occurred in a number of samples, and were particularly high in samples 2 and 4. The high sulphate levels observed in the saturation extracts of these samples suggests that the sulphides are reactive although adequate buffering and neutralising capacity is available to prevent the establishment of acid conditions. The significance of these high EC values is discussed in conjunction with Salinity Status.

TABLE 5.8.1

ACID-BASED ANALYSIS AND SATURATION EXTRACT PARAMETERS

Stratigraphic Unit	SMA Sample No.	Totals %	ANC %CaCO3	NAPP %CaCO3	pH	EC dS/m
Overburden						
Arties Seam Overburden	1	0.01	4.1	-4.1	5.7	2.28
	11	0.13	5.4	-5	6.1	1.2
Middle Liddell Seam Overburden	13	nd	6.8	-	6.3	2.05
Interburden and Partings						
Arties-Upper Liddell Interburden and Partings	2	0.44	7	-5.6	6.1	4.15
	12	0.04	5.9	-5.8	6.2	1.25
Upper Liddell-Middle Liddell Interburden	3	0.01	3.4	-3.3	6	2.1
Middle Liddell-Lower Middle Liddell Interburden	4	0.95	7.8	-4.9	6.1	6.85
Lower Middle Liddell-Lower Liddell Interburden	5	0.07	4.5	-4.3	6	2.79
Lower Middle Liddell-Lower Liddell Interburden	6	0.08	2.8	-2.5	6	1.62
Lower Liddell-Upper Barrett-Lower Barrett Interburden	7	0.21	9	-8.3	5.9	1.5
	14	0.21	4.1	-3.5	6.2	0.58
Upper Hebden Partings	8	0.04	2.6	-2.5	6.2	1.27
Upper Hebden-Lower Hebden Interburden	9	0.02	4	-3.9	6.1	2.39
Lower Hebden Partings	10	0.11	2.7	-2.3	6.2	0.98

TABLE 5.8.2
SATURATION EXTRACT COMPOSITION (MAJOR PARAMETERS)

Stratigraphic Unit	SMA Sample No.	pH	EC dS/m	Ca mg/l	Mg mg/l	Na mg/l	K mg/l	HCO3 mg/l	SO4 mg/l	Cl mg/l	SAR
Overburden											
Arties Seam Overburden	1	5.7	2.28	14	27	470	4.9	36	440	450	16.9
	11	6.1	1.2	4	6.8	260	6	230	320	97	18.3
Middle Liddell Seam Overburden	13	6.3	2.05	9.7	6.6	470	8.7	140	610	290	28.5
Interburden and Partings											
Arties-Upper Liddell Interburden and Partings	2	6.1	4.15	140	160	630	22	190	1900	370	8.6
	12	6.2	1.25	2.1	3.8	280	5.5	210	250	150	26.6
Upper Liddell-Middle Liddell Interburden	3	6	2.1	26	50	410	14	170	700	250	10.8
Middle Liddell-Lower Middle Liddell Interburden	4	6.1	6.85	120	250	1900	32	190	4800	230	22.7
Lower Middle Liddell-Lower Liddell Interburden	5	6	2.79	80	120	480	18	150	1200	300	7.9
Lower Middle Liddell-Lower Liddell Interburden	6	6	1.62	22	33	320	9.9	140	630	100	10.1
Lower Liddell-Upper Barrett-Lower Barrett Interburden	7	5.9	1.5	12	18	310	8.4	64	480	160	13.2
	14	6.2	0.58	7.3	6.3	110	3.3	110	130	47	7.2
Upper Hebden Partings	8	6.2	1.27	7.5	11	270	6.9	150	370	120	14.7
Upper Hebden-Lower Hebden Interburden	9	6.1	2.39	37	52	460	19	130	860	310	11.4
Lower Hebden Partings	10	6.2	0.98	3.2	4.6	200	6	96	210	130	16.8

TABLE 5.8.3

MULTI-ELEMENT COMPOSITION OF SATURATION EXTRACTS

Element	Arties O/B Sample 1	Arties O/B Sample 11	Liddell O/B Sample 13	Liddell I/B Sample 5	Hebden Partings Sample 8
Al	0.59	3	0.45	<0.01	3.1
Fe	<0.01	1.6	<0.01	<0.01	2.3
Ba	<0.05	<0.05	<0.05	<0.05	<0.05
Mn	3.7	0.04	0.04	0.6	0.08
Zn	2.1	0.17	<0.01	0.15	0.27
Cu	<0.01	0.02	0.06	0.26	0.06
Ni	0.16	<0.01	<0.01	0.06	<0.01
Pb	<0.2	<0.2	<0.2	<0.2	<0.2
Cr	<0.01	<0.01	<0.01	<0.01	<0.01
Co	<0.2	<0.2	<0.2	<0.2	<0.2
Mo	0.006	0.67	0.37	0.074	0.69
Cd	<0.005	<0.005	<0.005	<0.005	<0.005
As	<0.01	0.23	0.29	0.02	0.08
Hg	0.03	0.01	<0.01	<0.01	0.01
Se	<0.1	<0.1	<0.1	<0.1	<0.1
Sb	0.005	0.01	0.015	0.005	0.01
Be	<0.002	<0.002	<0.002	<0.002	<0.002
B	0.11	<0.01	<0.01	<0.01	<0.01
Ag	<0.002	<0.002	<0.002	<0.002	<0.002
Sn	<0.005	<0.005	<0.005	<0.005	<0.005
U	<0.002	0.004	0.006	0.006	0.006
Th	<0.002	<0.002	<0.002	<0.002	<0.002
Si	1.4	7.5	2	2.8	8.3

Element Solubility

The concentration of the major parameters in saturation extracts of all samples are given in Table 5.8.2 and the multi-element composition of selected samples are given in Table 5.8.3. The results show that the pH of extracts ranged from 5.7 to 6.3 . The solutions were dominated by sulphate salts with lesser amounts of chloride and a moderated alkalinity (indicated by the bicarbonate concentration).

The multi-element analysis given in Table 5.8.3 indicates that a number of constituents are slightly soluble including the environmentally significant elements Al, Zn, Cu and As. Even though the concentrations and solubility of these elements are low and unlikely to be an environmental concern, their concentrations will be periodically monitored in drainage water from the spoil dump areas.

Salinity Status

A relatively high soluble salts content was observed in Samples 2 and 4. These samples represent the Arties-Upper Liddell interburden and the Middle Liddell-Lower Middle Liddell interburden, respectively. The high salinity is due to higher sulphate and sodium concentrations in solution. These samples had the highest sulphur content (see Table 5.8.1) and the results therefore suggest that the sulphide in these samples is relatively reactive and oxidises following exposure.

The calculated sodium adsorption ratio (SAR) for each sample is given in Table 5.8.2. The results show that all samples have a relatively high SAR which suggests that the materials are potentially sodic and the clay fraction may be unstable to wetting resulting in clay dispersion problems. This is a common concern with overburden in the Hunter Valley.

6. REHABILITATION

6.1 LEGISLATIVE REQUIREMENTS

The NSW Department of Minerals and Energy (DM&E)[9] is responsible for the specification of rehabilitation standards and the granting of approval for compliance following completion of rehabilitation works.

The assessment of the success of rehabilitation includes a comparison of the pre-mining and post mining land capability or sustained stock carrying capacity as well as an evaluation of the vegetative cover.

Following Development Consent and granting of a Coal Lease, detailed rehabilitation plans must be prepared and approved by the DM&E prior to commencement of mining. Approval is for a period of five to seven years during which time annual rehabilitation reports must be submitted to the Department. These plans are required to show the extent of mining, proposed landforms following mining, including drainage patterns and an assessment of topsoil quantities and suitability for topdressing purposes.

Security deposits must be lodged with the Department to ensure that the site can be rehabilitated should the mining company be unable to fulfil its rehabilitation commitments. The amount retained is calculated according to the maximum area unrehabilitated at any time.

6.2 POST MINING LAND USE

6.2.1 Alternatives

It is necessary to assess preferred post mining land uses prior to mining in order that criteria to accomodate these uses can be incorporated into the final landform. These include considerations of slope, drainage and distribution of stripped topsoil. As disturbed areas will be progressively rehabilitated it is important that post mining land uses are compatible with the on-going land management plan for the site.

A range of post mining land uses were evaluated for the Project, but due to the uncertainty of the long term future of the site (which includes the possibility of underground mining with access from the South Pit) the assessment cannot be definitive. The site master plan will be flexible enough to cater for changes on the site, alterations to land use on adjacent sites and changing economic and usage patterns in the community.

The alternative uses evaluated were:

Grazing. This represents the major land use for the site, adjacent properties and the Hunter Valley. Existing property sizes vary from smaller properties of 80 to 120ha to the average size of about 400ha.

A grazing post mining land use results in the least number of constraints to rehabilitation planning as the development of a satisfactory pasture sward can be established within one to three years after reinstatement of the surface. This land use is best restricted to slopes less than 10°.

The re-establishment of pastures for grazing use on land rehabilitated following mining has been developed to a stage where a high level of confidence can be predicted. The results of a recently completed five year field trial has indicated that rehabilitated mining sites are capable of sustaining similar or better stocking rates than native pastures on equivalent land (Dyson et al). In this trial, ground coverage was found to improve from 50% to 90% over a five year period for one of the study areas which did not receive topdressing material.

9 Provisions relating to rehabilitation are set out in Part VII of the Coal Mining Act, 1973. Section 41 (6) of the Act, provides legislative responsibility for the Soil Conservation Service to approve of conditions included in the coal lease for the reinstatement, levelling, regrassing, reafforesting and contouring of land. One of these conditions is that disturbed land should be returned to at least its former stability, capacity and productivity.

Forestry. Coverage of the site by Eucalypt woodland (both remnant natural and regenerative) amounts to about 25% of the Authorisation area, as depicted in Figure 7.6.1. The site, in common with most of the Upper Hunter Valley is not capable of producing marketable timber from the establishment of Eucalypt forest. The alternative of recreating Eucalypt woodland similar to the present natural vegetation is feasible, as demonstrated by the results at the Saxonvale Mine and from trials conducted at the Hunter Valley No 1 Mine and the Drayton Mine.

Recreational Use. The Project site is approximately 10km from Singleton and therefore is probably too far for consideration as an area for active recreational use, given the adequate supply of sporting facilities within close proximity to the town. Recreational use of restricted sections of the site for picnicking, camping and a caravan park, related to the large water storage dams along the eastern side of the site may be feasible.

Waste Disposal. A void is proposed to remain within the South Pit at the end of the 21 year lease period as a means of entry to underground resources. This would be available in the long term for the disposal of coal washery reject material from the Camberwell Project should underground mining be developed and adjacent projects if required. The disposal of urban waste material from Singleton represents a further long term alternative use of the void which could be investigated during the latter part of the initial lease period.

6.2.2 Preferred Post Mining Land Use

A broadscale post mining land use strategy for the site comprises a combination of all the above alternatives, with grazing as the predominant use.

The redevelopment of small farm units will enable the site to be integrated with the existing farm management practices of the surrounding buffer zone and nearby farms. Rehabilitation of the mined land to a standard suitable for grazing should be readily accomplished by adoption of proven practices.

Natural timbered areas will be established along ridgelines, watercourses, gullies and on slopes exceeding 10° with the objective of re-establishing the current landscape character and ensuring surface stability of land with a higher erosion potential.

Limited recreational use of the SLA area, related to the larger water storage dams would represent a desirable component of the end land use of the site.

6.3 LANDFORM DESIGN

6.3.1 Design Criteria

Post mining topography has been designed to fulfil the following objectives:

- compatibility with adjacent natural land surfaces;
- creation of a stable, erosion-free surface suitable for the proposed end land use;
- minimisation of overburden rehandling and haulage distance consistent with the Project's economic criteria; and
- progressive rehabilitation of backfilled areas to ensure disturbed areas are kept to a minimum.

To achieve these criteria, slopes will be reformed predominantly at less than 10° (1V:6H) and where possible not exceeding 6° (1V:10H). Drainage density will be increased above the present density and where possible an additional stream order will be incorporated within the new landform compared to the existing four and five order drainage pattern. Numerous small dams will be located on reformed watercourses and drainage gullies to provide short term retention and erosion control functions in the early establishment period. The larger dams in this system will be retained for stock watering purposes and possible recreational use as part of the post mining land use proposal.

An overburden swell factor of 30% has been assumed for the purposes of landform design.

6.3.2 Interim and Final Landforms

North Pit and Out-of-Pit Overburden Emplacements

Out-of-pit dumping of overburden generated from the North Pit will occur during the first six years of operation. From Year 3 overburden will also be backfilled into the North Pit.

Dump areas will be prestripped ahead of dumping operations and prestripped soil material stockpiled. This material will be respread at the earliest opportunity.

Initial dumping of overburden along the northwestern boundary of the pit will create an effective bund to ameliorate potential noise, dust and visual impacts as well as provide protection to the pit from floodwaters. It will be constructed during the first year of operations and revegetated immediately.

Emplacement within the main overburden dump located east of the North Pit (see Figure 3.1.3) will commence from the eastern boundary. This will provide an effective visual screen to later overburden emplacement and mining activities in the North Pit when viewed from the almost one km distant Bridgman Road. The dump will initially be constructed with two areas of operation – one for daytime dumping and a second for night-time dumping set back from the perimeter to ameliorate night-time noise impact. This eastern section of the dump will be rehabilitated within the first two years of operations.

The dump will extend over the worked out North Pit as soon as mining conditions permit (Figure 3.1.5). The South Pit overburden will be dumped in the North Pit up to Year 13. Coal preparation reject material will be disposed of within the defined spoil areas.

The overburden dump east of the North Pit has been designed to represent a southern extension of the existing east-west orientated major ridgeline. An objective of the rehabilitation programme will be to endeavour to restrict all dumping below the crown of the ridge. Overburden will be emplaced along a north-south front which will progress in a westerly direction. The "targeted" maximum fill height for the dump will be RL 120 which is 5m below the top height of the existing ridgeline. The "worst case" scenario, presented in Figures 3.1.3 to 3.1.9 has a maximum height of RL 130. Slopes of the new landform will vary between a maximum of 1V:5H (20%) to a minimum of 1V:70H (1.5%).

The distribution of slope classes for the two alternative proposed landforms is shown in Table 6.3.1.

TABLE 6.3.1

COMPARISON OF PRE-MINING & POST MINING TOPOGRAPHY

Slope Class %	Pre-mining Landform	"Targeted" Landform %occurrence	"Worst Case" Landform
North Pit & Dump			
0-1	27	–	–
1-5	36	80	27
5-10	31	17	48
10-15	6	1	23
15-20	-	2	2
South Pit & Dump			
0-1	–	–	
1-5	40	43	
5-10	56	40	
10-15	4	15	
15-20	_	2	

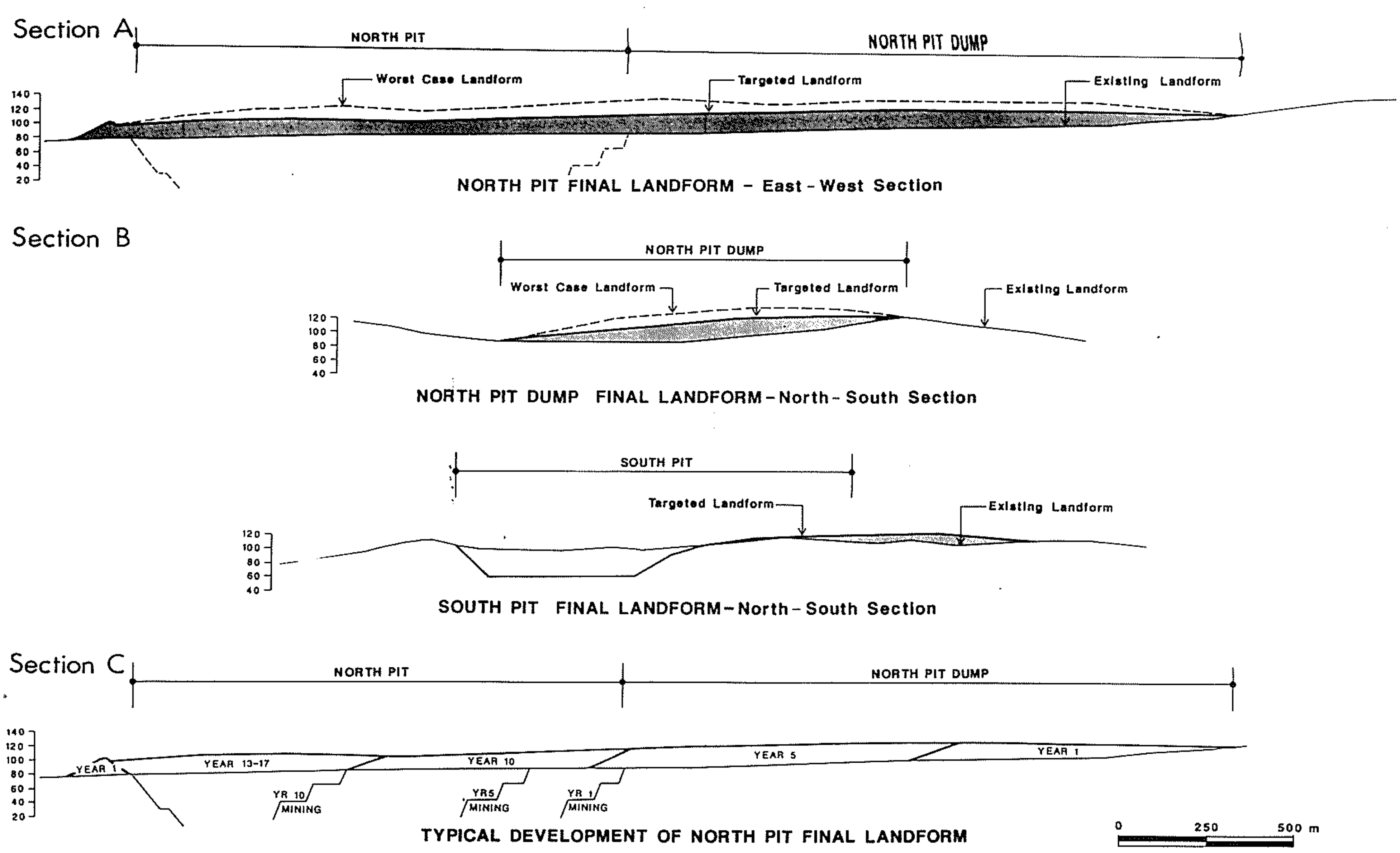


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Figure 6.3.1

FINAL LANDFORM SECTIONS

This analysis of topography indicates that for either scenario, maximum slopes of the recreated North Pit landform are within acceptable limits based upon stability criteria, viz. less than 1V:6H (16.5%). Section A of Figure 6.3.1 illustrates typical profiles of the two alternative proposed landforms in comparison with the existing surface.

To compensate for the increase in surface slopes and the backfilled nature of the landform, drainage density[10] of the proposed land surfaces will be increased from 0.047 at present, to 0.031.

The targeted landform has a capacity of approximately 135 x $10^6 m^3$ while the "worst case" landform will accommodate about 180 x $10^6 m^3$. Both emplacement alternatives occupy an area of approximately 435ha, which includes 155ha of the North Pit.

Rehabilitation of the North Pit will be undertaken sequentially in a southeast to northwest direction, as an extension of the landform described for the overburden emplacement. While some backfilling will occur within the North Pit from Year 3 onwards, at the same time as overburden is being emplaced out-of-pit, final reshaping within the Pit will not occur until about Years 5 to 6.

Final rehabilitation will be undertaken by about Year 13 for the targeted landform and by Year 17 for the "worst case" landform.

South Pit and Out-of-Pit Overburden Emplacements

Pre-stripping within the northwestern corner of the South Pit is scheduled to commence from Year 7, with overburden being emplaced out-of-pit (Figure 3.1.6).

The spoil emplacement south east of the South Pit could have a capacity of approximately 2.5 x $10^6 m^3$, established within the existing north to northeast trending valley. The upper reaches of this valley are hidden from the Main Northern Railway by a prominent knoll rising to a maximum height of 110m. At the northern end, the emplacement will finish at least 100m from the Railway in order to allow vegetative screening to be established.

Where possible, in accordance with the land ownership situation prevailing at the time, bunding along the western margin of the South Pit could be constructed as an extension to the knolls and ridges located on either side of the northwest orientated valley. It is anticipated that the bunding could be constructed by Year 9 with progressive rehabilitation being undertaken to ensure quick integration with adjacent landforms. This bund construction would ameliorate the noise, dust and visual impacts generated during the early stages of the South Pit mining operations for the benefit of residences located along the Glennies Creek alluvial flats.

It is planned that major in-pit dumping could commence in Year 13. It is not practical to commence in-pit dumping at an earlier stage in the South Pit because of the need to retain numbers of working faces and to provide practical working room. The advancing face of a multi-bench mine is about 16° which consequently extends over a large area of both these relatively small pits. The South Pit does not have the advantage of the North Pit in working from the subcrop of the lowest coal bed allowing early back fill into the pit. Some of the spoil from the South Pit will be placed in the North Pit until in-pit dumping can commence. Scheduling requirements determining the duration of this spoil transferral, will determine whether the "targeted" landform for the North Pit can be achieved.

Rehabilitation will be progressive behind the advances in mine development. However, as in-pit dumping occurs late in the life of the South Pit, a final void of about 70ha in area and up to 80m deep will remain. This final void is a desirable feature with regard to potential future access to underground resources and provision of space for pit head facilities or as a base for deepening the Pit should economic conditions allow for this.

Final topography of the 185ha area rehabilitated at Year 20 will be generally similar to the pre-mining landform. As depicted in Table 6.3.1 there will be an increase within the 10 to 15% slope class. Section B of Figure 6.3.1 illustrates the post-mining landform in comparison with the existing land surface.

10 Drainage density is the catchment area in hectares divided by the total channel length in metres.

Table 6.3.2 provides a comparison of the area disturbed and rehabilitated during the life of the open cut. The extent of progressive rehabilitation is shown graphically in Figures 5.4.2 to 5.4.4, whilst schematic development of the post-mining landform is shown in Section C of Figure 6.3.1.

TABLE 6.3.2

COMPARISON OF AREA DISTURBED & AREA REHABILITATED

Year	Area Disturbed (ha)	Progressive Total of Area Disturbed (ha)	Area Rehabilitated (ha)	Progressive Total of Area Rehabilitated (ha)
North Pit & Dump				
1	153	153	–	–
2	93	246	110	110
5	154	400	105	215
10	34	434	129	344
13	–	434	5	394
17	–	434	40	434
20	–	434		
South Pit & Dump				
1	–	–	–	–
2	–	–	–	–
5	–	–	–	–
10	180	180	64	64
13	63	243	–	64
17	7	250	17	81
20	4	254	104	185 (final void 69ha)

Post Mining Land Capability

Table 6.3.3 provides a comparison between the rural land capability at present (as defined in Section 7.9.2) and the capability of the final landform at Year 20.

The analysis for the North Pit shows that the post mining land surface should be capable of supporting a similar land use to that which exists at present. This interpretation is supported by the slope and terrain classes being less than 25% and the intention of respreading a minimum of 10cm of topdressing material over a reasonably well drained substratum of compacted overburden (<4mS/cm salinity).

The South Pit final landform, whilst resulting in a higher proportion of Class IV and V land than prior to mining, will inherit a significant percentage of Class VIII land due to the presence of the void.

TABLE 6.3.3

COMPARISON OF PRE-MINING & POST MINING LAND CAPABILITY

Rural Land Capability Class	Premining Landform %	Targeted Landform %	Worst Case Landform %
North Pit & Dump			
IV	20	90	70
V	67	5	27
VI	8	–	–
VII	5	5	5
South Pit & Dump			
IV	39	58	
V	36	15	
VI	25	–	
VII	–	–	
VIII	–	27 (final void)	

6.4 REVEGETATION PROCEDURES

6.4.1 Guidelines

Revegetation of landforms resulting from open cut mining has developed to a sophisticated level as a result of collaboration between many Hunter Valley mining companies, the Soil Conservation Service of NSW, the Forestry Commission of NSW and the input of numerous research projects including those funded under the NERDDC[11] programme.

Where appropriate these guidelines will be altered to suit site specific circumstances, particularly with respect to the results of on-site revegetation trials.

Clearing

The majority of the site which is proposed to be disturbed has been cleared previously of vegetation and exists as grazing land. The northeastern and southwestern sections of the South Pit represent the main areas where clearing of woodland vegetation would be undertaken.

Timber suitable for use as fence posts, milling and for landscaping purposes will be removed prior to clearing. Remaining timber will be cleared and windrowed by bulldozer and burnt in accordance with the requirements of the local bushfire brigade. Consideration will be given to the chipping of smaller diameter vegetative material to be used as a mulch in landscaped areas and for use as organic material in the rehabilitation programme.

Topsoil Stripping

Vegetation and topsoil stripping will be limited to a zone varying between two and three mine strips or 60m to 240m in advance of mining. Wherever possible, topsoil will be respread onto current rehabilitation areas soon after stripping in order to maintain its viability. For certain areas such as the surface facilities site it will be necessary to stockpile topsoil for up to one or two years. These stockpiles will be limited to 60cm in height and sown with a cover crop to maintain viability and to prevent surface erosion.

11 National Energy Research Development and Demonstration Council.

Stripping will be undertaken to the extent and depths shown on Figure 7.2.3, using either scraper loaders or a combination of bulldozer, loader and truck.

Calculations summarised in Table 6.4.1 indicate that sufficient topdressing material will be available for respreading over the final landforms to an average depth of 10cm. Surplus material stripped from the North Pit and Dump would enable respreading to a thicker depth along gullies, water courses and areas of steeper slope. These calculations do not allow for the long term storage of topsoil for later treatment of the final void.

TABLE 6.4.1

ESTIMATED QUALITY OF SUITABLE TOPDRESSING MATERIAL

Stripping Depth (cm)	Area (ha)	% Occurence	Volume (m^3)
North Pit & Dump			
0	73	17	0
10	118	27	118,000
15	115	26	172,000
20	112	26	224,000
25	16	4	40,000
	434	100	554,000
South Pit & Dump			
0	63	25	0
10	191	75	190,000
	254	100	190,000
Surface Facilities			
0	3	10	–
10	–	–	–
15	26	90	39,000
	29	100	39,000

Suitability of Overburden and Interburden.

Analysis of representative overburden and interburden material as described in Section 5.7.2 has shown the material to be largely representative of coal measures strata elsewhere within the Hunter Valley. The main difference is the acid nature (pH 5.7 to 6.3) compared with the predominantly alkaline material (pH 7 to 9) normally encountered on other sites.

The material is non-acid forming and therefore leachate from overburden dumps and the pits is expected to be of satisfactory quality. Salinity levels are moderate with average values within the range 2 to 3mS/cm for saturated extracts and a maximum value of 6.9mS/cm being recorded. Relatively high salinity levels have been identified in a couple of strata units. Geochemical tests are in progress from additional sites within the Pits to further clarify the suitability of overburden for final placement. Monitoring of salinity and other tests addressed here will continue during mine operations. High salinity material will not be placed on or close to the final surface.

Sodium absorption ratios are high (7 to 28) indicating that surface setting will be a problem in inhibiting germination and creating excessive surface erosion. This sodium imbalance will be ameliorated by the addition of gypsum to the overburden at a rate of about 5t/ha and by the use of topsoil for the creation of a suitable seed bed.

In common with most coal measures material, the overburden and interburden has a low fertility status. It will require initial fertiliser addition followed by top dressing applications at regular intervals as scheduled in Table 6.4.2.

Final Shaping

Overburden will be placed approximately to the contours shown on Figures 3.1.3 to 3.1.9, subject to verification by subsequent, more detailed rehabilitation plans prepared to a scale of 1:4000. This will be undertaken as part of the detailed mine planning process.

The removal of large surface rocks in excess of 50cm diameter, deep ripping along the contour and final shaping of surfaces to optimal slope profiles will be undertaken by appropriately-sized machinery. Drainage lines, small sedimentation dams and graded banks will be constructed as part of the rehabilitation programme prior to topsoil respreading. The surface will be left in a rough state to promote infiltration and minimise surface erosion.

Surface Preparation

Approximately 75% of the fertiliser specified in Table 6.4.2 will be incorporated into the overburden prior to topsoil spreading. This is to encourage deeper root penetration and increase the drought resistance of the sown pastures.

Topsoil will be spread over the overburden by shallow ripping along the contour, to produce a suitable seed bed. Areas of higher erosion potential, including drainage lines, dam walls, erosion control structures and areas of steep slope will receive thicker coverage of topsoil.

Seeding

Seeding of rehabilitated areas will be undertaken in autumn or spring in accordance with the seed and fertiliser requirements listed in Table 6.4.2. These represent general recommendations provided by the Soil Conservation Service of NSW for the Whittingham Coal Measures. Variations to this specification are likely to occur depending upon the results of on-site revegetation trials and continuing rehabilitation procedures.

The remainder of the fertiliser not incorporated into the overburden prior to topsoiling, will be ground broadcast with the seed by agricultural implements following cultivation and the onset of suitable rain.

TABLE 6.4.2

RECOMMENDED FERTILIZER & SEED APPLICATION FOR REVEGETATION

			kg/ha
Fertilizer	Initial application	Starter 15	400
	Maintenance applications	Starter 15	200
		Nitram	100
Species	Autumn sowing:	Rhodes grass	8–15
		Couch	4–6
		Wimmera rye	4–8
		Lucerne	2–4
		Sephi barrel medic	4–8
		Sub-clover	2–4
		Bambatsi or green panic	6–12
			30–57
	Spring Sowing:	Rhodes grass	8–15
		Bambatsi or green panic	6–12
		Couch	4–6
		Lucerne	2–4
			20–37
Cover Crops	Spring	Pearl Millet	5–10
	Autumn	Cooba oats	5–10

Tree planting

It is proposed to re-establish areas of open forest vegetation type on the newly contoured surfaces typical of the Hunter Valley forest that was originally cleared for farming.

Broad plantings of trees to similar densities as the existing remnant woodland will be established along ridge lines, water courses and areas of steep slope (ie. steeper than 10°). Figure 6.4.1 provides an indication of the extent of planting envisaged at the end of Year 20. It is anticipated that these areas will be established by direct seeding techniques involving the ground broadcasting of suitable indigenous tree and shrub seed together with a quick growing cover crop as listed in Table 6.4.3. The intention of the cover crop is to provide fast cover to the ground surface, minimising surface erosion and dust generation until the tree and shrub species become established.

Within the areas of pasture establishment, shade trees will be planted as tube stock and protected by fencing from stock.

TABLE 6.4.3

SPECIES LIST FOR FORWARD TREE PLANTING PROGRAMME AND REHABILITATION

	Scientific Name	Common Name
Shrubs	Acacia amblygona	Fan Wattle
	A. decora	Western Silver Wattle
	A. falcata	Sickle Wattle
	A. salicina	Cooba
	Indigofera australis	Indigo
Trees	Allocasuarina leuhmannii	Bull Oak
	Angophora floribunda	Rough-barked Apple
	Casuarina glauca	Swamp Oak
	C. stricta	Drooping Sheoak
	Eucalyptus crebra	Narrow-leaved Ironbark
	E. moluccana	Grey Box
	E. maculata	Spotted Gum
	E. tereticornis	Forest Red Gum

6.4.2 Field Trials and Monitoring of Rehabilitation

Ample research and experimentation concerning the rehabilitation of opencut coal mines in the Upper Hunter has been undertaken in recent years for example, NERDDC funded programmes on coal mine rehabilitation (Dyson et al) and the reafforestation of open cut coal mines using direct seeding techniques (Burns).

Characterisation of overburden, interburden and soils (Sections 5.7.2 and 7.2) has shown the materials on this site to be generally typical of materials on adjoining sites and elsewhere within the Upper Hunter Valley.

For these reasons field trials will be limited to the development of optimal rehabilitation techniques. These will include the amelioration of material deficiencies by varying rates of gypsum, fertiliser type and application rates, optimal thickness of topdressing materials, pasture seed mixes and the direct seeding of tree and shrub species. Trials would be undertaken on the outer faces of out-of-pit overburden dumps.

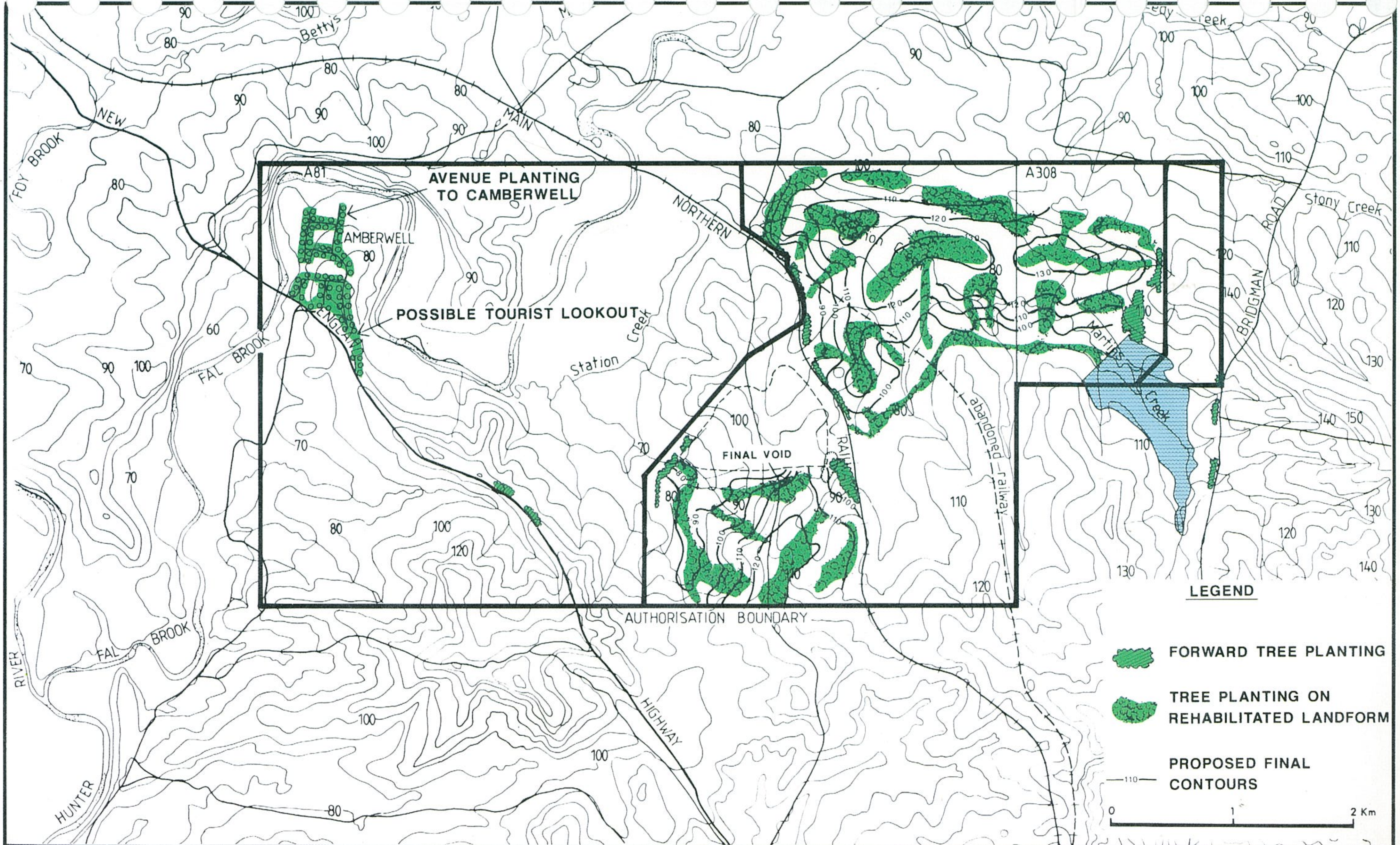

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Figure 6.4.1

AREAS PROPOSED FOR FORWARD TREE PLANTING

Monitoring techniques to assess the effectiveness of site rehabilitation will be selected from a number of methods, such as:

- Aerial photographs taken on a regular basis (annually, for example), provide a means of assessment for the comparison of rehabilitated land and adjacent undisturbed land. Factors to be assessed include vegetative coverage, erosion and landscape character.
- Ground measurements of vegetation density and species diversity can be made within specified plots. Measurement of the growth rates of stock over specified periods provides an additional method of monitoring the viability of the recreated pasture (Dyson et al).

Periodic testing of overburden, interburden and topdressing material will be undertaken over the life of the Project. This willl ensure that any deleterious horizons are identified and that adjustments to fertiliser and gypsum rates can be made if necessary.

6.4.3 Land Management Plan

The site land management plan will combine management objectives and procedures for the buffer zone, the North and South Pits and rehabilitated areas following the completion of mining. The total area under management as defined in Plate 2.8.1 is expected to be approximately 2,000ha.

It is anticipated that all agricultural land will be managed by a CCJV appointed farm manager who will work in conjunction with the Company's environmental officer with respect to rehabilitated areas. Detailed arrangements of the land management scheme will be prepared after receival of Development Consent and finalisation of land purchases.

A number of alternative means of managing the land are possible and the final land management plan may comprise a combination of these. Alternatives include:

- the owner leasing the property back from the Company and continuing existing agricultural pursuits;
- grazing by agistment under the control of the Company's representative; or
- the Company managing the site as a large grazing concern.

Following mining and rehabilitation, it is expected that grazing of rehabilitated land would not take place for at least two or three years. During this period, management practices would include weed control by spraying, maintenance applications of the fertilisers recommended in Table 6.4.2 for up to five years and if necessary the slashing of pasture grasses to encourage the growth of a healthy sward. Grazing on rehabilitated land will be controlled to ensure that ground cover is maintained at not less than 70% as this is considered the minimum value required to control erosion (Dyson et al).

Fencing to protect rehabilitated areas will be electric-type, temporary fencing in the initial years. Following the development of a healthy pasture on sufficient area, permanent fencing to define paddocks will be installed. Paddocks will be designed to suit the recreation of similar sized farming units to that which existed prior to mining.

Once rehabilitated areas have been approved by the DM&E, consideration will be given to the resale of these farming units provided that an adequate buffer zone exists around the current mining area.

7. EXISTING ENVIRONMENT AND ENVIRONMENTAL IMPACT ASSESSMENT

7.1 PHYSIOGRAPHY

Authorisations 81 and 308 have a topographic relief of between 60 and 150m ASL and generally consist of gently undulating cleared grazing and cropping land.

The area is crossed by the Main Northern Railway, New England Highway and Glennies Creek with its broad ephemeral tributary valleys. The north-south Bridgman and Middle Falbrook Roads lie to the east and in the centre of Authorisation 81 respectively.

The village of Camberwell is located in the north-western corner of Authorisation 81. Rural settlements spread across the area, although most of those affected by the Project are adjacent to Middle Falbrook Road.

In general, Project activities are fairly well screened by natural ridges on all sides.

Detailed topographical mapping of the area likely to be disturbed was undertaken in accordance with the five standard slope classes and six terrain units shown on Figure 7.1.1. The area studied is defined in this figure which details the topography of the Authorisations and surrounding areas in contour form.

The area mapped can be broadly divided into the following three morphological units:

(i) *A ridge along the northern Authorisation boundary* which has its highest elevation at Box Tree Hill (147m) at the eastern boundary of Authorisation 308. This ridge has side slopes to the south ranging between 6% and 17% compared to 1% to 11% to the north. Bedrock outcrop occurs on the upper slopes and along the crests of spurs.

(ii) *The central portion* of the area studied, comprising the upper catchments and drainage plains of Martins Creek, Blackwall Creek and Station Creek. Slopes generally occur within the 0-6% range. Bedrock outcrops along the channels of Martins Creek and Blackwall Creek. Alluvium is restricted in lateral extent and the depth upstream of the junction of Blackwall and Martins Creeks rarely exceeds 1m in depth. Salt accumulation is evident in the basal alluvium along Station Creek.

(iii) *Ridge crests and upper slopes* occur west of the main northern railway line. This area is characterized by extensive conglomeratic outcrop on ridge crests and upper slopes and has side slopes within the range 6 to 17%. Streams draining the side slopes flow into the lower reaches of the Station Creek drainage plain.

The areal extent of each slope class is shown in Table 7.1.1.

TABLE 7.1.1

DISTRIBUTION OF SLOPE CLASSES

Slope Class (%)	Area (ha)	Percentage
0-1	93	8
1-5	426	37
5-10	565	49
10-15	58	5
>15	2	<1
	1,144	100

7.2 SOILS

7.2.1 Soil Survey

Soils throughout the Project area are of low fertility with moderate to severe sheet erosion evident and severe gullying along watercourses and on side slopes.

A soil survey was undertaken by Wayne Perry and Associates (1989) over an area of approximately 1,100ha comprising Authorisation 308 and the eastern half of Authorisation 81, which represents the area to be disturbed during open cut mine operations and out of pit overburden disposal.

The aims of the soil survey were to provide:

- descriptions of the major soil types and a map of their distribution according to the Northcote classification[12] and Great Soil Group classifications;
- an assessment of the suitability of topsoil for stripping, stockpiling and topdressing during rehabilitation.

The survey is based on landscape physiography.[13] A terrain map at a scale of 1:10,000 (Figure 7.1.1) was prepared from aerial photographs prior to commencement of the survey. The map was based on a slope classification system with six morphological classes and five slope classes.

Boundaries of the soil units were delineated by soil profile descriptions, terrain classification and spot checks of A horizon material between principal sampling points, particularly across changes in terrain class (Figure 7.2.1).

7.2.2 Soil Profile Descriptions

General Soil Characteristics

Four groups of soils have been distinguished within the area mapped as shown on Figure 7.2.1. Their distribution is related to geomorphic processes and geological outcrop patterns. Typical soil profiles are shown in Figures 7.2.2 A and B.

Group 1: These soils are formed on depositional material on floodplains and drainable flats. Their areal extent is limited except along Station Creek, where they form a valley fill up to 600 metres wide. The maximum depth of alluvium is 1.5 metres. Primary profile forms (Northcote 1974) include Um, Uc, Dy and Db classifications.

Group 2: Duplex soils are the most common profile type in the area mapped. Two groups of duplex soils have been identified on the basis of A horizon textures, structure, presence of an A2 horizon, profile depth, stoniness and dispersibility of the B horizon.

Group 2(a): These soils have loamy A horizons and superplastic medium clay B horizons. They occur on moderately steep, upper and lower slopes, particularly in the northern part of the Authorisation. Primary profile classification forms include Db, Dy and Gn classifications.

Group 2(b): These comprise shallow soil profiles with light-textured, stony A horizons overlying dispersible medium clay. These soils occur principally through the central part of the area mapped on slopes of 1 to 18 %. Primary profile forms include Dy, Dr and Uc classifications.

Group 3: These are stony, skeletal soils, of Uc classification which occur on the conglomeratic ridge on which Falbrook Road is located.

12 Northcote 1974

13 The soil survey strategy follows the guidelines set out by Charman (1978), and specific recommendations for surveys of open cut mining sites (Soil Conservation Service, 1985). Soil sampling followed a series of catenary transects across terrain classes. The sampling pattern is illustrated in Figure 7.2.1. A total of 45 soil profiles were fully described in the field, following the system of Morse, Atkinson & Craze (1982). Most observations were made by digging a shallow pit to the upper B horizon and augering through the lower B and C horizons. This enabled in situ observation of A horizon properties. When natural sections were available, (eg. gully side walls or railway cuttings) these were described.

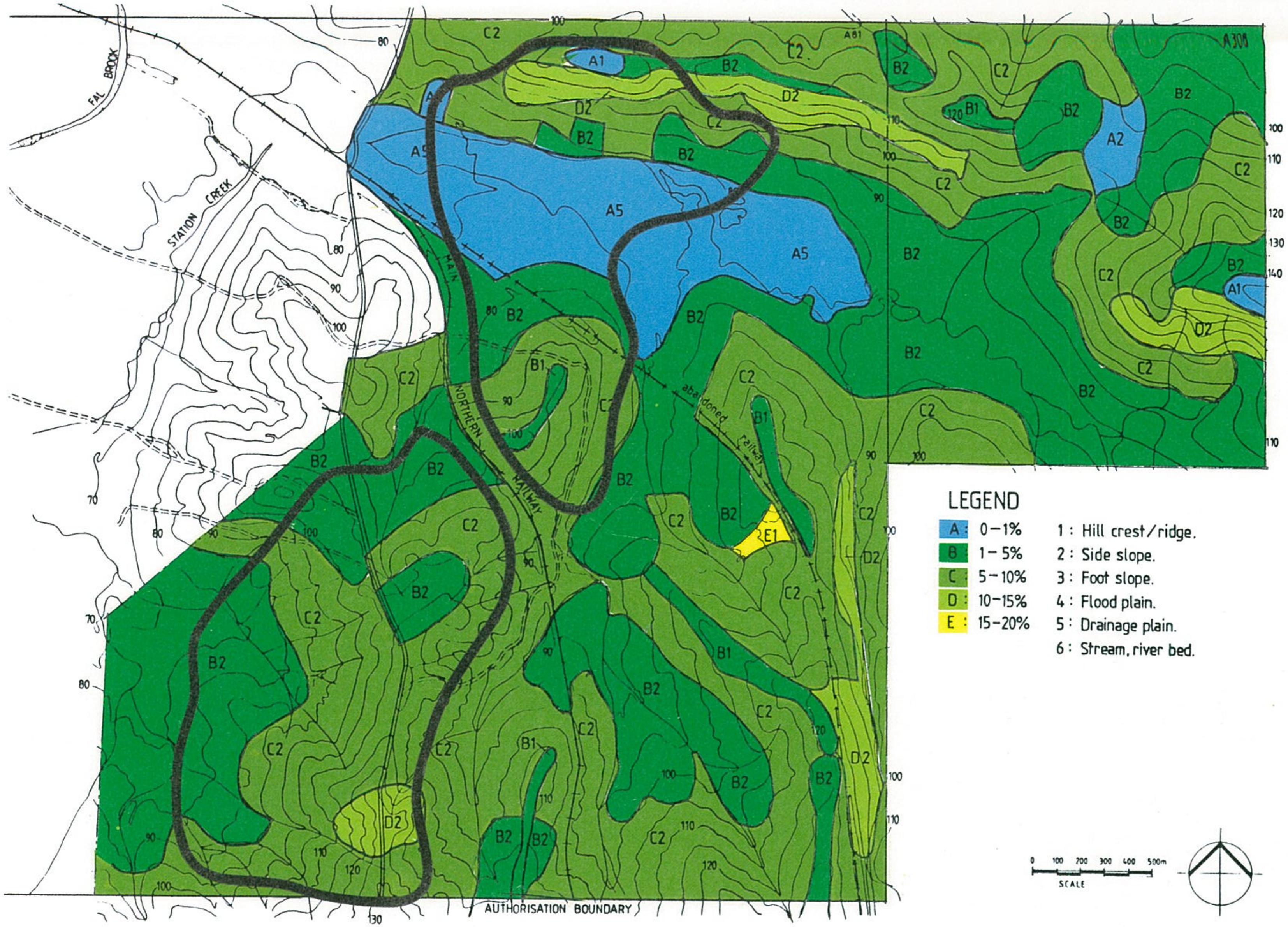

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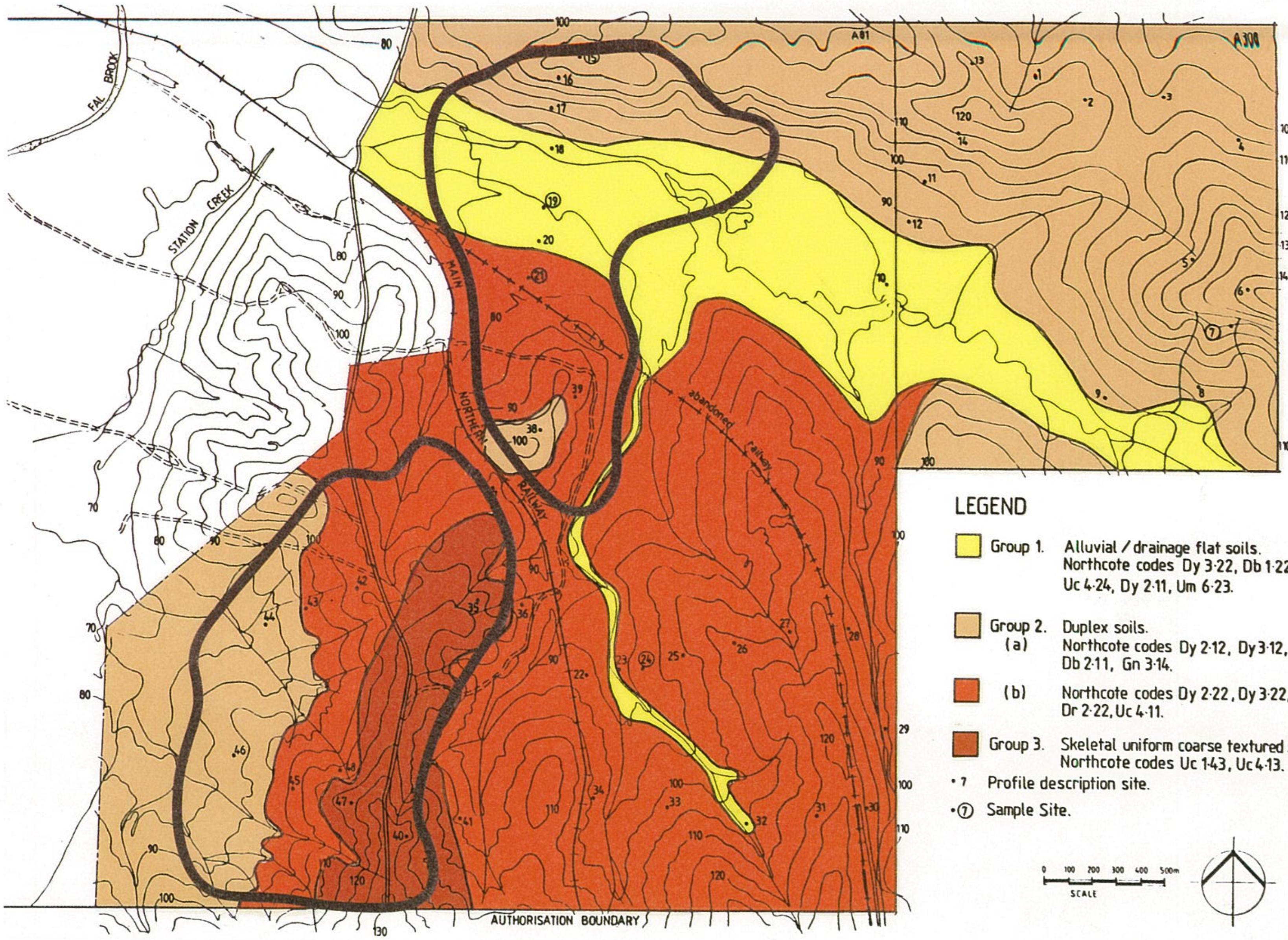
Figure 7.1.1

TOPOGRAPHY



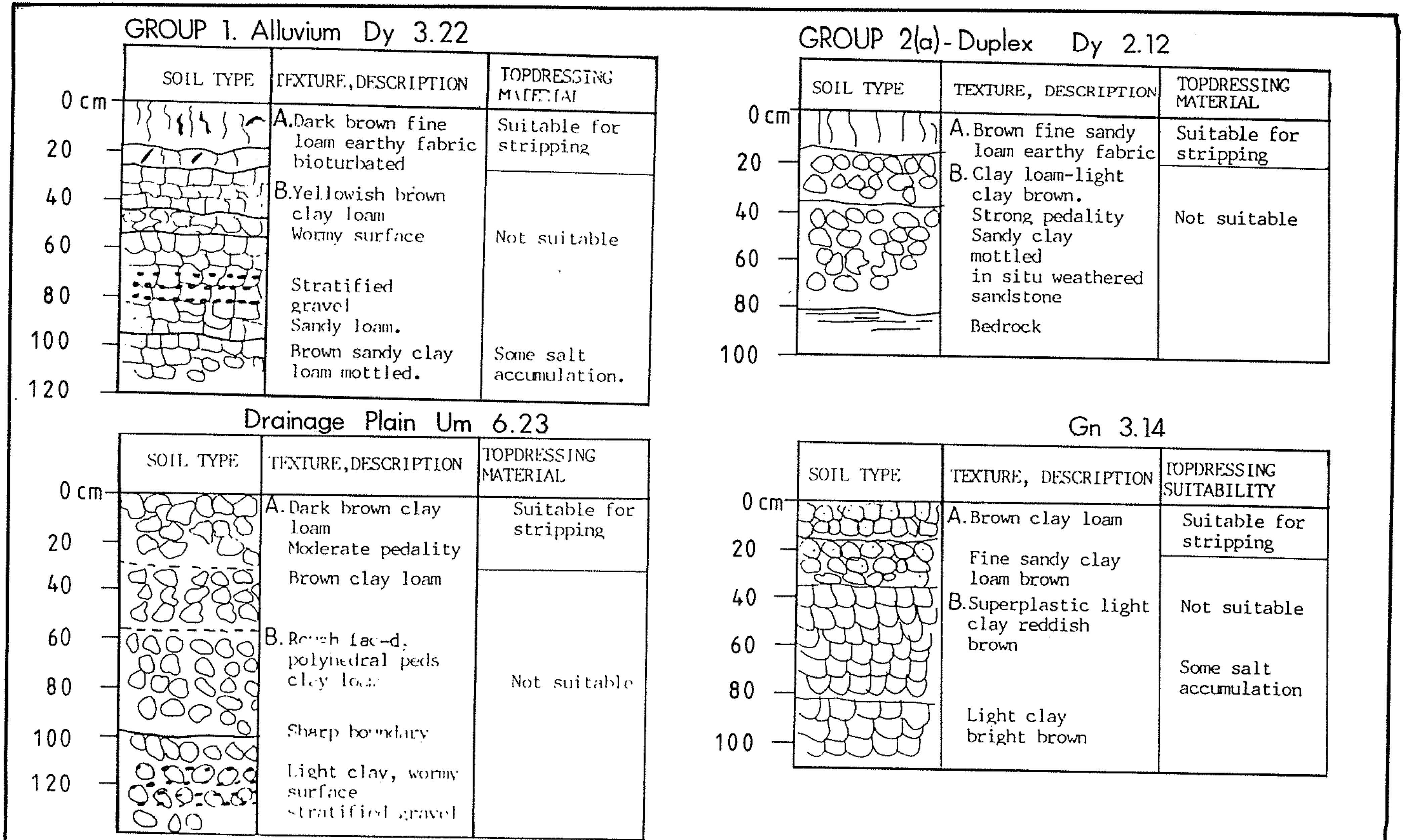
LEGEND

- Group 1. Alluvial / drainage flat soils. Northcote codes Dy 3·22, Db 1·22, Uc 4·24, Dy 2·11, Um 6·23.
- Group 2. (a) Duplex soils. Northcote codes Dy 2·12, Dy 3·12, Db 2·11, Gn 3·14.
- (b) Northcote codes Dy 2·22, Dy 3·22, Dr 2·22, Uc 4·11.
- Group 3. Skeletal uniform coarse textured soils. Northcote codes Uc 1·43, Uc 4·13.
- •7 Profile description site.
- •⑦ Sample Site.

SCALE 0 100 200 300 400 500m

CAMBERWELL COAL PROJECT | Date Sept 88 | Figure 7.2.1

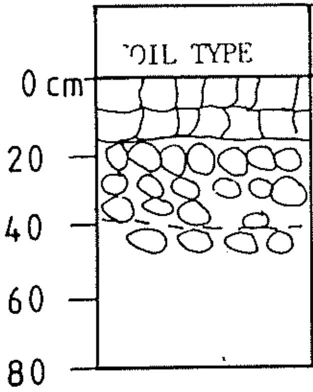
SOIL DISTRIBUTION



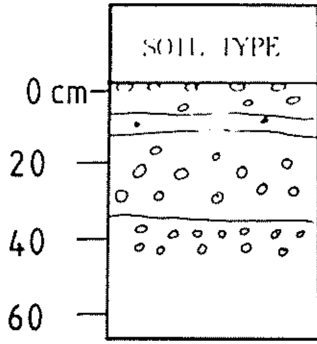
CAMBERWELL COAL PROJECT | Date SEPT 88 | Figure 7.2.2A

SOIL PROFILES - GROUPS 1 & 2(a)

GROUP 2(b) - Duplex Dy 3.22

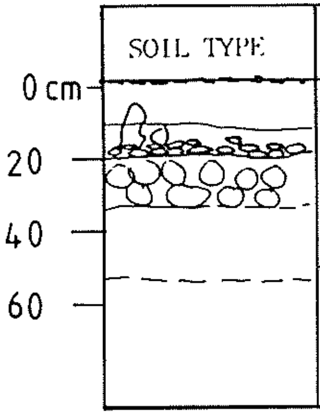
SOIL TYPE	TEXTURE, DESCRIPTION	TOPDRESSING SUITABILITY
	A. Dull yellowish brown fine sandy loam bleached A_2 weak pedality B. Mottled light clay yellowish brown Sandstone bedrock	High conc. sol. salts Not suitable for stripping

GROUP 2(b) - Uc 4.11

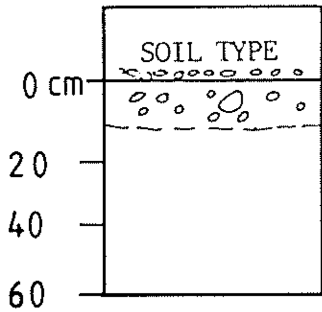
SOIL TYPE	TEXTURE, DESCRIPTION	TOPDRESSING SUITABILITY
	A. Brownish black fine sandy loam weak pedality B. Sandy loam, gravelly grey yellowish brown conglomerate	Not suitable for stripping

Note: The A horizon of some Group 2(b) soils is suitable for stripping depending upon stone content.

Dr 2.22

SOIL TYPE	TEXTURE, DESCRIPTION	TOPDRESSING SUITABILITY
	A. Ironstone float brownish black fine sandy loam bleached A_2. Stones concretions B. Light-medium clay reddish brown dispersible Siltstone bedrock	Not suitable for stripping. Not suitable

GROUP 3 Skeletal Uc 1.43

SOIL TYPE	TEXTURE, DESCRIPTION	TOPDRESSING SUITABILITY
	Gravelly surface sandy loam brown conglomerate	Not suitable for stripping

CAMBERWELL COAL PROJECT | Date SEPT 88 | Figure 7.2.2B

SOIL PROFILES - GROUPS 2(b) & 3

Throughout the area mapped, A horizon material generally displays weak consistence and brittle shearing characteristics. B horizon clays may display tough consistence when dry and have crumbly shearing characteristics depending upon moisture status.

Clayey ironstone concretions and weathered conglomeratic pebbles occur as float in skeletal and duplex profiles. Strong concentrations of stones occur in the A2 horizon of group 2(b) soils. Gravel is rare in the A horizon of alluvial soils.

pH values are generally slightly to moderately acid. Alkaline pH values are recorded only in the lower B and C horizons of alluvial soils along Station Creek. Excessive salt concentrations are localized.

Soils throughout the area mapped are of low fertility. They also have physical and chemical properties which may limit plant germination and growth, and require specific procedures in their handling by machinery.

7.2.3 Analytical Results

Of the soils sent for laboratory testing,[14] samples 7A, 7B, 15A and 15B were from group 2(a), sample 19 from group 1, and samples 21A, 21B and 24A from group 2(b). No soils were tested from group 3 because the shallowness and stoniness of these soils precluded most utilization options. The analytical results are summarized in Tables 7.2.1 and 7.2.2.

The soil chemistry results indicate the following important features:

- all soils are low in phosphorous, nitrogen (as ammonium and nitrate), sulphate and both soluble and exchangeable potassium;
- the cation exchange capacity of A horizon samples from soil group 2(b) and the alluvium was very low;
- excess magnesium occurred in sample 15B (group 2B) and sample 21B (group 2A). Magnesium is also high in samples 7B, 15A;
- calcium levels were low in all samples from group 2(b) and the alluvium;
- the Ca/Mg ratio was very low for all samples except sample 24A;
- the pH of samples 7B (group 2(a)), 19(A) (group l), and 21A, and 24A (group 2(b)) was less then 6 (low pH values favour Mn/Al toxicity);
- two samples (7B and 21A) had excessive soluble sodium and chloride levels; and
- high levels of zinc were recorded in samples 7A and 21A.

These results indicate that soils in this area are generally of low fertility.

14 Eight soil samples were tested for physical properties by the Soil Conservation Service (SCS), Scone, and for chemical properties by Sydney Environmental & Soil Laboratory Pty. Ltd. Properties selected for laboratory analysis are those listed by the SCS. (1985) as essential for assessment of soil materials associated with open cut mining proposals. These include grain size analysis, Atterberg limits, Emerson aggregate test, linear shrinkage and volume expansion, pH, electrical conductivity, chlorides, soluble and exchangeable cations, cation exchange capacity, aluminium, and various nutrients and trace elements.

TABLE 7.2.1

SUMMARY OF CHEMICAL ANALYTICAL RESULTS

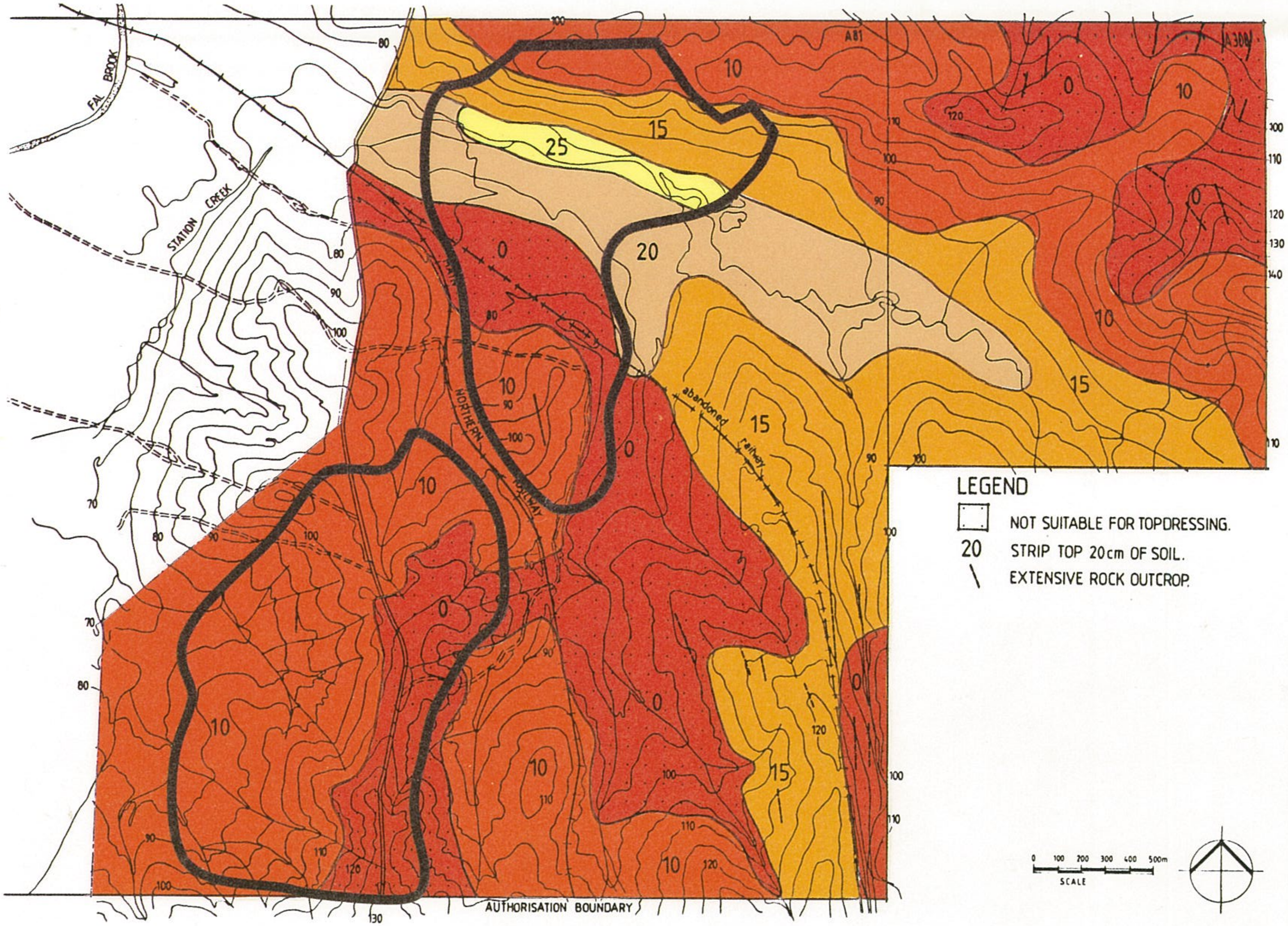
Parameter	7A	7B	15A	15B	19A	21A	21B	24A
pH*	6.0	5.3	6.0	6.5	5.9	5.3	6.8	5.6
Salinity mmhos/cm*	0.1	0.4	0.2	0.2	0	1.5	0.2	
Chlorides ppm	60	236	76	106	0	812	0	4
Soluble cations ppm								
Sodium	14	110	18	46	0	221	74	0
Potasium	5	1	17	16	4	75	109	3
Calcium	6	9	8	12	3	88	25	2
Magnesium	5	3	1	6	1	166	9	0
Sol. & exchangeable cations ppm								
Sodium	46	414	81	184	0	219	426	0
Potassium	121	64	296	199	78	183	74	51
Calcium	1280	1880	1260	1400	240	280	520	100
Magnesium	842	1488	1684	1757	268	1781	12	
Cation exchange cap	12.2	21.2	19.1	20.8	2.5	4.1	16.5	1.7
Ca/Mg ratio	1.5	1.3	0.7	0.8	0.9	1.0	0.3	8.2
% aluminium	0	0	0	0	0	0	0	0
Nutrients ppm								
Phosphorus	14	11	15	13	12	13	12	10
Nitrogen NH_4	8.0	5.2	6.0	2.5	3.6	17.1	0.9	3.3
Nitrogen NO_3	1.5	1.5	3.1	2.3	2.6	41.5	2.9	3.8
Sulphate	7	6	10	12	11	96	15	12
Iron	4.4	8.8	1.1	3.1	11.4	7.0	4.4	34.6
Zinc	108	19.7	55.8	23.6	40.0	106	26	32.0
Copper	0.4	0.9	0.3	0.4	0.3	0.6	0.5	0.7

TABLE 7.2.2

RESULTS OF PHYSICAL AND MECHANICAL SOIL TESTS

	Particle Size Analysis (%)								
Sample	Clay	Silt	Fine Sand	Coarse Sand	EAT	PL (%)	LL (%)	LS (%)	VE (%)
7A	26	24	48	2	3(2)	24	36	8.0	5
7B	52	22	25	1	3(4)	24	48	14.0	17
15A	46	28	18	8	3(3)	29	45	10.0	8
15B	59	24	9	8	3(3)	28	55	13.0	21
19A	13	21	56	10	3(1)	NP	16	1.0	S
21A	12	20	43	25	3(1)	NP	16	1.0	S
21B	44	13	27	16	2(2)	18	41	10.0	NA
24A	8	14	41	37	3(1)	NP	17	0.5	S

EAT: Emerson aggregate test
PL: Plastic limit
LL: Liquid limit
LS: Linear skrinkage
VE: Volume expansion
NP: Non-plastic
S: Sample shrank
NA: Test not appropriate due to soil dispersibility



CAMBERWELL COAL PROJECT	Date Sept 88	Figure 7.2.3

SOIL STRIPPING MAP

Physical and mechanical properties of the soils and their implications are as follows:

- **Grain Size:** Soils from group 2(b) have a minimum of 25% coarse sand. These soils have low water holding capacities in the A horizon. In addition, soils from group 1 and group 2(b) have low clay and silt contents. All B horizons contain more than 40% clay.
- **Linear Shrinkage and Volume Expansion:** Soils from group 2(a) have moderate linear shrinkage and volume expansion properties. The B horizon sample from group 2(b) was highly dispersible and did not give a volume expansion result.
- **Emerson Aggregate Test:** The B horizon of group 2(b) soils is EAT class 2(2) and hence the material is regarded as unstable. All other soils are classified as class 3 and if cultivated or worked by other means when wet, clay dispersion is likely to occur with the application of water, leading to surface crusting and consequent poor seed germination. B horizon material from group 2(a) is classified as subclasses 3(3) and 3(4). These are also subject to dispersion and will only be used in earthworks after consultation with the Soil Conservation Service (SCS). A horizon material from group 2(a) and 2(b) is EAT class 3(1) or 3(2) and suitable for water holding structures following SCS guidelines.
- **Atterberg Limits:** The liquid limit, plastic limit and plasticity index are used to determine the cohesiveness and compressibility of the soil. These properties are important in the construction of soil conservation earthworks. Soil samples 7B and 15B from group 2(a) are the only soils with more than 50% clay. Only soil sample 15B has a liquid limit greater than 50%. A horizon samples 19A, 21A and 24B from groups 1 and 2 (b) have low liquid limits, and are not plastic. These soils are not cohesive. Soils in the area mapped generally have low compressibility characteristics. Only samples 7B and 15B from group 2(a) have moderate to high compressibility.

7.2.4 Suitability of Soils for Stripping, Stockpiling and Topdressing

The assessment of suitability of soils for use in rehabilitation has been undertaken in accordance with the criteria presented in Elliot & Veness (1981). Soils not suitable for topdressing and rehabilitation uses have the following characteristics:

- Surface sealing, weak structure, brittle coherence (ie breaking to single grains with very weak force).
- Mottling.
- Large peds – reducing infiltration, tendency to massive structure when wet.
- Peds which have very strong consistence when dry. This is an indication of dispersibility.
- Textures coarser than sandy loam are generally considered unsuitable for use in the Hunter Valley, although they may be suitable elsewhere. Likewise very heavy textured A or B horizons which retain excess water may not be suitable.
- A total gravel and sand content of greater than 60%. Soils with a high proportion of stones at the surface, or in a sandy A horizon are thus unsuitable.

Figure 7.2.3 shows the extent and depths of soils suitable for topdressing purposes. This figure also shows the distribution of bedrock outcrop, as this interferes with the operation of stripping machinery and reduces the volume of topdressing material available.

Generally Uc soils, both on ridge crests and drainage lines, are not suitable for topdressing because of their coarse texture and stoniness. Duplex soils on hillslopes may be stripped to a depth of 10cm, and up to 15cm on some footslopes with restrictions due to gravelly A2 horizons, excessively sandy A horizon, or high salt content of the A horizon.

When the B horizon has either a high salt content (eg upper southern slopes of Box Tree Hill) or is dispersible (eg sample 21) it must not be included in the stripped soil material. Other B horizon material is unsuitable because mottling indicates poor drainage characteristics and should be avoided during stripping. B horizons of soils in group 2(b) are generally unsuitable because of colour characteristics and dispersibility.

The greatest depth of strippable material is from the alluvial/colluvial plain of Station Creek, when stripping to a depth of 20cm to 25cm is possible. Soil of similar origin along lower order streams is unsuitable.

Although many A horizon materials are poorly structured and have low consistence when dry, they have been included in the strippable material because they are more coherent when wet.

The volume of soil suitable for stripping is indicated in Table 7.2.3. The total volume of soil suitable for stripping and stockpiling is approximately 1.2 x $10^6 m^3$.

TABLE 7.2.3

ESTIMATED VOLUME OF SOIL SUITABLE FOR TOPDRESSING

Depth (cm)	Area (m^2)	Volume (m^3)
Strip 10	5,160,000	516,000
Strip 15	2,784,000	417,000
Strip 20	1,085,000	217,000
Strip 25	1,530,000	38,250
TOTAL	9,182,000	1,188,250

7.2.5 Erosion Status

Extent

Mapping of existing surface erosion within the area to be disturbed was undertaken by aerial photographic interpretation and field inspection and is shown in Figure 7.2.4. Erosion within the area surveyed is predominantly determined by a combination of slope, soil type and land use.

Erosion is most pronounced within Authorisation 308, where moderate to severe sheet erosion is evident on the upper slopes of Box Tree Hill and active, severe gully erosion occurs along watercourses on side slopes. Further west along this ridge (within Authorisation 81), where sheep are not grazed, only minor sheet erosion occurs.

Within the central drainage plains, erosion is generally confined to the gullying of alluvium located along watercourses. Gully floors are located on sandstone bedrock.

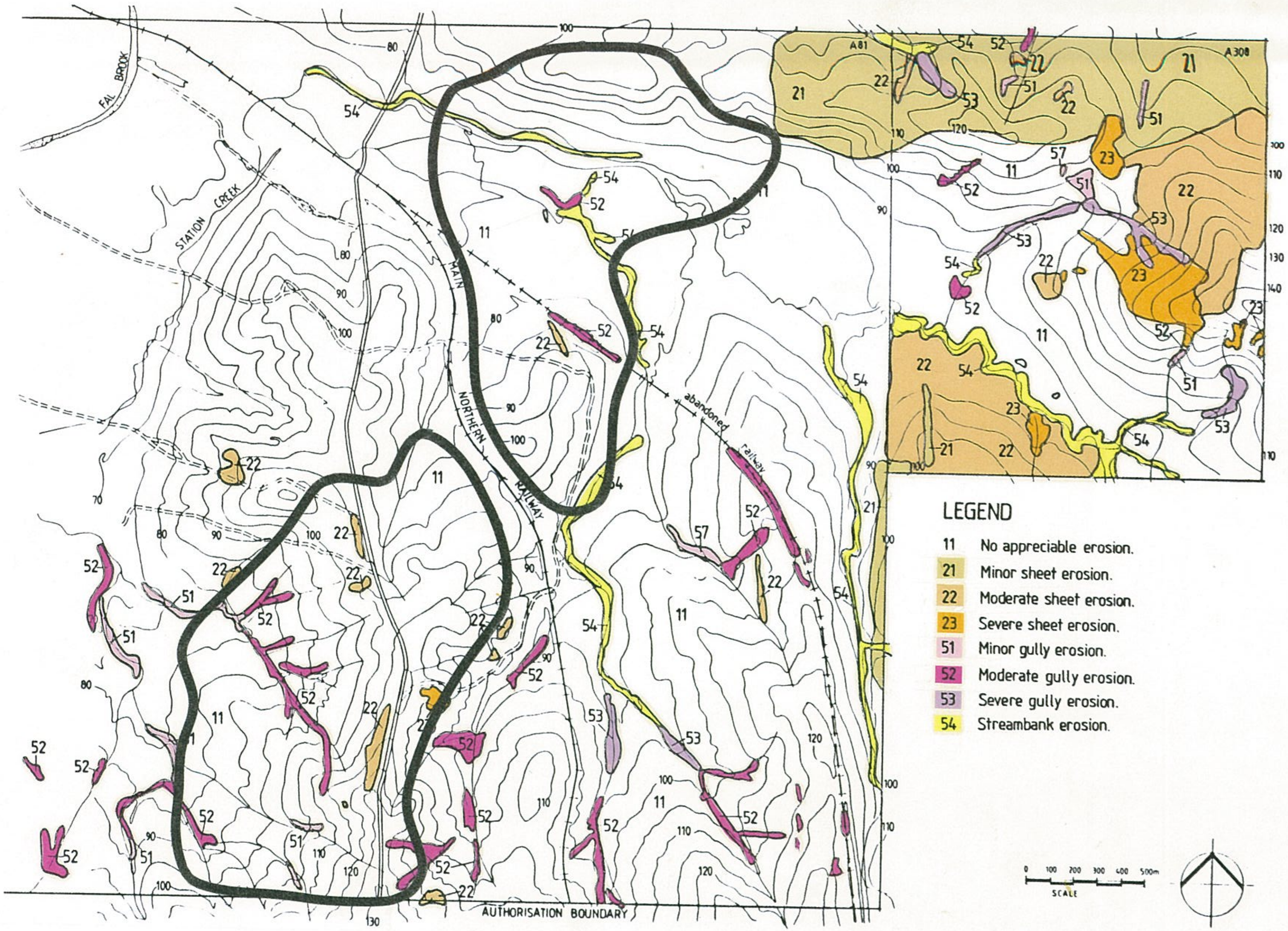
Minor sheet erosion occurs on the conglomeratic ridge and spurs of the area west of the Main Northern Railway. This increases in intensity on the lower slopes. Minor to moderate gullying also occurs along watercourses.

Erodibility of Soils

Generally erodibility of the A horizon increases with an increase in the fine sand and silt content, increasing pedality and a decrease in organic content and horizon depth. Erodibility of the B horizon increases with increased texture (both clay content and the presence of fine sand and silt), degree of dispersibility, and increasing pedality.

Within the area surveyed, soil erodibility ranges from medium to very high. A horizon infiltration capacity is low and A horizons are shallow (less than 20cm). Water holding capacity is low in soils with coarse textured (sandy to sandy loam) A horizons (groups 1, 2(b) and 3).

Although the B horizons of soils in this area are pedal, the material is dispersible and expands moderately on wetting, so that overall permeability is low. Group 2(b) soils exhibit this characteristic as the lower A horizon was noted to be saturated in the field after moderate rain. The dispersibility of B horizon material, particularly in group 2(b) soils, indicates a susceptibility to tunnelling. However, no tunnelling was observed in the field.



CAMBERWELL COAL PROJECT	Date Sept 88	Figure 7.2.4
EXISTING EROSION		

Erosion Hazard

Erosion hazard is determined by a combination of soil erodibility, topographic position and land use.

The present condition of the Box Tree Hill area within Authorisation 308, indicates that these soils (group 3a) particularly those on sideslopes, have a very high erosion hazard where land is used for sheep grazing, or any land use which removes grass cover.

Soils in the western portion of the area surveyed (group 2(a) and group 3) illustrate that different management practices can reduce erosion hazard. These soils carry cattle on superphosphate treated pasture. Sheet erosion is minor on the upper side slopes, increasing on lower side slopes and foot slopes but less severe than that evident on the group 2(a) soils at Box Tree Hill. Incision of drainage lines is restricted to foot slopes.

Group 2(b) soils which occur throughout the central part of the area mapped have a very high erosion hazard if vegetation is removed. The present use of this area for cattle grazing on native pastures has resulted in only minor sheet erosion and the incision of third and fourth order streams. This contrasts with the gullying of first order drainage lines on Box Tree Hill.

Erosion hazard is high for the group 3 skeletal soils which occur on the conglomeratic ridge and its side spurs.

7.2.6 Environmental Management of Soils

Chemical Management

To improve seed germination and pasture growth, both on topsoil stockpiles and on respread topdressing material the following procedures will be adopted:

- Nitrogen dressings. Nitrogen will be added as ammonium to cause less interference with calcium uptake. Seasonal dressings of 50 kg/ha will be applied over several years.
- Applications of superphosphate to redress phosphorous deficiencies. Application of at least 150 kg/ha will be required.
- Low calcium levels indicate that soils from group 2(b) and group 1 will benefit from additions of gypsum and/or lime.

Proposed Stripping Practice

Stripping will be carried out when the soil is in a slight to moderately moist condition, in order to best maintain structure. This will also prevent puddling and crusting of any incorporated B horizon material.

The following techniques will be adhered to in the stripping and stockpiling of soil.[15]

- If both A and B horizons are to be stripped, the material will be well blended.
- Stripping will preferably be undertaken when the soil is slightly moist, since moisture content affects the structural integrity of the soil material.
- As excessive movement of machinery across the soil during stripping operations can destroy soil structures, machinery movements will be minimised. Preferably, A horizon material of soils in group 2(b) and light textured soils in group 2(a) will be stripped and respread in one operation. These soils are particularly susceptible to structural deterioriation.
- The optimal depth for soil stockpiles is 60cm. Stockpiles will be sown with suitable seasonal cover crops to protect the surface and maintain root matter within the soil. Proposed crops are Japanese millet or sorghum during Spring and Summer and Wimmera rye grass or oats during Autumn and Winter.

Reduction of Erosion Hazard

Erosion hazard will be reduced on group 2(a) soils with a change in land use and use of some structural soil conservation measures to control run off and sheet erosion on ridges and gullying of drainage lines.

15 Elliot & Veness 1981

7.3 HYDROLOGY AND WATER QUALITY

7.3.1 Hydrology

The Project area is essentially drained by the Station Creek catchment. This system drains into Glennies Creek which joins the Hunter River 10km below Camberwell. Station Creek generally flows east to west and has as its tributaries the northward flowing Martins Creek, Blackwall Creek and two other unnamed creeks. Figure 7.3.1 shows the creeks together with their catchment boundaries.

Monitoring of streamflows in Glennies Creek has been carried out by the Water Resources Commission (and now the Department) for almost 30 years. Two gauging stations are currently being maintained, one immediately downstream of Glennies Creek Dam and the other at Middle Falbrook which lies just to the north of the Authorisation areas. Results from the gauging station at Middle Falbrook have the most relevance for estimating flood levels at the site.

Records for the Middle Falbrook gauging station are available for the period 1956 to 1983. Two basic types of data are available:

- mean daily flow rates and daily "instantaneous" peaks; and
- mean daily stream heights and daily "instantaneous" peaks.

The former would be calculated directly from the latter using stage/discharge rating curves.

The other available data source for flooding, is the records kept by the Department of Water Resources of heights reached by the Hunter River during the 1955 flood. In the vicinity of the Mine Site these consist of a number of spot levels along the main stream of the Hunter River.

Glennies Creek Flood Levels

Basis of Calculations

No detailed survey data could be obtained of historic flood levels along Glennies Creek. In addition, no information is available on the effects of Glennies Creek Dam upon flood levels in the lower reaches of the creek. The Dam is located about 40km upstream of the Hunter River Junction, or 28km upstream of the Bridge where the Main Northern Railway crosses Glennies Creek near Camberwell. The Dam controls a significant percentage of the total drainage catchment, including high rainfall areas in the headwaters of the creek.

There are two potential types of flooding in Glennies Creek near the proposed Mine.

(i) Backwater flooding caused by a surcharge of the Hunter. This can be estimated using historical levels from the 1955 flood.

(ii) Flooding due to storms in the Glennies Creek subcatchment. This can be determined from gauging data and conventional hydrological analysis.

1955 Flood Levels

One recorded flood level of relevance to the site is available from the 1955 flood of the Hunter River. The 1955 flood is considered to be approximately equivalent to a 1 in 100 year flood in the main channel of the Hunter, although this may not be the case for all its tributaries. The recorded level was taken opposite the confluence of Glennies Creek and the Hunter River and indicated a maximum height reached of 62.6m AHD[16]. Backwater calculations were performed on Glennies Creek by conservatively extrapolating this level at the bed slope of the creek. This gave an estimated flood level of 65.7m AHD at the confluence of Glennies Creek and Station Creek.

16 Australian Height Datum.

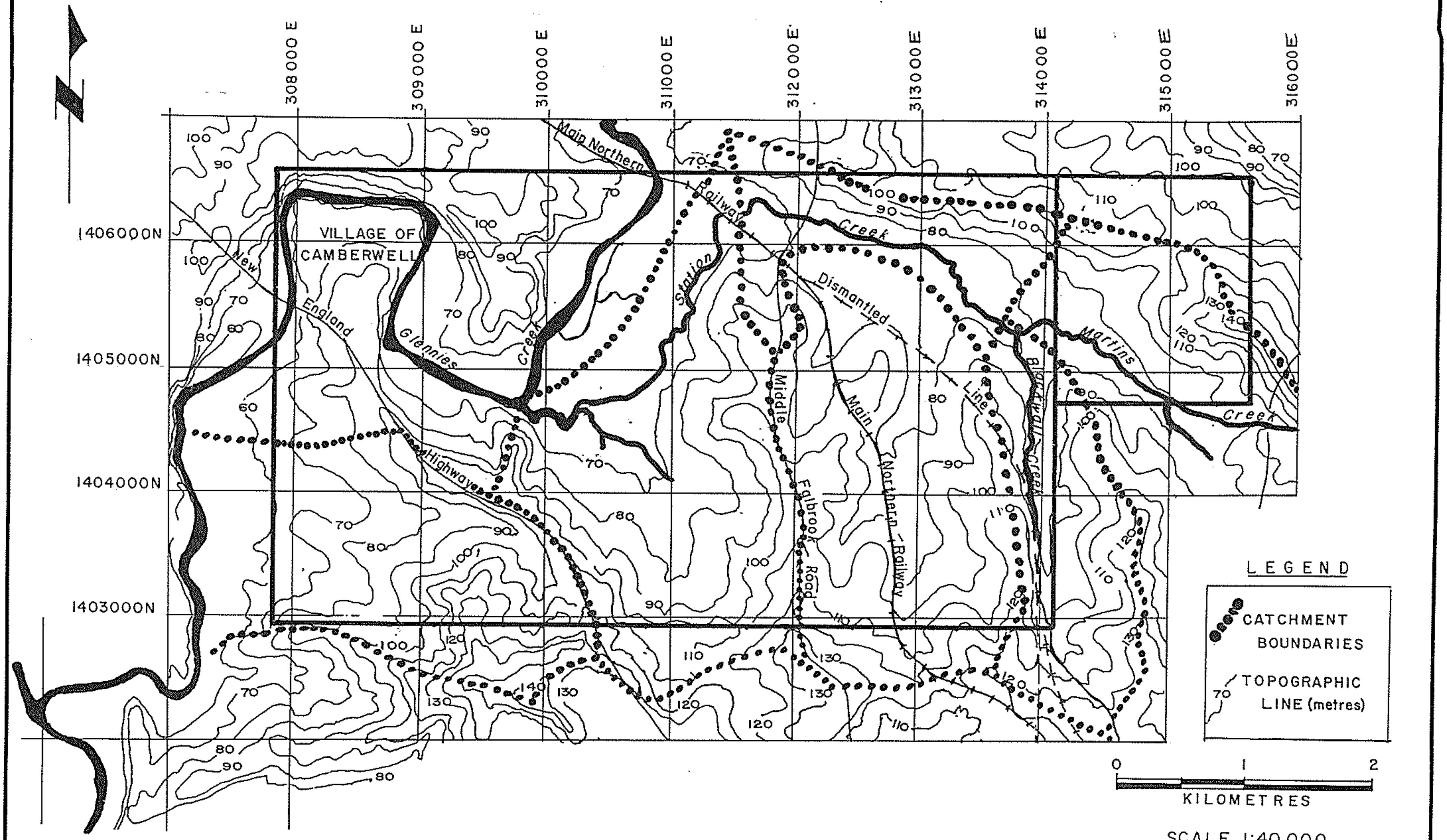


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Figure 7.3.1

MAIN CATCHMENT BOUNDARIES

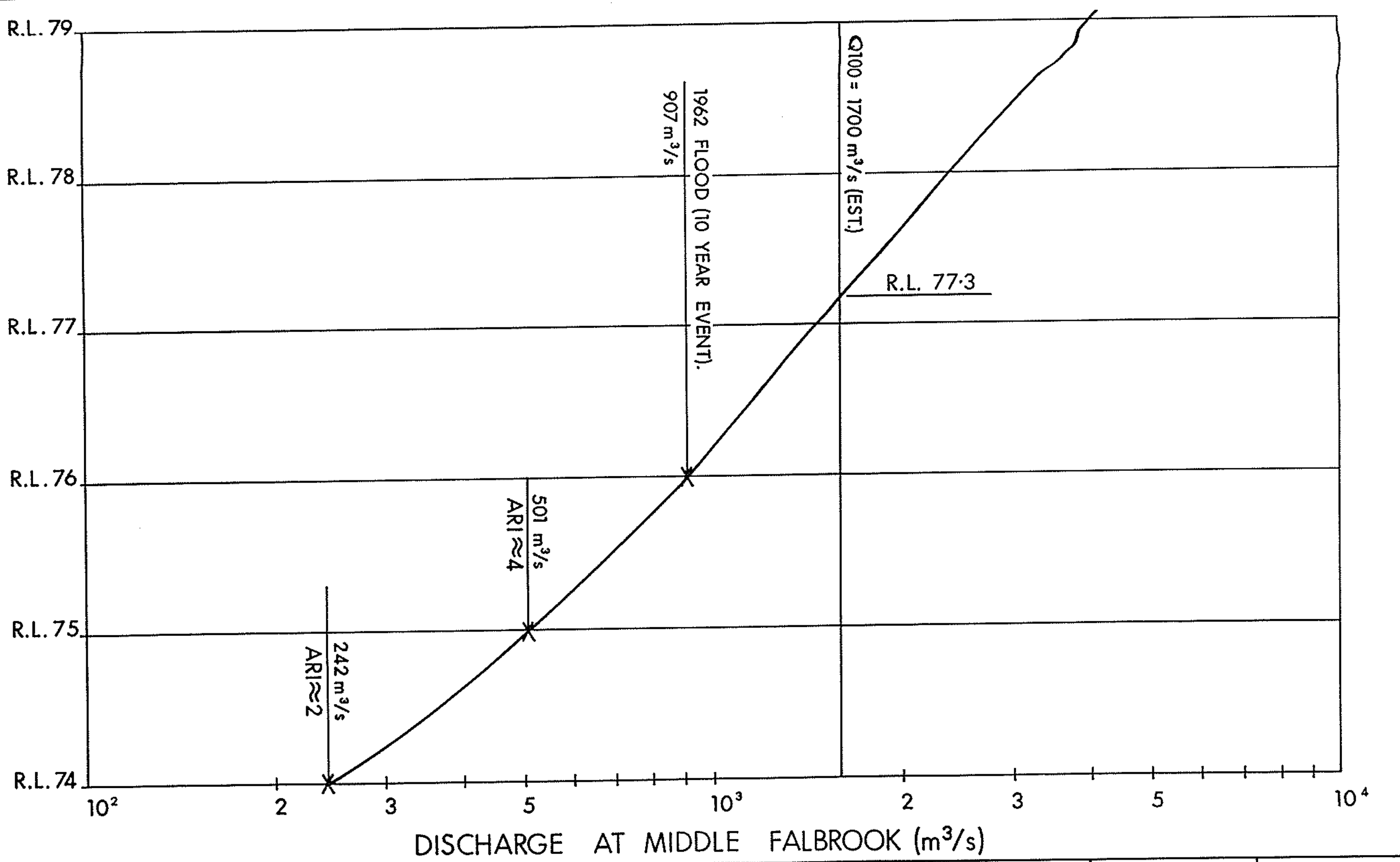

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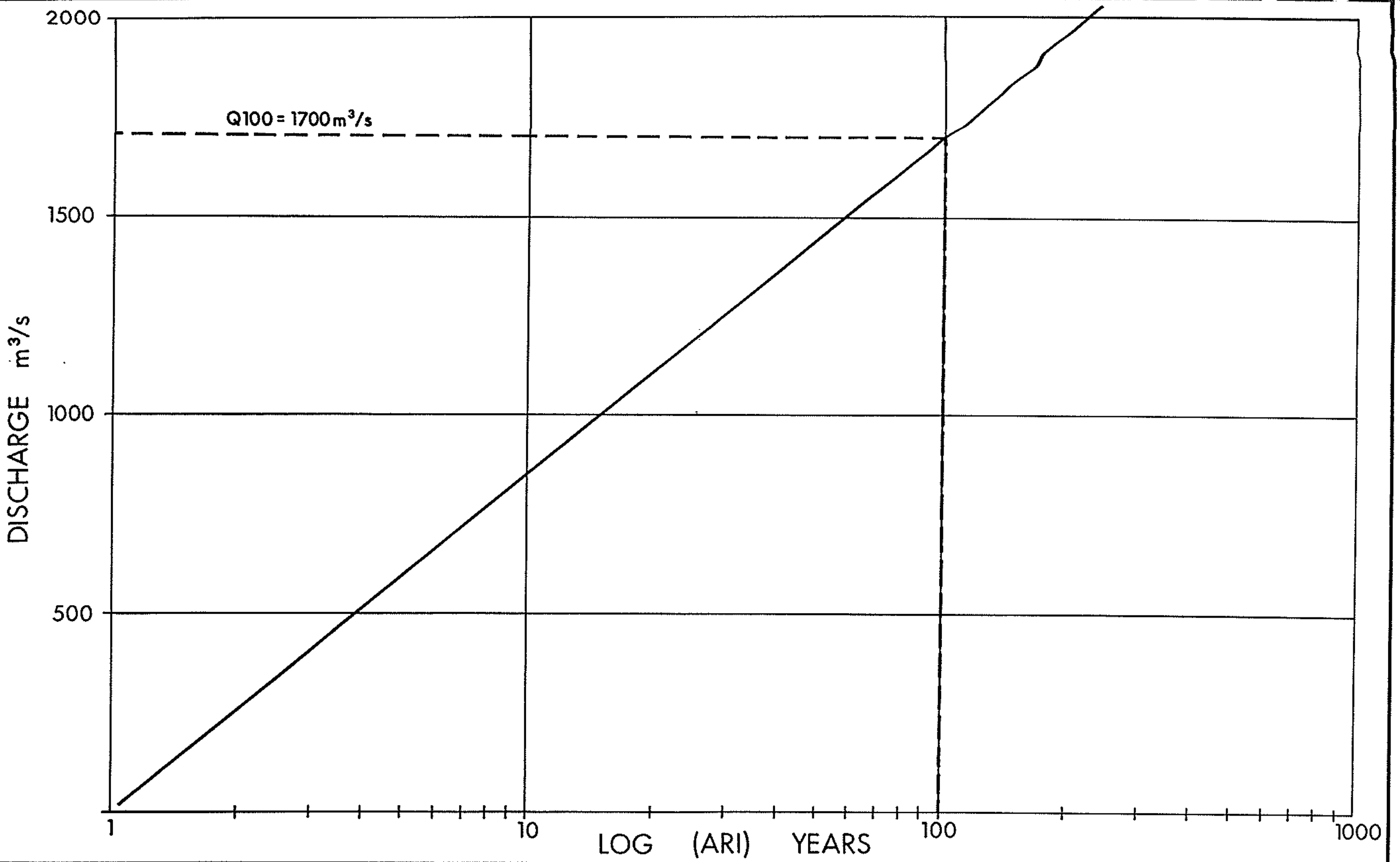
Figure 7.3.2

FLOOD LEVEL vs DISCHARGE AT MIDDLE FALBROOK GAUGE STATION



CAMBERWELL COAL PROJECT

Date AUG.'89 | Figure 7.3.3

DISCHARGE vs AVERAGE RECURRENCE INTERVAL OF GLENNIES CREEK

The flow rate and flood level in 1955 have been estimated using frequency analysis and extrapolating from the available records. This information is shown in Figure 7.3.2 which relates flood level to discharge at the gauge site, and Figure 7.3.3 which relates discharge to average recurrence interval. The estimated 100 year discharge is 1,700m^3/s. The records are useful in determining not only peak flow rates, but also minimum rates and long term averages (ie. 30 years in this case).

Examination of flow rates both before and after construction of the Glennies Creek Dam gives an indication of the effect which the Dam has had on the downstream flow rates. Since construction of the Dam insufficient years have elapsed for a definite pattern to emerge, however it is interesting to note that a flood which occurred in 1985 was the fourth highest on record and was only 10% lower than the highest recorded event. This would suggest that the Dam has had little effect on peak discharge rates.

It would be expected that even if the Dam was full, the effects of reservoir routing would generally decrease downstream flood heights. This may not be the case however if a lagged hydrograph caused flooding to coincide with peak discharges in the mainstream of the Hunter River.

Estimates of Flows

Estimates of streamflows have been made for the creeks draining into Glennies Creek.[17] Flow rates have been determined for several storm recurrence intervals commonly used for design purposes. These are 1 in 10 year, 1 in 20 year, 1 in 50 year and 1 in 100 year return periods. These intervals correspond to rainfall events which have a probability of occurring in any one year of 10%, 5%, 2% and 1% respectively. Table 7.3.1 summarises streamflow estimates for the locations given on Figure 7.3.1.

TABLE 7.3.1

GLENNIES CREEK TRIBUTARIES – STREAMFLOW ESTIMATES

Stream Location	Catchment Area (hectares)	1 in 10 yr	1 in 20 yr	1 in 50 yr	1 in 100 yr
1. Martins Creek	750	10.9	15.0	22	27
2. Blackwell Creek	280	7.4	10.5	13.8	16.6
3. Unnamed Creek	575	10.6	15.1	21	26
4. Upper Station Creek	1,030	14.9	21	30	36
5. Middle Station Creek	1,705	7.6	13.6	23	34
6. Lower Station Creek	2,285	8.3	9.5	18.3	33
7. Unnamed Creek	250	6.6	9.4	12.8	15.6
Total	6,875				

17 The estimates have been made using the rational method as detailed in Australian Rainfall and Runoff (Institution of Engineers, Australia, 1977).

7.3.2 Surface Water

Usage

Water flows in Glennies Creek are regulated by Glennies Creek Dam, built in the upper catchment of the creek. A major reason for construction of the Dam was to replace waters extracted from regulated releases of Glenbawn Dam for the Bayswater Power Station (Coulter, 1981).

Flows in Glennies Creek are used for agricultural irrigation. The Department of Water Resources advised that at the end of 1987 there were 57 authorised irrigation users licensed for 963ha. Since that time a further approximately 50ha have been licensed. The maximum land area within the Glennies Creek catchment to be supplied by irrigation is 1,500ha. The maximum annual allocation for non-permanent plantings is 6Ml/ha/a indicating a peak irrigation allocation of 9,000Ml/a. Glennies Creek Dam also provides regulated flow to the Hunter River and in 1989/1988 41,000Ml was released for irrigation purposes.

Water from Glennies Creek Dam is used in the town water supply for Singleton. A supply pipeline extends from the Dam to the town passing along Bridgman Road to the east of the Mine Site. There is currently surplus capacity in the pipeline.

Water Quality

Monitoring Programme

Two data sources are available to characterise the water quality of surface waters within and adjacent to the proposed Mine. A two year baseline monitoring programme was performed over the period September 1985 to August 1987 by Southland Coal Pty Limited. In addition the Department of Water Resources maintains two gauging stations on Glennies Creek where water samples are periodically collected for analysis.

The Southland Coal Pty Limited programme regularly sampled water quality in four watercourses: Martins Creek, Station Creek, Glennies Creek (also referred to as Fal Brook) and the Hunter River. The programme obtained baseline information on the existing water quality of watercourses potentially affected by proposed mining activities.

Figure 7.3.4 shows the location of the nine monitoring sites, while Table 7.3.2 describes each site and the reason for the site selection. The rationale behind the programme was to obtain baseline information on existing water quality in watercourses that may be affected by proposed mining activities.

In addition to the main watercourses, four farm dams as shown on Figure 7.3.4 were regularly sampled. These provided information on water presently used for stock watering and other agricultural purposes.

Monitoring results are presented in Tables 7.3.3 to 7.3.14.

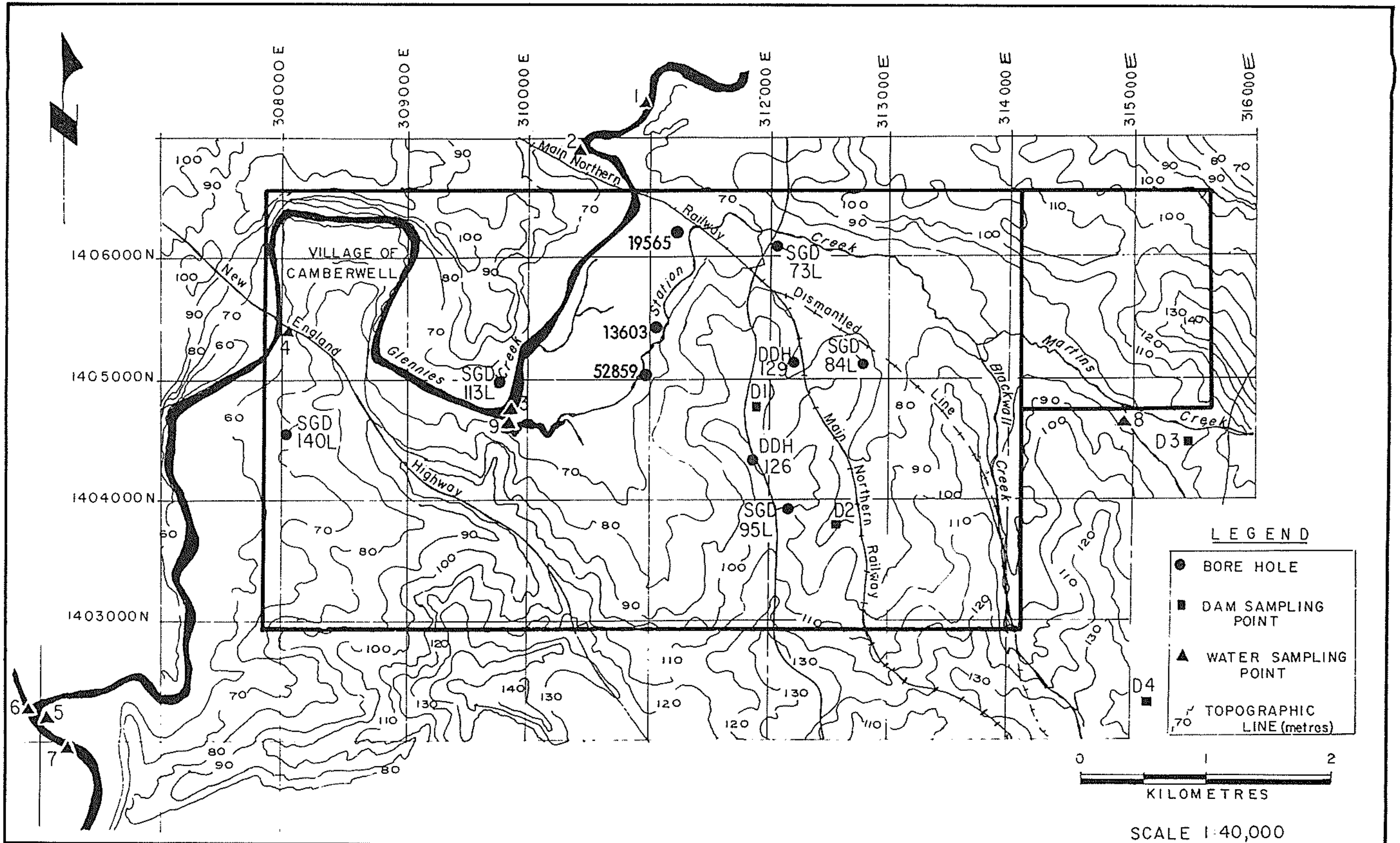


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Figure 7.3.4

WATER MONITORING LOCATIONS

TABLE 7.3.2

DESCRIPTION OF SURFACE WATER MONITORING SITES

Number	Location	Rationale
1.	Glennies Creek at Nobles Crossing	Quantifies water quality upstream of the site.
2.	Glennies Creek at Main Northern Railway Crossing	Almost on the Authorisation boundary. Downstream of Main Creek a major tributary of Glennies Creek.
3.	Glennies Creek upstream of Station Creek	Station Creek is the main drainage catchment within the Authorisation. This station monitors water quality in Glennies Creek prior to Station Creek contribution.
4.	Glennies Creek at New England Highway crossing	This station is on the downstream Authorisation boundary.
5.	Glennies Creek at the confluence of the Hunter River	Provides data on the contribution of Glennies Creek to the Hunter River.
6.	Hunter River upstream of Glennies Creek	Quantifies water quality upstream of Glennies Creek.
7.	Hunter River downstream of Glennies Creek	Quantifies water quality downstream of Glennies Creek. Acts as a check on the results of Stations 5 and 6.
8.	Martins Creek at Authorisation Boundary	Martins Creek drains a large area upstream of the proposed Mine Site. The station monitors water quality entering the site.
9.	Station Creek prior to entering Glennies Creek	Quantifies water quality of the main drainage catchment of the proposed Mine.

TABLE 7.3.3

WATER MONITORING RESULTS – pH

Sampling Location	No of Samples	Median	Range
1	24	7.5	7.3 – 8.1
2	23	7.6	7.3 – 7.9
3	24	7.6	7.1 – 8.1
4	23	7.8	7.5 – 8.5
5	24	7.7	7.4 – 8.0
6	23	8.3	7.8 – 8.6
7	24	7.8	7.4 – 8.1
8	10	6.5	6.0 – 7.5
9	24	7.6	6.5 – 8.4
Dam 1	24	7.1	6.2 – 8.9
Dam 2	24	6.6	5.6 – 7.2
Dam 3	24	6.9	6.0 – 7.6
Dam 4	24	6.5	5.7 – 7.7

TABLE 7.3.4

WATER MONITORING RESULTS – Conductivity (micro siemens/cm)

Sampling Location	No of Samples	Median	Range
1	16	450	310 – 720
2	16	540	350 – 1,150
3	16	620	400 – 1,010
4	15	660	400 – 940
5	16	725	430 – 920
6	15	740	480 – 1,070
7	16	725	430 – 920
8	7	835	590 – 1,830
9	16	850	680 – 11,750
Dam 1	16	155	90 – 270
Dam 2	16	200	130 – 280
Dam 3	16	210	60 – 270
Dam 4	16	180	90 – 240

TABLE 7.3.5

WATER MONITORING RESULTS – Total Dissolved Solids (mg/l)

Sampling Location	No of Samples	Median	Range
1	16	290	200 – 460
2	16	345	220 – 736
3	16	400	255 – 645
4	15	420	255 – 600
5	16	455	275 – 580
6	15	475	305 – 685
7	16	465	275 – 590
8	7	535	380 – 1,170
9	16	545	275 – 7,520
Dam 1	16	100	60 – 175
Dam 2	16	125	85 – 180
Dam 3	16	110	40 – 175
Dam 4	16	115	60 – 155

TABLE 7.3.6

WATER MONITORING RESULTS – Suspended Solids

Sampling Location	No of Samples	Median	Range
1	16	4.5	ND – 48*
2	16	2.5	ND – 18
3	16	3	ND – 114
4	15	2	ND – 10
5	16	3	ND – 178
6	15	3	ND – 23
7	16	2	ND – 48
8	7	187	11 – 339
9	16	9	3 – 319
Dam 1	16	57	8 – 93
Dam 2	16	30	9 – 552
Dam 3	16	44	4 – 777
Dam 4	16	390	51 – 711

* ND = Not detected

TABLE 7.3.7

WATER MONITORING RESULTS – Turbidity

Sampling Location	No of Samples	Median	Range
1	16	2	ND – 5
2	16	2	ND – 5
3	16	2	ND – 7
4	15	2	ND – 4
5	16	2	ND – 5
6	15	1	ND – 7
7	16	1	ND – 5
8	7	125	10 – 210
9	16	5	ND – 100
Dam 1	16	26	11 – 90
Dam 2	16	30	10 – 93
Dam 3	16	16	2 – 280
Dam 4	16	240	160 – 600

TABLE 7.3.8

WATER MONITORING RESULTS – Sodium (mg/l)

Sampling Location	No of Samples	Median	Range
1	5	–	25 – 59
2	5	–	30 – 279
3	5	–	37 – 75
4	5	–	39 – 69
5	5	–	37 – 69
6	5	–	25 – 78
7	5	–	39 – 69
8	3	–	76 – 230
9	5	–	55 – 2,370
Dam 1	5	–	10 – 30
Dam 2	5	–	16 – 32
Dam 3	5	–	6 – 18
Dam 4	5	–	10 – 23

TABLE 7.3.9

WATER MONITORING RESULTS – Potassium (mg/l)

Sampling Location	No of Samples	Median	Range
1	5	–	2 – 3
2	5	–	2 – 3
3	5	–	2 – 3
4	5	–	2 – 4
5	5	–	2 – 4
6	5	–	2 – 4
7	5	–	2 – 4
8	3	–	5 – 8
9	5	–	2 – 6
Dam 1	5	–	4 – 8
Dam 2	5	–	4 – 8
Dam 3	5	–	3 – 8
Dam 4	5	–	4 – 10

TABLE 7.3.10

WATER MONITORING RESULTS – Calcium (mg/l)

Sampling Location	No of Samples	Median	Range
1	5	–	18 – 39
2	5	–	18 – 123
3	5	–	18 – 40
4	5	–	18 – 38
5	5	–	20 – 37
6	5	–	29 – 42
7	5	–	20 – 38
8	3	–	12 – 47
9	5	–	13 – 100
Dam 1	5	–	2 – 4
Dam 2	5	–	2 – 4
Dam 3	5	–	2 – 12
Dam 4	5	–	2 – 4

TABLE 7.3.11

WATER MONITORING RESULTS – Magnesium (mg/l)

Sampling Location	No of Samples	Median	Range
1	5	–	15 – 35
2	5	–	15 – 35
3	5	–	17 – 35
4	5	–	17 – 33
5	5	–	19 – 36
6	5	–	30 – 47
7	5	–	19 – 38
8	3	–	26 – 91
9	5	–	19 – 456
Dam 1	5	–	3 – 10
Dam 2	5	–	4 – 9
Dam 3	5	–	3 – 14
Dam 4	5	–	4 – 12

TABLE 7.3.12

WATER MONITORING RESULTS – Bi-carbonate (mg/l)

Sampling Location	No of Samples	Median	Range
1	8	125	92 – 195
2	8	134	92 – 189
3	8	138	98 – 195
4	8	137	93 – 189
5	8	137	104 – 189
6	8	216	195 – 293
7	8	140	104 – 214
8	4	–	25 – 91
9	8	186	76 – 914
Dam 1	8	34	18 – 55
Dam 2	8	24	16 – 57
Dam 3	8	40	4 – 91
Dam 4	8	27	8 – 60

TABLE 7.3.13

WATER MONITORING RESULTS – Chloride (mg/l)

Sampling Location	No of Samples	Median	Range
1	8	76	57 – 138
2	8	95	57 – 156
3	8	117	71 – 167
4	8	103	71 – 150
5	8	103	74 – 166
6	8	114	60 – 174
7	8	102	74 – 168
8	4	–	35 – 330
9	8	182	89 – 3,213
Dam 1	8	25	5 – 71
Dam 2	8	37	7 – 53
Dam 3	8	26	18 – 50
Dam 4	8	28	7 – 50

TABLE 7.3.14

WATER MONITORING RESULTS – Sulphate (mg/l)

Sampling Location	No of Samples	Median	Range
1	8	5	1 – 50
2	8	6	1 – 14
3	8	10	2 – 32
4	8	10	1 – 19
5	8	10	1 – 54
6	8	58	5 – 101
7	8	12	3 – 25
8	4	–	50 – 950
9	8	41	2 – 1,683
Dam 1	8	4	0.5 – 25
Dam 2	8	3	0.5 – 59
Dam 3	8	3	ND – 5
Dam 4	8	4	0.5 – 104

The CCJV's monitoring programme has been supplemented by information available from the Department of Water Resources' two gauging stations on Glennies Creek (Fal Brook), where water samples are periodically collected for analysis (see Table 7.3.15 and 7.3.16).

TABLE 7.3.15

GLENNIES CREEK WATER QUALITY - STATION 210 044 MIDDLE FALBROOK
JULY 1979 TO OCTOBER 1985
(Source: Department of Water Resources)

Parameter	No of Samples	Median	Statistical Analysis 25*	75*	Range
1. pH	34	7.9	7.80	8.11	7.50– 8.80
2. Turbidity (Formazin Units)	35	1.1	0.7	1.5	0.2 – 70
3. Colour	34	12	8	17	0 – 76
4. Electrical Conductivity (µS/cm @ 25°C)	35	600	369	759	259 – 1,163

* 25 = 25th Percentile
75 = 75th Percentile

TABLE 7.3.16

GLENNIES CREEK WATER QUALITY - STATION 210 084 THE ROCKS NO 2
JULY 1979 TO OCTOBER 1985
(Source: Department of Water Resources)

Parameter	No of Samples	Median	Statistical Analysis 25*	75*	Range
1. pH	71	7.83	7.6	8.12	6.7 – 10.4
2. Turbidity (Formazin Units)	74	2.7	1.5	9	1.0 – 350
3. Colour	33	12	9	20	5 – 50
4. Electrical Conductivity (µS/cm @ 25°C)	75	405	240	598	171 – 2,950
5. HCO_3 (mg/l)	33	138	116	161	12 – 234
6. Cl (mg/l)	34	85	66	120	39 – 320
7. Fe (mg/l)	30	0.17	0.07	0.33	ND – 7.04
8. NO_3 (mg/l)	34	0.05	0.02	0.25	ND – 3.85

* 25 = 25th Percentile
75 = 75th Percentile
**ND = Not detected at the limit of measuring

Results

The monitoring programme has shown that:

- Water from all sources can generally be considered of a reasonable quality, classed as low to medium salinity, low sodium water, suitable for almost all current agricultural uses in the Hunter Valley. Median suspended solids concentrations for Glennies Creek are low at only 3 to 4mg/l. During wet weather suspended solids levels increase, but do not become excessively high.
- There are no significant variations in water quality along the section of Glennies Creek surveyed although there is a steady increase in dissolved solids from station 1 through to station 5. This is usual for most river systems including the Hunter itself. The increase could be due to irrigation return waters, evaporation and groundwater accession.
- The Hunter River is of similar quality to Glennies Creek although the river consistently had higher concentrations of dissolved solids.
- The quality of water in Station Creek is generally poorer than Glennies Creek having higher concentrations of dissolved and suspended solids. There is also a wider range of results in the parameters tested probably due to runoff from the smaller catchment of Station Creek having a greater sensitivity to rainfall events. Martins Creek upstream of the Authorisation is moderately saline, with total dissolved solids (TDS) concentrations ranging up to 5,337 mg/l. The water is slightly more acid than elsewhere in the immediate area, but this could be more related to the small catchment size and ephemeral nature of flows rather than substantive geological differences. Samples are consistently relatively high in suspended solids, which indicates possible localised soil erosion. The level of suspended solids is slightly unusual in moderately saline natural creeks, and points to possibly high sodium absorption ratio soils in the subcatchment.
- Farm dam waters generally have higher concentrations of suspended solids than water courses, but lower concentrations of dissolved solids.

7.3.3 Groundwater

Groundwater Study

A preliminary hydrogeological study has established general background data on groundwater occurrence, flow patterns, and quality (see Table 7.3.17). Flow tests have been carried out on several exploration holes, and standing water level data from all existing holes has been analysed.

There appear to be three main aquifer types in the Project area:

- unconsolidated surficial sediments associated with Glennies Creek and Station Creek,
- weathered rock, and
- coal seams.

In the latter two the groundwater is primarily contained and transmitted in fractures and bedding planes. The rock itself, including the sandstone, is generally either cemented or has argilliceous material in the matrix between the sand grains. In the unconsolidated material the water is contained and transmitted by way of pores or voids between the grains of sediment.

An analysis of standing water level data in all previous holes indicates a continuous groundwater system throughout the coal measures strata. Recharge is by means of rainfall infiltration through the soils and discharge by upward seepage to the weathered zone and alluvium particularly along Station Creek. The weathered rock aquifers are apparently connected to Glennies Creek and receive recharge from this source. High permeabilities exist in the shallow weathered rock zones along the western boundary, and along Station Creek.

The groundwaters are consistent in quality and are typical of those from the coal measures strata in the Hunter Valley. Results from the site boreholes indicate a saline water with total dissolved solids ranging from 6,200mg/l to 7,200mg/l. Sodium and chloride are the dominant ions. These waters would not be suited for agricultural usage.

Marine sediments of the Maitland Group underlie the Wittingham Coal Measures. They outcrop to the east of the SLA and in the core of the Camberwell Anticline which bisects the underground coal resource area. This unit is probably responsible for most of the brackish groundwater that seeps into Station Creek and its tributaries and sustains the creek during low flow conditions.

Aquifer Characteristics

A series of short airlift/recovery type pumping tests were performed in several boreholes to determine the transmissivity and permeability of the various aquifer types (Table 7.3.18). This method of testing generally produces only approximate results, but these are considered sufficiently reliable to estimate the order of magnitude of likely groundwater inflows, particularly since there is a relatively good data base on the characteristics of the coal measure aquifers in the Upper Hunter for comparison.

Hole LDH3 (SGD 73L) has the main inflow from a depth of 4 to 8m in alluvium and weathered rocks. The inflow contribution and transmissivity of lower coal seams was relatively small.

Hole LDH4 (SGD 84L) was virtually impermeable with low inflow from the Barrett Seam and none from the Hebden.

Hole LDH5 (SGD 95L)also was fairly impermeable with low inflows from the Middle and Lower Liddell Seams and none from the Barrett and Hebden Seams.

In general, the eastern or open pit (low dip) areas are of low permeability and low potential inflow. Inflow problems could exist along the Station Creek area from shallow weathered rock and alluvium aquifers.

The potentiometric surface generally reflects the topographic drainage but in a subdued manner. There are a number of local irregularities in the surface which may be due to either anomalous data, or local geological features, eg. faults. The standing water levels are typically between 10 and 15m below the surface.

Groundwater is moving from the higher ground towards the lower ground where it discharges from coal seams to weathered rock and alluvium and thence into local streams, eg. Station Creek, as brackish seepages when the water table is relatively high. Rates of groundwater movement are expected to be very slow due to the low permeability of the rock mass and the relatively shallow hydraulic gradient. Recharge is from general infiltration of rainfall.

Groundwater Monitoring Programme

Standing water levels at six locations were periodically measured as part of the environmental monitoring programme. (See Table 7.3.19). Figure 7.3.4 shows the locations of the boreholes where the water levels were measured.

The results were reasonably consistent over time with the exception of SGD 126 which showed a variation of 4.3m. Low standing water levels were recorded during or immediately following periods of low flow in Glennies Creek.

In 1985 water samples were taken from selected drill holes (LDH 3, 4 and 5) and analysed at the Soil Conservation Service laboratory at Scone. In 1989 additional samples were analysed by the Australian Coal Industry Research Laboratories (DDH 60, 74, 57 and 98). The results of both lots of samples are presented in Table 7.3.20.

TABLE 7.3.17
CAMBERWELL BOREHOLE TEST DATA

Hole (LDH)	SWL (m)	Test Depth (m)	Transmissivity (m^2/day)	Discharge (l/sec)	Salinity (mg/l)	Date (1985)	Notes
3	1.6	40.40	9.9	1.5	6800	19/11	Cased to 8m
		75.10	3.3	1.1	8000	27/11	Cased to 13.25m
		117.03	4.0	1.63	7200	3/12	
3R	4.1	65.64	2.5	0.55	-	17/12	No casing
4	10.18	29.6	3	0.01	-	27/9	Main aquifer
		42.26	2.3	0.01	6300	29/9	
		56.2	2.3	0.2	7500	1/10	
5	36.95	60.0	V. Low	Seep	-	11/11	
		89.29	0.2	0.3	5500	12/11	
		110.00	0.1	0.3	5700	14/11	
		121.60	0.8	0.42	5300	18/11	

TABLE 7.3.18
ESTIMATED TRANSMISSIVITY AND PERMEABILITY OF COAL MEASURES AQUIFERS

Bore	Depth Interval (b) (m)	Transmissivity (T) (m)	Permeability m/day	Permeability m/s	Coal Seam
LDH3	8* - 40.1	9.9	0.31	3.6×10^{-6}	U. Liddell
	13.25 - 75.1	3.3	0.05	5.5×10^{-7}	M/L. Liddell
	75.1 - 117.03	0.7	0.02	2.5×10^{-7}	Barrett/Hebden
LDH4	10.01 - 29.6	3.0	0.15	0.15×10^{-6}	Barrett
	11.0 - 56.2	Low	-	-	Arties/U. Liddell
	60.0 - 89.3	0.2	0.007	8.3×19^{-8}	M/L.Liddell
	89.3 - 121.6	Low	-	-	Barrett/Hebden

* Casing length

NB: Permeability (T/b) calculated is the average effective value for the section of the hole tested. In practice the permeability would be confined to smaller specific zones of higher value.

TABLE 7.3.19
MONITORING OF STANDING WATER DEPTHS IN DRILL HOLES

Date	LDH3	LDH4	LDH5	DDH126	DDH129
	Hole Number				
1/2/86	1.54	10.16	36.41	20.74	9.73
7-8/3/86	2.45	10.12	36.34	19.81	9.80
5-6/4/86	2.30	10.10	36.40	20.90	9.80
7-8/6/86	2.25	10.33	36.47	21.38	9.98
5-6/7/86	2.32	10.31	36.53	21.26	10.05
2-3/8/86	2.40	10.38	36.45	17.26	10.04
6-7/9/86	2.30	10.50	36.50	17.40	10.05
4-5/10/86	2.24	10.40	36.45	17.30	10.15
1-2/11/86	2.20	10.53	36.72	21.55	10.25
6-7/12/86	2.00	10.20	36.30	21.25	9.80
10-11/1/87	#	9.80	36.20	20.05	9.90
6-7/2/87	-	10.35	36.25	17.30	9.85

\# Bore hole caved in

TABLE 7.3.20

CHEMICAL ANALYSIS OF GROUNDWATER

Drillhole	LDH3	LDH4	LDH5	DDH60	DDH74	DDH57	DDH98
Date	03.12.85	01.10.85	18.11.85	1989	1989	1989	1989
Depth	117.03	56.2	121.6	60	30	62	105
pH	7.7	7.5	7.5	7.6	7.4	7.0	7.1
T.D.S.* (mg/l)	9,190	8,755	6,988	6,600	7,000	7,600	6,200
Hardness (mg/l $CaC0_3$)	1,865	3,065	2,215				
E.C. (mS/cm 25°)	14.36	13.68	10.92	11.2	11.2	11.8	9.5
Na (mg/l)	2,750	2,302	1,824	2,100	2,200	2,300	1,800
K (mg/l)	12	39	20	20	15	20	17
Ca (mg/l)	88	162	130	82	130	140	210
Mg (mg/l)	400	647	460	200	300	320	370
HCO_3 (mg/l)	1,238	1,129	763	1,100	1,000	1,050	850
$S0_4$ (mg/l)	470	1,633	764				
Cl_4 (mg/l)	4,200	3,426	3,638				

* calculated from E.C. x 640

Electrical Conductivity measurements in the field indicate a saline groundwater between 5,000-7,000mg/l total salts (Table 7.3.17). The groundwaters sampled are all of the same sodium chloride rich facies. They are brackish with TDS concentrations ranging from 6,500 to 9,200mg/l. This groundwater is unsuitable for irrigation on the soils available but may be suitable for certain stock and industrial uses.

Existing Registered Groundwater Bores

The records of the Department of Water Resources contain three registered groundwater bores within the Authorisation. The locations of these bores are given on Figure 7.3.4. Details are summarised in Table 7.3.21.

No data are available on the yield of the bores nor the strata in which they were drilled. However they appear to be located in alluvial material. The two bores on Station Creek are recorded as having fair and hard water flows. This suggests an interconnection between the bores and surface water systems.

Bore 19565 is nearer to Glennies Creek and has better quality water.

TABLE 7.3.21

REGISTERED GROUNDWATER BORES

Bore No	Total Depth (m)	Standing Water Level (m)	Salinity	Use
13603	12.8	7.9	Fair	Irrigation
19565	7.3	6.1	Good	Stock and Domestic
52859	9.1	3.7	Hard	Stock and Domestic

Source: Water Resources Commission, June 1986

7.3.4 Impact Assessment – Hydrology and Water Quality

Surface Waters

The site of the proposed Mine is contained within the catchment of Station Creek. A range of safeguards is proposed to control the quality of surface runoff.

Saline groundwater inflows into the pits and rainfall runoff within the disturbed mining area will be fully utilized on site. There will be no need to discharge such waters from the site. All other surface runoff liable to contamination with suspended solids, will be directed to sedimentation ponds which will remove most non soluble materials.

Trade and domestic wastes will be separately collected, treated and disposed of on site by land irrigation. There will be no discharge of such waters from the site.

The combination of water controls and consumption of poorest quality waters on site will safeguard the integrity of Station Creek. A surface water monitoring programme will be maintained during the operational phase of the Mine. This will be developed in consultation with the SPCC to verify the satisfactory environmental operation of the Mine.

Abstraction from Glennies Creek

The Mine and its upstream catchments will not be sufficient to satisfy the Mine's requirements under all meteorological conditions. It is proposed to supply this deficit with water pumped from Glennies Creek. Water would be pumped to Dam C2 from which potable and non-potable demands will be met. Maximum withdrawal from Glennies Creek would occur during two successive drought years and nil groundwater inflow. Under these conditions abstraction would be necessary between 8% and 16% of the time with a maximum annual withdrawal of 674Ml. This maximum annual withdrawal is 1.4% of the regulated base allowance from Glennies Creek Dam. Any harvesting of unregulated flows will reduce this relatively small percentage even further.

The proposed Glennies Creek and Rixs Creek coal mines will also require make-up water. The EIS for Rixs Creek indicates that make-up water if required, will be drawn from the Singleton pipeline, not directly from Glennies Creek. No formal documentation is available for the Glennies Creek Mine. However, it is understood that non potable make-up water is proposed to be drawn from the creek. The mine will produce a maximum of 3.9Mtpa and the maximum annual extraction from Glennies Creek is assumed to be around 600Ml. The cumulative effect of Camberwell and Glennies Creek Mines will be to extract about 2.6% of the regulated base allocation for Glennies Creek Dam. However, should it be necessary to impose restrictions upon irrigation water extraction, then the effect of the Mine would be to increase the length and extent of restrictions. This assumes that all Mine requirements are met from the current irrigation allowance.

Groundwater

The quantities of groundwater inflows to the Mine have been estimated from the data currently available. Significant inflows could cause a localised decline in the potentiometric head of the surrounding groundwater system. As the coal seams have low permeability, the areal extent of any reduction in potentiometric head would be confined to the vicinity of the Mine. By comparing permeabilities with other open cuts in similar hydrogeological settings in the Upper Hunter Valley, the expected pumping rates from inpit sumps could be between 300 and 600m^3/day. This water will be saline.

Provision will be made to cut off the alluvium and the deep weathering zones across the Station Creek valley, which would otherwise be main inflow zones for groundwater.

There are three registered bores located adjacent to Station Creek. These are all shallow bores extracting groundwater flows from the surficial sediments. As these are only surface bores it is unlikely these would be affected by any local decline in groundwater potentiometric head. However, this would be reviewed once the local groundwater flow characteristics have been determined.

Mining impacts upon the quality of local groundwaters similarly depend on the local groundwater flow regime. Geochemical investigations completed for the Project indicate that geochemical issues are unlikely to be a concern (Stuart Miller & Associates, 1989). The limited amount of analysis performed indicates that the quality of long term drainage through the spoil and overburden emplacement will not be dissimilar to the local groundwaters.

No existing users of the saline groundwater in the coal measures aquifers have been identified within the radial area expected to be influenced by mining. Along Station Creek there are numerous small dams essentially collecting rainfall runoff but perhaps also depending upon some groundwater inflow during drought periods. These dams will be lost to the open cut areas.

The impact of mining on existing users of groundwater is considered to be negligible. The main water source for water users in this area is Glennies Creek. It is expected that groundwater changes due to mining activities will not affect this flow.

Large scale on-site harvesting of surface water in the catchment of Station Creek could deplete reserves available for alluvial recharge.

7.4 CLIMATE AND AIR QUALITY

7.4.1 Climate

Data Sources

The Camberwell Project is located approximately 10km northwest of Singleton. Climatic data are available from long term Bureau of Meteorology records and from the Singleton Army meteorological station. Wind data recorded from the Glendell Project area (located approximately 6km northwest of the Camberwell Project) are also used, as it is the wind monitoring station most relevant to the proposed development.

Wind

Figure 7.4.1 illustrates the difference in the distribution of winds between day and night for the Glendell meteorological data set,[18] for the periods 7am to 7pm and 7pm to 7am. There is very little difference in the distribution of winds with direction, although as would be expected, the diagrams show that there is a marked reduction in average wind speed for the night period.

Figure 7.4.2 shows seasonal and annual windroses derived from Glendell. For these diagrams, Summer has been taken as December to February, Autumn as March to May, Winter as June to August and Spring as September to November. The windroses show the strong northwest-southeast alignment of winds which is characteristic of much of the Hunter Valley (for example windroses for Lochinvar and Jerrys Plains exhibit similar wind patterns). As with other parts of the Valley, a marked seasonal variation is also apparent, with the prevalent winds in Summer and Autumn being from the southeast, and in Winter from the northwest. Winds in Spring are reasonably evenly distributed between the northwesterly and southeasterly directions.

From a mine planning point of view, the diagrams indicate that dust transport will mostly occur to the northwest in the warmer months and southeast in the cooler periods. Figure 7.4.3 shows the pattern for Summer and Autumn combined and Winter and Spring combined.

The annual average wind speed for the Glendell site was 3.3m/s, which can be compared with the value of 3.5m/s at Lochinvar and 3.6m/s at Lemington.

18 Dames & Moore 1986

Extreme Wind Gusts

Table 7.4.1 provides an estimation of the maximum wind gusts to be expected for various return periods of 10, 20, 50 and 100 years, within the Singleton area. Wind gusts of 39m/s are likely to be experienced once in every 10 years.

Rainfall

Rainfall data monitored at Singleton Army Base since 1969, are summarised in Table 7.4.2.

The data shows that Singleton can expect to receive rain in all months of the year with the wettest period being Summer and the driest Winter. Average rainfall for the driest month, August, is 23mm, while the wettest month, January, receives 97mm.

Evaporation

Evaporation data are available in the *"Climatic Atlas of Australia"* (Bureau of Meteorology, 1975). Evaporation for January, April, July and October are approximately 225, 125, 75 and 175mm respectively. Annual evaporation is approximately 1,700mm. (For further details see Table 5.6.1.)

Temperature and Humidity

Temperature data for Singleton are shown in Table 7.4.3. The hottest months are January and December with July being the coldest month.

Humidity data for Singleton are presented in Table 7.4.4. Humidity for 9am data, ranges from 62% in October to 81% in June and 3pm data, ranges from 40% in December to 56% in June. The average 9am and 3pm humidities are 72% and 48% respectively.

Frost

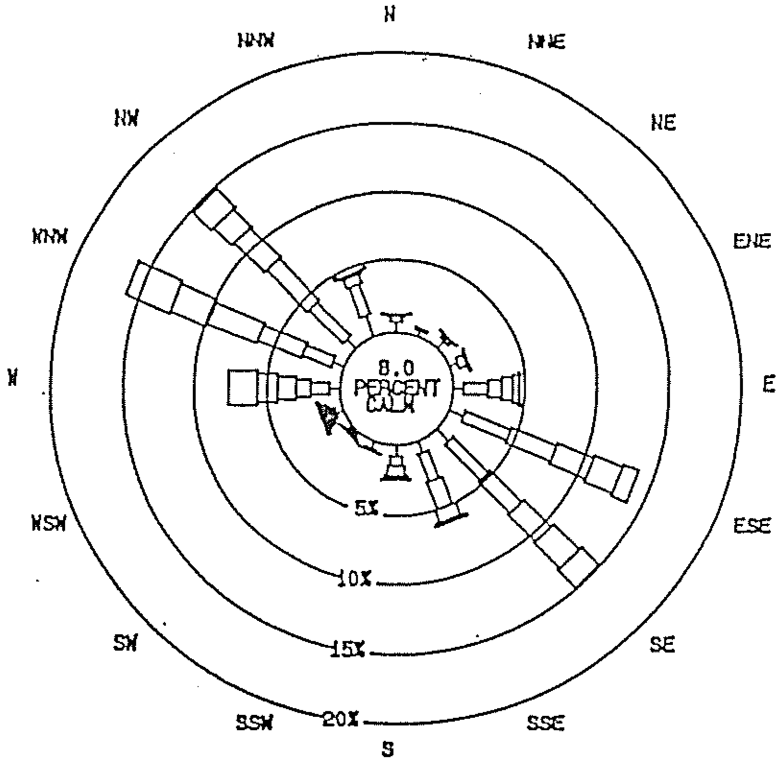
Bureau of Meteorology records for Singleton show that frost generally occurs in June, July and August with the highest number of frost days occurring in July (see Table 7.4.5).

TABLE 7.4.1

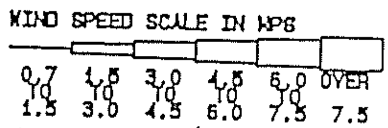
ESTIMATED EXTREME WIND GUSTS FOR THE SINGLETON DISTRICT

Return Period (yrs)	10	20	50	100
Extreme Gust (m/s)	39	41	46	48

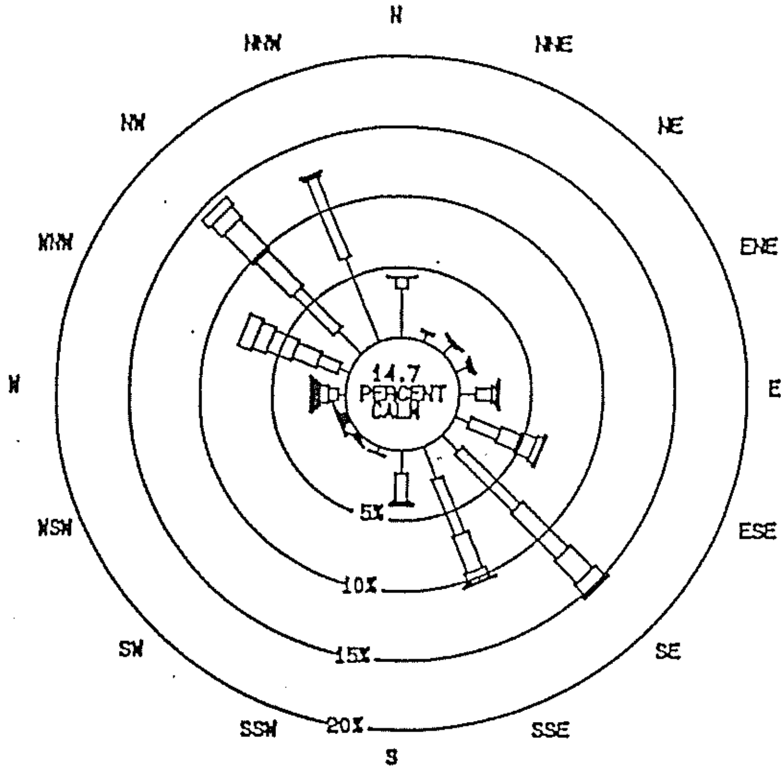
Source: Wittingham, (1964).



ANNUAL 7am -7pm



DISTRIBUTION OF WINDS
FREQUENCY OF OCCURRENCE IN PERCENT



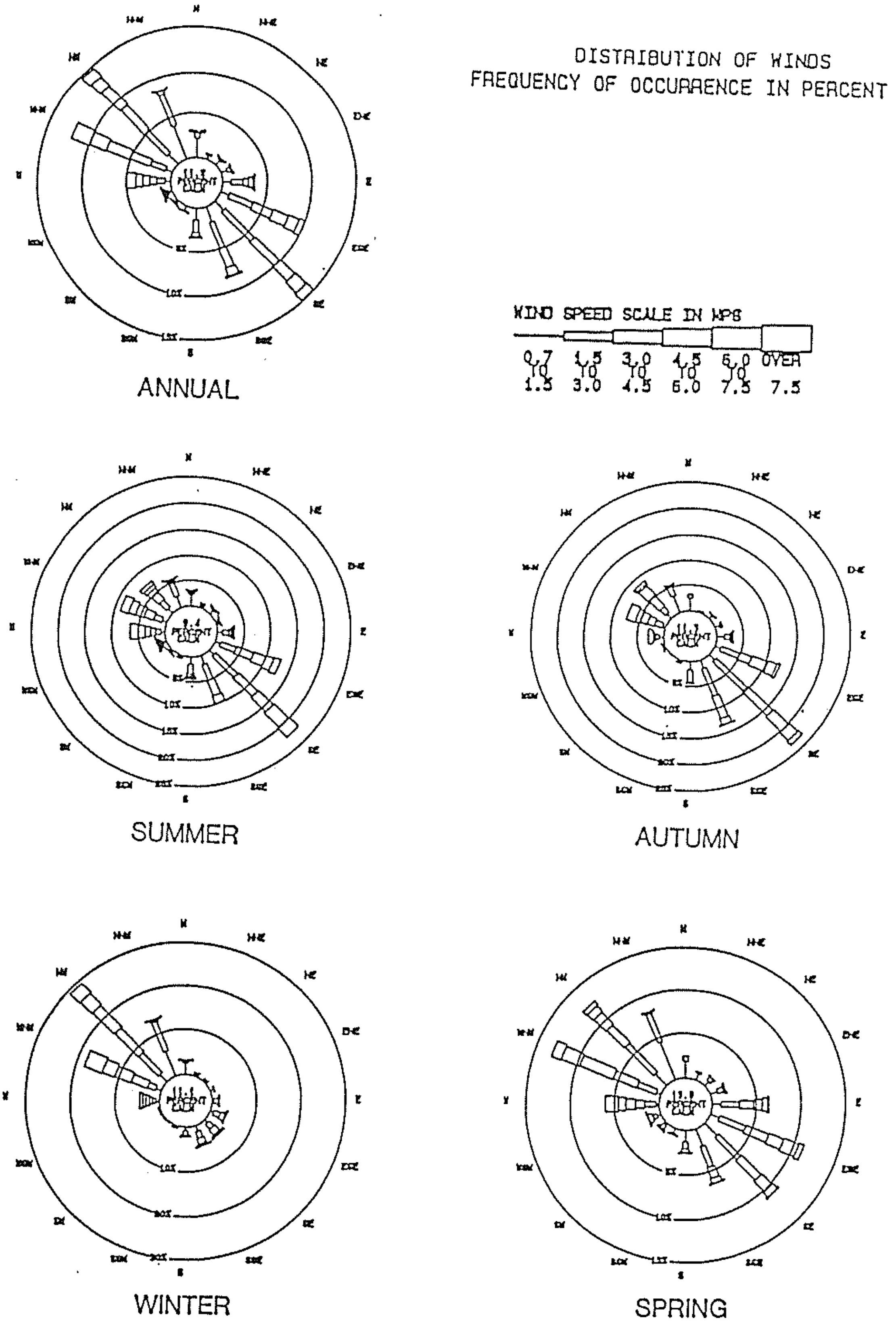
ANNUAL 7pm - 7am

CAMBERWELL COAL PROJECT

ANNUAL NIGHT/DAY WINDROSES

Date SEPT 88

Figure 7.4.1

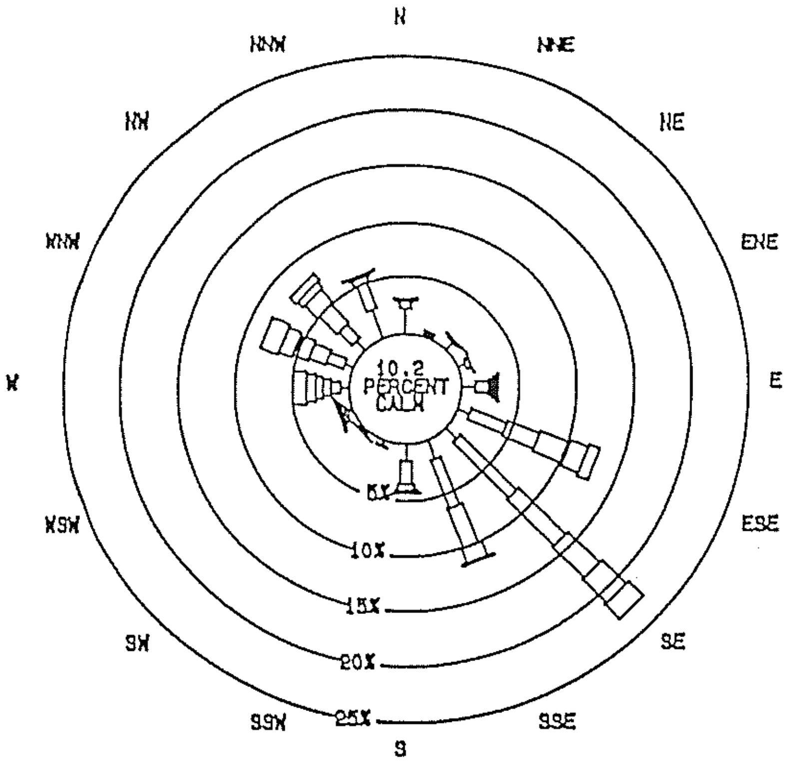


CAMBERWELL COAL PROJECT

ANNUAL AND SEASONAL WINDROSES

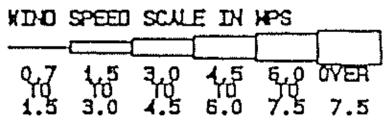
Date SEPT 88

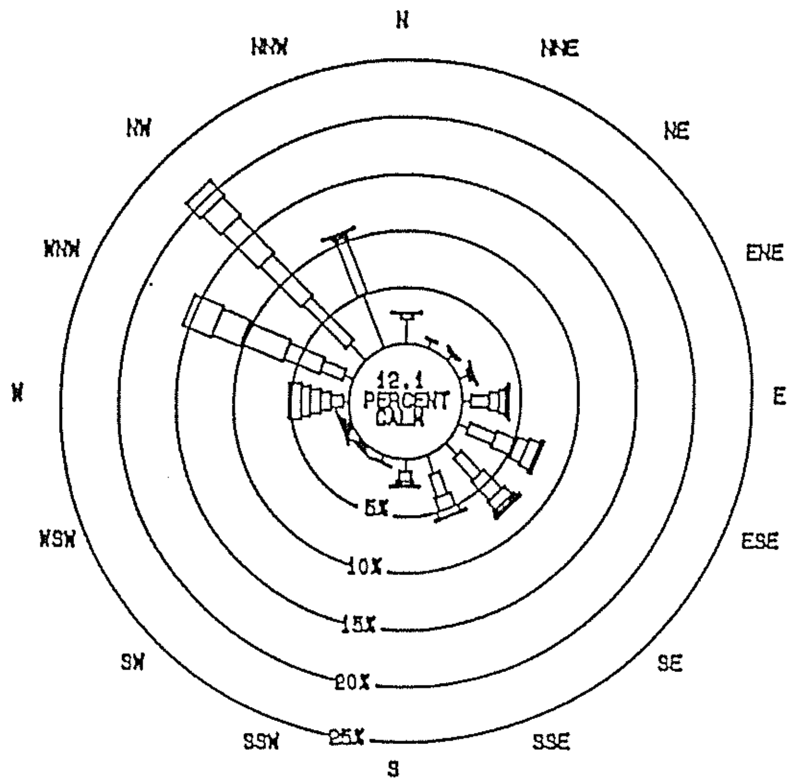
Figure 7.4.2



SUMMER/AUTUMN

DISTRIBUTION OF WINDS
FREQUENCY OF OCCURRENCE IN PERCENT





WINTER/SPRING

CAMBERWELL COAL PROJECT

SUMMER/AUTUMN AND WINTER/SPRING WINDROSES

Date SEPT 88

Figure 7.4.3

TABLE 7.4.2

RAINFALL DATA FOR SINGLETON (1969-1985)

	Summer		Autumn			Winter			Spring			Sum	
	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec	Year
Mean (mm)	97	92	77	49	63	38	25	23	46	62	65	60	697
Median (mm)	71	92	69	43	56	26	21	17	34	46	61	56	
Mean Number of Raindays	11	11	11	10	9	10	7	7	9	10	11	8	

Source: Bureau of Meteorology (1986)

TABLE 7.4.3

TEMPERATURE DATA FOR SINGLETON (1969-1985)

	Summer		Autumn			Winter			Spring			Sum	
	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec	Year
Mean daily max temp (°C)	30.7	29.7	28.0	24.8	20.9	17.8	17.2	19.5	22.3	25.3	27.5	30.6	25.3
Mean daily min temp (°C)	17.9	18.2	16.1	12.5	9.0	6.8	5.1	6.1	8.9	12.2	14.4	17.0	12.0

Source: Bureau of Meteorology (1986)

TABLE 7.4.4

RELATIVE HUMIDITY (MEAN) SINGLETON (1970-1985)

	Summer		Autumn			Winter			Spring			Sum	
	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec	Year
9am humidity %	72	77	74	75	79	81	77	71	64	62	66	63	72
3pm humidity %	49	51	51	49	54	56	51	41	42	43	43	40	48

Source: Bureau of Meteorology (1986)

TABLE 7.4.5

FROST DATA FOR SINGLETON (1969-1985)

	Summer		Autumn			Winter			Spring			Sum
	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec
Average no frost days	0	0	0	0	0	1	5	2	0	0	0	0

Source: Bureau of Meteorology (1986)

7.4.2 Air Quality Assessment

The Study

An Air Quality Assessment was prepared for the Camberwell Project by Nigel Holmes & Associates (1989).

The approach to the assessment has been to analyse the operation of the mine for three periods in its development, Years 5, 10 and 13 and to develop estimates of the dust that will be generated from each component of the mining operation. These estimates of dust emissions have then been used with a long-term dispersion model and meteorological data from Glendell to estimate annual average dust deposition rates and dust concentrations at a grid of points surrounding the Mine.

An analysis of the cumulative effect of the Camberwell Mine with the Rixs Creek Mine is also presented.

The predicted deposition rates and concentrations are presented as contour plots which can be used to assess the impact of the Mine by comparing the predicted deposition rates and concentrations with relevant air quality criteria.

A dispersion model capable of predicting 24-hour dust concentrations has also been used to evaluate impacts that would be expected to occur under "worst-case" episodic conditions.

Local Setting

The two open cut pits and surface facilities are shown in detail in Figure 3.1.1 and illustrated on the model in the frontspiece. The terrain within Authorisations 81 and 308 is gently undulating with the highest point being at approximately 140m above mean sea level and the lowest at 60m above mean sea level. Most of the area which will become the open cuts and the surface facilities lies between 80 and 120m.

As described in other sections of the EIS the area is lightly wooded and is presently used primarily for grazing. The Glennies Creek river flats west of the proposed mine areas are used for irrigated crops.

Aspects of the Project Influencing the Assessment

The Mine is proposed to be developed over a 21-year period with the first of these years being devoted to pre-mine development. Thus the total period of active open cut mining is nominally 20 years.

The North Pit will be developed over Years 1 to 9 while initial development of the South Pit will be commenced in Year 6 and continue working until the end of the life of the Mine in Year 20. Site facilities will comprise a crusher, washery, stockpile area and rail load-out facilities (Figure 3.1.1). Out-of-pit dump areas are also shown in the series of Figures 3.1.3 to 3.1.9. Mining will take place by truck and shovel.

The equipment operating inventory for Years 5, 10 and 13 is presented in Table 7.4.6. Details of this inventory for other years are presented in Table 3.2.1. Detailed data on the amounts of coal and waste that will be handled during each year in the life of the Mine is shown in Table 3.1.2. The information presented in this section is a summary of these data for the three selected years with emphasis being given to information that is relevant for dust generation.

TABLE 7.4.6

INVENTORY OF DUST GENERATING EQUIPMENT OPERATING IN SELECTED YEARS

	Year 5	Year 10	Year 13
Drills	2	2	2
Electric shovels	1	1	1
Dozers 834B	1	1	1
Trucks 85t for coal/rejects	6	6	6
Trucks 240t for Waste	7*	7*	7*
Front-end loaders 922C Waste	1	1	1
Front-end loaders 922C Coal	1	1	1
Front-end loaders 580	1	1	1
Dozers D10 and D11	4	4	4
Scrapers	1	1	1
Graders	1	1	1

* This figure may include some trucks of smaller capacity

Method of Assessing Impact

The three years were selected for detailed study to define the areas affected by dust over the life of the mine. These years are believed to be representative of various stages of mine development. They outline the extreme limits of areas subject to potential air quality impacts, and additionally, in the case of Year 5, involve the largest volume of annual overburden movements.

Year 5: In Year 5 most of the extraction of coal and waste will take place in the northern part of the North Pit. Approximately 11.3Mbm^3 of waste will be extracted: 20% will be dumped in the pit and the remainder in the waste dump located to the east of the open cut (approximately half in the north and half in the south of the dump). About 2.0Mt of raw coal will be produced which will give approximately 1.3Mt of product coal. The waste and coal haul roads as they will be in Year 5 are shown on the dust deposition and concentration diagrams presented in Section 7.4.7.

Year 5 represents the maximum northern extent of the area that will be affected by dust.

Year 10: In Year 10 the North Pit will no longer be used for extracting coal, but will still be used for the placement of waste. The extraction of coal and waste will take place in the extreme south of the South Pit. Approximately 10.7Mbm^3 of waste will be extracted: 10% will be dumped in the pit and 90% will be placed in the North Pit. About 2.0Mt of raw coal will be produced giving approximately 1.4Mt of product coal after processing. The waste and coal haul roads as they will be in Year 10 are shown on the dust deposition and concentration diagrams in Section 7.4.7.

Year 10 can be used to define the most southerly areas affected by dust during the life of the mine.

Year 13: In Year 13 most of the extraction of coal and waste will take place in the middle of the South Pit. Approximately 10.7Mbm^3 of waste will be extracted: 15% will be dumped in the pit and the remaining 85% will be placed along its western side. Approximately 1.9Mt of raw coal will be produced which will give approximately 1.3Mt of product coal. The waste and coal haul roads are shown on the dust deposition and concentration diagrams in Section 7.4.7.

Additional Dust Generation Considerations: Through the life of the Mine the surface facilities will remain unchanged. The washery will have a capacity of approximately 350tph. The raw coal and product coal stockpiles will cover areas of approximately 5.3ha and 12.6ha respectively.

Two other nearby coal deposits may also be developed during the life of the Camberwell Mine. The most significant of these will be the 1.5Mtpa Rixs Creek Project located adjacent to the southern boundary of the SLA.

North of the SLA the Glennies Creek Mine and surface facilities may also be developed. As this project will be an underground mine the dust emissions will be relatively minor. The schedule for development for the Glennies Creek Mine is uncertain and a detailed description of the project is not yet publicly available. For these reasons a cumulative impact assessment including this mine could provide misleading information and consequently has not been considered in this assessment.[19]

Similarly for the Glendell Project, north of the Glennies Creek Project, the timing and ultimate nature of the proposed development are unknown. To include details of either project in accumulative assessment at this stage would be a meaningless exercise.

19 The Commissioners of Inquiry for the Rixs Creek Mine did however refer to the potential cummulative impact in their 1989 Report as follows:

"We are of the view that there is likely to be an increase in the area affected by increased dust deposition and dust concentrations as a result of the cumulative impact of the Rixs Creek, Camberwell and Glennies Creek coal mining developments. The area so impacted is also likely to extend towards the rural residential areas along Bridgman Road and The Retreat. It is not possible however to ascertain with any accuracy the extent of the likely impact as the timing of the three projects is not known."

7.4.3 Dispersion Meteorology

Introduction

A dispersion model has been used to predict dust deposition rates and dust concentrations in the vicinity of the Mine. The model requires as input, information about the dispersion characteristics of the area. In particular, data are required for rainfall to assist in estimating dust emission rates from stockpiles and areas subjected to wind erosion, on wind speed and wind direction (see Section 7.4.1) and on atmospheric stability class and mixing height.

Wind Data

The wind data used for the study were collected for the Glendell project at a site approximately 10km to the northwest of the proposed Mine Site. The equipment was mounted on a 10m mast and data were recorded electronically and logged on to a magnetic tape. The data were made available to the Project by Glendell Mining Pty Ltd. The wind monitor at the site has been operated for several years and seasonal and annual windrose diagrams for 1985, 1986 and 1987 are presented as Figures 7.4.1, 7.4.2 and 7.4.3.

Examination of the windroses shows that there is little difference in the distribution of winds for day time and night time conditions.

The data show the same general alignment of winds and the same seasonal changes that are common for most of the central axis of the Hunter Valley. Annual average winds have the strong tendency to blow either from the northwest or southeast, with the southeasterly winds being most common in Summer and the northwesterlies being most common in Winter and Spring. Autumn has winds approximately evenly distributed between northwest and southeast.

The annnual average wind speed for 1985 was 3.3m/s.

Mixing Height and Stability Class

Information on mixing height and stability class are required as input to the dispersion model. Mixing height refers to the height that atmospheric emissions are ultimately mixed in the atmosphere. For dust dispersion models, where most of the sources are non-buoyant groundlevel emissions the predictions are not particularly sensitive to the mixing height. No direct measurements on mixing height are available for the area and theoretically derived values have been used. The theoretical values have been estimated by assuming that the maximum mixing height reached during the day was 1,500m, 1,200m, 1,000m and 1,200m for Summer, Autumn, Winter and Spring respectively.

Stability class is used by dispersion models to determine the rate at which the plume grows by the process of turbulent mixing. Each stability class is associated with a dispersion curve[20] which is used by the model to calculate the plume dimension and dust concentration at points downwind of the source.

The frequency of occurrence of particular stability classes in the 1985 Glendell data set, which was used in the dispersion model, is shown in Table 7.4.7.

TABLE 7.4.7

FREQUENCY OF OCCURRENCE OF STABILITY CLASSES

Stability	Occurrence (%)
A	5.7
B	17.9
C	11.2
D	21.7
E	11.2
F	27.4

20 In the model used here the Pasquill- Gifford dispersion curves have been used.

Stability Class A applies under sunny conditions with light winds when dispersion of the plume is at its most rapid. Stability Class D applies under windy and/or overcast conditions when dispersion is moderately rapid and stability Class F applies at night when winds are light and the sky is clear. Dispersion under Class F conditions is poor. Classes B, C and E describe intermediate conditions.

7.4.4 Air Quality Criteria

The effects of dust on health and amenity can be assessed by comparing dust deposition rates and dust concentrations with recognized air quality criteria established as a result of research both in NSW and internationally. To cover the full range of possible adverse impacts it is necessary to make reference to criteria for both long-term (annual averages) and short-term (24-hours) periods.

Short-term Criteria

Concentration

New South Wales has no regulations concerning acceptable short-term concentrations of dust in the ambient air. However, in assessing the acceptability of mining projects the SPCC refers to the United States Environmental Protection Agency (US EPA) primary and secondary ambient 24-hour air quality standards, which are 260 and 150µg/m respectively. The primary standard is designed to protect the public against adverse health effects with an "adequate margin of safety". The secondary standard is designed to protect against nuisance effects.

Deposition

There are no air quality criteria for short-term dust deposition rates.

Long-term Criteria

Concentration

The SPCC refers to the NH&MRC[21] 90µg/m^3 annual average goal when assessing long- term dust impacts. This level is recommended as the maximum permissible level that should be permitted in urban environments.

Deposition

In the past the SPCC has considered that residential areas would begin to experience dust related nuisance impacts when annual average dust (insoluble solids) deposition levels exceeded 4g/m^2/month, and that dust impacts would be at unacceptable levels when they reached 10g/m^2/month (SPCC 1983).

Recent research[22] has refined these criteria and it is now considered that perceptible degradation of air quality occurs as a result of a specific project, if the project results in dust deposition levels increasing by a certain margin. The permitted marginal increment in deposition level before the nuisance level is reached depends on the existing dust deposition levels.

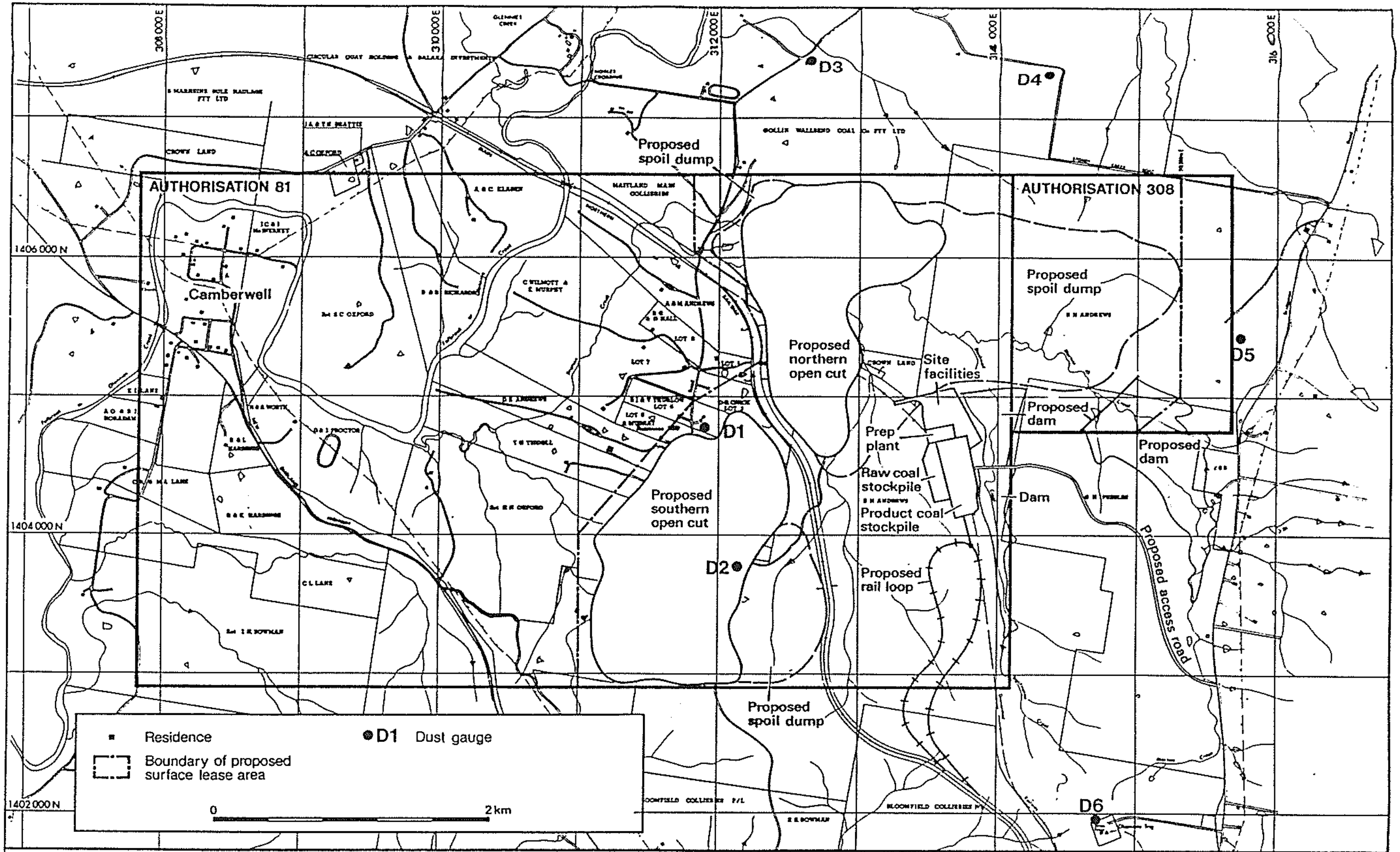
For rural/semi-rural areas such as Camberwell, experiencing annual average deposition levels of between 1 and 2g/m^2/month, dust deposition levels would be allowed to increase by 2g/m^2/month before it would be considered that a significant degradation in air quality had occurred. One or two months at 5g/m^2/month would also be acceptable.[22]

7.4.5 Existing Air Quality

Dust deposition levels have been measured (using the procedures specified in Australian Standard AS 2724.1 1984) at six sites in the vicinity of the Camberwell Project (see Figure 7.4.4 for location of dust monitoring sites). Monthly dust deposition levels (insoluble solids) for periods in 1985, 1986 and 1989 are presented in Table 7.4.8.

21 National Health and Medical Research Council (Australia)

22 Mitchell, 1988 *Derivation of Appropriate Control Standards from Sociological Research* Coal Journal No 20 p1-12.



CAMBERWELL COAL PROJECT

LAYOUT OF SURFACE FACILITIES AND LOCATION OF DUST GAUGES

Date October 1989

Prepared by
NIGEL HOLMES & ASSOCIATES
FIGURE 7.4.4

TABLE 7.4.8

MONTHLY DEPOSITION RATE OF INSOLUBLE SOLIDS

1986	Summer		Autumn			Winter			Spring		Sum	
Gauge	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Avg
D1										1.9	1.7	2.4	2.0
D2										2.1	1.8	1.5	1.8
D3										1.5	1.7	1.8	1.7
D4										1.2	1.7	2.2	1.7
D5										1.5	1.4	1.5	1.5
D6										–	2.5	1.1	1.8

1987	Summer		Autumn			Winter			Spring		Sum		
Gauge	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Avg
D1	1.8	1.2	0.8	0.4	1.3	2.5	1.8	1.4	2.0	2.4	1.3	4.0	1.7
D2	1.9	2.2	1.1	1.1	1.5	1.5	2.6	1.1	1.3	1.8	1.8	1.4	1.6
D3	2.3	3.0	–	1.0	–	–	1.3	0.6	–	2.2	1.6	1.3	1.7
D4	1.7	2.0	1.6	1.6	–	1.3	2.0	1.8	0.4	1.0	2.7	2.9	1.7
D5	1.5	1.3	3.0	1.0	1.7	–	1.6	1.8	1.6	1.0	2.1	2.9	1.8
D6	1.7	1.9	4.6	1.1	–	1.5	2.3	4.0	1.7	1.9	1.3	1.2	2.1

1989	Summer		Autumn			Winter			Spring		Sum		
Gauge	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Avg
D1			0.7	0.9	0.8	0.5	0.5						0.7
D2			0.6	0.7	0.7	0.6	0.4						0.6
D3			0.9	0.7	0.6	0.5	0.8						0.7
D4			1.2	1.1	0.7	0.3	0.6						0.8
D5			0.6	2.5	0.5	0.3	0.4						0.9
D6			0.2	–	0.4	0.5	0.3						0.3

Notes:
1. – missing sample
2. The interruption to the monitoring, which occurred between 1988 and the early part of 1989 was a result of uncertainties concerning the timing of the development. The monitoring programme was suspended between January 1988 and February 1989.

Monthly deposition rates for the area can be seen from Table 7.4.8 to vary from 0.2g/m^2/month to 4.0g/m^2/month. Annual average rates vary from 0.3 to 2.1g/m^2/month. The more recent data (1989) show very much lower deposition level than the values recorded in 1986 and 1987. The reason for this is not clear, although the early to middle period of 1989 had an unusually high number of raindays, and this coupled with thicker than usual vegetative cover, may have depressed dust generation in the area.[23]

On the basis of this data the background dust deposition level can be taken as having an upper limit of approximately 2g/m^2/month and according to the discussion in Section 7.4.4 an acceptable increase in annual average deposition rate due to the operation of the mine would be 2.0g/m^2/month.

23 This should be considered as speculative explanation at this stage. A different laboratory has been responsible for the analysis of the more recent dust gauge samples and it is possible that this has introduced a bias. However, both the 1986/87 and 1989 analyses have been conducted in accordance with the same standard analytical procedure and thus the two data sets should be comparable.

7.4.6 Emissions Inventory

As discussed in Section 7.4.2 dust emissions have been estimated by analyzing the mine plan for Years 5, 10 and 13 and using emission factors developed both locally and by the US EPA. Table 7.4.9 summarizes the emission factors used in the calculations and shows the estimated dust generated from each mine associated operation.

TABLE 7.4.9

INVENTORY OF DUST EMISSIONS

Activity	Emission factor (After controls if applicable)	Estimated Emission (t) Year 5	Year 10	Year 13
Hauling overburden	2.0kg/km*	668.5	1329.8	1333.6
Loading overburden	0.025kg/t	626.8	586.7	586.6
Dumping overburden	0.012kg/t	300.8	281.6	281.5
Drilling	0.6kg/hole	0.5	0.4	0.4
Blasting	(see US EPA, 1981)	33.7	33.7	33.7
Hauling coal	2.0kg/km	180.1	318.2	332.6
Loading coal	0.029kg/t	58.0	56.7	55.3
Dumping coal	0.01kg/t	~~200.0~~ 20	~~195.4~~ 19.5	~~190.7~~ 19.1
Ripping coal	50.4kg/h	312.1	312.1	312.1
Dozer on overburden	2.75kg/h	0.7	0.7	0.7
Scraper on overburden	14.0kg/h	86.7	86.7	86.7
Graders	0.615kg/km	2.3	4.6	4.6
Stockpile wind erosion	0.4kg/ha/h	63.1	63.1	63.1
Mine wind erosion	0.4kg/ha/h	175.0	210.2	350.4
Waste dump wind erosion	0.4kg/ha/h	87.6	87.6	87.6
Dozer on stockpile	38.0kg/h	29.4	29.4	29.4
TOTAL		~~2,825.3~~ 2645.3	~~3,596.9~~	~~3,749.0~~

*kg/km: actually kg of dust per km of vehicle travel

Using the figures in Table 7.4.9 the quantity of dust generated per tonne of raw coal produced is 1.41, 1.84 and 2.00kg/t for Years 5, 10 and 13 respectively. Typical values for dust to raw coal ratios for the Hunter Valley open cut mines are in the range 0.5 to 2kg/t. The estimated ratios are within but towards the upper end of the range. The reason for this is largely the length of the overburden haul roads, particularly for the times when waste is to be transferred from the South to North Pits and also due to the large exposed areas that will exist in the later years of the life of the mine.

For these figures to be applied with the dispersion model they have to be assigned coordinates. The dust deposition and concentration contour diagrams in Section 7.4.7 show the locations of the major areas of dust generation.[24] In addition, for dust deposition rates to be estimated, data has to be provided on the distribution of particle sizes in the emission. The size distributions used in the present study are summarized in Table 7.4.10.

24 In the dispersion model haul roads were represented as point sources spaced at 250 metre intervals and wind erosion sources were represented as area sources.

TABLE 7.4.10

PARTICLE SIZE DISTRIBUTIONS BY MASS FROM MINING OPERATIONS (%)

Operation	Fine particles (0-2.5μm)	Inhalable particles (2.5-15μm)	Coarse particles (15-30μm)	Reference
Haulage of overburden	6	53	41	D&M 1986*
Loading of overburden	taken to be the same as for overburden dumping.			
Dumping of overburden	4	44	53	D&M 1986
Dozer on overburden	20	54	26	USEPA 1981‡
Graders	6	48	46	USEPA 1981
Drilling	9	62	29	D&M 1986
Blasting	5	39	56	USEPA 1981
Haulage of coal	6	53	41	D&M 1986
Wind erosion	0	67	33	USEPA 1981
Dumping of coal	4	49	47	D&M 1986
Ripping coal	3	49	48	USEPA 1981
Loading coal	5	58	37	D&M 1986

* D&M (1986) *Particle Size Distributions in Dust for Open Cut Coal Mines in the Hunter Valley.* Dames & Moore and Tunra Ltd on behalf of the SPCC.

‡ US EPA (1981) *Improved Emission Factors for Fugitive Dust from Western Surface Coal Mining Sources,* US EPA, Office of Research and Development. Cincinnati, Ohio.

7.4.7 Air Quality Impact Prediction

Modelling

Air quality impacts have been assessed using a computer-based dispersion model known as DUSTGLC.[25] The model is only useful for estimating long-term dust deposition and concentrations. It cannot be used to estimate short-term, for example 24-hour averages, of deposition or concentration.

To properly evaluate impacts from the Mine it is necessary to estimate short-term dust concentrations under "worst-case" conditions (that is dry dusty episodes, referred to as episodic conditions) and compare these with short-term air quality criteria. This has been done using AUSPLUME, which is a Gaussian dispersion model using hourly meteorological data. AUSPLUME was developed for use by the Victorian Environment Protection Authority (VEPA) for use in licensing stationary air pollution sources in Victoria.[26]

Long-term Impacts

The emission estimates presented in Section 7.4.6 and summarized in Table 7.4.9 have been used with the particle size data and meteorological data described in Section 7.4.3 to predict the increase in annual average dust deposition rates and dust concentrations in the vicinity of the Mine. The predictions of increase in dust deposition, due to emissions from the Camberwell Mine in isolation, for Years 5, 10 and 13 are presented in Figures 7.4.5, 7.4.7 and 7.4.9. Year 10 is the period when open cut mining will reach its most southerly extent.

25 DUSTGLC has been widely used in the Hunter Valley and a full technical description is presented in the Environmental Impact Statement for the Lemington Northern Open Cut Extension (CSR, 1984). Validation of the model, in which predicted dust deposition levels are compared with measured deposition levels at two operating mines in the Hunter Valley, is also presented in the same report.The model uses work by Slinn (1982) to estimate dust deposition rates and is based on the sector average model outlined by Turner (1970).

26 A full technical description of the model is provided in VEPA (1986) *The Ausplume Gaussian Dispersion Model.*

The most northerly area of the Rixs Creek mine extends to the southern boundary of the Camberwell Mine, hence it is relevant to consider the dust emissions from the two mines assuming that they operate simultaneously. There is however still some uncertainty about the relative progress of the two mines.

For the purposes of assessing cumulative impact it has been assumed that the Rixs Creek Mine is developed two to three years ahead of the Camberwell mine so that the "worst-case" cumulative impact will occur in approximately Year 10 of Camberwell's development, which would correspond to Year 7 or 8 of Rixs Creek's development. The Camberwell open cut mine is planned to operate for 20 years while Rixs Creek Mine is designed for a 40-50 year life.

Figure 7.4.11 shows the predicted increase in dust deposition for Camberwell's Year 10 taking into account dust emissions from both Camberwell and Rixs Creek.

Figures 7.4.6, 7.4.8 and 7.4.10 show the predicted increase in annual average dust concentrations for Years 5, 10 and 13 with Camberwell being considered in isolation and Figure 7.4.12 shows the predicted annual average increase in dust concentration taking both Rixs Creek and Camberwell emissions into account.

The air quality criteria for *deposition* are now based on increments in dust deposition rather than total deposition rates. This allows the figures for predicted increases in dust deposition to be used directly for assessing the affects due to long-term deposition.

For dust *concentrations* however, the air quality criterion is for absolute amounts and thus the background should be added to the predicted level. No monitoring data are available to provide information on background levels, but data presented at the Rixs Creek Public Inquiry indicates that existing 24-hour average dust concentrations in the area can be expected to be in the range 11 to 66$\mu g/m^3$.

It would seem likely that appropriate annual average concentrations (ie for locations remote from specific sources of dust) would be in the range 20 to 30$\mu g/m^3$. Thus approximately 20 to 30$\mu g/m^3$ should be added to the predicted dust concentration contours before they are compared with the NH&MRC 90$\mu g/m^3$ annual average goal.

Examination of Figures 7.4.5 to 7.4.12 shows that using the 2g/m^2/month increment contour is a more stringent assessment criterion than using the 90$\mu g/m^3$ incremental concentration contour.

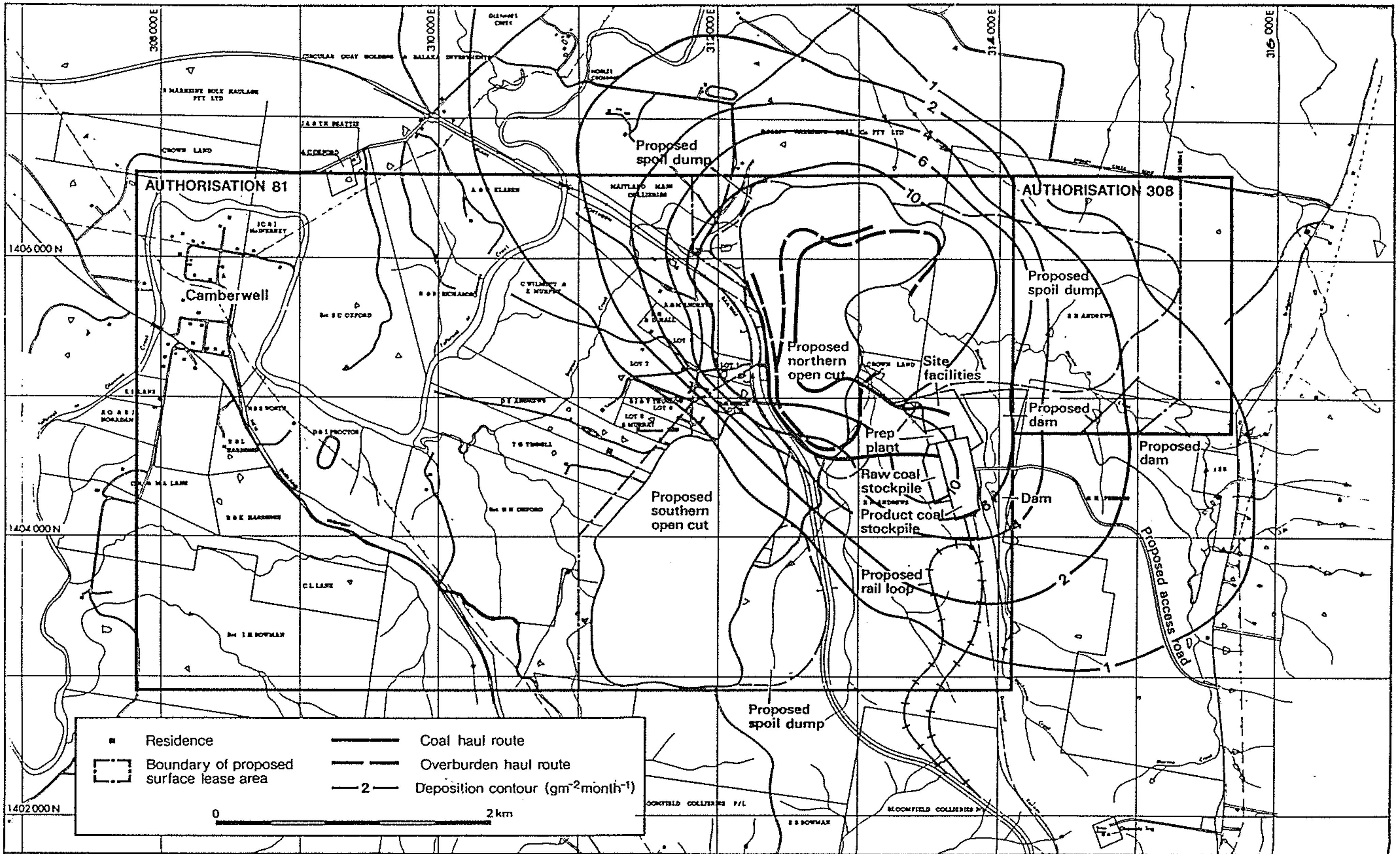
A reasonable approach to the assessment therefore, is to develop an envelope of the 2g/m^2/month incremental deposition contour for the life of the Mine. This envelope then defines the area where dust will affect the amenity at some stage during the life of the Mine. This envelope contour is presented as Figure 7.4.13. The numbers on the edge of the envelope identify approximately the year in the mine's development, which determines the particular section of the contour.

Figure 7.4.13 also includes the envelope for the daytime noise contour of 40dB(A) over the life of the Mine (see Section 7.5.4 and Table 7.5.4). *This figure combining the contour plots of dust and noise levels considered to be acceptable in the context of the Camberwell Project, defines the Zone of Affectation for the Project.*

The CCJV recognizes that residential areas within the *Zone of Affectation* will be adversely affected at some stage during the life of the Mine by dust fallout and/or noise levels. The degree of impact from dust will range from marginal for those residences experiencing close to 2g/m^2/month to severe for properties experiencing levels above 8g/m^2/month. The CCJV has negotiated, or is presently negotiating with the land-holders within the *Zone of Affectation* to either purchase the land, or to reach some other mutually acceptable arrangement to compensate for the loss of amenity.

Short-term Impacts

Short-term impacts have been estimated using an assumed "worst-case" emissions scenario and the dispersion model AUSPLUME to estimate the 24-hour average dust concentration at a set of receptors spaced at 200m intervals and running from the southern end of the stockpile in a south-southeasterly direction away from the stockpile to a point approximately 3km south of the centre of the southern edge of the stockpile area, or 3.5km beyond the southern edge of the northern open cut. The predicted concentrations decrease as the distance from the stockpile increases.



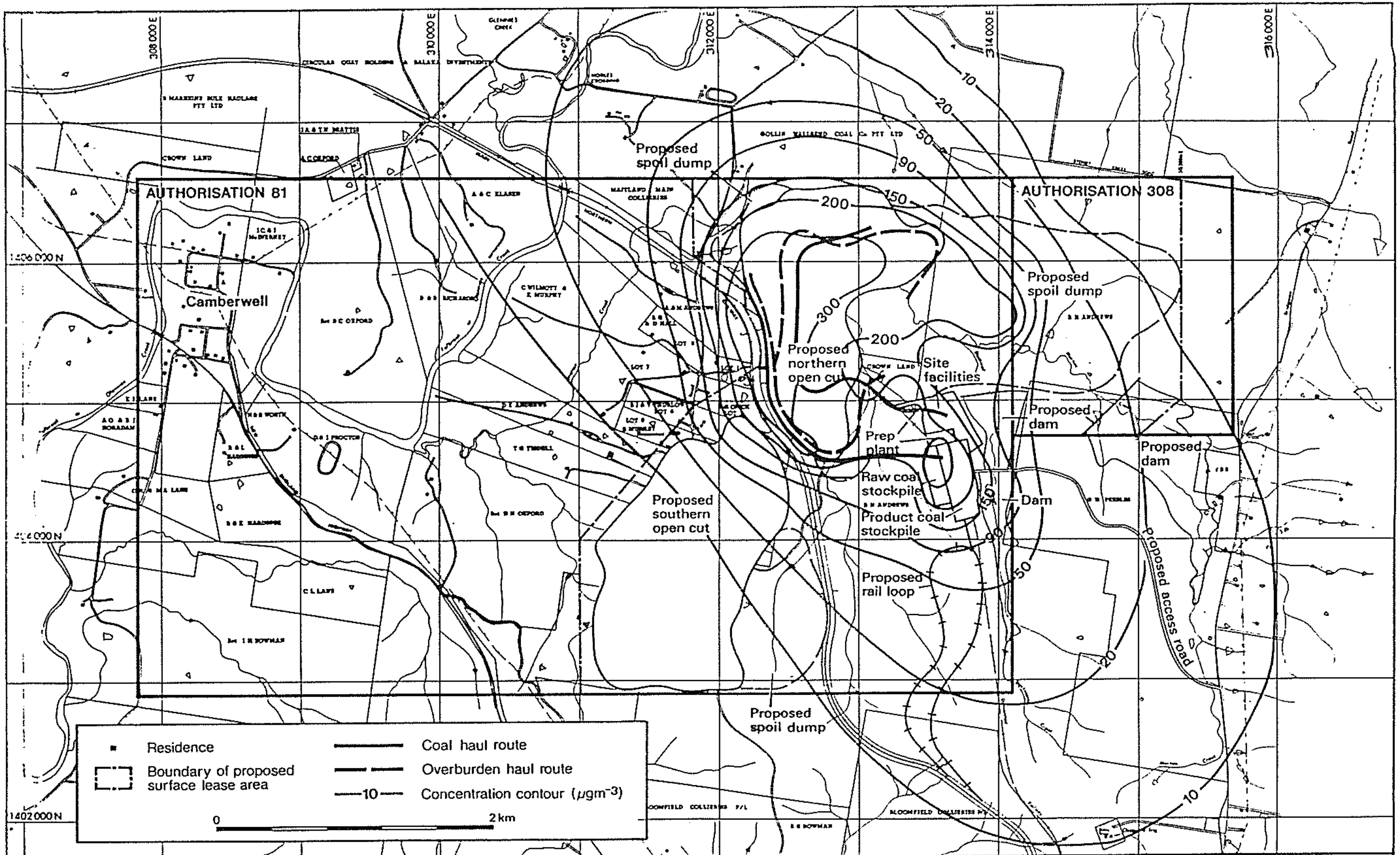
CAMBERWELL COAL PROJECT

PREDICTED INCREASE IN ANNUAL AVERAGE DUST DEPOSITION FOR YEAR 5

Date October 1989

Prepared by NIGEL HOLMES & ASSOCIATES

FIGURE 7.4.5



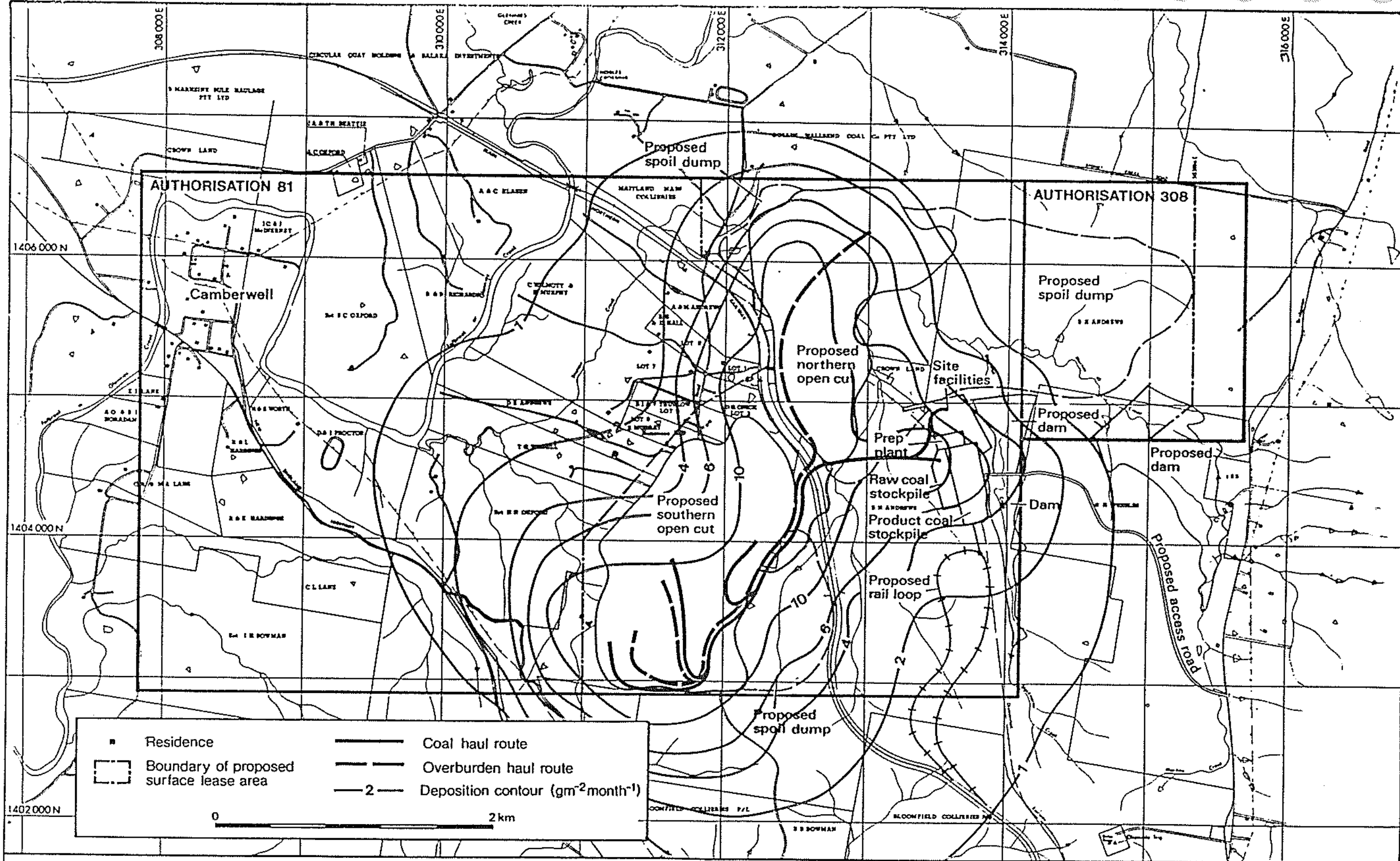
CAMBERWELL COAL PROJECT

Date October 1989

PREDICTED INCREASE IN ANNUAL AVERAGE DUST CONCENTRATION FOR YEAR 5

Prepared by NIGEL HOLMES & ASSOCIATES

FIGURE 7.4.6

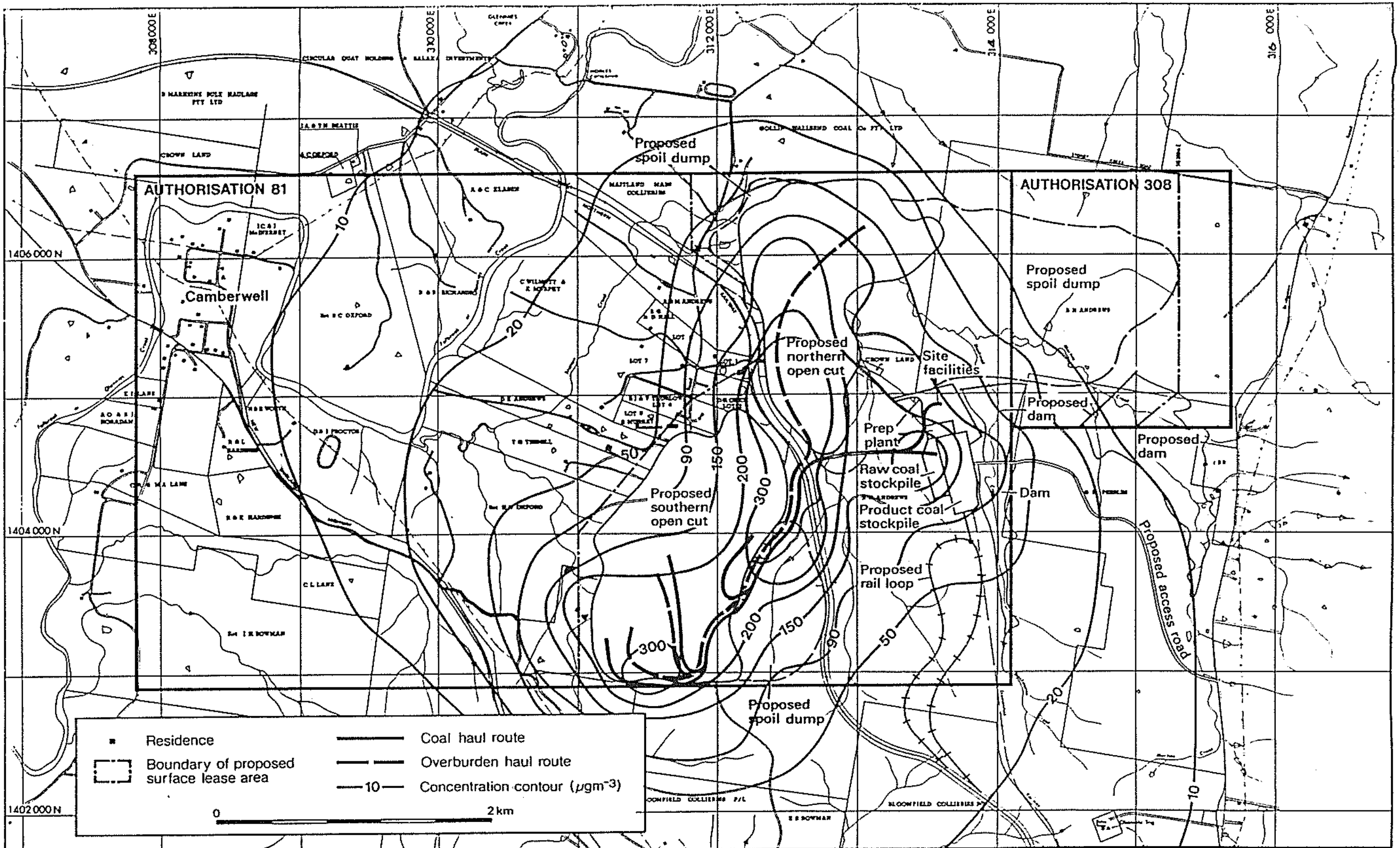


CAMBERWELL COAL PROJECT

Date October 1989

PREDICTED INCREASE IN ANNUAL AVERAGE DUST DEPOSITION FOR YEAR 10

Prepared by
NIGEL HOLMES & ASSOCIATES
FIGURE 7.4.7



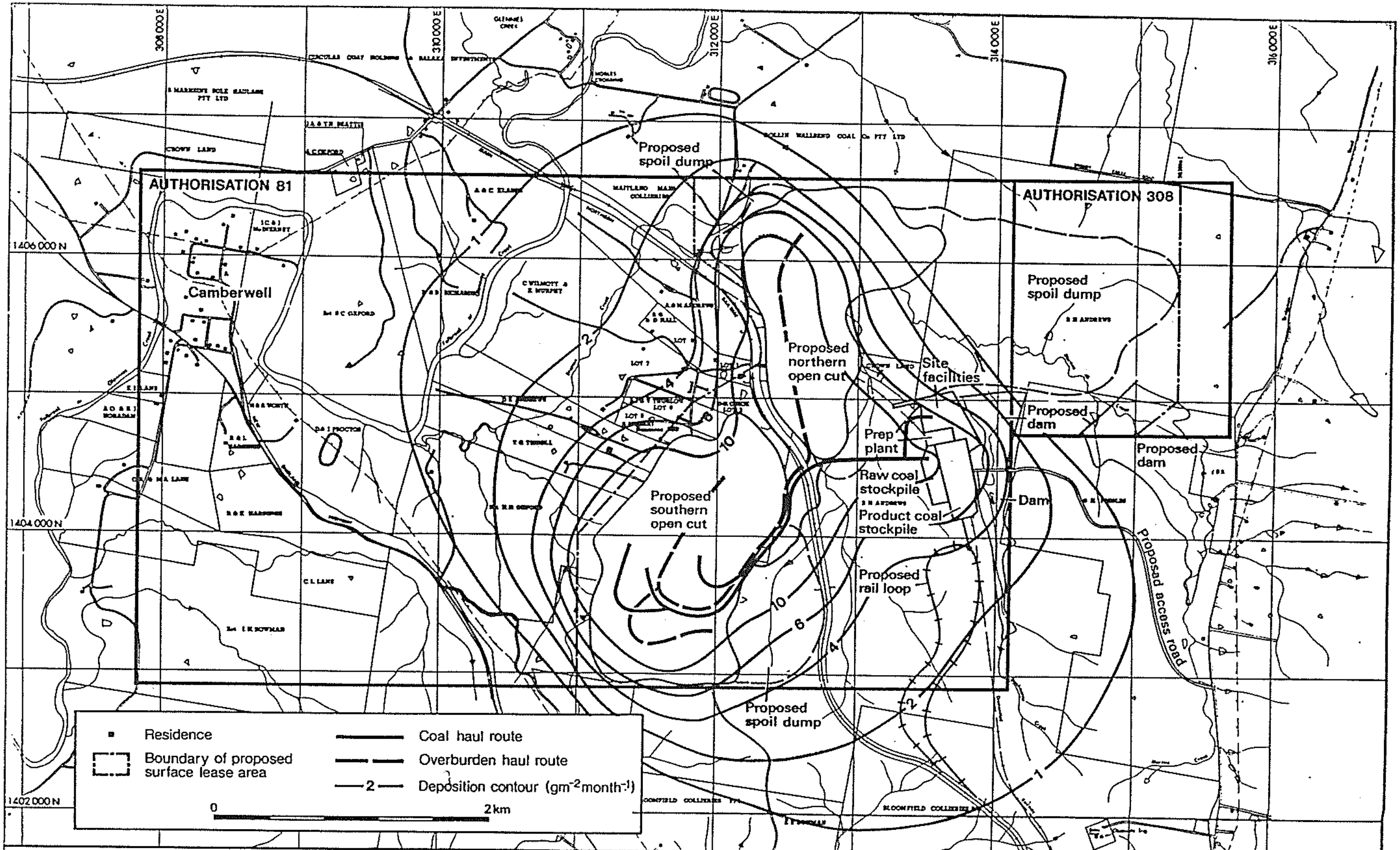
CAMBERWELL COAL PROJECT

Date October 1989

PREDICTED INCREASE IN ANNUAL AVERAGE DUST CONCENTRATION FOR YEAR 10

Prepared by NIGEL HOLMES & ASSOCIATES

FIGURE 7.4.8



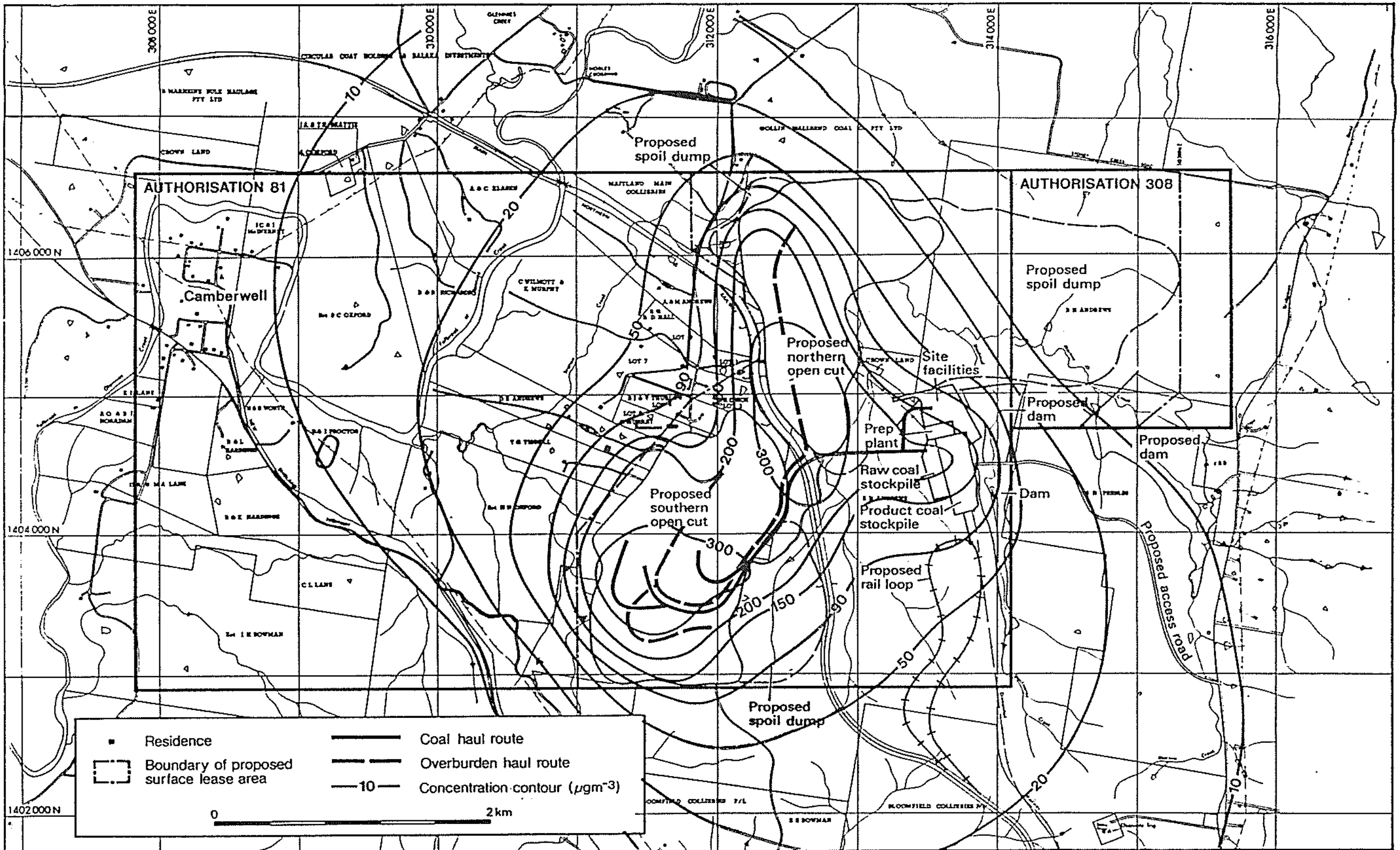
CAMBERWELL COAL PROJECT

PREDICTED INCREASE IN ANNUAL AVERAGE DUST DEPOSITION FOR YEAR 13

Date October 1989

Prepared by NIGEL HOLMES & ASSOCIATES

FIGURE 7.4.9

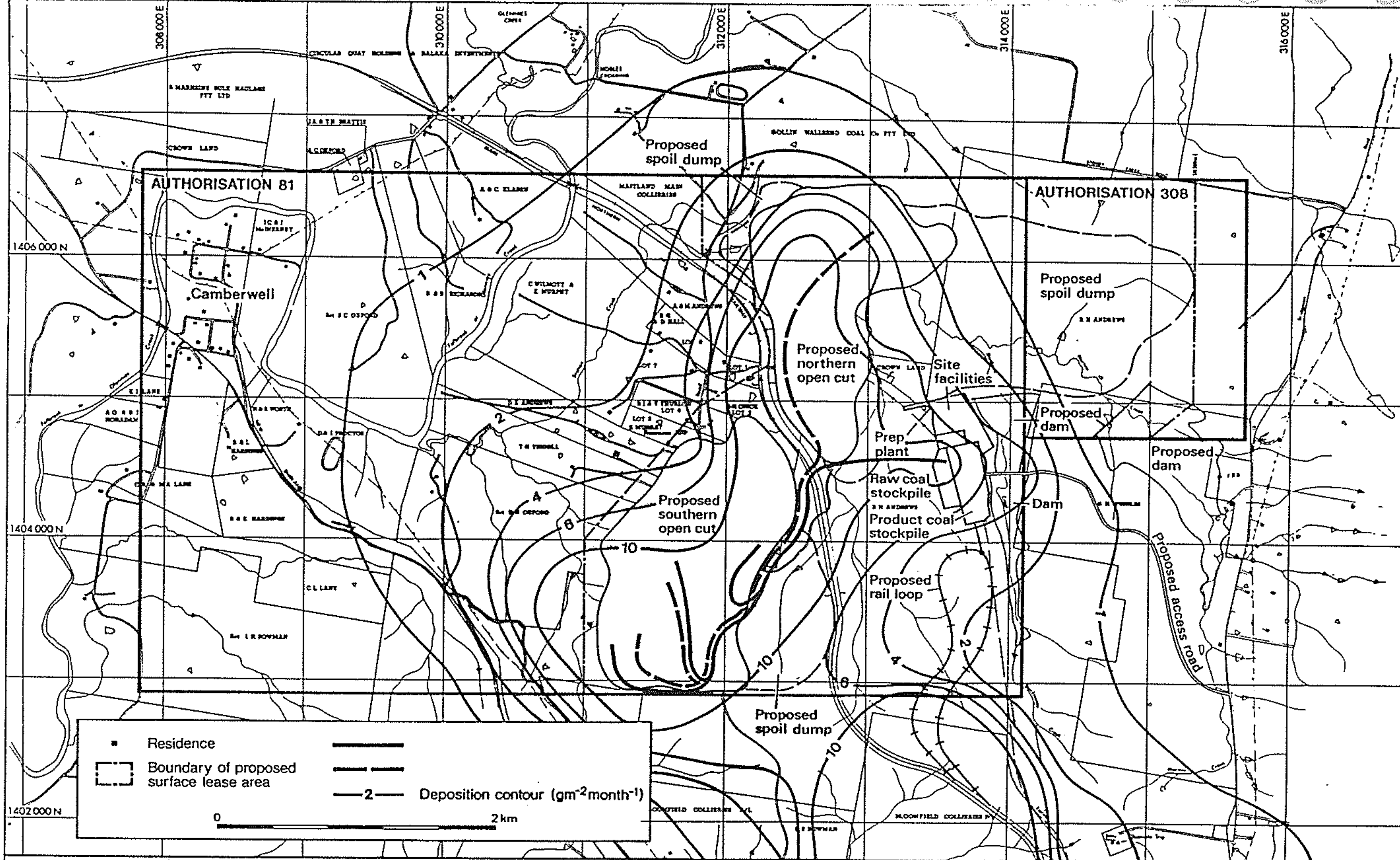


CAMBERWELL COAL PROJECT

Date October 1989

PREDICTED INCREASE IN ANNUAL AVERAGE DUST CONCENTRATION FOR YEAR 13

Prepared by
NIGEL HOLMES & ASSOCIATES
FIGURE 7.4.10

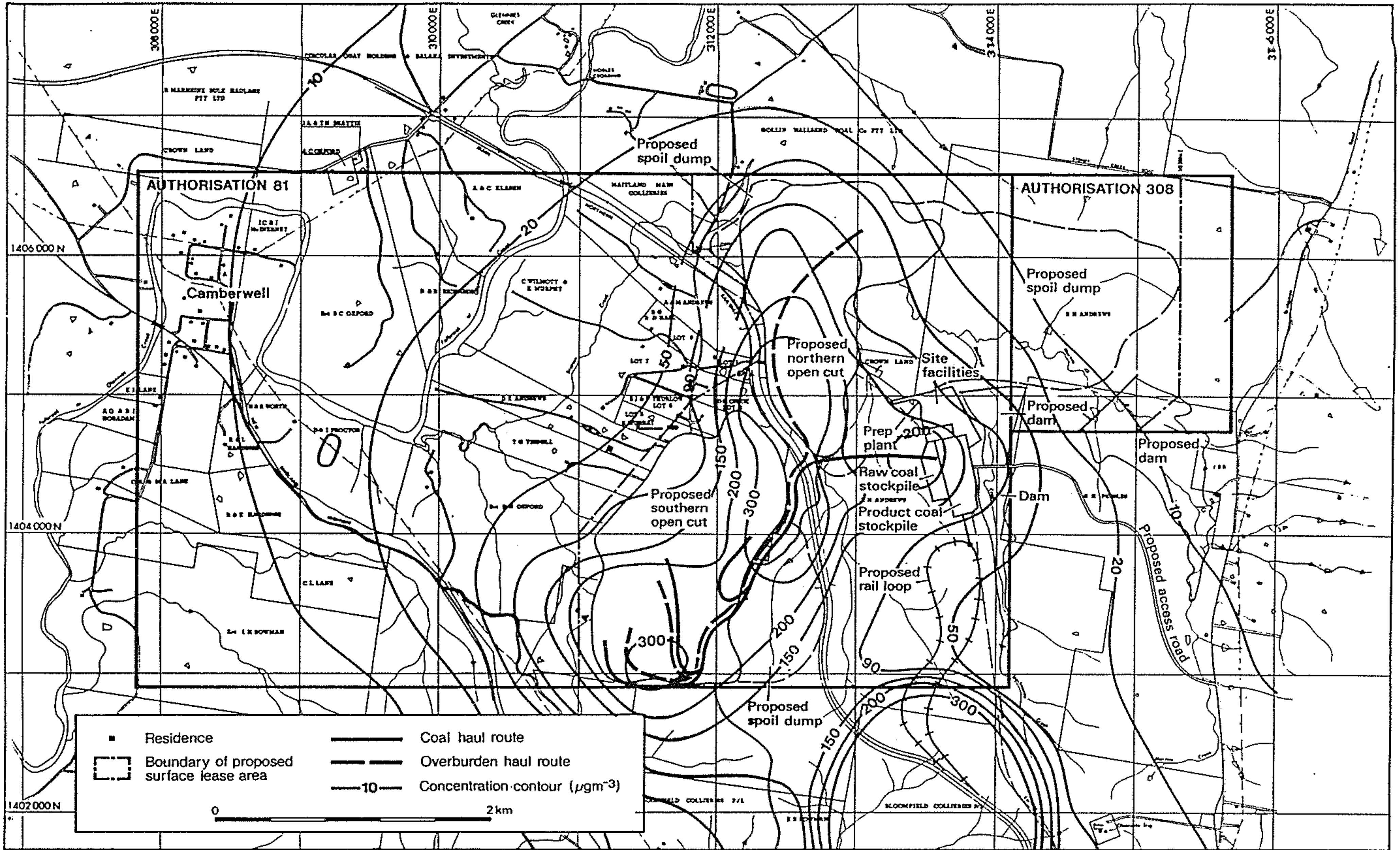


CAMBERWELL COAL PROJECT

Date October 1989

PREDICTED INCREASE IN ANNUAL AVERAGE DUST DEPOSITION FOR YEAR 10 INCLUDING THE CONTRIBUTION FROM RIX CREEK

Prepared by
NIGEL HOLMES & ASSOCIATES
FIGURE 7.4.11

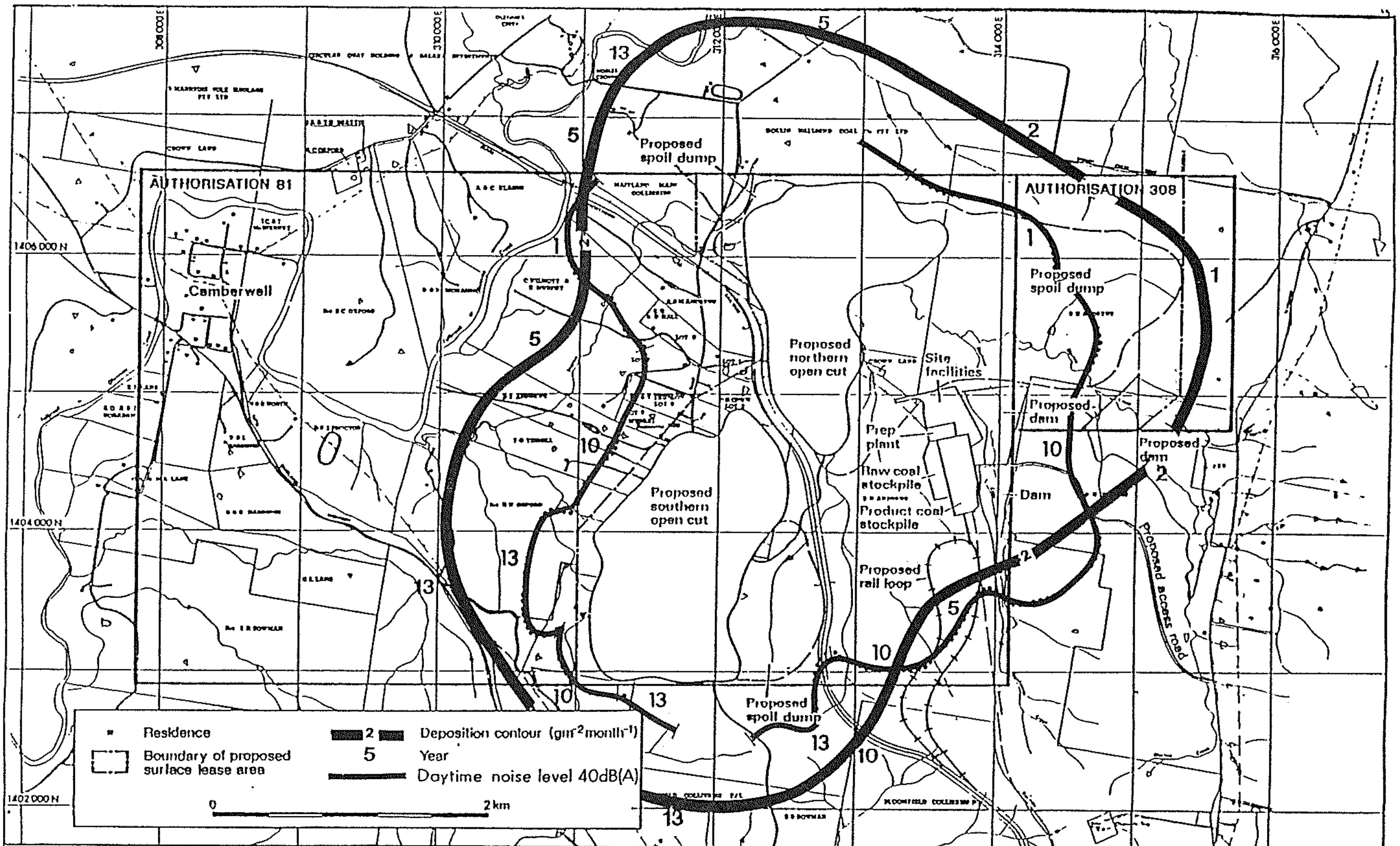


CAMBERWELL COAL PROJECT

Date October 1989

PREDICTED INCREASE IN ANNUAL AVERAGE DUST CONCENTRATION FOR YEAR 10 INCLUDING THE CONTRIBUTION FROM RIX CREEK

Prepared by
NIGEL HOLMES & ASSOCIATES
FIGURE 7.4.12



CAMBERWELL COAL PROJECT

Date Oct, 1989

Figure 7.4.13

ZONE OF AFFECTATION (NOISE/DUST LEVELS)

Prepared by NIGEL HOLMES & ASSOCIATES

In calculating the "worst-case" concentrations it has been assumed that the hourly average wind speed was 17m/s, that all mining activity has ceased and that all dust emissions are due to wind erosion from the stockpile area and exposed areas in the Mine. In calculating the dust emission it has been assumed that all the erodible material from the stockpiles and exposed areas becomes suspended and is removed during the 24-hour episode.[27]

The total emissions over the 24-hour episode from the 12.6ha product coal stockpile and 5.3ha raw coal stockpile are 7,761 and 3,264 kg respectively. The combined exposed area of the emission from the exposed areas on the North Pit and waste dump has been taken to be nominally 200ha. Thus the total dust emission over the 24-hour episode is 22,400kg. The South Pit is assumed not to be developed at this stage. The two areas were set up as area sources in AUSPLUME and predictions were made for the 24-hour average dust concentrations at the set of receptors discussed above. The estimated concentrations are summarized in Table 7.4.11.

TABLE 7.4.11

ESTIMATED DUST CONCENTRATION UNDER "WORST-CASE" EPISODIC CONDITIONS

Downwind distance (m)	Concentration (µg/m)
200	575
400	415
600	309
800	242
1000	198
1200	167
1400	143
1600	125
1800	112
2000	101
2200	92
2400	84
2600	78
2800	73
3000	68

27 Using data from the US EPA (1981) study the erosion potential of an uncrusted stockpile at 17m/s is 616kg/ha and the erosion potential from the exposed areas on the mine and waste dumps is 112kg/ha. This latter figure of 112kg/ha is the erosion potential of scoria for a wind speed of 16m/s. No figure for 17m/s is available.

Table 7.4.11 shows that the US EPA Secondary 24-hour Standard of 150μg/m^3 would be exceeded to a distance of approximately 1.4km from the stockpile area in these circumstances. Additional dust contributed from the pit would cause that concentration to rise again as the plume from the stockpiles blew over the exposed area of the pit. Concentrations are, however, estimated to have fallen below the 24-hour 150μg/m^3 concentration for locations beyond a few hundred metres from the edge of the pit.

There are no residences within the range where short-term episodic conditions would cause concentrations to rise above the 150μg/m^3 (24-hour average).

7.4.8 Health Criteria

The criteria adopted by the SPCC on the recommendations of the NH&MRC and the USEPA are the appropriate criteria to consider potential health impacts and risks.

Nigel Holmes & Associates have assessed that the Mine will have no implications for impact on public health when assessed in the context of the above standards.

As stated by Dr Thomas, (an expert witness at the Rixs Creek Inquiry who appeared for the Singleton Community Group), it is not possible to predict the effect that changes in air quality will have on any specific individual, even at generally accepted levels of dust concentration. Some people are sensitive to dust and will be affected by dust in certain wind conditions from a variety of sources including farming and mining.

The environmental controls adopted by the Camberwell Project, particularly in regard to land purchase of affected properties, will ensure that this Mine is capable of operating well within the criteria for public health risks.

7.4.9 Impact Assessment - Air Quality

Development of emissions inventories and their use with meteorological data from Glendell as inputs to the dust dispersion model DUSTGLC, have enabled estimates to be made of annual average dust deposition rates and annual average concentrations for an area 9km x 7km, with the Mine at the approximate centre.

The areas where dust concentrations or deposition could be expected to be at levels that would affect amenity have been identified by means of contour plots. Negotiations are proceeding with those landholders who own land in the affected area to either purchase land, or to reach some other mutually satisfactory compensation arrangement.

Assessment of short-term dust impacts that might occur under episodic conditions show that no adverse impacts beyond the area discussed above are expected to occur as a result of dust generation from Camberwell Mine.

7.5 ACOUSTICS

This section presents the results of acoustical investigations conducted by Richard Heggie & Associates Pty Ltd to determine the existing acoustic environment, potential noise impact on nearby premises and, where necessary, recommend the best practicable means for noise control. The blasting impact of the Project has also been assessed.

7.5.1 Existing Acoustic Environment

Noise surveys were carried out on 18 and 19 April, 1989 to establish the existing noise environment in the area of the proposed operations. Details of monitoring procedure, instrumentation and results are contained within Appendix 3.

The overall surface infrastructure associated with the Project is shown in Figure 3.1.1 and the closest residences to the proposed operations are shown in Figure 7.5.1. Background noise monitoring positions representing individual residences or residential areas are being labelled BG1, BG2, BG3 and BG4.

Positions BG3 and BG4 are adjacent to residential properties closest to the proposed mining operations. Position BG1 is adjacent to residential premises in close proximity to the Mine access road which runs off Bridgman Road and is indicative of residences east of Bridgman Road. Position BG2 is adjacent to residential premises on Middle Falbrook Road to the north of the SLA area, which was considered to approximate the Village of Camberwell. These sites were chosen to measure indicative existing background noise levels, they will not necessarily remain occupied residences throughout the life of the Project.

The minimum noise levels measured during the weekday daytime (7.00am to 10.00pm) and night-time (10.00pm to 7.00am) surveys are listed in Table 7.5.1.

TABLE 7.5.1

BACKGROUND NOISE LEVELS AT MONITORING POSITIONS

Monitoring Position	Background Noise Level (L_{90}) Day	Night
BG1	30	27
BG2	27	29
BG3	31	28
BG4	33	33

For the purposes of noise impact assessment, the SPCC Environmental Noise Control Manual states "where the existing background noise level at the receptor is less than 30dB(A), as may occur in a quiet suburban or rural area, then 30dB(A) should be assumed to be the existing background noise level".

7.5.2 Major Noise Sources from the Project

A comprehensive survey was conducted of the noise emission level from items of coal processing/surface handling plant and mobile equipment similar to those proposed for the Camberwell Project. The octave band and linear sound power levels of the major noise sources are listed in Appendix 3.A.4.

The major noise sources may be grouped into three distinct areas for the purpose of impact assessment. These are:

- mobile equipment;
- coal processing and handling plant; and
- coal transport (coal train line).

The noise level from the combined coal processing and handling plant comprised contributions from the following:

- enclosed washery/processing plant;
- coal stackers and feed conveyor; and
- primary crusher.

Noise levels for items of mobile equipment which were unable to be measured at similar open cut mining operations were individually input into the prediction program on the basis of levels obtained during previous studies.

7.5.3 Evaluation of Noise Emission Levels

Coal Processing/Surface Handling Plant and Mobile Equipment

In order to determine the acoustical impact of coal processing/surface handling plant and mobile equipment, a computer model[28] was developed incorporating all proposed noise sources, the surrounding terrain and nearby potentially affected residences.

28 The Camberwell Coal Project computer model was prepared using Road & Transport Authority (RTA) Software's Environmental Noise Model, a commercial software system developed in conjuction with the NSW SPCC. The acoustical algorithms utilised by this software have been endorsed by the Australian Environment Council and all State Pollution Authorities throughout Australia.

The model calculated the maximum contributed noise emission levels from the processing and handling plant and mobile equipment to the following receiver locations (see Figure 7.5.1):

R1 – Dulwich Homestead
R2 – Hillview (Lot 7)
R3 – Lot 6 Thurlow
R4 – Lot 7 Willmot
*R5 – Bellevue (Peebles)
R6 – Camberwell Village

* Purchased by the CCJV or under an option agreement.

These calculations were repeated for each major stage of the mining development which included Year -1 start and end, Year 1, Year 2, Year 5, Year 10, Year 13, Year 17, Year 20.

The significant noise level contributions under neutral atmospheric conditions, of all major noise sources, including the processing and handling plant but excluding coal trains, are summarised in Table 7.5.2.

TABLE 7.5.2

NOISE LEVEL CONTRIBUTIONS (dB(A))

Receiver	Contributing Noise Sources at Receivers	Year -1 start	Year -1 end	Year 1	Year 2	Year 5	Year 10	Year 13	Year 17	Year 20
R1	Trucks, loaders, scrapers, water cart	49	49	49	38	40	45	47	34	38
R2	Trucks, loaders, scrapers, drill	47	47	45	40	42	43	51	37	41
R3	Trucks, loaders, scrapers, water cart	42	43	43	38	41	50	56	39	43
R4	Trucks, loaders, scraper, drill	33	35	40	31	32	40	45	35	34
R5	Trucks, scrapers	27	31	42	27	29	30	30	29	29
R6	Trucks, loaders, drill, scrapers, water cart	23	26	27	22	22	29	27	24	24

Coal Transport

The maximum octave band and linear sound power level previously measured during the passby of a loaded coal train is presented in Appendix 3.A.4. The corresponding L_{Aeq} sound level over a 3 minute period is 54dB(A).

The noise levels[29] resulting from the coal trains and the distances from the near point of the rail line to the closest residences are shown in Table 7.5.3.

It is proposed that up to seven coal trains each with a net capacity of about 6,400t may enter and leave the proposed Mine Site each day.

TABLE 7.5.3

NOISE LEVELS FROM COAL TRAINS AT CLOSEST RESIDENCES

Receiver	Distance to Rail Line (m)	Noise Level L_{eq} (24 hours)	L_{Amax}
R1	550m	24dB(A)	46dB(A)
R2	600m	24dB(A)	46dB(A)
R3	950m	20dB(A)	42dB(A)
R4	1200m	18dB(A)	40dB(A)
R5	1800m	14dB(A)	36dB(A)
R6	1200m	18dB(A)	40dB(A)

7.5.4 Noise Impact Assessment Procedures

General Objectives

In implementing its environmental noise control policy, the SPCC has two broad objectives:

- that noise from any single source does not intrude greatly above the prevailing background noise level; and
- that the background noise level does not exceed the level appropriate for the particular locality and land use.

In order to limit the potential offensiveness of noise from a specific source, any increase in the background noise level should generally not exceed 5dB(A). For this purpose, the increase is determined as the difference between the L_{10} value at the receptor with the intrusive noise occurring and the L_{90} value determined in its absence.

The residences or existing residential areas around the proposed site potentially most affected by the noise of the proposed operations are represented by monitoring positions BG1, BG2, BG3 and BG4, as shown in the location map, Figure 7.5.1.

Design Goals for Rural Areas

In relatively undeveloped rural areas, the existing background levels can be quite low. When development is permitted to proceed in such areas (eg in view of its social worth or as a result of government decisions on resource use and infrastructure development), the land use designation may change, and there will often be a change in the noise climate.

29 Using the formula:

$$L_{Aeq}\,(24\text{ hours}) = L_{Aeq(T)} + 10\log N - 10\log \frac{24 \times 60 \times 60\text{ seconds}}{T\text{ seconds}}$$

where:

T = measured period of the train passby

L_{Aeq} (T) = measured A-weighted L_{eq} over time T seconds

N = number of train passbys/day.

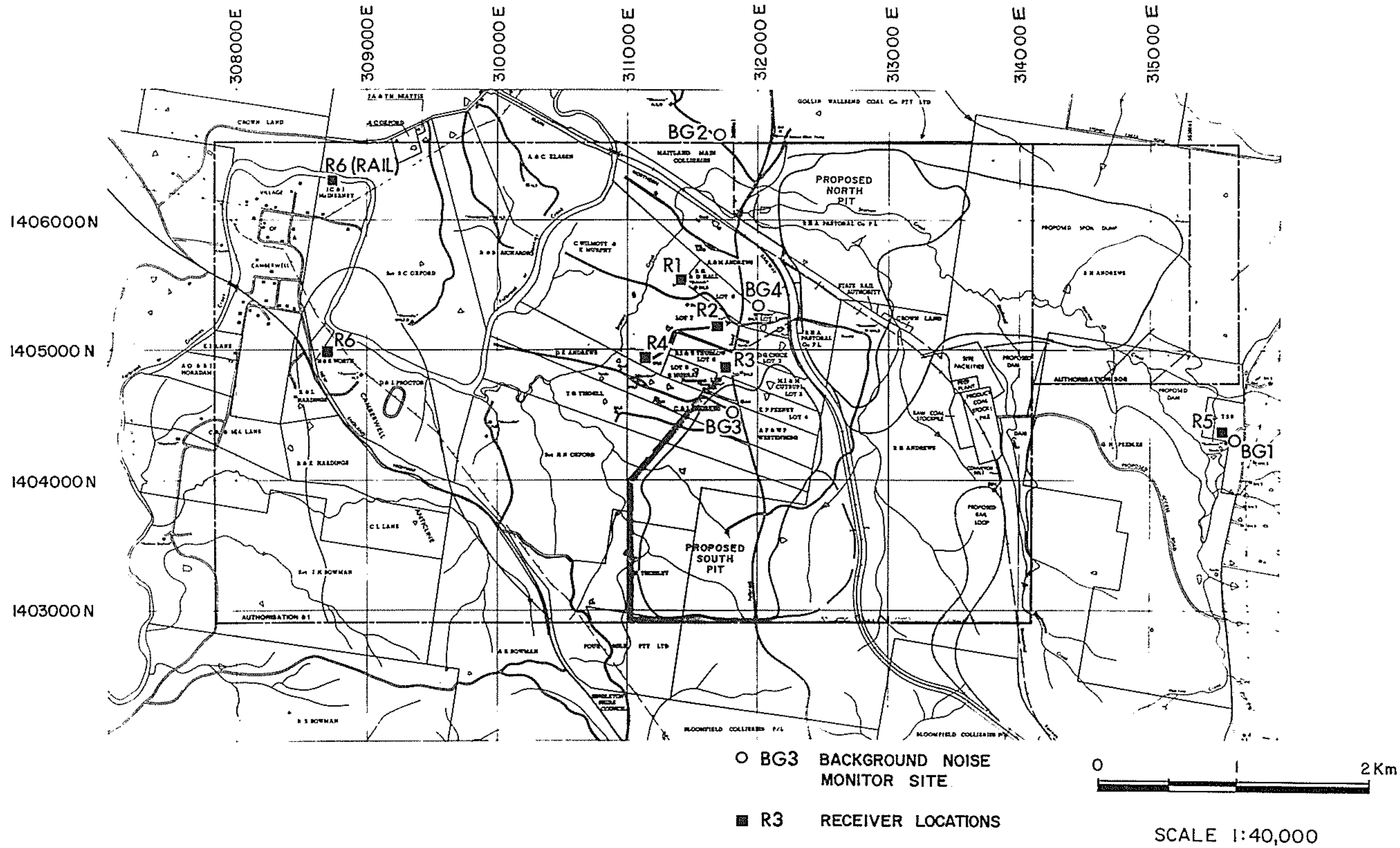


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Figure 7.5.1

BACKGROUND NOISE MONITORS & RECEIVER LOCATIONS

To assist in balancing the individual and community effects and benefits arising from such situations, the SPCC has drafted a schedule of recommended background noise levels for various land-use categories. An extract from the schedule relating to the two most stringent classifications is detailed in Table 7.5.4.

TABLE 7.5.4

RECOMMENDED OUTDOOR BACKGROUND LEVELS AT RESIDENCES

Zoning Description	Time Period*	Recommended Limit – L_{90} Acceptable	Maximum
Residences in Rural Areas	Day	45dB(A)	50dB(A)
	Night	35dB(A)	40dB(A)
Residences Near Industrial Areas	Day	50dB(A)	55dB(A)
	Night	40dB(A)	45dB(A)

*For Monday to Saturday, "day" is defined as 7.00am to 10.00pm.

The average minimum background noise levels to be used for noise impact assessment purposes, based on lowest measured levels, are 30dB(A) at all receptors during night-time operations and 35dB(A) at all receptors during daytime operations. The "Acceptable Limits" recommended by the SPCC for Residences in Rural Areas for daytime operation is 45dB(A) ("Maximum Limit" of 50dB(A)), and 35dB(A) for night-time operators ("Maximum Limit" of 40dB(A)).

The SPCC's overall objective is for background noise levels not to exceed the specified "Acceptable Limit". Where the recommended "Acceptable" level is not achievable (for technical or economic reasons), then the lowest level achievable may be permitted, provided the resultant noise levels at the receptors do not exceed the relevant "maximum" noise level limit.

Rail Traffic Noise

Noise criteria for residential receivers are recommended by the SPCC as a 24-hour L_{AeqT}[30] and as a maximum level, neither of which should be exceeded.

Planning Levels		Maximum Levels	
$L_{Aeq,24hr}$ =	55dB(A)	$L_{Aeq,24hr}$ =	60dB(A)
L_{Amax} =	80dB(A)	L_{Amax} =	85dB(A)

7.5.5 Predicted Noise Impact

The noise level contributions during full capacity operation of the proposed Mine are illustrated in contour form in Figures 7.5.2, 7.5.3 and 7.5.4. This data is tabulated in Appendix 3.A.2 which also includes corresponding design goals for assessment purposes and the exceedances of these levels.

The predicted noise level contributions from the processing plant and mobile equipment significantly exceed daytime and night-time design goals at receiver locations R1, R2, R3 and R4 on a number of occasions throughout the life of the mining operation. These levels of exceedance are due wholly to the operation of mobile equipment and range from 1dB(A) to 21dB(A).

30 Using the formula:

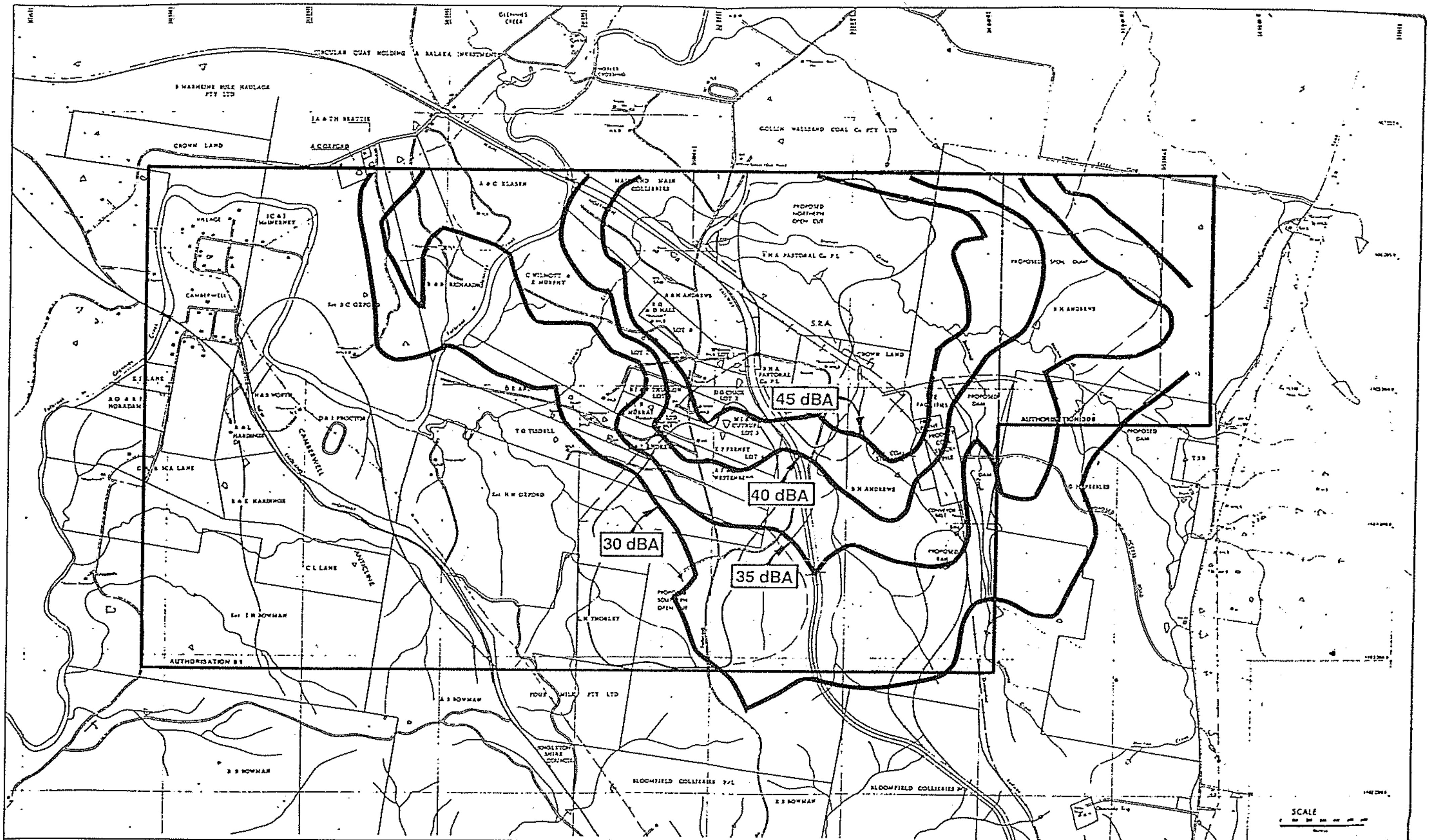
$$L_{Aeq}(24\text{ hours}) = L_{Aeq(T)} + 10\log N - 10\log \frac{24 \times 60 \times 60\text{ seconds}}{T\text{ seconds}}$$

where:

T = measured period of the train passby

L_{Aeq} (T) = measured A-weighted L_{eq} over time T seconds

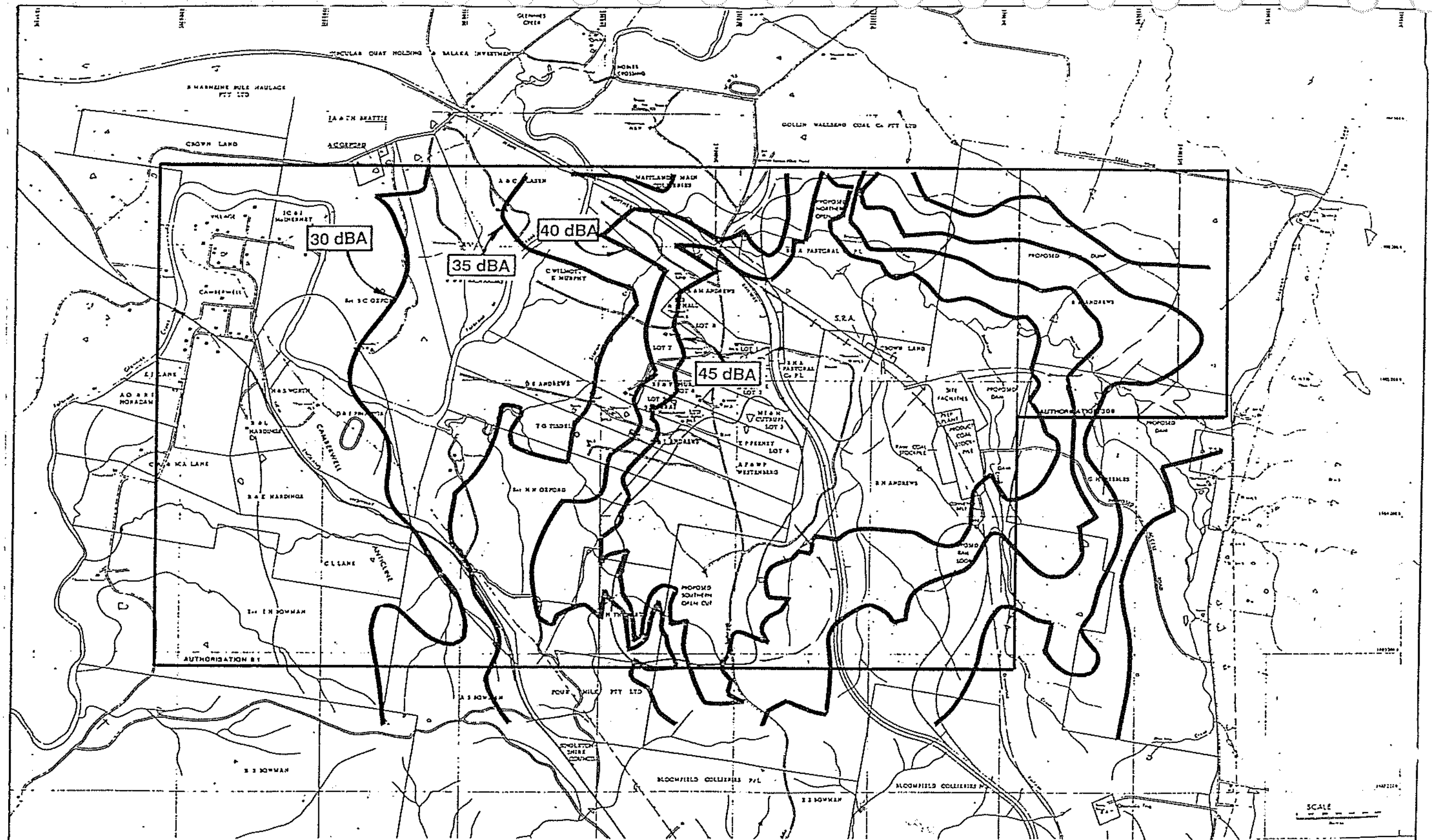
N = number of train passbys/day.



CAMBERWELL COAL PROJECT	Date	Figure 7.5.2
NOISE CONTOURS (YEAR 1 START)		

CAMBERWELL COAL PROJECT | Date | Figure 7.5.3

NOISE CONTOURS (YEAR 10)



CAMBERWELL COAL PROJECT	Date	Figure 7.5.4
NOISE CONTOURS (YEAR 13)		

The predicted noise level emissions received at position R5 exceed the daytime and night-time design goals by 2dB(A) and 7dB(A) respectively during Year 1. This exceedance is also due to the operation of the mobile equipment. At all other times, the design goals are achieved.

Figure 7.4.13 illustrates the potential *Zone of Affectation* for the life of the Project by defining the area affected by an increased dust fallout level in excess of 2gm/m^2/month and a daytime noise level in excess of 40dB(A) during some part of the mine life. The 40dB(A) contour was selected as it represents a balance of a noise level that is acceptable in the daytime but a maximum permitted level at night-time at residences in a rural area.

The noise level contributions at the receiver location R6 (Camberwell Village) clearly comply with the noise level design goals for both daytime and night-time periods of operation.

The design goals for rail traffic noise are easily achieved at all receiver locations.

7.5.6 Noise Mitigation

In order to achieve the design goals adopted for the assessment of the noise impact, reductions of the noise emissions from mobile equipment will be required.

Whilst it is possible to affect reductions of approximately 5dB(A) by creating bund walls to screen mobile equipment, greater reductions can only be achieved by increasing the distance between source and receiver or by reduction in the source noise level. This latter technique is often possible, as is the case with enclosure of fixed machinery, however it is not a feasible control measure in this instance.

The only means available whereby the coal mining operation may continue without disturbances to residences in the immediate vicinity is to purchase the affected residential properties or suitably compensate affected residents. The CCJV has adopted a policy of land acquisition as the most appropriate measure of effective noise control management.

The noise levels received at Location R5 during Year 1 may be successfully reduced by night-time dumping of waste material 500m further west of the dump location and by ensuring that dumping is kept to the lowest bench. Recalculation of the noise level received after implementation of this control measure resulted in a level of 38dB(A) at receiver R5. In Heggies recalculation, only the effect of additional distance between source and receiver was allowed for. We would expect a further loss of 3dB(A)to 5dB(A) in the received night-time level due to the additional shielding provided by the dump itself. As a result, we anticipate that both daytime and night-time design goals will be satisfied at receiver R5.

7.5.7 Blasting

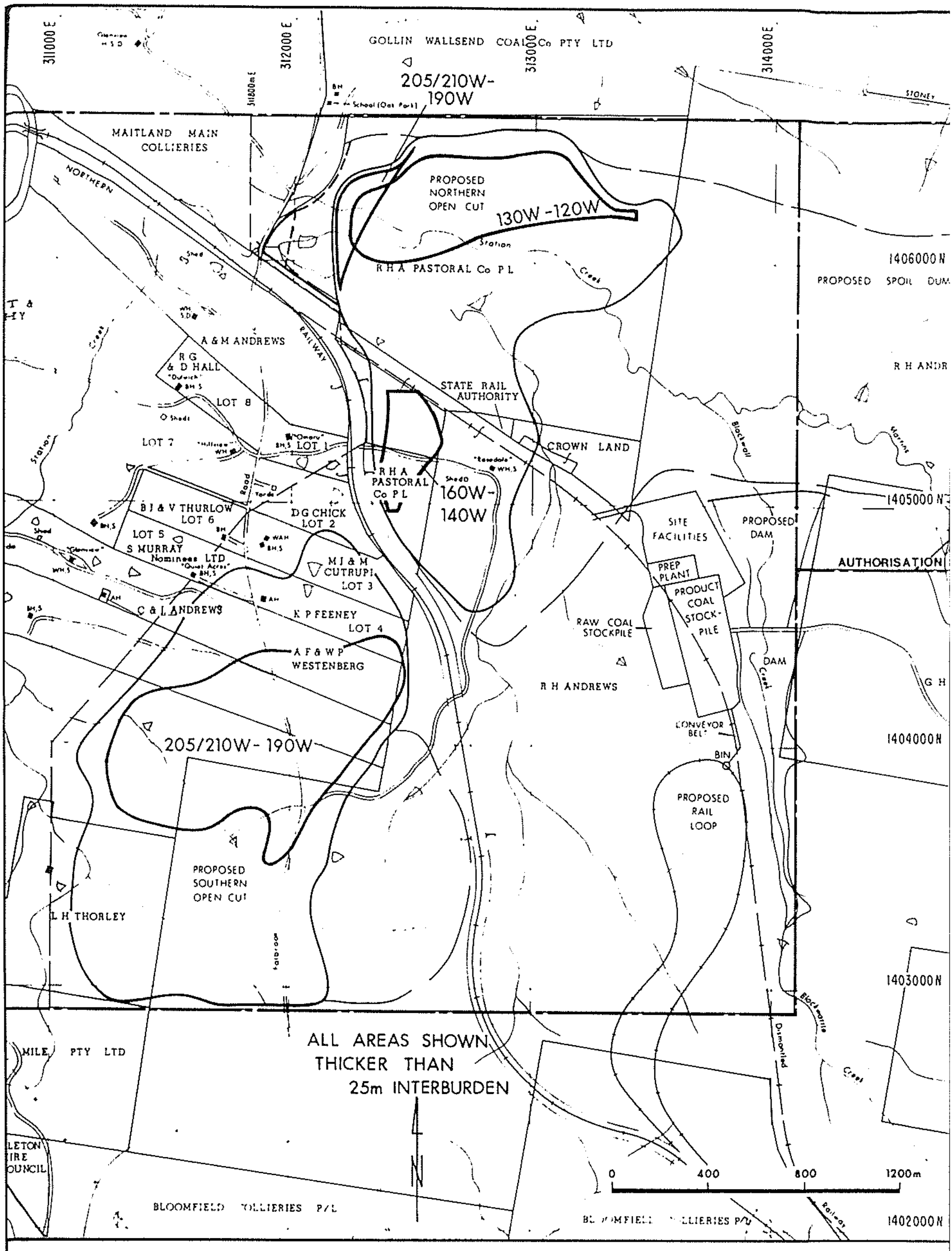
Material to be Blasted

As approximately 16% of the overburden material within the North and South Pits of the Camberwell Coal Project is less than 5m thick it can be excavated without the use of explosives. This overburden includes weathered overburden which the North Pit is 8m to 10m thick and in the South Pit 12m to 18m thick. This weathered material can be excavated by ripping with a bulldozer.

The Blasting Assessment study reviewed the preliminary blast designs for the various thicknesses of material to be removed, the current blasting criteria for human comfort and structural damage, the likely impact of the preliminary blast designs on the nearby residences and the proposed trial blast programme to establish ground vibration and airblast overpressure site laws to optimise production blast design (Appendix 4).

Predicted Levels of Blast Emission

Table 7.5.5 presents the predicted levels of ground vibration (pvs) and airblast overpressure at the nearby residences surrounding the North and South Pits of the proposed mine. The predictions are based on blasting in the North and South Pits at the near point of the pit boundary to the surrounding residences using blast design CAMBER 2 (Section 4.A.6), firing one hole per delay. Figure 7.5.5 shows predicted CAMBER 2 blast design areas within the North and South Pits.



CAMBERWELL COAL PROJECT

PREDICTED CAMBER 2 BLAST DESIGN AREAS

Date

Figure 7.5.5

TABLE 7.5.5

PREDICTED BLAST EMISSION LEVELS

Residence	Distance to Residence (m)		Predicted Blast Emission# Ground Vibration* (mm/s – pvs)		Airblast Overpressure* (dB Linear)	
	North	South	North	South	North	South
Dulwich	740	800	6.4 (8.2)	5.7 (7.3)	119 (120)	118 (119)
Hillview	560	500	10.0(12.9)	12.0 (15.4)	122 (123)	123 (124)
Willmott	1,190	530	3.0 (3.9)	11.0 (14.1)	114 (115)	122 (123)
Tisdell	1,520	500	2.0 (2.6)	12.0 (15.4)	111 (112)	123 (124)
Bellevue	2,650	3,000	0.8 (1.1)	0.7 (0.9)	105 (107)	104 (105)
Camberwell	3,700	2,900	0.5 (0.6)	0.7 (0.9)	102 (103)	102 (103)

* Figures in brackets are for wet holes using Powergel.
# Figures account for 25m benches at the pit perimeter where this will occur, see Figure 7.5.5.

Blasting Impact

The use of blast design CAMBER 2 in the North Pit is predicted to result in exceedances of the SPCC's recommended "design" comfort criterion for ground vibration (5mm/s pvs) at Dulwich and at Hillview by 2.4mm/s and 5.0mm/s respectively for dry blast holes when ANFO can be used, based on ICI's prediction formula.

If wet holes are encountered when blasting in 25m benches using CAMBER 2 design and Powergel is required, the predicted exceedances at Dulwich and Hillview are 3.2mm/s and 7.9mm/s respectively; predicted levels 8.2mm/s and 12.9mm/s pvs. The predicted levels of ground vibration resulting from blasting in the North Pit for dry blast holes comply with the upper human comfort limit recommended by the SPCC (10mm/s pvs for 5% of the total number of blasts) at all surrounding residences. However, this limit would be exceeded at Hillview by 2.9mm/s pvs if wet blastholes are encountered.

The predicted level of ground vibration at the Dulwich, Hillview, Willmott and Tisdell residences resulting from blasting 25m benches with dry blast holes in the South Pit exceed the recommended "design" comfort criterion (5mm/s pvs) by 0.7mm/s, 7.0mm/s, 6.0mm/s and 7.0mm/s respectively. For wet blast holes the corresponding exceedances are 2.3mm/s, 10.4mm/s, 9.1mm/s and 10.4mm/s.

The recommended upper limited of 10mm/s is exceeded at Hillview (by 5.4mm/s), at Willmott's (by 4.1mm/s) and at Tisdell's (by 5.4mm/s).

The predicted levels of air blast overpressure, using the ICI formula, firing dry holes in 25m benches in the North Pit exceed the SPCC's recommended "design" comfort criterion of 115dB Linear at Dulwich and Hillview by 4dB and 7dB respectively and for wet holes by 5dB and 8dB. Compliance is met at all other residences.

The predicted levels comply with the recommended limit of 120dB Linear allowable for 5% of the total number of blasts at all residences except for Hillview where there are exceedences of 2dB and 3dB for dry and wet holes respectively.

Corresponding, blasting dry holes in the South Pit is predicted to result in exceeding the "design" criterion at Dulwich, Hillview, Willmott and Tisdell by 3dB, 8dB, 7dB and 8dB respectively; the upper limit criterion is also exceeded at Hillview by 1dB, Willmott (by 2dB) and Tisdell (by 3dB).

The use of wet holes in the South Pit is predicted to result in exceedances of the design criterion at Dulwich, Hillview, Willmott and Tisdell by 4dB, 9dB, 8dB and 9dB respectively with exceedance of the upper limit of 120dB Linear at Hillview, Willmott and Tisdell by 4dB, 3dB and 4dB respectively.

The ICI formula on which the above comfort criteria exceedances are based, are very conservative and it is anticipated that the site specific prediction formulae established during the proposed trial blasting programme will predict much lower levels of ground vibration and airblast overpressure once the blast design is optimised.

The use of blast design CAMBER 2 and 25m benches will be required for only a small percentage of the time throughout the life of the Mine and would therefore rarely exceed the SPCC's upper limit criterion of 10mm/s pvs for ground vibration and 120dB Linear for airblast overpressure.

It is therefore anticipated that the SPCC's recommended comfort criteria for ground vibration and airblast overpressure can be met for the majority of production blasting under all but adverse weather conditions.

Under moderately high wind, low cloud cover or temperature inversion conditions, the levels of airblast overpressure could increase. It is therefore proposed that, where practical, a number of faces be drilled in advance of their requirement to be fired to avoid necessary firing under adverse weather conditions. Also, blasting will be conducted between 11.00am and 1pm, where possible, when the existence of a temperature inversion is least likely.

The predicted "worst case" levels of airblast overpressure are well below the recommended damage criterion of 132dB Linear. However, the predicted ground vibration levels at Dulwich, a National Trust listed property, exceed the damage criterion of 2mm/s for historic buildings as in AS 2187 by up to 5.3mm/s. This exceedance is not great however, and any contribution to damage in the property would be quite minor, and unlikely to lead to progressive deterioration.

The damage criteria in AS 2187 for residential buildings (10mm/s) is also exceeded at Hillview, Willmott and Tisdell by 5.4mm/s, 4.2mm/s and 5.4mm/s respectively.

A thorough inspection will be made of the closest surrounding residences that remain occupied and reports will be drawn up on their condition prior to any blasting. Also, a rigorous blast emission monitoring programme will be implemented, particularly at Dulwich and the closest residence to the blasting at any one time. Initial blasting in mining areas furthest from Dulwich provides time to modify techniques and blast patterns to minimise any adverse effect to the house.

The blast emission levels at the closest residences may sometimes be both felt and heard when blasting in the higher benches, particularly if blasting has to be conducted under adverse weather conditions. With blast design optimisation via the trial blasting programme, the CCJV's land acquisition policy for properties in the *Zone of Affectation* and close monitoring of the blasting operations, it is not expected that there will be disturbance to nearby occupied residences or any significant damage to structures.

7.5.8 Impact Assessment

Acoustics

Noise levels emitted by the proposed coal mining and processing operations significantly exceed recommended design goals at residences in close proximity to the open cut pits and waste dumps due to the operation of mobile equipment. In order to carry out mining activities without creating an adverse impact to the surrounding neighbourhood, acquisition of affected properties is necessary. Compensation may be considered as an alternative option where landowners prefer to remain on their properties. Calculations show that recommended design goals will be achieved at residences east of Bridgman Road and within the Village of Camberwell.

The activity of coal trains will not adversely affect the acoustic amenity of nearby residents and noise emission levels clearly comply with the SPCC's guidelines.

Blasting

The inherently conservative ICI blast emission formulae predict levels of ground vibration and airblast overpressure in excess of the SPCC's comfort criteria at some of the nearby residences when blasting the highest benches (approximately 25m) in the North and South Pits, closest to these surrounding residences.

Exceedances of the damage criteria recommended in AS 2187 by ground vibration levels is also predicted using the ICI formula. In practice however, the blast emission levels will be likely to be lower than those predicted by the ICI formula, and it is proposed to minimise any potential adverse effects of blasting by optimising blast design during a period of trial blasting.

There will be an ongoing monitoring programme for ground vibration and airblast overpressure and where necessary nearby residences will be inspected, and their condition referred to a pre-blast survey and monitored for structural damage.

This assessment of blasting has been conducted using the "worst case" situation of blasting 25m benches at the near point of the extraction boundary to the residences, however benches this deep occur in only a small proportion of the extraction area and most benches will generally be less than 10m high. If the trial blast programme shows it to be necessary, the higher benches in critical locations could be fired in stages.

The effects from blasting in the North and South Pits will be felt and heard at the closest residences only when high benches are being blasted in close proximity, and at more distant residences only during adverse weather conditions. These occurrences will be minimised by drilling faces in advance and only firing certain faces when conditions are favourable.

The blast emissions associated with the proposed Camberwell Project are likely to have minimal adverse effect on the surrounding residences and then only for a relatively short time when blasting high (20m to 25m) benches at the near point of the extraction boundary to individual residences.

7.6 VEGETATION

A vegetation survey of the Project area was conducted by T.J. Fatchen & Associates over three days in July 1985, in conjunction with the fauna survey (T.J. Fatchen & Associates, 1985).

In common with most of the coal producing areas of the middle Hunter Valley, Authorisations 81 and 308 at Camberwell have a long history of clearing and agricultural or pastoral land use which has resulted in considerable modification of remaining native vegetation and faunal habitat.

Figure 7.6.1 shows the distribution of vegetation in the Authorisations. The bulk of the area has been cleared for pasture with irrigation on the Glennies Creek floodplain. Clearing has resulted either in grassland devoid of trees, or in an artificially induced open woodland with scattered mature trees (cover 5%) remaining. There are, however, considerable cleared areas on the poorer soils which through a reduction in domestic grazing pressure now show major tree regeneration.

Woodland of narrow-leaved grey ironbark, spotted gum and grey box are present on higher ground, largely in the southern portion of the area. These woodlands have also been modified depending on land use. Areas released from grazing display active and strong regeneration of tree species, although the woodland plant communities as a whole can be considered floristically depauperate. Fringing woodland of swamp oak persists in a discontinuous band along Station and Blackwall Creeks, but the original river oak fringing woodland along the perennial Glennies Creek has been much reduced in area and greatly modified by the incursion of alien species.

Eucalypt woodlands are present on the higher and steeper terrain in the southwestern part of Authorisation 81, with another area of woodland about Middle Falbrook Road in the centre of the Authorisation and extending onto the area of the southern open-cut operation. Casuarina fringing woodlands are found along the subsidiary drainage of Station and Blackwall Creeks, and partially along the course of Glennies Creek.

Species recorded in the vegetation mapping units are given in Table 7.6.1. None of the species on the threatened lists of Leigh et al. (1981) are present, however the maidenhair fern (Adiantum aethiopicum) is protected under the National Parks and Wildlife Act 1974.

A high proportion of alien species shown in Table 7.6.1 is indicative of the extent to which land alteration has taken place.

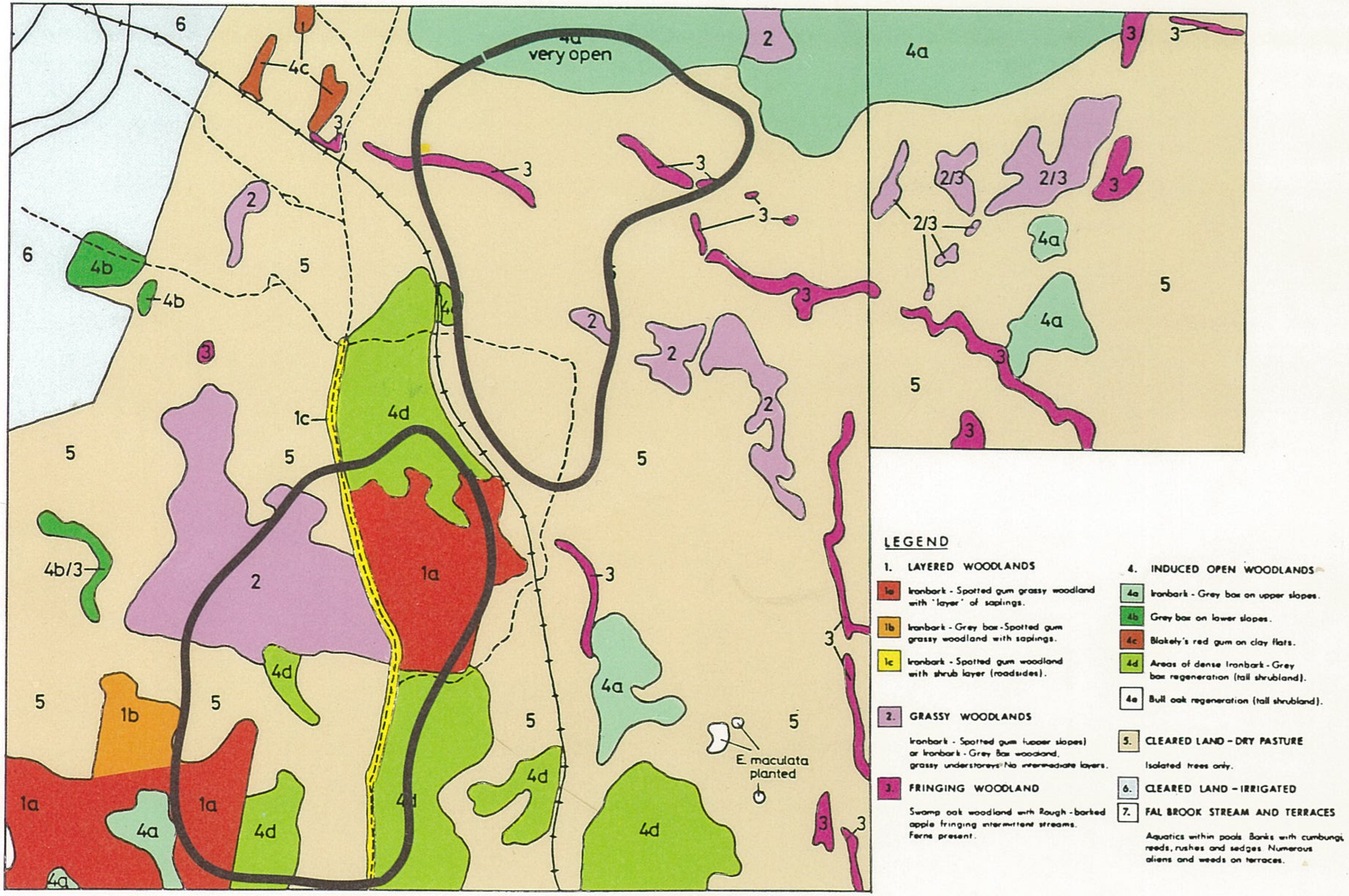


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Figure 7.6.1

VEGETATION TYPES

7.6.1 Woodland

Most of the areas shown as woodland are remnant vegetation only in the sense that some of the major species originally present have persisted despite European land use. The plant communities reflect past land use and vegetation alteration rather than resembling a pre-settlement state ie they are not relict communities.

Recognising the importance of vegetation structure in determining animal, especially bird habitat, woodlands have been classified as layered woodland, grassy woodland (both with eucalypts as the main tree species) and fringing woodland on drainage lines (with Casuarina spp. as the main species).

Layered woodlands *(Mapping unit 1)* have an intermediate shrub layer with a grassy ground cover. Tree height and cover are in the ranges 15-20m and 15%-25% respectively. Trees are generally mature and hence can probably be regarded as remnants rather than secondary growth. The following three variants have been mapped.

1a. On the shallower soils of crests and upper slopes, narrow-leaved red ironbark ("ironbark", eucalyptus crebra) and spotted gum (E. Maculata) are the main trees. Grey box (E. Moluccana) is frequently present, and a few individuals of forest red gum (E. Tereticornis) have been noted. The intermediate layer is provided by saplings of ironbark and spotted gum. Height and cover of this intermediate layer varies from place to place, in response to differences in past land management. Height is generally between 2 and 4 m, with cover as high as 40% in places.Some western silver wattle (Acacia decora) is also present. Ground cover is grass, particularly aristida, danthonia, stipa and themeda spp. Mat-rushes (Lomandra spp.), rock fern (Cheilanthes sieberi) and dianella laevis are locally common in this grassy layer.

1b. Grey box becomes more important on lower slopes with deeper soils, joining ironbark and spotted gum as a major tree species. Apart from a higher contribution of grey box saplings in the intermediate layer, the unit is otherwise similar to 1a.

1c. The third variant is confined to roadsides, largely along Middle Falbrook Road. Tree species are identical to 1a and 1b but as well as some sapling development, there is a more diverse shrub component. Calytrix tetragona, blackthorn (Bursaria spinosa), native cherry (Exocarpos cupressiformis), drooping sheoak (Casuarina stricta) and myoporum montanum are present, if sparse. Other species are indicated in Table 7.6.1. The greater development of shrubs on roadsides is probably a joint function of limited grazing and absence of burning or other clearing operations.

Grassy woodlands *(Unit 2)*, of ironbark-spotted gum on upper slopes and ironbark-grey box on lower slopes, are mapped for areas where grazing pressure has prevented the development of a sapling layer. The ground cover is almost entirely grassy, with an assortment of both native and introduced species (Table 7.6.1). Cottonbush (Maireana microphylla) is sparsely present in some areas.

Fringing woodland *(Unit 3)* of swamp oak (Casuarina glauca) is found on the intermittent streams of Station and Blackwall Creeks, with some outliers on upslope drainage. Interspersed with the swamp oak are scattered individuals of rough-barked apple (Angophora floribunda).

The woodland is present as a very narrow band of timber. Tree heights reach 15m along stream courses, and cover may be as high as 80% in places, hence much could be regarded as forest formation rather than woodland. The band is not completely continuous, however.

There is very little cover under the trees themselves. Maidenhair and necklace ferns (Adiantum aethiopicum, asplenium flabellifolium) are present but sparse. Stream beds and levees carry a mixture of grasses and sedges such as three-awns (Aristida spp.), red-leg grass (Bothriochloa macra), couch (Cynodon dactylon), plume grass (Dichelachne micrantha), with rushes and sedges juncus, eleocharis and gahnia spp. (Table 7.6.1). Small areas of reed (Phragmites australis) are present, although usually better developed around dams.

Only patches remain of the river oak woodlands (Casuarina cunninghamiana) which once would have fringed the course of Glennies Creek. The fringing woodland now includes willow (Salix spp.), with an understorey dominated by alien herbs and grasses (Table 7.6.1)

7.6.2 Induced Open Woodland and Wholly Cleared Land

Unit 4: Open woodland (tree cover under 10% and over most of the area under 5%) has been created from the former forest and woodland through clearing. The original pattern of tree distribution is still evident with ironbark-grey box on upper slopes *(Unit 4a)*, grey box on deeper soils of lower slopes *(Unit 4b)* and some very small remnants of Blakely's red gum (Eucalyptus blakelyi, *Unit 4c*) on the clay flats of lower Station Creek. Pastures are grass, with red-leg grass, three-awns, couch, wallaby grasses (Danthonia spp.) and spear grasses (Stipa spp.) most common. Where there has been at least a partial release from grazing, ironbark and grey box in particular are freely regenerating *(Unit 4d)*. At the extreme, in the subdivisional area east of Middle Falbrook Road, the saplings are 3-4m tall with cover 30-40%, the mature trees being present as scattered emergent individuals. Limited areas of fan wattle (Acacia amblygona) are also present.

Regeneration on the common at Camberwell *(Unit 4e)* is 3-6m bull oak (Casuarina luehmanii) with cover up to 40% under a very open woodland of mature to senescent grey box *(Unit 1e)*.

Cleared land has been shown either as dryland pasture *(Unit 5)* or irrigated land *(Unit 6)*. The former is grassland with occasional trees and species a combination of native and alien grasses. Irrigated land is used both for cropping and pasture. Cover primarily comprises alien species including numerous undesirable species (eg skeleton weed, saffron and spear thistles). Some small plantations of spotted gum are present in grassland in the southeastern portion of the Authorisation.

7.6.3 Farm Dams and Glennies Creek

Individual farm dams *(Unit 7)* have not been shown on the map. They share with scattered pools in the minor creeks a mixture of semi-aquatic and aquatic vegetation. Swamp lily (Ottelia ovalifolia) and water ribbons (Triglochin procera) are the most obvious aquatic species, in very turbid water. Dams and pools are fringed by common reed and cumbungi (Typha orientale) with other sedges and rushes (Table 7.5.1), particularly the introduced sharp rush (Juncus acutus).

Pools within Glennies Creek have well developed aquatic vegetation, with water ribbons and pondweeds (Potamogeton spp.). Banks are lined with reed, cumbungi, sedges and rushes (Table 7.5.1) but also with numerous introduced species, particularly fennel (Foeniculum vulgare) and verbena hispida.

7.6.4 Impact Assessment - Vegetation

Open cut development itself will take place largely on cleared land, much of which is, in any case the site of past mine workings. Eucalyptus woodland east of Middle Falbrook Road will be affected either by pit or infrastructure development, and some loss of woodland and woodland habitat in the short term is anticipated. Further, there is likely to be a loss of swamp oak woodland along watercourses within the eastern part of the Authorisation.

The effect of the development will only be of local significance, given that:

- The woodlands have been highly modified by past land use (indeed much of the woodland is a direct derivative of that land use), and
- The plant communities and habitats involved are widespread in the region.

TABLE 7.6.1.
VEGETATION SPECIES LIST

FAMILY/Scientific Name	Common Name	Vegetation Unit 1	2	3	4	5	6	7	8
Pteridophytes									
ADIANTACEAE									
Adiantum aethiopicum L.	Maidenhair fern	.	.	+	.	.	.	.	+
Cheilanthes sieberi Kunze	Rock fern	+	+	.	+	+	.	.	.
ASPLENIACEAE									
Asplenium flabellifolium Cav.	Necklace fern	.	.	+	.	.	.	.	.
DENNSTAEDTIACEAE									
Pteridium esculentum (Forst. F.) Cockayne	Bracken	+	.	.	+	.	.	.	+
Angiosperms – Monocotyledons									
CYPERACEAE									
Eleocharis acuta R.Br.		.	.	.	.	.	+	+	+
Eleocharis sp.		.	.	+	.	.	+	+	+
Gahnia aspera (R.Br.) Spreng.		.	.	+	.	.	.	+	+
HYDROCHARITACEAE									
Ottelia ovalifolia (R.Br.) L.C. Rich	Swamp lily	.	.	.	.	.	.	+	.
JUNCACEAE									
* juncus acutus L.	Sharp rush	.	.	+	.	.	+	+	.
Juncus sp.		.	.	.	.	.	.	.	+
Juncus usitatus L.A.S. Johnson	Common rush	.	.	.	.	.	+	+	+
JUNCAGINACEAE									
Triglochin procera R.Br.	Water ribbons	.	.	.	.	.	.	+	.
LILIACEAE									
Dianella laevis R.Br.		+	.	+	+	+	.	.	.
POACEAE									
Agropyron scabrum (Labill.) Beauv.	Common wheat grass	+	+	.	+	+	.	.	.
Agrostis avenacea gmel.	Blown grass	+	+	.	+	+	.	.	.
Aristida sp.		+	+	+	.	.	.	.	.
Aristida vagans cav.	Three-awn		+	+	+	+	+	.	.
Bothriochloa macra (Steud.) S.T. Blake	Red-leg grass	+	+	+	+	+	+	.	+
* Bromus unioloides kunth	Prairie grass	+	+	+	+	+	.	.	.
* Chloris gayana Kunth.	Rhodes grass	.	.	.	.	+	+	.	.
Cynodon dactylon (L.)Pers.	Couch	.	.	+	.	+	+	.	+
Danthonia sp.		+	+	.	+	+	.	.	.
Dichelachne micrantha (Cav.) domin	Short-haired plume grass	+	+	+	+	+	.	.	.
* Hordeum leporinum link	Barley grass	.	.	.	.	+	.	.	.
* Paspalum dilatatum Poir.	Paspalum	.	+	.	.	+	+	+	
Paspalum paspaloides (Michx.) Scribn	Water couch	.	.	+	.	.	+	.	+
* Pennisetum clandestinum hochst. Et chiov.	Kikuyu grass	.	.	.	.	.	+	.	+
Phragmites australis (Cav.) Trin.	Common reed	.	.	+	.	.	.	.	+
* Sorghum halepense (L.) Pers.	Johnson grass	.	.	.	.	.	+	.	+
sporobolus virginicus (L.) Kunth	Saltwater couch	.	.	.	.	.	.	.	+
stipa ramosissima Trin.		+	+	.	+	+	.	.	.
Stipa scabra (complex)	Rough speargrass	+	+	.	+	+	.	.	.
Stipa sp.		.	+	.	.	.	.	.	.
Stipa variabilis (complex)	Spear grass	+	+	.	+	+	.	.	.
Themeda australis (R.Br.) Stapf	Kangaroo grass	+	+	.	+	+	.	.	+

FAMILY/Scientific Name	Common Name	Vegetation Unit 1	2	3	4	5	6	7	8
POTAMOGETONACEAE									
Potamogeton pectinatus L.	Sago pondweed	.	.	.	.	.	.	+	+
Potamogeton perfoliatus L.	Clasped pondweed	.	.	.	.	.	.	.	+
TYPHACEAE									
Typha orientale presl	Cumbungi, Bullrush	.	.	.	.	.	.	+	+
XANTHORRHOEACEAE									
Lomandra longifolia labill.	Spiky mat-rush	+	.	+	+	.	.	+	+
Lomandra multiflora (R.Br.) J. Britt.		+	.	.	+	.	.	.	.
Angiosperms – dicotyledons									
AIZOACEAE									
* galenia secunda (L.f.) Sond.	Galenia	.	.	.	.	.	.	.	+
ANACARDIACEAE									
* Schinus molle L.	Pepper tree	.	.	.	.	+	+	.	+
APIACEAE									
* Foeniculum vulgare mill.	Fennel	.	.	.	.	.	.	.	+
* Hydrocotyle bonariensis Lam.	Pennywort	+	.	.	.	.	.	.	+
APOCYNACEAE									
Parsonsia straminea (R. Br.) F. Muell.		.	.	.	+	.	.	.	.
ASCLEPIADACEAE									
* Gomphocarpus fruticosus (L.)R.Br.	Swan plant	.	.	.	.	.	.	.	+
ASTERACEAE									
* Carthamus lanatus L.	Saffron thistle	+	+	.	+	+	.	.	+
* Chondrilla juncea L.	Skeleton weed	.	.	.	.	+	.	.	.
* Cirsium vulgare (Savi) Ten.	Spear thistle	.	.	.	+	+	.	.	+
* Conyza albidus willd. Ex Spreng.	Tall fleabane	+	+	+	+	+	.	.	+
* Conyza bonariensis (L.) cronquist	Flax-leaf fleabane	+	+	+	+	+	.	.	+
Cotula coronopifolia L.	Water buttons	.	.	.	.	.	.	.	+
Gnaphalium luteo-album L.	Jersey cudweed	+	.	.	+	.	.	.	.
Helichrysum apiculatum (Labill.) D. Don	Yellow buttons	+	.	.	.	.	.	.	.
Helichrysum semipapposum (Labill.) DC		.	.	.	.	+	.	.	.
Senecio glossanthus (Sond.) Belcher	Slender groundsel	.	.	.	.	.	.	.	+
Senecio lautus	Groundsel	+	+	+	+	+	.	.	.
(ASTERACEAE)									
* Senecio spp.		.	.	.	.	.	.	.	+
* Sonchus asper (L.) Hill	Milk thistle	.	.	.	.	.	+	.	+
* Taraxacum officinale Wever ex Wiggers	Dandelion	.	.	.	+	+	.	.	+
* Xanthium spinosum L	Bathurst burr	.	.	.	.	.	.	.	+
CACTACEAE									
* Opuntia stricta (Haw.) Haw.	Prickly pear	+	+	+	+	+	.	.	+
CASUARINACEAE									
Casuarina cunninghamiana miq	River oak	.	.	.	.	.	.	.	+
Casuarina glauca sieb. Ex spreng.	Swamp oak	+	.	+	.	.	.	.	.
Casuarina luehmanii R.T. Baker	Bull oak	+	.	.	+	.	.	.	
Casuarina stricta		+	.	.	.	.	.	.	.
CELASTRACEAE									
Maytenus silvestrus (present near study area in C. Luehmanii woodland)									
CHENOPODIACEAE									
Maireana microphylla (Moq.) P.G. Wilson	Cottonbush	.	+	.	+	+	.	.	.
CONVOLVULACEAE									
Dichondra repens Forst. et f.	Kidney weed	+	.	.	.	.	.	.	.

FAMILY/Scientific Name	Common Name	Vegetation Unit 1	2	3	4	5	6	7	8
DILLENIACEAE									
Hibbertia spp		+	.	.	.	.	.	.	.
FABACEAE									
Glycine clandestina Wendl.	Glycine pea	+	.	.	+	.	.	.	.
Hardenbergia violacea (Schneev.) Stearn		+	.	.	+	.	.	.	.
Indigofera australis var australis Willd.	Indigo	+	.	.	.	.	.	.	.
* Trifolium sp.	Trefoil	.	.	.	+	+	+	.	+
LORANTHACEAE									
Amyema miquelii (Lehm. Ex Miq.) Tiegh.	Mistletoe	+	+	+	+	.	.	.	+
MIMOSACEAE									
Acacia amblygona A. Cunn. Ex benth.	Fan wattle	+	.	.	+	.	.	.	.
Acacia decora Reichb.	Western silver wattle	+	.	.	+	+	.	.	.
MYOPORACEAE									
Myoporum montanum R.Br.		+	.	.	+	.	.	.	.
MYRTACEAE									
Angophora floribunda (Sm.) Sweet	Rough-barked apple	.	.	+	+	.	.	.	+
Calytrix tetragona labill.		+	.	.	.	.	.	.	.
Eucalyptus blakelyi Maiden	Blakely's red gum	.	.	.	+	.	.	.	.
Eucalyptus crebra F. Muell.	Narrow-leaved red ironbark	+	+	.	+	.	.	.	.
Eucalyptus maculata Hook.	Spotted gum	+	+	.	.	.	.	.	.
Eucalyptus moluccana Roxb.	Grey box	+	+	.	+	.	.	.	.
Eucalyptus tereticornis sm.	Forest red gum	+	.	.	.	.	.	.	.
ONAGRACEAE									
* Oenothera stricta Ledeb. Ex Link	Evening primrose	.	.	.	.	+	+	.	+
OXALIDACEAE									
Oxalis corniculata L.		+	.	.	.	.	.	+	+
PITTOSPORACEAE									
Bursaria spinosa cav.	Blackthorn	+	.	.	.	.	.	.	.
PLANTAGINACEAE									
Plantago varia R.Br.		.	.	.	.	.	+	.	+
POLYGONACEAE									
* Rumex spp.	Dock	.	.	.	.	.	+	.	+
ROSACEAE									
* Rosa rubiginosa L.	Sweet briar	.	.	.	+	+	.	.	+
SALICACEAE									
* Salix babylonica L.	Willow	.	.	.	.	.	.	.	+
SANTALACEAE									
Exocarpos cupressiformis labill.	Native cherry	+	.	.	.	.	.	.	.
VERBENACEAE									
* Verbena hispida Ruiz et Pav.		.	.	.	.	.	+	.	+

Vegetation units:
1. Ironbark-Spotted gum grassy woodland with layering of saplings.
2. Ironbark-Grey box (lower slopes) or ironbark-Spotted gum woodland with grassy understorey, no shrubs or saplings.
3. Swamp oak low woodland to low open-forest along local drainage.
4. Ironbark-Grey box induced open woodland over pasture. Some areas of regenerating ironbark included.
5. Grassland (cleared land)
6. Irrigated pasture, cropland (not closely examined)
7. Farm dams and surrounds
8. Glennies Creek stream and terraces.

* alien species

7.7 FAUNA

A field survey was conducted in the Project area over three days in July 1985 in conjunction with the vegetation survey. The highly altered nature of the landscape and the considerable amount of survey information already available, made the value of further survey work questionable.

The woodlands remaining on the Authorisations contribute significantly to the maintenance of bird species diversity in the district, however the avifauna is typical of similar areas in this part of the Hunter Valley. Eastern grey kangaroos are the most abundant of the native mammals as they appear to have been favoured by existing land use patterns. The remaining mammal fauna is believed not to include any animal which might preclude or otherwise limit the development. Reptiles and amphibians have not been examined in any detail, but those observed suggest again that the total fauna is unlikely to be significantly different from elsewhere in the district.

7.7.1 Birds

Forty-seven bird species were recorded during the field survey. The species, the habitats in which they were seen and an indication of relative abundance are given in Table 7.7.1. Habitat types 1-8 are largely equivalent to the vegetation mapping units described in Section 7.6.

Further species may well utilise the area in different seasons. In particular, more waterbird species could be expected to utilise the perennial stream at Glennies Creek over a complete year than Table 7.7.1 would suggest.

Nevertheless the overall view is of an assemblage of relatively common bird species normally associated with woodland and grassland, with no significant departure from those which would be expected in a much altered district. All species except the Starling and House Sparrow are native.

The most common species in woodland and open woodland was the Eastern Rosella, and in grassland or very open woodland habitat, the Australian Magpie and the Starling.

For most species, however, absolute numbers were generally low. Cleared dryland pastures contributed least to bird diversity, although irrigated pasture and cropland provided feeding habitat for some waterbirds and waders which would otherwise not be present within the Authorisation area. The wooded areas provided habitat for the majority of species. Habitat 3, dense swamp oak along secondary creeks, contained some of the smaller passerines which were poorly represented in or absent from other habitats. Welcome Swallows utilised abandoned mine adits on the Rosedale property as nesting sites.

Three Wedge-tailed Eagles were seen during the survey. Comments from local residents suggest that there is only one group which visits the Authorisation area and that nesting sites are northeast of the Authorisation, not within it.

7.7.2 Mammals

Mammal species known to be present in the Authorisation area are listed in Table 7.7.2. The most evident native mammal is the Eastern Grey Kangaroo. Between the New England Highway and the railway line, (some 6km along Middle Falbrook Road), dawn and dusk counts returned between 11 and 16 individuals usually within 0.5km of layered woodland (mapping unit 1) and approximately half on and half immediately south of, the Authorisation area. Residents report that up to 30 individuals have been seen in the northeast corner of the Authorisation, where it abuts a dense bull oak woodland along Stoney Creek. There appears to be two resident populations on or near the Authorisation, associated with layered or dense woodland. A large population[31] inhabits the southern part and adjoining wooded land, and a smaller population is resident outside the north-east part of the Authorisation but ranges onto it from time to time.

31 Of the order 100-200 given the limited area actually sampled and the extent of the woodlands to the south of the Authorisation.

TABLE 7.7.1.

BIRD SPECIES

Common Name	Scientific Name	Habitats 1	2	3	4	5	6	7	8	9	10	Relative Abundance
Hoary-headed Grebe	Poliocephalus poliocephalus	.	.	.	.	.	.	x	x	.	.	R
Little Pied Cormorant	Phalacrocorax melanoleucos	.	.	.	.	.	.	.	x	x	.	R
White-necked Heron	Ardea pacifica	.	.	.	.	.	x	.	.	.	.	R
White-faced Heron	Ardea novaehollandiae	.	.	.	.	.	x	x	x	.	.	R
Straw-necked Ibis	Threskiornis spinicollis	.	.	.	.	.	x	.	x	.	.	MC
Royal Spoonbill	Platalea regia	.	.	.	.	.	.	x	.	.	.	R
Black Duck	Anas superciliosa	.	.	.	.	.	.	x	x	.	.	MC
Grey Teal	Anas gibberifrons	.	.	.	.	.	.	.	x	.	.	R
Wood-duck	Chenonetta jubata	.	.	.	.	.	x	x	.	.	.	MC
Wedge-tailed Eagle	Aquila audax.	.	.	.	.	.	.	.	x	.		R
Nankeen Kestrel	Falco cenchroides	.	.	.	.	x	.	.	.	.	.	R
Brown Falcon	Falco berigora		.	.	.	x	.	.	.	.	.	R
Brown Quail	Coturnix australis.	.	.	.	x	.	.	.	.	.		U
Swamp Hen	Porphyrio porphyrio	.	.	.	.	.	.	.	x	.	.	R
Masked Lapwing	Vanellus miles	.	.	.	.	x	.	.	.	.	.	R
Coot	Fulica atra	.	.	.	.	.	.	.	x	.	.	R
Crested Pigeon	Ocyphaps lophotes	.	.	.	x	x	.	.	.	.	.	MC
Sulphur-crested Cockatoo	Cacatua galerita	.	.	.	x	.	.	.	.	.	.	R
Eastern Rosella	Platycercus eximius	x	x	.	x	.	.	.	.	.	.	VC
Red-rumped Parrot	Psephotus haematonotus	.	.	.	x	.	.	.	.	.	.	R
Pallid Cuckoo	Cuculus pallidus	x	.	.	x	.	.	.	.	.	.	U
Boobook Owl	Ninox novaeseelandiae	.	x	.	.	.	.	.	.	.	.	R
Laughing Kookaburra	Dacelo novaeguineae	x	x	.	x	x	.	.	.	.	.	MC
Sacred Kingfisher	Halcyon sancta	.	.	.	x	.	.	.	.	.	.	R
Welcome Swallow	Hirundo neoxena	.	.	.	x	x	.	.	.	.	x	MC
Richards Pipit	Anthus novaeseelandiae	x	x	.	x	x	.	.	.	.	.	MC
Black-faced Cuckoo-shrike	Coracina novaehollandiae	x	.	.	x	.	.	.	.	.	.	U

Common Name	Scientific Name	Habitats 1	2	3	4	5	6	7	8	9	10	Relative Abundance
Little Grassbird	Megalurus gramineus	.	.	x	.	.	.	.	.	.	.	U
Brown Songlark	Cincloramphus cruralis	.	.	.	x	x	.	.	.	.	.	MC
Weebill	Smicrornis brevirostris	x	.	x	x	.	.	.	.	.	.	C-VC
Yellow-rumped Thornbill	Acanthizia chryssorhoa	x	.	x	.	.	.	.	.	.	.	VC
Yellow Thornbill	Acanthizia nana	.	.	x	.	.	.	.	.	.	.	MC
Speckled Warbler	Sericornis sagittata	x	.	x	x	x	.	.	.	.	.	MC
Grey Fantail	Rhipidura fuliginosa	x	.	x	.	.	.	.	.	.	.	U
Willie Wagtail	Rhipidura leucophrys	x	.	x	x	x	.	.	.	.	.	U
Restless Flycatcher	Myagra inquieta	x	.	x	.	.	.	.	.	.	.	U
Rufous Whistler	Pachycephalax rufiventris	.	.	x	.	.	.	.	.	.		MC
Varied Sitella	Daphoenositta chrysoptera	x	.	.	.	.	.	.	.	.	.	U
Noisy Miner	Manorina melanocephala	x	x	x	x	x	.	.	.	.	.	C
House Sparrow	Passer domesticus	.	.	.	.	.	x	.	.	.	x	U
Australian Raven	Corvus coronoides	.	x	.	x	x	x	.	.	.	.	MC
Starling	Sturnus vulgaris	.	.	.	.	x	x	.	.	.	.	VC
Australian Magpie-lark	Grallina cyanoleuca	.	x	.	x	x	x	.	.	.	.	MC
White-winged Chough	Corcorax melanoramphos	x	x	.	x	.	.	.	.	.	.	U
Pied Butcherbird	Cracticus nigrogularis	x	x	.	x	.	.	.	.	.	.	MC
Grey Butcherbird	Cracticus torquatus	.	x	.	x	.	.	.	.	.	.	U
Australian Magpie	Gymnorhina tibicen.	x	.	x	x	x	.	.	.	.		VC

Habitats:
1. Ironbark-Spotted gum woodland with understorey of immature eucalypts.
2. Ironbark-Grey box and Ironbark-Spotted gum woodlandwith grassy understorey, no shrubs or immature trees.
3. Low woodland to low open-forest of Casuarina glaucaalong drainage (dense cover)
4. Ironbark-Grey box induced open woodland over pasture, including some areas of regenerating ironbark.
5. Grassland: cleared land, dryland pasture
6. Irrigated pasture, cropland.
7. Farm dams and surrounds
8. Major stream and surrounds
9. Overhead (not assignable to specific habitats withinstudy area)
10. Buildings, mineshafts.

Relative abundances:

VC	very common	groups seen frequently every day
C	Common	groups seen every day
MC	Moderately common	Several observations during study
U	Uncommon	4-10 birds seen during study
R	Rare	No more than 3 birds seen seen during study

The clearing of pastures and subsequent regeneration of tree species has probably favoured the Eastern Grey Kangaroo, through an increase in extent and quality of grass pastures together with the maintenance or creation of resting and hiding places in the woodlands.

Other species seen were largely alien. Rabbits are numerous about old mine workings on Rosedale but apparently not frequent elsewhere. Hares were seen in grassland. One Common Brushtail was observed in the proposed open cut area but residents have indicated that the species is not common in the Authorisation area.

Residents report very infrequent incursions by Dingoes (rather than feral dogs).

The bull oak stands along Stoney Creek, just beyond the northeast corner of the Authorisation, appear to be much more significant as mammal habitat than any of the lands within the Authorisation. Although stocked, these stands appear little grazed by domestic stock. The cover is high (50-70%) and, unlike the relatively clear-floored woodlands on the Authorisation, there is considerable variety in ground microhabitat created by outcropping rock and fallen trees. During the survey, evidence of the Red-necked Wallaby, the Wombat and Echidna were noted. The habitat here also matches that elsewhere in the district in which the Yellow-footed Antechinus has been found (Croft 1984).

7.7.3 Reptiles and Amphibians

The season and cold conditions during the survey mitigated against a comprehensive examination of the herpetofauna. Species present or likely to be present are listed in Tables 7.7.3 and 7.7.4.

The provision of numerous farm dams, and mine subsidence on the Rosedale property, may have favoured some frog species and is certainly a major factor in maintaining what appears to be, even on very limited inspection, a moderate to large population of the Long-necked Tortoise within the Authorisation area.

7.7.4 Impact Assessment - Fauna

The effect of the development will only be of local significance as the known and probable faunal assemblages are generally typical of this part of the Hunter Valley.

Nevertheless the woodlands provide maintenance of local wildlife populations in a largely cleared district, even if these populations themselves reflect the extent of landscape alteration. The loss of some of the remaining woodland, unavoidable in planning for mine development and infrastructure, will be compensated for by the development of similar woodland elsewhere in the Authorisation and on rehabilitated areas. This will avoid a further incremental loss in wildlife habitat diversity and a consequent loss in wildlife diversity.

In the case of eucalypt woodlands, most of the bird and larger terrestrial vertebrates would be displaced, but would not necessarily be able to re-establish in nearby unaffected woodlands because of the wildlife populations already resident. In the case of swamp oak fringing woodland, the habitat is only represented within the eastern part of the Authorisation.

The rehabilitation programme will include a staging process involving establishment of woodland in mined areas as well as enhancement of the woodland already existing on former cleared land at an early stage of the construction programme.

Widening of Middle Falbrook Road, will result in the virtual elimination of mature representatives of shrub species which have all but vanished from the woodlands on private grazed land. Use of these species in the rehabilitation programme will ensure that the species do not disappear from the area irreparably.

TABLE 7.7.2

MAMMAL SPECIES‡

Common Name	Scientific Name	Comment
(a) Known to be present within study area		
Eastern Grey Kangaroo	Macropus Giganteus	Between 11 and 20 seen in4 consecutive dawn or duskroad surveys in study area.group of up to 30 reported to enter NE corner of study area. Very common.
Common Brushtail	Trichosurus vulpecula	One only sighted.
Unidentified Microchiropteran bat		
* Red Fox	Vulpes vulpes	
* European Hare	Lepus eruipaens	
* Rabbit	Oryctolagus cuniculus	
* House Mouse	Mus musculus	
* Black Rat	Rattus rattus	
* Cat	Felis catus	
(b) Reported within study area		
Dingo	Canis familiaris dingo	Residents indicate very occasional intrusions.
(c) Observed near study area		
Red-necked Wallaby	Macropus rufogriseus	In dense bull oak NE of study area. Uncommon.
Common Wombat	Vombatus ursinus	Hole showing recent activity in same area as preceding.
Echidna	Tachyglossus aculeatus	Diggings in same area as preceding.
(d) Potentially present in or near study area		
Water Rat	Hydromys chrysogaster	Probably present in pools of Fal Brook
Yellow-footed Antechinus	Antechinus flavipes	Expected in bull oak area NE of study area.

* alien species (domestics not included)

‡ Nomenclature follows Strahan 1983 with reference to Ride 1970

TABLE 7.7.3

REPTILE SPECIES‡

Common Name	Scientific Name		Observed Comment
(a) Reptiles observed on site			
Lace Monitor	Varanus varius	1	Residents report 2-3 in woodland, uncommon
Tree Skink	Egernia striolata	2	Probably very common
—	Morethia boulengeri	1	Probably very common
Long-necked Tortoise	Chelodina longicollis	1 + shells	Common
(b) Reptiles reported by residents, not observed			
Eastern Blue-tongued Lizard	Tiliqua scincoides		Uncommon
Red-bellied Black Snake	Pseudechis porphyriacus		Common
Eastern Brown Snake	Pseudonaja textilis		Common
Eastern Tiger Snake	Notechis scutatus		Uncommon
(c) Reptiles recorded in the district and likely to occur on site			
Eastern Water Dragon	Physignathus lesueurii		
Bearded Dragon	Amphibolurus barbatus		
Skink	Ctenotus robustus		
Red-throated Skink	Leiolopisma platynotum		
Wood Gecko	Diplodactylus vittatus		
Red-naped Snake	Furina diadema		

‡ Nomenclature follows Cogger 1983

TABLE 7.7.4

FROG SPECIES‡

Common Name	Scientific Name	Comment
(a) Observed on site		
Leseur's Frog	Litoria leseurii	Common
Verreaux's Tree Frog	Litoria verreauxii	Common (calls)
Spotted Grass Frog	Lymnodynastes tasmaniensis	Common
(b) Probably present, recorded for similar sites in the region		
Green Tree Frog	Litoria caerulea	
Dainty Green Tree Frog	Litoria gracilenta	
Dwarf Tree Frog	Litoria fallax	
Peron's Tree Frog	Litoria freycinetti	
Ornate Burrowing Frog	Lymnodynastes ornatus	

‡ Nomenclature follows Cogger 1983

7.8 HISTORICAL BACKGROUND

7.8.1 Local History

The history of the Glennies Creek – Camberwell area has been well researched and documented in Lillian M. Noble's *"The Glennies Creek Story"* (1988).

This history documents early aboriginal settlement of the area, the early history of white man's penetration into the district and describes the personalities, the rural and industrial development and the everyday life in the district from those early days through to the present.

The Glennies Creek Story encapsulates many of the elements of the country's early development and the countryside is today still closely tied to the original history and families of the early settlers. Many of the descendants of those original families are still living in the district.

The history of the Glennies Creek area is closely tied to the development of coal mining in NSW, with the first attempts to mine coal commencing in the mid 1800's and continuing through to 1921. Since that time many of the residents have maintained their connections with the coal industry by working in the mines in the surrounding districts.

7.8.2 Archaeology

A number of archaeological surveys have already been carried out in the immediate region. Table 7.8.1 compares the data from these other studies with the results of the recent survey of the Project area. (Brayshaw & Associates 1986)

Brayshaw's survey identified 31 sites and 13 isolated artefacts, of which three locations have particular archaeological interest (see Figure 7.8.1).

1. Martins Creek, towards the east of the area studied, represented by sites GCC1-15;
2. Upper Blackwall Creek (in the south east corner) notably sites GCC19 and 20; and
3. Site GCC27 on the central creek, with a large volcanic flake.

Martins Creek

In terms of their position in the landscape, these sites are typical of many other sites already subjected to salvage investigation elsewhere in the Hunter Valley. However the value of this location is the high concentration of sites in a small area. Construction of the Project's water storage system will affect many of these sites, thus necessitating further investigation prior to permits being issued and necessary salvage work commencing.

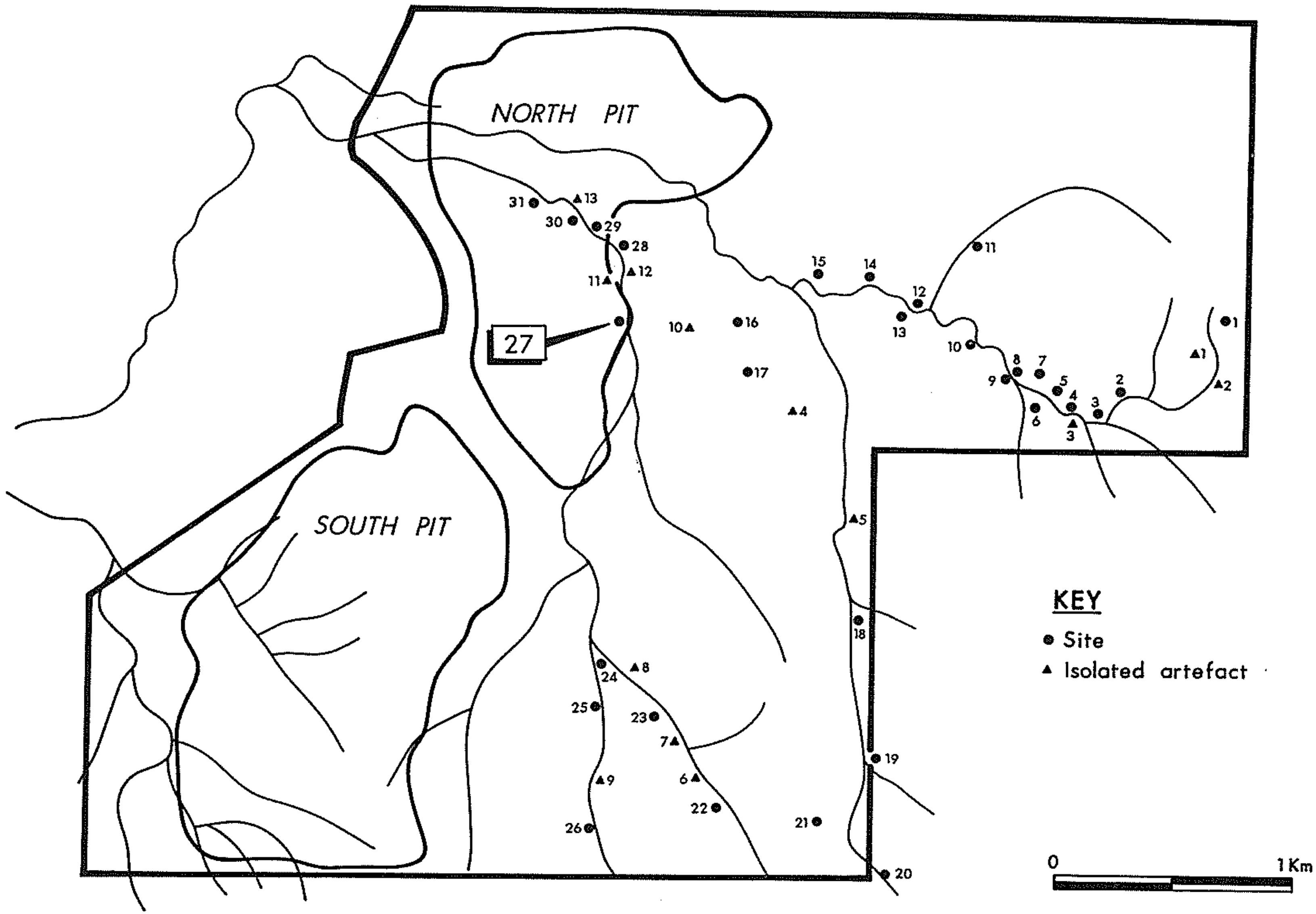
Upper Blackwall Creek

GCC19 and 20 are among the richest and most artefactually dense sites in the area studied, both with undisturbed deposit. Being situated high on the hillslope distinguishes them from other sites so far selected for salvage excavation in this area of the Hunter region. Site GCC19 is on the very edge of the area studied and GCC20 is well outside it, and therefore neither site will be affected by the development.

Site GCC27

The large volcanic flake found at this site closely resembles artefacts recently dated to the Pleistocene period. Consequently this site has a significance which will warrant further investigation prior to issuing of a permit and conducting salvage work. Figure 7.8.1 illustrates the proximity of this site to development of the proposed North Pit and hence the need to salvage the site.

The Wanaruah Local Aboriginal Land Council, representing the local Aboriginal community, have been advised about the development and the results of the survey. The assistance of the Council will be sought for any salvage work required.



CAMBERWELL COAL PROJECT | Date Sept 88 | Figure 7.8.1

ARCHAEOLOGICAL SITES

TABLE 7.8.1

ARCHAEOLOGICAL DATA

Comparison With Data From Other Studies In The Region – Excavated and Surface Assemblies

Area	No of Sites	No of Artifacts	% Indurated Mudstone	% Silcrete	% Other	Number Backed Pieces	% Modified	Number Modifed	% Total
Hunter Valley Extended *(Brayshaw 1983b)*	1	822	39	40	21	7	29	24	2.9
Ravensworth No 2 *(Brayshaw & Haglund 1984)*	19	3645	21	72	7	27	36.9	73	2
Rix's Creek *(Brayshaw 1983a)*	7	326	60.8	32.8	6.4	7	77.8	9	2.7
Hunter Valley No 2 *(Brayshaw & Haglund 1983)*	1	2665	66.5	20.3	13.3	17	24.2	70	2.6
BBC-84 *(Brayshaw 1984)*	4	691	71.3	17.9	10.5	18	28.5	63	9.1
CSR [BBC]-86 *(Brayshaw 1986)*	4	161	41.6	53.4	5	0	0	9	5.6
North Singleton *(Stern & Attenbrow 1981)*	52	541	63	26	11	3	2	120	22
Singleton Heights *(Dallas & McDonald 1986)*	17	157	30.5	25.5	43	0	0	22	15.3
Camberwell *(Brayshaw 1986)*	20	303	58.7	31	10.2	1	2.3	44	14.5

7.9 LAND USE, CAPABILITY, TENURE AND ZONING

7.9.1 Land Use

The major forms of land use in Singleton Shire comprise mining, agriculture, Army Base activities and to the southwest of the Shire, the Wollemi National Park. In 1986-87 only 31% of the Shire's area was included in rural holdings.

Land use mapping for the Project was undertaken within an area of approximately $97km^2$ comprising Authorisations 81 and 308 and a peripheral zone about 2km from the Authorisation boundaries (Wayne Perry & Associates, 1989). Land use is summarised in Table 7.9.1 and shown in Figure 7.9.1.

TABLE 7.9.1

LAND USE*

Land Use Type	Area (ha)	Percentage area Shown in Figure 7.9.1
Urban	68	0.7
Cropping	332	3.4
Cropping & grazing on improved pastures	556	5.7
Grazing on improved pastures	546	5.6
Grazing on cleared native pastures	4,341	44.5
Scattered timber & rough grazing	2,526	25.9
Dense timber	1,375	14.1
Gravel quarrying	10	0.1
	9,754	100

* On and within the vicinity of Authorisations 81 and 308

Cropping

Cropping is confined to the alluvial terraces and plains adjacent to Glennies Creek although limited cropping occurs on sloping land near Station Creek and in Middle Falbrook. Approximately 20 properties in the area are involved in cropping and most of these use the crops to provide quality fodder for dairy and beef cattle.

Production of cash crops which include oats, sorghum, maize, wheat and sunflowers is undertaken to a limited extent and generally in rotation with pastures and forage crops.

Dairying

There were eight dairies[32] operating in the area studied at the time of survey (Figure 7.9.1).

Dairying is confined to the irrigated alluvial flats since improved pastures are necessary to maintain production. Friesians make up the major part of dairy herds although some Jersey and Guernsey cows are included to maintain butterfat levels.

32

Dairy	Owner	Reference No on Fig 7.9.1
"Glenedge"	W. Gardner	6a and 6b
"Ventura"	Cheathams	9
"Sydenham"	A. Noble	15
	A. Klasens	19
"Glenview"	S. Wilis	36
	Ashton Pastoral Co (sold early 1989)	43
"Mayfield"	C. Lane	106
	Ashton Pastoral Co.	118

Forage crops, including sorghum, oats and lucerne are either grazed or baled. Under intensive production, the irrigated flats can sustain 2.5 head per ha.

An integral part of the dairies are 'dry runs' which are dryland grazing paddocks owned or leased specifically to run dry cows and for the growing of heifers. These dry runs are an important part of the dairying enterprise although they do not necessarily adjoin the dairying block.

A typical dairy farm in the area produces approximately 6,500-7,500l of milk per week. About 50ha of the property is irrigated forage crops and pastures and the remainder is used as a dry run. Approximately 110 beasts graze the lucerne, rye grass, white clover crops and pastures. Of these 65 to 70 are milkers.

Studs

There are five studs in the area surveyed. "Abervale" in the southeast and "Fairview" in the central west of the area are both horse studs. The "Willowvale" stud located on Mayfield station produces Australian Illawarra Shorthorn while stud beef cattle are produced on "Glenville" station and Angora goats on Dulwich.

Dryland Grazing

These pastures comprise low productivity native grasses although production can be improved with incorporation of superphosphate and clovers. Stocking rates for cattle on unimproved dryland pastures varies between one head per 2.4ha to 4ha. Once fertilized and sown, they can support one head per 1.5ha to 2ha.

Stock grazing on cleared native pastures is the most common form of land use in the area studied. Beef cattle production is dominant. Mixed cattle and horse, cattle and sheep and in one instance goat properties also occur.

Beef cattle properties are usually about 140ha in area while smaller properties of 80ha to 120ha use the cattle to supplement off-farm incomes.

Scattered and densely timbered areas are also used for stock grazing. They have lower productivity than other grazing lands but serve as shelters and windbreaks for stock and wildlife.

Hobby farming is undertaken mainly in the east of the area. Small scale cattle and horse production are most common on these properties.

Urban Land Use

Urban development in the area is restricted to the Village of Camberwell which is located adjacent to the New England Highway in the northwestern portion of Authorisation 81.

The village comprises a separate older area of 18 occupied residences to the north and a more recently developed area to the south of 20 residences. The land adjacent to this Village is mainly pastoral.

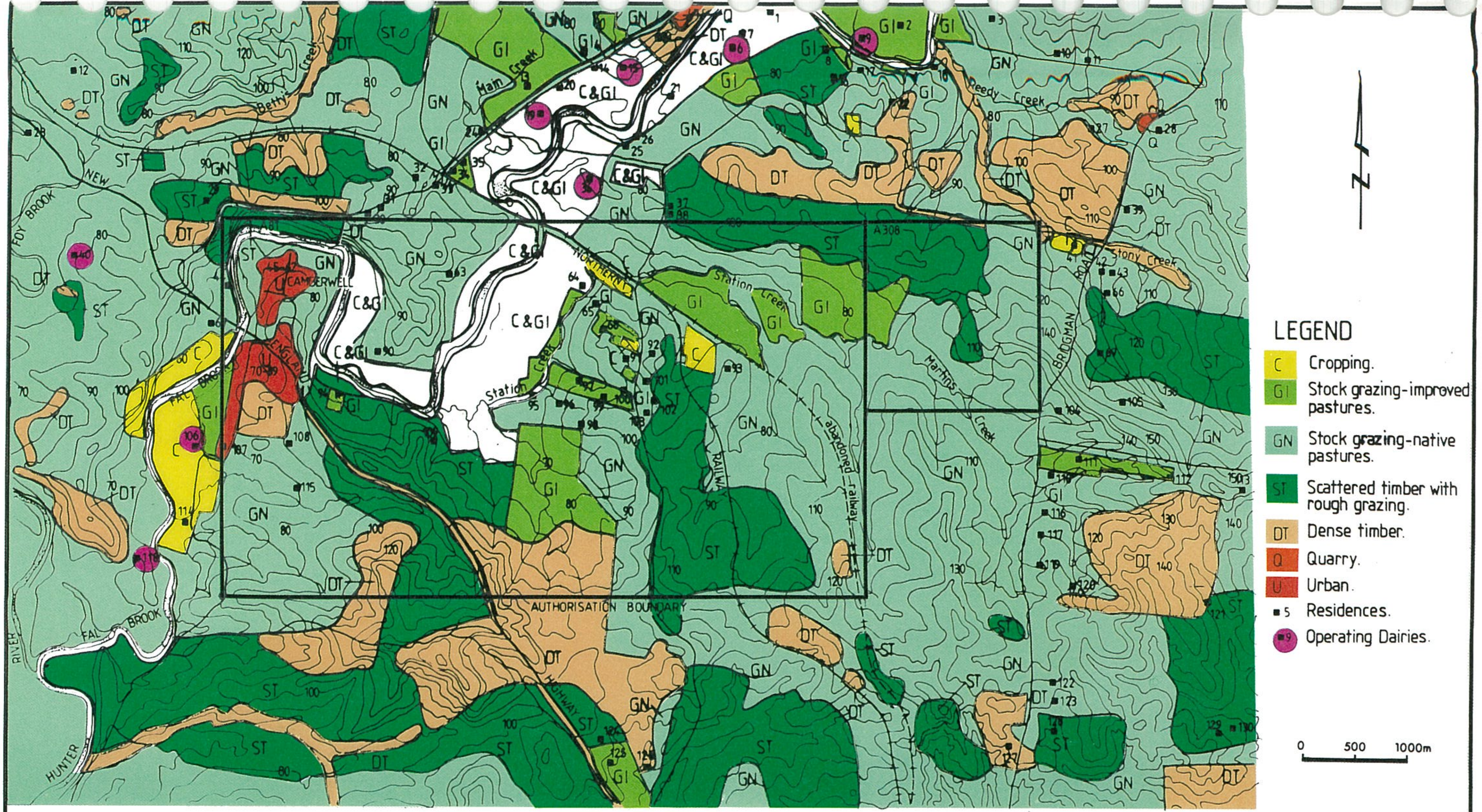
Camberwell has a community hall and a church but no retail outlets or school. The sandstone St. Clement's Church was constructed in 1891 and repaired in 1966. Many cracks are visible in the exterior walls.

In Middle Falbrook there is a sport and recreation centre.

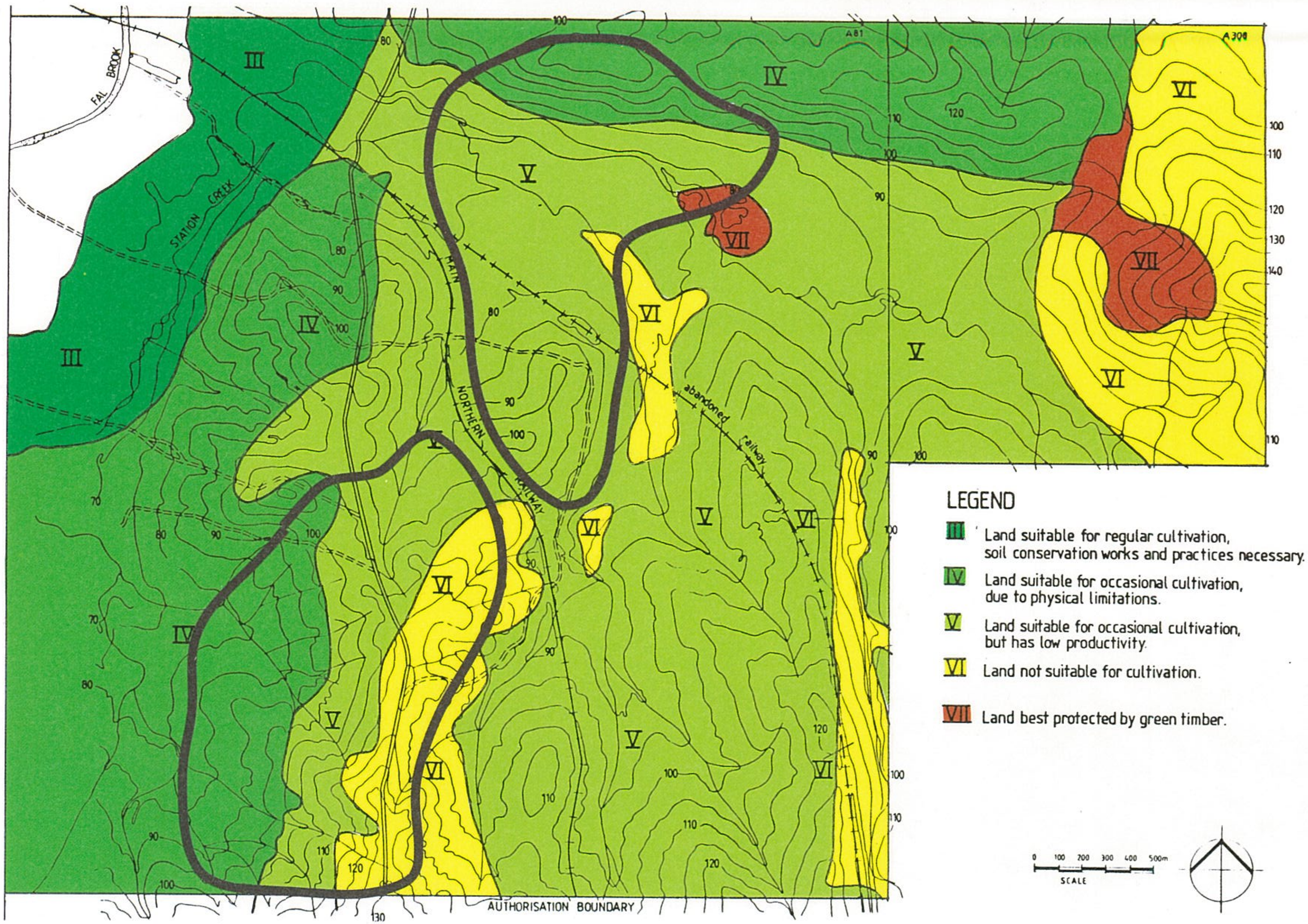
Agricultural Trends

There has been a marked decrease in the number of dairies operating in the Glennies Creek and Camberwell areas during the past 20 years. This trend is likely to continue. Whilst the number of dairies has decreased, this has been offset by a 32% increase in total milk production over the same period.

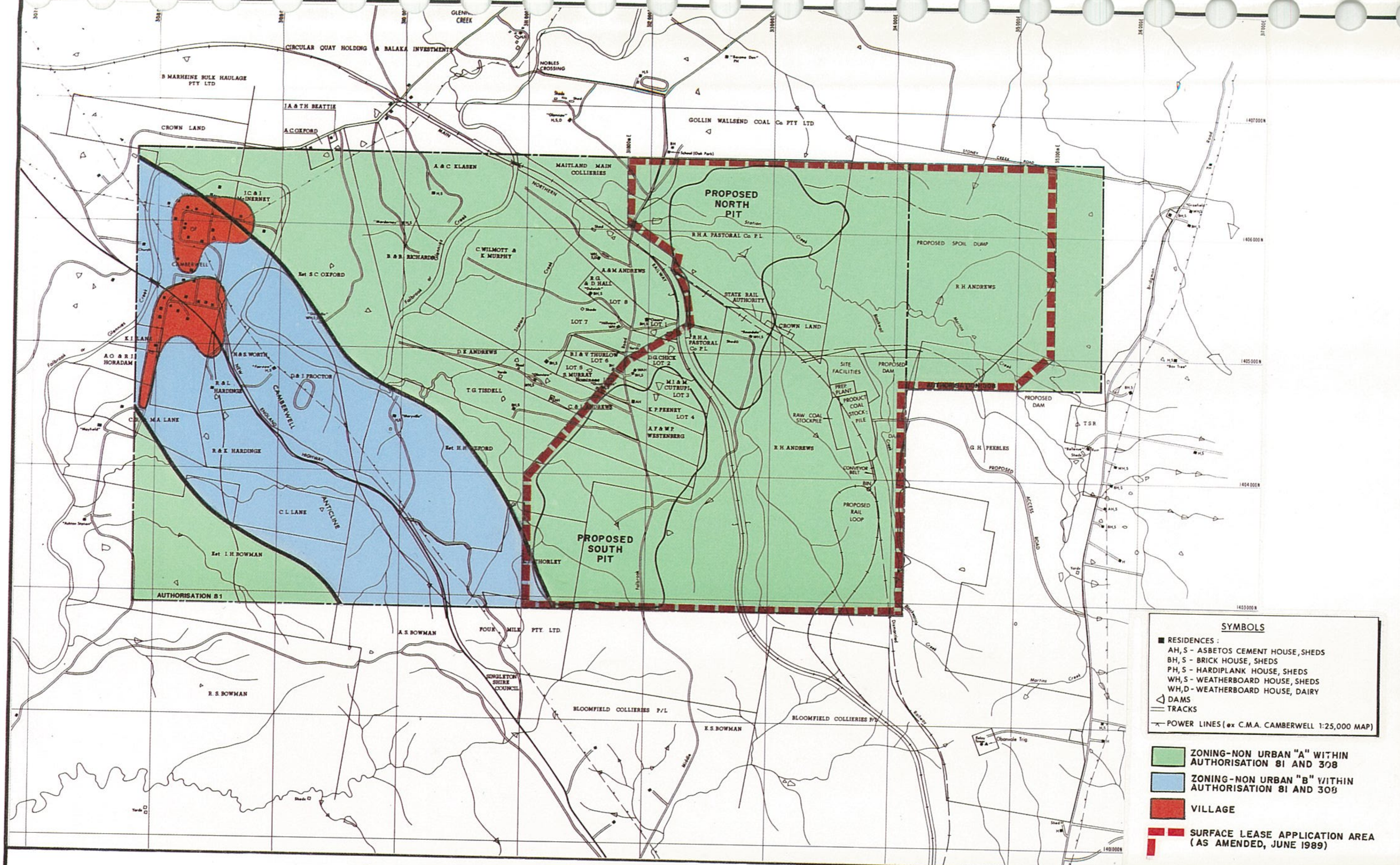
Another marked trend is the continuing subdivision of properties into hobby farm-sized properties. A number of residents in the area are employed in nearby mines and power stations.



CAMBERWELL COAL PROJECT	Date	Figure 7.9.1
LAND USE		



CAMBERWELL COAL PROJECT	Date Sept 88	Figure 7.9.2
RURAL LAND CAPABILITY		



CAMBERWELL COAL PROJECT

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Figure 7.9.3

LANDHOLDERS

ZONING OF PROPERTY DETAILS IN RELATION TO OPEN CUT MINE LAYOUT, PROPOSED AUTHORISATION & SURFACE LEASE BOUNDARIES

7.9.2 Rural Land Capability

A rural land capability assessment was conducted by Wayne Perry and Associates for the area mapped as shown in Figure 7.9.2. The assessment indicates the agricultural potential of the area independent of current land use.

Land capability classifications were based on the eight class system devised by Emery (1985) and used by the SCS. It relies upon an assessment of the biophysical characteristics of the land, the extent to which these will limit a particular type of land use and the current technology that is available to the management of land. The majority of the area comprises Class V land with lesser areas of Class IV and Class VI and can be broadly classified as being suitable for grazing.

Table 7.9.2 provides a summary of the area of each rural land capability class.

TABLE 7.9.2

RURAL LAND CAPABILITY CLASSES

Class	Area (ha)	Percentage
IV	220	19
V	671	59
VI	223	19
VII	30	3
	1144	100

Apart from an area located on the lower reaches of Station Creek, adjacent to Glennies Creek, the area mapped is not suitable for cropping as a result of the shallow depth, low nutrient status, low to moderate water holding capacity, impeded drainage and poor to weak surface structure of the soils. Some soils occurring within the group 1, 2(a) and 2(b) categories may be cultivated occassionally for the establishment of improved pasture.

7.9.3. Land Tenure and Zoning

Land tenure and zoning in the vicinity of the proposed SLA area is shown in Figure 7.9.3. Building locations are shown in Figure 7.9.4.

The area covered by the proposed lease is zoned Non Urban "A". Nearby variations to this zonation are the "village" zoning applied to Camberwell Village and a Non Urban "B" category, 800m either side of the New England Highway. The Non Urban "B" zone just clips the southwestern corner of the proposed lease area, nevertheless the use of coal mining is a permitted industry with Council approval, in both Non Urban zones.

A real property description of surface lands within the SLA area is included in Appendix 5.

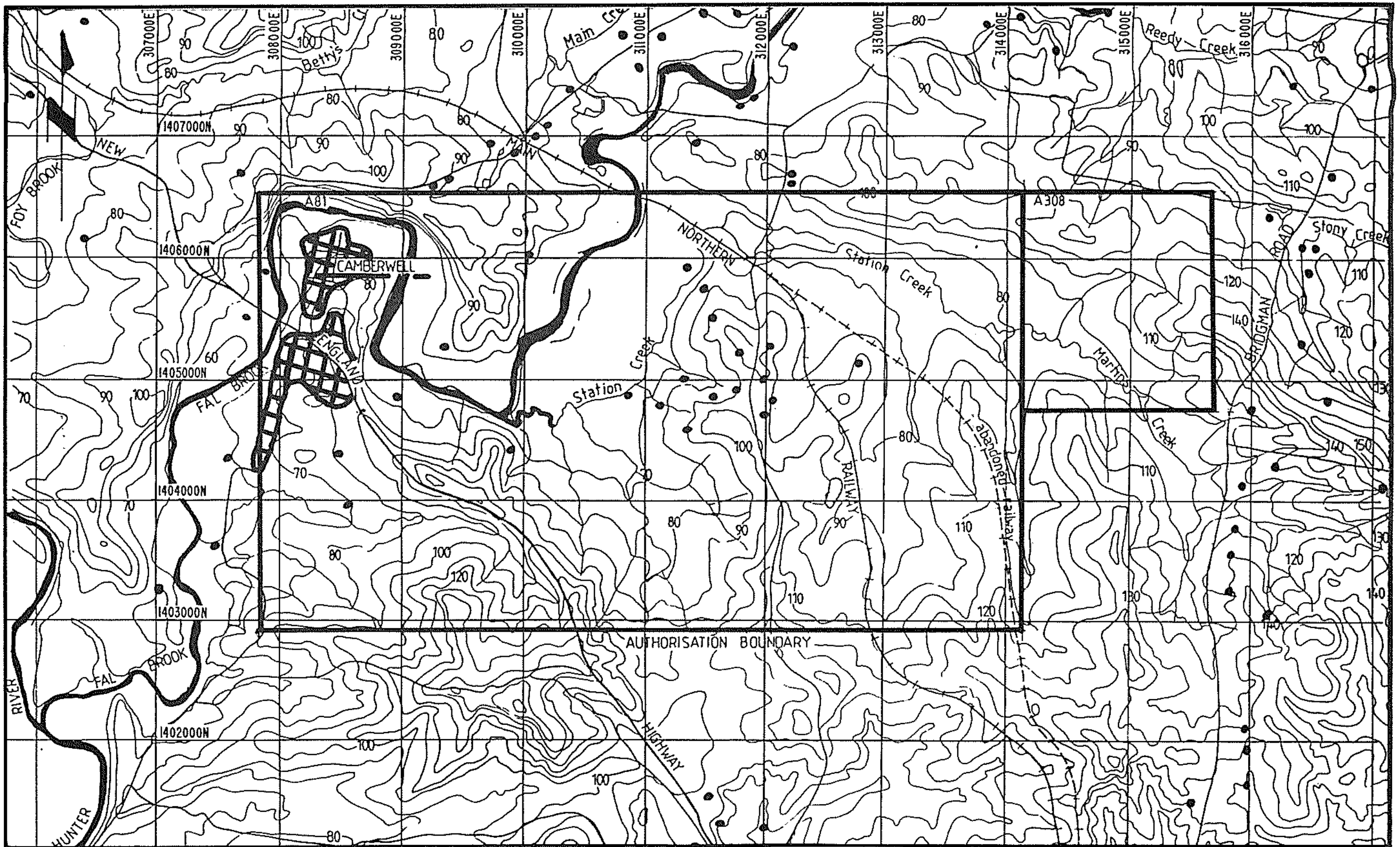

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Figure 7.9.4

BUILDING LOCATIONS

Scale 1 : 40 000

7.10 AESTHETICS

7.10.1 Existing Landscape Characteristics

Regional Context

The study area is shown on Figure 7.10.1, representing an area in excess of 90km^2 measuring approximately 12km by 7.5km. The Hunter River is located to the south of the study area. The adjacent flood plains support a diverse range of agricultural land uses and with its colours, tones and textures creates a composition of high scenic value. Rugged mountains occur to the west and northeast of the study area. The Hunter and Wambo Ranges are located to the west and the Mount Royal, Barrington and Gloucester Tops Ranges are situated to the northeast. These ranges are largely untrafficable and with their dense vegetation cover, they represent scenic landscapes of wilderness quality.

The majority of the Upper Hunter comprises undulating topography which has been cleared for grazing use. Forested and woodland cover occurs to a limited extent. It is less spectacular than the riverine and mountain landscapes but has a relatively scenic combination of topography, drainage and vegetation. The Ravensworth State Forest is situated 5km north of the study area within this landscape type.

The Region has a long history of coal extraction and many current and worked out open cut mines exist within close proximity of the study area. The Bayswater and Liddell Power Stations are situated approximately 10km north west of the study area and are visible from various positions within it.

Landscape Character Types

Six distinct landscape character units[33] were identified within the study area, based upon variations in land forms, vegetation and land use (Plates 7.10.1 to 7.10.5). The distribution of the units is shown in Figure 7.10.1.

Scenic Quality

The relative scenic quality of landscape character units is based upon an assessment of the variety or diversity which exists within each unit. Units with the most variety or diversity are normally assigned a higher scenic quality rating.[34]

The water bodies unit and the alluvial flats unit have been assessed as having high scenic quality. The cleared/grazing and forested areas are rated as having moderate scenic quality whilst the extractive and urban units are considered to have a low scenic status.

33 Landscape character definition and the evaluation of scenic quality have been based upon techniques developed by the Forest Service of the US Department of Agriculture and subsequently used widely by the Victorian Forests Commission.

34 The following criteria are used as a basis to assist in the generally subjective assessment of scenic quality:-

- **Topographic ruggedness and elevation:** Elevated landforms and those with steep slopes and rock outcrops are considered to be distinctive.
- **Vegetation patterns:** Unusual or outstanding diversity in plant species including strong contrasts contribute to high scenic quality.
- **Land use patterns:** Natural and agricultural landscapes have a higher scenic rating than disturbed and urban or man-made landscapes.
- **Waterforms:** Perennial creeks, rivers, lakes and large dams are considered to be distinctive.

Viewer Sensitivity Levels

Sensitivity levels reflect viewers' concern for the visual environment within the study area. These levels are based upon a combination of distance, and the type of route or viewing position.[35]

Major highway routes which carry high volumes of traffic, residents who view the site and tourists rather than commuters rank highest in viewer sensitivity levels.

Three levels of sensitivity have been identified within the study area.

Level 1: The villages of Camberwell and Glennies Creek, the New England Highway and the Main Northern Railway.

Level 2: Middle Falbrook Road, Bridgman Road and the Camberwell-Glennies Creek Road.

Level 3: Nobles Crossing Road and the road connecting Middle Falbrook Road and Bridgman Road.

Landscape Management Zones

Landscape management zones are determined by a combination of the scenic quality classes and the sensitivity levels.[36]

Whilst based upon forestry management practices, the concept of landscape management zones is useful in determining the most suitable location for structures and areas of disturbance in addition to assessing the level of safeguards for development.

The distribution of the two landscape management zones determined for the Project area are shown in Figure 7.10.2.

Landscape Management – Zone A

This zone (the coloured area on Figure 7.10.2) represents the area of highest concern for visual resource with respect to the siting of development, the level of safeguards and the duration of modification. It comprises the alluvial flats/cropped land and the foreground along either side of the New England Highway and the Main Northern Railway.

The western portion of the North Pit and the northeastern corner of the South Pit represent the only proposed development within this zone. Visual management for this zone allows for disturbances to the landscape to be completely screened or only temporarily visible. When visible, project management will endeavour to limit the period of disturbance to a period not exceeding one year.

35 **Distance definition for landscape assessment***

	Foreground	Middleground	Background
Distance	0 - 500m	500m - 1 km	>1 km
Sight capacity	detail	detail & general	general-no detail
Object viewed	rock outcrop	entire ridge	systems of ridges
Visual characteristics	species of individual plants	textures (palms) and hardwoods)	patterns (light and dark)

* *Adapted from USDA, Forest Service, National Forest Landscape Management, Vol. 1., Agric. Handbook 434, Washington, 1973.*

36 **Landscape management zones**

Scenic Quality Class	fg-1	mg-1	bg-1	fg-2	mg-2	bg-2	fg-3	u
	Distance Zone – Sensitivity Level*							
High	A	A	A	A	B	B	B	B
Moderate	A	B	B	B	B	C	C	C
Low	B	B	B	B	C	C	C	C

* Distance Zones: fg – foreground, mg – middleground, bg – background, u – unseen.

Sensitivity Levels: 1 – high, 2 – moderate, 3 – low.

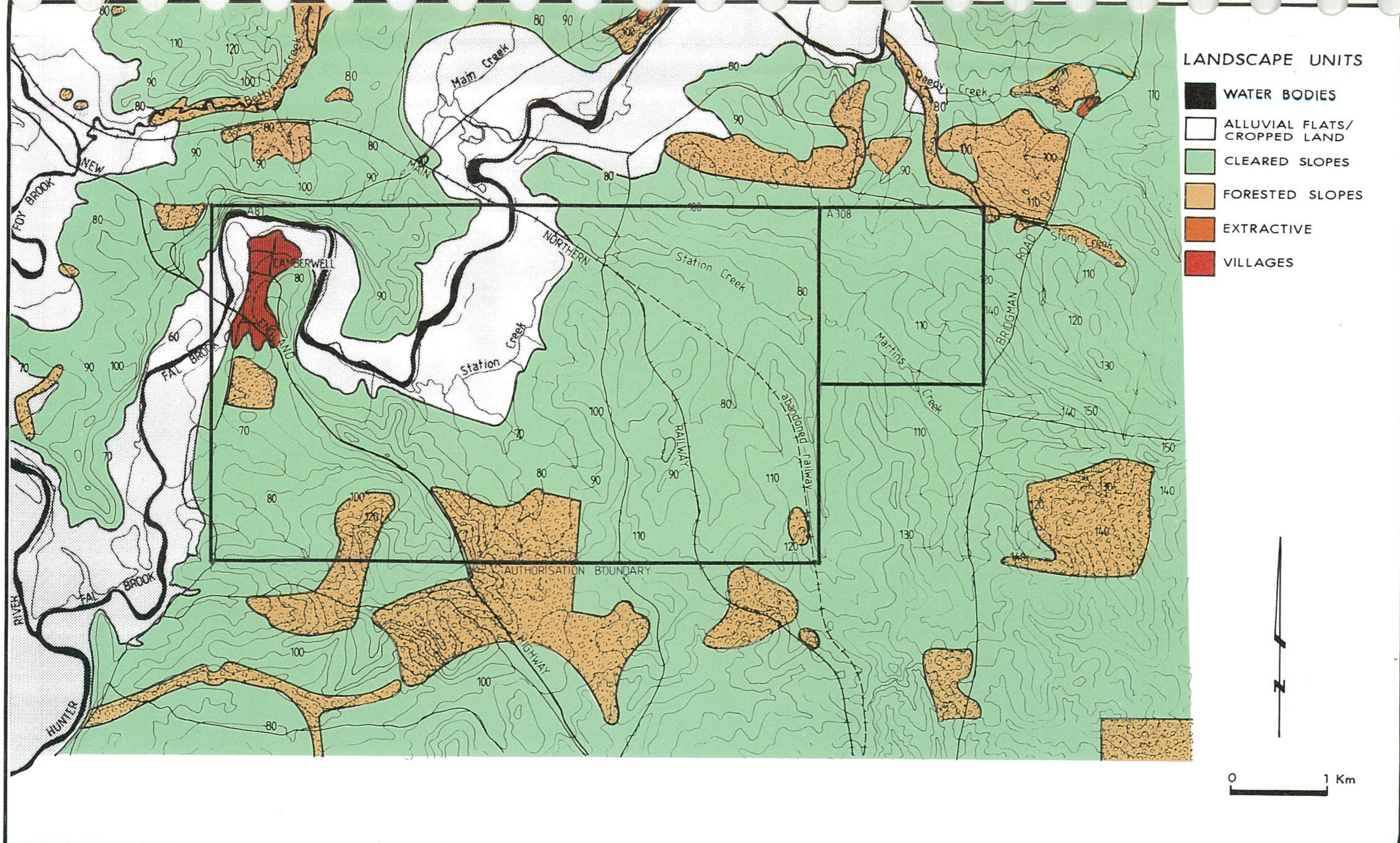

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Figure 7.10.1

EXISTING LANDSCAPE CHARACTER

Plate 7.10.1 – **Water Bodies Landscape Unit**

The Hunter River is the main water body within the study area. It is situated in the south western corner of the area and is not visually significant. Glennies Creek is a tributary of the Hunter River and exhibits incised meanders through the north western sector of the study area. It position is defined by intermittent riverine vegetation along its banks combined with crop development on the adjacent river flats.
The other main watercourses within the study area, Reedy Creek and Station Creek do not contain permanent water and are recognisable only by the densely wooded banks.

Plate 7.10.2 – **Alluvial Flats/Cropped Land Landscape Unit**

This landscape type is situated adjacent to the Hunter River and Glennies Creek and supports a diverse range of agricultural activities. The contrast in colours, textures and patterns results in a landscape of high scenic attraction.

Plate 7.10.3 – **Cleared Slopes Landscape Unit**

This rural landscape unit occupies the majority of the study area. It consists predominantly of undulating topography rising to ridges and knolls. The scattered timber which occurs over much of the area provides depth and scale to the landscape.

Plate 7.10.4 – **Forested Slopes Landscape Unit**

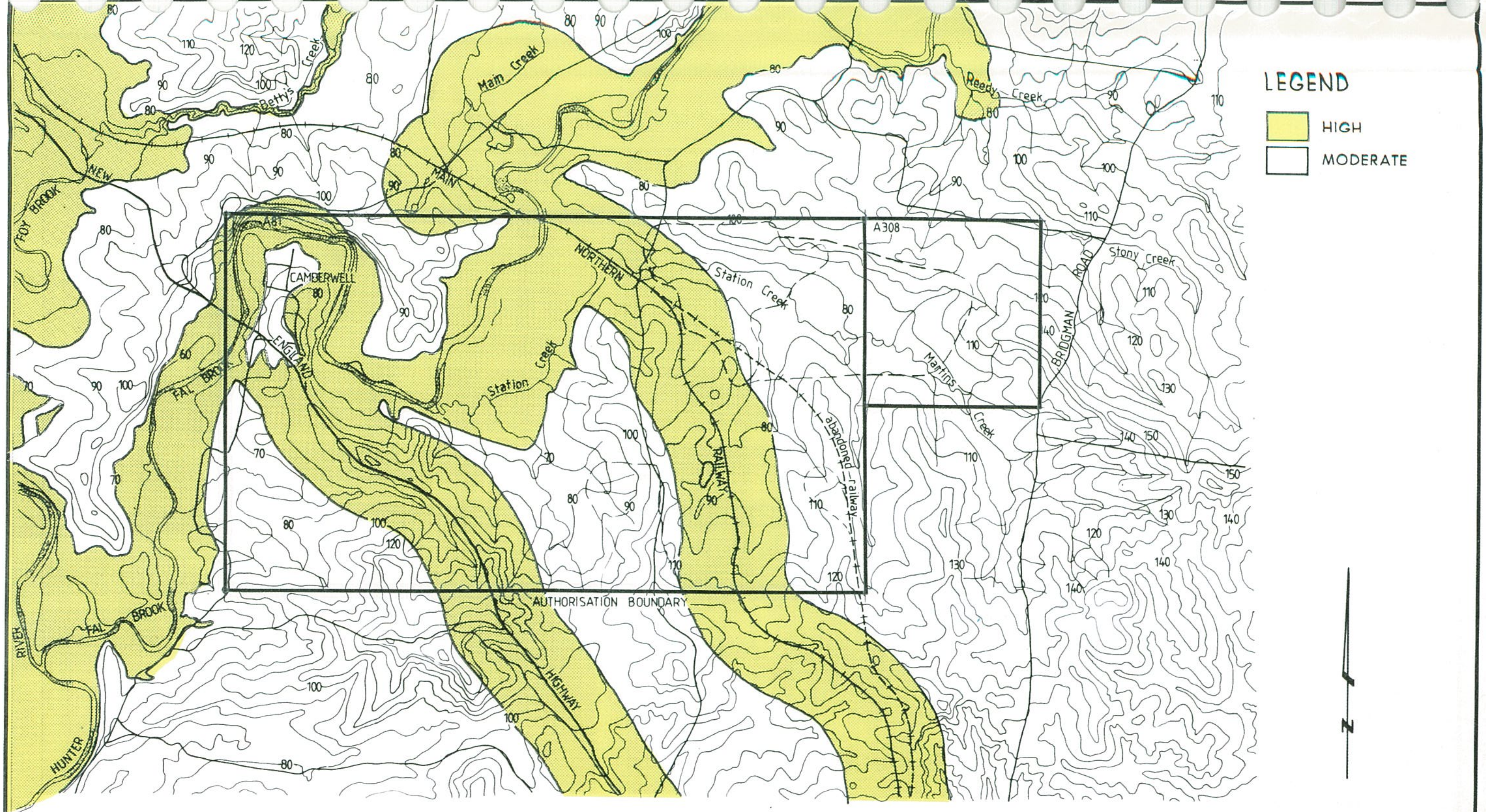
The forested landscape unit occurs throughout the study areas as distinctive pockets of varying size. Most common occurrence is on ridges or along watercourses. The dark green colour and the distinctive textures of this unit contrast with the adjacent pastures of the cleared slopes landscape unit.

Plate 7.10.5 – **Village Landscape Unit – Camberwell**

Both Camberwell and Glennies Creek Village are characterised by low density development of residential buildings and the general lack of vegetation. The New England Highway bisects Camberwell while Glennies Creek Village is situated at the junction of the Main Northern Railway and the Camberwell to Glennies Creek Road.

Extractive Landscape Unit – Camberwell

The extractive landscape unit represents a very small proportion of the study area. Two gravel quarries operate in the north of the study area. The quarries are characterised by the contrasting colour of their disturbed surface. They are not visually significant due to their limited scale and screening by vegetation and topography.



CAMBERWELL COAL PROJECT

Date

Figure 7.10.2

LANDSCAPE MANAGEMENT ZONES

Landscape Management – Zone B

This zone (uncoloured area on Figure 7.10.2) is characterised by a moderate concern for visual resource. The remainder of the study area is within this management zone.

Visual management recommendations are that alterations should range from visually apparent, yet subordinate to existing landscape characteristics, to visually dominant. The period of visual dominance should not exceed two years.

7.10.2 Visual Safeguards

Visual safeguards comprise a combination of forward tree planting programmes for screening purposes, the repair and stabilisation of areas disturbed during the construction phase and amenity-type landscaping around surface facilities buildings and structures.

Surface Facilities

The surface facilities site comprises a 29ha area located along a north-northwestern orientated ridgeline close to the eastern Authorisation boundary. The site is relatively remote from farm residences and is 1km east of the Main Northern Railway. Vehicular access will be from Bridgman Road.

The layout of the surface facilities and proposed landscape treatment is shown in Figure 7.10.3. The surface facilities as illustrated is typical of modern coal handling and washing plants and will be designed to a high standard to ensure that an integrated site results. The majority of buildings will be constructed from portal steel frames with Colorbond cladding to the roof and walls.

The site is predominantly cleared of trees and comprises pasture grasses. Existing stands of trees will be retained where practicable, to the extent shown in Figure 7.10.3. The intention of the proposed landscape treatment is as follows:

1. To stabilise all areas cleared and altered during construction. This will comprise regrading of batters to slopes generally not exceeding 1V:3H, ripping of access roads no longer required and the replacement of stored topsoil prior to fertiliser and seed application. Seeding will be undertaken using conventional agricultural implements and the grass seed and fertiliser as specified in Table 6.1.1. Steeper batter slopes will be seeded using hydromulching techniques.
2. The establishment of broad belts of trees and shrubs at a similar density to the remnant Eucalypt woodland. The large areas proposed will be implemented by means of deep ripping and direct seeding techniques. This treatment will have the dual advantages of minimising the visual impact of an industrial facility situated on pasture land and reducing wind velocities within the surface facilities precinct on an otherwise exposed location.
3. To create an attractive work environment for employees and visitors by the establishment of attractive amenity-type planting within the administrative office, bath-house and other office precincts. Shade trees will be planted within the periphery of all car parks.

Tree and shrub species will be selected from those indigenous to the site with additional amenity-type plants being included for reason of colour, foliage contrast and fragrance.

Screening Proposals

Out-of-Pit Overburden Emplacements

Two out of pit overburden emplacements are proposed specifically to ameliorate potential noise, dust and visual impacts, should land ownership arrangements permit.

North Pit. A small overburden emplacement is proposed to be located between the northwestern extent of the Pit and Middle Falbrook Road, as shown in Plate 7.10.6. This would serve the dual purpose of protecting the pit from floodwaters backed up in Glennies Creek and substantially reducing the view potential to the North Pit from the Main Northern Railway, from Camberwell and the New England Highway and residences located west of Middle Falbrook Road.

South Pit. An overburden emplacement could be constructed immediately west of the South Pit as shown in Plate 7.10.6. This would be located across a northwesterly facing valley, effectively eliminating visibility to the South Pit from Camberwell and farm residences located between the South Pit and Camberwell. Revegetation of the emplacement would include tree and shrub species which can be expected to grow to a height of up to 3m in the first year.

This emplacement would be revegetated as described previously for the North Pit emplacement.

Forward Tree Planting Programmes

Five areas are being considered for forward tree planting in order to reduce visual impact from key viewing positions. The location of these areas (Figure 6.4.1) has been determined by a combination of line of sight analysis and field inspection. The intention of the programme is to establish belts of dense tree and shrub plantings prior to site construction and mining so that screening is more effective once these activities commence. In most cases the location of planted areas will be designed to provide filtering of views to site components rather than total screening, so that existing panoramic views can be maintained. Planting will be established by direct seeding of indigenous seeds into ripped and prepared areas as this represents the most cost effective means of establishing broadacre planting.

The five areas intended for forward tree planting are:

1. Avenue-type planting of selected tree species along all streets within the Village of Camberwell. Due to topography, the Project will not be visible from the village precincts and therefore this planting is intended to improve the visual amenity of the Village and to assist in the reduction of wind generated dust.

   The Project will be visible from along the southern access road linking the New England Highway with the Village. In conjunction with tree planting along this access road, consideration will be given to the construction of a tourist lookout area at this vantage point.

   These proposals will be discussed fully with Village residents, the Singleton Shire Council and relevant Statutory Authorities prior to implementation.

2. Along either side of the Main Northern Railway to reduce long distance views and break the continuity of close views to the North Pit, South Pit and the South Pit eastern overburden emplacement. The end result would be similar to that experienced along rural roads where trees are retained within the road reserve.

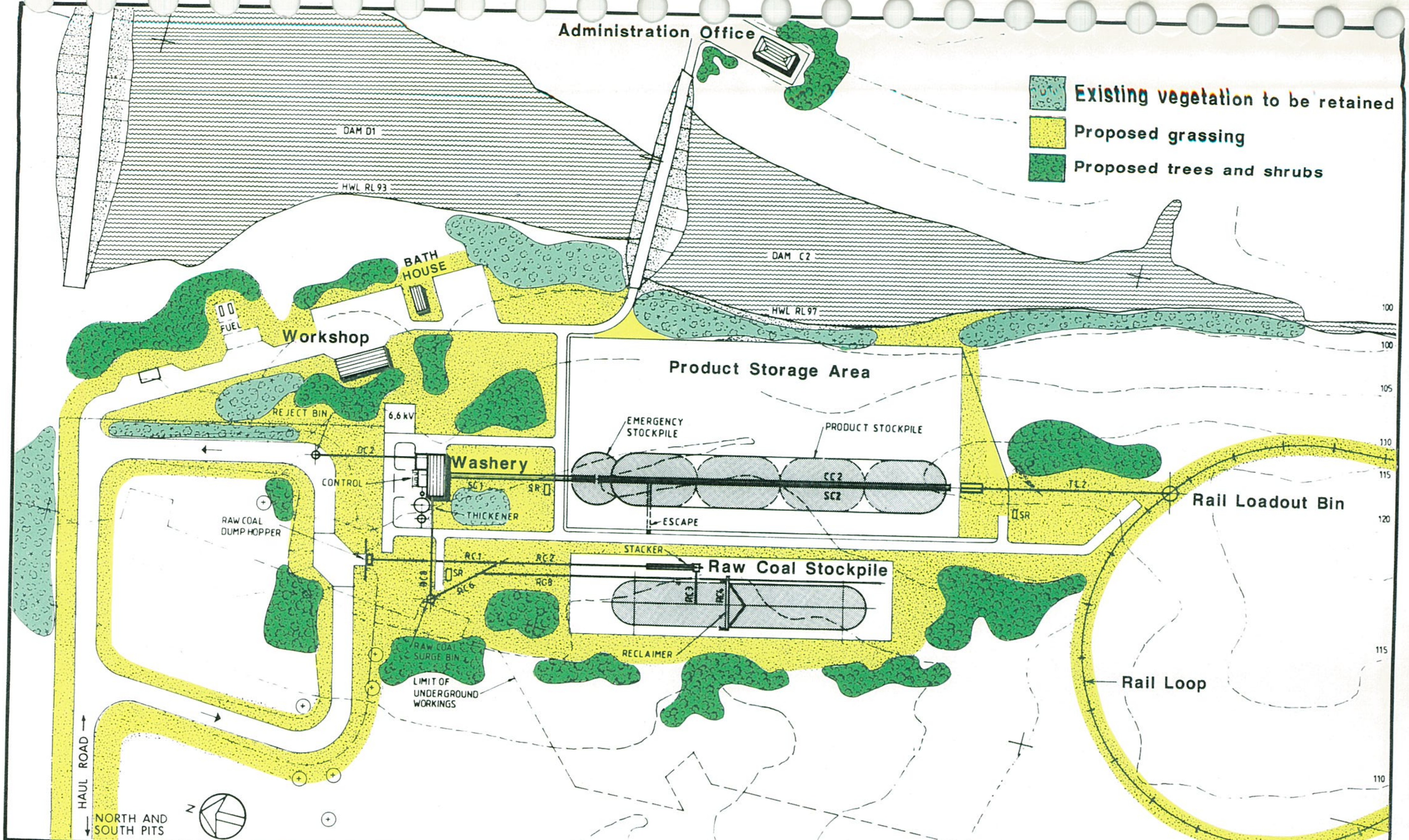
3. In selected areas along the western toe of the proposed South Pit western overburden emplacement, should this bund be constructed. This planting would be to reduce the impact of the overburden emplacement rising directly from cleared grazing land.

4. Infill planting along the western side of Bridgman Road and at the eastern extent of the North Pit eastern overburden emplacement. This planting will filter views to the overburden emplacement which is expected to be active for about five years but moving away from Bridgman Road.

5. Planting in selected locations and along limited sections of the New England Highway. As this area is both distant from Project components (1.5km) and is not located on land owned by the CCJV, this proposal is rated as a lower priority than the previous proposals and would be the subject of further planning and negotiation. Planting would be in the form of tube stock species because of the restricted access and small areas involved.

Management

The landscaped areas around the surface facilities site and the administration office will be maintained by a gardener in accordance with normal horticultural practices. It is proposed that sewage effluent will be disposed of via an automatic irrigation system installed within these landscaped areas.



CAMBERWELL COAL PROJECT

SURFACE FACILITIES LANDSCAPING

Date

Figure 7.10.3

View catchment from Camberwell access road

PLATE 7.10.6

7.10.3 Impact Assessment - Aesthetics

This section provides an assessment of the impact of changes to the site topography and landscape character as well as the visual impact resulting from mining operations and the imposition of structures on the site.

The assessment was undertaken by reference to line of sight determinations, field inspection and use of the topographical model. The effects of proposed safeguards including forward tree planting, out-of-pit overburden emplacements and the progressive rehabilitation of backfilled mine areas were taken into account.

Views were assessed from farm residences, Camberwell Village, the Main Northern Railway, the New England Highway and Bridgman Road.

Project Components Creating Visual Impact

A summary of major Project components which will be visible to residents of surrounding properties, urban settlements, motorists and train travellers is provided in Table 7.10.1.

Views from Urban Settlements

Camberwell. The residential area of Camberwell is situated to the west and below the brow of a small hill which screens views to the Project area. However on the eastern side of this hill and along the access road linking the Village and the New England Highway, views to both Pits and the Surface Facilities will be possible. The extent of these views is limited by a north-south orientated ridge line located either side of Glennies Creek. An indication of the view catchment from this location before and after rehabilitation of the North Pit and Dump is illustrated in Plates 7.10.6 and 7.10.7 (Camberwell is the pink area in lower right hand foreground).

Views to the South Pit will be reduced should the western bund be constructed. The ability to construct this bund will be dependent upon landholding status at the time. The proposed forward tree planting programme within the Camberwell Village precinct will further diminish views to all Project components.

Residents of Camberwell will be aware of a general glow emanating from the working areas of both Pits and from the Surface Facilities at night-time. This effect will be similar to that observed for other mining operations within the Hunter Valley. Dumping locations , lighting directions and times can be modified to ameliorate any specific night-time glare problems.

Glennies Creek. The small settlement of Glennies Creek, centred upon the crossing of Glennies Creek Road at the Main Northern Railway is approximately 2.5km distant from the North Pit. Visibility of the North Pit will be diminished by the existing vegetation along Glennies Creek and the topographic high along which Middle Falbrook Road is located.

Singleton Heights. The Project will not be visible from Singleton Heights due to topographic effects (see Plate 7.10.6). The southern most components of the Project are located 5.5km in a straight path from the perimeter of Singleton Heights.

Views from Farm Residences

Bridgman Road. The extent of views to the North Pit Dump from residences east of Bridgman Road will be dependent upon their elevation and the extent of existing vegetation both along Bridgman Road and within the approximately 1km wide zone between the eastern boundary of the Dump and Bridgman Road. About eleven houses (numbers 41, 42, 43, 66, 104, 105, 110, 111, 112, 116 and 117 of Figures 7.9.1 and 7.10.4) are likely to view the North Pit Dump. House numbers 105 and 112 because of their elevated positions will have views cross the North Pit and Dump and to the Surface Facilities. The extent of views from all residences will be reduced by the proposed forward tree planting along Bridgman Road and at the eastern extent of the overburden dump. The proposed sequence of commencing overburden dumping at the easternmost extent and backfilling in a westerly direction behind a rehabilitated screen will further reduce the potential impact of this operation. Viewing distances are 1km to 1.5km at the closest positions.

Within a 1km zone west of the North and South Pits. An analysis of view potential to the Project from farm residences located within this zone is summarised in Table 7.10.2.

TABLE 7.10.1
SUMMARY OF PROJECT COMPONENTS CREATING VISUAL IMPACT

Component	Items Creating Visual Impact	Viewing Positions and Distance	Duration of Visual Impact	Proposed Visual Mitigation
North Pit	Trucks, shovel, scraper loaders and dozers during construction: Colour contrast until revegetated. Topographical contrast due to increased elevation, particularly for the "worst case" final landform.	Foreground views (100m min distance) from Main Northern Railway, Middle Falbrook Road and closest, elevated farm residences. Glennies Creek and Camberwell access road.	13 to 17 years depending upon the amount of spoil transferred from the South Pit	Construction of bund along northwestern corner of pit and immediate revegetation of outer face with tree and shrub species. Progressive rehabilitation. Forward tree planting adjacent to Main Northern Railway.
North Pit & Dump	Trucks, shovel, scraper loaders and dozers during construction: Colour contrast until revegetated. Topographical contrast due to increased elevation, particularly for the "worst case" final landform.	Bridgman Road and houses located east of Bridgman Road. 1km to 2.5km.	Overall dumping duration five years	Establishment of forward tree planting areas along Bridgman Road and at the eastern toe of the emplacement. Progressive rehabilitation at outer or eastern face providing a screen to subsequent dumping in a westerly direction.
South Pit & Dump	Mining equipment as for North Pit; topographical contrast of reshaped landform; colour contrast until revegetated.	Foreground views (100m-500m) from Main Northern Railway and closest farm residences. Background views from farm residences . New England Highway and Camberwell access road.	13 years commencing in Year 7	Forward tree planting adjacent to the Main Northern Railway. Progressive rehabilitation of eastern overburden emplacement, commencing at eastern extremity closest to Railway. Possible construction of western bund subject to land holding status.
Surface Facilities Site	Major equipment, buildings and coal stockpiles. Surge bin 50m height and 15m diameter represents highest structure. Rail Loading Bin 35m: Washery 25m; Reject Bin 21m, Coal Stockpiles 27m height.	Generally screened from view by topography and vegetation Middle ground views (1km) from Main Northern Railway. Background views to higher structures from residences located to the west.	For the duration of the mining operation.	Screen planting around the periphery of the site and landscaping within.

PLATE 7.10.7

To reduce the Project's visibility when viewed from Houses 65 and particularly 68 and 91 would require selective tree planting in the foreground view zone of these houses. Any arrangements would by subject to the agreement of the relevant landowners.

Night-time visibility effect are likely to create a more significant visual impact than during daylight hours as a result of the normally low background light levels experienced at night in rural areas. Working locations, times and lighting equipment would be varied to resolve specific problems encountered upon start-up of the Mine.

Residences located further than 1km west of North and South Pits. The view potential from these locations is summarised in Table 7.10.3. If necessary, the need for tree planting within the foreground viewing zone of House 63 would be discussed with the relevant landowner.

TABLE 7.10.2

RESIDENCES WITHIN A 1 KM ZONE WEST OF THE NORTH AND SOUTH PITS

Residence Number (refer Figures 7.9.1 and 7.10.3)	View Potential
109 'Maryville'	View to South Pit will be reduced by existing vegetation and the possible construction of the western bund.
131	Uphill view to South Pit will be reduced by existing vegetation and the possible construction of the western bund.
96 'Glenview'	Unlikely to view either North or South Pits due to topographic and vegetative screening.
97	Unlikely to view either North or South Pits due to topographic and vegetative screening.
99	View to northern extent of South Pit, particularly during prestripping operations.
100	View to northern extent of South Pit, particularly during prestripping operations.
91 'Hillview'	Elevated position will allow views to northern section of North Pit.
68 'Dulwich'	Elevated position will allow views to northern section of North Pit.
65	View over existing trees located along Middle Falbrook Road to elevated sections of North Pit final landform.
64	Unlikely to view North pit due to topography.

TABLE 7.10.3

RESIDENCES LOCATED GREATER THAN 1 KM WEST OF NORTH AND SOUTH PITS

House Number (refer Figure 7.9.1 and 7.10.3)	View Potential
63	Elevated position allows view over both Pits. View to North Pit "targeted" landform will be shielded by out-of-pit, north western bund wall. "Worst case" landform would be visible above the bund wall. View to southern section of South Pit, reduced by trees located along the northern margin of the Pit. Closest distance approximately 2.5 km.
90	Project components likely to be shielded by topography and existing trees along Glennies Creek.
94	Project components likely to be shielded by topography and existing trees along Glennies Creek.

Views from Public Roads

The New England Highway was assessed as a route with Level 1 or high viewer sensitivity. The visual impact of Project components is expected to be slight when viewed from the Highway due to either distance or short viewing duration. Views to the Project from elevated sections of the Highway north of Camberwell, are in excess of 4.5km distant. Shorter distance views (1km) to the South Pit occur south of Camberwell as shown on Figure 7.10.4, but at both positions viewing duration is short due to topographical and vegetative screening effects adjacent to the Highway. Screening proposals involving tree planting at these latter locations will further reduce views to the site.

Middle Falbrook Road, Bridgman Road and Glennies Creek Road represent routes with a moderate viewer sensitivity. Views to the Project will occur from all three roads, with Middle Falbrook Road views being the most significant due to its proximity to both the North and South Pits. Beyond Year 7, Middle Falbrook Road will need to be diverted (Section 3.7.2). Views of the North Pit will occur from the elevated section of Middle Falbrook Road immediately south of the Main Northern Railway level crossing. North of the crossing, views will be diminished by the proposed western bund wall.

Views to the eastern section of the North Pit Dump will be possible from short sections of Bridgman Road. Viewing distances will generally be in excess of 1km and visual impact will be reduced by the proposed forward tree planting adjacent to Bridgman Road and along the eastern toe of the dump.

Progressive filling of the Dump in a westerly direction will be screened by early rehabilitation.

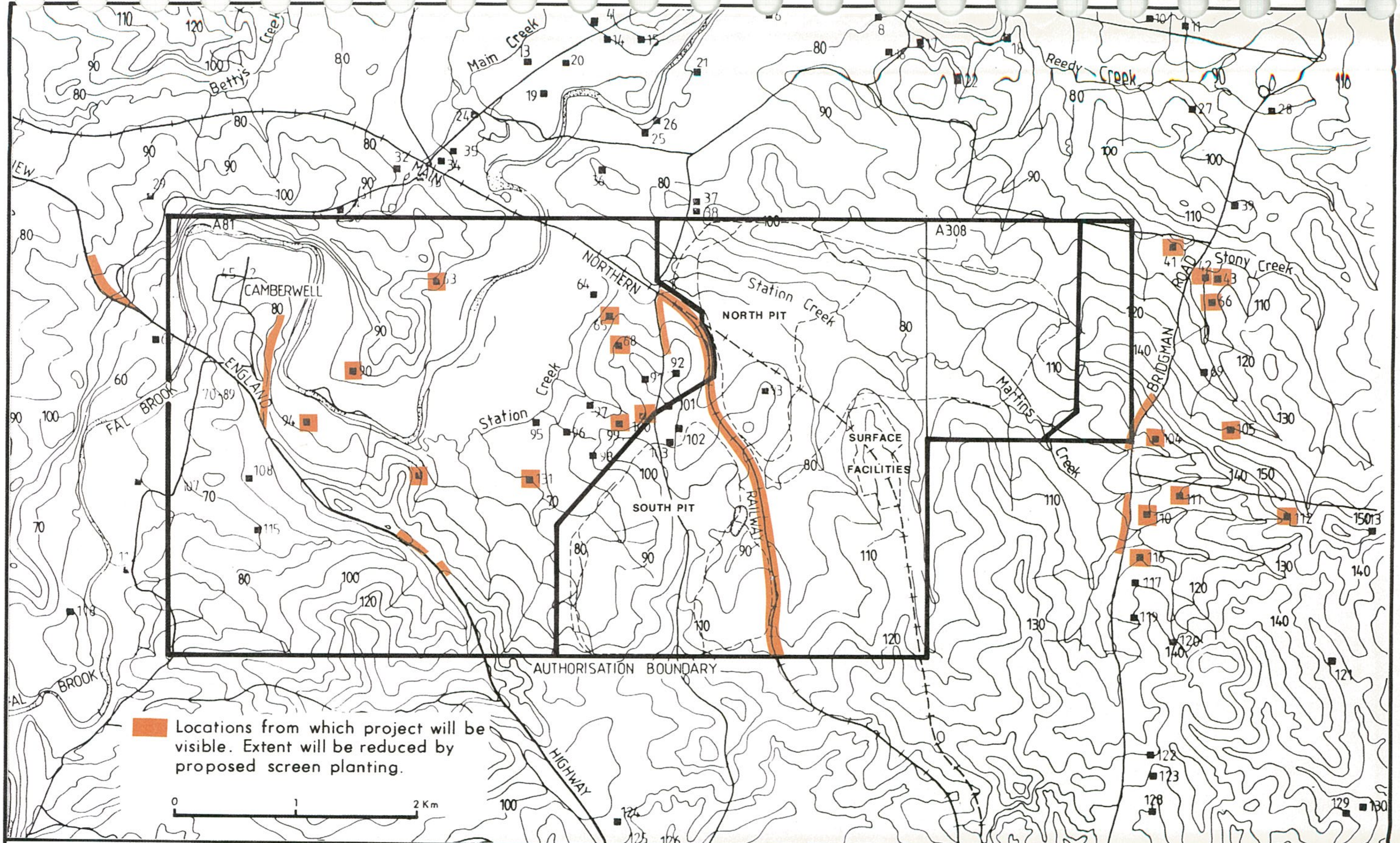
From elevated sections of Glennies Creek Road, to the north of Camberwell, views to the northern section of the North Pit will be possible. For the "targeted" landform, mining and subsequent backfilling will be 15m higher than the western bund. For the "worst case" landform, filling will extend some 40m above the bund and will be visible from the road. Viewing distances will be about 4km.

Views from the Main Northern Railway

The Main Northern Railway will be within 100m of both the North Pit and the South Pit. Visual impact of the operations is expected to be significant although diminished by the effects of forward tree planting proposals and the western bund to the North Pit. However considered in another context, the mining operation may represent a point of interest to train travellers.

The South Pit will be screened from the view of railway travellers by existing vegetation. The South Pit Dump will be within 100m of the line, but its impact will be reduced by the effects of progressive rehabilitation.

The Surface Facilities site will be visible from the Railway, but views to the site will be filtered by the proposed screen planting around the site's periphery.



CAMBERWELL COAL PROJECT

Date

Figure 7.10.4

VIEW POTENTIAL PROJECT COMPONENTS

7.11 TRANSPORT

7.11.1 Regional Coal Transport

The CCJV will transport its coal by rail in accordance with Government Policy. The existing rail infrastructure for the Hunter Region is shown on Figure 7.11.1. The Port of Newcastle is the nominated coal export terminal for mines in the Hunter Valley.

7.11.2 Road Network

The Mine Site is located approximately 10km north of Singleton, 3km east of the Village of Camberwell. Existing roads in the area include Bridgman Road to the east and Middle Falbrook Road (passing through the centre of the Project area), which both connect to the New England Highway south of the Mine Site, and to Stony Creek Road north of the Mine Site (see Figure 7.11.2). Details of a traffic and transport study conducted for the CCJV are included in Appendix 6.

It is anticipated that the North Pit will be operational within the next two years and that the South Pit will come on stream in seven years time. Mine site access will be restricted to Bridgman Road via an access road to the Site.

New England Highway (S.H.9), to the south and west of the Project area. The Highway is the main link between Singleton and Muswellbrook, the two regional centres in the area. The Highway (a high quality carriageway) is lanemarked as two lanes, although extra width exists due to broad shoulders (up to 2m on both sides) along much of its length. Additional turning lanes are provided along both sides of the intersection approach to Bridgman Road, and climbing lanes are provided on grades.

Bridgman Road, to the east of the Project area, also has a high quality carriageway. The two-lane undivided carriageway is one of two access routes to the residential developments in Singleton Heights, and the sole access route to Hunter View Estate, just north of New England Highway.

Middle Falbrook Road is a narrow two-lane undivided sealed carriageway running approximately 5km to the west and parallel to Bridgman Road. The road is generally sealed with a thin gravel pavement on a narrow carriageway with loose gravel shoulders. Width varies from 3-4m to the south to about 7m near Stony Creek Road. It crosses the Main Northern Railway Line via a level crossing towards the road's northern end.

Stony Creek Road to the north of the Project area is a narrow unsealed single-lane carriageway of approximately 4m width. It is badly rutted and has poor sight distance, particularly the eastern section. Running east-west, it connects Bridgman Road and Middle Falbrook Road, and eventually links with the New England Highway north-west of Camberwell via Noble's Crossing and Glennies Creek.

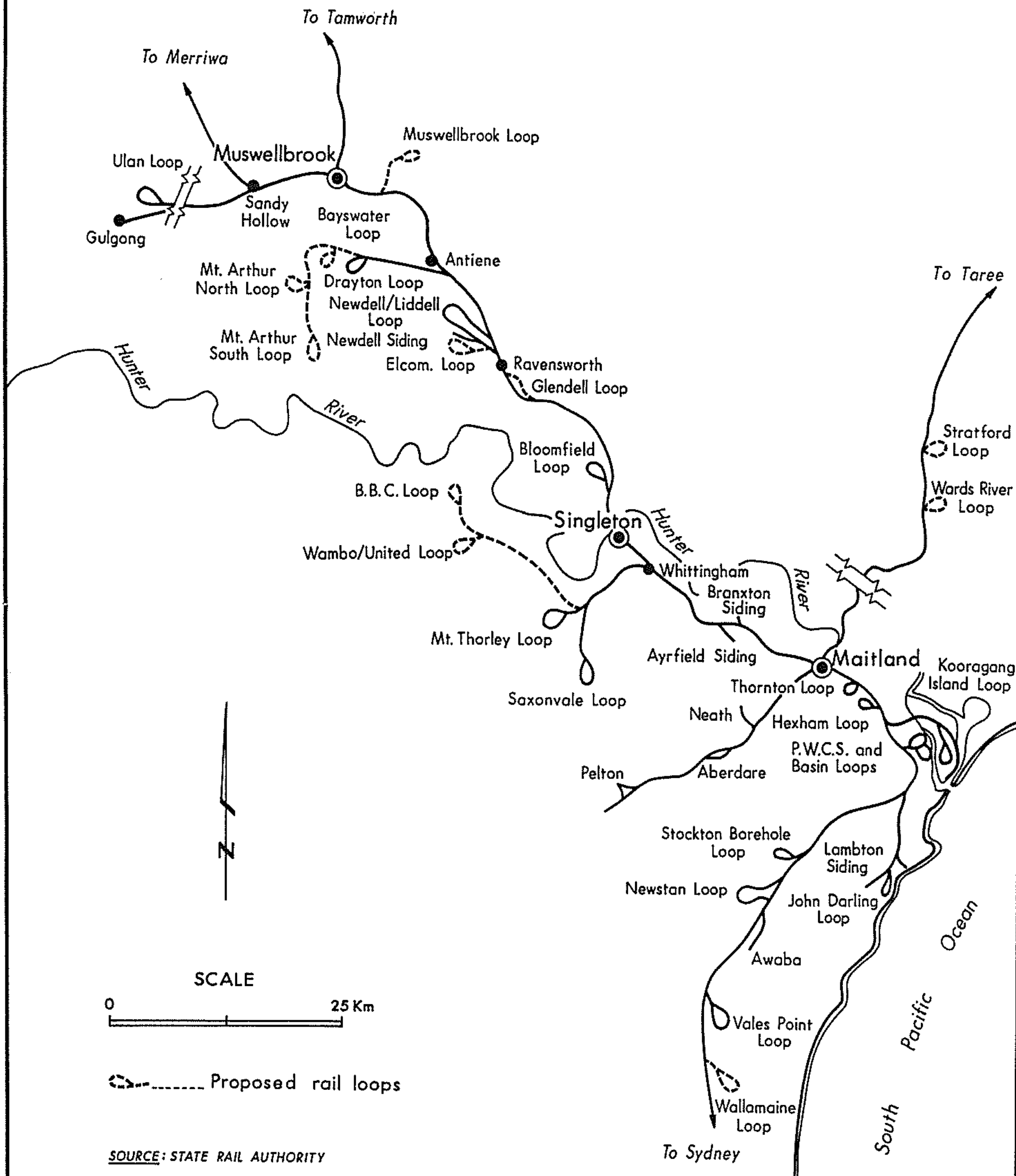
It is understood that Nobles Crossing and the railway crossing at Middle Falbrook Road are subject to flooding twice a year.

Bridgman Road and Middle Falbrook Road operate at Level of Service A (freeflow almost no delays). The section of New England Highway west of Bridgman Road has a Level of Service B (stable flow, slight delays); the section east of Bridgman Road operates at Level of Service C (stable flow, acceptable delays).

Bridgman Road south of the Residential Development is substandard for its existing role of feeding residents into the Arterial Road network (see Figure 6.A.1 – Appendix 6). Plans for upgrading this section of road up to the New England Highway by realignment and the provision of a four lane divided carriageway, have been drawn up by Council for implementation in the near future, subject to funding.

The high volume of right turning traffic from the New England Highway northbound into Bridgman Road, conflicting with a high volume of eastbound traffic along the New England Highway is a major cause of delays at this intersection.

The intersection of the New England Highway with Middle Falbrook Road has very good operational characteristics during both the morning and afternoon peak hourly periods.

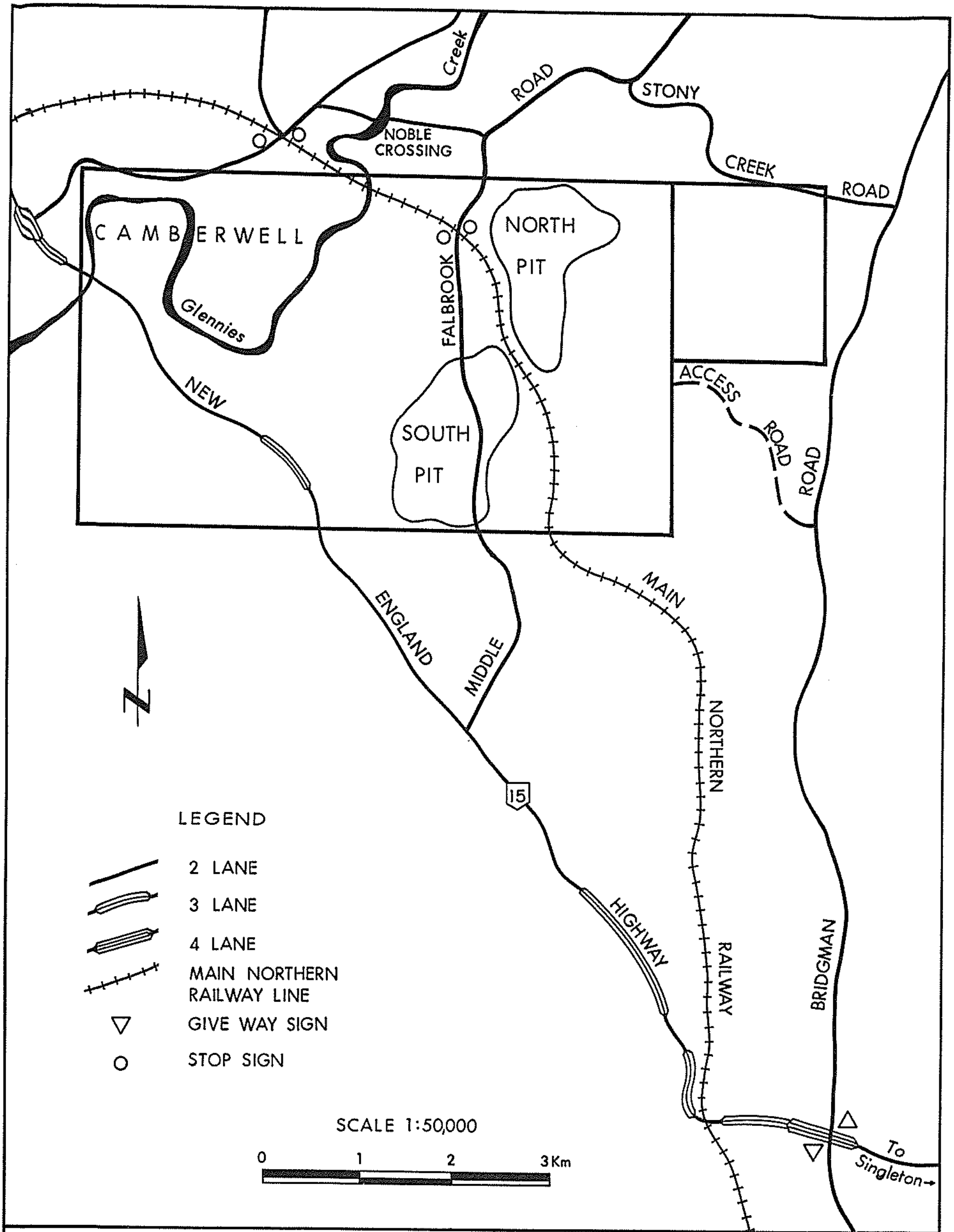


CAMBERWELL COAL PROJECT

RAIL INFRASTRUCTURE IN THE HUNTER REGION

Date

Figure 7.11.1



CAMBERWELL COAL PROJECT

STREET INVENTORY

Date AUG. '89

Figure 7.11.2

7.11.3 Emergency Road Haulage of Coal

An essential component of the Camberwell Coal Project is a commitment to coal transport by rail. There is no intention of using road transport during emergency situations because the Mine will have adequate stockpile provisions. Nevertheless, in discussions with the Singleton Council Engineer, it was indicated that Council would be concerned with the possibility of a rail strike which might create a political need for road transport of coal.

Accordingly, contingency plans for alternative coal haulage from the Mine Site which may be required in the unlikely event of an emergency such as an extended rail strike, were assessed. In this situation, it is anticipated that Bridgman Road would be used for transport access to and from the New England Highway.

Taken in isolation, the increase in traffic due to road haulage of coal from the Mine Site is unlikely to significantly affect road capacity within the area. The planned upgrading of the south section of Bridgman Road, and the recommended upgrading of its intersection with the New England Highway, should provide sufficient spare capacity for road haulage from all sites feeding into Bridgman Road should the need ever arise.

Of more concern to Council would be the detrimental effect on road surface quality as a result of heavy vehicle haulage. It is anticipated that pavement inspection would occur prior to the commencement of the road transport period, and be repeated after its completion. Any damage to the road surface agreed by the company to be incurred by its trucks would be repaired. If other heavy vehicles use the same road over the same period, the cost of repair would need to be assessed in proportion to the percentage of heavy vehicles using the road.

7.11.4 Impact Assessment - Transport

It is not expected that the Camberwell Project will have any major impact on the transport services in the area.

Bridgman Road will carry much of the additional traffic generated by the Project. Council has indicated that this road is able to accommodate the traffic generating potential of the development without the need for any upgrading.

Middle Falbrook Road is not affected by increased traffic as it is not intended to be used by Mine personnel, hence the level of service at its intersection with New England Highway should not change. Middle Falbrook Road will have to be repositioned once mining of the South Pit commences.

Future one-way peak hourly volumes for the major approach roads during both the construction phase and the operational phase were determined (Transport Environment Consultants, 1989) and are summarised in Table 7.11.1, together with the expected levels of service.

As indicated, the proposed mine will have no significant impact on these roads and would only marginally affect the intersection of New England Highway with Bridgman Road. The construction of a roundabout at this location will easily cater for the existing and future traffic conditions.

TABLE 7.11.1

CARRIAGEWAY LEVEL OF SERVICE

MAJOR STREETS		No of Effected Lanes	Peak Hour Volumes (One-way)	Level of Service
(i) Construction Phase				
New England Highway	– E of Bridgman Rd	2	1120 (E)	C
Bridgman Road	– N of New England Hwy	2	442 (S)	B
	– N of Hunter View Est.	2	283 (S)	A
(ii) Operational Phase				
New England Highway	– E of Bridgman Rd	2	1008 (E)	C
Bridgman Road	– N of New England Hwy	2	351 (S)	B
	– N of Hunter View Est.	2	171 (S)	A

7.12 SOCIO ECONOMICS

7.12.1 Introduction

In 1987 27.6Mt of coal (33% of the NSW total output) was produced in Singleton Shire from 13 separate operations. Of this total output, 25% was used for power generation – representing 38% of NSW's power from coal.

There are currently a number of new mines proposed for Singleton Shire. It is recognised that the socio-economic impact of the Camberwell Project will be affected to a greater or lesser extent by these proposals. The effect on labour supply and the demand for housing and community facilities will, however, depend on how many projects proceed and the timing of these.The Shire Council anticipates the establishment of at least four new mines in the period 1990-1995.

The production of coal from the Camberwell Project will provide employment opportunities for workers residing in Singleton Shire. It will also provide employment opportunities for workers living in neighbouring Shires such as Cessnock and Muswellbrook.

In assessing the impact of the proposed development the following issues have been considered:

- employment situation;
- demographic characteristics;
- economic impact;
- accommodation and housing; and
- community services and facilities.

Figures provided refer principally to Singleton Shire since this is the area most likely to be affected by the proposal. Mining statistics are based on the Singleton North West district as identified by the Joint Coal Board.

7.12.2 Employment Characteristics

Table 7.12.1 indicates the scale of mining operations in the Singleton North West District both in terms of value of production and total numbers of employed.

An analysis of employment figures by industry for Singleton Shire residents (Table 7.12.2) indicates that the mining section is the most significant employer of Singleton residents and that as at 1986 some 1,700 Singleton Shire residents worked in the mining industry.

Information presented to the Rixs Creek Inquiry (1989) by Singleton Shire Council indicated that at the time of the Inquiry the mining industry directly employed about 2,000 persons in Singleton Shire, representing about 23% of the workforce. Of this workforce, less than half live in the Shire.

An analysis of Tables 7.12.1 and 7.12.2 show that the mines of the Singleton North West District attract workers from the Local Government areas of Muswellbrook, Cessnock and as far afield as Newcastle (Singleton Shire Council 1988).

These results are not inconsistent with a 1982 study by Gibbs and Wiggers who concluded that:

- 60% of open cut mine workers came from within the region: 56% of these were from Singleton, 27% from Muswellbrook and 12% from Cessnock.
- 40% of open cut requirements were met by immigration: 50% of professional workers and 70% of skilled tradesmen came from outside the region.
- 75% of those workers who came from outside the region chose to live in Singleton Shire.

TABLE 7.12.1

MINES & EMPLOYMENT, SINGLETON NORTH WEST DISTRICT

	No of Mines	Total Employed	Total Open Cut	Total Underground
June 1987	25	6,064	4,016	2,048
June 1988	22	5,396	3,776	620

TABLE 7.12.2

SINGLETON SHIRE – WORKFORCE BY INDUSTRY (1986)

	Singleton			
	Male	Female	Total	%
Agriculture, Forestry	477	256	733	9.7
Fishing, Hunting, Mining	1,663	69	1,732	22.8
Manufacturing	182	68	250	3.3
Electricity, Gas, Water	346	43	387	5.1
Construction	412	58	470	6.2
Wholesale/Retail	530	560	1,090	14.4
Transport & Storage	220	56	276	3.6
Communication	37	18	55	.7
Finance, Property & Business	169	208	377	5.0
Public Administration, Defence	828	170	998	13.1
Community Services	186	489	675	8.9
Recreation Personnel, Other	94	233	327	4.3
Non-classifiable	43	20	63	0.8
Total (including not stated)	5,284	2,313	7,597	100

Effect of the Proposed Development on Employment

The proposed development will directly employ up to 250 construction workers required during the 15 month construction period. It is estimated that some 65% of the construction workforce will be recruited locally, and so reduce numbers of unemployed unskilled workers in the area in the short term. While figures for unemployment are not available it would appear from Table 7.12.1 that mine closures have recently reduced job opportunities in the area. The project has the potential to attract some of these displaced workers.

At full production the Camberwell Project will employ 299 people. If the trends identified by Gibbs and Wiggers are found to apply to the Camberwell Project, it can reasonably be expected that the permanent workforce will comprise residents from Singleton Shire as well as those from Cessnock, Muswellbrook and Newcastle. In addition a number of mine employees particularly in the professional and skilled trade categories will be recruited from outside the region and most probably choose to reside in Singleton Shire. Recent discussion with Singleton Council has indicated that the supply of "community workers" into Singleton has decreased and it can reasonably be expected that in the future, greater numbers of workers employed at mines in Singleton Shire will reside in the Shire.

Demographic Characteristics

The age structure of the Singleton Local Government area is shown in Table 7.12.3. The age profile of the area compared with that of the Hunter region and the rest of Australia is shown in Table 7.12.4.

The population of Singleton Shire could generally be described as young with more than 70% being less than 39 years of age. The proportion of all people less than 39 years is much greater than for the Hunter Region and for Australia as a whole. The proportion of those in the 50-59 group and 60+ group is very significantly less than for either the Hunter Region or Australia as a whole. The large proportion of the population in the 10-15 and 15-19 group suggests that a pool of "local labour" may be available in the short to medium term to provide a local labour source for developments such as the Camberwell Project.

Impact of the Proposal on Population

Any population changes as a result of the movement of construction workers into the area would be of a temporary nature and their impact minimal.

Assuming 40% of the operational workforce will be new workers to the area, and assuming 90% are married and with an average family size of 1.6 children, population growth in the subregion will increase by about 387 persons. If 75% of these workers settle in Singleton Shire then the population of Singleton Shire should increase by some 290 (as 80 families) as a result of the Camberwell Project.

TABLE 7.12.3

AGE STRUCTURE OF SINGLETON LOCAL GOVERNMENT AREA (1986)

Age Groups	Male	Female	Total	%
0-4	844	787	1,631	9.4
5-9	776	744	1,520	8.8
10-14	815	817	1,632	9.4
15-19	866	691	1,557	9.0
20-24	785	627	1,421	8.2
25-29	832	753	1,585	9.2
30-39	1,631	1,428	3,059	17.7
40-49	1,004	803	1,807	10.5
50-54	347	311	658	3.8
55-59	325	327	652	3.8
60-64	260	233	493	2.9
65-69	193	224	417	2.4
70-74	157	185	342	2.0
75-79	87	148	235	1.4
80-84	51	102	153	0.9
85+	29	95	124	0.7
Total	9,002	8,275	17,277	100

TABLE 7.12.4

COMPARATIVE AGE PROFILE FOR SINGLETON (1986)

	Singleton %	Hunter %	Australia %
0-9	18.2	15.0	15.1
10-19	18.4	16.3	16.7
20-29	17.4	15.8	16.5
30-39	17.7	15.2	15.8
40-49	10.5	11.1	11.6
50-59	7.6	9.7	9.3
60+	10.3	16.7	15.1

Impact Assessment – Socio Economic

Economic

The large initial capital investment of M$127 and ongoing expenditure will contribute to the substantial economic impact of coal mining in the region. The impacts will be both direct and in direct and will be spread widely throughout the economy.

The economic impact can be divided into a number of component parts:

- *Initial capital expenditure during construction.* Construction expenditure is estimated at M$127 over 3.5 years.
- *Operational workforce salaries.* Salaries of permanent employees will be the major ongoing economic effect of the development. Total expenditure on salaries once the mine reaches full production is estimated at $M14 pa.
- *Employment,output and income multipliers.* These multipliers indicate likely direct and induced economic effects. However, little assessment has been undertaken of their validity and accuracy in practice, despite their application to new coal projects within the Upper Hunter Region of NSW (Garlick, 1979; Croft and Associates 1986). In relation to the Camberwell Project the regional multipliers are likely to be in the general range 1.3 to 1.5. The induced effects will be distributed widely throughout the Hunter Region, whereas a significant proportion of the direct effect will be concentrated in Singleton Shire.
- *Government charges and revenue.* Total revenue generated by the mine will be substantial. The Federal Government will derive income in the form of company tax, excise, income tax and export duty. The State Government will benefit through royalties, payroll tax and receipts from transport and port charges. Local Government will benefit through increases in its rate revenue.

The development of the Camberwell Mine is an important addition to the economic mining base of Singleton on land which does not have a prime value for economic agricultural use. The mine will be an important source of both direct and indirect income and will serve to reinforce the importance of mining as the most significant economic activity and employer within Singleton Shire. Government revenues from the development will be substantial.

Socio Economics

The Camberwell Project will provide for a continuation of the established pattern of employment in the Singleton and neighbouring Local Government areas. The Project will primarily provide employment for Singleton Shire residents. Its potential to employ a proportion of those Singleton Shire residents currently approaching working age is significant.

The Project will generate substantial economic benefits to Government revenue within the Hunter Region.

7.13 HOUSING AND COMMUNITY SERVICES

7.13.1 Housing

In the years 1976-1986 Singleton Shire's population grew by approximately 44% to 17,277 persons. Demand for housing and housing land in the subregion increased particularly rapidly in the period 1980-1982. In response to this, Singleton Shire Council established many home sites and set up a land bank which has the capacity to meet projected population growth.

In recent years demand for residential land has focused on rural residential land (ie. hobby farms) rather than for conventional allotments.[37] Despite a potential population expansion in the years to 1995 that could equate to the expansion experienced in the last 10-15 years, the Shire would appear to have the capacity to meet demands for owner occupied housing which might arise from the Camberwell Project. The extent to which this capacity may be stretched will depend entirely on the number of coal mines and other proposed developments that will in fact proceed in the next 5 years.

37 Singleton Shire Council 1988

To meet projected demands the Shire does however require further provision of:

- crisis accommodation for disadvantaged groups;
- medium term low cost temporary accommodation; and
- additional low cost rental housing.

7.13.2 Community Services & Facilities

In Section 7.12 it was stated that the Project could lead to an increase in the Singleton Shire population of some 59 families (214 people). In assessing the impact of the proposal on existing community services it is therefore necessary to focus on the facilities which are particularly required by families.

7.13.3 Education & Pre-Education

There are already two pre-schools and an occasional child care centre operating in the Shire. In its 1988 submission to the Hunter Area Assistance Scheme, Singleton Council indicated that an additional pre-school and more occasional care was required.

There are a number of schools in Singleton Shire. The enrolments at these schools and others in the Upper Hunter Valley that could be used by families of employees of the Camberwell Project are shown in Table 7.13.1.

Singleton High School has experienced significant growth in the last 10 years and Singleton Council has indicated that a second high school is probably needed.

TABLE 7.13.1

SCHOOL ENROLMENTS – UPPER HUNTER VALLEY 1979-1988

	1979	1986	1988
Primary Schools			
Broke	49	91	96
Jerry's Plains	40	40	47
King Street Singleton	676	550	507
Ravensworth	15	16	closed
Singleton	300	320	379
Singelton Heights	292	550	542
Muswellbrook	647	550	556
Denman	196	215	207
South Muswellbrook	534	600	579
St Xaviers Singleton	272	246	236
Singleton Catholic Junior	205	168	175
St James Muswellbrook	289	361	
Martindale		27	27
Sandy Hollow		65	54
High Schools			
Singleton	804	1,135	1,217
Muswellbrook	828	1,008	972

7.13.4 Health Services

Singleton Shire is well serviced with a full range of Health Services including a hospital, community health centre, baby health centre and school dental service clinic. A wide variety of medical and paramedical specialist services operate in the Shire.

The immigration of a number of families, as may occur with the development of the Camberwell Project, may generate need for more obstetric hospital and specialist services.

7.13.5 Community Infrastructure

The Singleton area has a wide range of facilities for its community. These include:

- parks, sporting fields and other spaces totalling 25ha;
- licenced clubs, hotels and sport and hobby clubs; and
- arts and musical society, theatrical society, museum, and library.

The rural community halls are also an important community resource.

7.13.6 Impact Assessment – Housing and Community Services

It is not anticipated that development of the Camberwell Project would result in any adverse effect on the housing and community services available within the district.

The chief variable regarding potential for straining community services and housing availability is the number of major projects that proceed within the Shire in the next few years. This cannot be predicted with accuracy at this stage.

While it does not appear that any of the district's facilities would be excessively strained by development of the Project, the following services may experience some need for expansion (as would be the case for population expansion generated by any other significant development):

- crisis accommodation for disadvantaged groups;
- medium term low cost temporary accommodation;
- additional low cost rental housing;
- additional high school facilities;
- obstetric hospital and specialist services.

8. ENVIRONMENTAL MONITORING PROGRAMME

An ongoing environmental monitoring programme will continue for the life of the Camberwell Project. The results of this monitoring will be required to be submitted at regular intervals to the SPCC, the DM&E and Singleton Shire Council. The nature of monitoring required will be detailed in the approvals and licences issued by these authorities.

The monitoring programme will include the following:

Air Quality

A meteorological monitoring station will be established on site to automatically record wind speed and direction. Rainfall will also be routinely monitored.

The dust gauge monitoring programme will be continued for the life of the mine. Assessment of monitoring results once the operation commences will dictate the need to extend or otherwise modify the number and locations of dust gauges.

Water

Water quality monitoring will be required from suitable locations upstream and downstream of the Mine, to determine any influence on the local waterways as a result of the operation of the Project. Groundwater quality and flow rates will also be required to be monitored.

A water monitoring programme for the life of the operation will be developed in conjunction with the SPCC as part of the licensing procedure.

Geochemical

Although it is apparent that geochemical issues are unlikely to be a concern, an operational monitoring programme will be conducted to confirm expected geochemical behaviour of materials disturbed.

Overburden monitoring will involve periodic sampling of overburden and interburden ahead of the mining face. For monitoring purposes, samples will be collected from blast drill hole cuttings and analysed for Net Acid Producing Potential (NAPP) and salinity. A site specific testing procedure will be developed during the early stages of the mine operation.

The quality of pit water and all spoil dump drainage will be monitored during the operation. Initially the chemical parameters determined will include pH, electrical conductivity, TDS, Na, Ca, Mg, SO_4, CL, Al, Zn, As and Cu. This monitoring will be reviewed at six monthly intervals. Ongoing overburden and interburden monitoring will identify any lithological units requiring special handling.

Noise and Vibration

A noise monitoring programme will be established in conjunction with SPCC as soon as construction activities commence. Noise monitoring sites will be determined by assessing affected residences that remain occupied within the area of influence of mine activities. These sites will undoubtedly change as activities influence different areas and land ownership arrangements change.

Prior to any major construction occurring residences likely to be affected by ground vibration and airblast overpressure will be surveyed to allow ongoing monitoring of any structural damage.

An ongoing monitoring programme for noise levels, ground vibration and airblast overpressure will be maintained by the CCJV's environmental officer. Results from this programme will be submitted to government authorities as part of the statutory licence and approval conditions.

Rehabilitation

Rehabilitation field trials will be directed towards development of optimal rehabilitation techniques. These will include amelioration of material deficiencies by varying rates of gypsum, fertiliser type and application rates, optimal thickness of topdressing materials, pasture seed mixes and the direct seeding of tree and shrub species. Trials will be undertaken on the outer faces of out of pit overburden dumps.

Monitoring of the effectiveness of site rehabilitation will be accomplished by regular aerial photography and ground measurement of vegetation density and species diversity within specified plots. Measurement of the growth rates of stock over specified periods will further verify viability of recreated pasture.

Periodic testing of overburden, interburden and topdressing materials will be undertaken over the life of the Mine. This will ensure that any deleterious horizons are identified and that adjustments to fertiliser and gypsum rates can be made if necessary.

The rehabilitation of the land to agricultural capability and the need for the CCJV to efficiently manage the agricultural lands that will be under their guardianship, will provide a mechanism for monitoring any deleterious effects of the Mine's operation on agricultural viability in the area.

The Joint Venture is committed to maintaining a responsible and high standard of environmental management. Its ongoing monitoring programme and liaison with the local community and government representatives will be sensitive to and reflect this commitment.

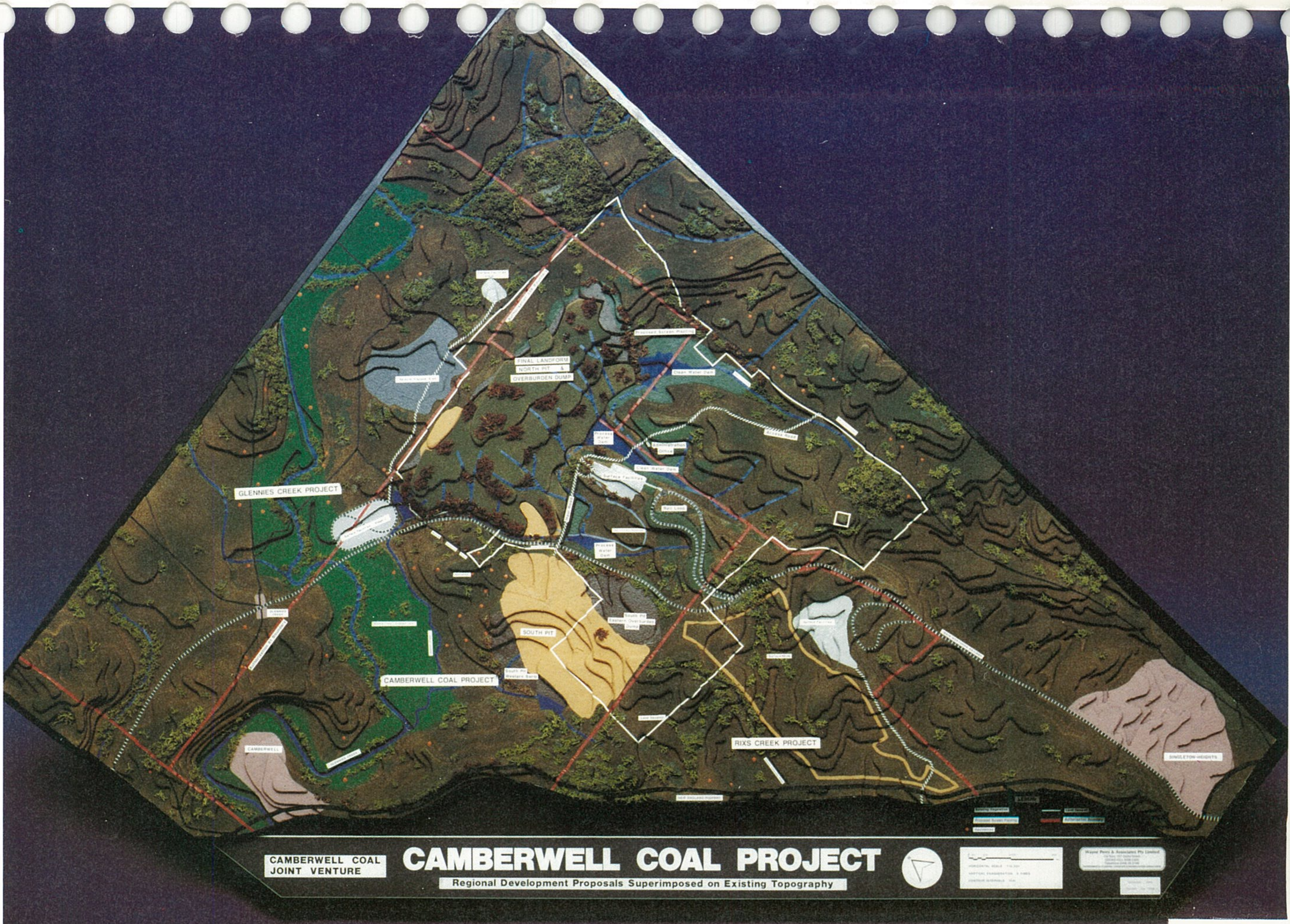

FINAL LANDFORM
NORTH PIT &
OVERBURDEN DUMP
GLENNIES CREEK PROJECT
SOUTH PIT
CAMBERWELL COAL PROJECT
RIXS CREEK PROJECT
CAMBERWELL
SINGLETON HEIGHTS
CAMBERWELL COAL
JOINT VENTURE
CAMBERWELL COAL PROJECT
Regional Development Proposals Superimposed on Existing Topography

PLATE 8.1.1

9. PROJECT TEAM AND REFERENCES

PROJECT TEAM

Engineering:

S.J. Coffey and Associates

Crooks Michell Peacock Stewart

Environment:

Epps & Associates Pty. Ltd.

Geological:

Standas Pty. Ltd.

P.J. Brooks & Associates

In addition to the above Consultants, the following reports have been prepared to assist Southland Coal in preparation of the Environmental Impact Statement.

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Nigel Holmes & Associates Pty Ltd (1989)
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Richard Heggie Associates Pty Ltd (1989)
"Noise Impact Statement" Camberwell Coal Project
"Assessment of Blasting Impact" Camberwell Coal Project

Mitchell McCotter & Associates Pty Ltd
"Southland Coal Pty Ltd: Water Quality Monitoring Results" (Camberwell Project) (1987)
"Southland Coal Pty Ltd: Water Management Study" (1989)

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Appendix 1

Geochemical Assessment of Waste Material

Study Approach

The investigation involved laboratory testing of samples of overburden and interburden. The details of the sampling and testing programmes are outlined below.

Sample Selection and Preparation

Samples of overburden, interburden and coal seam partings were collected from drill core material. Individual profile samples were collected from 4 bore holes. The sample descriptions and sample intervals are given in Table 1.A.1.

The full geological profile was sampled from borehole DDH 132 and specific interval samples were taken from DDH 68, 114 and 115. The profile samples were collected from a number of drill holes to represent the major overburden and interburden units to be mined at Camberwell. The stratigraphic units represented by each sample are given on Table 1.A.1. The profile samples were prepared by taking sub-samples from each 1m interval and pooling these into the individual depth sample.

A total of 14 samples were collected and crushed to nominal 4mm size for analysis.

Testing Programme

The individual samples were analysed for total sulphur, acid neutralising capacity (ANC) and saturated extract pH and electrical conductivity (EC). The net acid producing potential (NAPP) was calculated from the total sulphur content and ANC.

Water saturation extracts were prepared on each sample and analysed for the major solution parameters pH, electrical conductivity (EC), Ca, Mg, Na, K, HCO_3, SO_4 and Cl. Multi-element analyses were carried out on the saturation extracts for samples 1, 5, 8, 11 and 13. The multi-element composition of the liquid samples was determined by a combination of Atomic Adsorption, Optical Emission Plasma Spectrometry and Inductively Coupled Plasma-Mass Spectrometry by Analytical Services (WA) Pty Ltd.

TABLE 1.A.1

WASTE MATERIAL SAMPLE DESCRIPTION

Sample No.	Borehole	Depth Interval (metres)	Rock Type	Stratigraphic Unit
1	DDH 132	5.8 – 15.3	Pebble/conglomerate	Arties Seam Overburden
2	DDH 132	16.2 – 29.6	Sandstone/Siltstone	Arties-Upper Liddell Interburden and Partings
3	DDH 132	30.3 – 44.6	Sandstone/mudstone	Upper Liddell-Middle Liddell Interburden
4	DDH 132	46.0 – 52.9	Siltstone/mudstone	Middle Liddell-Lower Middle Liddell Interburden
5	DDH 132	54.2 – 67.2	Sandstone	Lower Middle Liddell-Lower Liddell Interburden
6	DDH 132	67.2 – 76.6	Sandstone/siltstone	Lower Middle Liddell-Lower Liddell Interburden
7	DDH 132	76.6 – 86.0	Siltstone/mudstone	Lower Liddell-Upper Barrett-Lower Barrett Interburden
8	DDH 132	86.0 – 92.6	Sandstone/mudstone	Upper Hebden Partings
9	DDH 132	92.6 – 110.6	Sandstone/conglomerate	Upper Hebden-Lower Hebden Interburden
10	DDH 132	110.6 – 118.6	Siltstone/Carb. mudstone	Lower Hebden Partings
11	DDH 68	9.0 – 10.5	Mudstone/Carb. mudstone	Arties Seam Overburden
12	DDH 68	10.5 – 16.75	Sandstone/mudstone	Arties Seam Partings
13	DDH 114	13.3 – 25.69	Sandstone	Middle Liddell Seam Overburden
14	DDH 115	65.40 – 65.72	Mudstone/Carb. mudstone	Upper Barrett-Lower Barrett Interburden

Appendix 2

Soils

Specific Soil Descriptions

Specific Soil Profile Descriptions

Dy 3.22

0-16cm	Dark brown (10YR 3/4) (m) fine sandy loam, pH 6.5 very weak consistence, brittle shear, hardsetting, apedal massive structure, earthy fabric, bioturbated. No stones, cracks <2mm, abundant roots. Sharp boundary.
16-22cm	Dull yellow orange 10YR 6/3(m), fine sandy loam, pH 7 very weak consistence, brittle shear, (dry) apedal massive structure, earthy fabric, bioturbated. No stone or concretions. Abundant roots. Sharp boundary.
22-42cm	Yellowish brown (10YR 5/6 (moist) with 10YR 5/4 mottle, diffuse throughout, clay loam, pH 7.5 moderate consistence, labile sheer (slightly moist). Strong pedality peds sub-angular blocky, 20-50mm, breaking to 10-20mm, rough faced, few cutans, cracks 2-5m, no stones or concretions, difficult to wet and work – slimy bolus. Field Dispersal Guide 2. Many roots, in ped and ex ped. Clear wavy boundary.
42-52cm	Yellowish brown 10YR 5/6 (moist) with 10YR 5/4 disuse mottle sandy clay loam, pH 8 moderate consistence, crumbly shear. Moderate pedality peds polyhedral 20-50mm dismatre, secondary polyhedral. 10-20mm cracks 2-5mm. Field dispersal grade 2, exposed surface has slightly wormy appearance. 10-20% stones (pebbles from conglomerate) and concretions (iron.manganese), sub-rounded-sub-angular, stratified, stones 2-20mm. Roots common gradual boundary. Difficult to wet and work – slimy bolus.
52-96cm	Yellowish brown 10YR 5/6 (moist) sandy loam. pH 8 moderate consistence, brittle shear. Moderate pedality, polyhedral, rough faced peds, 20-50mm. No cutans. Cracks 2-5mm, 10-20% stones, stratified, 2-20mm, few roots. Clear boundary.
96-120cm+	Brown 10YR 4/6 (moist), with 10YR 6/3 mottle. Sandy clay loam, pH 8, strong consistence, unmodified shear (dry) strong pedality, no stones. Salt crystallization on exposure of C horizon.

Uc 4.24

0-7cm	Brown 7.5YR 4/4 (moist) sandy loam, pH 6.5. Very weak consistence, brittle shear, apedal massive structure, hardsetting, earthy fabric, cutans <2mm, no stones, abundant roots, clear boundary.
7-22cm	Dull brown 7.5YR 5/3 (moist) clayey sand. pH 6. Very weak consistence, brittle shear, apedal massive structure, earthy fabric, cracks <2mm, abundant roots, no stones. Clear boundary.
22-40cm	Dull yellowish orange 10YR 6/3 (moist) clayey sand, pH 6. Very weak consistence, brittle shear, apedal massive structure, earthy fabric, cracks <2mm, no stones.
40-60cm	Dull yellowish orange (10YR 6/3 (moist) with diffuse mottle. 10YE 6/6, light sandy clay, pH 6. Slightly wormy appearance to exposed surfaces. Weak pedality. Very strong consistence, no change shear. Peds sub-angular blocky 20-50 blocking 20-50mm, rough faced. 20-50% stones sub-rounded-sub-angular, stratified, 2-20mm diameter.

Db 1.22

0-17cm	Dark brown 10YR 3/4 (moist), fine sandy loam, pH 6. Very weak consistence, brittle shear, hardsetting. Apedal massive structure, earthy fabric, no stones, abundants roots, surface ploughed.
17-22cm	Dull yellow orange 10YR 6/3 (moist), fine sandy loam, pH 6.5. Very weak consistence, brittle shear (d), weak pedality. Polyhedral peds 20-50cm, rough faced, no cutans, porous, no stones, many roots. Field dispersal grade 2, sharp boundary.
22-35cm	Brown 7.5YR 4/4 (moist) clay loam. pH 6. Weak consistence, crumbly shear, weak pedality. No stones, field dispersal grade 2-3, clear boundary.
35-75cm+	Yellowish brown 10YR 5/6 (moist), fine sandy clay loam, pH 6. Weak consistence, crumbly shear, moderate pedality, field dispersal grade 2-3, no stones.

Um 6.23 Drainage plain

0-28cm	Dark brown 10YR 3/4 (moist) clay loam, pH 7 moderate consistence, crumbly shear (slightly moist). Weak-moderate pedality, friable surface, slightly sticky, rough faced peds. Polyhedral 20-50mm diameter, braking to 5-10mm diameter, no cutans, porous, cracks 2-5mm. Abundant roots inped/exped, no stones. Clear boundary.
28-58cm	Brown 10YR 4/4 (moist) clay loam, pH 7. Slightly sticky, moderate consistence, crumbly shear (dry) moderate pedality, polyhedral peds 20-50mm, breaking to 10-20mm, fine cutans, cracks 5-10mm, not porous, no stones, many roots inped, diffuse boundary.
58-100cm	Brown 10YR 4/4 (moist) clay loam, pH 7.5, slightly sticky. Moderate consistence, crumbly shear (dry), strong pedality, peds polyhedral 20-50un, secondary 5-10mm rough faced, cutans common, cracks 5-10mm, many roots. No stones.
100-150cm+	Bright brown 7.5YR 5/8 (moist), light clay, pH 8.0, field dispersal grade 3. Moderate-strong consistence, crumbly shear (dry), strong pedality, peds polyhedral 50-100mm, shear breaking to 20-50 and 10-20mm, rough faced, cracks 2-5mm. 20-50% stratified stones, sub-angular, 2-20mm drain. Numerous infilled old root and animal burrow channels throughout.

Group 2. Duplex Soils

Two groups of Duplex soils occur with the study area.

2(a)	Texture contrast profiles with fine sandy loam-clay-loam. A horizon, no A_2, and light-medium clay superplastic B horizons.
2(b)	Texture contrast profiles with hardsetting light texture A horizons, very pale frequently stony A_2 horizon, overlying sandy clay – medium clay, dispersible B horizons.

Distribution

Soils of group 2(a) occur in the northeastern corner of the lease area, on crests, and upper and lower side slopes of 5-15%. They also occur along the western edge of the study area. Soils of group 2(b) occur through the central portion of the lease area, on slopes of 10°.

General Characteristics

In addition to the characteristics listed above, group 2(a) soils may have saline B horizons (rare). B horizons are whole coloured or mottled depending on catenary position. The A horizons are subject to moderate-severe sheet erosion. There are extensive areas of ironstone float. Active gullies are developing on 1st and 2nd order drainage lines, incised to bedrock. There are minor areas of sandy skeletal soils on low spurs at the northern margin of the lease area.

Group 2(b) soils are generally shallow, with a maximum profile depth of 60-70cm. B horizons may be whole coloured or mottled, and are moderately-severely dispersible. This characteristic produces waterlogging of the A_2 horizon after rain. These soils have exceptionally low nutrient status in the A horizon.

Principal Profile Forms

Group 2(a) Dy 2.12, Dy 3.12, Db 2.11, Dy 4.22, Gn 3.14, Dr 3.12, Db 3.12, Uc 1.41.

Group 2(b) Dy 2.22, Dy 3.22, Dr 2.22, Uc 4.11.

Profile Descriptions

Group 2(a)

Dy 2.12

0-14cm Hardsetting surface. Brown 10YR 4/3 (moist), fine sandy loam, pH 6. Weak consistence, brittle shear, apedal massive structure, earthy fabric, no stones. many roots, sharp boundary.

14-37cm Brown 10YR 4/4 (moist), clay loam, light clay, pH 7. Mod-strong consistence (d), crumbly shear. Strong pedality, rough faced polyhedral peds, 20-50mm drain, few cutans, cracks 2-5mm, no stones or concretions. Field dispersal grade 2. Bolus slimy, difficult to work.

37-80cm Bright brown 10YR 5/8 (moist) 10YR 6/3 mottle, sandy clay (in situ) weathered sandstone) pH 6.5. Field dispersal grade 2. Moderate consistence, labile shear, moderate pedality. Bedrock at 80cm. Exposed surface wormy.

Dy 3.12

0-15cm Hardsetting surface, ironstone float, slight sheet erosion. Dark brown 10YR 3/3 (moist) sandy loam, pH 6. Very weak consistence, brittle shear, apedal massive structure, earthy fabric, <2% stones (including small caly-ironstone concretion fragments). Abundant roots. Sharp wavy boundary.

15-25cm Yellowish brown 10YR 5/6 (moist) with 10YR 6/2 mottle Sandy clay, pH 6.5. Field dispersal grade 2. Bolus slimy and difficult to wet. Weak-moderate consistence, crumbly shear. Weak-moderate pedality, rough face sub-angular-blocky peds, no cutans, no stones, many roots.

Dy 3.12 Friable surface, conglomerate pebble float

0-8cm Dark brown 10YR 3/3 (moist) loam, pH 6.5, slightly sticky, moderate consistence, crumbly shear (dry) moderate pedality, rough faced polyhedal peds 20-50mm diameter, breaking to 10-20mm, cracks <2mm, 2-10% stones (conglomerate pebbles) rounded-sub-rounded, many roots clear boundary.

0.25cm Dark brown, 7.5YR 3/4 light dry. pH 7.5, slightly stocky. Moderate consistence, labile shear. Moderate pedality, rough faced peds, no stones many roots. Gradual boundary. Bolus slimy and difficult to work.

25-35cm Dull yellowish brown, 10YR 5/4 (moist) light-medium clay. pH 7.5, slightly sticky. Moderate consistence, plastic shear. Moderate-strong pedality, <2% stones, roots common.

Dr 3.12

0-9cm Hardsetting, gravelly (ironstone), surface, moderate sheet erosion. Dull reddish brown 5YR 5/3 fine sandy loam, pH 6 moderate consistence, crumbly shear (sl. moist) weak pedality. Sub-angular blocky, rough faced reds, 50-100mm. No stones below surface. Roots common. Clear boundary.

9-39cm Dull reddish brown 5YR 4/3 (moist) with slight 10YR 6/3 mottle, pH 5.5, light clay, superplastic, sticky. Bolus is slimy and difficult to wet. Strong pedality, cutans common. Smooth faced peds, no stones, roots common.

39-45cm Bright reddish brown 5YR 5/8 (moist) medium clay, pH 5.5, sticky, bolus difficult to wet, superplastic, slight-mod consistence plastic shear, strong pedality, few roots.

Gn 3.14

0.1 3cm A horizon overlain by 5cm of wash from sheet erosion. Brown 7.5YR 4/4 (moist) clay loam, pH 6, field dispersed grade 2, strong consistence, brittle shear (dry) strong pedality, sub-angular blocky rough face porous peds, no cutans, 20-50mm diameter, breaking to 2-5mm, cracks <2mm, <2% stones including clay ironstone concretion fragments, (2-6mm) sub-angular, dispersed. Roots common inped/exped. Clear wavy boundary.

13-27cm Brown 7.5YR 4/6 (moist). Fine sandy clay loam, pH 6, field dispersal grade 2. Slightly sticky, strong consistence, no shear (dry). Strong pedality, rough faced polyhedral peds 20-50mm, breaking to 10-20mm, no cutans, cracks 2-5mm. <2% stones (including reworked concretion fragments). Clear boundary.

27-80cm Reddish brown 5YR 4/6 (moist) light clay superplastic, pH 6, field dispersal grade 3. Moderately sticky, strong coherence, no shear (dry). Strong pedality, smooth faced sub-angular <2mm, <2% stones/concretion fragments.

80cm+ Bright brown 7.5YR 5/6 (moist) light clay, moderately sticky, strong coherence, no shear (dry), strong pedality.

Group 2(b)

Dy 3.22 Hard setting surface

0-7cm Dull yellowish brown 10YR 4/3 (moist) fine sandy loam, pH 5.5. Slightly sticky, very weak coherence, crumbly shear (moist). Weak pedality, rough faced, sub-angular blocky peds, 20-50mm diameter, breaking to 10-20mm, no cutans. Cracks <2mm, no stones or concretions. Abundant roots. Sharp wavy boundary.

7-16cm Greyish yellow brown 10YR 4/3 (moist) fine sandy loam, saturated pH 6. Very weak coherence, crumbly, weak pedality, rough faced sub-angular blocky peds 20-50mm, no cutans, cracks <2mm, no stones, sharp boundary.

16-28cm+ Yellowish brown 10YR 5/6 with dull mottle 10YR 5/3 (mostly infilling and burrows etc) light clay pH 6.5, weak consistence, plastic shear, moderately sticky. Moderate pedality, peds rough faced, polyhedral 20-50mm, breaking to 5-10mm, no stones, many roots in and exped.

Uc 4.11 Hardsetting surface, profile developed on conglomerate

0-7cm Brownish black 10YR 3/2 (moist) fine sandy loam, pH 6 very weak consistence, crumbly (very moist), weak pedality in moist state, sub-angular blocky, rough face ped 50-100mm diameter, breaking to 5-10mm, no cutans, cracks <2mm, <2% stones, many roots. Sharp boundary.

7-11cm Greyish yellow brown 10YR 4/2 (moist) fine sandy loam pH 6.5, very weak consistence, crumbly shear (very moist). Weak pedality – rough faced sub-angular blocks peds, 50-100mm diameter, breaking to 5-10mm, no cutans, cracks <2mm, 2-10% stones. Clear boundary.

11-22cm Grey yellowish brown 10YR 4/2 (moist) sandy loam, gravelly pH 6.5. Very weak consistence, crumbly shear (very moist). Weak pedality, rough faced porous peds 20-50mm diameter. No cutans, 20-50% stones – mostly pebbles weathering out of conglomerate.

Other Uc 4.11 profiles have apedal massive structure, otherwise similar characteristics.

Dr 2.22 Hardsetting surface with some clay ironstone gravel float

0-10cm Brownish black 10YR 3/2 (moist) fine sandy loam, pH 6. Slightly sticky, very weak consistence, crumbly shear (moist) weak pedality rough faced polyhedral peds, 10-20mm diameter, no cutans, cracks <2mm, <2% stones many roots.

10-20cm Dull yellowish brown 10YR 5/3 (m) sandy loam with numerous stones, clay ironstone concretions concentrated at base (20-50% of material). pH 6.5, slightly sticky, very weak consistence, crumbly shear (moist) weak pedality. Stones sub-rounded-sub-angular 2-200mm diameter. Many roots. Sharp wavy boundary.

20-30cm Reddish brown 5YR 4/8 (moist) light medium clay, pH 7, moderately sticky, weak-moderate consistence, plastic shear moderate pedality. Peds rough faced, polyhedral, 20-50mm drain, breaking to 10-20mm, few cutans. No stones or concretions, many roots.

Group: Skeletal stony soils Uc 1.43, Uc 4.13

Distribution

This group of soils occurs along the ridge crust and upper spurs adjacent to the Middle Falbrook Road.

General Characteristics

The soils have developed on conglomerate which outcrops over about 60% of the ground surface. There is a large volume of pebble float derived from weathering conglomerate. Soils are shallow and coarse textured.

Uc 1.43 Hardsetting, gravelly surface.

0.12cm Brown 7.5YR 4/4 (moist) sandy loam, gravelly pH 5.5. Very weak consistence, brittle, apedal massive structure. 20-50% stones, dispersal 2-60mm, derived from conglomerate, roots common.

Appendix 3

Acoustics

Noise Level Surveys – Existing Background & Proposed Plant

Instrumentation

TABLE 3.A.1

NOISE LEVEL SURVEYS – INSTRUMENTATION

Instrument	Model	Manufacturer
Modular Precision Sound Level Meter Condenser Microphone	Type 2231 Type 4155	Brüel & Kjaer12mm Brüel & Kjaer
Sound Level Calibrator	Type 4230	Brüel & Kjaer
Sound Level Meter	700	Larsen Davis Labs
Sound Level Calibrator	CA250	Larsen Davis Labs
Precision Sound Level Meter	Type 2215	Brüel & Kjaer
Portable 2-channel Tape Recorder	CP430	Marantz

Survey Procedure

The surveys were conducted in accordance with Australian Standard 1055-1984 "Acoustics – Description & Measurement of Environmental Noise", the State Pollution Control Commission (SPCC) Environmental Noise Control Manual, and Australian Standard 1217-1985 "Acoustics – Determination of Sound Power Levels of Noise Sources".

Background Noise Levels

Noise level surveys were conducted at a number of residences closest to or potentially most affected by the proposed operation. Measurements were made on 18 and 19 April, 1989.

Locations BG1, BG2 and BG3 were used for intermittent measurements of ambient sound levels. Sampling was caried out at each site for 15 minute durations at various times throughout the visit.

At location BG4, a permanent monitoring station was installed with continuous sampling carried out over a 24-hour period. The sample interval was also of 15 minutes duration.

From the data obtained over the 15 minute sample period, the L_1, L_{10}, L_{90} and L_{eq} levels were determined. The L_1, L_{10} and L_{90} are statistical descriptors representing the noise levels exceeded for 1%, 10% and 90% of the monitoring duration. These levels are normally referred to as the maximum, average maximum and average minimum levels respectively. The L_{90}, or average minimum, is used to approximate the background A-weighted sound pressure level.

The L_{eq} level is the equivalent continuous sound level over the monitoring period.

The results of the surveys are summarised in Table 3.A.2

TABLE 3.A.2

NOISE LEVEL SURVEYS – EXISTING BACKGROUND

Monitoring Position Date & Time		Noise Levels dB(A) L_{eq}	L_1	L_{10}	L_{90}	Weather Conditions
BG4						
18.4.89	1205	56	68	60	36	Temperature 21.5°C
	1220	49	62	52	33	Relative Humidity 45%
	1235	52	66	55	34	Wind 1.5-2m/s with
	1250	54	67	57	34	gusts to 3m/s (SW)
	1305	53	67	56	33	
	1320	48	63	49	33	
	1335	44	57	48	33	
	1350	43	53	47	33	
	1405	38	49	41	33	
	1420	37	51	35	33	
	1435	47	59	51	33	Temperature 23°C
	1450	46	59	49	33	Relative Humidity 42%
	1505	35	44	36	33	Wind 0.5-1m/s (SW)
	1520	36	46	39	33	
	1535	43	57	40	33	
	1550	41	54	40	33	
	1605	44	61	44	33	
	1620	40	53	42	34	
	1635	46	57	50	35	
	1650	38	47	38	36	
	1705	49	62	51	36	
	1720	41	52	41	36	
	1735	42	55	41	36	Temperature 19.5°C
	1750	42	54	43	36	Relative Humidity 50.5%
	1805	45	55	46	41	Wind 0.5-1m/s (SSW)
	1820	52	66	54	43	
	1835	43	46	44	41	
	1850	45	58	47	38	
	1905	52	63	57	36	
	1920	52	64	54	36	
	1935	39	51	37	36	
	1950	48	61	53	36	
	2005	54	63	61	36	
	2020	37	49	36	35	
	2035	50	64	47	35	
	2050	36	37	37	35	
	2105	35	37	36	35	
	2120	49	62	52	35	
	2135	35	38	35	34	
	2150	35	42	35	34	
	2205	50	62	51	34	
	2220	50	61	51	34	Temperature 15°C
	2235	35	39	36	34	Relative Humidity 71%
	2250	46	56	52	34	Calm Conditions
	2305	35	39	37	34	
	2320	55	69	60	34	
	2335	48	61	54	34	
	2350	48	61	54	34	

Table 3.A.2 (continued)

Monitoring Position Date & Time		Noise Levels dB(A) L_{eq}	L_1	L_{10}	L_{90}	Weather Conditions
BG4						
19.4.89	0005	47	57	53	34	Temperature 15°C
	0020	47	60	45	34	Relative Humidity 71%
	0035	44	60	42	34	Calm Conditions
	0050	49	62	50	34	
	0105	45	60	47	33	
	0120	34	34	34	33	
	0135	49	61	53	34	
	0150	35	40	36	34	
	0205	34	37	35	33	
	0220	56	48	34	33	
	0235	34	36	35	33	
	0250	46	60	44	34	
	0305	34	36	35	33	
	0320	34	36	34	33	
	0335	49	64	45	34	
	0350	50	65	40	33	
	0405	35	41	38	34	
	0420	34	36	35	33	
	0435	48	58	54	34	
	0450	34	37	35	33	
	0505	49	63	45	33	
	0520	44	55	45	33	
	0535	41	54	39	34	
	0550	39	51	40	34	
	0605	51	65	52	35	
	0620	51	64	56	36	
	0635	50	64	54	35	
	0650	50	62	55	36	
	0705	50	64	51	35	
	0720	40	51	42	34	
	0735	41	52	44	34	
	0750	50	63	54	35	
	0805	41	54	44	34	
	0820	53	70	52	34	
	0835	46	58	50	35	
	0850	49	65	50	34	
	0905	45	60	45	34	
	0920	49	61	54	33	
	0935	53	64	57	35	
	0950	51	63	55	34	
	1005	54	66	58	35	Temperature 20°C
	1020	59	71	63	36	Relative Humidity 74%
	1035	57	70	61	37	Wind 2-3m/s with
	1050	58	70	62	36	gusts to 5m/s (SW)
	1105	62	74	66	36	
	1120	61	73	66	40	
	1135	63	72	67	46	
	1150	65	74	70	44	

TABLE 3.A.3

NOISE LEVEL SURVEYS – EXISTING BACKGROUND LEVELS

Monitoring Position	Day and Time		Noise Levels dB(A) L_{eq}	L_1	L_{10}	L_{10}	Major Noise Sources	Weather Conditions
BG1	18.4.89	1100	53	56	40	31	Two cars passing, birds, trees rustling	Temperature 21.5°C Relative Humidity 45% Wind 1.5-2m/s with gusts to 3m/s (SW)
BG2	18.4.89	1130	50	53	40	28	Birds, one car, rustling grass, blasts from Singleton range audible	
BG3	18.4.89	1213	38	45	39	31	Trees rustling, birds, insects, distant traffic on highway	
BG1	18.4.89	1442	60	73	47	30	Birds, cars	Temperature 23°C Relative Humidity 42% Wind 0.5-1m/s (SW)
BG2	18.4.89	1515	30	38	31	27	Birds, rustling grass	
BG3	18.4.89	1600	54	68	45	33	Birds, three cars, distant highway traffic, truck	
BG1	18.4.89	1730	64	78	60	36	Cars, birds, frog, insects, dog barking in distance	Temperature 19.5°C Relative Humidity 50.5% Wind 0.5-1m/s (SW)
BG2	18.4.89	1800	58	66	54	42	Cows, insects, birds, cars	
BG3	18.4.89	1826	53	59	56	50	Insects dominant, distant traffic, train	
BG1	18.4.89	2220	51	62	40	27	Cars, frogs	Temperature 15°C Relative Humidity 71% Calm conditions
BG2	18.4.89	2248	41	55	38	29	Frogs, insects, distant traffic	
BG3	18.4.89	2315	32	40	34	28	Frogs, insects, distant traffic	
BG1	19.4.89	1003	63	76	52	32	Wind rustling trees and grass, cars, birds,truck	Temperature 20°C Relative Humidity 74% Wind 2-3m/s with gusts to 5m/s (SW)
BG2	19.4.89	1030	35	43	38	30	Birds, rustling trees and grass, blasts from Singleton range	
BG3	19.4.89	1052	45	55	46	38	Birds, wind rustling, trees and grass, distant traffic, insects, train	

TABLE 3.A.4
NOISE LEVELS OF PROPOSED PLANT

Item	Octave Band Sound Power Level dB re 10^{-12}									
	A	31	63	125	250	500	1k	2k	4k	8kHz
Shovel	117	104	104	99	96	105	113	108	106	110
Cat 834B	107	112	109	105	103	104	102	102	98	89
Cat 789*	115	112	108	113	114	116	110	106	105	96
D11N	107	112	109	105	103	104	102	102	98	89
Cat 637E	111		116	115	109	107	106	104	97	92
D10N	109	114	115	114	101	105	104	102	94	88
Cat 992C	113	111	111	119	112	111	107	106	98	90
Hough 580	116	114	114	122	115	114	110	109	101	93
Cat 777B 85T	121	112	118	119	114	116	113	117	107	98
Cat 773	105	97	103	105	106	102	100	95	90	77
Cat 16G	113	105	111	113	114	110	108	103	98	85
10t truck	109	112	119	112	109	104	103	102	97	87
BE 49R Drill	120	97	103	111	102	107	111	113	115	113
Screen & Crusher	117	112	106	108	109	115	110	106	110	96
Washery & Processing (Enclosed)	111	127	119	116	111	111	105	102	97	91
Loaded Coal Train	109	121	122	116	112	108	101	96	90	81

* Up to 240 tonne class truck

Received Noise Levels and Exceedances

TABLE 3.A.5

RECEIVER LOCATION R1 - DULWICH

Year	Received Level dB(A)	Design Goals dB(A) Day	Design Goals dB(A) Night	Exceedance dB(A) Day	Exceedance dB(A) Night
-1 start	49	40	35	9	14
-1 end	49	40	35	9	14
1	49	40	35	9	14
2	38	40	35	-	3
5	40	40	35	-	5
10	45	40	35	5	10
13	47	40	35	7	12
17	34	40	35	-	-
20	38	40	35	-	3

TABLE 3.A.6

RECEIVER LOCATION R2 - HILLVIEW

Year	Received Level dB(A)	Design Goals dB(A) Day	Design Goals dB(A) Night	Exceedance dB(A) Day	Exceedance dB(A) Night
-1 start	47	40	35	7	12
-1 end	47	40	35	7	12
1	45	40	35	5	10
2	40	40	35	-	5
5	42	40	35	2	7
10	48	40	35	8	13
13	51	40	35	11	16
17	37	40	35	-	2
20	41	40	35	1	6

TABLE 3.A.7

RECEIVER LOCATION R3 - LOT 6 (THURLOW)

Year	Received Level dB(A)	Design Goals dB(A) Day	Design Goals dB(A) Night	Exceedance dB(A) Day	Exceedance dB(A) Night
-1 start	42	40	35	2	7
-1 end	43	40	35	3	8
1	43	40	35	3	8
2	38	40	35	-	3
5	41	40	35	1	6
10	50	40	35	10	15
13	56	40	35	16	21
17	39	40	35	-	4
20	43	40	35	3	8

TABLE 3.A.8

RECEIVER LOCATION R4 - LOT 7 (WILLMOT)

Year	Received Level dB(A)	Design Goals dB(A) Day	Night	Exceedance dB(A) Day	Night
-1 start	33	40	35	-	-
-1 end	35	40	35	-	-
1	40	40	35	-	5
2	31	40	35	-	-
5	32	40	35	-	-
10	40	40	35	-	5
13	45	40	35	5	10
17	35	40	35	-	-
20	34	40	35	-	-

TABLE 3.A.9

RECEIVER LOCATION R5 - BELLEVUE (PEEBLES)

Year	Received Level dB(A)	Design Goals dB(A) Day	Night	Exceedance dB(A) Day	Night
-1 start	27	40	35	-	-
-1 end	31	40	35	-	-
1	42	40	35	2	7
2	27	40	35	-	-
5	29	40	35	-	-
10	30	40	35	-	-
13	30	40	35	-	-
17	29	40	35	-	-
20	29	40	35	-	-

TABLE 3.A.10

RECEIVER LOCATION R6 - CAMBERWELL

Year	Received Level dB(A)	Design Goals dB(A) Day	Night	Exceedance dB(A) Day	Night
-1 start	23	40	35	-	-
-1 end	26	40	35	-	-
1	27	40	35	-	-
2	22	40	35	-	-
5	22	40	35	-	-
10	29	40	35	-	-
13	27	40	35	-	-
17	24	40	35	-	-
20	24	40	35	-	-

Appendix 4

Blasting Assessment

Blasting Emissions Criteria

Introduction

For many years an Australian Standard (AS 2187) has offered guidelines for the maximum safe ground vibration from blasting in respect to damage to structures. The Standard's original specification did not make sufficient allowance for a structure's tendency to amplify ground vibration, and this phenomenon has been included in the 1983 version of AS 2187. The Standard still contains no recommended maximum limit for airblast overpressure.

The SPCC has a responsibility under the *Noise Control Act 1975*, for the prevention, minimising and abatement of noise and vibration that may be harmful, offensive, or interfere with the comfort or repose of a person.

In 1985, the SPCC published guideline limits for both ground vibration and airblast overpressure. These guidelines are based on "comfort" rather than "damage" effects and were published in the Commission's Environmental Noise Control Manual. The SPCC guidelines are likely to be introduced on a National basis through the Australian Environment Council.

Guideline Limits

Human Comfort – SPCC Environmental Noise Control Manual

In summary, the experience of the SPCC to date suggests that;

i Blasting that causes airblast overpressure values in excess of 115dB (Linear) and ppv[38] ground vibration values in excess of 5mm/s cause serious annoyance to some people and may be regarded as offensive.

ii Environmental criteria of 115dB (Linear) airblast overpressure and 5mm/s ppv ground vibration are generally achievable in practice and are consistent with best practical technology currently available.

The criteria[39] for impact on residential premises are detailed in Table 4.A.1.

TABLE 4.A.1

LIMITING CRITERIA FOR THE CONTROL OF BLASTING IMPACT AT RESIDENCES

Time of blasting		Airblast overpressure (dB-Linear)	Ground vibration Peak Vector Sum (mm/sec)
Monday – Saturday	9am – 3pm	115	5
Monday – Saturday	6am – 9am	105	2
Monday – Saturday	3pm – 8pm	105	2
Sunday, Public Holiday	6am – 8pm	95	1
Any day	8pm – 6am	95	1

38 peak particle velocity

39 Chapter 154 of the SPCC Environmental Noise Control Manual relating to blasting was issued in its final form in May 1985.

A number of comments follow this table (ie. Table 4.A.1) in the SPCC Manual, including:

a. Comfort criteria have been adopted which are marginally lower than damage criteria. Department of Minerals & Energy's current damage criteria are: airblast overpressure 120dB (Linear); peak vector sum 10mm/s. The SPCC has no responsibility with respect to damage to buildings except that such cases would involve excessive noise and vibration.

b. All measurements are to be taken at any affected residence.

c. The SPCC accepts that there could be some exceedance of the overpressure limit of 115dB (Linear) on infrequent occasions. This should be limited to not more than 5% of the total number of blasts and should not exceed 120dB (Linear) at any time.

d. The ground vibration also may exceed the limit of 5mm/s on infrequent occasions. This should be limited to not more than 5% of the total number of blasts and should not exceed 10mm/s at any time.

e. Specialised monitoring equipment is necessary since the energy content of noise and vibration is predominantly of ultra-low frequencies:

   i Airblast overpressure monitoring equipment should have a cut-off frequency of 4Hz and cover a range of at least 2Hz to 250Hz.

   ii Ground vibration monitoring equipment should have a cut-off frequency of 4Hz and cover a range of at least 4Hz to 100Hz.

Effects on Structures – AS 2187 – Explosives Code

Australian Standard 2187 – 1979; Part 2 "Use of Explosives" was revised in 1983. Largely as a result of the work conducted by the CSIRO, this later version of AS 2187 qualifies the limit on ground vibration by saying that the influence on buildings and people should be below the amount that might lead to damage or human discomfort.

The conclusion of the CSIRO work was that a peak vector sum of 5mm/s at 8Hz is considered safe, in view of the susceptibility of damage to brick veneer constructions at this frequency and the large variability in the ground's response to blasts of equal size.

Australian Standard AS 2187 – Part 2 1983 contains the criteria given in Table 4.A.2. These criteria refer to the peak vector sum vibration velocity measured in the ground near the foundations of a building.

TABLE 4.A.2

RECOMMENDED PEAK PARTICLE VELOCITY – AS 2187 – PART 2

	Type of Building or Structure	Peak Vector Sum (Vp) mm/s
1.	Historical buildings and monuments, and building of special value or significance	2
2.	Houses and low-rise residential buildings; commercial buildings not included in item 3 below	10
3.	Commercial and industrial buildings or structures of reinforced concrete or steel construction	25

NOTES:

1. *This table does not cover high-rise buildings, buildings with long-span floors, specialist structures such as reservoirs, dams and hospitals and buildings housing scientific equipment sensitive to vibration. These require special consideration which may necessitate the taking of additional measurements on the structure itself, to detect magnification of ground vibrations which might occur within the structure. Particular attention should be given to the response of suspended floors.*
2. *In the specific instance, where substantiated by careful investigation, a value of peak particle velocity other than that recommended in the table may be used.*
3. *The peak particle velocities in the table have been selected taking no consideration of human discomfort and the effect on sensitive equipment within the building. In particular, the limits recommended for buildings Types 2 and 3 may cause complaints.*

The comments in AS 2187 – Part 2 relating to the level of airblast overpressure resulting from blasting are as follows:

Where blasting is carried out in proximity to buildings or structures, airblast overpressure shall be kept within limits related to the probability of damage and/or human discomfort.

NOTE: Airblast overpressure can cause discomfort to persons and in some cases damage to structures. Acceptable levels for airblast overpressure may be obtained from the appropriate authority. The effect of airblast overpressure on structures should not be confused with the effect of ground vibration. Major factors affecting airblast overpressure are the following:

a. Magnitude of blast
b. Exposure of explosives
c. Topography
d. Atmospheric conditions

The Standard does not however, recommend quantitative criteria.

The Response of Structures and People to Blast Emissions

Ground Vibration – Effects of Structures

The vibration velocity "damage" criteria recommended in the Standards Association's Explosive Code, AS 2187 – 1983, vary according to the type of building and are defined in terms of the peak vector sum (pvs), as shown in Table 4.A.2.

It is now generally recognised, however, that the damage criteria should not be specified in terms of peak vector sum alone, but should be further defined with an associated frequency or frequency range to account for possible resonance effects within structures.

There is also evidence (DIN 4150) that the resultant particle velocity of the ground may not be the best indicator of structural response, and that attention may also need to be given to the individual orthogonal components of the ground vibration in the directions of the major axes of the structure.

Vibration amplification can occur within a structure if the frequencies of significant levels of ground vibration energy are close to or coincide with the natural frequencies of structural components.

Structures have many modes of vibration, however the natural frequencies of major building elements are usually well below 40Hz. Most structures have a superstructure or "whole body" natural frequency in the order of 5Hz, while walls and floors have fundamental frequencies generally between 8Hz and 25Hz.

As structural resonant frequencies are functions of construction materials and building design, the vibration amplitudes included in the various sections of a structure (eg walls, floors, etc) can vary accordingly. In some highly damped structures, the measured vibration levels inside the structure can be amplified by up to 10 times relative to the levels in the ground outside the building.

Furthermore, suspected damage to structures caused by ground vibration from blasting is usually accompanied by damage from other causes. These include poor foundation preparation, differential foundation settlement, reactive soils and changing weather patterns, differential thermal expansion, incorrect structural design, deficient construction methods and structural overloading.

Generally, no single factor is solely responsible for the onset damage. Cracks that are present after a blast that were not there before, occur when the vibration-induced stress together with the existing stress exceeds the ultimate tensile strength of the cracked material or construction.

Most commonly specified 'safe' blasting limits are designed to minimise the risk of threshold or cosmic surface cracks, and should cater for the existing stress condition of the structure by setting different criteria for each class of structure.

Dynamic strain from blast vibrations can accelerate the development of the damage. However, even normal use of the structure results in induced dynamic strain as occupants walk, run, move furniture etc.

TABLE 4.A.3

COMPARISON OF INTERNAL WALL STRAINS IN BUILDINGS

Loading Phenomena	Induced Strain µm/m	Corresponding Blast Vibration Levels (mm/s)
Daily environmental changes:		
Reflection of daily range of	149	30.0
temperature and humidity levels	385	76.0
Household activities:		
Walking	9	0.8
Heel drops	16	0.8
Jumping	37	7.1
Door slams	49	12.7
Driving nails	89	22.4

Table 4.A.3 compares strains produced in internal walls from daily environmental changes (temperature and humidity) and household activities, with the corresponding level of blast vibration (USBM, R1 8896 – 1984) that would typically be required to cause similar levels of strain.

This shows that in the course of daily life, family activities will produce strains in walls similar to those produced by blasting vibrations of 1mm/s to 12mm/s. The strain resulting changes in temperatures and humidity are often large enough to crack plaster.

Airblast Overpressure

Based largely on work carried out by the U.S. Bureau of Mines (USBM) detailed in Table 4.A.4 the U.S. Office of Surface Mining has promulgated the following regulatory limits for airblast from blasting (depending on the low frequency limit of the measuring system):

TABLE 4.A.4

REGULATORY LIMITS FOR AIRBLAST FROM BLASTING

Low Frequency Limit	Peak Airblast Level Limit
2Hz or lower	132dB (Linear)
6Hz or lower	130dB (Linear)

These criteria are structural damage limits based on relationships between the level of airblast and probability of window breakage, and include a significant safety margin. It has been well documented that windows are the elements of residential buildings most at risk to damage from airblast from blasting.

While cracked plaster is the type of damage most frequently monitored in airblast complaints, research has shown that window panes fail before any other structural damage occurs (USBM, R1 8485 – 1980). The probabilities of damage to windows exposed to a single airblast overpressure event are shown in Table 4.A.5

TABLE 4.A.5

PROBABILITY OF WINDOW DAMAGE FROM AIRBLAST

Overpressure dB (Linear)	Level kPa	Probability of Damage	Effects and Comments
140	0.2	0.01%	"No damage" – windows rattle
150	0.6	0.5%	Very occasional failure
160	2.0	20%	Substantial failures
180	20	95%	Almost all fail

Human Comfort and Disturbance

The ground vibration and airblast levels which cause concern or discomfort to residents are significantly lower than the threshold levels at which damage has been observed.

The recommended criteria[40] for blasting in NSW based on human discomfort relating to daytime blasting (9.00am – 3.00pm Monday to Saturday) are:

Airblast Overpressure Level – 115dB (Linear) – 2Hz cut-off
Ground Vibration – 5mm/s (pvs)

Overpressure may exceed 115dB (Linear) for not more than 5% of the total number of blasts, up to a maximum of 120dB.

Ground vibration may exceed 5mm/s (pvs) for not more than 5% of the total number of blasts, up to a maximum of 10%.

Effects of Blasting on Animals

Animals are generally affected more by the airblast overpressure rather than ground vibration resulting from blasting.

Sonic booms from aircraft are similar in character to airblast overpressure waves. Research conducted into the effects of sonic booms from aircraft (Casady and Lehmann) concluded that, for sonic booms in the range of 125dB to 136dB "the reactions of the sheep and horses to sonic booms were slight". The numbers of animals observed in this study were about 10,000 commercial feedlot beef cattle, 100 horses, 150 sheep, and 320 lactating dairy cattle. The authors developed a summary by species and farms which indicated that the few abnormal behavioural changes observed were well within the range of activity variation within a group of animals.

Prediction of Blast Emissions – Methodology

Ground Vibration

Principal factors affecting the degree of confidence in predicting ground vibration levels from blasting are differences in the geometry of the explosions, changes in geological conditions and differences between types of explosives and their performance.

A widely accepted general form of the equation for the prediction of peak vector sum vibration velocity (pvs) is:

$$V = Kx^n \qquad (1)$$

Where, V is the peak vector sum vibration velocity (pvs)
x is the square root scaled distance $D/W^{0.5}$, where
D is the distance from the blast and W is the maximum instantaneous charge (MIC)
K and n are constants peculiar to a specific site.

Based on research carried out by the USBM the formula for ground vibration prediction (pvs) recommended by ICI is given below – formula (2).

This formula will normally give very conservative vibration predictions and is used as a "first estimate" in the absence of any site specific data from trial blasting. The constants K and n [formula (1)] used in the ICI formula relate to "average" rock under "worst case" conditions.

The ICI formula is:

$$V = 1143\,(D/W^{0.5})^{-1.6} \qquad (2)$$

Airblast Overpressure

The equivalent to equation (1) for predicting the level of airblast overpressure is:

$$P = Kx^n$$

Where, P is the airblast overpressure level (kPa)
x is the "scaled distance" $D/W^{0.33}$ where
D is the distance from the blast and
W is the maximum instantaneous charge (MIC)
K and n are constants peculiar to a specific site.

The ICI formula for the prediction of airblast overpressure from confined explosives blasting corresponding to formula (2) is:

$$P = 33\,(D/W^{0.33})^{-1.2} \qquad (3)$$

The above airblast pressure values can be expressed as linear decibel (dB Linear) values as follows:

$$A\ (\text{dB Linear}) = 164.2\ (\log D - 0.33 \log W) \qquad (4)$$

This prediction formula, like the ICI ground vibration prediction formula, is generally conservative and is used only where site specific airblast overpressure data from trial blasting is not available.

Effects of Weather Conditions on Airblast Overpressure

Temperature Inversions

On initiation of a blast, as the airblast wave front progresses from the blast, its path is modified by the prevailing atmospheric conditions. These conditions determine the speed of the sound in air.

Normally the air temperature decreases with altitude. If the temperature increases with height, a temperature inversion exists. This is a layer of warm air overlying a layer of cool air. Under these conditions, the sound speed at the inversion altitude increases markedly, deflecting the wave front in the direction of the ground and bending the sound waves downwards. Hence levels of airblast overpressure at certain points can be raised by focusing the sound rays to that point. Alternatively sound shadow zones may occur, in which the overpressure levels are lower than would be expected.

Since temperature inversions normally appear at night and disperse an hour or two after sunrise, blasting should not be conducted during these periods.

Under temperature inversion conditions, an increase of between 8dB and 20dB is possible at a radius of up to 1.4km to 2km from the blast site. In this event it is recommended that blasting operations be confined to the hours of 11.00am to 1.00pm.

Similarly, low cloud cover 'reflects' sound waves increasing their intensity on the ground. This is possibly due to the existence of atmospheric temperature gradients which occur in the presence of cloud cover.

Wind

Another situation under which amplification of the level of airblast overpressure can occur is that of wind velocity increasing with altitude, resulting in a corresponding increase in sound speed.

The variables of wind speed and direction and temperature lapse rate, determine the speed of sound at various altitudes in any given direction. The rate of change of sound speed with altitude is termed the acoustic gradient. It is this gradient that modifies the wave front as it propagates from the blast and creates the path that the wave front will follow.

A difference of 5dBA may occur within a 180° change in location to the wind direction at the same distance from the blast site.

Trial Blasting – Development of Mean Site Laws

Preliminary

Once approval for the proposed Camberwell Project has been granted, it is proposed to conduct a series of trial blasts to optimise the initial blast design. The results of monitoring the ground vibration and airblast overpressure emission levels during the trial blasting phase will be used to develop "site laws" as a basis for ongoing blast design optimisation.

Ground Vibration Prediction

As already discussed, the principal factors which affect the degree of confidence in predicting ground vibration levels from blasting are differences in the geometry and configuration of the explosions, changes in geological conditions and differences between type of explosives and their performance. If a systematic programme of blast vibration tests is carried out at a particular site, careful analysis of the results can significantly improve confidence in predicting the vibration level due to a given weight of charge. This, together with the optimisation of production blast design, will be the object of the Camberwell Project's trial blast programme.

When measured ground vibration results are available from the site, the constants K and n in the formula described for prediction of peak vector sum vibration velocity can be found either by calculation or directly from a graph of peak vector sum velocity at each monitoring point plotted (on the Y-axis) against scaled distance (on the X-axis), using a log – log scale.

When all the points relating to each monitoring position for each blast are plotted, theoretically they should form a straight line. In practice, however, there is some scatter due to the factors mentioned above, and a straight line of best fit or "mean" may be drawn through the points using regression analysis.

The site specific ground vibration prediction formula is then used to establish a set of blast design curves by plotting the maximum instantaneous charge (MIC – kilograms) against distance from the blast (metres), using log – log scales.

These curves permit blast design engineers and shot firers to predict the mean level of ground vibration at a given distance on the proposed mine site.

Probability of Exceedance – Ground Vibration

The "site law" data described above are based on the mean of the measured data. In practice therefore, there would be approximately 50% probability that the predicted levels would be exceeded. In regard to the SPCC's comfort criterion of 5mm/s however, only 5% of a series of blasts are usually permitted to exceed the nominal limit.

It is also proposed therefore to establish the regression line through the trial blast data corresponding to the 5% probability of exceedance.

Consideration of the permissible probability of exceedance has a very significant effect on the maximum charge weight (MIC) that the blast designer may select. Consequently, blast design curves will also be developed which indicate the MIC required to ensure that the SPCC's comfort criterion of 5mm/s is not exceeded for 5% or 50% of blasts.

Airblast Overpressure Prediction

In a similar way to the ground vibration monitoring results, the measured levels of airblast overpressure resulting from the trial blasting will be carefully analysed to significantly improve confidence in predicting the level of airblast overpressure due to a given charge weight.

As for ground vibration, K and n can be found either by calculation or directly from a graph of airblast pressure level at each monitoring point plotted (on the Y-axis) against scaled distance on the X-axis, on a log-log scale.

The graph of airblast pressure level versus scaled distance for all results of the trial blasting exercise can be plotted and the line of best fit using the best squares method established.

This formula will then be used to establish a set of design curves by plotting the maximum instantaneous charge (MIC-kilograms) against distance from the blast (metres), using log-log scales.

These curves will permit blast design engineers and shot firers to predict the **mean** level of airblast overpressure at a given distance on the proposed Mine Site.

Probability of Exceedance – Airblast Overpressure

The "site laws" determined as described above are based on the **mean** of the measured data. In practice, therefore, there would be approximately **50% probability** that the predicted levels would be exceeded. In regard to the SPCC's comfort criteria of 115dB (Linear), however, only 5% of a series of blasts are usually permitted to exceed this nominal limit.

The regression line corresponding to the 5% probability of exceedance will also therefore be determined.

Proposed Production Blast Design

When the overburden and interburden material in both Pits is not removable by ripping, excavation using conventional drill and blast techniques will be adopted.

Initial blasting will therefore, in many areas, be in weathered material and will consequently only need to be lightly charged. In more competent material, higher MIC's will be used.

An assessment has been carried out by ICI Australia nominating the different areas where blasting is likely to be required, the thickness of the material in these areas, the suggested blast hole diameter and the associated nominal blast designs.

The blast designs, labelled CAMBER 1 to CAMBER 5 are for ranges of bench height of 10m to 20m in moderate strength material, 20m to 25m in high strength material, 2m to 5m in moderate strength rock, 2m to 5m in high strength rock and 5m to 10 m in high strength rock respectively.

The corresponding Powder Factors for these five designs in dry blast holes are 0.4kg/m^3, 0.6kg/m^3, 0.5kg/m^3, 0.7kg/m^3 and 0.6kg/m^3. Although the majority of benches in the North and South Pits are much less than 20m, (average 15m and general range 12m to 18m), the blast design CAMBER 2 has been used for the blasting impact assessment. This represents the "worst case" throughout the life of the mine.

The details of ICI Australia's blast design CAMBER 2 are as follows:

DESIGN

20m to 25m bench
Massive material
High strength rock
Powder factor 0.6 kg/m^3 (nominal)
(0.8 kg/m^3 for wet holes)

	ANFO Pattern	
SHOT PARAMETERS	**Dry Hole**	**Wet Hole**
Hole diameter (mm)	270	270
Bench height (m)	25	25
Stemming height (m)	6.6	7.5
Burden (m)	7	7
Spacing (m)	8	8
Yield/shot hole (m^3)	1,400	1,400
COLUMN LOAD	**ANFO**	**Powergel**
Density g/cm^3)	0.80	1.15
REE (% ANFO)	100	99
Charge length (m)	18.4	17.5
Charge weight (kg)	843	1,152
Powder factor	0.60	0.82

Appendix 5

Real Property Description of Surface Lands Within The Development Application (SLA) Area

Parish Auckland

Land in the Parish of Auckland, Part Lot 5 in Deposited Plan 264089, part Lots A, F & G in Registered Plan 613, disused Railway line along northern boundary of Portion 22 and Lot A in Registered Plan 613, Lots 3 & 4 and part Lots 1, 2, 5 & 6 in Deposited Plan 246434, Lot 1 and part Lot 2 in Deposited Plan 597205, part Lot 710 in Deposited Plan 624853, Portions 22, 91 & 92, and land adjoining Portion 92, Part Portions 23, 71, 85 & 89 and closed roads.

Parish Broughton

Land in the Parish of Broughton, Portion 1, part Portions 2, 6, 7, 10 & 120, Lot 1 in Deposited Plan 581908 and closed roads.

Parish Darlington

Land in the Parish of Darlington, Portion 246, part Portions 3, 26, 43, 44, 75, 77, 78, 82, 98 & 137, Lot 1 and Part Lots 2 & 3 in Deposited Plan 581908 and closed roads, disused railway line within Portion 3 and along the eastern boundary of Portion 131.

The above land is all within the County of Durham, Shire of Singleton.

The abovedescribed lands are those delineated within the heavy black line on Figure A.5.1. These lands are encompassed within Council Assessment Nos 2404, 2405/4, 2416, 2416/1, 2417, 2439, 2440, 2456, 2457, 2458, 2459, 2460, 2461, 2464/1, 2465, 2467, 3031 and unalienated Crown Lands.

CAMBERWELL COAL PROJECT

Date

Figure 5.A.1

REAL PROPERTY DESCRIPTION SURFACE LEASE APPLICATION AREA

Appendix 6

Road Transport

Traffic Study

As part of the feasibility studies for the Project, Transportation Environment Consultants conducted a Traffic Study.

The objective of the study was to analyse the current and future traffic loadings on the existing road network. Matters assessed included:

- the likely traffic generation of the mine;
- the expected traffic loadings along Bridgman Road and Middle Falbrook Road;
- the adequacy of Bridgman Road and Falbrook Road based on the existing and future level of service along the road;
- the standard of intersection required at the site entrance and Bridgman Road; and
- the standard of intersection of Bridgman Road with the New England Highway.

The report summarised the investigations and findings of the study in relation to traffic patterns and associated traffic problems in the study area. It further estimates future traffic growth associated with the proposed mine for different situations and the effect it will have on the road system.

Evaluation of Existing Traffic Conditions

Street System Inventory

An inventory of all streets within the Study Area, including road types, traffic control, circulation, road closures and road conditions was carried out.

Road conditions for all roads within the Study Area have been classified by visual inspection as meeting most of the following criteria:

- Good - sealed, few potholes, cracks or ruts on road surface, kerb and guttering on both sides of road, sealed shoulders, good width and sight distance for the carried traffic.
- Fair - unsealed or sealed, moderate potholes, cracks or ruts on road surface, little or no kerb and guttering on either side of road, soft shoulders, adequate width and sight distance for the carried traffic.
- Poor - unsealed or sealed, with many potholes, cracks or ruts on road surface, no kerb and guttering, soft shoulders, inadequate width and sight distance for the carried traffic.

All roads within the Study Area fail to meet all criteria for good quality classification due to the lack of kerb and guttering and predominance of soft shoulders. Such items are, however, not critical in a rural environment and have therefore been disregarded for the purposes of this classification.

Roads which generally meet the criteria for a good classification include New England Highway and Bridgman Road north of Hunter View Estate.

Traffic Volumes

Intersection Counts

Intersection counts were conducted by Transportation Environment Consultants at the intersection of New England Highway with Middle Falbrook Road on Wednesday, 23rd of February, 1989, from 2:30 pm to 5:30 pm, and Thursday, 23rd of February, 1989, from 7:00 am to 10:00 am.

Further counts were obtained from the Roads and Traffic Authority for the intersection of New England Highway with Bridgman Road, conducted over the same time periods as those above on Thursday, 1st of September, 1988, and Friday, 2nd of September, 1988 respectively.

Morning and afternoon peak hour volumes at these intersections were calculated from these counts. The highest traffic volumes occurred between 8:15 am and 9:15 am, and between 3:15 pm and 4:15 pm during the morning and afternoon respectively. The afternoon volumes were almost 40% higher than the morning counts. Peak hourly volumes at these intersections are presented in Figure 6.A.2.

Classification Counts

Automatic classifiers were installed along Bridgman Road and Middle Falbrook Road from 28th of February, 1989 to 3rd of March, 1989 to complement the information obtained from the intersection counts. Hourly and daily volumes along these streets were recorded by type of vehicle. This information was then used to establish current non-urban traffic levels within the Study Area. Average daily traffic volumes at these locations are included in Table 6.A.1 together with the vehicle classification.

TABLE 6.A.1

CLASSIFICATION COUNTS

	Bridgman Road North of S.H.9		Middle Falbrook Rd North of S.H.9		New England Hwy (SH9)* East of Middle Falbrook Rd		Total	
Type	Number	%	Number	%	Number	%	Number	%
Cars/Vans	1,715	90	213	79	12,440	93	14,368	92.6
Trucks+	159	9	53	19	560	4	772	5.0
Semi trailers	16	1	4	2	350	3	370	2.4
Total	1,890	100	270	100	13,350	100	15,510	100

* Estimated
\+ Includes coaches

Hourly Volumes

Peak hourly volumes have been derived from the intersection and mid-block counts. Hourly volumes for the peak periods along these roads are detailed in Table 6.A.2. It should be noted that volumes peaked during the afternoon period.

TABLE 6.A.2

PEAK HOURLY VOLUMES

		N/E	S/W	Total
New England Highway	– E of Bridgman Rd	947	453	1,400
	– W of Bridgman Rd	690	380	1,070
	– E of Middle Falbrook	427	178	605
	– W of Middle Falbrook	424	170	594
Bridgman Road	– N of New England Hwy	316	269	585
	– N of Hunter View Est.	71	110	181
Middle Falbrook Road	– N of New England Hwy	23	7	30

Capacity of Existing Street System

An evaluation of the present capacity of major routes and critical intersections within the Study Area was carried out to identify existing deficiencies in the road system.

Carriageway Capacity

The capacity of major access roads was based on an assessment of their operating Level of Service[41].

One-way peak hourly volumes for the major streets within the Study Area are summarised in Table 6.A.3.

TABLE 6.A.3

CARRIAGEWAY LEVEL OF SERVICE

Major Streets		No of Effec Lanes	Peak Hour Volumes (one-way)	Level of Service
New England Highway	– E of Bridgman Rd	2	947 (E)	C
	– W of Bridgman Rd	2	690 (E)	B
	– E of Middle Falbrook	2	427 (E)	B
	– W of Middle Falbrook	2	424 (E)	B
Bridgman Road	– N of New England Hwy	2	316 (S)	A
	– N of Hunter View Est.	2	110 (S)	A
Middle Falbrook Road	– N of New England Hwy	2	23 (N)	A

41 Level of Service is defined as a "qualitative measure of the effects of a number of features, which include speed and travel time, traffic interruptions, freedom to manoeuvre, safety, driving comfort and convenience, and operating costs. Levels of Service are designated from A to F from best (free flow conditions) to worst (forced flow with stop start operation, long queues and delays)

A service volume is the maximum number of vehicles that can pass over a given section of roadway in one direction during one hour while operating conditions are maintained at a specified level of service. One-way hourly volumes for interrupted traffic flow at different levels of service, obtained from a DMR document (1984a), are summarised in Table 6B1

It is suggested that ideally arterial and sub-arterial roads should not exceed service volumes at level of service C. At this level, whilst most drivers are restricted in their freedom to manoeuvre, operating speeds are still reasonable and acceptable delays experienced. However, in urban situations, arterial and sub-arterial roads operating at Level of Service D, are still considered adequate.

Table 6B1

ONE-WAY TRAFFIC VOLUMES (PCU)* FOR URBAN ROADS AT DIFFERENT LEVEL OF SERVICE

- Interrupted Flow Conditions -

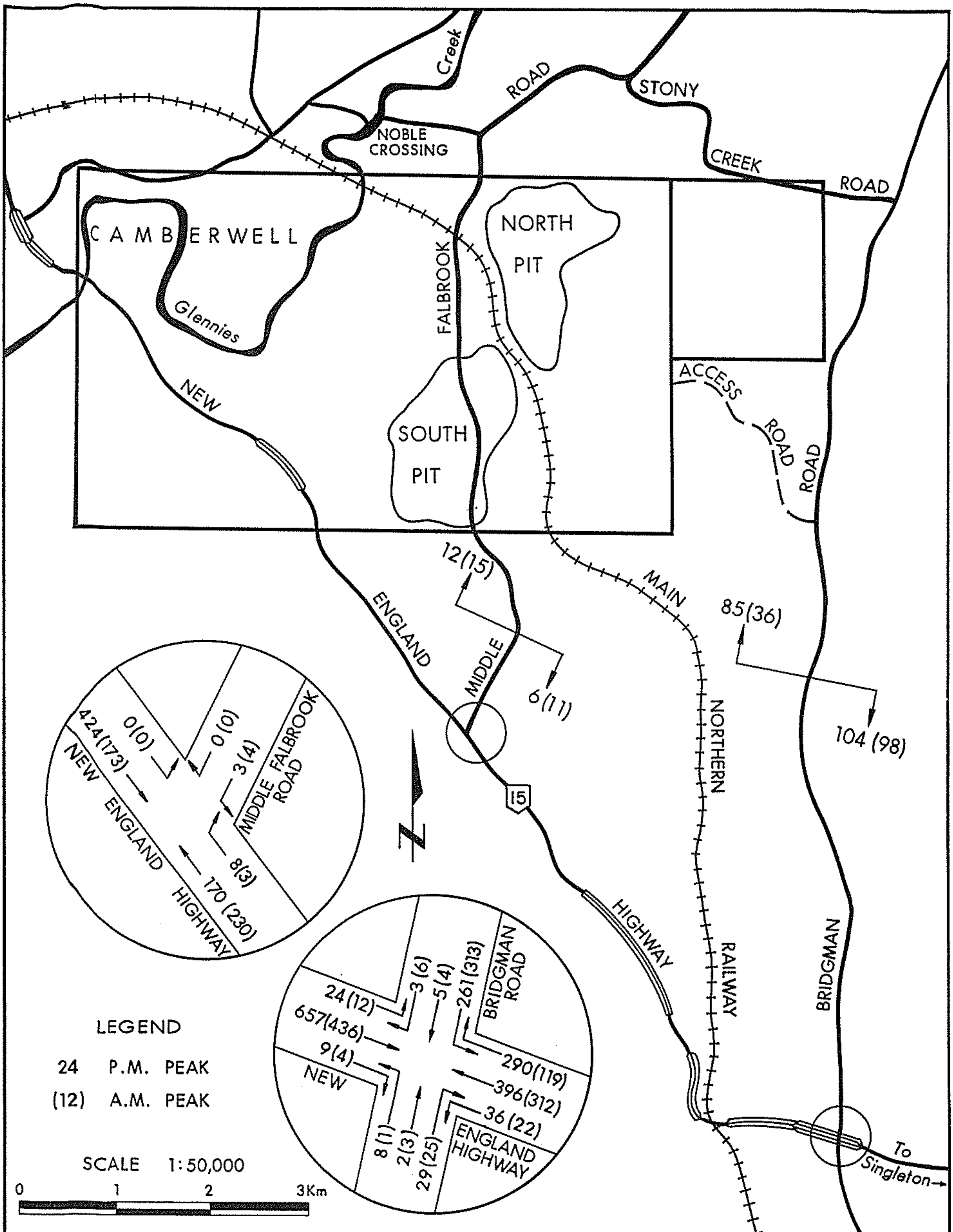
Source: DMR (1984a)

TYPE OF ROAD CARRIAGEWAY	LEVEL OF SERVICE‡ A	B	C	D	E	F
2 Lane Undivided	540	630	720	810	900	FORCED FLOWS
4 Lane Undivided	900	1050	1200	1350	1500	
4 Lane Undivided with Clearways	1080	1260	1440	1620	1800	
4 Lane Divided with Clearways	1140	1330	1520	1710	1900	
6 Lane Undivided	1440	1680	1920	2160	2400	
6 Lane Divided with Clearway	1740	2030	2320	2610	2900	

‡ Level of Service A - Free flow (almost no delays)
B - Stable flow (slight delays)
C - Stable flow (acceptable delays)
D - Approaching unstable flow (tolerable delays)
E - Unstable flow (congestion; intolerable delays)
F - Forced flow (jammed)

* PCU Passenger car unit,ie heavy vehicles volumes are converted into passenger car equivalent

Note: The Service Volumes and Capacity in the above Table can increase by 20 to 40% where, amongst other factors, the absence of significant traffic movements entering /crossing the major roadway from minor streets or major developments, and where these movements are restricted by major road priority controls.



CAMBERWELL COAL PROJECT

TRAFFIC VOLUME COUNTS

Date AUG.'89

Figure 6.A.1

Capacity of Critical Intersections

The capacity of the street system is largely dependent on the capacity of critical intersections.[42] Critical intersections in the Study Area, including unsignalised locations, were analysed assuming signal control. The operational characteristics of an intersection are reflected by the intersection flow ratio (Y) and the intersection degree of saturation (X). The parameters and operational Level of Service at these intersections are summarised in Table 6.A.4.

TABLE 6.A.4

OPERATIONAL CHARACTERISTICS OF INTERSECTIONS

Intersection	AM Peak Y	AM Peak X	AM Peak LoS	PM Peak Y	PM Peak X	PM Peak LoS
New England/Middle Falbrook	0.12	0.21	A	0.26	0.41	A
New England/Bridgman	0.47	0.64	C	0.58	0.76	E

42 The capacity of a signalised intersection depends on the volumes of traffic entering the intersection, the physical characteristics of the intersection and the cycle lengths and phase splits of the signals. The factors are reflected by the intersection flow ratio (Y) and the degree of saturation (X). The degree of saturation "X" for a signalised intersection is defined as the largest movement degree of saturation which is the ratio of arrival flow to capacity for a movement approach and is given by

$X = Y \times C/(C - L)$ where

Y = Ratio of arrival flow to saturation flow for the intersection

C = Cycle length (seconds)

L= Loss time (sum of intergreen time between each phase of cycle; i.e., amber and "all red" times).

Calculation of these parametres has been based on the method included in a document published by the Department of Main Roads (1984b).

Suggested criteria for the evaluation of signalised intersection operation and unsignalised intersections assuming signal control are summarised in Tables 6B2 and 6B3 respectively.

TABLE 6B2

CRITERIA FOR EVALUATING CAPACITY OF SIGNALISED INTERSECTIONS*

Level of Service		Optimum Cycle Length (SECS) (CO)	Volume/ Saturation Y	Intersection Degree Of Saturation X
A/B	Very good operation	<90	<0.70	<0.80
C	Satisfactory	90-120	0.70-0.80	0.80-0.85
D	Poor but manageable	120-140	0.80-0.85	0.85-0.90
E/F	Bad, extra capacity required	>140	>0.85	>0.90

TABLE 6B3

CRITERIA FOR EVALUATION CAPACITY OF UNSIGNALISED INTERSECTION ASSUMING SIGNAL CONTROL*

Level of Service		Optimum Cycle Length (SECS) (CO)	Volume/ Saturation Y	Intersection Degree Of Saturation X
A/B	Very good operation	<30	<0.4	<0.6
C	Satisfactory	30 to 60	0.4 to 0.55	0.6 to 0.65
D	Alternative control (round-about) or more capacity may be required	>60	0.55 to 0.60	0.65 to 0.75
E/F	Roundabout, traffic signals or other major treatment should be considered	>60	>0.60	>0.75

* Source: D.M.R. 1984

The critical intersections are:

(i) Intersection of New England Highway with Bridgman Road

The existing operational characteristics of this intersection appear to be satisfactory during the morning peak period.

During the afternoon peak hour, the analysis indicates a requirement for alternative traffic control such as traffic signals or roundabouts. A closer assessment of turning movements showed that the problem is largely due to the high volume of right turning traffic from New England Highway northbound into Bridgman Road, conflicting with a high volume of eastbound traffic along the New England Highway. It is therefore concluded that a roundabout be provided at this location to cater for existing traffic flows.

(ii) Intersection of New England Highway with Middle Falbrook Road

This intersection has very good operational characteristics during both the morning and afternoon peak hourly periods. However it is situated on a 1.8km straight section of highway, presenting entry and exit problems due to speeding traffic and lack of acceleration/deceleration lanes. Middle Falbrook Road will not be used in conjunction with the Camberwell mining activities.

Future Capacity of Critical Intersections

The parameters and operational Level of Service of the intersection of New England Highway with Bridgman Road are summarised in Table 6.A.5 and assessed below.

TABLE 6.A.5

OPERATIONAL CHARACTERISTICS OF THE NEW ENGLAND HIGHWAY - BRIDGMAN ROAD INTERSECTION

	AM Peak			PM Peak		
Intersection	Y	X	LoS	Y	X	LoS
Existing	0.47	0.64	C	0.58	0.76	E
Construction Phase	0.47	0.67	C	0.68	0.83	E
Operational Phase	0.50	0.67	C	0.65	0.81	E

The activity associated with the Camberwell Project would only marginally affect this intersection. The construction of a roundabout at this location as suggested in (i) above would easily cater for the existing and future traffic conditions.

Access Road To The Mine Site

Construction of the mine includes construction of an access road from the North and South Pits eastward to Bridgman Road, situated approximately 7km north of the New England Highway intersection. A two lane carriageway roadway is proposed.

The use of this road as a construction site access route and possible truck haul road dictates the need for an intersection design of higher standard than estimated volumes might suggest.

The possibility of slow vehicles entering and exiting the mine site necessitates the provision for a southbound acceleration lane and a northbound deceleration lane on Bridgman Road south of the intersection.

Appendix 7

Project Concept Design Details

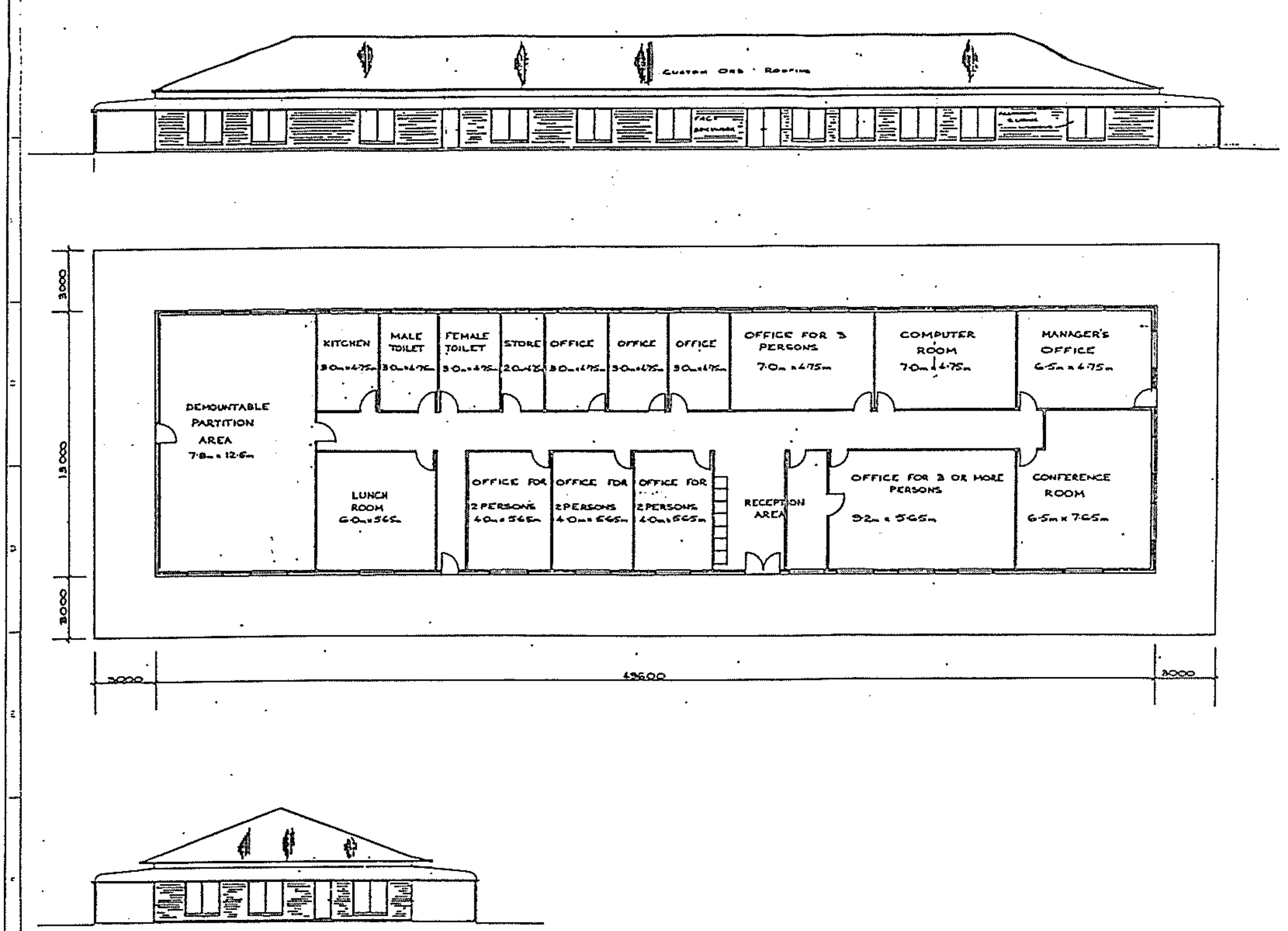


Figure 7.A.1

DELPAH PTY LTD

CAMBERWELL COAL PROJECT
TYPICAL ADMINISTRATION
BUILDING

CMPS

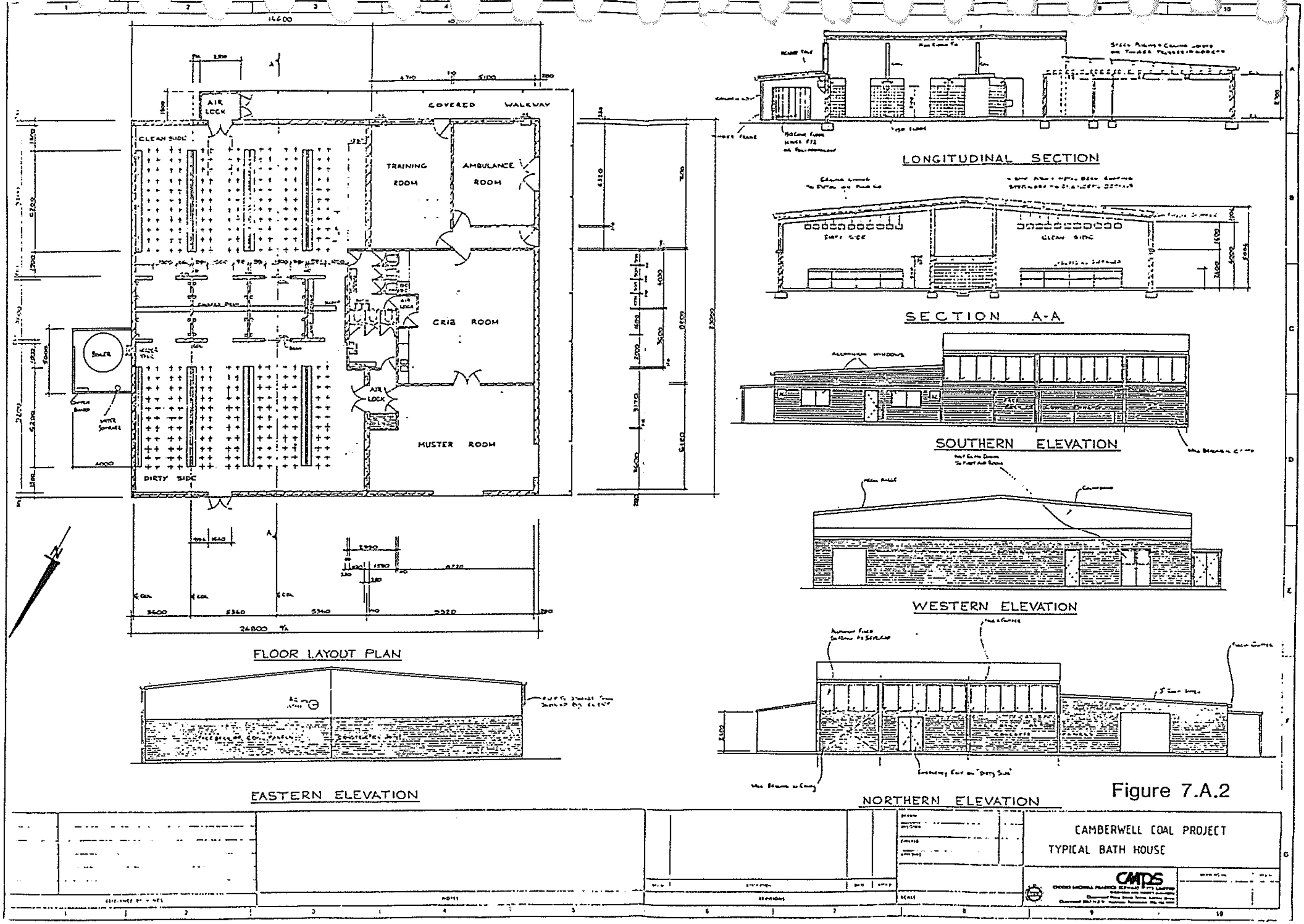

LONGITUDINAL SECTION
SECTION A-A
SOUTHERN ELEVATION
WESTERN ELEVATION
NORTHERN ELEVATION
FLOOR LAYOUT PLAN
EASTERN ELEVATION
COVERED WALKWAY
AIR LOCK
CLEAN SIDE
DIRTY SIDE
TRAINING ROOM
AMBULANCE ROOM
CRIB ROOM
MUSTER ROOM
BOILER
14600
24800
CAMBERWELL COAL PROJECT
TYPICAL BATH HOUSE
CMPS

Figure 7.A.2

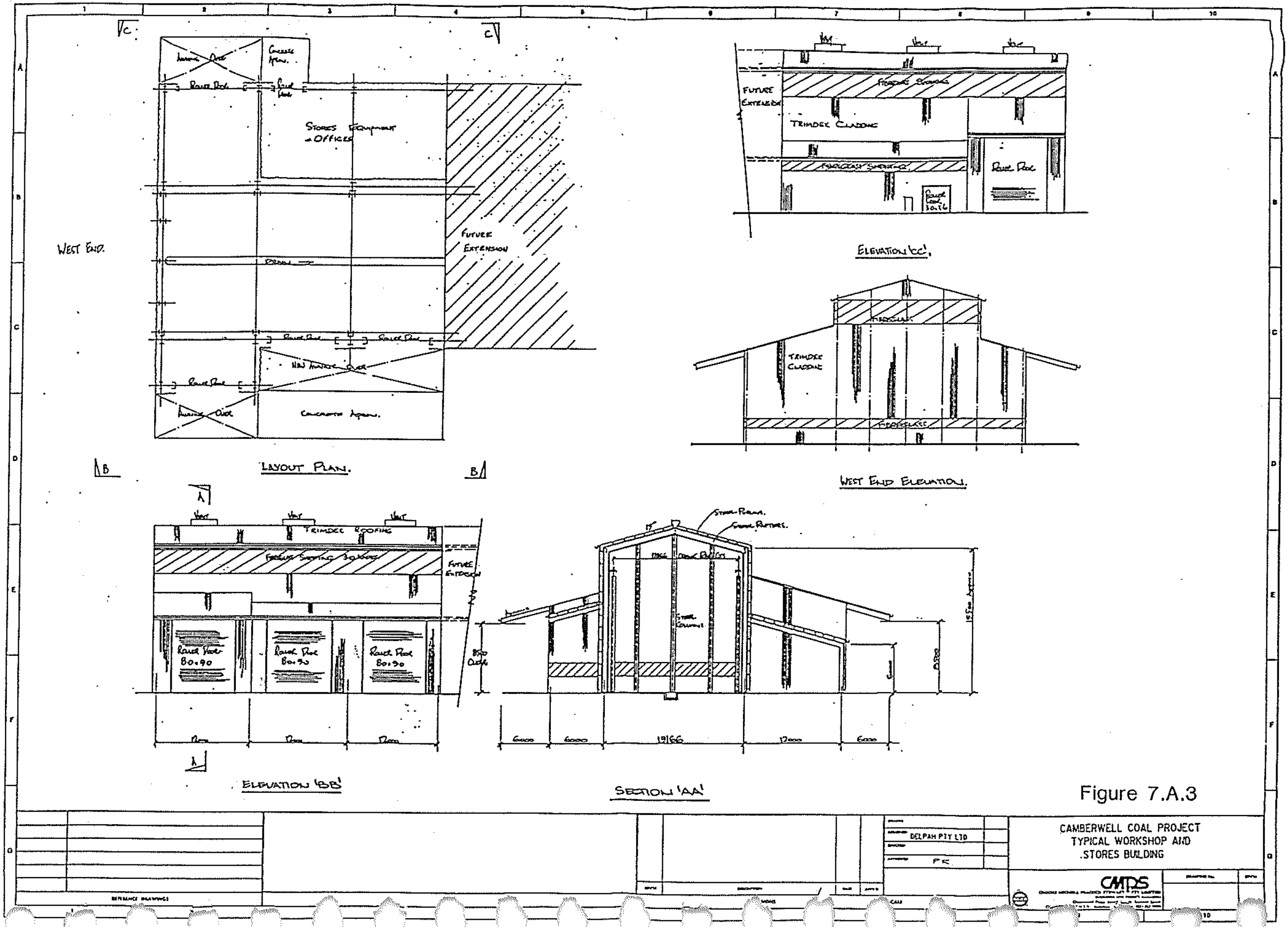
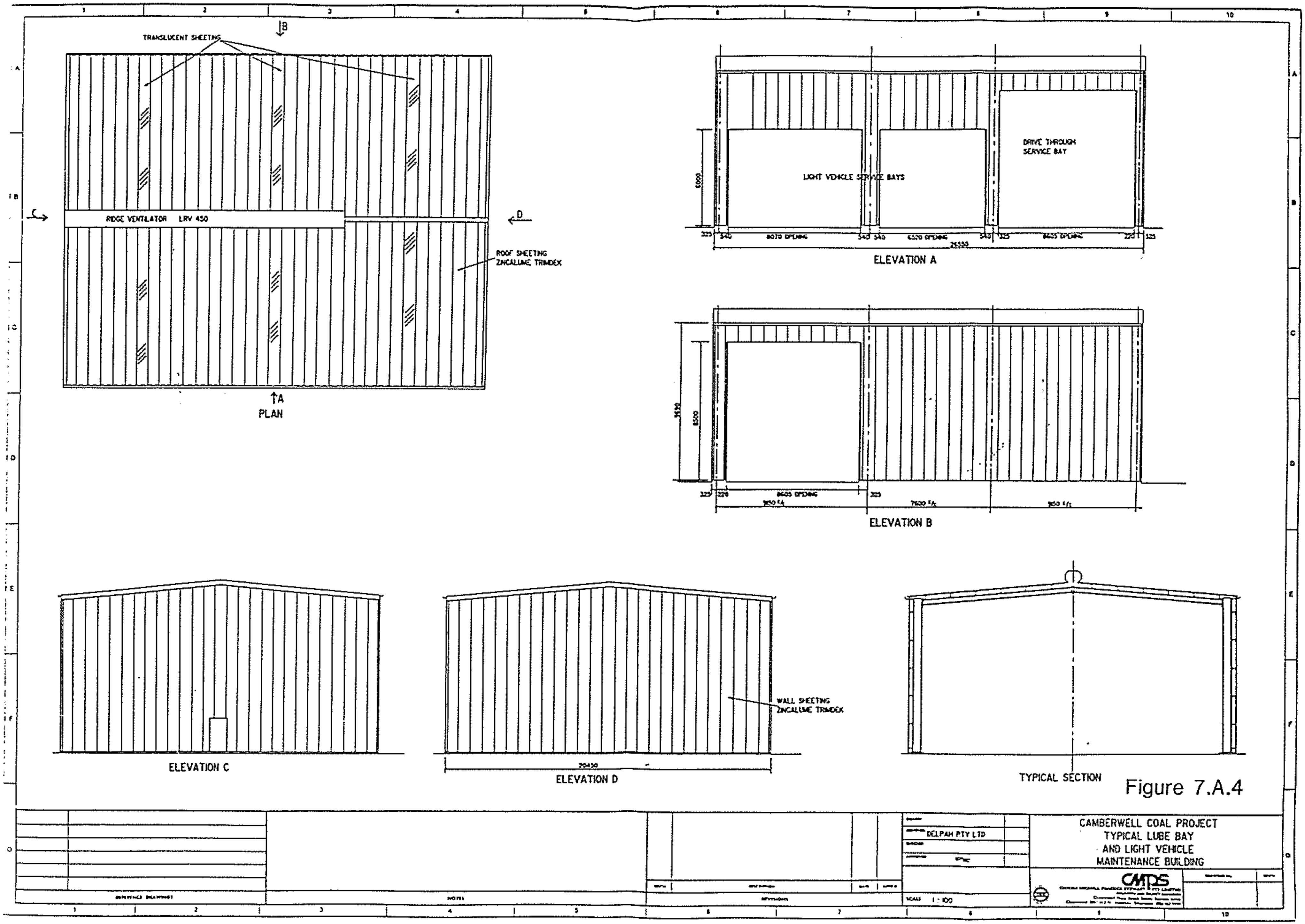


Figure 7.A.3

CAMBERWELL COAL PROJECT
TYPICAL WORKSHOP AND
.STORES BUILDING



TRANSLUCENT SHEETING
RIDGE VENTILATOR LRV 450
ROOF SHEETING ZINCALUME TRIMDEK
PLAN
LIGHT VEHICLE SERVICE BAYS
DRIVE THROUGH SERVICE BAY
8070 OPENING
6570 OPENING
8605 OPENING
25550
ELEVATION A
8605 OPENING
7600 f/c
9550 f/c
ELEVATION B
ELEVATION C
WALL SHEETING ZINCALUME TRIMDEK
20450
ELEVATION D
TYPICAL SECTION
DELPAH PTY LTD
SCALE 1:100
CAMBERWELL COAL PROJECT
TYPICAL LUBE BAY
AND LIGHT VEHICLE
MAINTENANCE BUILDING
CMPS

Figure 7.A.4

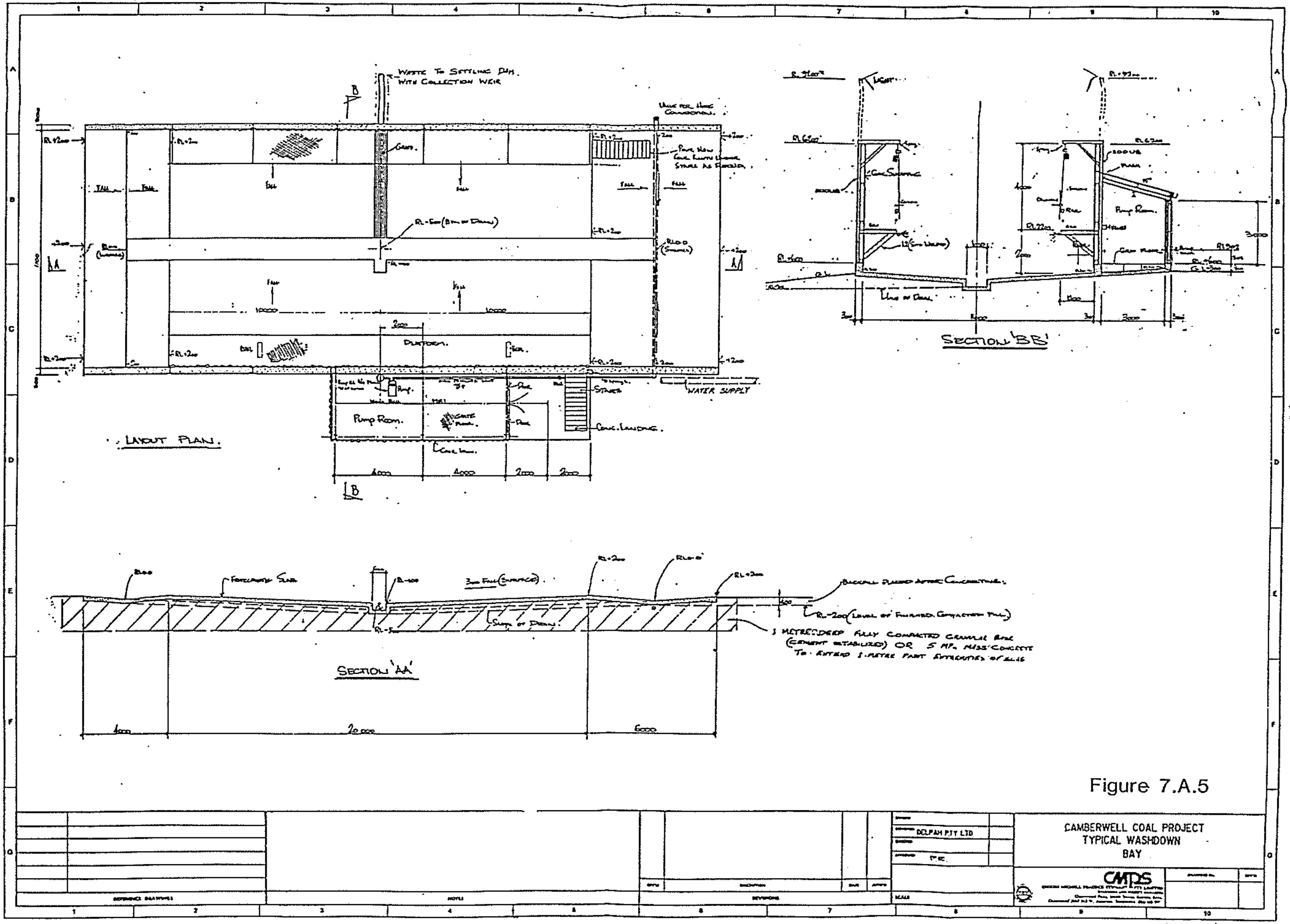

WASTE TO SETTLING DAM, WITH COLLECTION WEIR
LAYOUT PLAN.
Pump Room.
WATER SUPPLY
SECTION 'BB'
SECTION 'AA'
1 METRE DEEP FULLY COMPACTED GRANULAR BASE (CEMENT STABILIZED) OR 5 MPa MASS CONCRETE TO EXTEND 1 METRE PAST EXTREMITIES OF SLAB
20 000
6000
4000
CAMBERWELL COAL PROJECT
TYPICAL WASHDOWN
BAY
DELPAM PTY LTD
CMPS

Figure 7.A.5

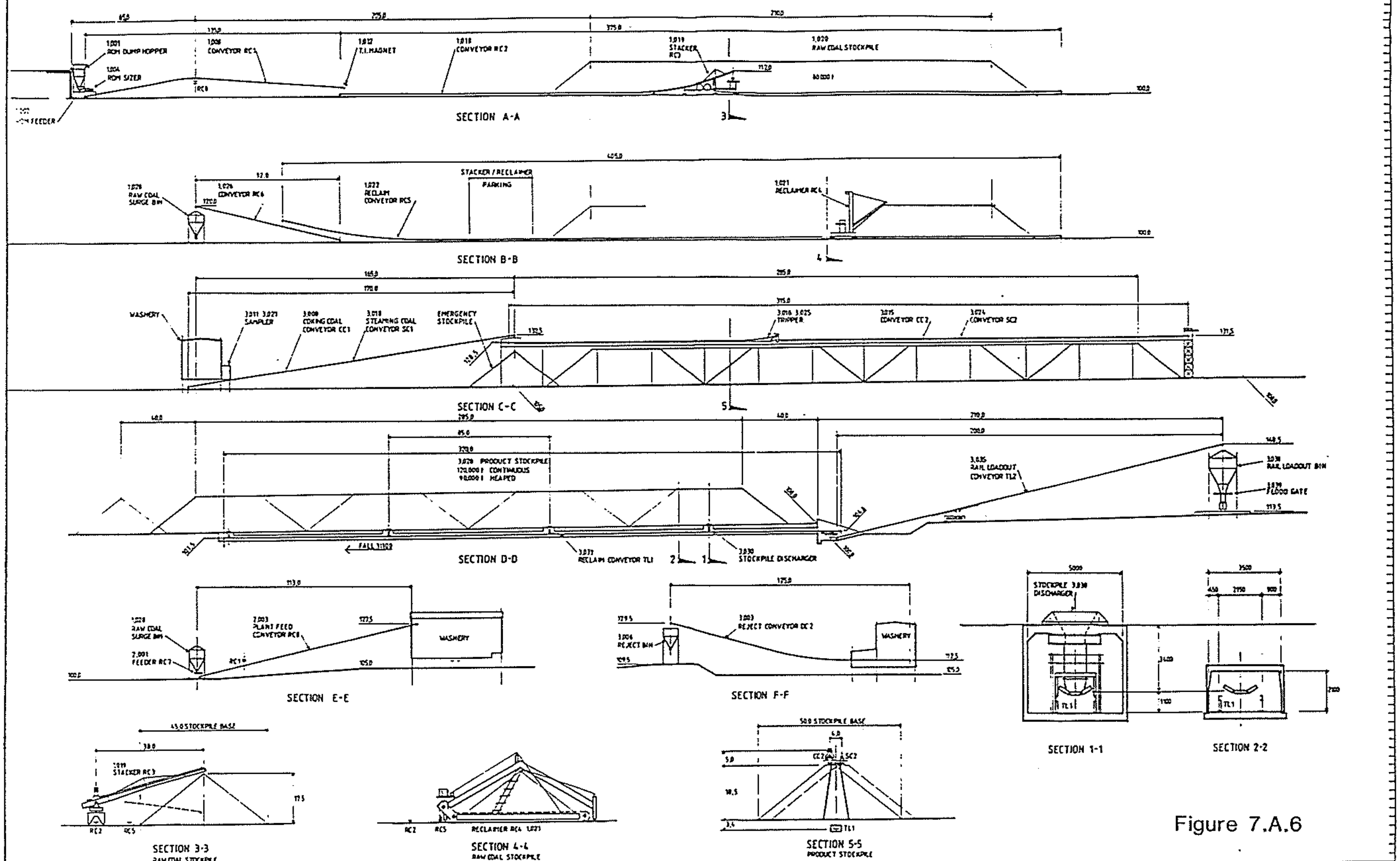


Figure 7.A.6

REFERENCE DRAWINGS

ISSUED FOR MANUFACTURE

Bulk Materials (Coal Handling) Pty Limited

3499 C

CAMBERWELL COAL PROJECT
PROPOSED WASHERY & MATERIALS HANDLING
MATERIALS HANDLING ELEVATIONS

18669

A	B	C	D	E	F

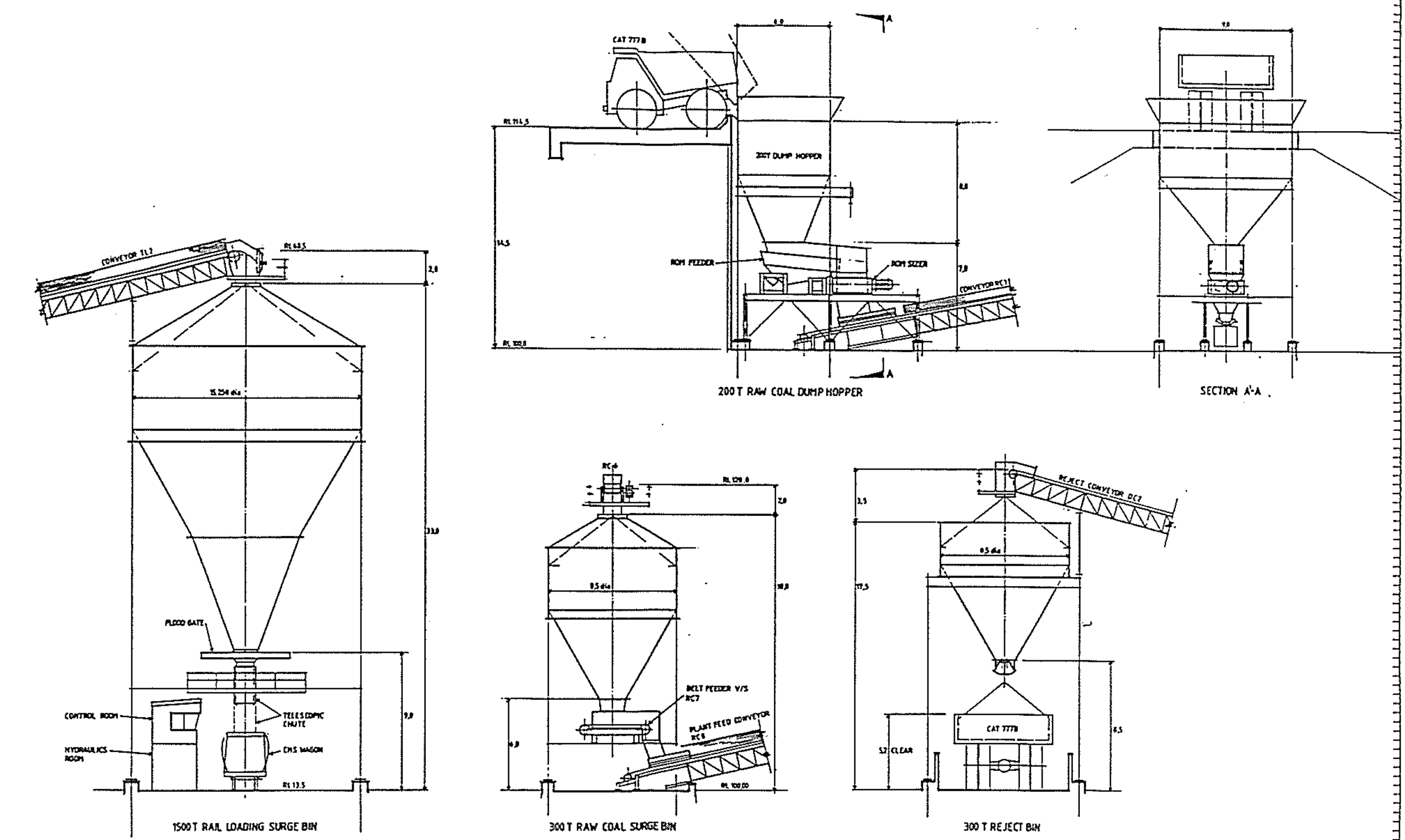


Figure 7.A.7

REFERENCE DRAWINGS	ISSUED FOR MANUFACTURE	Scale 1:100
Bulk Materials (Coal Handling) Pty Limited	CAMBERWELL COAL PROJECT PROPOSED WASHERY & MATERIALS HANDLING MATERIALS HANDLING DETAILS	3499C / 18672
Drawn: JACKSON	Date: MAY '89	A B C D E F

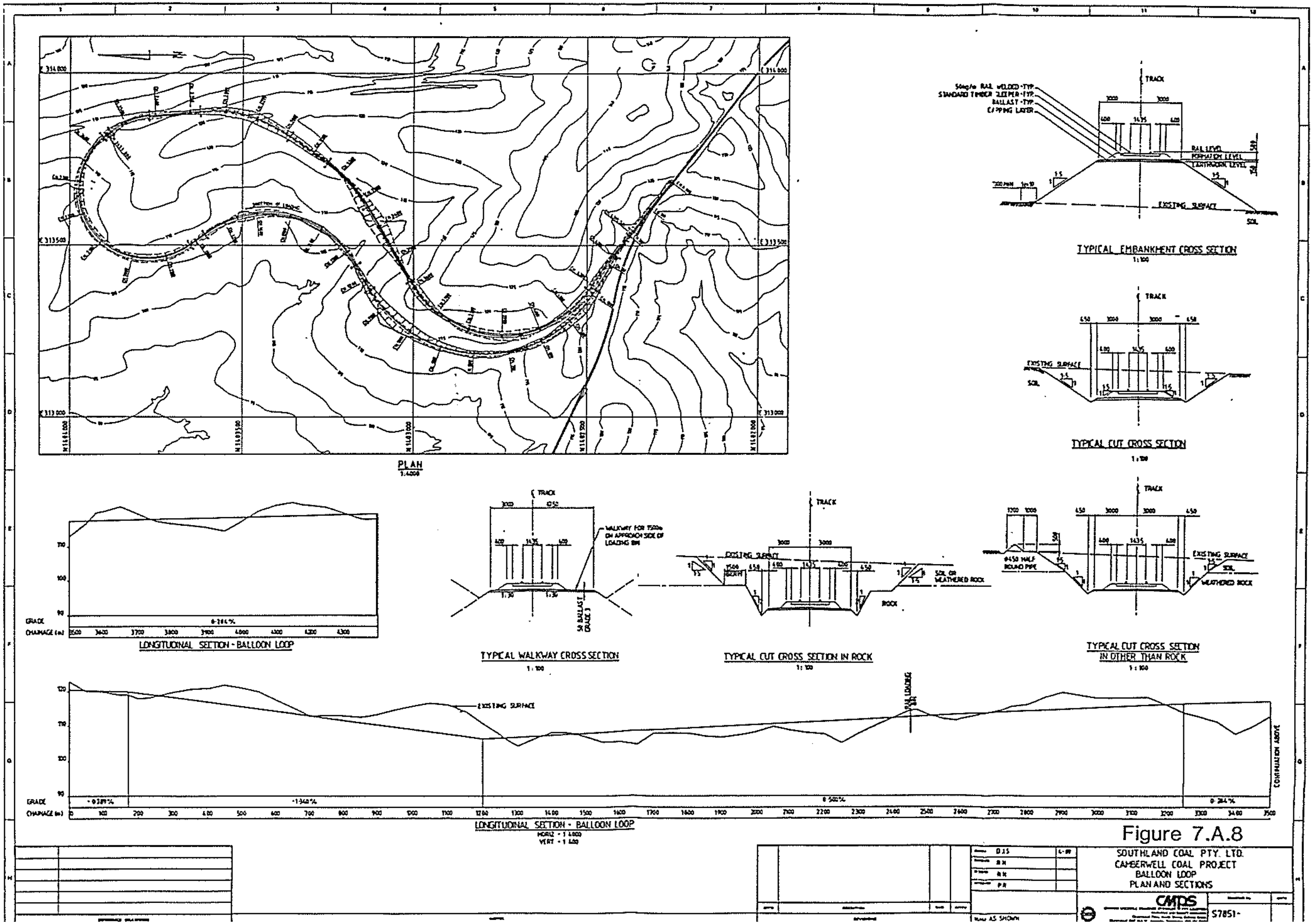
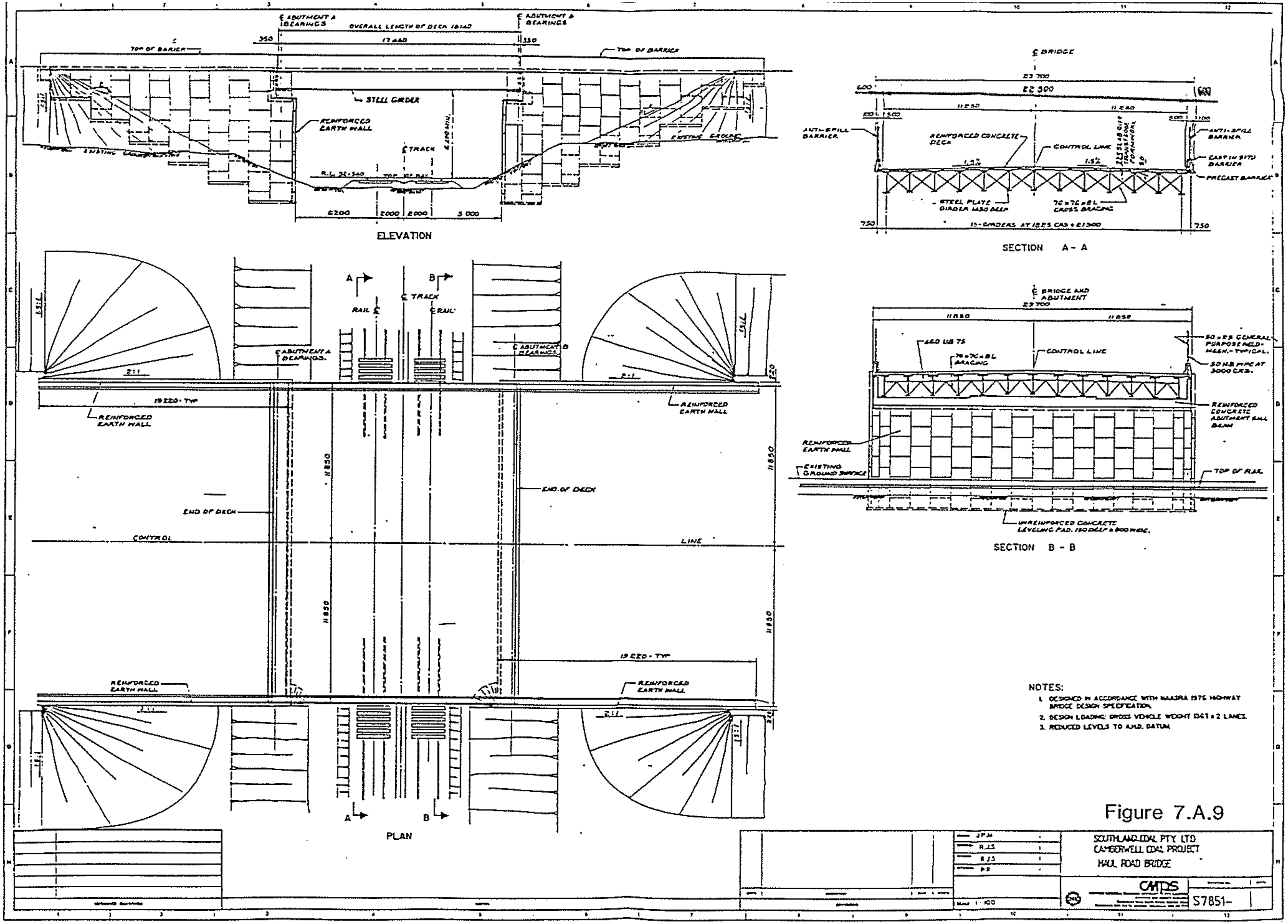


Figure 7.A.8

SOUTHLAND COAL PTY. LTD.
CAMBERWELL COAL PROJECT
BALLOON LOOP
PLAN AND SECTIONS

CMPS

S7851-


ELEVATION
PLAN
SECTION A - A
SECTION B - B
STEEL GIRDER
REINFORCED EARTH WALL
TOP OF BARRIER
OVERALL LENGTH OF DECK 18140
END OF DECK
CONTROL LINE
REINFORCED CONCRETE DECK
ANTI-SPILL BARRIER
CAST IN SITU BARRIER
PRECAST BARRIER
STEEL PLATE GIRDER 1430 DEEP
15 - GIRDERS AT 1825 CRS = 21300
EXISTING GROUND SURFACE
TOP OF RAIL
UNREINFORCED CONCRETE LEVELING PAD. 150 DEEP x 800 WIDE.
NOTES:
1. DESIGNED IN ACCORDANCE WITH NAASRA 1976 HIGHWAY BRIDGE DESIGN SPECIFICATION.
2. DESIGN LOADING: GROSS VEHICLE WEIGHT 136T x 2 LANES.
3. REDUCED LEVELS TO A.H.D. DATUM.
SOUTHLAND COAL PTY. LTD.
CAMBERWELL COAL PROJECT
HAUL ROAD BRIDGE
CMPS
S7851-
Figure 7.A.9