



EIS 301

AA053481

Environmental impact statement : proposed Wolgan extended
colliery for Coalex Pty Limited

NSW DEPT PRIMARY INDUSTRIES



AA053481

ENVIRONMENTAL IMPACT
STATEMENT

PROPOSED WOLGAN EXTENDED
COLLIERY

FOR

COALEX PTY LIMITED

DRAFT

PREPARED BY:

DAMES & MOORE

DATE: MAY 1977

JOB NO: 8082-003-70

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DAMES & MOORE

CONSULTANTS IN THE ENVIRONMENTAL AND APPLIED EARTH SCIENCES

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17 MYRTLE STREET, CROWS NEST, N.S.W. 2065, AUSTRALIA

TELEPHONE: 929-7744 • TELEX 21378 • CABLE ADDRESS: DAMEMORE

16 May 1977

Coalex Pty Ltd
BMA Building
Cnr Pacific Highway & Help Street
Chatswood, NSW 2067

Attention: Mr R Renshaw

Dear Sir:

Final Draft - Environmental Impact Report
Proposed Wolgan Extended Colliery, NSW

Please find enclosed six copies of the final draft report. Amendments discussed with you on 28 April 1977 have been made and several other minor editorial changes effected. We look forward to your final comments and discussion with the Mines Department and State Pollution Control Commission on your behalf.

In due course we will present to you a selection of cover materials for you to choose from for the final report. Meanwhile, please contact us if we can be of further assistance.

Yours faithfully
DAMES & MOORE

A P Campbell
Associate

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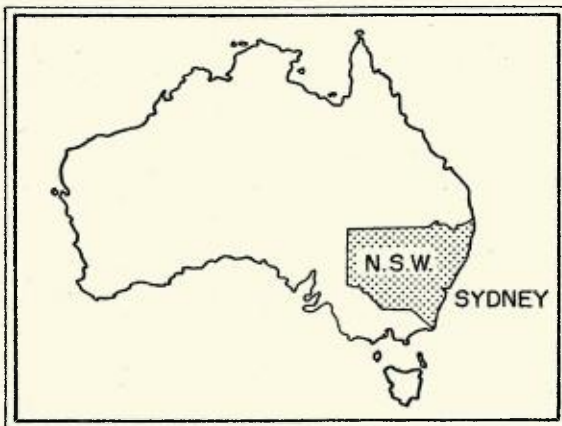
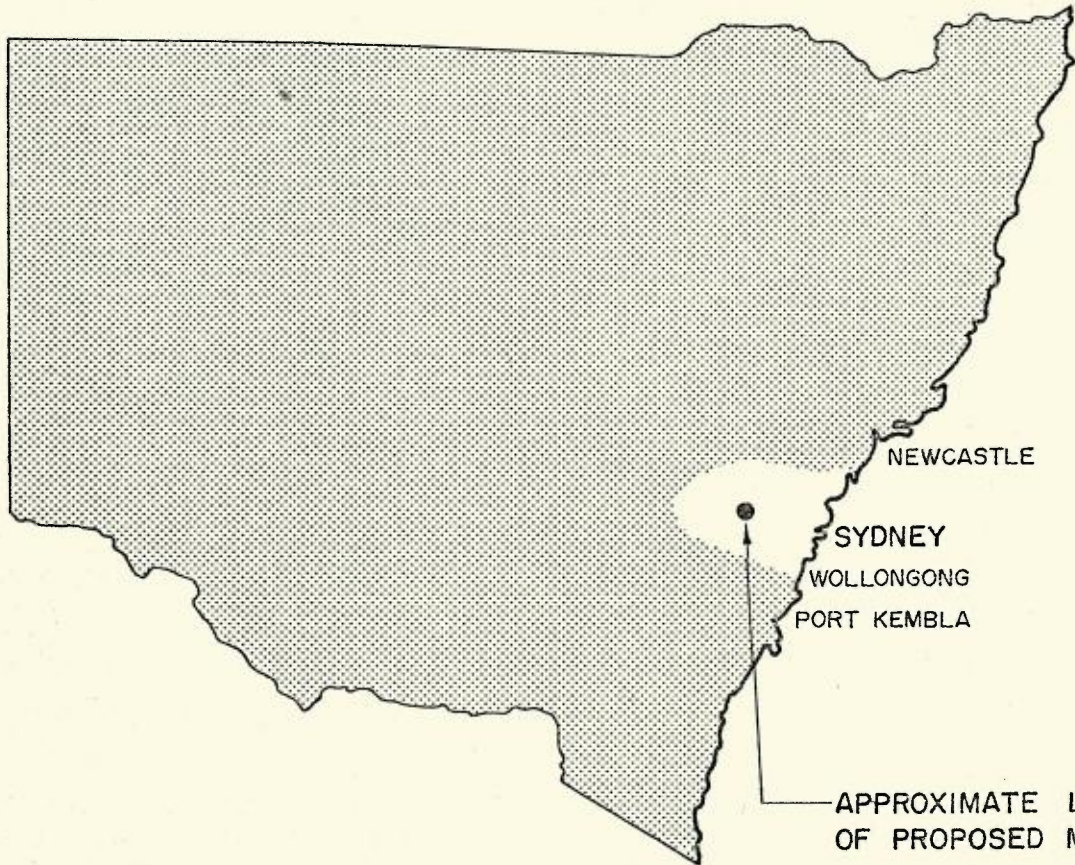
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1.0 INTRODUCTION

Coalex Pty Limited has applied for a mining purposes lease in the Wolgan area as indicated on Figures 1 to 3 for the purpose of mining coal from the Wolgan coal seam for export as a coking coal and sale locally as a steam coal. Experimental workings have been carried out through an adit in the Wolgan Valley, but it is not proposed to use this opening except perhaps as a ventilation portal. The company has a coal for which an export market exists as a blending coal. To produce coal suitable for this market a coal preparation plant is required with storage of washed coal and rail transport to an export point on the coast of NSW. Because the full seam of coal has a high reject content, suitable areas for the disposal of refuse in a satisfactory manner are required.

This report describes the results of over 15 months investigation into the existing environment around the colliery site, including consideration of a number of alternate mine sites, alternate coal preparation plant sites, refuse disposal areas and coal transport and storage. Preliminary plans for colliery water management and recycling, construction of dam walls, dust control by means of water sprays and revegetation have been made and their mitigating effects taken into account in assessing potential environmental impact.



COALEX PTY. LTD.

LOCATION: WOLGAN EXTENDED COLLIERY

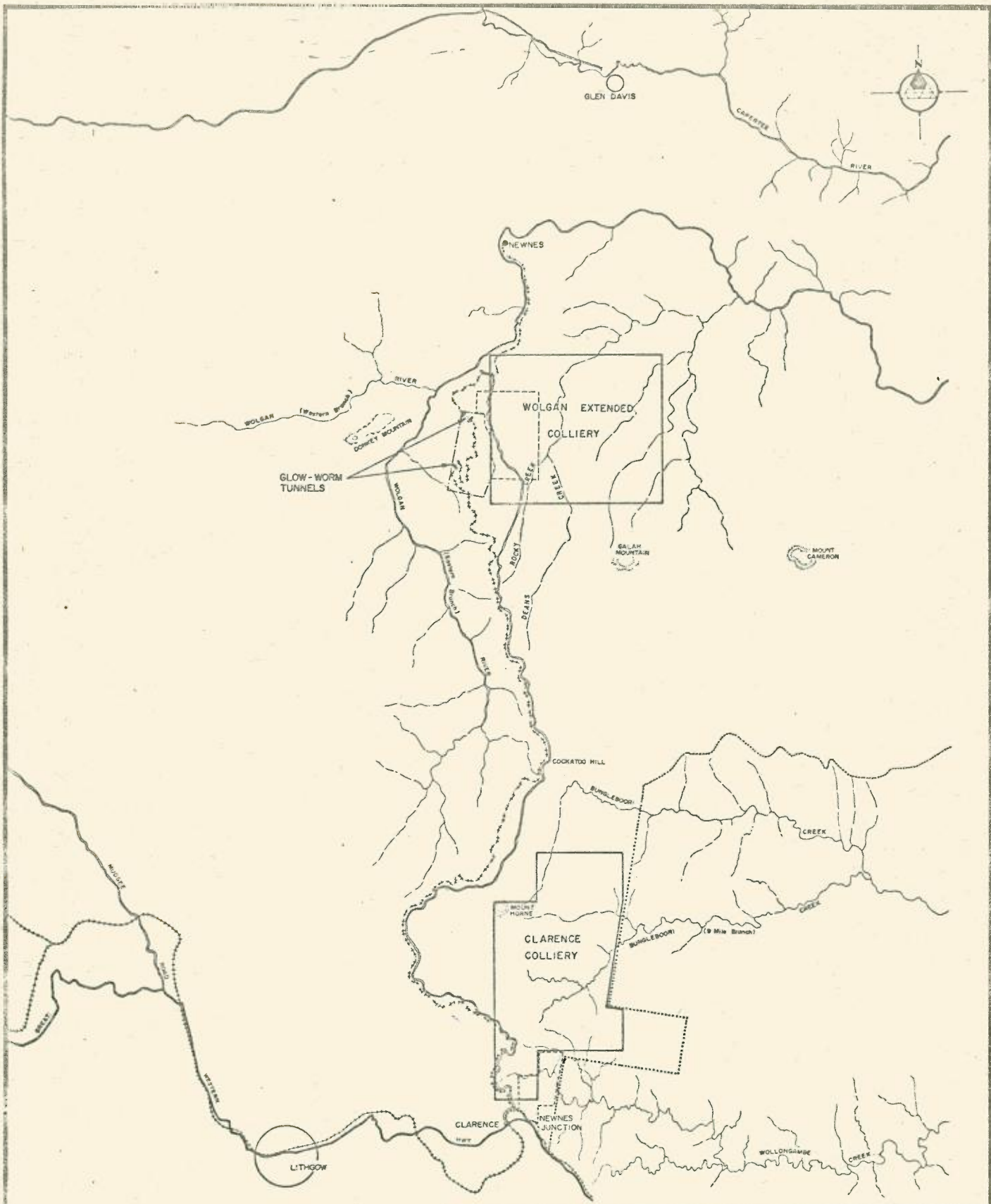
TITLE: LOCATION MAP

JOB No.: 8082 - 003 - 70

DATE: February, 1977

FIGURE I

DAMES & MOORE



LEGEND

- | | | | |
|--|-----------|---------------------------|-----------|
| MAJOR ROAD | ————— | PUBLIC RECREATION RESERVE | - - - - - |
| MINOR ROAD | ————— | ABANDONED RAILWAY | ++ ++ |
| RAILWAY | ————— | | |
| NATIONAL PARK BOUNDARY (approx.) | | | |
| UNDERGROUND MINING LEASE BOUNDARY | ————— | | |
| PROPOSED MINING PURPOSE LEASE BOUNDARY | - - - - - | | |

COALEX PTY. LTD.

LOCATION: WOLGAN EXTENDED COLLIERY
 TITLE: SITE VICINITY

FIGURE 2

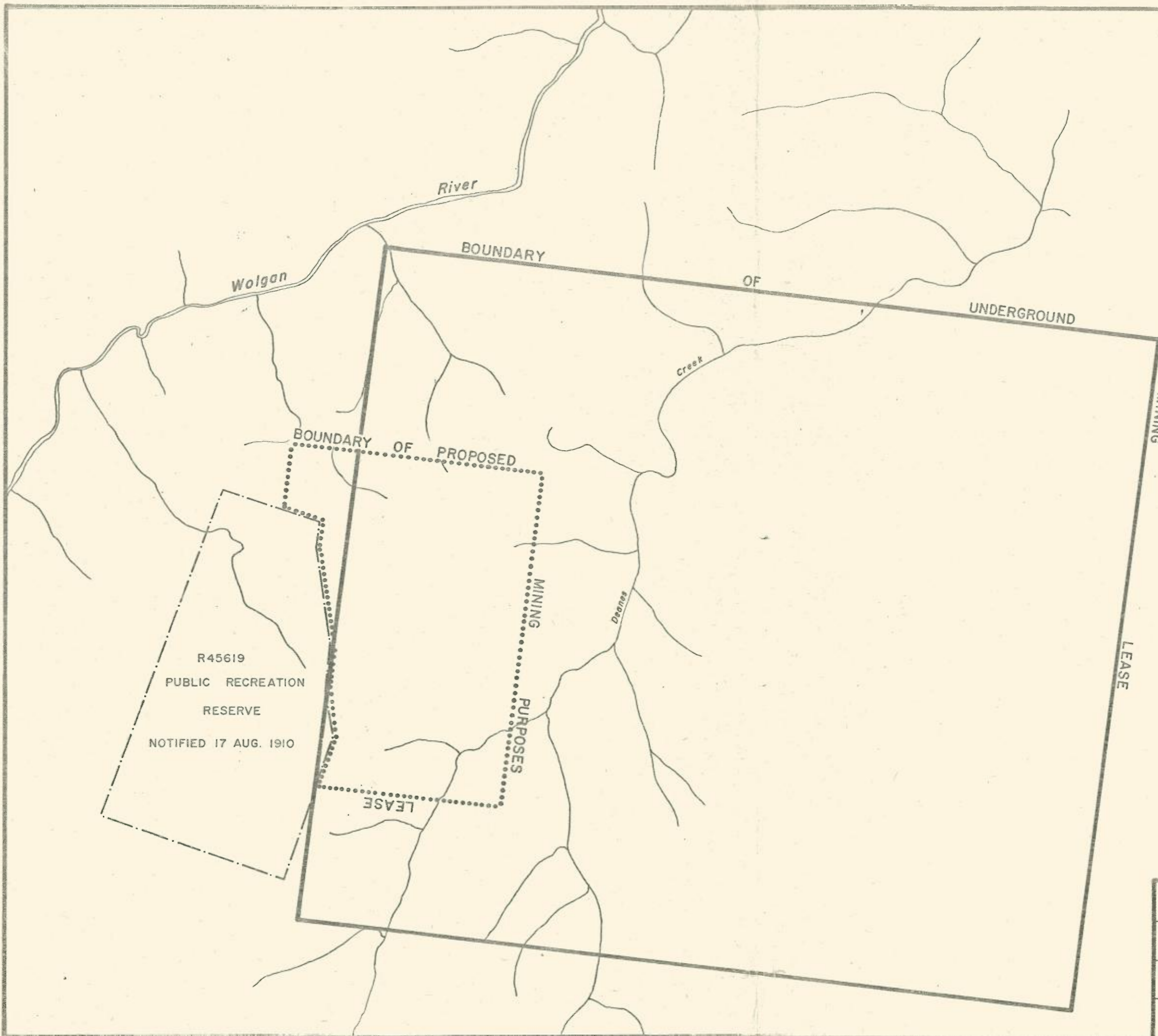
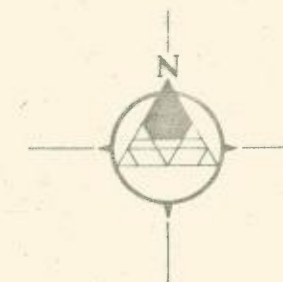
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COALEX PTY. LTD.	
LOCATION: WOLGAN EXTENDED COLLIERY	FIGURE 3
TITLE: LOCATION OF MINING LEASE & MINING PURPOSES LEASE	JOB No.: 8082-003-70
SCALE: 	DATE: December, 1976
REF: PARISH OF BARTON MAP, DATED JUNE 12, 1970	DAMES & MOORE

2.0 SUMMARY

This report presents a description of the establishment and operation of the proposed Wolgan Extended Colliery and the consequent environmental impacts. Mitigation procedures are suggested wherever a significant impact occurs.

A number of alternative courses have been investigated for the location of the colliery facilities. The most favoured proposal is to place the pit-top at the head of the gully through which the Old Coach Road passes en route from the Wolgan Valley to the plateau surface and place the coal preparation plant on the plateau above. This arrangement has a number of environmental and economic advantages such as:

- reduction of visual impact of the colliery on the Wolgan Valley
- proximity of suitable refuse disposal sites
- favourable transport options
- location of pit-head close to the centre of the lease area.

The report provides a description of all stages of mine and preparation plant operations and facilities with more detailed attention paid to those aspects which are likely to have some significant environmental impact, such as

- Transfer of raw and product coal within the colliery complex. This will be mainly by conveyor belts which will be enclosed to prevent the spread of coal dust.
- Refuse disposal of both fine and coarse fractions from the coal preparation plant which will be deposited in a wet state in the refuse disposal dams.
- The transportation of product coal from the colliery in 'on-highway' type trucks of 50-70 tonne capacity; coking coal to the railhead at Newnes Junction and steaming coal to Wallerawang Power Station.
- The highway-standard road which will be constructed from the Wolgan Colliery to the Clarence Colliery. This road will provide access for the area not previously available.

A preliminary study has been carried out for the design of the refuse dam walls. These will be constructed of coarse refuse material compacted and

layered with clay. The outer face of the wall will be benched to aid erosion control and the establishment of a vegetation cover over its surface.

The water requirements of the colliery will be supplied mainly from runoff within the mining purposes lease area. The main water storage dam will be constructed in the gully just below the pit-top site. Comprehensive water treatment and conservation facilities will ensure that the colliery has a minimum impact on the hydrology and water quality of the surrounding area.

A study has been made of the existing physical, biological and social environment. From this data various impacts of the development have been delineated and the following mitigating procedures recommended:

- Waste water will be collected and processed to meet a 10:10 standard equivalent to drinking water standards for meeting the NSW SPCC P classification. This will be achieved through a water management plan.
- Dust generation will be controlled by dust control procedures.
- Erosion control measures will be implemented through effective construction control, revegetation and provision of drainage.
- Impacts on flora and fauna will be minimised because of minimal disturbance of relatively small habitat areas and effective management of construction, bushfire control, and revegetation programmes.
- Aesthetics impacts will be minimised by adopting the current design layout and through revegetation.
- Any potential for spontaneous combustion in refuse areas will be avoided by an effective refuse disposal scheme.
- Long term impacts will be minimised by continued maintenance of the refuse areas and erosion control.

3.0 ALTERNATIVE COURSES OF ACTION

A number of alternative courses of action have been considered for the development of the colliery. Those considered in some detail were:

1. No action.
2. On-site treatment facilities and refuse disposal.
3. On-site treatment facilities with off-site refuse disposal.
4. Off-site treatment facilities and refuse disposal.

3.1 No Action

The Western Coalfields region has been declining economically since the post-war period. In the period 1966-1971 population in the Blaxland Shire decreased by 8.7% and the number of private dwellings fell by 2.5%. In the past this region has supplied only the steaming coal market, a market which is far more effected by rises and falls in the world economy than is that for coking coal. If the Wolgan seam, which contains a high quality coking coal, is not brought into production and long term export markets developed then economic instability and depression in the region will be aggravated.

3.2 On-Site Treatment Facilities and Refuse Disposal

This alternative has been chosen by the company as the most practical and economical means of establishing the colliery with the least impact on the environment. Placement of the mine, treatment plant and the refuse disposal areas all in close proximity to each other avoids excessive materials handling and transport costs and aids in management of the operations and rehabilitation program.

A number of possible sites were investigated before the presently proposed site was chosen. Details of:

1. Alternative sites
2. Proposed colliery operations and facilities, and
3. Environmental impact and mitigation procedures

are presented in the following sections.

3.3 On-Site Treatment Facilities with Off-Site Refuse Disposal

A major input to the decision on siting of the coal preparation facilities was the availability of suitable refuse disposal areas. If refuse disposal takes place at sites distant from the coal preparation site then a major problem is created by the large number of trucks which must use public roads to transport the refuse to these sites. There do not appear to be any refuse disposal areas in the vicinity of Lithgow which have a distinct advantage over on-site disposal. Refuse disposal areas at the Wallerawang and Hermitage Collieries are already committed. Finally, it is generally considered better for the mine management to have direct responsibility for its own refuse disposal.

3.4 Off-Site Treatment Facilities and Refuse Disposal

In order to implement off-site treatment and refuse disposal it will be necessary either to build new facilities at some suitable site or make use of other existing or planned facilities. Construction of new off-site treatment facilities is unlikely to solve any of the existing problems and will probably create new ones, so will not be considered further.

It is possible to use the company's existing facilities at Wallerawang and Hermitage Collieries but this would require extensive modification and expansion of these coal preparation facilities and disposal areas. There is not sufficient land readily available at either location for such expansion.

Transport of raw coal to Wallerawang and Hermitage by either road or rail will create its own problems. Road transport could, if the mine is to be located in the most suitable location economically and environmentally, necessitate large numbers of coal trucks passing through the Lithgow city area so causing dust, noise and traffic levels which will not be acceptable to the local population. Similar objections can be raised to rail transport of the raw coal.

Existing rail facilities, which are already overtaxed, would have to be upgraded. The resulting extra rail traffic would lead to increased effects of noise and a decrease in existing residential environmental quality of Lithgow.

The problem of fine dust released to the atmosphere by loading and unloading operations is very much greater for raw coal than for washed coal. Washing removes the fine dust and the higher moisture content of the washed coal practically eliminates the dust problem, provided storage time is short.

Another alternative is that of washing raw coal from the Wolgan Extended Colliery at the planned coal preparation facility at the Clarence Colliery. This would have the advantage of simplifying the operation and reducing the duplication of surface facilities. However, this would mean that a greater quantity of material would have to be hauled from the Wolgan mine to the Clarence coal preparation facility and provision would have to be made either to dispose of this additional refuse at the Clarence site or return it to the Wolgan site. It must be noted that the boundary to the Blue Mountains National Park lies adjacent to the eastern side of the Clarence Colliery site so that the possibility of any extension to these coal treatment and refuse disposal facilities would be limited.

3.5 Selection of On-Site Treatment Plant and Refuse Disposal Areas

A number of alternative sites have been considered for the placement of mine and coal preparation plant. These are:

1. Mine at present Wolgan Experimental Mine Site and the preparation plant at the same location.
2. Mine at present Wolgan Experimental Mine Site and the preparation plant on the plateau just above upper gate on the Old Coach Road.
3. Mine located below the first cliff face, just downhill from the upper gate on the Old Coach Road and the preparation plant located on the plateau above.
4. Mine and preparation plant located near Deanes Creek.

A discussion of each of these alternatives is presented in the following sections 3.5.1 to 3.5.4 and the reasons for choosing alternative 3 are given.

3.5.1 Mine at Present Wolgan Experimental Mine Site and Coal Preparation Plant at Same Location

This is the arrangement proposed in the Environmental Impact Statement submitted by Coalex in 1974. According to that submission the pit-top would be located at the present Wolgan Experimental Mine site and the coal preparation plant would be located about 2.5 km to the south. Coal refuse was to be disposed of in shallow timbered valleys further south of the preparation plant.

Disadvantages of this scheme are:

- visual impact of the coal preparation plant and refuse disposal areas on the scenic values of the Wolgan Valley
- the higher construction cost of an access road because of the section of steep terrain between the Wolgan Valley and the plateau surface
- added cost of travelling time of mining personnel to the coal face with a corresponding loss of productive time by miners.

3.5.2 Mine at Present Wolgan Experimental Mine Site and Coal Preparation Plant on the Plateau

This alternative was studied in detail by Coalex Pty Ltd in 1975. In this plan the mine would again remain at the present Wolgan Experimental Mine site while the preparation plant would be located on the plateau about 2.5 km to the southeast and at an elevation of 380 m above the mine. The proposed treatment plant site would be on a spur running out from the dissected plateau edge bounded on the western side by the unnamed gully through which the Old Coad Road passes en route from the Wolgan Valley to the plateau surface.

Transport of raw coal from the mine workings to the preparation plant would be either by surface conveyor up the plateau escarpment or by underground drift conveyor.

The advantages of this plan over that in the previous section (3.5.1) would be:

- reduced visual impact on the Wolgan Valley
- a more suitable site for construction of the preparation plant and refuse dumps
- a more suitable route for transport of washed coal to the rail head.

Disadvantages of this scheme would be:

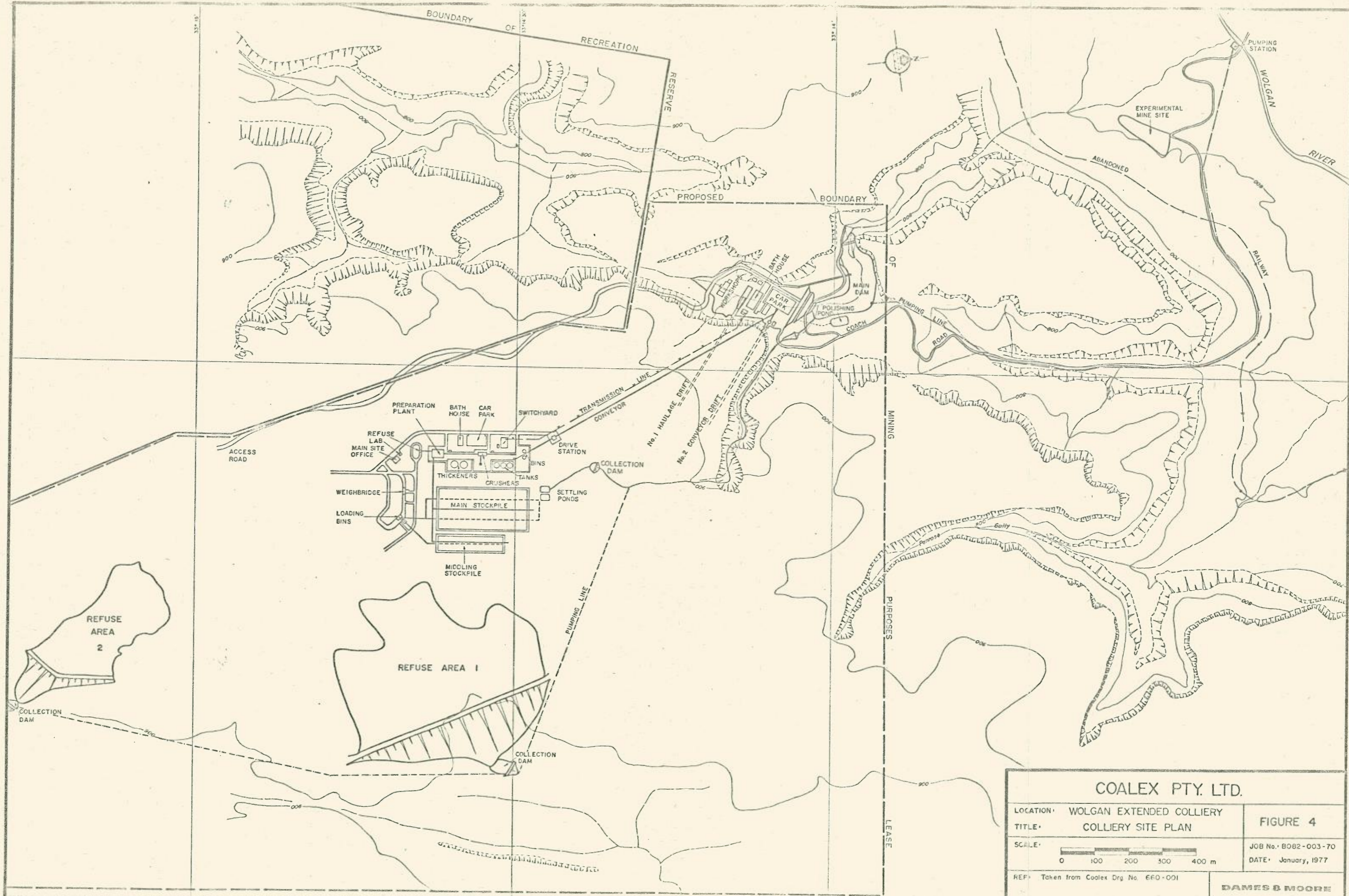
- the continued visual impact of the pit-top on the Wolgan Valley
- the high cost of construction of either an overland conveyor or an underground drift conveyor
- the added cost of increased travelling time to the coal face and corresponding loss of productive time.

3.5.3 Mine Site Adjacent to Coal Preparation Plant Site on the Plateau Edge

This is at present the most favoured proposal and the layout is shown in Figure 4. The preparation plant is to be located on the plateau edge as described in the previous section (3.5.2) and the mine's surface facilities will be below the first cliff face, just downhill from the upper gate on the Old Coach Road. Raw coal will be carried from the pit-top to the preparation plant, a distance of 1 km, by an overland conveyor.

The advantages of having the preparation plant at this site have already been discussed in the previous section. The advantages of having the mine head in the location proposed here are:

- removal of the visual impact of the development from the Wolgan Valley
- more cost effective development of the seam arising from having access nearer the center of the lease area
- better transport options as discussed in section 3.5.2.



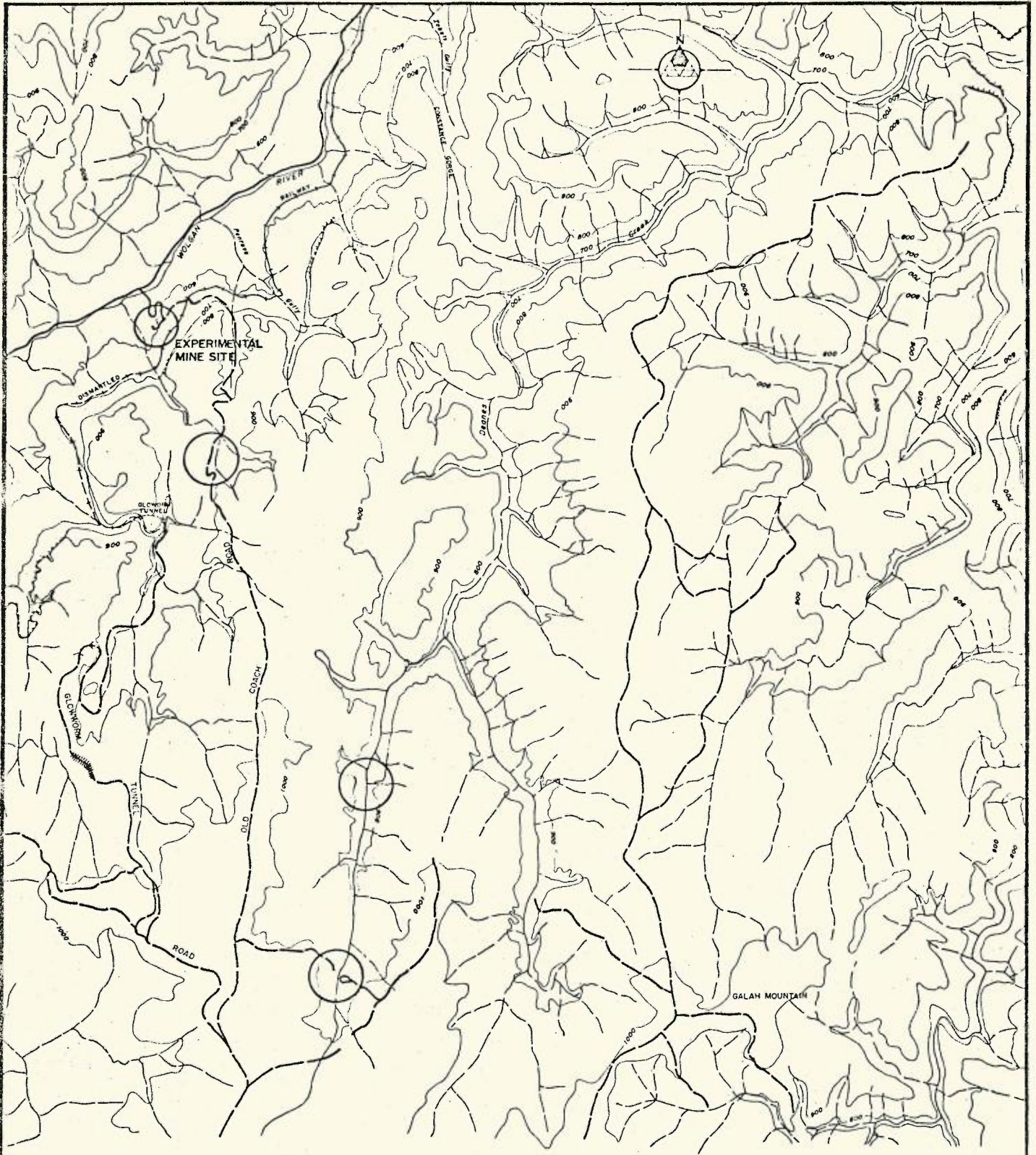
COALEX PTY. LTD.		
LOCATION:	WOLGAN EXTENDED COLLIERY	FIGURE 4
TITLE:	COLLIERY SITE PLAN	
SCALE:		JOB No. B082-003-70
REF:	Taken from Coalex Drg No. 660-001	DATE: January, 1977
		DAMES & MOORE

3.5.4 Mine and Coal Preparation Plant Located near Deanes Creek

Suitable sites for a mine and coal preparation plant exist at the locations indicated in Figure 5, near the existing dam on Deanes Creek. The possible preparation plant site here is level and there is a good water supply and suitable refuse disposal sites nearby. The possible mine site has a number of advantages. These are its position near the centre of the lease area and the depth of the valley in which the mine could be placed. These two factors would mean a considerable saving in initial capital installation costs. However, there are also several disadvantages associated with this location. These are:

- difficulty in gaining access to the proposed pit-top site
- erosion problems related to constructing the access road
- there are hydrological safety problems associated with locating the pit-top in a narrow valley which forms the outlet for a moderately large catchment. The valley bottom was so narrow that in order to have enough area to carry out mine top activities it would be necessary to enclose the creek and fill in the area above it.

In the following sections, 4.0 to 4.7, a discussion is presented of the nature of the colliery facilities and operations, in sufficient detail to provide an understanding of their possible environmental impacts.



COALEX PTY. LTD.	
LOCATION: WOLGAN EXTENDED COLLIERY ALTERNATIVE SITES ON DEANES CREEK	FIGURE 5
TITLE:	JOB No. 8082-003-70
SCALE:	DATE: January, 1977
REF.: Taken from 1:25 000 Series Sheets 8931-I-S, -IV-S, -II-N, -III-N	DAMES & MOORE

4.0 DESCRIPTION OF MINE AND PREPARATION PLANT OPERATIONS AND FACILITIES

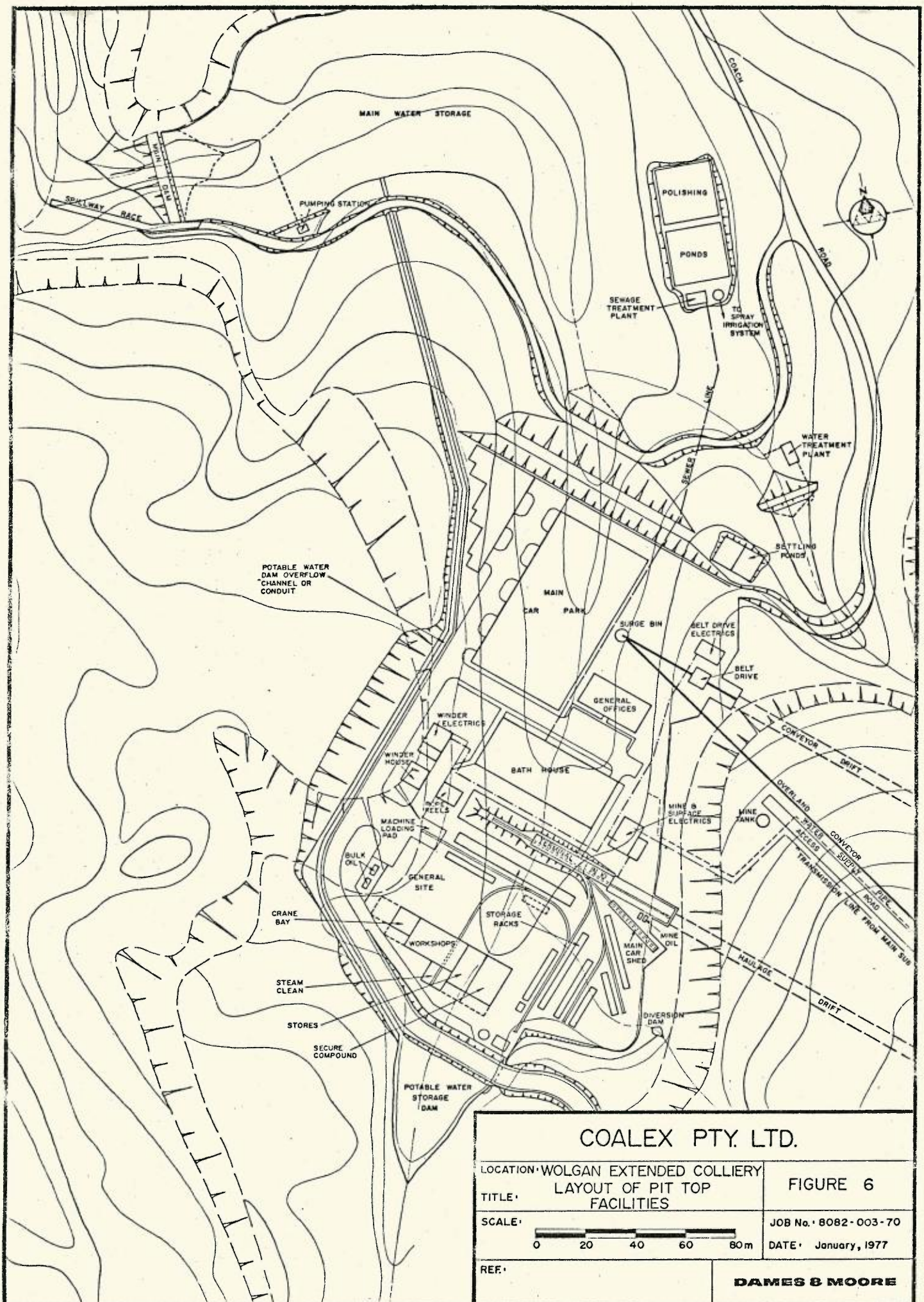
4.1 Introduction

Coalex Pty Limited are proposing to develop a new underground coal mine within the Western Coalfields District of NSW. It will be located approximately 33 km northeast of Lithgow between Clarence to the south and Newnes to the north. The Wolgan seam yields a high quality coking coal although it has a high ash content. A coal preparation plant will be constructed to treat the run of mine (ROM) coal to reduce the ash content and so produce a coking coal suitable for the export market.

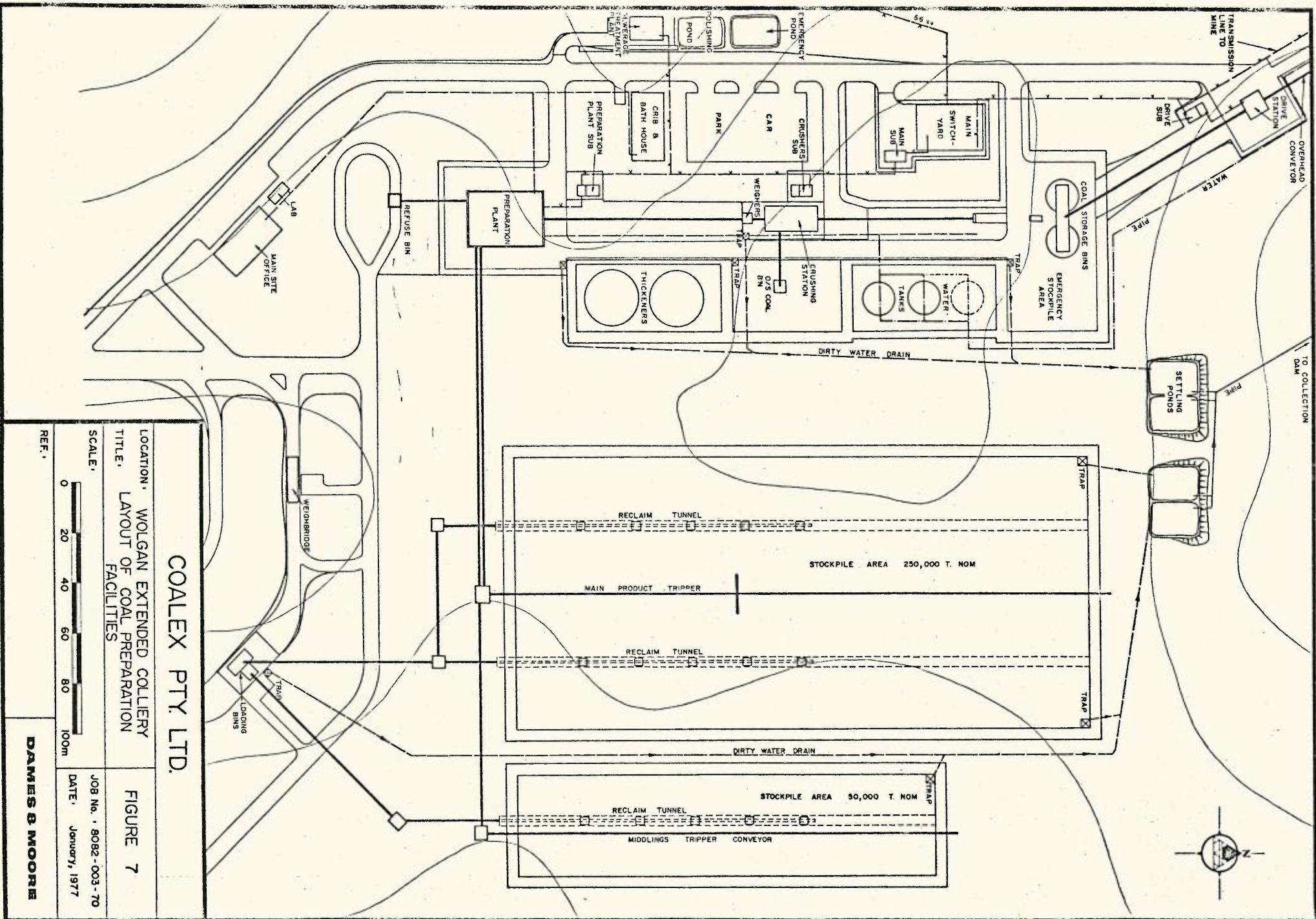
The proposed mine is designed to produce nearly two million tonnes of ROM coal per annum. Treatment of this amount of ROM coal in the preparation plant will yield up to 1,040,000 tonnes of coking coal (55%), most of which will go to overseas markets, and up to 285,000 tonnes of middlings coal (15%) with high ash content, most of which will be sold locally for steam generation.

The layout of the surface facilities at the proposed pit-top and preparation plant sites is shown in Figures 6 and 7 respectively. They are designed so as to form installations which are as compact as possible. Roadways will be paved and guttered so that rainwater runoff can be collected and directed to the main storage dam for subsequent use in the coal preparation plant.

Lists of the structures and facilities to be constructed at each of the mine and treatment plant sites are given in Table 1. Those items in these lists with some significant environmental impact are marked with asterisks and are discussed in more detail in the relevant sections.



COALEX PTY. LTD.		
LOCATION: WOLGAN EXTENDED COLLIERY	FIGURE 6	
TITLE: LAYOUT OF PIT TOP FACILITIES		
SCALE:		JOB No. 8082-003-70
REF.:		DATE: January, 1977
DAMES & MOORE		



COALEX PTY. LTD.

LOCATION: WOLGAN EXTENDED COLLIERY
 TITLE: LAYOUT OF COAL PREPARATION FACILITIES

FIGURE 7

SCALE: 0 20 40 60 80 100m
 JOB No. : 8082-003-70
 DATE: January, 1977

REF.: **DAMES & MOORE**

TABLE 1

LIST OF SURFACE FACILITIES AT WOLGAN EXTENDED COLLIERY

Mine Top Area

- Conveyor drift portal
- Haulage drift portal
- Belt drive and drive substation
- Winding house and winder substation
- Mine surface substation
- * Surge bin and overland conveyor
- * Bath house
- General offices
- Storage racks
- * Workshop and stores building
- * Steam cleaning bay
- * Diversion dam east slope
- * Potable water storage dam
- * Main water storage dam
- Pumping station
- * Settling ponds
- * Small collection dam
- * Water treatment plant
- * Sewerage treatment plant and polishing ponds
- * Overflow channel and conduit from potable water storage dam
- Workers' car park and access road
- Mine tank
- * Surface drainage lines

TABLE 1 (continued)

Preparation Plant Area

- * 66 KV power line
Main switch yard and substation
Drive, crusher and washery substations
Conveyor drive station
- * ROM coal storage bins
- * Emergency ROM stockpile area
Water tanks
- * Crushing station
- * Over-size coal storage bin
- * Coal preparation plant
- * Refuse bin
Thickeners
- * Main product stockpile area with tripper conveyor and reclaim tunnel
- * Middlings stockpile with tripper conveyor and reclaim tunnel
- * Road loading bins
Weighbridge
- * Crib and bath house
- * Sewerage treatment plant and polishing pond
Main site office
Laboratory
Office and preparation plant car parks
- * Access road

NOTE: * Facilities with some environmental impact

4.2 The Mining Operations

The proposed mining will be carried out as underground workings at a depth of 250-300 m. The coal seam is almost horizontal and mining will be confined to these depths. Extraction will be carried out mainly by the bord and pillar method. It is aimed to recover as much of the coal as is possible by this method of mining, which is usually about 70% of the in-situ deposits.

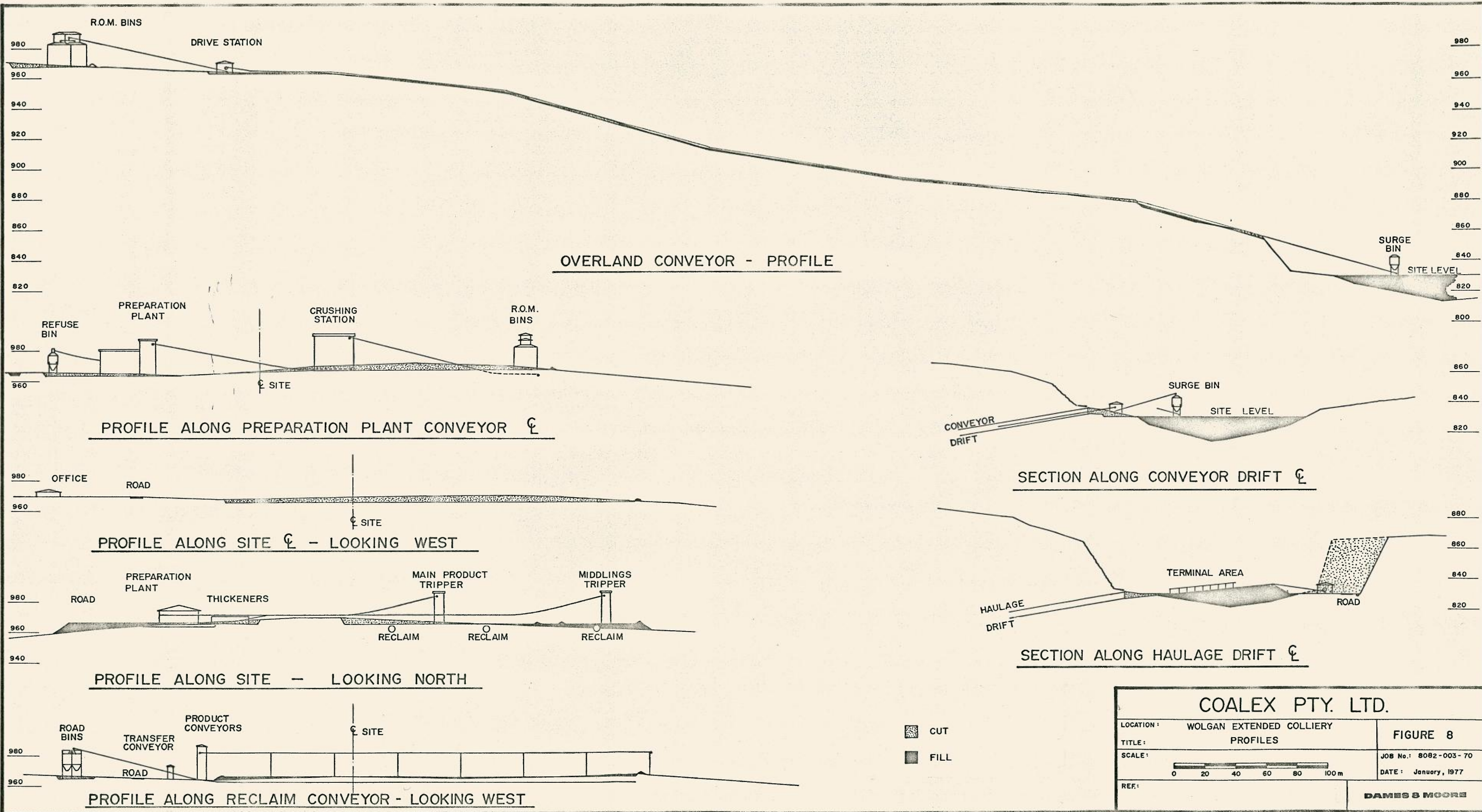
After extraction of the coal the goaf will break above the extracted area until the void is choked. The broken material occupies a volume one third greater than the solid, so in a 2.3 m seam the breakage would go to about 9 m. Above that, further bending and cracking will occur. This method of extraction will cause some surface subsidence but for the Wolgan seam which ranges in thickness from 1.5 to 2.3 m, this should not exceed 0.3 m at the surface. The area affected will be roughly 0.4 sq km for each million tonnes of coal extracted, eg, approximately 0.8 km per year. This amount of subsidence is unlikely to be noticed except for rigid man-made structures and minor swampy drainages.

There appear to be no surface structures in the area of the mining lease so that subsidence should have no effect on man-made structures. Very minor effects could occur on the smaller drainage areas represented by some minor marshes scattered throughout the region.

4.3 Raw Coal Handling

4.3.1 Seam Access and Coal Handling to the Surface

The haulage and conveyor drifts will descend from two surface portal structures to the mine working area with a gradient of 1 in 6 (see Figure 8). The haulage drift provides access for men and machinery while raw coal is transported to the surface via the conveyor drift. This conveyor will have a capacity of 750 tonnes of raw coal per hour.



COALEX PTY. LTD.		
LOCATION:	WOLGAN EXTENDED COLLIERY	FIGURE 8
TITLE:	PROFILES	JOB No.: 8082-003-70
SCALE:		DATE: January, 1977
REF:		DAMES & MOORE

Ventilation to the underground operations will initially be supplied from fans located in the mine portal area. As the underground operation proceeds raised bores will be installed to maintain the necessary ventilation.

The positions of the ventilation shafts are as shown in Figure 9. It should be noted that these shafts are located so as to require very little additional road work to that already existing for the test bore holes. Initially there will be at least four shafts and additional ones will be drilled as the mine develops. An earlier plan to locate the ventilation shafts at the bottom of gullies was rejected for environmental reasons.

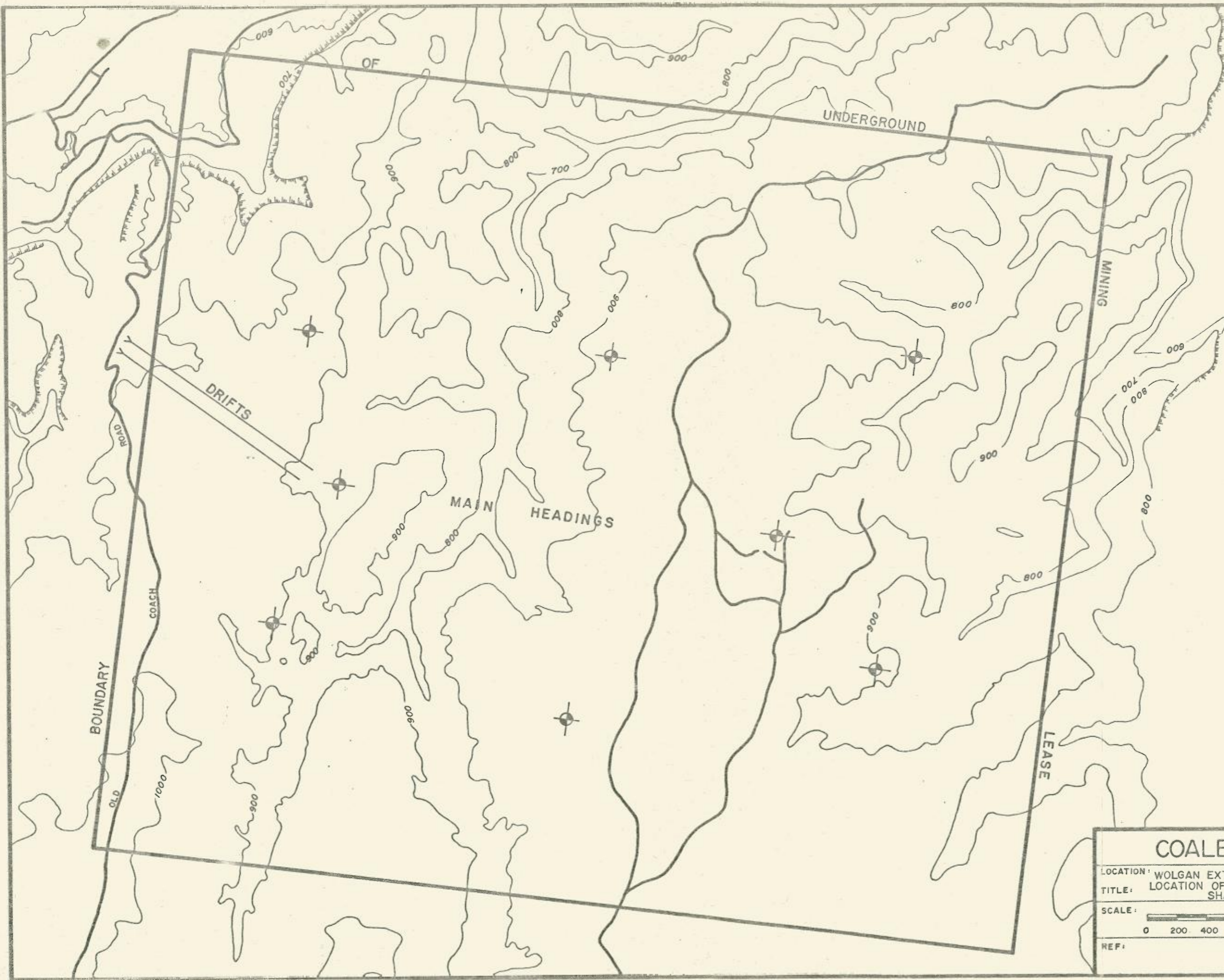
The spoil from the shafts, being raise bored, drops into the mine and is disposed of by the normal mine refuse system. For this reason, the ventilation installation will have little impact at the surface and will consist simply of the fan housing and an access road which will be used once each day for inspections.

4.3.2 Coal Handling from Conveyor Drift Portal to Preparation Plant



Raw coal from the mine conveyor will be transferred to the overland conveyor via a surge bin (see Figure 8). The overland conveyor will have a carrying capacity of 750 tonnes per hour and will be covered to prevent spread of fines through wind action and spillage. It will terminate at a storage bin with a capacity of 3000 tonnes which will feed the coal preparation plant. Should an overflow occur due to a breakdown in the preparation plant, the raw coal will bypass the bin to an adjacent emergency stockpile area. This stockpile area will be surrounded by a bund wall to collect drainage water from the area for reticulation to the washery recirculation system (see Figure 7).

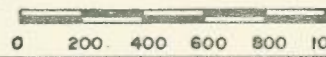
Automatic water spray equipment will be provided to control dust production.

Raw coal from the ROM coal storage bin will be fed to the crushing station by a covered and elevated conveyor (see Figure 8). On the occasions when the emergency stockpile area is used, a front-end loader will be used to retrieve the coal and load it onto the conveyor via a hopper below the storage bin.



LEGEND

-  RAISED BORE
-  BOUNDARY OF UNDERGROUND MINING LEASE

COALEX PTY. LTD.	
LOCATION: WOLGAN EXTENDED COLLIERY	FIGURE 9
TITLE: LOCATION OF VENTILATION SHAFTS	JOB No.: 8082 - 003 - 70
SCALE: 	DATE: December, 1976
REF:	DAMES & MOORE

A further covered conveyor belt will feed the crushed coal to the preparation plant. A sampling and automatic weighing station will be located on this conveyor with a remote readout in the plant's main control room.

4.3.3 Coal Preparation Plant

The preparation plant will treat the ROM coal to reduce the ash content and produce two saleable products, a low ash coke blend coal and a higher ash middling coal for steam generation.

The preparation plant will be constructed to the latest modular design and will consist of two modules of 250 tonnes per hour capacity which will operate semi-independently of each other. The washing will be completely enclosed to prevent dust emissions, reduce noise levels and provide satisfactory working conditions for employees during the cold winter months.

4.3.4 Description of the Coal Preparation Process

A two stage process will be used to wash Wolgan coal to produce a low ash coke blend coal, a middling coal for steam generation and a reject material or waste product.

To achieve this the process planned at this stage will be as follows:

The ROM coal will be crushed to 100 mm top size. This material will be fed, unsized, into a Baum jig at the normal rate of 500 tonnes per hour. The jig is a water only process and will remove the high ash stone and clay materials which will be dewatered and despatched to the refuse dump without further treatment. The jig products will be dewatered and sized on a screen. The coarse material, 100 mm x 19 mm will be crushed to pass 19 mm.

The jig products, now all 19 mm x 0, will be deslimed or sized at 0.5 mm. The 19 mm x 0.5 mm fraction will then be processed in a heavy medium cyclone system. In this process the "low ash" product is separated from the

"middling" product in an artificially created medium with density control at a particular specific gravity. The medium is made up using finely ground magnetite (90-95% minus 53 microns, Fe_3O_4) in suspension in water. This material (magnetite medium) is used in a closed circuit and only a very small quantity is lost from the plant (about 0.5 to 1.0 kgs per tonne of coal through the plant). The loss is by material adhering to the coal products or discarded with the fine reject material.

The fines (0.5 mm x 0) from the desliming screen will be further deslimed in classifying cyclones to remove much of the minus 125 micron material. The fine material, dosed with a frother (kerosine or distillate) and a collector (M.I.B.C.) will be processed in froth flotation system. The "low ash" product will be dewatered on a filter and the fine rejects from the flotation plant, together with dirty water from other sections of the plant fed to a rake thickener sized so as to settle out the fine solids. To assist in this settlement a flocculant will be used. The acidity of the process water will be controlled at the thickeners by monitoring the pH and automatically dosing liquid caustic solution into the circulating water. The concentrated solids from the thickener underflow will be discharged to the refuse sump. A detailed description of the arrangements for refuse disposal is given in section 4.5.

4.3.5 Product Coal Conveyors and Stockpiles

The preparation plant produces two types of coal product, coking coal and middling coal. Separate conveyors and stockpiles will be provided for these two products as shown on Figures 7 and 8. The product will be transferred from the preparation plant output conveyor to stockpile conveyors through transfer points which will be designed to prevent spillage and escape of dust.

The main product (coking coal) stockpile conveyor will be equipped with a double-sided tripper which will form two parallel stockpiles with a combined capacity of 250,000 tonnes. The middlings coal stockpile

conveyor will have a single tripper and will supply a stockpile of 50,000 tonnes capacity.

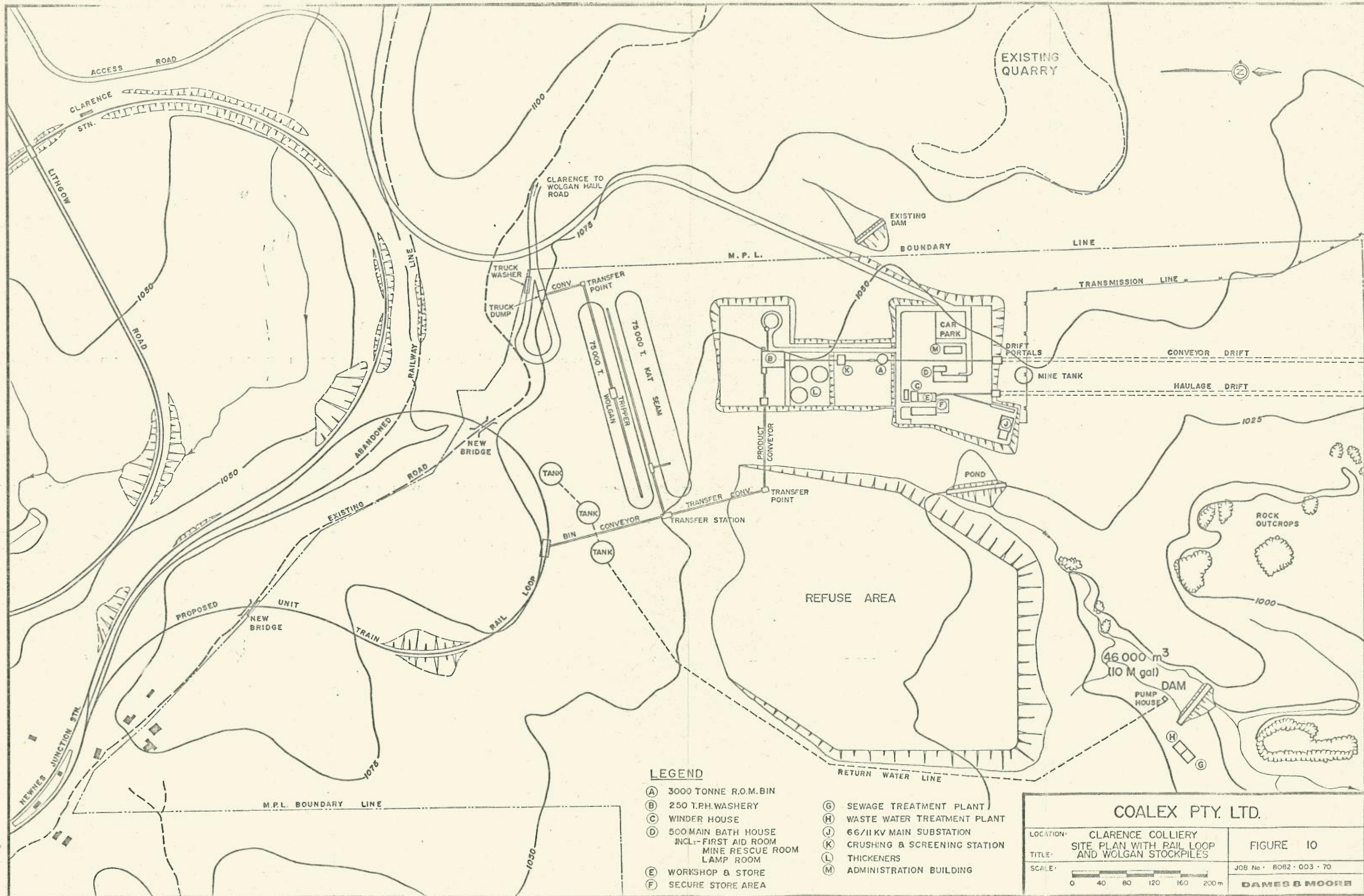
The stockpile area will be surrounded by bund walls to permit collection of drainage water for reticulation to the treatment plant circulation system and automatic water sprays will be provided for dust control.

Beneath each stockpile will be a reclaim tunnel fitted with feeders and a reclaim conveyor rated at 3,000 tonnes per hour. Covered conveyors will transfer the reclaimed coal to an overhead surge bin at the truck loading bay (see Figure 8). The product coal will be transported to the rail head at the Clarence Colliery by "on-highway" type trucks.

4.3.6 Transport of Coal Products to Markets

The rail head at Newnes Junction will provide a good outlet for washed coal from the Wolgan Extended Colliery. Facilities attached to the Clarence Colliery, at present under construction at Newnes Junction, will provide storage and loading for Wolgan coal. Figure 10 shows the layout of the Clarence Colliery coal handling facilities, the rail loop which connects to the main Western Railway and the additional stockpile capacity required to accommodate coal from Wolgan.

For transport of the coal product from the Clarence Colliery to the export point it is proposed to use 2,300 tonne gross unit-trains made up of new 76 tonne waggons which the Public Transport Commission is planning to build. Investigations are proceeding to determine whether 3,000 tonne gross trains can be used to reduce the number of unit-train trips. Traffic density on the main line will be the equivalent of that which now occurs when ships are being loaded. With the provision of adequate stockpiles at both the mine and the port, together with sufficient rolling stock and good unit train loading facilities, it will be possible to run an orderly and well regulated transport programme. This will contrast with the present difficulties being experienced in shipping coal from the Western Districts to overseas customers.



LEGEND

- (A) 3000 TONNE R.O.M. BIN
- (B) 250 T.P.H. WASHERY
- (C) WINDER HOUSE
- (D) 500 MAIN BATH HOUSE
INCL:- FIRST AID ROOM
MINE RESCUE ROOM
LAMP ROOM
- (E) WORKSHOP & STORE
- (F) SECURE STORE AREA
- (G) SEWAGE TREATMENT PLANT
- (H) WASTE WATER TREATMENT PLANT
- (J) 66/11 KV MAIN SUBSTATION
- (K) CRUSHING & SCREENING STATION
- (L) THICKENERS
- (M) ADMINISTRATION BUILDING

COALEX PTY. LTD.	
LOCATION: CLARENCE COLLIERY TITLE: SITE PLAN WITH RAIL LOOP AND WOLGAN STOCKPILES	FIGURE 10 JOB No. 8082-003-70
SCALE:	
DAMES & MOORE	

The middlings coal will be used mainly for steam raising at Wallerawang Power Station. The coal will be transported there by truck because the power station has no rail unloading facilities. If such facilities become available in the future then the rail linkage can be used.

4.3.7 Coal Transport Alternatives

Washed coal can be transported away from the Wolgan Extended Colliery by either road or rail. These two alternatives have been considered in some detail by Coalex Pty Ltd.

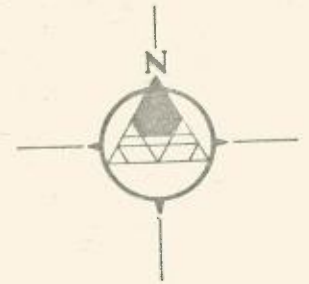
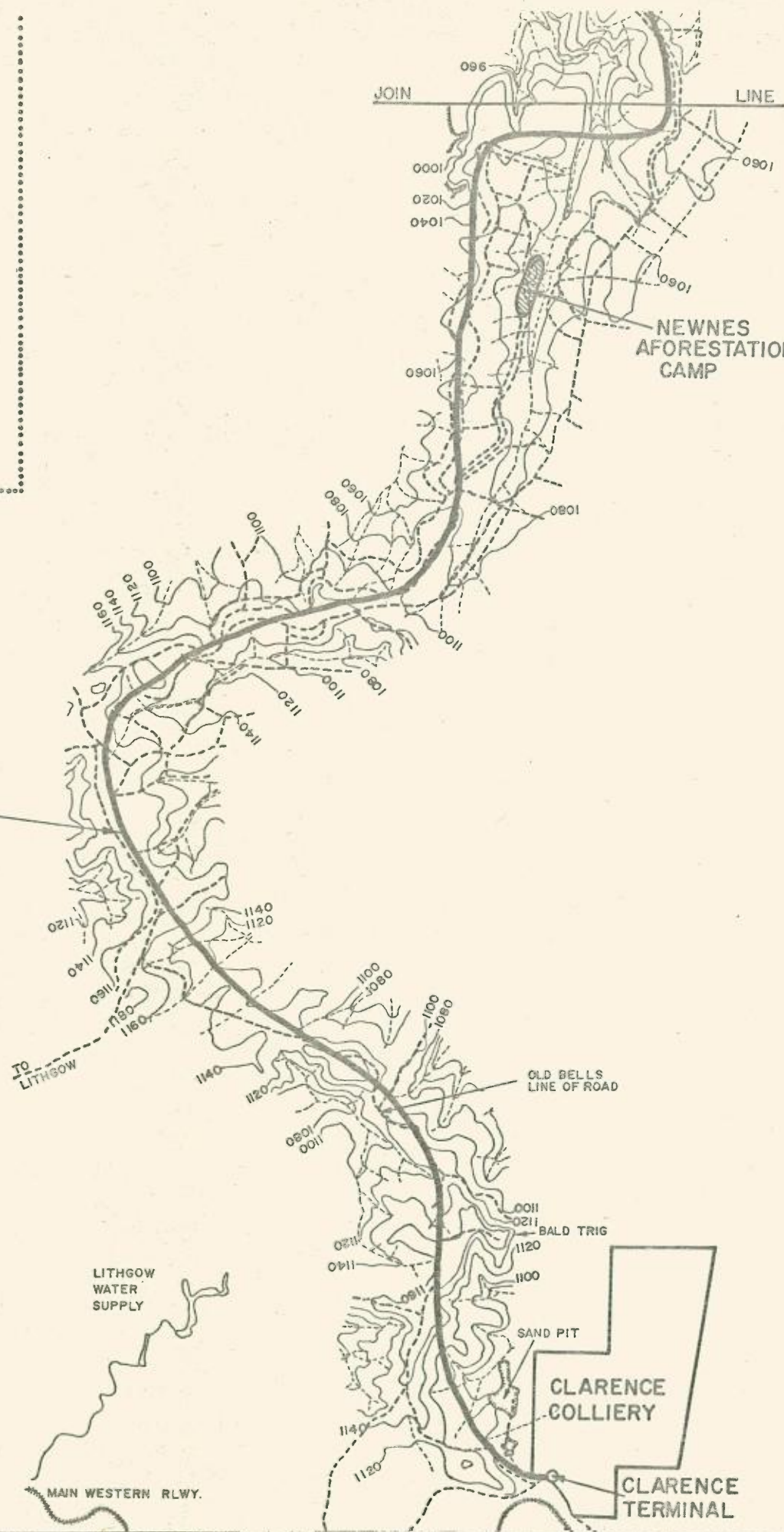
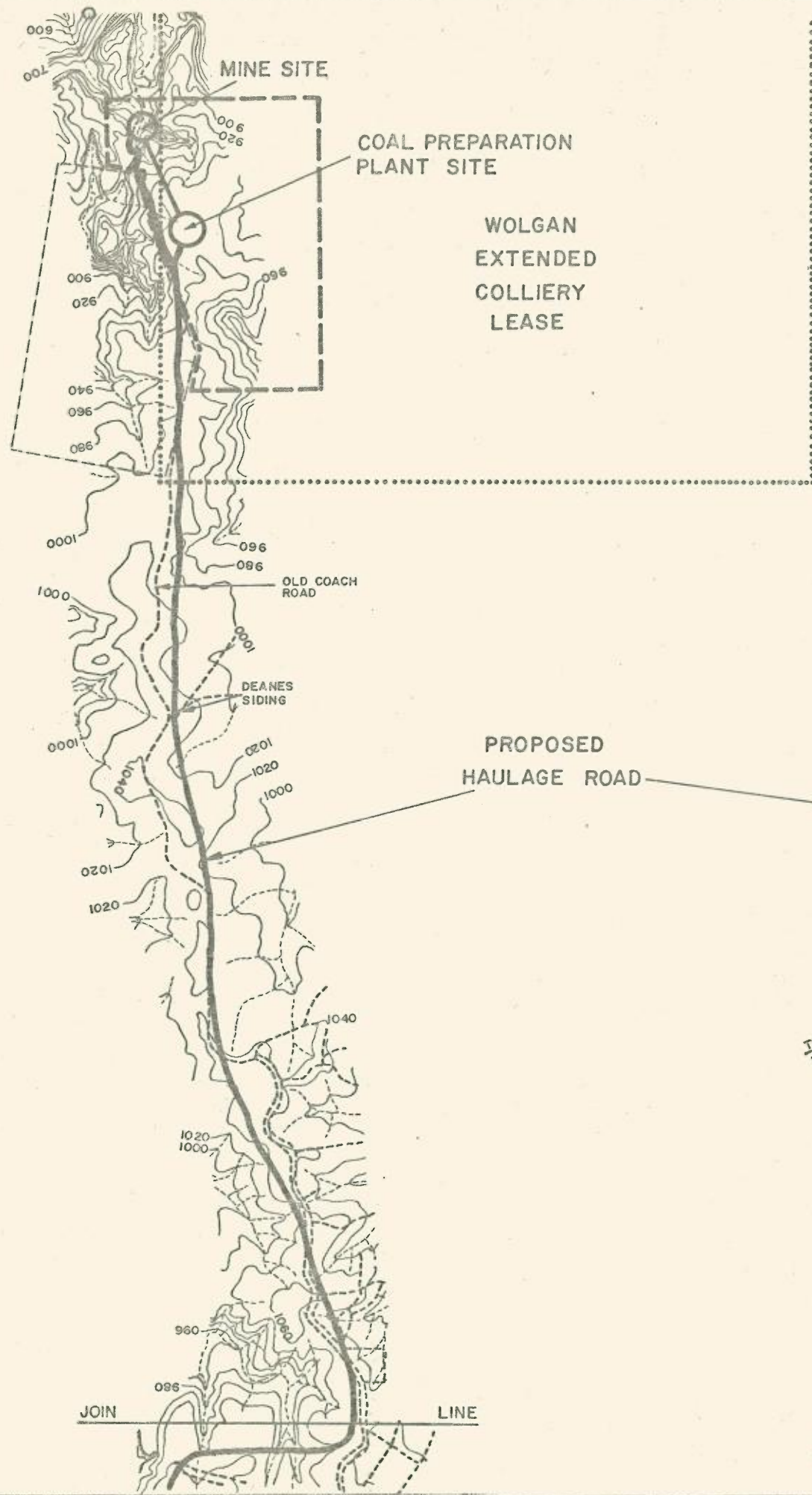
4.3.7.1 Rail Transport

Preliminary studies by Coalex suggest that the old Wolgan Valley railway could be rebuilt from Newnes Junction to Deanes Siding and a new line built across the plateau to the coal preparation plant site. The use of rail transport has certain environmental advantages and this alternative was initially favoured by Coalex in 1974. However, the cost of reconstruction of the line to haul only 1 million tonnes per year, the amount of coal the company plans to mine initially, would be prohibitive. In addition to this, it would still be necessary to upgrade the existing roads for use by mine personnel, emergency use, the Prison Farm, etc.

4.3.7.2 Road Transport

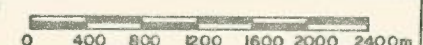
The proposed route for the road from the Wolgan Extended Colliery to the Clarence Colliery is shown in Figure 11 and follows approximately the alignment of the Old Coach Road and the "Old Bells Line of Road". This route appears to be the most suitable one because it follows the least difficult terrain and for the most part follows existing roads.

The road will be constructed to Department of Main Roads highway standard with a paved width of 9.14 m and a service corridor to carry the 66 kV



LEGEND

- UNDERGROUND MINING LEASE BOUNDARY
- PROPOSED MINING PURPOSE LEASE BOUNDARY
- - - - PUBLIC RECREATION RESERVE

COALEX PTY. LTD.	
LOCATION: WOLGAN EXTENDED COLLIERY	FIGURE 11
TITLE: TRANSPORT ROUTE FROM WOLGAN TO CLARENCE	JOB No. 8082-003-70
SCALE: 	DATE: January, 1977
REF: COALEX DRG. No. 760-006	DAMES & MOORE

transmission line and the telephone line. An estimated 3,500 tonnes of washed coal will be initially transported per day in "on-highway" type trucks of 50/70 tonne capacity. This will involve up to 80 round trips per day of 20 hours over a period of up to 300 days per annum.

4.4 Additional Surface Facilities

4.4.1 Bath Houses

There will be a bath house at both the pit top and the coal preparation plant. These will be of modern design and will comply in all respects with the requirements of the Coal Mining Regulation Act, the Mines Department and the Department of Health. Waste waters from the showers, toilets, etc, will be treated in a sewerage treatment plant, the effluent from which will be directed to the spray irrigation system used in the revegetation scheme. The bath house at the pit top will accommodate 400 men while that at the preparation plant will have facilities for only 30 men.

4.4.2 Workshops and Store

The workshops and store will be accommodated in a modern building which will contain office accommodation for electrical and mechanical engineers and storemen. Drainage from the area of the workshops and store building will be collected and passed through drainage pits, and oil and grease separators prior to flowing to the washery recirculation system. The workshops and store building will be located near the portal of the haulage drift as shown in Figure 6.

4.4.3 Bulk Stores Area

The bulk stores will be kept in an open paved storage area with a drainage system connected to the water recirculation system. The area will contain an "A" frame gantry and will be used to store timber, drums of oil, reels of cable and conveyor belting, steel, etc. The area will be enclosed with a wire mesh fence 1.8 m high with access gates for trucks and personnel.

4.5 Refuse Disposal

4.5.1 General

The size distribution of the coarse and fine refuse material will be determined by the nature of the particular coal seam and is also affected by contract specifications for the coal product. The expected quantities of coarse and fine materials from the Wolgan Washery are shown in Table 2.

Subsurface exploration at the mining site has shown that the refuse material will be composed mainly of shale and dark grey mudstones together with some fine to medium-grained sandstones.

Mineralogical analyses of these strata indicate that this material is composed predominantly of clays, including up to 50% kaolinite together with some montmorillonite and illite, up to 45% siderite in some bands, and quartz.

The cleaned coal product will be mechanically dewatered after leaving the preparation plant. The coal products will then be stockpiled and the refuse deposited in a sump. The mixture of coarse and fine refuse will be pumped as a thickened slurry to the refuse disposal area at a consistency of approximately 0.5 kg/litre. Coarse refuse material required separately for dam wall construction at the disposal areas will be collected before mixing with the fines occurs in the pump sump.

4.5.2 Physical Properties of Refuse Materials

To assist preliminary design studies for refuse dams in the disposal areas, laboratory testing has been carried out on a bulk sample taken directly from the existing experimental mine at Wolgan. The results of these tests, detailed in Appendix A1, indicate that the coarse fraction should be quite suitable for construction purposes in the form which the company proposes to produce it. At this stage however, it should be stressed that these

TABLE 2

WOLGAN EXTENDED COLLIERY: PRODUCTION AND REFUSE QUANTITIES FOR 10 YEARS OPERATIONS

Year	ROM Coal Tonnes	Saleable Coal Tonnes	Total Refuse Tonnes	Total Refuse Vol (m ³)	Coarse Refuse Vol (m ³)	Fine Refuse Vol (m ³)
1	189,000	132,300	56,700	35,401	23,577	11,824
2	626,000	438,200	187,800	117,255	78,092	39,163
3	1,000,000	700,000	300,000	187,308	124,747	62,561
4	1,500,000	1,050,000	450,000	280,961	187,121	93,840
5	1,900,000	1,330,000	570,000	355,883	237,019	118,864
6	1,900,000	1,330,000	570,000	355,883	237,019	118,864
7	1,900,000	1,330,000	570,000	355,883	237,019	118,864
8	1,900,000	1,330,000	570,000	355,883	237,019	118,864
9	1,900,000	1,330,000	570,000	355,883	237,019	118,864
10	1,900,000	1,330,000	570,000	355,883	237,019	118,864
Total for first 10 years	14,715,000	10,300,500	4,414,500	2,756,225	1,835,651	920,572

results can only be considered as preliminary and that additional testing and design studies will be needed.

4.5.3 Alternative Fine Refuse Disposal Systems

At present it is proposed to dispose of the fine refuse by mixing it with coarse refuse and pumping this to the refuse dams where it will be left in this state. If the fine refuse could be dried before disposal then the capacity required of the disposal areas would be considerably reduced and additional water would be available for recycling. With these facts in mind the following systems which are being considered in some collieries in Australia were examined.

4.5.3.1 Drum Vacuum Filter

This would possibly produce a fine material dry enough to transport in conventional road trucks, say with the coarse refuse. The fine material would readily become a slurry if contact were made with water.

Only small pilot plant units have been tested. A trial run on tailings found these to be difficult to filter and heavy dosing with pulverised fuel from a power station was required for satisfactory operation.

4.5.3.2 Filter Presses

These would produce a similar effect to the vacuum filter. They are used in applications where the material is difficult to handle. It seems that no units have been tried in either pilot plant or commercial operations.

4.5.3.3 Solid Bowl Centrifuge

Again the product would be similar to the filter product with possibly a lower end moisture. The material will still turn into a slurry readily on contact with water, but dispersed evenly with the coarse product this

problem could be minimised. However, it would seem that tailings dam construction will still be necessary to prevent damage to the environment.

Pilot plant units have been tried on coal similar to that from the Wolgan seam with some success. It is understood that one company is purchasing a commercial size unit, but that this will not be in commercial operation for some months.

4.5.3.4 Fluidised Incineration

This is very much in the developmental stage only. Joint investigations by Clutha Development Pty Ltd and the CSIRO have been announced. Small pilot plants have been run for short periods in the United States but have not proven feasible on all types of tailings. The product in this case is almost completely inert and is suitable for a number of commercial uses as well as reducing the risk of environmental contamination.

As yet, none of these systems are in successful commercial operation. Further developments will be kept under review in case any should develop into a favourable alternative to the currently proposed system.

4.5.4 Refuse Disposal Dams

Two refuse disposal areas, of sufficient cumulative capacity for the operating life of the mine, have been defined in the vicinity of the Wolgan Extended Colliery (see Figure 4). A preliminary design study has been carried out for the dam walls which will be followed by a more detailed study before construction begins.

The following method of construction of the refuse dams is considered to be the most suitable for the type of refuse and existing conditions in the proposed disposal areas. A cellular downstream wall will be constructed. The wall will be constructed of coarse refuse

compacted to a minimum of 100% standard compaction by pneumatic tyred or other suitable compacting equipment. The refuse will be formed into cellular sections contained between clay seals to eliminate the risk of spontaneous combustion within the refuse.

The discharge pipeline from the coal preparation plant will be positioned adjacent to the upstream face of the dam wall and directed away from the wall. Discharging the refuse in this manner will deposit the coarse fraction near the wall and the finer (weaker) fraction away from the wall. In addition, excess water from the washery process will be ponded upstream at some distance from the constructed wall. The coarse fraction that will discharge behind the wall will be compacted to increase the stability of the final wall.

A source of clay, to be used for the cores and seals of dam walls will be found before the final designs are presented so that adequate testing of the clay can be carried out to determine its suitability as an impervious material. The compaction characteristics of the clay will also be evaluated by adequate testing.

The crest of each refuse dam will be raised in stages. As each stage is completed, a protective layer of soil and rock will be placed on the outer slope and establishment of a vegetation cover commenced. Benches will be constructed on the wall for tree planting and where practical, the contours of the wall will be made to blend into the surrounding slopes. The final wall crest heights for the refuse dams will be 75 m for Refuse Area 1 and 50 m for Refuse Area 2. Further information is given in Appendix A1 which contains detailed notes relevant to the construction and operation of the refuse dam.

The estimated volume capacity of the refuse dams is as follows:

Refuse Area 1	- Estimated wall volume	= $2.23 \times 10^6 \text{ m}^3$
	- Estimated wet refuse volume	= $2.5 \times 10^6 \text{ m}^3$
Refuse Area 2	- Estimated wall volume	= $0.3 \times 10^6 \text{ m}^3$
	- Estimated wet refuse volume	= $1.26 \times 10^6 \text{ m}^3$

When disposal of refuse is completed for each of the dams, the surface will be graded and covered with a 15 cm layer of impervious soil material to seal the disposal area. The impervious soil will then be covered with 50 cm of suitable rockfill to provide a drainage and armour layer to inhibit future erosion of the disposal area. This in turn will be covered with 30 cm of topsoil to allow for revegetation.

4.6 Water Flow for Mine and Coal Preparation Plant

4.6.1 General

A schematic of total water flow for the Wolgan Extended Colliery is shown in Figure 12. There are three possible sources of water from the mining and coal preparation operations. These are:

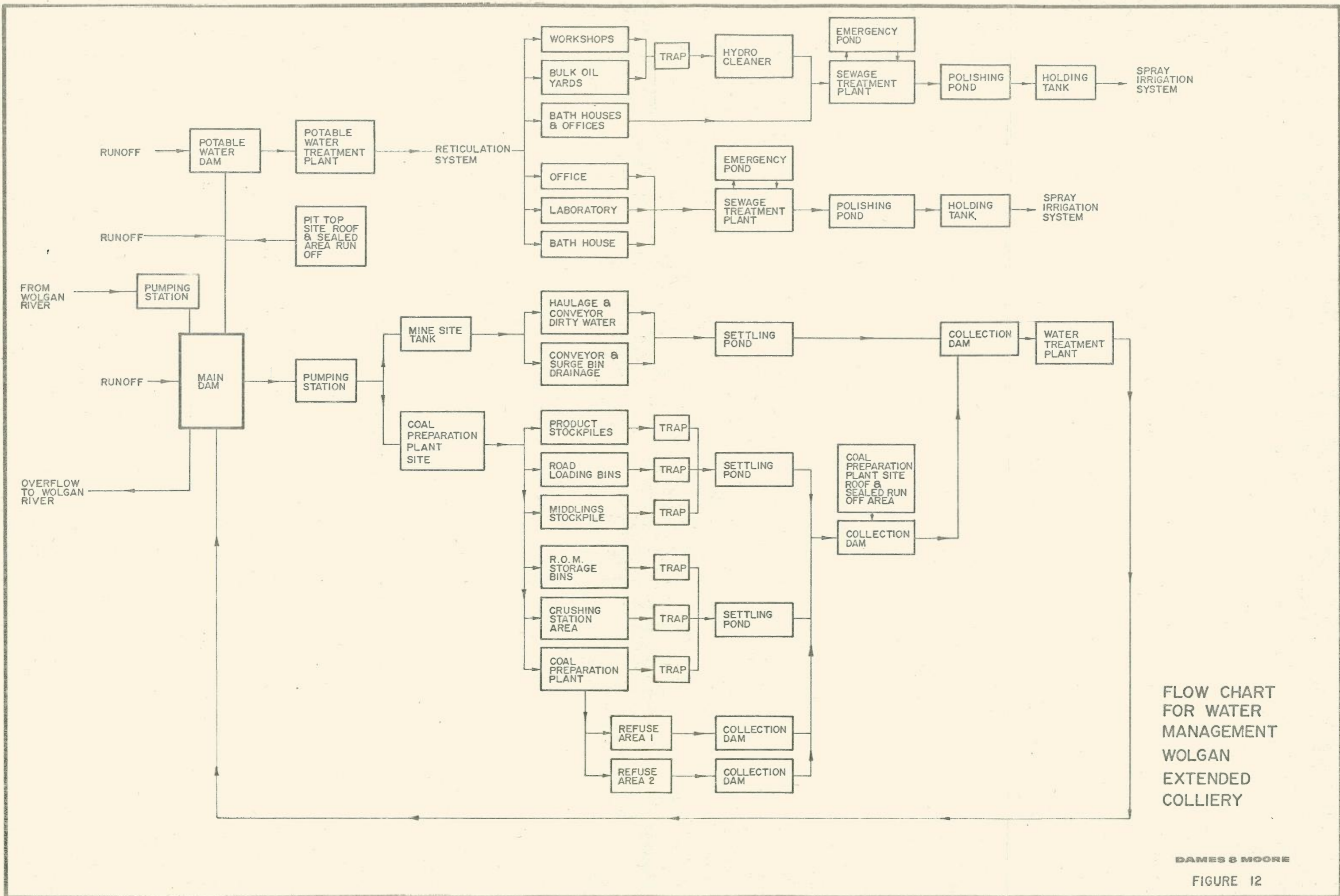
- runoff collected within the mining purposes lease area
- water pumped up from the Wolgan River
- water recovered from mine dewatering.

It is envisaged that the major source of water for the colliery complex will be runoff collected within the mining purposes lease area. Comprehensive water conservation and treatment facilities will ensure an almost complete recycling of process water. Only a comparatively small amount of make-up water (if any) will have to be pumped from the Wolgan River.

Experience from the old Wolgan Mine, which was worked in the 1920's, and more recently from the Wolgan Experimental Mine has shown the Wolgan seam to be dry. Geological conditions are such that any future workings in this seam should also be dry (see Section 5.1.5).

The only water outflow from the colliery complex will be overflow from the main storage dam during periods of very intense rainfall (see Section 5.1.4).

A preliminary surface hydrology study and rainfall analysis has been carried out to aid the design of surface drainage structures. This is presented in Appendix A2.



FLOW CHART FOR WATER MANAGEMENT WOLGAN EXTENDED COLLIERY

The major component of the water flow system are discussed in the following sections.

4.6.2 Main Storage Dam

The main storage dam, with a capacity of 68 million litres, is located at the pit-top area as shown in Figure 6. This dam will supply water to the two washery holding tanks, each of 2,270,000 litres capacity and to the pit-top tank, capacity 113,500 litres. Locations of these tanks are shown in Figures 4 and 7.

In order to conserve water all output water from washing and mining operations, decanted and seepage water from the refuse dams and surface runoff from the operations and storage area, will, after treatment, be run into the main storage dam.

Site investigation and design studies for the main storage dam wall have not been carried out yet. At the present time it is envisaged that the dam will be of rockfill construction with a maximum embankment height of about 15 m. The crest length will be about 50 m. A spillway will be constructed at the right abutment.

4.6.3 Potable Water Storage Dam

Surface runoff water will be collected in a small dam of about 500,000 litres capacity which will be located on the south end of the mine site. Water from this dam will be purified in an adjacent treatment plant and used as potable and bathing water throughout the colliery. Overflow from the potable water dam will be run into the main storage dam via an overflow channel as discussed in Appendix A2.

The wall of the potable water storage dam will be formed by the hill used to level the pit-top operations area plus an additional embankment over which the main access road will pass.

4.6.4 Water Treatment

Discarded water from the mine operations and surface runoff water from the pit-top site will be collected and routed through the settlement tanks and water treatment plant shown in Figure 6 before discharge into the main water storage dam. Water output from the coal preparation plant, decanted and seepage water from the refuse dams and runoff from stockpiles and coal handling areas will be collected and run into the settlement tanks located adjacent to the preparation plant (see Figure 7). Several alternatives exist for the next stage in handling the water output from these settlement ponds, these are:

1. Discharge of the overflow water from the settling tanks directly into the adjacent gully where it will flow down to a collection dam and thence to the pit-top sites' water treatment plant.
2. A water treatment plant could be installed at the preparation plant site and the settlement tank outflow routed through this before discharge into the adjacent gully.
3. A pipeline could be constructed to carry water from the preparation plant site settlement tanks to the pit-top site water treatment plant.

Although Figures 4 and 6 show facilities for alternative 1, a final decision on the system to be installed has not been made.

All output water will be treated to the specifications required by the Clean Waters Act. Classification of the Colo River catchment, which includes the Wolgan River, has been finalised as class 'P' and notification of this was published in Government Gazette No.25. This means that water affected by the colliery operations, either process water or runoff from colliery operations areas will have to be treated to the standard of drinking water before its release or discharge into natural waterways.

4.6.5 Water Budget

The expected maximum daily makeup water required for the mining and treatment plant operations is 1.36 million litres. The mine and preparation plant will be in operation 220 days per year which means an annual water requirement of 296.9 million litres. The recorded median annual rainfall for the region is 1097 mm (see section 5.1.7.3). For a catchment area of 43 ha and assuming a runoff coefficient of 0.95 the yield of the catchment is estimated as 427.3 million litres. This is only 30.5% more than annual requirements and does not make sufficient allowance for annual rainfall variability.

The main storage dam is capable of providing the total make-up water needs of the colliery for up to 50 days given an initially full condition. In periods of prolonged drought it could be necessary to pump water from the Wolgan River. It should be noted that Coalex Pty Ltd already holds a license from the Water Resources Commission (License No. 73/3347) to pump 2724 litres per minute (3.92 million litres per 24 hour day) from the Wolgan River. The pumping station and pipeline are shown in Figures 4 and 12. Estimates of Wolgan River yield made from Cox's River records (see Appendix A5) indicate that although the instantaneous flow rates could fall below requirements the monthly flow rates should always be adequate. Careful management of the colliery's water storage and pumping capacity should minimise any impact caused by pumping from the Wolgan River during prolonged dry periods.

4.6.6 Sewage Treatment Plants

Modern package sewage treatment plants will be installed at both pit-top and treatment plant sites will operate on the activated sludge principle and with internal digestion. These plants will accommodate sewage and bathroom waste water and the effluent water quality is expected to be 20 ppm BOD and 20 ppm suspended solids. A polishing filter will be added as a final stage producing an effluent quality of 10 ppm BOD and 10 ppm suspended solids which will meet the requirements of the Clean Waters Act. Output water from the sewerage treatment plant will be used for spray irrigation systems installed

as part of the revegetation programme.

4.7 Electricity Supply

The main power supply for both the pit and coal preparation plant will be a 66 kV transmission line from Lithgow. The route of the transmission line will be along the service corridor provided by the road from the Clarence Colliery. The line will run first to the 66/11 kV substation at the coal preparation plant site and from there to another 66/11 kv substation at the pit-top site. Distribution from these substations will be 11 kV or 415 V as required. The capacity of the two main substations will be each 5 megawatts.

At the colliery site, separate 11 kV/415 V substations and switchyards will be provided for the mine and coal preparation plant. All electrical equipment will be constructed to comply with regulations regarding lightning strikes, earth faulting and switching. The combined load on the electricity supply will not exceed 10 megawatts - the design capacity of the substation transformers. The anticipated maximum power demand is 9 megawatts. Electrical reticulation within the colliery site will be by ducted or buried cable.

5.0 DESCRIPTION OF EXISTING ENVIRONMENT

5.1 Physical Environment

5.1.1 Geomorphology

The lease area is southwest of the Colo Highlands, and in the catchments of Deanes Creek and the Wolgan River. The landscape is characterised by steep-sided upland valleys separated by wide, gently rolling plateaux. Minor tributaries feed into the valley through narrow gorges.

The highest point within the lease area is 1,015 m, although Galah Mountain to the southeast lies 1,040 m above sea level.

5.1.2 Geology

The proposed Wolgan Extended Coal Mine is situated in the Western Coalfield of NSW, which occupies a section of the western edge of the Sydney Basin. The broad stratigraphic relations of the Illawarra Coal Measures within the area are summarised in Table 3. The strata are generally horizontal, with the coal measures dipping 1 to 2 degrees to the northeast.

Jointing is a pronounced feature of these sediments and two major jointing directions have been observed, one tending northeast and the other northwest. These joints are visible in aerial photographs and their control over the erosion and drainage pattern is evident. Many of the joints are found only in sandstones and not in the seams and so have little effect on the working of the coal or roof control in pillar extraction. In other areas in the Western field, joints in the sedimentary rock sometimes correspond with micro-faulting in the seam. A major study is at present underway to determine the relationship of surface features to underground conditions and the results of this work will be available before the mine design is finalised. The presence of steep-sided valleys cutting through the Triassic sandstones and exposing the coal measures, particularly in the Wolgan Valley, gives rise to

outcrop access to the seams and also to rapid changes in cover across the area. These features have had to be taken into account in deciding on the location of access points to the mine for men and machines, for the positioning of ventilation shafts and for planning underground pillar extraction.

There are five coal seams in the area of the proposed Wolgan Extended Colliery. In descending order these are as follows:

- Katoomba Seam (Top and Bottom Split)
- Middle River Seam
- Wolgan Seam
- Capertee Seam
- Lithgow Seam.

Only the Wolgan Seam and the bottom split of the Katoomba Seam can be regarded as economic in the area under review. The Katoomba Seam ranges in thickness from 1.5 m to 2.0 m and has moderate coking properties although it is high in ash (20 to 25 percent). Its best development is confined to the western half of the area. The Wolgan Seam, however, is well developed over the whole of the proposed mining lease area with a thickness of 1.8 m on the western side and up to 2.3 m towards the eastern side. Coal from this seam is high in ash (up to 30 percent), but on washing, yields a 10.5 percent ash product with good coking properties.

5.1.3 Soils

Soils in the mining lease area are derived primarily from Triassic sandstone parent materials, and are relatively shallow and somewhat acid. Such soils are typically low in nitrogen, potassium, and occasionally calcium, and

TABLE 3

STRATIGRAPHY OF THE WESTERN COALFIELD

Quaternary	Alluvium, sand, silt
Tertiary	Olivine basalt Hawkesbury Sandstone - massive quartzose sandstone
Triassic	Narrabeen Group Burrell Formation - shale, sandstone Gross Sandstone - quartzose, becoming lithic towards base; sandstone, minor red-brown claystone Caley Formation - claystone, shale, sandstone Illawarra Coal Measures - sandstone, shale, claystone, conglomerate, coal and torbanite seams
Permian	Shoalhaven Group Berry Formation - siltstone, limestone, minor evaporites Megalong Conglomerate - lithic sandstone, basal conglomerate, minor shale
Lower Carboniferous	- granite
Devonian	- quartzite, limestone, shale

very low phosphorus levels may even affect the distribution of native vegetation (Beadle, 1954, 1962). Soil nutrient status may improve somewhat in low-lying areas and in gullies, where nutrients and organic material can accumulate over time. Nevertheless, the main land use on these poor soils is restricted to forestry, grazing of native pastures, or recreation.

5.1.4 Surface Water Hydrology

The hydrology of the coal preparation plant and pit-top sites has been treated in some detail in the discussion of the colliery water flow (Section 4.6) and in Appendix A2 which reports a study carried out to aid the design of surface drainage structures at the pit-top site.

The coal preparation plant is located on a fairly level, free draining site which contains no permanent waterways. Runoff from this site flows ultimately to the Wolgan River by two main routes; via Deanes Creek to the northeast and via the unnamed creek flowing to the northwest.

The gully in which the pit-top will be located does not contain a permanent stream. Further details on water flow through this site may be obtained from the report on the surface hydrology study, in Appendix A2. The small gully, immediately to the east of the pit-top gully, receives a major part of its water flow from the area of the preparation plant site.

In general, the colliery area consists of well-drained upland areas with high runoff coefficients. No major streams pass through the sites which form only a very small proportion of the catchment areas in the immediate vicinity.

5.1.5 Groundwater Hydrology

There is little evidence of groundwater flow near the surface anywhere

within the area directly affected by the preparation plant or pit-top site. A drilling program carried out by Coalex shows that in the center of the mining lease area there is mainly sandstone to 216 m. The presence of joint cracks in the sandstone substrata together with the high runoff rates of the surface offers little opportunity for a groundwater profile to develop.

5.1.6 Water Quality

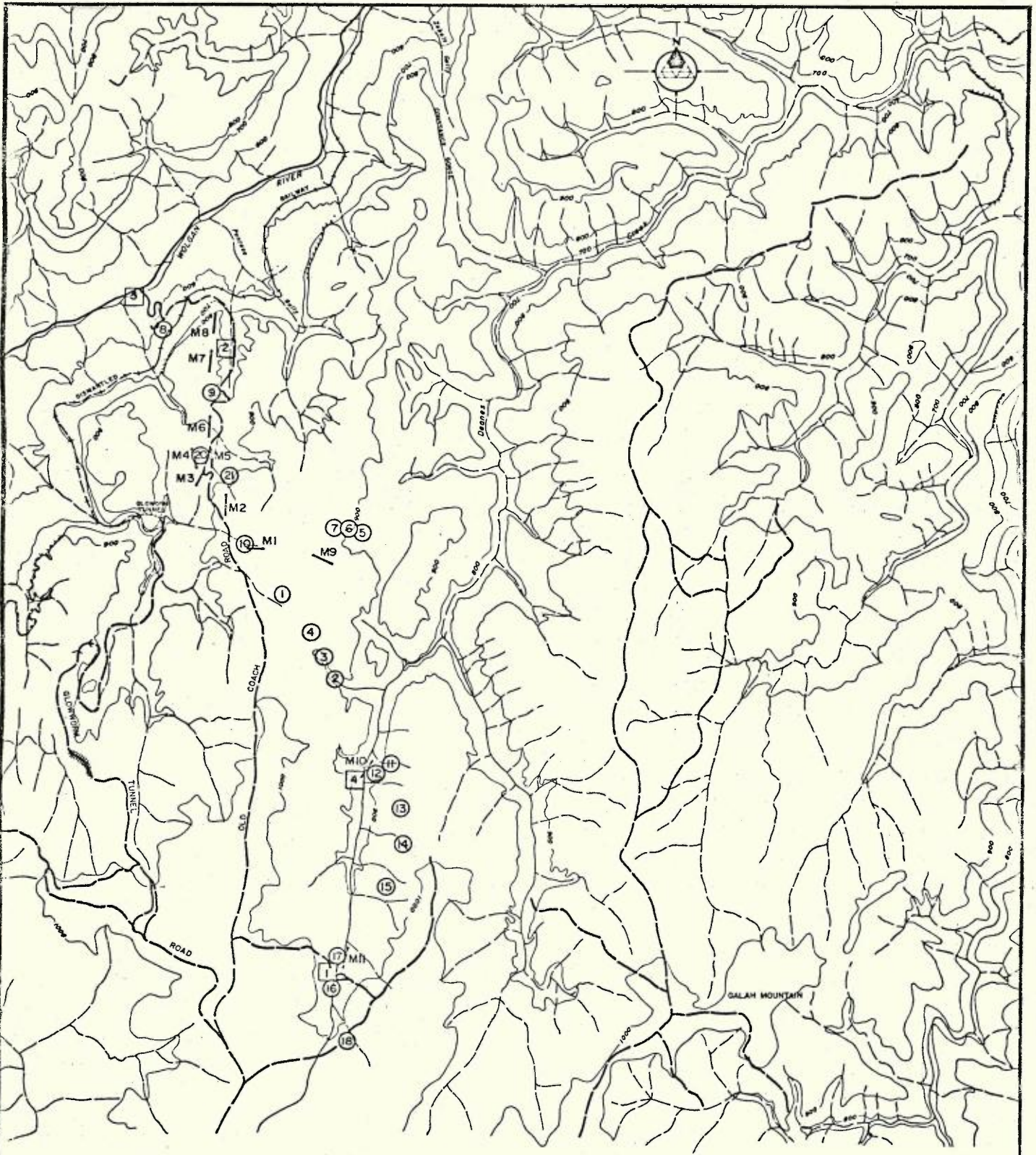
Natural surface waters in the vicinity of the proposed colliery are of high quality as shown by the analyses of samples (Table 4) taken at the four sites on Figure 13.

The pH of natural stream water in the area is comparatively low at 5.8 to 6.3 and is similar to the conditions encountered in the vicinity of the proposed Clarence Colliery near Newnes Junction. However, pH of stream water of this order is not uncommon in the natural environment.

The total alkalinity of the natural waters exists entirely as the bicarbonate ion (HCO_3^-) and is quite low. Consequently, these waters have a low buffer capacity and the pH can therefore be considerably altered by the addition of relatively small amounts of acid or alkali. The Wolgan River has a substantially higher buffer capacity than the streams in the mine site vicinity and would be less susceptible to pH fluctuations from effluent discharges.

5.1.7 Climate

The most representative climatological station near the area of the proposed development is at Newnes Prison Afforestation Camp. Although some doubt has been cast upon the reliability of records from this station (particularly for rainfall) the observing station is 13 km south southwest of the general pit-top area and with an elevation of 1033 m is directly comparable to most of the possible surface facility sites examined. Records have been kept at



- ⑭ PLANT SAMPLING SITES
- M3 MAMMAL SAMPLING SITES
- ② WATER SAMPLING SITES

TRANSPARENT OVERLAY OF FIGURE 5,
TO BE INCLUDED IN FINAL

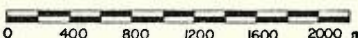
COALEX PTY. LTD.	
LOCATION: WOLGAN EXTENDED COLLIERY	FIGURE 13
TITLE: WATER, ANIMAL & PLANT SAMPLING SITES	JOB No. 8082-003-70
SCALE: 	DATE: January, 1977
REF.: Taken from 1:25 000 Series Sheets 8931-I-S, -IV-S, -II-N, -III-N	DAMES & MOORE

TABLE 4

WATER QUALITY ANALYSES, WOLGAN EXTENDED COLLIERY

ANALYSIS	<u>SITE NUMBER</u>			
	<u>1</u>	<u>2</u>	<u>3</u>	<u>4</u>
pH	5.8	5.9	7.5	6.3
Total Dissolved Solids	30	38	58	18
Suspended Solids	0.5	1	6	<0.1
Total Hardness (as CaCO ₃)	2	6	24	1.5
Total Alkalinity (as CaCO ₃)	5.9	7.9	24	6.9
Phenolphthalein Alkalinity (as CaCO ₃)	nil	nil	nil	nil
Calcium	0.1	1.4	5.5	0.1
Magnesium	0.4	0.6	2.5	0.4
Iron (Ferrous) Fe ⁺⁺	0.03	0.03	2.0	0.08
Iron (Ferric) Fe ⁺⁺⁺	0.02	0.01	0.36	0.04
Chloride	8.4	11.9	16.1	10.5
Sulphate	<0.1	<0.1	2.3	<0.1
Phosphate	<0.01	<0.01	<0.01	<0.02
Nitrate	<0.05	<0.05	<0.05	<0.05
Fluoride	0.06	0.06	0.08	0.15

the camp since 1938 and the period of record used in this study extends to 1974. Table 5 sets out the existing climatic statistics for the Newnes camp for 0900 and 1500 hours local time.

5.1.7.1 Temperature

The warmest month is January when a mean maximum of 23.3°C is experienced. Because the station is at a relatively high altitude the temperature range is large so that the mean minimum temperature in the coolest month (July) is only -1.1°C . The altitude also causes a large diurnal temperature range and monthly range in extremes which is indicated by the 86 and 14 percentile values given in Table 5.

5.1.7.2 Humidity

Dew point temperature values follow the same monthly trend as the air temperatures, except that February tends to have higher values than January. Highest relative humidity occurs in May or June because of the decline in mean air temperature, but in general the range in monthly values is moderate, with none lower than 58%.

5.1.7.3 Rainfall

Rainfall in the area is adequate on an annual basis, being 92% of the annual evaporation rate of approximately 1143 mm. January and February are the wettest months with much rain in this period coming from thunderstorms generated over the high plateau area in the moist warm summer air. However, the upland areas of the Blue Mountains also receive considerable winter rains from weather systems moving from the west, so that even the driest month at Newnes Prison Camp receives 64 mm on average. From November through to February, more than half the days in each month have rain and in all but three months of the year rain falls on more than one third of the days in each month.

TABLE 5

MEAN MONTHLY AND ANNUAL CLIMATIC DATA AT NEWNES PRISON AFFORESTATION CAMP

Air Temperature, Temperature Extremes, Dew Point Temperature (°C)

Humidity (%), Rainfall (mm), Rain days (No), Evaporation (mm)

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YR
Mean Temperature													
0900 Dry Bulb	17.7	17.3	15.6	13.1	8.7	5.8	<u>5.4</u>	6.7	9.8	12.6	14.4	16.9	12.0
Dew Point	11	<u>13</u>	11	8	6	4	3	<u>2</u>	5	7	9	10	7
1500 Dry Bulb	<u>21.5</u>	<u>19.5</u>	19.1	16.1	11.6	8.8	<u>8.6</u>	9.5	12.7	15.4	17.0	20.7	15.0
Dew Point	12	<u>15</u>	12	9	9	<u>4</u>	<u>4</u>	<u>4</u>	8	7	10	11	9
Daily Max. Temps.													
Mean	<u>23.3</u>	22.7	20.9	18.0	13.5	10.6	<u>10.0</u>	11.1	13.8	18.0	19.7	22.7	17.0
86% ile.	<u>29.3</u>	28.9	25.0	22.2	17.3	13.9	<u>12.5</u>	14.4	18.9	23.3	24.6	24.3	
14% ile.	16.9	<u>17.2</u>	16.1	13.6	9.7	7.3	<u>7.2</u>	7.8	9.4	12.4	14.4	16.3	
Daily Min. Temps.													
Mean	10.4	11.2	9.8	5.7	3.1	0.1	<u>-1.1</u>	0.5	2.0	7.6	8.7	<u>11.9</u>	5.8
86% ile.	14.0	13.9	12.5	9.4	7.4	3.7	<u>3.3</u>	4.3	6.1	14.0	16.1	<u>17.4</u>	
14% ile.	6.6	<u>7.8</u>	6.7	2.2	-2.2	-3.8	<u>-5.6</u>	-3.9	-1.9	1.7	3.8	6.1	
Extreme Temperatures													
Maximum	38.3	34.1	32.6	25.0	22.8	16.6	16.1	21.4	26.6	29.4	36.1	35.0	38.3
Minimum	-1.1	-1.7	-1.1	-5.6	-6.7	-8.3	-12.2	-10.8	-7.8	-6.7	-3.9	-2.2	-12.2
Mean Humidity													
0900	67	76	75	73	82	<u>87</u>	84	74	72	68	68	<u>63</u>	74
1500	55	76	65	66	<u>84</u>	<u>71</u>	71	67	73	56	65	<u>53</u>	67

TABLE 5 Continued

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YR
Rainfall													
Mean	<u>122</u>	120	88	74	73	93	<u>64</u>	81	66	91	87	93	1052
Median	<u>136</u>	96	76	63	59	62	<u>49</u>	77	61	84	74	66	1097
Days	<u>17</u>	<u>19</u>	13	<u>7</u>	9	11	<u>11</u>	14	9	13	17	15	155
Maximum for Record Period	281	338	246	221	287	320	241	207	207	212	208	303	1889
Minimum for Record Period	19	6	5	16	12	5	2	10	0	6	13	13	495
Estimated Evap. (Class A Pan)	<u>165</u>	124	114	86	48	<u>38</u>	48	51	74	97	145	152	1143

Snow falls once or twice each year and these amounts are included in the rainfall figures as they are minor. It is rare for snow to remain on the ground for more than 24 hours.

5.1.7.4 Evaporation Rate

Mean annual evaporation rate estimated using nearby class A evaporation pan measurements is a little in excess of mean precipitation (see Table 5). On a monthly basis, evaporation is less than precipitation from May through to August inclusive, but greater for the remaining 8 months. Maximum evaporation rate usually occurs in January (165 mm) when the rainfall is also a maximum and in general this trend follows through the year. The greatest water deficit occurs in December when the evaporation rate is 152 mm and the rainfall 93 mm giving a shortfall of 59 mm. Over the three months November to January the mean accumulated deficit is 160 mm, while in the remaining 9 months there is a water surplus of 70 mm.

5.1.7.5 Wind

Wind speeds and directions are shown for 4 months of the year which are representative of the general seasonal changes in Table 6. Although calms are uncommon, light winds of less than 1 m per second are frequent, all months shown having frequencies higher than 50% at 1500 hours. Whether these light winds apply generally to the alternative sites discussed in this report depends on the degree of shelter at each location.

Estimates of extreme wind gust intensity and frequency are given in Table 7. These have been derived from data given by Whittington (1964). It is probable that they underestimate the actual values for the Wolgan Extended Colliery site as it is located at an elevation about 300 m higher than Lithgow, the nearest source of long term data used for the estimates.

TABLE 6

WIND DATA ^{1 2}: PERCENTAGE OCCURRENCE BY SPEED VERSUS DIRECTION BASED ON 9 YEARS OF RECORDS

STATION: 063062 NEWNES PRISON FARM

PRODUCED BY M.I.S.S. 20th November 1973

JANUARY 0900 HOURS LST
Speed km/hr

CALM	2	1	5.5	13.0	20.3	29.5	40.7	50.0	A
	to	to	to	to	to	to	&		L
DIRN	3.7	11.1	18.6	27.8	37.0	48.0	UP		L
N	3	1	*			*			4
NE	15	6	1						21
E	5	3	*						8
SE	14	15	1						31
S	1	1							2
SW	7	3	1	1					11
W	5	3							8
NW	7	3	2			*			13
ALL	55	36	5	1	1				

NO. OF OBS. 172

APRIL 0900 HOURS LST
Speed km/hr

CALM	6	1	5.5	13.0	20.3	29.5	40.7	50.0	A
	to	to	to	to	to	to	to	to	L
DIRN	3.7	11.1	18.6	27.8	37.0	48.0	UP		L
N	1								1
NE	8	4	1						13
E	6								6
SE	15	6							21
S	3								3
SW	11	9	1	1			2		23
W	9	1		1					11
NW	9	4	1	2					17
ALL	61	24	5	3			2		

NO. OF OBS. 133

JULY 0900 HOURS LST
Speed km/hr

CALM	9	1	5.5	13.0	20.3	29.5	40.7	50.0	A
	to	to	to	to	to	to	&		L
DIRN	3.7	11.1	18.6	27.8	37.0	48.0	UP		L
N	2	1							3
NE	4	1				1			6
E	1	1							2
SE	6	3							9
S	2	1	1						4
SW	17	2	*	4					28
W	19	5	1	3					28
NW	6	3	1		1	1			12
ALL	56	24	3	6	1	1			

NO. OF OBS. 140

OCTOBER 0900 HOURS LST
Speed km/hr

CALM	14	1	5.5	13.0	20.3	29.5	40.7	50.0	A
	to	to	to	to	to	to	to	&	L
DIRN	3.7	11.1	18.6	27.8	37.0	48.0	UP		L
N	1	1	*			*			3
NE	12	2	1						16
E	4								4
SE	11	3	1		1	1			18
S	3								3
SW	6	3	3	1					14
W	8	1	*	1	1				13
NW	8	3	2	1	2	1			17
ALL	55	14	8	3	4	1			

NO. OF OBS. 148

* Less than 1% 1. Reference - Spencer Thomas & Associates, 1974
2. Reference - Beaufort Scale estimates only

TABLE 6 Continued

WIND DATA ^{1 2} PERCENTAGE OCCURRENCE BY SPEED VERSUS DIRECTION BASED ON 9 YEARS OF RECORDS

STATION: 063062 NEWNES PRISON FARM

PRODUCED BY M.I.S.S. 20th November 1973

JANUARY 1500 HOURS LST
Speed km/hr

CALM	2	1	5.5	13.0	20.3	29.5	40.7	50.0	A
		to	to	to	to	to	&		L
DIRN	3.7	11.1	18.6	27.8	37.0	48.0	UP		L
N	2	4	*						7
NE	9	7							16
E	8	8							15
SE	14	11	2	1					29
S	1								1
SW	5	3	*	1					10
W	2	2	*						4
NW	8	7	1						16
ALL	50	42	5	2					

NO. OF OBS 123

APRIL 1500 HOURS LST
Speed km/hr

CALM	3	1	5.5	13.0	20.3	29.5	40.7	50.0	A
		to	to	to	to	to	&		L
DIRN	3.7	11.1	18.6	27.8	37.0	48.0	UP		L
N	2								2
NE	16	3							19
E	3	1							4
SE	13	7							20
S	1								1
SW	10	11	1		2	1			25
W	1	3							4
NW	8	7	7						22
ALL	53	32	8		2	1			

NO. OF OBS 90

JULY 1500 HOURS LST
Speed km/hr

CALM	4	1	5.5	13.0	20.3	29.5	40.7	50.0	A
		to	to	to	to	to	&		L
DIRN	3.7	11.1	18.6	27.8	37.0	48.0	UP		L
N	3	1	1						5
NE	6	2				1			9
E	2	1							3
SE	8	2	1	1					12
S	2	1							3
SW	9	9	3	2	1	1			25
W	10	4	1	2		1			17
NW	7	8	3	1	2				20
ALL	46	28	9	6	3	3			

NO. OF OBS 93

OCTOBER 1500 HOURS LST
Speed km/hr

CALM	13	1	5.5	13.0	20.3	29.5	40.7	50.0	A
		to	to	to	to	to	&		L
DIRN	3.7	11.1	18.6	27.8	37.0	48.0	UP		L
N	1	1				1			4
NE	9	3	2						13
E	5								5
SE	15	2	3	1					22
S	1	1		*					2
SW	4	3	2	3					12
W	5	2	*	*	2	1			10
NW	9	4		3	2	1			18
ALL	50	16	7	7	5	2			

NO. OF OBS 123

* Less than 1%
 1. Reference - Spencer Thomas & Associates, 1974
 2. Reference - Beaufort Scale estimates only

TABLE 7

Est. extreme wind gust statistics derived for Wolgan and compared to statistics for Sydney and Canberra

Location	Lithgow	Sydney	Canberra
Modal values of annual maximum gusts (m/sec)	28.6	30.6	26.5
Extreme gusts for given return period (m/sec)			
10 years	38.3	40.3	34.1
20 years	40.8	43.4	34.2
50 years	44.4	47.4	36.7
100 years	46.9	50.5	38.3

(Date obtained from Whittington, H.E. (1964) 'Extreme wind gusts in Australia'. Bureau of Meteorology Bulletin No. 46).

Note: values for Lithgow were obtained by interpolation between those given for Sydney and isopleths drawn on Figures in Whittington (1964).

5.1.8 Air Quality

No measurements exist in the neighbourhood of the proposed mine development. At the present time there are no known sources of air pollution of any significance within 50 km, so general air quality is good. During the summer, some suspended material is advected in from the Sydney metropolitan area, but while this is sometimes sufficient to reduce visibility to about 5 km it is unlikely that concentrations ever rise high enough to damage plants or cause health problems. Much greater reductions in visibility and higher levels of suspended particulates occur from time to time as a result of local bushfires.

5.2 Biological Environment

5.2.1 BOTANY

5.2.1.1 Summary

The vegetation covering the mining lease area is relatively uniform, particularly across the plateau surface bounded by Deanes Creek and Tunnel Creek (Figure 13). Structurally it consists of *Eucalyptus* shrubby open woodland and layered open forest. Within these formations there are associations of different species of *Eucalyptus*, with stringybark and gum types most common. The shifts in species dominance are influenced by aspect, slope and soil moisture. The distribution of understorey shrubs is not obviously correlated with changes in the dominant *Eucalyptus* species. *Bossiaea*, *Dillwynia* and *Oxylobium* predominate in the shrub layer. Sedgeland areas are common in seepage areas; as well as herbs and sedges they may contain small shrub species which are not found in the woodland vegetation. An open heath vegetation occurs on rocky outcrops and along the rims of gorges, areas which are relatively dry and exposed to winds. There is frequently a broad ecotone between open heath and woodland vegetation.

Generally speaking, because of increased relief the vegetation is more varied, or broken up, near streams and in gorges, and consequently a greater range of animal habitats occurs in these areas. There are at least two narrow, steep gorges in the lease area which contain some rain forest species, notably the tree fern *Dicksonia antarctica* and opossum wood, *Quintinia sieberi*. The largest single vegetation type is the shrubby eucalyptus woodland of the plateau surface.

Although the plateau areas have been subjected in the past century to disturbances such as timber felling and possibly changes in fire frequency, it is improbable that these events have significantly changed the vegetation structure (see Pidgeon, 1937, 1938).

5.2.1.2 Introduction

The objectives of the vegetation survey carried out for this report were two-fold: to document the structure and composition of the vegetation at a number of locations within the mining lease boundaries, and to search for rare or unusual plant species or vegetation types which would warrant protection.

In addition to describing the present vegetation, the data could be used as a basis for monitoring impacts and in bushfire control and revegetation programmes.

5.2.1.3 Methods and Sampling Locations

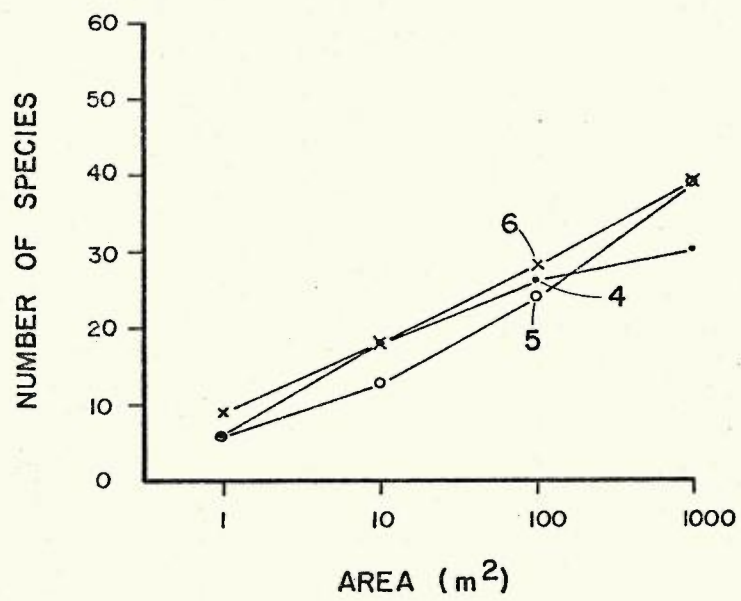
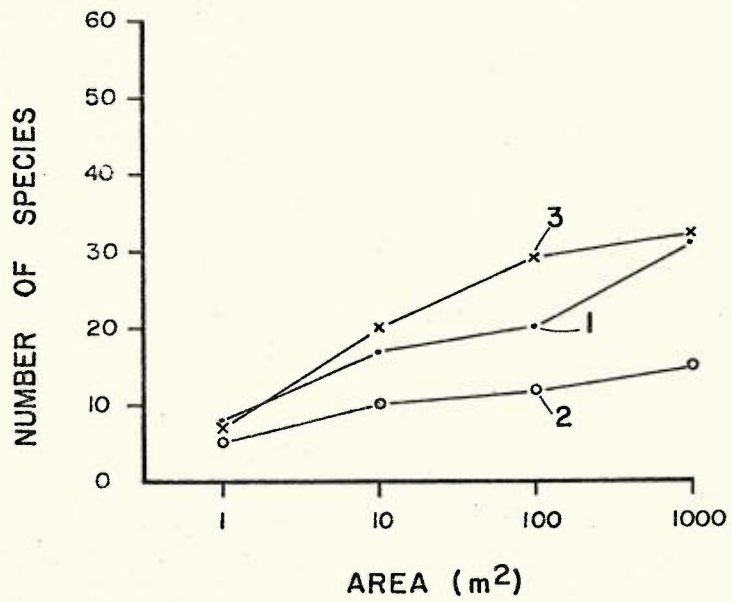
Plant species diversity data were obtained for 20 locations using a fixed area method (Whittaker, 1965). Data was collected in a 0.1 ha plot which extended 10 m on each side of a 50 m tape, and species presence recorded in nested plots of 1 m² (10 plots), 10 m² (2 plots), 100 m² (1 plot), and 1000 m² (1 plot). Plant cover for each species present and the vegetation structure was recorded for the 0.1 ha plot. These data are presented as species-area curves, to show species richness in the area, and are also the basis of a Bray-Curtis ordination.

A variety of ordination techniques have been developed for the purpose of demonstrating relationships between environmental factors and community properties, and to clarify information contained in large sets of phytosociological data. Given certain constraints the performance of a Bray-Curtis ordination has been shown to be better than several other common types of ordination (Gauch & Whittaker, 1972), and is relatively simple. As a similarity measure between sample areas it uses the coefficient of community, which in pairs of plots compares the sum of species present in the two plots to the number of species common to both. Because the technique uses presence-absence data it was suitable for evaluating the information collected in this study.

The parameter of species richness should be specified in relation to the size of the area sampled. Generally, the larger the area examined the more species are found, so that the number of species increases linearly with the logarithm of the area examined. For most of the Wolgan transects, species did increase linearly with the logarithm of area examined. As shown in Figures 14-16, vegetation can be characterised both by the number of species present in the sample and by the shape of the species-area curve. The curves tend to be fairly smooth, indicating homogeneity in the individual transects. There is also a rather high degree of similarity in curve shape among transects, especially those from eucalypt forests and woodlands. Two of the curves (transects 16 & 17) show a sharp break upwards at 100 m². Both were on slopes with a broken tree canopy, which may have caused patchiness in the habitats, so that new species were quickly encountered. Neither transect had unusually high species numbers at the 1 m² level.

A Bray-Curtis ordination of the 20 transects was done, using the coefficient of community values, and using several different pairs of transects as endpoints. Varying the choice of endpoints did not change the basic pattern. Figure 17 shows an ordination using extremes of vegetation structure (transects 1 & 21; shrubby open forest and open heath) as endpoints of the x-axis, and extremes of soil moisture (transects 2 & 9; open forest in north trending gully and sedgeland) as endpoints of the y-axis. The structural gradient is an artificial simplification of a large number of environmental factors, including slope, exposure to winds, moisture, and edaphic conditions, which contribute to the fact that transects 1 and 21 had no species in common. It is useful however, in that within a circumscribed area one would expect the properties of a number of samples to be distributed between these two extremes.

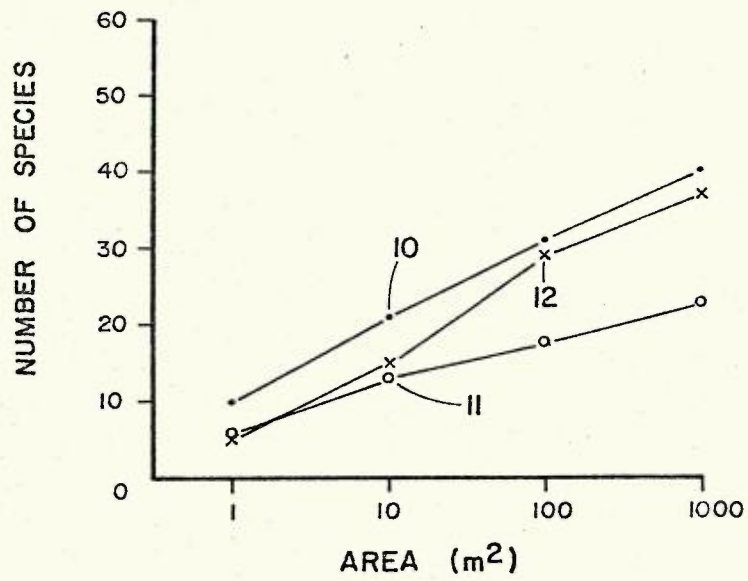
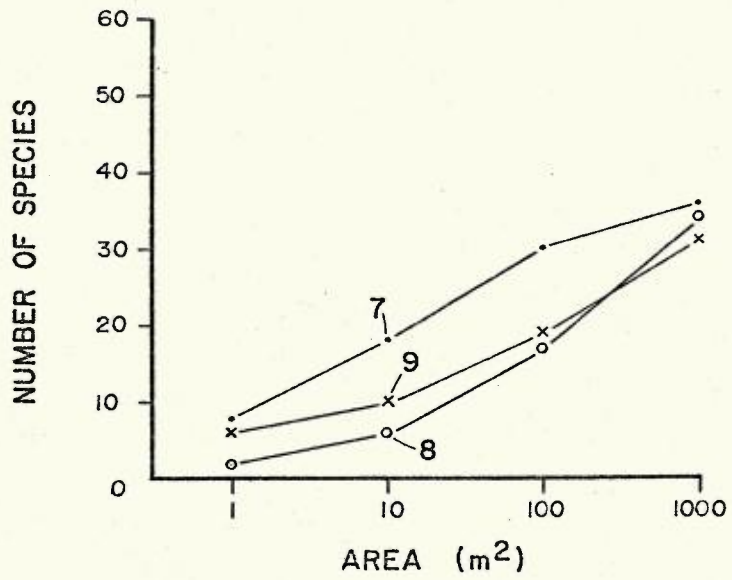
The moisture difference between transect 2 and transect 5 is real, with transect 5 being quite wet. There was a clear distinction in vegetation structure between these sites (Table 8), but several species were common to both (Appendix A3).



PLANT SPECIES AREA CURVES

DAMES & MOORE

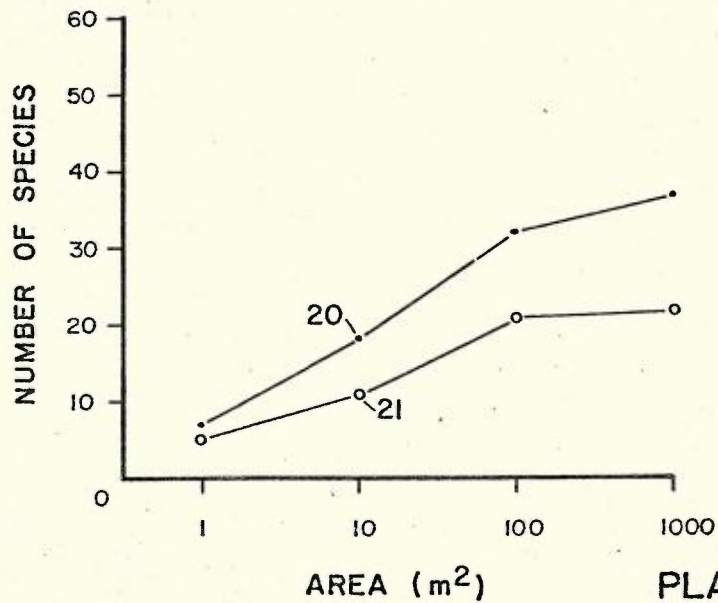
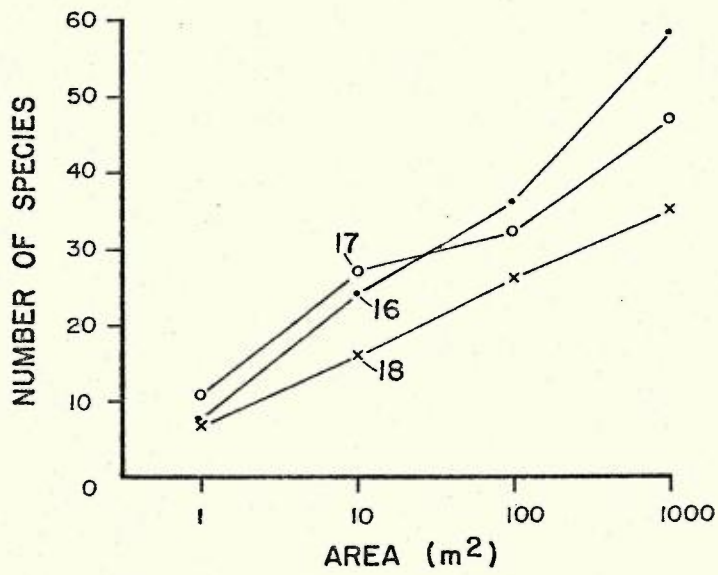
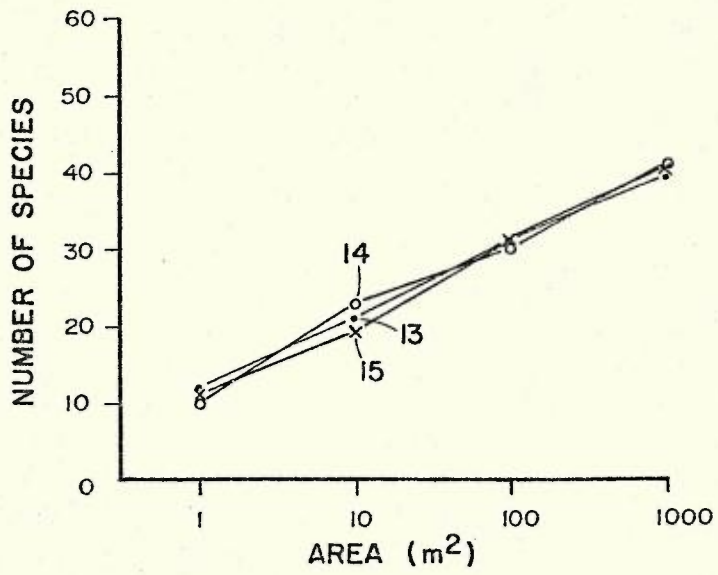
FIGURE 14



PLANT SPECIES AREA CURVES

DAMES & MOORE

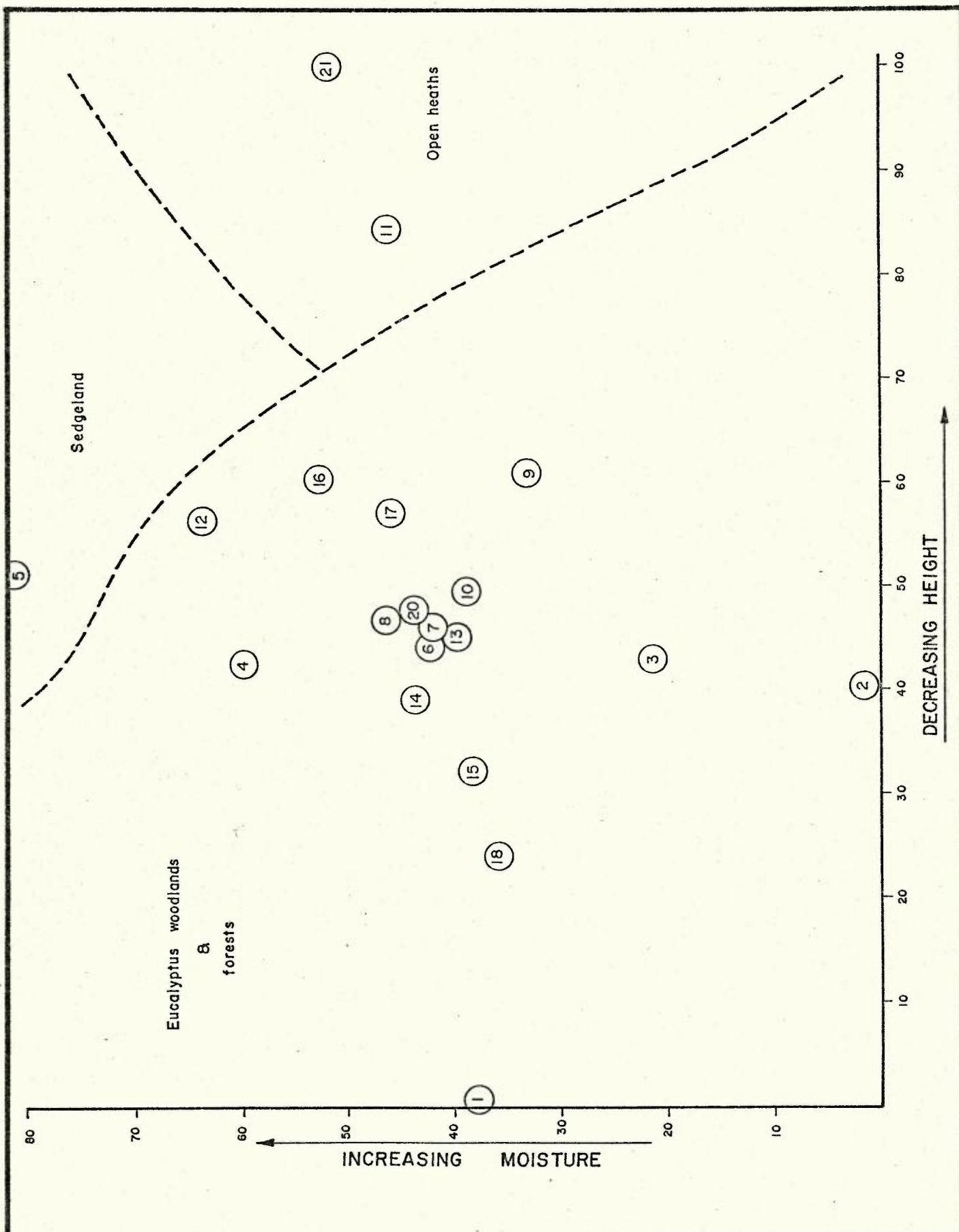
FIGURE 15



PLANT SPECIES
AREA CURVES

DAMES & MOORE

FIGURE 16



BRAY - CURTIS ORDINATION OF 20 TRANSECTS USING THE COEFFICIENT OF COMMUNITY. THE CLUSTERING OF TRANSECTS 6, 7, 8, 13 & 20 INDICATES THAT THEY ARE STRUCTURALLY AND FLORISTICALLY MORE SIMILAR THAN MOST OF THE OTHER TRANSECTS. THE LINES DRAWN BETWEEN THE TRANSECTS ARE BASED ON THE STRUCTURAL APPEARANCE OF THE VEGETATION.

COALEX PTY. LTD.

LOCATION: WOLGAN EXTENDED COLLIERY

TITLE: BRAY - CURTIS ORDINATION

JOB No: 8082 - 003 - 70

DATE: January, 1977

FIGURE 17

DAMES & MOORE

TABLE 8

Vegetation formations present in Wolgan area. Vegetation structure, species richness and general habitat information are given for each site.

SITE	FORMATION	SPECIES/0.1ha	COMMENTS
1	Shrubby open forest	31	Flat plateau; dry
2	Open forest	15	Flat fully bottom
3	Woodland	32	East aspect; gentle slope
4	Open forest	30	North-east aspect; gentle slope
5	Sedgeland	39	North-east aspect; gentle slope; wet
6	Low woodland	39	Heath-forest interface; east aspect, gentle slope
7	Woodland	36	Flat; dry
8	Woodland	34	West aspect; dry; moderate slope
9	Layered tall open forest	31	Gully bottom; intermittent stream; gentle slope to north
10	Woodland	40	South-west aspect; moderate slope; dry
11	Open heath	23	West aspect; exposed rim; moderate slope; seasonally wet
12	Open shrubby forest	37	West aspect in deep gorge; moderate slope
13	Shrubby woodland	39	East aspect; gentle slope; heath-woodland margin
14	Shrubby woodland	41	West aspect; gentle slope
15	Shrubby woodland	40	West aspect; gentle slope
16	Shrubby woodland	58	East aspect; moderate slope; mesic
17	Shrubby woodland	47	East aspect; moderate slope; mesic
18	Woodland	35	Flat; dry; burned 1974
20	Shrubby tall open forest	37	North-east aspect in deep gully; gentle slope
21	Open heath	22	Flat, rim of gorge

The alternative sites considered in the survey and the location of 20 of the sampling transects are shown in Figure 13. In this report the sites are referred to as the experimental mine, the Deanes Creek mine and coal preparation plant, the Coach Road mine, and the Plateau coal preparation plant and refuse complex. Data from transect 19 have not been included in the vegetation analysis.

The experimental mine is located on a northwest facing slope above the Wolgan River, and is about 5 km north of the plateau top. Small amounts of coal have been extracted from it for testing market quality. The Deanes Creek mine site is on a steep northeast trending tributary of Deanes Creek, with the coal preparation plant site about 6 km upstream from the pit head. It is probable that the stream flows year-round except during droughts. The associated coal preparation plant site is on a sand flat at about 950 m elevation. The Coach Road site is in a steep-walled but relatively wide valley lying between the experimental mine and the Plateau coal preparation plant site. An intermittent stream flows down the valley and ultimately into the Wolgan River. The Plateau coal preparation plant is located at about 950 m above sea level on flat sandy uplands; the associated refuse areas are located in the steep northeast facing gullies which lie above the lower sections of Deanes Creek.

The area was sampled in January, April and August, 1976.

5.2.1.4 Vegetation Structure and Species Composition

Most of the sites investigated had roughly the same numbers of species present in the 0.1 ha plot, with an average of 35 (Table 8). The values are closely similar to those found for vegetation of similar structure nearer the coast. Sites with relatively dense tree canopy (>30%) ranged from 31 to 38 species per 0.1 ha. On sunny open slopes with the tree canopy less continuous (5 - 30%), the diversity was generally higher. Lowest species numbers were found in the dry open heaths, (transects 11 & 21), and in one open forest site dominated by bracken fern in the understorey (transect 2).

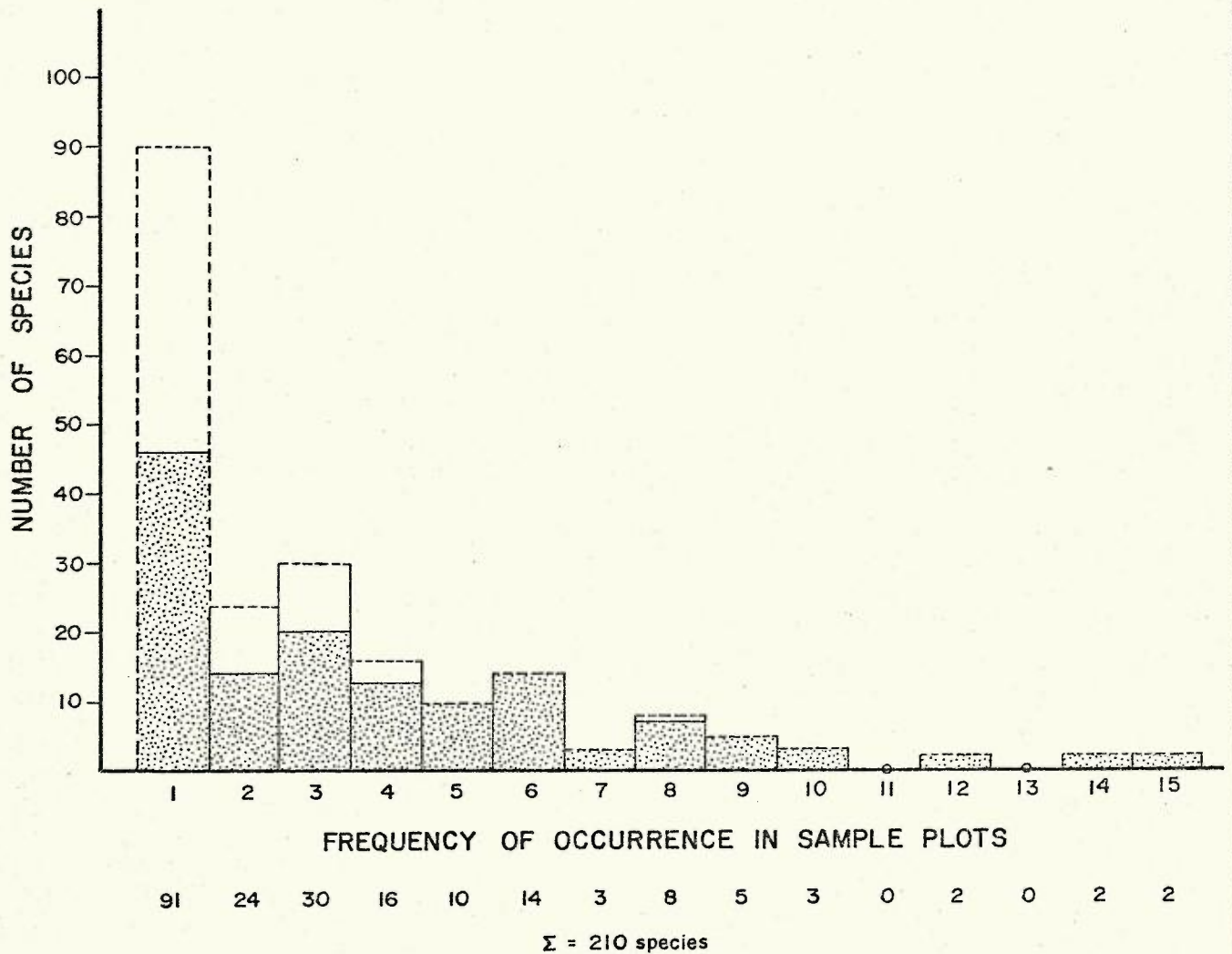
The ordinations tend to confirm the field observation that although extremes can be identified, most sample sites were not dissimilar. The most common association is eucalypt woodland and forest which falls almost midway between both extremes of moisture and species differences; transects 6,7,10 13 & 20 show very strong similarities. These sites have in common several co-dominant understorey species (eg shrubs *Bossiaea microphylla*, *Oxylobium illicifolium*, *Lomatia silaifolia*, *Acacia botrycephala*), but the occurrence of the minor species present and the species mix of the overstorey trees varies considerably between sites. Of 210 species recorded in the transects, 50% were found in 1 or 2 transects (Figure 18), while the remaining 105 species occurred in 3 to 15 of the plots. Three families account for 42% of the species listed in Appendix A3.

These various data analyses indicate that the vegetation structure is quite uniform across the flat upland surfaces and slopes, and there is no striking difference in species richness between most of the samples. However, although the same dominant species occur in a number of different areas, the distributions of those species which are uncommon in the understorey do not invariably show the same distribution patterns as dominant species.

5.2.1.5 Rare Species and Unusual Habitat Types

Two plant species in the Clarence-Wolgan area, *Boronia deanei* and *Dillwynia stipulifera*, are listed (Specht et al., 1974) as rare. *Boronia deanei* was once a common shrub in "swampy" areas between Clarence and Wolgan (Maiden and Betche, 1906). Neither species was found either within or near the Wolgan mining lease area, although a recorded population of *Dillwynia stipulifera* was located near Clarence.

A very mesic habitat containing several rainforest species occurs in the gorge at Deanes Creek and in an east trending tributary near the Coach Road site. The vegetation in these locations was not quantified, but dominant plants are *Dicksonia antarctica* (soft tree fern) and *Quintinia sieberi* (opossum wood). This vegetation type is widespread in deep gullies and on cooler moist slopes in the Blue Mountains; it is only "unusual" in the sense that it is not common within the mining lease area.



FREQUENCY DISTRIBUTION SHOWING THE NUMBER OF TIMES ANY GIVEN SPECIES OCCURRED IN A TRANSECT. FOR EXAMPLE, 91 SPECIES WERE FOUND IN ONLY ONE TRANSECT, WHILE 2 SPECIES WERE RECORDED IN 15 OF THE 20 TRANSECTS. THE LATTER SPECIES COULD THEREFORE BE TERMED COMMON IN THE AREA, AND THE FORMER SPECIES SCATTERED OR UNUSUAL. THE UNSHADED PORTIONS OF THE GRAPH INDICATE PLANTS IN VEGETATIVE CONDITION WHICH WERE NOT IDENTIFIED TO SPECIES.

COALEX PTY. LTD.	
LOCATION:	WOLGAN EXTENDED COLLIERY
TITLE:	FREQUENCY DISTRIBUTION
JOB No.:	8082-003-70
DATE:	January, 1977
FIGURE 18	
DAMES & MOORE	

The moist sedgeland vegetation type (transect 5) is widespread in the Blue Mountains, and consists of small discontinuous units. Some information is available on soils and plants in sedgelands, but little is known about the fauna which live in them. It is possible that some animals rely heavily on sedgeland resources during certain seasons of the year.

5.2.1.6 Bushfire Potential

The study area and most of the surrounding woodlands have not been burned for a number of years, although a normal fire frequency might be as short as 8 - 10 years (P. Koperberg, pers. comm.). A few hectares at the top of Deanes Creek (transect 18) was burned in 1974. It is interesting to note that the fire has not affected the number of species per unit area in transect 18 (Table 8), and although the cover values for shrubs are lower than in other comparable woodland sites, many of the same species are present (Appendix A3).

In general, the vegetation is quite dense (see Plates 3 and 4) and there is considerable litter on the ground. The plateau is very dry with only one or two permanent streams, and is periodically subject to strong northwesterly winds and high temperatures. These factors strongly suggest that there is a high probability of uncontrollable bushfires occurring. Such fires could originate from within the mining facilities, as well as from outside sources such as camper's fires or lightning strikes.

5.2.2 Zoology

5.2.2.1 Summary

A field survey of fauna was made on the Wolgan Valley colliery project site during January, April and the period 10 to 12 December, 1976. Time permitted only a *status quo* examination of the following vertebrate groups: birds, small mammals and arboreal mammals. Other records are incidental to the main survey.

Observations and trapping results were classified according to their occurrence in one or more habitats defined by vegetation structure. No species have been added to the lists presented other than species recorded on the site or in essentially similar habitat in the valleys draining toward the glowworm tunnel area. It is considered that since the site surveyed is in highly dissected terrain the movement of certain species is greatly restricted. In particular this is probably the case for the red-necked wallaby, the grey kangaroo and the wombat, none of which were recorded during the survey. It is not known whether this broken landscape also restricts some species specifically to upland valleys, but all species recorded occur in similar habitat elsewhere.

Several species are worth particular attention. The rock warbler (*Origma solitaria*) is restricted in range and habitat and probably warrants first priority in conservation measures. The great glider (*Schoinobates volans*) although common in this region, may specifically require large hollow trees for breeding and cover. This condition is apparently satisfied on the present site.

5.2.2.2 Survey Method

Birds, small mammals and arboreal mammals were specifically surveyed. Other mammals, reptiles and amphibians were recorded incidentally during the specific surveys.

Birds were recorded during the day and at night by audiovisual means. During the day, species were recorded as observed and the habitat noted. An approximate measure of abundance was obtained by counting individuals of each species along a transect 450 m long (Figure 13) for one hour. This was done in each of the forest habitats and in the woodland. Shorter transects were used in rocky outcrops and on the heath; many fewer bird species and individuals were encountered in these habitats.

During the night, birds were recorded by call and during spotlight sessions for other animals.

Small mammals were trapped along transects 250 m long, each with 25 evenly spaced Elliott live traps. All habitats were trapped except the rocky outcrops which were partially covered by the heath transect, and are generally known to be poor in small mammal numbers.

The traps were baited with the standard peanut butter and rolled oats mixture. Most areas were sampled for more than one 24-hour period. Trapped animals were identified, sexed, weighed and removed from the site. The cumulative totals for five habitats, and two seasons (April & December) are reported.

Arboreal mammals were observed by spotlight. On two nights during December a transect was walked from M1 to M8 along the Old Coach Road (see Figure 13) and at points along the road diversions were made into other habitats. The forest profile and undergrowth was scanned thoroughly and sightings recorded. During the April survey transects were walked across the upland areas west of Deanes Creek, and along the creeklines.

Animals were counted and located on forward and return journeys, the highest count for each species being reported.

All animals seen, heard or trapped were identified *in situ*.

5.2.2.3 Location & Habitat Designations

Specific sites for mammal trapping transects are shown in Figure 13. Sites M1 to M8 were sampled in December 1976, and sites M9 to M11 sampled in April 1976. The habitats are described in Table 9, in terms of vegetation structure and topographic features.

5.2.2.4 Results

Bird species abundance is shown for each of the six habitats in Appendix A4. The number of species for each habitat are also shown in two ways:

- the number actually recorded during survey
- the number expected, which is a figure derived from all species recorded on the survey and known occurrences in similar habitats elsewhere.

A list is provided (Appendix A4) of the species considered likely to occur on the site but which were not recorded at the time of survey. This is in addition to species shown in Appendix A4.

In all 55 species were recorded, 33 of which are either permanent breeding residents or which return to the same location each year for breeding. All species listed are likely to have bred in the general locality. Positive indications of breeding were shown by four species whose nests were found and by another two species who were feeding young out of the nest.

Small mammals trapped are shown for five habitats in Table 10.

Two juvenile *Rattus fuscipes* were recorded in the heath and one juvenile *R. fuscipes* was caught in the shrubby, tall open forest. Two water skinks (*Sphenomorphus quoyii*) were also trapped at M8 on the second day. Their presence is due to the running permanent stream in the lower half of the Old Coach Road gully.

TABLE 9

Animal habitats recognised for Wolgan bird and mammal survey

HABITAT NUMBER	FORMATION	MAMMAL TRAP SITE NUMBER	ELEVATION (m)	RELIEF	SLOPE (degrees)	UNDERSTORY TYPE	DENSITY	LITTER DENSITY	DRAINAGE	NESTING HOLLOWS
1	Rocky outcrops		900+	0 - 100m	0 - 90	Nil	-	Very sparse to nil	Very dry	0
2	Tall woodland	M1, M11	900+	0 - 80m	0 - 15	Dry shrubs grass,herbs	Sparse to very sparse	Sparse	Well drained to dry	Few
3	Heath (with occasional rocky outcrops)	M2	900+	0 - 10m	0 - 10	Herbs,grass	Very sparse	Sparse to moderate	Well drained some soaks	0
4	Dry open forest	M4	750 - 900	80m	15 - 30	Dry shrubs grass,herbs	Sparse to medium	Moderate	Well drained	Few
5	Tall, shrubby open forest	M3, M5, M6 M9, M10	750 - 850	0 - 2m	0 - 10	Dry shrubs + wet shrubs grass, bracken	Medium to very dense	Moderate to very dense	Well drained	Many
6	Tall, ferny open forest	M7, M8	700 - 850	0 - 10m	0 - 10	Ground ferns, tree ferns, herbs, wattles	Very dense	Dense to very dense	Well drained running water	Many

TABLE 10

Results of trapping small ground mammals during spring and summer.

Habitat	Period	Total Trap Nights	No. Animals Trapped		Trapping Success %
			Rattus fuscipes	Antechinus stuartii	
Tall Woodland	April	100	2 ^a	5 ^a	7.0
	December	50	-	1(F) ^b	2.0
Heath	April	-	-	-	-
	December	50	3(1F)	-	6.0
Dry Open Forest	April	-	-	-	-
	December	25	-	-	0
Shrubby Tall Open Forest	April	150	2	3	3.3
	December	75	2(1M)	-	2.7
Ferny Tall Open Forest	April	-	-	-	-
	December	50	2(2F)	-	4.0
Total, all habitats		455	11	9	4.0

^a near stream

^b symbols: F = female; M = male

During December, two species of arboreal mammals were sighted: the great glider (*Schoinobates volans*) and the common ring-tailed possum (*Pseudocheirus peregrinus*). Three individuals of the greater glider were sighted in the main gully close to the creekline. One ring-tailed possum was sighted in dry open forest in the main gully. Three gliders were also sighted in the Old Coach Road gully. A low density of brush-tailed possum pellets (*Trichosurus vulpecula*) was noted in all forest and woodland habitat.

Larger mammals recorded: one swamp wallaby (*Macropus bicoler*) in both the main gully and the Old Coach Road gully. Fecal pellets are present in all habitats for this species.

One dingo (*Canis familiaris*) was heard at night calling from nearby rocky outcrops.

Casual observations were made of the following five species:

- Giant barred frog (*Misophyes iteratus*) in the gloworm tunnel stream but not on the site
- Lace monitor (*Varanus varius*) on site in dry, open forest
- Eastern blue-tongued lizard (*Tiliqua scincoides*) on site in forest and woodland
- Eastern brown snake (*Pseudonaja textilis*) in forest and woodland on site.

5.2.2.5 Discussion

Fauna diversity within the two open forest types and over the area as a whole is moderately high. A conservative estimate of presumed bird species, using the additional list in the Appendix A4 and the known occurrences from Appendix A4 gives a total of 72. Diversity increases with structural complexity of the vegetation habitats and is also related partly to an increase in plant species diversity. This is the expected pattern in the south-eastern Australian environment. The tall, shrubby open forest in the main gully is the richest habitat and this is due to a very diverse understorey. This is clumped, contains many saplings and tall wattles and has good ground cover provided by bracken, fern and grasses.

No single bird species is confined to one habitat within the region although for a number of species only one individual was recorded during this survey. Two species, the barking owl and the rock warbler, are considered to be sensitive to change. The rock warbler (*Origma solitaria*) is the most restricted in its distribution and in its habitat requirement of any bird recorded on the site. In this location, the rock warbler is close to the western limit of its distribution. The barking owl (*Ninox connivens*) is regarded as uncommon anywhere in its range.

Two birds recorded, the gang gang cockatoo and the king parrot, require large nest hollows in trees. These are at present amply available in all gullies in and around the project site.

The low trapping rate of small mammals was probably partly due to the very hot weather encountered during the summer survey. Both species recorded normally occur in all habitats but at relatively low numbers on rocky outcrops. The dry nature of most of the site is also conducive to small populations.

Very little change would be expected to these two species following development unless the introduced mammals, the house mouse (*Mus musculus*) and the house cat (*Felis catus*), were transported on site.

Notably absent from the site is the grey kangaroo (*Macropus giganteus*), red-necked wallaby (*Macropus rufogriseus*) and the common wombat (*Vombatus ursinus*). This may be due to the broken terrain and the confined nature of the habitats which considerably decreases and lowers the availability of suitable grazing.

5.3 Social Environment

5.3.1 Socio-Economics

5.3.1.1 The Coal Industry

The total NSW coal production for the period 1974-1975 amounted to 42 million tonnes, an increase of 15.5% over 1973-1974. Based on the previous year's prices, the total value of the 1974-1975 coal production would be about \$281 million of which \$127 million would be paid out in wages and salaries and \$3.7 million in coal royalties to the State Government. Exports of coal from NSW in 1974-1975 amounted to 14.8 million tonnes (35.2% of total production) and were worth about \$178 million of which 87% was for coal sent to Japan.

The Western Coalfields Region in NSW accounted for 6.2% of the State's total raw coal production in 1974-1975. Table 11 indicates the destination of coal delivered from the Western mines from 1965-1966 to 1974-1975. The trend towards a higher proportion to export is clearly seen.

5.3.1.2 Employment and Workforce Structure

In the period 1974-1975 there were 14,447 people employed in the NSW coal industry. The number who were miners was approximately 9662 (68%). The weekly average earnings of miners at this time was \$212.70 and the overall industry average was \$227.80. Figure 19, taken from the Joint Coal Board Annual Report 1974-1975 shows the then existing trends in miners earnings and compares these with average worker earnings and with the basic/minimum wage.

Tables 12 and 13 present an analysis of the workforce structure, existing at the time of the 1971 Census, for a number of statistical subdivisions within, adjacent to, or of relevance to, the Western Coalfields Region. The importance of the mining industry to the Lithgow area can be judged by

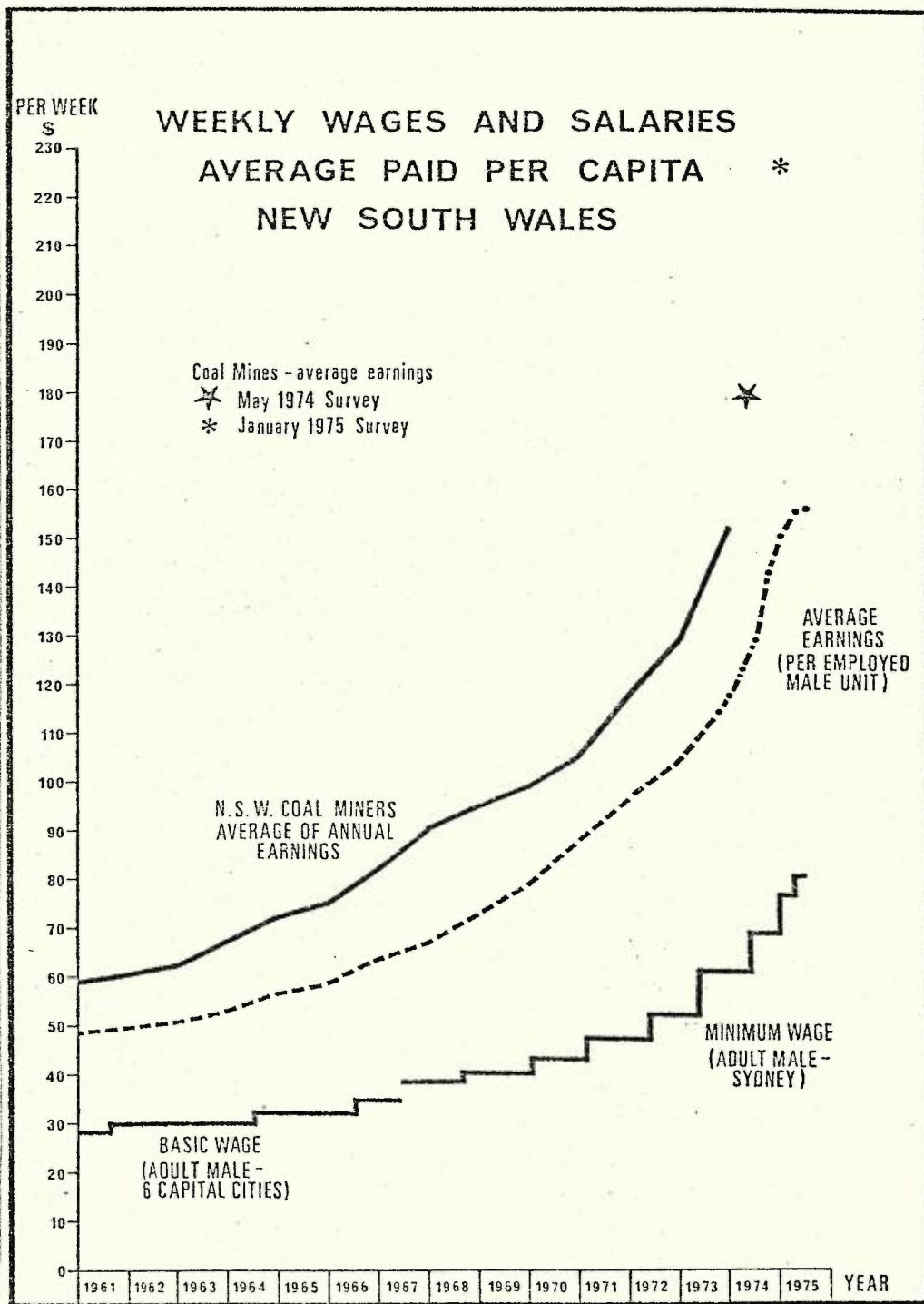
TABLE 11

COAL DELIVERED FROM WESTERN MINES

(From Joint Coal Board Annual Reports 1965-1966 to 1974-1975)

Figures are in '000's tonnes/year

Initial Destination	1965 - 66	1966 - 67	1967 - 68	1968 - 69	1969 - 70	1970 - 71	1971 - 72	1972 - 73	1973 - 74	1974 - 75
Iron and Steel Australia	55	42	99	28	51	205	325	207	294	117
Electricity NSW	845	843	852	828	867	885	896	939	754	158
Rail and Gas NSW	61	31	17	13	12	9	4	3	2	2
Cement NSW	333	270	261	224	249	293	297	315	386	457
Others NSW	296	267	273	271	275	269	264	242	238	228
Interstate Consumers Australia				2						
Total Australia	1590	1453	1502	1366	1454	1661	1786	1806	1674	962
Direct Overseas			146	310	369	407	506	47	109	1433
Total Deliveries		1453	1648	1676	1823	2068	2292	1853	1783	2395



REF. Joint Coal Board Annual Report 1974 - 1975

DAMES & MOORE

FIGURE 19

TABLE 12

WORKFORCE STRUCTURE OF MAJOR TOWNS IN THE VICINITY OF WOLGAN, COMPARED TO SYDNEY AND NSW AS PERCENTAGE OF TOTAL WORKFORCE AT 1971

	Lithgow	Bathurst	Blue Mts	Orange	Sydney	NSW
<u>Total Workforce</u>	5184	6440	6131	9351	1268768	1960129
<u>Structure of Workforce (%)</u>						
Primary						
Agriculture	0.7	3.9	1.5	3.3	0.7	5.8
Mining	6.0	0.4	0.2	0.4	0.3	1.4
Secondary	34.3	17.1	10.1	24.7	27.9	24.5
Tertiary I	21.8	19.4	19.4	16.5	16.1	16.5
Tertiary II	33.1	54.6	62.3	49.9	49.2	46.3
Other	2.9	2.7	4.3	3.1	4.4	4.0
Unemployed	1.2	1.9	2.1	2.1	1.4	1.6

TABLE 13

WORKFORCE STRUCTURE IN BLAXLAND AND ADJACENT SHIRES AS PERCENTAGE OF TOTAL WORKFORCE AT 1971

	Blaxland	Colo	Oberon	Rylstone	Turon	Wollon- dilly
<u>Total Workforce</u>	2458	3009	1544	1684	871	4930
<u>Workforce Structure</u>						
Primary						
Agriculture	13.7	19.4	37.6	24.2	47.5	17.6
Mining	8.2	0.9		4.1	0.7	12.5
Secondary	22.0	15.6	16.7	30.3	6.3	12.5
Tertiary I	23.5	18.5	14.2	11.8	13.8	25.1
Tertiary II	24.4	40.7	26.0	23.3	23.3	27.1
Other	3.6	3.5	4.1	4.5	7.0	3.9
Unemployed	2.8	1.4	1.4	1.7	1.4	1.2

comparing the proportion of the workforce employed there in the mining industry with that in Sydney, in country towns such as Bathurst and Orange, in Wollondilly Shire which is an important coal mining area, and the NSW average. Wollondilly, at 12.5% represents a high proportion for mining industry workforce, Lithgow and Blaxland Shire* have levels of 6% and 8.2% which is also high compared to the NSW average of 1.4%.

It is generally accepted that for each person employed in the mining industry additional employment opportunities are created for another three people. This implies that for Lithgow, any change in employment in the mining industry could affect up to another 18% of the workforce.

5.3.1.3 Community Services and Living Standards

Lithgow will be the main city directly affected by the development of the Wolgan Extended Colliery. However, Bathurst and the Blue Mountains City** also provide services to this part of the Western Coalfield Region. In Table 13 an analysis is presented of the central place functions, by number, existing in these cities. Lithgow with a population 75% the size of Bathurst only has 50% as many central place functions. A comparison with the Blue Mountains gives a similar result (70% and 54%). Nevertheless, Table 14 shows Lithgow to have a fairly comprehensive set of central place functions and this will include hospital and medical services, police, fire protection and local government services.

A possible indicator of the socio-economic status of a community is the standard of private dwellings and the level of occupier-ownership. Table 15, compiled from 1971 Census data, enables a crude comparison to be made for these factors among Lithgow, Bathurst, Blue Mountains, Sydney and the State as a whole. Overall, Lithgow does not differ markedly from Bathurst and Sydney whereas the Blue Mountains City region does give indications of having a lower socio-economic status.

** In the 1971 Census the communities of Mt Victoria, Blackheath, Katoomba, Leura, Wentworth Falls and Lawson are treated as a single statistical unit titled the Blue Mountains City.

* Lithgow and Blaxland Shires were amalgamated in 1977 to form the "Greater Lithgow City Council". (Gazetted 11/2/77).

TABLE 14

SELECTED CENTRAL-PLACE FUNCTIONS, BY NUMBER, 1975-1976

	Blue Mts	Bathurst	Lithgow	Oberon	Wallerawang	Portland
Population (1971)	18,438	17,196	12,825			
Accountants & Auditors	12	6	3			
Dentists	7	6	2			
Medical Practitioners	17	14	5	1		2
Optometrists	1	2	1			
Pharmacists	12	8	6	1	1	1
Solicitors	9	5	2	4		
Banks	9	8	5	2		2
Department Stores	1	4	5			1
Government Departments	12	27	21	3	4	4
Insurance Companies	3	9	1			
Hotels (Licensed)	12	12	9	1	1	2
Motels	17	10	3	1		
Restaurants & Cafes	19	11	8			
Schools & Colleges	12	18	6	1	2	2
Accounting Machine Dealers & Distributors		8		1	1	
Stock & Real Estate Agents	22	22	3	5		
Motor Mechanics & Garages	6	25	22	6	3	3
Carriers	17	27	16	7	3	2
Builders & Bricklayers	45	47	7	3	1	
Electrical Contractors	12	11	4	2		1
Plumbers & Fitters	19	11	5	1		
Butchers	13	12	16	2	1	2
Bakers	1	3	1	1	1	
Totals	278	306	151	42	18	22

TABLE 15

DWELLING AND HOUSEHOLD CHARACTERISTICS IN MAJOR TOWNS IN THE VICINITY OF WOLGAN COMPARED TO NSW TOTAL AT 1971

	Lithgow	Bathurst	Blue Mts	Sydney	NSW
Total Dwellings	4159	5023	8506	849,369	1,489,064
Owner Occupied(%)	62.9	61.2	50.4	65.3	60.6
Unoccupied (%)	5.7	5.4	27.5	6.3	8.4
< 2 Bedrooms (%)	4.7	7.3	7.8	12.0	9.8
Brick or BV (%)	40.6	54.6	13.9	64.1	43.7
No Sewer or Septic (%)	4.7	1.9	9.1	7.2	11.6

5.3.2 Land Use

5.3.2.1 Present Land Use

Present land use in the region includes farm and pastoral holdings in the Wolgan Valley, Blue Mountains National Park to the east and south-east, and the Newnes State Forest pine plantations to the south. The experimental mine site is located on the east side of the Wolgan Valley on land dedicated to mining purposes. Some rough grazing is available on the nearby slopes. Otherwise, the alternative pit head and washery sites are located in woodlands not presently used for any industrial or agricultural purpose. There are no development recreational facilities in the area.

5.3.2.2 Recreational Use

Even though there are no developed facilities there is recreational use of the area. This is mostly weekend use by people living in the Sydney region. The sheer cliffs of the Wolgan Valley and its larger tributaries are used by rock climbers and the road into the valley provides a number of departure points for bushwalkers. It is not known how many bushwalkers actually pass through the proposed site especially as several locked gates and private land block access from the valley by means of the Old Coach Road. It is likely that very few spend time on the plateau top, although the Old Coach Road gully may get occasional walkers as 'spin off' either from Penrose Gully or the Glow-worm Tunnels.

5.3.3 Archaeology

At the time of initial contact with Europeans, the tribe inhabiting the area which encompassed the Wolgan Valley were the Daruk (Tindale 1974), otherwise known along the Hawkesbury River as the Broken Bay tribe. The Wolgan Valley is near the eastern boundary of Wiradjuri territory and although these people are reasonably well documented, very little is known about the Daruk.

It has been demonstrated that the general region around the Wolgan Valley does have considerable archaeological potential. During the years 1958-1960 Frederick D. McCarthy, Curator of Anthropology at the Australian Museum, carried out a comprehensive survey of the Capertee Valley and excavated a number of archaeological sites. The more important of these sites are in the vicinity of Glen Davis, which is approximately 12 km north of the proposed Wolgan Valley Colliery site (McCarthy 1964). The prehistoric deposits which McCarthy exposed were quite extensive and rich in stone artifacts. One site overlooking the Capertee River contained a deposit which was over three metres deep but, unfortunately, the age of these deposits was never determined.

Areas of proposed development were closely examined for prehistoric sites (see Figure 4). Particular attention was paid to the site of the Old Coach Road gully pit-head and dam and the Deane's Creek pit-head, all of which are situated in rugged, dissected terrain. These areas were traversed on foot and rock shelters with potential were investigated. A number of well developed and habitable rock shelters do occur in the vicinity of the proposed mine site but these did not show any evidence of prehistoric occupation. The absence of prehistoric deposit is understandable in view of the ruggedness of the terrain. While the general region seems to be archaeologically rich, the mining lease area which is in the plateau above the Wolgan Valley does not appear to contain Aboriginal relics.

A rock shelter of European origin is positioned about 300 m west of the pit head in the Old Coach Road site. The entrance is partially enclosed by a rubble wall supported with axe-hewn posts and three niches are cut into the back wall. There is no habitation debris and its original purpose is unknown.

5.3.4 Historical Interest

The region in which the mining lease is located has several points of historical interest. The Glow-worm Tunnels which were built for the now abandoned railway are located to the southwest in the Tunnel Creek headwaters. The railway itself was constructed in the early 1900's to service the coal and oil shale mining operations at Newnes and Glen Davis. Oil shale mining and processing took place at Newnes during the period 1911 - 1922; when a processing plant was erected to produce such diverse products as oil and candle wax. The works were closed due to competition from imported oil.

In that period coal from the Wolgan seam was coked in the beehive ovens at Newnes and transported throughout NSW for use in smelting operations.

In 1937 an oil shale mining and processing works was opened at Glen Davis in the Capertee Valley. Petrol produced from the works was pumped via Newnes to Newnes Junction for distribution. The operation was discontinued in 1951 and the plant and pipeline dismantled.

5.3.5 Aesthetics

The photographs presented as Plates 1 to 4 illustrate visual aspects of the environment. Vegetation cover in the lease area consists mainly of areas of open heath and Eucalyptus woodlands (Plate 1).

Although the plateau surface is mainly flat it is deeply dissected in some areas and there are several spectacular views from the Old Coach Road across deep gorges to the west and north (Plate 2). Parts of Deanes Creek and the

Old Coach Road gully contain impressive stands of tall eucalypts and tree ferns (Plates 3 and 4). For the most part, the flowering shrub component of the native flora contributes more to the local scenery than do geological formations.



PLATE 1: Open heath and Eucalyptus woodland on plateau near proposed site



PLATE 2: View across the Wolgan Valley looking west from Old Coach Road



PLATE 3: Eucalypt forest in the Old Coach Road gully

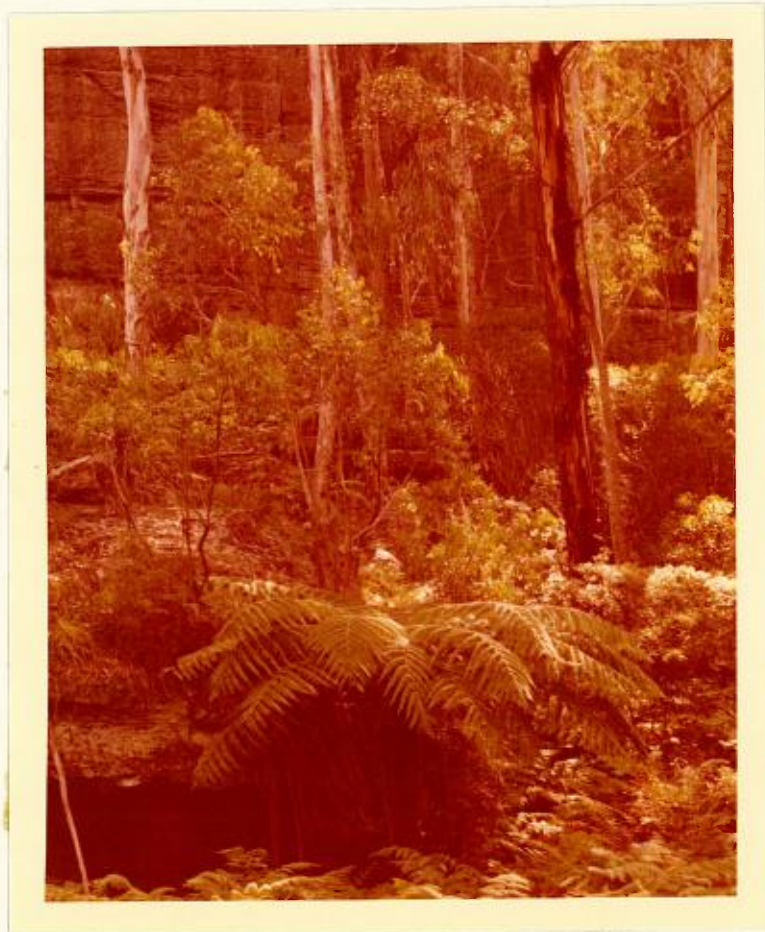


PLATE 4: Vegetation typically found in deep gullies near Deanes Creek and the Old Coach Road

6.0 ASSESSMENT OF ENVIRONMENTAL IMPACT AND MITIGATION PROCEDURES

6.1 Physical Environment

6.1.1 Water Wastes

During construction operations considerable sediment may be produced downstream of the construction sites which will have short term effects on the streams. Although quantities will not be large enough to interfere with the flow regime, some impact on aquatic biota will occur.

Provided that the water holding dam is constructed first and that revegetation of embankments and dam walls is undertaken as soon as possible, these effects will be only transitory and minor.

It is proposed that treated sewage water will be used to irrigate revegetated and landscaped areas so that nutrients contained in it will have little chance of directly entering the natural streams, but will instead be used on site.

The potential impact of waste water discharge from operating mining activities has in the past been one of those causing the greatest concern. The Wolgan Extended Colliery is sited near drainage head waters so that there is only modest run-off which can be readily diverted or collected.

Mine planning includes a water management plan (Section 4.6) which will be adequate to collect and process any waste water or excess surface drainage. Treatment facilities will be provided to treat any discharge water so that it is suitable for reception by waters classified P. There should therefore be no deterioration in the aquatic environment.

The Wolgan seam is dry and it is expected that some water make-up for the plant will be needed during dry spells. Interception of drainage is minimal and should not cause noticeable changes in downstream conditions.

6.1.2 Air

Dust produced during the construction of the colliery is unlikely to cause any harmful effects. Observation of vegetation around a nearby quarry in similar rock formations shows no evidence of deleterious effects on vegetation or habitat.

Once coal is being produced by the mine, dust control procedures will be necessary and these are provided for by the mine operating plan. Water sprays will be installed around all coal stockpiles, conveyors and transfer points will all be covered and roads will be paved. Within the colliery itself, no coal will be transferred except by conveyor belt or loading equipment at the stockpile areas so that only very small amounts of coal dust will be liberated. No impact on the environment surrounding the colliery is foreseen.

Refuse material from the coal preparation plant will be wet at all times and will not be a potential source of air pollution.

Trucking of coal by road to Clarence will be in accordance with requirements, with trucks being covered and washed. At Wolgan, the same controls over dust generation from stockpiles and loading facilities will be installed as exist at the Clarence colliery and for the loading of coal from the Clarence mine.

6.1.3 Soil

Some erosion of surface deposits will occur during project construction, but the site is rocky and presents a low erosion hazard.

Once the colliery is operating all disturbed surfaces will be revegetated to minimise erosion and sediment production. No noticeable impact will occur if these measures are carried out and maintained.

Upgrading of the road between the proposed Wolgan Extended Colliery and the Clarence loading area is a potential erosion hazard. Observation of conditions around the existing road indicates very little erosion has occurred even though it is not properly constructed. Provided that normal road drainage control measures are undertaken, no erosion is likely. Efforts should be made to restrict the construction machinery, camps and other facilities to use of as narrow a right of way as possible.

6.2 Biological Environment

6.2.1 Flora and Fauna

6.2.1.1 Impacts

The mining operation will destroy about 46 ha of vegetation, most of this in the area of the coal preparation plant and refuse areas. Mostly eucalyptus woodland and forest vegetation types occur in these locations, and carefully regulated removal of such vegetation over a restricted area should not be harmful.

However, there are some vegetation types which, if damaged, could have detrimental effects on other areas or organisms. An example is the moist sedgeland (sample site 5 in Figure 13), which is widespread geographically on Triassic sandstone soils. Since so little is known about these habitats or their fauna, it is impossible to make an assessment of impact based on biological criteria. Equally, it is difficult to recommend using such areas as refuse sites merely because no damaging results can definitely be predicted.

The open heath between the Old Coach Road gully and the plateau coal preparation plant site will be particularly susceptible to damage by construction activities or permanent structures such as conveyor belts. Dry heath tends to be a rather fragile vegetation - that is, the individual plants are easily broken and damaged, and recovery is slow - and the problem is compounded by shallow rocky soils on steep slopes. Vegetation damage will make

soil erosion more likely, which if unchecked will make re-establishment of any plant cover on the damaged and peripheral areas very difficult.

Two bird species, the rock warbler and the barking owl, are liable to be sensitive to habitat destruction. The rock warbler is restricted to the Hawkesbury Sandstone geological formation, while the barking owl is thinly distributed throughout woodland areas in New South Wales. The population of greater gliders (*Schoinabates volans*) on the Old Coach Road gully site will also lose part of its forest habitat to development.

The presence of a dam will certainly add some bird species to the site, notably waterfowl and waders. To predict the number of species would require detailed knowledge of the construction; however, a dam with gently sloping sides generally will provide habitat for more species than a steep sided one. Similarly, mammal and reptile populations will increase, at least in numbers if not in species diversity.

Although this report is made only on terrestrial fauna, it is evident that the main area of impact is likely to be on the aquatic biota in streams and rivers into which project effluents of various sorts will drain. Since the Wolgan-Colo River system is relatively unpolluted the project operators should ensure that not only do effluents meet legal requirements but that no permanent changes will be incurred in the river systems.

Finally, retention of the high diversity gully fauna depends directly on preservation and protection of the complex understorey. It is quite feasible to fulfil this and the other conservation requirements on the site, but fire prevention programmes must be carefully managed in order not to destroy large sections of habitat during any one burn.

6.2.1.2 Mitigating Procedures

Judging from the general density of understorey vegetation and from the large size of individual shrubs - such as *Acacia botrycephala* - the area appears

to have been unburned for at least 10 - 15 years. Strong northwest winds in conjunction with high temperatures may occur on the plateau; and such conditions could support severe bushfires.

With respect to the coal mining operation the bushfire problem is a dual one, as it will be necessary to protect mine facilities from fires of external origin and to protect the surrounding woodland from sources of fire within the colliery. Such sources include combustion of stockpiles, sparks from equipment and matches or cigarettes dropped by mine personnel.

It is recommended that a bushfire mitigation programme be initiated at the same time as construction works. Because of the extremely rough terrain near all pit-head sites, it may be necessary to clear underbrush in and around these areas by winter burning and repeating the operation at intervals. No very large trees need to be removed for this purpose, although some thinning may be necessary in all other layers. In an area such as the plateau coal preparation plant site a preferable plan might be to slash underbrush and small - mid sized trees, winter burn the heavy brush and annually tritter the buffer zone to keep brush down. This method encourages the growth of native perennial grasses and the buffer is less prone to erosion when grasses are present. Similar buffer zones should be maintained along roads, conveyor belts and around mine ventilation shafts.

Prescribed burns should be planned so that, after the initial clearing off, small areas are burned in a patchy fashion at different times, rather than re-burning the entire area at set intervals. This technique retains refuge areas for fauna and maintains variability in the vegetation patterns.

Because of the erosion potential of the heath areas, activity across dry heath should be kept to a minimum during construction and mining phases of development. If at all possible, the heath should be revegetated with native species after construction of the conveyor. An adjoining access road will be required for maintenance of machinery. Proper construction and maintenance of this road,

appropriate to its low level of usage, will be carried out to ensure that no erosion damage to the slope is caused by its presence.

Revegetation procedures should only be necessary on road verges, dam walls, bund walls (eg, around the pit-head platform) and on tailings dams. Provisionally, it is recommended that native species and perhaps some exotic annual grasses be used, and fertilisation of seedings or plantings minimised. By the time Wolgan Colliery comes into production, the Clarence revegetation programmes on similar terrain and soils will have been on trial for several years. The data and experience from the Clarence programmes should be used in setting up the Wolgan revegetation programme.

In order to minimise vegetation damage and the subsequent need for rehabilitation, a covenant will be reached with construction contractors to prevent unnecessary or careless removal of large trees and gratuitous cutting of roads. Such an agreement would be of particular importance in preserving the community of large eucalyptus trees which harbour a population of greater gliders in the Old Coach Road gully.

In order to disturb the rock warbler, barking owl and greater glider populations as little as possible, disturbance to major rocky outcrops, cliffs and rock faces adjacent to other habitats should be avoided. The retention of thick undergrowth along all creek lines and of all large hollow trees is also recommended.

The use of sedgelands (wet heath) for purposes such as refuse disposal should be avoided if possible, and woodland areas used instead.

6.3 Social Environment

6.3.1 Regional, State and National Economic Conditions

The development of the proposed Wolgan Extended Colliery will benefit the economy in a number of ways. It will

- increase Australia's export earnings
- provide additional income to local, state and national government through payment of taxes, royalties, etc.
- inject millions of dollars into the economy through purchase of plant and machinery
- expand the industrial base of the region
- provide employment to hundreds of workers both directly in mine operations and indirectly in supporting industries and services.

During the construction stage of the colliery there will be a considerable demand for construction materials. At the present time many Australian industries are operating under capacity so any increase in demand should be beneficial.

The Wolgan Extended Colliery will produce coking blend coal for which there is an assured long term and stable market. In the past the Lithgow district has supplied mainly coal and the market for this has been far more affected by rises and falls in the economy than is that for coking coal. The capacity of supplying coking coal from the Wolgan Extended Colliery will provide greater economic stability to the Lithgow district.

The Lithgow district has a long history of coal mining and steel making so a well established infrastructure exists. Services such as water, electricity and rail as well as specialist supporting industries and services are readily available. Because of this the costs for development of the Wolgan Extended Colliery can be minimised and a high level of efficiency maintained during operations.

It should be noted that the Western Coalfield has the highest average output for manshift in NSW (figures are given in Joint Coal Board Annual Report 1974-75 pp40-41). In 1972 the Coalex group had an average of 29 tons output per manshift (29.5 tonnes OMS) which compares well with the district average of 14.5 tons (14.7 tonnes OMS) and the overall NSW average of 9.5 tons per manshift (9.7 tonnes OMS).

6.3.2 Employment

The development of the Wolgan Extended Colliery will provide employment for over 300 once operating at the maximum permitted level. During the construction stage a labour force of up to 200 will be required. The source of this labour force will be primarily the existing pool of workers with mining experience in the Lithgow area with some contribution from other nearby areas such as the Blue Mountains and Bathurst.

Coalex currently employs about 350 people in its Lithgow operations. It is not expected that these would be phased out if the new mine were not developed.

6.3.3 Community Health and Social Services

Adverse impact on the development of the colliery on community and social services would only occur if it led to a sudden increase in population in the district. Because of the declining trend in the labour force over the past 20 years in this area many community facilities may in fact be under-utilised at the present time. It is intended that the Wolgan Extended Colliery will be gradually brought to full production capacity over a period of three to five years. This, together with the availability of an existing pool of miners, supporting staff and trainable unemployed persons, will keep any adverse impact on community health and social services to a minimum. Any increase to the economic well being of the district should bring with it an increase in the availability and quality of these services.

6.4 Aesthetics

At the present time the entire area proposed for the coal mine development is a bushland area remote from human habitation and with relatively poor access. The pit-top area is a valley site with large trees and rock walls and has a most pleasing appearance. Similar areas exist nearby. The coal preparation plant and refuse sites are in less appealing locations with woodland vegetation on rocky surfaces.

Each of the pit-top, coal preparation plant and refuse disposal areas is remote from any dwelling. The access and coal haulage road between Clarence and Wolgan is also remote, but will pass near the Newnes Afforestation Camp.

The pit-top site is well below the skyline and so will not be visible to hikers and bushwalkers in the area, or to tourists visiting the nearby gloworm tunnels. Similarly, the refuse disposal areas are in depressed areas and like the pit-top will only be visible from nearby. The coal preparation plant occupies a higher site so that the top of buildings and coal stockpiles may be visible above the trees from some vantage points in the area, but only to a minor extent. Again the facilities will not be visible to tourists at the gloworm tunnels.

Access to the area will be improved so that there will be an increase in the amount of traffic noise and pollution as well as visual effects.

Both the pit-top area and the coal preparation plant will be paved, curbed and landscaped. Embankments and earth dam walls will be revegetated and benches will be provided on the refuse dam walls for tree planting.

6.5 Construction Phase Impact

Establishment of the colliery will involve clearing of vegetation from the preparation plant and pit-top sites and from access routes for roads, conveyors, pipelines, etc. Surface drainage facilities, (bund walls,

settling ponds, collection dams and storage dams) will be constructed at a very early stage in the development thus minimising any impact caused by runoff from the construction site. Fairly extensive excavation and filling will be required in leveling the pit-top site. This site has an area of about 3 ha and is concealed in the gully. Ground profile diagrams shown in Figure 9 indicate the amount of excavation that will be required for the sites. Efforts will be made to restrict machinery, camps and other facilities to the minimum area possible during and after the construction phase.

6.6 Spontaneous Combustion

All stockpiled coal will be kept wet and turnover time will be short so spontaneous combustion should not occur and if it does it can be readily dealt with in these areas. Combustible material in the refuse dams will be kept permanently wet so no problem is likely to occur. Coarse refuse material used in the dam wall construction will be compacted and sealed into clay cells. These measures should eliminate the possibility of spontaneous combustion problems arising.

6.7 Long Term Impacts

At completion of the mine's operational life, most sources of environmental impact from the proposed plant complex and rejects disposal area will be eliminated. Surface facilities at the coal preparation plant and pit-top can be removed, mine portals and ventilation shafts sealed and the sites restored to an acceptable condition. However, the refuse dams will remain as a permanent feature and provisions will have to be made for their continued maintenance. The refuse material in the dam may remain wet indefinitely and seepage will continue from the base of the refuse dam walls. Facilities for treatment of this seepage will have to remain as a permanent installation or until seepage stops or some alternative is found.

It is essential that long term erosion control is implemented for the refuse

dam walls. In order to achieve this, a protective layer of soil and rock will be placed on the walls and a vegetation cover established. In order to achieve this a protective layer of soil and rock will be placed on the walls and a vegetation cover established as each stage of the refuse dam walls is completed. Benches will be constructed on the wall for tree planting and where practical the contours of the wall will be made to blend into the surrounding slopes. Careful 'landscaping' and the use of plant species native to the area will ensure that minimum visual impact is created by the refuse dam walls, even from those restricted directions (to the north and east) where they can be seen from outside the mining purposes lease. The requirements for erosion control and vegetation establishment will be taken into account in deciding on the final slope of the outer face of the walls. The maximum allowable slope is generally considered to be 1 in 5 (20%).

Roads constructed for use by the colliery will lead to greater access to the area for recreational and other usage. The long term impact of this extra usage may need to be considered in particular as to whether access to other than colliery vehicles should be allowed and whether the road should be maintained after colliery operations cease.

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APPENDIX A1

REFUSE DAM WALLS - PRELIMINARY DESIGN

A1.1 Mechanical Properties of Refuse

Laboratory tests were carried out on a bulk sample taken from the Wolgan Experimental Mine in order to obtain data for use in preliminary design calculations.

The following laboratory testing procedure was used:

- (1) The sample was mechanically broken down to 40 mm maximum particle size,
- (2) the sample was then sieved and the 25 mm to 0.5 mm size was retained for further testing,
- (3) the retained fraction (coarse refuse size) was compacted in a mould to near standard compaction (ASA 89 1966 Test 11A) to evaluate the compacted density,
- (4) the sample was tested in a falling head permeameter to evaluate the permeability of the material to assist in seepage calculations,
- (5) the sample was then placed in a triaxial shear testing machine - back pressure saturated, and a staged consolidated undrained triaxial test - with pore pressure measurements carried out to evaluate the effective shear strength parameters,
- (6) finally a sieve analyses of the sample following testing was carried out to enable an assessment of particle breakdown during saturation and compaction to be evaluated.

The results of the above tests are calculated below and the results of the sieve analyses of the sample are shown in Figure A1.1. Figure A1.2 shows the proposed refuse disposal scheme and figure A1.3 is a simplified schematic representation of the dam wall construction assumed for calculation of slope stability factor of safety.

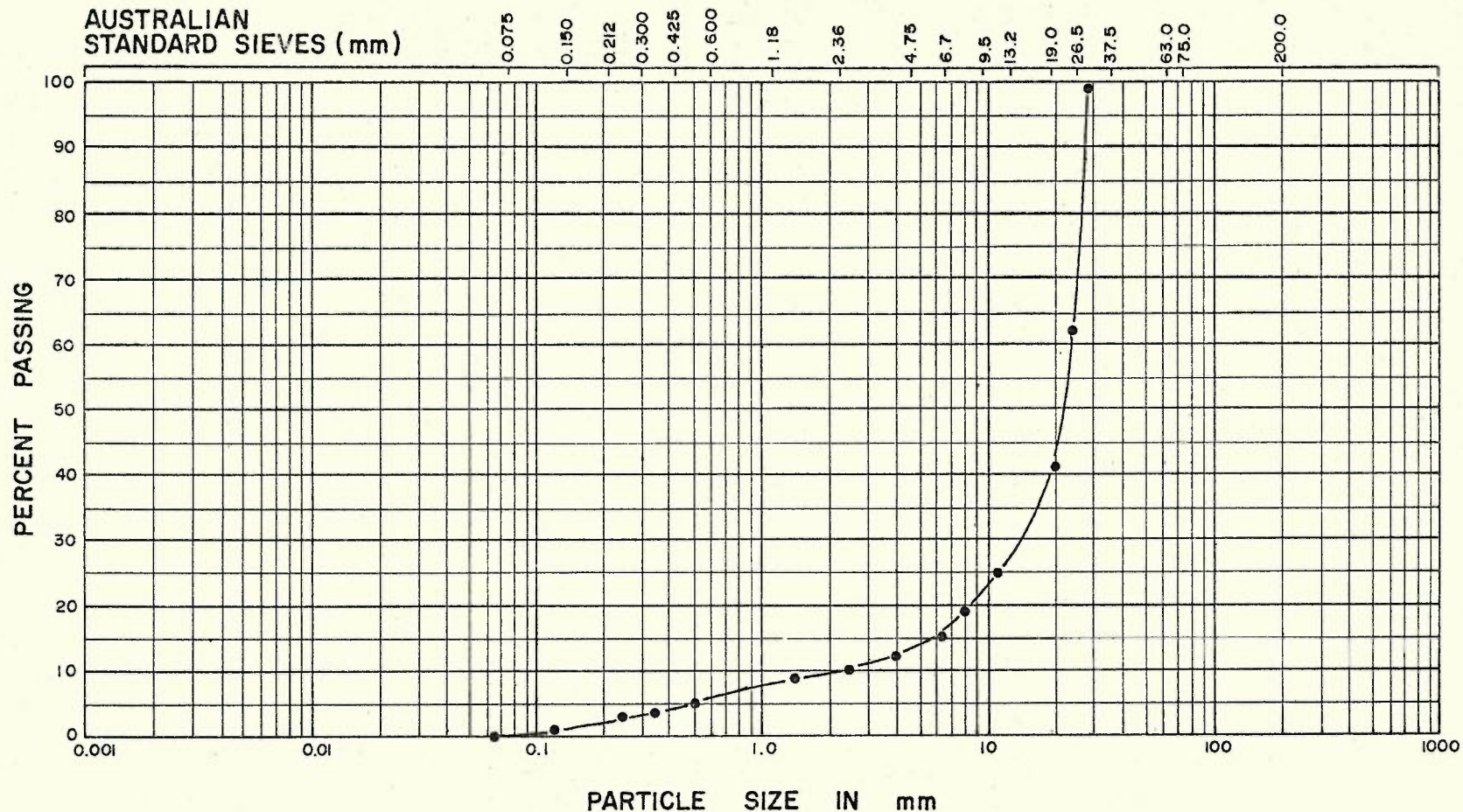
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BY _____ DATE _____



CLAY	Fine	Medium	Coarse	Fine	Medium	Coarse	Fine	Medium	Coarse	COBBLES
	SILT			SAND			GRAVEL			

TEST TYPE DRY SIEVE

MATERIAL COAL REFUSE

CLASSIFICATION MEDIUM GRAVEL

GRADATION CURVE

Refuse Material from Wolgan
Experimental Mine

DAVID S. MOORE
FIGURE A1.1

TEST TYPE	COMPACTED DRY DENSITY	MEASURED PERMEABILITY	
Permeability	1.42 tonnes/m ³	0.95-1.08 cms/sec	
Triaxial Testing	1.42-1.44 tonnes/m ³	EFFECTIVE SHEAR STRENGTH PARAMETERS	
Consolidated Undrained with pore pressure measurements		Cohesion C'	Internal Friction Angle ϕ'
		kPa	
		7 - 14	24.0-26.0

An internal friction angle of 30° was used in the computer analysis of dam wall slope stability rather than the measured values of 24° to 26°. This assumption was made because the coal preparation plant process will remove the finer fraction from the refuse material leaving the coarser, more durable material used for wall construction.

The stability analysis indicates a maximum allowable wall slope of 1:2.5 (vertical:horizontal). However, the final slope of the refuse dam wall may be determined more by revegetation than slope stability.






A1.2 Design Notes

1. Inner clay core required to prevent seepage of water through dam wall and drying out of stored refuse leading to possible fire hazard.
2. Cellular construction of downstream face to maintain a seal for the coarse refuse and along with adequate compaction to prevent the possible spontaneous combustion of the refuse.
3. The outer slope of the refuse disposal dams will be benched to limit erosion and assist in revegetation. Benching will result in overall slope not exceeding 1:2.5 (vertical:horizontal). During staged construction of a lift height of 5 m will be used. (Reducing the overall slope to 1:5 would further improve erosion control and revegetation).
4. A floating pump system will be installed to recycle ponded water, held in the refuse dam, back to the washery and to handle storm deluge on the surface of the refuse dam storage areas to prevent overtopping. Water

will be discharged back to the washery and if necessary to the downstream seepage dam.

5. A downstream seepage dam will be constructed to collect seepage water and excess storm deluge or discharge from the floating pump system. The water will be treated in a water treatment plant to restore the water to a satisfactory standard for release into the streams.
6. Surface drainage and storm run off from the catchment surrounding the refuse disposal area will be diverted by drainage channels and collected to discharge downstream of the downstream seepage dam.
7. The combined coarse and fine refuse fractions from the washery will be discharged from a pipeline placed adjacent to the compacted coarse refuse dam wall to enable deposition of the coarser fraction near to the wall. This coarser fraction will be compacted by the movement of plant.
8. It may initially be necessary to construct an upstream excavation to pond slurry fines and form a pond for water and floating pump installation.
9. Prior to final design and construction the area beneath the proposed refuse dam wall will be adequately investigated by a competent geotechnical engineer to evaluate the presence of any weak and/or permeable subsoils. These, if found should be removed and a foundation of adequate strength placed.
10. Depending on the foundation conditions revealed, it may be possible to use a decant pipeline beneath the wall to handle recycling of ponded water to the washery and storm deluge.
11. Adequate freeboard of at least 0.5 m will be maintained at all times at the crest of the dam to deal with emergency storm conditions or pump breakdowns.
12. No downstream concrete pipework or support structures will be used because of possible sulphate attack from the seepage water.
13. The downstream seepage dam may be a conventional earth-fill centre core dam with the upstream zone constructed of compacted coarse refuse. However, the downstream zone will not be constructed from refuse owing to the possibility of acid seepage water.
14. During the construction of the refuse dam wall periodic inspection and testing of the compacted refuse will be undertaken to ensure that construction techniques are adequate.

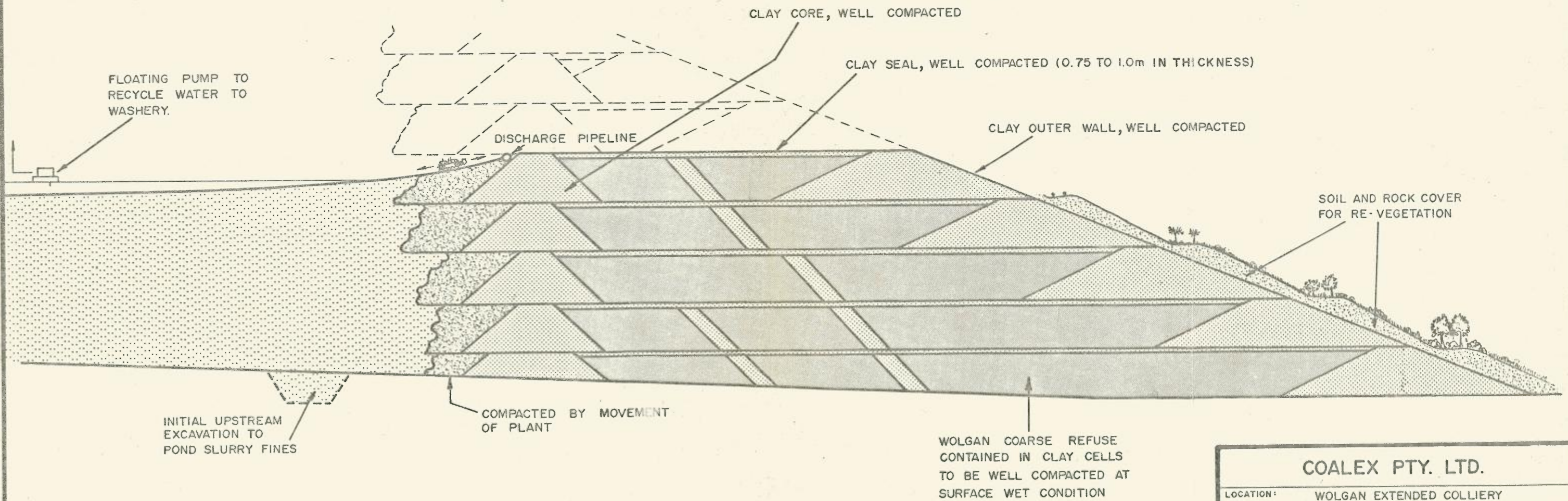
LEGEND

-  SOIL AND ROCK COVER FOR RE-VEGETATION
-  WELL COMPACTED CLAY
-  WELL COMPACTED COARSE REFUSE
-  COARSER FRACTION OF REFUSE
-  FINER FRACTION OF REFUSE

SEE ATTACHED NOTES

NOTE





THE GROUND SLOPE BENEATH THE DAM WALL WILL VARY FROM LOCATION TO LOCATION. HERE IT IS SHOWN RELATIVELY FLAT TO ALLOW A CLEARER SCHEMATIC PRESENTATION OF THE STAGED CONSTRUCTION.

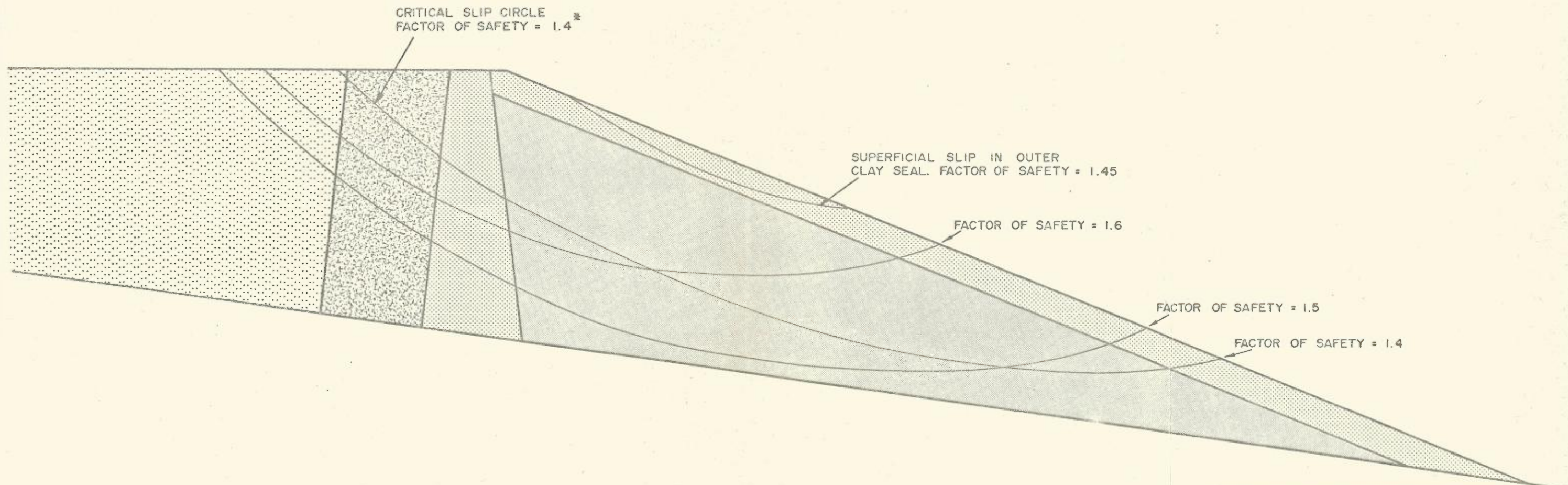


COALEX PTY. LTD.	
LOCATION:	WOLGAN EXTENDED COLLIERY
TITLE:	PROPOSED REFUSE DISPOSAL SCHEME
JOB No.:	8082 - 003 - 70
DATE:	February, 1977
FIGURE A1.2	
DAMES & MOORE	

REVISIONS
 BY DATE
 FILE
 BY DATE
 CHECKED BY DATE

LEGEND

-  WELL COMPACTED CLAY
-  WELL COMPACTED COARSE REFUSE
-  COARSER FRACTION OF REFUSE
-  FINER FRACTION OF REFUSE
- * ASSUMES THAT COMPETENT BEDROCK IS CLOSE TO THE NATURAL GROUND SURFACE.



NOTE

STABILITY CALCULATIONS HAVE BEEN CARRIED OUT FOR THE MAXIMUM GROUND SLOPE AT THE REFUSE DAM WALL LOCATION (REFUSE AREA 2)

COALEX PTY. LTD.	
LOCATION:	WOLGAN EXTENDED COLLIERY
TITLE:	REFUSE DISPOSAL DAM - SLOPE STABILITY FACTOR OF SAFETY
JOB No.:	8082 - 003 - 70
DATE:	February, 1977
FIGURE A1.3	
DAMES & MOORE	

APPENDIX A2

PRELIMINARY SURFACE HYDROLOGY STUDY FOR THE DESIGN OF
PIT-TOP SITE DRAINAGE STRUCTURES

A2.1 INTRODUCTION

A2.1.1 Object of the Study

The object of this study is to provide estimates of the peak potential runoff from the pit-top and coal treatment plant areas and from the slopes surrounding the pit-top area. This information will aid in the design of surface drainage structures; in particular, the overflow channel and conduit which runs from the potable water storage dam (Control Dam) to the main storage dam.

A2.1.2 Extent of the Study

The area considered in this study is shown in Figure A2.1. For purposes of calculating discharge rate the total catchment area is divided into a number of individual sub-catchments. These are described in section A2.2.1.

This is a preliminary study based on accepted design formulae as given in:

1. The Institution of Engineers, Australia (1958) First Report of the Storm-water Standards Committee of the Institution on Australian Rainfall and Runoff.

(Which will be referred to as 'Australian Rainfall and Runoff')

2. Department of Main Roads, NSW (1976) Waterway Calculations for Bridges and Culverts. M.R. Form No. 371A (Metric) (Revised January, 1976).

(Which will be referred to as Waterway Calculations)

A different method for determining rainfall intensity-frequency-duration-tables is given in a new edition of 'Australian Rainfall and Runoff' which is currently being prepared. This method appears to give lower rainfall intensities

than the earlier version and so would result in smaller drainage structures if adopted. The design figures given in this study therefore can be considered as conservative.

A2.1.3 General

The potable water storage dam overflow channel and conduit is the major drainage structure protecting the pit-top site. It needs to be designed to cope with the worst case 50 year storm conditions in which it is assumed that the potable water storage dam is filled to capacity and antecedent rainfall has brought the contributing catchment area to maximum wetness.

A2.2 Catchment Characteristics

A2.2.1 Sub-catchments

For purposes of estimating runoff the total catchment area has been divided into a number of sub-catchments as shown in Figure A2.1. Estimates of the area, slope, maximum stream length and maximum overland flow distance for each of the sub-catchments is shown in Table A2.1. The profile sections used to estimate the weighted average slopes are shown in Figure A2.2. The sections along which the profiles were taken are shown on the map in Figure A2.1.

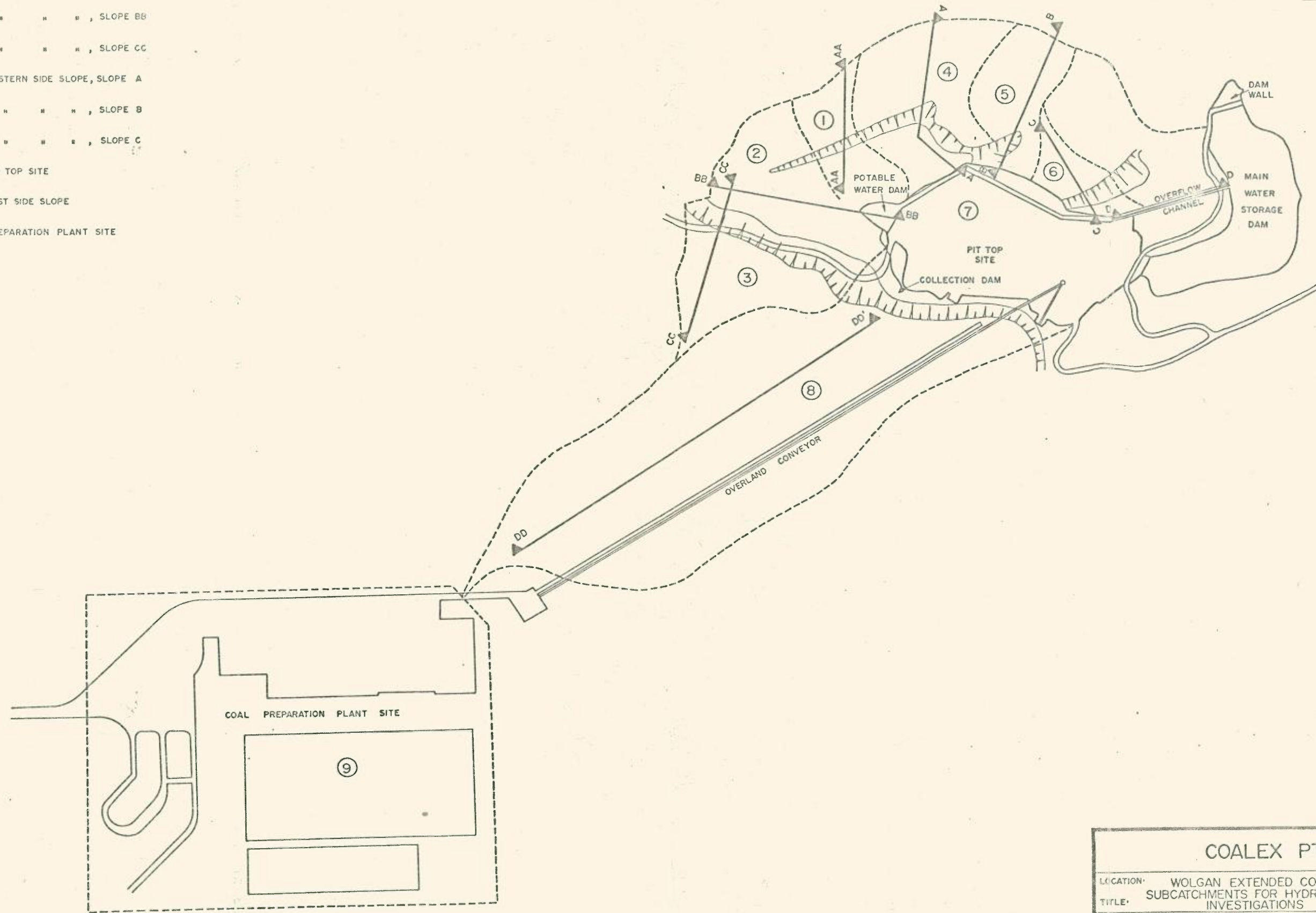
A2.2.2 Surface Cover and Runoff Coefficients

A2.2.2.1 Catchment Slopes

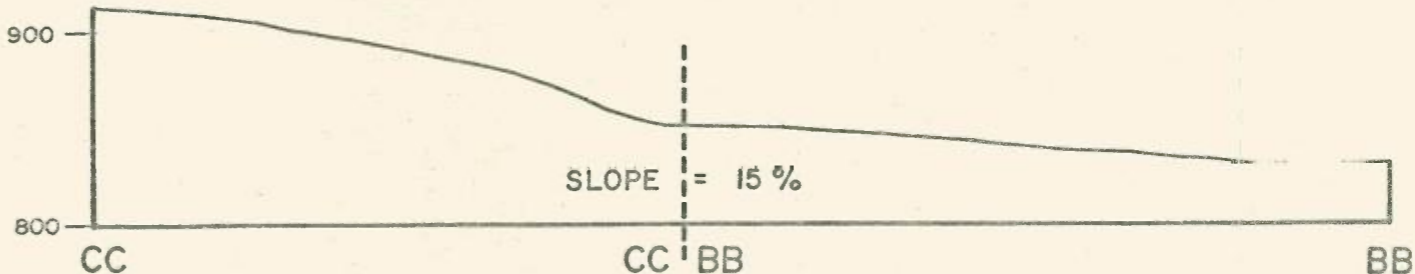
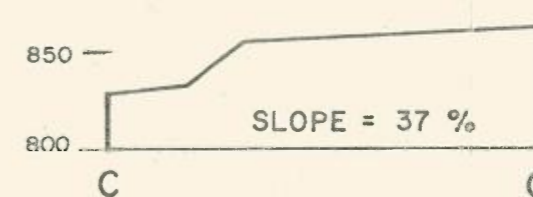
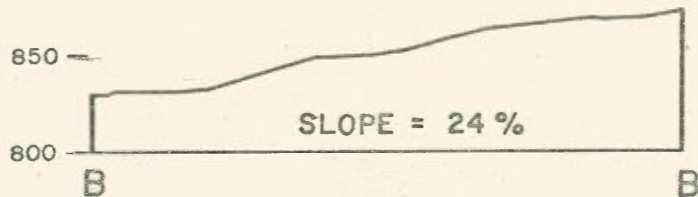
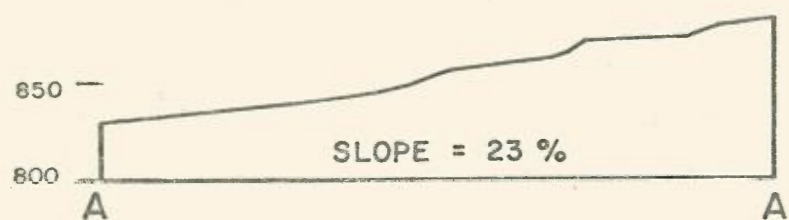
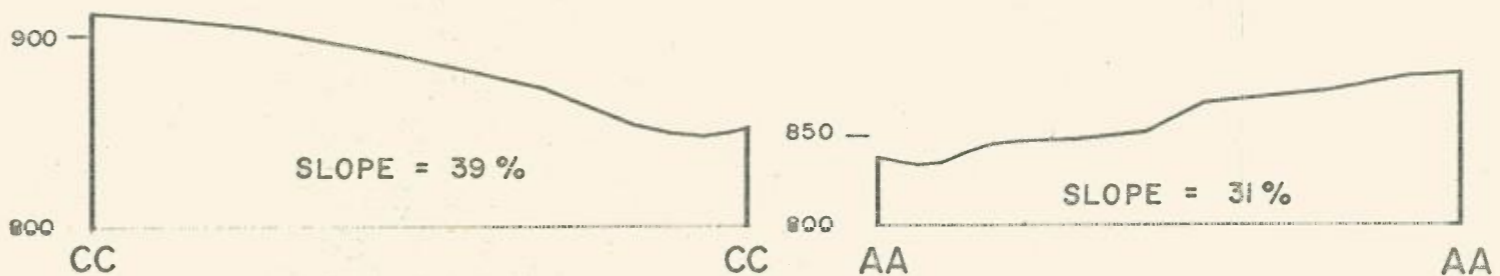
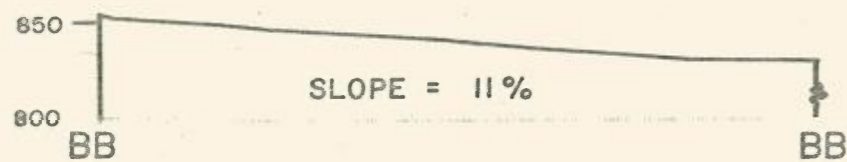
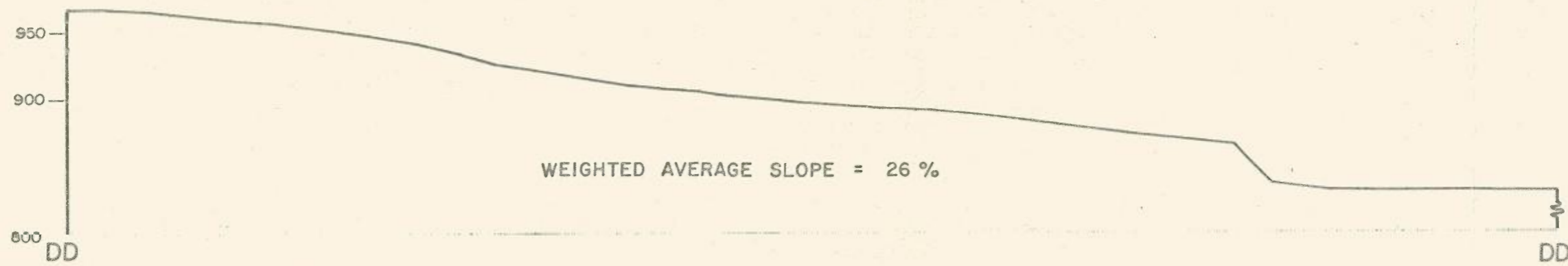
These have thin soils, large areas of exposed sandstone and a light to medium vegetation cover. This fact together with a weighted average slope of 15 to 37% implies a maximum runoff coefficient in the range 0.9 to 0.97. For the purposes of this preliminary study a maximum runoff coefficient of 0.95 will be used for all slope sub-catchments.

SUB - CATCHMENTS

- ① POTABLE WATER DAM , SLOPE AA
- ② " " " , SLOPE BB
- ③ " " " , SLOPE CC
- ④ WESTERN SIDE SLOPE, SLOPE A
- ⑤ " " " , SLOPE B
- ⑥ " " " , SLOPE C
- ⑦ PIT TOP SITE
- ⑧ EAST SIDE SLOPE
- ⑨ PREPARATION PLANT SITE



COALEX PTY. LTD.	
LOCATION: WOLGAN EXTENDED COLLIERY	FIGURE A2.1
TITLE: SUBCATCHMENTS FOR HYDROLOGICAL INVESTIGATIONS	JOB No. 8082-003-70
SCALE:	DATE: February, 1977
REF:	DAMES & MOORE



COALEX PTY. LTD.

LOCATION:	WOLGAN EXTENDED COLLIERY	FIGURE A 2.2
TITLE:	SLOPE PROFILES: CATCHMENT AREAS AROUND MINE TOP	
SCALE:	0 20 40 60 80 100 m HORIZONTAL	JOB No.: 8082 - 003 - 70
	0 50 100 150 m VERTICAL	DATE: February, 1977
REF.:	DAMES & MOORE	

TABLE A2.1

WOLGAN EXTENDED COLLIERY SUB-CATCHMENT DIMENSIONS

Sub-Catchment	Area (ha)	Weighted Average Slope (%)	Max Stream Length (m)	Approx. Max. Overland Flow Dist. (m)
Potable Water Dam AA	1.3	31	178	60
Potable Water Dam BB+CC	4.3	15	420	120
Western Side Slope A	2.7	23	214	60
Western Side Slope B	1.4	24	184	60
Western Side Slope C	0.7	37	136	60
East Side Slope	12.1	26	586	120
Pit-Top Site	3.6	1	254	120
Preparation Plant Site	16.9	1	508	180

A2.2.2.2 Pit-top and Treatment Plant Sites

These will be level grassed, paved or built upon areas with a slope of between 0.1% and 1%. The maximum runoff coefficient of such surfaces should be in the range of 0.75 to 0.80. However the installation of an efficient system of surface drainage would increase this runoff coefficient. In this study, as a first approximation, a runoff coefficient of 0.85 will be applied to the pit-top and treatment plant areas.

A2.3 Estimation of Maximum Discharge Rate from the Catchment

A2.3.1 Introduction

The rational method for estimating maximum discharge rates (as presented in Waterway Calculations) involved applying the appropriate rainfall intensity figures to data on area and runoff coefficients determined for the catchment under consideration. An appropriate rainfall intensity is that for a storm of a duration equivalent to the minimum time of concentration estimated for the catchment and for the recurrence interval (frequency) determined by the design safety factor required.

A2.3.2 Time of Concentration

The time of concentration is the minimum time required from the beginning of any rainfall event for water from all parts of a catchment area to be flowing past the discharge point at the same moment. It is the sum of the maximum stream flow time and maximum overland flow time.

A2.3.2.1 Chezy's Number

This is the parameter used in estimating the velocity of water flow over a surface and is given by the equation:

$$ch = \frac{1}{n} (R)^{1/6}$$

where ch is Chezy's number
 n is the roughness coefficient of the surface
 R is the hydraulic radius of the stream ($R = \frac{\text{Waterway Area}}{\text{Wetted Perimeter}}$)

For a shallow mountain stream the values of n and R are 0.04 and 0.3 respectively (Ref: Waterway Calculations). Thus for the slope areas:

$$\begin{aligned} ch &= \frac{1}{0.04} (0.3)^{1/6} \\ &= 20.24 \\ &\approx 20 \end{aligned}$$

For the surface drainage structures take n as 0.013 and R as 0.3. Thus

$$\begin{aligned} ch &= 62.94 \\ &\approx 63 \end{aligned}$$

A2.3.2.2 Initial Approximation: Maximum Stream Flow Time of Concentration (Ta)

This may be calculated using the formula

$$T_a = \frac{L}{v \times 60} \quad (\text{mins})$$

where L is the length of the stream (m)
 v is the velocity of the stream (m sec^{-1})

For a small mountain stream v should be between 0.75 and 1.50 m sec^{-1} where the slope is greater than 17% and between 0.20 and 0.45 m sec^{-1} when the slope is less than 5%. (Ref: Waterway Calculations). Values for Ta are presented in Table 2.2 using $v = 1.50 \text{ m sec}^{-1}$ for the slopes and $v = 0.45 \text{ m sec}^{-1}$ for the level areas.

A2.3.2.3 Maximum Stream Flow Time of Concentration Calculated by Friend's Equation

Friend's Equation:

$$T = \frac{858}{ch (CFyKS)^{0.15}} \times \frac{L}{M^{0.1} H^{0.4}}$$

where

T is time of concentration (mins)

ch is Chezy's number

L is the length of stream (m)

C is the runoff coefficient

Fy is the frequency factor for a recurrence interval of y years

K is the rainfall factor for a given location

S is the shape factor which allows for the effect of catchment shape on time of concentration

M is the catchment area (km²)

H is the weighted average slope (%)

Values of Fy and K were obtained by the method given in 'Australian Rainfall and Runoff'. For the Wolgan area the value Fy (for a return period of 50 years) is 2.9 and K is 15.5 (Ref. Waterway Calculations). The shape factor will be taken as 1.0 because of the small sub-catchment areas involved.

Thus for sub-catchment areas with a runoff coefficient of 0.95 and Chezy's number of 20

$$\begin{aligned} T &= \frac{858}{20 (.95 \times 2.9 \times 15.5 \times 1.0)^{0.15}} \times \frac{L}{M^{0.1} H^{0.4}} \\ &= 24.43 \times \frac{L}{M^{0.1} H^{0.4}} \end{aligned}$$

and where the runoff coefficient is 0.85 and Chezy's number 63

$$T = 7.99 \times \frac{L}{M^{0.1} H^{0.4}}$$

Values of maximum stream flow time of concentration, calculated for all sub-catchment areas are presented in table A2.2.

A2.3.2.4 Overland Flow Time

This has been estimated using Figure 12 in the reference 'Waterway Calculations'. Values are presented in Table A2.2.

A2.3.2.5 Total Time of Concentration

The times of concentration for the sub-catchments which discharge into the potable water storage dam overflow channel range from 9 to 15 mins. Thus use of minimum storm duration of 6 minutes should provide a sufficiently conservative estimate of maximum discharge rate through the overflow channel. Discharge from the treatment plant area does not flow through the overflow channel so will not be treated further here, but instead will be examined in the colliery water flow section.

A2.3.3 Rainfall Intensity-Frequency-Duration

There are no pluviograph records available for the Wolgan region from which a Rainfall Intensity-Frequency-Duration table can be derived, therefore the method given in 'Australian Rainfall and Runoff' will be used.

The rainfall intensity for a given frequency and duration is obtained from the equation:

$$I_{oy} = \frac{25 Fy \cdot K}{(t+5)^m}$$

where

I_{oy} is the maximum rainfall intensity at a point 0 for a recurrence interval (frequency) of y years.

Fy is the frequency factor for recurrence interval y years.

K is the rainfall factor for a given location

t is the storm duration in mins

m is an index dependent on locality.

TABLE A2.2

Estimated Time of Concentration (mins)

Sub-catchment	Max Stream Length	Stream Crude Est.	Flow Time Friend's Eq.	Approx Max Distance Overland Flow (m)	Approx Overland Flow Time (mins)	Approx Total Time of Conc. (mins)
Potable Water Dam AA	178	2.0	1.7	60	8	10
Potable Water Dam BB+CC	420	4.7	4.8	120	10	15
West'n Side Slopes A	214	2.4	2.2	60	8	10
West'n Side Slopes B	184	2.0	1.9	60	8	10
West'n Side Slopes C	136	1.5	1.3	60	8	9
East Side Slope	586	6.5	4.8	120	10	15
Pit-Top Site	254	9.4	2.9	120	11	14
Preparation Plant Site	508	18.8	4.9	180	17	22

Recurrence intervals of 20 and 50 years will be used in the following calculations. These should provide an adequately conservative estimate of maximum discharge rate for a small catchment. For the Wolgan region the relevant parameters obtained from 'Waterway Calculations' are:

$$F_{20} = 2.4 \text{ (20 year recurrence)}$$

$$F_{50} = 2.9 \text{ (50 year recurrence)}$$

$$K = 15.5$$

$$m = 0.68$$

Rainfall intensities calculated using these values are presented in Table A2.3. For small catchment areas the area average rainfall intensity I_{av} is taken as being equal to I_{oy} .

TABLE A2.3

Rainfall Intensity-Frequency-Duration at Wolgan. Calculated using method in Aust Rainfall & Runoff, 1958

Frequency (Recurrence Interval in years)	Intensity (mm hr ⁻¹)		
	6 (mins)	30 (mins)	60 (mins)
20	182.1	82.9	54.4
50	220.1	100.2	65.7

A2.3.4 Maximum Discharge Rate from Wolgan Extended Colliery Catchment Area

The catchment discharge rate is given by the equation

$$Q = 2.78 \times 10^{-3} CI_{av}M \text{ (m}^3\text{sec}^{-1}\text{)}$$

for a maximum intensity, 20 year recurrence, 6 minute duration storm

$$I_{av} = 182.1 \text{ mm/hr}$$

assuming a runoff coefficient (c) of 0.95 then

$$Q_{20} = 2.78 \times 10^{-3} \times 0.95 \times 182.1 \times M$$

$$= 0.481 \times M \quad (\text{m}^3 \text{sec}^{-1})$$

and for a 50 year recurrence interval where $I_{av} = 220.1$

$$Q_{50} = 0.581 \times M \quad (\text{m}^3 \text{sec}^{-1})$$

For the pit-top and treatment plant areas where the runoff coefficient is 0.85 the discharge rates are given by

$$Q_{20} = 0.430 \times M \quad (\text{m}^3 \text{sec}^{-1})$$

and

$$Q_{50} = 0.520 \times M \quad (\text{m}^3 \text{sec}^{-1})$$

The estimated discharge rates for each sub-catchment are presented in Table A2.4.

TABLE A2.4

Maximum discharge rates for Wolgan Colliery Sub-catchments

Sub-catchment	Area (ha)	Q_{20} ($\text{m}^3 \text{sec}^{-1}$)	Q_{50} ($\text{m}^3 \text{sec}^{-1}$)
East Side Slope	12.1	5.8	7.0
Potable Water Dam AA	1.3	0.6	0.8
Potable Water Dam BB + CC	4.3	2.1	2.5
West'n Side Slope A	2.7	1.3	1.6
West'n Side Slope B	1.4	0.7	0.8
West'n Side Slope C	0.7	0.3	0.4
Pit-Top Site	3.6	1.5	1.9
Total Contributing to Overflow Channel & Conduit	26.1	12.3	15.0
Treatment Plant Site	16.9	7.2	8.8
Overall Total	43.0	19.1	23.3

A2.4 Discharge Through the Overflow Channel and Conduit

A2.4.1 Introduction

It is proposed that a channel will be constructed around the west side of the pit-top site to conduct overflow from the potable water storage dam, as well as runoff from the pit-top and surrounding slopes, to the main water storage dam. The channel will pass into a large closed conduit running down the slope from the pit-top site to the main storage dam. The channel and conduit will have to be designed to cope with the maximum probable discharge rates calculated in the previous section. For the maximum 50 year storm the peak discharge rate has been estimated as $15.0 \text{ m}^3\text{sec}^{-1}$.

A2.4.2 Diameter of Overflow Conduit

The location of the conduit is shown in Fig. A2.1 as the section marked D to D'. The pipe length is about 100 m and the slope ($\frac{\text{height diff}}{\text{length}}$) is 0.20.

A2.4.2.1 First Approximation for Conduit Diameter using Talbots Formula (Ref Waterway's Calculations)

Talbots Formula: $W = 0.183 \text{ CM}^{3/4}$

where W is waterway area in m^2
 C is runoff coefficient
 M is catchment area in hectares

Thus given a catchment area of 26.1 ha and runoff coefficient of 0.95 the approximate waterway area required is

$$\begin{aligned} W &= 0.183 \times 0.95 \times (26.1)^{3/4} \\ &= 2.01 \text{ m}^2 \end{aligned}$$

which gives a pipe diameter of 1.60 m

A2.4.2.2 More Precise Estimate of Conduit Diameter

The discharge rate of a full pipe may be calculated by the following equation (Sellin, 1969)

$$Q_f = \frac{D^{8/3} s^{1/2}}{3.21n}$$

where Q_f is the discharge rate for a full pipe ($m^3 sec^{-1}$)
 D is the diameter of the pipe (m)
 s is the slope of the pipe (ht. diff/length)
 n is the roughness coefficient of the pipe

Rearranging the above equation

$$D = (3.21n Q_f / s^{0.5})^{0.375}$$

Thus for a full pipe discharge rate of $14.5 m^3 sec^{-1}$ where $n = 0.013$ and $S = 0.20$ the diameter required is

$$\begin{aligned} D &= (3.21 \times 0.013 \times 14.5) / (0.20)^{0.5} \quad 0.375 \\ &= 1.12 \text{ m} \end{aligned}$$

The results of these calculations suggest that the conduit diameter should lie between a minimum of 1.15 m (say 1.20 m) and 1.6 m.

A2.4.3 Size and Capacity of Overflow Channel

A preliminary estimate of the size of the overflow channel will be made assuming that each sub-catchment discharges its entire outflow into the overflow channel at a single point. The size of waterway sufficient to cope with the 50 year peak discharge rate at each inlet point is calculated below. The calculations are for an open channel with semi-circular cross-section flowing at bank-full condition.

The width ($D_{1/2}$) of such a channel is obtained using an equation derived from that used in section A2.4.2.2.

$$D_{1/2} = (6.42n Q/S^{0.5})^{0.375} \quad (\text{m})$$

and similarly water way area ($W_{1/2}$) is given by

$$W_{1/2} = \frac{\pi}{2} (D_{1/2}/2)^2 \quad (\text{m}^2)$$

The sizes of the inlet channels and overflow channel segments are presented in Table A2.5 and the schematic diagram in Figure A2.3 illustrates the layout assumed for the purpose of these preliminary calculations. As noted previously the channel has been taken as being semi-circular thus the width at any point is twice the channel depth. The size of the channel at any point is a function of discharge rate and channel slope. Below the pit-top site the slope increases sharply. The channel width decreases over this section to connect with the circular conduit which carries the discharge water to the main storage dam. For a 20% slope a conduit diameter of 1.2 m would be the minimum sufficient to cope with the estimated maximum discharge rate.

A2.5 Conclusions

The object of this study has been to provide preliminary figures to aid in the design of the main drainage structures at the pit-top site. Because of the limited data available the aim has been to provide some conservative over-estimation of the size of the structures to provide an adequate margin of safety. As the design progresses further and more data becomes available the estimates should be revised to provide more cost-effective structures.

Careful management of on-site storage and drainage structures can minimise the amount of overflow from the main storage dam during periods of intense rainfall and reduce the amount of water which needs to be pumped from the Wolgan River during prolonged dry periods. A rough estimate of catchment yield can be made using some of the data obtained in the present study. However implementation of any catchment management program would require a more detailed on-site investigation.

RUNOFF EAST SIDE SLOPE

RUNOFF POTABLE WATER DAM CATCHMENT

COLLECTION DAM

POTABLE WATER DAM

NOTES

- ① Open channel, semi-circular, width 1.6, depth 0.8, slope 0.025
- ② Open channel, semi-circular, width 2.7, depth 1.35, slope 0.004
- ③ Open channel, semi-circular, width 1.3, depth 0.65, slope 0.004
- ④ Open channel, semi-circular, width 2.8, depth 1.4, slope 0.004
- ⑤ Open channel, semi-circular, width 1.0, depth 0.5, slope 0.004
- ⑥ Open channel, semi-circular, width 2.9, depth 1.45, slope 0.004
- ⑦ Open channel, semi-circular, width 0.8, depth 0.4, slope 0.004
- ⑧ Open channel, semi-circular, width 2.9, depth 1.45, slope 0.004
- ⑨ Open channel, semi-circular, width 1.4, depth 0.7, slope 0.004
- ⑩ Open channel, semi-circular, width 3.1 reducing to 1.5, depth 1.55 reducing to 0.75, slope 0.004
- ⑪ Closed conduit, circular cross-section, diameter 1.2, slope 0.20

RUNOFF PIT TOP SITE

③ RUNOFF SLOPE A

⑤ RUNOFF SLOPE B

⑦ RUNOFF SLOPE C

MAIN STORAGE DAM

COALEX PTY. LTD.

LOCATION: WOLGAN EXTENDED COLLIERY
TITLE: SCHEMATIC OF OVERFLOW CHANNEL LAYOUT

JOB No.: 8082 - 003 - 70

FIGURE A 2.3

DATE: February, 1977

DAMES & MOORE

TABLE A2.5

Cumulative discharge and waterway size at each inlet point on overflow channel

Inlet Point	Contributing Sub-catchment/ Source	Discharge into Inlet Point Q_{50} ($m^3 sec^{-1}$)	Cumulative Discharge Q_{50} ($m^3 sec^{-1}$)	Inlet		Overflow Channel	
				$D_{1/2}$ (m)	W_a (m^2)	$D_{1/2}$ (m)	W_a (m^2)
(1)	Potable Water Dam Overflow (East Side Slope + Pot. Water Dam Slopes)	10.3	10.3	2.7	2.8	2.7	2.8
(2)	West Side Slope A	1.6	11.9	1.3	0.7	2.8	3.2
(3)	West Side Slope B	0.8	12.7	1.0	0.4	2.9	3.3
(4)	West Side Slope C	0.4	13.1	0.8	0.2	2.9	3.4
(5)	Pit-top Site	1.9	15.0	1.4	0.8	3.1	3.78
	East Side Slope (From diversion dam to Pot Dam)	7.0		1.6	1.0		
	Channel at Conduit Inlet	15.0		1.5	0.9		

APPENDIX A3

Distribution of those plant species which were positively identified to generic level. The numbers signify percent cover of a species in the sample transect (0.1 ha); a + signifies cover of less than 1%.

SPECIES	TRANSECT																				
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	20	21	
ADIANTACEAE																					
Adiantum sp.																					+
BLECHNACEAE																					
Blechnum cf nudum									45								+	+			
DENNSTAEDTIACEAE																					
Pteridium esculentum	+	98				+			45			+					+	1	+	3	
GLEICHENIACEAE																					
Gleichenia cf dicarpa												2									+
LINDSAEACEAE																					
Lindsaea sp.									+	+											+
CUPRESSACEAE																					
Callitris endlicheri												2									1
CYPERACEAE																					
Caustis flexuosa				+	+	1				+			+	+							
Lepidosperma laterale											1		1	+							+
Lepidosperma lineare																					+
Lepidosperma sp.																					+
Gahnia microstachya	+		+			+	+									+					
Gahnia sieberana					+																1
Schoenus melanostachys										+							+			+	+
GRAMINEAE																					
Avena sp									+						+	+	+	+			
Entolasia stricta				+	+	+	+	+	+	1	+	+		+	+	+	+			1	+
HAEMODORACEAE																					
Haemodorum planifolium						+															

APPENDIX A3 Continued

SPECIES	TRANSECT																				
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	20	21	
IRIDACEAE																					
<i>Patersonia Sericea</i>							1	+		+		+	+	+	+		+	+	+		
LILIACEAE																					
<i>Dianella caerulea</i>			1	+		1	+	+		+						+		+	+		
<i>Geitonoplesium cymosum</i>										+											
<i>Stypandra glauca</i>						+				+											
XANTHORRHOEACEAE																					
<i>Lomandra filifolia</i>																			+		
<i>Lomandra longifolia</i>	+				+				+			+				+	+			2	
<i>Xanthorrhoea cf media</i>	5							+			+	+	+	+							
ARALIACEAE																					
<i>Polyscias sambucifolia</i>		1	+			+										+					
CAMPANULACEAE																					
<i>Wahlenbergia sp.</i>								+	+			+					+	+			
CASUARINACEAE																					
<i>Casuarina littoralis</i>										+											
<i>Casuarina nana</i>											5									30	
COMPOSITAE																					
<i>Cassinia aureonitens</i>			1	+								+								+	
<i>Helichrysum leucopsidium</i>						+													+		
<i>Lagenophora stipitata</i>		+						+	+							+	+	+			
CONVOLVULACEAE																					
<i>Cuscuta australis</i>											+									+	
<i>Dichondra repens</i>		+														+	+				
DILLENIACEAE																					
<i>Hibbertia obtusifolia</i>																			+		
<i>Hibbertia serpyllifolia</i>	1									1					+	+		+			
DROSERACEAE																					
<i>Drosera sp.</i>					1																

APPENDIX A3 Continued

SPECIES	TRANSECTS																					
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	20	21		
ELAEOCARPACEAE																						
<i>Elaeocarpus reticulatus</i>									1													
EPACRIDACEAE																						
<i>Epacris pulchella</i>					1																	
<i>Epacris purpurescens</i>																+						
<i>Leucopogon juniperinns</i>								+														
<i>Leucopogon lanceolatus</i>						+	1		+								+		2	+		
<i>Leucopogon microphyllus</i>			2	+							+										2	
<i>Leucopogon muticus</i>																					+	
<i>Leucopogon setiger</i>												3		+	1	+			+		+	
<i>Monotoca scoparia</i>	2			+		+	1			+		+	+									
<i>Woolsia pungens</i>																					+	
EUPHORBIACEAE																						
<i>Poranthera microphylla</i>						+	+														+	
GOODENIACEAE																						
<i>Dampiera stricta</i>					+							+	+	+	+	+	+		1			
<i>Goodenia sp.</i>					+	+										+	+					
<i>Goodenia bellidifolia</i>	+																					
HALORAGACEAE																						
<i>Haloragis micrantha</i>					+																	
<i>Haloragis tetragyna</i>			+	+	+	1	+			+	+					+					+	
LABIATAE																						
<i>Prostanthera linearis</i>																						+
<i>Stachys arvensis</i>									+													

APPENDIX A3 Continued

SPECIES	TRANSECTS																				
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	20	21	
LEGUMINOSAE																					
<i>Acacia botrycephala</i>	5		+	+	5	+	+			+		3	+	+	+	+	+			1	
<i>Acacia cyanophylla</i>	+								+					+							
<i>Acacia kybeanensis</i>																					+
<i>Acacia longifolia</i>																		+			
<i>Acacia maidenii</i>			2	1	+		+	+	+			5		+							
<i>Acacia ulicifolia</i>							+	+		+			+	+	+	+	+				
<i>Bossiaea heterophylla</i>															+						
<i>Bossiaea lenticularis</i>																		1			
<i>Bossiaea obcordata</i>	10	+	2			40	30			3			15	5	5	+		+	+		
<i>Bossiaea scolopendria</i>	+																				
<i>Daviesia latifolia</i>																+	+	+			
<i>Dillwynia phyllicoides</i>						5				2					+						
<i>Dillwynia retorta</i>							1					2	1	+		+	+				
<i>Dillwynia sericea</i>																					+
<i>Gompholobium virgatum</i>	10			+						2			1	+	+						
<i>Hardenbergia violaceae</i>	+								+										+		
<i>Indigofera australis</i>									+												
<i>Oxylobium ilicifolium</i>	30			5	+	2	+	+		1											10
<i>Phyllota squarrosa</i>	25												+	+	10		1	+			
<i>Platylobium formosum</i>		+			+										+						
<i>Pultenea scabra</i>				+	+			+		+											
LOBELIACEAE																					
<i>Lobelia gracilis</i>	+					+	+														
LOGANIACEAE																					
<i>Mitrasacme paludosa</i>																					+

APPENDIX A3 Continued

SPECIES	TRANSECTS																				
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	20	21	
MYRTACEAE																				15	
Baeckea utilis																					
Baeckea linifolia					5											1					
Callistemon citrinus					1	+															
Eucalyptus deanei								+	10							10	3		10		
Eucalyptus gummifera						10	5	+		+											
Eucalyptus haemastoma								+					20	15	3	1	1				
Eucalyptus oblonga	20	10	5	10	5		20			8		20	1	3	2	2	1	2	5		
Eucalyptus piperita	10				+	20	10					5						10			
Eucalyptus urceolaris							+														
Leptospermum arachnoides																				1	
Leptospermum attenuatum			15	15								+	+			+			+	15	
Leptospermum brevipes					1	5				8		1			2				10		
Leptospermum flavescens			1						+	5		+	1	+		1	2				
Leptospermum juniperinum			1	6							35							+			
Leptospermum lanigerum					10											1	+				
Leptospermum scoparium											10										
Micromyrtus ciliata														+							
PITTOSPORACEAE																					
Billardiera scandens		+	+			+	+					+	+		+	+	+		+		
PROTEACEAE																					
Banksia asplenifolia			1																		
Banksia ericifolia											+										
Banksia marginata																8					
Banksia serrata										+				1							
Grevillea laurifolia	+																		+		
Grevillea sericea													5	+	1				+		
Hakea dactyloides			+								+									+	
Hakea salicifolia												1	1	+	1	1	1				
Isopogon anemonifolius					+					+			3	2	+						
Isopogon anethifolius											5										
Lomatia silaifolia	1		+	+	+	+	+			+		+	+	+	+	+		1	2		

APPENDIX A3 Continued

SPECIES	TRANSECTS																				
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	20	21	
PROTEACEAE - Continued																					
<i>Persoonia acerosa</i>				+																	
<i>Persoonia chamaepitys</i>	+		+				+														
<i>Persoonia lanceolata</i>												+	+		+						
<i>Persoonia laurina</i>							1					+									
<i>Persoonia levis</i>	+			+	+	+				+		+	1	+	1	+					
<i>Persoonia linearis</i>					+	1	2	+	+	+		+				+				+	
<i>Petrophile fucifolia</i>	+													+	+						
<i>Petrophile sessilis</i>					+					+						+					
RANUNCULACEAE																					
<i>Clematis aristata</i>		2								+						+				+	
RHAMNACEAE																					
<i>Pomaderris</i> sp.			+	1		+				+		+		1		+	+				
RUBIACEAE																					
<i>Galium australe</i>		+	+							+											
<i>Pomax umbellata</i>				+			+	+		+										+	
RUTACEAE																					
<i>Boronia ledifolia</i>												1									
<i>Boronia microphylla</i>	1				+	+	+			+											
<i>Boronia mollis</i>												+	+								
<i>Boronia pinnata</i>														+					+		
<i>Ziera pilosa</i>											+										+
SANTALACEAE																					
<i>Amperea xiphoclada</i>							+														
<i>Choretrum candollei</i>	+			2		+		+							+					+	
<i>Leptomeria acida</i>							+	+				+				+	+			+	
<i>Omphacomeria acerba</i>														5							

APPENDIX A3 Continued

SPECIES	TRANSECTS																				
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	20	21	
STACKHOUSIACEAE																					
<i>Stackhousia viminea</i>																					+
STYLIDIACEAE																					
<i>Stylidium graminifolium</i>			+	+	+		+			+		+		+		+					+
<i>Stylidium lineare</i> (?)											1										+
THYMELAEACEAE																					
<i>Pimelea glauca</i>	1		+	1	+	+				+		+	+	1	+	+	+				
TREMADRACEAE																					
<i>Tetratheca ericifolia</i>	1			2											+	+					
UMBELLIFERAE																					
<i>Actinotus minor</i>							+			+			+								
<i>Hydrocotyle acutilobium</i>		2			+																
<i>Platysace lanceolata</i>			+	2		+	1			+		+					+	+			
<i>Platysace linifolia</i>													5	2	1					+	
<i>Xanthosia atkinsoniana</i>	10												+	+	+					+	
<i>Xanthosia pilosa</i>			+	+						+		+	+							+	
<i>Xanthosia tridentata</i>																					+
VIOLACEAE																					
<i>Hybanthus vernonii</i>	+																				

APPENDIX A 4

Distribution of bird species recorded within Wolgan survey area. The expected number of species per habitat is a value derived from observations in similar habitats outside of the survey area.

Species	Habitat Type ^{a, b}						Comments
	1	2	3	4	5	6	
Peregrine falcon, <i>Falco peregrinus</i>	P	P		P			R
Gang-gang cockatoo, <i>Callocephallon fimbriatum</i>		P		P	P	A	R
King parrot, <i>Alisterus scapularis</i>				P	A	P	R, Y
Crimson rosella, <i>Platycercus elegans</i>	P			P	P	A	R
Eastern rosella, <i>Platycercus eximius</i>				P	+		R
Fan-tailed cuckoo, <i>Cuculus pyrrhophanus</i>		P		+	P	P	
Horsefield's bronze cuckoo, <i>Chrysococcyx basalis</i>				P	+	+	Y
Boobook owl, <i>Ninox novaeseelandiae</i>		+		P	P	P	R

a See Table 8 for descriptions of animal habitats.

b Symbols: P = species present; one or two birds observed.

R = a breeding resident present most or whole of the year. All other species listed probably breed on the site.

A = species abundant in habitat, ie, either two breeding pairs, or frequently observed, or family groups.

Y = birds feeding young out of nest.

+ = species regularly recorded in similar habitat elsewhere in the region, but not observed in the habitat at the Wolgan site.

N = nest(s) located.

* = species observed in similar habitat in the adjacent south-flowing gully.

c Near stream.

APPENDIX A4 Continued

Species	Habitat Type ^{a, b}						Comments
	1	2	3	4	5	6	
Barking owl, <i>Ninox connivens</i>					P	+	R
Laughing kookaburra, <i>Dacelo gigas</i>				P	A	P	R
Superb lyrebird, <i>Menura novaehollandiae</i>				P	P	P	
Welcome swallow, <i>Hirundo neoxena</i>				P		+	
Black-faced cuckoo-shrike, <i>Coracina novaehollandiae</i>				P	+		
Flame robin, <i>Petroica phoenicea</i>		P		P	+	+	R
Scarlet robin, <i>Petroica multicolor</i>		+		P	+		R
Eastern yellow robin, <i>Eopsaltria australis</i>		P		P	P		R
Crested shrike-tit, <i>Falconculus frontalis</i>				P	P		R
Rufous whistler, <i>Pachycephala rufiventris</i>		P		+	P		
Golden whistler, <i>Pachycephala pectoralis</i>		P		+	P	P	R
Grey shrike-thrush, <i>Colluricincla harmonica</i>		P		P	P	+	R
Rufous fantail, <i>Rhipidura rufifrons</i>						P	
Grey fantail, <i>Rhipidura fuliginosa</i>		P		P	P	P	N, R

APPENDIX A 4 Continued

Species	Habitat Type ^{a, b}						Comments
	1	2	3	4	5	6	
Eastern whipbird, <i>Psophodes olivaceus</i>				P	A	A	R
Superb blue wren, <i>Malurus cyaneus</i>					P*	+	R
Pilot bird, <i>Pycnoptilus floccosus</i>					P*	+	R
Rock warbler, <i>Origma solitaria</i>	P					P	R
White-browed scrub wren, <i>Sericornis frontalis</i>			+		P	A	R
Brown thornbill, <i>Acanthiza pusilla</i>		P	P		A	A	R
Striated thornbill, <i>Acanthiza lineata</i>		P		P	P	A	R
White-throated treecreeper, <i>Climacteris leucophaea</i>		P		P	P	A	R
Red-browed treecreeper, <i>Climacteris erythrope</i>				P	P*	P	R
Red wattlebird, <i>Anthochaera carunculata</i>				+	P	+	
Noisy friar bird, <i>Philemon corniculatus</i>				P	+	+	
Yellow-faced honeyeater, <i>Lichenostomus chrysops</i>				+	P	P	
Yellow-tufted honeyeater, <i>Lichenostomus melanops</i>				P	+		R
White-eared honeyeater <i>Lichenostomus leucotis</i>		+		+	+	P	R

APPENDIX A4 Continued

Species	Habitat Type ^{a, b}						Comments
	1	2	3	4	5	6	
Eastern spinebill, <i>Acanthorhynchus tenuirostris</i>		P	+		P	P	R
Spotted pardalote <i>Pardalotus punctatus</i>		+		+	P	P	N, R
Striated pardalote, <i>Pardalotus striatus</i>		+		+	P	+	R
Silvereye, <i>Zosterops lateralis</i>		+		P	P	+	R
Red-browed firetail, <i>Emblema temporalis</i>		+		A	P	P	N
Pied currawong, <i>Strepera graculina</i>		P		P	P	P	N, R
Grey currawong, <i>Strepera versicolor</i>				P	P		R
Weebill, <i>Smicornis brevirostris</i>		P			P		
Willie wagtail, <i>Rhipidura leucophrys</i>		P			P		
White-winged Chough, <i>Corcorax melanorhamphos</i>				P			
Black-backed magpie, <i>Gymnorhina tibicen</i>					P		
Yellow-tailed cockatoo, <i>Calyptorhynchus funereus</i>					P		
Sulphur-crested cockatoo, <i>Cacatua galerita</i>					P		
Tawny frogmouth, <i>Podargus strigoides</i>					P		

APPENDIX A4 Continued

Species	Habitat Type a, b						Comments
	1	2	3	4	5	6	
Spotted quail-thrush, <i>Cinclusoma punctatum</i>					P		
Brush turkey, <i>Alectura lathami</i>					P		c
Rose robin, <i>Petroica rosea</i>					P		
Raven, <i>Corvus sp.</i>					P		
Total number of species:	55						
Recorded number of species per habitat type	2	16	1	29	39	23	
Expected number of species per habitat type	2	21	3	33	39	31	

List of Additional Birds Presumed to Occur
On this Site or Similar Sites
Within the Region

(Common names only)

Wedge-tailed eagle
Nankeen kestrel
Wonga pigeon
Pallid cuckoo
White throated night-jar
Spine tailed swift
Tree martin
Satin flycatcher
Buff-rumped thornbill
Varied sittella
Brown-headed honeyeater
White-naped honeyeater
New holland honeyeater
Olive-backed oriole
Satin bower bird
Dusky woodswallow
Grey butcherbird

APPENDIX A5

WOLGAN RIVER YIELD

Gauging Stations

Location	Catchment Area km ²	Period
(a) Wolgan River at Newnes	238	1973-
(b) Wolgan River at Wolgan Gap	52	1968-
(c) Cox's River at Bathurst Road	200	1951-
(d) Cox's River at Lithgow	400	1960-

Catchment area of possible weir on Wolgan River for Coalex equals 176 km².

Wolgan River flow records are too short to be reliable for yield determinations. However, from the short period flows of six months in 1973 it appears that the unit area runoff from the Wolgan River at Newnes is approximately 80% of the unit area runoff from the Cox's River at Lithgow.

If the above is accepted then the flow at the Wolgan River weir = $\frac{0.8 \times 176}{400}$
the Cox's River at Lithgow gauge = 0.35 x Lithgow gauge.

Coalex's requirement is approximately 1.5 cusecs, ie, equivalent minimum flow of Cox's River at Lithgow = $\frac{1.5}{0.35} = 4.28$ cusecs
= 10.47 Ml/day

Flow records of the Cox's River at Lithgow are available from 1960 onwards and this period includes a severe short duration drought in 1965. There are a number of occasions when the instantaneous flow has fallen below 4.28 cusecs or 10.47 Ml/day (313 Ml/month), but the monthly flow has always been adequate. The occasions of low flow are:

	<u>Instantaneous Ml/day</u>	<u>Month Ml</u>
1973 January	9.79	1310
1970 January	10.5	4610
1969 January	1.22	438
February	0.98	3700
1968 November	1.22	370
December	2.94	585

APPENDIX A5 (continued)

	<u>Instantaneous Ml/day</u>	<u>Month Ml</u>
1967 Decmeber	1.71	573
1966 January	9.79	624
February	9.79	614
196 February	6.85	477
March	6.12	415
1962 September	1.3	4300

It is suggested that reliance should not be placed on run-of-river flows. Depending on the degree of importance of this water supply and the conservatism that should be adopted, a small storage should be provided.

In addition, rainfall-runoff modelling of flows at Lithgow was made to cover the period 1890-1960. This would indicate smaller flows than experienced in the period of records 1960 onwards.

AGENCIES CONTACTED

Bureau of Meteorology

Joint Coal Board

Mine Department of NSW

National Parks & Wildlife Service

Planning & Environment Commission

State Pollution Control Commission

PRIMARY INVESTIGATORS

A.P. Campbell	M.Sc	Principal-in-Charge, Meteorologist
J.A. Hemmett	B.A.	Project Manager, Applied Earth Scientist
B.L. Rice	Ph.D	Plant Ecologist
J.P. McNamara	B.Sc, M.App.Sc	Water Chemist
J. Kamminga	B.A. (hons)	Archaeologist
W. Rohen-Jones	B.Agric.Sc	Zoologist
J. Edser	B.Sc	Zoologist
J. Herrington	B.Eng, M.Eng.Sc	Applied Earth Scientist

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Proposed Wolgan extended colliery
for Coalex Pty Ltd

