Baal Bone Colliery : environmental impact statement

COALEX PTY. LTD.

BAAL BONE COLLIERY

ENVIRONMENTAL REPORTS

MAY, 1981

PREPARED BY: NEXUS ENVIRONMENTAL STUDIES

BAAL BONE COLLIERY

ENVIRONMENTAL IMPACT STATEMENT

SUPPLEMENTARY TECHNICAL REPORTS

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FOREWORD

This "Environmental Reports" volume contains the written submissions completed by specialist sub-consultants from the Nexus Environmental Studies study team.

At the commencement of the work programme associated with the Environmental Impact Statement the specialist sub-consultants were issued with briefs to undertake studies and prepare reports on specific environmental issues pertaining to the proposed Baal Bone Colliery development envisaged by Coalex Pty. Ltd. in 1980. The first reports were completed during July and August 1980. Since that time Coalex Pty. Ltd. has modified the proposed layout of the Colliery and incorporated a comprehensive range of environmental safeguards, resource management strategies and a rehabilitation programme into the development proposal. The recommendations of the consultants have been referred to in the formulation of these safeguards, strategies and programmes as described in the Environmental Impact Statement.

The Environmental Reports have been used also as the main base information, description and source of impact assessment in the preparation of the Environmental Impact Statement. The team members have frequently consulted with Coalex Pty. Ltd. in the course of developing these safeguards, strategies and programmes.

Several of the environmental reports were written prior to the final confirmation and adoption of safeguards and management strategies. This explains certain differences in the detail of documentation when comparing the individual reports and the final Environmental Impact Statement.

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BAAL BONE COLLIERY

PIT TOP AND MINING PROPOSAL

AT CULLEN BULLEN

ASSESSMENT OF IMPACT ON THE ACOUSTIC ENVIRONMENT

Prepared for:

COALEX PTY. LTD.

March, 1981

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1. INTRODUCTION

The purpose of this report is to provide the results and findings of an acoustical environmental impact study carried out in connection with the Proposed Baal Bone Colliery Project, by Coalex Pty. Ltd., in the Cullen Bullen District, N.S.W.

The purpose of the assessment was to reveal and report on the acoustical impact of developing a full scale colliery operation as it relates to surrounding rural and forestry lands.

The object of the assessment was to clearly establish the ambient background noise levels presently existing in the district, and to compare them with predicted noise levels during the Proposed Colliery operating periods and construction stages.

2. PREAMBLE

The Proposed Baal Bone Colliery is intended as a replacement for the existing Wallerawang Colliery. The latter is becoming less efficient as a colliery for the extraction of coal from the Lithgow Coal Seam.

It is proposed to phase out the Wallerawang Colliery as the Proposed Baal Bone Colliery is being developed. During the transition period there will be mining and associated activities based at both Wallerawang and Baal Bone.

The Proposed Baal Bone Site is located 3.5 km north-east of the Cullen Bullen township and 2 km east of the Mudgee Road. The Site lies partly in rural and forestry land, where some of the rural portion has been subjected to open cut mining and pastoral activities.

The underground mining plans have been laid out for the use of continuous miners with the possibility of introducing a long wall mining unit at a later stage.

Surface development of the Proposed Colliery, will encompass the full spectrum of mining related activities and plant. The development will be located at the northern end of the mining lease, occupying some 36 Ha and will provide for pit top, stores, office, bathhouse complex, workshop, coal preparation plant, stock pile areas, rail and road transport loading facilities.

A layout of the Baal Bone District showing the location of the Proposed Colliery and its relationship to the nearby residents, Mudgee Road and the township of Cullen Bullen is illustrated in Appendix A.

3. SUMMARY

The acoustical impact of establishing and operating a Colliery in the area known as Baal Bone has been investigated and the results presented in this report.

The district at present is mainly rural and forestry lands, where some of the rural portion has been subjected to open cut mining and pastoral activities. The Proposed Site is located 3.5 km north-east of the Cullen-Bullen township and 2 km east of the Mudgee Road. Scattered throughout the district there are a few isolated dwellings which have been established off the Mudgee Road. The area would be classified under Australian Standard AS1055 - 1978 'Noise Assessment in Residential Areas' into two main zones. These zones would be classified under categories ranging from R1.... 'areas with negligible transport', to R2.... 'areas with low density transport'.

The existing ambient noise levels measured in the district during daytime and nighttime hours are in accord with the area classification level.

We are of the opinion that the Collieries contribution to the existing acoustical climate will be free from prominent tonal and impulsive components. A predicted noise level of 43 dB(A), during operating hours compares with the measured existing acoustical amenity at the nearest residence (McMahon) of 26 dB(A) nighttime and 34 dB(A) daytime.

The normal operation of the Colliery during daytime and nighttime periods will cause an increase to the existing background noise levels at the 'McMahon Dwelling'. An increase by 17 dB(A) nighttime and 9 dB(A) daytime could be experienced.

Noise levels expected from refuse removal activities will vary throughout the project, depending upon the actual location of specific activities. Average maximum (L_{10}) noise level contributions of up to 45 dB(A) for earthmoving equipment and 47 dB(A) for trucking movements could be experienced at the McMahon residence; these levels compare to a broadband background noise level of 43 dB(A).

Noise levels generated by the transport of bulk coal from the Site and the movement of employee's vehicles to and from the Site have been analysed. The 'McMahon Dwelling' will be most effected by the activities and this mostly due to the passing of fully loaded trains. Calculated peak noise levels of 48/49 dB(A) compare against a broadband background noise level of 43 dB(A) L_{90}.

Construction activity shall be confined to daylight hours where noise generating events are concerned. There is a number of construction activities which will generate minimal noise and there is no reason from an acoustical viewpoint why they cannot proceed outside normal daylight hours. Average maximum (L_{10}) noise levels from earth moving equipment from the Site, of 39 dB(A) at the 'McMahon Dwelling' in an L_{10}/L_{90} daytime ambient of 40/34 dB(A) have been calculated.

We are of the opinion that although the Colliery will be constructed in a manner to control prominent tonal and impulsive noise components and decrease noise propogation from the Plant, the introduction of this Colliery will have a controlling acoustical effect on the McMahon Dwelling.

Due to the prevailing distances and local topography the introduction of this Colliery will have little significant acoustical effect on the other existing residents of the District.

4. MEASUREMENT TECHNIQUES

The findings presented in this report are based on the results of site inspections and precision sound level measurements carried out on equipment and activities likely to be applicable at the Proposed Baal Bone Colliery.

Measurements were taken with a Bruel and Kjaer Statistical Noise Level Analyser Type 4426 with NATA Calibrated Condenser Microphone Type 4165 with Random Incidence Correction and Precision Sound Level Meter Type 2215. The calibration of instruments was checked prior to and after measurements.

Measurement techniques were in accordance with the recommendations of the Australian Standard AS 1055 - 1978, 'Noise Assessment in Residential Areas', and the requirements of the N.S.W. State Pollution Control Commission.

Propagation losses used in this Report for the determination of noise levels at the 'McMahon Dwelling' are based on subtracting 6 dB per doubling of distance from the original noise source, together with attenuation losses due to triangular path differences across hill formations.

The resulting noise level is considered to be a realistic average between,

a. greater attenuation provided by ground absorption, upward curving defraction and other topographical influences, and

b. less attenuation due to inversion layers, thermal defraction and low velocity breeze bending and focusing the noise onto the dwellings in the district.

5. BACKGROUND NOISE LEVEL SURVEYS

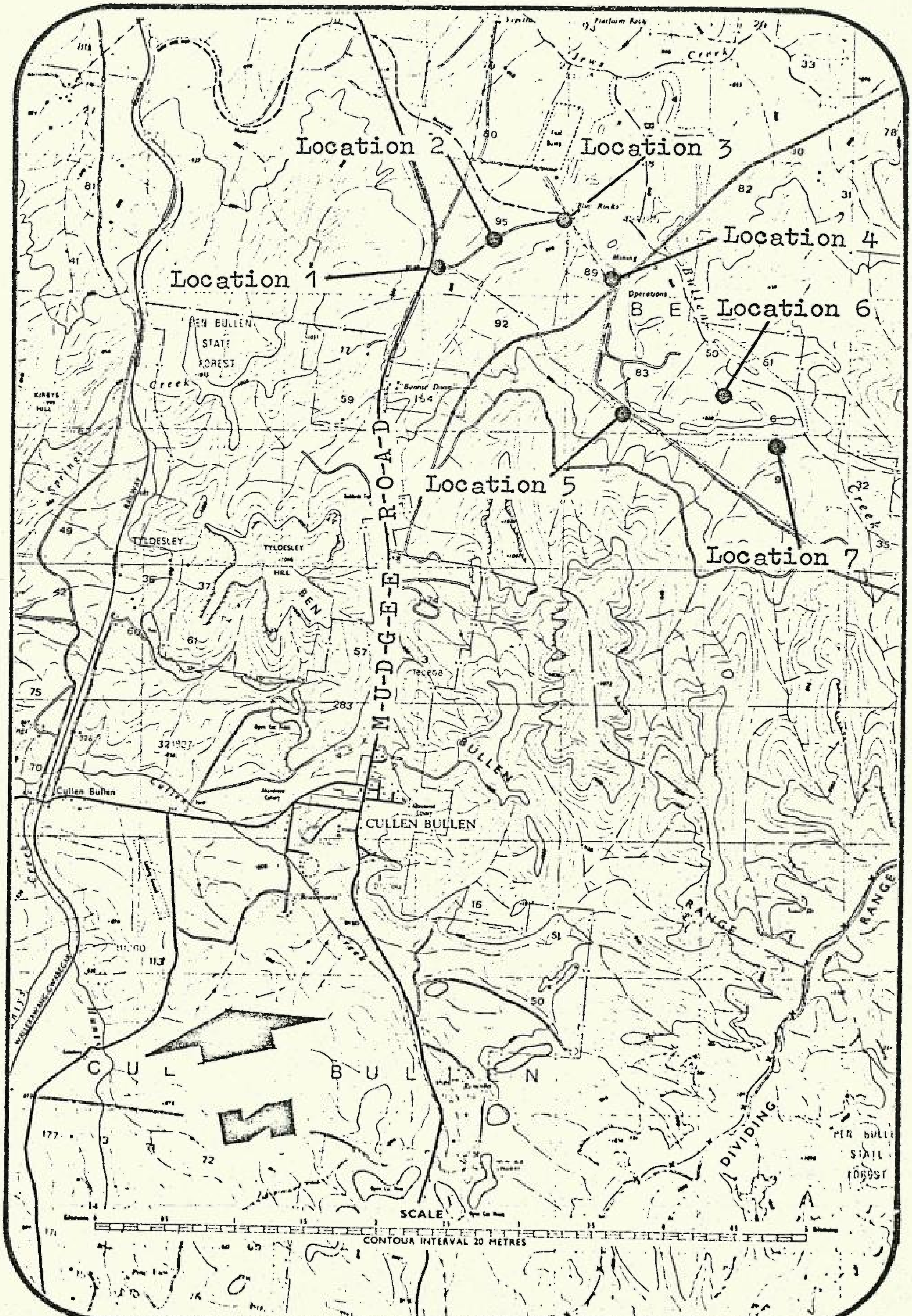
In determining the background noise level conditions that exist in the district surrounding the Proposed Colliery Development, comprehensive dB(A) Scale sound level measurements of the average mean maximum (L_{10}), average mean minimum (L_{90}) and equivalent continuous (L_{eq}) values were recorded.

The surveys were conducted between March and July 1980. Noise was measured at seven (7) selected locations and statistically analysed over minimum twenty (20) minute sample periods, during both daytime (0700 - 1800 hours) and nighttime (2200 - 0600 hours) periods, weekdays and weekends. The results have been tabulated in Appendix B.

The measurement locations selected included woodlands, open-cut mining wastelands, Mudgee Road corridor and areas in close proximity to the McMahon residence as illustrated in Figure 1.

Measurement Locations

Figure



6. EXISTING ACOUSTIC ENVIRONMENT AND SITUATION

For the purpose of acoustical assessment under Australian Standard AS1055 - 1978 'Noise Assessment in Residential Areas' properties within the valley area adjoining the Proposed Site have been broudly classified as falling into two zones as shown in Figure 2.

(a) Zone I.

The corridor of the existing Mudgee Road which is dominated by the low volume of passing traffic. This zone would be classified under AS1055 as Category R2 'Areas with low density transportation'.

(b) Zone II.

The zone/area extends for the Mudgee Road corridor into the Mountain Range. The main contributions to noise in this area are from birds, rustling trees and leaves. This area would be classified under Category R1, of the Australian Standard, 'Areas with negligible transport'.

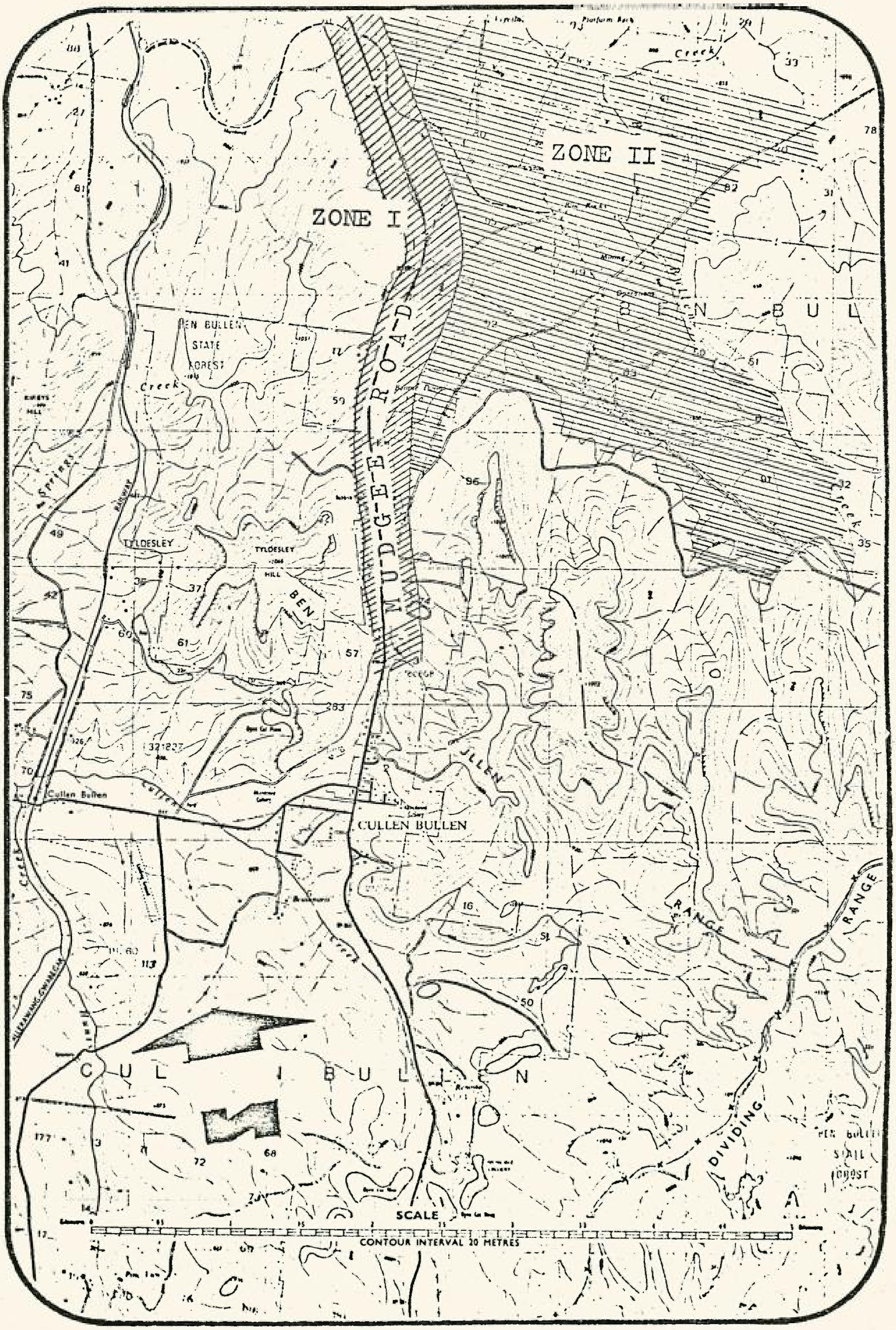
The Proposed Site is located 3.5 km north-east of the Cullen Bullen township and 2 km east of the Mudgee Road. The Site lies partly in rural and forestry land, where some of the rural has been subjected to open-cut mining and pastoral activities.

The ground topography at the Site is generally depressed with hill formations to the east, south and west which shield a number of the Dwellings from the Colliery activities.

The ground formation to the north of the Site consisting of open-cut mining wastelands (Mounds and Valleys) partly shields the colliery and its activities from the remaining rural dwellings in the immediate area. The one potentially exposed rural dwelling (McMahon) is situated to the north at approximately 1000 metres from the Colliery's surface equipment.

The McMahon Dwelling is also exposed to the Colliery's access road and rail links for approximately 2 km with the closest point at 800 metres. A plan layout of the area is shown in Fig. 3.

Existing Acoustic Enviornment Figure 2



7. PREDICTION OF NOISE EMISSIONS FROM SURFACE FACILITIES DURING PLANT OPERATION

The basic conditions for the acoustical evaluation are based on full production capacities, operating five (5) days a week over three (3) operating shifts per day (0000 hours to 2100 hours).

The predicted noise emission levels adjacent to the Proposed Colliery have been developed through the analysis of individual noise sources which will be generated from the Site, the resultant Noise Emission Contours during plant operation are shown in Appendix D. These contours compare to noise emission levels measured at nearby Collieries of similar capacity and layout.

The major items of surface development have been located at the northern end of the Site. The distance between the surface activities and the nearest resident (McMahon) is approximately 1000 metres. The Site Layout takes some advantage of shielding provided by the existing waste stockpiles left by the Lease Holders of the previous open-cut operation.

The equipment considered in predicting the operational noise levels and the environmental safeguards incorporated at this Site are:-

7.1 Conveyors

Conveyor systems used on this Site shall be of two (2) basic designs, standard Elevating Belt Conveyors and the Stockpile Tripper Belt Conveyor.

All conveyors will incorporate rubber belts and shall be partly enclosed to reduce noise emissions. Drive motors and gearboxs shall be fully enclosed in steel cladding housing.

Total noise emission from each conveyor system shall not exceed 55 dB(A) at ten (10) metres.

7.2 Breaking Station

The Breaking Station is located some five hundred and fifty (550) metres from the Material Drift entrance. The rotary breaker of eight hundred (800) tonne per hour capacity shall be housed on a portal frame clad with colour bond steel sheeting.

The Breaker will operate continuously between 0000 hours and 2100 hours.

Total noise emission from this source shall not exceed 85 dB(A) at ten (10) metres. The normal spectrum associated with this type of equipment follows:

Hz	63	125	250	500	1K	2K	4K	8K
dB	76	76	78	81	81	77	72	68

7.3 Crushing and Screening Station (Washery)

Coal will be conveyed from the Breaker to the Crushing and Screening Station. The Station will have a capacity of six hundred (600) tonne per hour, with coal being fed direct to a single deck screen and the undersize coal being directed straight to the stockpile conveyor system. The oversize coal will feed to the crushers and thence to the stockpile conveyor system. The equipment will be housed within a portal frame structure clad in colour bond steel sheeting.

This total operation will process coal continuously between 0000 hours and 2100 hours.

Total noise emission from this source shall not exceed 85 dB(A) at ten (10) metres. The normal spectrum associated with this type of equipment follows:

Hz	63	125	250	500	1K	2K	4K	8K
dB	88	81	83	80	78	78	77	75

7.4 Washing Plant

Coal will be conveyed from the Crushing and Screening Station to the Washing Plant. The coal will be processed through the Washery, with the washed coal being conveyed to the Washed Coal Tripper Conveyor, the Middlings conveyed to the Middlings Stockpile and the Refuse conveyed to the Refuse Holding Bin.

The steel cladded Washery will have a capacity of two hundred (200) tonne per hour it will operate continuously between 0700 hours and 2100 hours.

Total noise emission from the Washery shall not exceed 85 dB(A) at ten (10) metres. The normal spectrum associated with this type of equipment follows:

Hz	63	125	250	500	1K	2K	4K	8K
dB	86	83	83	82	79	78	71	55

7.5 Ventilation Shaft

The ventilation of the mine will be provided by the installation of two vent shafts, located to the north and south of the two (2) drifts. Two (2) fans will be run in parallel to provide up to 230 m^3/sec of air to 1.7pa.

Total noise emission from each fan shall not exceed 70 dB(A) at ten (10) metres. The normal spectrum associated with this type of equipment follows:

Hz	63	125	250	500	1K	2K	4K	8K
dB	58	61	63	68	65	63	61	59

7.6 Auxillary Equipment

The remaining surface facilities consisting of Administration, Bathhouse, Workshop and Sub-Station have no significant acoustical value compared to major items that have been analysed.

7.7 Impact

We are of the opinion that the Collieries contribution to the existing acoustical climate will be free from prominent tonal and impulsive components. A predicted ambient noise level of 43 dB(A) during operating hours compares with the measured existing acoustical amenity at the nearest residence (McMahon) of 26 dB(A) nighttime and 34 dB(A) daytime.

The normal operation of the Colliery during daytime and nighttime periods will cause an increase to the existing background noise levels at the 'McMahon Dwelling'. An increase by 17 dB(A) nighttime and 9 dB(A) daytime could be experienced. The introduction of the Colliery will have a marked acoustical effect on the 'McMahon Dwelling'.

8. PREDICTION OF TRAFFIC NOISE DURING OPERATION

The environmental impacts of traffic movements to and from the site fall into three categories:- road freight, rail freight and employees' vehicles.

8.1 Road Freight

Access to the 'Pit Top' will be via an all weather two lane heavy duty sealed road running in a South-East direction from the Mudgee Road. The road will be approximately three (3) kilometers long and will be the sole means of access during the construction phase and the initial term of routine operation.

During the initial routine operation coal will be road freighted to the Wallerawang Colliery for processing. It is proposed to use twenty-five (25) tonne trucks up to fifteen (15) hours per day, five (5) days a week. The number of truck trips per day will be approximately three hundred and twenty (320) to and from the Wallerawang Colliery, an estimated nine (9) trucks will be involved.

Calculated noise levels at the 'McMahon Dwelling' generated by truck movements along the access road are tabulated below. These values can be compared to the broad-band background noise level contributing 43 dB(A) L_{90} from the pit top facilities.

Situation	dB(A)		
	L_{10}	L_{eq}	L_{90}
Bulk freight 25 trucks/hour	43	34	-

8.2 Rail Freight

A rail spur link and loop will be constructed to freight processed coal from the site, it is anticipated that this system will be commissioned in 1984. The spur link from the main Wallerawang-Gwabegar rail line will run parallel to the access road for approximately two (2) kilometers and then into the loop.

The rail link operation depends on the Public Transport Commission (PTC) who require coal to be available for loading twenty-four (24) hours per day, seven days a week. With sea freight commitments and timetables it is understood that rail movement from Baal Bone will be over four (4) consecutive days in every ten (10) days.

It is understood that the PTC will use unit trains consisting of two (2) - 48 class diesel locomotives pulling forty (40) CTS - 56T or thirty-one (31) CHS - 76T, waggons.

Noise level measurements of fully loaded trains used in this report as the basis for calculating noise impact are as follows:

2 - 48 class diesel locomotives pulling twenty (20) loaded CHS waggons of 1500 tonnes total capacity at approximately 5-6 km per hour.

73dB(A) at 50 metres with the following octave spectrum:

Hz	63	125	250	500	1K	2K	4K	8K
dB	86	74	73	73	68	62	54	45

The locomotive noise emission level is expected to increase by 3 dB(A) hauling thirty-one (31) loaded CHS waggons of 2400 tonnes total capacity.

Applying these measured noise levels to the Cullen Bullen District and in particular the 'McMahon Dwelling' a calculated maximum noise level of 49 dB(A) for rail movement against a 43 dB(A) background noise level could be expected.

8.3 Employee Vehicles

The noise generated by employees motor vehicles entering and leaving the site at the change of a shift is a potential noise source affecting the 'McMahon Dwelling'.

There will be four shift (4) changes per day (0000, 7000, 1400, 2100 hours). It has been estimated that up to one and hundred and sixty (160) car movements could occur over a one hour period at the change of shift.

Calculated noise impacts at the 'McMahon Dwelling' are tabulated below and can be compared to a daytime and nighttime background noise level of 43 dB(A).

Situation	dB(A)		
	L_{10}	L_{eq}	L_{90}
Shift Change 160 cars/hour	40	36	-

8.4 Impact

Noise levels generated by the transport of bulk coal from the site and the movement of employee's vehicles to and from the site have been analysed. The 'McMahon Dwelling' will be most affected by the activities and this mostly due to the passing of fully loaded trains. Calculated peak noise levels of 48/49 dB(A) compare a background noise level of 43 dB(A) L_{90}.

The rail line is exposed to the 'McMahon Dwelling' for a distance of approximately 2 km and the train is expected to move at 6-8 km per hour; the noise of the locomotives will be audible at the Dwelling at 46 dB(A) to 48/49 dB(A) and back to 43 dB(A) over a period of 15 to 20 minutes.

9. PREDICTION OF NOISE DURING CONSTRUCTION

The environmental acoustical impact on the Baal Bone District during the construction period falls into three categories:- traffic, earth works, construction. These major site activities will only take place during daylight hours (0700 - 1800) Monday to Friday and Saturday morning (0700 - 1200).

Noise emissions from site activities outside these hours shall be controlled so that their contributions at the nearest residence is less than 25 dB(A) L_{10} in a night-time L_{10}/L_{90} ambient 30/25 dB(A).

9.1 Traffic

The main components of construction traffic noise will be from employees' vehicles, trucks carrying road base aggregates, low level loaders, concrete trucks and similar.

The McMahon dwelling opposite the Proposed Colliery access road is potentially the most exposed situation. Average maximum noise levels outside this dwelling resulting from employee vehicle movements could be 38/40 dB(A) L_{10}, with levels of 40/43 dB(A) L_{10} from heavy transport movement, compared with the measured existing acoustical climate daytime 40 dB(A) L_{10} and 34 dB(A) L_{90}.

9.2 Earth Works

The main noise producing activities occurring within the relatively short duration road building and site preparation phase will consist of tree cutting, topsoil stripping, grading, excavating and road building.

The dominant noise sources in this phase will be dozers, end loaders, trucks, graders, chain saws, jack hammers and blasting operations, and will be the most difficult aspect of the project from an acoustical standpoint.

9.2.1 Road and Railroad Building

The McMahon Dwelling opposite the proposed access road is potentially the most exposed during the construction of the access road and the rail link. This phase of the development program has been scheduled to take place over a short duration.

9.2.2 Site Preparation

Earth moving equipment considered in predicting site preparation noise emissions are:- 'D9', 'D10', and 'D6' Bulldozers. The findings are summarised below:

PREDICTED EARTH MOVING EQUIPMENT NOISE EMISSION LEVELS

Description	Distance (metres)	Sound Pressure Level (dB(A)) (L_{10})
'D9' Bulldozer	20	88
	80	74
'D10' Bulldozer	20	82
'D6' Bulldozer	15	81
	100	64

Average maximum (L_{10}) noise levels from earth-moving equipment within the site, together with distance attenuation and shielding, can be expected to contribute 42 dB(A) L_{10} at the 'McMahon Dwelling' in an L_{10}/L_{90} ambient of 40/ 34 dB(A).

Blasting operations will be required to assist in the opening of the mine drifts.

Noise and ground vibration levels will be minimised by using delayed blasting techniques and regulating the amount and depth of explosive.

Blasting Operations will be restricted to daylight hours.

9.3 Construction

Noise during the construction phase will be produced by material handling, construction of foundations, erection of structures and buildings, and installation of equipment.

The dominant noise sources during this period will be from cranes, end loaders, backhoes, dozers, trucks, hammering and welding activities.

Average maximum (L_{10}) noise levels from construction activities within the site shall not exceed 95 dB(A) at one (1) metre from the source, and can be expected to contribute not more than 25 dB(A) L_{10} at the 'McMahon Residence' in an L_{10}/L_{90} ambient of 40/34 dB(A).

9.4 Impact

Construction activity shall be confined to daylight hours where noise generating events are concerned. There is a number of construction activities which will generate minimal noise and there is no reason from an acoustical viewpoint why they cannot proceed outside normal daylight hours. Average maximum (L_{10}) noise levels from earthmoving equipment from the Site, of 42 dB(A) at the 'McMahon Dwelling' in an L_{10}/L_{90} daytime ambient of 40/34 dB(A) have been calculated.

10. PREDICTION OF NOISE EMISSIONS FROM REFUSE REMOVAL EARTH MOVING EQUIPMENT DURING PLANT OPERATIONS

The basic conditions for the acoustical evaluation are based on full production capacities, operating for two (2)/ three (3) days per week, between the hours of 0700 and 1800.

Earth moving equipment proposed for this facility will consist of or be similar to, twenty five (25) tonne tip trucks, a 'D8' Bulldozer and a '637' Scraper. In predicting noise emissions from this operation, the following levels have been used.

PREDICTED EARTH MOVING EQUIPMENT
NOISE EMISSION LEVELS

Description	Sound Pressure Level dB(A) L_{10} @ 7m
'D8' Bulldozer	88
'637' Scraper	86
Coal Truck Hauling	94
Coal Truck Returning	92

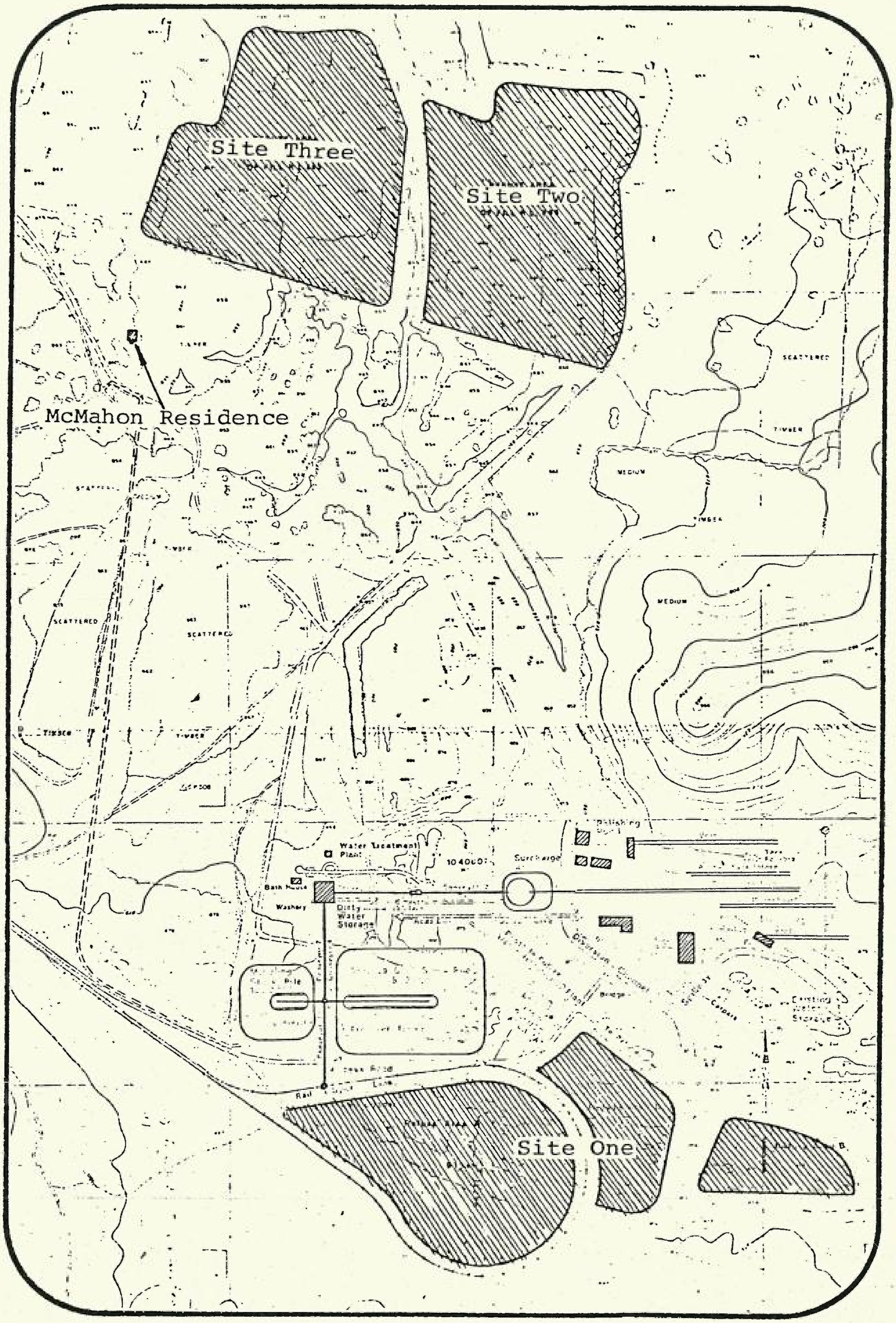
The acoustical impacts of the earth moving equipment movements can be categorised into three areas, being the areas proposed for the deposit of mine refuse (Fig. 3). These areas have been evaluated as follows:

10.1 Rail Loop Area (Mine Site)

This area has a life expectancy of three (3) years. It is proposed to work it from the commencement of mine operations.

Mine Refuse Areas

Figure 3



The distance between this refuse area (Site One) and the nearest resident (McMahon) is approximately 1500 metres. The area between the site and the resident is crossed by a number of existing open-cut waste stockpiles which offer additional attenuations for noise controls.

Calculated average maximum (L_{10}) noise levels from earth moving equipment can be expected to contribute not more than 38 dB(A), at the 'McMahon Residence', and compares to a broadband background noise from the Pit Top of 43 dB(A) L_{90}.

10.2 Western Side of Ben Bullen Creek (Southern Parcel)

This area has a life expectancy of some ten (10) years. It is an area of potential acoustic concern to the nearest residence (McMahon).

The distance between McMahon and this refuse area (Site Three) ranges from 200/650 metres, with some shielding being offered to the McMahon residence by existing waste stockpiles.

During earthworks operations in the rail-loop refuse area, it is proposed to develop an acoustic model so as to establish suitable techniques for bank construction and a work program for Site Three. This practical solution will be used to establish earth (refuse) banks around Site Three so as to control noise to the nearest residence (McMahon).

Average maximum (L_{10}) noise levels from the earth moving equipment can be expected not to exceed 45 dB(A) at the McMahon Residence and compare to the background noise level of 43 dB(A) L_{90}.

10.3 Eastern Side of Ben Bullen Creek (Southern Parcel)

This area has a life expectancy of some seven (7) years.

The distance between the nearest resident (McMahon) and this refuse area (Site Two) ranges between 500 and 1000 metres. Earth moving equipment working this area will be partly shielded from the McMahon residence due to waste stockpiles from previous open-cut operations.

Additional acoustical shielding to the McMahon residence will be developed with the construction of earth (refuse) banks along the Western boundary of this refuse area.

Average maximum (L_{10}) noise levels from the earth moving equipment can be expected not to exceed 45 dB(A) at the 'McMahon' residence and compares to the background noise level of 43 dB(A) L_{90}.

10.4 Refuse Material Trucking

During the operations of reclaiming the second and third sites, it will be necessary to road freight refuse to these areas. It is proposed to use up to twenty-five (25) tonne capacity trucks. It has been estimated that up to eighty (80) truck movements to and from the site could be experienced per day.

The access road will be located to take maximum advantages of shielding offered by existing topography and open-cut stockpiles. Generally the access road will follow a R.L. 850 contour compared to R.L. 860 at the McMahon Residence.

Average maximum noise levels of 45/47 dB(A) resulting from Truck movements compare to the background of 43 dB(A) L_{90}.

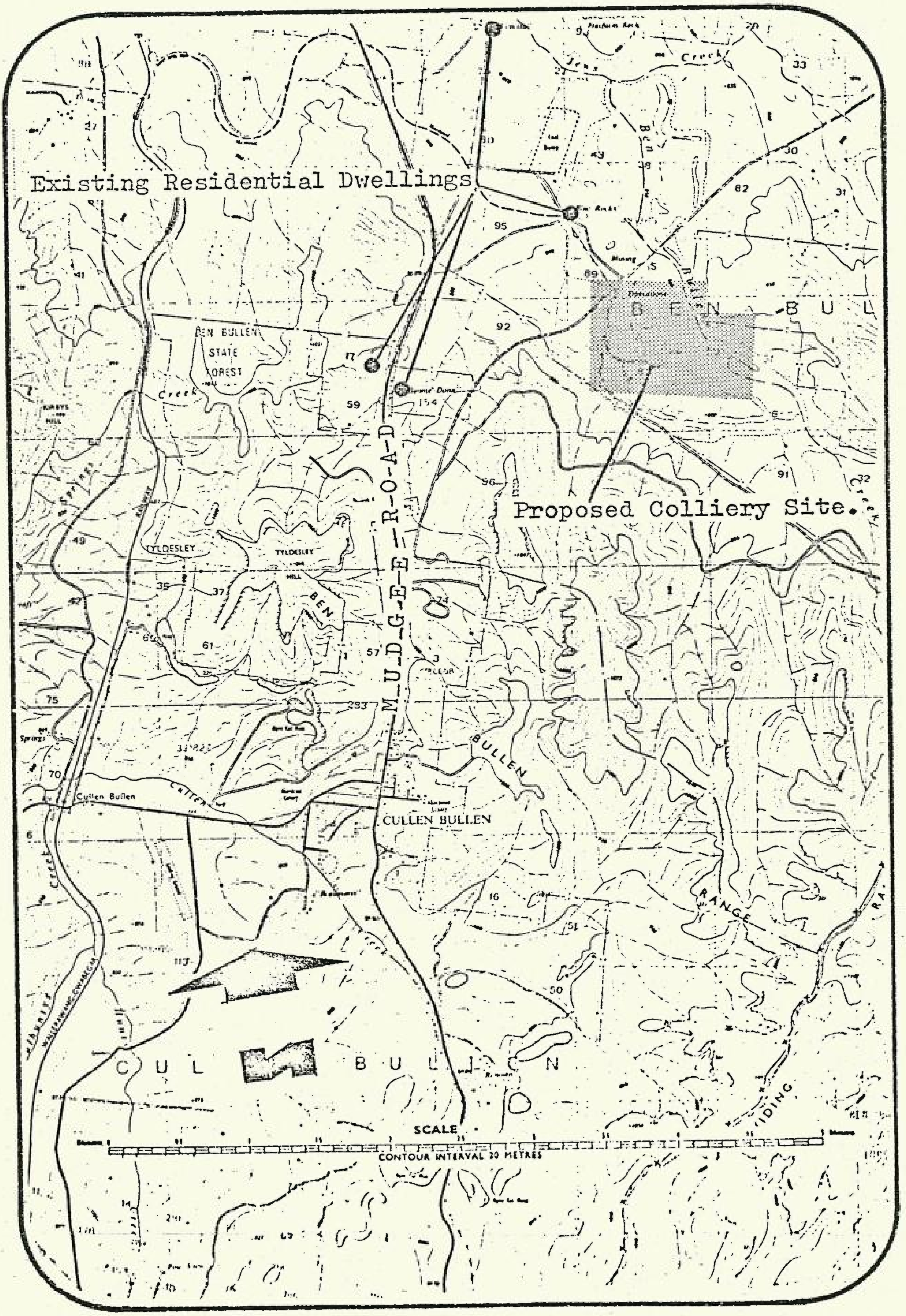
10.5 Impact

Noise levels expected from refuse removal activities will vary throughout the project, depending upon the actual location of specific activities.

The most exposed situations have been assessed for each refuse site. Average maximum (L_{10}) noise level contributions of up to 45 dB(A) for earth moving equipment and 47 dB(A) for trucking movements could be experienced at the McMahon residence; these levels compare to a broadband background (L_{90}) noise level of 43 dB(A) from Pit Top mining activities.

APPENDIX A

Baal Bone District



APPENDIX B

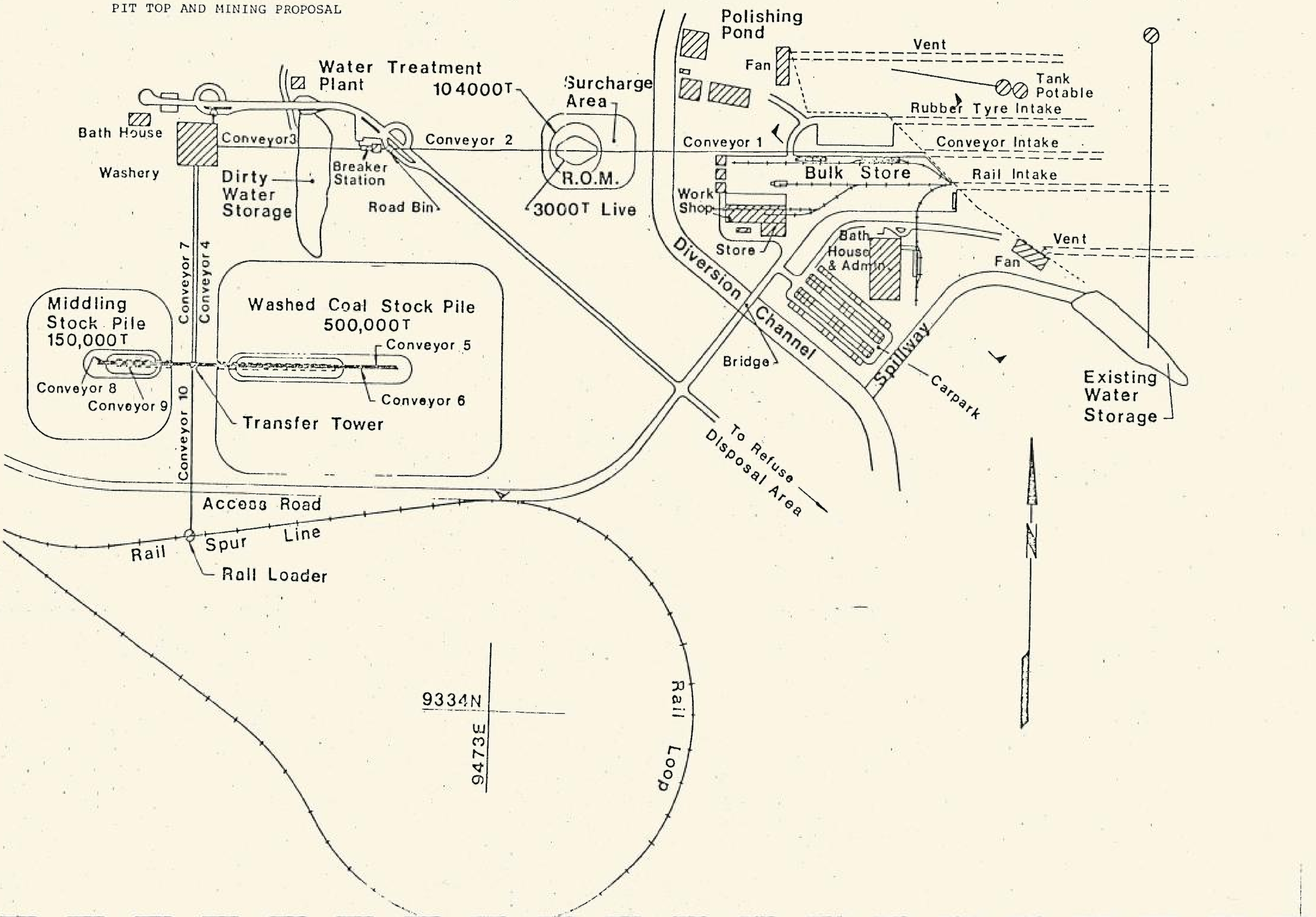
RESULTS OF SOUND PRESSURE LEVEL MEASUREMENTS IN BAAL BONE DISTRICT

Location	Date	Time	S.P.L. dB(A) L_{10}	L_{90}	L_{eq}	Highway Traffic Count (30 mins) Cars	Trucks
1	30.3.80	1000	56	35.1	57.1	25	3
	30.3.80	0030	31.8	30	32.6	5	-
	3.7.80	0255	31.0	26.1	27.4	2	-
	3.7.80	0945	58.3	37.5	59.8	30	8
2	29.3.80	1100	40.5	30.0	36.8	-	-
	29.3.80	2345	32.0	29.0	31.3	-	-
	3.7.80	0220	30.0	25.0	26.1	-	-
	3.7.80	1020	45.5	36.5	41.1	-	-
3	29.3.80	1135	39.1	32.0	34.9	-	-
	29.3.80	2300	31.2	26.0	30.5	-	-
	3.7.80	0145	30.4	25.5	27.0	-	-
	3.7.80	1330	41.1	36.0	38.2	-	-
4	20.3.80	1500	33.5	27.5	37.8	-	-
	21.3.80	0130	30.4	24.0	30.8	-	-
5	3.7.80	1215	37.5	36.5	36.8	-	-
	3.7.80	0100	31.0	26.5	28.6	-	-
6	2.7.80	1600	31.5	29	30.9	-	-
	2.7.80	2300	30.0	25.3	29.2	-	-
7	2.7.80	1500	30.0	26.5	28.1	-	-
	2.7.80	2345	29.0	25.0	28.3	-	-
	3.7.80	1130	39.5	36.5	37.5	-	-

FOR LOCATIONS REFER FIGURE 1.

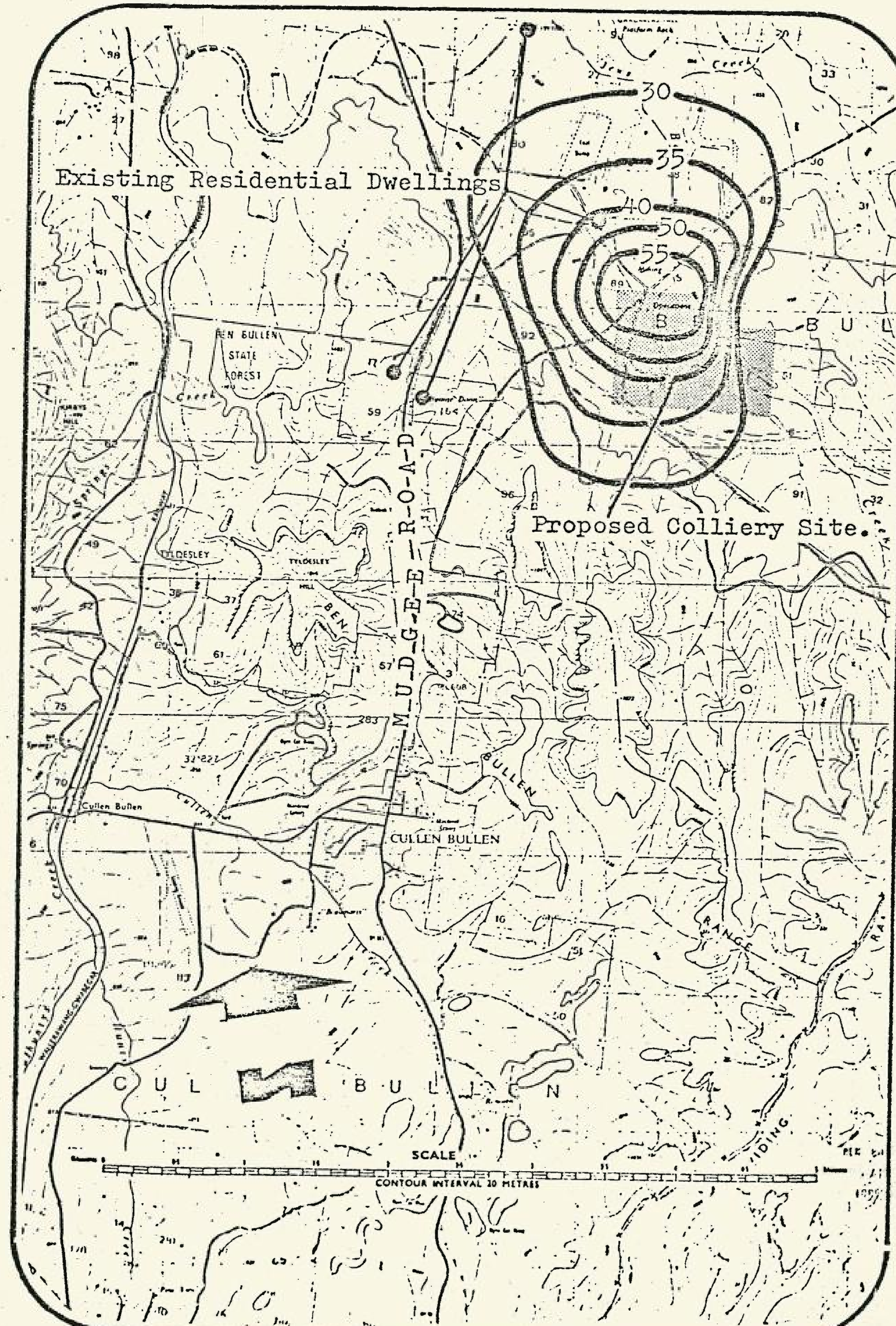
APPENDIX C

BAAL BONE COLLIERY
PIT TOP AND MINING PROPOSAL



APPENDIX D

PREDICTED PLANT OPERATING
NOISE CONTOURS



WATER SUPPLY AND WATER MANAGEMENT PLANNING

FOR THE PROPOSED BAAL BONE COAL MINE

PREPARED BY:

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FOR

NEXUS ENVIRONMENTAL STUDIES

APRIL, 1981

WATER SUPPLY AND WATER MANAGEMENT PLANNING FOR THE PROPOSED BAAL BONE COAL MINE

1. INTRODUCTION AND SCOPE

This report concerns water supply and water management planning for the proposed Baal Bone coal mining project. It should be read in conjunction with the companion report on Water Quality Impact which follows.

The recommended plan is outlined in Section 2 herein and the remaining sections give additional descriptive information and supporting calculations. Figures 1.1 and 1.2 are location plans showing watercourses and catchments, sources of clean and contaminated waters, points of water demand and proposed water storage and treatment facilities. Figure 1.3 is a flow sheet giving quantitative estimates of supply and demand and also showing the treatment processes proposed.

Objectives of the plan are as follows:

- to ensure supplies of potable and non-potable water to the project by the development of two water storages located within and adjacent to the site. One storage* will contain runoff from the natural catchment above the mine area and the second will store contaminated water* generated as a result of the project.

- the separation of clean water runoff from contaminated waters by means of diversion channels and catch drains located within and around the mine area.

- the operation of the storages so as to maximise the consumption of contaminated water by activities within the mine area. This course will minimise the occurrences of uncontrolled releases of contaminated water during storms, by the provision of air space in the contaminated water storage.

- the treatment of any surplus contaminated flows prior to their controlled release to natural water courses downstream of the mine area.

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* These storages are labelled "Main Water Supply Dam" and "Dirty Water Storage" respectively in the Figures.

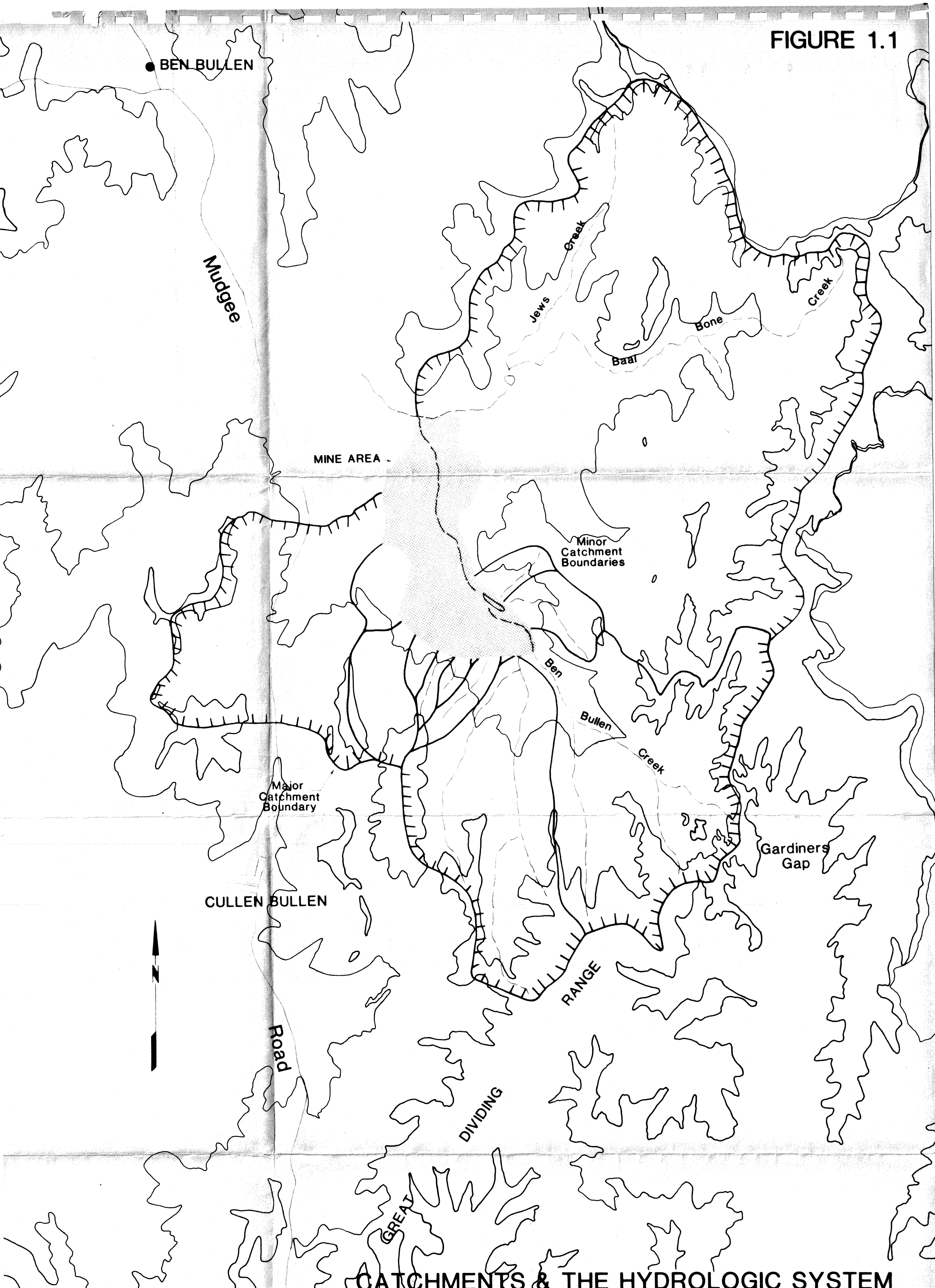
- to propose a plan for the disposal of reject material from the washery which will prevent contamination of downstream natural drainage lines due to release of acid leachates.

Section 3 details anticipated water demands and sources of contaminated water.

Section 4 gives the results of detailed hydrologic calculations which were carried out to size the various works.

Additional details on the sizing and method of operation of the various water storage facilities are given in the Annexure at the end of this Appendix.

FIGURE 1.1

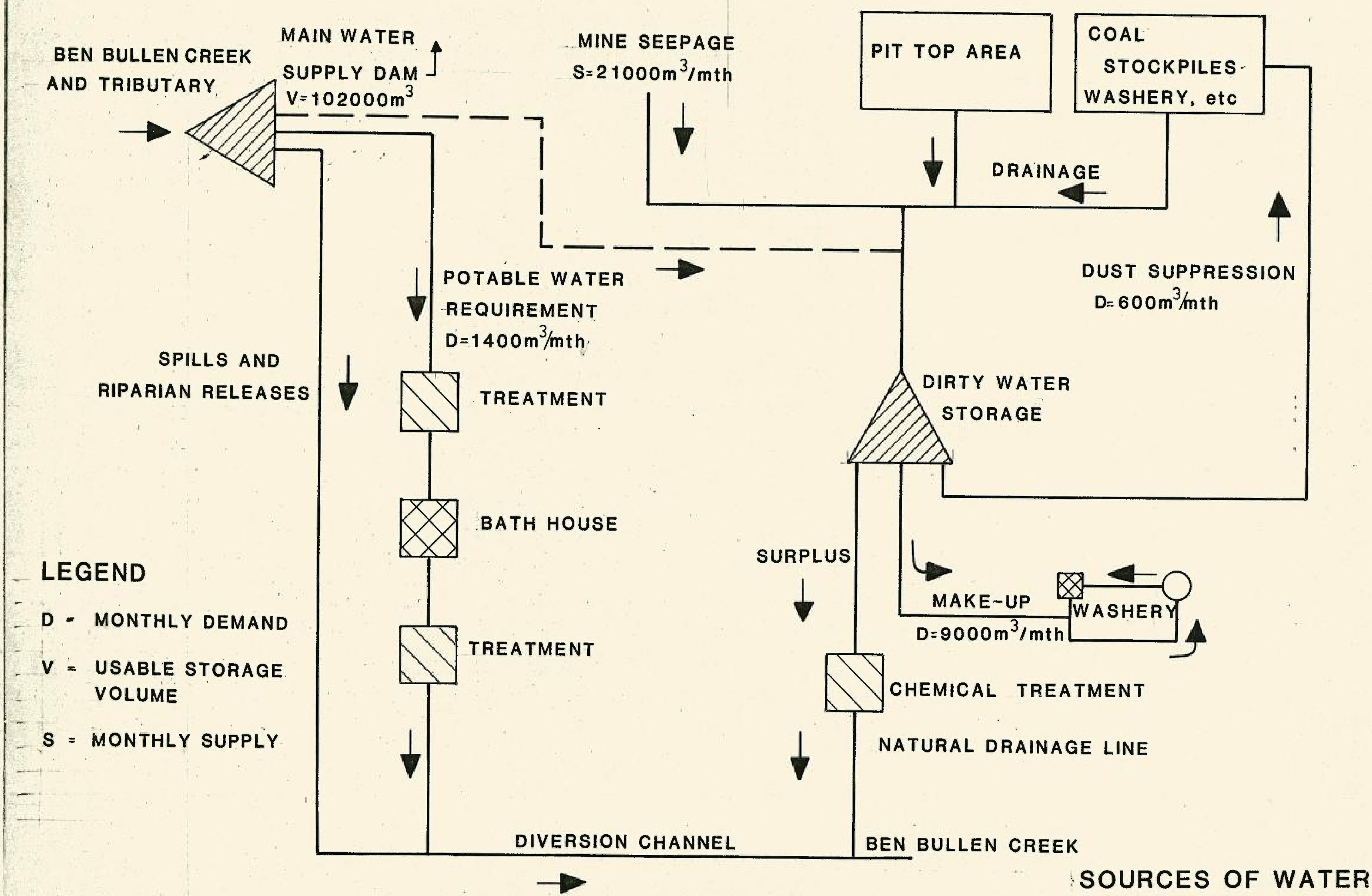


CATCHMENTS & THE HYDROLOGIC SYSTEM

FIGURE 1·2.

Figure 1·2

WATER MANAGEMENT



SOURCES OF WATER SUPPLY & DEMAND

2. THE RECOMMENDED WATER MANAGEMENT PLAN

2.1 Provision of Potable and Non-Potable Water Supplies

The mine site lies in the catchment of Ben Bullen Creek. This stream rises in the Great Dividing Range and flows in a north-westerly direction before joining Jews Creek downstream of the mine. (Figure 1.1). The existing dam to the south east of the mine site will be re-built and extended to the right bank of Ben Bullen Creek so as to regulate flows from this stream as well as from its tributary. The storage level will be raised by about 3 metres compared with present conditions. Potable water supplies will be drawn from the enlarged storage, treated and reticulated to the pit top and bath house areas. Overflows from the dam will pass over the spillway and will be conveyed along an excavated diversion channel which will run adjacent to the pit top area and re-join Ben Bullen Creek upstream of the existing road crossing. The storage will be referred to herein as the "main water storage dam" (MWSD).

Non-potable water requirements which comprise water for dust suppression, fire fighting, the coal washery and for washing down will be taken from the existing pit located between the proposed coal stockpile areas. This pit will be developed as a storage for drainage from the coal stockpiles, seepage flows pumped from the mine adits and runoff from the pit top area. It has been denoted the "dirty water storage" (DWS) in this report as it will contain water which will to some extent be contaminated by the project.

It is likely that mine seepage will exceed non-potable water requirements, so that the project will be a net producer of dirty water. The DWS will act as a detention storage to remove settleable solids and chemical treatment will be effected, if required, before the surplus flow is returned to the downstream natural drainage system. Lining of the DWS is recommended to prevent the possibility of groundwater pollution due to seepage into the pervious talus heap forming the right bank of the pit. A low bund around the DWS would isolate it from its present catchment and ensure that only drainage flows piped from the coal stockpiles and the other dirty water areas entered the pit.

Provision of Potable and Non-Potable Water Supplies (Cont'd)

The resulting reduction in inflow would reduce the possibility of an untreated overflow of polluted water during storm periods due to surcharging. Contaminated water in the DWS should always be used preferentially to satisfy non-potable demands.

In the event of seepage flows pumped from the mine being insufficient to satisfy non-potable water requirements, the shortfall would be drawn from the MWSD which has been sized with this possibility in mind. Reticulation to the DWS from the MWSD could be provided, or alternatively, releases could be made from this storage into the diversion channel and pumped out at a point adjacent to the DWS.

Proposed operating levels and storage volumes are given in Table 2.1. They have been assessed from operational studies carried out on the computer to simulate the behaviour of the two storages. These studies showed that it was possible to release water from the MWSD for maintaining flows in Ben Bullen Creek during low flow periods while still ensuring security of supply to the project.

TABLE 2.1

DETAILS OF WATER SUPPLY ELEMENTS

Item	Operating Levels RL-m	Storage Volume - m^3	Usable Storage - m^3	Surface Area - ha	Flood Level RL-m	Total Storage at Flood Level - m^3	Surface Area at Flood Level - ha
Main Water Storage Dam	Max.875 Min.872	111000 9000	102000	5.5	876.9	250000(2)	10(2)
Dirty Water Storage	(1)	(1)	(1)	0.4	864.5	20000(3)	0.4

Notes:

(1) All non-potable supplies will be drawn from this storage and any surplus water released after treatment. This approach maximises the capacity of this storage to detain drainage from the coal stockpiles, seepage from the mine and runoff from the pit top area.

(2) These are estimates only as the available contour information does not cover the surface area of the pondage at its top flood level.

(3) This is the total volume available at the by-wash level for the storage of dirty water.

2.2 Drainage from the Mine Site and Adjacent Areas

As mentioned, dirty water from the coal storage and other areas shown on Figure 1.2 will be conveyed into the DWS by piped systems.

Sewage effluent and bath house water will be treated prior to release. The treated water should be consumed within the site in preference to its being released to the diversion channel.

Where the existing dump areas are to remain undisturbed, rainfall should be allowed to infiltrate into the pervious mass and drain to Ben Bullen Creek by sub-surface flows as at present. Runoff from disturbed areas should not be allowed to concentrate and cause erosion. Diversion banks should be provided to intercept sheet flows, reduce velocities and encourage infiltration. Where these are not practicable, runoff should be piped to the nearest stabilised watercourse. The soils on the natural catchments to the east and west of the site are dispersive and hence vulnerable to erosion once the vegetative cover has been removed. Careful attention will be required to reduce velocities of runoff from any of these areas which are disturbed. Appropriate measures are detailed in Ref (4).

Drainage from two catchments to the south-west of the proposed rail loop will be collected in an excavated channel and diverted around the rail loop into the diversion channel. Peak discharges from these catchments, which are denoted I and II in Figure 1.2 is given in Section 4.4.2. Runoff from the hill catchment above the pit top area will be intercepted in a catch drain and diverted into the diversion channel via the existing pit.

2.3 Drainage from Coal Refuse Areas

The mine will develop 2.4×10^6 m^3 of coal refuse (i.e., washery reject) material over its 20 year life which must be placed at the rate of 120000 m^3 per annum.

The total surface area available for disposal over the dumps left by the old open cut mining area has been estimated by Coalex at 1.5×10^6 m^2. This area is the remainder after allowing for the area to be devoted to the diversion channel and other activities.

Therefore, if all of the area were to be used without regard to the implications of leachate from the coal refuse on water quality in the downstream waterways, disposal would be a relatively simple process. The area could then be filled to an average depth of 1.6 m and accommodate all of the refuse to be produced by the project.

The results of the tests carried out in the waterbodies and watercourses of the mine area indicate that the leachate from the refuse dumps is not causing a significant deterioration in the water quality in Ben Bullen Creek. The existing dumps have been in location for the past 30 years and it is likely that they have now been mostly "spent" as far as contaminating leachate is concerned. It is questionable whether this would continue to be the case if washery reject material were placed in a haphazard manner on the dumps without regard to the natural drainage pattern. Use of a "control area" as proposed in the following paragraphs will resolve the uncertainties and ensure against downstream water pollution.

It is recommended that over the initial years of the project, washery reject be disposed of within the area bounded by the proposed rail loop. The existing downstream pit* should be developed to act as a storage of runoff and leachate which drains from this area (shown as area A on Figure 1.2). The advantages of this course of action are that the quality of water in the pit could be monitored to determine whether leachate is a problem and if necessary, chemical treatment could be effected prior to release. Calculations have shown that approximately 400000 m^3 of material, equivalent to 3 years operation, could be stored within this area. This assumes that filling is carried out to an elevation of RL 875 m. This level corresponds with the predominant level of the existing dumps within the rail loop area. Drainage from the area within the rail loop will enter the pit as a combination of sub-surface flow through the pervious strata forming the refuse dumps (as occurs at present) and also as surface runoff directed into the storage through a pipe beneath the rail embankment. The sides of the pit should not be sealed so that the sub-surface flows from area A can be intercepted and stored.

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* This pit is labelled "Tailings Pond" on Figure 1.2.

Drainage from Coal Refuse Areas (Cont'd)

The adjacent area (denoted area B on Figure 1.2) would give an additional 2 years of storage. Drainage from this area will flow towards the existing pits and thereby to the Ben Bullen Creek diversion channel. Control of runoff and leachate from this area would be difficult should experience gained from operation of area A show a water quality problem associated with the fresh reject material. This area could be used to store selected refuse material, i.e. weathered shale and sandstone of low pollution potential. However, as this material may be better used in the rehabilitation and stabilisation programme (see Section 3.7 of the companion report on water quality) this area would best not be used. Filling operations should proceed after area A to the other areas discussed below.

Two other areas suitable for refuse disposal are shown as C and D on Figure 1.2. They are located on what is known as the Southland Parcel, on the western and eastern sides of the present course of Ben Bullen Creek. Calculations have shown that it is possible to store a total of 4×10^6 m^3 of material in the two areas by filling to the predominant levels of the ridges of the existing dumps. These levels are RL 868 m on the eastern side and RL 863 m on the western side. The above volume is well in excess of anticipated requirements.

Should the operation of area A indicate the presence of contaminating leachates, the following measures should be adopted when filling in areas C and D (see also Section 3.5 of the companion report):

(i) runoff from the grazing and timbered lands bordering the dump areas should be intercepted and conveyed downstream to Jews Creek by catch drains.

(ii) Tailings ponds should be developed to trap runoff and leachates generated within the areas and chemical treatment carried out if necessary, prior to release to natural waterways downstream. Initial site inspection indicates that area C is the more suitable for development as a filling area, as it would be easier to intercept drainage. This point is developed further in the Annexure to this Appendix.

(iii) Filling should be carried out within bunds constructed of clean fill so that contaminated runoff shedding from the surface does not enter Ben Bullen or Jews Creek.

(iv) Once filled, sealing of the areas would be desirable to reduce the volumes of leachate and the cost of treatment. However, in view of the scarcity of suitable impervious material for topsoil, it may prove more economical to chemically treat the leachate, within the tailings ponds, if required, over the life of the project. By analogy with the behaviour of the existing dumps, it is likely that leachates from the refuse areas will eventually lose their potential for pollution. By the time operations have ceased after 20 years, the placed reject material may have been spent. Whether this will be the case, or whether sealing will be required prior to abandonment of the area cannot be stated with certainty at this time. Carrying out initial filling operations within the control area A as outlined above would help resolve these questions.

On the other hand, if experience gained with operation of area A indicates that leachates do not cause a significant reduction in downstream water quality, requirements for containment of runoff and tailings ponds could be relaxed. Control of drainage would then concentrate on the prevention of erosion from the dump surfaces and sediment spills into the watercourses. Procedures are outlined in Ref (4) published by the Soil Conservation Service. The Company intend to maintain close liaison with this organisation in this respect. Their advisory services have been used by the Company in the past.

3. PROJECT WATER DEMANDS

3.1 Potable Demands

Potable water requirements are estimated at 70 KL per day, which is equivalent to 1400 m^3 per month based on a 20 days per month operation. This allows approximately 158 litres per capita per day for the 374 man workforce.

3.2 Non-Potable Demands

The major user of water will be the coal washing plant. Although this operation forms a closed system as far as water usage is concerned, with water being continually re-used after clarification, a makeup volume around 450 KL per day (9000 m^3 per month based on 20 days of operation) of non-potable water will be required. It is estimated that on the average, a volume of about 30 KL per day (600 m^3 per month*) will also be required for dust suppression, fire fighting and washing down purposes.

3.3 Mine Seepage Volumes

It is not possible to calculate seepage ingress to the mine prior to the commencement of operations. Seepage at the nearby Clarence Colliery has currently stabilised at about 1400 KL per day. However, it is considered by Coalex that smaller seepage volumes will be experienced at Baal Bone. Their "best estimate" is 700 KL per day (21000 m^3 per month). In the event of seepage volumes of this magnitude, the project will become a net producer of dirty water. The water balance in the DWS arising from a 700 KL per day seepage is discussed in Section 3.5. In view of the uncertainties regarding this estimate however, the conservative approach has been adopted herein in the proposed sizing of water supply facilities (Section 4). It has been assumed that the mine will be comparatively dry and yield no more than 25 per cent of the above value, or 5400 m^3 per month, towards satisfying non-potable water demand.

3.4 Implications of Demand on Existing Storage

The existing dam to the south-east of the mine site contains about 9000 m^3 of storage below its estimated storage level of RL 872 m.

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*During extended dry periods, this demand may be exceeded. In the behaviour analysis of the main water supply dam (Section 4), a possible increase in this demand to 1200 m^3 per month during dry months has been allowed for.

Implications of Demand on Existing Storage (Cont'd)

At a demand rate of 1400 m^3 per month for potable water and allowing for evaporation from the water surface, this represents less than 4 months of supply during drought periods.

Inspection of local streamflow records showed the occurrences of several droughts in which sequences of low flows of up to 6-12 months duration were experienced. In 1965, for example, runoff was only 12.8 mm.# The distribution of runoff within the year during drought periods is such that several months of almost zero flows are likely. Further, inspection of annual rainfalls recorded at Sunny Corner over the period 1903 to date indicated the likelihood of more severe droughts than that of 1965 over the life of the project.

Security of continuing operation of the mine during drought periods therefore required a substantial augmentation of existing water storage facilities. Hydrologic investigations which are described in Section 4 were therefore directed towards the determination of adequate volumes of storage.

3.5 Water Balance in the DWS

From the above, total requirements for non-potable water will therefore amount to 480 KL per day, (9600 m^3 per month). Sources of contaminated water to satisfy this demand comprise seepage water estimated at 700 KL per day (21000 m^3 per month), plus runoff from the pit top which comprises a dirty water catchment area of 4.3 hectares and from the coal storage and other areas indicated on Figure 1.2, which total 8.2 hectares. Runoff from these latter two areas is of course storm dependent* and is difficult to estimate in view of the disturbed nature of these catchments. If they were natural catchments, about 15000 m^3 of runoff would be expected in a normal year.

Net evaporation from the surface of the DWS would account for a minor amount of the surplus dirty water; no more than 200 m^3 per month in the summer months.

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*Storm runoff into the DWS is discussed in Section 4.4.4.

#According to Ref (1), the average annual runoff from catchments in this area is about 150 mm.

Project Water Demands (Cont'd)

On these figures, the project would be a net producer of contaminated water at the rate of about 12,000 m^3 per month. Consumption within the mine area would not be possible without the construction of large evaporation ponds. In normal years, the net evaporation amounts to about 290 mm. On 8 months of the year, evaporation exceeds rainfall and over the remaining months, the position is reversed (Table 3.1). In order to evaporate a year's production of surplus dirty water over the period of a normal climatic year, a pond with a surface area of around 50 hectares would be required. An area of this magnitude is not available.

A better approach would appear to be the temporary detention of the surplus water in the DWS to remove suspended solids, followed by chemical treatment if necessary to yield an acceptable effluent and release to the downstream drainage system.

Water could be stored to an elevation of RL 864.5 m which would give approximately 20000 ML of storage, sufficient to contain about 6 weeks' net production of surplus dirty water. Section 4.4.4. discusses the possibility of uncontrolled (i.e., untreated) surcharges from this storage during storm periods. It is concluded that the DWS is capable of fully containing the runoff from intense storms of high recurrence intervals, provided it is operated as the primary source of non-potable water and any surplus water is released after treatment.

TABLE 3.1

EXCESS OF AVERAGE MONTHLY

EVAPORATION OVER RAINFALL*

(VALUES IN MM)

J	F	M	A	M	J	J	A	S	O	N	D	YEAR
97	73	64	21	-17	-52	-47	-29	3	16	67	93	290

* Based on Sunny Corner rainfalls and Bathurst Pan Evaporation.

Negative values indicate rainfall exceeds evaporation.

3.6 Irrigation of Regenerated Areas

The water balance above has not considered the possibility of consuming untreated dirty water by means of irrigation of revegetated surfaces as they are progressively rehabilitated over the life of the project. The areas undergoing rehabilitation will in the main comprise those devoted to the storage of washery reject material. (From Section 2.3, areas A, C and D of Figure 1.2 were proposed for this purpose). It is difficult to arrive at quantitative estimates of irrigation consumption as these would vary with climate, the season of the year (Table 3.1) and the stage of the project. The method of rehabilitation proposed does not involve use of topsoil to act as a temporary moisture store of applied irrigation water for later evapotranspiration. Therefore it is likely that a considerable proportion of this water will be lost due to deep percolation into the pervious dump mass and movement as sub-surface flow into the downstream drainage lines. Unless there was a pit available below each irrigated area to intercept sub-surface flows, release of contaminated water into the drainage system is possible if untreated dirty water were used.

Development of refuse area A and the downstream tailings ponds in the early years of operation, as outlined in Section 2.3 would assist in determining whether untreated dirty water from the DWS could be used as irrigation water without running the risk of downstream contamination. If poor quality irrigation return flows are detected in the pit, it may then be necessary to ensure that only chemically treated water is used for this purpose. Alternatively, tailings ponds may be required downstream of each washery reject area to intercept irrigation return flows, irrespective of whether these are required for storage of leachates from the washery reject material.

4. DETAILED HYDROLOGIC INVESTIGATIONS

4.1 The Existing Hydrologic System

Ben Bullen Creek rises in the Great Dividing Range near Gardiners Gap and flows through the mine site in a generally north-westerly direction before joining Jews Creek below the site (Figure 1.1). These streams form the headwaters of the Turon River which eventually joins the Macquarie River downstream of Sofala.

The catchment area of Ben Bullen Creek just upstream of the site is about 6.2 square kilometres. A tributary located on the left bank of Ben Bullen Creek and which is controlled by a small dam about 2 metres high, adds runoff from a further 4 square kilometres of area. Additional runoff enters the site from hill catchments which total 3.5 square kilometres in area and flow into the site from the east and west. The mine area itself covers an area of about 1.2 square kilometres from the dam site to the junction of the road across Ben Bullen Creek.

The drainage pattern within the mine site has been completely altered by the open cut mining operations of the 1940's. The area was excavated to the coal seam, with progressive backfilling of overburden and waste coal to form a series of dumps ranging between 5 to 10 metres in height above the general excavation level. The direction of natural drainage of the area is from south-east to north-west while the dip of the coal seam is from west to east. These factors, together with the haphazard pattern of forming the dumps has resulted in the formation of a number of pits within the area, some of which permanently contain water.

During storm periods, flows from Ben Bullen Creek and the other catchments drain directly into the pits which are also filled by sub-surface drainage through the dumps. Most of the rain falling directly on the dump surface infiltrates into this pervious material. Surface runoff would only occur during intense rainfall bursts. Following cessation of rainfall, the water table within the dump mass would gradually fall to an equilibrium level as water is slowly released from this groundwater storage into the surface drainage system.

The pits appear to be able to store permanent water only to the level of the interface between the rock/coal seam and the pervious dumps. Where the sides of the pit comprise pervious material (e.g., the proposed DWS pit) any water contained above the interface would eventually be lost due to infiltration into the dumps. As the dumps are hydraulically connected, the water would, in the course of time, seep into Ben Bullen Creek downstream of the mine.

4.2 Catchment Water Yield Studies

4.2.1 Generation of Streamflows

Neither Ben Bullen Creek nor its tributary stream has been gauged. In order to fix the storage level of the MWSD, it was necessary to determine the water yield from these catchments.

Ben Bullen Creek rises in the headwaters of the Turon River which has been gauged at Sofala since 1947*. The catchment area at Sofala is 883 km^2 compared with 10.2 km^2 at the MWSD dam site. Streamflows entering the storage were derived by pro-rating the Sofala flows according to the ratios of the catchment areas.

Average annual rainfalls on the Turon River catchment below the dam are slightly less than on the Ben Bullen Creek catchment. At Sofala the average rainfall is 648mm per annum, compared with 919mm at Sunny Corner and 750mm at Portland, to the southwest of the mine site. Table 4.1 shows average monthly rainfall depths and the number of raindays at these locations. Because of the higher

* The Water Resources Commission has processed the records up to the end of the year 1975, giving 29 years of recorded streamflows for analysis.

rainfalls on the Ben Bullen Creek catchment, the derived set of streamflows may be slightly on the low side. However, the error is small. The average annual runoff for the derived flows over the 1947-1975 period is 145 mm, compared with a yield of 150 mm of runoff for streams in this vicinity according to Bell and Gatenby (Ref. 1).

Table 4.1 - Sofala Rainfall

Means and Medians for the Period 1892 to 1978 Using All Available Data

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR
Mean Rainfall (mm)	71	57	55	45	39	51	47	51	50	62	56	64	648
Median Rainfall (mm)	59	43	48	36	27	42	44	49	44	54	41	49	643
No.of Rainfall obs	86	87	87	87	87	87	87	87	87	87	87	87	86
Mean No.of Raindays	6	5	5	5	6	8	8	8	7	8	6	6	78
No.of Rainday obs	84	86	86	85	87	87	85	85	86	87	86	86	

- Sunny Corner Rainfall

Means and Medians for the Period 1903 to 1978 Using All Available Data

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR
Mean Rainfall (mm)	91	79	69	61	67	83	80	76	71	90	73	79	919
Median Rainfall (mm)	86	62	56	59	52	67	74	74	66	80	63	67	920
No. of Rainfall obs	73	74	75	75	75	75	76	76	75	74	74	73	70
Mean No.of Raindays	8	8	7	7	9	11	10	10	9	9	8	7	103
No. of Rainday obs	71	73	74	75	75	75	76	75	74	73	73	72	

Source: Bureau of Meteorology

All of the streams show higher persistent flows and total runoff volumes in the winter months when evapotranspiration is lowest. (Table 4.2 shows pan evaporation at Bathurst). However, the highest floods tend to occur in the summer months and some summer monthly runoff volumes are outstanding due to the effects of individual floods.

Table 4.2

Average Monthly Pan Evaporation at Bathurst Experimental Farm - mm

J	F	M	A	M	J	J	A	S	O	N	D	YEAR
188	152	133	82	50	31	33	47	74	106	140	172	1209

(28 years of Record) Source: Bureau of Meteorology

4.2.2 Behaviour Study of Water Storages

A behaviour study was carried out on the computer which simulated the operation of the MWSD and DWS water storages when subjected to the streamflow as estimated above and the demands for water imposed by the proposed mine, together with releases for maintaining flow in Ben Bullen Creek downstream from the mine. Other inputs and outputs such as rain falling directly on the storages, runoff from the catchment of the DWS, evaporation and seepage from the mine were also considered in the analysis. A schematic representation of the computer model which was operated on a monthly time step over the 29 year period 1947 to 1975* is given in Figure 4.1. The method of operating the model is briefly as follows:

In each month of the period, the streamflow was added to the current storage in the MWSD together with rain falling directly onto the water surface. After abstracting evaporation losses, the volume in excess of the storage capacity was assumed to flow over the spillway and along the diversion channel to Ben Bullen Creek.

Runoff entering the DWS from the pit top and coal storage areas was allowed for in the simulation. The volume of runoff was estimated by multiplying the monthly rainfall by a monthly runoff coefficient. A check was made to determine whether the non-potable demand could be satisfied from the volume currently stored in the DWS. If necessary, releases were also made from the MWSD to satisfy the outstanding requirement.

This strategy lowers the water level in the DWS so as to maintain as much empty storage as possible to act as a buffer against the surcharging of the pit during storm periods. This minimises the possibility of an uncontrolled release of untreated dirty water to the downstream drainage system.

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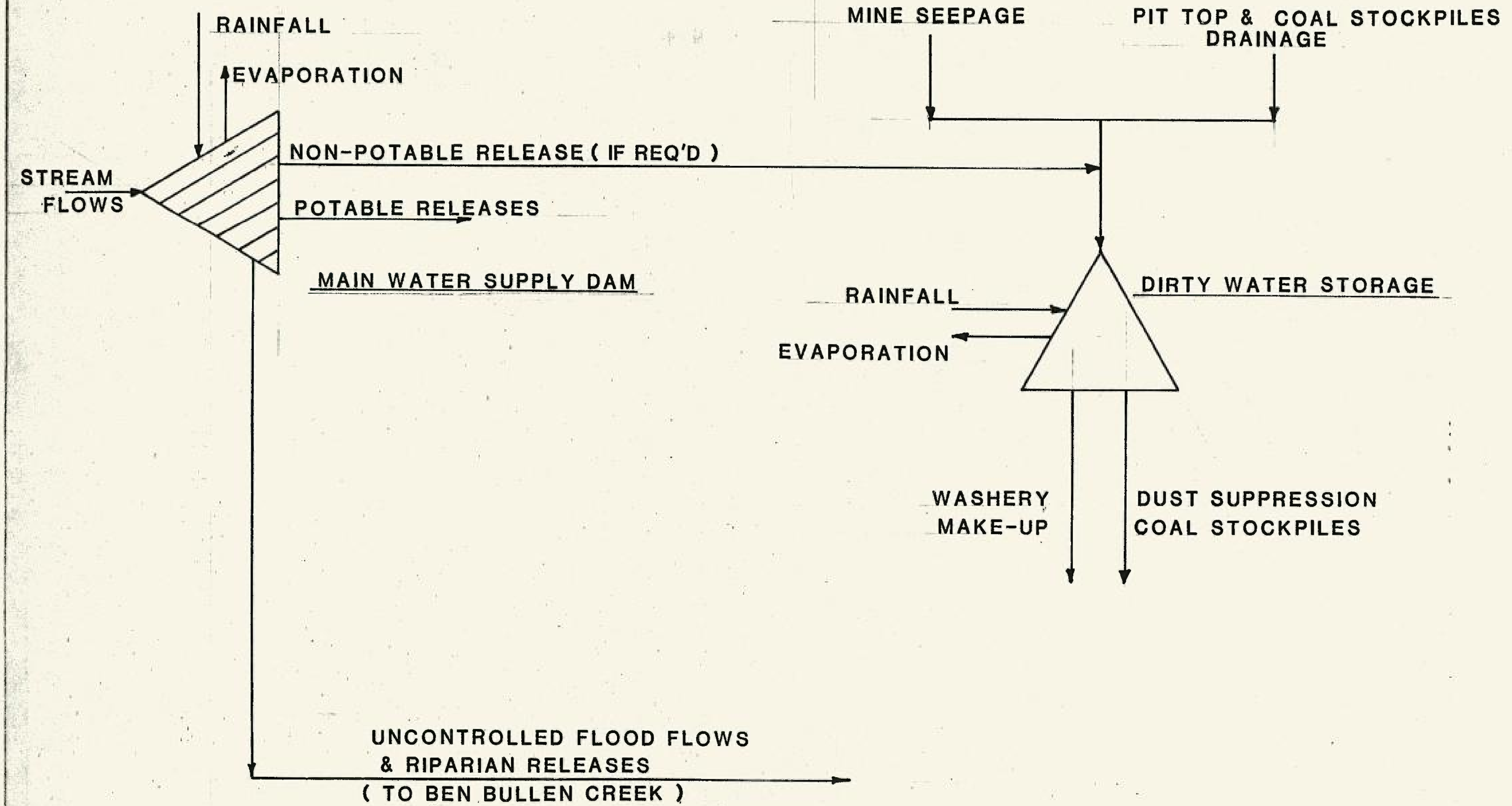
*This assumes that the climatic pattern experienced over the past 29 years is representative of that which will be experienced over the life of the project.

FIGURE 4.1



SCHEMATIC DIAGRAM OF BEHAVIOUR STUDY MODEL

Behaviour Study of Water Storages (Cont'd)

The behaviour studies have assumed that the Water Resources Commission when approached for a licence to construct the dam will require that continuous releases be made from the storage for the purposes of maintaining flows during low flow periods. The form of rule usually specified calls for the release of either a certain volume from the storage per day or a volume equal to the inflow to the storage, whichever is the lesser.

The required rate of release is not known at present. Accordingly, the behaviour analysis was run on a trial and error basis to determine the release which could be made without prejudicing supply to the mine.

4.2.3 Results of Behaviour Studies

Adoption of a storage level of RL 875 m for the MWSD, together with operation of the DWS as described above would give sufficient regulated flow to withstand severe droughts such as those of 1965-66 and 1957. This statement assumes that the seepage volume from the mine will amount to at least 5400 m^3 per month (180 KL per day). This rate is about 25 per cent of the current best estimate of seepage. The simulation showed that at the lowest storage level reached in May 1966, about 20000 m^3 of usable storage would have remained in the dam out of a total usable storage of 102000 m^3. In addition to the MWSD supplying the potable demand of 1400 m^3 per month and if necessary, the non-potable demand of 9600 m^3 per month, a target release of 8000 m^3 per month (0.27 Ml/day) was allowed for from the storage to maintain low flows in Ben Bullen Creek. The release rule adopted permitted the target to be met provided the monthly inflow to the storage exceeded 8000 m^3 per month. When the inflow fell below 8000 m^3 per month, only an amount equal to the inflow was released.

Table 2.1 gives details of the operating levels of the water supply elements of the project. Figure 4.2 shows the drawdown of the dam storage over the 1965-66 drought (curve A). Figures 4.3 and 4.4 show the elevation-storage characteristics of the MWSD and DWS.

Inspection of the yearly rainfall depths prior to 1947 indicated that a drought equal to or more severe than the 1965-66 event would have occurred 5 times since 1903, or on the average once every 16 years. Hence, there is a reasonable chance that such an event will occur over the 20 year life of the project.

As a sensitivity study, the behaviour model was re-run with a reduced rate of mine seepage. A monthly volume of 3300 m^3 per month was assumed which corresponds with 15 per cent of the best estimate of seepage provided by the Company. The target release of 8000 m^3 per month for maintenance of low flows on Ben Bullen Creek was unaltered. In this case the storage contents of the dam was lower during drought periods and the factor of safety against failure of supply reduced. In two months of the critical 1965-66 drought period, restrictions would have been placed on non-potable supply to the mine. The drawdown of the dam storage over the critical drought period is shown as curve B of Figure 4.2

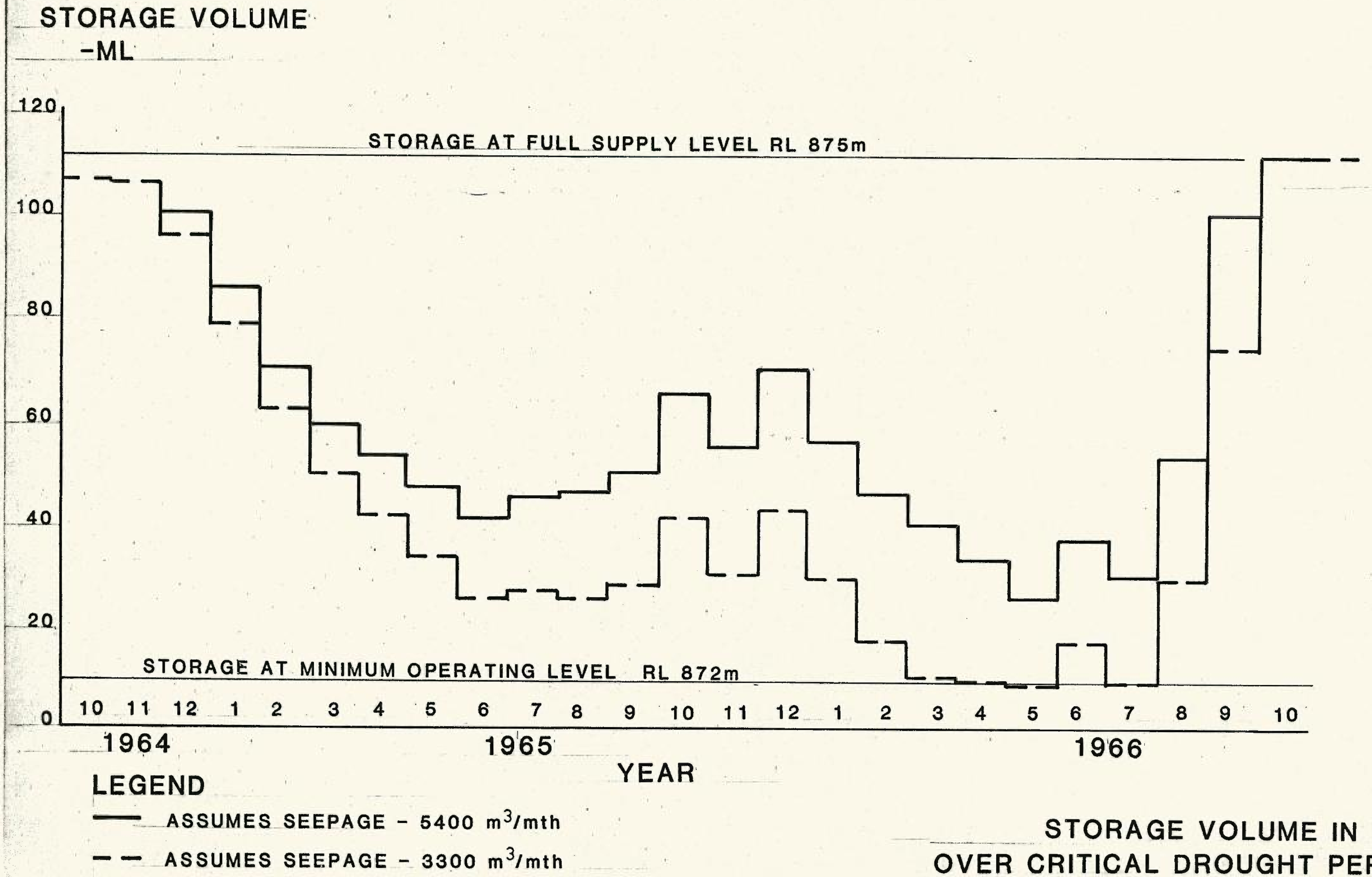
In the unlikely event that the mine proves to be as dry as assumed above, the water contained in the pits at the head of the diversion channel can be brought into operation to eliminate the shortfall.

4.3 Effects of the Project on Flow Pattern in Ben Bullen Creek

The Water Resources Commission has advised that there are no existing licences for usage of water on Ben Bullen Creek. One licence has been issued for 35 hectares of irrigation on Jews Creek.

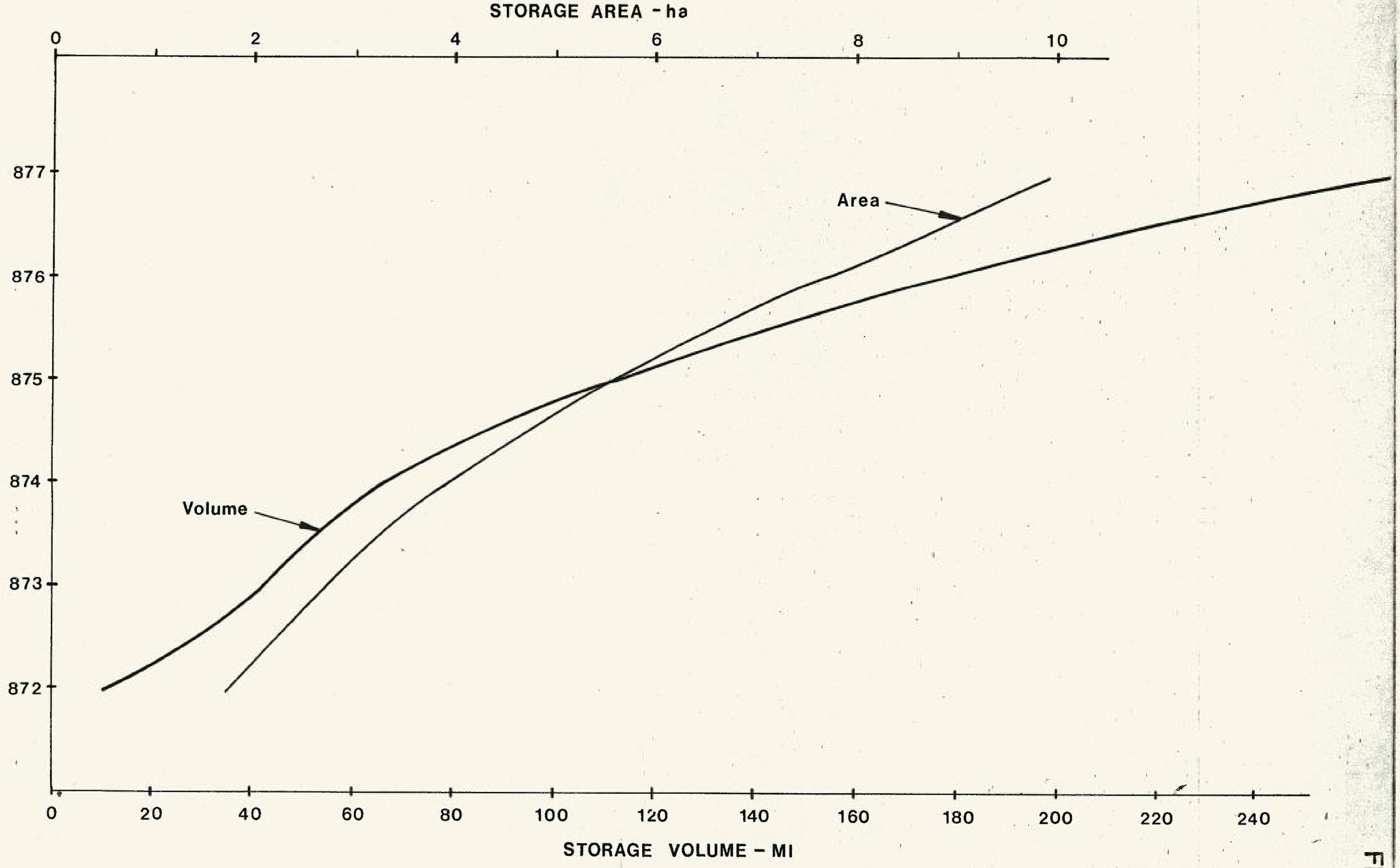
As stated, it is likely that mine seepage will exceed requirements for non-potable water and the MWSD will be called on to supply only the 1400 m^3 per month of potable demand. This volume represents on an annual basis only about 1 per cent of the average annual

FIGURE 4.2



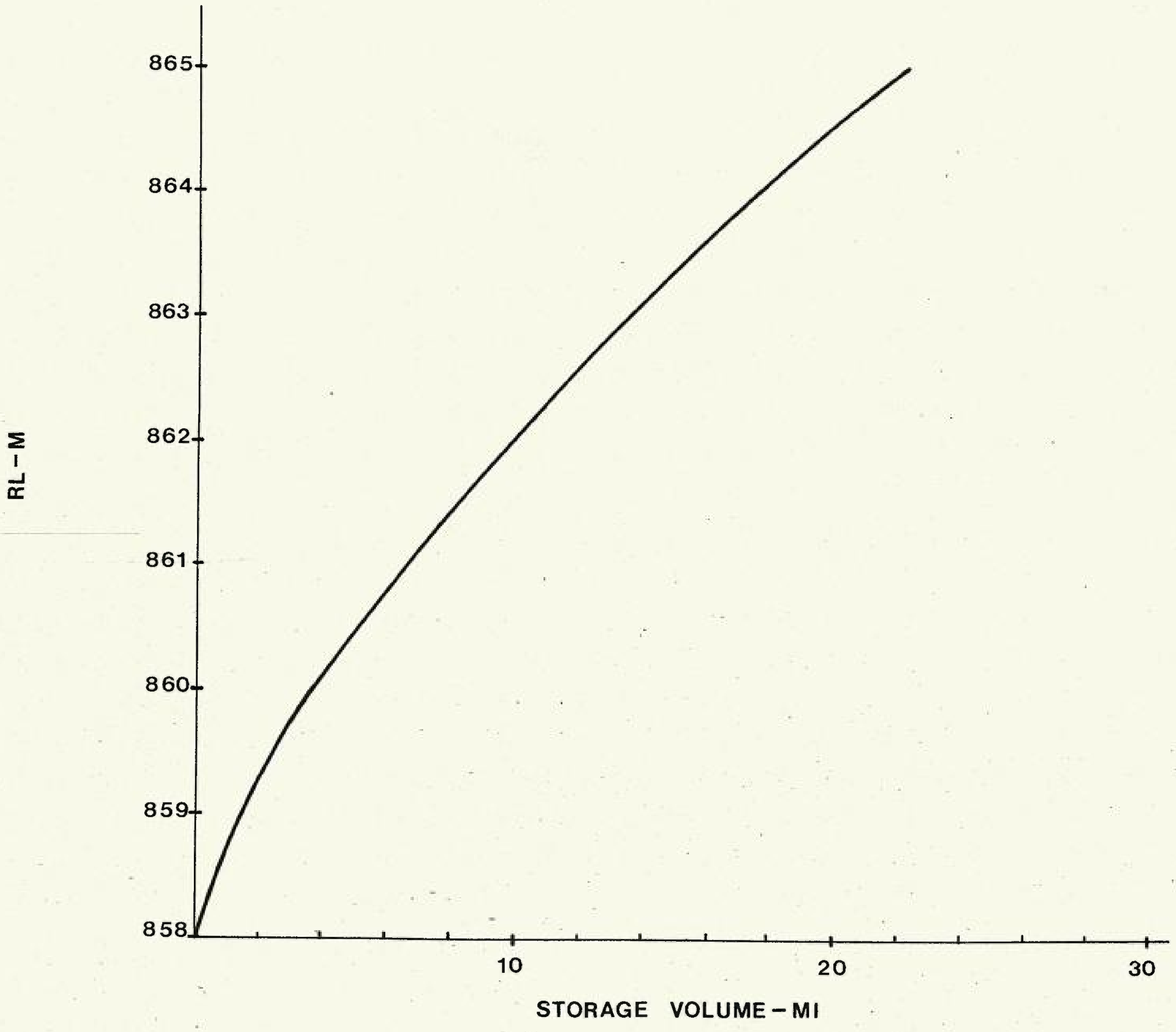
STORAGE VOLUME IN DAM
OVER CRITICAL DROUGHT PERIOD
OCT. 1964 - OCT. 1966

FIGURE 4.3



BAAL BONE MINE WATER SUPPLY DAM
ELEVATION / STORAGE RELATIONSHIP

FIGURE 4.4



BAAL BONE MINE
DIRTY WATER STORAGE
ELEVATION / STORAGE
RELATIONSHIP

runoff from the catchments above the dam. During normal years the effect of the project on the pattern of streamflows would be negligible and the storage would on most occasions be full, with water continuously flowing over the spillway. In dry spells, the storage would be drawn down slightly by evaporation but the release rule previously mentioned will ensure maintenance of flow in Ben Bullen Creek.

Should the mine prove to be relative dry yielding say, 5400 m^3 per month or 25 per cent of the best estimate, the MWSD would supply the potable demand plus outstanding portion of the non-potable demand. This amounts to 5600 m^3 per month * in total, which corresponds on an annual basis to 4 per cent of the average annual streamflow. During normal years the pattern of streamflows would not be significantly affected by a withdrawal of this magnitude.

However, although generally well watered, the region is prone to periods of below average runoff lasting from 4 to 6 months. During such periods, the effects of the dam on flows in Ben Bullen Creek will be severe unless provision is made for the continuous releases previously discussed. Table 4.3 has been extracted from the behaviour studies to show the low flow sequences under natural or "pre-mine" conditions (Column 4) and if the mine had been in operation over the study period; "post-mine" (Column 5). A rate of seepage of 5400 m^3 per month has been assumed. Also shown, in Column 3, are the total runoff volumes over the period if the year had been a normal year as far as runoff was concerned.

For example, over the six months from April to September 1954 when 740 megalitres of run-off would have been expected if the year had been a normal year, 38.4 megalitres of runoff actually occurred and with the project in operation, 37.4 megalitres of this runoff would have been released. With no provision for continuous release all of this runoff would have been stored.

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* This comprises 1400 m^3 per month potable plus (9600 - 5400) m^3 per month non-potable shortfall.

Low flow sequences similar to those shown on Table 4.3, apart from the 21 month sequence from December 1964 to August 1966, could be expected to occur on the average once in 3 years. The December 1964 to 1966 drought was clearly of unusual severity, although it appears to have been matched by the current drought in that area. During a recent site inspection (February 1981) Ben Bullen Creek upstream of the mine area had ceased to flow.

TABLE 4.3

EFFECT OF PROJECT ON

FLOWS IN BEN BULLEN CREEK

DURING LOW FLOW PERIODS

Drought Period	Duration - Months	Total Volume of Runoff over period in a normal year - Ml	Total Volume of Runoff - Ml	
			Pre-Mine	Post-Mine
April 1954 - Sept 1954	6	740	38.4	37.4
Dec 1956 - March 1957	4	490	61.6	32.0
Oct 1957 - Jan 1958	4	490	100.4	18.3
April 1958 - July 1958	4	490	45.1	26.8
Jan 1960 - April 1960	4	490	43.7	28.6
Feb 1961 - June 1961	5	620	33.0	31.0
Mar 1962 - June 1962	4	490	32.9	21.7
Dec 1964 - Aug 1966	21	2600	218.8	104.0
April 1967 - July 1967	4	490	24.3	20.3
April 1972 - Sept 1972	6	740	61.1	61.0
Dec 1974 - May 1975	6	740	71.8	38.5

NOTE: Volumes shown are in Megalitres (Ml)
1 Ml = 1000 cubic metres

4.4 Flood Hydrology

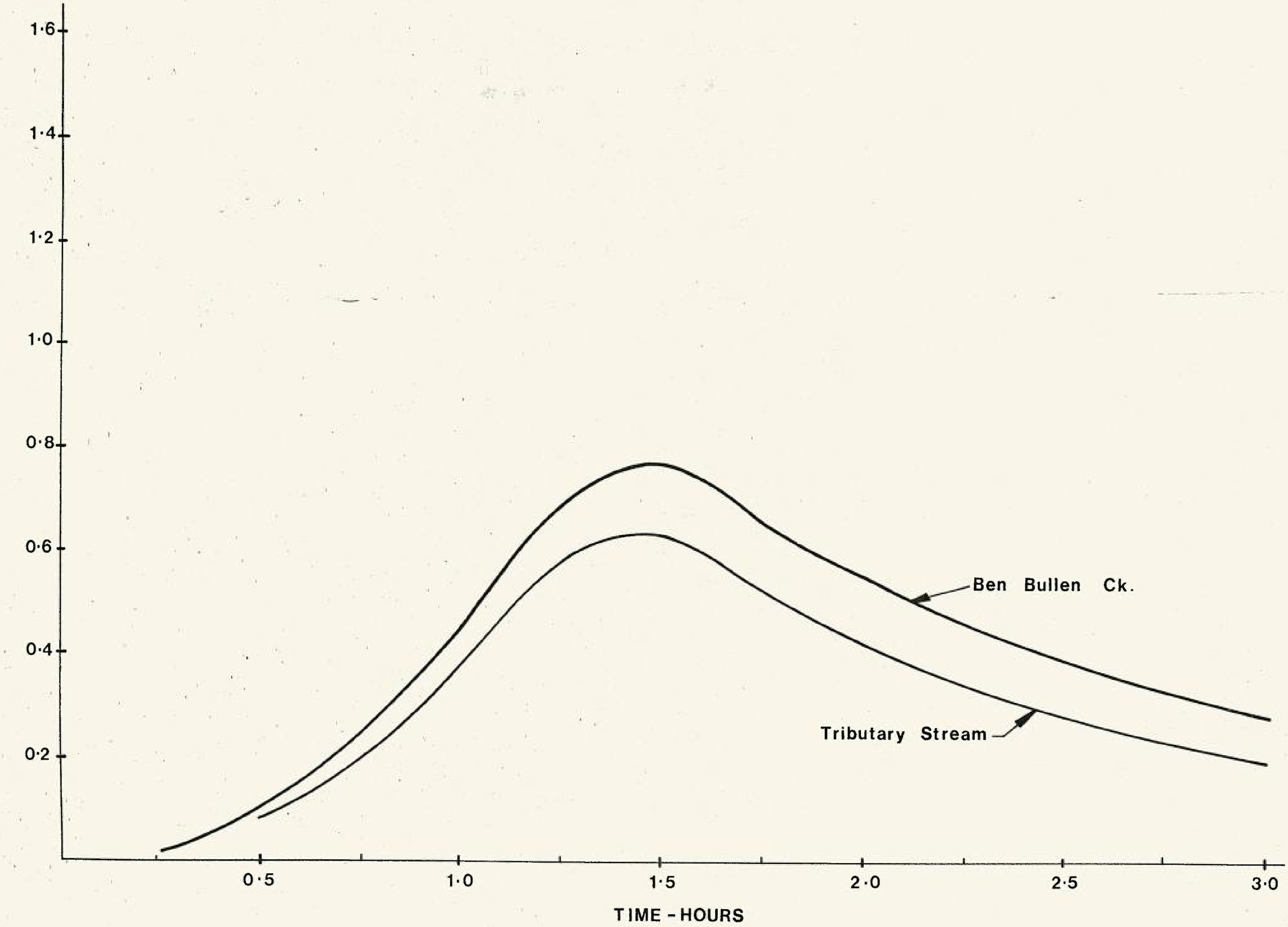
This section deals with the hydrologic design of the dam spillway, capacity of the diversion channel and estimation of flood runoff from the natural catchments to the south-west of the site which will drain to the diversion channel. Finally, possible surcharging of the dirty water storage during storm periods is discussed.

4.4.1 Storage Dam Spillway

The spillway was designed to accommodate runoff from the 100 year flood, which was estimated using a design storm-loss rate - unitgraph technique. Intensities and time distributions of rainfall for storms of 100 year recurrence interval and durations from 1 to 2.5 hours were estimated using procedures outlined in Ref. 2. Hyetographs of rainfall excess were derived by subtracting a continuous infiltration loss of 2.5 mm per hour from the gross rainfall. For the sake of conservatism, no allowance was made for initial loss.

The synthetic unitgraph procedure of Cordery and Webb (Ref. 3) was used to derive unitgraphs for Ben Bullen Creek and its tributary stream. These are plotted on Figure 4.5 and characteristics of the unitgraph are shown on Table 4.4. These unitgraphs are consistent with those derived in previous flood runoff studies on other catchments in respect to peak discharge and shape.

Inflow flood hydrographs to the storage were calculated by applying the hyetographs to the synthetic unitgraphs. These were then routed through the storage using a computer programme based on the standard level pool routing approach. It was assumed that the storage was at its full supply level of RL875 m at the time of the flood. Figure 4.6 shows inflow and outflow hydrographs. The critical storm duration is 2 hours as it results in the maximum flood storage level and peak outflow. These results apply for an uncontrolled broad crested weir spillway of 16 m width. The storage - elevation relationship for the dam shown on Figure 4.3 was calculated by planimetry from a 1:1000 scale plan with 1 m contours. The storage volumes shown are conservatively small as the contour plan did not extend to the upstream limit of the storage area and planimetering was only carried out within the areas contoured.



BAAL BONE MINE
SYNTHETIC UNITGRAPHS

FIGURE 4.5

TABLE 4.4

PARAMETERS OF

SYNTHETIC UNITGRAPHS

STREAM	CATCHMENT AREA - KM^2	C - HR	K - HR	PEAK DISCHARGE M^3/S
Ben Bullen Creek	6.2	1.27	1.45	0.78
Tributary Stream	4.0	1.24	1.33	0.64

Table 4.5 gives peak inflow and outflow discharges and the maximum storage elevation. Allowing for freeboard, the recommended crest level of the dam is RL 877.5.

TABLE 4.5

RESULTS OF

FLOOD ROUTING CALCULATIONS

INFLOW FLOOD PEAK M^3/S	OUTFLOW FLOOD PEAK M^3/S	PEAK STORAGE LEVEL RL-M
72	64	876.9

Note: These results apply for a 16m wide spillway.

4.4.2 Natural Catchment Flood Peaks

The runoff from two natural catchments to the south-west will be channelled and directed around the rail loop to the main diversion channel. The catchments are denoted "I" and "II" on Figure 1.2.

Estimates of the 1 in 100 year peak flow were made using the rational method. The times of concentration and runoff coefficients were estimated using results of recent research carried out at the University of N.S.W. Details are given in Table 4.6

Table 4.6

FLOOD RUNOFF FROM NATURAL CATCHMENTS I AND II

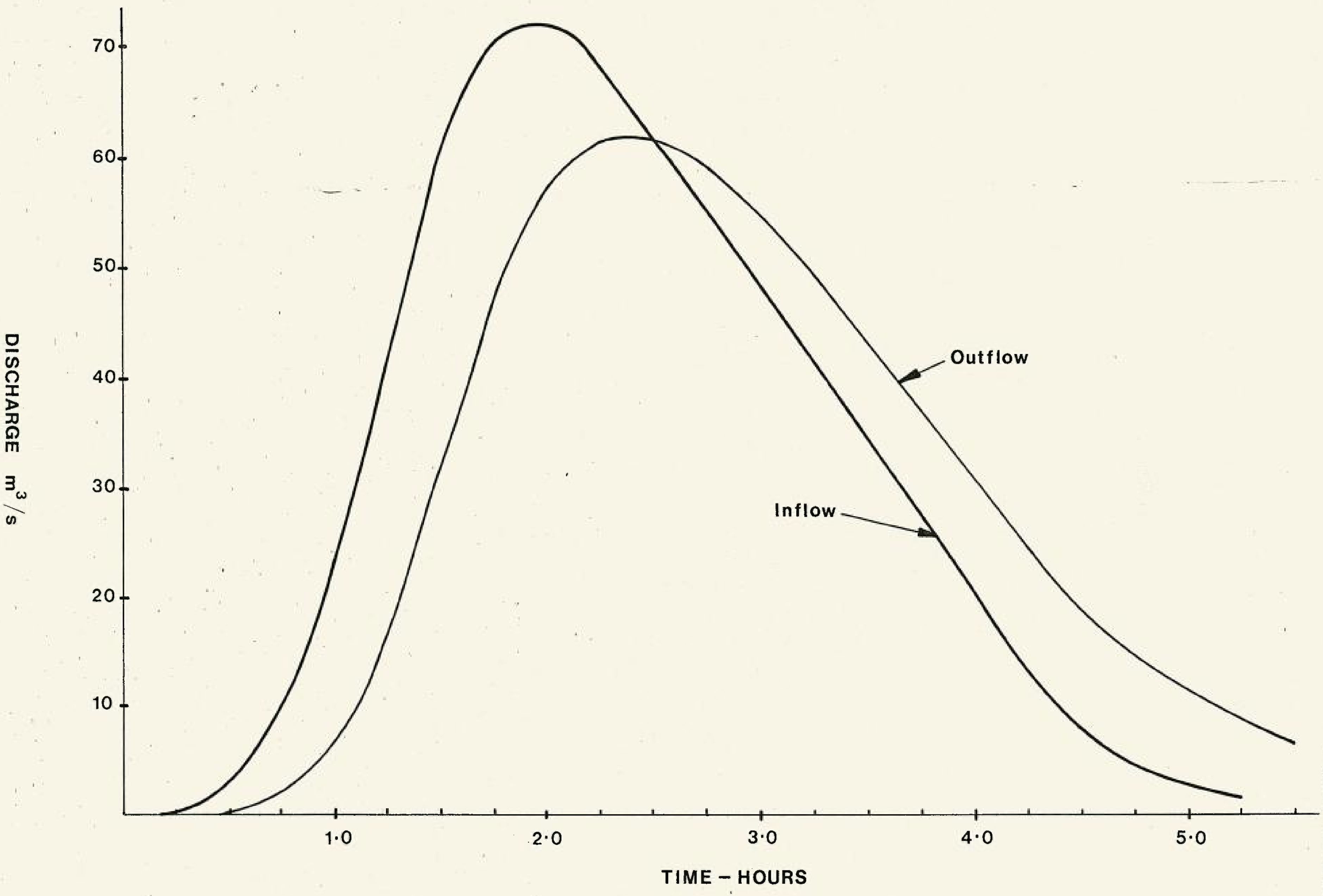
CATCHMENT AREA - KM^2	TIME OF CONCENTRATION - HOURS	PEAK DISCHARGE Q100 - M^3/S
1.13	0.80	8.5
0.33	0.50	3.3

4.4.3 Diversion Channel Flood Peaks

The diversion channel will be sized so that it is capable of passing the outflow hydrograph from the dam and natural catchment runoff which enters downstream of the spillway. From Figure 4.6, the 1 in 100 year peak outflow from the dam was estimated at 64 m^3/s and its time of occurrence 2.5 hours after the commencement of the storm. The response time of the natural catchments is much less (Table 4.6), so that during occurrences of intense rainfall approximating that of the design storm, the hydrographs from these sources will have already passed through the diversion channel. The possibility of a synchronisation of the spillway outflow and natural catchment flood peaks is so remote that it is considered acceptable to size the diversion channel for 64 m^3/s.

FIGURE 4.6

INFLOW & OUTFLOW
HYDROGRAPHS AT DAM
FOR 2 HOUR STORM



Diversion Channel Flood Peaks (Cont'd)

It is to be noted that water levels in the diversion channel will probably be controlled by the discharge capacity of the existing culvert opening beneath the road downstream of the mine. The pit located just upstream of the road will tend to act as a detention storage and to some extent "swallow up" the outflow flood hydrograph from the MWSB. Flood routing and backwater calculations along the diversion channel will be required at the design stage to establish peak water levels adjacent to the pit top. This matter is outside the scope of this present study.

4.4.4 Surcharging of the Dirty Water Storage

The catchment area of the DWS totals 12.5 hectares and comprises 8.2 hectares devoted to coal storage areas and the remaining 4.3 hectares are pit top and miscellaneous areas as shown on Figure 1.2. The coal storage areas would tend to store a large percentage of rain falling directly on them due to their large void space. Drainage to the DWS would be delayed by this storage effect. The response time of the pit top and other dirty water areas would be more rapid with a larger proportion of the rain entering the DWS runoff.

If the bywash from the DWS is set at around RL864.5 m, a total volume of 20000 m^3 is available for storage of runoff from the above areas.

Insight into the behaviour of the DWS during isolated storm events can be gained by considering storm rainfall intensity - frequency relationships for the area given in Ref (2) and daily rainfall data supplied by a local landowner. This latter data comprises a record of daily falls experienced over the period 1966 to date at a point near Ben Bullen.

Tables 4.7 and 4.8 below are derived from these sources. Runoff volumes shown in column (5) were obtained by applying runoff coefficients to the gross rainfall depths. On the basis of these calculations it appears that even infrequent storm events could be contained within the DWS storage. The hydrologic behaviour of coal storage areas is of course uncertain as no published data could be found regarding runoff coefficients. However, the provision of 20000 m^3 of storage would permit a large error in the coefficients assumed herein, whilst still ensuring containment of runoff.

TABLE 4.7

STORM RUNOFFS TO DWS

1 In 2 Years Recurrence Interval

Storm Duration - hours (1)	Gross Rainfall - mm (2)	Assumed Runoff Coefficients		Runoff Volumes - m^3 (5)
		Coal Storages (3)	Dirty Water Catchment (4)	
12	60	0.2	0.6	2500
24	80	0.2	0.5	3000
72	115	0.2	0.5	4500

1 In 50 Years Recurrence Interval

Storm Duration - hours (1)	Gross Rainfall - mm (2)	Assumed Runoff Coefficients		Runoff Volumes - m^3 (5)
		Coal Storages (3)	Dirty Water Catchment (4)	
12	108	0.25	0.8	6000
24	144	0.2	0.6	6000
72	230	0.2	0.5	9000

NOTE: Runoff volumes are calculated on the basis of the following catchment areas:

Coal Storage Area = 8.2 hectares

Remainder of Dirty Water Catchment = 4.3 hectares

TABLE 4.8

MAXIMUM RAINFALLS
RECORDED NEAR BEN BULLEN
(1966 - 1980)

Duration - hours (1)	Gross Rainfall - mm (2)
24	101
48	180
72	200

LIST OF REFERENCES

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3. Cordery, I. and Webb, S.N.
   "Flood Estimation in Eastern New South Wales - A Design Method".
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   N.S.W.

ANNEXURE

ADDITIONAL DETAILS ON SIZES

&

OPERATION OF WATER STORAGES

DIRTY WATER STORAGE DETAILS

The proposed DWS is an existing pit which will be developed to form a storage of dirty water by the construction of an embankment dam at its northern end, together with outlet works to deliver flows to a nearby treatment plant and lining with a suitable impervious material to prevent groundwater contamination due to seepage into the pervious spoil on the right bank. This storage will be used as a pumping pool for the delivery of non-potable supplies to the various consumption points around the site. The storage will be approximately 130 m long by 30 m wide and 6 m in depth and at the suggested top water level of RL 864.5 is capable of retaining about 20,000 m^3 (20 ML).

Water surplus to non-potable requirements will be treated, should water quality monitoring show that it is required, and released to the downstream drainage lines and thence to Ben Bullen Creek or, alternatively, the treated water could be used for irrigation of revegetated surfaces. In the unlikely event of a storm of sufficient intensity to cause an overflow (i.e. an uncontrolled release), a bywash spillway would come into operation to prevent overtopping of the embankment. During normal climatic periods, however, the storage would be maintained at a low volume, no more than 5000 m^3, in order to maximise its flood storage capability.

Several possible materials could be used to form the impervious liner: synthetic rubber sheeting, shotcrete i.e. spray concrete, or rolled clay. The final choice is, of course, a matter for detail design, where the engineering feasibility and relative economics can be explored in detail. Adoption of rubber sheeting may possibly involve the lowest installation cost as it would require minimal reshaping of the pit sides. However, maintenance costs may be high as the liner would be vulnerable to damage by plant during de-silting which will probably be required over the life of the project.

Shotcreting would not require extensive re-shaping and would probably not incur excessive maintenance costs, provided attention was given to the design of a suitable drainage system to relieve excessive unbalanced groundwater pressures which could be developed behind the shotcrete layer when the storage is drawn down. Initial costs may be higher than the other alternatives due to the labour involved in preparing the surfaces of the pit.

The third method, clay lining, would be the most desirable from the maintenance viewpoint, but would require extensive re-shaping of the pit to ensure side slopes sufficiently flat to accept the clay layer. A drainage system may be required here also, to relieve unbalanced groundwater pressures.

All of the above matters, including final selection of a top water level compatible with other elements of the project, will be resolved during the design phase.

TAILINGS POND - REFUSE AREA A

A tailings pond* could be developed by means of a low embankment across the gully to give a storage of about 80 m in length and 20 m in width. At a maximum storage level of RL 862 m, which corresponds with a water depth of 2 m, it would retain about 4000 m^3 (4 ML), which is equivalent to 20 mm of runoff from the area within the rail loop.

At present, any surface runoff generated within the area flows into the inverted tee-shaped gully and passes through the proposed storage area. Similarly, it appears that rainfall which infiltrates the spoil would travel as subsurface flow towards the gully, which is the lowest point in the area, and eventually reappear as seepage. Therefore, provided the storage was left unlined, it should intercept the major portion of flows originating from the proposed refuse area. A pipe would, of course, need to be located in the gully where it is traversed by the rail loop.

Depending on the quality of the stored water, the storage would either be evacuated by a low level outlet through the embankment, with the outflow being directed to the main diversion channel or, if necessary, flows would be piped to the DWS for treatment prior to release to Ben Bullen Creek. In the event of poor water quality, the storage should be drawn down by continuous release to the DWS so as to maximise its capacity for retaining flood runoff and leachates. The proposed storage volume, when operated in this manner, would be capable of fully retaining significant storms and, as a minimum, storing the first flush of runoff from long duration rainfalls.

From the drainage viewpoint, filling of area A would best take place from the circumference of the rail loop towards the gully, followed by filling of the head of the gully and proceeding in the downstream direction. Provision would need to be made for channelling surface runoff to the pipe mentioned above. However, these details, together with final selection of the storage dimensions and the top water level, are matters for detailed investigation at the design stage.

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*See Figure 1.2 for location.

MAIN WATER SUPPLY DAM

The existing dam across the tributary will be removed and replaced by an earth embankment extending to the right bank of Ben Bullen Creek. The embankment will have a maximum height of about 8 metres from crest to stream bed level. A spillway cut through the left abutment will convey overflows to the main diversion channel and thence to Ben Bullen Creek (the hydrologic design of the spillway is discussed in Section 4.4).

The storage will have a 3 m operating range, RL 872 m to RL 875 m (see Table 2.1 for storage details) and the outlet works will be designed so as to be able to draw off supplies in this range. The outlet works will incorporate facilities for providing controlled releases via reticulation to the pit top area and to the DWS if "top-up" supplies are required. An additional outlet will be provided so that flows can be maintained in Ben Bullen Creek during periods when the storage level falls below the spillway crest.

In order to construct the embankment and to maintain good water quality during the early operational period, a large bed of reeds located on the line of the dam and within the storage area will need to be removed. The storage area appears relatively water tight so that losses to groundwater are not expected to be significant. During extreme flood events the storage level could rise about 1.9 m above spillway crest level, however this rise would only last for several hours at most. No development is located within the tailwater influence of the dam which could be adversely affected.

TAILINGS PONDS - REFUSE AREAS C & D

Operation of area A and its tailings pond will clarify requirements for ponds in the above areas. For this reason, locations of ponds have not been finalised in this present investigation.

From site inspection, it appears that it may be easier to intercept drainage from area C than area D. Two suitable sites which lie in the path of surface and sub-surface drainage lines from this area are indicated on Figure 1.2. Site C.1 is an existing pit which could be easily developed to intercept drainage from the deep excavation immediately upstream. (It is logical to expect that filling operations would commence in these existing excavations.) Site C.2 is located adjacent to Ben Bullen Creek and could be developed into a storage area by construction of a low embankment across a gully. Although close to the creek, the site has a rocky bed so that the volume of untreated water likely to by-pass the treatment facility due to seepage from the storage would be small.

Site D.1 was located for a tailings pond on the eastern side of Ben Bullen Creek. However, it is felt that this site alone would not be capable of development to ensure capture of drainage from all of area D. The best strategy for filling may therefore be to concentrate operations in area C and to limit filling of area D to the existing deep excavations which are present on this side also, together with filling of that part of area D from which drainage could be controlled by a storage at site D.

Section 2.3 in this report and Section 3.5 on the companion report "Water Quality Impact Assessment" give further background information on requirements for controlling drainage from these areas. Of necessity, they are of a generalised nature at this time. Experience gained with the operation of area A will permit design of appropriate anti-pollution measures.

BAAL BONE COLLIERY PIT-TOP AND MINING PROPOSAL AT CULLEN BULLEN

WATER QUALITY IMPACT ASSESSMENT

BY

A.G. FANE, B.SC., PH.D., C.ENG., M.I.CHEM.E.

APRIL, 1981

CONTENTS

1. INTRODUCTION

Coalex Pty. Ltd., propose to establish a mine in a coal bearing area, known as Baal Bone, as a replacement for the Wallerawang Colliery which is due to cease operation in 1981-82.

The proposed colliery will include pit-top facilities, bathhouse, workshop, coal preparation plant, stockpiles for coal and refuse areas. Road and rail access will also be constructed.

This report provides an evaluation of the existing water quality at the Baal Bone site, assesses the possible impacts of the proposed colliery and its operation on the aqueous environment, and assesses the recommended safeguards for environmental protection. It should be read in conjunction with the report on Water Supply and Water Management.

2. THE EXISTING ENVIRONMENT

2.1 The Site

The area chosen for the surface development of the colliery occupies about 40 ha sloping down to the north-west between RL 880 and RL 860. Ben Bullen Creek, which rises at the head of the valley to the south east flows through the site in a north and westerly direction and joins Jews Creek about 2 km north of the site. Jews Creek is a contributor to the water stored in the Burrendong Dam. An additional area of about 50 ha adjacent to and south of Jews Creek at its junction with Ben Bullen Creek, has been set aside for the disposal of refuse.

The catchment of Ben Bullen Creek and its tributaries is mainly open eucalypt forest but becomes swampy just upstream of the site. Several small water courses run into the site from the south-west out of an area which is partially cleared for grazing.

The site itself was used for open cut mining operations 30 to 40 years ago, and has many deep water-filled excavations and piles of spoil containing broken shale, soil and residual coal. These abandoned workings continue to the north-west as far as Jews Creek. A feature of the site is that there are signs of significant erosion of the topsoil and subsoil (clay).

The natural flow of Ben Bullen Creek has been disturbed by the open cut operation, and it appears that the water finds its way through the interconnected excavations by direct flow (in wet weather) or seepage (in dry weather). As it passes through the workings, the water quality changes (see below).

2.2 Water Quality

Water samples were collected from various locations shown on the map (Figure 1) on five separate occasions. Three occasions (21/3/80, 5/4/80 and 12/2/81) were after periods of dry weather, and two (21/5/80 and 1/7/80) were after significant rainfall. Although limited in number, these samplings are probably fairly representative of conditions at the site except for storm flow. Analytical data and observations are detailed in Tables 1 to 6 in Appendix 1, and some are plotted in Figure 2.

The results are summarized below:

(i) The waters in Ben Bullen Creek above the site, and tributary water in the existing dam, are slightly acid (pH 6.0 to 6.5) with relatively low dissolved solids (average 55 ppm). This is typical of natural streams in sandstone areas.

(ii) As soon as the water enters the excavations it becomes alkaline to a maximum pH of about 8.5 to 9.0 and the total dissolved solids increase to between 150 and 250 ppm (see Figure 2).

(iii) The increase in total dissolved solids and pH occurring as water enters the site is primarily brought about by an increase in total alkalinity and hardness (see Table 6). This indicates the presence of carbonates in the exposed subsoil or in the old refuse material. Salinity (as sodium and chloride ions) and sulphates also increase significantly, particularly over the downstream section of the workings.

(iv) A steady drop in pH (from the maximum at site 4, occurs across the excavations to give an approximately netural pH at the downstream end of the site; the drop in pH is more evident in wet weather (see Figure 2). An increase in sulphate ions (Table 6) matches the drop in pH, which suggests that acid leachate may be entering the stream flow and neutralising the alkalinity introduced at the top end of the excavations.

(v) Wet weather analyses (Table 6) tend to give slightly lower compositions than dry weather analyses, presumably as a result of dilution. (NOTE: On the fourth sampling the flow downstream (point 6) appeared to be noticeably more than at the inlet (point 2) of the workings. This may be caused by ground water flow or the delayed surge effect of the large capacitance system).

(vi) Wet weather samples from sites 5, 6, 7, 4A and 4B, and to a lesser extent 4, are noticeably turbid (Tables 3 and 4). This is probably due to an influx of fine clay or colloidal shale suspension washed from the faces of the excavations, adjacent eroded areas and from the old spoil heaps.

(vii) Ben Bullen Creek above the site contains a small amount of iron, and on passage through the workings the iron content first drops (as the water becomes alkaline) and then rises to double the input concentration as it leaves the site. This provides further evidence that leachate or run-off from the old refuse material is affecting the water quality.

(viii) Analyses for heavy metals, i.e. copper, zinc and cadmium, were below the detection limits of the instrument.

Clearly the aqueous chemistry of the old excavations is complex. However, it appears that the first excavation boosts the alkalinity of the stream flow and that the subsequent excavations modify this by input of run-off or leachate (acid-water) which lowers the pH, and increases the sulphate and iron content. These changes in water quality would be expected to result in differences in aquatic fauna upstream and downstream of the site. Indeed, this occurs as indicated in the Report on Existing Wildlife. However, it should be stressed that the water quality of Ben Bullen Creek as it leaves the site and enters Jews Creek is relatively high. Although the changes currently induced by the old refuse are noticeable, they are not a serious problem, suggesting that the spoil has a well-weathered surface which reduces its pollution potential.

2.3 Regulations and Water Quality Criteria

Neither Ben Bullen Creek nor any of the downstream water systems into which it flows are currently classified under the N.S.W. Clean Waters Act. Nevertheless, under Section 19 and Regulation 11A of the Act, the approval of the State Pollution Control Commission must be obtained for the installation and operation of water pollution control equipment and for the storage, treatment or disposal of mining wastes/ The State Pollution Control Commission document EGM 2 (Ref. 1) provides a guide to the environmental controls of coal washery reject material. In general, treatment will be necessary to a level that will not greatly affect downstream users and natural fauna. Permits will also be required from the Water Resources Commission for diversion and usage of waters flowing onto the site.

A question arises concerning the quality for water discharged from any new project to Ben Bullen Creek. At present, the water quality is noticeably changed, as it crosses the existing excavations; in other words, there is an existing environmental impact caused by the previous open-cut operation.

Nevertheless, the criteria for future discharge to the Creek should be aimed at not significantly adding to the existing impact. Consequently, the quality for discharge should comply approximately with that for discharge to Restricted Waters, which is the least stringent classification for fresh waters which have been classified (see Appendix 2). The more pertinent criteria are those which restrict the pH of discharges to the range 6.5 to 8.5, and which restricts the filterable iron (in the waters) to 0.3 mg/l. The fact that the existing environment (Table 6) already has, under some conditions and at certain locations, iron contents in excess of 0.3 mg/l may require this criterion to be relaxed.

3. POTENTIAL ENVIRONMENTAL IMPACT. RECOMMENDED CONSTRUCTIVE SAFEGUARDS

3.1 Introduction

The proposed water management scheme (Figure 1.3 in the Report on Water Supply and Water Management Planning) anticipates a water surplus under normal conditions. This surplus occurs because the best estimate of mine seepage rate (21,000 m^3/month) greatly exceeds the water demand for washery make-up (9000 m^3/month). As indicated in the Report on Water Supply (etc.) - Section 3.5, zero discharge would require excessively large evaporation ponds. The alternative strategy involving collection, monitoring and treatment of contaminated waters is the only practical approach.

Several features of the proposed water management scheme have potential impact on Ben Bullen Creek and waters downstream, as follows:

(i) effect of the Main Water Storage Dam (MWSD) on stream flow,

(ii) discharge from the Dirty Water Storage (DWS), which collects pit-top drainage (including Workshop Effluent), mine seepage water, and coal stockpile run-off and drainage,

(iii) discharge from the sewage treatment plant which handles effluents from the bath-house and administration block,

(iv) discharge from the refuse areas.

Other factors which require consideration are the initial (construction phase), rehabilitation and the final (end of project) condition.

3.2 Effect of Storage on Streamflow

The enlargement of the existing dam to form a 'main water storage dam' (MWSD) could result in an interruption of the flow in Ben Bullen Creek during drought conditions, and this could have adverse environmental effects. However, the Water Resources Commission can be expected to require continuous releases be made from the dam to maintain flow in the Creek. This requirement will mitigate the effect of the MWSD.

The behaviour study (see Report on Water Supply and Water Management Planning - Section 4.3) compares the effect of eleven droughts, over a previous 20 year period for the pre-mine and post-mine conditions. The study adopts a conservative estimate of mine seepage (25% of the best estimate) which means that the MWSD is required to top-up the DWS for supply of washery water. Even assuming this water deficit condition, the stream flow in Ben Bullen Creek is reduced by only 40% or less on seven out of eleven droughts. This study suggests that the MWSD should have a minimal effect on the streamflow provided it is operated according to the specified criteria.

At the end of project life, when the MWSD is no longer supervised, it may be necessary to reduce the overflow level of the MWSD to avoid flow interruption of the creek during drought.

3.3 Dirty Water Storage (DWS) Effluents

The DWS is proposed as a detention pond for,

(a) pit-top drainage,

(b) mine seepage water,

(c) coal stockpile run-off.

3.3.1 Pit-Top Drainage

Pit-top drainage may contain coal particles and leaked oil. Both would have adverse effects (mainly aesthetic) if allowed to enter the creek without treatment. The proposal to drain the pit-top area to a concrete pit-top settling pond and thence to the DWS will effectively reduce the level of suspended solids (see 3.3.4). Contamination by leaked oil from machinery can be minimised by locating the machinery under cover.

Waters from the Workshop will also be sent to the pit-top settling pond. These waters may be contaminated with oil and grease and if directly discharged would pollute the creek. Oil separators will be required for the oily workshop wastes and the oil so collected will have to be burned or disposed of off-site. Once the major oil components have been removed the water may then be sent to the concrete settling pond taking the pit-top waste waters. It is recommended that as part of a continuing monitoring programme, the oil/grease content of the settling pond overflow be determined. If an oil problem is identified, the Company would be expected to install additional treatment plant, possibly involving parallel plate interceptors in the settling pond and automatic oil skimming equipment.

3.3.2 Mine Seepage Water

Mine seepage water may be produced at a rate of 21,000 m^3/month, although a lower figure may be anticipated in the initial stage of the project. The quality of the mine seepage water is an unknown, but it could become quite acidic and contain moderate levels of iron, particularly as the mine ages. For example, analysis at the nearby Wallerawang Colliery showed a mine water of pH 3.2 with 44 mg/l of iron (Ref. 2). The discharge of a large volume of waste water with such a composition would have a serious impact on the water quality of the creek and downstream environment.

The proposal suggests the collection, possible usage or controlled discharge after treatment of the mine seepage waters. The effectiveness of the proposed strategy is discussed in Section 3.3.4.

3.3.3 Coal Stock-Pile Run-Off

Coal stock-pile run-off and infiltrate may contain suspended solids, be slightly acidic, and have noticeable iron content and salinity. Direct discharge of these waters could pollute the creek, although the small flow rates anticipated would minimise the impact. Nevertheless the proposal is to divert these waters to the DWS for appropriate management (see Section 3.3.4).

3.3.4 Design and Operating Strategy of DWS

The contents of the Dws may be contaminated with suspended matter, dissolved solids, particularly iron and salinity, and some acidity. Water quality in the DWS will be mainly influenced by the quality of the mine seepage water, since this is expected to be the predominant input. The build-up of dissolved solids in the DWS is unlikely since the extent of recycle (e.g. water for dust suppression returning as stockpile drainage) is negligible.

It is recommended that the DWS be suitably lined to avoid ground water contamination by infiltration. The lining used should be sufficiently robust to allow for the removal of accumulated settled solids from time to time.

Uncontrolled discharge of the contents of the DWS would have an impact on the creek - similar to that of the direct discharge of the contaminated waters discussed in 3.3.1 to 3.3.3 except that a lower suspended solids content could be expected. The proposed operating strategy (Section 3.5 in Report on Water Supply etc.) should be able to reduce the impact to an acceptable level.

The behaviour study (Section 4.4.4 in Report on Water Supply etc.) demonstrates that by allowing a buffer storage in the DWS of 20,000 m^3, surcharging due to storm run-off is most unlikely even for the 1 in 50 year storm event. Should surcharging occur in an extreme situation, the buffer storage will account for the first flush, and dilution would further minimise the impact.

In order to maintain its buffer capacity it will be necessary to discharge from the DWS in a controlled manner. The rate of discharge will depend critically on the rate of mine water seepage. For the 'best-estimate' mine seepage rate of 21,000 m^3/month the surplus for controlled discharge from the DWS would be about 12,000 m^3/month. High rainfall and more mine seepage could significantly raise this figure. For example, if the seepage rate of the Baal Bone Mine were to reach the value of about 42,000 m^3/month experienced at the Clarence Mine the surplus flow for discharge would be 32,000 m^3/month. However a working level as low as 5,000 m^3 in the DWS would still provide a detention time of 5 days for this high throughput of water. A detention time of this duration would be more than adequate to settle all but colloidal solids. Following a disturbance, such as a storm, a settling period of 12 to 24 hours may be required before controlled discharge is allowed. For undisturbed conditions it should be possible to maintain a steady discharge from the DWS.

The quality of the DWS discharge water must be carefully monitored to check for pH, suspended solids, dissolved solids, iron etc. Should any ofthe parameters exceed prescribed limits (see Appendix 2 for example) the Company must be prepared to treat the discharge. Treatment to control both pH and iron could involve the use of ultrafine limestone followed by aeration to produce ferric hydroxide precipitate. Settling would then be necessary to clarify the effluent (see for example Ref. 3). Should this chemical treatment cause an unacceptable increase in the hardness of the water it may be necessary to use caustic soda in lieu of limestone. It will be necessary to remove and dispose of the settled sludge off-site and not in the refuse area.

Although the quality of the DWS discharge is an unknown, and may vary during the project life, it is recommended that the above treatment facilities be installed at the beginning of the project. This recommendation is made because under drought conditions the discharge from the DWS may greatly exceed the flow of Ben Bullen Creek. In this case the quality of water flowing off-site and into Jews Creek may depend critically upon the ability to treat adequately the DWS overflow. It is possible, albeit unlikely, that the treated discharge could have an unacceptably high content of dissolved solids. In this case it may be necessary to provide additional water storage for release of the treated effluent at an appropriate time of high stream flow. Alternatively further treatment such as desalination by reverse osmosis, may be required. The need for such extreme measures would not be known until the project was underway.

Provided the proposed operating strategy and above recommendations are adhered to the discharge from the DWS should not have an adverse impact on the quality of Ben Bullen Creek.

3.4 Sewage Treatment Plant Effluents

The 1400 m^3/month (70 kl/day for 20 days) of potable supplies will leave the bath-house and administration block as sewage. Assuming an average occupancy of 150 people and a BOD_5 equivalence of 75 g per person per day the effluent would have a BOD_5 of about 160 mg/l for 5 days of the week; during the weekend the flow rate would drop significantly but the BOD_5 level would probably remain the same. Direct discharge of this effluent to the Creek could cause both fecal contamination and oxygen depletion due to the anticipated BOD_5 load.

The proposed treatment of the sewage in a package activated sludge treatment plant followed by a polishing pond should eliminate the potential environmental impact. A final effluent quality of 20 mg/l BOD_5 and 30 mg/l suspended solids should be achievable with such a system. Details of the package system will be specified at the design stage using Ref. 4 as a guide. However, the plant will have to be able to accommodate the intermittent flows anticipated by the 5 day working week schedule. Some form of flow balancing may be required, or an alternative to this would be the use of an intermittent system, such as the Pasveer channel. The use of polishing ponds prior to direct discharge is favoured by the State Pollution Control Commission, who recommend a pond sized to give a 10 day residence time (Ref. 4). Details such as the need for chlorination, sludge disposal and monitoring are best deferred to the design stage and/or the time for approval by the SPCC.

A problem may arise during severe drought conditions when the ratio of the stream flow to the sewage effluent flow could fall below 10:1 (this would appear to be a suitable criteria for Ben Bullen Creek even though it is not classified under the Act.) For example the 'average' flow during the 4 month period October 1957 - January 1958 was only 4,600 m^3/month, which is less than four times the effluent flow. Under such conditions it may be possible to make use of the treated sewage effluent for either dust suppression of the coal stockpiles or for irrigation in areas of re-vegetation and rehabilitation (see 3.7 below). These uses may also be appropriate under normal (non-drought) conditions, and would allow consumption of the treated water within the site rather than its being released.

3.5 Refuse Area Effluents

The mining operation will generate large quantities of washery reject material which is to be disposed of on-site by placing in refuse areas.

Coal washery reject material can have serious impact on the aqueous environment. Run-off and leachate may be acidic, have raised iron content and salinity, and contain suspended and colloidal matter. These contaminants may have adverse effects on the Creek and downstream users. The SPCC document EGM-2 (Ref. 1) outlines the potential problems and provides guidelines for control procedures.

The Baal Bone project has the option to use areas designated A, B, C and D (see Figures 1.1 and 1.4 in Report on Water Supply etc.) for refuse disposal. These are not alternative sites for reject placement since the majority of their combined areas may be required.

Refuse area A is located within the rail loop and is close to the washery. It is proposed that initial reject placement should be in this area, and that run-off and leachate be collected in a tailings pond located outside the rail loop. The acid-producing potential of fresh reject material and the quantity of leachate involved are unknown. It is proposed to monitor the leachate quality and install treatment facilities only if deemed necessary. The plant required would be similar to that recommended for the treatment of the DWS discharge (Section 3.3.4). This staged approach avoids the unnecessary provision of control equipment, at the same time ensuring adequate environmental protection. If seriously contaminated leachate is detected prior to installation of treatment facilities at the tailings pond overflow, it would be possible to pump the leachate to the DWS or the DWS treatment facility.

The area denoted Refuse Area B is not well suited for the disposal of potent 'fresh' reject material. It cannot be readily contained and leachate and run-off control would be difficult. The area could be used for deposition of weathered shale and sandstone of low pollution potential. However this material may be better used in the rehabilitation and stabilisation programme (see Section 3.7). In view of its limited storage capacity of 2 years, it is recommended that this area not be used but be recontoured in accordance with the guidelines in Reference 5, unless excessive amounts of weathered material are in need of placement.

Refuse areas C and D are both suitable for the disposal of reject material. Which area is used first is not important from a water quality viewpoint. although other factors (see Report on Acoustics) suggest a preference for area D. Both areas have deep excavations at their outer edge, and these should be filled initially to reduce the number of steep sided water holes at the end of project life (as suggested in Ref. 5).

It is probable that each refuse area will require a tailings pond for run-off and leachate collection. Both areas have suitable sites for ponding and treatment facilities. The level of treatment required can be based on experience gained with refuse Area A, and on the results of an on-going monitoring programme. This staged approach again provides for the most effective use of resources whilst avoiding adverse environmental impact.

Leachate control, by sound emplacement practice and by progressive sealing or stabilising the surface, will also reduce the potential for pollution. The proposed project acknowledges the need for this form of leachate control. Its implementation will depend on the availability of suitable top soil, or weathered sandstone, or artificial covering. The advice of the Soil Conservation Service will be sought on these matters. Rehabilitation of the site, which is linked to this problem, is discussed below (3.7).

3.6 Initial (Construction) Phase

The proposed construction programme acknowledges in a general sense the need to cater for water flow and diversion at an early stage. However the cut and fill operations required for site levelling in some areas will expose top-soil, sub-soil and old refuse material. Since these seem prone to water erosion, plans are required to prevent storm flows from these areas entering the diversion channel and causing large increases in the particulate load of Ben Bullen Creek and Jews Creek. Special attention must be paid to the disturbance of old refuse material, since this will inevitably lead to the exposure of unweathered spoil which may have a pollution potential (Ref. 5). It is recommended that, if at all possible, during these operations run-off and leachate from disturbed areas be channelled to ponds not directly connected to Ben Bullen Creek. It is also recommended that the advice of the Soil Conservation Service and the Water Resources Commission be sought on these matters.

3.7 Rehabilitation and Final Condition of the Site

The aim of the rehabilitation strategy must be to leave the site in a stable, non-polluting and safe condition. Rehabilitation of the site for commercially profitable purposes, such as grazing, does not appear to be justified according to an independent evaluation of the existing derelict open-cut operation (Ref. 5).

It is proposed to progressively seal refuse areas A, C and D as the final levels are achieved. This approach is supported by the SPCC document EGM-2 (Ref. 1), and should reduce the run-off and leachate potential of the refuse. However, the lack of top-soil and weathered sandstone may present a problem if the fresh refuse is initially toxic to plants. In this situation it may be more effective to allow the surface to weather before inducing vegetation. The advice of the Soil Conservation Service should be sought in formulating the most appropriate programme. It is recommended that refuse area B be left untouched, unless it is recontoured as recommended in Ref. 5.

Gradual revegetation should be part of the rehabilitation programme. To aid plant growth and provide nutrients, it should be possible to selectively spray-irrigate using the treated effluent from the package sewage treatment plant (Section 3.4). This usage will at the same time avoid discharge of this effluent to Ben Bullen Creek.

At the end of the project all water storages should be evaluated in terms of their safety and pollution potential. The MWSD should have its overflow level lowered to avoid undue attenuation of the flow in Ben Bullen Creek during drought or dry periods. The DWS should be allowed to reach its equilibrium level, and providing the input of mine seepage water is ceased the DWS water quality should improve to a point where surcharging will not be a pollution problem. It may be necessary to modify the steep sides of the DWS for safety reasons (Ref. 5). Tailings ponds should be retained as water bodies, although they should be monitored from time to time after the end of the project to detect any acid leachate problems.

3.8 Monitoring Programme

A monitoring programme during and following the project is recommended, because several of the discharges from the proposed operation are of unknown quantity and quality.

The discharges concerned are those from the Pit-top (Section 3.3.1) which could contain oil and grease, Dirty Water Storage (Section 3.3.4), which could contain suspended solids, iron and be acid, and Refuse tailings ponds (Section 3.5) which could contain similar contaminants. It is important to note that mine-seepage water, which is collected in the DWS, and refuse area tailings ponds could deteriorate with the life of the project. Consequently, unless treatment facilities are installed initially (as recommended for the DWS), careful monitoring of these discharges is most important as it would provide a guide to the degree and type of treatment required in the future.

At the end of the project there will still be a need to monitor discharges to the Creek from the refuse areas, which could have an impact for many years unless effectively stabilised and not producing leachate or suspended solids.

4. REFERENCES

1. 'Environmental Controls for the Disposal of Coal Washery Reject Material', State Pollution Control Commission Guide EGM-2, (1979).

2. Cant, N.C., Supplementary Technical Report (Water Pollution) in Environmental Impact Statement for North Hermitage Pit-Top Proposal at Fernbrook, (September, 1980), p.15.

3. Burke and Cudmore, Aust. Coal Ind. Res. Labs. Progress Report 72-5, (1972).

4. Wright, J.J. and Goronszy, M.C. 'The Usage of Package Sewage Treatment Plants in New South Wales', paper presented at Symposium on Package Wastewater Treatment Plants, University of New South Wales, (January, 1977).

5. 'Rehabilitation of Derelict Open-Cut Mines, Lithgow Mining Division, N.S.W.', report to S.P.C.C. by Coffey and Hollingsworth Pty. Ltd. (1976).

APPENDIX 1

Water Quality Data

Table 1: Results of Sampling on 21 March, 1980.

Site[c]	pH	Total Dissolved Solids[a]	Appearance
1	6.0	61	No particulate matter evident.
2	7.0	51	No particulate matter evident.
3	6.8	120	Slightly muddy
4	8.8	164	Clear[b], some algal growth, bullrushes present.
5	8.3	190	Clear[b], greenish tinge.
6	-	-	Clear[b], algal growth, bullrushes present.
7	-	-	Clear[b]
8	7.7	180	No particulate matter evident.
9	7.7	170	No particulate matter evident.
10	8.3	130	Stagnant, slightly muddy.

(a) In mg/litre (estimated from conductivity measurements).

(b) Clear indicates objects clearly visible at vertical depth of 600 mm.

(c) Refer to Figure 1 for sample locations.

Table 2: Results of Sampling on 5 April, 1980.

Site	pH	Total Dissolved Solids(a)	Appearance
2	6.3	56	No particulate matter evident.
3	6.0	145	Slightly muddy.
4	7.7	194	Clear(c)
5	7.3	356	Clear(c), greenish tinge
6(b)	6.8	312	Clear(c) .
7(b)	7.7	327	Clear(c)

(a) In mg/litre (estimated from conductivity measurements).

(b) There was no apparent flow between these sites.

(c) Clear indicates objects clearly visible at vertical depth of 600 mm.

Table 3: Results of Sampling on 21 May, 1980.

Site	pH	Total Dissolved Solids(a)	Appearance
2	6.6	71	No particulate matter evident
3	6.4	120	Muddy (objects visible only at depths less than 200 mm).
4	8.5	166	Clear (objects visible at depth of 500 mm).
5	7.0	294	Greenish-white, cloudy (objects visible at depths less than 250 mm).
6(b)	7.0	285	Yellowish white, very cloudy (objects visible only at depths less than 100 mm).

(a) In mg/litre (estimated from conductivity measurements).

(b) Noticeable flow between sites 6 and 7.

Table 4: Results of Sampling on 1 July, 1980

Site	pH	Total Dissolved Solids (a)	Appearance
1	6.2	62	No particulate matter evident Algal growth on rocks
2	6.5	70	as 1
3	-	-	-
4	8.5	154	Clear (1000 mm depth visible)
5	7.8	248	Cloudy
6	7.1	246	Milky-brownish (300 mm visible depth)
7	7.0	223	Milky-greenish (300 mm visible)
4A	8.0	262	Cloudy, grey-blue (300 mm visible)
4B	7.5	337	Cloudy, grey-green (300 mm visible)

(a) In mg/l (estimated from conductivity measurements)

Table 5: Results of Sampling on 12 February, 1981

Site	pH	Total Dissolved Solids (a)	Appearance
2	6.25	27	Stagnant, slightly muddy.
3	7.2	185	Slightly muddy
4	9.0	231	Clear
5	7.7	308	Clear
6 (b)	7.6	316	Muddy, light brown
7	7.5	246	Muddy, light brown
8 (b)	7.8	189	Clear, no particulate matter
10 (b)	6.7	239	Clear, no particulate matter
11	7.9	373	Slightly muddy, bluish-grey
12	6.2	116	(Seepage from old chitter)
13	6.85	104	Muddy
14	6.9	119	Slightly muddy
15	6.7	73	(Unmarked creek), Clear.
16	7.6	424	Muddy

(a) In mg/litre (from conductivity)

(b) Noticeable flow.

Table 6: Chemical Composition[(a)] of Samples Collected on 21/3, 5/4, 21/5 and 1/7/80

Parameters	Sample (b)	2	3	4	5	6/7
Total Hardness (as $CaCO_3$)	2 3 4	28 18 16	- 25 -	98 88 78	121 112 82	131 130 98
Total Alkalinity (as $CaCO_3$)	2 3	12 15	- 27	90 80	53 50	81 75
Chloride	2 3	13 15	- 30	18 17	45 43	39 26
Sulphate	2 3	13 4	- 9	11 5	93 78	67 87
Sodium	2 3 4	11 9 10	- 21 -	14 13 12	44 39 32	34 28 25
Calcium	3 4	2.7 5	4.5 -	0.8 9	8.4 7.4	11.6 11
Iron	1 3 4	0.6 0.8 0.7	0.8 1.5 -	0.05 $<$0.1 0.13	- 0.5 0.6	- 1.9 1.3
Magnesium	4	0.5	-	8	13.5	15.5
Cadmium	4	$<$ 0.01	-	$<$0.01	-	$<$0.01
Copper	1	$<$ 0.05	$<$0.05	$<$0.05	-	-
Zinc	1	$<$ 0.05	$<$0.05	$<$0.05	-	-

(a) In mg/litre (b) Date of sampling

1 21/3/80 After dry period
2 5/4/80 After dry period
3 21/5/80 After rain (mm from 5/4/80)
4 1/7/80 After rain (mm from 21/5/80)

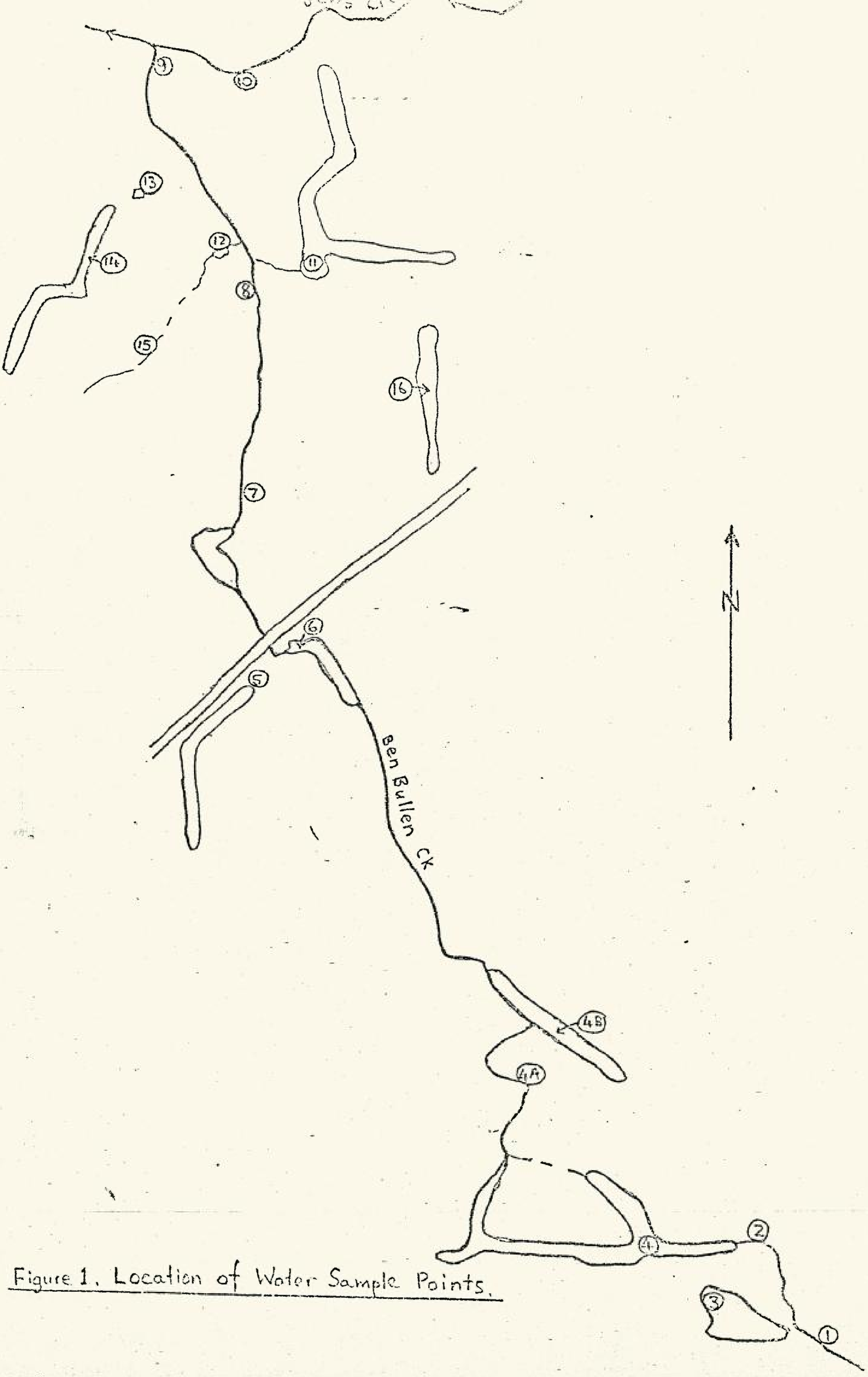


Figure 1. Location of Water Sample Points.

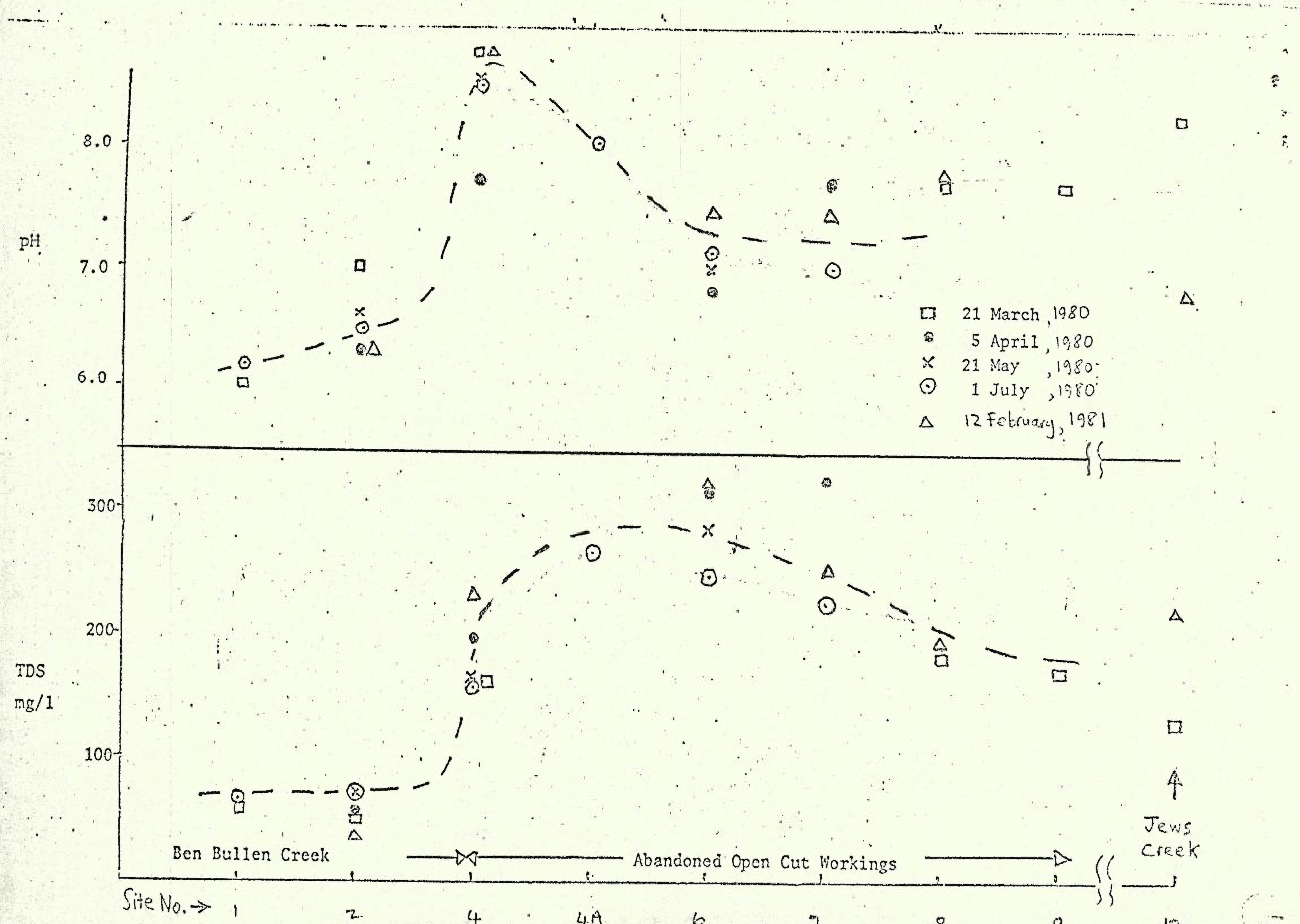


Figure 2. Profile of pH and Total Dissolved Solids in Stream Flow Across Proposed Site

APPENDIX 2

Extract from Clean Waters Act, 1970

Class R: Restricted Waters

CLASS R: *Restricted Waters*—waters into which—

(a) wastes are not to be discharged except as provided in respect of this classification;

(b) where sewerage is available, wastes which are of a type acceptable to the sewerage authority are not to be discharged otherwise than by way of a sewer;

(c) overflows from sewers, wastes pumping stations, treatment works or other parts of a sewerage system are not to be discharged except in accordance with approved conditions;

(d) organic wastes are not to be discharged unless they are so treated that the resulting effluent has—

(i) where the relative proportion of the water to the wastes is 9:1 or more but not more than 19:1—a biochemical oxygen demand of not more than twenty milligrams per litre and a non-filtrable residue of not more than thirty milligrams per litre or such other biochemical oxygen demand or non-filtrable residue as may be approved;

(ii) where the relative proportion of water to the wastes is less than 9:1 and the oxygen content of any portion of the waters is, or is likely to be reduced as a result of the discharge to, less than 60 per cent of saturation during average dry weather conditions for the area in which the waters are located—such a lower biochemical oxygen demand and non-filtrable residue as may be approved; or

(iii) where the relative proportion of water to the wastes is more than 19:1 and the oxygen content of the waters is, or is likely to be maintained after the discharge at; more than 75 per cent of saturation during average dry weather conditions for the area in which the waters are located—such a higher biochemical oxygen demand and non-filtrable residue as may be approved;

(e) infectious wastes or wastes in which faecal coliforms are likely to be present are not to be discharged unless—

(i) the wastes are treated in an approved manner; and

(ii) in the case of waters likely to be used for recreational purposes—the faecal coliform density as determined in an approved manner after sampling at an approved location does not exceed 1,000 per 100 millilitres as determined otherwise than during a period of rainfall run-off and within an approved period thereafter;

(f) wastes are not to be discharged unless they are visually free of grease, oil, solids and unnatural discolouration and free of settleable matter;

(g) wastes are not to be discharged if the resulting concentration of the wastes in the waters—

(i) is or is likely to be harmful, whether directly or indirectly, to aquatic life or water-associated wildlife;

(ii) gives rise to or is likely to give rise to abnormal concentrations of the wastes in plants or animals;

(iii) is likely to affect the subsequent use of those waters for watering stock or the irrigation of land; or

(iv) gives rise to or is likely to give rise to abnormal plant or animal growth;

(h) wastes containing a restricted substance are not to be discharged into the waters if the discharge would result in the concentration of that restricted substance in any part of the waters exceeding the concentration specified opposite that substance in Schedule 2; Substituted, Gov. Gaz. No. 129 of 8/12/72.

(i) wastes are not to be discharged if the pH value of the wastes is less than 6.5 or more than 8.5 or if the discharge induces a variation in the pH value of the waters of more than 0.5;

(j) thermal wastes are not to be discharged except in approved cases and subject to approved conditions;

(k) wastes are not to be discharged if the radioactivity level of the wastes exceeds by more than ten times the levels specified in Schedule 3 and the radioactivity level of the receiving waters beyond the approved zone is caused by that discharge to exceed the levels specified in that Schedule.

SCHEDULE 2.

RESTRICTED SUBSTANCES.

Column 1. *Substance*	Column 2. *Not in excess of*
Arsenic	0.05 milligrams per litre
Barium	1.0 milligrams per litre
Boron*	1.0 milligrams per litre
Cadmium	0.01 milligrams per litre
Chloride*	250 milligrams per litre
Chromium (hexavalent)	0.05 milligrams per litre
Copper	1.0 milligrams per litre
Cyanide	0.05 milligrams per litre
Fluoride*	1.5 milligrams per litre
Iron (filtrable)	0.3 milligrams per litre
Lead	0.05 milligrams per litre
Manganese (filtrable)	0.05 milligrams per litre
Mercury	0.001 milligrams per litre
Methylene blue active substances	0.5 milligrams per litre
Nitrogen (ammonia)	0.5 milligrams per litre
Nitrogen (nitrate plus nitrite)	10.0 milligrams per litre
Pesticides (individual or total in group)	
Endrin, chlordane, toxaphene	0.001 milligrams per litre
Other organochlorides	0.01 milligrams per litre
Organophosphates	0.05 milligrams per litre
Carbamates	0.1 milligrams per litre
Fluorinated hydrocarbons	0.001 milligrams per litre
Substituted phenols and cresols	0.001 milligrams per litre
Weedicides including 2,4-D (including salts and esters), 2,4,5-T (including salts and esters), Phenyl ureas, Triazines, Amides, Quaternary salts, Dipyridyls, Acrolein	0.1 milligrams per litre
Phenolic compounds	0.001 milligrams per litre
Selenium	0.01 milligrams per litre
Silver	0.05 milligrams per litre
Sulphate*	250 milligrams per litre
Uranyl ion	5.0 milligrams per litre
Zinc	5.0 milligrams per litre

* Limits indicated do not apply to these substances in regard to tidal waters.

COALEX PTY. LTD.

REPORT ON THE IMPACT OF COAL MINING UPON FAUNA AT THE BAAL BONE SITE, CULLEN BULLEN, N.S.W.

Prepared by: Dr. M.J.S. Denny BSc.(Hons), PhD.

Report on the Impact of Coal Mining upon Fauna at the Baal Bone Site, Cullen Bullen, N.S.W.

by Dr.M.J.S.Denny.

1 Methodology

1.1 Mammals

1.1.1 Small mammals were surveyed using Elliott aluminium live traps. The traps were set in lines through different habitat types at the main mine site. Two hundred traps were used at the site. All traps were baited with oats, peanut butter and bacon fat and were left set for at least five nights. All traps were checked each morning and any captured mammals removed, identified then released in the area captured. Cotton waste was added to each trap to prevent the animal freezing.

1.1.2 Large mammals were observed during spot-light transects and in the early morning and evening. Indirect evidence was also used to assess the presence of a mammal, e.g. droppings,scratchings,burrows and the inspection of predator faeces e.g. foxes.

1.2 Birds

These were surveyed by direct observation at any time of the day,but early morning and late evening proved most productive.

1.3 Reptiles

These were surveyed by direct observation whilst searching for other animals, or were searched for under logs,bark,stones etc. Several specimens were obtained from road kills which resulted from the relatively large numbers of trucks etc on the site during the survey.

1.4 Amphibians

Frogs were searched for at night with a torch. The main areas searched were creeks,dams,swamps and the large bodies of water between the coal refuse dumps.

1.5 Water Fauna

Two creeks will be influenced by the establishment of a coal mine at Baal Bone. One of these creeks,Cullen Bullen Creek, flows through the main mine site and will probably be used for drinking water at the mine. This creek then passes through a series of ponds formed between the coal dumps left behind from an old open cut mine. It finally flows into Jew's Creek which also receives water from areas north of the mine site.

Samples of aquatic fauna were taken from various points on Cullen Bullen Creek to discover if the previous mine workings had influenced the productivity ofthis creek.

In flowing water, a 0.5mx0.25m net was placed in the stream and rocks upstream from the net were displaced. Any animals living under the rocks were washed into the net. The contents of the net were shaken into a white dish and the animals separated and later identified. In still waters, sweeps were made with a small hand net and the resultant contents sorted. Larger animalse.g. fish,yabbies were also searched for in the creeks.

2 Baal Bone Site

2.1 Division into Habitats

The area to be used for the main mine site was divided into five different habitats for the purposes of surveying terrestrial fauna and avi-fauna. The choice of habitats was not necessarily based upon botanical composition although the vegetation differences were important. Also used to judge the different habitats were type and quantity of ground cover,slope of ground and evidence of water flow or storage. The five habitats sampled within the mine site were

(a) Hill slopes in the vicinity of the proposed drift site. This area consisted of tall,open woodland with a sparse ground cover of grasses*,bracken,rocks,logs and litter.

(b) Level ground in the vicinity of the proposed work-shop complex. This area was partially cleared and the remainder was covered with tall,open forest with a ground cover of grasses and blackberry.

* For a detailed description of the vegetation see report by Dr. T. Howard

(c) Swampy area on Ben Bullen Creek, south-east of the main mine site. This area was thickly covered with sedge, blackberry and rush.

(d) Tops of coal refuse dumps. These were covered by isolated clumps of trees and a sparse ground vegetation of grasses and blackberries.

(e) Between coal refuse dumps. Where there was no water, this habitat consisted of bare cracking soil surrounded by dense shrub (mainly blackberries), grass and rush.

(f) On proposed route of road from Baal Bone mine to the Mudgee railway line. This habitat was severely disturbed by fire, stock grazing, logging and refuse dumping. Remaining vegetation consisted of open forest, shrub and grassland.

and (g) Area surrounding existing dam on Ben Bullen Creek at Baal Bone. The vegetation in this habitat was similar to habitat (b).

2.2 Areas Sampled

All seven habitats were sampled for mammals using Elliott traps. The proportion of each habitat sampled was obtained by calculating the percentage of the 200 traps used in the different types of ground cover. It was found that 21% of the traps were placed in areas covered with grasses (all habitats), 5% in densely covered swampy areas (habitat c), 39% near or under logs, litter, rocks, (habitats a,b,d,e,f and g), 12% near trees (habitats a,b,d,e,f and g), 10% near rushes (habitats c,e and g), 6% in blackberry bushes (habitats b,c,d,e and g), 1% in bracken (habitats a and g) and 6% on bare ground (all habitats except c).

Transects using a spot-light were carried out each night. These were undertaken in two main areas. The first area was in the southern end of the proposed mining lease and was associated with the Ben Bullen Creek. The other area surveyed by spot-light was associated with the proposed road leading from the mine site at Baal Bone. Spot-lighting was from a vehicle driving along existing tracks where open woodland, swamp, cleared pasture and coal dumps were sampled.

Walks in search of avi-fauna were taken in those areas not normally visited during the sampling of the terrestrial fauna. These areas included parts of the Ben Bullen Creek and along the tops of the coal refuse dumps. Searching for birds also extended north of the main mine site towards Baal Bone Gap.

Aquatic fauna was sampled from six sites on Ben Bullen Creek,

(a) upstream of the coal refuse dumps, within the swampy area

(b) dowmstream of the coal refuse dumps, near Jew's Creek

(c) within a pond formed by the coal refuse dumps

(d) within a pond formed by the coal refuse dumps

(e) within a pond formed by the coal refuse dumps

and (f) within a pond formed by the coal refuse dumps

3. Animals Found

During the survey period,102 animal species were recorded (not including aquatic fauna). This represents 14 species of mammal (see Table 1),72 species of bird (see Table 2),5 species of reptile and 3 amphibians (see Table 3). A preliminary list of aquatic fauna is given in Table 4.

4. Discussion

The existing conditions of the Baal Bone site cannot be regarded as natural. Previous developments at the site have greatly changed this area. These developments have been; a State-owned open-cut coal mine,which operated in the 1950's, land-clearing,stock grazing,logging and fire. Consequently,the impact of a new coal mine development on a "natural" environment at the Baal Bone site would be minimal.

The number and diversity of terrestrial animal species at the Baal Bone site is similar to that found in the region. A survey by the Australian Museum on Newnes Plateau and Colo River revealed 242 species of animal (39 mammals,121 birds,50 reptiles and 32 amphibians). My survey didnot yield as many animals,however, limitations of time and area and the onset of the cooler months precluded such a large faunal list. A similar survey at Fernbrook Farm,Marrangaroo, gave a similar number of terrestrial species as that found during the Baal Bone survey.

Many more water birds were found during the Baal Bone survey than that found by the Australian Museum. These birds were using the large ponds of water formed by the old coal refuse dumps. The high number of water birds associated with these ponds may have due to the dry conditions existing elsewhere at the time. Also, the amount of food available at some of the ponds may have attracted the birds. In some of the ponds,there was a relatively high number of invertebrate species (e.g. at sampling sites d and e in Table 4). These ponds also carried the highest number of water birds.

The disturbance caused by the development of a coal mine at Baal Bone would initially cause movement away from the site by many animals. About 70% of the avi-fauna found at Baal Bone are known to be either nomadic or migratory (see Table 2). These birds would be capable of moving away from the area. As the site is adjacent to large tracts of native forest (Ben Bullen State Forest) there would be sufficient habitat available for many of the displaced species. Many of the water birds are capable of moving long distances and would be able to seek other bodies of water in the region. During the normal pattern of rainfall other favourable habitats would be available. Some sedentary birds may move the relatively short distances required to obtain new habitats in the surrounding areas. It is anticipated that some of these species as well as some of the more mobile birds will recolonize the mine site. This has happened at other mining operations in the region e.g. Wallarawang Colliery. Because of the small size of the development site, the number of bird species affected by the mining operation will be small compared with the overall numbers in the region.

Large mammals e.g. kangaroos,wallabies and wombats are relatively mobile and will be able to move away from the source of disturbance. It was observed that large mammals were in low density at the Baal Bone site. Those seen were very timid,and it can be deduced that persistant shooting of these animals has produced a low population of wary animals. Interviews with the land-owner and observations of night-time shooters at the site reinforced this conclusion. Consequently,most kangaroos,wallabies and wombats kept to the more remote forested areas. Thus activity associated with mine development should not seriously affect these species.

Small mammals may be affected by the coal mining operations,as movement away from the area is restricted. However, all small mammals caught were relatively common in the region and the overall impact would be small. Two species of small mammal caught at Baal Bone (House Mouse and Ship Rat) are introduced species and their disappearance from the area would not be regretted. A Water Rat was observed in the rushes surrounding a coal refuse dump pond. This rodent is known to occur in the area but in low numbers. Such a sighting emphasises the importance of the large tracts of water, particularly for native fauna.

Comparison between samples of the aquatic fauna found in Ben Bullen Creek showed that there was a variable impact by the coal refuse dumps upon the ecology of the waters. There was a great difference between the number and diversity of the species of aquatic fauna found upstream and downstream of the coal dumps. However, some of the ponds showed a low diversity and quantity of species. This variation could indicate differences between the ponds in the coal dumps, and may be related to differences in water quality between the ponds (see Water Quality Report). It will be important that care be taken if these coal refuse dump ponds are emptied during the mining activity. Judging from the diversity and quantity of aquatic fauna found in Jew's Creek below the junction with Ben Bullen Creek i.e. few animals were found in any samples taken at that site, then the output from Ben Bullen Creek after it passes through the dumps must affect Jew's Creek. A greater output of water from the coal refuse dump ponds may cause a fall off in productivity in Jew's Creek for a considerable distance along this water course.

If the coal mine is established at Baal Bone I recommend that;

(i) The swampy area on Ben Bullen Creek, South-east of the mine site should not be disturbed. This area is a valuable resource and is used by many animals for shelter and food.

(ii) Emptying of the water ponds formed by the coal refuse dumps should be carefully monitored to prevent possible increased pollution of Jew's Creek

(iii) Serious consideration should be given to the suggestion that some of the ponds formed by the coal refuse dumps be retained in the future as a small lake area to be used by the native fauna in the region.

and (iv) Rehabilation of the mine site should include the planting of trees and shrubs to promote the movement of animals back into the coal mining area.

* * *

General licence number SL.F 669 was issued to Dr. M.J.S.Denny by the New South Wales National Parks and Wildlife Service for the faunal survey.

Table 1: Mammals Observed at Baal Bone Site (March-April,1980)

Marsupialia		
Dasyuridae		
	Brown Antechinus	*Antechinus stuartii*
Petauridae		
	Species unknown, heard but not seen.	
Macropodidae		
	Eastern Grey Kangaroo	*Macropus giganteus*
	Red-necked Wallaby	*Macropus rufogriseus*
Vombatidae		
	Common Wombat	*Vombatus ursinus*
Chiroptera		
	Species unknown,heard but not collected	
Rodentia		
	Bush Rat	*Rattus fuscipes*
	Ship Rat	*Rattus rattus*
	House Mouse	*Mus musculus*
	Water Rat	*Hydromys chrysogaster*
Lagomorpha		
	Rabbit	*Oryctolagus cuniculus*
Carnivora		
Canidae		
	Feral Dog	*Canis familiaris*
	Red Fox	*Vulpes vulpes*
Felidae		
	Feral Cat	*Felis lybica lybica f. catus*
Artiodactyla		
	Cattle	*Bos indicus*
	Pig	*Sus scrofa*

Table 2: Birds Observed at Baal Bone Site (March-April, 1980)

		Classification
Australasian Grebe	*Tachybaptus novaehollandiae*	S/N
Hoary-headed Grebe	*Podiceps poliocephalus*	S/N
Little Pied Cormorant	*Phalacrorax melanoleucos*	S/N
Little Black Cormorant	*Phalacrocorax sulcirostris*	S/N
White-faced Heron	*Ardea novaehollandiae*	S/N
White-necked Heron	*Ardea pacifica*	S/N
Dusky Moorhen	*Gallinula tenebrosa*	S/N
Black-fronted Dotteral	*Charadrius melanops*	S/N
Pacific Black Duck	*Anas supercitiosa*	S/N
Grey Teal	*Anas gibberifrons*	S/N
Freckled Duck	*Stictonetta naevosa*	S/N
Little Eagle	*Hieraaetus morphnoides*	S
Brown Quail	*Coturnix australis*	S/N
Eurasian Coot	*Filica atra*	S/N
Common Bronzewing	*Phaps elegans*	S/N
Yellow-tailed Black Cockatoo	*Calyptorhynchus funereus*	N
Gang-gang Cockatoo	*Callocephalon fimbriatum*	N
Galah	*Cacatua rosiecapilla*	S/N
Crimson Rosella	*Platycercus elegans*	S/N
Eastern Rosella	*Platycercus eximius*	S/N
Turquoise Parrot	*Neophema pluchella*	S/N
Laughing Kookaburra	*Dacelo novaequineae*	S
Superb Lyrebird	*Menura novaehollandiae*	S
Welcome Swallow	*Hirundo neoxena*	M
Richard's Pipit	*Anthus novaeseelandiae*	S/N
Scarlet Robin	*Petroica multicolor*	S/N
Eastern Yellow Robin	*Eopsaltria australis*	S/N
Crested Shrike-tit	*Falcunculus frontatus*	S/N
Grey Shrike-thrush	*Collurincincla harmonica*	S
Grey Fantail	*Rhipidura fuliginosa*	S/N/M
Willie Wagtail	*Rhipidura leucophrys*	S/N
Spotted Quail-thrush	*Cinclosoma punctatum*	S
Superb Fairy-wren	*Malurus cyaneus*	S
Variegated Fairy-wren	*Malurus lamberti*	S
White-browed Scrub-wren	*Sericornis frontalis*	S

S = Sedentary, N = Nomadic, M = Migratory.

Brown Gerygone	*Gerygone mouki*	M
White-throated Gerygone	*Gerygone olivacea*	M
Brown Thornbill	*Acanthiza pusilla*	S
Striated Thornbill	*Acanthiza lineata*	S
Little Thornbill	*Acanthiza nana*	S
Buff-tailed Thornbill	*Acanthiza reguloides*	S
Varied Sitella	*Daphoenositta chrysoptera*	S/N
White-throated Tree-Creeper	*Climacteris leuceophaea*	S
Red-browed Treecreeper	*Ctimacteris erythrops*	S
Red Wattlebird	*Anthochaera carunculata*	S/N
Yellow-faced Honeyeater	*Lichenostomus chrysops*	S/N/M
White-eared Honeyeater	*Lichenostomus leucotis*	S/N/M
White-naped Honeyeater	*Melithreptus lunatus*	S/N/M
White-cheeked Honeyeater	*Phylidonyris nigra*	S/N/M
New Holland Honeyeater	*Phylidonyris novaehollandiae*	S/N
Eastern Spinebill	*Acanthorhynchus tenuirostris*	S/N/M
Spotted Pardalote	*Pardalotus punctatus*	S
Striated Pardalote	*Pardalotus striatus*	S
Gold Finch	*Carduelis carduelis*	S
Red-browed Firetail	*Emblema temporalis*	S/N
Australian Magpie-lark	*Gymnorhina tibicen*	S
Pied Currawong	*Strepera graculina*	S
Grey Currawong	*Strepera versicolor*	S
Australian Raven	*Corvus coronoides*	N
Wood Duck	*Chenonetta jubata*	N
Masked Plover	*Vanellus miles*	M
Noisy Friarbird	*Philemon corniculatus*	M/N
Wedge-tailed Eagle	*Aquila audax*	N
White-winged Chough	*Corcorax melanorhamphus*	S/N
King Parrot	*Alisterus scapularis*	N
Eastern Whipbird	*Psophodes olivaceus*	S

Table 3: Amphibians and Reptiles Observed at Baal Bone Site (March-April, 1980)

(a) Amphibians

Leptodactylidae	
Common Eastern Froglet	*Ranidella signifera*
Yellow-spotted Toadlet	*Uperoleia marmorata*
Hylidae	
Lesueur's Frog	*Litoria lesueurii*

(b) Reptiles

Squamata	
Scincidae	
Copper-tailed Skink	*Ctenotus taeniolatus*
	Lampropholis delicata
	Lampropholis quichenoti
Elapidae	
Red-bellied Black Snake	*Pseudechis prophyriacus*
Eastern Brown Snake	*Pseudonaja textilis*

Table 4: Preliminary List of Aquatic Fauna Caught at Baal Bone

(a) Cullen Bullen Creek, upstream of coal refuse dumps.

Invertebrates
Class: Insecta

Order: Coleoptera
Family: Gyrinidae (Whirlygig Beetles)
Order: Trichoptera (Caddis Fly Pupae)
Order: Hemiptera
Suborder: Heteroptera
Family: Notonectidae (Water Boatmen)
Order: Odonata (Dragon-fly Nymphs)
Suborder: Anisoptera
Suborder: Zygoptera
Family: Chlorocyphidae
Family: Calopterygidae
Order: Plecoptera (Stone Fly Nymphs)
Order: Diptera (Two-winged Fly Larvae)
Order: Lepidoptera (Moth Pupae)

(b) Cullen Bullen Creek, downstream of coal refuse dumps.

Invertebrates
Class: Insecta

Order: Hemiptera
Suborder: Heteroptera
Family: Notonectidae (Water Boatmen)

Phylum: Mollusca
Class: Bivalva
Genus: *Hyridella* (Fresh-water Mussel)

Class: Crustacea
Order: Decapoda
Family: Parastacidae (Yabbies)

Vertebrates

Fish,unknown species

(c) Water pond,formed by coal refuse dumps.

Invertebrates

Class: Insecta

Order: Ephemeraptera
  Family: Siphlonuridae(May Fly Nymphs)
Order: Hemiptera
  Suborder: Heteroptera
    Family: Corixidae(Lesser Water Boatmen)

Class: Crustacea
Order: Decapoda
  Family: Parastacidae(Yabbies)
  Family: Palaemonidae(Freshwater Shrimps)

(d) Water pond

Invertebrates

Class: Insecta

Order: Odonata(Dragon Fly Nymphs)
  Suborder: Anisptera
  Suborder: Zygoptera
Order: Ephemeraptera
  Family: Siphlonuridae(May Fly Nymphs)
Order: Coleoptera(Larval Beetles)
Order: Coleoptera
  Family: Gyrinidae(Whirlygig Beetles)
Order: Lepidoptera(Moth Pupae)
Order: Hemiptera
  Suborder: Heteroptera
    Family: Notonectidae(Water Boatmen)

Class: Crustacea
Order: Decapoda
Family: Palaemonidae(Freshwater Shrimp)

Phylum: Mollusca
Class: Gastropoda(Water Snail)

(e) Water pond.

Invertebrates
Class: Insecta

Order: Plecoptera
Family: Capniidae(Stone Fly Nymphs)
Order: Odonata
Family: Zygoptera(Dragon Fly Nymphs)
Order: Coleoptera(Beetle Larvae)
Order: Hemiptera
Suborder: Heteroptera
Family: Corixidae(Lesser Water Boatmen)
Order: Diptera
Family: Culicidae
Subfamily: Culicinae(Mosquito Wrigglers)

Class: Crustacea
Order: Decapoda
Family: Palaemonidae(Freshwater Shrimp)

(f) Water pond.

Invertebrates
Class: Insecta

Order: Lepidoptera(Moth Pupae)

Class: Crustacea
Order: Decapoda
Family: Palaemonidae(Freshwater Shrimp)

5. SUMMARY: EXISTING WILDLIFE

During the survey period, 89 animal species were recorded at Baal Bone(not including aquatic fauna). Thirteen species of mammals were located, ranging from small native marsupials such as the Brown Antechinus to the larger kangaroos such as the Eastern Grey Kangaroo. Of the native mammals found, all appeared to be relatively common in the Baal Bone region. There were several introduced species of mammal in the region, including the House Mouse, Ship Rat and the rabbit. Other mammals usually associated with human occupation such as dogs, cats and cattle were also present. The relatively high diversity of introduced mammals may have been a consequence of the disturbed nature of the region.

Of the fifty-eight species of avi-fauna located at Baal Bone, a relatively high number were water birds. These were apparently attracted to the large ponds of water formed by the old coal refuse dumps. Food availability within several of these ponds was high. The majority of the birds observed were common to the region and most species can be classed as capable of ranging over a wide area.

Captures of reptiles and amphibians were, unfortunately, low. This was mainly due to the survey taking place within the colder months of the year. However, several species of cold blooded vertebrates were located and all were common to the region.

There was a wide range of aquatic invertebrates associated with Cullen Bullen Creek. The productivity of different pools of water in the coal dumps varied and may have been related to different levels of chemicals in the water.

6. SUMMARY: IMPLICATIONS FOR WILDLIFE

The disturbance caused by the development of the coal mine and colliery at Baal Bone will be minimal. However, the initial reaction of many of the animal species will be to move away from the site. About 70% of the avi-fauna found at Baal Bone are known to be either nomadic or migratory. These birds would be capable of moving away from the area. As the site is adjacent to large tracts of native forest (Ben Bullen State Forest) there would be sufficient habitat available for many of the displaced species. Many of the water birds are capable of moving long distances and would be able to seek other bodies of water. Some sedentary birds will be able to move the relatively short distances required to obtain new habitats in surrounding areas. It is anticipated that some of these species, as well as some of the more mobile birds, will recolonize the mine site. This has happened at other mining operations in the region e.g. Wallarawang Colliery. Because of the small size of the development site, the number of bird species affected by the mining operation will be small compared with the overall numbers in the region.

Large mammals e.g. kangaroos, wallabies and wombats are relatively mobile and will be able to move away from the mining site. Because of intensive shooting in the area most large mammals are confined to the more remote parts of the region. Small mammals, however, will be affected by the coal mining operations, as movement away from the area is restricted. However, all small mammals caught were relatively common to the region and the overall impact would be small.

Comparison between samples of the aquatic fauna found in Cullen Bullen Creek showed there was a variable impact by the coal dumps. There was a great difference between the number and diversity of species of aquatic fauna found upstream and downstream of the coal dumps. This would indicate that the water fauna is affected by the coal dumps. It will be important that care be taken if these ponds are emptied during the mining development. If several of the ponds do contain high levels of pollutants, then their release into Jew's Creek may cause problems for the aquatic fauna further downstream of the mine site.

If a coal mine and colliery is established at Baal Bone I recommend that;

(i) The swampy area on Cullen Bullen Creek, south-east of the mine site, should not be disturbed. This area is a valuable resource and is used by many animals for shelter and food.

(ii) Emptying of the water ponds between the coal dumps should be carefully monitored to prevent possible increased pollution of Jew's Creek.

and (iii) Rehabilitation of the mine site should include the planting of trees and shrubs to promote the movement of animals back into the coal mining site.

With respect to (i) above it is the Company's intention to raise the level of the existing dam to develop a main water supply dam of sufficient capacity to achieve water management strategy objectives. This will result in inundation of the swampy <u>Carex</u> sedgeland area. While, as stated above, it would be preferable to protect the sedgeland it is concluded that to flood it would be an acceptable impact. There are similar swampy areas in the local environment. Also, the dam will provide fauna with a water supply and a swampy-marshland fringe will evolve around the periphery of the dam lake. This will serve to at least partly compensate for the loss of sedgelands.

COALEX PTY. LTD.

BAAL BONE COLLIERY PROPOSAL

VEGETATION AND REHABILITATION STUDY

PREPARED BY: DR. TRUDA M. HOWARD, B.Sc., Ph.D.,
CONSULTING ECOLOGIST AND LANDSCAPE
ANALYST

TABLE OF CONTENTS

BAAL BONE COLLIERY SITE

1. EXISTING VEGETATION

1.1 Summary

The vegetation of the area of the proposed adit portals, water supply dam, surface works and road and rail access is considered under four headings, defined by a combination of topography and proposed use.

(i) Valley wall slopes (c.30°): drift portal and air vent. This area is low on a south aspect and is vegetated by Grassy Open Forest, dominated by Eucalyptus dalrympleana and a few individuals of Eucalyptus macrorhyncha. This represents but a tiny portion at a widespread association in the region.

(ii) Undulating Plain: Water Supply Dam. This area contains three natural communities and some cleared grazing land.

(a) Sedgeland. This waterlogged community occurs athwart the course of Ben Bullen Creek, and is dominated by Carex gaudichaudiana. Grazing, trampling and possibly some past cultivation make it a poor sample of this widespread vegetation type, however its role in water supply regulation due to a considerable build-up of peat (2m. at the outlet) may be significant.

(b) Riparian Grassy Open Forest.
A small stand of Eucalyptus viminalis lines the banks of Ben Bullen Creek from the Sedgeland to the Open Cut. Whilst significantly affected by headward erosion of the creek, weed infestation and grazing, the trees themselves are healthy and vigorous. This community is poorly represented throughout the region having on the whole been either cleared for cultivation, or prevented from regeneration by grazing.

(c) Shrubby Open Forest.
The composition of this community probably reflects that of extensive areas of upland plain prior to clearing. The major trees are Eucalyptus rubida which dominates the shallow valleys and Eucalyptus macrorhyncha which dominates the hill crests of the gently undulating land surface. A few trees of Eucalyptus dives and Eucalyptus rossii are present on north aspects and hill crowns; the Snow Gum (Eucalyptus pauciflora) occurs locally around the fringes of the open cut area. Part of this community has been

inundated in the past to supply water, the new dam would increase the area inundated centred on the existing dam.

(iii) Undulating Plain: Road and Rail Access Areas.
This area is dominated, to the west of the highway, by a Woodland composed of Eucalyptus dalrympleana with a scattering of Eucalyptus macrorhyncha and Eucalyptus rossii. To the east of the highway, on the old travelling stock route, a well developed Grassy Open Forest dominated by Eucalyptus rubida, with some Eucalyptus dalrympleana, Eucalyptus rossii and Eucalyptus macrorhyncha occurs. This community appears to be an excellent example of this association, as it has been free of grazing and burning for some years. The perennial grassy understorey is well developed and undoubtedly the annual herbs and grasses would be rich and diverse in Spring. This community grades into that of (ii) (c) towards the mine site, where it becomes much grazed and partly cleared.

(iv) Dune and Swale Talus Fill: Surface works and rail loop.
The generally east-west striking dunes of shale talus within the old open cut are interspersed by occasional deep lagoons, kept water-filled by Ben Bullen Creek. The vegetation is composed of randomly scattered (reputedly planted) individuals of Pinus radiata, groups of Acacia dealbata showing successive generations of development from the initial individual colonized seedling, shrubby weeds (Blackberry and Sweet Briar) and herbaceous natives and introduced weed species. The lagoons are fringed by Bullrushes (rooted in the water) and blackberries. Whilst the trees show a random distribution regardless of slope position, angle or aspect, the herbaceous species tend to be most prominent on the flatland dune creast. Only Skeleton weed shows an ability (limited) to colonize the steep (c.30°) upper strike slopes of the dune. Natural succession has proceeded slowly on this artificial land surface, but considering the nature of the "soil" both Acacia dealbata and the planted Pinus radiata have been successful in over-coming the limitations of the site.

1.2 Introduction

The surface works, including road and rail access of the proposed Baal Bone Colliery, lie predominantly in the lower reaches of Ben Bullen Creek. Ben Bullen Creek drains portion of the Ben Bullen State Forest on the western slopes of the Great Dividing Range. In its upper reaches the Ben Bullen Valley is narrow with a gently sloping base, the walls are steep slopes (c.30°) which rise to vertical escarpments where the Grose Valley Sandstone capping is present over the Permian coal measures into which the valley is incised.

At the site of the surface works, the Ben Bullen Valley has widened prior to debouching into an extensive upland plain composed of low hills, with slopes of 2 - 10°. These low hills are drained by tributaries of Ben Bullen Creek, and Jews Creek of which Ben Bullen is itself a tributary. A considerable portion of the upland plain at the site of the proposed surface works has been subject to open cut mining, the resulting excavation has been roughly refilled in a dune and swale pattern (striking roughly east - west) with shale talus, leaving an irregular land surface which contains a number of deep lagoons which are kept filled with water by Ben Bullen Creek.

The majority of the surface works are to be located on the reshaped talus dumps, but the water supply dam and road and rail access will cross the undulating upland plain country. Only the air vents are to be located low down on the steep (c. 30°) valley wall slopes.

1.3 Vegetation

The existing vegetation will be considered in four groups dictated partly by topography and partly by proposed use. These areas are indicated in Figure 1.

(i) Valley wall slopes (c.30°): Air Vents.
(ii) Undulating Plain: Water supply dam.
(iii) Undulating Plain: Road and rail access areas, some surface works.
(iv) Dune and Swale talus fill: Remaining surface works and rail loop.

(i) Valley wall slopes (c.30°): Drift Portals and Air Vent.

The vegetation of the lower portion of the steep, south aspect slopes (30°+) which rise abruptly from the margin of the Ben Bullen Valley is Open Forest (protective crown cover 30 - 70%, height 10 - 30 m) dominated by *Eucalyptus dalyrmpleana* with a few individuals of the stringy barked

Figure 1.

GEOGRAPHIC GROUPING OF EXISTING VEGETATION

0004.1 3/00

Eucalyptus macrorhyncha scattered amongst the predominantly gum-barked association. The understorey is grassy (e.g. Danthonia pallida) with a good litter cover, though bare rocks are also common. Silver Wattle (Acacia dealbata) forms an irregular small tree stratum; inspection further afield suggests that the size and prominence of this stratum reflects the time since the last fire. This site has not been burnt recently, though considerable portions of the Ben Bullen Valley have been burnt in the last two years.

This Grassy Open Forest represents a small portion of a complex system of Open Forests which occur around the escarpment base, with the grassy phase occuring on south and lower east aspects, and a shrubby phase on north and west and higher east aspects. The overstorey eucalypts also vary in relationship to the position on and aspect of the slope.

(ii) Undulating Plain: Water Supply Dam.

The water supply dam site contains considerable variation in natural vegetation as it spans Ben Bullen Creek itself at the point where the valley widens into the upland plain. Three communities are represented; Sedgeland, Riparian Grassy Open Forest and Shrubby Open Forest, as well as considerable amounts of cleared grazing land.

(a) Sedgeland.

Just upstream of the open cut area on Ben Bullen Creek, the creek becomes lost in a Sedgeland. This is a waterlogged community, composed of tussocks of monocotyledons and delicate herbs, with trees almost entirely absent except along the edges of an ill-defined stream.

The Sedgeland is dominated by tussocks of Carex gaudichaudiana with tussocks of sedges and grasses (Deyeuxia sp, Juncus sarophorus, Baumea rubiginosa, Poa sp.) more common around the margins. The herbaceous component is made up of both native herbs Geranium potentilloides, Epilobium sp.,Hypericum sp.,Veronica gracilis, Haloragis heterophylla, Senecio minimus, Brachycome sp. and introduced pasture (Trifolium repens) and weed (e.g. Cirsium valgare) species. Along the margins of the flowing water thickets of Leptospermum flavescens and mounds of blackberries (Rubus vulgaris) occur sporadically. Seedlings of the Silverwattle (Acacia dealbata) are scattered throughout the area, though there is evidence that this is the product of a prolonged dry period coinciding with an after-fire seed bed, not a long term feature.

The geomorphological origin of this sedgeland is not known, however it is a product of impeded drainage, which creates local waterlogged soil conditions. Peat build-up which raises the overall level of the Sedgeland occurs as successive generations of plants die and fail to decay in the anaerobic waterlogged conditions created by the raised water table. This sedgeland has at its outfall, a peat build-up of 2m., which has been exposed by the headward erosion of Ben Bullen Creek (precipitated by the open cut downstream). The depth of the peat build-up elsewhere is unknown.

The condition of the living vegetation is not particularly good due to extensive grazing / trampling, which was probably particularly severe during the 1979-80 summer draught due to lack of fresh feed elsewhere. Introduced pasture species, and possibly past fertilizer application and cultivation make this a degraded sample of Carex gaudichaudian Sedgeland, but it may none the less be important in regulating the watersupply of Ben Bullen Creek downstream.

(b) Riparian Grassy Open Forest.

A narrow stand of Eucalyptus viminalis fringes Ben Bullen Creek from the toe of the Sedgeland to the top of the open cut. Whilst the tree canopy is well developed and the overall form and size of the trees is superior to that of other Open Forests of the area, the understorey is much disturbed, both as a result of the headward erosion of Ben Bullen Creek and grazing pressure. Tangles of blackberries (Rubus vulgaris), sweet briar (Rosa rubiginosa) and thistles (mainly Cirsium vulgare) occur beneath the trees mixed with native grasses, some pasture species, bracken (Pteridium esculentum) and wild raspberry (Rubus parvifolius). Saplings of Eucalyptus viminalis are abundant, and a few individuals of Acacia dealbata are also present to form an intermittant small tree stratum.

(c) Shrubby Open Forest.

A considerable portion of the proposed water storage dam area is occupied by well developed Shrubby Open Forest. The composition of this community probably reflects that of the extensive areas of undulating upland plain, now cleared for agriculture.

The major trees are Eucalyptus rubida (Candlebark Gum), which is dominant in the shallow valleys, and Eucalyptus macrorhyncha (Red Stringybark) which occupies the hill crowns. Present in smaller number are Eucalyptus dives (Broad-leaf Peppermint) on north aspects and hill crowns, Eucalyptus rossii (Scribblybark) on hill crowns, and Eucalyptus pauciflora around the fringes of the most open area (the open cut area). The understorey is very sparse, with small shrubs of Acacia buxifolia the most common component. Remnants of annual herbs and grasses suggest that the community blossoms briefly with a carpet of green in the Spring. Perennial grasses may have been present in the past, but extensive cattle grazing of the understorey has eliminated any sign of them.

Silverwattle (Acacia dealbata) forms a sporadic small tree stratum, but here as throughout the region, it appears to be a short-lived member of the community, reflecting past fire history. The general form (woodland) and height of the trees (c.12m.) and the light canopy cover, about 30%, puts this community on the boundary between Open Forest and Woodland.

(iii) Undulating Plain: Road and Rail Access Areas.

The rail access area to the west of the main highway is vegetated by a Woodland (Projective Crown cover 10 - 30%, height 10 - 30 m.) composed of rather knarled woodland form trees, predominantly Eucalyptus dalrympleana, with a scattering of Eucalpytus macrorhyncha and Eucalyptus rossii. The ground cover is composed of small herbs (mainly a species of Goodenia) and small shrubs of Acacia buxifolia. A few perennial grass tussocks (Themeda australis, Danthonia pallida, Aristida sp.) are also present, as well as the remains of annual herbs and grasses. The litter layer is well developed, and Acacia dealbata almost absent, suggesting that the area has been unburnt for a considerable time. Occasional areas of very shallow soil over solid rock are occupied by a Low Shrubland (0 - 2m. tall, 10 - 30% projective crown cover) of Kunzea parvifolia, with only an occasional tree. The litter cover of these areas is sparse, but mosses and lichens are prominent. These areas probably reflect a soil which is intermittantly waterlogged.

To the east of the highway, the proposed road and rail access route follows an old travelling stock route - so old that it is now completely revegetated with a well developed Grassy Open Forest. This Open Forest is dominated by Eucalyptus rubida, with some individuals of Eucalyptus dalrympleana, Eucalyptus rossii and Eucalyptus macrorhyncha. The litter cover and understorey are well developed, probably due respectively to a long period without fire and the absence of stock grazing. Further to the east, nearer to the works area where the road and rail access route passes through some partly cleared land, and the vegetation shows signs of heavy grazing, fence post cutting and burning

(iv) Dune and Swale Talus Fill: Surface Works and Rail Loop.

The previous open cut coal mine worked in the early 1950's was backfilled with the crushed shale overburden in a series of dune-like ridges striking generally east - west. These shale dunes are generally unlevelled except for the summits which must have been used as roads to give access to subsequent fill areas. The individual dunes and swales vary in actual height above sea level, but overall two main patterns can be distinguished.

(a) Blocks of closely placed dunes with swales between 4 - 5 m. below the tops, interspersed by,

(b) deep swales reaching (presumably) to the base of the open cut, with long slopes and up to 15 m. + difference in height between the crests of dunes and swale bases. These are generally water filled at present, when they extend below an elevation of 860m.

Whilst the orientation of low amplitude dunes is overall north - south, the deep swales may occur in both north - south and east to west orientation, though this does not appear to effect the distribution of colonizing vegetation on the long slopes to any extent.

The angle of rest of the shale debris on the strike slopes of the swales appears to average 33°, whilst the partly flattened dune crests display considerable variation from flat to c.16°). In general this lower slope phase supports a much more continuous vegetation than the steep strike slopes, however the two tree species present show less preference in terms of slope, being apparently distributed at random over both steep and low slopes, nor is any preference for position on or aspect of the slope displayed by these species.

Herbaceous cover is very largely confined to the dune crests except where the randomly distributed trees have built-up sufficient humus to support an understorey. Despite the random distribution of trees,there is sufficient evidence still present to indicate that the dune tops were the first areas to be colonized.

The margins of the artificial lagoons in the deep swales support a specialised form of vegetation - a band of bullrush swamp. The distribution of the species found on the shale dunes and swales is shown in Figure 2. In Photos P1-6 a number of the stages in succession found on the dune tops are shown. Initially it appears that herbaceous species, including the pasture weeds Chondrilla juncea (skeleton weed), a Buzzy (Acacia echinata) and several native herbs and grasses (Themeda australis, Agrostis avenacea, Epilobium billardieranum,

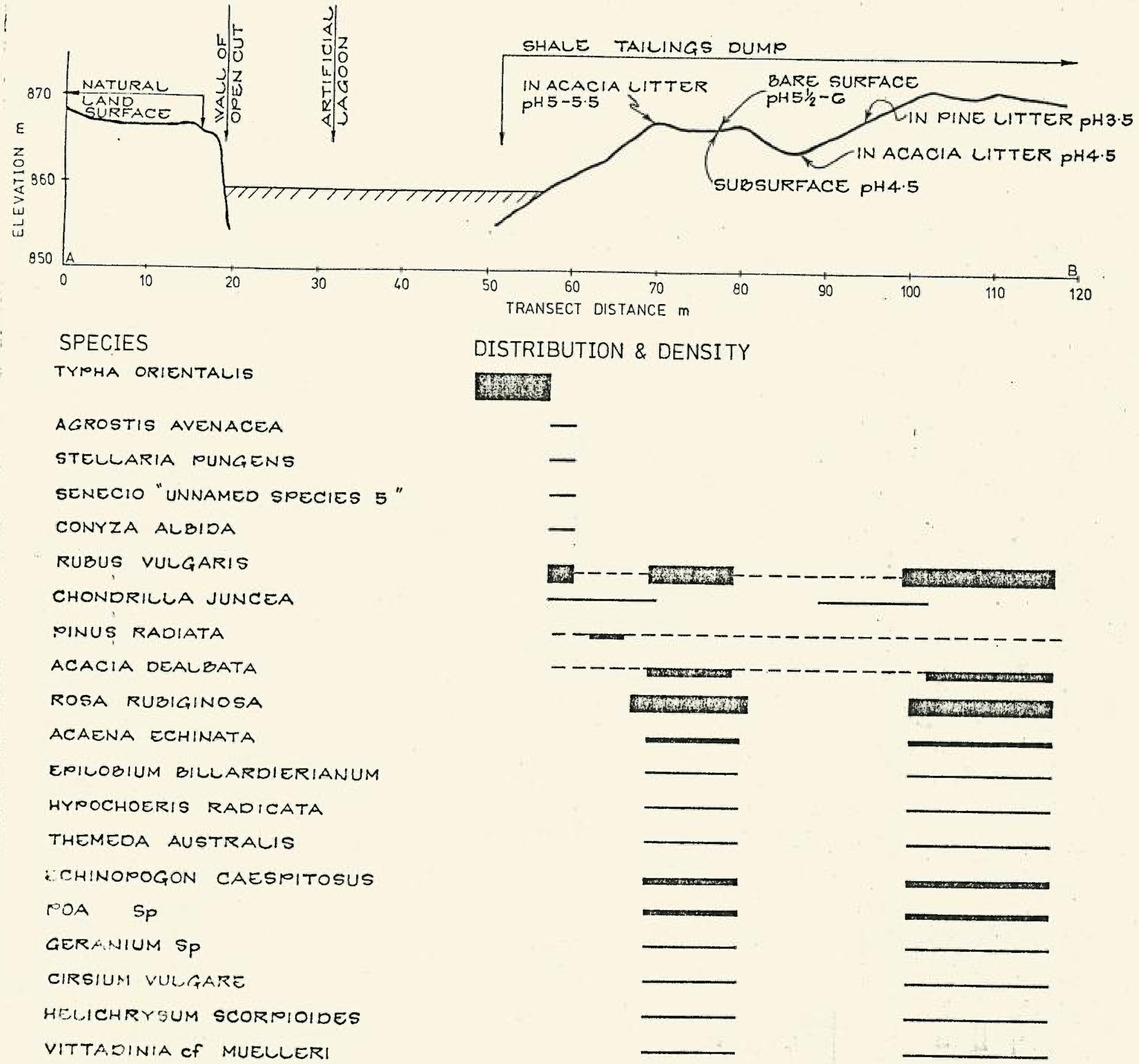


FIGURE 2

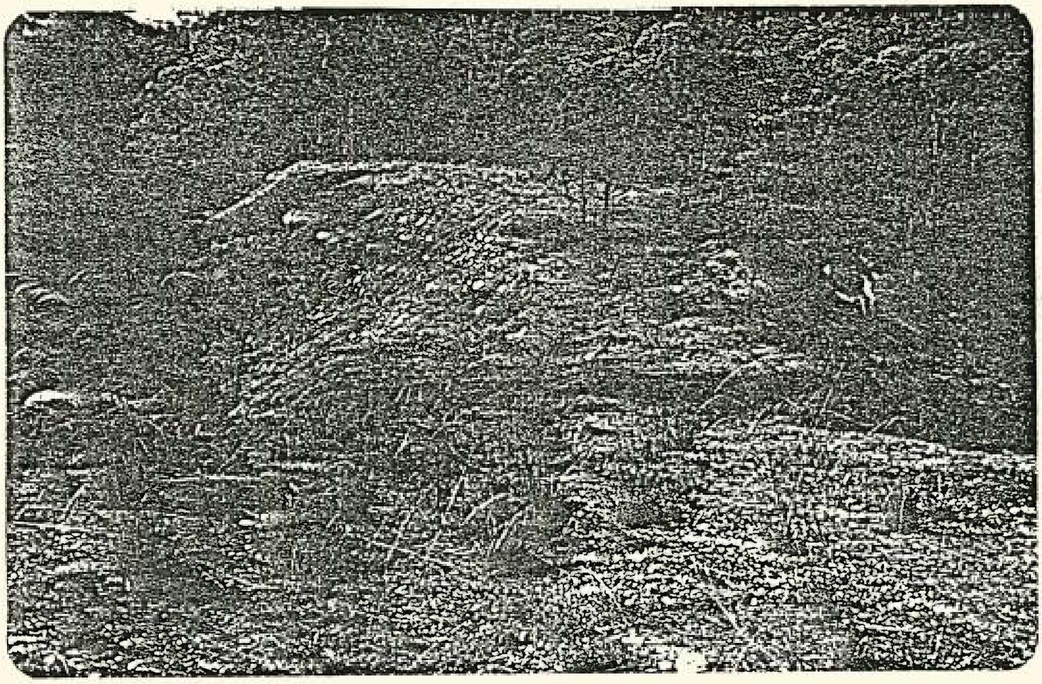
BAAL BONE OPEN CUT TALUS DUMPS

SCALE CROSS SECTION A-B (1:500) SHOWING NATURAL LANDSURFACE, OPEN CUT EDGE, LAGOON & TALUS DUMPS.
ACTUAL SPECIES PRESENT ON TRANSECT A-B SHALE TALUS DUMPS ONLY.

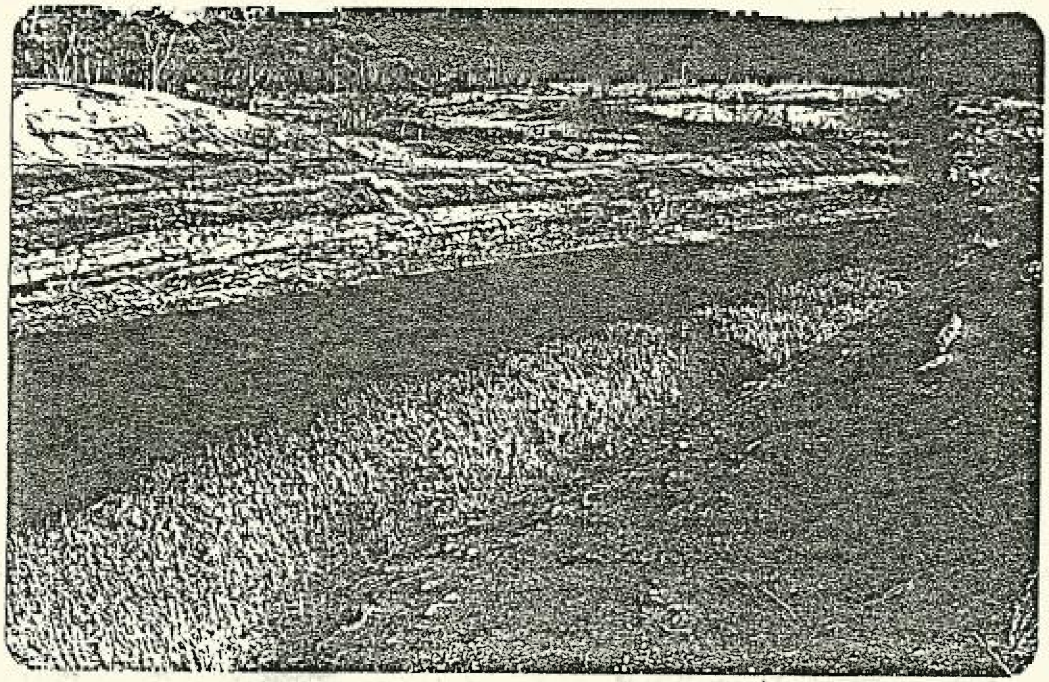
DENSITY (% COVER)

+	0-1%
1	1-5%
2	5-25%
3	25-50%
4	50-75%
5	75-100%

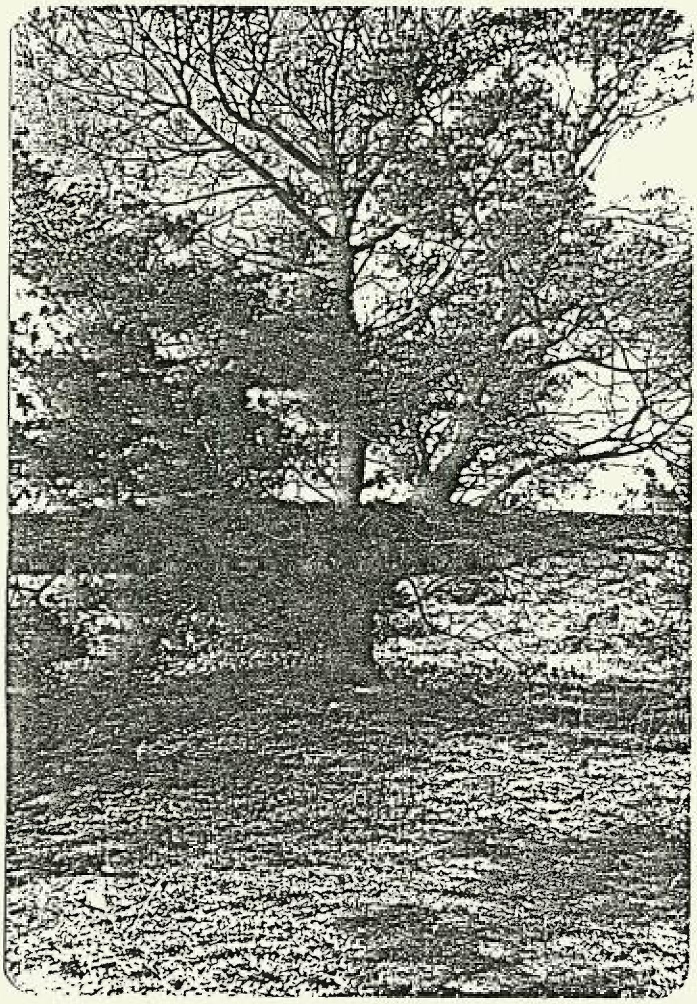
- - - - - - - THESE SPECIES MAY OCCUR AT ANY POSITION ON VARIOUS ASPECTS AS INDIVIDUAL OR CLUMPED PLANTS. (BASED ON GENERAL OBSERVATION IN THE AREA.)



P-1 Herbaceous cover on low angle slopes on dune tops compared with almost complete absence on steep long slopes.

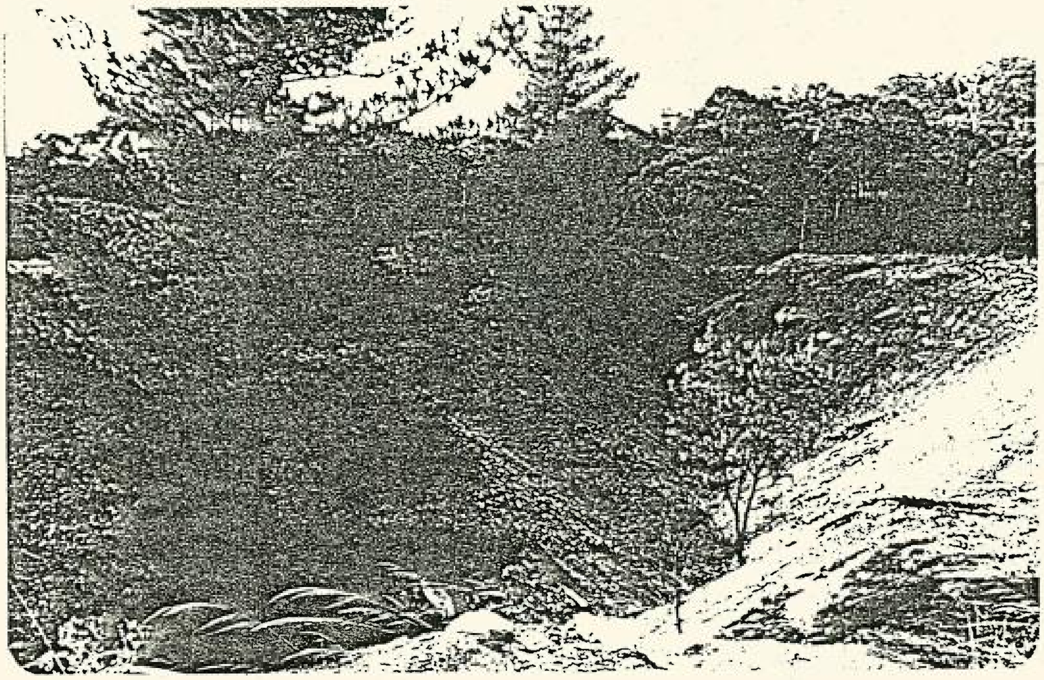


P-2 Typha zone and steep strike face of shale dune in the foreground, the other wall of the lagoon is the edge of the opencut.

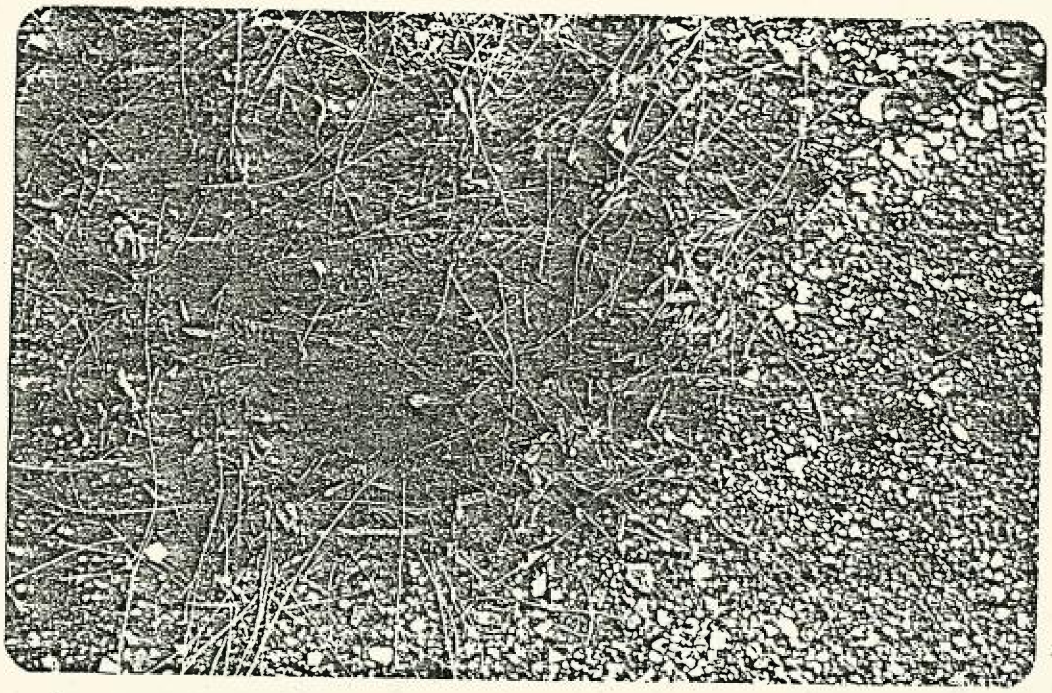


P-3 An individual Acacia dealbata of mature age. Showing local litter build-up and herb layer of a first generation clump.

P-4 Mature group of Acacia dealbata. Showing at least 3 stages of spread - dead in centre, mature and sapling, seedlings were also present on perimeter though not visible in photo.



P-5 Random distribution of trees especially Pinus radiata in relation to slope position.
Note litter build-up around trees.



P-6 Acaena echinata: an early colonizer of bare shale. Note the trapping of litter which takes place once the herb has established.

Danthonia spp., Danthonia pallida, Bothriochloa decipiens etc.) established on the shale, and either a little later, or at the same time, seeds of *Acacia dealbata* managed to germinate and establish a first generation of trees. Subsequently, spread from these chance colonizers occured laterally, presumably from the oldest dunes nearest the native surrounding vegetation to younger and more distant dunes. Accompanying these herbs and silverwattle, two bird dispersed shrubby weeds (Blackberry and Sweet Briar) also invaded and spread over the dune tops. Blackberry has also successfully established along the lagoon margins above the bullrush zone, and because of its semi-decumbent growth form, and ability to root at the nodes, has been much more successful in spreading onto the steep strike slopes than the sweet briar.

Individual clumps of *Acacia dealbata* display the mechanism of colonization with text book nicety. As this species is fairly short lived, perhaps 25 years maximum, it is possible to find groups with a central partly decayed initial colonizer individual, surrounded by successive bands of younger trees, saplings and seedlings.

The *Pinus radiata* trees which occur at random over this site are reputedly planted, though there is some tendency for "family" group formation around some individuals. Flowering and seed set on this species has been most prolific, though the subsequent dispersal of seeds is something of a mystery. Several cones were found on the ground torn apart in a manner reminiscent of cockatoos - so perhaps these are the seed dispersing agents.

It is possible that there is little inter-relationship between each group of colonizers - herb, shrub and tree, each having followed their own path, though benefiting from each other as chance allowed. This is a somewhat academic question which would require very detailed floristic analysis to settle. However, it is noticeable, that the *Pinus radiata* an exotic and probably planted species, "keeps to itself", its humus is not colonized / utilized by herbs and grasses. As this is a common phenomenon in pine plantations, and is usually attributed to both pH and shading, the former was investigated briefly (shading is irrelevant as the trees are mainly solitary).

pH Results.

Test Site		pH
Shale debris	dune top, subsurface	4.5
Shale debris	surface (no colonizers)	5.5 - 6.0
Humus	Acacia dealbata, dune top	5.0 - 5.5
Humus	Acacia dealbata, shallow swale	4.5
Humus	Pinus radiata, on slope.	3.5

It does appear likely that the very low pH of the pine litter is the reason for failure at secondary invasion by herb species. The almost complete absence of colonizers from the Acacia litter in the shallow swales, may also be a pH effect - the litter itself was up to 10 cm. deep and moist, a generally ideal situation for establishment.

In Table 1 the introduced species which form a part of the succession on the talus dumps are summarized, and their general status as agricultural weeds summarized. Of these weeds probably the most infamous are the Skeleton Weed and Blackberry.

TABLE 1

Baal Bone. Introduced Species on Talus dumps and their general status in the flora.

Scientific Name	Common Name	Status
Chondrilla juncea	Skeleton Weed	Very serious agricultural weed. (annual-biennial).
Cirsium vulgare	Spear Thistle	Widespread agricultural weed (annual)
Conyza albida	Tall Fleabane	Widespread weed of disturbed ground (annual)
Hypochoeris radicata	Cat's Ear ("dandelion")	Widespread weed of distrubed ground (perennial)
Pinus radiata	Monterey Pine	Widespread softwood forestry plantation species; partly naturalized on deserted farmland.
Rosa rubiginosa	Sweet Briar	Weed of pastureland particularly in highland areas (perennial shrub)
Rubus vulgaris	Blackberry	Widespread weed of moist ground. (perennial shrub).

2. EFFECT OF PROPOSED WORKS ON VEGETATION

2.1 Summary

The impact of the surface works and access routes on the vegetation will be minimal in both the local and regional context, in that most of the landsurface affected is either much altered by agriculture or part open cut coal mining.

However, some vegetation will have to be removed, and earthworks carried out during the construction phase, and some new landsurfaces created from the mine tailings during the life of the mine. To minimise the impact of these operations, a set of principles for minimizing impacts has been drawn up as follows:-

(a) "Good public relations".

That minimum damage should be done to the existing ecosystems and that during construction and after completion of the project, minimum signs of this minimal damage should be obvious.

(b) "Good housekeeping".

That only areas to be immediately utilized in some phase of construction be disturbed, and that when work is complete the area undergo immediate rehabilitation treatment.

(c) That biologically active materials be neither imported to nor exported from the site.

(d) That only local plant material be used in rehabilitation.

(e) That long term rehabilitation planning be initiated in conjunction with the rest of the project, so that maximum benefit can be gained from each stage of the project development.

Revegetation, particularly of the talus fill should be viewed as a long term objective - in the 30 years which have passed since the open cut was abandoned, native and introduced species have made slow progress in recolonizing the shale talus with a not unpleasing result. Techniques suggested are designed simply to aid this natural process and no dramatic or "instant" affects have been suggested. The post mine phase is going to be infinitely long in comparison with the working life of the mine, and it is with the longterm viability and ecological appropriatness of the landscape rehabilitation that I have been largely concerned.

Local reduction of wind speed, and provision for shade tree planting require special techniques where they are to be carried out on the talus fill, and appropriate methods using stockpiled topsoils and watering have been suggested.

2.2 Effect of Proposed Works

Whilst it is apparent that some areas of natural vegetation will have to be removed during the process of construction, the majority of the works site is to occupy the already artificial landscape produced by previous open cut mining, or on land cleared for agriculture. In the regional context the impact of removing portions of Sedgeland, Eucalyptus dalrympleana Open Forest, Eucalyptus rubida Shrubby Open Forest and Woodland is likely to be minimal as each community is widely represented in the region. The Eucalyptus viminalis Riparian Grassy Open Forest however, is poorly represented, due probably to both its naturally restricted distribution and to past clearing for agricultural purposes. The sample on the works area is however an already much disturbed fragment of this community which does not warrant any special measures for its preservation.

In the local context the impact is likewise likely to be minimal, provided that the initial vegetation removal is carried out in a sympathetic manner. In this context a set of principles for minimizing impact on the vegetation is suggested as follows:-

(a) That minimum damage should be done to the existing ecosystems and that during construction and after completion of the project, minimum signs of this minimal damage should be obvious.

This principle can be summarized as "good public relations". It entails the complete removal of all necessary vegetation prior to earthmoving, or flooding, so that the final construction looks finished. This means that sufficient space should be allowed for earthmoving machinery to manoeuvre and that all such machinery should be rigidly excluded from the surrounding vegetation which is to be retained in its natural state.

In the case of the new dam, all trees falling within the maximum flood height area should be fallen, removed and the roots grubbed. This latter is particularly important in the flood storage allowance area, as nearly all the tree species present on the site coppice from cut stumps, and could regrow sufficiently prior to the first prolonged high water period to result in a ring of dead skeletons around the dam. At the time of construction it would also be desirable to fall the dead trees standing in the existing dam.

In the case of road and rail access routes, particularly where embankments are to be constructed, sufficient width must be cleared to prevent trees being partially buried by the embankment construction, as such trees will die.

Where cuttings are to be constructed, such as access to the air vent and parts of the stock pile area, trees should be removed if they are likely to have more than a quarter of their root area severed by subsequent excavation.

Complete removal of trees from the site is an essential component of this good public relations - tangled heaps of rocks, soil and dead trees do not soothe the souls of sensitive observers, at the same time the plant material is an important resource, either as chip mulch (crowns) or ash (trunks and roots) for rehabilitation schemes.

(b) That only areas to be immediately utilized in some phase of construction be disturbed and that when the work is complete the area undergo immediate rehabilitation treatment. This principle can be summarized as "good housekeeping", and results in the area being largely either undisturbed or rehabilitated, - the active phase (such as filling) during the life of the mine should represent only a small percentage of the surface area, though during construction this will undoubtedly be the dominant phase <u>for a short time</u> only.

This principle should be extended from areas of natural vegetation to the <u>whole</u> site. In the case of the talus dunes in the old open cut, the vegetation is the result of nature trying to overcome man's previous influence on the landscape. As much of the area is to be reworked in the long-term, the impact of activities will be maximal. It is to be hoped however, that the final result will be more sympathetic to the surrounding natural landsystems than the present "lunar" landscape. However the existing landscape, however artificial has an ecological and visual unity which should be treated with as much respect as the very much older natural landscape of the rest of the site.

(c) That biologically active materials be neither imported to nor exported from the site. The importation of soil, plants etc. should be minimal (except to establish local landscaping round the plant) thus reducing the risk of importing both weed seeds and plant diseases (Ben Bullen Creek is high up in a very large catchment which passes through agricultural land). The importation of native plants (even of locally abundant species) should also be avoided - there are large areas of native vegetation including completely wild and natural areas in the immediate neighbourhood; genetic pollution of these areas should be avoided by this precaution.

The export of biologically active materials (soil, vegetation) is simply wasteful - these can be utilized on the site during rehabilitation.

(d) That only local plant material be used in rehabilitation.

This is a corollary of (c), with the same exception. It has however, a further implication. Plant material already present on the site has already been subjected to local selection pressures and is hence much more likely to establish successfully than imported material.

Whilst the previous discussion covers principles of managing the impact of the proposed works on the natural vegetation, one area merits further consideration. The <u>Carex</u> Sedgeland poses considerable problems as it occurs in the back up area of the water supply dam. Long term intermittant flooding of the peat underlying this sedgeland could result in breakdown of the peat and consequent contamination of the water held in the dam. The sedgeland is however a naturally waterlogged community, so has considerable tolerance of long periods of waterlogging. Some peat will have to be removed to form a firm base for the dam wall, it may be [illegible] worth while removing all the peat, as the peat could be used in rehabilitation treatment and the storage capacity of the dam increased. As the volume of peat and the underlying landsurface profile are at present unknown, test bores would need to be sunk to determine whether this would be a practical course.

3. PROPOSED REHABILITATION

For the purposes of rehabilitation, the site can be divided into two very distinct sections - the area on the shale talus fill and that on natural undisturbed landforms and soils. The majority of disturbance to the natural landforms will take place during the construction of the water supply dam, and road and rail access. This phase should be over within 18 months of the commencement of the project, so that after 2 - 2½ years all the raw embankments, cuttings etc. should have been suitably treated to enable vegetation to

At the termination of the life of the mine, the only areas left for rehabilitation should be the stock pile and pit top amenities sites; these areas, because of their compaction will require a further development of the strategies developed to rehabilitate natural landform/ soil areas or unconsolidated talus fill.

3.1 Treating Natural Landform / Soil Areas.

Where cuttings have been made into natural soils and their underlying rock strata, it does not appear to be necessary to do anything to the cut faces except to ensure that they are stable, and that the vegetation is removed sufficiently beyond the cut to prevent the death of trees after the work is complete. Compliance with (a) and (b) of the Principles for Minimising Impact on the Vegetation should result in no greater impact than that created by a normal road cutting.

On site embankments, such as the front of the dam wall, where later filling with tailings are not intended to ultimately form a new higher land surface, also be covered with topsoil and grassed.

3.2 Treating Talus Fill.

As the talus fill area is the area which will be effected throughout the life of the mine by tailings disposal and reshaping, and is already an artificial landsystem, considerable thought and discussion has been expended on a suitable method for treating the area in terms of rehabilitation.

In the section on the existing vegetation, it has been pointed out that the unconsolidated, largely shale fragments have undergone, in the last 30 years or so, considerable natural succession, recruits including both natural tree (Acacia dealbata) and grass species, weed species (blackberry, sweet briar, skeleton weed) and planted Pinus radiata. The greatest success in producing a good plant coverage has been on the flattened dune tops, and of the species present Pinus radiata has been both the least successful in spreading, and the least able to integrate into an overall successional strategy.

Amongst the aims for rehabilitation suggested has been returning the area to pasture via a topsoiling and seeding programme. This would be very expensive;(where is the soil to come from?) has a high probability of not being stable in the long term and is ecologically unsound. Due to the artificial soil profile and the high porosity of the talus fill, leaching of the topsoil down through the fill material is highly likely, leaving a "soil" surface very similar to that of the raw fill; such treatment simply delays by many years the opportunity for the local species to come to grips with the real problem of colonizing the talus fill.

The new surface to be created could be almost level, providing conditions already observed to be most favourable for colonization. With a little assistance to overcome some of the physical limitations of the talus fill, there is every reason to suppose that the natural revegetation process could be speeded up without imposing unnatural pressures on the colonizing species.

It is proposed that as each area is filled and levelled, a thin mulch of native vegetation, ash and tree seed,be applied to the area which is then left quite uninterfered with to "do its own thing". As it is undesirable to encourage the spread of woody weeds (blackberry, sweet briar) the only exception to leaving well alone would be a yearly check on foot, and removal of such undesirable seedlings as have appeared. No additional water from any source should be applied at any time, as the withdrawal of such artificial aids would lead to a rash of tree deaths while the community adjusted to the changed conditions.

The application of mulch overcomes one of the greatest problems of such dark coloured, coarse material - the rapid overheating and drying of the surface, which is so inimical to the establishment of young seedlings. The mulch (and ash, which improves the nutrient status) should be derived from the trees fallen during the construction phase (principle (c)) the crowns being passed through a chipper, and the larger parts burnt. This material can be stock piled, and should last for 2 or 3 years, during which time quite a large portion of and the "in-between" areas around the works site should have been treated. Subsequently the acacias on each site prior to treatment should be chipped (it would probably be best to burn the pines in toto due to their acid humus and to destroy the seeds), and as this will not provide sufficient material if peat is removed from the Carex Sedgeland this could be added.

In compliance with principle (d), seed to be applied should be of Acacia dealbata, harvested each year from trees growing on the talus fill (caught on mesh trays pegged beneath the trees). As the existing succession on the talus dunes has not proceeded past the acacia phase, it is difficult to assess what will happen next under natural conditions, however a nudge in the direction of returning to a eucalypt woodland / open forest should be given by including local eucalypts in the broadcast seed. This seed can be collected right at the start of the whole operation by stripping, by hand, (one man with large airy, fine woven bag) the mature capsules from the trees as they are fallen. It is irrelevant if the species are mixed up. The seed will fall out of the capsules as they dry and can then be seperated and stored in air tight jars for a number of years, to be used as each area is treated.

It would appear from the comparative lack of success of the Pinus radiata that this species should be excluded from the regeneration scheme; it is not a native, and appears to integrate poorly with the natural succession. Rehabilitation to a pine plantation alone is also out of the question, such a plantation requires expert maintenance and has a limited life, after harvesting the trees the area would be in a worse situation (due to the acid pine litter) than it is as raw talus.

In compliance with principle (b), the areas to be filled with tailings during the life of the mine should be clearly delineated, only one area at a time being used, and on completion, the area should be treated as suggested, then left alone. In the initial construction phase considerable talus areas will be reworked to provide stockpile areas, and as access to conveyor construction. As this phase draws to a close, the areas "left-over" not to be used as permanent access for maintenance etc., should be levelled and rehabilitated as the first stage of the long term plan.

Within the rail loop, the surface is composed of highlevel dunes and a deep T shaped lagoon. Two strategies are possible here. In the first, the highlevel areas in the eastern sector could be filled first and treated as already suggested. In this case the area should be divided into compartments, each allowing for 6 - 8 months filling. The small eastern sector could then be filled, and lastly the deep lagoon area.

In the second strategy, the high level dunes could be left untouched alltogether, maximising the benefit of the already established vegetation, the deep lagoon alone should provide enough volume for most of the life of the mine. However, if this area is visualised as a back up to the dirty water storage, complete filling of the whole area may not be desirable. Further advantages of filling the deep lagoon is that the fill area will be out of sight, and the resulting surface area to be finally rehabilitated will be much less extensive than that created by re-working and filling the high level dunes.

3.3 Post Operations Treatment.

Whilst it is not possible to predict at this time the degree to which the plant and buildings will be dismantled on mine closure, it is obvious that three extensive bare areas occupied by the stockpiles will remain. As these will have a consolidated surface, treatment in the manner suggested for the talus fill areas will have to be proceeded by surface ripping to allow normal water percolation to occur.

It should be stressed that the success of reducing the impact of the mine operations on the vegetation depends very much on compliance with the principles suggested, and on forward planning of and ongoing attention to rehabilitation throughout the life of the mine. The results of the method suggested for rehabilitating the talus fill may not look particularly impressive at first, but over the years the natural regeneration which develops will be seen to conform with the surrounding vegetation, to survive the vicissitudes of the local climate and to provide an ecologically sound foundation on which the native plants of the area can build a stable natural ecosystem.

In conclusion the principles of minimising impact on the vegetation are repeated, with an addition which incorporates rehabilitation. Although placed last, it is not of least importance, perhaps of most, planning to minimise impact on the landscape both immediate and long term must start before the first sod is turned, and be regarded as of equal importance with all other parts of the project.

3.4 Principles for Minimising Impact on the Vegetation

(a) "Good public relations".

That minimum damage should be done to the existing ecosystems and that during construction and after completion of the project, minimum signs of this minimal damage should be obvious.

(b) "Good housekeeping".

That only areas to be immediately utilized in some phase of construction be disturbed, and that when work is complete the area undergo immediate rehabilitation treatment.

(c) That biologically active materials be neither imported to nor exported from the site.

(d) That only local plant material be used in rehabilitation.

(e) That long term rehabilitation planning be initiated in conjunction with the rest of the project, so that maximum benefit can be gained from each stage of the project development.

3.5 Local Landscape Improvement.

Whilst most of the area is best left to follow its own natural successional path, there may be certain locations within the talus fill area where planting of screens, windbreaks or shade trees may improve the comfort and outlook of the personnel. Areas around the carpark and the administration block would both be such cases.

As the talus itself is obviously not a particularly suitable "soil", some of the soils stockpiled during construction of road and rail access routes should be set aside for these plantings. After the sites have been levelled, and buildings constructed, the areas to be planted should be excavated to a depth of 1.5 m., to form pits no less than 2 x 2 m. in surface area. These pits can then be filled with subsoil for the bottom 1 m., and topsoil for the upper 0.5 m. As the shale material is only marginally below the pH to which most Australian native plants are accustomed, the pits do not need to be lined in any way to prevent longterm pH changes in the soil. Into the beds so created a wide range of native and exotic trees and shrubs can be planted, the surface mulched to keep down weeds and conserve moisture and the whole area kept regularly watered. Species which are locally available and which grow successfully in Lithgow gardens would be appropriate planting material, with an emphasis on those species known to be fast growing.

COALEX PTY. LTD: BAAL BONE COLLIERY PROPOSAL

Implications for Communities, Development and Planning

BY COLLIN C. DONGÉS AND ASSOCIATES

JULY 1980.

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PREAMBLE

This report has been requested by Nexus Environmental Studies as a contribution to an Environmental Impact Statement being prepared for Coalex Pty. Ltd., a Company with longstanding involvement in the coal industry, and currently proposing to develop a new colliery at Baal Bone.

Attention is focussed on the evaluation of the social, developmental and planning implications likely to be generated should the Coalex proposal proceed. Implications are discussed in the Local, and Western Coalfields Regional, contexts. Recommendations as to how benefits can be maximised and disadvantageous effects minimised, are presented.

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ADDENDUM

- May, 1981.

During the period August, 1980 to April, 1981 Coalex Pty. Ltd. has significantly modified the development plan on which this report is based, the principal changes being as follows:

- modification of the colliery layout;
- increase in the maximum rate of coal production;
- incorporation of water management, refuse disposal, rehabilitation and water quality control strategies and safeguards;
- increase in the workforce, which will result in an increase in employment opportunities and population growth generated indirectly by the Colliery development.

Consequently, Collin C. Dongés & Associates has consulted with Nexus Environmental Studies in the preparation of specific parts of the Final Draft Environmental Impact Statement with the result that information and assessment contained in the EIS relates to the final development plan as detailed in April, 1981. A significant amount of new research has been involved in this process.

Therefore, certain sections of this Report on "Implications for Communities Development and Planning" are now out of date and have been superseded by the relevant parts of the Environmental Impact Statement.

PART 1.

The Colliery Proposal: Background.

1.1 Introduction: Evolution of the Coal Industry.

More than one hundred years have elapsed since the Lithgow Coal Seam was first mined using primitive open cut techniques, and intensive manpower. The importance of, and demand for, coal has been overshadowed by the global dependence on oil for much of the past World War 2 period. Coal, in fact, has been viewed as a resource which man could eventually do without, freeing communities and the environment from the disadvantages of the coal industry - coal dust, air and water pollution, dangerous underground work, visually unpleasant black stockpiles and collieries. Towns which had evolved around the coal industry declined, in appearance, wealth and reputation. The Western Coalfields of New South Wales have been a classic example.

Political unstability, and the awareness that oil supplies are vulnerable, and reserves finite, along with disillusionment over the potential of nuclear power, has triggered a new wave of interest in coal.

Australian reserves are vast and well in excess of internal demand. Surplus coal is available for export and has proved attractive to countries desparate for a reliable and secure supply of fuel.

Rejuvenation and expansion of the Coal Industry in the Western Coalfields is well under way with several developers (Elcom, Coalex, Austen & Buta and Clutha) in the process of constructing and / or planning new collieries and coal-fired power stations.

Historically, the fortunes of the coal industry have considerably determined the conditions of the settlements and communities in their vicinity. The Western Coalfields Region is now at a critical stage in its history as the planning initiatives, environmental policies and socio-economic adjustments that are bought into play now, and in the short term future, will decide how and to what degree society can benefit from the growth stimulus. Uncertainty as to the longer term future demand for coal makes it imperative that the region evolves an economic structure capable of surviving in a healthy state should coal decline in popularity as it has done in the past.

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This report discusses the prospective impacts of the Baal Bone proposal on the local and regional communities and their social and economic conditions. Suggestions are also made as to how the proposal can be developed in such manner as to maximise benefits and minimise cost.

1.2. Production and Development Objectives.

Coalex Pty. Ltd. is committed to increasing output from its Western Coalfield Collieries to satisfy demands from the Japanese market.

Baal Bone Colliery is planned to:-

(1) Replace the existing Wallerawang Colliery which will phase down production from July 1981 to April 1983 when operation will cease.

(2) Achieve an ultimate annual output of 1.5 million tonnes of prepared coal. This compares with output of 1.0 million tonnes per annum from Wallerawang Colliery and therefore represents a 50% increase once the target output is reached.

Closure of Wallerawang Colliery is inevitable as the existing lease is almost exhausted while immediately adjacent leases are worked out.

Coalex aims to manage a smooth transfer of some capital and most employees from Wallerawang to Baal Bone so as to promote -

(i) a continuity of employment for all employees and avoid under utilisation of labour, and

(ii) a reasonably consistent flow of coal from the two collieries.

Coal will be extracted from the lease over a 20 year mine lifetime.

By commissioning an Environmental Impact Statement, the developer will have access to recommendations designed to minimise environmental disturbance and promote socio-economic benefits for the affected communities and employees. Adoption of objectives aimed at environmental protection and conservation by Coalex and other developers is crucial to the welfare of the locality and the region in general.

PART 2.

Colliery Development and Operation.

Brief description of the location, structural components, and operational characteristics associated with the pit top and mine, provides a basis for prediction and evaluation of implications for local and regional land uses and communities.

2.1 The Site.

2.1.1. Location.

"Baal Bone" Colliery will be sited about 4 km. directly north east of Cullen Bullen, a small settlement in the Western Coalfields Region about 20 km. north of the City of Lithgow. (Reg. Fig. 1)

The pit top and mine entrance will sit at the mid-eastern margin of an extensive (2.5 km.^{2}) area previously disturbed by an open cut mining operation promoted by the Joint Coal Board about 30 years ago. This past activity has violated the natural environment giving rise to a unique landscape, appearing from majestic and intriguing to appalling,depending on the eye of the beholder. The site abuts the Western slopes of the Great Dividing Range in a valley system comprising part of the catchments of Ben Bullen and Jews Creeks.

2.1.2. Zoning.

Coalex has an option to purchase Lots 83, 50, 51, 6, 91, 32, 33 in the County of Roxburgh, Parish of Ben Bullen. These freehold properties are zoned Non-Urban A under Interim Development Order No. 1 Shire of Blaxland.

The Colliery is classified as an "extractive industry"and, following literal interpretation of the code, requires only Council (of the City of Greater Lithgow) approval. However, under the expected provisions of the Environmental Planning and Assessment Act 1979, a colliery is deemed "designated development", thus requiring approval from a range of Government Departments.

The Colliery Access Road and railway will cross a strip of land zoned Non Urban B extending at a width of 400 metres parallel to, and both sides of the Mudgee Road.

2.2 Plant Components and Establishment.

A modern colliery incorporating a dense medium cyclone coal preparation plant will be constructed. An adit will connect the

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surface installations with the Lithgow Seam within Antharisation Area Number 161. Coal will be extracted by seven mining units before being conveyed to the surface, prepared and transported from the site.

2.2.1. <u>Conveyor System and Preparation Plant</u>.

The coal conveying and preparation plant will comprise the following components operating during the detailed respective times:

- Conveyor system: usual operation 0000 - 2100 hours. 24 hour operation when train loading in process.
- Breaker station: 0000 - 2100 hours.
- Road Bin: 0700 - 2100 hours only during first 10 months of production.
- Crushing & Screening Station: 0000 - 2100 hours.
- Washery: 0700 - 2100 hours.
- Coal Stockpile area
- Train loading overhead hopper system located above rail loop.

2.2.2. <u>Service and Support Installations</u>.

Mining and preparation plant activities will be supported by a series of service structures and installations focussed in the pit top area. These are:

- bath-house / administration building.
- workshop.
- waste water treatment plant.
- potable water treatment plant.
- water storage dams.
- 66/11 KV Substation.
- 66 KV power line (from Invincible Colliery)
- storage yard.
- car parking space (..... vehicle capacity)
- ventilation ducts and fans.
- air intake vents.
- refuse storage spaces.

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At the time of writing (July 1980) Coalex had not confirmed with finality the exact location and arrangement of plant components, nor put the construction contract up for tender. For these reasons the construction stage cannot be accurately described. However, there is sufficient knowledge of plant development to allow a quite reasonable assessment of implications for the local and regional populations.

2.3 Access.

2.3.1. Road Development

A private access road will connect the pit top with the Mudgee Road. This will cross property yet to be acquired by Coalex, as well as Forestry Commission land along an old Travelling Stock Route.

The intersection with the Mudgee Road will be considerably upgraded to D.M.R. specifications.

2.3.2. Railway Development.

A railway spur, about 8 km. in length, will connect the site with the Wallerawang - Gwabegar line to the west. The line will be supported on a bridge over the Mudgee Road and terminate, at the pit top, in a balloon shaped rail loop facilitating train turn around and coal loading from an overhead bin system.

2.4 Routine Operation

2.4.1. Programme.

Removal of coal from the Lithgow Seam will commence during September 1981, or at a later date if development deadlines are not achieved. The following routine operational phases will take place:

(i) The first of seven mining units will be removed from Wallerawang Colliery in July 1981 freeing its crews shortly afterwards.
To efficiently employ these operators it is aimed to commence extraction from Baal Bone during September 1981, by which time it is planned to have completed all but the railway spur and coal preparation plant. While these latter compenents are being constructed (completion by June 1982) coal will be trucked to, and prepared at Wallerawang.

(ii) By the end of May 1982 three more units will be removed from Wallerawang,leaving three to operate until the Colliery closes in April 1983. During this period output from Baal Bone will rise. Equipment and employees will be transferred to Baal Bone in stages. Coal will be transported by rail to export ports (see section 2.4)

(iii) After 2 years' operation a long wall mining unit will be introduced, provided conditions are conducive and output targets so warrant.

(iv) Production will progress to a target of 7000 tonnes per day.

(v) During the second 10 years of operation rehabilitation initatives will be introduced and

(vi) Phasing down of the Colliery operation is probable around the turn of the century, with eventual abandonment of the Colliery occuring soon thereafter.

2.4.2. Employment Generation.

Labour requirements for both the construction and routine operational phases are given in Table 1. The timing of the introduction of new mining unit crews and support staff to Baal Bone will depend on whether development programme deadlines, which are intimately linked with the phasing down of Wallerawang, can be achieved. During the construction event the manpower numbers,quoted in Table 1, will be greatly increased by the construction crew operating on behalf of the contractor.

Wallerawang Colliery employs 180 staff. By the time Baal Bone is operating at near full capacity over 250 jobs will be filled, thereby creating over 70 new positions. This represents a 40% employment increase over Wallerawang Colliery.

Although the coal industry has become increasingly capital intensive, it does not appear as though it is about to be rationalised by a new wave of labour replacing technology and it is therefore expected that the above staff requirements will be maintained over the lifetime of the operation.

Of the present Wallerawang Colliery employee workforce 60 - 65% reside in Lithgow, 15% in Wallerawang and 20 - 25% between Wallerawang and Portland.

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TABLE 1 CONSTRUCTION AND PRODUCTION MANNING TABLE (SOURCE: COALEX PTY. LTD.)

YEAR AND QUARTERS	80/81 1	80/81 2	80/81 3	80/81 4	81/82 1	81/82 2	81/82 3	81/82 4	82/83 1	82/83 2	82/83 3	82/83 4	83/84 1	83/84 2	83/84 3	83/84 4
Production T/D	-	-	-	-	500	500	1000	1250	2250	2250	3500	7170	7170	7170	7170	7170
CONSTRUCTION PHASE																
DRIFT																
Staff		6	6	6												
PIT BOTTOM DEVELOPMENT																
Staff					6	6										
Surface					5	5										
Underground					13	13										
PRODUCTION																
Staff							8	12	12	17	17	19	19	19	19	19
Surface							10	11	12	12	18	21	21	21	21	21
Underground							33	33	66	66	98	192	192	192	192	192
COAL PREPARATION PLANT							5	14	14	21	21	21	21	21	21	21
TOTAL		6	6	6	24	24	56	70	104	116	154	253	253	253	253	253
15% ABSENTEES					3	3	8	10	15	17	23	38	38	38	38	38
GRAND TOTAL		6	6	6	27	27	64	80	119	133	177	291	291	291	291	291

NOTE: The above figures allow for combination of longwall and continuous miner operation. Should all continuous miners [redacted]

2.4.3. Activity Patterns - On Site and Underground.

Activity will be focussed around the operation of the coal extraction, coal preparation and support plant and installations outlined in Section 2.2.

There will be three 7 hour mining shifts during the following times on 5 days per week:

- 7 am. - 2 pm. Day Shift.
- 2 pm. - 9 pm. Afternoon Shift.
- Midnight - 7 am. Night Shift.

A conveyor maintenance shift will operate during the residue 3 hours, 9 pm. to midnight. Overlap of shifts can be avoided by using a high speed underground transport system.

The mining crews and back up men work to the following daily routine:

- arrive and park cars or disembark from bus
- change into working clothes in bath-house, collect lamp
- travel down adit to working face
- perform mining work
- travel out of adit
- change into street clothes and
- leave colliery.

A much smaller number of employees is involved in operation of the coal preparation plant(maximum 21), administration / management functions (maximum 19) and trades activities. These personnel work mostly at the surface.

Coal will be conveyed out of the mine and processed through the preparation plant before stock piled ready for loading onto trains.

A sealed, internal road network will permit efficient vehicle movement over the site.

2.4.4. Road Traffic Generation.

All traffic entering and leaving the site will have to traverse the Mudgee Road - nearly all these vehicles will travel that road south of its intersection with the Colliery access road. There will be minimal traffic using the northwards stretch of the road.

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2.4.4.1. Construction Vehicles.

The majority of heavy construction mobiles will remain on the site during the period prior to commencement of extraction. The volume of traffic generated by the construction contractor and his crew is not known - nor are the likely places of residence of the crew if manpower has to be bought in from outside the Region.

Coalex staff can be expected to make around 50 - 60 trips per day along Mudgee Road during the construction phase.

There will be minimal requirement to transport fill to or from the site so that a significant volume of heavy trucks fulfilling this function is not anticipated. There will be periodic trips by trucks carrying road base aggregates, concrete and railway material.

2.4.4.2. Coal Trucking.

During the first 10 months of resource out put, that is until mid - 1982, coal will be transported from Baal Bone to Wallerawang Colliery by 25 tonne trucks. Preparation will take place at Wallerawang until the Baal Bone preparation plant and railway facilities are completed.

During this period around 400,000 tonne of coal will be taken out of Baal Bone mine at a rate of 1500 (early) to about 4000 tonnes (maximum) per day. Assuming around 200 working days over this period, average output is 2000 tonnes per day.

Using 25 tonne capacity trucks, the following truck trips would be required to handle the above variable outputs.

- minimum 1500 tonnes
  - 60 trips loaded trucks from Baal Bone to Wallerawang.
  - 60 trips empty trucks from Wallerawang to Baal Bone.
  - total 120 trips per day.
- average 2000 tonnes
  - 80 loaded
  - 80 unloaded.
  - total 160 trips per day.
- maximum 4000 tonnes
  - 160 loaded.
  - 160 unloaded.
  - total 320 trips per day.

9 to 10 trucks will be involved.

D.M.R. traffic engineers have advised that the Invincible Colliery has an average weekly output of 20,000 tonnes over a 6 day week. At times output is almost double this level.

Average daily transport requirement is therefore about 3330 tonnes generating about 133 loaded and 133 unloaded truck trips down the Mudgee Road, i.e. total 266 trips per day.

Around 400 heavy vehicles, in addition to those from Invincible, traverse Mudgee Road daily.

Trucking of coal from Baal Bone will be of very temporary duration (10 months) and along a 14 km. stretch of Mudgee Road which is essentially undeveloped except for Cullen Bullen township. Trucks will operate up to 14 hours per day from 7 am. to 9 pm.

2.4.4.3. Employee and Service Vehicle Trips.

These will constitute the only regular road traffic generated by the Colliery after completion of the railway spur in 1982.

Employees of Wallerawang Colliery have initiated a vehicle pooling system and co-operate in transporting themselves to work. V.W. Kombies are used and management estimates that there are, on average, 2 - 3 employees per vehicle. Baal Bone,being 14 km. more distant from residential settlements (than Wallerawang) makes the attractiveness of pooling, or a bus service, even greater.

Traffic movements will peak during the 30 minute periods immediately before and after the daily shift changes at midnight, 7 am., 2 pm. and 9 pm. The roads likely to be traversed are as follows:

- Mudgee Road between Wallerawang and the Colliery Access Road.
  Estimate: 80 - 85% total employee traffic.
- Great Western Highway between Lithgow and Wallerawang, thence Mudgee Road to Colliery Access Road.
  Estimate: 40 - 50% of total traffic.
  Note: (This assumes around 40% of employees will reside in Lithgow and 40 - 45% in Wallerawang.)
- Portland to Cullen Bullen Road, thence Mudgee Road between Cullen Bullen and Colliery Access Road.
  Estimate: 15 - 20% of total employee traffic.

Traffic volumes cannot be accurately calculated until worker transport arrangements are confirmed. Should every employee use his private vehicle,trip generation will be (250 x 2) 500 trips per day, plus service vehicle trips.

Assuming 2 employees per vehicle, 250 trips would be made and if an efficient pooling arrangement is used, trip generation may be as low as 100 - 150 trips per day, plus service vehicle trips. These estimates are not excessive when compared with existing Mudgee Road volumes.

The most likely and desirable (from a traffic volume, fuel conservation and worker transport "cost") situation will be to have a worker to vehicle ratio of 3:1, or better. Should this situation eventuate, then, on an average working day, the following traffic movements are predicted once full operation is underway - refer Table 2.

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TABLE 2

TIME	DESCRIPTION OF MOVEMENT	NO. OF VEHICLES
11.30 pm.- midnight	Vehicles travel to Colliery via Mudgee, Portland - Cullen Bullen and Great Western Hwy. Night Shift arrival.	24 - 25
6.30 am. - 7 am.	As above from Lithgow, Wallerawang and Portland towns and environs. Day Shift arrival.	35 - 40
7 am. - 7.30 pm.	Vehicles leave Colliery and travel the above routes to above destinations. Night Shift departure.	24 - 25
1.30 pm. - 2 pm.	Vehicles travel to Colliery. Afternoon shift arrival.	24 - 25
2 pm. - 2.30 pm.	Day Shift departure	35 - 40
9 pm. - 9.30 pm.	Afternoon Shift Departure	24 - 25

SUMMARY

Total employee trips generated = 166 to 180.

Total service vehicle trips (estimate) = 40 to 60.

Total trip generation = 206 to 240.

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2.4.5. Railway Movements.

Ultimate daily coal output from the Colliery will be in the vicinity of 7000 tonnes per day with an annual target of about 1.5 million tonnes. After completion of the preparation plant and railway (1982), it is anticipated that all coal will exit from the site via rail. There are no committments to supply coal to Wallerawang Power Station at this stage.

2.4.5.1. Coal Trains.

A typical train will consist of:

(i) two diesel main line locomotives between Baal Bone and Lithgow, thence electric locomotives to the ports.

(ii) forty CTS 57 tonne capacity waggons, or

(iii) thirty CHS 77 tonne capacity waggons.

Total haulage weight is normally about 3000 tonnes for a loaded coal train.

Each train will carry about 2300 tonne of coal. On this basis an anticipated 1300 (650 x 2) train movements per year will be required to convey 1,500,000 tonne from Baal Bone.

2.4.5.2. Travelling Routes.

Baal Bone coal is destined for export and will follow the established routes to export port loading facilities. At present the loaders are at Port Kembla and Balmain which, until expanded greatly, appear incapable of efficiently handling the increased coal flow.

Trains from Baal Bone will traverse the railway spur then turn south down the Wallerawang - Gwabegar line to Wallerawang, connect with the Main Western Railway and proceed to Port Kembla where, it is anticipated, the bulk of Baal Bone coal will be loaded.

2.4.5.3. Scheduling of Train Movements.

It is well recognised that:

"....... the creation of an immensely expanded world trade in coal is in part dependant upon the adoption and execution of co-ordinated Government policies......" *

* "Steam Coal - Prospects to 2000." OECD International Energy Agency 1978.

- especially those relating to promoting a smooth and consistent flow of export coal to international markets. There has been, in New South Wales, a bottleneck with respect coal movement at the export ports. Realisation of this and the severe implications for coal industry expansion has stimulated studies, including the "Coal Export Strategy Study" by a Task Force of the N.S.W. Government (1979). Steps are being taken to rationalise and maximise coal handling efficiency.

However, scheduling of coal transport from Baal Bone will be significantly determined by loading facility capacity during the 1980's. Loader capacities and stockpiling spaces at Port Kembla and other ports are not always capable of transferring coal to ships as the demand arises - expensive shipping delays result. Another consequence is that large dunes of coal are stockpiled at Collieries. It is envisaged that train movements to and from Baal Bone will be concentrated into 96 hour (4 day) periods every 10 days. During these times trains will operate over 24 hours.

It is estimated that these 4 day bursts of "intensive" train movement will take place around 30 - 35 times per year (i.e. 120 - 140 days per year) and that there will be about 10 train movements per day (i.e. 5 trains each making an inward and outward journey).

PART 3.

Local Development and Population.

3.1. Setting.

The Baal Bone site and environs are dominated by massive violations of the natural topography created by prior open cut mining operations. Small mountains of grey-black waste rock rise above the natural contours; most ridges now being colonised by pinus radiata and acacia scrub. Dry and water-filled "U" and "V" shaped ravines separate the rock-waste piles. An atmosphere of desolation and isolation persists.

Surrounding countryside is exclusively rural with the Ben Bullen State Forest enclosing the valley system containing Jews and Ben Bullen Creek, except at its mouth to the north-west. These creeks drain into the Turon River system.

3.2. Land Uses.

3.2.1. Ben Bullen State Forest.

The forest lies on the west facing slopes of the Great Divide in the Ben Bullen / Baal Bone / Cullen Bullen district. It accomodates a variety of stringy bark, snappy gum, brittle gum, scribbly gum and mountain gum species which are periodically cut to supply mining timbers. Saw logging does not take place but ornamental rock is occasionally removed and sold. Ben Bullen and other forests in the district are public domains to which access is permitted for reasonable activities.

The extent of the forest is shown in Fig..... Except for rock outcrops its canopy forms a relatively unbroken cover over the landscape.

3.2.2. Homesteads.

Dwellings in the Baal Bone vicinity, and along the Mudgee Road, are generally associated with large rural holdings where the grazing of horses, sheep and cattle is the primary activity.

The nearest homesteads, Blue Rocks, Veretta and Bonnie Doon are respectivelly located over 1 km., 3 km. and 2 km. from the colliery site.

The Blue Rocks property is separated from the colliery site by tree-topped open cut ridges and grassland with a scattering of mature trees. The access road and railway will be screened from the dwelling

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by the same features and, to the west, by a belt of more dense vegetation. Immediately north of the homestead is a coal dump accomodating several small piles of coal.

Blue Rocks has access from Mudgee Road via a dirt road which will not be inconvenienced or interrupted by Coalex development.

Veretta, 3 km. northwards, is separated from the site by extensive open cut workings and rolling topography, while Bonnie Doone, which is located beside Mudgee Road, is separated by a substantial ridge within the State Forest.

Other homesteads in the vicinity are identified on Figure .... Each homestead is usually surrounded by a series of out-buildings supporting non-intensive grazing activities.

3.2.3. Cullen Bullen Township.

Cullen Bullen is a small coal mining settlement bisected by the Mudgee Road, and located at a point approximately 4 km. south of the proposed entrance to the Colliery Access Road.

It has about 230 inhabitants, accomodated in around 70 older style, wooden, dwellings. The residences are accompanied by small out-buildings and yards, which are generally in a derelict condition. The occasional horse grazes the yards and adjacent paddocks.

The coal industry, through the Invincible Colliery and Wallerawang Power Station, employs the majority of men in the work force. Households vary in age composition - there are a few retired people.

The focus of the community is the hotel, store, post office and school - all fronting Mudgee Road, as do many of the dwellings.

A representative of the Cullen Bullen Progress Association revealed that the main concerns of residents are:

- decline in services to and within the settlement, and absence of development.
- smoke pollution from household fires.
- noise vibration and safety hazards from heavy vehicles passing through the town at excessive speed.

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Cullen Bullen has been a settlement effected by economic and developmental decline and stagnation over recent decades. However, its character must appeal to at least a certain percentage of residents and any future expansion must be directed so as not to compromise the qualities that are now valued.

3.2.4. <u>Ben Bullen Settlement</u>.

This minute settlement is focussed around the intersection of the Wallerawang-Gwabegar rail line, Mudgee Road and Quarry Road which leads to "Woodlands" Homestead. The small railway station is associated with nearby 7 derelict dwellings and out-buildings in similar condition.

3.2.5. <u>Transportation System Features</u>.

3.2.5.1. <u>Roads</u>.

The Mudgee Road links Lithgow / Wallerawang with Mudgee 100 km. northwards. In the Cullen Bullen area the two lane road is sealed with unformed shoulders.

In 1976 AADT was 1500 vehicles. Up-to-date counts are now being recorded with the D.M.R. daily estimate being in the vicinity of 1800 - 2000 vehicles, of which 20% or 360 - 400 are classified as heavy vehicles. The road is being extensively upgraded in the Blackmans Flat area.

Rural properties and the open cut mine in the Baal Bone vicinity have private access roads linking with Mudgee Road and farm roads providing access to parts of the holdings. Ben Bullen Forest has its own roading network.

Cullen Bullen has a restricted network of residential streets and accomodates both Mudgee Road and the Portland - Cullen Bullen Road.

3.2.5.2. <u>Railways</u>.

The Wallerawang - Gwabegar rail line runs in a north - south direction about 4 km. west of the site and crosses the Mudgee Road near Ben Bullen Station, 6 km. to the north - west. The line continues south through the now abandoned Cullen Bullen Station to Portland, then turns to run in a south easterly direction to Wallerawang and a connection with the Main Western Railway.

Both passenger and freight trains travel the Wallerawang - Gwabegar line. Public Transport Commission advice indicates the following train movements along that part of the line between Wallerawang and Mudgee.

(a) Wallerawang - Mudgee: 2 passenger trains each way per day.
: 1 freight train each way per day.

(b) Kandos - Wallerawang: 1 freight train each way per day.

(c) Portland - Wallerawang: 1 freight train each way per day.

A rail spur was developed through the Ben Bullen State Forest during the 1940's to carry coal from the open cut workings. This spur terminated in the vicinity of the Blue Rocks homestead, but has long been abandoned.

3.2.6. Existing Collieries (North of Wallerawang).

Baal Bone is located 6.5 km. in a direct line from Invincible, the nearest colliery. Invincible fronts Mudgee Road and is visible, although partly screened by trees from the road. Trucks are used to transport coal therefrom.

About 6 km. further south, over an extensive ridge of the Great Divide, are the Western Main and Wallerawang Collieries, both of which are blatantly visible from Mudgee Road as it passes across Blackmans Flat.

Advice from Lithgow Council is that Wallerawang Colliery:

(i) is responsible for considerable pollution of the waters of the creek flowing into the Coxs River. Fish life has been badly affected.

(ii) generates undesirable air and noise pollution.

(iii) is visually unappealing.

It would appear that the closure and rehabilitation of this colliery would propel an increased quality of rural amenity and environmental condition in the area.

3.3. Future Development and Council Attitudes.

3.3.1. Development Initiatives.

There are no current development applications pertaining to land or activity in the Baal Bone / Cullen Bullen area. The planned Coalex

Baal Bone Colliery is the only known proposal.

3.3.2. Council Goals - Local.

The Council of the City of Greater Lithgow recognises the strong growth impetus arising from the expansion of the coal and dependent electricity generation industries (See Section .... for further discussion).

There is unconfirmed but obvious scope for expansion of Cullen Bullen township and revitalisation of the services provided therein. However, there is no definite, or immanent commitment or goal to stimulate its growth.

The agricultural and forestry activities in the area are certain to predominate as the principal land uses into the future and both Council, the Forestry Commission and other Government Agencies are concerned to see these land uses promoted and the environment conserved. Council has no specific goals or policies directed to the future development of Baal Bone and environs, but is cognizant of the need to:

- maintain water quality and hydrologic system functioning to support agricultural endeavours.
- preserve the visual environment, especially that visible from Mudgee Road and areas of human activity.
- preserve trees and forests.
- prevent subsidence.
- minimise disruption to traffic flows on the Mudgee Road.
- rehabilitate colliery type operations once their active life has ceased.
- preserve the amenities valued by the rural community.

3.3.3. Summary.

Demand for residential, rural-residential and perhaps commercial opportunities and land, may rise in the Cullen Bullen area during the 1980's, but it is predicted that the existing rural, non-intensive farming and forestry character will remain.

PART 4.

Western Coalfields Regional Development.

4.1. Introduction.

Baal Bone Colliery is but one of about ten development proposals (in either the planning or construction stages) which, combined, represent a major drive towards increasing coal and electricity output from the Western Coalfields. Alone, the colliery cannot be expected to catalyse major socio-economic changes or stimulate in the regional context, urban and infrastructure expansion.

However, in creating, 50 - 70 new employment opportunities and promoting a 50% production increase over Wallerawang, this colliery will have an effect.

Discussion of Baal Bone, other proposals and the planning response follows.

4.2. Coal and Electricity Industry Expansion.

The Electricity Commission of N.S.W., Coalex Pty. Ltd., Austen and Butta (Collieries) Pty. Ltd. and the Clutha Development Company are the four major proponents of coal and electricity industry expansion. Japanese investers are involved in many projects.

Their recent initiatives and short term future intentions, subject to approvals, are as follows:

4.2.1. Elcom.

- Elcom operates the Wallerawang Power Station which has recently increased capacity by 500 megawatts. An additional 500 mw. capacity is planned for 1981.

- Angus Place Colliery was opened in September 1978. It is located 6 km. north of the Power Station and directs its entire production thereto.

- Coal mining activity in the Angus Place district will be greatly increased during the 1980's, with planning for two new collieries, and expansion of the existing one. Output will supply the needs of the proposed Mt. Piper coal fired power station.

- Mt. Piper power station will have two 660 mw. output capacity and is expected to commence operation in 1986.

. Japanese interests have combined with Elcom to develop a colliery at Birds Rock in the Newnes State Forest 11 km. north of Lithgow. This colliery will produce export coal only.

. Elcom proposes to construct a 330 kv. power line linking Wallerawang Power Station with Wellington. The line will eventually carry power to most of western N.S.W.

4.2.2. Coalex Pty. Ltd.

Coalex operates the existing Wallerawang and Hermitage Collieries. The massive Clarence Colliery with a target output of 2 million tonnes per annum is recently completed and will now significantly boost Coalex output. Clarence benefits from an isolated location and convenient access to the Main Western Railway.

Current Coalex intentions are:

(1) to develop a drift facilitating man and materials access to the Hermitage Lease Northern Extension. The site preferred is at Fernbrook in the north-east corner of Marrangaroo Valley.

(2) in 5 - 6 years time, to submit a proposal to develop a new colliery in the Springvale Valley, 4 - 5 km. east of Wallerawang. This will replace Hermitage, which is becoming uneconomic,especially as a base from which to exploit the Northern Lease.

(3) phase-out Wallerawang Colliery and replace it with Baal Bone

(4) in the short term future, consider proposing a colliery in the Wolgan Valley area.

Coalex initiatives are directed primarily towards extracting export coal although supply to certain N.S.W. comsumers will continue.

4.2.3. Austen and Butta (Collieries) Pty. Ltd.

Western Main and Invincible Collieries are operated by this Company. The Invincible Lease is to be expanded, and a new colliery is proposed for the East Lithgow area.

4.2.4. Clutha Development Company plans an expansion of its Ivanhoe Colliery.

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4.2.5. The Future.

These proposals appear to be based on the expectation that coal will be in strong demand over, at least, the remainder of the 20th. century - most mines have a 20 year, or thereabouts, lifetime. Depending on the evolution of the global energy supply / demand situation, and the relative attractiveness of new and existing fuels,matters which can be violently rocked by events and decisions over which most consumers have little control, the demand may continue to expand and may well extend for more than two decades.

It is a disturbing realty that continuation of political instability and uncertainty overseas,especially in the Middle East, is to be a major determinant of demand for Western Coalfields coal. Whatever, it is almost certain that internal demand for coal from the electricity generation sector will be maintained, and in all probability increase, should economic growth occur. No serious, acceptable challengers have appeared on the horizon.

4.3. The Planning Response.

The planning challenge today, and during the early 1980's, is to direct and encourage:

(1) coal and electricity industry initiatives and

(2) development directly and indirectly, catalysed by the creation of new jobs and healthy economic performance,

- all, in a way that will maximise benefits and minimise costs of all kinds.

In-migration and new potential for business is inevitable - in fact already happening, and not before time, in a region which has conspicuously suffered from socio-economic decline and stagnation qualified by out-migration, unemployment and low income levels of disturbing proportions.

The Council of the City of Greater Lithgow is aware of the crucial role in participating in the planning process and has commissioned studies designed to present and recommend alternative futures and development directions for certain parts of the Region.

The requirement of developers to produce Environmental Impact Statements to accompany major applications is also of planning relevance.

4.4. Population and Employment Growth Predictions.

Projections have recently been completed and published in the document "Wallerawang Planning Study. A Report to the Council of the City of Greater Lithgow," prepared by the firm of Gutteridge, Haskins and Davey Pty. Ltd., Consulting Engineers, Planners and Surveyors.

Population and employment opportunity trends during the 1980 - 1986 period are illustrated in the Tables and Graphs in Appendix A to this report.

Between 3720 and 6200 new job opportunities are expected to be created during 1981 - 1986 in the Greater Lithgow area. This increase will be accompanied by a 7840 - 13,000 population increase over the same period with population continuing to rise, though at a slower rate, between 1986 and 2001 (note that employment predictions are based on a multiplier effect expectation).

It is considered in the above report that Wallerawang, because of its:-

> "..... distinct locational and environmental advantages as a place of residence. Specifically ...... proximity of place of employment to coal mines and the proposed power station, and the visual and recreational appeal of Lake Wallerawang and the immediate surrounding countryside",

- will absorb a disproportionately high percentage of this new population (Ref. Appendix A).

Other potential growth areas within the Coalfields as identified by Council are:

- Portland
- Marrangaroo
- Bowenfels
- Lithgow (very limited)

To support this expected influx of people, it is imperative that infrastructure be planned, ideally to supply both the general and specific needs of the evolving community.

To buffer against a downturn in the coal and electricity industry it is important that a diversity of business be encouraged with an expansion of social, economic, cultural and employment alternatives.

PART 5.

Implications for Local Land Uses and Population.

5.1. Distinctive Considerations.

Important features of the Baal Bone site and proposed colliery which have a strong bearing on the nature and magnitude of impacts incident on land uses and humans are:

- The site is isolated from significant settlements by topographical features and distance.
- "Blue Rocks" homestead owned by Mr. S. McMahon is the closest dwelling, being a little more than 1 km. from the coal preparation plant and colliery headquarters.
  No other homesteads are within 2 km. of the site.
- Land uses in the vicinity are exclusively rural, non-intensive grazing and forestry being the dominant activities.
  Human activity is very limited.
- The open cut mine features endow the site with a unique appearance and a history of early industrial activity.
- The colliery will be self sufficient in most respects and will comply with the State Government's policy of promoting coal transport by rail in preference to road.

5.2.1. Impact on Agricultural Activity.

Consultation with a Department of Agriculture Officer (with experience and knowledge of dairy, beef and sheep grazing in coalfield areas) reveals that there are no significant longstanding conflicts between those forms of agriculture and colliery operation and coal transport. These land uses appear quite compatible as long as air and water pollution is kept to a reasonable level.

Coal dust has posed no threat to animal health, in fact, due to its organic composition it may contribute as a fertiliser - grass growth in the vicinity of collieries, is sometimes quite prolific. This effect, however, has not been substantiated.

Beef cattle quickly get used to the existence of collieries. The main consideration is on the basis of safety - it is necessary to keep animals away from potentially dangerous components of the industry, railways, roads and landforms which could trap an animal or cause bone breakages. This can be easily avoided by separating pastureland and the colliery site with stock fences.

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5.2.2. Ben Bullen State Forest.

Minimal felling of trees at the margin of the forest and along the railway and road access routes will be required. Forestry Commission approval will be requested.

A 66 KV power line from Invincible Colliery to Baal Bone is proposed and will be the subject of a separate environmental study. The most direct route for the line is across the Forest - a path with a minimum width of twice the height of the surrounding trees would be cut, physically and visually disecting the forest-scape in an ugly scar. It is recommended that either;

(i) the line be routed along the Mudgee Road, or

(ii) the route zig-zag across the forest,

- in order to minimise tree disturbance and loss of visual amenity. State Forests are domains accessible to the public for certain activities, thus justifying measures aimed at the preservation of their aesthetic qualities.

Provided pollutants, in the form of coal dust, water contamination, are controlled, and interference with the forest ecosystem minimised, impact on the forest will be small.

5.2.3. Open Cut Mine Workings.

Around 30 - 40 ha. of the open cut mine will be modified by colliery development. Essentially, this involves replacement of one form of mining activity by another and is thus a reincarnation of a past use which has had a dramatic impact over a 2.5 $km.^2$ area. Changes to the environment external to the site were not monitored during the lifetime of the open cut, but there is strong evidence that it caused significant changes to the hydrological system, water quality and ecosystems in the valley.

The present environmental challenge is to minimise the impact of potentially damaging changes induced by the proposed colliery. Ecosystems downstream of the open cut system have to some extent, adjusted to its influence, for this reason it would appear wise to ensure that quality and volume of water exiting from the site does not change in a way capable of upsetting ecological balance.

5.2.4. Long Term - The Rehabilitation Issue.

The lifetime of any colliery is relatively short - usually around 20 years. The resource in the Baal Bone lease will eventually be depleted and if coal is still well in demand, Coalex will direct its efforts elsewhere in the way an animal community moves on to new grazing or hunting grounds when food in a certain territory becomes scarce.

Rehabilitation is an intriguing issue. Past attempts to restore open cut mines (in Australia and N.S.W.) have often been unsuccessful despite considerable expenditure, planning, effort, and the best of intentions. Climatic and other unforseen events have frustrated rehabilitation initiatives. Meanwhile, if nature is left to its own resources, there is usually little response in the short term.

The Chief Forester for the Lithgow area (Mr. A. Johnston) advises that periodic dry spells are likely to retard rehabilitation measures at Baal Bone. The policy with most chance of success will be to stockpile all topsoil removed during plant development and, during the colliery's operational lifetime, progressively topsoil areas which become disused, and to plant thereon species most likely to survive. This would encourage colonisation of the site and restore it to a semi-vegetate condition.

Ideally, in terms of promoting efficient land use, it is desirable to transform the abandoned area to a condition conducive to a prospective future use. Unfortunately, it is not possible to predict the intentions of future owners and users of this land. Due to the massive physical disturbance created by the open cut mine and the inevitable further impact from Baal Bone Colliery it is unavoidable that, by the turn of the century a violated scene will exist. In the opinion of the writer this scene has some very definite attractions and presents some interesting contrasts - perhaps by 2001 it will present some exciting opportunities in the recreational, leisure, sightseeing, tourist or alternative industrial spheres. The potential for such activity will depend on the growth of the Western Coalfields Region over the next 20 years.

Recommendation.

That revegetation of the colliery site be encouraged where possible over the mine lifetime. That a review of the rehabilitation issue take place, say every 5 years, with the aim of directing rehabilitation towards the achievement of future land-use objectives and the minimisation of impact on the environment during and after operation.

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Levelling and consequent expensive grassing and planting on the site should be avoided as this will:

- have little chance of success.
- obliterate a landscape which, although violated, has a distinct beauty and appeal. This expanse of open cut is the largest in the region and is a physical remnant of the early history of open-cut mining operations.

5.3. Effect on Local Homesteads and Inhabitants.

5.3.1. Visual Impact.

The colliery will not be directly visible from existing homesteads, due to the screening affect of topography and trees. Smoke from burning, and dust, especially during windy periods, may be visible, but these effects are not uncommon in the locality.

The Colliery will be visible to observers on the forested slopes around the site but will not interfere with the visual amenity of the forest itself, unless the power line and access routes are developed without regard to the conservation of the visual environment. Attempts should be directed towards minimisation of the visual impact of the power line if it crosses the forest as, from Mudgee Road, a pleasant and near complete forestscape view is enjoyed. (Ref. Section 5.2.2.)

5.3.2. Noise.

Blue Rocks homestead is the only dwelling which can be considered vulnerable to noise from the pit top or access road and railway. The acoustic consultant calculates a peak noise level of 48 - 49 d B (A) against a night-time ambient of 31 d B (A) L 10 and 26 d B (A) L 90, resulting from the movement of coal trains - fully loaded trains will generate the loudest noises. These trains, as stated previously, will operate over 4 day periods with a maximum of about 10 movements per day, movements being of 15 - 20 minute duration.

On-site activities and access road traffic movements will create minimal deterioration of the acoustical environment at the Blue Rocks homestead.

The value that the local residents place on a rural lifestyle with its inherent peace and quiet is recognised and the siting and design of the colliery appears to have given due respect to this factor.

5.3.3. Impact of other Pollutants.

Provided the recommendations presented in the other consultants' reports are adopted, it is expected that the welfare of local residents will be well protected. There are viable safeguards which can act to minimise deterioration of atmospheric conditions, ecosystem and water quality. The colliery will generate more intense activity in the valley but this will be geographically focussed at the site, along the roads and railway, and will be unlikely to interfere with the lifestyles of the locals.

5.3.4. Summary.

Residential amenity will not be significantly compromised by the colliery development, provided pollutant emission is controlled by realistic measures.

5.4. Implications for Cullen Bullen and Ben Bullen Settlements.

5.4.1. Cullen Bullen.

Representatives of the community were briefly interviewed, and asked to comment on their personal, and likely community attitudes to the colliery proposal.

Inhabitants are aware of the desirability of creating industry and employment in the region and would like to see business in Cullen Bullen stimulated marginally - this may occur, if some Baal Bone employees;

(i) decide to reside in Cullen Bullen, or

(ii) stop at Baal Bone on their journey home for a drink at the hotel, or to shop at the store.

The main concern relates to the safety hazard, noise vibration and dust generated by coal trucks. Baal Bone, however, will generate trucks for less than 12 months and during this time these trucks will contribute to a 30 - 50% increase in heavy vehicle trips through Cullen Bullen.

Recommendations.

1. That a speed limit of 60 km. per hour be introduced and enforced for that section of Mudgee Road passing through Cullen Bullen.
2. That coal trucks be covered to eliminate escape of coal dust.
3. That coal trucks be fitted with standard and, if considered necessary, specialised muffler and emission filter systems.

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5.4.2. Ben Bullen.

No significant impact is expected as coal trains and road vehicles will not pass through the settlement and it is well removed from the pit top.

5.5. Local Transport System Impact.

5.5.1. Mudgee Road.

This route will carry most Baal Bone traffic. The D.M.R. is not concerned by the increased traffic load,provided the intersection with the Colliery Access Road is designed to its specifications. With respect to traffic volume increases:

(i) there will be an estimated 11% increase in vehicle movements along Mulgee Road after trucking has finished. Most will be cars and small personnel vehicles.

(ii) while trucking is in progress a 30 - 50% increase in heavy movements is expected north of Invincible Colliery, with a 20 - 50% increase along that stretch of Mudgee Road between Invincible and Wallerawang Colliery.

(iii) Traffic generation during construction cannot be accurately calculated at this time.

As trucking will be temporary, it is not considered necessary to upgrade Mudgee Road specifically as a result of the Baal Bone proposal.

5.5.2. Other Roads.

Little impact is expected on other roads as present travel patterns from employee residences and service bases to Mudgee Road will not alter greatly apart from marginal increases in volumes.

Volumes on the Portland - Cullen Bullen Road will increase most significantly as this route is not currently used by Wallerawang Colliery employees.

5.5.3. The Wallerawang - Gwabegar Railway.

P.T.C. advice identifies 10 train movements daily (4 passenger / 6 freight) along the railway between Wallerawang and the proposed intersection with the colliery railway spur to the north. This corresponds to around 3,600 movements annually.

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Baal Bone will generate around 1300 movements per year resulting in an annual 36% increase in movements. However, these movements will concentrate into 4 day periods when the number of movements on the line will effectively double. These trains will contribute to some deterioration of acoustical amenity in the regional context (Ref. Section 6.)

PART 6.

Closure of Wallerawang Colliery.

Benefits and improvements resulting from the closure and subsequent rehabilitation of Wallerawang Colliery cannot be used directly to support development at Baal Bone. However, there appear to be some positive impacts associated with closure.

6.1. Visual Amenity.

Wallerawang Colliery is set against Mudgee Road and is considered somewhat of an eyesore by Council and others. Removal of plant and rehabilitation of part of, or the whole of the site can only improve the appearance of the Blackmans Flat area.

6.2. Pollution Elimination.

Provided leachates are controlled, coal stockpiles removed and exposed surfaces, revegetated, it is likely that the water, air and noise pollution, generated by Wallerawang (and, according to Council sources, having significant deleterious environmental impact) will be sharply reduced.

6.3. Employee Benefits and Costs.

The 150 - 160 Wallerawang employees who are expected to transfer to Baal Bone will have access to facilities and, according to Coalex Lithgow management, enjoy working conditions far superior to those at Wallerawang. The fact that only 18 out of 180 employees have applied to transfer to Clarence Colliery suggests an acceptance of Baal Bone as a satisfactory new place of work.

The obvious disadvantage of Baal Bone from an employee point of view, is its distance from residential areas - 14 km. further than Wallerawang Colliery. Coalex and its staff have opportunity to introduce cost saving co-operative transport arrangements.

PART 7.

Impact on the Western Coalfields "Region".

7.1. Coal Industry Expansion - Cumulative Effects.

The proposed coal and related industrial expansion projects, including those by Coalex, will have the following general effects:

- catalyse a major population increase in the existing urban areas, especially Wallerwang.
- generate, directly, a large number of new job opportunities (Ref. Section 4.4.) and also a range of employment positions in other sectors,e.g. service, Government, commercial and retail.
- create opportunity for new business endeavours aimed at supplying goods and services for an expanding market.
- cause social changes in that there will be in-migration to the region and probably a diversification of community needs and demands.
- generate demand for residential opportunities in rural and semi-rural areas. Not all of the population will wish to reside in towns.
- place new demands on regional services and infrastructure. Water supply appears to be of crucial concern.

The adoption and implementation of realistic and co-ordinated objectives and policies by State and Local Government agencies is vital if the inevitable growth impetus is to be directed and accomodated beneficially. Responsibility for the natural environment lies with the mining companies and Government.

If this challenge is efficiently met, the expansion of industry will be of national interest in that:

- new employment positions will arise at a time when unemployment in the Region is severe.
- export revenue will increase.
- decentralisation of growth, away from the coastal cities, will be promoted.

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7.2. Baal Bone Colliery and the Natural Environment.

The Colliery will, to a degree, be responsible for the effects listed in Section 7.1. More specifically it may generate changes in the following respects.

7.2.1. Residential Demand.

Baal Bone Colliery is situated out on a limb as far as the Region is concerned, being presently the most northerly colliery proposed.

There may arise some demand for residential opportunities (by employees) in the Cullen Bullen settlement area, or even in rural areas along the Mudgee Road. Council must decide whether such opportunities should be created or whether to direct as much growth as possible into Wallerawang township. The latter alternative, on the basis of limited information available, may appear preferable because:

- Servicing will be more convenient and centralised.
- Invasion of sporadic development in rural areas fronting main roads will be avoided.

However, a range of lifestyle alternatives should be prsented to prospective residents.

7.2.2. Impact on the Natural Environment.

Provided the safeguards recommended in the consultants reports (and reiterated in the E.I.S.) are adopted, environmental impact will be low. It is considered important that the quality of water eminating from the site and flowing into Ben Bullen and Jews Creeks be maintained as these pass through agricultural land and feed into the Turon River System.

7.2.3. Transport System Impact.

The N.S.W. Government recognises its role in providing an adequate and efficient rail system from collieries in all parts of the State to the ports - it would be fatal to have the ability to produce coal but fail to provide its smooth exit from N.S.W.

Baal Bone will contribute to an increase in railway movements on the Main Western Railway, but it will be one colliery that completely complies with the Government's goal of transporting the maximum possible volume of coal via rail.

Should the expected population and development "booms" proceed in the Coalfields region significant upgrading of important routes may be necessary.

REPORT ON ATMOSPHERIC POLLUTION RISK ASSOCIATED WITH PROPOSED COAL MINING DEVELOPMENTS AT BAAL BONE

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Applied Climatology

July, 1980.

CONTENTS

SUMMARY

Assessments have been made of atmospheric pollution potential using data from long-term climatic records of stations in the area, and also from limited aerological data obtained under stable, anticyclonically-controlled weather conditions at a nearby site having a similar topographic setting. The assessment of airflow patterns at the specific location of the pit top facilities is by inference, calling upon known relationships between active or passive air movement and the form of the terrain.

The passage of pressure and wind systems over eastern Australia gives the area alternating periods of varying length with relatively strong or weak ventilation. Occurrences of slow moving anticyclones - with their characteristic calm or slack air conditions, upper level subsidence, and strongly developed nocturnal surface temperature inversions - could be expected to promote the concentration of pollutants over periods of several days if any substantial and continuing emissions from combustion or other sources occurred at such times. Sequences of five or more days with such conditions have occurred at all times of the year, but these are most frequent in Autumn.

From temperature soundings to a height of 220 metres with clear, stable, anticyclonic weather conditions at 'Fernbrook' (18 km distant and having similar topographic setting), it is deduced that very strong nocturnal surface temperature inversions would quite commonly persist until the mid morning hours over the cooler half of the year. On occasions with retarded surface heating after sunrise (e.g. with onset of early morning cloud or dense fog layer) such stable conditions favouring the accumulation of pollutants in the surface layers would likely persist until about midday.

Effective dispersal of pollutants during the daytime could normally be expected due to the onset of anabatic airflow toward steep upper slopes in the vicinity of the site. With minimal release of combustion products to the atmosphere at the site of these proposed developments, no serious degradation of air quality would be expected. Whenever possible, the burning of waste materials should be carried out in periods other than when calm, stable weather prevails, due attention being given, of course, to bushfire risk at the time.

Atmospheric pollution from the lifting of fine, dry materials under windy conditions while handling or stockpiling of coal, or from bare earth surfaces during the operational and constructional stages of these developments, could occur if preventive measures are not taken. Strong winds from compass points between south and northwest occur most frequently during winter and spring, and an examination of the incidence of daily rainfalls in excess of the potential evaporation indicates that dry surface conditions extending over periods of a week or longer can occur in all parts of the year. In the spring and summer months dry day sequences of this duration have a mean recurrence interval (return period) of between once in two years and once in each year. Recommendations are made for minimizing air pollution associated with the lifting of dust by wind.

Report on Atmospheric Pollution Risk Associated with Proposed Coal Mining Developments at Baal Bone

1. Introduction and Objectives

The extent to which any proposed industrial or minerals extraction operations is likely to cause degradation of the existing atmospheric environment depends upon macro- and micro-scale meteorological controls and processes that set the atmospheric pollution potential, as well as the magnitude and spatial/temporal incidence of pollutant releases from all point, line or area sources at the site.

The objectives of this report are (a) to assess the existing atmospheric pollution potential from all available meteorological and climatic data for locations in the vicinity of the proposed mining development at Baal Bone, and (b) to appraise the likely impact of this development on air quality in the light of the existing meteorological conditions and known or expected pollutant sources accompanying that development.

2. Study Method, Limitations, and Available Data

Ideally air pollution potential and the risk of degradation of air quality should be assessed after long-term monitoring of the aerodynamic characterics of the atmospheric boundary layer close to the site of development. Such monitoring should extend over a sufficiently long period as to include a wide range of conditions (e.g. day-to-day and seasonal changes in thermal gradients and air movements). Because of time and expense limitations, monitoring programmes of this kind are not often undertaken, and are mostly reserved to development proposals involving exceptionally large or hazardous additions to the pollutant load. In this study no such monitoring was feasible, and the assessment of atmospheric pollution potential and likely impact on air quality rests on inferential interpretation of existing relevant climatic data, and on aerological data collected at a nearby site having similar topographic conditions. Data avaliable from established climate stations within the Bureau of Meteorology network are relevant only in respect of macro-scale controls of atmospheric pollution potential.

They cannot directly reveal any unique regularly occuring boundary layer conditions at the specific site that could be important in pollutant concentration and dispersal locally. However, when such data are examined with due consideration of probable micro-scale. topographically-related processes at the site, an objective appraisal of the existing potential for atmospheric pollution can be made, and the likely risks of degraded air quality associated with the planned mining installations and operations can be seen.

In this investigation the assessment of macro-scale aspects of atmospheric pollution potential is based mostly upon daily climatic data from the Bureau of Meteorology climate station at Lithgow, (lat.33 deg.28's; long.150 deg E; elev. 917.4m). Lithgow is 24km south-southwest of the Baal Bone site in an area having generally similar surrounding topographic characteristics. Additional macroclimatic data used in this study are from Sydney Kingsford Smith (Mascot) Airport (for barometric pressure) and from a continuously recording anemometer installed and maintained by the Electricity Commission of N.S.W. at its Wallerawang Power Station, approximately 14 km south of the Baal Bone site and in a similar topographic setting.
Assessments of micro-scale aspects of atmospheric pollution potential is made largely by inference from well established relationships between topography and microclimate, and from limited special purpose measurements and observations made by the author at 'Fernbrook' (18 km south-southwest of Baal Bone site).

3. Existing Atmospheric Environment and Air Pollution Potential

3.1 Regional Circulation Controls

The broadscale features of atmospheric circulation at this location are consistent with its latitudinal position and with north-south seasonal migration of the characteristic tracks of anticyclone centres (Gentilli, 1971; Karelsky, 1954). In Summer anticyclone tracks are well to the south, passing over the southern margin of the continent, and causing winds between north and east to dominate over eastern N.S.W. In Winter anticyclone centres pass across eastern Australia over a wider range of latitude than in the western half of the continent, but commonly these are located at about the latitude of 30 deg S, causing southwesterly and westerly winds to be dominant over a large area of southeastern Australia.

Another important seasonal difference in the circulation control is the generally more rapid eastward progress of the anticyclones (and frontal troughs to the south) in Winter/Spring than in Summer/Autumn. The Winter and Spring months also bring steeper pressure gradients within the frontal troughs that pass over the southerly portions of the continent between the successive anticyclone cells. This not only produces generally better ventilation over the whole of southeastern Australia in Winter and Spring, but also imparts a more definite periodic character to the day-to-day weather, with shorter periods of anticyclonic dominance at the latitude of interest here.

At times the eastward progression of the anticyclonic systems becomes sluggish or stagnates into a 'blocking' condition. This produces widespread slack air movement and subsidence, with marked stability within the middle troposphere and conditions favourable to increasing pollution levels over successive days. These pollution prone synoptic conditions can occur at any season, but are more likely in autumn than in other seasons.

3.2 Macroclimatic Conditions

3.2.1. Anticyclonic Incidence and Duration

Not only are the anticyclonic cells of fundamental importance in the broad regional circulation and daily weather controls, they are also of particular interest in the context of air pollution potential because they often create widespread upper level temperature inversions that preclude the mixing of pollutants from surface sources through any great depth of the troposphere. Further adding to the significance of anticyclone occurrence is the fact that these systems are characterized by calm, clear skies conducive to strong nocturnal surface temperature inversions. These conditions render the lowest layers of the troposphere extremely stable, and inhibit losses of particulate and gaseous pollutants from the shallow layer near the surface. The characteristic day-to-day atmospheric pressure regime is thus of fundamental significance in the macro-scale assessment of atmospheric potential.

No pressure measurements are made at the Lithgow climate station, but because anticyclones are large systems that maintain identity over long distances, the pressure data from Mascot Airport at Sydney is as useful for the study.

To obtain meaningful interpretation of pressure data, a criterion for the identification of periods having strong anticyclonic dominance was adopted. For this purpose a seasonally changing pressure threshold, based on a detailed study by Karelsky (1965) of the average, minimum, and maximum pressures observed at the centres of anticyclones occurring within five-degree grid squares over a 12-year period, was used. The choice of pressure threshold is to some degree arbitrary, but it was considered that for this purpose the pressure level used should be such as to include most, if not all, anticyclonic systems passing over or close to the Baal Bone site. The threshold was therefore taken to be midway between the 12-year average and minimum pressures from Karelsky's study. To obtain a value that can be regarded most appropriate for central eastern N.S.W., the data for three adjoining grid squares were combined to give weighted values for each month shown in Table 1.

Table 2 shows the frequency of runs of days during which the reported barometric pressue at 0900 and 1500 hours exceeded the adopted threshold. It is evident from these data that anticyclonic conditions extending over more than ten days have at times occurred, and that runs of five days and longer are not at all uncommon. These frequencies provide some general indication of the likelihood of conditions that would favour widespread upper level and surface inversions, atmospheric stability, and a general degradation of air quality if accompanied by calm conditions (as is common), and if there are continued releases of pollutants over these periods.

3.2.2. Wind Conditions

Wind conditions observed at 0900 and 1500 hours at Lithgow also give insight on pollution potential. Table3 shows the frequency of periods of varying length having wind speeds at these two times less than 3 knots (5.5 km per hour). Although the occurrence of such light winds at these hours would not necessarily indicate that winds were continuously below that threshold throughout the day, the identification of runs defined in this way is instructive of the basic episodic character of poor ventilation that would favour pollution build up.

Periods of four or more days with such light wind conditions have occurred in all months. April stands out as the month having the longest sequences of days with such light air movement, and thus a month that can be expected to have particularly high pollution potential even apart from considerations of strong atmospheric stability induced by slow moving anticyclones (Table 2). It is notable that the spring and summer months have frequent short periods (1 and 1.5 days) with light winds and few very long periods. This indicates that day-to-day wind speed conditions are highly variable, probably as a result of short lived periods with moderate wind strength associated with localized daytime convection within these seasons.

It is fortunate that additional wind data are available from a continuously recording totalizing anemometer installed at a height of 32 metres at Wallerawang Power Station. Summarized data in the form of wind roses for three-month seasons and for the year as a whole were generously made available for this study. These original computer-drawn wind roses showed complete frequency distributions of wind speeds averaged over one-hourly intervals and including all ahours of the day. All records available between 1968 and 1977 were used. In Fig.1 seasonal and annual wind roses are given in a modified form that shows the frequency of winds from eight compass points within four windspeed classes.

For the year as a whole, one quarter of all hourly wind speeds is classed as 'calm' (less than 2 km/hour), and the frequencies of all wind speeds from the eight compass points are not greatly dissimilar. However, winds of high speed (in excess of 20 km/hour), are clearly most frequent from the southwest and west, whereas the lightest winds (2 to 10 km/hour) come more frequently from compass points between northwest and east.

Summer and Winter seasons have distinctly contrasting wind patterns, most winds in Summer being from the northeast, and most in Winter from the southwest. The transition seasons also have distinctive features. Autumn has a conspicuously large percentage of all hours with 'calm' conditions (31%), and also has the most uniform directional distribution of winds with speeds less that 10 km/hour. Spring has the least hours of 'calm' conditions (19%), but has overall wind characteristics more like those of Winter than of Summer.

If frequency of winds classed as 'calm' or in the 2 to 10 km/hour category is taken as a simple indicator of the potential for pollution build up in the area (e.g. as would occur if accompanied by upper level or surface inversions) then clearly Autumn stands out as the season most likely to have highest pollution levels, and Spring the season that is least pollution prone. The comparatively high percentage of 'calm' conditions in Winter (27%) is doubtless at least in part a reflection of the greater number of hours during which the stability of nocturnal surface temperature inversions occurs, i.e. with little or no surface air movement (hence favouring pollutant accumulation).

With mining operations, a pollution hazard may exist through the occurrence of strong winds that raise dust during the handling or disturbance of fine, dry surface materials or the mineral product. The frequency of winds of greater strength thus deserve attention as well as the occurrence of lighter air movement.

Table 4 shows the frequency of winds having a rating of 5 or greater on the Beaufort Scale (approx. 17 knots) as observed at Lithgow. This 'fresh breeze' condition can be taken as an approximate threshold for the lifting of dust from loose, dry surfaces. The data for 1500 hours is most relevant here because at that time superadiabatic lapse rates and instability are more likely in the air layers close to the surface - a condition that leads to strong turbulance close to the surface and so causing a lifting of loose materials into the turbulent flow. From the data it is seen that winds of greater strength occur most frequently in August. A moderately high frequency of winds above the adopted threshhold occurs from July to November (all above 5% at 1500 hours), and the lowest frequencies occur in February and March.

Table 5 shows in numerical form the percentgae frequencies of winds at all hours in excess of 20 km/hour as are shown graphically in the seasonal and annual wind roses of Fig.1. For most directions, less that 5 per cent of all hourly intervals have mean windspeeds in excess of 20 km/hour. The exception to this is for southwesterly and westerly directions during autumn, winter and spring (March to November inclusive), when the frequency is between 5 and 10 per cent, and also for northwesterly winds in spring (six percent). The latter case is especially noteworthy because northwesterly winds usually occur with passage of the rear of the easterly moving anti-cyclones, often after there has been a sequence of rainless days leaving the surface in a dry condition. Northwesterlies are also frequently gusty and turbulent prior to the passage of frontal systems, and these conditions commonly lead to the lifting of dust from dry earth surfaces.

3.2.3 Dry Day Sequences

The potential for pollution due to wind-lifted particles from earth surfaces or from coal being processed or stockpiled depends on size fractions of the materials being disturbed or handled, and upon the moisture condition of the materials and their cohesion. These factors are important in addition to windspeed and turbulence structure close to the surface. A general but useful indication of the climatic control of surface dryness is had from the length of time between recorded daily rainfalls, giving consideration to a drying time required to lose a specified quantity of water with the prevailing levels of evaporation. Evaporative losses from bare soil surfaces characteristically occur in two phases; (a) an initial high rate of evaporative loss, approximately equal to that of a free water surface while the surface is distinctly moist, and (b) a subsequently rapidly declining rate as the upward supply of water to the evaporating surface becomes limiting.

Data in Table 6 show the frequency of dry day sequences, these being defined here as runs of rainless days that occur after a computed drying period that follows one or more days having recorded rainfall. The length of the drying period is taken to be equal to the time (to nearest day) required for evaparation of 5mm of water at the long-term mean daily rate of pan evaporation from measurements at Bathurst, N.S.W.

Table 6 clearly shows the much greater likelihood of having long dry day sequences through the late Spring, Summer and Autumn months than in winter and early spring. Dry day sequences of six days or longer occur with a mean frequency of about once in four years in June and July to about once in each year in December. Sequences of two weeks or longer are by no means rare. A good indication of seasonal trends in the likelihood of surface and other materials of fine texture being in a dry state, and prone to being lifted with occurrence of strong winds, is shown in the final column. From October to April, of the order of 40 to 50 per cent of all days are identified as dry days after allowing for drying time, whereas in June and July only about 10 per cent of all days are so identified.

3.2.4 Other Macroclimatic Indicators of Air Pollution Potential

The recorded occurrence of reduced visibility and of fog provide further indirect indication of atmospheric pollution potential. Data for both of these meteorological elements are available from the Lithgow daily climatic records.

The choice of visibility threshold is largely arbitrary, but for purposes of this study it was assumed that when visibility is reduced to 3 km or less (in the absence of rain) the existing conditions would likely promote pollution build up if there were significant emissions of pollutants to the lower atmosphere at such times. Data on the occurrence of visibility reduction to 3 km or less are given in Table 7.

With the usual occurrence of radiation fog under stable conditions of nightime surface temperature inversions, a considerably greater frequency of reduced visibility at 0900 hours than at 1500 hours is as would be expected. The greater frequency of reduced visibility at 0900 hours during winter months is also expected because, with sunrise and surface heating occurring at a later hour, the effects of nocturnal surface inversions will more often still be felt at that time. The data for 1500 hours shows that up to about 3 per cent of all days have visibility reduced to or below the adopted 3 km threshold even at that late hour of the day. Unlike the 0900 hours frequencies, no clear seasonal trend is in evidence with the afternoon observations.

Table 8 shows that fogs at Lithgow occur on average on from about 5 to 8 percent of all days from January to April; their occurrence then increases to reach about 11 per cent in July, and thereafter falls to about 3.5 per cent of all days in November. It is notable that the seasonal trends in observed fog occurrence closely matches those in reduced visibility at 0900 hours as shown in Table 7.

The presence of dense fog until a late hour after sunrise is a condition that may actually increase (in an active sense) atmospheric pollution potential. Surface heating is much retarded by fog, and stable stratification of the lower atmosphere may not be broken down to allow mixing and upward transport of those emissions from a number of pollution sources established with daytime activities and operations. Unfortunately fog occurrence data available from the climatic record give no indication of the timing of the formation and disappearance of fogs.

3.3 Microclimatic Conditions

3.3.1 Topography

Local relief at Baal Bone is basically similar to that at a site at 'Fernbrook' for which an assessment of air pollution risk in association with the developer's proposal to establish pit top mining facilities there had earlier been made.

At both locations nearby hills are capped by residuals of the massive sandstone strata, the surface of which rises to elevations in excess of 1000 m, or about 150 m above the general basal levels of the valley floors. One notable difference between the basic topographic form of these sites is in the size and shape of the lowland areas. At Baal Bone the lowland area adjacent to Ben Bullen Creek, on which all of the mine operations facilities would be located, is only about

1.5km in width, and this lowland extends in a northwesterly direction, broadening out to about 2-3 km downstream from the junction with Jews Creek. The lowland area at 'Fernbrook' has the form of a broad, roughly circular basin with a diameter of about 4 km.

With the exception of winds from the northwest, a degree of sheltering from nearby uplands is expected at Baal Bone. For northwesterly winds, there is a clear fetch of approximately 12 km upwind from the proposed pit top facilities. Ben Bullen Range to the southwest provides some sheltering from southwesterly winds. However, the slopes immediately to the southwest of the site are moderate, and this upland area is dissected by several long, straight valleys converging toward the site. With stronger winds from between southwest and southeast, funneling through gaps in the upper levels of Ben Bullen Range and along these valleys can be expected.

There is no reason to believe that active downslope (katabatic) airflow during the nightime cooling period would be any less in evidence at Baal Bone than at 'Fernbrook'. Measurements made at 'Fernbrook' of temperature to 220 m above the valley floor are thus instructive of the character of thermal stratification to be expected at Baal Bone. Inferences drawn from these limited aerological data are therefore reported below without alteration of the text of the original report (Fitzpatrick, 1980).

3.3.2 Thermal Stratification and Stability

On the morning of 27th April, 1980 temperature measurements were made at the proposed site using a tethered, helium filled balloon to carry a light weight thermistor sensor to a height of 220 metres. On this date the weather was under the dominance of an anticyclone centred over South Australia with ridge extending east ward across New South Wales. Clear skies and completely calm conditions had prevailed over the whole of the previous night. Thus the data obtained can be regarded as representative of conditions favouring strong nocturnal cooling and katabatic flow.

Seven vertical temperature profiles at half-hourly intervals between 0620 and 0920 hours were constructed from data collected during four balloon soundings. Measurements were made at 20 metre intervals. Results are shown in Fig. 2 . When observations commenced at 0600 hours, no part of the basin was receiving direct solar radiation. The curve for 0620 is therefore probably representative of minimum temperature reached at all levels during the period of nightime cooling. The sequence of temperature profiles from that time onward is instructive on the breakdown of a well developed temperature inversion with the onset of daytime solar heating, ultimately reaching a condition a approximately neutral stability in the final profile for 0930 hours.

At 0650 hours distant hills to the south and that part of the basin southward of the Great Western Highway were receiving direct solar radiation, but the near portion of the basin was in shade from uplands to the east. At 0700 hours the closer hills to the southwest of the site were in direct sunlight, but the observation site near the proposed development was still in shade. By 0800 hours all of the basin except west-facing slopes were in direct sunlight.

At 0720 hours a very steep inverted lapse rate occurred up to 80 metres (exceeding 1 deg C rise with 10 metres elevation), and approximately isothermal conditions existed above 120 metres. Warming since the previous profile was only 1 deg C in the layer up to 20 metres above the surface, but above 60 metres warming was closer to 2 deg C, apparently due to an influx of warmer air aloft from more rapidly heating areas to the south. By 0820 hours the temperature at 1.5 metres had risen by about 8 deg C from the original below freezing level; at this time the layer up to 20 metres height was isothermal, but above that level temperature increased with height at a rate of about 0.5 deg C with 10 metres ascent. Approximately isothermal conditions had developed through the entire depth sampled (0to 220m) by 0850 hours, i.e. without inversion but yet stable. Through continuing surface heating, unstable conditions had developed in the layer up to 40 metres by 0920 hours, but above that level, stability still prevailed. As seen from Fig.2, the overall slope of the vertical temperature profile at this time approximates the dry adiabatic rate (neutral stability), but within intervals of 20 to 40 metres both instability and stability are in evidence up to 100 metres. At this time the first perceptible air movement at ground level was noticed, and by 0920 hours the area became partly overcast, and winds quickened to make further tethered balloon ascent impossible. Over the whole of the three-hour period of measurements, the temperature increased steadily and by about equal amounts at levels above 120 metres; these upper levels remained vertically isothermal over this period, and hence stable.

In total, these data support relationships emerging from a study by Laughlin (1978) of surface temperature at a range of elevations near Blackheath, and demonstrate that under strong anticyclonic control, nocturnal surface temperature inversions in April would persist at such sites for about two and one half hours from time of earliest surface warming. Even with maximum levels of insolation after sunrise (as was the case with these observations), overall neutral conditions within the lowest 100 metres did not occur until about three hours after sunrise. It can reasonably be expected therefore, that in mid-winter the stability of the lower atmosphere under these conditions would not likely be broken down until about 1000 hours, and if morning insolation was reduced by persistent cloud cover or fog, probably not until midday.

To supplement data obtained by the balloon soundings, some qualitative evidence of the thermal structure and stability conditions near the surface was obtained by time lapse photography of point source smoke releaseson the evening of 26 April and on the morning of 27 April. The behaviour of these smoke releases revealed the following features under the clear, calm conditions prevailing at that time:

(a) Cooling of the surface layers shortly after sunset is extremely rapid at a low-lying site at the base of the uplands, and this cooling quickly creates a condition that would promote the retention of pollutants close to the surface.

(b) Movement and dispersion of smoke at sunrise time is slow in such enclosed valley situations and is largely controlled by differential heating of slopes.

(c) East-facing slopes exposed to direct solar radiation become the foci toward which pollution in the surface layers is drawn as a result

of apparent

establishment of weak, convective currents.

(d) While heating is occurring on slopes with an easterly aspect, weak katabatic flow continues within valleys and along slopes not yet receiving direct exposure to direct solar radiation

3.3.3 Expected Topographically Related Airflow Patterns

Airflow patterns expected at the site in relation to the major terrain features are shown in Fig.3. The diagram is self explanatory in the light of the descriptions given in sections 3.3.1 and 3.3.2

4 Potential Impacts on Air Quality and Control Measures.

The impacts on air quality that may be expected with the proposed mining development can be identified according to pollutant source.

a. Dust arising from various above ground coal handling operations, including conveyor transport, crushing, stockpiling and loading.
b. Dust arising from on site use of earthmoving equipment during constructional, operational and site rehabilitation stages.
c. Dust arising from trafficking of unsurfaced roads and parking areas associated with the development.
d. Smoke arising from burning of waste materials during constructional phase and with normal operations.
e. Smoke and gaseous pollutants as might occur with spontaneous or inadvertent burning of stockpiled coal or coal reject material.
f. Contaminated waste air from the ventilation system for underground mining operations.
g. Emission from diesel locomotives at the rail loading facility.

Problems of dust are most acute over long periods of dry weather and when the major weather controls promote strong winds and turbulence at ground level. The incidence of such conditions at the site has been described earlier. Minimization of wind borne dust from handled materials or from trafficking dry surfaces is necessary at all stages of the proposed development. A variety of control measures is available:

a. avoidance of earthworks in exceptionally dry windy weather,
b. avoidance of direct wind exposure of coal crushing and conveyancing facilities,
c. avoidance of handling methods involving any significant distance of free fall of dry usable coal product or mineral wastes with exposure to wind,
d. spraying facilities for wetting stockpiled coal and wastes in dry windy weather,
e. surfacing of all access and service roads and parking areas and establishment of vegetation on other bare areas at the earliest practicable time,
f. planting or construction of windbreaks to lessen wind exposure of operations creating dust.

At the Baal Bone site windbreaks to reduce windspeed from directions between northwest and southeast are most important and should be established at the earliest practicable time.

Burning of waste materials, if necessary, should be carried out at locations and times minimizing fire risks and also minimizing impact on air quality, the most favourable times clearly being when moist soil conditions occur and when atmospheric conditions favour effective mixing and dispersal. In particular, burning of wastes should be avoided during periods of strong anticyclonic dominance and calm stable atmospheric conditions as described in sections 3.2.1 and 3.2.2.

Fire restrictions may require burning only after a prescribed hour in the evening. To avoid build-up of pollution at night, such burning during the period between sunset and sunrise should be restricted to times with good ventilation and absence of strong surface inversion conditions (as depicted in Fig.2).

It is especially important that all areas of stockpiled coal be protected from fires, and that effective fire control facilities at these locations are established and are available for fire control with minimal delay.

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Table 1 - Derived barometric pressure data from a study by Karelsky (1965) showing pressures occurring at centres of anticyclones over eastern central New South Wales. *

	Minimum (mb)	Maximum (mb)	Average = (Max+Min)/2 (mb)	Adopted Threshold for Frequency Tabulation in Table 2 ** (mb)	Number of Anticyclone Centres
JAN	1013.5	1027.0	1019.5	1016.5	11
FEB	1013.5	1022.5	1019.0	1016.3	7
MAR	1013.6	1027.0	1020.3	1017.0	15
APR	1014.3	1031.3	1024.6	1019.5	22
MAY	1018.3	1034.3	1027.3	1022.8	21
JUN	1019.3	1035.6	1028.3	1023.8	20
JUL	1016.6	1037.6	1028.0	1022.3	28
AUG	1017.3	1035.3	1026.0	1021.7	26
SEP	1014.3	1037.3	1025.3	1019.8	28
OCT	1011.6	1029.3	1021.3	1016.5	26
NOV	1009.3	1028.3	1020.0	1014.7	24
DEC	1006.0	1024.6	1015.6	1010.8	15

* Values shown in the table are averages of three five-degree grid squares used by Karelsky,thus giving an improved estimate specifically appropriate to this area. Based on records from twelve years, 1952 - 1963.

** Adopted threshold = (Ave + Min)/2

Table 2 - Frequency of periods of varying length having barometric pressures exceeding levels commonly occurring at the centres of anticyclones over eastern New South Wales. *

	Length of Period in Days						
	1 - 2½	3 - 4½	5 - 6½	7 - 8½	9 - 10½	11 - 12½	13 and over
JAN	20	10	5	6	1	1	
FEB	21	13	1	2			
MAR	30	12	8		1	1	
APR	20	11	9	4		3	
MAY	14	8	4	1	1		
JUN	27	13	3	3		1	
JUL	13	9	7	3			
AUG	11	15	5			1	1
SEP	24	12	1	1			
OCT	28	18	3	2	1		1
NOV	26	14	4	6			
DEC	21	19	4	7	3	1	2

* Based on 14 years of daily records of barometric pressure at 0900 and 1500 hours at Sydney Kingsford Smith Airport (Mascot). 1957 - 1970.

Table 3 - Frequency of periods of varying length having estimated wind speeds less than 3 knots (5.5 km hr^{-1}) at Lithgow, New South Wales.*

	Length of Period in Days								
	1 & 1.5	2 & 2.5	3 & 3.5	4 & 4.5	5 & 5.5	6 & 6.5	7 & 7.5	8 & 8.5	9 & over
JAN	44	11	6	1		1			
FEB	45	14	2	2	1			1	
MAR	22	14	7	8	4	1	1		
APR	26	10	4	5	2	1	1	1	2
MAY	29	14	7	2	1				
JUN	26	11	4	4	2		1		
JUL	36	15	3	2		2			
AUG	40	8	1	2	1	1			
SEP	43	6	4	1			1		
OCT	33	12	4	7	3				
NOV	32	15	3	2					
DEC	48	8	1	5	2			1	

* From 12 years of daily 0900 and 1500 hours observation: August 1965 - June 1974 and July 1976 - July 1979.

Table 4 - Frequency of wind observations equal or greater than 5 on the Beaufort Scale (Fresh Breeze, approx. 17 knots) at Lithgow, New South Wales.*

	0900 hours		1500 hours	
	Number of Occurrences	Percentage Frequency	Number of Occurrences	Percentage Frequency
JAN	15	4.0	18	4.8
FEB	1	0.3	2	0.5
MAR	9	2.4	9	2.4
APR	11	3.1	17	4.7
MAY	24	6.5	28	7.5
JUN	19	5.3	16	4.4
JUL	11	3.0	21	5.6
AUG	26	7.0	40	10.8
SEP	21	5.8	22	6.1
OCT	12	3.2	19	5.3
NOV	17	4.7	21	5.8
DEC	2	0.5	13	3.5

* Based on 12 years of record: August 1965 - June 1974 and July 1976 - July 1979.

Table 5 - Percentage frequency of winds with speeds greater than 20 km per hour determined over one-hour intervals for all hours of the day *.

	N	NE	E	SE	S	SW	W	NW	ALL DIRECTIONS
SUMMER	2	3	4	2	2	4	3	3	23
AUTUMN	1	1	3	4	2	5	5	4	25
WINTER	2	1	1	3	4	10	7	4	32
SPRING	4	1	2	2	2	7	8	6	32
YEAR	3	2	2	3	2	6	5	4	27

* Data from anemometer installation at 32 metres at Wallerawang Power Station over the period 1968 - 1977.

Table 6 - Frequency of Dry Day sequences following an initial drying period of the length shown, and total number of dry days for each month at Lithgow *.

	Mean Daily Pan Evaporation (mm)	Drying Period to Evaporate 5 mm** (days)	Frequency of Dry Day Sequences ≥ X Days Long X = 1	2	4	6	8	10	12	14	Total Dry Days	Dry Days as Per-cent of All days (%)
JAN	6.1	1	54	39	19	8	6	6	1	-	193	44
FEB	5.4	1	53	25	14	9	7	2	2	1	148	38
MAR	4.3	1	51	40	21	10	4	2	-	-	187	43
APR	2.7	2	33	27	17	12	6	4	2	1	166	40
MAY	1.6	3	24	20	10	8	6	3	2	2	136	31
JUN	1.0	5	9	7	5	4	1	-	-	-	40	10
JUL	1.1	5	13	7	5	3	-	-	-	-	40	9
AUG	1.5	3	29	21	14	7	4	1	1	-	104	24
SEP	2.5	2	36	23	12	6	2	1	-	-	111	26
OCT	3.4	1	53	42	23	11	5	4	2	1	204	47
NOV	4.7	1	53	38	24	11	6	4	2	2	214	51
DEC	5.6	1	45	34	25	15	8	3	2	2	196	45

* From daily rainfall records of 14-year period, 1966 to 1979

** Drying period defined as days required to evaporate 5 mm of water at mean daily rate of pan evaporation observed at Bathurst, N.S.W. (Col. 1).

Table 7 - Frequency of visibility equal to or less than 3 km (not including cases associated with heavy rainfall).*

	0900 hours		1500 hours	
	Number of Occurrences	Percentage Frequency	Number of Occurrences	Percentage Frequency
JAN	16	4.3	5	1.3
FEB	15	4.4	3	0.9
MAR	25	6.7	8	2.1
APR	13	3.6	4	1.1
MAY	21	5.6	12	3.2
JUN	35	9.7	6	1.6
JUL	64	17.2	9	2.4
AUG	28	7.5	7	1.9
SEP	13	3.6	4	1.1
OCT	11	3.0	1	0.2
NOV	12	3.3	4	1.1
DEC	9	2.4	8	2.1

* Based on 12 years of record: August 1966 - June 1974 and July 1975 - July 1979.

Table 8 - Frequency of fog at Lithgow, New South Wales. *

	Number of Occurrences	Percentage Frequency
JAN	21	5.6
FEB	22	6.4
MAR	24	6.5
APR	27	7.5
MAY	36	9.6
JUN	39	10.8
JUL	42	11.3
AUG	29	7.8
SEP	13	3.6
OCT	20	5.4
NOV	13	3.6
DEC	13	3.5

* Based on 14 years of daily records: 1966 - 1979

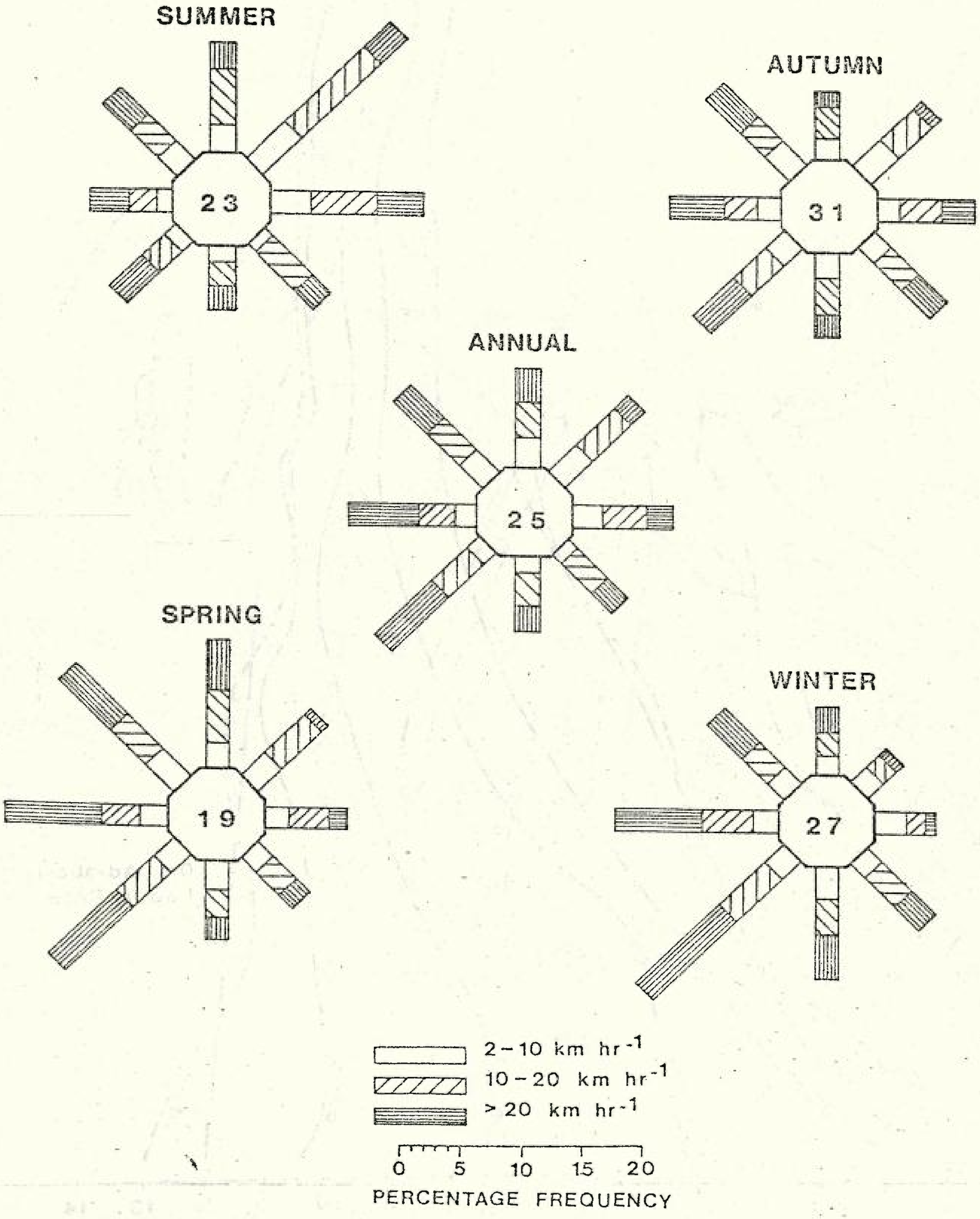
Captions for Figs. 1 to 3

Fig. 1 Annual and seasonal wind roses for anemometer installation at Wallerawang Power Station. Frequencies are for winds of a given windspeed class over all hours of the day. Numerals at centres of wind roses show percentage of total hours having 'calm' conditions (less than 2 km per hour).

Fig. 2 Vertical temperature profiles between surface and 220 metres from 0620 and 0920 hours on 27 April, 1980 at 'Fernbrook' obtained by balloon soundings.

Fig. 3 Principal lines of airflow at Baal Bone site. Heavy broad arrows show expected major nighttime katabatic/(downslope) flow lines contributing to cold air accumulation at the site, and reverse anabatic (upslope) flow lines after warming of slopes exposed to morning insolation (principal foci of warming are enclosed by heavy dotted lines).

FIGURE 1



ANNUAL & SEASONAL
WIND ROSES