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Proposed quarry on Lot 28, Mulgoa : environmental impact statement

MULGOA QUARRIES PTY LIMITED

PROPOSED QUARRY ON LOT 28, MULGOA

ENVIRONMENTAL IMPACT STATEMENT

DECEMBER 1982

PREPARED BY

SINCLAIR KNIGHT & PARTNERS PTY LTD

MULGOA QUARRIES PTY LIMITED

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1 Chandos Street St Leonards
New South Wales 2065 Australia Phone (02) 436 7222

Form 4

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

ENVIRONMENTAL IMPACT STATEMENT.

This Statement has been prepared by or on behalf of Mulgoa Quarries Pty. Ltd. being the applicant making the development application referred to below.

The Statement accompanies the development application made in respect of the development described as follows:–

Clay, Shale and Sandstone Quarry

The development application relates to the land described as follows:–

Portion 28, D.P. 222144, Parish of Mulgoa, County of Cumberland.

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

Name, Qualifications and Address of person who prepared Environmental Impact Statement.	Bruce J. R. Masson BSc(Eng), M Eng Sc. Sinclair Knight & Partners Pty Ltd 1 Chandos Street St. Leonards, NSW 2065

Certificate

I, Bruce J. R. Masson of Sinclair Knight & Partners Pty Ltd, hereby certify that I have prepared the contents of this statement in accordance with clauses 34 and 35 of the Environmental Planning and Assessment Regulation, 1980.

BJRMason

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Signature

11 th March 1983

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Date

TABLE OF CONTENTS

TABLE OF CONTENTS (Continued)

TABLE OF CONTENTS (Continued)

1. SUMMARY

1.1 PROPOSAL BACKGROUND

This Environmental Impact Statement has been prepared in support of a proposal by Mulgoa Quarries Pty Limited, a member of the Wearn Industries Group, to establish a clay/shale/sandstone quarry on its property, Lot 28 in the Mulgoa area of Penrith. The location of the site is indicated on **Exhibit 1.**

Over the past 20 years there has been a strong demand in the Sydney brick industry for light coloured bricks, and light burning clay/shale presently comprises 30 percent of the total clay/shale demand for brickmaking.

Geological investigation of Lot 28 indicates that the upper strata contains clay/shale material from the Wianamatta Group which can be selectively extracted to provide pale burning brick making material. The estimated likely quantity of marketable clay/shale material is 1.9 million cubic metres based on a 70 percent recovery rate.

Minchinbury sandstone occurs beneath the cream burning shale layers. It is proposed to extract and crush this sandstone, whilst uncovered by the clay/shale extraction, for use as road sub-base material or for other engineering purposes.

The Department of Mineral Resources reported in 1980 that of the 13 million tonnes of pale burning reserves approved for extraction about 6.5 million tonnes were controlled by one brickmaker. The Department identified a further 6.3 million tonnes of reserves for which extraction approval was still required. Since then approved reserves have been depleted by about two million tonnes but a further deposit of about 14.5 million tonnes has been identified in the Mulgoa Area. Thus proven reserves of cream burning material are presently about 32 million tonnes of which about 21 million tonnes require extraction approval.

The estimated cumulative demand for cream burning material (based on current cost and availability) is 4.4 million tonnes by 1985 and about 20.6 million tonnes by the year 2000. Thus while total reserves appear adequate for the next 25 years if new sources of cream burning clay/shale material are not approved in the near future a partial or complete monopoly in the production of cream and light bricks would occur with consequent adverse effects on the price and availability of these bricks to the community.

1.2 THE PROPOSAL

The proposed quarry extraction sequence is indicated on **Exhibit 4.** The main operations would involve:- clearing of vegetation, stripping and stockpiling of topsoil, selective extraction of clay/shale material, blasting and extraction of sandstone, restoration of the landform using quarry overburden, spreading of topsoil, and re-establishment of vegetation. A complex system of drainage and retention dams would ensure that water discharged from the quarry would not be polluted.

Clay/shale material from the quarry would be transported over a new haul road to Bringelly Road which would be constructed at the commencement of operations on Lot 28. The proposed haul road would be funded and used by all new quarries in the area. Its location is indicated on **Exhibit 2.**

Sandstone would be carted in dump trucks via a haul road over a section of land on the eastern boundary of Lot 21 which is to be incorporated in Lot 28 to provide a direct link from Lot 28 to Lot 22 which is owned by Wearn Industries. The sandstone would then be crushed in the crusher already established on Lot 22 and transported to road construction markets in various areas on either the new haul road to Bringelly Road (the Northern Road) or on the existing quarry road from Lot 22 to Mulgoa Road.

Based on the current clay/shale market it is proposed initially to extract about 100 000 tonnes per annum of clay/shale material. On this basis the maximum life of the quarry at full operation would be about 23 years. Sandstone extraction rates would be much more variable because of the variability of local road making demand. Accordingly it is proposed that clay/shale extraction rates set the pace for quarry operation. Restoration would follow depletion of clay/shale resources at the same rate. Should sandstone demand not keep pace with the rate of exposure in the quarry it would be either stockpiled or abandoned. This would keep the area of workings opened up at any one time to a minimum.

Extraction techniques would be essentially the same as presently being employed on the existing quarry on Lot 22 with the exception being that a scraper may be used on the flatter slopes.

The proposed rehabilitated landform would generally be no steeper than one in six. Revegetation would mainly comprise open pasture with isolated wood lots in keeping with the prevailing landscape in the district. In the process of rehabilitation special compaction would be applied to designated zones to allow possible future residential or other development on the site.

1.3 THE EXISTING ENVIRONMENT

The site is currently zoned for "non-urban" uses and was found to contain no structures, sites or relics of historical or archaeological importance.

The topography of the site is dominated by the escarpment to the east of Mulgoa Creek with rises up about 25 metres above the creek bank. The ridge at the top of the escarpment runs from the northwest of the site to intersect the southern boundary about midway along it. The land then falls away at slopes between about one in twenty five and one in five to a creek system which skirts the eastern and northeastern boundaries of the site.

The site is covered in light to dense tree growth most of which is remnant forest on the steep slopes but regrowth after clearing for agricultural purposes on the gentler slopes. The most noteworthy trees on the site are rough barked apples (Angophora floribunda) which appear to have survived previous clearing operations.

A survey of fauna on the site found rich bird life. Mammals noted were mainly introduced species, with one sugar glider and one brush tailed possum being the only native specimens noted. No kangaroos or wallabies were seen. No fish or amphibians were recorded on the site and only one reptile and a skink were seen.

Soils on the site have generally only a thin organic layer at the surface and are sensitive to erosion when exposed.

The sharp undulating nature of the site would make the use of tractors for cultivation and seeding difficult. Levelling and drainage improvements would be needed if any agricultural activity other than grazing were contemplated.

Investigation of noise levels in the area indicated that traffic on Bringelly and Mulgoa Roads and quarry operations are the main sources of noise in the area. Daytime background noise levels varied between 32 and 47 dBA. These levels are compatible with noise levels in a quiet residential area.

The area is served by two main roads, Mulgoa Road and Bringelly Road (The Northern Road). The former has a poor alignment and carries about 2 200 vehicles per day. The latter has a good alignment and carries between 7 000 and 11 000 vehicles per day. Existing quarries on Lots 21 and 22 generate, typically, about 190 trucks and up to 100 light vehicle movements per day on days when the weather permits deliveries. All truck access to these quarries is via Mulgoa Road so that clay/shale deliveries are made either through Penrith itself or along Mulgoa Road through Mulgoa and Wallacia.

1.4 ENVIRONMENTAL SAFEGUARDS

Operation of the proposed quarry has been planned with the direct aim of protecting the environment. The following safeguards are proposed:

. reduction in the size of the working areas to protect sensitive fringe areas,

. planting of additional trees on the perimeter to screen distant views of the workings,

. preserving topsoil and restoring the land to pasture and woodlots comparable to the prevailing landscape in the district,

. minimising the area of quarry being worked at any one time,

. provision of sediment dams and a complex drainage system to protect the quality of water being discharged from the quarry,

. fencing of the quarry working areas to prevent the encroachment of the quarry into areas of natural habitats to be preserved,

. restriction on the hours of working and on the size of blasts,

. construction of a new haul road to Bringelly Road to reduce heavy traffic on Mulgoa Road,

. watering of working areas and haul roads and fitting of dust jackets to drilling rigs to minimize dust generation,

. sealing of the new haul road for 250 metres as it passes the nearest residence to reduce dust and noise generation.

1.5 IMPACTS OF THE DEVELOPMENT

The interactions of the proposed quarry with the existing environment are summarised below:

Topography
Short term disruption while quarrying proceeds. Long term modification to be comparable with existing topography.

Water
Possible minor increase in silt load of streams during periods of heavy rain. Generally minimal impact on water quality.

Fauna
Loss of habitat for birds over about 65 percent of site. Most species should be able to continue to exist in the protected heavily wooded fringe areas of the site. Little impact on mammals, reptiles or amphibians.

Landscape and Views
Limited impact on short distance views from properties immediately adjacent to the site on the southeast, east and north. No impact on distant views.

Adverse impact on landscape on site during the life of the quarry. No significant impact after quarrying ceases and restoration complete.

Soils
Topsoil to be saved and fertilized to provide improved pasture.

Archaeology
No impact on archaeological sites or relics.

Noise
Noise generated by the quarry would be within acceptable levels and would only exceed the design goal by the order of 5 dBA at residences along Mulgoa Road and by up to 8 dBA on the southern edge of the Housing Commission land to the north of the quarry where there is currently no development. Future impacts on housing would be reduced by limiting development on Housing Commission land to north of the 65 metre ridge line.

Blasting
Limitation on the number of holes blasted at one time as indicated on **Exhibit 11** would contain overpressure and vibration to within acceptable limits at nearby residences.

Traffic
Truck movements generated by quarries in the area (Lots 21, 22, 28 and the Kay site) would increase from a present typical level of about 190 movements per day to a future level of about 250 movements per day. The average generation would be slighly lower as deliveries are not made every day. The construction of a haul road to Bringelly Road would have a significant beneficial impact in reducing the amount of truck traffic on Mulgoa Road and passing through Mulgoa, Wallacia, Regentville and Penrith itself. Increases in light traffic would be negligible in relation to existing traffic flows on Bringelly and Mulgoa Roads.

Social
Development of the proposed quarry would provide about 10 jobs. Flow on effects to the regional economy will also assist in the creation of other employment in the outer western suburbs.

Long Term Site Use

Rehabilitation of the site will lead to improvements in landform and drainage which would allow the cultivation of significantly better pasture than can presently be economically developed. There will also be provision for a post-extraction urban use of the site, in order to maintain options for long term land use.

1.6 CONCLUSIONS

The subject site contains a significant deposit of cream burning clay/shale material for which there is a strong demand in the Sydney market. Several brickmaking companies in the Sydney area are dependent on Wearn Industries for raw material supplies and while proven reserves appear to be adequate for the next 25 years, most of the reserves currently approved for extraction are in the control of only one manufacturer. If approval for the subject site and other quarries in the Mulgoa area are not forthcoming there will be a shortage of cream coloured bricks in the Sydney area with consequent cost increases to the housing industry.

Investigation of the existing environment on the site and the operation of the proposed quarry reveals that there are no features of such overriding significance or no effects of such serious detriment to the environment that the quarry should not proceed. On the basis of the assessment it is concluded that with careful adherence to the safeguards outlined in this document, the quarry can proceed without serious impact on the local environment and should proceed in view of the importance of the resource on the site to the community at large.

2. INTRODUCTION

2.1 REPORT BACKGROUND

This Environmental Impact Statement relates to a proposal by Mulgoa Quarries Pty Limited, a member of the Wearn Industries Group, to develop a clay/shale/sandstone quarry on Lot 28 (DP 222144) in the Parish of Mulgoa in the County of Cumberland. The site is situated in a non-urban area about five kilometres south of Penrith. Its location is indicated on **Exhibit 1.**

The statement has been prepared by Sinclair Knight and Partners Pty Ltd with the assistance of the following persons and companies:

Dr Tim Kingston	-	Department of Environmental Studies, Australian Museum
Dr Helen Brayshaw	-	Archaeologist
Mr Rowan Hayes	-	Rowan Hayes and Associates Landscape Consultant
Mr Peter Sacre	-	Wilkinson Murray Consulting Pty Ltd
Mr Barry Murray	-	Wilkinson Murray Consulting Pty Ltd
Mr John Bacon	-	Agricultural Consultant

2.2 SCOPE AND OBJECTIVES OF THIS ENVIRONMENTAL IMPACT ASSESSMENT

This document is presented to detail formally the proposal for development of a quarry on Lot 28 and to describe the relationships and impacts between the quarrying proposal and the existing environment and procedures proposed to safeguard that existing environment.

The document has been prepared in accordance with the relevant sections and clauses of the Environmental Planning and Assessment Regulations 1980.

2.3 BRINGELLY ROAD NAME

In the course of the study the name of Bringelly Road was changed by the Department of Main Roads to "The Northern Road" to overcome the confusion arising due to the number of roads bearing the same name. In this report the name of Bringelly Road has been retained to maintain compatibility between the main report and the reports of the technical consultants and because it is considered that residents in the area may not have become familiar with the new name of the road.

2.4 APPROVAL PROCESS

The proposed development is permissible with the consent of Penrith City Council under the non-urban zoning controls which apply to the site. Council is the determining authority.

Under the regulations of the Environmental Planning and Assessment Act, 1979, the proposal is a "designated development". For such a development an environmental impact statement is required to be prepared in a form stipulated in the regulations. In preparation of the statement the person preparing the statement is required to consult with the Director of the Department of Planning and Environment and following completion of the statement have regard to any requirements notified to him in writing by the Director in respect of the form and content of the statement.

On receipt of a development application with accompanying environmental impact statement Council is obliged to put these on public display for a minimum of 30 days and to notify interested parties. It is also required to furnish a copy of the statement to the Department of Planning and Environment.

After the display period Council is obliged to forward any representaions or objections received to the Department of Planning and Environment. If the Department does not intervene within 21 days of the representations being forwarded Council may make a decision on the application having regard to environmental policies and instruments, environmental impact and the public interest.

3. PROJECT BACKGROUND

3.1 QUARRY OBJECTIVE

The objectives of the project are as follows:

. to extract clay/shale material for brickmaking

. to extract laminite (gritstone) and sandstone for road building and other construction activities

. to restore the working area to a landform suitable for various future development options including agriculture, 2 hectare residential allotments or other more intense urban uses

Geological investigations of the site and experience in the adjoining quarry indicate that there are about 1.9 million cubic metres of clay/shale material on the site which will be suitable for brickmaking. It is expected that about half of this material will be suitable for the manufacture of cream bricks for which material supplies in the Sydney region are limited. The remainder would be used for the manufacture of a range of brick colours between fawn and terra-cotta.

The brickmaking material to be extracted forms the upper geological strata on the site and varies in thickness from a maximum of about 20 metres down to nothing on the lower slopes.

In lenses within and beneath the shale material there are layers of siltstone and sandstone material which is suitable for road foundations, hard fill and bank stabilization. Sandstone is currently being extracted from within shale lenses in Wearn Industries existing quarry to the south of the proposed development and markets have been found for the stone as road sub-base material with various Municipal Councils in the area. There is also a potential market for the stone as bank stabilization for the Nepean River.

The plasticity and colour of the clay/shale material on the site makes it suitable for blending with some of the harder pale burning material found in nearby deposits in the Mulgoa area. It is therefore proposed to operate the subject proposal along with another proposed quarry in this area on the Kay site in order to make available a constant supply of similar material to brickmaking plants. The quarry on the Kay site will also be operated by Mulgoa Quarries Pty. Limited and is the subject of a separate environmental impact statement **(Reference 9).** The location of the quarry is indicated in **Exhibit 2.**

3.2 CLAY/SHALE RESOURCES IN THE SYDNEY AREA

3.2.1 Demand

The Geological Survey of New South Wales in the Department of Mineral Resources reviewed the clay/shale resources in the Sydney region in 1980 **(Reference 1).** The survey found that in 1977/78 the brick industry in Sydney produced a total of about 570 million bricks and employed about 1 750 persons. In 1979/80 production increased to 620 million bricks. An estimated 2.5 million tonnes of clay/shale material were used to produce these bricks.

Since the late 1960's there has been a strong demand for lighter colour bricks. These were generally produced using light burning shale or a blend of light and dark burning shales. Through the blending technique a wide variety of brick colours and styles are produced. At present light burning clay/shale makes up more than 30 percent of total clay/shale demand for brickmaking.

The demand for clay/shale products varies with the fortunes of the housing industry. Given an expected 0.82 percent annual population growth rate in the Sydney area, together with a gradual decline in dwelling occupancies and a trend towards the construction of higher quality housing stock than in the past, it is expected that demand for clay/shale for brickmaking might grow at an annual rate of 2 percent per annum. **Table 3.1** summarises the likely future demand for material based on this rate.

TABLE 3.1 - FUTURE CLAY/SHALE DEMAND FOR BRICKMAKING IN THE SYDNEY AREA

Year	Total Demand (million tonnes) Annual	Cumulative	Light Burning Demand (million tonnes) Annual	Cumulative
1979/80	2.50	-	0.85	-
1985	2.75	13.25	0.90	4.40
1990	3.05	27.95	1.02	9.30
1995	3.35	44.10	1.10	14.70
2000	3.70	61.95	1.25	20.65

It should be noted that the above demands would only eventuate if adequate supplies are available.

3.2.2 Resources

The Department of Mineral Resources estimated **(Reference 1)** that in 1980 the in situ reserves of cream burning and red burning clay/shale material in the Sydney region from currently operating pits approved for extraction were as follows:

Material Type	Reserves in Pits Being Operated
Cream Burning	13 022 000 tonnes
Red Burning	264 265 000 tonnes

Of the cream burning reserves about half were owned by Pacific Brick Pty Ltd and supplies were and are not available to other manufacturers.

Potential reserves available to other manufacturers would be about 6.2 million tonnes.

Since the report was prepared more than 2 million tonnes of cream burning material have been used.

In addition to the above approved extraction sources several known cream burning clay/shale deposits requiring development consent before the commencement of extraction were also identified.

In total, reserves of about 6.3 million tonnes of cream burning material requiring extraction approval were identified along with another 13 million tonnes of clay/shale reserves containing an unspecified proportion of cream burning material. The latter deposit is in the Kurrajong area and so far there have been environmental objections to its development.

About half of the 6.3 million tonnes is in the Mulgoa area on Lot 28, the subject proposal, and on Lot 1, owned by Zacuba Pty. Limited (refer to **Exhibit 2).**

Recent investigations undertaken by the Department of Mineral Resources in the Mulgoa Area have identified further significant deposits of cream burning clay/shale in the Mulgoa area between the existing quarries on Lots 21 and 22 and Bringelly Road (see **Reference 7).** The resource is located on the site of the proposed Kay quarry, on Housing Commission land to its north, and on property owned by Reddan on its south. These sites are also indicated on **Exhibit 2.** The estimated pale burning clay/shale material in this area is 14.5 million tonnes.

Thus, while there are presently abundant supplies of dark burning clay/shale brickmaking material in the Sydney area, reserves of pale burning material are limited. Resources likely to be exploited might be summarized as follows:

TABLE 3.2 - IDENTIFIED RESERVES OF PALE BURNING CLAY/SHALE MATERIAL IN THE SYDNEY AREA LIKELY TO BE EXPLOITED (1982)

Approval Status	Quantity (tonnes)		
	Available to Open Market	Available to Single Manufacturer	Total
Approved	6 500 000	6 500 000	13 000 000
Require Development Approval	6 300 000		6 300 000
Recently Proved, Require Approval	14 500 000		14 500 000
Less Reserves Used Since 1980			- 2 000 000
TOTAL			31 800 000

* Note no allowance for Kurrajong deposit.

Thus, of approximately 32 million tonnes of pale burning clay/shale brickmaking material likely to be exploited in the Sydney area, about 20 percent is in the control of one manufacturer. Of the remainder 17.5 million tonnes, or about 55 percent, are found in the Mulgoa area in the vicinity of the existing Wearn Quarry between Mulgoa Road and Bringelly

Road. If this material, all of which requires extraction approval, is not exploited, new reserves will have to be discovered or all but one brickmaking company will be forced to severely curtail production of light coloured bricks after 1985.

Wearn Industries presently supplies six brickmaking plants owned by four different companies from its quarry on Lot 22. A survey of the needs of these plants of Penrith Council found that all have a high dependence on Wearn Industries for light burning material supplies and have no other ready source once the quarry on Lot 22 is exhausted within the next year.

In the medium term it is possible that the brick companies may be able to make use of the limited alternative resources such as clay lenses from Hawkesbury sandstone or from coal washery tailings but because of different ceramic properties expensive alterations to brickmaking plant would probably be necessary.

On the basis of Penrith Council's survey the working party into the management of clay/shale extraction in the Mulgoa area comprised of Penrith Council and six State Government Departments concluded **(Reference 6)** that:

". . .

- There are limited available reserves of pale burning clays and shales in the Sydney region;

- There are no confirmed alternative deposits outside the Mulgoa area of pale burning clay/shale with characteristics comparable to the shale now supplied by Wearn Industries Pty Ltd;

- There is a clear demand and need for additional pale burning shale deposits to be proven and extracted within the study area."

3.3 SANDSTONE RESOURCES IN THE SYDNEY AREA

3.3.1 Demand

Discussions with the Quarrymasters Association indicate that the current demand for sandstone for roadbase in the Sydney area is between about 350 000 and 400 000 tonnes per annum. Sandstone is acceptable to most road authorities in Sydney, including the Department of Main Roads, for the sub-base (lower granular) layer of road foundations.

Sandstone which meets a certain specification is acceptable to some road construction authorities for the base course (upper granular) layer of subdivision roads which carry only moderate traffic flows. Notable amongst these is the Land Commission of New South Wales which is currently extremely active in the development of residential subdivisions.

In addition to the market for road material there is also a market for sandstone for use as fill material or for rubble stabilization of earth banks and the sides of waterways. Because the demand for much of this material is satisfied from excavations undertaken in building projects, there is no industry record of the overall demand.

The Minchinbury sandstone found in the vicinity of the proposed quarry tends to be finer and tougher than the typically softer and more crumbly Hawkesbury sandstone. It is very suitable for use as a road sub-base. It is believed that the demand for this sandstone will grow considerably in the future as the "hard" rock supplies in Sydney are exhausted.

3.3.2 Supply

Sydney is generally well supplied with sandstone quarries and there is no foreseeable shortfall in the resource. However, because it is essentially a low value, high volume resource its extraction cost is highly sensitive to the costs of overburden removal and transportation.

Minchinbury sandstone does not typically outcrop in vast formations and is generally covered by moderate to thick layers of overburden. It is therefore of great advantage to extract this material from existing quarries where overburden material is removed for another purpose and where established quarry facilities reduce overhead costs.

In the Penrith area the main sandstone suppliers are Wearn Industries from its Quarry on Lot 22 (see **Exhibit 2),** a quarry at Wallacia and a quarry at Riverstone. The latter quarries produce Hawkesbury rather than Minchinbury sandstone. Pioneer Concrete own the nearest competing Minchinbury sandstone quarry in the Mount Druitt area.

4. DESCRIPTION OF THE PROPOSAL

4.1 INTRODUCTION

The objective of the proposal is to extract approximately four million tonnes of clay/shale material for brickmaking and 450 000 tonnes of sandstone for engineering uses, over a 23 year period, and to rehabilitate the site in a form suitable for future uses. This section describes the resources of the site, the measures and sequences proposed to exploit those resources and the proposed method of rehabilitating the site.

4.2 MINERAL RESOURCES

4.2.1 Materials

Clay resources on Lot 28 were investigated by Earth Resources Pty Limited in two reports dated August 1977 and August 1979 **(Reference 2).** Four fully cored diamond drill holes were used to evaluate the quality and quantity of the clay/shale reserves. The location of these holes is indicated on **Exhibit 3.** Cross Sections and bore logs relating to the holes are contained in **Appendix 1.**

The investigation found clay and shale material of the Bringelly Shale sequence suitable for brickmaking in strata in the upper 20 metres of the site. The depth and contours of the clay/shale material are shown on **Exhibit 3.** The upper layers of this material tend to be oxidised and are characterised by leached and mottled plastic clays. The mottling is due to the presence of siderite (ferruginous) nodules which cause otherwise pale burning clay to fire in terra-cotta colours. These nodules can be removed by tumbling.

Modern brickmaking plants require reasonably plastic materials to suit the extrusion techniques normally used. The plastic clays found in the upper strata are suitable for blending with less plastic material which would otherwise be unsuitable for use in existing brickmaking plants.

The lower strata are comprised of shale which develops moderate plasticity and fires to shades varying between mid brown and fawn.

Within the clay and shale layers of the Bringelly Shale sequence there are layers of sandstone and laminite (also called gritstone) which need to be selectively removed. These materials are not usually suitable for brickmaking but are used for road sub-base and shoulder material.

The Bringelly Shale is underlain by Minchinbury Sandstone in a layer varying between 1.5 and 5 metres in depth. This material is also suitable for road sub-base and shoulder construction and as "hard" fill.

The Minchinbury Sandstone overlies the Ashfield Shale sequences. The latter formation occurs commonly in the Sydney area and was the source of much of the material used for the production of red bricks in Sydney in earlier days.

4.2.2 Quantities

Extensive drilling in the area, together with experience gained on the quarries on Lots 21 and 22, indicate that there is considerable horizontal

variation within the Bringelly Shale sequence across the area. It is necessary to selectively extract pale burning material in each working area and the proportion of this material cannot be accurately predicted.

On the other hand, the demand for material which fires "off-white" in the mid brown to terra-cotta depends on market fluctuation and is variable from year to year.

Accordingly, extraction quantities for the proposed quarry on Lot 28 have been determined on the basis of Wearn Industries' experience on Lot 22. On this basis the company expects to remove a maximum of 70 percent of the material between the upper topsoil layer and the Minchinbury Sandstone layer. Of this, 60 percent would be clay/shale material suitable for brickmaking and 10 percent would be laminite, sandstone or shale for use in roadmaking or other engineering applications.

It is also proposed to exploit the Minchinbury Sandstone while it is uncovered. Final quantities removed will depend on market demand from time to time. However, to maintain natural drainage on the site and to retain sufficient overburden material such that restored slopes need be no steeper than one in six, it is proposed that a maximum of 200 000 cubic metres (about 450 000 tonnes) of Minchinbury Sandstone be removed. This represents an average depth of about 600 millimetres over the quarry working area. In the event that the overburden to clay/shale ratio in the Bringelly Shale formation proves to be higher than expected, it would be possible to increase the volume of Minchinbury Sandstone to be removed. This would depend on product demand at the time and would be limited to the removal of that which could be extracted within the operating time frame set by clay/shale extraction in each working zone.

Anticipated maximum extraction quantities to be removed from the site are summarized below in **Table 4.1.**

TABLE 4.1 - MAXIMUM EXTRACTION VOLUMES

Material	Volume (cubic metres)
Clay/shale from Bringelly Shale	1.92 million
Engineering Material from Bringelly Shale	0.31 million
Minchinbury Sandstone	0.20 million
Total volume to be removed	2.43 million

4.3 QUARRY OPERATION AND REHABILITATION

4.3.1 Operational Sequence

In order to provide the optimum control of run-off and siltation and to minimize the area being worked at any one time it is proposed to work the quarry in six stages. These stages fall within four catchment management zones which are numbered one to four and are indicated on **Exhibit 4.** Catchment management zones one and two include four working stages (1A, 1B, 2A and 2B) while zones three and four each represent one working stage (3 and 4).

The general operational sequence within each work zone will be as follows:

. implement sediment controls,

. clear trees and grub up roots,

. remove topsoil to stockpiles,

. extract clay/shale material and transport directly to markets,

. extract sandstone/gritstone material and transport to crusher on Lot 22 for crushing prior to transportation to markets,

. transport overburden material to part of same work zone or previous work zone and deposit for use in re-contouring,

. after completion of extraction of brickmaking material in the work zone, shape discarded overburden material to form rehabilitated landform; include controlled engineering compaction in designated areas for possible future urban uses,

. spread topsoil to minimum 300 millimetre depth over the rehabilitated landform and fertilize,

. spread brush cleared from other sections of the site onto areas designated for woodlots to act as a seedstock and plant a limited number of saplings,

. seed the remaining section of rehabilitated land and tend until the pasture is well established.

The water management and sediment control programme is discussed in detail in **Section 4.4.** The remaining activities in the extraction stages are outlined more fully below:

Site Clearing
The initial stage of operations would be the clearing of all trees and shrubs over the area to be worked. During this operation roots of larger trees would be grubbed, but grass would be left in place to be removed with the topsoil. Cleared vegetation would either be burned following clearing or, if fire restrictions were in force, left for future burning or removed to a tip.

During the clearing operations, a bulldozer normally used in quarrying the clay/shale would be diverted for clearing when required.

Stripping and Stockpiling of Topsoil
It is intended to strip an average depth of 300 millimetres of topsoil over the entire working area. This would be somewhat deeper in flat areas to compensate for the thin layers which would be difficult to remove in steep areas and in gullies. The stripping process would be by scraper or bulldozer with dump truck and would remove humus, small roots, grass and seeds for use in plant re-establishment.

Where possible topsoil would be deposited directly on an area being rehabilitated. This would not be possible in the initial or final stages and at certain other times during the project when the timing of resource extraction and rehabilitation in successive work zones do not match. To cover these needs, topsoil stockpiles would be created from time to time in

positions indicated on **Exhibit 4.** In order to preserve the integrity of the organic material, topsoil would generally be stockpiled for no longer than twelve months.

Clay/Shale Extraction
Over the entire site, the thickness of the resource varies from virtually zero to approximately twenty metres as shown on **Exhibit 3** and the method of working within various areas of the site will vary slightly depending on the depth and nature of material encountered. However, the procedure for extraction will generally be as described below.

Working faces of between 400 and 600 metres in total length will be open at any one time. This length allows sufficient room for machinery to manoeuvre and allows extraction of clay/shale to proceed at a steady rate while spoil is removed from other areas.

Clay, which forms the top layer of the resource, and clay/shale, the majority of the resource, will be loosened by ripping with a bulldozer, up to three of which would be used at a time. The machines will work downwards from the top of the working face, generally maintaining a batter slope of approximately one vertical to one horizontal. Loosened material would be pushed by the bulldozer into stockpiles from where it would be loaded, using a front end loader or the dozer itself, directly into trucks for transportation to the brickworks.

Some portions of the shale contain siderite (ferruginous) nodules which, if not removed, would cause iron staining in the bricks. These will be removed at the quarry face by tumbling in portable tumblers which use a spinning process to separate particles of different densities. Tumbled clay would then be loaded and transported as above.

Sandstone Extraction
Within the Bringelly Shale formation there are layers of sandstone and siltstone of varying thickness interspersed with the clay/shale. This material is recoverable as road base shale or rip rap (bank protection) but this use will be dependent on the prevailing market and on the thickness encountered during working.

Layers of sandstone up to 500 millimetres in thickness will generally be removed by ripping. Thicker layers, or occasional lenses of tougher material, will be broken by light blasting, involving 62 millimetre diameter holes on a 3 metre by 3 metre pattern. This process generally leaves rock fragments too large for crushing and they would be used either for engineering applications such as bank or waterway stabilisation or would be left in the quarry as fill for rehabilitation.

Thick layers of gritstone (laminite) and Minchinbury Sandstone would be shatter blasted, using 62 millimetre diameter holes drilled on a pattern of 2 metres by 2 metres, to produce small fragments suitable for crushing. This material would be transported to the crusher and thence to markets following crushing.

In general, the method of blasting will be the same as that currently used on Lot 22 and will include stemming to a depth of 0.15 to 0.3 metres.

Rehabilitation
Rehabilitation of the landform will follow the depletion of brickmaking resources in each work zone. This task will involve placing of overburden material on areas to be rehabilitated and shaping of the overburden to suit the rehabilitated landform indicated on **Exhibit 4.**

Generally the landform has been derived to satisfy the following requirements:

- to provide a landform capable of sustaining pasture in the short to medium term and possibly some form of urban development in the long term,
- to meet existing contours smoothly at the outside edge of the works,
- to leave the majority of the working area with moderate to gentle slopes (minimum slopes of 0.5 percent) suitable for various subsequent land uses with maximum slopes held to about 17 percent (1 vertical to 6 horizontal) where necessary to meet existing boundary levels,
- to maintain existing drainage patterns where possible,
- to allow an approximate balance of overburden production and disposal in each stage.

The contours indicated on **Exhibit 4** are indicative of the final land form that will result from the rehabilitation proposed. Restored contours actually achieved will be similar but will depend on actual material recovery rates.

Overburden material would generally be moved by scraper or dump truck and deposited in loose layers or piles. These would be shaped by bulldozer to a level 300 millimetres below the desired finished profile. Topsoil from stockpiles or direct from a succeeding work zone being stripped of topsoil at the time would then be spread to achieve the finished levels.

Generally, overburden and topsoil material would be shaped without controlled compaction, although it is expected that the method of overburden placement will achieve a compacted density of about two tonnes per cubic metre. To keep future options open it is proposed in specific areas to spread overburden in layers and compact this material to a density suitable to support road or building foundations. These areas are indicated on **Exhibit 5** which also shows a notional two hectare lot subdivision on Lot 28 and on adjacent Lots 21 and 22. Compaction would be achieved through rolling and through specifically routing quarry haul vehicles over compaction zones. Topsoil would be without specific compaction over these areas to allow regrowth of pasture prior to any future development.

The subdivision plan shown on Figure 5 allows for flexible post quarry use.It could potentially accommodate the development of factory units, cluster houses or other urban uses. No decision will be made until development trends in other parts of Mulgoa become more firmly established.

Revegetation

As topsoil is spread to the final landform it will be fertilized in accordance with the recommendations of an agricultural consultant to be retained to advise on pasture regeneration. Fertilization would be followed by seeding with a mix of grass seed types to regenerate a vigorous pasture which is suitable for livestock, able to bind soil and prevent erosion and appropriate to the climate. Details of initial fertilizer and seed mixes are presented in **Appendix 3.**

In the initial stages of pasture establishment the land being rehabilitated would be watered and stock excluded. During the first year of establishment light rapid grazing or slashing would be appropriate to stop vigorous grasses from smothering clovers or other weaker grasses and to check weed growth. Subsequently rehabilitated sections could be fenced off and used

It is also proposed to establish random wood lots to recreate some of the present wooded nature of the site and to replace bird habitats. These will be created by scattering branches and brush cleared from other parts of the site onto the designated wood lot area to act as a seed source and as wind and scour protection. Selected saplings would also be planted and tended in these areas to aid the process. Until the woodlots were well established it would be necessary to keep livestock from grazing on seedlings.

4.3.2 Working Sequence

Extraction and rehabilitation of work zones will take place sequentially in the order 1A, 1B, 2A, 2B, 3, 4 as indicated on **Exhibit 4.**

It is proposed that at any one time a maximum of three work zones be worked with the following activities taking place successively on each:

. clearing of trees and bush and topsoil stripping and/or stockpiling
. extraction of clay/shale and sandstone
. rehabilitation

In the early development of Stage 1 it may be necessary to remove overburden from the site to prevent having to double handle it until an exhausted area of sufficient size was available to receive overburden. It is expected at this stage that this material would be deposited on Lot 22 as fill and then replaced if necessary from overburden that will need to be removed from other proposed quarries in the area.

In the final stage (Stage 4) it will be necessary to stockpile topsoil material on part of Stage 3. This would be mean that revegetation of the affected part of Stage 3 would be delayed to take place concurrently with Stage 4.

Quantities associated with each stage are presented below in **Table 4.2.**

TABLE 4.2 - STAGE EXTRACTION QUANTITIES

Work Zone	Area (m^2)	Topsoil m^3	Clay/Shale m^3	Sandstone/Gritstone m^3	Spoil m^3
1A	52 600	15 750	300 000	80 000	150 000
1B	57 600	17 000	590 000	140 000	300 000
2A	55 150	16 500	480 000	110 000	240 000
2B	55 700	16 700	190 000	70 000	100 000
3	60 000	18 000	280 000	80 000	140 000
4	32 450	9 750	78 000	30 000	40 000
Total	313 500	93 700	1 918 000	510 000	970 000

Note: Total site area is about 54 hectares.

4.4 WATER MANAGEMENT

4.4.1 General

The planned staging of the quarry is based on minimising the area of site disturbed at any one time. It is also based on managing stormwater runoff so that rain water falling on or running across disturbed areas is treated to remove small particles of soil washed from the disturbed areas which would otherwise increase turbidity in downstream watercourses.

Removal of sediment from runoff would be achieved by diverting the catchments from disturbed areas via catch drains into sediment basins which would detain the water thereby allowing most soil particles to settle. Water would be discharged slowly so that the basins would empty some time after the storm ceased.

Details of the parameters used in the design of sediment basins and catch drains and of the sequence of catchment diversions necessary to suit the quarry staging proposal are presented below.

4.4.2 Sediment Basin and Catch Drain Design

Following current practice in New South Wales, sediment basins were sized to retain all of the water running off during a one in ten year frequency storm. After consideration of losses and using design storms for the Sydney Region presented in Australian Rainfall and Runoff (AR & R) **(Reference 3)** the appropriate design storm was determined to be of 10 hours duration which would produce runoff of 450 cubic metres per hectare. Provision for such a volume is considerably more conservative than the Soil Conservation of Service of New South Wales's recommendations of 120 cubic metres retention capacity per hectare for construction sites.

Catch drains and check banks were designed in accordance with guidelines presented in AR & R. A one in one hundred year frequency design storm was used to size these as there is only a small economic disadvantage in adopting this high standard.

Peak runoff was determined to be 0.25 cubic metres per second per hectare.

Catch drains would be used to collect runoff from working areas and lead it into the sediment basins. Check banks would be constructed at the top of working faces to divert unpolluted runoff before entering working areas. Four general sizes of catch drains would need to be used from time to time. These are described in **Table 4.3** which is based on a drain slope of 0.3 percent.

TABLE 4.3 - CATCH DRAIN SIZES

Catch Drain Type	Area Served (ha)	Flow Carried (m^3/s)	Depth (m)	Flow Velocity (m/s)
A	4	1.0	0.6	0.8
B	6	1.5	0.7	0.9
C	8	2.0	0.8	1.0
D	10	2.5	0.9	1.1

Four sediment basins are proposed for the project as indicated on **Exhibit 4.** The holding capacities and areas to be served by these basins are listed in **Table 4.4.**

TABLE 4.4 - SEDIMENT BASIN SIZES

Basin	Basin Volume (m^3)	Max allowable Contributing Catchment (ha)	Expected Peak Flow (m^3/s)
1	9 000	20.0	3.0
2	3 500	7.8	1.5
3	2 700	6.0	1.5
4	1 500	3.3	1.0

4.4.3 Control Sequence

The runoff control sequence is integrally connected with the proposed operating sequence. Staging is indicated on **Exhibit 4** and outlined below in point form.

Stage 1

. Intercept runoff from work zones 1A and 1B in a south flowing catch drain along the eastern edge of the workings.

. Detain runoff from work zones 1A and 1B in Sediment Basin 1 in the south-east corner of the site.

. Detail runoff from temporary topsoil stockpile on work zone 2B in Sediment Basin 2.

. Construct catch drains where necessary but otherwise use natural drainage lines to lead the runoff from the stockpiles to Sediment Basin 2.

Stage 2

. After rehabilitation of work zone 1A break out the north-south catch drain to the east of it and let runoff find its own way into natural watercourses.

. Construct a major catch drain between work zones 1A and 1B and use this to lead runoff from work zone 2A into Sediment Basin 1.

. Construct a catch drain between work zones 1A and 2B to lead runoff from work zone 2B into Sediment Basin 2.

. Construct Sediment Basin 3 and suitable catch drains to detain runoff from any temporary topsoil stockpile on work zone 3.

Stage 3

. Let runoff from work zone 2B continue to flow into Sediment Basin 2 while the land is being rehabilitated.

. Extend the major catch drain between work zones 1A and 1B along the division between work zones 2A and 2B to collect runoff from the rehabilitated work zone 1B and from any temporary stockpile for work zone 3 on work zone 2A.

. Construct a catch drain between the Stage 3 and the Stage 2 area to lead runoff from work zone 3 into Sediment Basin 3.

. Construct Sediment Basin 4 towards the end of Stage 3 to intercept runoff from those parts of Stage 3 which would naturally drain into it.

Stage 4

. Construct a catch drain between Stages 3 and 4 to lead runoff from Stage 4 into Sediment Basin 4.

. Restore the landform on the Stage 3 area so that all runoff is fed to Sediment Basin 3.

. Remove catch drains for work area 2B to allow natural drainage into watercourses.

. Retain remaining Stage 3 drainage controls.

On Completion

. On completion of quarrying the long term end use of the site should be known. On the basis of this, catch drains could be stablized to form drainage watercourses or filled in to achieve the finished contours shown on **Exhibit 4.**

. Similarly after stable vegetative cover had been established sediment basis could be removed or modified to serve as stock ponds or to serve as an urban runoff control detention system.

4.5 TRANSPORT

4.5.1 Transport Routes

Four alternative access routes to the existing quarries on Lots 21 and 22 were considered in an Environment Impact Statement on access prepared in 1979 (Reference 8).

The routes were as follows:-

. **Route 1** - the existing access to Lots 21 and 22 from Mulgoa Road.

. **Route 2** - an existing gravel road linking Lot 22 to chain of Ponds road via Lot 17, a property owned by Wearn Industries.

. **Route 3** - a route from Lot 22 along the northern boundaries of Lots 18, 19, 25, 26, 27, 28, 29 and 30 chain of Ponds Road and then back to Chain of Ponds road along the boundary of Lots 30 and 31.

. **Route 4** - a route along a right of way between the Housing Commission land and the northern boundaries of Lot 1 (Zacuba's land) and the Kay site to feed into Bradley Street.

The assessment of these alternatives concluded that:-

. Route 4 would have the greatest noise impact on existing dwellings (on Bradley Street).

. None of the routes would have any significant impact on air quality.

. Routes 3 and 4 would involve the construction of new roadway with consequent disturbance to vegetation and habitats - however no major impact on natural systems was expected.

. Route 4 would be the most convenient for the quarry/tip proposal and Route 1 the least.

On balance it was concluded that in terms of traffic generated by Lots 21 and 22 (the only proposal at the time) Route 2 would provide the best alternative. However measures would be necessary to reduce the loss of amenity to properties on Chain of Ponds Road.

Subsequently when it emerged that the clay/shale resource of the valley was very significant it became apparent that a common transport route for all future quarries was desirable. Further as the traffic carried by this road would be much greater than was envisaged in the earlier EIS, potential transport impacts on residential areas could be much greater. It was thus more important to develop a route which passed as far as possible from residential areas.

Route 1 met this criteria on the site, although it would lead traffic past the villages on Mulgoa Road. Routes 2, 3 and 4 would all pass reasonably closely to residential areas.

Accordingly Route 5 was devised to make use of a right of way along the northern boundary of the Reddan property (DP 224861), well away from all but two houses. From the right of way the route was aligned northwards across the Kay property, (DP 541090), which is owned by Mulgoa Quarries and then along the northern boundary of the Kay and Zacuba (Lot 1 DP 272144) properties. The deviation was necessary to avoid the clay/shale resource on the Kay and Reddan sites.

There is an existing 50 feet wide right of way along the boundary of the Zacuba property which could be used.

However a better alignment would be achieved slightly further away from the Housing Commission land and an agreement with Zacuba Pty Ltd is being negotiated to construct the route in the optimum location. The agreement will cover the construction, location, maintenance and use of the haul road by all future quarry traffic generated in the area.

4.5.2 Transport Operations

It is proposed to load clay/shale material directly into semi-trailer haul trucks and to transport the material over the proposed Route 5 quarry haul road directly to Bringelly Road and thence to the brickworks. The location of the proposed haul road is indicated on **Exhibit 2.** The first 250 metres of the road off Bringelly Road will be sealed to minimize noise and dust affectation on nearby residences. It is proposed to construct the haul road at the commencement of quarry operations.

The haul trucks using the road will carry about 20 to 24 tonnes of material each.

Sandstone and gritstone material will be carried in "off road" haul trucks to Wearn Industries' existing crusher on Lot 22 or, possibly to a portable crusher at the proposed Kay quarry. The route to Lot 22 will be via a haul road on a strip of land 30 metres wide along the eastern boundary of Lot 21 which is to be incorporated into Lot 28.

From the crusher on Lot 22 crushed rock would be carried to markets via either the new haul road to Bringelly Road or via the existing road from Lot 22 to Mulgoa Road. This material would also be carried in 20 to 24 tonne articulated vehicles.

It is expected that with clay/shale extraction of about 100 000 tonnes per annum there would be 20 to 30 truck delivery round trips on a typical day.

4.6 MANAGEMENT, FACILITIES AND PLANT

Operations on Lot 28 will be controlled by a quarry manager who will be assisted by a site foreman. The various work areas would be controlled by leading hands. Altogether some 40 person would be employed to work on Mulgoa Quarries (Wearn Industries) Quarry sites in the Mulgoa area. Personnel would be moved about the various working areas depending on the types of material exposed at any one time (eg while blasting was proceeding in one area, staff operating earthmoving plant could be deployed elsewhere). Normally there would be no more than 20 persons working directly on Lot 28 and on average there would be 10.

It is not proposed to construct any offices or works buildings on Lot 28. Instead, those already available on Lot 22 would be used. It may, however, be necessary to have available temporary toilet units near the working area.

It is proposed to work on the site between 6.00 am and 6.00 pm on weekdays and Saturdays. Generally operations would cease before about 5.00pm and work would only extend beyond that time infrequently during times of high product demand (say following an extended period of rain when deliveries could not be made to brickworks) or for emergency plant maintenance.

On Sundays work would only take place on Lot 28 to cope with drainage emergencies or to service broken down plant.

The following plant would be available for use on Lot 28:

. 12 to 15 tipper truck and tipper truck-trailer combinations
. 1 elevator sraper
. 3 bulldozers
. 4 front end loaders
. 2 air track drilling units
. 1 grader
. miscellaneous water carts, pumps, cranes etc

4.7 PROJECT TIMETABLE

Lot 28 is fully owned by Mulgoa Quarries Pty Limited and quarrying could start immediately after necessary approvals are received.

It is proposed initially to extract about 100 000 tonnes of clay/shale material from the quarry per annum with the balance of anticipated initial demand for Wearn Industries cream burning brickmaking material of about 400 000 tonnes per annum being satisfied from the proposed Kays/Reddans Quarry. The 1:3 material supply ratio for each quarry is based on the blending proportions which are expected to be necessary to readily bring the lower hard layers of cream burning shale material from the latter quarry to a plasticity suitable for brick extrusion and to maintain product colour control.

Wearn Industries expects its market share to grow due to the depletion of alternative supplies. Assuming a 5% annual production increase on Lot 28 approximately four million tonnes of clay/shale material in the quarry would be exhausted in about 23 years. The timing of individual stages would be approximately as follows:

Work Zone	**Year of Operation**
1A	0 to 6
1B	6 to 14
2A	14 to 19
2B	19 to 20
3	20 to 23
4	23

It should be noted that this timetable represents the likely maximum operating life of the quarry and if the expected rate of clay/shale recovery of 70 percent is not achieved the quarry life would be shortened.

5. EXISTING ENVIRONMENT

5.1 LAND USE

The proposed quarry site and land in its vicinity are zoned for non-urban uses. This allows the land to be used for country dwellings, agriculture and rural industries but does not allow the development of dwelling houses in residential subdivisions.

As shown on **Exhibit 2,** two quarries exist to the south of the site on Lots 21 and 22. A golf course lies to the north of the site and there is a subdivision of 10 hectare rural residential lots along Chain of Ponds Road. The remainder of the land in the vicinity is presently undeveloped and is being used for agricultural purposes. Trails throughout the undeveloped area indicate that there is some recreational use of the area by horseriders and trail bike riders.

The Housing Commission currently owns a site to the northeast of Lot 28, incorporating most of the land between Mulgoa and Bringelly Roads on the west and east respectively and the Western freeway to the north, as indicated on **Exhibit 1.** There are no firm plans for this land but possible development of the northern section is being investigated by the Land Commission.

So far only limited residential development has taken place in the 10 hectare lots along Chain of Ponds Road. Most other residential development in the area is scattered along Mulgoa and Bringelly Road.

5.2 WATER REGIME

The proposed quarry site lies on a ridge between two water courses so that under natural conditions stormwater runoff from the site is in two directions:

. to the west draining to Mulgoa Creek (10 ha)

. to the east and north draining to a tributary of Mulgoa Creek (40 ha).

At the site, the catchment of Mulgoa Creek is about 2 900 hectares and the catchment of the tributary to the east of the site is about 650 hectares. Contribution of flow to these two creeks from the site is therefore seen to be small.

Runoff from the site draining towards Mulgoa Creek is not concentrated into water cources before leaving the site.

Runoff draining to the tributary of Mulgoa Creek is from three separate catchments having areas of 10, 10 and 20 hectares. The average stream length within the site of watercourses from these catchments is 250 to 300 metres and the average slopes about 5%. The time of concentration for flow from these catchments is estimated to be about 12 minutes and the peak flow per hectare to be 0.3 m^3 per second and 0.25 m^3 per second for the 100 and 20 year storms respectively. There is no continuous dry weather flow from the site.

5.3 TOPOGRAPHY

The topography in the vicinity of the site is generally rolling with watercourses forming moderate to steep gullies in places.

Mulgoa Creek is the major watercourse in the area and all water from the site eventually drains into it. A steep escarpment to the east of Mulgoa Creek forms the dominant element of physical relief on the site. The pattern of watercourses, gullies and hills in the shale resource area can be seen on **Exhibit 2.** Greater detail of the topography on the site itself is presented on **Exhibit 4.**

The western boundary of the site is formed by Mulgoa Creek. From the creek the site rises about 20 to 30 metres up a steep, thickly wooded, escarpment. At the top of the escarpment the land falls generally from the southern boundary towards the north and east forming a plane which is incised by three watercourses. The two western watercourses feed into a tributary of Mulgoa Creek which runs east to west along the northwest of the site. The eastern watercourse runs towards the east and then feeds another watercourse which drains Lots 21 and 1 and runs generally from south to north along the eastern boundary of the site eventually feeding to the Mulgoa Creek tributary mentioned above.

The highest part on the site is about 72 metres above sea level and is located to the west of the centre point on the southern boundary. On the upper parts of the site (excluding the escarpment) slopes vary from a minimum of about 1 in 40 up to a maximum of about 1 in 8 to 1 in 10.

In the gullies carrying the watercourses slopes sometimes increase to about one in one.

The watercourses, along the eastern and northern boundaries fall at slopes of 1 in 100 and 1 in 150 respectively. To the north of the site the watercourse develops into a series of ponds about four hundred metres in length. To the northeast of the watercourse the land then rises up steeply again into the Housing Commission land.

5.4 CLIMATE

Climatic data for the site was obtained from the Bureau of Meteorology's station at the RAAF base at Richmond about 30 kilometres north of the site. This is the closest weather station to the site and it is expected that conditions would not be markedly different at the subject site.

5.4.1 Wind

Wind roses for the four seasons and for the year as a whole are presented on **Exhibit 7.** These indicate that spring is the windiest time of the year with winds generally heavy from all directions, but strongest from the west.

In summer the winds are predominantly from the east whereas in winter the westerly wind is predominant. Winds are lightest and fairly uniform in autumn. In winter and autumn there were many more calm periods than in summer and spring (41 - 42% of the time vs 26 - 28%).

5.4.2 Rainfall

Monthly rainfall averages are presented on **Exhibit 6.** These show that the highest rainfall occurs in the late summer months, being 80 to 100 millimetres per month. By comparison, only about half as much rain falls in late winter/early spring. The intervening spring and autumn months provide on average about 55 to 75 millimetres each.

5.4.3 Temperature

Mean monthly temperatures are also provided on **Exhibit 6.** These indicate average daily maximum and minimum temperatures of about 29 degrees and 17 degrees respectively in summer and about 18 degrees and 4 degrees respectively in winter.

5.4.4 Evaporation

Mean daily pan evaporation statistics on **Exhibit 6** confirm the close relationship between evaporation and temperature. In mid winter mean evaporation is about 2 millimetres per day while in December this increases to about 8 millimetres per day.

5.5 GEOLOGY

5.5.1 Regional Geology

The Sydney region is mostly underlain by Triassic sedimentary rocks. In the region of the subject site, the geology comprises the lower section of the Middle Triassic Wianamatta Group. This Group overlies the older and more commonly seen Hawkesbury Sandstone. The following description is quoted from **Reference 1.**

The Wianamatta Group is an essentially non-out cropping rock unit which forms the characteristically low, undulating topography of the Cumberland Basin. It is the chief source of raw material for the clay/shale based industry in the Sydney region and is likely to remain so for the foreseeable future. It is divided into three formations being, in ascending order, the Ashfield Shale, the Minchinbury Sandstone, and the Bringelly Shale.

Minchinbury Sandstone is a quartz-lithic sandstone up to 4.2 metres thick and can be used as road foundation material. The Ashfield and Bringelly Shales have different ceramic properties which influence their use in the clay/shale based industries. These are outlined below.

Ashfield Shale
The Ashfield shale is up to 62 metres thick and comprises a lower sequence of dark grey to black, sideritic claystone-siltstone which grades upwards into a fine, sandstone/siltstone laminite. The mineral content of the shale basically comprises clay minerals (45 to 60 percent), quartz (25 to 45 percent), and disseminated siderite (10 to 12 percent). The relatively large amounts of siderite present causes plasticity to be very low and causes the fired colours to be dark red, which is characteristic of the bricks of the older inner Sydney Suburbs. When highly weathered, Ashfield Shale can produce a clay/shale that fires to light colours.

Bringelly Shale
The Bringelly Shale is a complex formation consisting mainly of shale with numerous thin laminate beds throughout. Sandstone beds are generally less than a few metres thick. Thin coal seams and highly carbonaceous claystone horizons occur in the basal Bringelly Shale.

The Bringelly Shale has a lower siderite content than the Ashfield Shale and may thus have a slightly higher plasticity. Siderite is variably distributed, mainly in the form of nodule layers and grain aggregates. Shale containing very little siderite fires to produce cream burning shale whereas shale with larger amounts produces pleasant light or orange-red colours.

Weathered Bringelly Shale generally fires to a bright red colour owing to the presence of iron oxides. The irregular and mottled distribution of iron oxide may, in places, allow the limited production of relatively iron free cream burning clay by selective extraction.

5.5.2 Site Geology

In order to evaluate the quality and quantity of the site's clay/shale reserves an investigation, using three diamond drill holes, was undertaken. The geology underlying the site was ascertained and is briefly described here, with details of the resource being presented in **Section 4.2.2.**

Bringelly Shale occurs in the surface zone of the site, in thicknesses of up to 20 metres, extending down to approximately RL 50 metres. At this general level the basal sequence of the Bringelly Shale overlies Minchinbury Sandstone, which is two to three metres thick. The Ashfield Shale is found beneath this, reaching a thickness of 25 metres at the limit of borehole exploration (RL 24 metres).

Borelogs taken at three points on the site are presented in **Appendix 1.** The location of the holes is presented on **Exhibit 3** which also indicates the depth of clay/shale resource on the site.

5.6 SOILS

5.6.1 Soils

The soil types generally occurring on the site are red-brown podzolics derived from Bringelly Shale and are typical of the Cumberland or Sydney plain area. These soils are common on the moderate and freely drained slopes of this district.

As with most podzolic soils within the region the surface organic layers is poorly developed and heavy leaching has resulted in a hydrogen dominated soil (pH 5-6), of low natural fertility. Such soils also tend to set hard when dry, making moisture penetration difficult.

The A_1 horizon is generally less than 20 centimetres thick across most of the site. The A_2 horizon is a well-structured brown clay averaging 30 centimetres in depth. The B & C horizons comprise red/brown to grey clays. The soil profile is characterised by numerous ironstone pebbles which aid infiltration.

5.6.2 Suitability for Stockpiling

The A and B horizons are generally suitable for stockpiling and should resist breakdown as they contain a large percentage of peds and have a strong structure. The lighter coloured lower horizon is less suitable for stockpiling due to a high pebble content and an otherwise unstable structure. The strippable soils are estimated to be 75 centimetres to 100 centimetres deep over the entire site.

5.6.3 Erosion Potential

Red podzolic soils are highly susceptible to both sheet and gully erosion. No major erosion occurs on the site at present but existing paths and tracks indicate the beginnings of erosion problems.

Aerial photographic interpretation indicates little gully erosion and moderate to severe sheet erosion occuring throughout the district with cleared and grazed areas having suffered considerable erosion damage.

5.7 FAUNA

A fauna survey of Lot 28 was undertaken in August 1981. As reptiles and amphibians are largely inactive and migratory birds are absent at this time of year, the study concentrated on mammals and resident bird species.

Comparative studies were also carried out at this time in the Castlereagh State Forest and at Schuyville, North of Windsor. The Castlereagh State Forest site contains poor quality forest modified by logging, fire and intensive recreational use. The site at Schuyville is on Crown Land, with the vegetation being secondary forest regeneration following clearing. Only bird census work was undertaken at these two sites. On the subject site the survey mainly consisted of small mammal trapping, bird censussing, spotlighting and general observation throughout the study period.

The major findings of the survey are presented below and full details are presented in **Appendix 2.**

Mammals
The recorded mammalian fauna of Lot 28 Mulgoa was dominated by introduced species such as Black Rat, House Mouse, Rabbit and Fox. No native small mammals were captured and no macropods (kangaroos or wallabies) were sighted during the seven days spent on the site. The two native mammals recorded were both arboreal species being a Sugar Glider and a Brush-tailed Possum. This result reflects the modified nature of the site, favouring arboreal species, and the proximity to settlement, in that arboreal species are relatively free from the impact of ground dwelling feral predators such as foxes, cats and dogs.

Birds
49 species of birds were recorded on the Mulgoa site, with 21 species observed in the Castlereagh State Forest and 52 species observed on the site at Schuyville. A list of the species occurring at each of the three sites is included in **Appendix 2.** The avifauna of the Castlereagh State Forest was considerably less rich than that of Mulgoa or Schuyville, a reflection of the compounded impacts of logging, burning and intense recreational use of the State Forest.

The avifauna of Mulgoa is typical of the forested areas of the Cumberland Plain but differs significantly from those of the sandstone areas around Sydney. Bird communities in forests or shrub habitats growing on shale areas, such as the Cumberland Plain, are richer in insectivorous species (eg. thornbills, treecreepers and robins) and poorer in nectar-feeders (eg honeyeaters and lorikeets) than sandstone areas on which nectar-bearing plants, such as Proteaceae, are abundant.

The Schuyville site is richer in both species and number of birds than the Mulgoa site, although the latter can also be described as rich. This is probably due to the former being a larger area of forest and also having been allowed to regenerate for a longer period since clearing. It is likely that if the Mulgoa site was left undisturbed the richness of the avifauna would eventually achieve equality with that of Schuyville.

Amphibians and Reptiles
No amphibians and only one species of reptile were recorded on site. The reptile was the Eastern Water Skink, encountered close to the creek.

Fish
No fish were recorded in the creek within the bounds of Lot 28, however one native species, the Firetailed Gudgeon and the introduced Mosquito Fish were caught in the creek downstream of the point at which it flows out of the property.

The value of Lot 28 Mulgoa as a refuge for fauna is almost entirely taken up by the avifauna. The avifauna was found to be rich considering the extent of forest clearing and habitation in the area generally. The richness of the bird community can be explained by the presence of a combination of a few mature trees that survived the original clearing process and the vigorous regrowth of native tree and shrub species in recent years. These mature trees are also important to the arboreal Brush-tailed Possum.

5.8 FLORA

5.8.1 Regional Context

The vegetation of the central basin of the Cumberland Plain is presented on a 1:100 000 Vegetation Map of the Penrith area **(Reference 4).** As stated in the map's explanatory notes, very little of the original native vegetation of the Cumberland Plain survives, due to grazing, agriculture and housing.

The vegetation on clay soils to the east of the Nepean River is shown as predominantly cleared with two main areas of undisturbed Eucalypt Woodland remaining to the north and northeast of the proposed quarry site. To the west of the Nepean, the vegetation mostly comprises open forest and low woodland on sandstone soils, with vegetation changes evident where clay soils occur.

5.8.2 Site Vegetation

Grazing has been carried out on the proposed quarry site and surrounding district for many years and the vegetation generally reflects this land use, although regeneration on this site has resulted through a reduction in grazing pressure. The vegetation formation over most of the site is predominantly an open sclerophyll woodland, with some changes in structure and species composition evident in gullies and creek lines.

The various stratum are described below and the full text of the Vegetation Survey is contained in **Appendix 3.**

Canopy
Five Eucalyptus species occur throughout the site and surrounding district. On lower and middle slopes the Forest Red Gum is most common. Occuring with the Forest Red Gum is the Cabbage Gum and a Stringybark. Ridge tops and upper slopes are dominated by remnant Ironbarks and Grey Box.

The tallest in the area are Rough-barked Apples, and approximately ten of these are to be found on the site.

Along drainage lines She-oaks and Paper-barks are found although their distribution is infrequent and numbers few. The protected species **Casaurina Cunninghamiana** which is important for watercourse scour protection is infrequently found along the drainage lines.

Black Wattle is found concentrated in discontinuous dense thickets throughout the proposed quarry site and surrounding district. They appear to be a somewhat ephemeral species which rapidly colonise bare ground and die out very quickly.

The Shrub Layer
The Black Thorn is the only shrub regularly occurring across the site. This shrub occurs in often dense thickets and also appears to be an early arrival in the regenerative processes of this particular woodland.

Other specis of shrubs which were found on the site included **Acacia elongata, Leptospermum flavescens** and **Dillwynia juniperina.**

Ground Cover
Native pasture grasses are found in thin, discontinuous swards throughout the site and surrounds. The most commonly observed native grasses were Couch, Red Grass, Meadow Rice and Three-armed Spear.

Common introduced species were also observed on the site and in surrounding paddocks. These include Rhodes grass,Paspalum and Rye grasses including Perennial Rye, Italian Rye and Wimmera Rye .

Small localised patches of legumes also occur. These consist of Medics and some naturalised clovers.

Along the damper water courses the incidence and variety of ground covers is much more diverse. Lomandra, Maidenhair Fern and Kidney weed are common.

Water Plants
A wide variety of water plants occur in water holes and along the semi-permanent waterways. These include patches of bull-rushes, Common Reed Common rush, Water ribbon and Common Sedge.

Weeds
Very few noxious weeds are found on the site. The common weeds found occurring within and around the site consist of Spear Thistle, Fat Hen, Curled Dock, Chick and Wire Weed.

5.9 LANDSCAPE

5.9.1 District Landscape

The Mulgoa district comprises a series of low undulating hills with gentle to steep convex slopes cut by several shallow, slow-flowing rivulets. These low hills are typical of the transition line between the extensive lowlands of the Cumberland plain and the 'jump-up' to the Blue Mountains.

The district has been traditionally grazed by sheep and cattle for over 150 years. Natural vegetation has been cleared almost entirely except for shelter-belts and isolated areas of steep topography and a well-wooded ridge line along the Nepean River.

The major landscape features of the district are presented on **Exhibit 9.** The major ridgeline to the south between Mulgoa Road and the Nepean River is well wooded but laced with fire trails through the bush and it is in this area that the woodland of the moderate rolling slopes of the lower Blue Mountains begins to break up to be replaced by paddocks and open pasture land.

In the areas immediately surrounding the proposed quarry site the landscape is gently rolling farmland with paddocks and cultivated fields interspersed with woodlots. Rural homesteads and farm buildings are scattered throughout the area but are predominantly concentrated along Bringelly Road to the east of the site.

To the north of the site the northeast perimeter creek drainage system falls into a moderately wooded secluded valley. The eastern wall of the valley rises up steeply to the thickly wooded area along the southern boundary of the Housing Commission site.

5.9.2 Local Landscape

The major floral features of the landscape on the site and immediate surrounds can be seen on **Exhibit 8** and are described in **Section 5.8.** The general impression is one of densely wooded steep slopes and gullies with variable regrowth on the flatter rolling sections.

The north-south running escarpment between the golf course to the west and Lot 28 provides an attractive contrast to the district's otherwise "gentle" land-form and it is well vegetated with mature forest trees,

Likewise, the creeks west and east of the proposed quarry are attractive and support a wide variety of vegetation. They also contain especially lovely water-holes and reaches.

The thickly wooded and relatively unmodified nature of these features, in contrast to the cleared agricultural land, are considered extremely important in both the local and district context and worthy of measures to ensure their protection.

The existing quarries on Lots 21 and 22 are unattractive features which contrast strongly with variable grassed and wooded rolling topography in the surrounds. However, the quarries are largely screened from view by the undulating topography. Localised soil erosion in the area results in turbid creek waters which also detracts from the amenity of the local landscape.

5.9.3 Lines of Sight

An analysis of views to the proposed site is presented on **Exhibit 10**

From this it can be seen that most views from the proposed quarry site (Lot 28) are short, enclosed views. One long viewing cone exists from the southern fence-line on the seventy metre contour. From this point it is possible to see to the Fernhill property and distant hills.

Otherwise views to the quarry site are few due to intervening tree screening at the site and from most prominent view-points. In particular it is not possible to see the site from most points along Chain of Ponds and Bringelly Roads.

While the proposed quarry section of the site is well screened, the escarpment on the west is extremely prominent in the area and can be seen from the high ground to the west of Mulgoa Road from "Fernhill" in the south to "Broadlands" in the north.

5.10 ARCHAEOLOGY

An archaeological survey was carried out on the proposed quarry site with particular attention being paid to eroding areas, ridges and the surrounds of watercourses. No archaeological relics or sites were found on Lot 28 and only one relic, a basalt broken edge ground axe, was found on the proposed Kay/Reddan quarry site. The survey report is included as **Appendix 4.**

5.11 NOISE

A noise survey was undertaken in order to establish the noise levels existing in the area likely to be affected by the proposed quarrying operations. Measurements were taken at seven locations as shown on **Exhibit 11.** The full text of the noise report, including a description of each site is presented in **Appendix 5.**

All locations were selected to represent, as closely as possible, the typical environment of nearby residences. However, difficulties in gaining access to private property resulted in some measurement locations being some distance from the residences they represent.

The noise levels in the area at present are primarily generated by traffic using Mulgoa and Bringelly Roads. Locations one and five, however, are some distance from these roads and the background noise levels measured here were predominantly affected by other sources, including the existing quarry operations.

Table 5.1, gives a summary of the background noise level in terms of L90. This level, representing a noise level which occurs for the majority of the sample period, is regarded as the most reliable descriptor of background noise.

TABLE 5.1 - BACKGROUND NOISE LEVELS

Location	L90 (dBA) 0500 - 0600	0600 - 0700	0700 - 1800
1	-	40	35 - 36
2	35	-	39 - 47
3	-	33	42 - 44
4	31	-	35 - 43
5	29	-	32 - 35
6	-	44	36 - 44
7	-	-	38 - 47

The L10 level represents a level which is exceeded for only 10 percent of the total measuring time and gives a measure of the high noise level events which dominate the noise environment. At locations two and three, traffic using Mulgoa Road caused L10 levels of approximately 60 dBA during the period of 0600 to 1800. Traffic on Bringelly Road resulted in L10 levels of 50 to 55 dBA being recorded at Location 7.

5.12 TRAFFIC

5.12.1 Road System

The Mulgoa quarry area is served by two main roads, Bringelly Road (The Northern Road) and Mulgoa Road, which both run in a generally north - south direction. Bringelly Road forms part of a continuous road system between Richmond in the north and Narellan in the south and is an important link in the western Sydney road system. It connects directly to the Western Freeway running east-west, to Elizabeth Drive (towards Liverpool) and via its northern continuation as Parker Road to the Great Western Highway. It is a well constructed two-lane road with generally good horizontal and vertical alignment.

Mulgoa Road runs parallel to Bringelly Road, linking Wallacia in the south, to Penrith. It has a winding alignment and passes through the villages of Wallacia, Mulgoa and Regentville. It has a narrow two-lane carriageway and at times is subject to inundation by the floodwaters of Mulgoa Creek which runs alongside it.

Local roads serving the area include Bradley Street, a part sealed but low standard cul-de-sac to the east of the site and Chain of Ponds Road, a rural subdivision road shaped as a cresent which links Bringelly Road to Kings Hill Road. Chain of Ponds Road is two lanes wide and passes over steeply undulating topography. Kings Hill Road forms one of the few links between Bringelly Road and Mulgoa Road.

Local access into the Mulgoa quarry area is available via a private quarry road from Mulgoa Road over Lot 21. A second access to the quarries for light traffic is available via a private gravel road over Lot 17, which is owned by Wearn Industries, from Chain of Ponds Road.

5.12.2 Traffic Flows

Annual average daily traffic flow records for Bringelly Road and Mulgoa Road, obtained from the Deparment of Main Roads are presented on **Table 5.2** .

TABLE 5.2 - ANNUAL AVERAGE DAILY TRAFFIC FLOWS ON BRINGELLY AND MULGOA ROAD

Road	Year						
	1965	1968	1971	1973	1975	1977	1979
Bringelly Rd,							
N of Elizabeth Drive	2050	2370	3330	3240	4800	5370	6770
S of Western Freeway				6290	6730	8320	10860
Mulgoa Road,							
N of St Thomas	1380	1560	2760	1870	1960	1960	2220

From **Table 5.2** it is evident that traffic flow on Bringelly Road is three to five times heavier than on Mulgoa Road. Additionally, growth on Mulgoa Road has been relatively moderate but it has been very rapid on Bringelly Road.

The Department of Main Roads' traffic records were supplemented by additional counts undertaken on Bringelly and Mulgoa Roads on the 4th of August 1981. These counts were taken to note the variation in flow throughout the day and the number of heavy vehicles in the traffic streams.

Flows on Mulgoa Road were found to vary between about 135 vehicles per hour at midday, of which about 20 were medium or heavy trucks, up to a maximum of about 200 vehicles per hour between 9.00 and 10.00am of which 48 were medium or heavy trucks. During daylight hours about 18 percent of traffic south of the access to Wearn's quarry was comprised of heavy or medium vehicles and north of the access, about 14 percent was comprised of heavy vehicles.

On Bringelly Road flows varied between about 370 vehicles per hour at midday up to about 625 vehicles per hour between 4.00 and 5.00pm. Heavy truck movements varied between about 70 and 110 vehicles per hour in daylight hours, comprising about 17 percent of all traffic.

On both roads the proportion of trucks fell off dramatically in the evening to between one and four percent. On a twenty four hour basis it is estimated that about 13.5 percent and 15 percent of vehicles on Mulgoa and Bringelly Roads respectively were medium or heavy trucks.

Despite the high proportion of heavy traffic on Mulgoa and Bringelly Roads the volumes were generally moderate and conditions free flowing at all times in the vicinity of the subject site.

5.12.3 Quarry Traffic

The volume of traffic to and from the quarries on Lots 21 and 22 each day depends on the weather as the brickworks will not accept material in wet weather. However, based on annual material sales and truck capacities the typical daily truck generation of Wearn Industries Quarry is about 70

trucks per day and of NJW Contractors about 25 trucks per day in each direction. Thus, typical total two way truck movements generated by both quarries would be about 190 per day. Because deliveries are not made every day average daily truck generation over the year would be somewhat lower at about 150 two way movements per day.

Light traffic generated by the quarry results mainly from staff vehicles. At present there are about 35 persons employed by Wearn Industries and up to 10 persons employed by NJW Contractors in the two quarries. These people would generate up to 100 two way light vehicle movements per day so that the total vehicular generation of the two quarries would be something less than 300 vehicle trips per day.

Quarry trucks at present make all deliveries via the Mulgoa Road access. The trucks are then restricted by Penrith Council to major roads in the area to protect minor roads from damage. Routes presently followed are Mulgoa Road south to Wallacia and then Park Road, Bringelly Road and Elizabeth Drive towards Liverpool, or Mulgoa Road north to Penrith and thence west along The Great Western Highway or east by Police request, along Jamison Road, Bringelly Road and the Western Freeway to the east.

In 1980 to 1981 Wearn Industries delivered about 300 000 tonnes of clay/shale material for brickmaking and about 18 000 tonnes of material for roadmaking and fill. NJW Contractors delivered an estimated 120 000 tonnes of clay/shale material.

The breakdown of deliveries and routes to markets by Wearn Industries in March 1981, a fairly typical month, are presented on **Table 5.3.**

TABLE 5.3 - WEARN INDUSTRIES MULGOA QUARRY MATERIAL, MARKETS AND TRANSPORT ROUTES, MARCH 1981

Customer	Factory Location	Material Delivered (Tonnes)	Transport Route
Clark Bricks	Prospect	6 250	Mulgoa-Jamison-Bringelly Roads and Western Freeway
	Bringelly	4 550	Mulgoa-Park-Bringelly Roads
Goodlet & Smith	Merrylands	1 650	Mulgoa-Jamison-Bringelly Roads and Western Freeway
P.G.H. Bricks	Doonside	1 050	Mulgoa-Jamison-Bringelly Roads and Western Freeway
	Schofield	3 450	Mulgoa-Jamison-Bringelly Roads and Western Freeway
	Horsley Park	400	Mulgoa-Jamison-Bringelly Roads and Western Freeway
Zacuba Brick	Cecil Park	12 850	Mulgoa-Park Roads-Bringelly Road Elizabeth Drive
Local Sales		1 050	Variable
TOTAL		31 250	

Table 5.3 indicates that sales to the east comprise over 95 percent of total sales with about 40% of deliveries on the Western Freeway and 60% via Elizabeth Drive.

About 13 000 tonnes were carried north along Mulgoa Road via an indirect route to the Western Freeway while most of the remainder was carried south along Mulgoa Road.

Thus in the absence of a direct outlet to Bringelly Road the existing quarries are obliged to transport their products in heavy trucks either through the villages on Mulgoa Road or through Penrith itself.

5.13 AGRICULTURAL POTENTIAL

The land use in the area of the proposed development is largely agriculture. At present no economic benefit is being derived from Lot 28 although some years ago the land was cleared and used for agricultural purposes. Lack of agricultural use since that time has allowed the vegetation to regenerate, resulting in the development of a savannah woodland on the site.

Should the site be developed towards an agricultural system, in keeping with surrounding land use, a high capital outlay would be required to carry out operations such as clearing, levelling and fencing. The structure of the soil is most suited to a pasture/grazing system, which would lift the organic matter content of the soil and help reduce acidity. Cropping or horticultural practices would be likely to result in erosion problems due to the thin topsoil and sharply undulating topography of the site. A report on the agricultural potential of the site is presented in **Appendix 3,** and this suggests two potential agricultural uses for the site; an angora goat enterprise and horse agistment. With the former, high market returns would be likely to justify the high intitial capital outlay. In the latter case, the proximity of Penrith, with its increasing number of families buying horses, may well favour the lower capital cost of providing an area for horse agistment.

6. ENVIRONMENTAL SAFEGUARDS

6.1 PROJECT DESIGN

Environmental consequences have been a major consideration in the planning and design of the proposed quarry. While a number of unavoidable effects must occur in the development of a quarry, particular effort has been made to minimize these effects and ensure that they do not endure beyond the life of the project. The principal environmental considerations incorporated into the design were as follows:

- protection of the sensitive western escarpment and creek bank areas through reduction of the area of operation
- maintenance of existing drainage system as closely as possible through staged workings and landform design
- control of pollution sources within the site to minimize any resultant effects outside the site.
- protection of local landscape and provision of final land use options through progressive rehabilitation of the site.

6.2 LANDSCAPE PROTECTION

6.2.1 Escarpment and Creek Line

The escarpment to the west of the site has been identified as being of particular importance to the area, both in terms of the visual amenity of the local landscape and in the provision of a screen to quarry operations, as discussed in **Section 5.9, Landscape.** In order to protect this amenity, it is proposed to limit quarry operations to east of the 60 metre contour above the escarpment. This would retain the tree cover of the escarpment and screen quarry operations from Mulgoa Road and from the high ground to the west of the quarry.

To provide a screen to the southern edge of quarry operations, the workings will be distanced at least 10 metres from the southern boundary of Lot 28. This strip of high ground is only thinly wooded at present and it is proposed to plant additional trees during the early stages of operation to further screen views from the southwest. The strip will also allow the restored contours of the Lot 28 quarry to blend with those on the Lot 21 quarry along the western half of the southern boundary.

The eastern section of the southern boundary is screened by the western escarpment and could be quarried without any significant impacts on views from the west.

A buffer strip will also be retained along the eastern boundary of the site to protect the creekline draining northwards to Mulgoa Creek. The vegetation in this area will serve an erosion control function for the creek banks, plus an additional filter for waterborne materials between quarried areas and the creek. Retention of this strip will also aid in maintaining the character of the area, with its vegetated watercourses, as well as acting as habitat for local wildlife.

6.2.2 Quarry Area

The very nature of the quarry operations will result in a major modification of contours on the site. It is proposed to minimise the aesthetic disruption of these operations by keeping the working area to the minimum necessary for efficient operation and by rehabilitating the site progressively as the resource in each work zone is depleted.

Rehabilitation plans provide for the recreation of the rolling topography typical of the district. The edges of the quarry will be carefully shaped to blend in with the contours of the adjoining areas while over the main body of the quarry variable grades between one in six and one in two hundred will be achieved.

6.3 PROTECTION OF WATERWAYS

The quarry site drains generally north and east into a tributary of Mulgoa Creek. During the operating life of the quarry these waterways will be protected and the existing drainage system maintained as closely as possible. To achieve this, it is proposed that quarry operations be undertaken in four main stages, governed by the constraint of runoff and siltation control. This is described in **Section 4.4**

Runoff of sediment laden water will be prevented from entering clean waterways through the use of sediment control basins located on the existing creeks, generally outside the working area. These basins will be sized to cater for silt-laden runoff from each stage of operation. Runoff from undisturbed or rehabilitated areas will, wherever possible, bypass the basin and flow directly into the creeks. Catch drains and check banks have been designed to divert all sediment from temporary stockpiles, working areas and areas undergoing rehabilitation into the control basins. These basins will be maintained during the life of the quarry and will be left in position at the conclusion of operations to be used as stock dams or for other purposes.

6.4 DUST CONTROL

Dust generation will occur from various activities associated with the quarrying operation.

The principal method of dust control would be through the use of a water cart spraying haul roads, stockpiles and working faces when necessary. An additional safeguard in relation to the haul roads would be to use moderately plastic crushed rock material from the quarry so that the road surface would bind well together and be less susceptile to dust generation.

In addition it is proposed to seal 250 metres of the road on the approach to Bringelly Road to reduce dust generation in the most sensitive part of the resource area.

In areas being rehabilitated it will also be necessary to employ mulching to suppress dust and keep topsoil moist.

It is proposed to use the rock crusher on Lot 22 and hence dust generation from this source will not exceed present levels.

Rock drilling equipment will be fitted with dust collection jackets.

6.5 NOISE CONTROL

In order to achieve acceptable noise levels at surrounding residences, it is proposed to restrict quarry working hours to generally between 0600 and 1800. An extension of working hours to 2000, will only occur on days of high product demand. Quarry operations will also be restricted to the eastern side of the 60 metre contour above the western escarpment which will provide significant shielding to residences near Mulgoa Road.

The construction of a new haul road to Bringelly Road will reduce traffic noise along Mulgoa Road. This road would pass by the proposed quarry on the Kay/Reddan site. Sealing of the section of this road which passes the nearest residence near Bringelly Road would help to minimise quarry traffic noise at that residence.

6.6 BLASTING CONTROL

In order to achieve acceptable blast design goals it is proposed to restrict the number of holes blasted on any one delay setting to the number indicated on **Exhibit 11.** These range between two holes per delay at the south western corner of the proposed quarry up to 7 holes per delay at the north western corner.

6.7 REHABILITATION

Rehabilitation safeguards proposed provide for the re-establishment of pasture and woodlots on a rolling landform to recreate the landscape typical of the district.

A study of the agricultural potential of the site was undertaken in order to determine the most effective rehabilitation procedures for return of the site to agricultural use. This is presented in **Appendix 3.** It is proposed that the recommendations contained in this report be implemented under the direction of a part-time agricultural consultant.

Through the use of fertilizers and modern seeding practices it is anticipated that the re-established pasture would support a higher density of grazing stock than the present unimproved pasture.

While the site is presently zoned for non-urban uses it is recognized that urban pressures are likely to lead to the need for more intense use of the site in the future. Accordingly a development plan for a two hectare rural residential subdivision has been prepared (see **Exhibit 5)** on which special zones have been designated to receive controlled compaction to an engineering standard such that roads and buildings could be constructed on them.

These zones are of sufficient size to allow flexibility in the end land use such that other urban land uses such as factory units or cluster housing might also take place. These zones would be grassed in the interim until any plans for future urban development were confirmed.

Outside of these zones fill material will also be compacted to minimize the cost of foundations of future buildings constructed on them. However special engineering control will not necessarily be applied.

It is also proposed to rehabilitate the landform as soon as possible after extraction is complete so that the maximum amount of natural compaction on the areas not designated for controlled compaction can take place while the quarry is operating.

7. ASSESSMENT OF ENVIRONMENTAL IMPACT

7.1 WATER REGIME

As there are no watercourses flowing across the proposed quarry area from catchments above it there will be no water discharges from the quarry during dry periods. The sediment dam detention systems are expected to control the sediment level in stormwater leaving the site to a level better than that presently being achieved by agricultural activities in the area. These systems have been designed in excess of the Soil Conservation Service guidelines and should ensure that silt loads carried from the site are within acceptable levels.

The detention dams will result in the attenuation of peak stormwater discharges from the site but with the overall period of discharge being extended. This would be of benefit in reducing flooding downstream in the Mulgoa Creek system.

7.2 FLORA AND FAUNA

The vegetation and wildlife on the site will be unavoidably affected by the proposed quarry operations, as vegetation will be cleared and fauna displaced.

The vegetation on the site is of a type once widespread on the Wianamatta Shale of the Cumberland Plain west of Parramatta but of which only small remnants survive. The vegetation on the quarry site however, has limited conservation value as it is mostly young regrowth on land previously cleared for grazing. An area with similar vegetation but not recently disturbed lies to the north of the site and consideration should be given to a proposal for it to become a nature reserve **(Reference 5).**

10 mature specimens of **Angophora floribunda** have been identified on the site, accompanied by seedling regrowth and there is some conservation value in these in the provision of a seed source for the district. It is proposed to retain at least five of these on the southern and western perimeters of the operation by fencing and one in the creek buffer area to the east.

An alignment for the quarry haul road has been chosen which will avoid specimens of **Casaurina cunninghamiana.**

The value of Lot 28 as a refuge for fauna is predominantly in terms of avifauna, which was found to be rich considering the extent of clearing of forest and habitat in the area generally.

A buffer strip is proposed along the creek to the east and north of the site, varying between 20 metres and 100 metres in width, and this will serve as habitat retention as well as providing erosion protection and an additional natural filter for water borne materials from the quarry.

The buffer area would be fenced in order to exclude domestic stock and trail bikes. It is expected that the majority of bird species recorded would be able to continue to exist along the buffer strip.

6.8 HABITAT PROTECTION

A buffer strip of natural vegetation would be left along the northern and western boundaries of the site and along the creekline to the east. This, together with the untouched bush on the western escarpment, would maximise the retention of habitats in the area thereby facilitating the repopulation of the quarry site by wildlife after operations are complete.

It is proposed to fence these buffer zones on the perimeter of the quarry area to ensure that quarry traffic does not encroach beyond the minimum area necessary for quarry operations. However, it will be necessary to construct the three small silt detention dams within the natural area and special precautions will be necessary to ensure that minimum disturbance of habitat taken place.

Altogether it is proposed that 23 hectares of the total site area of 54 hectares will be undisturbed by normal quarry operations. In the section of quarry haul road outside the working area an alignment has been chosen that avoids specimens of the protected plant species **Casaurina Cunninghamiana** .

A further safeguard of natural habitat will be that only limited land clearing in advance of quarrying will take place. Thus while quarrying is taking place in Stage 2 of operations, vegetation on most of Stage 3 and all of Stage 4 would be undisturbed. By the time operations are moved to the Stage 4 area, vegetation would have had several years to re-establish in the Stage 1 area.

A final safeguard to the natural environment proposed is the modification of the working area to preserve six of the ten Rough Barked Apple trees on the site to act as a seed source to promote the future propagation of these trees on the site. The proposed fence line has been indented on the southern and western edges of the working area to exclude five trees from the working area, and the sixth tree is located in the creek buffer area to the east of the site.

6.9 TRANSPORTATION

At present, transport of quarry materials in the vicinity of Lot 28 takes place along Mulgoa Road, with resultant adverse effects on the environment. In order to minimise the need for traffic generated by this quarry to use Mulgoa Road, it is proposed to construct a haul road with direct access to Bringelly Road. Much of the existing quarry traffic would also use this road, easing impacts on Mulgoa townships and Penrith itself.

The use of this haul road would also provide the quarry traffic with a more direct access route to the western Sydney road network, channelling traffic onto roads suitable for heavy vehicle transport and reducing distances travelled by these vehicles.

Other fauna on the site will be displaced by quarrying operations. However, rehabilitation will occur progressively over the site and vegetation plantings will make use of local species. Fauna recolonisation of the site will occur but numbers and diversity will of course be dependent on the chosen final land use and type of habitat provided after quarrying ceases.

In the meanwhile the re-establishment of pasture and woodlots will assit the recolonisation process.

7.3 ARCHAEOLOGY

In the archaeological survey of the site, no sites or artefacts were found on the site of the proposed quarry. Only one relic was found on the proposed Kay/Reddan quarry site. Hence there will be no impact of archaeological significance.

7.4 LANDSCAPE AND VIEWS

7.4.1 During the Life of Quarry

During the life of the quarry it is proposed that only about ten hectares will be disturbed at any one time with the balance of the 32 hectares to be either revegetated after restoration of contours or not yet cleared.

There is no practical way of changing the short direct views of the land actually being quarried. However the surrounding topography is such that short direct views will only be available from Lots 21, 22 and 1 to the south. Diffused medium range views over the quarries on Lots 21 and 22 are theoretically possible from five lots on Chain of Ponds Road but in practice a clear view of quarry activity on Lot 28 would be difficult because of intervening vegetation. Similarly, medium range views from the Kays and Reddans sites to the east of Lot 28 would be broken by ridge lines and vegetation.

Short views to the site from the Housing Commission site will also be strictly limited because of a ridge line running diagonally across the southern boundary of the property and the thick vegetation in the south west corner of the property.

Sections along typical sight lines and an analysis of more distant views to the quarry are presented on **Exhibits 9 and 10.**

These exhibits indicate that the quarry would have no serious impact on the regional landscape.

7.4.2 Following Rehabilitation

After rehabilitation the topography would be more flattened than at present but the revegetation, consisting of pasture interspersed with woodlots, would be consistent with the surrounding topography. Long term impact on landscape and views would be minimal.

7.5 NOISE

7.5.1 Noise Design Goals

Noise impacts will result from the proposed quarry, both from operations on the quarry itself and from the transportation of quarry products. A noise survey was undertaken to determine the level of impact and is presented in full in **Appendix 5.**

In order to assess the impact of noise from the proposed quarry operations, design goals, likely to be acceptable to residents in the area, were established.

Table 5.1 presented the existing noise levels at six representative sites in the area. However, it is considered that proposed and possible quarrying developments will mean a change in character of the area and the existing background noise levels are not totally appropriate.

Hence the quietest area category of Australian Standard 1055-78 (Table 1) "Noise Assessment in Residential Areas" was used for assessment purposes, although an allowance was made for earlier rising times in this rural area than the suburban areas for which these levels were derived.

The following levels were then set as the steady noise design goals:

. 0600 - 1800 - 45 dBA

. 1800 - 2200 - 35 dBA

Quarrying Operations
At normal operating distances of the quarry from the nearest property, noise from quarry operations is likely to be reasonably steady although punctuated by the occasional impacts due to trucks loading rock in the pit. The maximum levels likely to result from these impacts should be acceptable to residents if they do not exceed the steady noise design goals or existing background noise levels by more than 5 dBA.

Transportation
At present there are relatively high volumes of traffic on Mulgoa and Bringelly Roads and the truck movements associated with the development of this quarry will not significantly raise noise levels on them.

On the private routes used for transporting product from the quarries to the public roads, the noise impact will depend on the number of movements and noise levels of each truck. It is considered that any significant impact is unlikely provided the maximum levels do not exceed the design goals or existing background noise levels by more than 15 dBA at nearby residences.

7.5.2 Noise Impacts

Quarrying Operations
Noise levels from the proposed operations have been calculated using equipment currently in use on Lot 22 and by allowing for attenuation with distance (6 dBA per doubling of distance), building attenuation where appropriate and shielding by pit walls and natural topography.

It has been assumed in these calculations that quarry operations will be limited to the 60 metre contour on the western side. This would provide significant additional shielding to western residences through the slope of the natural topography.

Steady noise contours were calculated for areas where residences exist or may be constructed and these are presented on **Exhibit 11.** The contours are for the worst time period during the life of the quarry, when quarrying operations are closest to the residences involved. However, because of the use of equipment over the whole of the site, in activities from prestripping to restoration, the levels are not anticipated to vary greatly.

In summary, the highest noise levels anticipated at noise sensitive areas nearby (taking into account the restricted operation on the western edge) are as follows:

. Kelly residence	- 46 dBA
. Ovindoli Pines	- 50 dBA
. Location 3	- 52 dBA
. Housing Commission Property (South of transmission lines)	- 53 dBA
. Housing Commission Property (North Transmission Lines)	- 41 dBA

At the Kelly residence, topographical shielding would result in day time levels only exceeding the design goal by 1 dBA. It is considered that this would not cause disturbance.

On part of the Housing Commission property, the daytime design goal of 45 dBA is significantly exceeded. However, should housing construction be restricted to north of the 65 metre ridge line, which passes through the wooded lot proposed to be retained as open space to the northwest of the quarry, the maximum level expected is 48 dBA. Whilst exceeding the design goal of 45 dBA, it is considered only slightly too high. Because of drainage considerations this restriction on residential development is thought to be likely in the short to medium term.

Apart from the quarrying limit set out at the 60 metre contour on the western boundary of the proposed quarrying area (already included in the calculations), there are no practical noise control measures to further reduce noise levels and the levels at Ovindoli Pines and Location 3 will remain in the order of 5 dBA above the design goal in the latter stages of the project.

Should full-scale quarrying operations be maintained beyond 1 800 hours, the design goal of 35 dBA would be exceeded at all locations. However, this would only occur on days of high product demand (eg after a prolonged period of rain in which brickwork stockpiles ran down).

Calculations were also made of the impact noise produced by loading rock into trucks. Allowing for significant shielding, in the order of 20 dBA, by pit walls, the following noise levels have been estimated.

. Kelly residence	- 45 dBA
. Ovindoli Pines	- 41 dBA
. Location 3	- 46 dBA
. Housing Commission property	- 44 dBA

These are all within 5 dBA above the expected steady level and are therefore considered to be acceptable.

It should be noted that the assessment is based on an extraction rate of 400 000 tonnes per annum which may take place initially if an interim proposal for stage 1 only is given. For the proposed extraction rate of 100 000 tonnes per annum noise of the same intensity would be generated but the number of days on which the full intensity were developed would be greatly reduced.

Transportation

Present and forecast delivery truck generation on Lots 21, 22 and 28 are presented on **Table 7.1.**

TABLE 7.1 - PRESENT AND FUTURE TYPICAL DAILY TRUCK MOVEMENTS

Operator:	Wearn		NJW	
Site:	Lot 22	New Quarries	Lot 21	Total
Existing	70	-	25	95
Future	13	87	25	125

The volume of truck traffic generated on Lot 28 would depend on whether or not a quarry on the Kay site was operated concurrently. In that event only about 22 trucks per day would originate from Lot 28.

If the Lot 28 quarry proceeded on its own all 87 vehicles per day would originate from it.

The proposed route to Bringelly Road would pass within 100 metres of the nearest residence and 250 metres of the next nearest residence. If the Kay quarry proposal does proceed, it will set the dominant noise pattern in the vicinity of those houses and transport noise from Lot 28 would be a secondary factor.

In the event that the Lot 28 quarry proceeded alone for a time, the following maximum noise levels are forecast at the nearest residences:

. Nearest residence - 63 dBA

. Next nearest residence - 55 dBA

For the "next nearest residence" this represents an increase in noise level of 15 dBA above the background design goal of 40 dBA and is considered acceptable for intermittent truck noise.

However, maximum noise levels at the nearest residences are expected to exceed the background noise level by up to 23 dBA. Whilst this is greater than 15 dBA above the design goal, it should be noted that such noise levels will be similar to those currently experienced from trucks on Bringelly Road and therefore will be generally consistent with the existing environment. Truck noise on the haul road is therefore not considered likely to cause a significant problem.

Truck levels on the access road to Mulgoa Road are likely to decrease once the new haul road to Bringelly Road is operating. However due to the predominance in the noise environment of traffic noise along Mulgoa road the quarry and haul road development is not likely to significantly change the existing noise pattern in the vicinity of Mulgoa Road.

7.6 BLASTING

Both groundborne vibration and airblast wave overpressure associated with blasting may cause damage to buildings and/or annoyance to residents if their levels are not controlled by blast design and blasting techniques.

In order to establish the site properties in respect of the transmission of vibration and propagation of overpressure, three production blasts at Wearn

Industries' quarry on Lot 22 were monitored. The two monitoring locations, shown on **Exhibit 11,** were selected to represent the minimum distances that blasting on Lot 28 would be from the nearest residences. The results and analysis of these tests are presented in full **Appendix 5.**

The State Pollution Control Commission has recommended the following vibration and overpressure levels from blasting to avoid disturbance to nearby residents:

. Vibration - 7 millimetres per second

. Overpressure - 115 dBL (decibels Linear)

These levels have been adopted as blast design goals as they are generally consistent with experience of neighbouring complaints and in addition, are well below levels recommended overseas for avoidance of damage to buildings.

Vibration Assessment
The peak particle velocity of vibration measured at a distance from a blast depends upon the charge weight and the type of ground or rock through which the vibrations are transmitted. The anticipated maximum charge per hole is 12 kilograms (equivalent AN60).

Acceptable vibration levels will be achieved at the Kelly residence (assuming quarrying is limited to the 60 metre contour) by limiting the number of holes fired per delay to six. For distances of 220 metres or greater from the Kelly residence, the commonly used seven or eight holes per delay will be acceptable.

Overpressure Assessment
Airblast wave overpressure depends on the distance from the blast, the Maximum Instantaneous Charge and the depth of the charge below the surface.

In order to achieve the design goal of 115 dBL, the following minimum distances have been calculated for a range of holes per delay.

Holes Per Day	Distance (m)
1	110
2	190
3	280
4	400
5	500
6	640
7	740
8	860

Some restrictions on the number of holes blasted instantaneously will be necessary as the Kelly Residence and the house near location three are 200 metres and 350 metres respectively from the nearest area to be quarried. These restrictions are tighter than those for vibration control and are shown on **Exhibit 11.** It is also assumed that no houses will be constructed on the southern edge of the Housing Commission property during the life of the quarry.

These restrictions are based on average overpressure level prediction curves and there is the possibility of design goals being slightly exceeded at the Kelly residence should high levels occur. It is therefore

recommended that monitoring be carried out during critical stages of quarrying to confirm that the design goal of 115 dBL is consistently being complied with.

7.7 TRAFFIC

7.7.1 Traffic Generation

The proposed quarry will result in an increased volume of traffic using the road system between the quarry and the product market.

In **Table 7.2** existing traffic flows generated by the quarries on Lots 21 and 22 are compared with future traffic generation forecasts for the proposed quarry on Lot 28 together with continuing operations in the quarries on Lots 21 and 22.

TABLE 7.2 - EXISTING AND FUTURE TYPICAL WEEKDAY TRAFFIC GENERATION (TWO WAY)

	Lot 21		Lot 22		Lot 28 *		Total	
	Cars	Trucks	Cars	Trucks	Cars	Trucks	Cars	Trucks
Existing (1980)	25	50	75	140	0	0	100	190
Future	25	50	25	25	100	175	150	250 +

* Based on no extraction on Kay site. If that proceeds concurrently generation of Lot 28 would be on average, 25% of the above

\+ Average generation would be slightly lower at about 240 two way movements per day

Thus, subject to Wearn Industries maintaining their present market share, it is expected that the total two way generation of the quarries would increase from nearly 300 vehicles per day at present up to about 400 vehicles per day in the future. Truck movements would increase from about 190 movements per day up to about 250 movements per day.

7.7.2 Traffic Distribution

The development of a new haul road to Bringelly Road would have marked impact on the present truck movement pattern. At present all trucks travel to Mulgoa Road with about 40 percent of Wearn Industries trucks then travelling to the north and about 60 percent travelling to the south.

In future only local sales would be made via Mulgoa Road and about 95 percent of truck movements would be directly to Bringelly Road.

Light traffic presently gains access to the site via Mulgoa Road or via Lot 17 from Chain of Ponds Road. In future light traffic will also use the new route to Bringelly Road as it would be considerably shorter than the Chain of Ponds route for vehicles from the north.

The proportions of light traffic using each route are likely to vary from time to time with the turn over of employment but in view of the development of the new route it is unlikely that either of the two existing routes would carry more light traffic generated by the quarries than they do at present.

7.7.3 Impact of Traffic

Overall it is considered that although the total amount of quarry traffic would increase due to the proposal, the traffic impact would be beneficial due to the removal of most trucks from Mulgoa Road. Particular benefits would be noted in Mulgoa, Wallacia and Regentville and along Jamison Road and through parts of Penrith itself.

The increase in traffic on Bringelly Road in the vicinity of the site would be of the order of 2 percent, a proportion which would generally not be distinguishable from the normal daily variation. With a flow of less than 400 vehicles per day using the haul road there should be no problems with capacity at its intersection and with Bringelly Road.

The proposed quarry haul road wold provide a considerably shorter distance for vehicles travelling between Wearn Industries' quarries and the east. Travel savings from the Lot 22 quarry would be in the order of 10 kilometres per round trip. This would provide significant savings in terms of fuel use and vehicle productivity.

7.8 SOCIAL

At present Lot 28 is unused and provides no direct social benefits. The development of the proposed quarry would provide about 10 jobs.

Flow on effects to the regional economy, through the demand generated by the quarry for local goods and services and through the consumer spending of the quarry workforce, would also improve income and employment prospects in the outer western suburbs of Sydney.

On the other side noise resulting from the development of the quarry will make residential development undesirable on Lot 29 to the north and on Lot 21 to the south for the duration of the quarry. Lot 21 is currently a quarry site and residential development in the foreseeable future is only a remote possibility. On Lot 29 noise levels would be higher than desirable but no worse than in many city residential areas. Notwithstanding this the topography of the site would make intensive residential development unlikely.

Part of the Housing Commission site is also affected but that section is expected to be preserved as open space. A small part of Lot 30 to the north of Lot 29 would be slightly affected by noise.

All of the above sites are currently zoned as "non-urban" and no land presently zoned for residential uses would be affected.

7.9 LONG TERM SITE USE

The sharply undulating nature of the site at present would create difficulties for the use of tractors for cultivation, seeding and other requirements of pasture improvement. Levelling and drainage improvement would be required if a cropping enterprise such as wheat were to be considered. The thin topsoil in conjunction with the undulating topography would be likely to result in severe erosion problems if cropping or horticultural enterprises were to be considered.

When recontouring of the quarry area is complete after extraction has ceased some 30 hectares of the site would be suitable for a variety of agricultural enterprises. The sediment dams provided for the quarry would be suitable either for stock watering or irrigation.

Two enterprises which would currently appear viable are angora goat farming or agistment of horses.

In order to keep open the options for long term use, residential use of the site has also been taken into consideration. A two hectare subdivision has been designed with zones designated for controlled compaction during rehabilitation. Such practices would ensure the site is not sterilised from either an agricultural or urban long term use.

7.10 ECONOMIC ASPECTS

The existing site is currently not used for any productive purpose. The proposed quarry would create about ten jobs with an annual payroll of about $200 000. About $50 000 of this would be returned to government as income tax. Direct payments to government by the quarry operations in the form of taxes, rates and charges would be about $100 000per annum.

Based on current market rates the estimated total value of clay/shale reserves within the quarry is $20 million. The potential value of sandstone in the quarry would be a further $2.4 million.

Finally it should be noted that several brickworks currently using cream burning clay/shale material from the Mulgoa area either have no alternative source of supply or would be faced with costly modifications to plant if material from other sources, with different properties, had to be used.

7.11 REGIONAL DEVELOPMENTS

It is important to assess the impact of the proposed quarry on Lot 28 in the context of other likely developments in the area.

7.11.1 Residential Development

A residential subdivision has recently been completed on the western side of Mulgoa Road between 'Fernhill and Ovindoli Pines'. So far there has been little or no dwelling development but this should follow gradually. It is possible that in time further subdivisions of this type will follow along the western side of Mulgoa Road.

Residential development in the rural subdivision along Mulgoa Road has been slow but full development is a distinct possibility within the life of the proposed quarry on Lot 28.

The Land Commission of New South Wales is currently investigating the residential development of 200 hectares on the tract of Housing Commission land bounded by Bradley Street in the south, the Western Freeway in the north and Mulgoa Road and Bringelly Road on the west and east respectively. A time table for the development of this land has not yet been announced but advice from the Housing Commission is that residential densities would be of the order of 45 persons (10 dwellings) per hectare. Open space reservation would largely comprise ridge top preservation areas and drainage systems through the valley. Generally open space would be provided in the order of 2.83 hectares per 1 000 persons. It is probable that the thickly wooded area immediately to the north and northeast of the quarry site would be included in the open space network for the residential development.

Due to the increases in residential development in this area the Heritage Council of New South Wales is undertaking a survey of the effects of development on the heritage value of the Mulgoa and Wallacia areas.

7.11.2 Quarry Activity

Total clay/shale resources in the quarries on Lots 21 and 22 are likely to be exhausted within the next five years (subject to steady market demand). Cream burning reserves on Lot 22 are likely to be exhausted within months at the current rate of supply. An application by Wearn Industries to extract sandstone from beneath the currently approved floor of each quarry and restore the two quarries through a solid waste disposal operation has been before Penrith Council for some years. Council has requested more information in relation to these proposals and this is currently being prepared.

A proposal to extract clay/shale material on Lot 1 has also been in front of Council for about two years. A target date for the development of the quarry has not yet been set but as the owner, Zacuba Brick Pty Ltd is dependent on Wearn Industries for the supply of cream burning shale, it would be a matter of urgency for that quarry to be developed if the Lot 28 quarry does not proceed before cream burning shale resources are exhausted in Wearn's Lot 22 quarry.

Plans for the development of a quarry to exploit the recently identified cream burning shale reserves identified on the Kay site have been prepared and it is proposed to exploit these resources concurrently with quarry operations on Lot 28. A separate environmental impact statement covers the proposal **(Reference 9).**

There are no current plans for the development of a quarry on the Housing Commission Land or on the Reddan property.

7.11.3 Overview

The medium to long term future pattern of development is likely to involve increasing pressures for residential development south of Penrith along Mulgoa and Bringelly Roads. Satisfaction of this demand will need to be achieved in the knowledge of the great importance of the clay/shale resources in the area and the incompatibility of quarry operations with adjacent residential development. Careful planning and planning controls will be essential to ensure that future quarry zones and residential zones allow optimal exploitation of both scarce land and scarce mineral resources.

7.12 CONSEQUENCES OF NOT PROCEEDING WITH THE PROJECT

It is believed that the environmental effects of the proposed development have been fully considered and that any adverse effects will be within acceptable levels and that the benefits of the proposal will be significant.

In particular, a significant clay/shale resource will be lost if the development does not proceed due to there being limited reserves of pale burning material presently identified in the Sydney area. Also, the development of alternative sources of pale burning shale will prevent the supply of light coloured bricks being monopolized by one manufacturer. This will have long term benefits in moderating the prices of these bricks and promoting variation in the urban and suburban built form.

In order to prevent sterilization of either the resources of the area or the potential for long term development of the site (agricultural or urban) it is unmistakably sound management to extract clay/shale and sandstone in the immediate future, followed by well designed rehabilitation measures.

7.13 ENERGY STATEMENT

The proposed quarry will rely on diesel fuel as the energy source to power the earthmoving and drilling equipment, trucks and small items of plant.

The existing quarry on Lot 22 uses about 625 000 litres of diesel per annum to produce about 36 000 tonnes per month of saleable product. On this basis but because of the shorter haul distance resulting from the new haul road to Bringelly Road it is expected that Lot 28 operations would require about 160 000 litres of diesel per annum at the beginning with a compound annual increase of about 5%.

Electricity will be required for the Lot 28 operations to provide power for the part of the operation of the existing plant workshop office and rock crusher on Lot 22 that would relate directly to the Lot 28 quarry. This requirement is estimated at 30 000 kilowatt hours per annum but will be variable depending on the demand for crushed rock.

Total electrical and liquid fuel energy use is expected to be about 6.5×10^{12}/joules per annum.

The final major form of energy to be used on the site would be explosives. This demand would be extremely variable as it would depend on the depth and hardness of rock encountered from time to time. On the basis of experience at the Lot 22 quarry it is estimated that annual demand for Nitropril and Gelignite would be in the order of 3.5 to 7 tonnes and 150 and 300 kilograms respectively.

REFERENCES

REFERENCE 1 **Management of Clay/Shale Resources in the Sydney Region**
R W Corkery, C J Baker and C Herbert
Geological Survey of New South Wales
Department of Mineral Resources GS 1980/050

REFERENCE 2 **Summary Report on Additional Drilling at Emu Plains Industrial Estates Pty Ltd Mulgoa Property**
Earth Resources Pty Ltd Aug 1979

REFERENCE 3 **Australian Rainfall and Runoff** - Flood Analysis and Design
The Institution of Engineers, Australia 1977

REFERENCE 4 **1:100 000 Vegetation Series** - Penrith. Map and Explanatory Notes
D H Benson, Royal Botanic Gardens New South Wales 1981

REFERENCE 5 Unpublished Paper
D H Benson 1980

REFERENCE 6 **Interim Report of Working Party to Examine Management of clay and Shale Resources, Mulgoa**

REFERENCE 7 **Preliminary Report, Mulgoa Ceramic Resource Assessment Drilling Programme**
Geological Survey of New South Wales, Department of Mineral Resources, L. Etheridge, 1981.

REFERENCE 8 **Access to Quarry and Proposed Tip in Mulgoa, Penrith Environmental Impact Statement,** Sinclair Knight and Partners January 1979.

REFERENCE 9 **Extraction of Materials for Brick Manufacturing and Road Making, Mulgoa. Environmental Impact Statement.** Resource Planning 1982.

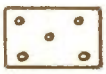
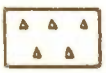
APPENDIX I

BORE LOGS

By Earth Resources Australia Pty. Ltd.
as presented in Reference 2

GRAPHIC LOG SYMBOLS

Sedimentary Rocks

Lithological Symbol	Lithological Description
	Cobble to boulder conglomerate
	Granule to pebble conglomerate and conglomerate in general
	Breccia
	Medium to very coarse sandstone and sandstone in general
	Very fine to fine sandstone
	Siltstone
	Claystone
	Mudstone
	Shale
	Graded unit eg. Mudstone at top through fine to coarse sandstone to conglomerate at base
	Thin bed of sediment (<0.6m thick) shown in true stratigraphic position within another litho-unit. eg. thin mudstone band within a sandstone unit

Note: Solid vertical line to represent 1/10 units; position across column gives ratio

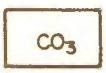
Laminite - Laminae generally < 1cm thick e.g. fine sandstone and siltstone laminite, sandstone: siltstone ratio 1:1

Interbedded unit - beds generally > 1cm thick eg. sandstone and siltstone interbedded in ratio 2/1

Chert or cherty unit

Concretions, geodes, nodules etc in general

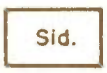
Oolites and pisolites in general



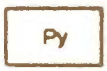
Carbonate in general

Sulphate in general

Calcite or calcareous unit



Siderite or sideritic unit

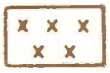


Pyrite or pyritic unit

Limonite, ironstone etc

Sulphur or sulphide in general

IGNEOUS AND MISCELLANEOUS ROCKS



Igneous rocks in general

Dolerite

Pyroclastic rocks, coarse grained (2mm grain size) includes granule to breccia tuff.

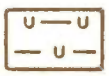
Pyroclastic rocks, fine grained (2mm in grain size) or tuff

Metamorphic rocks in general

Basement in general, undifferentiated

Limestone in general

Soil, dirt, alluvium etc



eg (1) Clay

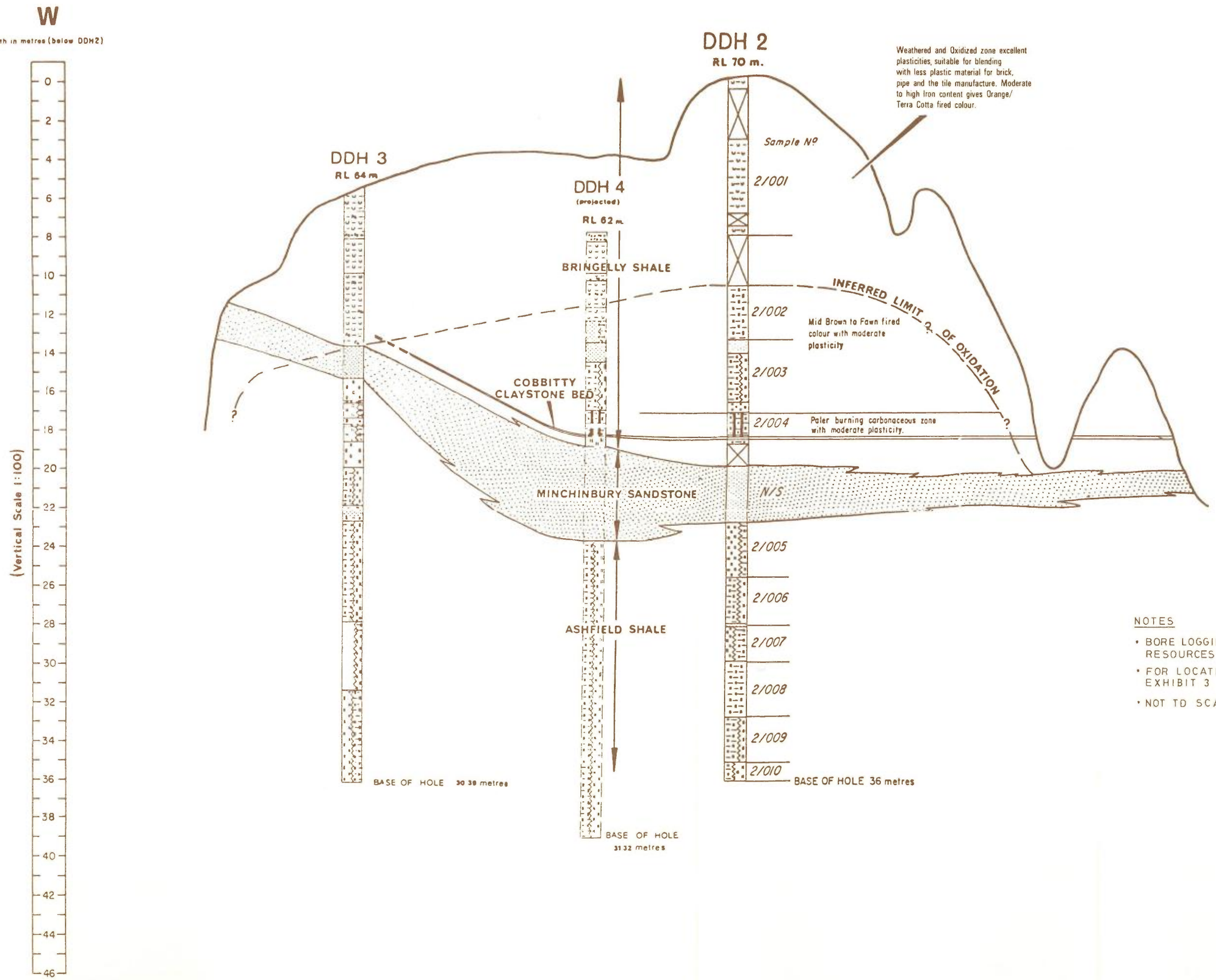
eg (2) Sand

Unknown unit - core loss, not drilled etc

Break in graphic log indicating part of sequence not shown

Cored interval

SOURCE : EARTH RESOURCES AUSTRALIA



NOTES

- BORE LOGGING AND DIAGRAM BY EARTH RESOURCES AUSTRALIA PTY. LTD.
- FOR LOCATION OF BOREHOLES SEE EXHIBIT 3
- NOT TO SCALE HORIZONTALLY.

MULGOA QUARRIES PTY LTD

PROPOSED QUARRY LOT 28 MULGOA

BORE LOGS

APPENDIX 2

FAUNA SURVEY

THE FAUNA OF LOT 28 MULGOA

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Department of Environmental Studies,
The Australian Museum,
Technical Report 81/2

Acknowledgements

Bird censuses were carried out by Mr Steve Clark at Mulgoa and Castlereagh State Forest and by Dr Harry Recher at Schuyville. Mammal survey at Mulgoa was carried out by Dr Tim Kingston and Mr Steve Clark.

The report was prepared by Dr Tim Kingston in consultation with Dr Harry Recher.

Faunal Survey of Lot 28 Mulgoa, City of Penrith

Following a request from Sinclair Knight and Partners Pty. Limited, The Australian Museum agreed to carry out a faunal survey of Lot 28 Mulgoa, City of Penrith, the site of a proposed shale quarry. The Museum undertook to carry out a study that would provide the following information:

1) A list of vertebrate species observed on the site during a five day sampling period.
2) An assessment of the relative abundance of each species.
3) An assessment of the relative importance to wildlife of the various habitat types found at the site.
4) Comments on the overall quality of the site as a faunal refuge.
5) Comments on how the proposed development could be implemented with least impact upon the fauna.

It was pointed out before the outset that to meet the deadline imposed would require the survey to be carried out during a less than ideal season, one in which migratory birds would be absent from the site and reptiles and amphibians would be largely inactive. As a consequence the study would concentrate on mammals and resident bird species.

Field work was conducted between the 12th and 19th August at Mulgoa and concurrently at two additional sites for comparative purposes. One of these was in the Castlereagh State Forest, the

other at Schuyville north of Windsor. The former was chosen as the closest extensive area of forest on the Cumberland Plain, the latter as an area known to possess an exceptionally rich avifauna. The Schuyville site was recommended as a nature reserve by the Scientific Committee advising the Minister for Lands during the early 1970's. The Castlereagh State Forest site was found to be poor quality forest modified by logging and fire and degraded by intensive recreational use. The site at Schuyville is on Crown Land allocated for Military exercise. The vegetation is secondary forest regeneration following clearing.

At Mulgoa survey work was concentrated along two transects, one across the middle of the site and one that followed the course of the creek that flows around the northern perimeter of the site. Ten and six census points were marked along these transects respectively, at intervals of 120 meters. Three small mammal traps were set near each point and one five-minute bird census was carried out at each on each of four days. Reptiles, mammals and additional bird records were sought while walking between census points and generally at all times while on the site. The presence of nocturnal mammals was investigated by spotlighting at night and the fauna of the creek was examined by dip netting.

At Castlereagh State Forest and Schuyville only bird census work was conducted, a single transect of 10 census points being surveyed at each site.

RESULTS

A) Mammals

The mammal fauna of Lot 28 Mulgoa was found to be dominated by species that are not native to Australia. Despite 240 trap-nights of small mammal trapping no native small mammals were captured. In addition, no macropods (kangaroos or wallabies) were sighted during the seven days spent on the site. The two native mammals recorded were both arboreal species; this is what would have been expected on a site so close to human settlement as arboreal species are relatively free from the impact of the ground-dwelling feral predators; foxes, cats and dogs and their habitat has been relatively little altered.

The mammal species recorded were:

Black Rat *Rattus rattus*

A single individual was caught close to the creek.

House Mouse *Mus musculus*

Three individuals were caught on a single site in a dry gully.

Rabbit *Oryctolagus cuniculus*

Observed in low numbers throughout the site.

Fox *Vulpes vulpes*

One sighting and several records of tracks and droppings, mostly along the creek and access roads.

Sugar Glider Petaurus breviceps

One individual was sighted by torchlight.

Brush-tailed Possum Trichosurus vulpecula

One individual observed during spotlighting in a mature Angophora floribunda. Relatively few trees on the site provide suitable refuges for this species.

B) Birds

49 species of birds were recorded on the Mulgoa site of which 40 were recorded during censuses and 9 additional ones at other times. 21 species were observed on the Castlereagh State Forest transect and 52 species on the one at Schuyville. A list of the species occurring at each of the three sites is included overleaf. Of the 21 species recorded at Castlereagh State Forest only three were found to be common, all of these occurred at Mulgoa and all were common at Schuyville. Of the remaining 18 species, 14 occurred at both Mulgoa and Schuyville and the other four at one of these two sites. Clearly the avifauna of the Castlereagh State Forest was considerably less rich than that of Mulgoa or Schuyville, a reflection of the compounded impacts of logging, burning and intense recreational use of the State Forest.

Comparison of Mulgoa with the Schuyville site is more interesting, revealing comparable degrees of richness of the

Bird species recorded at Lot 28 Mulgoa (column 1), Castlereagh State Forest (column 2) and at Schuyville (column 3)

U = Uncommon C = Common

		1	2	3
White-faced Heron	Ardea novaehollandiae	U	-	-
Wood Duck	Chenonetta jubata	U	-	-
Australian Goshawk	Accipiter fasciatus	-	-	U
Collared Sparrowhawk	Accipiter cirrhocephalus	U	-	-
White-breasted Sea-eagle	Haliaetus leucogaster	U	-	-
Painted Quail	Turnix varia	U	-	-
Peaceful Dove	Geopelia placida	U	U	C
Spotted Turtle Dove	Streptopelia chinensis	-	-	U
Common Bronzewing	Phaps chalcoptera	U	U	-
Crested Pigeon	Ocyphaps lophotes	U	-	-
Yellow-tailed Black Cockatoo	Calyptorhyncus funereus	U	-	-
Sulphur-crested Cockatoo	Cacatua galerita	U	-	-
Little Lorikeet	Glossopsitta pusilla	U	-	-
Crimson Rosella	Platycerus elegans	U	-	-
Eastern Rosella	Platycerus eximius	U	U	U
Golden Bronze Cuckoo	Chrysococcyx lucidus	-	-	U
Horsfield's Bronze Cuckoo	Chrysococcyx basalis	U	U	C
Brush Cuckoo	Cuculus variolosus	-	-	U
Fan-tailed Cuckoo	Cuculus pyrrhophanus	-	-	C
Pallid Cuckoo	Cuculus pallidus	-	-	U
Laughing Kookaburra	Dacelo novaeguineae	U	-	C
Welcome Swallow	Hirundo neoxena	U	-	C
Black-faced Cuckoo-shrike	Coracina novaehollandiae	C	U	C
Little Cuckoo-shrike	Coracina robusta	-	-	U
White-winged Triller	Lalage leucomela	-	-	U
Rose Robin	Petroica rosea	U	-	U
Eastern Yellow Robin	Eopsaltria australis	U	-	C
Jacky-winter	Microeca leucophaea	-	-	C
Shrike-tit	Falcunculus frontatus	-	-	C
Golden Whistler	Pachycephala pectoralis	C	-	C
Rufous Whistler	Pachycephala rufiventris	-	-	U
Grey Shrike-thrush	Colluricincla harmonica	U	U	C

Restless Flycatcher	*Myiagra inquieta*	-	-	U
Grey Fantail	*Rhipidura fuliginosa*	C	U	U
Willie Wagtail	*Rhipidura leucophrys*	U	U	U
Eastern Whipbird	*Psophodes olivaceus*	U	-	C
Superb Blue Wren	*Malurus cyaneus*	C	U	C
Speckled Warbler	*Chthonicola sagittata*	U	-	U
Weebill	*Smicrornis brevirostris*	C	U	U
White-throated Warbler	*Gerygone olivacea*	U	-	U
Brown Thornbill	*Acanthiza pusilla*	C	-	U
Buff-rumped Thornbill	*Acanthiza reguloides*	-	-	C
Yellow Thornbill	*Acanthiza nana*	C	-	U
Striated Thornbill	*Acanthiza lineata*	U	-	C
Orange-winged Sittella	*Neositta chrysoptera*	U	-	U
White-throated Treecreeper	*Climacteris leucophaea*	U	U	C
Brown Treecreeper	*Climacteris picumnus*	-	-	U
Noisy Friarbird	*Philemon corniculatus*	C	-	U
Noisy Miner	*Manorina melanocephala*	U	U	-
Yellow-faced Honeyeater	*Lichenostomus chrysops*	C	-	U
Fuscous Honeyeater	*Meliphaga fusca*	U	C	C
Brown-headed Honeyeater	*Melithreptus brevirostris*	-	-	C
White-naped Honeyeater	*Melithreptus lunatus*	C	-	C
Spotted Pardalote	*Pardalotus punctatus*	C	C	C
Striated Pardalote	*Pardalotus striatus*	-	U	C
Silvereye	*Zosterops lateralis*	C	-	C
Red-browed Finch	*Aegintha temporalis*	U	-	U
Double-barred Finch	*Poephila bichenovii*	U	-	-
Starling	*Sturnus vulgaris*	-	-	U
Olive-backed Oriole	*Oriolus sagittatus*	C	U	C
White-winged Chough	*Corcorax melanorhamphos*	U	-	-
Australian Magpie-Lark	*Grallina cyanoleuca*	U	U	C
Dusky Wood-swallow	*Artamus cyanopterus*	-	U	U
Grey Butcherbird	*Cracicus torquatus*	U	U	U
Australian Magpie	*Gymnorhina tibicen*	C	U	C
Pied Currawong	*Strepera graculina*	U	-	-
Australian Raven	*Corvus coronoides*	U	C	C

avifaunas. Excluding the nine species recorded at Mulgoa outside the standard counts, 40 species were recorded there as against 52 at Schuyville. Schuyville is richer in both species and in numbers of birds (26 "common" species at Schuyville, 14 at Mulgoa). The avifauna of Schuyville is recognised as being exceptionally rich; that of Mulgoa could also be described as rich.

The avifauna of Mulgoa is typical of the forested areas of the Cumberland Plain but differs significantly from those of the sandstone areas around Sydney. Bird communities in forests or shrub habitats growing on shale areas, such as the Cumberland Plain, are richer in insectivorous species (eg. thornbills, treecreepers, robins) and poorer in nectar-feeders (eg. honeyeaters, lorikeets). Nectar feeders are more numerous on sandstone because of the abundance of plants rich in nectar, especially the Proteaceae. The abundance of insectivorous birds on the shale probably reflects the higher production of plants, and hence of insects, on the more fertile soils.

The increased richness of the avifauna of Schuyville over that of Mulgoa probably results from a combination of the former being a larger area of forest and having been allowed to regenerate for longer since being cleared. It is likely that if the Mulgoa site was left undisturbed the richness of the avifauna would eventually achieve equality with that of Schuyville.

C) Amphibians and Reptiles

No amphibians and only one species of reptile were recorded. The reptile was the Eastern Water Skink Sphenomorphus quoyii, a few individuals were encountered close to the creek.

D) Fish

No fish were recorded in the creek within the bounds of Lot 28, however one native species, the Firetailed Gudgeon Hypseleotris galii, and the introduced Mosquito Fish Gambusia affinis were caught in the creek downstream of the point at which it flows out of the property.

Discussion and Conclusion

The value of Lot 28 Mulgoa as a refuge for fauna is almost entirely taken up by the avifauna. The avifauna was found to be rich considering the extent of forest clearing and habitation in the area generally. The richness of the bird community can be explained by the presence of a combination of a few mature trees that escaped the original clearing process and the vigorous regrowth of native tree and shrub species in recent years.

As proposed, the quarry will not approach within about 10 meters of altitude of the creek system. This will result in the retention of a buffer of vegetation along the creek varying in width from 20 to more than 100 meters. Considerable advantage can be taken of this buffer strip to minimise erosion and maximise the retention of bird habitat. Specifically, we suggest that the intended boundary of the quarry be fenced along its northern and eastern margins where it follows the line of the permanent creek. If domestic stock (cattle, horses) is retained on the property once quarrying begins it should be denied access to the creek by extending the fence to join the boundary fence around the property. Such fencing would also deny access to the buffer area and the creek itself to trail bikes, the impact of these machines on the narrow strip could otherwise be severe. A buffer strip retained in this way would not

only prevent erosion by stock and trail bikes but would act as a filter to reduce the amount of water-borne materials from the quarry edge reaching the creek.

If these precautions are followed we would expect the majority of bird species recorded to be able to continue to exist along the buffer strip. However, the value of the buffer strip both as a refuge and as a mitigator of erosion would be greatly enhanced by each additional meter of width permitted, a benefit that should be considered when a final decision is made concerning the precise extent of the quarry. Retention of a buffer of natural vegetation along the creek and of the bird habitat that it represents will retain maximum land-use options for Lot 28 following exhaustion of the quarry.

APPENDIX 3

FLORA LANDSCAPE & AGRICULTURE

Proposed Quarry on Lot 28, Mulgoa

By Mulgoa Quarries Pty. Ltd.

INVESTIGATION OF

FLORA, LANDSCAPE AND AGRICULTURAL ASPECTS

by

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ENVIRONMENTAL DESCRIPTION

1. Description of Flora
   - 1.1 General
   - 1.2 Vegetation formation
   - 1.3 The dominant trees
   - 1.4 The shrub layer
   - 1.5 The grass cover
   - 1.6 Other ground cover
   - 1.7 Water plants
   - 1.8 Weeds
   - 1.9 Quantitative assessment of woodland
   - 1.10 Vegetation mapping

2. Description of Soils
   - 2.1 General
   - 2.2 Strippable layer
   - 2.3 Fertility
   - 2.4 Erosion potential
   - 2.5 Capability class

3. Value of Land for Agriculture
   Assessment of Reinstated Land

4. Assessment of Site Characteristics
   - 4.1 General
   - 4.2 Land use
   - 4.3 Unique physical features
   - 4.4 Historical features
   - 4.5 Aesthetics
     - 4.5.1 Scenic views
     - 4.5.2 Visual pollution
     - 4.5.3 Special visual attributes
   - 4.6 Recreation
   - 4.7 Man-made structures and buildings
   - 4.8 Intrinsic values
   - 4.9 Effect of a quarry on the site

5. Rehabilitation of the Landscape
   - 5.1 General
     - 5.1.1 Protection of overall landform
     - 5.1.2 Protection of plant groups
     - 5.1.3 Maintenance of water quality in creeks
     - 5.1.4 Erosion control
   - 5.2 Monitoring and research
     - 5.2.1 Restoration supervision
   - 5.3 Restoration proceedure
     - 5.3.1 General
     - 5.3.2 Field Trial plots
     - 5.3.3 Grassing
   - 5.4 Tree planting
     - 5.4.1 Design of woodlots
     - 5.4.2 Species for planting
     - 5.4.3 Plant supply
     - 5.4.4 Planting technique
     - 5.4.5 Special treatment of steep slopes
   - 5.5 Protection of Angophora floribunda
6. Interaction with the environment

1.0 F L O R A

1.1 GENERAL

The proposed quarry site and surrounding district have been the centre of subsistance grazing for many years. Woodland, although locally dense at present consist mainly of young (10 to 15 year old) Eucalyptus species and small wattle trees estimated to be 2 to 3 years old. The eucalypts and wattle have obviously regenerated because of the lack of grazing pressure on these particular lots.

All regrowth species noted are the same as the scattered mature trees dotting the district. Woodland re-growth species were observed in all stages from seedling to sapling to pole. Regeneration of this natural plant community is indicative of this land's ability to recover from many years of rural activity.

1.2 Vegetation Formation

Most of the area is covered with an open sclerophyll woodland consisting of an overstory of mixed Eucalyptus and occasional Angophoras. Some areas have a middle story invariably consisting of Acacia and shrub layer of Black Thorn (Bursaria spinosa).

Where the middle and lower vegetation stratas are absent a thin grass ground cover is present.

The gullys and creek lines contain the same species as found on the slopes with the addition of some She-oaks, Paper-barks, Ti-trees and a much more diverse range of ground covering plants.

1.3 The Dominant Trees

Five Eucalyptus species occur throughout the site and surrounding district. Their distribution appears to be dictated to some extent by the topography.

On lower and middle slopes the Forest Red Gum (Eucalyptus tereticornis) is most common. Occuring with the Forest Red Gum is the Cabbage Gum (Eucalyptus amplifolia) and a Stringybark (Eucalyptus eugenioides). Occasional River She-oaks (Casuarina cunninghamiana) occur along Mulgoa creek and its tributaries.

Ridge tops and upper slopes are dominated by remnant Ironbarks (Eucalyptus fibrosa) and Grey Box (Eucalyptus moluccana).

A few (estimate less than ten) very large Rough-barked Apple (Angophora floribunda, formerly A. intermedia) are to be found on the site.

Along drainage lines She-oaks (Casuarina glauca) and Paper-barks (Melaleuca stypheloides) are found although their distribution is infrequent and numbers few.

Black Wattle (Acacia mearnsii) is found concentrated in discontinuous dense thickets throughout the proposed quarry site and surrounding district. These trees rarely exceed seven metres in height and trunks are mostly less than ten centimetres thick. They appear to be a somewhat ephemeral species which rapidly colonise bare ground and die out very quickly. Most trees occuring within the district have been subject to massive attack by insects (borer) and have died after 2 to 3 years.

1.4 The Shrub Layer

The Black Thorn (Bursaria spinosa) is the only shrub regularly occurring across the site. This shrub occurs in often dense thickets and also appears to be an early arrival in the regenerative processes of this particular woodland. Shrubs are discontinuous with residual grass swards still dominating some areas of the woodland.

Other single species of shrubs which were found on the site included Acacia elongata, Leptospermum flavescens and Dillwynia juniperina.

1.5 The Grasses

Native pasture grasses are found in thin, discontinuous swards throughout the site and surrounds. The most commonly observed native grasses were Couch (Cynodon dactylon), Red Grass (Bothriochloa ambigua), Meadow Rice (Microlaena stipoides) and Three-armed Spear (Aristida spp.).

Common introduced species were also observed on the site and in surrounding paddocks. These include Rhodes grass (Chloris gayana) Paspalum (Paspalum dilatatum) and Rye grasses

including Perennial Rye (Lolium perenne) Italian Rye (Lolium multiflorum) and Wimmera Rye (Lolium rigidum).

Small, localised patches of legumes also occur. These consist of Medics (Medicago spp.) and some naturalised clovers.

1.6 Other Ground Covers

Along the damper water courses the incidence and variety of ground covers is much more diverse. Lomandra (Lomandra obliqua), Maidenhair Fern (Adiantum aethiopicum) and Kidney weed (Dichondra repens) are common.

1.7 Water Plants

A wide variety of water plants occur in water holes and along the semi-permanent water ways. These include patches of bull-rushes (Typha orient alis), Common Reed (Phragmites australis), Common rush (Scirpus fluviatilis), Water ribbon (Triglochin procera) and common Sedge (Cyperus lucidus).

1.8 Weeds

Very few noxious weeds are found on the site. The following common weeds were found occurring within and around the site:
Spear thistle (Cirsium vulgare), Fat hen (Chenopodium album), Curled dock (Rumex crispus), Chick (Phytolacca octandra) and Wire weed (Polygonum aviculare).

1.9 Quantitative Assessment of Woodland

1.9.1 Height

The tallest trees within the site are occasional mature Angophora floribunda species, which achieve a height estimated at about 30 metres. Mature eucalypts range from 15 to 25 metres in height.

Re-growth eucalypts occur throughout the site and range from 2 to 20 metres in height.

1.9.2 Density

The majority of the site is covered by a medium density tree cover (20% to 70% crown cover of the land surface). There are several patches with only scattered trees (less than 20% crown cover).

1.9.3. Quality

All species observed on the site and around the district are in good health and display no signs of stress. Die-back or other common eucalypt problems are not noticeable. Acacia species are often near death and appear to be ravaged by borers and some eucalyptus are infested by scale insects.

1.10 Mapping Methodology

Plant communities were delineated using stereoscopic colour aerial photography. Nominally boundaries were drawn to separate out plant communities of different type, varying density, varying height classes and varying condition.

Plant descriptions list the most frequently occuring species first and species occuring rarely are listed last.

Field surveys were made to confirm and refine photo interpretive data and mapping was carried out 1:4000 (approx.).

2.0 DESCRIPTION OF SOILS

2.1 General

The site has soils which may be described as red-brown podzolic soils typical of the Cumberland or Sydney plain area. These soils are common on the moderate and freely drained slopes of this district.

This podzolic soil is derived from the Bringelly shale overlying Minchinbury sandstone.

As with most podzolic soils within the region it has a poorly developed surface organic layer. The A_1 horizon is generally less than 20 cm thick across most of the site.

The A_2 horizon is a well-structured brown clay averaging 30 cm in depth.

The B & C horizons comprise heavily leached (due to high annual rainfall) red/brown to grey clays. Where soil disturbance has occured and the organic layer is eroded away, ironstone pebbles are noticeable. These tend to keep the clays open and prevent packing which aids infiltration of rainfall.

2.2 Strippable Layer

The A & B horizons are quite strong in structure and should resist breaking down when disturbed. These soils contain a large percentage of peds which make them generally suitable for stockpiling. The lighter coloured lower horizon is less suitable for stockpiling due to high pebble content and otherwise unstable structure. The strippablesoils are estimated to be 75 cm to 100 cm over the entire site.

2.3 Fertility of Soils

Strong leaching has left a hydrogen dominated (pH 5-6) soil of low natural fertility. The soil is low in organic matter due to its historical natural vegetation cover of dry sclerophyll forest.

This soil type presents cultivation problems because of its low pH, which reduces the availability of nutrients and a tendency to set hard when dry thus making moisture penetration difficult.

2.4 Erosion Potential

Red podzolic soils are highly susceptible to both sheet and gully erosion. No major erosion occurs on the site at present but existing pads and tracks are beginning to indicate the beginnings of erosion problems.

Aerial photographic interpretation indicates moderate to severe sheet erosion occuring throughout the district. There is little gullying but cleared and grazed areas have suffered considerable erosion.

2.5 Capability Class

Using Soil Conservation Service guidelines it is estimated that the land if cleared is best suited to grazing as long as simple soil conservation measures are maintained. These measures would include pasture improvement, livestock control, fertilisation, contour ploughing and maintenance of generally flattish slopes.

3.0 VALUE OF LAND FOR AGRICULTURE.

3.1 Value of existing site.

3.1.1 Description of site.

The state of regrowth on the site indicates that the land was cleared about 20 years ago presumably for some agricultural use. The small presence of introduced pasture species such as paspalum (paspalum dilatatum) would tend to confirm this.

The A_1 horizon is a well structured loam type soil but in most locations was only about 12 cm deep. It is low in organic matter and mildly acidic - pH 5.5-6.0. The A_2 horizon has a higher clay content and is more acidic - pH 5.0-5.5. The B horizon is a clay type soil with a pH of about 5. The structure of the soil is thus most suited to a pasture/grazing system as this will help to lift the organic matter status of the soil and aerate the clay layers. A pasture stand would also help to reduce the acidity.

The sharply undulating nature of the site creates difficulties with the use of tractors for cultivation, seeding etc. so that levelling and drainage would be necessary if a cropping enterprise such as wheat were to be considered. The thin topsoil in conjunction with the undulating topography would be likely to result in severe erosion problems if cropping or horticultural enterprises were to be considered.

The average annual rainfall in the area over the last 79 years is 793mm. Of this 33% or 265mm occurs in the summer months of January, February and March whereas

only 17% or 134mm occurs in the winter months of July, August and September. This summer rainfall pattern needs to be taken into account when selecting appropriate pasture species.

3.1.2 Development of existing site.

A high capital outlay would be necessary to develop the site to a point where an agricultural system could be developed. It is doubtful that any enterprise of an agricultural nature could be justified on an economic basis.

The site needs to be cleared of the secondary regrowth, retaining some of the larger trees for stock to shelter under. Some levelling and drainage would enable annual applications of fertiliser to be made more efficiently and safely.

The existing native grasses would provide feed for a small number of stock, but to justify the capital outlay a pasture improvement programme would need to be instigated. Grass species such as perennial ryegrass (Lolium perenne) and a legume such as subterranean clover (trifolium subterraneum Cv. Woogenellup) would be appropriate. A liming and fertiliser programme would facilitate their establishment and growth. The presence of dense stands of Blackthorn on the site would persist in the initial pasture phase and require manual removal or slashing to control.

The existing boundary fence is not stockproof and would require extensive repair or replacement. Internal fences would need to be constructed to enable a grazing programme to be managed and to avoid erosion problems associated with overgrazing.

Existing market conditions would favour an Angora goat enterprise for although initial capital costs are high, returns for mohair and breeding stock would readily

justify the expense. An alternative with a lower capital cost would be to agist horses. With the rapid growth in the population of Penrith, there are an increasing number of families buying horses and needing somewhere to keep them. The agistment of such horses would probably represent the most profitable way to utilise the improved land. It is apparent that other landholders in the area have come to similar conclusions.

3.2 Assessment of reinstated site.

3.2.1. General.

The criteria for developing the site for agricultural purposes differ in some respects to those used for solely conservational purposes. While it would be ESSENTIAL to very quickly establish ground cover to prevent erosion,the species chosen must be of a type that are not only quick to establish but which also have a high nutritional value for grazing stock. Economic considerations must also be made. The very purpose of including legumes in a pasture mix is so that they, via the process of atmospheric nitrogen fixation, provide all the nitrogen requirements of the sward. The high levels of nitrogen addition generally recommended in conservation programmes radically diminish the ability of legumes to perform this fixation process so that one is thus paying money for fertliser whilst at the same time cutting down the amount of "free" nitrogen one would otherwise obtain.

3.2.2 Restoration.

When the site is being levelled attention should be given to making gradients shallow enough to permit the safe use of tractors. At the very maximum gradients could be 1:3, but 1:4 would be more desirable.

Care would need to be taken to minimise mixing of the topsoil and subsoil layers when they are replaced.

3.2.3 Selection of pasture species.

Trial plots should be established in order to determine the most suitable pasture mixes and the most economical seeding rates for the rapid establishment of a productive pasture. In view of the summer rainfall pattern mixtures of the following species should be tested:

Grasses:

1. Perennial Ryegrass Cv. Grasslands Nui. - establishes easily and rapidly, responds well to autumn rains, has good winter growth and withstands heavy grazing.
2. Phalaris Cv. Sirosa. - initial establishment slow, but once established then very persistent and vigorous, especially in the dry winter situation.
3. Cocksfoot Cv. Currie - well adapted to the somewhat acidic soil.
4. Rhodes grass Cv. Pioneer. - extensive and fibrous root system makes it very useful for binding soil and minimising erosion. It is palatable and withstands heavy grazing.
5. Couch grass. (Hulled) - an aggressive perennial grass which acts as a very efficient soil binder. Especially recommended because at the site unusually vigorous areas of couch were noted. They had established themselves on heaps of overburden,so would appear to enjoy conditions at the site.

Legumes:

1. Subterranean clover Cv.Woogenellup - vigorous autumn and winter growth and proven reliability on similar country.
2. White clover Cv. Haifa - well adapted to soils of moderate fertility and able to withstand winter drought.
3. Red clover Cv. Grasslands Turoa - suits acid conditions and persists well.

3.2.3 Preparation of seedbed.

Minimise cultivation to minimise erosion risks.

All cultivations must be on the contour.

One pass with a chisel plough should be sufficient.

Depth of ploughing should be dictated by prevailing weather conditions. If rain is ex ected plough to about 10 cm. However, in drier conditions, ploughing to 20 cm would help to reduce the compaction that would have occured to the soil during levelling.

3.2.4 Seeding.

Any clovers used should be innoculated with appropriate Rhizobia bacteria and lime pelleted. Lime pelletting is essential due to the acid nature of the soil.

Seed to a depth of about 2cm.

Apply fertiliser in a band with the seed. Fertiliser type and rate of application should also be established with trial plots. Most likely responses would be expected to indicate 250kg/ha of Single Superphosphate with 0.02% Mo as the most appropriate. However, trials using Starter 15 (15:13:13) with 0.02% Mo at 200kg/ha and 150kg/ha are recommended to see if the additional nitrogen can enable the grasses to establish quicker but without diminishing the fixing ability of the clovers.

The ideal time of planting would be in April or May so that the pasture is well established before the heavier summer rains occur. Satisfactory establishment can also be expected with spring planting.

3.2.5 Management of new pasture.

During the first year of the pasture some grazing is needed to stop vigorous grasses from smothering the clovers or other weaker grasses, to check weed growth and to encourage the sward to thicken up.

Grazing should be rapid and light. If stock are not available when the pasture height needs to be reduced, the

sward should be slashed so as to leave about 15cm height.

Do not graze if the seedlings are likely to be pulled out by stock.

A year after seeding topdress with 250kg/ha of single superphosphate with 0.02% Mo and follow up in subsequent years with annual dressings of 125kg/ha of single superphosphate.

3.2.5 Selection of enterprise.

In the current economic climate it is probable that agisting horses would be the most profitable way to use the land. If the climate changes other enterprises, such as angora goats or cattle may also offer attractive returns.

Each of these enterprises would require different fence construction and location so it would be important to select the enterprise before such improvements were carried out.

3.3 Conclusion.

It is very doubtful that development of the site as it stands now, for agricultural purposes, could be economically justified.

If, as a result of quarrying, the land had to be levelled and put down to some form of cover crop anyway, then for comparatively little additional outlay a profitable enterprise could be established. This would be aided by the fact that the replaced soils would be unlikely to contain many active weed seeds so that pastures could be established quickly and without competition.

In the current economic climate it is probable that agisting horses would be the most profitable choice of enterprises.

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4.0 ASSESSMENT OF SITE CHARACTERISTICS

4.1 General

The Mulgoa district comprises a series of low undulating hills with gentle to steep convex slopes cut by several shallow, slow-flowing rivulets. These low hills are typical of the transition line between the extensive lowlands of the Cumberland plain and the 'jump-up' to the Blue Mountains National Park.

4.2 Land Use

The district has been traditionally grazed by sheep and cattle for over 150 years. Natural vegetation has been cleared almost entirely except for shelter-belts and a remaining well-wooded ridge-line along the Nepean river. The proposed quarry site has a regenerated open woodland estimated to be less than 20 years old.

4.3 Unique Physical Features

No unique features were found on the site.

4.4 Historical Features

No recognisable historic features occur on the site. A number of historically noteworthy properties are found in the surrounding district. Most important of note are the properties "Broadlands","Fernhill" and the "Country Club". St. Thomas' church has also been identified as having some historic significance.

4.5 Aesthetics

4.5.1 Scenic Views

Most views from the proposed quarry site (Lot 28) are short, enclosed views. One long viewing cone exists from the southern fence-line on the seventy metre contour. From this point it is possible to see to the Fernhill property and distant hills.

Views to the quarry site are few due to intervening tree screening at the site and from most prominent view-points.

4.5.2 Visual Pollution

The existing quarries on lots 21 & 22 are ugly blights on the district's landscape. Service roads to the quarry, local soil erosion and turbid creek water all add to the blighted nature of the neighbourhood around lot 28. Blighted views are confined to the local area.

4.5.3 Special Visual Attributes

The escarpment between the golf course to the west of Lot 28 provides attractive and extraordinary relief to the district's otherwise "gentle" land-form. It is well clothed with mature forest trees and should be regarded as a precious asset and completely inviolable.

Likewise, the creeks west and east of the proposed quarry are attractive and contain a wide variety of vegetation. They also contain especially lovely water-holes and reaches.

4.6 Recreation

Little evidence was found of recreational pursuits being conducted on the study site. Some horse-riding trails are present and trail-bike riders have created some tracks through the area.

At present there appears to be little other potential for recreation other than individual pursuits as afore mentioned. The creek lines provide potential picnic and nature study reserves if well managed.

4.7 Man-made Structures and Buildings

No man-made structures or buildings exist on the site except for some internal post & wire fencing.

4.8 Intrinsic Values

The land which is proposed to be quarried is a valuable resource for rural or urban development. The area would be suitable for almost any planned development as long as the creeks and escarpment are regarded as inviolable.

4.9 Effect of a Quarry on the Site

The proposed quarrying operation will dramatically change the land form of the site but with careful adherence to modern mine management principles and proper rehabilitation programme it is expected that the area can be restored essentially to its existing role in the landscape.

Noise levels, traffic generation & other polluting effects of quarrying are likely to be similar to the neighbouring quarry. However, this proposed quarry site does have a good vegetative screen and it is on a land form amenable to restoration after quarrying.

5.0 REHABILITATION OF THE LANDSCAPE

5.1 General Principles of Restoration

The new landform arising from the quarried land should conform as nearly as possible to the surrounding untouched land. Restoring of the original morphology will be impossible but the site does lend itself to a re-shaping which should be harmonious with the surrounding environs.

The new landform should be shaped for stability and resistance to erosion. Initially the aim should be to create a grazing landscape with vigorous grass cover. This initial method of restoration will create a physically stable and productive land resilient to climatic and management changes.

Finally, woodlots will be added through an intensive tree planting programme. Tree groupings will be located to represent shelter belts and remnant stands of the original dry sclerophyll woodland.

5.1.1 Protection of Overall Landform

Aesthetic and practical considerations dictate the need for quarrying to be kept away from the escarpment and natural drainage lines and screening ridge lines.

5.1.2 Protection of Plant Groups

It is recognised that tree groups within the quarrying boundary cannot be practically saved. However, all protective measures must be adopted to minimise damage to surrounding trees and shrubs. Trees surrounding the site are necessary for a viable seed bank, and will create an environment conducive to rapid restoration as well as providing an effective screen to quarrying operations.

5.1.3 Maintenance of Water Quality in Creeks

Careful planning and monitoring of overland water-flow at an early stage will be essential for protection of water quality in the creeks. It is expected that a number of settling dams will need to be constructed. No doubt these will be useful as farm dams after restoration.

5.1.4 Erosion Control

Excessive erosion of the site must be avoided at all costs and proper erosion measures implemented at an early stage of any development.

Soil disturbance should be carefully controlled by planned movement on the site. In areas which are worked re-vegetation should be implemented progressively and as early as possible.

General Erosion Controls

Given the podzolic soil type occuring on this site the following general erosion control recommendations are made:

(a) All cultivation should be along the contour.

(b) Maintenance of a very fine tilth should be avoided. A rough, large clodded, surface is preferable.

(c) Contour banks, gently graded embankments and contour furrows should be used to stop erosion at its earliest stages.

(d) Where plant loppings or rubble is available these materials should be layed on the ground where overland flow may occur during re-shaping of land.

(e) Restoration of the green mantle should be regarded as urgent. The vegetation rapidly creates a canopy to reduce impact of rain, retards overland run-off rates and binds the soil through its root systems.

5.2 Monitoring and Research

A programme of simple experimentation should be begun immediately upon approval to mine. The setting up of experimental trial plots for re-grassing and soil treatment are essential to identify restoration problems.

The preliminary experimental programme should be designed to review and evaluate site data such as physical and chemical characteristics of the materials set aside to be vegetated.

Looking further ahead, the availability of nursery facilities able to produce the desired plant materials will be important. It is important that a wide range of species, methods and treatments be included in a programme of tests. This approach will improve chances of success and enable future comparison of the cost effectiveness of various treatments.

5.2.1 Restoration Supervision

Related to the establishment of an experimental programme is the need for supervision of restoration techniques by 'in-house' staff or an environmental consultant. A suitably qualified person will supervise and interpret rehabilitation works and ensure that restoration is not compromised through poor management.

5.3 Restoration Proceedure

5.3.1 General

The restoration strategy for this quarry should include the following major elements.

(i) Field trials to determine the best means of restoring vegetative ground cover.

(ii) The removal, storage and re-location of topsoil.

(iii) Redistribution and shaping of overburden.

(iv) New drainage and water-storage systems.

(v) Temporary erosion control systems.

(vi) Appropriate land management of the revegetated site in order to ensure success.

5.3.2 Field Trial Plots

Trial plots need to be set up as early as possible in order to establish viable re-establishment proceedures. Bearing in mind that storage of topsoil should be for as short a time as possible it is essential that restoration begin early in the life of the quarry if a stable, re-worked surface with a vigorous ground cover is to be achieved.

Trial plots should include examples of the various overburdens available and need to represent the shape of the proposed new land formations.

Trial plots should also be oriented to an aspect which is similar to the proposed slopes. If this is impractical then a westerly aspect will be the best, assuming that this aspect experiences the harshest climatic conditions. Species established on these plots would be expected to grow well on similar or more favourable aspects.

Separate sites ought also be established for winter and summer grasses and legumes should be appropriately inoculated with reliable rhizobia to test persistence and ability to spread through the soil media under consideration.

5.3.3 Grassing - The Intention

The whole mined site is intended to be grassed to provide an initial stable surface. After establishment of a temporary grass cover, decisions can then be made regarding future management of the area, ie. whether to:

(i) Continue to improve pastures
(ii) Re-forest the site
(iii) Re-develop for other purposes.

It is recommended that a homogeneous grass mixture be developed through trial plots information and other expert sources.

5.4 Tree Planting

Upon establishment of a stable land-form it will be necessary to provide scattered woodlots to maintain the site character. These woodlots will be representative of the remnant open woodland.

5.4.1 Design of Woodlots

Trees will be planted to form 'plantations' resembling the nature of the remnant stands occurring in the district. Each lot will be approximately four tenths of a hectare (or one acre) and will be set out in a random manner as found naturally. No attempt will be made to plant in rows or at equal distance.

5.4.2 Species for Planting

Species associations will be derived from those existing on the site at present. These species are recognised as good pioneer trees and should establish quite satisfactorily. Nevertheless, constant monitoring of plantation development should continue for some time. If certain species prove unsuitable then species mixes ought to be biased.

5.4.3 Plant Supply

The supply of plant material needs to be anticipated. Planning needs to consider adequacy of supply and stock ought to be produced in time for 'hardening-off' before planting.

Ideally seed should be collected from the site or at least the district. It should be easy to collect large quantities of seed during clearing operations prior to commencement of stripping.

5.4.4 Planting Technique

Close adherence to the following principles for planting tube-stock trees is recommended:

(i) The plant should be removed with care from its tube

(ii) Upon planting soil should be firmed to the tube soil level.

(iii) An earth dish should be formed around each plant for water retention.

(iv) A mulch should be used to conserve moisture and prevent weed and grass competition. This mulch can be provided by chipping some of the cleared material during early stages of quarrying.

(v) Water immediately with a minimum of 10 litres.

(vi) Use a wire-netting surround for protection from rabbits.

5.4.5 Special Treatment for Steep Slopes

Steep slopes represent special revegetation problems. These areas may need to be hydro-mulched with seed collected from the site.

The mulch base should be conventional bituminous emulsion containing a fibrous component and fertilizer as well as indiginous seeds. Hydro-mulching plots for tree re-generation ought to be included in early experimentation.

5.5 Protection of Angophora floribunda

On Lot 28 seedling regrowth of Angophora floribunda is prolific around the few remaining trees. At the time of study these seedlings were subject to trampling and damage from a sizeable herd of horses agisted on the property.

The conservation value of these Angophoraslies in their ability to disperse seed and ultimately be the source for re-establishment of this native species in the district. Although they do not constitute a valuable contribution to scenic quality the Angophoras growing near the top of the escarpment are visible from the Glenmore Country Club and more distant views as they presently stand above the average tree canopy.

It is suggested that at least the six Angophoras closest to the proposed quarry fence should be preserved if this does not compromise the viability and operation of the quarry.

6.0 Interaction with the Environment

The existing woodland is mostly young regrowth which is in the process of re-establishing on land once cleared for grazing.

The number of mature trees on the site are few. There are approximately 30 mature Eucalypts and about 10 mature Angophoras.

The vegetation contributes to the local environmental quality through its aesthetic value and its contribution as a seed pool for further re-generation within the district.

All species present display good colonising ability. Seedlings representive of all observed species abound on Lot 28 and adjoining wooded areas.

No rare or endangered species exist on Lot 28. However, of special note are 10 Angophora floribunda trees located on the block.

It is not known exactly what the numbers and distribution of these trees was like in this district originally but now these trees do not occur in large numbers.

In the Mulgoa region it is estimated that there is less than 1 Angophora floribunda per 10 hectares. Apart from the trees found on Lot 28 there are a few specimens in Mulgoa Park, one near the Glenmore Country Club and several growing close to Mulgoa Road between the quarry site and Mulgoa village. These Angophoras occur sporodically in the well-wooded ridge between Mulgoa and the Nepean River.

The proposed haul road should be aligned to avoid any specimens of Casuarina cunninghamiana at creek crossings.

APPENDIX 4

ARCHEOLOGY

Note: The route of the local haul road investigation in this report crossed the proposed Kay/Reddon quarry site. The currently proposed route is slightly to the north along the northern boundary of Lot 1.

ARCHAEOLOGICAL INVESTIGATION OF LOT 28, IN THE MULGOA DISTRICT OF THE CITY OF PENRITH.
WEARN INDUSTRIES QUARRY

July 1981

Helen Brayshaw
Consultant Archaeologist

On July 21st, 1981, an archaeological survey was conducted on Lot 28 in the Mulgoa district of the City of Penrith. This is the site of Wearn Industries' proposed Clay/Shale/Sandstone quarry. Also investigated was their proposed haul road.

This work was carried out on behalf of Sinclair Knight and Partners Pty Ltd.

THE AREA SURVEYED

Lot 28 is approximately 50 hectares, and the haul road about 3 kilometres long.

Lot 28 is largely covered by dense schlerophyll timber, with stringy bark dominant. Extensive clearing has taken place along most of the haul road route, and the few remaining trees are predominantly box. This area is used for grazing.

The entire area is principally Tertiary sand, silt, clay and gravel.

THE SURVEY

The survey was conducted on foot. Particular attention was paid to eroding areas, ridges, and the surrounds of watercourses. The main watercourse is Mulgoa Creek, which forms the western boundary of Lot 28.

WHAT WAS FOUND

No archaeological relics were found on Lot 28. There are no large extrusions of rock, and therefore no shelters or art sites, and no axe grinding grooves. No scarred trees were observed, or scattered artefacts.

The one relic found was a broken edge ground axe near the proposed haul road (Penrith 1:25,00 8463 5560). This axe is of basalt, and measures 10 x 7.2 x 3 cm.

RECOMMENDATION

On the basis of this archaeological survey there can be no archaeological objection to Wearn Industries constructing the haul road and quarrying Lot 28.

APPENDIX 5

NOISE

PROPOSED QUARRY, LOT 28, MULGOA

NOISE AND VIBRATION INVESTIGATION

Report No W4308-1

May 1982

Prepared for

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TABLE OF CONTENTS

1. INTRODUCTION

Mulgoa Quarries Pty Ltd proposes to develop and operate a quarry on Lot 28 in the Shire of Mulgoa, south of Penrith. This Report has been prepared to assist in the granting of approval for the project by the Council and is part of the Environmental Impact Statement being prepared by Sinclair Knight & Partners Pty Ltd.

The location of Lot 28 and the proposed quarry area are shown on Figure 1 and are approximately 3.6 km north of the Village of Mulgoa and approximately 5 km south-west of Penrith. There are two quarries in the area at the present time. One is operated by Wearn Industries Pty Ltd on Lot 22, situated approximately 500 m south of Lot 28, and the other, which is worked by NJW, is on Lot 21, situated between Lot 28 and Lot 22. It is possible that future quarrying may take place on Lots 1 and 26 to the east of Lot 28.

The aim of this assessment is to establish whether noise levels associated with quarry operations are acceptable and, where necessary, to determine appropriate control measures. It is also concerned with assessing the effect of vibration and overpressure resulting from any blasting required. A further report, based on up-to-date information, will need to be submitted to the State Pollution Control Commission with an Application for Approval under Section 27 of the Noise Control Act.

2. DESCRIPTION OF PROJECT

2.1. Quarry Area

The location of the proposed quarry on Lot 28, in the Shire of Mulgoa, is shown on Figure 1. It will be situated approximately 500 m north

of the existing quarry on Lot 22 operated by Wearn Industries Pty Ltd. The nearest residential properties to the proposed quarry will be houses situated on Mulgoa Road. These include the Kelly residence situated approximately 150 m to the south-west of the proposed quarry limits, an unoccupied dwelling on the western side of Mulgoa Road close to the entrance to Glen Allan, approximately 300 m from the western quarry limits, and dwellings close to the entrance of Glenmore Country Club approximately 600 m west of the quarry limits.

To the north-east of the proposed site at approximately 300 m is land owned by the Housing Commission. However, at this stage, it is unclear when this land will be used for residential development. North of the transmission lines (600 m north) lies further Housing Commission land which is being investigated for development by the Land Commission and it is likely that this land will be developed first.

The nearest existing dwellings to the north of the site would be at approximately 1100 m from the quarry limits. East of the site, the nearest dwellings are close to the Bringelly Road at approximately 2.2 km. There are a number of recently-built residences on the Chain-o-ponds Road istuated approximately 1.2 km south of the proposed quarry. However, in this direction, the residences of Ovindoli Pines and Warra-wong, both situated near the Mulgoa Road, will be closer, at about 900 m.

2.2. Proposed Operations

It is proposed that the quarry will extract clay and shale for the local brick manufacturing industry and sandstone and gritstone for roadbase purposes. Clay and shale will be transported by truck direct from the quarry pit to the brickworks, whilst gritstone and sandstone will be taken to the crushing plant before transportation

by truck from the area.

Once quarry operations commence, it is hoped that permission will be granted for transportation to take place on Route 5, as shown in Figure 1, to intersect with the Bringelly Road, 400 m south of Bradley Street. However, until permission is granted to use this particular route, transportation will continue to take place via the currently used Route 1, intersecting at Mulgoa Road.

At the present time, approximately 30,000 tonnes per month of product and 30,000 tonnes per month of overburden is extracted from the quarry on Lot 22 by Wearn Industries Pty Ltd. In future, once the quarry on Lot 28 commences production, these figures will fall to 5,000 and 2,000 tonnes per month of product and overburden respectively, whilst operations on Lot 28 will result in 35,000 and 20,000 tonnes per month of product and overburden respectively.

Basically, quarry operations will take place with land clearance and product and overburden removal to the 50 m contour followed by rehabilitation. Extraction will be carried out in four stages, dependent on land drainage requirements, and these stages are shown in Figure 1.

It is understood that the quarry would operate during the following hours:

Monday to Friday	-	0600 - 2000 hours
Saturday	-	0600 - 1800 hours

There will be no Sunday working, except in emergency situations.

The operation will involve clearing of the area using dozers, followed by removal of topsoil using a scraper. Overburden will then be ripped

and loaded, using front-end loaders, on to haul trucks for disposal. Clay and shale will also be ripped and loaded directly on to trucks for delivery to the brickworks. When bands of sandstone and gritstone are encountered, these will be drilled and blasted for loading on to haul trucks for either dumping on waste dumps or crushing and screening. The crushed sandstone and gritstone product will then be transported from the site by truck.

3. EXISTING NOISE ENVIRONMENT

A noise survey was carried out to establish the existing noise environment at 7 locations representative of the nearest residences in the area with potential for being affected by the proposed quarry operations on Lot 28. Existing noise in the area is primarily due to transport using Mulgoa and Bringelly Roads, despite the quarrying operations on Lots 21 and 22.

3.1. Measurement Locations

Because of the difficulty of gaining access to private property, some measurement locations were some distance from the residences they represent. However, all locations were selected to represent as closely as possible the typical environment of the associated residences and each location as shown in Figure 1 is discussed below.

- Location 1: 2 m from the front gate of Mulgoa Place on Chain-o-Ponds Road, approximately 5 m from the sealed road surface.

- Location 2: ON the western side of, and approximately 40 m from, Mulgoa Road in a lane leading to Mayfair Park. This location can be assumed to be representative of Ovindoli Pines.

- Location 3: On a track leading to unoccupied property adjacent

to the entrance to Glen Allan and approximately 30 m to the west of Mulgoa Road.

- Location 4: On the entrance road to the Glenmore Country Club, at a distance of approximately 100 m from Mulgoa Road.

- Location 5: On the continuation of Luttrell Street, 200 m north of the nearest existing dwelling north of the site, and chosen to be representative of future property on the Housing Commission land north of the transmission line.

- Location 6: On Bradley Street, at the entrance to Blue Hills, approximately 400 m west of Bringelly Road.

- Location 7: On Bradley Street, approximately 300 m from Bringelly Road. It was selected to represent the nearest residence to the proposed haul road which is also approximately 300 m from Bringelly Road.

3.2. Method of Measurement

During the survey, noise levels were monitored using a Bruel & Kjaer Noise Level Analyser Type 4426 via a Preamplifier Type 1619 and a Microphone Type 4165. A record of the noise levels was read out from the memory system of the instrument once the period had elapsed in terms of the statistical levels, L1, L10, L50 and L90 and the Equivalent Continuous Sound Level, Leq. The values L1 to L90 are those levels which are exceeded from 1% to 90% of the sampling time. The L10 represents a level which is exceeded for only 10% of the total measuring time and gives a measure of the high noise level events which dominate the noise environment. The L90 level which represents a noise level which occurs for the majority of the sample period, is regarded as the most reliable descriptor of background noise. The value, Leq, is the mean time-weighted level calculated logarithmically.

The instrumentation was calibrated before and after each sample, using a Bruel & Kjaer Calibrator Type 4230 and the drift was well below the required specification of ± 1 dB.

The existing noise was monitored at each of the measurement locations for a 5 to 10 minute period with the Analyser set to sampling rates of 10 per second. The measurements were repeated at different times of the day from 0500 to 1800, in order to establish the likely noise environment during the period of operation of the proposed quarry and also immediately prior to the proposed commencement time. During the sample periods, comments were noted as to the sources contributing to the existing noise environment. Results of the measurements, together with these comments, are included in Table 1.

Generally, the surveys were carried out during periods when the weather conditions were calm and therefore when it seemed likely that the lowest background noise level existed. However, if wind was prevalent during a measurement period, details of its speed and direction have been given in Table 1.

3.3. Discussion of Noise Environment

The existing noise environment at all but two of the 7 locations considered was primarily affected by traffic using Mulgoa and Bringelly Roads. Due to the distance from these roads, background noise levels at Locations 1 and 5 were predominantly affected by other sources, including existing quarry operations.

A summary of the background noise level is presented below.

	L90 (dBA)		
Location	0500 - 0600	0600 - 0700	0700 - 1800
1	-	40	35 - 36
2	35	-	39 - 47
3	-	33	42 - 44
4	31	-	35 - 43
5	29	-	32 - 35
6	-	44	36 - 44
7	-	-	38 - 47

Examples of the existing noise environment at Locations 2, 5 and 7 during the 0700 to 1800 period are illustrated in Figure 2 by short period graphic level recordings.

At Locations 2 and 3, traffic using Mulgoa Road during the period 0600 - 1800 caused L10 levels of approximately 60 dBA and L1 levels of between 65 and 75 dBA. Dwellings close to Position 7 experienced L1 levels of approximately 60 dBA, with L10 levels of 50 - 55 dBA. The peak levels were caused by traffic on Bringelly Road and are between 13 - 21 dBA above the L90 level.

4. FUTURE NOISE DESIGN GOALS

In order to assess the noise level from future quarry operations, it is necessary to establish design goals which are likely to be acceptable to residents in the area. In assessing future quarrying noise, the levels both from quarry operations and also due to transportation from the quarry must be considered.

4.1. Quarrying Noise

At normal operating distances of the quarry from the nearest property,

noise from quarry operations is likely to be reasonably steady but punctuated by the occasional impacts due to trucks loading rock in the pit.

During the hours of 0600 - 1800, the existing background noise levels in areas some distance from Mulgoa and Bringelly Roads are of the order of 35 dBA, but close to these roads they are of the order of 40 dBA.

To assess steady operating noise levels, Australian Standard 1055 - 1978, 'Noise Assessment in Residential Areas', proposes that predicted quarry noise levels should be compared to the existing background level. If the predicted quarry level exceeds the existing background level, the noise is likely to be annoying. However, excesses of 5 dBA or less may be of marginal significance.

If the existing background levels in the area are not appropriate for assessment purposes, then the Australian Standard advises the use of calculated background levels shown in Table 1 of the Standard. We consider in this case that the proposed quarrying developments and possible future developments will mean a change in character of the area and that the existing background noise levels are not totally appropriate. We, therefore, consider that the quietest area category quoted in Table 1, 'Areas with negligible transportation' should be used for assessment purposes. The relevant calculated background levels from that Table are as follows, for a weekday:

. 0600 - 0700 - 35 dBA
. 0700 - 1800 - 45 dBA
. 1800 - 2200 - 35 dBA

In a rural area such as this, rising time is probably earlier than in suburban areas for which these calculated background levels have

been derived. We therefore consider that it is reasonable to extend the daytime period from 0600 to 1800 and propose that the following levels be set as steady noise design goals (taking into account the fact that other quarries may be developed in the area):

. 0600 - 1800 - 45 dBA
. 1800 - 2200 - 35 dBA

The maximum levels likely to occur as a result of loading of haul trucks should be acceptable to residents, provided they do not exceed the proposed steady noise level by more than 5 dBA.

4.2. Transportation Noise

Because of the relatively high volumes of traffic on Mulgoa Road and Bringelly Road, increased truck movements on these roads associated with quarry development will be insignificant.

On the private routes used for transporting product from the quarries to the public roads, the impact of noise will depend upon the maximum noise level from each truck movement and the number of movements per day. It is considered that, provided the maximum levels do not exceed the existing background levels by more than 15 dBA at nearby residences, there is unlikely to be any significant impact. The assessment of truck haulage on Route 1 should also take into account the fact that development of Lot 28 will result only in an increase of movements in this area and that the maximum noise levels will not change.

5. BLAST MONITORING

Ground vibration, and to a lesser extent overpressure, resulting from

blasting is dependent on the local geology and is thus site dependent. In order to establish the site properties in respect of the transmission of groundborne vibration and the propagation of overpressure, a number of production blasts were monitored at Wearn Industries Quarry on Lot 22. The results from the blasts were analysed and used so that predictions of vibration and overpressure associated with the proposed blasting on Lot 28 could be made at nearby residences.

5.1. Details of Blasting

Production blasts were carried out on three separate occasions (14/7/81, 21/7/81 and 5/8/81) and monitored at two locations, shown as A and B in Figure 1. The monitoring locations were selected to represent the minimum distances that blasting in the future quarry area would be from the nearest residences; that is, 600 m to the north and 300 m to the west.

On the first two occasions, bench blasts orientated towards the south-west were fired with exposed 'Redcord' trunk lines. On the third occasion the bench was orientated towards the south-east and the 'Redcord' trunk line was covered with a minimum of 100 mm of fine screenings.

Details of the test blasts carried out are given in Table 2, indicating the design parameters, including the Maximum Instantaneous Charge, number of holes per delay and also drilling data. Details of the weather conditions at the time of the blasting have also been noted in this Table.

The test blasts were carried out in gritstone and all holes were loaded in a similar way. The three 25 mm diameter cartridges of AN60 gelignite were loaded in the base and the remaining column depth was filled with nitroprill to within 0.15 - 0.3 m of the bench surface, the remaining length being stemmed with paper.

5.2. Vibration and Overpressure Measurements

Groundborne vibration was recorded using a three component geophone assembly, enabling measurements in the three orthogonal directions, coupled via an instrumentation amplifier to three of the four channels on a Teac Type R61 FM Tape Recorder for subsequent analysis in the Laboratory. The geophone assembly was mounted on the surface of the ground to ensure the highest amplitude of vibration was monitored.

The overpressure was monitored using a Bruel & Kjaer Impulse Precision Sound Level Meter Type 2209 fitted with a 1" Microphone Type 4145 and set to the lower limiting frequency of 2 Hz. This system was in turn coupled to the remaining channel on the FM Tape Recorder for later analysis. Measurements were recorded with the Impulse Precision Sound Level Meter set to the linear peak hold response and the meter was calibrated using a Bruel & Kjaer Pistonphone.

Subsequent analysis in the Laboratory was carried out using a Tektronix Cathode Ray Oscilloscope Type 513N. A typical record of the resulting vibration and overpressure wave forms obtained from one of the bench blasts is shown in Figure 3.

The resulting overpressure and vibration levels recorded are listed in Table 2.

6. RECOMMENDED BLASTING LIMITS

Since both groundborne vibration and airblast wave overpressure associated with blasting may cause damage to buildings and/or an noyance to residents, their levels should be controlled by blast design and blasting techniques.

The State Pollution Control Commission has recommended the following

vibration and overpressure levels from blasting to avoid disturbance to nearby residents:

- Vibration - 7 mm/s
- Overpressure - 115 dBL (decibels Linear)

These levels are well below levels recommended overseas to avoid damage to buildings and are generally consistent with our experience of neighbouring complaints. We have, therefore, adopted these levels as blast design goals.

7. IMPACT OF NOISE

7.1. Quarrying Noise

The equipment to be used for the quarrying operations proposed for Lot 28 is that currently being used on Lot 22. The noise levels produced by this equipment have been measured under typical operating conditions and the Equipment Schedule and noise levels are given in Table 3.

Noise levels around the proposed quarry resulting from quarrying operations have been calculated from the equipment noise levels and by allowing for attenuation with distance (6 dBA per doubling of distance), building attenuation where appropriate and shielding by pit walls and natural topography. Each piece of equipment has been allocated a location and a noise level consistent with its required mode of operation. Since equipment clearing and prestripping will work well in advance of extraction and restoration equipment and also haul trucks will travel over the site, a considerable spread of equipment will exist at all times.

Because of the slope of the ground on the western edge of the propsed quarrying area, significant additional shielding to residences west of the area may be achieved if quarrying is limited to the 60 m contour on the western side. Since the residences near Mulgoa Road, particularly the Kelly residence, are very close to the proposed quarry, and high noise levels may be expected, we recommend that the western boundary of the area to be quarried be the 60 m contour, which is shown in Figure 4.

On this basis, the steady noise contours calculated for areas where residences exist or may be constructed are shown in Figure 4 and a typical calculation to Location 3 from Stage 3 is shown in Table 4. The contours are for the worst time period during the life of the quarry; that is, when quarrying is carried out in that area closest to the residences involved. However, because of the spread of equipment from prestripping to restoration, it is not anticipated that the levels will change greatly with time.

In summary, the highest noise levels anticipated at noise sensitive areas nearby (taking into account the restricted operation on the western edge) are as follows:

. Kelly residence	- 46 dBA
. Ovindoli Pines	- 50 dBA
. Location 3	- 52 dBA
. Housing Commission property (s of Transmission Lines)	- 53 dBA
. Housing Commission property (n of Transmission Lines)	- 41 dBA

It can be seen that the levels close to the western edge of the proposed quarry area, near the Kelly residence, are lower than those further out as a result of shielding by natural topography. Since the level anticipated at the Kelly residence exceeds the daytime

(0600 - 1800) design goal by only 1 dBA, we consider that this level should not cause disturbance.

At Ovindoli Pines, Location 3 and on part of the Housing Commission property, the daytime design goal of 45 dBA is significantly exceeded. It should be noted that if houses are not constructed on the Housing Commission property south of the transmission lines in the area south of the 65 m ridge line, the maximum level expected is 48 dBA. Whilst this still exceeds the design goal of 45 dBA, it is considered only slightly too high.

Apart from the quarrying limit set at the 60 m contour on the western boundary of the proposed quarrying area (already included in the calculations), there are no practical noise control measures to further reduce noise levels. The levels at Ovindoli Pines and Location 3 will, therefore, remain in the order of 5 dBA above the design goal.

During the 2-hour period, 1800 - 2000, the design goal of 35 dBA will be exceeded at all locations considered if full-scale quarrying operations are maintained. However, it is proposed that quarrying during this period of the day will be restricted to those days of high product demand.

There are no practical quarrying operations which may be carried out before the proposed starting time of 0600. Based on Australian Standard 1055 - 1978, the design goal for the period before 0600 would be 30 dBA and off-road haul trucks, delivery trucks, crusher/screens, dozers and scrapers all individually exceed these levels at the nearest residences.

Calculations of the impact noise produced by loading rock into trucks within the pits have been carried out in a similar way. Allowing for significant shielding, in the order of 20 dBA, by pit walls, the

following levels, all within 5 dBA above the expected steady level, have been estimated.

- Kelly residence - 45 dBA
- Ovindoli Pines - 41 dBA
- Location 3 - 46 dBA
- Housing Commission property - 44 dBA

7.2. Transportation Noise

Route 1 is currently used to transport product from the quarries on Lots 21 and 22 to Mulgoa Road for distribution in the Sydney area. The following Table shows the number of truck loads per day currently going on on this route and the predicted number after the proposed quarry on Lot 28 becomes operational.

	Wearn		NJW	
	Lot 22	Lot 28	Lot 21	Total
Existing	70	-	25	95
Future	13	87	25	125

The proposed quarry development represents an increase of approximately 35% in total transportation.

During the time during which Route 1 continues to be used, the maximum levels associated with trucking will not change. However, the frequency of occurrence will increase by approximately 35%.

At the nearest residence to Route 1, the Kelly residence, at approximately 150 m, we have estimated a maximum level from truck movements of 60 dBA. At the next nearest residence near Location 3 (250 m) the level would be approximately 56 dBA, but it should be noted that this residence is quite close to Mulgoa Road.

Taking into account the existing maximum levels at the residences, we consider that a 35% increase in the number of truck movements on Route 1 should not represent a significant change to the noise environment.

There are currently no truck movements on the proposed route, Route 5. When trucking begins, we would anticipate the following maximum noise levels at the nearest residences:

- Nearest residence (100 m) - 63 dBA
- Next nearest residence (250 m) - 55 dBA

Based on the background noise level measurements at Location 6 (36 - 44 dBA) and Location 7 (38 - 47 dBA), we would anticipate that 40 dBA is a typical background noise level during quarry operational hours at the nearest and next nearest residences. Since the 55 dBA anticipated at a distance of 250 m from the route exceeds this background noise level by 15 dBA, we would anticipate no impact upon the residents at that location.

However, maximum noise levels at the nearest residence are expected to exceed the background noise level by up to 23 dBA. Whilst this is above our design goal, it should be noted that such truck levels will be similar to those currently experienced from trucks on Bringelly Road (generally indicated by the L1 levels in Table 1) and therefore will be generally consistent with the existing environment.

8. IMPACT OF BLASTING

The expected levels of vibration and overpressure associated with proposed blasting on Lot 28 have been estimated from monitoring carried out on Lot 22. Since similar rock exists on both sites, the predictions made are considered valid and suitably accurate.

Our predictions of vibration and overpressure have been based on methods recommended by Duvall and Devine. Their methods have been confirmed by recent experience to be the best prediction methods available.

Since a consistent measure of charge weight is necessary, the following predictions are based on the equivalent weight of AN60 gelignite and it has, therefore, been necessary to convert the charge weight of Nitropril used during the blast monitoring to the equivalent weight of AN60.

8.1. Proposed Blasting

Blasting within the quarry will be limited to the extraction of sandstone and gritstone. In general, two types of blasts will be involved:

- Where rock bands are greater than 2 m in depth, they will be blasted to give good fragmentation so as to allow crushing to produce roadbase. Such blasting will involve 62 mm diameter holes drilled on a pattern of 2 m x 2 m.

- Where rock bands are less than 2 m in depth, less controlled blasting will be used to remove the rock for dumping as waste. Such blasting will involve 62 mm diameter holes on a 3 m x 3 m pattern.

In general, the method of blasting will be the same as that currently used on Lot 22 and will include stemming to a depth of 0.15 - 0.3 m.

The type of blast with the greatest potential for producing vibration and overpressure will be that used to generate roadbase (2m x 2 m). Our assessment of blasting has, therefore, been based on this type so

that levels predicted by us are the highest to be expected.

8.2. Vibration Assessment

The peak particle velocity of vibration measured at a distance from a blast depends upon the charge weight and the type of ground or rock through which the vibrations are transmitted. For a particular area, graphing of the scaled distance ($D/C^{\frac{1}{2}}$, where D is distance in m and C is charge weight in kg) against vibration level results in a straight line. Figure 5 shows the vibration monitoring results and the line drawn on the graph shows the likely upper level expected from blasting in the area, based on the slope recommended by Duvall and Devine and confirmed by us at other locations. The spread of results obtained is consistent with expectations as a result of blast variations.

It can be seen from this graph that, to achieve a maximum level of 7 mm/s, the scaled distance should not be less than approximately 23 $m/kg^{\frac{1}{2}}$.

Based on the anticipated maximum charge per hole of 12 kg (equivalent AN60), it will be necessary to limit the number of holes fired per delay to 6 to achieve the vibration design goal at the Kelly residence when blasting is carried out at the nearest location (assuming quarrying is limited to the 60 m contour).

For distances of 220 m or greater from the Kelly residence, the commonly used 7 or 8 holes per delay will be acceptable. Since other residences are further away, no additional restrictions are necessary to achieve acceptable vibration levels.

8.3. Overpressure Assessment

Airblast wave overpressure depends not only upon the distance from the blast and the Maximum Instantaneous Charge, but also upon the depth of the charge below the surface. In addition to this, it is commonly found that similarly loaded holes in similar rock may lead to different overpressure levels, probably because of the variability in the structure of the rock.

Based on work by Duvall and Devine, Figure 6 has been prepared showing the relationship between the results of overpressure monitoring and the scaled distance for each scaled depth of charge. In this case, scaled distance is calculated by dividing the distance in m by the cubed root of the charge in kg and the scaled depth by dividing the depth in m by the cubed root of the charge in kg.

As for vibration measurements, there is a significant spread of results obtained from overpressure monitoring but the lines drawn for different scaled depths generally apply. It should be noted that the lines in this case are the average lines and with the spread of results expected, overpressure levels may exceed those indicated by these lines.

Taking into account the expected charge per hole of 12 kg, Figure 6 allows calculation of the following minimum distances to achieve the design goal of 115 dBL for a range of holes per delay:

Holes per Delay	Distance (m)
1	110
2	190
3	280
4	400
5	500
6	640
7	740
8	860

Since the Kelly residence is approximately 200 m from the nearest area to be quarried (based on a 60 m contour limit) and the house near Location 3 is approximately 350 m away, some restrictions in the number of holes blasted instantaneously will be necessary. These restrictions are tighter than those for vibration control and have been shown in Figure 7. They assume that no houses will be constructed on the southern edge of the Housing Commission property during the life of the quarry and if such houses are constructed, then further restrictions may apply on the northern parts of the quarry.

Since these restrictions are based on average overpressure level prediction curves shown in Figure 6, there are possibilities that when high levels occur, the overpressure design goals may be slightly exceeded at the Kelly residence. We therefore suggest that monitoring be carried out during critical stages of quarrying to confirm that the design goal of 115 dBL is consistently being complied with.

9. CONCLUSION

The proposed quarrying of Lot 28, Mulgoa, has potential for generating noise levels at nearby residences, particularly those to the west of the area, which exceed the daytime design goal of 45 dBA. We therefore recommend that the area to be quarried be limited on the western side by the 60 m contour.

Even with this restriction, noise levels at Ovindoli Pines, Warrawong and the unoccupied residence near the entrance to Glen Allan are likely to exceed the design goal by in the order of 5 dBA and levels on the southern edge of the Housing Commission property are likely to exceed the design goal by up to 8 dBA. However, if no residences are

constructed on the Housing Commission property south of the 65 m ridge line, then the maximum level expected at the houses will be 3 dBA above the design goal, which is considered only slightly too high. There are no practical noise control measures to further reduce noise levels at those residences to the west and south-west of the quarry area.

Whilst the proposed increase in trucking will not have a significant effect upon the noise environment near the currently used Route 1, if Route 5 is approved as the main transportation route, then the noise levels at the nearest residence to the route are expected to be above the design goal. It should be noted that these maximum levels are generally consistent with the maximum levels currently experienced at this residence from trucks travelling on Bringelly Road.

To control overpressure levels generated by blasting at the Quarry, restrictions on the number of holes that may be blasted instantaneously will be necessary. Figure 7 summarises these restrictions.

W4308-1 : TABLE 1

RESULTS OF EXISTING NOISE SURVEY

Date	Start Time	Measurement Location	Noise Level, dBA Leq	L90	L50	L10	L1	Weather	Major Noise Sources
14.07.81	1615	1	40	35	38	42	51	Calm - light N	Quarry, birds
05.08.81	0615	1	48	40	45	50	61	Calm	Quarry, birds & 1 car passby
05.08.81	1455	1	39	36	39	42	45	Light - mod SE	Quarry, birds, light plane
14.07.81	1630	2	56	47	53	62	66	Calm - light N	Traffic, pump
05.08.81	0550	2	45	35	38	47	57	Calm	Traffic, birds & insects
05.08.81	1515	2	60	39	50	63	72	Light - mod SE	Traffic, quarry, light plane
14.07.81	1640	3	57	44	53	62	66	Calm - light N	Traffic
05.08.81	0600	3	59	33	40	58	74	Calm	Traffic (incl 2 car & 1 truck p/by)
05.08.81	1150	3	58	42	51	61	69	Light - mod SE	Traffic, quarrying?
14.07.81	1655	4	51	43	48	53	61	Calm - light N	Traffic, birds & dog
05.08.81	0535	4	33	31	32	36	41	Calm	Traffic & insects
05.08.81	1130	4	53	35	41	57	66	Light - mod SE	Traffic & helicopter
14.07.81	1710	5	37	35	37	38	41	Calm - light N	Freeway traffic & birds
05.08.81	0520	5	32	29	31	34	38	Calm	Traffic, quarry & insects
05.08.81	1100	5	36	32	34	40	44	Light - mod SE	Birds & quarry
14.07.81	1725	6	45	42	44	47	51	Calm - light N	Traffic
05.08.81	0635	6	46	44	46	49	50	Calm	Traffic & birds
05.08.81	0710	6	49	44	48	52	-	Calm	
05.08.81	1035	6	40	36	39	42	46	Light - mod SE	Traffic
05.08.81	0700	7	52	47	51	56	60	Calm	Traffic & dog
05.08.81	1000	7	49	38	45	53	59	Light - mod SE	Traffic, birds, explosions
05.08.81	1030	7	46	41	46	52	59	Light - mod SE	Traffic, birds, explosions
05.08.81	1630	7	46	40	43	49	54	Light - mod SE	Traffic

W4308-1 : TABLE 2

BLAST DATA AND RESULTS OF MONITORING

Date:	14.07.81	21.07.81	05.08.81
No of holes	22	23	29
Diameter of holes	62 mm	62 mm	62 mm
Depth of holes	5.8 m	5.8 m	5.8 m
Sub-drilling	0.9 m	0.9 m	0.9 m
Burden - approx	2 m	2 m	2.5 m
Spacing - approx	2 m	2 m	2 m
Stemming depth - nom	0.15 - 0.3 m	0.15 - 0.3 m	0.15 - 0.3 m
Total Charge Weight (equivalent to AN60)	240 kg	300 kg	315 kg
No of trunklines	3	4	5
Delays (L series)	0, 2, 4	2, 2, 2, 2	0, 1, 2, 3, 4
Holes/delay	7, 8, 7	23	6, 6, 4, 6, 7
MIC	98 kg	330 kg	84.5 kg
Weather	Clear, dry, few clouds	Overcast, drizzle	Clear & dry
Wind	Calm - light NW	Calm	Calm - light SE
Measurement Location:	A	B	B
Distance from blast approx:	300 m	600 m	600 m
Overpressure*	125 dBL	129 dBL	118 dBL
Groundborne Vibration**	1.9 mm/s	3.7 mm/s	0.5 mm/s

*dBL - decibel linear peak
**Maximum peak particle velocity

W4308-1 : TABLE 3

PLANT SCHEDULE AND NOISE LEVELS

Equipment & Type		Size	No	Operation	A-weighted Sound Power Level
Dozer -	Komatsu 155	240 kW	1	earthmoving	115
	Komatsu 155A	240 kW	1	ripping	118
	Komatsu D85A	165 kW	1	earthmoving	113
Front-end loader	Cat 966C	127 kW	1		
	Cat 980	201 kW	1	loading	110
	Yale 6000		1		
Off Highway Haul trucks	Wabco	24 t - 32 t	5	idling	103
				hauling	112
	Euclid	27 t	1	hauling up	115
				loading	130
Grader	Cat 12E	101 kW	1		109
Drill	IR 350 CM		2		119
Offsite Trucks	Mack) Merc)	34 - 38 t	11 - 15	idling hauling	103 111
Crushing & Screening plant		-	1		119
Water cart			2		107
Scraper	Cat 631	336 kW	1		114

W4308-1 : TABLE 4

CALCULATION OF NOISE LEVELS AT LOCATION 3

Equipment & Duty	Item No	Sound Power Level	Distance (m)	Shielding	Distance Attenuation	Noise Level at Loc 3 (dBA)
Scraper	S	114	400	8	60	46
Dozer - earthmoving	D1	115	450	8	61	46
- ripping	D2	118	750	15	66	37
- earthmoving	D3	113	1050	14	68	31
Front-end loaders	P1	110	750	15	66	29
(loading)	F2	110	600	20	64	26
	F3	110	950	20	68	22
Grader	G	109	800	14	66	29
Haul Trucks - idling	HT1	103	600	20	64	19
- hauling	HT2	115	700	15	65	35
- hauling	HT2	112	800	5	66	41
- hauling	HT3	112	750	13	66	33
Trucks - idling	T1	103	750	15	66	22
- hauling	T2	111	1000	14	68	29
- hauling	T3	111	1600	15	72	24
- hauling	T4	111	900	20	67	24
Water Cart	WC	107	900	14	67	26
Crusher/Screens	C/S	119	800	5	66	48
Drill	Dr	119	600	20	64	35
			TOTAL NOISE LEVEL			52

W4308-1 : FIGURE 1

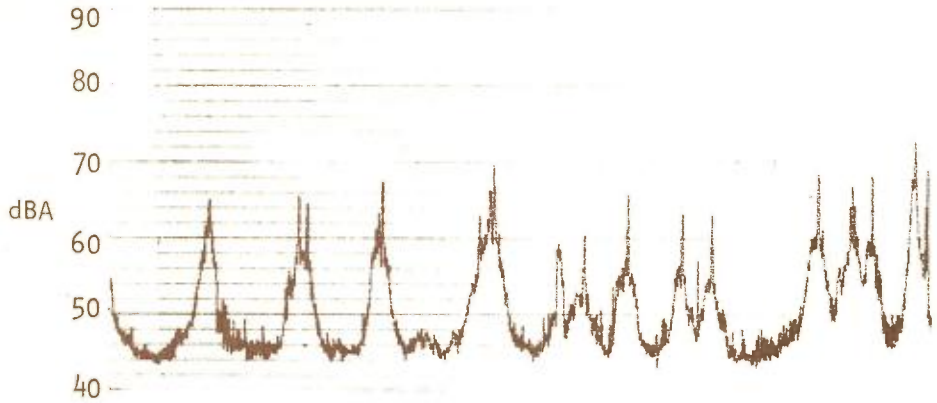
LOCALITY PLAN SHOWING NOISE AND BLAST MEASUREMENT LOCATIONS

(1) Noise

(A) Blast

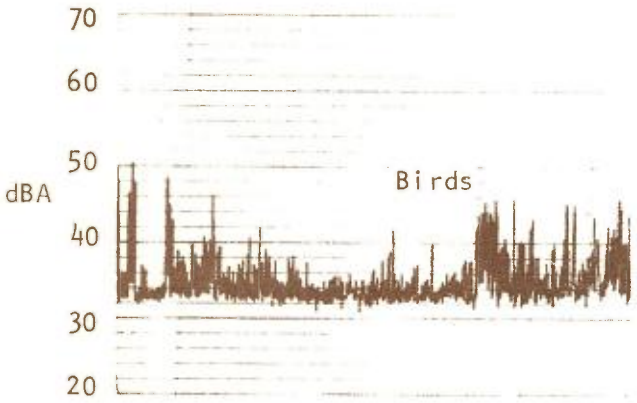
W4308-1 : FIGURE 2

GRAPHIC LEVEL RECORDINGS OF DAYTIME AMBIENT NOISE AT LOCATIONS 2, 5 AND 7



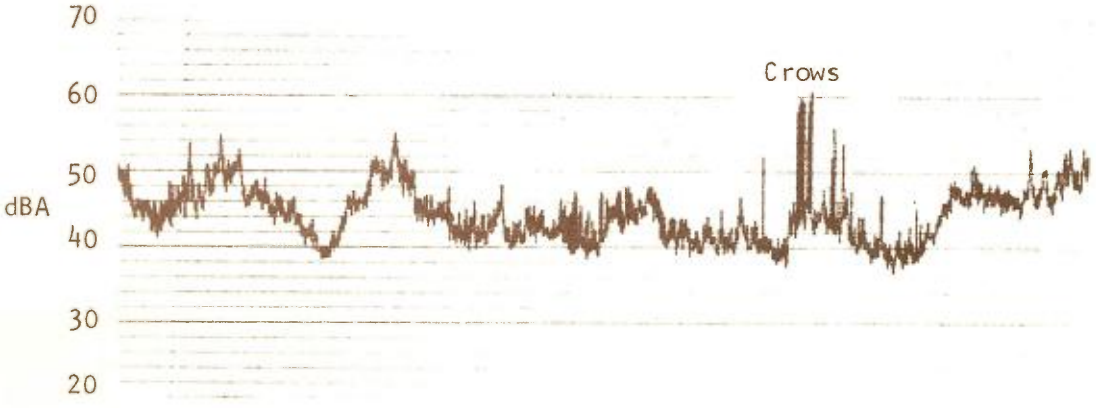
3 mm/s

Location 2



3 mm/s

Location 5

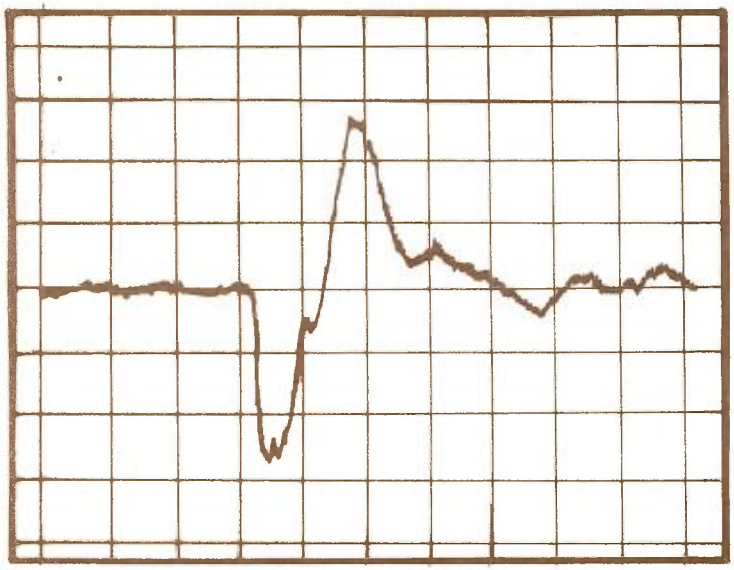


3 mm/s

Location 7

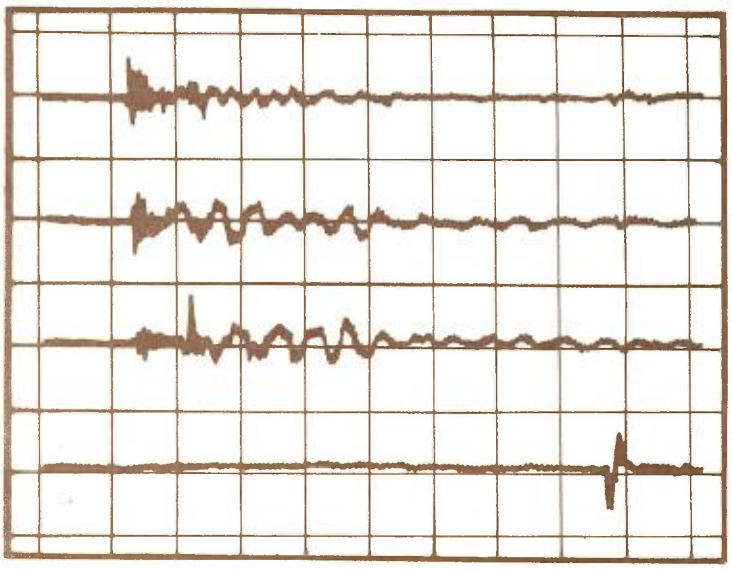
W4308-1 : FIGURE 3

VIBRATION AND OVERPRESSURE TRACES FOR BLAST, 21/7/81



20 ms/div

Overpressure



Vibration

Vertical

Longitudinal

Transverse

Overpressure

0.2 sec/div

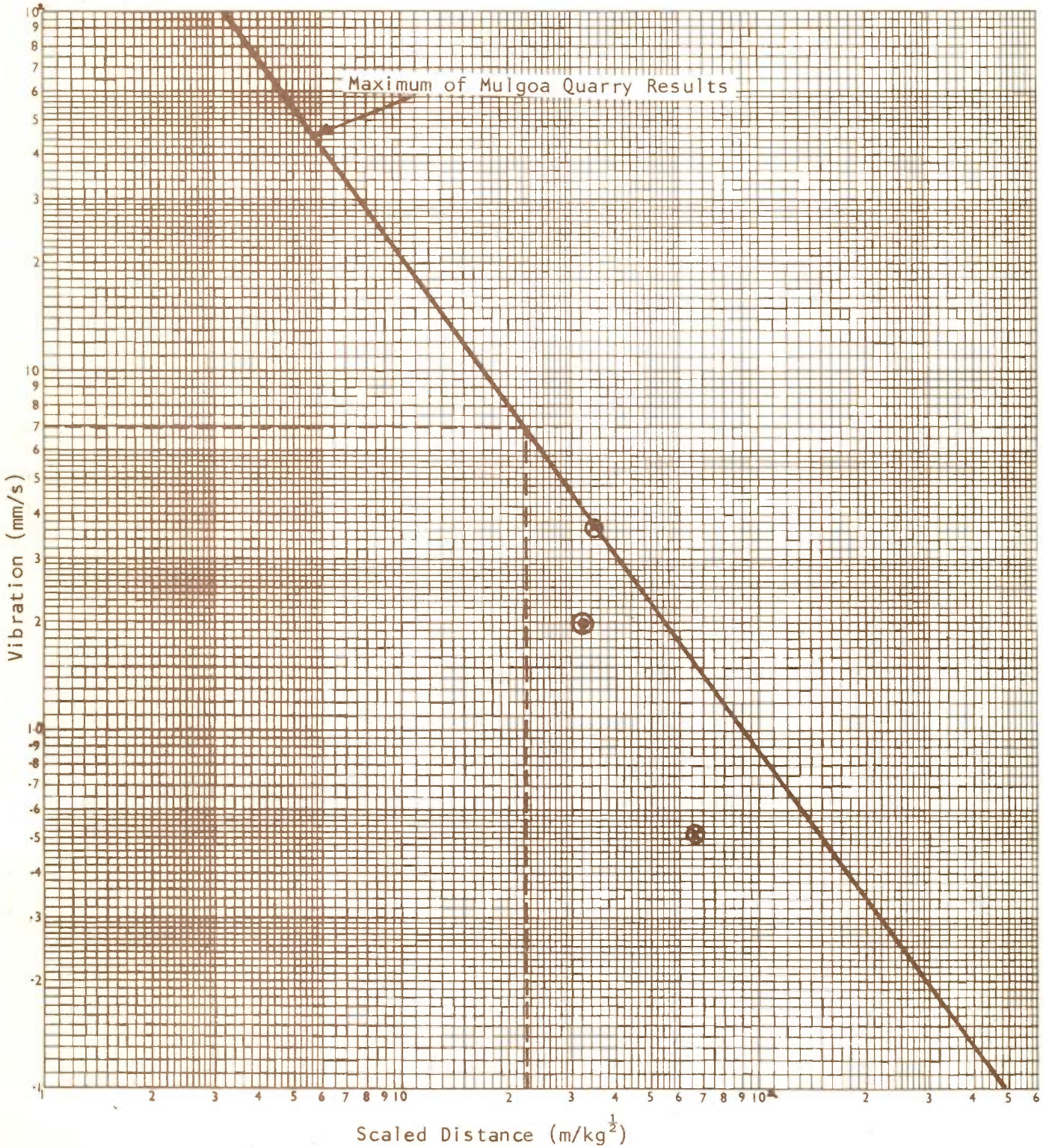
Vibration and Overpressure

W4308-1 : FIGURE 4

PREDICTED STEADY NOISE CONTOURS IN dBA FOR QUARRYING OPERATIONS

W4308-1 : FIGURE 5

RESULTS OF BLAST VIBRATION MONITORING AND PREDICTION CURVE



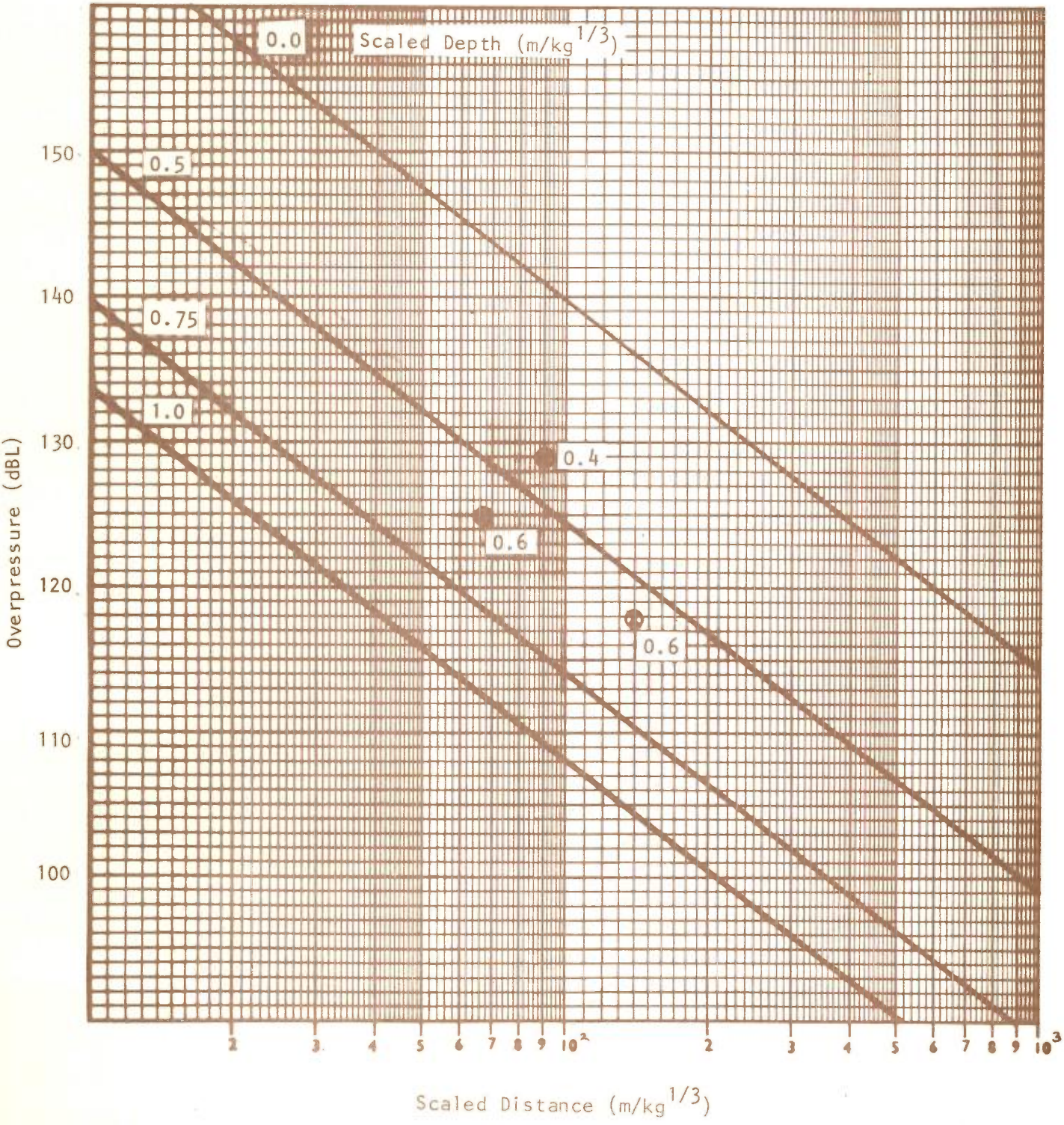
Line based on attenuation rate obtained from Duval & Devine but aligned to Mulgoa Quarry maximum

⊙ Location A at 300 m

⊗ Location B at 600 m

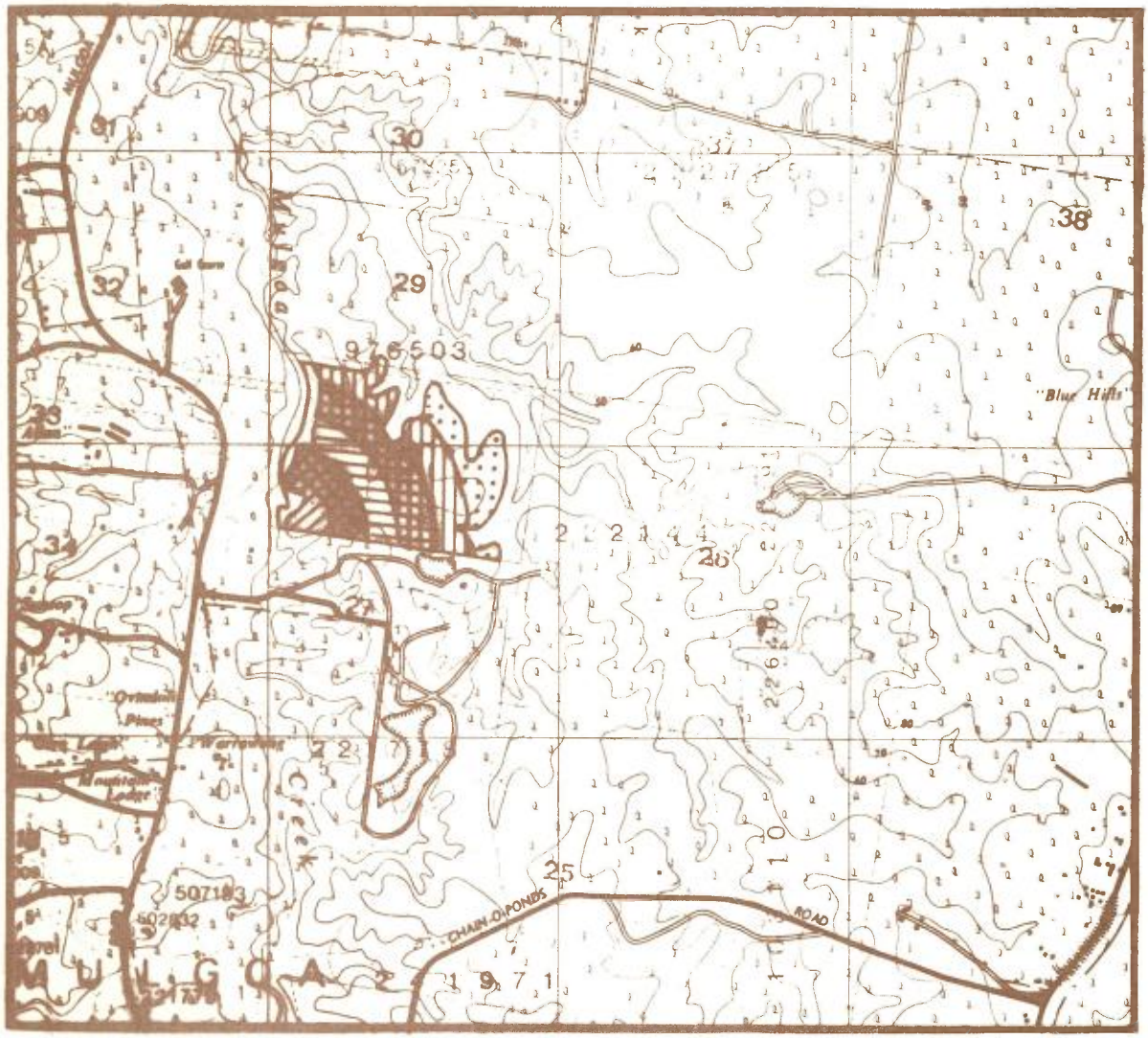
W4308-1 : FIGURE 6

RESULTS OF BLAST OVERPRESSURE MONITORING AND PREDICTION CURVES



W4308-1 : FIGURE 7

RECOMMENDED RESTRICTION ON HOLES/DELAY TO MEET OVERPRESSURE LIMITS



Maximum 2 holes/delay

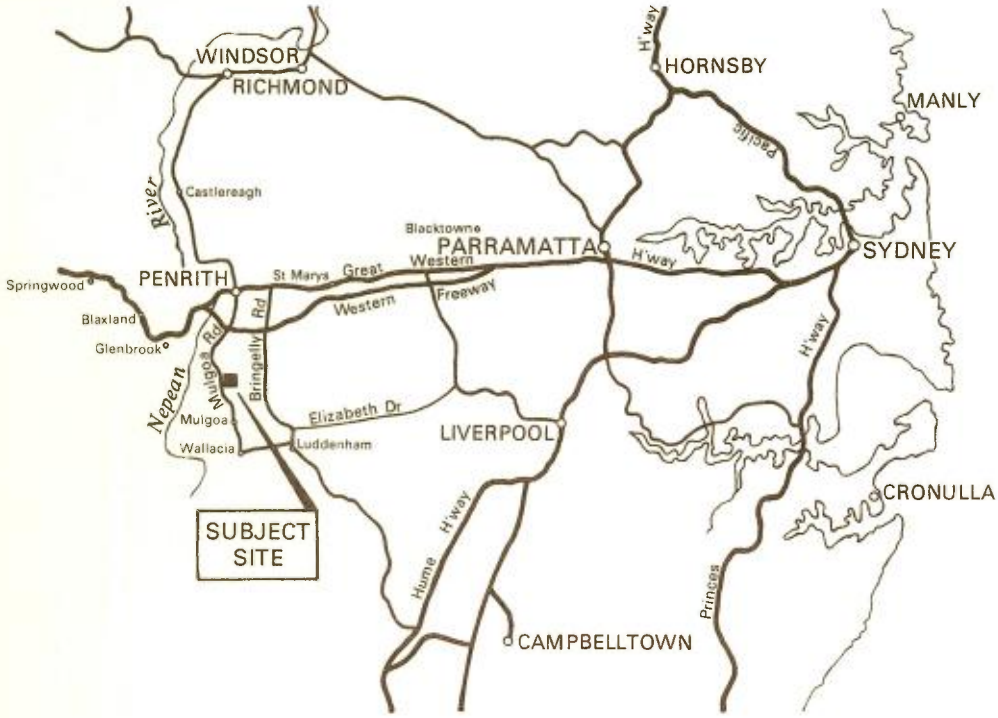
Maximum 3 holes/delay

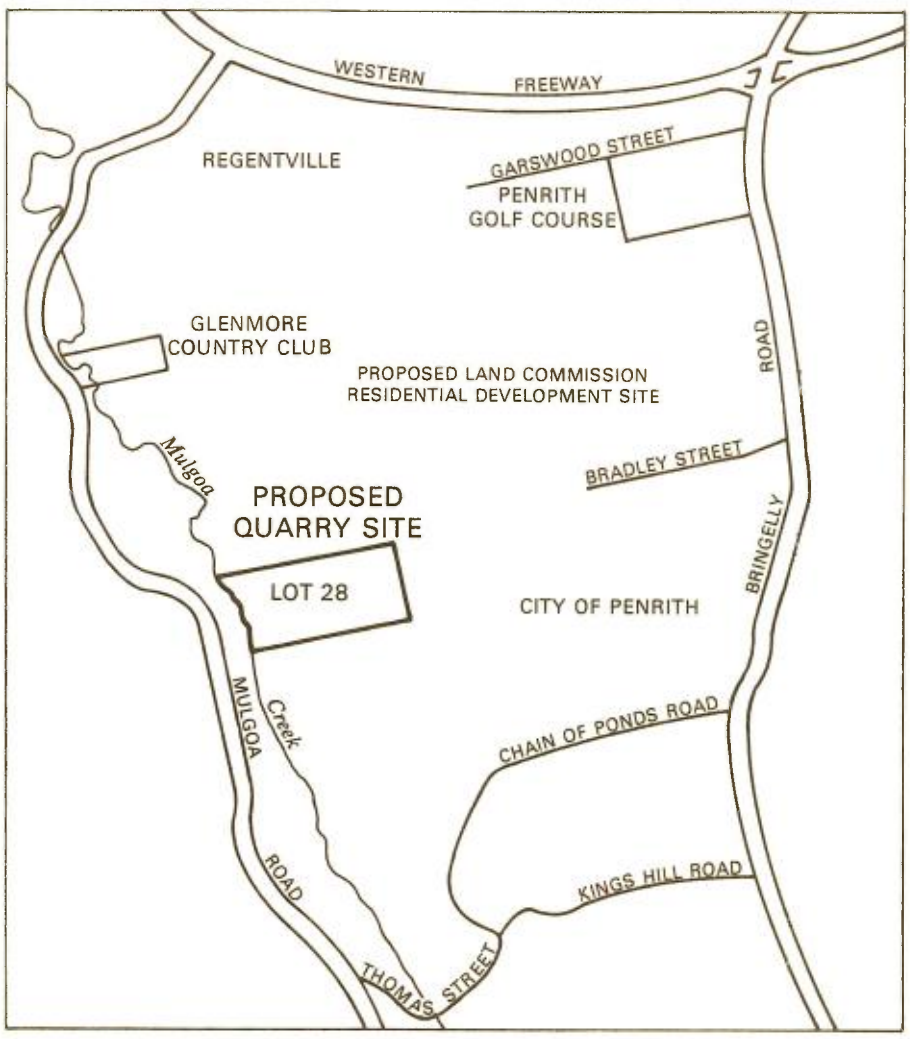
Maximum 4 holes/delay

Maximum 5 holes/delay

Maximum 6 holes/delay

Maximum 7 holes/delay





MULGOA QUARRIES PTY. LTD.

PROPOSED QUARRY LOT 28 MULGOA

LOCALITY PLAN

SINCLAIR KNIGHT & PARTNERS PTY. LTD.

EXHIBIT 2

LOT 30

65 METRE RIDGE LINE

THICKLY WOODED AREA
TO BE RETAINED AS OPEN SPACE.

HOUSING COMMISSION LAND

GOLF COURSE

LOT 29

PROPOSED QUARRY
LOT 28

POSSIBLE
CLAY/SHALE
QUARRY ON
HOUSING
COMMISSION LAND

"BLUE HILLS"

PROPOSED QUARRY

ESCARPMENT
ABOVE MULGOA
CREEK

LOT 28 DP 222144

LOT 1 DP 222144

HAUL ROAD

BRADLEY STREET

PROPOSED
KAY QUARRY

LOT 21
DP537922

KELLY
RESIDENCE

EXISTING
WEIGHBRIDGE

QUARRY ON
LOT 21

FUTURE
QUARRY ON
LOT 1

DP 541090

PROPOSED
WEIGHBRIDGE

EXISTING
HAUL ROAD

POSSIBLE QUARRY
ON REDDAN PROPERTY

REDDAN
DP 226490

PROPERTY

DP 224861

RAAF
AMMUNITION
DEPOT

DP 221778

THE COTTAGE

LOT 22
DP 537922

30 METRE STRIP OF LAND ON
EASTERN BOUNDARY OF LOT 21
TO BE INCORPORATED IN LOT 28.

NAVAL ARMAMENT
DEPOT

WEARN INDUSTRIES
QUARRY LOT 22

MULGOA
PLACE

10 HECTARE SUBDIVISION

CHAIN-O-PONDS ROAD

BRINGELLY ROAD

0 100 200 300 400m

Dwelling

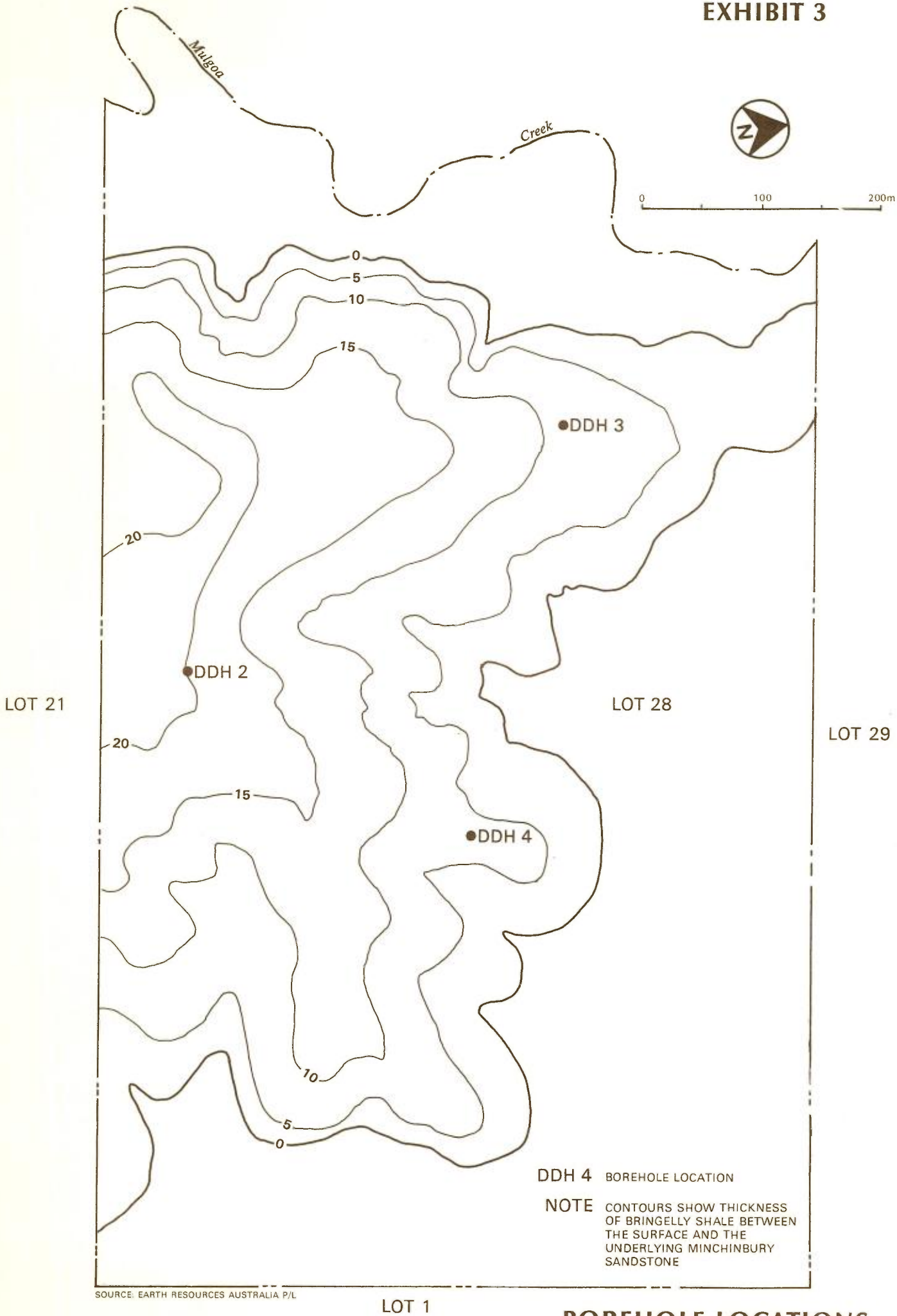
MULGOA QUARRIES PTY. LTD.

PROPOSED QUARRY LOT 28 MULGOA

RESOURCE AREA PLAN

SINCLAIR KNIGHT & PARTNERS PTY. LTD.

EXHIBIT 3



SOURCE: EARTH RESOURCES AUSTRALIA P/L

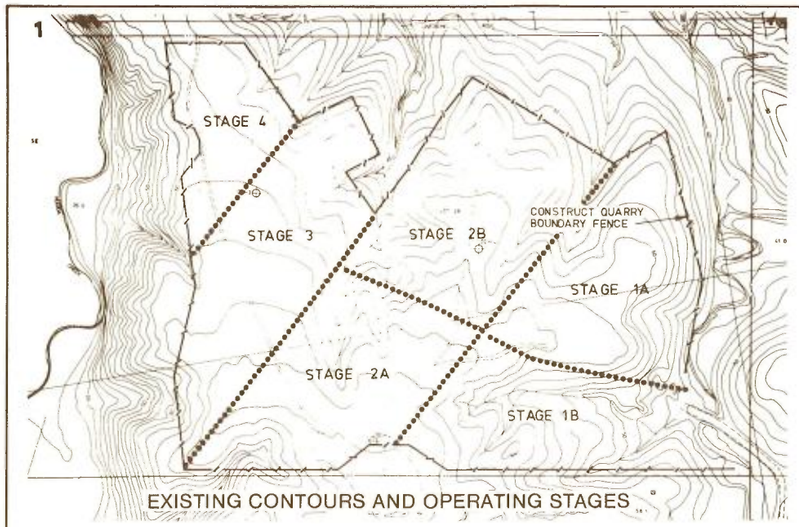
MULGOA QUARRIES PTY. LTD.

PROPOSED QUARRY LOT 28 MULGOA

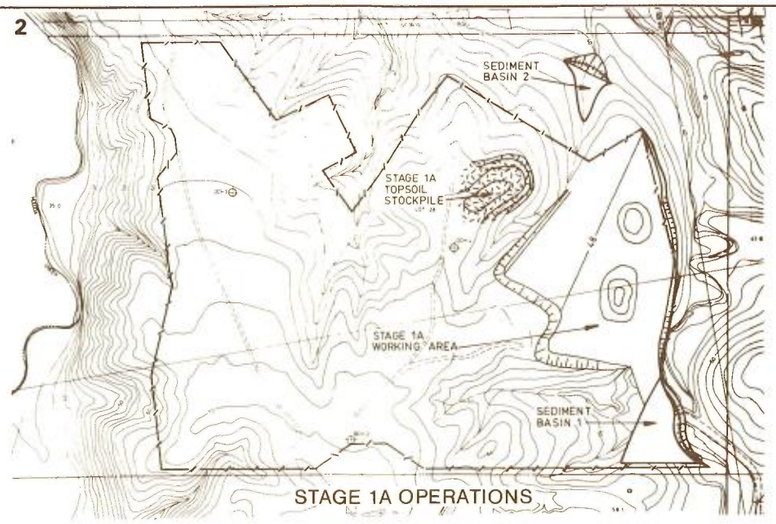
BOREHOLE LOCATIONS AND CLAY/SHALE DEPTH

SINCLAIR KNIGHT & PARTNERS PTY. LTD.

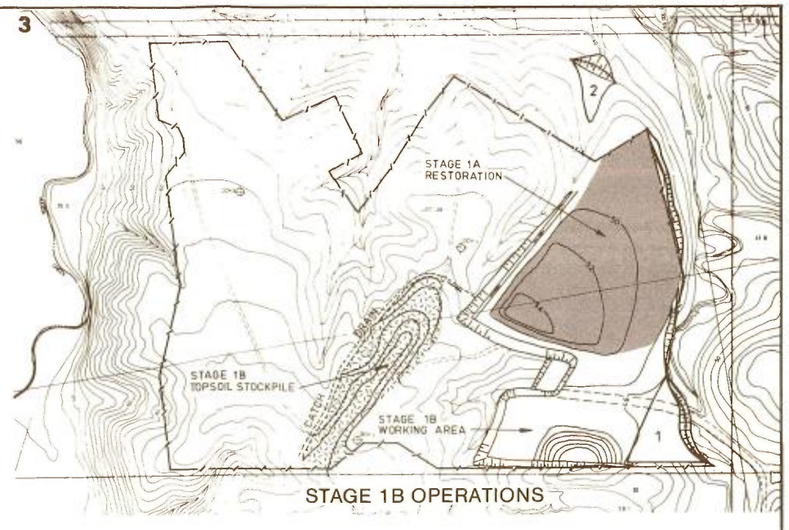
EXHIBIT 4



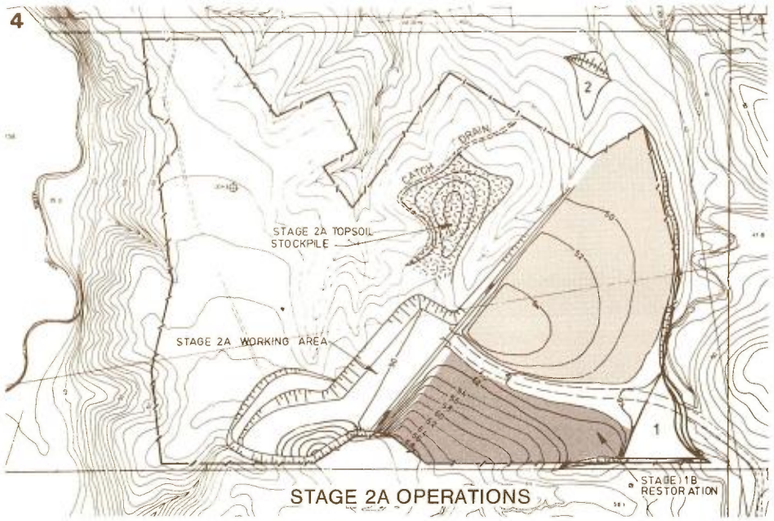
EXISTING CONTOURS AND OPERATING STAGES



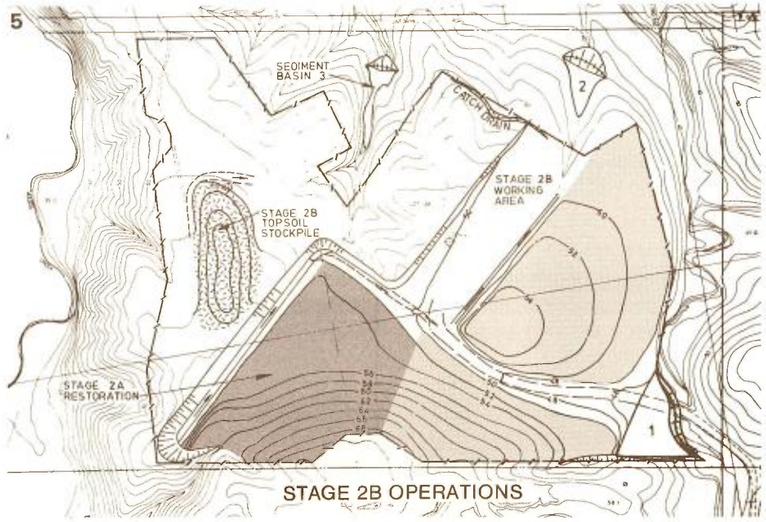
STAGE 1A OPERATIONS



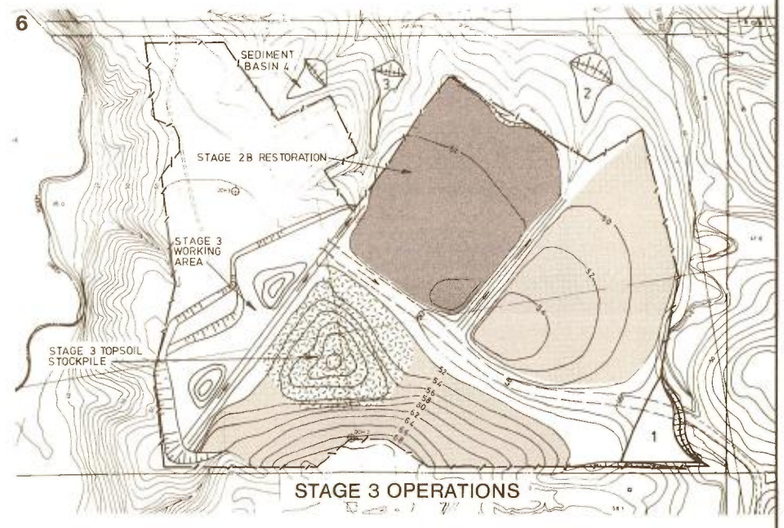
STAGE 1B OPERATIONS



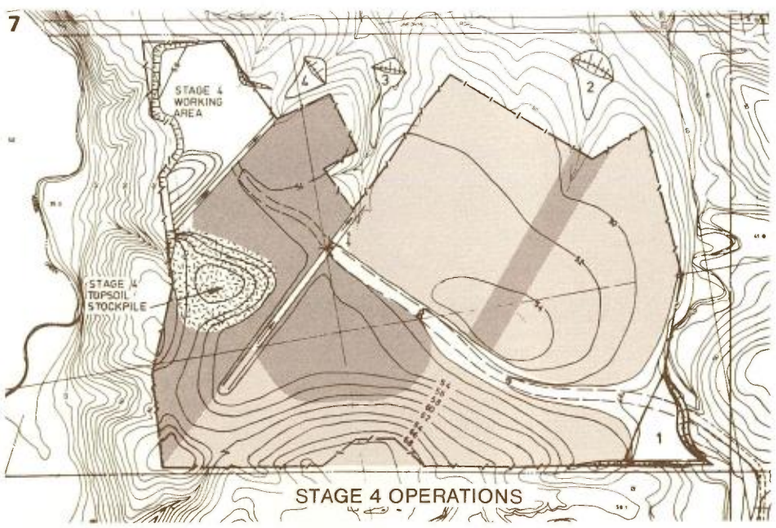
STAGE 2A OPERATIONS



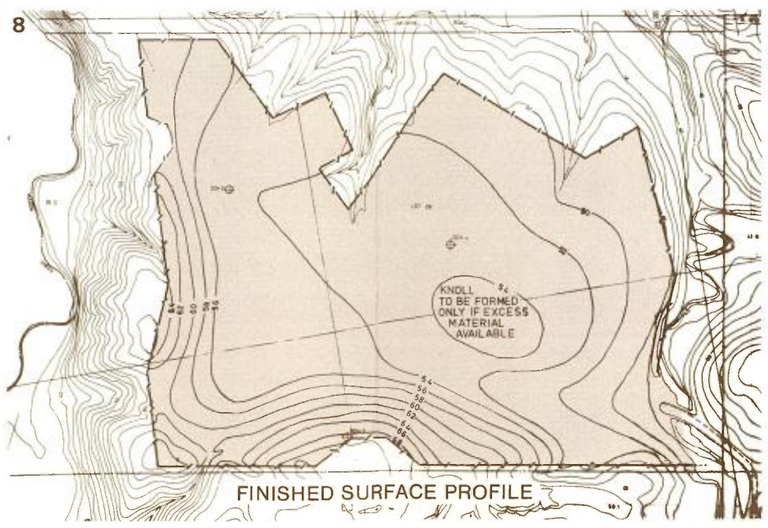
STAGE 2B OPERATIONS



STAGE 3 OPERATIONS



STAGE 4 OPERATIONS



FINISHED SURFACE PROFILE

LEGEND

- FENCE TO BE CONSTRUCTED PRIOR TO COMMENCEMENT OF QUARRYING
- 56 FINISHED OR TEMPORARY SURFACE CONTOUR
- AREA UNDERGOING REHABILITATION
- FULLY REHABILITATED AREA
- TEMPORARY TOPSOIL STOCKPILE

N

0 100 200 300 400m

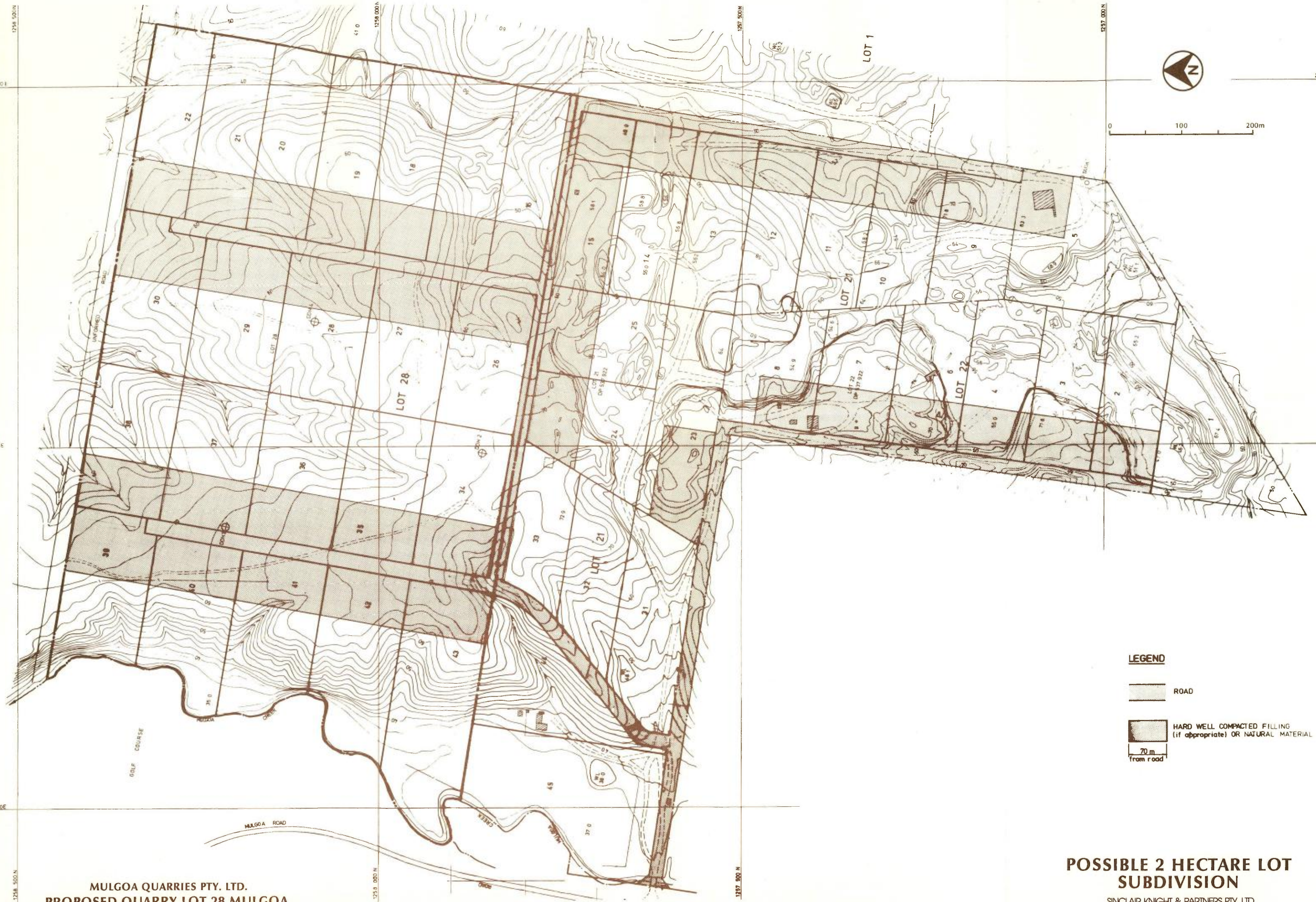
MULGOA QUARRIES PTY. LTD.

PROPOSED QUARRY LOT 28 MULGOA

DEVELOPMENT PLAN

SINCLAIR KNIGHT & PARTNERS PTY. LTD.

EXHIBIT 5

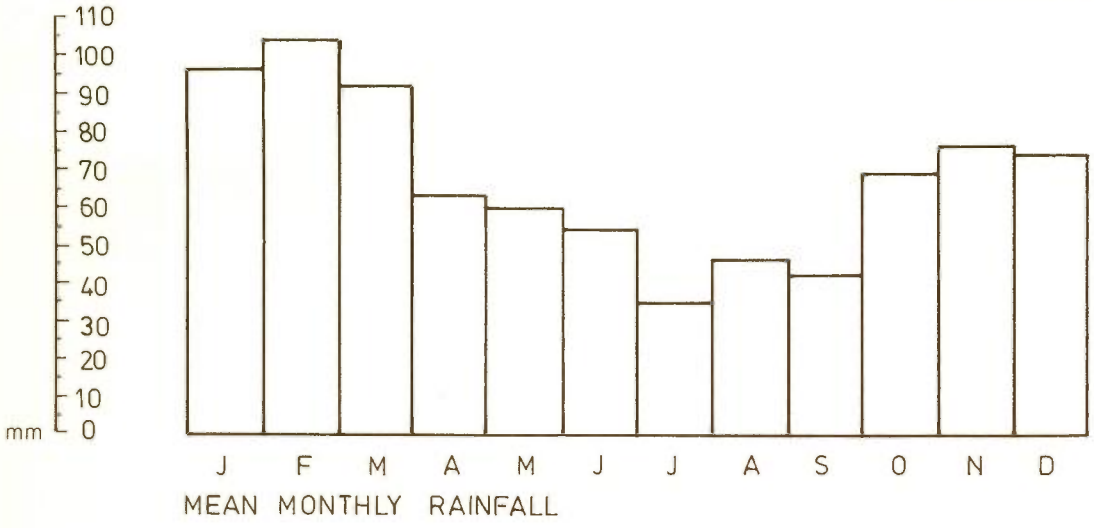


MULGOA QUARRIES PTY. LTD.

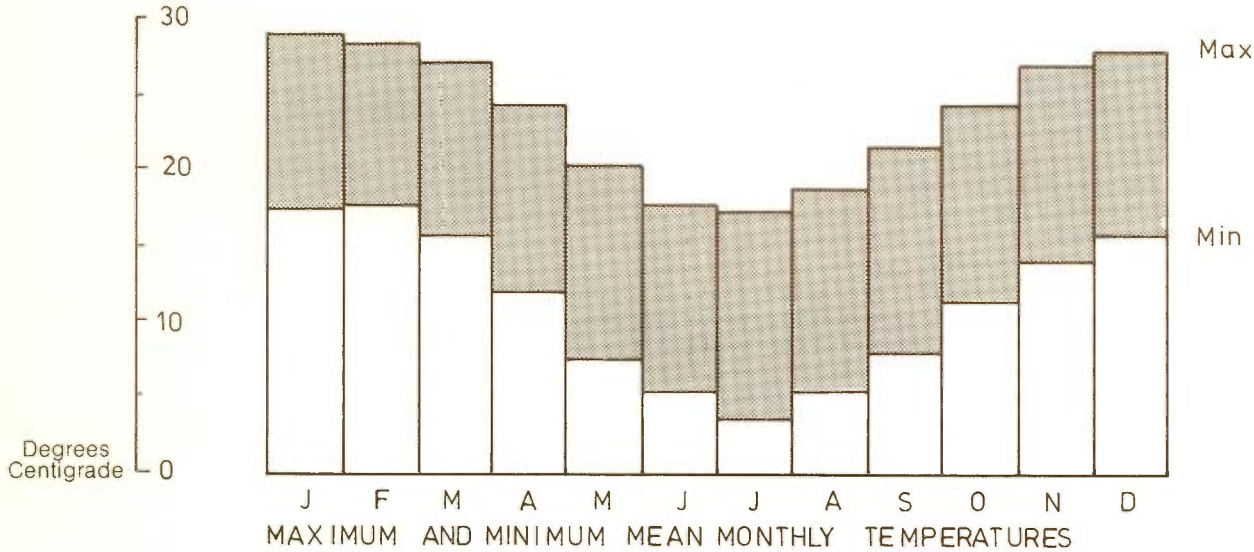
PROPOSED QUARRY LOT 28 MULGOA

POSSIBLE 2 HECTARE LOT SUBDIVISION

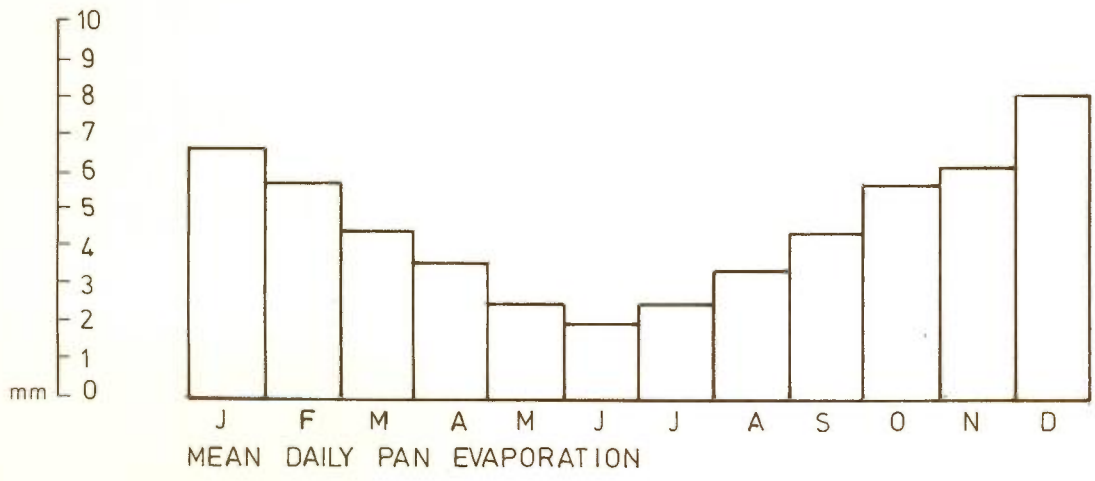
SINCLAIR KNIGHT & PARTNERS PTY. LTD.



MEAN MONTHLY RAINFALL



MAXIMUM AND MINIMUM MEAN MONTHLY TEMPERATURES



MEAN DAILY PAN EVAPORATION

SOURCE: BUREAU OF METEOROLOGY, RAAF RICHMOND

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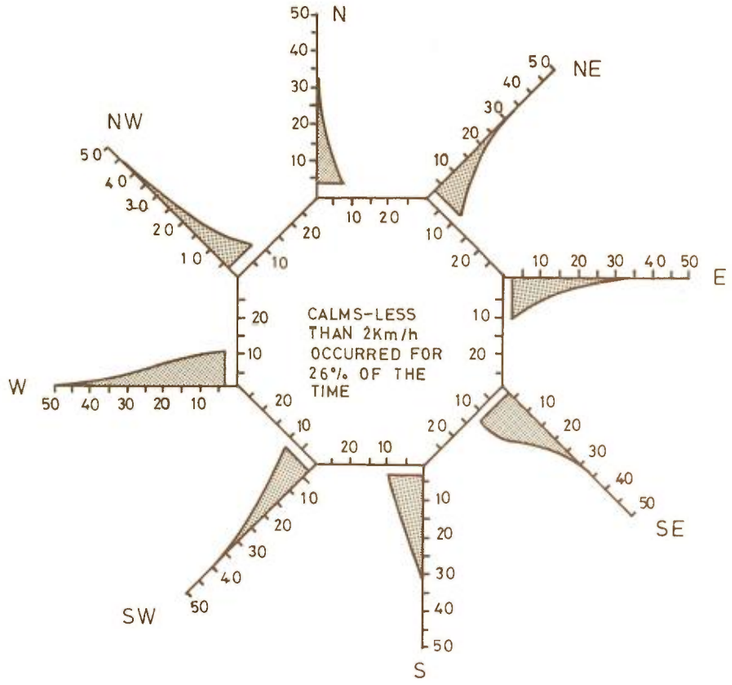
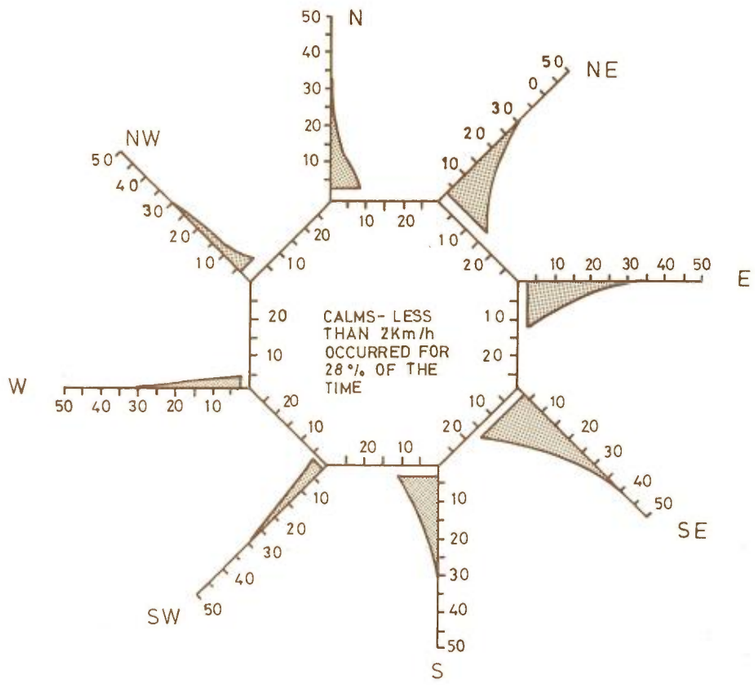
CLIMATIC DATA

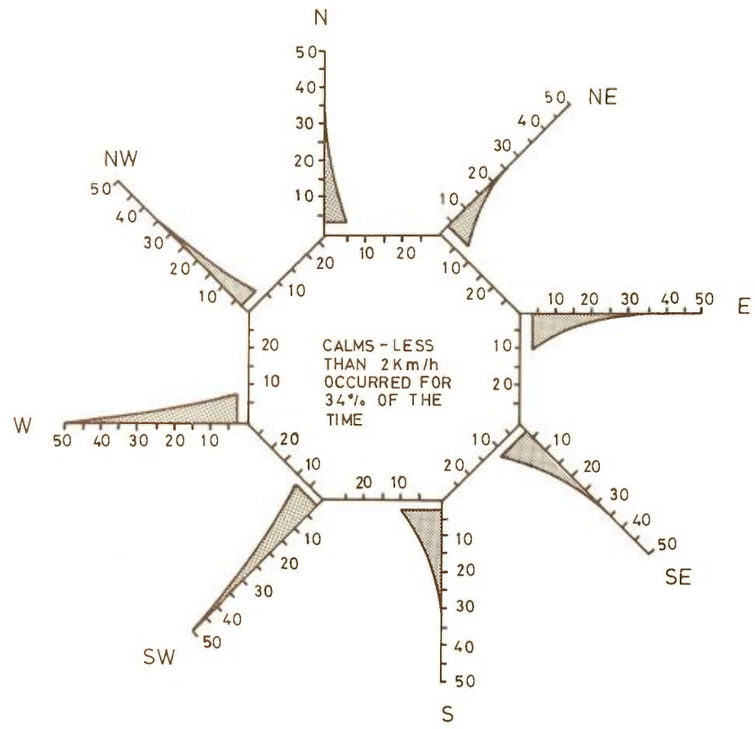
SINCLAIR KNIGHT & PARTNERS PTY. LTD.



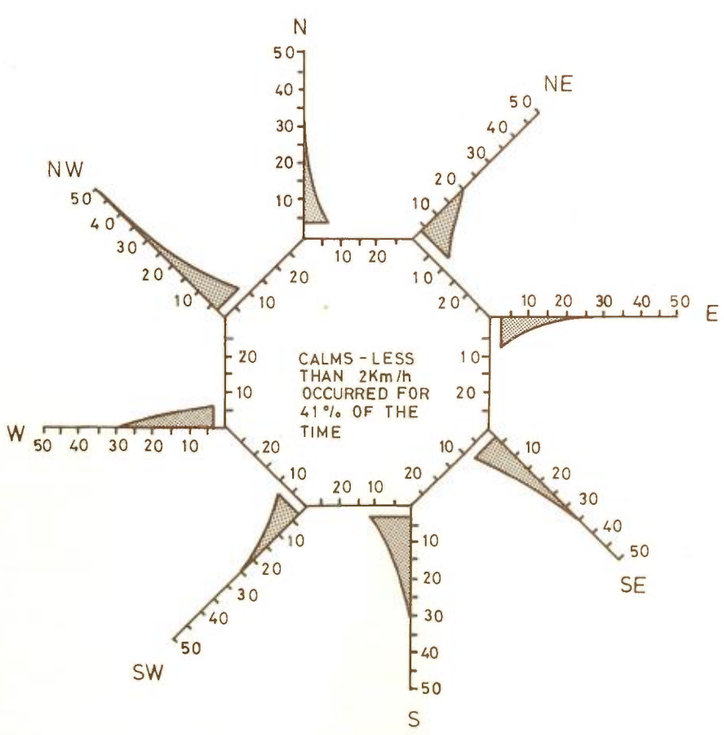
SPRING



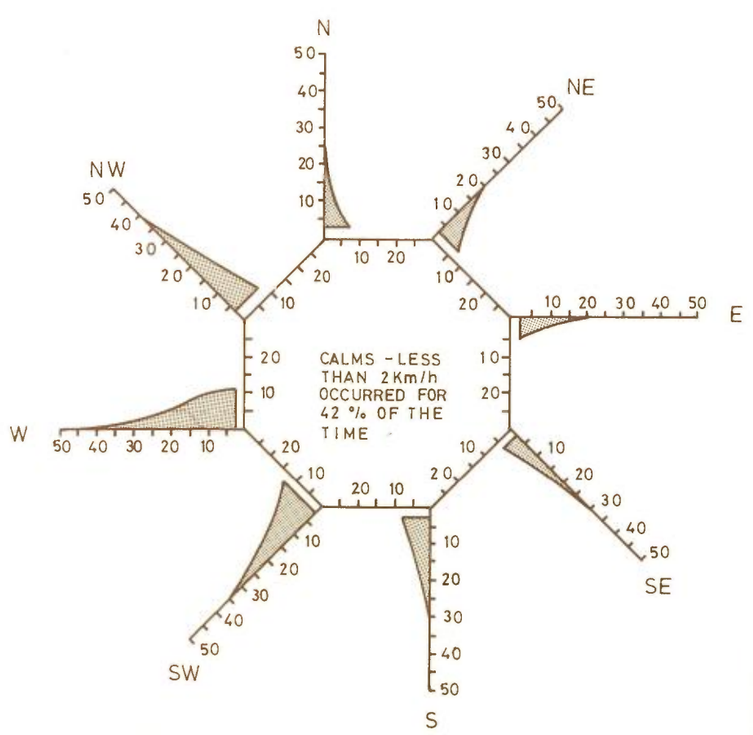
SUMMER



ANNUAL



AUTUMN



WINTER

MULGOA QUARRIES PTY. LTD.
PROPOSED QUARRY LOT 28 MULGOA

SOURCE: BUREAU OF METEOROLOGY, RAAF RICHMOND

WIND ROSES

SINCLAIR KNIGHT & PARTNERS PTY. LTD.

EXHIBIT 8

GOLF COURSE

MOSTLY OPEN PASTURE

MEDIUM DENSE Ev & e.

MOSTLY DEAD A.

LOT 29

MOSTLY OPEN PASTURE

MEDIUM DENSE Ev t & SCATTERED MATURE SPECIMENS OF SAME SPECIES. A, B.

BOUNDARY LOT 28

0 100 200m

MEDIUM DENSE E t, a, e. A, OCCASIONAL An, M, C DIVERSE NATIVE G.C. & W.P.

SCATTERED MATURE E t, e, DENSE A, B.

MEDIUM DENSE MATURE E t, a, e, OCCASIONAL C, A, L, D

MOSTLY OPEN PASTURE

LOT 28

DENSE A OCCASIONAL E.

SCATTERED Ev, MEDIUM DENSE A, B.

SCATTERED MATURE E t, a, e. OCCASIONAL MATURE An MEDIUM DENSE Ev SCATTERED B, A.

MEDIUM DENSE MATURE E a, t, e, SCATTERED A & Ev SHRUB LAYER B.

MEDIUM DENSE MATURE E.

HEALTHY DENSE A.

POOR GRASSLAND SCATTERED MATURE E t, a.

MEDIUM DENSE Ev, t, m, f. SCATTERED A, B UNDERSTORY

SCATTERED Ev, A.

MEDIUM DENSE MATURE E t, a, e, m. OCCASIONAL A, SHRUB LAYER B.

MATURE E f.

EXISTING QUARRY

LOT 21

MEDIUM DENSE MATURE E a, t, e, SCATTERED STANDS OF A & Ev SHRUB LAYER B.

LEGEND

E	GENUS EUCALYPTUS
An	ANGOPHORA FLORIBUNDA
●	MATURE A. FLORIBUNDA
C	CASUARINA CUNNINGHAMIANA OR GLAUCA
M	MELALEUCA STYPHELIOIDES
A	ACACIA MEARNSII
a	EUCALYPTUS AMPLIFOLIA
e	EUCALYPTUS EUGENIOIDES
f	EUCALYPTUS FIBROSA
m	EUCALYPTUS MOLUCCANA
t	EUCALYPTUS TERETICORNIS
r	EUCALYPTUS REGROWTH
B	BURSARIA SPINULOSA
D	DILLWYNIA JUNIPERINA
L	LEPTOSPERMUM LAEVIGATUM
G.C.	GROUND COVERS
W.P.	WATER PLANTS
	PROPOSED QUARRY FENCE LINE
	PROPOSED QUARRY SEDIMENT DAM

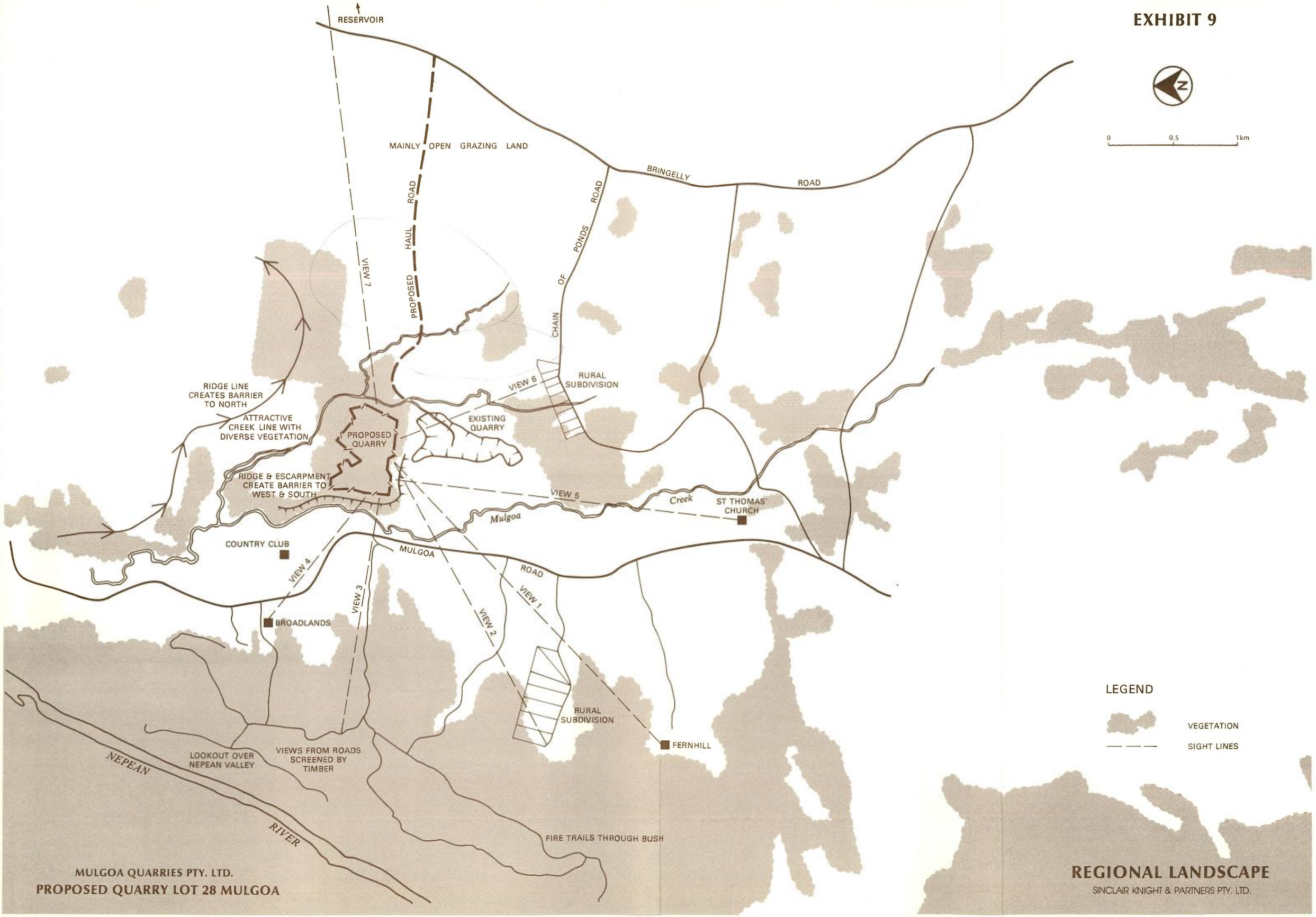
MULGOA QUARRIES PTY. LTD.

PROPOSED QUARRY LOT 28 MULGOA

VEGETATION SURVEY

SINCLAIR KNIGHT & PARTNERS PTY. LTD.

EXHIBIT 9



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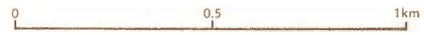
PROPOSED QUARRY LOT 28 MULGOA

REGIONAL LANDSCAPE

SINCLAIR KNIGHT & PARTNERS PTY. LTD.

VIEW 1



VIEW 2

VIEW 3

VIEW 4

VIEW 5

VIEW 6

VIEW 7

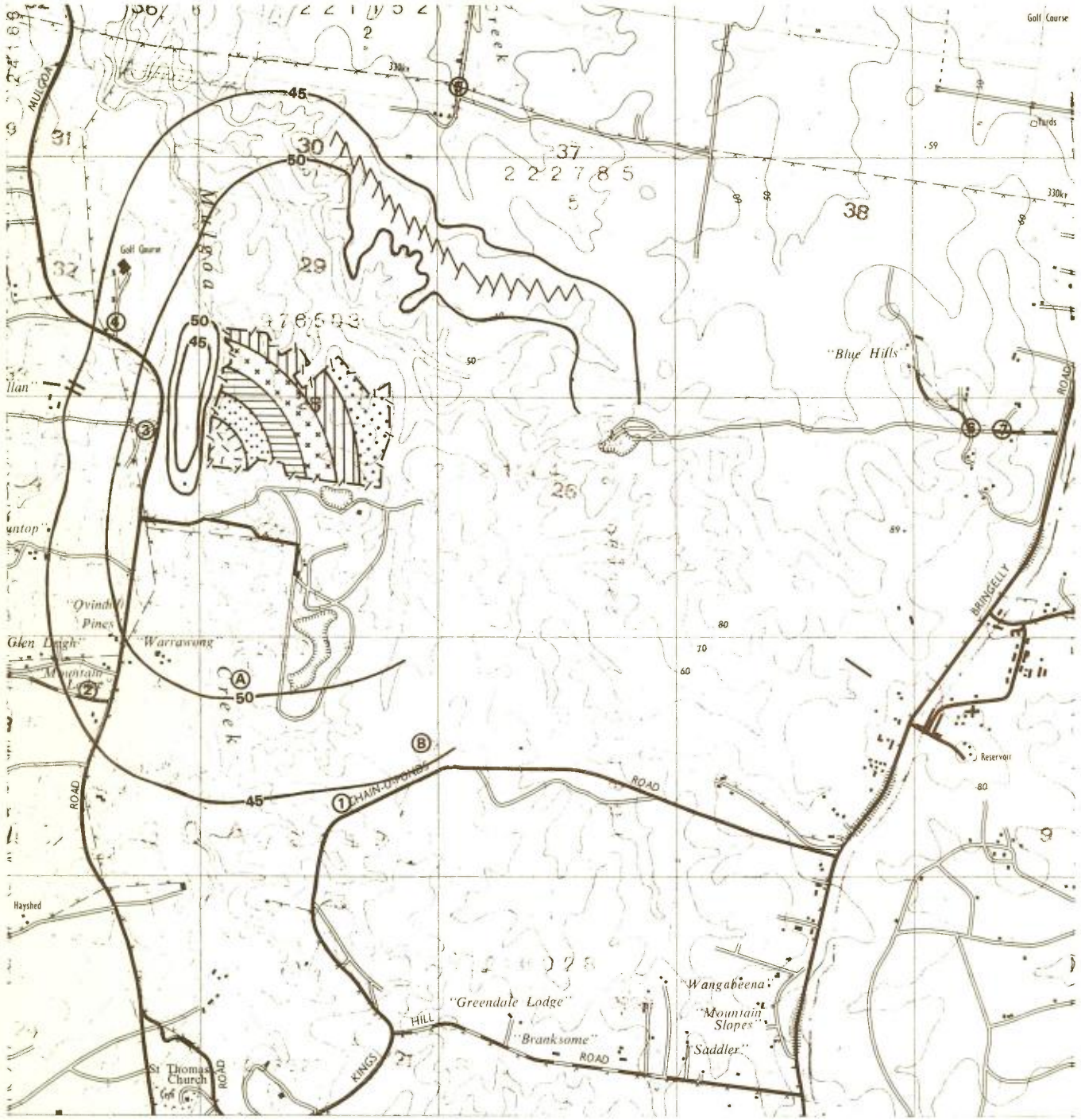
MULGOA QUARRIES PTY. LTD.

PROPOSED QUARRY LOT 28 MULGOA

SIGHT LINES

SINCLAIR KNIGHT & PARTNERS PTY. LTD.

EXHIBIT 11



LEGEND

- ① NOISE MEASUREMENT LOCATION
- Ⓐ BLAST MEASUREMENT LOCATION
- —45— PREDICTED STEADY NOISE CONTOUR (dBA)

RECOMMENDED BLASTING RESTRICTIONS

- MAXIMUM 2 HOLES/DELAY
- MAXIMUM 3 HOLES/DELAY
- MAXIMUM 4 HOLES/DELAY
- MAXIMUM 5 HOLES/DELAY
- MAXIMUM 6 HOLES/DELAY
- MAXIMUM 7 HOLES/DELAY

N

0 0.5 1km

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PROPOSED QUARRY LOT 28 MULGOA

NOISE AND BLASTING ASSESSMENT

SINCLAIR KNIGHT & PARTNERS PTY. LTD.

MULGOA QUARRIES PTY LTD

EIS
193

Proposed quarry on Lot 28, Mulgoa

Borrower's name	Date	Ext

RAECO

MULGOA QUARRIES PTY LTD

EIS
193

Proposed quarry on Lot 28, Mulgoa