EIS 194

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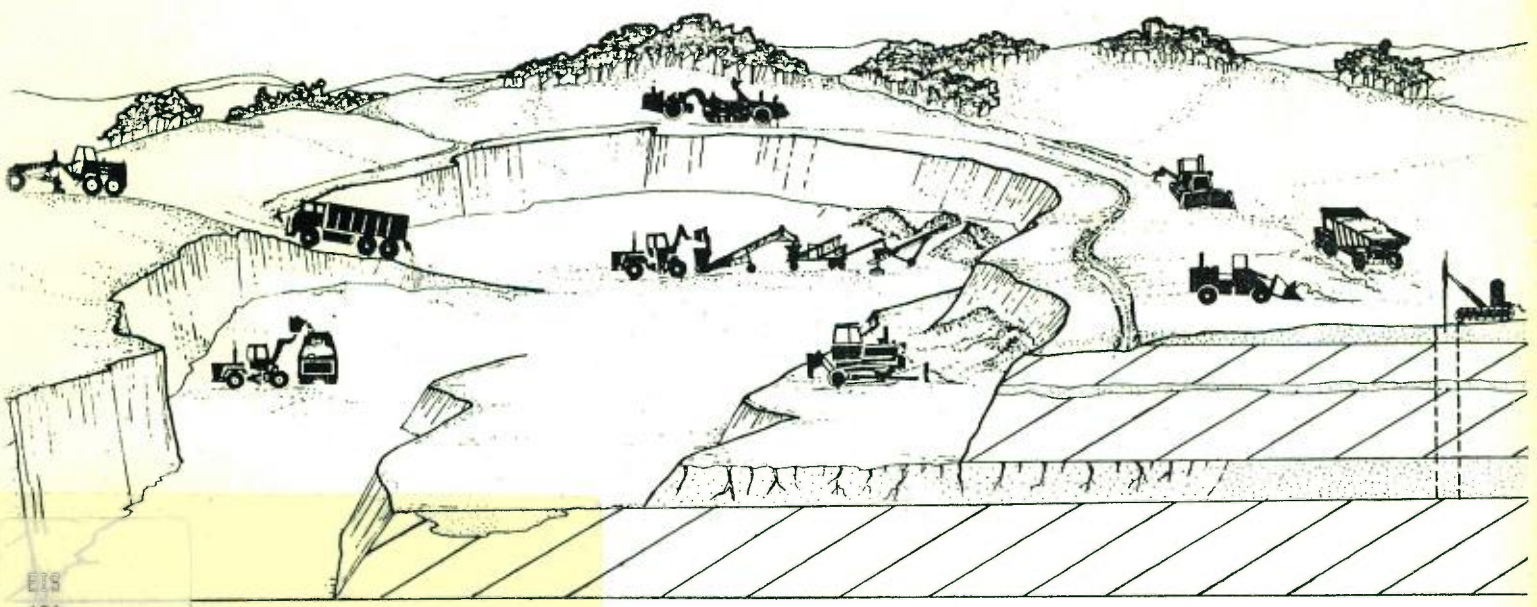
Environmental impact statement -- extraction of materials for brick manufacturing and road making, Mulgoa

MULGOA QUARRIES PTY LIMITED

A MEMBER OF THE WEARN GROUP OF COMPANIES

ENVIRONMENTAL IMPACT STATEMENT

FOR EXTRACTION OF MATERIALS FOR BRICK MANUFACTURING AND ROAD MAKING. MULGOA



RESOURCE PLANNING

EIS 194

M83/1428

MULGOA QUARRIES PTY LIMITED

A member of the

WEARN GROUP OF COMPANIES

ENVIRONMENTAL IMPACT STATEMENT

EXTRACTION OF MATERIALS FOR BRICK MANUFACTURING AND ROAD MAKING, MULGOA.

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February 1983

FORM 4

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

This Statement has been prepared on behalf of

Mulgoa Quarries Pty Limited

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:

The extraction of claystone, siltstone, laminite, and sandstone

The development application relates to the land described as follows:

Lot 1, D.P. 541090. Part portion 26, Parish of Mulgoa, County of Cumberland, City of Penrith.

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

CERTIFICATE

This is to certify that this Environmental Impact Statement has been prepared in accordance with Clauses 34 and 35 of the Environmental Planning and Assessment Regulation, 1980.

Valerie Smith

Valerie Smith
DIRECTOR

Date 7th February, 1983

TABLE OF CONTENTS

TABLE OF CONTENTS (CONT)

TABLE OF CONTENTS (CONT)

TABLE OF CONTENTS (CONT)

TABLE OF CONTENTS (CONT)

TABLE OF CONTENTS (CONT)

LIST OF FIGURES

TABLE OF CONTENTS (CONT)

PAGE

LIST OF FIGURES (CONT)

LIST OF TABLES

LIST OF PLATES

SECTION 1

SUMMARY

1.0 SUMMARY

1.1 OBJECTIVES OF THE PROPOSAL

This environmental impact statement has been prepared by Resource Planning for Mulgoa Quarries Pty Limited a member of the Wearn Group of Companies to accompany a Development Application to Penrity City Council for the extraction of claystone, siltstone, sandstone, and laminite from a site at Mulgoa, 8km south of Penrith. The location of the site is shown on Figure 1.

A total area of 75 hectares is being purchased by Mulgoa Quarries Pty Limited (Lot 1 DP541090) and the quarry will occupy an area of 25 hectares or 33 per cent of this land.

The primary objective of the extractive operation is to make available reserves of claystone suitable for the manufacture of light coloured bricks.

The "by products" produced from the extractive operations (siltstone, laminite, sandstone, and some claystone) are proposed to be used as road materials and in rehabilitating worked out extraction sites.

1.2 DEMAND FOR LIGHT-FIRING CLAY/SHALE FOR BRICKMAKING

Light-firing clay/shale has been in demand for brickmaking since the late 1960's and is of importance in the production of a wide range of brick colours and types. Its primary use is in blends to produce bricks ranging in colour from off white to light apricot/brown; the darker colours being achieved by blending with clay/shale that has a dark firing colour.

Jointly, the brick manufacturing industry in the Sydney region produces over 600 million bricks per year of which 50 per cent contain some proportion of light-firing clay/shale.

Secured reserves of light-firing material total about 13 million tonnes of which more than three quarters are held by two brick manufacturing companies. It has been estimated that 21 million tonnes of light-firing clay/shale will be required by the year 2000. On the basis of present and future demand, most of the pits supplying light-firing clay/shale will be worked out by 1990.

The Wearn Group currently supplies a total of 6 brick manufacturing plants in the Sydney Region, but existing reserves of light-firing material are nearing depletion and will be exhausted in less than 6 months.

Approximately 70 per cent of the total number of bricks produced by these plants use clay/shale from the pits operated by the Wearn Group of Companies at Mulgoa either totally or in some combination with other materials.

The plants produce some 29 per cent of the entire Sydney Region's brick output and have a high degree of dependence upon the light-firing clay/shale from the Mulgoa area.

Studies undertaken by the New South Wales Department of Mineral Resources have shown that the Mulgoa deposit constitutes the largest identified resource of light-firing clay/shale in the Sydney Region. It contains in-situ resources of 18.5 million tonnes.

Mulgoa Quarries Pty Limited is a major supplier of light-firing clay/shale to the brickmaking industry through the operation of the Wearn Industries Pty Limited quarry at Mulgoa.

The proposed development site is being purchased to ensure a continuous and reliable long-term supply of light-firing raw materials to the brickmaking industry, and to provide secure employment for 40 persons.

About 7.3 million tonnes or 67 per cent of the total resource occurs within the area proposed for extraction in this document.

1.3 DESCRIPTION OF THE PROPOSAL

Mulgoa Quarries proposes to quarry claystone for brickmaking and sandstone/siltstone/laminite for road materials from a maximum of 25 hectares (33 per cent of the total holding).

Quarrying will be carried out in a series of 5 stages with a minimum area disturbed at any one time. Rehabilitation of worked out areas will follow progressively to provide a stable and usable landform at the end of quarrying activities.

Where of sufficient thickness and quality, topsoil will be stripped and stockpiled for later respreading. The underlying units with the exception of sandstone, will be ripped, pushed up, and loaded directly into trucks for transportation to the brickworks or for disposal in worked out areas.

Occasionally, claystone may be stockpiled for blending with claystone from other parts of the quarry to provide the required blend for brickmaking.

The more competent sandstone and laminite units will be drilled and blasted. Initially sandstone ahead of the quarry face will be fragmented by blasting over a large area so that overpressure impact will be absorbed by the units above the sandstone. As quarrying proceeds, small scale blasting may be necessary to remove minor sandstone lenses not intersected during the initial fragmentation blasting.

The sandstone will be crushed in a mobile plant on site. The predominant use of this material will be in roadmaking blended with small quantities of laminite or red-burning material to increase plasticity.

An objective of the extraction programme will be the maximum utilisation of the ceramic and potential road construction materials present. However, it is expected that some materials will not meet road material or brickmaking requirements, and will be used initially in the construction of bund walls and roads, and thereafter as filling for worked out extraction sites.

It is proposed that a maximum of 400,000 tonnes of light-firing claystone will be extracted annually and used in brickmaking plants in the western suburbs of Sydney. Total in-situ reserves are adequate to supply the brickmaking industry for 25 years.

Material from the site will be transported on a private haul road to The Northern Road and from there to markets. At peak production, it is expected that daily traffic movements as a result of quarrying activities on this site will be in the order of 120 trucks and 60 light vehicles.

Operations on the site will be conducted during daylight hours (6am to 6pm), six days a week.

Altogether some 40 persons would be employed in quarries operated by Mulgoa Quarries Pty Limited in the Mulgoa area.

A number of alternatives to the proposed extractive operation and transport of materials were considered.

These include:

1. *Alternative sources of light-firing clay/shale.*
2. *Alternative materials for the manufacture of bricks.*
3. *An alternative extraction plan.*
4. *Alternative transport routes.*
5. *The alternative of not proceeding.*

The studies showed that the proposed development will result in valuable reserves of economically extractable light-firing claystone being made available to the brickmaking industry.

Impacts will be low and the environmental management procedures to be adopted are the optimum to protect the existing environment of the site.

1.4 ENVIRONMENTAL MANAGEMENT PROCEDURES

1.4.1 Water Management

* *Upslope runoff will be diverted away from areas disturbed by quarrying operations through a series of diversion channels, constructed in the impermeable clayey subsoils.*

* *To prevent soil erosion it is proposed to limit the area stripped ahead of quarrying activities to a minimum. Grazing activities will be limited to give areas not proposed to be disturbed an opportunity to regenerate naturally. Heavy traffic will be confined to constructed roads and will not unnecessarily traverse undisturbed areas ahead of the face.*

* *The access road will be provided with adequate drainage channels, causeways, and creek crossings.*

* *Runoff from the quarry and working areas will be collected by a system of channels and directed to sedimentation dams for clarification. Following settlement, the water will be used for dust suppression or discharged to the natural drainage system downstream of the site during high flow periods. There will be no dry weather discharge.*

1.4.2 Overburden Handling and Disposal

Material not suitable for brickmaking or road materials will be used for filling excavations to return land in terms of topographic appearance as closely as possible to its original condition.

The overburden will be carted by off highway dump trucks to disposal areas, compacted to a density of about 2.0 tonnes/m^3, graded, contoured and improved by tillage and the addition of fertilisers.

It is expected that there will be sufficient void for disposal of all unused material.

1.4.3 Dust Controls

* *Air quality will be protected by preventing or minimising the quantity of dust produced at potential site generation points.*

* *The access road will be bitumen sealed for 250m from the intersection of The Northern Road to the crest of the ridge and gravelled to the extraction area. Gravelled sections will be regularly maintained and watered.*

* *Exhausts from vehicles using the road will be diverted away from the ground to prevent dust generation and truck loads will be covered to prevent dust emissions. Speeds will be restricted as far as practicable to below 50kph.*

* *The rig used for drilling blast holes will be fitted with dust collection equipment to minimise dust emissions.*

* *The blasting pattern for fragmenting sandstones will be designed to minimise overpressure and the generation of dust. Blasting will not be undertaken during strong wind periods when potential exists for dust to be conveyed towards residential areas.*

* *The quarry face and bund wall will provide protection from prevailing wind directions and shield any stockpiles located on the quarry floor, truck loading operations, and the mobile crushing and screening plant.*

1.4.4 Noise and Vibration Control

* *All access and haul roads will be maintained in good condition and constructed with grades of less than 8.5 per cent. The gentle grades will minimise engine noise generated by laden trucks and by maintaining roads in good condition, noise normally associated with empty trucks will be reduced.*

* *Trucks will not transport materials from the site in convoy and at speeds greater than 50kph as far as practicable. Trucks will be normal roadworthy highway vehicles which will be maintained in good condition and regularly serviced. All mobile equipment will be fitted with noise reduction equipment on exhausts and shielding around motors to ensure levels do not exceed rated values.*

* *An earthen bund wall will be constructed along the northern perimeter of the property and will reduce noise levels from quarrying and hauling operations at proposed residential areas north of the site.*

* *Blasting will be carried out during daylight hours and where possible will take place at the same time of day and during suitable weather conditions. Blasting will not be carried out when strong winds are blowing in the direction of residences, or when there is likely to be temperature inversions in the area. Prevailing meteorological conditions will be checked before blasting.*

* *The operation will be required to be licensed with the State Pollution Control Commission who set limits on overpressure levels and ground vibrations at the boundary of the property.*

* *A 500m buffer zone is proposed between the quarry and residential areas. The buffer zone together with the bund wall and tree plantings will effectively reduce noise levels at nearest residences.*

1.4.5 Screening and Rehabilitation

* *Tree plantings will be carried out initially in the area immediately east of the quarry site at the time of road construction.*

* *A bund wall will be constructed on the northern side of the property and hydroseeded with a mixture of stabilising grasses and indigenous trees and shrubs.*

* *Rehabilitation of worked out areas will be carried out progressively during extractive operations.*

* *Overburden used to fill excavations will be compacted and topsoil respread. Areas will be graded and contoured, and improved by tillage and the addition of fertilisers.*

* *A stable landform suited to a variety of final land uses are possible. Land use options include:*

  - *Residential*
  - *Industrial*
  - *Passive Recreation*
  - *Forestry*
  - *Agriculture*

1.4.6 Controls on Operations

The operation will be subject to compliance with conditions imposed by Penrith City Council and licensed with the State Pollution Control Commission.

Regular inspections are made by inspectors from the Department of Industrial Relations and Council to ensure compliance with safety regulations and imposed conditions.

1.4.7 Environmental Management

In conjunction with the high standard of safeguards incorporated in the design of the project, the Company will carry out regular monitoring and reporting of its operations:

* *Penrith City Council will be provided every two years with a progress report on the stage of operations.*
* *Water samples will be collected and measured on a regular basis and results made available to relevant authorities.*
* *Blasting will be regularly monitored by the Company and results made available to authorities.*
* *A forestry officer will monitor the progress of rehabilitation and screen plantings and provide regular reports on progress.*

1.5 ENVIRONMENTAL IMPACTS

A. NATURAL PHYSICAL ENVIRONMENT

Topography and Slopes: *The proposed quarrying operation will alter the topography of the site by displacing the existing ridge line to the east and lowering the elevation of the ridge by an average of 20m. A gentle slope to the west will be created.*

Geology: *The main alteration to the geology will be the removal of part of the lower 65m of Bringelly Shale occurring in this area.*

Soil Erosion: *The safeguards designed into the project for the control of runoff across disturbed areas will minimise impacts on soil erosion. It is expected that areas under rehabilitation or temporarily disturbed may be subject to some erosion before vegetation becomes established. These areas will be quickly repaired as part of site management procedures.*

Surface Drainage: *The existing flow directions of stream courses will be partly modified by quarrying activities.*
There will be some reduction in flow downstream of the site as a result of sedimentation dams. As existing flows are intermittent and the area contributes only 3.6 per cent of flows to the unnamed creek draining the area, retention of runoff is expected to have an insignificant impact on creek flows.
Upstream flows diverted around disturbed areas will rejoin water courses downstream of the site without altering the hydraulic characteristics of the channels.

Flooding: *Safeguards for the control of runoff from the site will prevent downstream flooding. The site is above known flood levels associated with the Nepean River.*

Groundwater: *The quarrying activities will not interfere with groundwater aquifers. Some minor flows into the quarry from groundwater sources may occur but these will be collected and treated.*

Water Quality: *Sedimentation dams constructed downstream of all disturbed areas will ensure that the contribution of suspended solids to flows will be low. With retention of runoff in sedimentation dams, discharge can be expected to be of better quality than existing runoff. The impact on water quality downstream will be low.*

Air Quality: *The potential for airborne dust to be carried to residences on The Northern Road, Chain-O-Ponds Road, or to proposed residential areas north of the site is minimised by the natural screening provided by the ridgeline east of the site, the screening from tree planting programmes, and the screening and filtering effect provided by the natural forest, bund wall, and buffer zone. It is expected that impacts from dust, in an area already exposed to a degree of airborne dust from agricultural activities, will be low.*

Native Vegetation: *The proposed quarrying operation will have minimal impact on native vegetation communities. The land is predominantly cleared grassland with scattered stands of trees left as shade for grazing animals. Clearing for the proposed internal haul road will have an unavoidable impact on the* E. viminalis - E. pilularis *closed-forest on the eastern side of lot 28. No areas of rare or endangered vegetation communities will be cleared and areas containing the protected species* (Casuarina cunninghamiana) *will be avoided.*

Wildlife and Habitats: *Clearing for the internal haul road on the adjoining land to the west will result in some loss of habitat for fauna using this area.*

Visual Impacts: *The quarry will be screened from the north or northeast for the first 10 years of operations, but will be visible from highlands west of Mulgoa Road. It is expected that as quarrying proceeds to the east, the operations will be visible above the tree screen initially planted on the eastern perimeter. Operations will be visible in Penrith South and from The Northern Road during later stages of the operation.*

B. MAN-MADE PHYSICAL ENVIRONMENT

Aboriginal relics and historical sites: *An extensive archaeological survey resulted in one broken edge ground axe being found. The site however is not considered one of archaeological significance. The quarry area will be remote from historical sites at Glenmore and Mulgoa.*

Planning: *The creation of a buffer zone on the northern side of the proposed quarry site will restrict the area that can be developed for housing in this area in the short to medium term. The buffer zone will have a beneficial effect by eliminating potential land use conflicts that arise when residential development is sited immediately adjacent to quarrying activities.*
The resource of light-firing claystone has been identified as being of significance and importance in the development of regional planning strategies.

Land Use: *The quarry will be located in an area currently used for horse and cattle grazing. The loss of this grazing land is not expected to result in a shortage of suitable grazing land.*
Impacts on agriculture, residential areas, recreational and special uses, and natural areas will be low.

Roads: *The proposed access road between the quarry and The Northern Road will be privately owned, constructed and regularly maintained by the quarrying Companies.*
The intersection with The Northern Road will be upgraded for 350m and provided with turning lanes to ensure the safe turning of vehicles. The cost of this upgrading will be borne by the quarrying Companies.
The addition of 48 heavy vehicles on The Northern Road to the north between the site and the Western Freeway between 6am and 6pm will increase total traffic levels by 0.6 per cent. The addition of 72 heavy vehicles on The Northern Road between the site and Elizabeth Drive turnoff will increase total traffic levels by 0.87 per cent between these hours. Overall, the increase in quarry traffic is only 1.5 per cent on existing vehicle levels between these hours. Since the travel distance between the quarry and the brickworks will be considerably shortened by the new route there will be considerable saving in fuel and hence a reduction in energy requirements.

Impact on Energy Resources: *The primary energy use of the proposed quarry will be 28.4×10^{12}J per annum for a 45 week working year. This is negligible compared with the total non-metallic mineral use of energy in New South Wales in 1981-82 of 41.4×10^{15}J.*

Noise Impact: *It is predicted that no existing or known proposed residence should experience noise levels from the quarry more than 5dB(A) above background. Noise levels from trucks on the access road are expected to peak at 66dB(A) at the nearest residence in Bradley Street. Background noise levels at residences along The Northern Road are high as a result of existing high traffic volumes. The additional traffic generated by the quarry operation will not significantly add to these levels.*

Impact from Blasting: *Limits on blast overpressure and ground vibration will be imposed by Government authorities. These levels are well below those recognised as causing damage to buildings. The results of blast tests carried out at the nearby quarry indicate that these limits will not be exceeded.*

C. SOCIAL AND ECONOMIC IMPACTS

Population: *Given that the direct employment contribution is nil there will be no immediate effects on the population characteristics of the area. New industries attracted to the area as a result of the extractive operation will accentuate and service population growth, and "balance-out" the youthful nature of the population so that as a whole the population has a lesser ratio of economically dependent persons.*

Housing, Accommodation and Services: *There will be no effects on housing characteristics nor services and facilities in the area as a result of the proposed development.*

Direct Employment: *The proposed development will not generate any additional direct employment and will not lead to unemployment.*

Indirect and Induced Employment: *With the potential entry of vertically and horizontally linked industry the proposed extractive industry could provide through secondary employment, opportunities for unskilled and unemployed persons in the region.*

Income Generation: *The project will result in a direct income effect from wages and salaries of probably in excess of $4 million together with an associated multiplier effect in the order of $25 million in the first five years of the operation.*
The project could provide a source of secondary employment and, as such would initiate multiplier effects on income generation in the order of $1.5 million.

SECTION 2

INTRODUCTION

2.0 INTRODUCTION

2.1 OBJECTIVES OF THE PROPOSAL

This environmental impact statement has been prepared by Resource Planning for Mulgoa Quarries Pty Limited a member of the Wearn Group of Companies, to support a Development Application to Penrith City Council for the extraction of claystone, siltstone, sandstone, and laminite from a site at Mulgoa, 8km south of Penrith. The location of the site is shown on *Figure 1*.

The primary objective of the extractive operations is to make available reserves of claystone suitable for the manufacture of light coloured bricks.

There are limited secured reserves of claystone or clay/shale material in the Sydney Region of this quality. Studies undertaken by the New South Wales Department of Mineral Resources have shown that the Mulgoa deposit constitutes the largest identified resource of light-firing clay/shale in the Sydney Region and considered an essential part of a clay/shale management strategy for the region. *(Etheridge 1981b)*.

The "by-products" produced from the extraction programme (siltstone, claystone, laminite, sandstone) will be utilised primarily as road materials or alternatively used for rehabilitating worked out extraction sites.

Material will be removed by a combination of ripping and dozing operations, with drilling and blasting of sandstone and competent laminite units. Material will be trucked to brickworks in the western Sydney Region and utilised in the manufacture of light coloured bricks or in blends to provide a range of brick types.

Between 300,000 and 400,000 tonnes of claystone will be extracted annually.

All operations will be carried out in accordance with the requirements of State and local authorities.

Plate 1. View to the northwest from Sovereign Trig. Station across the Stage 2 extraction area. The existing abandoned shale pit can be seen to the left of the photograph.

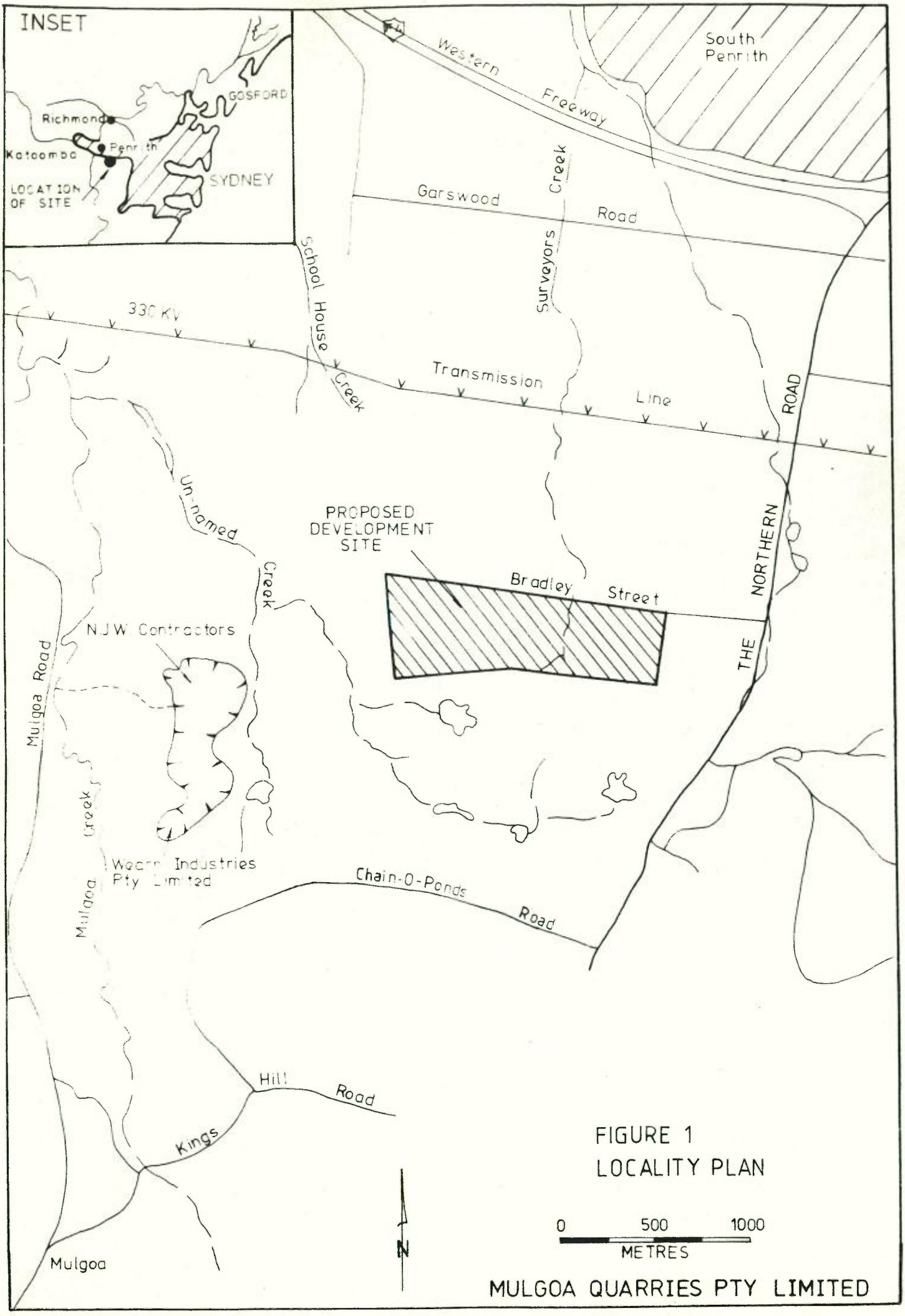


FIGURE 1
LOCALITY PLAN

MULGOA QUARRIES PTY LIMITED

2.2 LAYOUT AND SCOPE OF THE IMPACT STATEMENT

The environmental impact statement has been prepared in accordance with Clause 34 and 35 of the Environmental Planning and Assessment Regulation 1980. The New South Wales Department of Environment and Planning was consulted as to the required form and content and these requirements taken into account in preparation of the Statement.

The document presents information in a number of sections following the approach adopted for investigations. This approach and parts of Clause 34 of the Regulations covered in the sections is summarised below:

1.0 SUMMARY

This section presents a summary of the findings of the environmental investigations.

2.0 INTRODUCTION

This section describes the objectives of the proposed development and describes the scope of the impact statement. The various authorities consulted during preparation of the document are listed and the background to the proposal is presented. (Item b of Clause 34).

3.0 DEMAND FOR LIGHT-FIRING CLAY/SHALE FOR BRICKMAKING

Fundamental to the proposed development is an understanding of the needs and requirements of the brickmaking industry in the Sydney Region. This section examines the industry, demand and production, and the likely future trends. The importance of the Mulgoa deposits in meeting an important part of these requirements is established.
The role that Mulgoa Quarries Pty Limited has played and expects to play in the future in the supply of raw materials to the brickmaking industry is examined. (Item f of Clause 34).

4.0 DESCRIPTION OF THE EXISTING ENVIRONMENT

This section forms the basis for the design of the quarrying operation (described in Section 5.0) by identifying the environmental constraints and opportunities afforded by the Mulgoa site.
The natural physical, man-made, and socio-economic environment of the site and surrounding area are described. (Item c of Clause 34).

5.0 DESCRIPTION OF THE PROPOSED DEVELOPMENT

This section provides full details of the proposed extraction operations including the staging of the operations, drilling, blasting, ripping and loading as well as operator facilities, truck movements and manpower requirements. (Item a of Clause 34).

6.0 MEASURES TO PROTECT THE ENVIRONMENT

The proposed extractive operations have been designed with consideration of the environment of the site. In this section, the measures that have been taken to protect these characteristics are described. (Item g of Clause 34).

7.0 ANALYSIS OF ENVIRONMENTAL INTERACTIONS AND IMPACTS

After the controls and measures have been built into the design of the quarrying operations, the potential environmental interactions must be identified and assessed. This section is an analysis of these impacts. (Items d and e of Clause 34).

8.0 ALTERNATIVES

This section examines the alternatives to the proposed development including the consequences of not proceeding with the project. (Items h and i of Clause 34).

2.3 DISCUSSIONS WITH AUTHORITIES

Discussions were held with a number of authorities and the information obtained used in preparation of the document.

Assistance from the following Government departments and statutory authorities is gratefully acknowledged:

Commonwealth Government

Australian Bureau of Statistics
Bureau of Meteorology
National Trust of Australia
Royal Australian Air Force

New South Wales Government

Department of Environment and Planning
Department of Mineral Resources
State Pollution Control Commission
Housing Commission
Department of Main Roads
Department of Industrial Relations

Local Government

Penrith City Council

The team for environmental investigations is presented in Appendix 1.

2.4 BACKGROUND

The New South Wales Department of Mineral Resources has carried out investigations *(Corkery et al 1980)* aimed at identifying the raw material needs of the brickmaking industry in the Sydney Region and to recommend a future plan of management.

The investigations had been prompted by specific problems that had arisen in the 1970's in ensuring a continuing and adequate supply of light-firing clay/shale for the manufacture of the popular light coloured bricks, and the results of the Culoul Range enquiry *(State Pollution Control Commission 1977)*.

A recommendation of this enquiry was that "the Department of Mines (now the Department of Mineral Resources) undertake a programme to identify and prove sources suitable for long-term extraction of clay-shale for the brick-making industry so as to rationalise the use of these resources as far as practicable and ensure that future demands for these materials can be met" *(p6, State Pollution Control Commission 1977)*.

The investigations by the Department determined that there were very limited secured reserves of light-firing clay/shale available for extraction within the Sydney Region.

The report *(Corkery et al 1980)* identified an area at Mulgoa as warranting further exploration and subsequent extraction of clay/shale.

A "working party" was established at the instigation of Penrith City Council to investigate current and proposed future clay and shale extraction operations in the Mulgoa area. The working party consisted of representatives from Penrith City Council, the Metropolitan Waste Disposal Authority, the Department of Main Roads, New South Wales Traffic Authority, the Department of Mineral Resources, the State Pollution Control Commission and the Department of Environment and Planning.

Since the area designated by the Department as warranting further exploration for clay/shale at Mulgoa covered in part land owned by the New South Wales Housing Commission and subject to increasing pressure for rezoning and subsequent development for residential purposes, it was considered imperative that the light-firing clay/shale resource areas be accurately defined.

This information was required to enable the formulation of a detailed management plan that would ensure the availability of adequate light-firing clay/shale resources in the Sydney Region as well as to identify the impact any future extraction would have on adjacent residential development.

A subsequent drilling and testing programme carried out by consultants *(Resource Planning 1981)* on behalf of the Department of Mineral Resources *(Etheridge 1981a, 1981b and 1981c)* identified an optimum extraction area underlain by significant reserves of light-firing clay/shale.

Guidelines for extraction from this area were prepared by the Department of Mineral Resources and State Pollution Control Commission in conjunction with the Department of Environment and Planning and the Housing Commission.

The findings of the working party are detailed in the report "Report of the Working Party Formed to Examine the Management of Clay/Shale Resources within the Mulgoa Area" and have been taken into account in preparation of this document.

Wearn Industries Pty Limited, a major supplier of light-firing clay/shale to the brickmaking industry in the Sydney Region subsequently purchased Lot 28, (previously identified as being underlain by light-firing material) and part of the optimum resource identified in the Departments investigations. The Company, which currently extracts clay/shale from quarries within the working party study area *(Figure 11)*, has limited reserves of light-firing clay/shale remaining in the existing quarry sites.

The purchase of the proposed development site and subsequent extraction of clay/shale was aimed at providing a continuous and reliable long-term supply of light-firing raw materials to the brickmaking industry, and secure employment for 40 persons.

SECTION 3

DEMAND FOR LIGHT-FIRING CLAY/SHALE FOR BRICKMAKING

3.0 DEMAND FOR LIGHT-FIRING CLAY/SHALE FOR BRICKMAKING

3.1 TYPES OF CLAY/SHALE

To provide a wide range of brick types, the brickmaking industry requires access to a wide range of clays and shales possessing different ceramic properties.

The fired colour of clay/shale is of great importance in marketing the finished product. Usually two or more types of clay/shale, each with a different fired colour are blended to obtain the desired product colour.

Light-firing clay/shale has been in demand for brickmaking since the late 1960's. The primary use of the light-firing material is to produce bricks ranging in colour from off white (little or no other material) to light apricot/brown (blended with darker firing material).

It has been determined that over 50 per cent of bricks manufactured in the Sydney area contain some proportion of light-firing clay/shale. *(Corkery et al 1980)*.

3.2 THE BRICK MANUFACTURING INDUSTRY

There are 22 brick manufacturing plants in the Sydney Region operated by 10 companies including the State Brickworks. Of these, a total of 16 *(shown on Figure 2)* use light-firing clay/shale derived from either on-site pits or purchased from independent suppliers, such as Wearn Industries Pty Limited.

Jointly, the brick manufacturing industry produces over 600 million bricks per year.

Light-firing clay/shale extracted by Wearn Industries Pty Limited is currently supplied to four brick manufacturers and used in a total of 6 plants. *(Shown on Figure 2)*. Approximately 70 per cent of the total number of bricks produced by these Companies use clay/shale from Wearn Industries either totally or in some combination with other materials.

The four Companies produce some 29 per cent of the entire Sydney region's brick output and have a high degree of dependence upon the light-firing clay/shale from the Mulgoa area.

Most brick companies extract all required red-firing clay/shale from pits adjacent to the brickworks, and few problems are expected in meeting future demand for this material provided that resources are secured and properly managed.

3.3 PRESENT SOURCES OF MATERIAL

Light-firing clay/shale used by the brickmaking industry in the Sydney Region is derived from two main geological units.

These are:

a) Bringelly Shale

b) Hawkesbury Sandstone

a. *Bringelly Shale*

Cream or light-firing claystone can be won from certain horizons within the Bringelly Shale by selective extraction. Only two brickmaking Companies currently extract light-firing clay/shale from pits in Bringelly Shale adjacent to the brickworks. Most Companies purchase light-firing material from independent suppliers operating in Bringelly Shale, such as Wearn Industries Pty Limited. The material is usually used as a major component or base material in a blend with other clay/shale.

b. *Hawkesbury Sandstone*

Weathered clay/shale lenses within the Hawkesbury Sandstone fire to white/cream colours. Independent suppliers operating small pits in shale lenses supply light-firing material to the brickmaking industry.

3.4 PRESENT PRODUCTION AND RESERVES OF MATERIAL

The quantity of clay/shale within land currently held by manufacturers of clay/shale products and clay/shale suppliers and for which consent to extract has been obtained are given in *Table 1*.

TABLE 1

SECURED RESERVES OF CLAY/SHALE

Red-firing Clay/Shale	Reserves (million tonnes)
Hawkesbury Sandstone shale lenses	9.6
Ashfield Shale	80
Bringelly Shale	169
Tertiary Clay	5.6
	264.2
Light-firing Clay/Shale	
Hawkesbury Sandstone shale lenses	2.0
Bringelly Shale	11.0
Tertiary Clay	0.1
	13.1

Source: *Corkery et al (1980)*

These reserves are not equally distributed amongst the operating Companies. For instance, more than 8 million tonnes of the reserve of light-firing clay/shale in the Bringelly Shale are held by two Companies (Boral Bricks (NSW) Pty Limited and State Brick).

Reserves held by other Companies are therefore extremely limited.

Approximately 2 million tonnes of clay/shale are produced annually and utilised by the clay/shale based industries in the Sydney Region.

At the present time, light-firing clay/shale makes up more than 30 per cent of demand.

On the basis of present and future demand, most of the pits supplying light-firing clay/shale will be worked out by 1990. In particular, many of the deposits supplying premium quality cream-firing clay/shale from lenses within the Hawkesbury Sandstone will be exhausted in 2 years. *(Corkery et al 1980)*.

The pit of Wearn Industries Pty Limited at Mulgoa is currently nearing depletion and reserves of readily accessible light-firing claystone will be greatly reduced within several months.

Approval to extract from the new areas is imperative if the dependent industries are to be supplied with adequate reserves of light-firing clay/shale to meet current and projected future demands.

3.5 FUTURE DEMAND FOR CLAY/SHALE

In the period 1950 to 1977/79 the average annual growth rate of clay/shale production in the Sydney Region was above 2.9 per cent compound *(Corkery et al 1980)*.

In predicting future clay/shale requirements to the year 2000, the Department of Mineral Resources has assumed a 2 per cent growth rate in clay/shale production. On this basis, about 62 million tonnes of clay/shale will be required in the next twenty years. If it is assumed that during this period an average of 30 per cent of the demand will be light-firing clay/shale, then approximately 21 million tonnes of this material will be required.

3.6 IMPORTANCE OF THE MULGOA DEPOSITS

Comprehensive studies conducted by the New South Wales Department of Mineral Resources have determined that:

1. Secured reserves of light-firing clay/shale in the Sydney Region are of the order of 13 million tonnes of which about three quarters are in the control of two brickmaking Companies. *(Section 3.4).*

2. On the basis of present and future demand, most of the pits supplying light-firing material will be worked out by 1990.

3. By the year 2000, it is expected that some 21 million tonnes of light-firing clay/shale will be required by industry. *(Section 3.5).*

4. The Mulgoa deposits are regarded as the largest identified resource of light-firing clay/shale.

The potential deposits at Mulgoa within the Bringelly Shale occur in four separate areas shown on *Figure 4*. *Table 2* presents the indicated reserves of light-firing clay/shale within these areas, determined from drilling programmes. While these figures represent total in-situ reserves the percentage of material that can be recovered economically and in an environmentally acceptable manner is considerably less.

TABLE 2

POTENTIAL LIGHT-FIRING CLAY/SHALE DEPOSITS AT MULGOA

Location	Landholder	Reserves (million tonnes) Light-firing	Red-firing
Lot 28	Wearn Industries Pty Limited	0.85	1.07
Lot 1 (DP222144)	Zacuba Pty Ltd	1.7	2.25
Lot 1 (DP541090)	Mulgoa Quarries Pty Limited		
Lot 1 (DP224861) and Lot 4 (DP226490)	J. Reddan	11	20
DP222785	Housing Commission	5	
Total		18.55	23.32

Reserves of readily accessible light-firing clay/shale remaining in the operating pits on lots 21 and 22 will be greatly reduced within several months.

3.7 ALTERNATIVE SOURCES

Other deposits of Bringelly Shale contain light-firing clay/shale horizons but few are of sufficient thickness or extent to support selective extraction. Economic deposits require the presence of relatively thick, continuous light-firing claystone horizons coupled with a favourable overburden to light-firing claystone ratio. These conditions exist for the Mulgoa deposits but have not been identified elsewhere within the Bringelly Shale on the same scale.

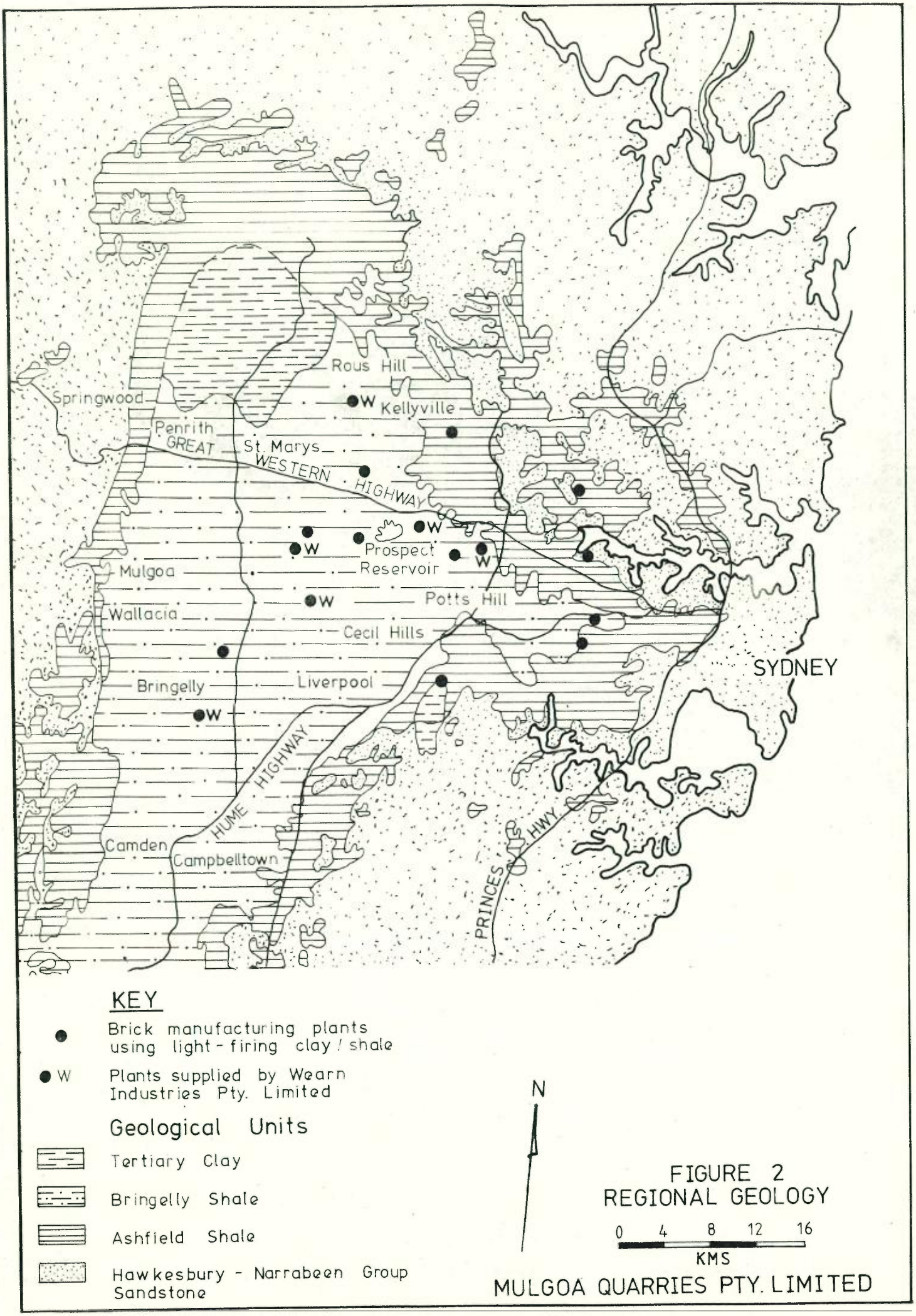
Only two existing brick manufacturers have sufficient light-firing clay/shale within the Bringelly Shale adjacent to their plants to last in excess of forty years.

Four Companies are dependent on light-firing clay/shale extracted from the Mulgoa deposits by Wearn Industries Pty Limited. Three of these Companies have indicated that if they were to substitute alternative materials they would have to modify their current production techniques and, as a consequence, may suffer adverse effects in respect to production costs, output, and quality.

The fourth Company, operating a smaller plant, would be required to cease production of some of its current range of bricks.

Studies conducted by the New South Wales Department of Mineral Resources have indicated that in addition to Bringelly Shale, light-firing material may be obtained from Hawkesbury Sandstone shale lenses, and Pleistocene clay deposits at East Kurrajong. Total identified in-situ resources of light-firing material not in secured deposits for which development consent is sought are in the order of 3 million tonnes for Hawkesbury Sandstone shale lenses and about 6 million tonnes for Pleistocene clay.

Most of these deposits are in environmentally sensitive areas and subject to a number of economic and environmental constraints. Most are more


Rous Hill
Springwood
Kellyville
Penrith
GREAT
St Marys
WESTERN
HIGHWAY
Prospect
Reservoir
Mulgoa
Potts Hill
Wallacia
Cecil Hills
SYDNEY
Bringelly
Liverpool
HUME
HIGHWAY
Camden
Campbelltown
PRINCES
HWY
KEY
Brick manufacturing plants using light - firing clay / shale
W
Plants supplied by Wearn Industries Pty. Limited
Geological Units
Tertiary Clay
Bringelly Shale
Ashfield Shale
Hawkesbury - Narrabeen Group Sandstone
N
FIGURE 2
REGIONAL GEOLOGY
0 4 8 12 16
KMS
MULGOA QUARRIES PTY. LIMITED

distant from markets and since transport costs are a major factor in the cost of the finished product, a cost which must be passed on to the consumer, it is imperative that transport costs be kept to a minimum.

3.7.1 Economic Considerations

The Department of Mineral Resources has determined that "effective management of clay/shale resources in the Sydney region is needed to ensure that adequate supplies of raw materials will be available to industry, and hence to the community at a reasonable price..." *(Corkery et al 1980)*. The Mulgoa deposit is one of the closest and most accessible, and with present technology, the cost of developing this deposit would be less than alternative sites. The rapid expansion of Penrith City places pressure on the exploitation of this source prior to the potential use of the land for residential purposes.

The proposed site is reasonably accessible to the Sydney market and relatively undeveloped, and can be economically quarried for light-firing clay/shale. Development of the site will lessen the problem of potential shortages and, being close to the markets, will lessen the prospect of higher costs of extraction.

Almost all of the large modern brickworks are presently sited on the Bringelly Shale in the Western Suburbs of Sydney and it is likely that additional future brickworks will be similarly located. These plants have seen an opportunity to locate near sources of raw material and also, coincidentally, the areas of rapid growth in population and subsequent housing development, which then provide the current market for the sale of the product. It is expected that the western suburbs will provide a strong demand for bricks well into the future.

Consequently, the proposed development site is not only close to Sydney and the growth centres of the western and southwestern suburbs, but also costs can be maintained at a economic level because a range of

different types of clay/shale can be obtained from the one site, and there are lower dislocation costs as a result of the lower population density in the area. In particular much of the land has a rural or semi-rural land use.

The inherent economic costs which would accrue if this area was not made available for extraction are the transport costs in bringing the resource from other regions further removed from Sydney (including fuel), and the additional wear and tear and potential noise pollution over a much longer road haulage distance.

The scarcity of light-firing clay/shale in the manufacture of bricks and other products is a significant issue as the impact of the growth or decline of the building industry on the overall state economy is significant. Extraction from the proposed development site will aid in continued economic growth. While the Bringelly shale is a large clay/shale resource, conflicting land uses preclude the exploitation of a large proportion of the resource in other areas.

3.8 FUTURE TRENDS

The brickmaking industry provides a wide range of bricks differing primarily in colour, texture, and surface appearance. It is a fashion industry, with each manufacturer endeavouring to produce a range of bricks different from those produced by other manufacturers.

Since the late 1960's consumers have shown a preference for lighter coloured bricks with a variety of different textures and surface finishes.

Industry believes that the consumer will continue to choose lighter coloured bricks and demand a wide range of brick types. General opinion within the industry is that there will be little change to this demand in the future.

3.9 MULGOA QUARRIES PTY LIMITED

3.9.1 Present Activities

Wearn Industries Pty Limited and N.J.W. Contractors currently extract clay/shale for brickmaking from Lots 22 and 21 Mulgoa Road, shown on *Figure 4*. In 1980/81 about 400,000 tonnes of clay/shale was extracted from these two pits and supplied to brickmaking companies. In addition, some 18,000 tonnes of sandstone was extracted and used as road material. *Figure 3* shows production of clay/shale and road material from these pits since 1970.

Wearn Industries has applied to Penrith City Council for Development Consent to extend extractive operations on Lot 22 and for restoration of the excavations by the operation of a waste disposal facility.

3.9.2 Outline of Proposal in the Mulgoa Area

To ensure continued long term supplies of raw materials to industry, Wearn Industries has secured land underlain by light-firing clay/shale of the quality required by industry, and has sought an extension of extractive activities in the existing pit to maximise the resource present.

Environmental Impact Statements are currently being prepared to accompany applications to extend operations on lots 21 and 22 and to dispose of waste within the worked out pits. A previous environmental impact statement was prepared in support of several transport options that were considered for the disposal of waste *(Sinclair, Knight and Partners Pty Limited 1978)*.

Two new areas have been secured by Wearn Industries as long term sources of clay/shale material. These include the proposed development area, and lot 28. (Shown on *Figure 4*).

Since reserves on lot 21 and 22 are nearing depletion, further extraction plans have been designed for the two new sites. An environmental impact statement is nearing completion which will accompany a Development Application for extraction from lot 28.

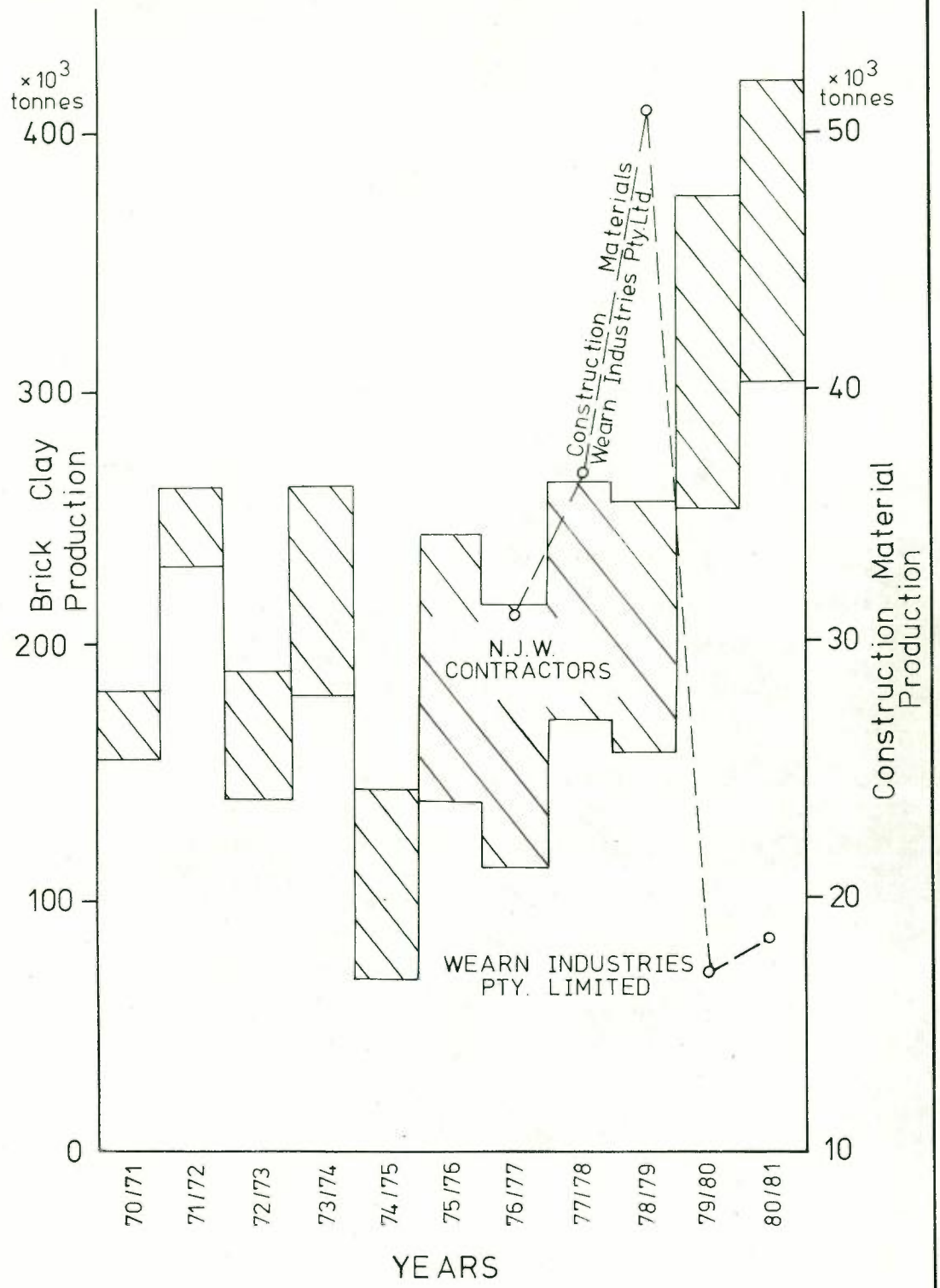


FIGURE 3
PRODUCTION

MULGOA QUARRIES PTY LIMITED

3.9.3 Future Strategy

The strategy proposed for future extraction from lots 28 and the proposed development area has been determined from a consideration of the quality of light-firing resources present on these sites.

The clay/shale resource consists of a highly plastic clay horizon at the surface which may extend to several metres in depth and less plastic, and more competent claystone horizons at depth. To make a brick of satisfactory plasticity usually requires highly plastic material from near the surface to be blended with semi-plastic material from deeper horizons.

Brickworks usually have two pits opened at any one time, or extract from different parts of one large pit simultaneously, to obtain plastic and semi-plastic materials.

Wearn Industries proposes to utilise materials from both the proposed development site and lot 28 to provide both plastic and semi-plastic material at any one time. Drilling has confirmed that the depth of weathering and hence depth of plastic clay is generally greater on lot 28 (10m) than the proposed development site (5m) and there are considerable economic advantages in blending the two materials on site, rather than importing material from more distant sources.

Material on lot 28 has a higher proportion of siderite than material on the proposed development site, but experience in working the material has shown that a high proportion of the siderite can be removed on site through weathering processes. However, to date the siderite rich material has not been marketable as sufficient reserves have not been available to justify the necessary treatment.

By operating two pits, siderite rich claystone from lot 28 can be stockpiled and allowed to weather to produce a marketable material, while siderite free material on the proposed development site can be worked. Blending material from the two sites can also "dilute" the colouring effect of the siderite to achieve the required fired colour.

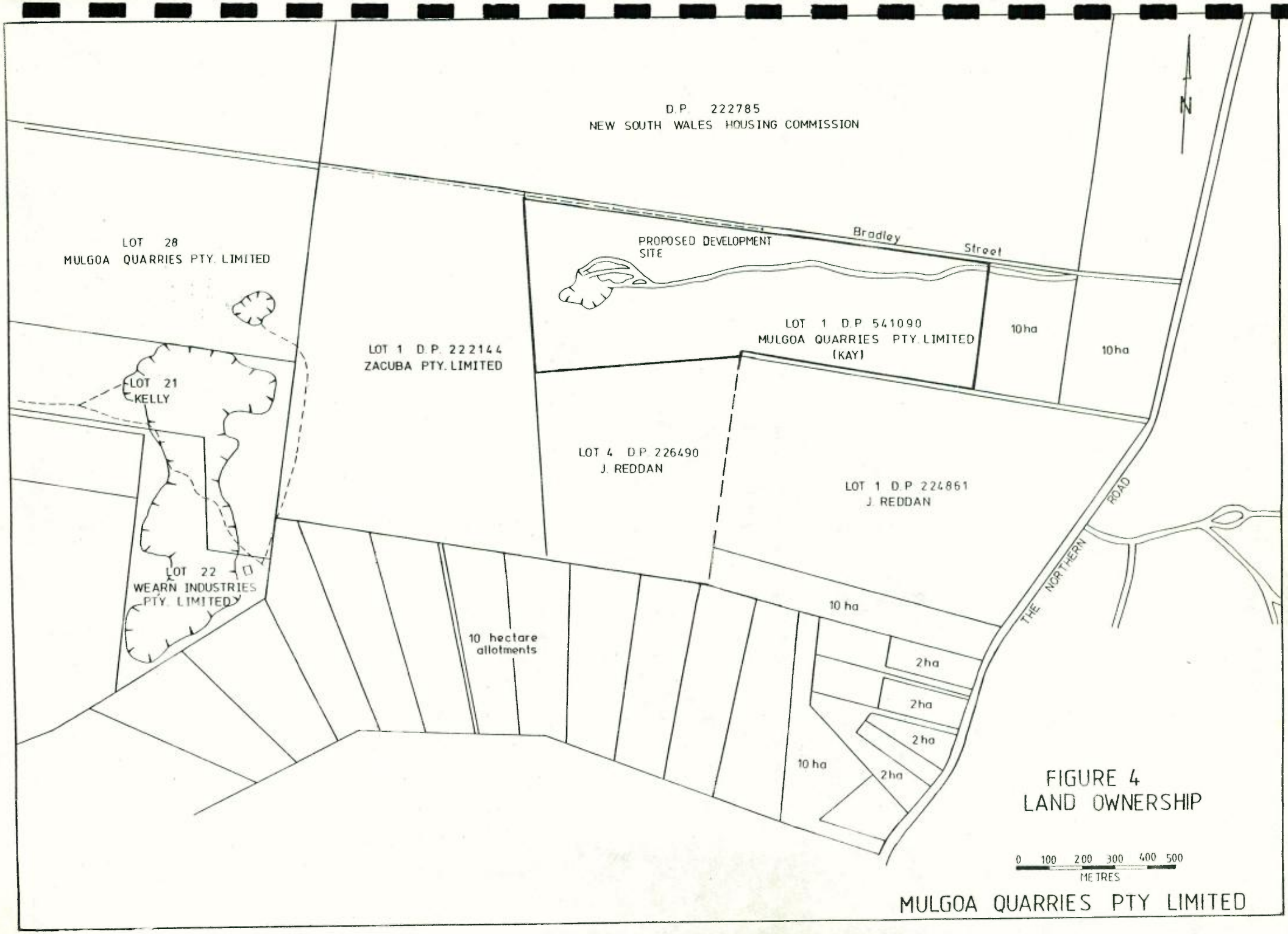


FIGURE 4
LAND OWNERSHIP

MULGOA QUARRIES PTY LIMITED

Consequently it is proposed to work the two sites together to provide at all times the necessary raw material required by customers for brick-making. The two sites complement each other and will be managed to ensure minimal impact on the environment.

Demand for light-firing clay/shale material from the Mulgoa area will be high, up to 400,000 tonnes per annum, or about 8,000 tonnes per week. For maximum resource recovery extraction from the two sites will take place concurrently in a ratio commesurate with the total resource present on both sites. While it is difficult to identify a precise ratio, as variances can be expected during the early extraction phase and with brick sales, it is reasonable to assume that 75 per cent of the annual requirements will be derived from the proposed development site, (i.e., 300,000 tonnes/annum) and 25 per cent from lot 28, (100,000 tonnes/annum).

If material from lot 28 is not available for blending with clay/shale from the proposed development site, it will be necessary to stockpile plastic surface material from the proposed development site for blending with less plastic material from deeper horizons.

The plastic clay/shale will be stockpiled in an area where it will not be disturbed by quarrying activities and blended as required with the semi-plastic materials from the working pit.

Blending material from the two sites maximises the available resource of light-firing clay/shale in the Mulgoa area.

3.10 ASSOCIATED DEVELOPMENTS

Zacuba Pty Limited owns land adjoining the proposed development site. This site is underlain by significant reserves of light-firing clay/shale which the Company proposes to develop in the near future. An environmental impact statement is currently being prepared to accompany a Development Application for extraction from this area.

The Mulgoa resource extends onto the adjoining Housing Commission land north of the proposed development site and on land owned by J. Reddan to the south. Significant reserves of light-firing claystone occur in these areas and it is possible that this material may be extracted in the future. The proposed extraction programme outlined in this document has been designed to ensure that any future extraction proposals on these sites can be integrated with the development programme.

SECTION 4

DESCRIPTION OF THE EXISTING ENVIRONMENT

4.0 DESCRIPTION OF THE EXISTING ENVIRONMENT

A full description of all components of the existing environment is given in *Appendix 2.*

Presented in this section is a summary of the characteristics of the natural physical, man-made, and socio-economic environments of the site.

A. NATURAL PHYSICAL ENVIRONMENT

4.1 LOCATION AND LAND OWNERSHIP

The proposed development site is 8km south of Penrith in an area primarily used for grazing and crop cultivation and is shown on *Figure 1.* It is accessible from The Northern Road by Bradley Street, a two lane gravel road servicing 10 hectare allotments.

The site (Lot 1, DP541090) is being purchased by Mulgoa Quarries Pty Limited a member of the Wearn Group of Companies from J. and D. Kay and includes a total area of 75 hectares.

It adjoins land owned by J. Reddan (Lot 4 DP226490 and Lot 1 DP224861), Zacuba Pty Limited (Lot 1 DP222144) and New South Wales Housing Commission (DP222785). These lands are shown on *Figure 4.*

4.2 TOPOGRAPHY AND SLOPES

The area is moderately undulating with an arcuate ridge forming the main physiographic feature.

Elevations range from 40m AHD in the northeast corner to 92.51m AHD on "Sovereign" Trig Station in the centre of the area. Contours are shown on *Figure 5.*

Slopes are gentle, tending to moderate in the stream gullies. Hillside slopes of 1:20 are common and these are well within the stability limits of shale based slopes in the southwest Sydney Region *(Dunkerly 1972).*

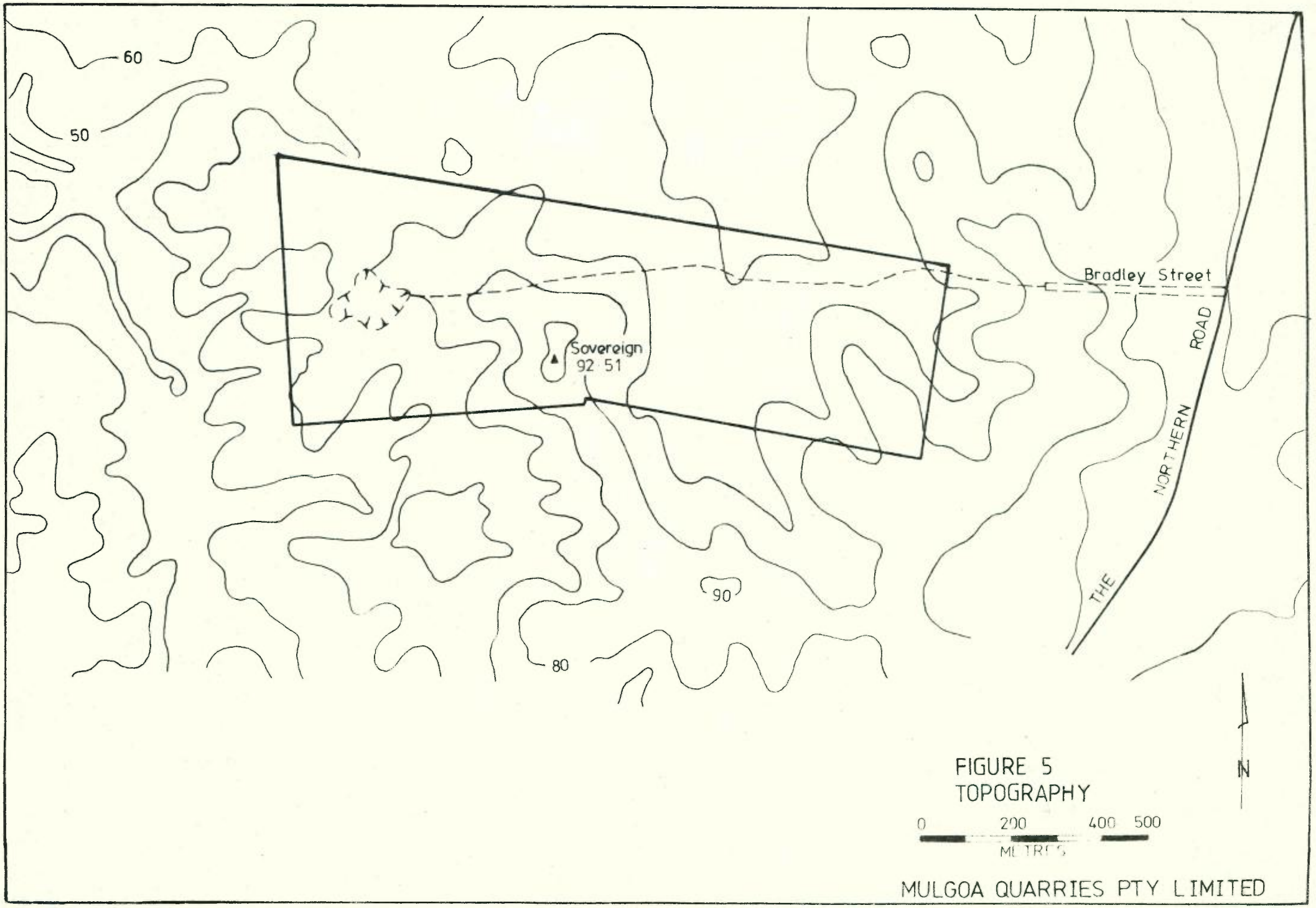


FIGURE 5
TOPOGRAPHY

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4.3 GEOLOGY

4.3.1 Regional and Site Geology

The proposed development site is located within a sequence of interbedded claystone, siltstone and sandstone known as the Middle Triassic Wianamatta Group, which crops out over a wide area to the west of Sydney. *(Figure 2)* The group forms the topmost part of the Permo-Triassic sequence which makes up the Sydney Basin sediments and is divided into 3 formations, the Bringelly Shale, Minchinbury Sandstone and Ashfield Shale.

The proposed development site is located on the lower 65m of the Bringelly Shale. The underlying Minchinbury Sandstone and Ashfield Shale crop out to the west of the site.

The most dominant lithologies present are claystone and siltstone with laminite sequences more common towards the base immediately overlying the Minchinbury Sandstone. Sandstone occurs as lenses throughout the sequences. These generally have limited lateral extent.

Geological cross sections showing lateral lithological variation and interpreted correlations are illustrated on *Figure 7*.

A total of six lithological or facies types, numbered A to F, have been identified. Their extent and characteristics are shown on *Figures 6* and *7*.

4.3.2 Resource Potential

Detailed ceramic testing of clay/shale from the area has shown that most claystone horizons are suitable for brickmaking with a high proportion of units being light-firing. As outlined in *Section 3.0*, the deposit constitutes the largest identified resource of light-firing clay/shale in the Sydney Region.

The interbedded sequences of sandstone, siltstone, and laminite, are potentially suitable for road making material and have been utilised sucessfully in the past for this purpose.

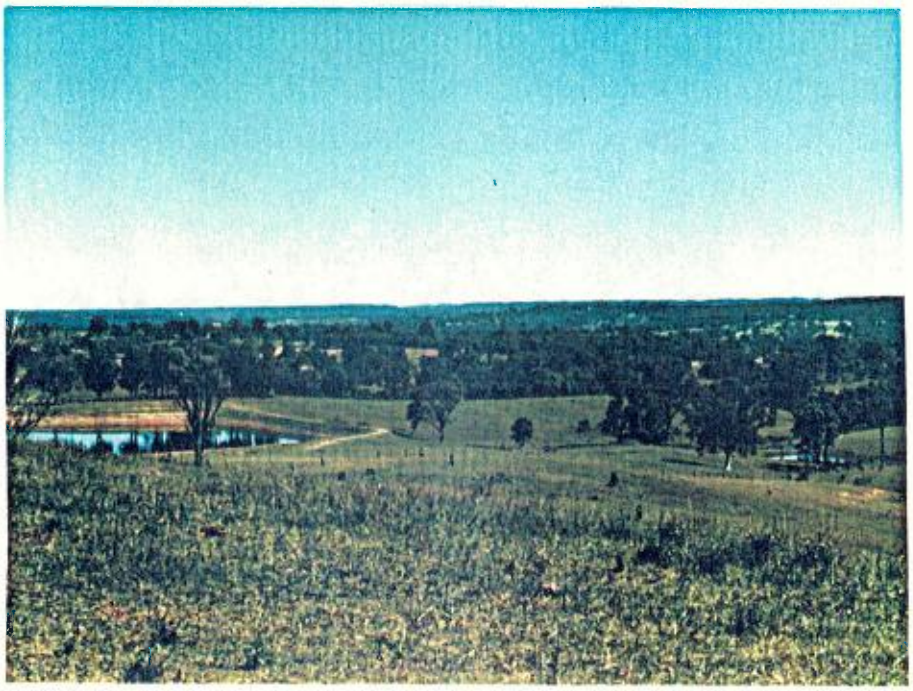

Plate 2. View to the southwest from Sovereign Trig.Station across the large farm dam.The plate shows the gently undulating topography of the grassed hills with vegetation stands retained in the water courses.

Plate 3. Interbedded sequence of claystone and laminite with a thin sandstone lens (top) exposed in the operating pit of Wearn Industries Pty Ltd at Mulgoa.

4.3.3 Extractive Industries

Clay/shale is currently extracted from the shale pit of Wearn Industries Pty Limited adjacent to the western boundary of the site as shown in *Figure 1*. In 1980/81, about 300,000 tonnes of clay/shale was extracted from this pit and supplied to four major brickmaking companies for use in a total of six brick plants. In addition, some 18,000 tonnes of sandstone was extracted and used as road material. *Figure 3* shows production of clay/shale and road material from this pit since 1970.

Reserves of clay/shale in this pit are nearing depletion.

N.J.W. Contractors Pty Limited also extract clay/shale from a pit adjacent to the northern end of the pit of Wearn Industries Pty Limited. Material is selective extracted and blended on site and used in two older type brick plants.

A small clay/shale pit was operated in the proposed development area in the mid-1960's-early 1970's by J. and D. Kay. Operations were short term and only small quantities of material were removed.

4.4 SOILS

4.4.1 Types and Characteristics

Following *Northcote's (1971)* system of soil description and classification, two main groups of soil have been identifled in the proposed development area. These are Uniform (Uf 6.12) and Duplex, including soils from Dr and Db groups. Profile descriptions for the sites shown on *Figure 6* are presented in *Table A3* in *Appendix 2*.

The Uniform profiles are very limited in extent and occur only on hilltops. They are thin clay soils grading directly into weathering shale with little or no A horizon.

FIGURE 6

KEY

QUATERNARY ALLUVIUM	°Qa°	Silt, clay
BRINGELLY SHALE	A	Clay, claystone, siltstone (Claystone ≃ 90%)
	B	Sandstone, siltstone, laminite, minor claystone (Claystone ≃ 11 - 25%)
	C	Claystone, minor siltstone, & laminite (Claystone ≃ 75 - 90%)
	D	Sandstone, laminite, siltstone, minor claystone (Claystone ≃ 0 - 18%)
	E	Claystone, minor laminite & siltstone, Sandstone lenses (Claystone ≃ 80 - 95%)
	F	Laminite, minor sandstone, siltstone, claystone (Claystone ≈ 8 - 18%)
MINCHINBURY SANDSTONE	Rwm	Sandstone
ASHFIELD SHALE	Rwa	Siltstone, laminite

M8 o Borehole location

S1 • Soil Sampling Site

⊗ Location of axe head

A — B Cross Sections (See Figure 7)

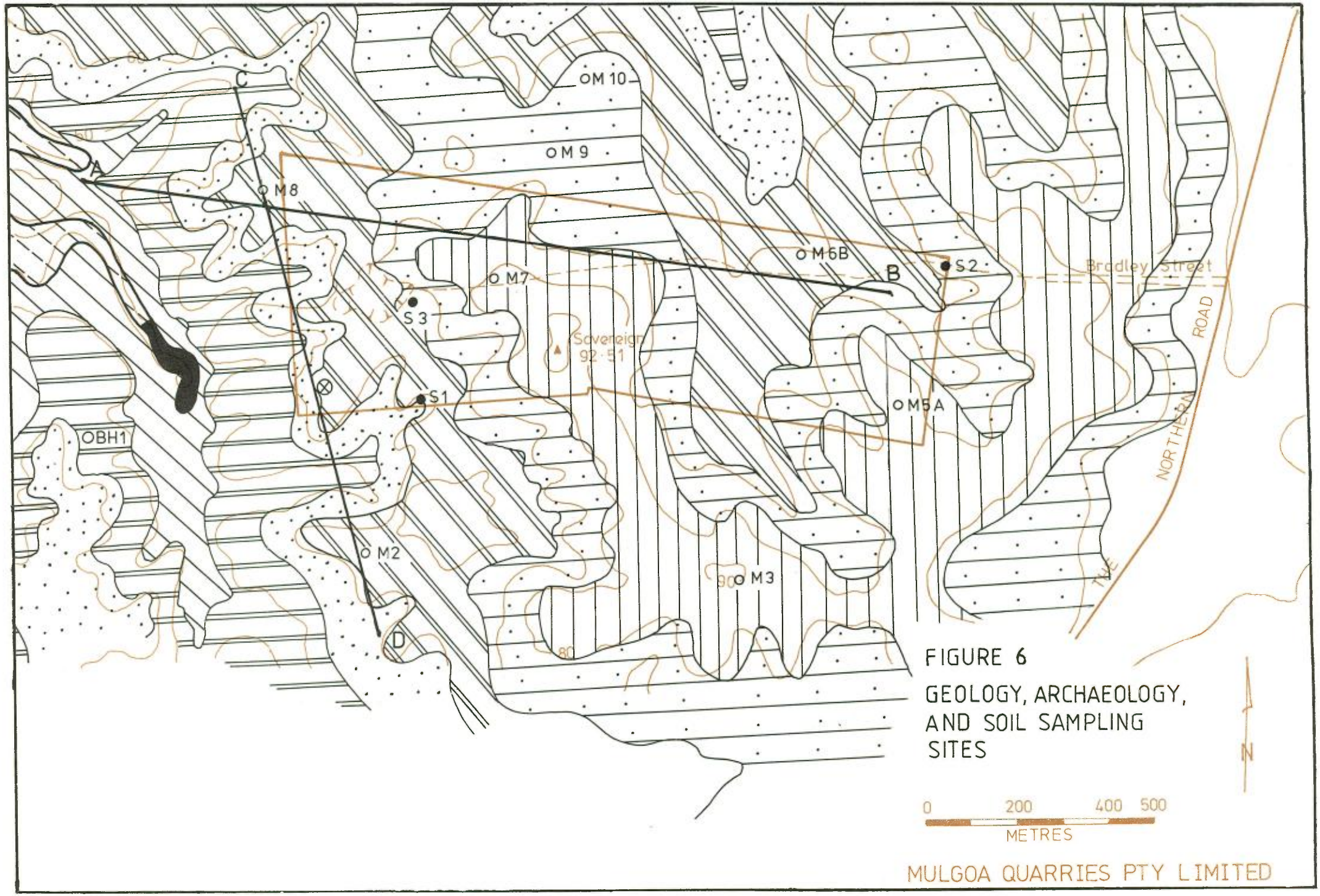

FIGURE 6

GEOLOGY, ARCHAEOLOGY, AND SOIL SAMPLING SITES

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KEY

Lithologies


Uncored


Sandstone


Laminite


Siltstone


Claystone


Slightly Carbonaceous


Carbonaceous

Units

A	Clay Claystone Siltstone (Claystone. ≈ 90%)
B	Sandstone , Siltstone, Laminite Minor Claystone (Claystone ≈ 11-25%)
C	Claystone, Minor Siltstone and Laminite (Claystone ≈ 75-90%)
D	Sandstone, Laminite, Siltstone Minor Claystone (Claystone ≈ 0-18%
E	Claystone, Minor Laminite and Siltstone Sandstone Lenses (Claystone ≈ 80-95%)
F	Laminite, Minor Sandstone Siltstone, Claystone (Claystone ≈ 8-18%)

FIGURE 7

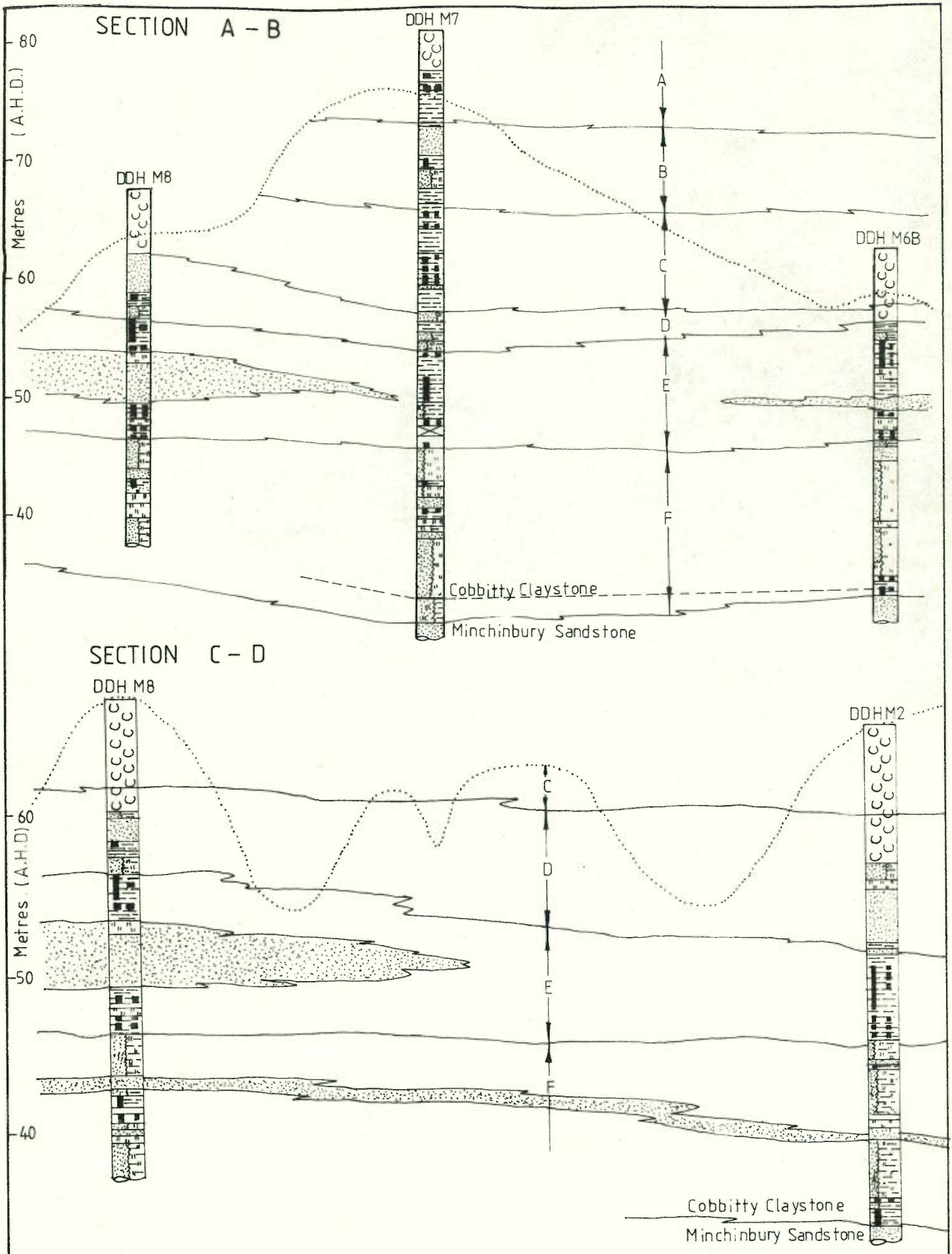


FIGURE 7

GEOLOGICAL CROSS SECTIONS

MULGOA QUARRIES PTY LIMITED

The duplex soil profiles show a combination of in situ weathering, which forms a mottled, highly pedal B horizon, and slow across-slope transport of weathered material which gives a slightly lighter textured (clay loam), but still well structured A horizon. There is little surface accumulation of organic matter, and no A_2 horizon which suggests that the profiles are well drained.

4.4.2 Topsoil

The soils of the study area, which consist of stable clay aggregates and well developed primary and secondary peds of moderate consistency would be suitable for stockpiling and use in rehabilitation. Usable "soil" however rarely exceeds 1m in depth and passes quickly into the underlying weathered claystone/siltstone/sandstone units.

4.4.3 Erosion Potential

The well developed structure and clay texture of the soils considerably reduces erosion potential. Under normal vegetation cover, these soils would be capable of absorbing a high proportion of precipitation by infiltration directly at the surface and along ped faces, thus minimising overland flow. There is some evidence that if vegetation is sparse, as occurs with overgrazing or strip clearing, some sheet erosion and surface scour would occur.

Unformed roads could also be subject to sheet and rill erosion on steeper slopes.

4.4.4 Evidence of Erosion

Small quantities of sediment from the existing small abandoned quarry is contributed to streams downstream from this site. Most of this material appears to come from the floor of the quarry, since the walls of the quarry are relatively stable, and indicates that although the soils have a well developed, stable pedal structure, this may be disrupted by the weight of heavy machinery.

The wall of the large farm dam shown on *Figure 8* also contributes some sediment to streams below.

4.5 HYDROLOGY

4.5.1 Catchments

The extent of stream catchments in the vicinity of the proposed development site is shown on *Figure 8*.

Catchment 1 encloses the upper reaches of Surveyors Creek which flows north to join Peach Tree Creek and the Nepean River at Penrith. A total area of 53.4 hectares of this catchment occurs within the proposed development site.

Streams in Catchment 2 also flow north to join Surveyors Creek in the vicinity of Penrith South.

Catchment 3 includes tributaries of an unnamed stream that rises in the vicinity of Kings Hill Road 1.5km south of the area and flows north to join Mulgoa Creek 1km downstream of the site. To point B immediately downstream of the site the stream and its tributaries drain an area of 595 hectares. Only 3.6 per cent of the total catchment (i.e. 21.6 hectares) occurs within the proposed development area.

The area proposed for development falls within parts of catchments 1 and 3.

4.5.2 Surface Drainage

The drainage pattern within the area is dendritic and all streams are intermittent. Almost all drainage lines are currently incised into shallow pre-existing valley fills. Small nick-point headwalls occur ranging in height from 20cm to 1.5m.

4.5.3 Flooding

The site is well above known flood levels. High streams flows are generally confined within the well defined channels of main creek systems.

4.5.4 Groundwater

No significant groundwater flows were recorded during drilling operations and there is no evidence of significant groundwater seepage into existing pits.

The groundwater table is expected to be below areas proposed for extraction.

4.5.5 Water Quality

Water samples were taken from 7 sites shown on *Figure 8* and analysed in the field for pH and specific conductance using a portable pH/conductivity meter. Samples from sites W1, W2, W3 and W7 were further analysed for a range of chemical parameters.

Samples were taken following a period of rainfall and hence most creeks were flowing. Results are presented in *Tables A4* and *A5, Appendix 2.*

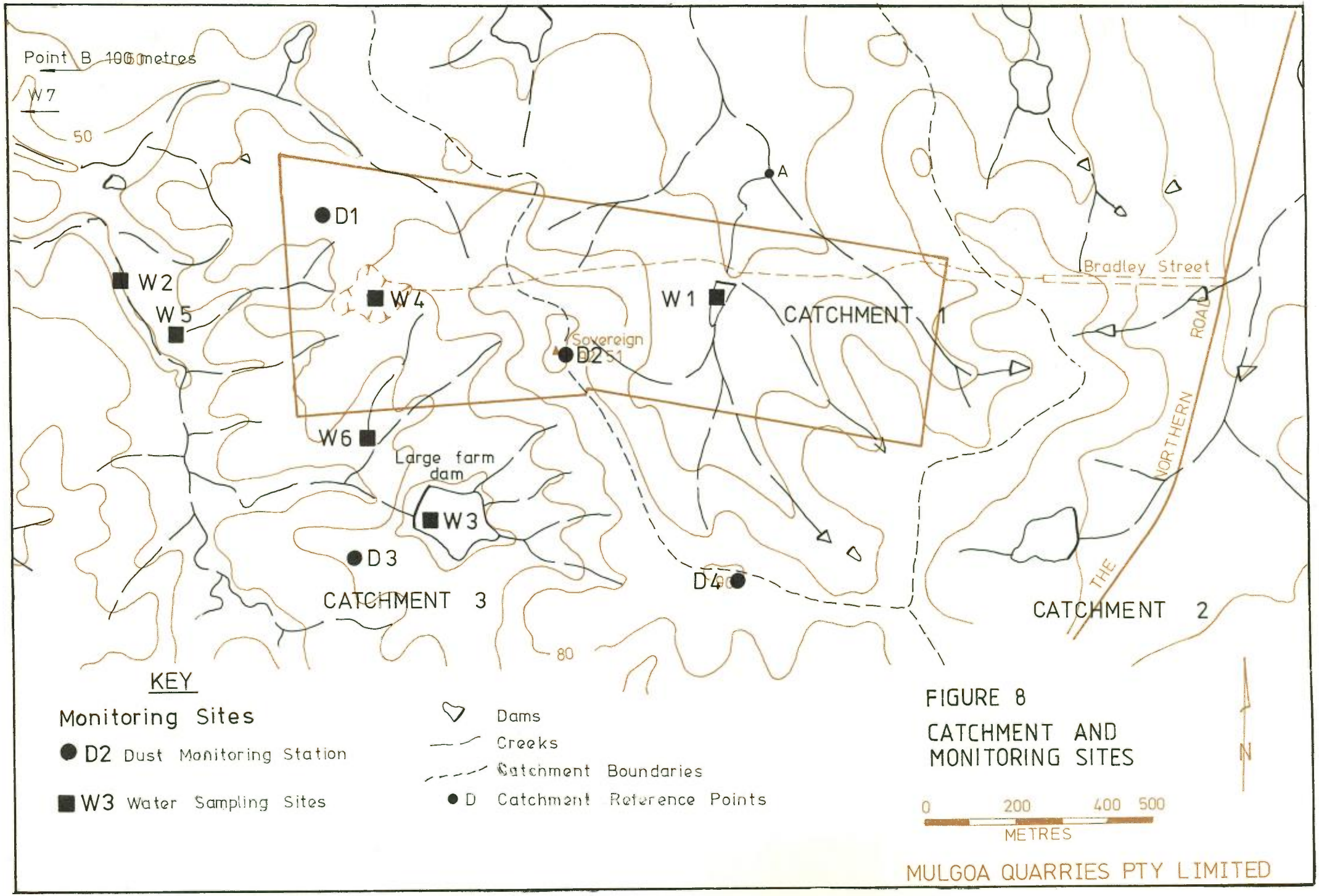
The results show that:

(i) Surface waters are slightly alkaline (pH 7.60-8.70) with the water sample W3 being clearly alkaline (pH 9.40). This is probably a result of surrounding cultivation and grazing activities. For water samples W3 (pH 9.40) and W4 (pH 8.70) the pH level exceeded the maximum permissible level of 8.5 specified in Schedule 2 of the New South Wales Clean Waters Regulations 1970.

(ii) Soluble salts and suspended matter are low to moderate and the water would be suitable for irrigation of most crops.

(iii) The sulphate and chloride levels are below the maximum permissible levels of 250mg/ℓ specified in Schedule 2 of the New South Wales Clean Waters Regulations 1970.

(iv) Total hardness, magnesium and calcium levels are low and the water would be suitable for stock and the irrigation of crops. Hardness levels are


Point B 1060 metres
W7
50
D1
W2
W5
W4
W1
A
CATCHMENT 1
Bradley Street
Sovereign
D2
W6
Large farm dam
W3
D3
D4
CATCHMENT 3
CATCHMENT 2
THE NORTHERN ROAD
80
KEY
Monitoring Sites
D2 Dust Monitoring Station
W3 Water Sampling Sites
Dams
Creeks
Catchment Boundaries
D Catchment Reference Points
FIGURE 8
CATCHMENT AND MONITORING SITES
N
0 200 400 500
METRES
MULGOA QUARRIES PTY LIMITED

below the Australian Water Resources Council's desirable maximum level of 600mg/ℓ for drinking water.

(v) Levels for measured parameters for water samples W1, W2, W4, W5, W6 and W7 are below the maximum allowable impurity level in water for human consumption. For water sample W3, levels for all measured parameters except pH (9.40) are below maximum allowable levels.

4.6 METEOROLOGY

The Penrith-Mulgoa area lies within a region of temperate climate with rainfall maxima in late summer-early autumn and minima in spring. As could be expected, the area experiences a slightly wider diurnal and annual temperature range and a decreased rainfall compared with coastal locations.

4.6.1 Temperature and Humidity

The mean daily maximum for the year is 23.7°C and minimum 11.1°C. Highest temperatures occur in January (29°C) and lowest in July (3°C).

The mean relative 9am and 3pm humidity readings for the year are 72 per cent and 45 per cent respectively. Overall the range of daily humidity readings show little variation.

4.6.2 Inversions and Fogs

Due to cold air movement in the Cumberland Basin during night and early morning periods, an inversion layer occurs and is identified by the brown photo chemical smog. This layer is most common during the mid-autumn-winter-early spring seasons.

The duration of the inversion layer is directly proportional to the prevailing winds and specifically to the heat penetration into the inversion layer in the early morning which tends to diminish the photo

chemical smog from about 10am and through the late morning to midday depending upon the cloud cover and prevailing winds. Inversions are generally dissipated by noon in this area.

4.6.3 Rainfall

Highest falls occur in February (104mm) when rain falls on an average of 16 days per month. Lowest falls occur in September (42mm) on an average of 6 days per month.

The mean rainfall for the year is 812mm.

4.6.4 Wind Speed and Direction

Wind roses for each month of the year are shown on *Figure 9*.

Southeasterly and easterly winds predominate in the middle summer to early autumn and attain speeds greater than 30km/hr for 1-2 per cent of the time.

April is a transition month when wind directions change from predominantly southeasterly to westerly.

Throughout winter and early spring the strongest and most frequent winds blow from the west and attain speeds greater than 30km/hr for 5 per cent of the time.

October through to December is unstable with winds originating from both the southeast and western sectors.

4.6.5 Microclimate

The proposed development area will be located on the western slopes of a north-south trending ridge which provides protection from winds from the south and east quadrants.

The site is flanked by east-west spurs extending from the main ridge to the unnamed creek west of the site but is relatively exposed to westerly and southwestly winds.

The ridge crests are "windswept"; winds have higher speeds on the ridge but become more gentle and turbulent in the lee of the hill. This phenomenon is illustrated by results obtained from air quality measurements. A dust station on top of the ridge (D2) recorded lower particulate levels than a station located in the lee of the hill. (D1).

4.6.6 Air Quality

Four dust monitoring gauges were installed on 19th November, 1981 at the locations shown on *Figure 8* to determine existing levels of particulates in the atmosphere. Samples were collected at monthly intervals (21st December, 1981 and 21st January, 1982) and analysed for total dust.

Results show that during the first month an average of 0.53g/m^2/mth of particulates were deposited on the site and during the second month an average of 5.96g/m^2/mth was recorded. To determine the inorganic fraction the samples were ashed at 450^{o}C. The analyses showed that during the first month, the samples contained an inorganic ("dust") level of 13.9 per cent and for the second month the mean "dust" content was 33.2 per cent. The remainder was organic matter such as blown seeding grasses.

During the months of December and January the prevailing winds blow from the northeast to southeast sector across areas used for grazing and cultivation. It is likely that the high result obtained for the second month was a result of agricultural activities in these areas, as well as from the abandoned quarry on the site.

4.7 NATIVE VEGETATION

4.7.1 Vegetation Assemblages

The area consists predominately of cleared grazing land with small areas of native vegetation retained along water courses.

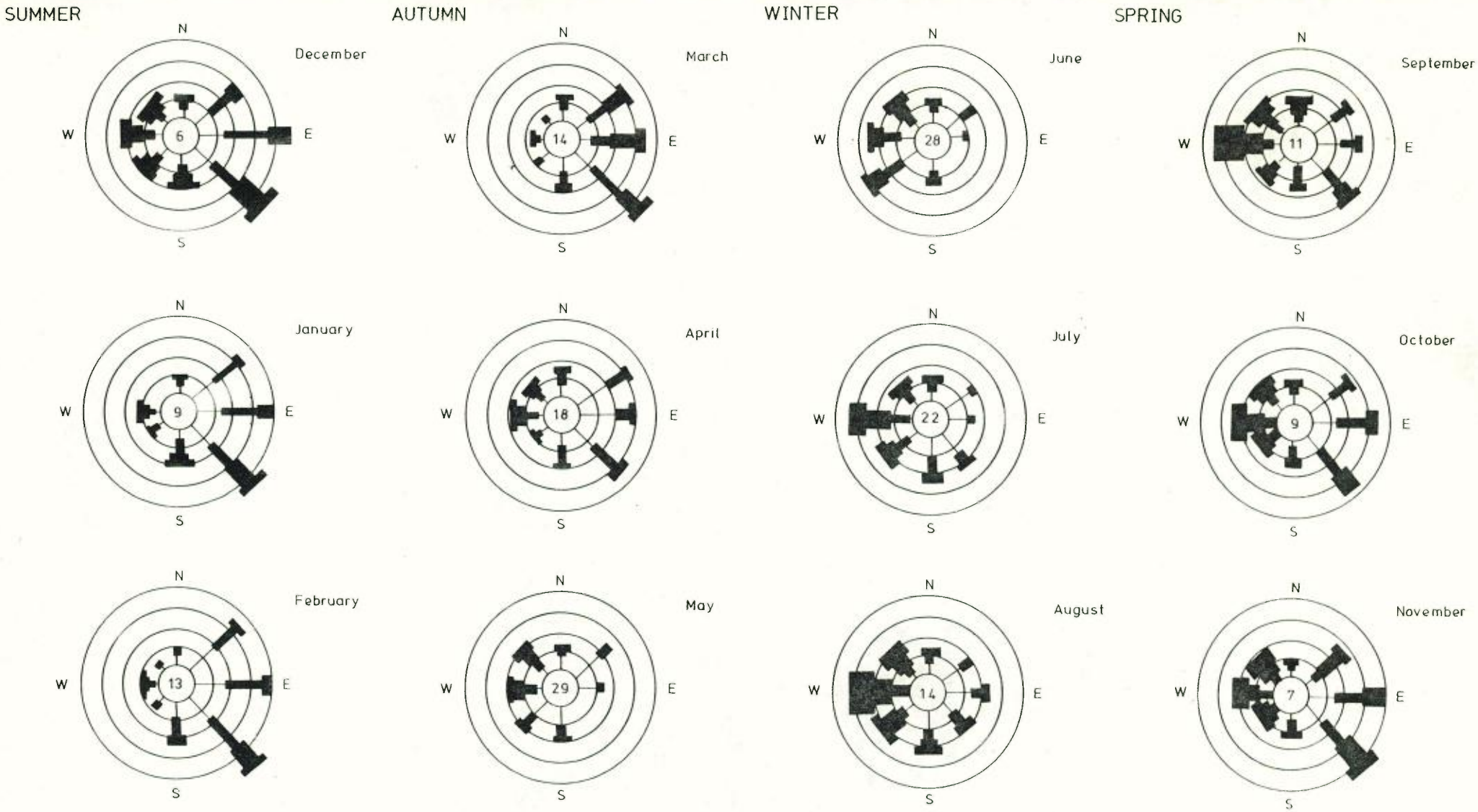


FIGURE 9
WIND SPEED AND DIRECTION

MULGOA QURRIES PTY LIMITED

Assemblages have been described following the structural classification of *Specht et al (1974)*. Species lists are given in *Table A10* in *Appendix 2*.

The areas delineated as "forest" on *Figure 10*, represent small remnants of mature native vegetation, and in some cases, regrowth of new vegetation following clearing. While the structure of the community is best described by the term forest, many areas do not attain the size or diversity normally associated with forests.

Listed below are the structural assemblages found within the area and shown on *Figure 10*. Full descriptions of these assemblages are given in *Appendix 2*.

1. *E. viminalis, E. pilularis* closed-forest
2. *Angophora floribunda* closed-forest
3. *E. pilularis* closed-forest with Boxthorn understorey
4. *E. viminalis, E. pilularis, A. subvelutina* closed-forest with Blackthorn understorey
5. *Lycium ferrocissimum* closed-scrub
6. *Juncus acutus* closed sedgeland
7. *Eucalyptus viminalis, Angophora subvelutina* open-forest with Blackthorn understorey
8. *E. viminalis, E. crebra, A. subvelutina* open-forest with native understorey
9. *E. globoidea* open-forest
10. *Bursaria spinosa* open-scrub
11. *E. viminalis, E. crebra, A. subvelutina* woodland
12. Closed-herbland

4.7.2 Past and present impacts on local vegetation

The area is almost entirely cleared of native vegetation with only small minor remnants occurring in water courses and as shade trees in grazed areas.

Continuous grazing by horses and cattle, and cultivation of land for crops has prevented regeneration of native species. Only to the west of the area, shown on *Figure 10*, where the site is less intensively grazed is regeneration of native species taking place.

The nearby *E. viminalis - E. pilularis - A. subvelutina* closed-forest, although disturbed by trail-bike riding, logging and rubbish dumping leading to the spread of Blackthorn, would be more indicative of the forest types that occurred on the site prior to clearing.

4.7.3 Status and Regional Significance

The flora of the area is typical of the vegetation of the western Sydney Region which has been extensively removed by clearing and cultivation since the early history of Sydney.

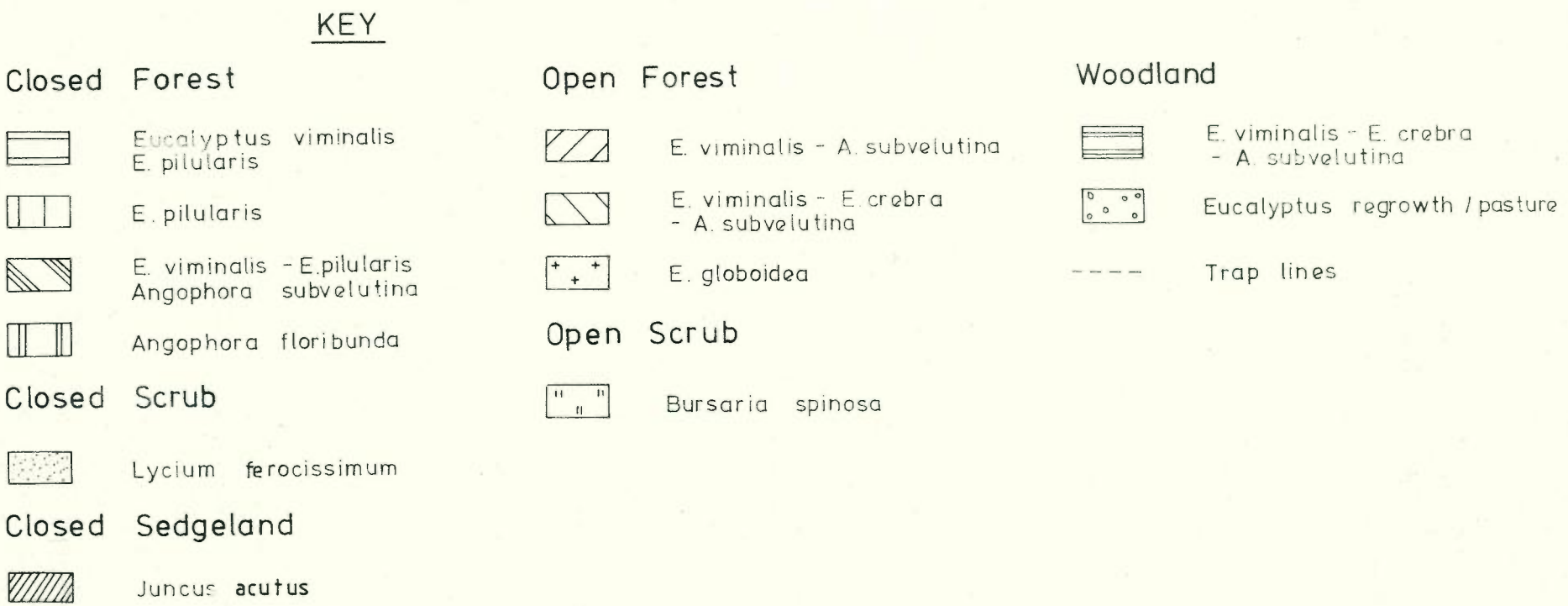
No rare or endangered species were identified in the area and two protected species, *Casuarina cunninghamiana* and *Adiantum aethiopicum* in the *Angophora floribunda* assemblage along the course of the unnamed creek were identified.

4.8 FAUNA AND HABITATS

4.8.1 Mammals

One native arboreal mammal, the Brush-tailed Possum *(Trichosurus vulpecula)*, and 5 individuals of the rodent, the House Mouse *(Mus musculus)* were captured in the forested areas west of the proposed development site during trapping programmes (December 1981 and February 1982). Mammals sighted included the Ring-tailed Possum *(Pseudocheirus peregrinus)* and Rabbit *(Oryctolagus cuniculus)*.

FIGURE 10


KEY
Closed Forest
Eucalyptus viminalis
E. pilularis
E. pilularis
E. viminalis - E.pilularis
Angophora subvelutina
Angophora floribunda
Closed Scrub
Lycium ferocissimum
Closed Sedgeland
Juncus acutus
Open Forest
E. viminalis - A. subvelutina
E. viminalis - E. crebra
- A. subvelutina
E. globoidea
Open Scrub
Bursaria spinosa
Woodland
E. viminalis - E. crebra
- A. subvelutina
Eucalyptus regrowth / pasture
Trap lines

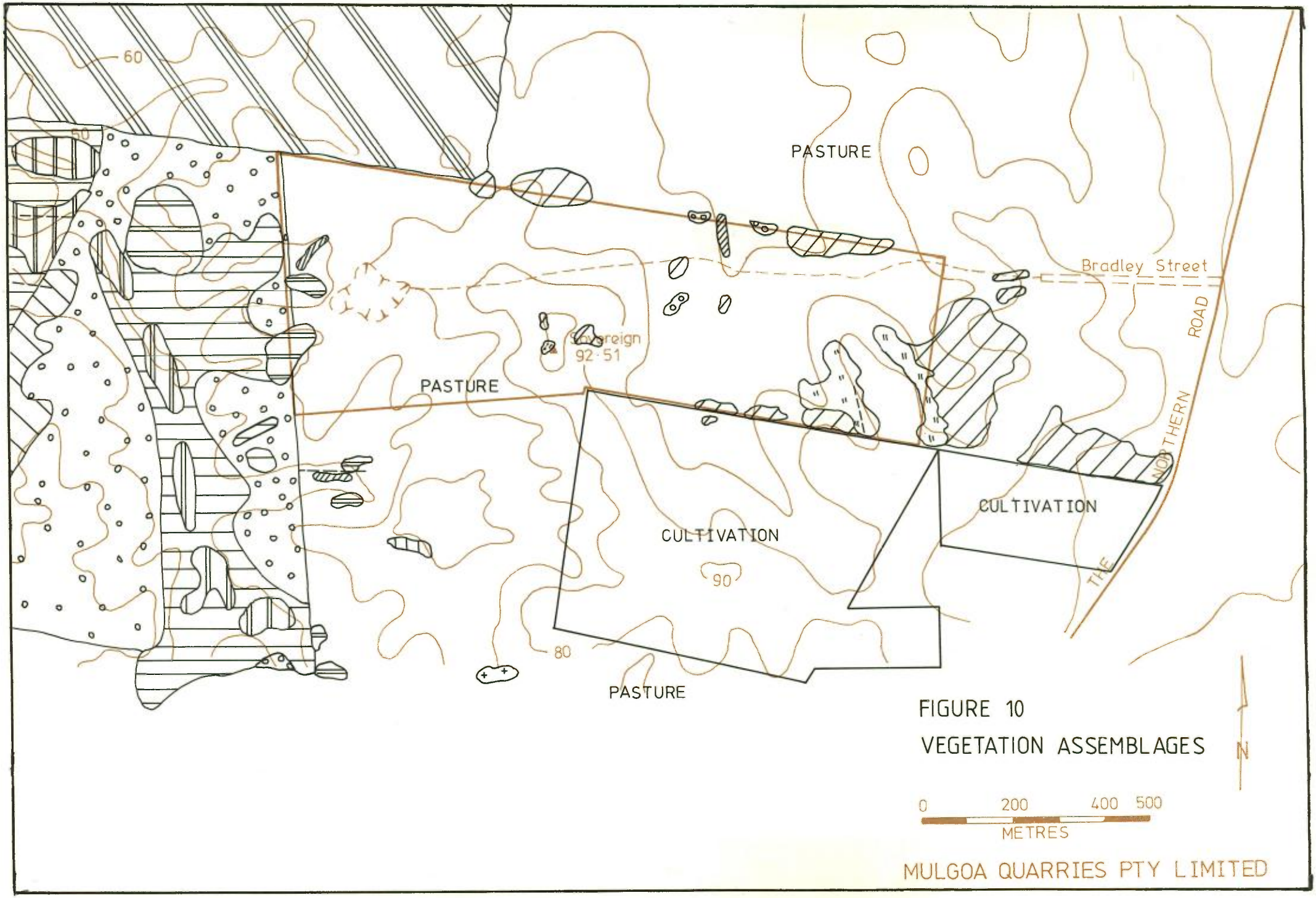


FIGURE 10

VEGETATION ASSEMBLAGES

MULGOA QUARRIES PTY LIMITED

4.8.2 Birds

Twenty nine species of birds were noted within the study area, of which four are introduced species. A full list of species is given in *Table A12* in *Appendix 2*.

The investigations indicated that:

(i) A large proportion of the habitat value of the study area, with respect to birds, is due to the presence of relatively large farm dams which are used by a number of water dependent birds.

(ii) There are a large number of insectivorous species. It has been suggested by *Kingston (1981)* that such an imbalance may be due to the higher production of plants growing on soils derived from shale. A high rate of production by plants will support a greater insect population. It is also evident that many plant species are under stress through insect attack.

(iii) There is a complete lack of strict nectar feeders. This is probably due to the lack of nectar rich vegetation, for example, members of the family *Proteaceae*.

The greatest habitat value for both mammals and birds lies in the patches of native forest, and farm dams.

4.8.3 Reptiles, amphibians and fish

No reptiles or amphibians were recorded during investigations but a few individuals of the Eastern Water Skink *(Sphenomorphus quoyii)* have been previously recorded near the unnamed creek. *(Kingston 1981)*.

One native species of fish, the Finetailed Gudgeon *(Hypseloetris galii)*, and the introduced Mosquito Fish *(Gambusia affinis)* have been recorded previously in the unnamed creek downstream of the site. *(Kingston 1981)*.

4.8.4 Status and Regional Significance

No rare or endangered species were recorded in the area.

The avifauna is generally rich considering the extent of clearing and proximity to habitation. This is due to the presence of a few native trees and regrowth of native trees and shrubs in recent years, and the few large farm dams.

4.9 VISUAL ASPECTS

4.9.1 Regional Scenery

The site consists predominately of gently rolling grassed hills with scattered stands of native trees left to provide shelter for grazing stock. To the south, areas are under cultivation with principal crops being sudex, millet and oats. The site is similar to the general Cumberland Basin landscape between Parramatta and Camden of gentle rolling hills utilised for agricultural pursuits.

Sited on the fringe of the urban areas south of Penrith, the surrounding areas have been subdivided into small farmlets (2, 10, and 40 hectare size). The RAAF and Naval Depot form a more commercial landscape element.

In contrast, the landscape between the historic buildings of St Thomas Church of England, "The Cottage", and Fernhill in the Mulgoa area is considered to be of very high landscape value, *(National Trust of Australia)* having remained essentially unaltered since first described in 1852.

4.9.2 Viewing Points

The prominent arcuate ridge is visible from parts of The Northern Road, Chain-O-Ponds Road and the Western Freeway south of Penrith. The ridge can also be seen from the relatively inaccessible high areas immediately east of the Nepean River but is screened from the Blue Mountains west of the river.

B. MAN-MADE PHYSICAL ENVIRONMENT

4.10 ABORIGINAL PRE-HISTORY

An archaeological survey of the study area was carried out on 9th December, 1981. The survey was intended firstly to locate and record any evidence of Aboriginal occupation of the proposed development site, and secondly to determine the significance of such sites in terms of the understanding of the prehistoric and pre-European culture of the Aborigines of this area. Finally, to determine the desirability of any site preservation for further investigation.

Only one relic was found. This was a broken edge ground axe composed of basalt and measuring 10 x 7.2 x 3mm *(Brayshaw 1981)*. The location of this site is shown on *Figure 6*.

The rare sandstone outcrops in gully floors to the west did not display any axe grinding grooves or small engravings. It is possible that this sandstone was not exposed in pre-European times.

The lack of suitable rock outcrop precludes quarry sites or rock art sites, and the clay soil is too stiff to have been excavated by Aborigines for burials.

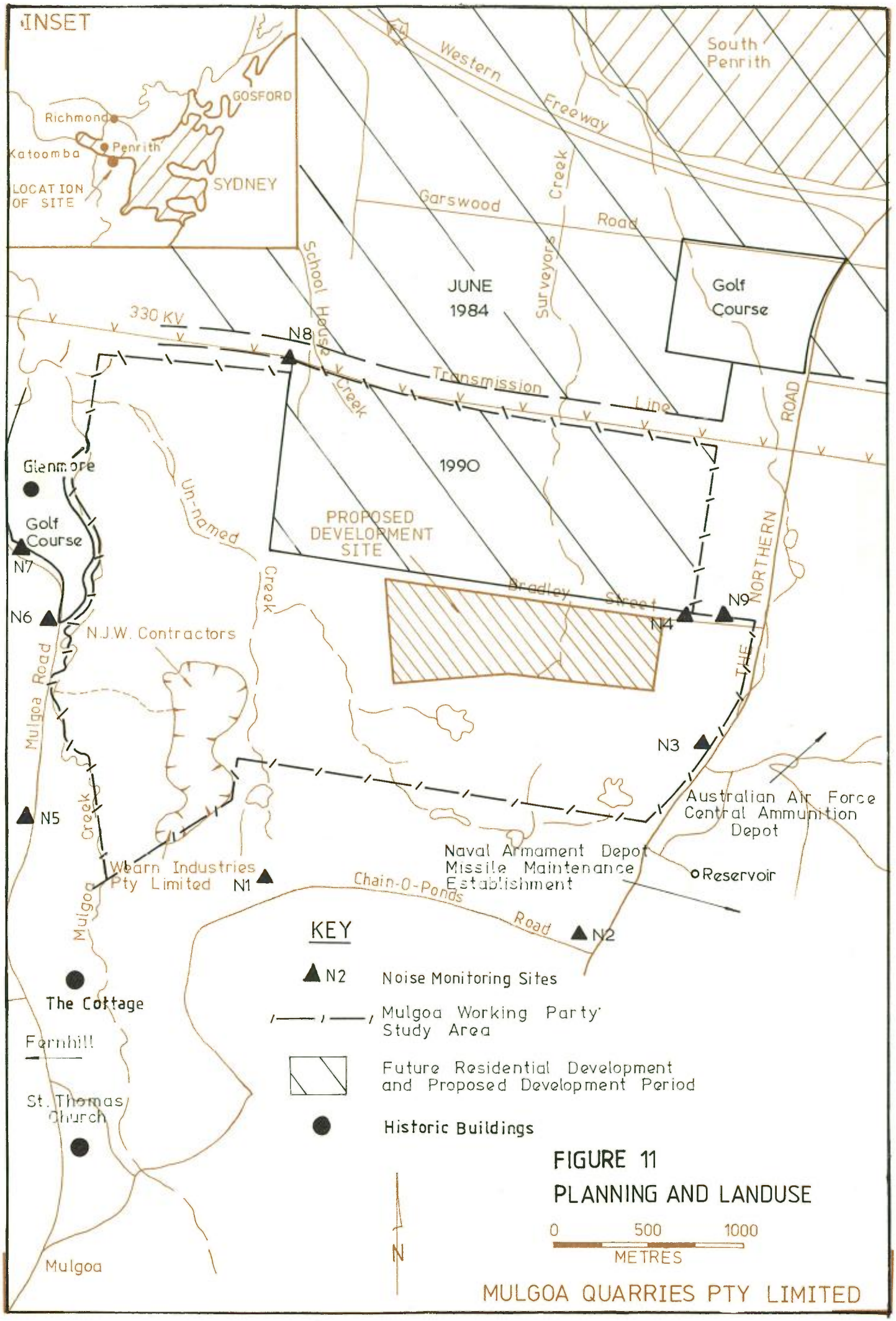


FIGURE 11

PLANNING AND LANDUSE

MULGOA QUARRIES PTY LIMITED

4.11 HISTORICAL SITES

The nearest historic homes to the site are shown on *Figure 11* and include "Fernhill", "St Thomas Church of England", "The Cottage", and "Glenmore".

All are greater than 1km from the site and only "Fernhill" has views of the proposed operations.

4.12 PLANNING

4.12.1 Regional Planning

Large tracts of land to the north are owned by the New South Wales Housing Commission and Land Commission and proposed for housing as part of a State Government housing and settlement programme. This land extends to the northern boundary of the proposed development site.

A total of 3,000 home building blocks are proposed for this area and it is expected that land as far south as the east-west transmission line *(Figure 11)* will be subdivided by June 1984 and first settled by June 1985.

Residential subdivisions will be extended to the limit of the area within a 6 to 10 year period.

On the eastern side of The Northern Road, the area between Wentworth Road and the Western Freeway are also proposed to be settled in a 10 year period.

All allotments are expected to be 600m^2 size with single detached dwellings. A small percentage of two storey town houses are also proposed.

4.12.2 Local Planning

Land to the east of The Northern Road is Commonwealth land and the site of the Royal Australian Air Force No. 1 Central Ammunition Depot and Naval

Armament Depot/Missile Maintenance establishment.

Land fronting the western side of The Northern Road southeast of the site is subdivided into 2 hectare lots, while 10 hectare lots with frontage to Chain-O-Ponds Road occur further to the south.

Areas between the proposed development site and Mulgoa Road are the sites of the clay/shale extractive operations of Wearn Industries Pty Limited and N.J.W. Contractors. Land owned by Zacuba Pty Limited also occurs in this area.

4.12.3 Land Zoning

The proposed development site is zoned Rural (A1) in which extractive industries are permitted only with the consent of Penrith City Council.

4.13 LAND USE

4.13.1 Agriculture

The area proposed for development has been primarily used for agricultural purposes.

The site to be quarried by Mulgoa Quarries Pty Limited has been used primarily for horse grazing. South of the site the land has been used for the grazing of Hereford cattle and cultivation of crops. Crops include sudax, millet, and oats which are irrigated from dams located on the site. The location of grazing and cultivated land is shown on *Figure 10*.

Lots of 10 hectare and 2 hectare size north and south of the site support "hobby farms", where the land use may be market gardening, cropping, or the grazing of a few domestic animals.

4.13.2 Residential

Dense urban development occurs south of Penrith and extends to the Western Freeway 2.5km north of the proposed development. South of this area, residential dwellings are scattered on 40, 10, and 2 hectare allotments fronting major access roads.

The village of Mulgoa occurs 4km to the southwest.

No residences occur within the proposed development site.

Residences on and adjacent to the proposed development site are shown on *Figure 25* and described in *Table A14* in *Appendix 2*.

4.13.3 Recreational

Two 18 hole golf courses occur to the north and northwest of the site as shown on *Figure 11*. The courses are over 2km from the proposed site. The area is remote from the Nepean River and Blue Mountains National Park and frequented recreational areas.

4.13.4 Special Uses

Both the Royal Australian Air Force and Navy maintain establishments in the area east of The Northern Road *(Figure 11)*.

A water treatment works and reservoir occur 1.5km to the east and north-east and the Warragamba-Prospect Water pipe line 3km to the south.

4.13.5 Mining and Extractive Industries

Shale quarries currently operated by Wearn Industries Pty Limited and N.J.W. Contractors occur to the west of the area as shown on *Figure 1*.

In the late 1960's - early 1970's, a small shale quarry was operated by J. and D. Kay in the area shown on *Figure 5*.

Operations were short term with only small quantities of materials removed.

4.13.6 Natural Areas

The area has been primarily cleared for grazing with only small stands of native vegetation occurring within stream courses or left as shade trees in grazing areas.

The most continuous stand of native vegetation occurs to the north of the proposed development area on land owned by the New South Wales Housing Commission and covers a total area of 50 hectares. The stand consists of *E. viminalis - E. pilularis - A. subvelutina* closed-forest and although heavily infested with Blackthorn, represents the largest "natural" area remaining in this region.

The area extends north along the water course of the unnamed creek draining the western portion of the proposed development site.

4.14 PUBLIC UTILITIES

The area is well serviced with electricity and telecommunications. Water is available in some areas along The Northern Road.

4.15 ACCESS AND TRANSPORT ROUTES

The Northern Road (Route 69) formerly Bringelly Road, provides the main transport route between Camden and Penrith and connects directly with the Western Freeway. It is a sealed two lane road with good alignment and is maintained by the New South Wales Department of Main Roads.

The road carries an AADT estimated at 13500 vehicles. *(Section A2.15 Appendix 2)*.

A one hour survey of traffic carried out between 8.20am and 9.20am on 24th March, 1982 at the intersection of Bradley Street and The Northern Road showed that of the total of 611 vehicles, 48.8 per cent travelled in a northerly direction, and 51.2 per cent to the south. Of the total number of vehicles, 14.7 per cent were "heavy" vehicles with destinations equally divided to the north and south.

Daily traffic levels (AADT) on Mulgoa Road have been recorded at 2,220 vehicles (1979) and have increased only 18.7 per cent since 1973. At the northern end of Mulgoa Road at Jamisontown, the AADT is 6,270 and has increased markedly since 1977 as a result of new subdivisions in the Jamisontown and Regentville areas.

A two lane gravel road (Bradley Street) currently provides access to the proposed development site from The Northern Road. This is joined by a narrow track which formerly provided access to the abandoned shale pit.

4.16 NOISE AND VIBRATION LEVELS

4.16.1 Background Noise Levels

Background noise levels were measured at nine sites, N1, N2, N3, N4, N5, N6, N7, N8 and N9 shown on *Figure 11*. Measurements were conducted by Resource Planning during March 1982 and by *Wilkinson-Murray Consulting Pty Ltd* during July and August 1981.

Measurements at all sites except N2 were recorded around the proposed commencement time for extractive operations when noise levels would be most significant, and at various times throughout the day. Only one measurement was recorded at site N2.

At sites N2, N3, N4 and N9 traffic on The Northern Road was the most prominent noise source throughout all times of the day. Traffic on Mulgoa Road was most audible at sites N5, N6 and N7 again throughout all times of the day.

Although not consistent, traffic on Chain-O-Pond Road at site N1 was a prominent noise source during the morning and traffic on the F4 Freeway produced highest readings at site N8 in the early morning and late afternoon.

At most sites birds, roosters, dogs and insects were also a prominent noise source and during five measurement periods, light planes, jets and helicopters flying overhead produced high noise readings.

Prominent noises during two measurement periods were explosions from the RAAF Central Armament Depot on The Northern Road. Explosions regularly occur at this depot resulting from disposal of old or faulty ammunition or demolition training.

Noise from the existing quarrying operation does not significantly alter the background noise levels. At site N1, L_{90} levels of 40dB(A) and 36dB(A) were recorded early in the morning and late morning on a day when the quarry was operating and corresponding L_{90} levels of 38.5dB(A) and 38.5dB(A) respectively on a day when the quarry was not operating.

Mean background readings of 32dB(A) at site N8 and 36.5dB(A) at site N7 are consistent with background levels experienced in rural areas. However, mean background levels of 38dB(A) to 48dB(A) at the other seven sites are high compared with background levels experienced in rural areas, but consistent with those levels experienced in built-up residential areas with low density to medium density through traffic.

4.16.2 Vibration and Overpressure Levels

Vibration and overpressure levels associated with routine blasting at the nearby quarries have been monitored by the Mines Inspection Branch of the New South Wales Department of Mineral Resources and were found to

be below maximum levels set by the Department and well below the maximum particle velocities for buildings indicated in the SAA Explosives Code AS2187, Part 2-1979.

Explosions associated with demolition work at the RAAF Central Armament Depot also cause vibration and overpressure in the district.

C. SOCIAL AND ECONOMIC ENVIRONMENT

4.17 POPULATION CHARACTERISTICS

4.17.1 Sub-Regional

The Western Sydney Subdivision comprises nine local government areas (LGA's) namely Auburn Municipality, Baulkham Hills Shire, Blacktown City, Blue Mountains City, Fairfield City, Holroyd Municipality, Parramatta City, Hawkesbury Shire and Penrith City.

Since 1971 the subregion's rate of growth has been consistently higher than the State average. The average annual rate of growth for the Western Suburbs Statistical Subdivision between 1971 and 1976 was 2.18 per cent and between 1976 and 1979 was 2.85 per cent, whereas comparable growth rates for New South Wales were only 0.98 per cent (1971-76) and 1.25 per cent (1977-79).

The subregion has experienced relatively high rates of natural increase (for 1971-76 an increase of 55,663 persons by natural increase) and also a reasonable net inward migration.

4.17.2 Penrith City

The population of Penrith City has grown rapidly over the past fifteen years and has exhibited annual growth rates well above those for New South Wales. Between 1966 and 1971 the average annual rate of growth was 5.39 per cent, while from 1971 to 1976 this figure was 5.54 per cent and lastly, from 1976 to 1979 the rate was 5.68 per cent. The present population of Penrity City is 107,000 well above estimates predicted by the New South Wales Planning and Environment Commission in 1977.

The age distribution of Penrith City reveals a youthful population, i.e., 34.5 per cent of the population in 1976 was aged between 20 and 39 years while 76.9 per cent were less than 39 years of age. Compared with the 1971 population distribution, there had been a proportional increase in the 0-4 years, the 20-29 years and 30-39 years age groups by 1976. In contrast there was a proportional decrease in the 5-14 years, 40-49 years and 50-64 years age groups, again highlighting the "youthful" nature of the population.

In terms of marital status, Penrith City again exhibited features differing from those of the Western Suburbs and New South Wales. In particular, there were proportionally more non-married and fewer divorced or widowed persons in Penrith as compared with New South Wales and the Western Suburbs Statistical Subdivision. This reflects the age distribution of Penrity City again.

Both Penrith and the Western Suburbs exhibit proportionally fewer Australian-born persons in their population than New South Wales. This more "ethnic" characteristic is becoming stronger. In 1971, 77.2 per cent of the population of Penrith City was Australian-born, in 1976 the figure was only 74.7 per cent. The contribution of a migrationary influence is reflected also in the following figures relating to growth of population. For the Western Suburbs, 64.6 per cent of the population increase between 1971 and 1976 was contributed by natural increase, while 35.4 per cent was from net migration. In contrast, the corresponding figures for New South Wales were 97.8 per cent and 2.2 per cent, respectively.

In both Penrith City and the Western Suburbs there are approximately equal numbers of males and females. The 1976 figures however reveal a decrease on the expected number of males on the basis of the 1971 figures. Thus, in summary, Penrith City exhibits several features at variance with the larger area of the Western Suburbs Statistical Subdivision. The most significant of these features would be its youthful population.

4.18 HOUSING AND ACCOMMODATION

4.18.1 Permanent

Consistent with the growth in the population and its "youthfulness" there has been a rapid growth in the stock of dwellings in Penrith City. Between 1971 and 1979 the average annual percentage growth rate in the stock of dwellings was 6.6 per cent. In the period 1976-79 this rate was 6.7 per cent. In comparison with this latter figure, the Western Suburbs recorded a growth in stock of dwellings of only 3.0 per cent. These data are consistent with the respective growths in the number of new dwellings completed. Between 1974-75 and 1979-80 the annual growth rate in Penrith City was 10.6 per cent while, for the same period, the Western Suburbs recorded a rate of 4.1 per cent.

In 1976 there was 1,522 unoccupied dwellings in Penrith City (i.e. 6.4 per cent of total dwellings) and in 1971 there were 1,001 such dwellings (i.e. 6.0 per cent of total dwellings). The corresponding figures for the Western Suburbs were 6.1 per cent and 5.6 per cent respectively. While these figures are reasonably high they are below the New South Wales figures of 9.2 per cent and 8.4 per cent, respectively.

The occupancy ratio for Penrity City of 3.5 persons per dwelling in 1976, and slightly higher at 3.8 in 1971, is consistent with national figures, and reflect the trend to smaller nuclear families. With the existing age distribution and marital status features it seems that there would be less contribution by numbers of single parents in Penrith City.

Total value of buildings approved during 1980 was $116,326,985 an increase of $26,005,643 or 28 per cent over 1979. Penrith City Council area recorded the highest rate of new dwelling construction in the metropolitan area for 1980.

4.18.2 Temporary

The Penrith area has several motels which provide temporary accommodation. Information on tourist accommodation indicates that there were 13 establishments operating at June 1974 but only 8 at December 1976 and 7 at June 1979, with an associated decline in employment in this field over the same period. The room occupancy rate during the 1978-79 seasons was 53.8 per cent. This rate appears to be comparable with other areas in New South Wales, for example, the comparable figure for the Western Suburbs was 53.9 per cent.

4.19 COMMUNITY SERVICES AND FACILITIES

4.19.1 Education

Penrith is adequately supplied with educational facilities. The city contains the Nepean College of Advanced Education, a Technical College and several high schools, primary schools and pre-schools.

At the 1976 Census, 15.2 per cent of the Penrith City's population was aged 5 years or under, whilst 24.3 per cent was of school age. These figures when compared with those for New South Wales (10.6 per cent and 21.0 per cent, respectively) and the Nation (9.1 per cent and 18.2 per cent respectively) again reflect a youthful population.

4.19.2 Health

Health Services

There are several hospitals in Penrith providing the basis of the health services. These include the Nepean District Hospital, the Jamison Private Hospital and the Governor Phillip Special Hospital. Other health services include an ambulance depot, a baby health centre, community nursing clinics, a Health Commission office and abundant doctors' services. With a

population of 107,000 in 1981 and approximately 70 doctors practicing, the recommended guideline of 1 doctor for every 2,000 persons is well accommodated.

Health Characteristics

Penrith City exhibits a higher statistic for births per 1,000 population than either the Western Suburbs or New South Wales as a whole. In 1978-79 there were 2,095 births in Penrith or 22.3 births per 1,000 population. In contrast the corresponding birth rates were 17.6 births per 1,000 population for Western Suburbs and 15.2 births per 1,000 population for New South Wales in total. These figures again reflect the population trends.

Corresponding data on deaths per 1,000 population reinforce this picture of a "youthful" population. While New South Wales in 1978-79 experienced 7.8 deaths per 1,000 population, Western Suburbs experienced 5.7 deaths per 1,000 population and Penrith only 3.9 deaths per 1,000 population.

In other terms, the contrast is quite striking. Penrith experienced only 176.6 deaths per 1,000 live births, while Western Suburbs had 324.6 deaths per 1,000 live births and New South Wales had 514.8 deaths per 1,000 live births in 1978-79.

4.19.3 Other Government Services

Penrith is a major centre for services in the western district of Sydney. Located west of Parramatta it is the last major centre before the Blue Mountains city of Katoomba. In particular, all major State Government departments have representation in Penrith. Apart from the Health Commission and the Department of Education, other State Government services provided in the City include the Commonwealth Employment Service, the Departments of Employment and Industrial Relations, Social Security, Labour and Industry, Motor Transport, and Tourism, the Housing Commission and the Public Transport Commission.

Other services include the police, the State Emergency services and civil defence organization, the community youth support scheme, the Dairy industry Authority of New South Wales, probation and parole services, an electoral office and the Army.

4.19.4 Community Services

The City also provides services in the form of library and swimming pool as well as ovals, parks and other community amenities. With regard to urban facilities, Penrity City Council spends 4.0 per cent of its total expenditure on library facilities, 3.2 per cent on street lighting and 3.6 per cent on town planning. These figures compare favourably with Sydney as a whole where the appropriate proportions are 3.7, 2.4 and 2.7 per cent respectively.

4.20 EMPLOYMENT

4.20.1 Employment Ratio

The employment ratio for Penrith in 1971 (i.e. labour force as a proportion of population) was 39.5 per cent which was consistent with other parts of New South Wales. Given the age distribution of Penrith in 1976, it is expected that this figure has increased.

4.20.2 Unemployment

In 1971 the rate of unemployment in Penrith was 1.8 per cent whereas in June 1977 the Sydney Metropolitan figure was 5.8 per cent, and in July 1979 and May 1980 the figures were 5.6 per cent and 5.6 per cent, respectively. However given the age distribution and marital status characteristics of Penrith City it is estimated that the levels of unemployment would be higher than these Sydney Metropolitan figures. The comparison New South Wales figures were 6.7 per cent, 7.0 per cent and 7.0 per cent respectively.

4.21 ECONOMIC BASE

4.21.1 Manufacturing Industry

The predominant industry in Penrith City is manufacturing, and within this category, of major importance is the fabricated retail products and other machinery and equipment classes. In 1971, manufacturing accounted for 30.6 per cent of the persons in the labour force, and over the period 1969-70 to 1977-78 the number of manufacturing establishments had risen significantly. Consistent with trends of labour replacement in the manufacturing of fabricated metal products there had been a consistent decline in the average level of employment per manufacturing establishment from 50.76 per cent in 1969-70 to 31.56 per cent in 1977-78.

4.21.2 Rural Industry

Agriculture has been of only minor significance in the area and has experienced a serious decline over the past decade, both in respect of number of agricultural holdings and total area of agricultural landuse.

4.21.3 Tertiary Industry

Consistent with world-wide trends, employment in the tertiary sector has increased over the period 1966 to 1976 for this area. The increases are particularly apparent in the Wholesale and Retail Trade. In 1971 this category accounted for 16.7 per cent of persons in the labour force and has experienced growth since that time. For example, data available indicate that the value of retail sales, deflated by appropriate C.P.I., had increased by 74 per cent between 1968-69 and 1973-74. Associated with this increase in the Penrith City area was a 17.9 per cent increase in the number of establishments and a 60.7 per cent increase in employment. The remaining industries of significance include (in order of importance) construction, community services, public administration and defence, finance and business services, etc., and transport and storage.

SECTION 5

DESCRIPTION OF THE PROPOSED DEVELOPMENT

5.0 DESCRIPTION OF THE PROPOSED DEVELOPMENT

5.1 OUTLINE OF PROPOSAL

Mulgoa Quarries Pty Limited proposes to extract light-firing claystone for brickmaking and sandstone/laminite/siltstone for road materials from a maximum of 25 hectares of land on the western portion of the area held by the Company.

The area proposed for quarrying represents only 33 per cent of the total holding of 75 hectares.

The proposed quarry plan has been designed with consideration of the characteristics of the existing environment identified and described in *Section 4.0*.

Quarrying will be carried out with a minimum area disturbed at any one time. Rehabilitation of worked out areas will follow progressively to provide a stable and usable landform at the end of quarrying activities.

Quarrying will be carried out in stages as described in *Section 5.2.3* and for each stage the procedures for development will be the same.

Where of sufficient thickness and quality, topsoil will be stripped and stockpiled for later respreading. The underlying units, with the exception of sandstone and laminite will be ripped, pushed up and loaded directly into trucks for transportation to the brickworks, for stockpiling, or for immediate disposal in worked out areas. Occasionally claystone may be stockpiled for blending with claystone from other parts of the quarry to provide the required raw material for brickmaking (see *Section 3.0*).

The more competent sandstone and laminite units will be removed by blasting. Initially sandstone ahead of the quarry face will be fragmented. As quarrying proceeds, small scale blasting of sandstone may be necessary to remove

minor lenses not intersected during the initial fragmentation blasting.

The sandstone will be crushed in a mobile plant on site. The predominant use of this material will be in roadmaking blended with small quantities of laminite or red burning material to increase plasticity.

An objective of the extraction programme will be the maximum utilisation of the ceramic and road construction materials present. However, it is expected that some materials will not meet road material or brickmaking requirements. This material will be used initially for the construction of bund walls and roads. Thereafter, overburden will be used as filling in the worked out pits, and for site rehabilitation.

It is proposed that a maximum of 400,000 tonnes of light-firing claystone will be extracted from the Mulgoa quarries annually and used in brick-making plants in the western suburbs.

Altogether some 40 persons would be employed in quarries operated by Mulgoa Quarries Pty Limited in the Mulgoa area.

5.2 EXTRACTIVE OPERATION

5.2.1 Extractive Material

The types of materials occurring on the site and their properties and uses are summarised in *Table A2* in *Appendix 2*.

The predominant material is a claystone or silty claystone that is highly suitable for use in brickmaking and currently used by a large proportion of brickworks in the Sydney Region. *(Section 3.0)*.

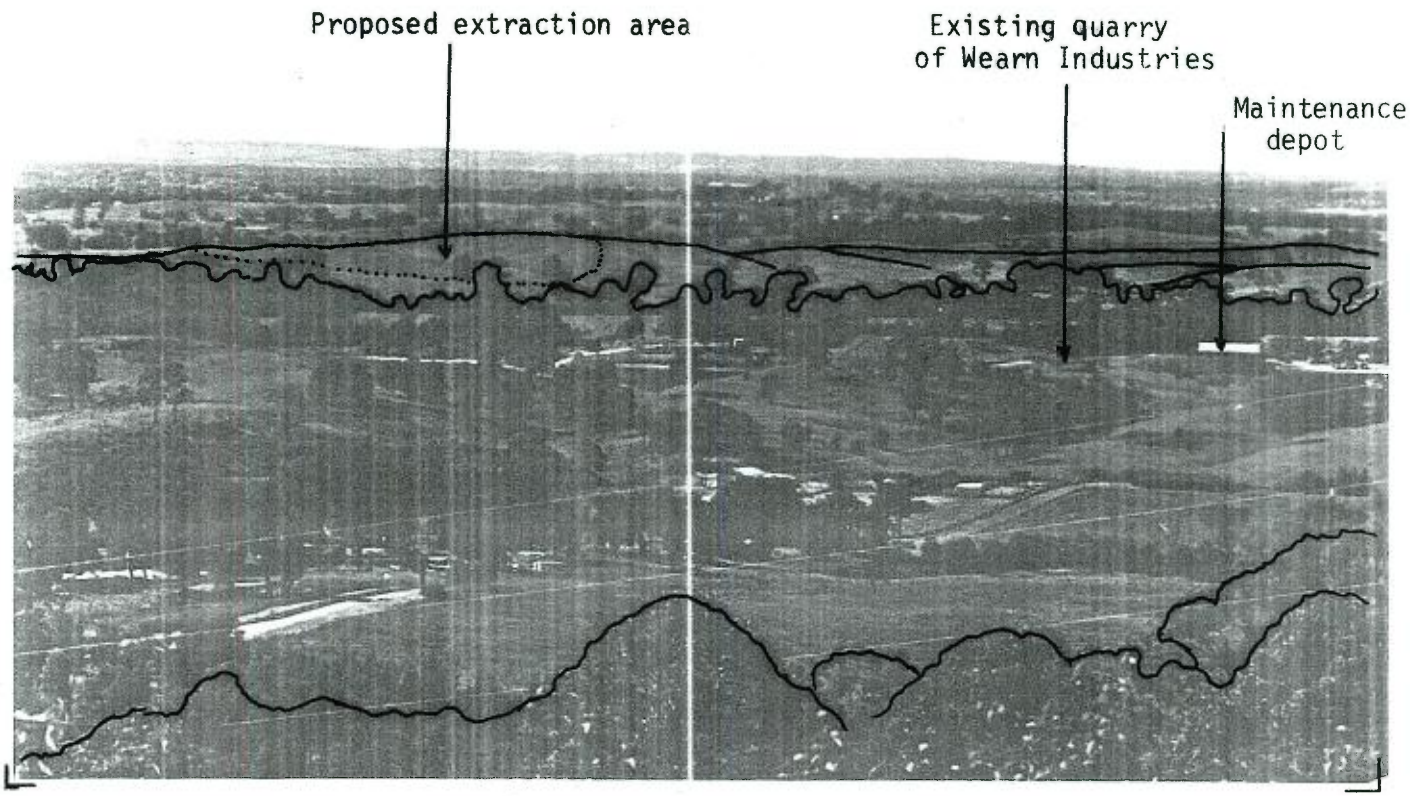


Plate 4. View from elevated areas west of Mulgoa Road to the east across the existing operating pit of Wearn Industries Pty Limited to the proposed extraction site. Superimposed on the plate is the area proposed to be quarried.

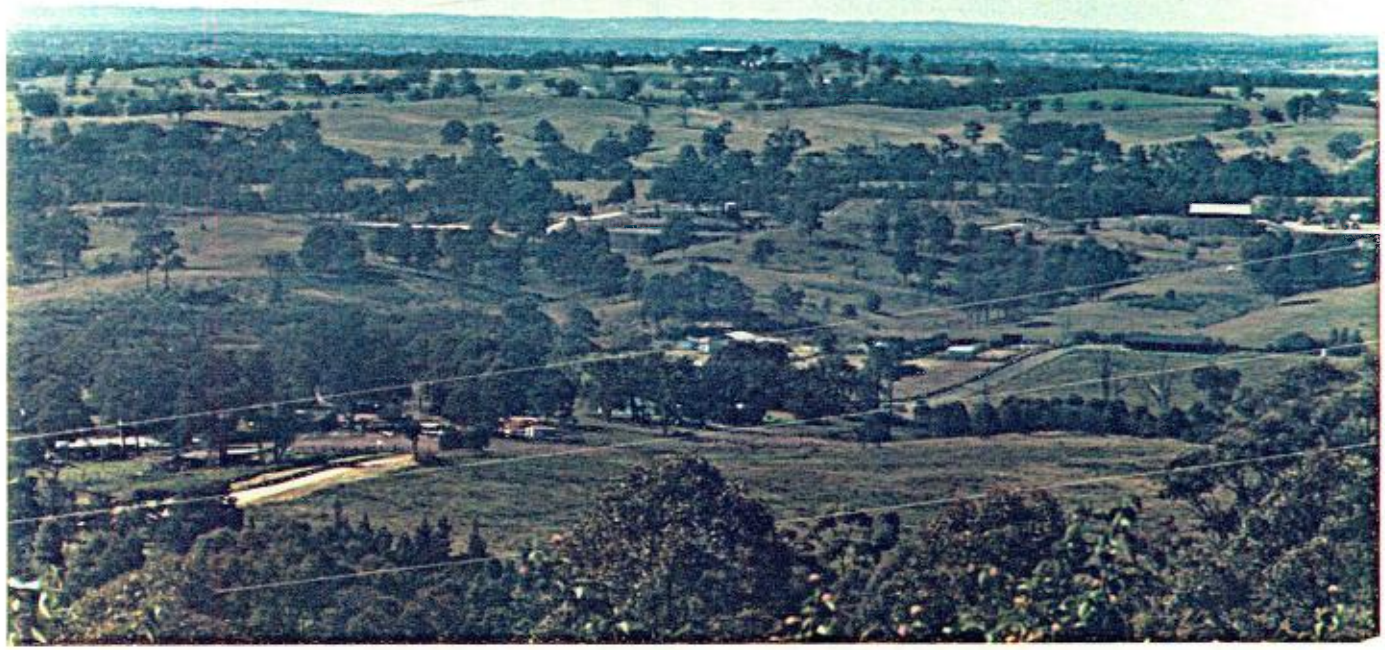


Plate 4. View from elevated areas west of Mulgoa Road to the east across the existing operating pit of Wearn Industries Pty Limited to the proposed extraction site. Superimposed on the plate is the area proposed to be quarried.

The fired colour of bricks manufactured from the claystone varies, depending on the proportion of siderite (iron carbonate) found naturally within the claystone horizons either as nodules or finely disseminated throughout. While it is possible to partly remove discreet nodules of siderite, disseminated material is less easily removed.

When fired using a kiln cycle suitable for firing Bringelly Shale (normally around 1000-1050^{o}C) claystone containing little siderite fires to produce cream coloured or pale coloured products, whereas claystone with larger amounts of siderite produce light orange to red colours.

The claystone occurring within the proposed development area is predominantly relatively siderite free within recognised horizons. Consequently, it is this material that will form the bulk of the material extracted because of its relative scarcity *(Section 3.0)* in the Sydney Region.

The "by-products" produced during the removal of the claystone include laminite, siltstone, and sandstone. As shown in *Table A2*, the bulk of these materials are suitable for use in roadmaking and will be used predominantly for this purpose. The likely quantities to be used will be variable as a result of the geology of the site but it is expected that between 20,000 and 100,000 tonnes per annum will be used for this purpose. The remainder will be used for fill, cover, and rehabilitation.

5.2.2 Quarry Planning and Design

In the selection of the proposed quarry plan consideration was given to the environmental factors identified and described in *Section 4.0*.

A major consideration was the maximum recovery of light-firing shale resources in a manner that would minimise impact on surrounding land uses and the natural environment of the site.

To do so required careful consideration of the geology and location of the required resource horizons on the site as well as the volume of "by-

product" materials, i.e., laminite, siltstone and sandstone.

The quarry has also been designed with the view that any proposed quarrying operations to the north, south and west in the adjoining areas underlain by the resource could be integrated with the existing proposal and if necessary extended in a manner that would minimise economic and environmental problems.

Consideration has also been given to access from haulage roads, screening from surrounding areas, site rehabilitation and post mining land use in the design of the quarry.

As a result of these considerations the quarry has been designed to be located on the western side of a central ridge line and screened from The Northern Road and adjoining residents in this direction by a second ridge shown on *Figure 5*.

The total surface area to be disturbed by quarrying activities is 25 hectares.

Geological investigations have shown that the light-firing claystone occurs predominantly in two main horizons at 56-62m AHD and 45-52m AHD.

The lowest point in the proposed development area is 48m AHD and consequently after allowing for settling dams, extraction can proceed to a level of 60m AHD maintaining a free draining surface.

To gain access to the remainder of the light-firing resource, and to maintain a free-draining site, Zacuba Pty Limited and Mulgoa Quarries Pty Limited have made arrangements for joint extraction of material on the common boundary separating the proposed development site from Zacuba's land to the west.

Zacuba Pty Limited will work that part of the deposit west of the boundary to a level of 45m AHD and proceed in an easterly direction until the common boundary is reached. Mulgoa Quarries Pty Limited will continue the extractive operation in an easterly direction from the boundary at 45m AHD.

Runoff from the quarry will be collected in sedimentation dams located on Zacuba's property to the west.

The joint extraction proposal will ensure that the sites remain free draining and a compatible final landform achieved at the end of extractive operations.

Alternatively, should extractive operations not proceed on Zacuba's property to the west, Mulgoa Quarries can excavate to 45m AHD on the proposed development site. Appropriate measures can be designed into the proposal for the disposal of quarry water through sedimentation dams on lot 1 DP541090. Extraction to only 60m AHD would render inaccessible 45 per cent of the light-firing claystone resource occurring in the proposed development area.

The alternative extraction proposal confining all operations to lot 1 DP541090 is described in *Section 8.3*.

It is proposed to initially dispose of excess overburden not used for brickmaking, bund walls, dams, or road materials in the excavation on lots 21 and 22 either as cover for the waste (should the waste disposal operation proceed) or for simply filling the excavation to return the land to a form similar to that existing before extractive operations.

Since the proposed extractive operation in the development area is a multiple bench operation to reach 45m AHD (in contrast to the single bench operations on lots 28 and lot 1 DP222144) it is not possible to immediately dispose of overburden in on-site excavations during the initial stages of development without sterilising part of the resource.

Accordingly, disposal of excess overburden in the existing excavation on lot 21 and 22 is considered more environmentally desirable than disposing of the material in large stockpiles on site.

Stockpiling material creates two problems. Firstly, the necessity to set aside a stockpile area that will not be disturbed by quarrying operations throughout the life of the quarry to avoid multiple handling of material, and secondly, the potential dust and visual problems that arise from stockpiles.

For overall management of the resource in an environmentally acceptable manner, Mulgoa Quarries Pty Limited considers that disposal of excess overburden in an existing excavation to return the land to a usable landform is more desirable than stockpiling material temporarily on site.

However, in the event that authorities do not permit the disposal of excess overburden on lots 21 and 22, a stockpile area has been identified on the eastern margin of the development area as shown on *Figure 13*.

To achieve an overall integrated quarry plan for extraction of the Mulgoa resource, conceptual extraction plans for the Housing Commission and J. Reddan properties have been integrated into the extraction plans for the proposed development site. These two properties are included to show that future extraction in these areas can be integrated with the extraction proposal and that a compatible, free-draining landform can be achieved at the completion of extractive operations.

5.2.3 Staging of Development

It is proposed to carry out extraction in a series of stages described below and shown on *Figures 13* to *17*. The quarrying operations are shown diagramatically on *Figure 12*. Typical sections through Stages including the Housing Commission and J. Reddan's property are shown on *Figure 18*.

The timing of the staged extraction programme is dependent on the demand and markets for materials derived from the site. The commencement and completion times given have been determined on the basis of an average of 300,000 tonnes of light-firing claystone being extracted annually over the life of operations. A higher or lower demand will markedly affect the extraction rate and hence the life of the operations. Figures quoted are intended to be indicative only.

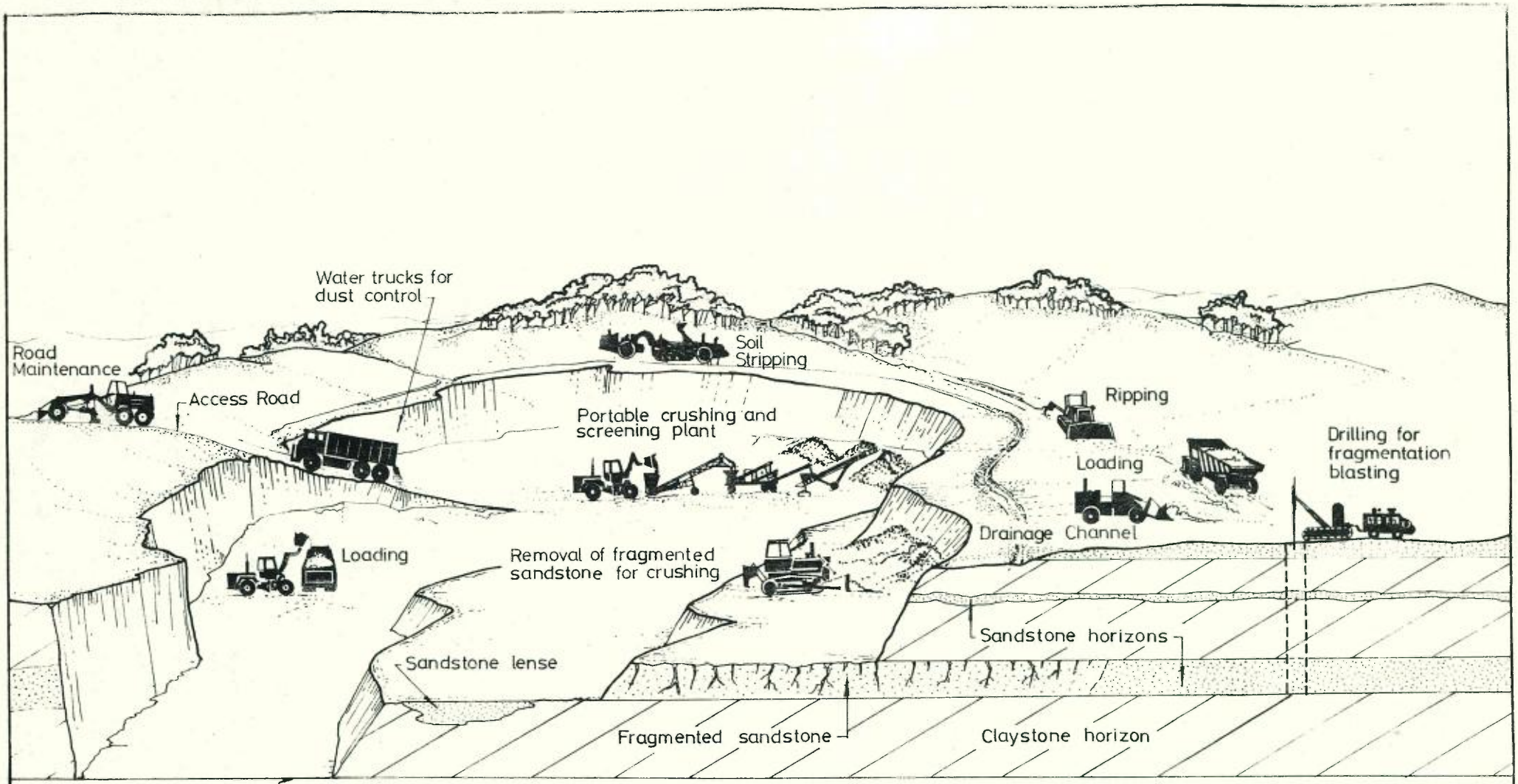


FIGURE 12
DIAGRAMMATIC SKETCH OF
QUARRYING OPERATION

MULGOA QUARRIES PTY LIMITED

STAGE 1 SCREENING

Initially attention will be given to the screening of the site and access roads from viewing points, and to improve the overall aesthetics of the area.

Plantings will be carried out along the eastern side of the access road and ridge line to the east and south. This will ensure that as operations proceed in these directions the plantings will be of a mature size to effectively screen the operations.

Bund walls will also be constructed on the northern side of the proposed access route at the sites shown on *Figure 13* to screen the access road and alternative stockpile area from areas north. The Company is prepared to vary the location of the bund walls in accordance with the requirements of authorities should extraction in the adjoining area to the north proceed.

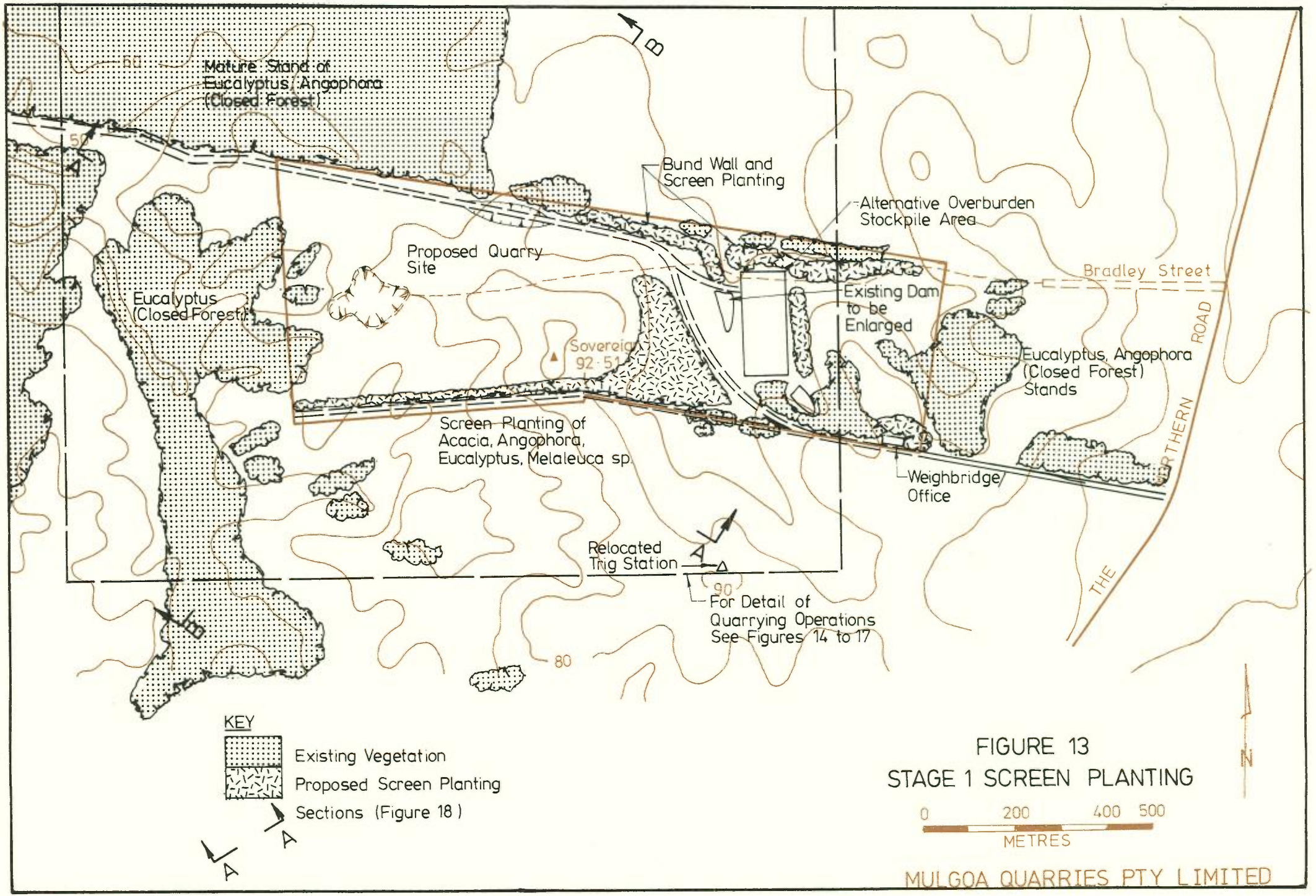
The bund wall will be graded and planted with native species to provide further screening from viewing points.

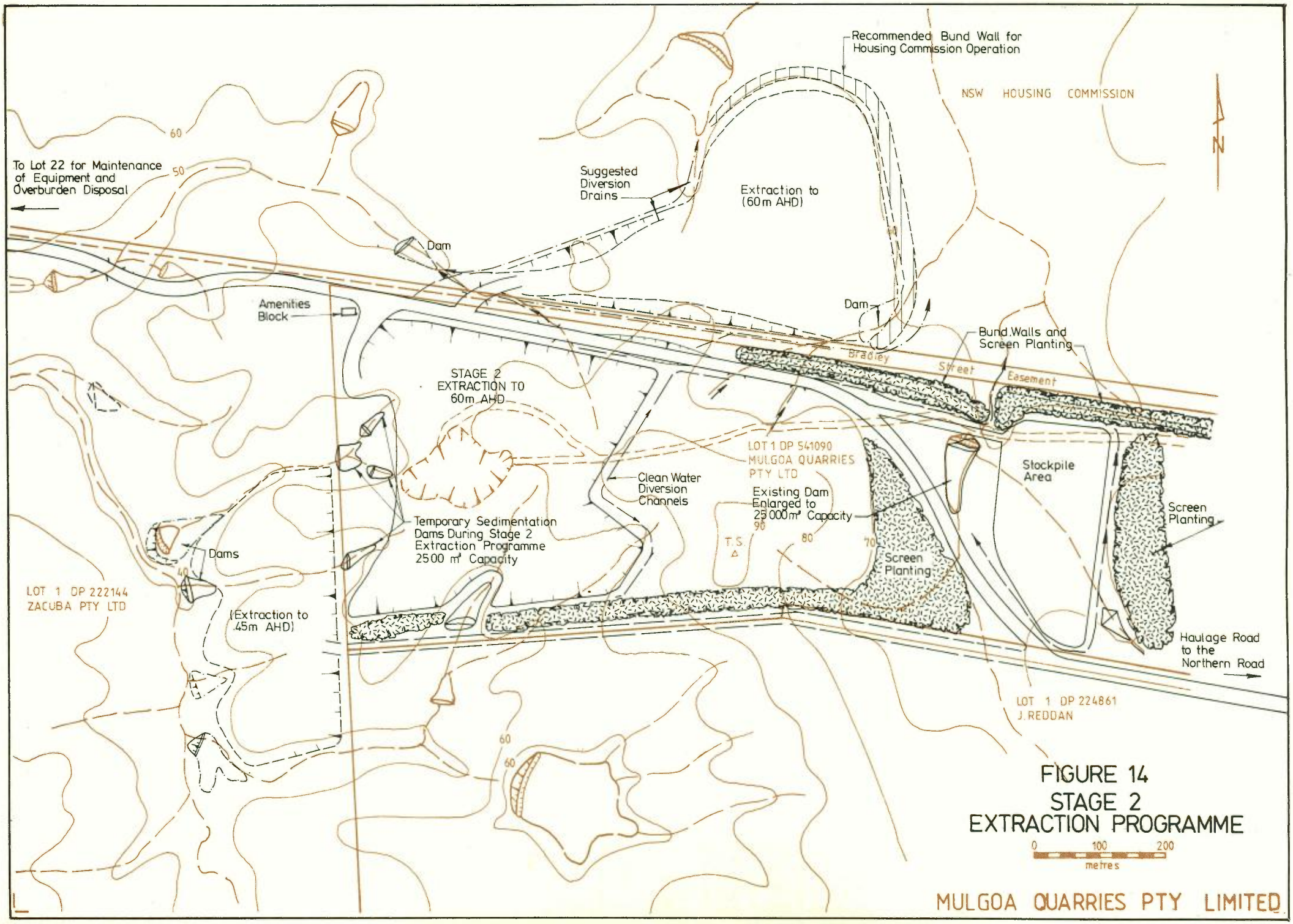
STAGE 2

Extraction will commence in the northwest corner of the site in the vicinity of the small abandoned pit shown on *Figure 14*.

Extractive operations in this area will be naturally well screened to the north by the *E. viminalis - E. pilularis - A. subvelutina* closed-forest, to the east and south by ridges and spurs, and to west by the valley of the unnamed creek and ridge areas.

Consequently, it is not expected that man-made screening of Stage 2 will be required but that material extracted from this area which is not utilised for brickmaking or road materials will be used for the construction of bund walls to provide screening to roads and to shield later stages of the operation.


Mature Stand of Eucalyptus (Angophora (Closed Forest)
Bund Wall and Screen Planting
Alternative Overburden Stockpile Area
Proposed Quarry Site
Bradley Street
Existing Dam to be Enlarged
Eucalyptus (Closed Forest)
Sovereign 92·51
Eucalyptus, Angophora (Closed Forest) Stands
Screen Planting of Acacia, Angophora, Eucalyptus, Melaleuca sp.
Weighbridge/ Office
Relocated Trig Station
For Detail of Quarrying Operations See Figures 14 to 17
THE NORTHERN ROAD
KEY
Existing Vegetation
Proposed Screen Planting
Sections (Figure 18)
FIGURE 13
STAGE 1 SCREEN PLANTING
0 200 400 500
METRES
N
MULGOA QUARRIES PTY LIMITED


Recommended Bund Wall for Housing Commission Operation
NSW HOUSING COMMISSION
N
To Lot 22 for Maintenance of Equipment and Overburden Disposal
Suggested Diversion Drains
Extraction to (60m AHD)
Dam
Dam
Amenities Block
Bund Walls and Screen Planting
Bradley Street Easement
STAGE 2 EXTRACTION TO 60m AHD
LOT 1 DP 541090 MULGOA QUARRIES PTY LTD
Clean Water Diversion Channels
Existing Dam Enlarged to 25 000m³ Capacity
Stockpile Area
Screen Planting
Temporary Sedimentation Dams During Stage 2 Extraction Programme 2500 m³ Capacity
T.S.
Dams
Screen Planting
LOT 1 DP 222144 ZACUBA PTY LTD
(Extraction to 45m AHD)
Haulage Road to the Northern Road
LOT 1 DP 224861 J. REDDAN
60
50
40
90
80
70
60
60
FIGURE 14
STAGE 2
EXTRACTION PROGRAMME
0 100 200
metres
MULGOA QUARRIES PTY LIMITED

Topsoil will be stripped from the Stage 2 area and stockpiled as shown. Material will be progressively removed down to 60m AHD with the working area free draining to the west. Runoff from all working areas will be conveyed to settling dams (shown on *Figure 14*) for the removal of fines prior to discharge to the unnamed creek.

Reserves

It is expected that 1.5 million tonnes of light-firing material will be extracted during Stage 2 and utilised for brickmaking. An additional 800,000 tonnes of red-firing claystone/siltstone, laminite and sandstone will be available for the construction of bund walls, and for use as road materials. Material not utilised for these purposes will be either transported to the worked out quarry on lots 21 and 22 for filling the excavation or stockpiled on site in the area shown on *Figure 13* for later site rehabilitation.

Stage 2 has a life of 5 years.

STAGE 3

Stage 3 will commence at the western boundary separating Zacuba's workings from the proposed development site *(Figure 15)* and are designed to remove material to 45m AHD. (Stage 3A).

During this stage, sedimentation dams constructed on Zacuba's property will be used to collect all runoff from the Stage 3A quarry operations. Agreements have been reached between the Companies with regard to joint use of the sedimentation dams.

The excavation will continue in a northeasterly direction at 45m AHD with drainage to the west.

As operations in the Stage 3A area are two thirds complete, extraction will commence in the area designated Stage 3B to reduce this level to 70m AHD to maintain stable quarry faces between the two benched areas. The floor

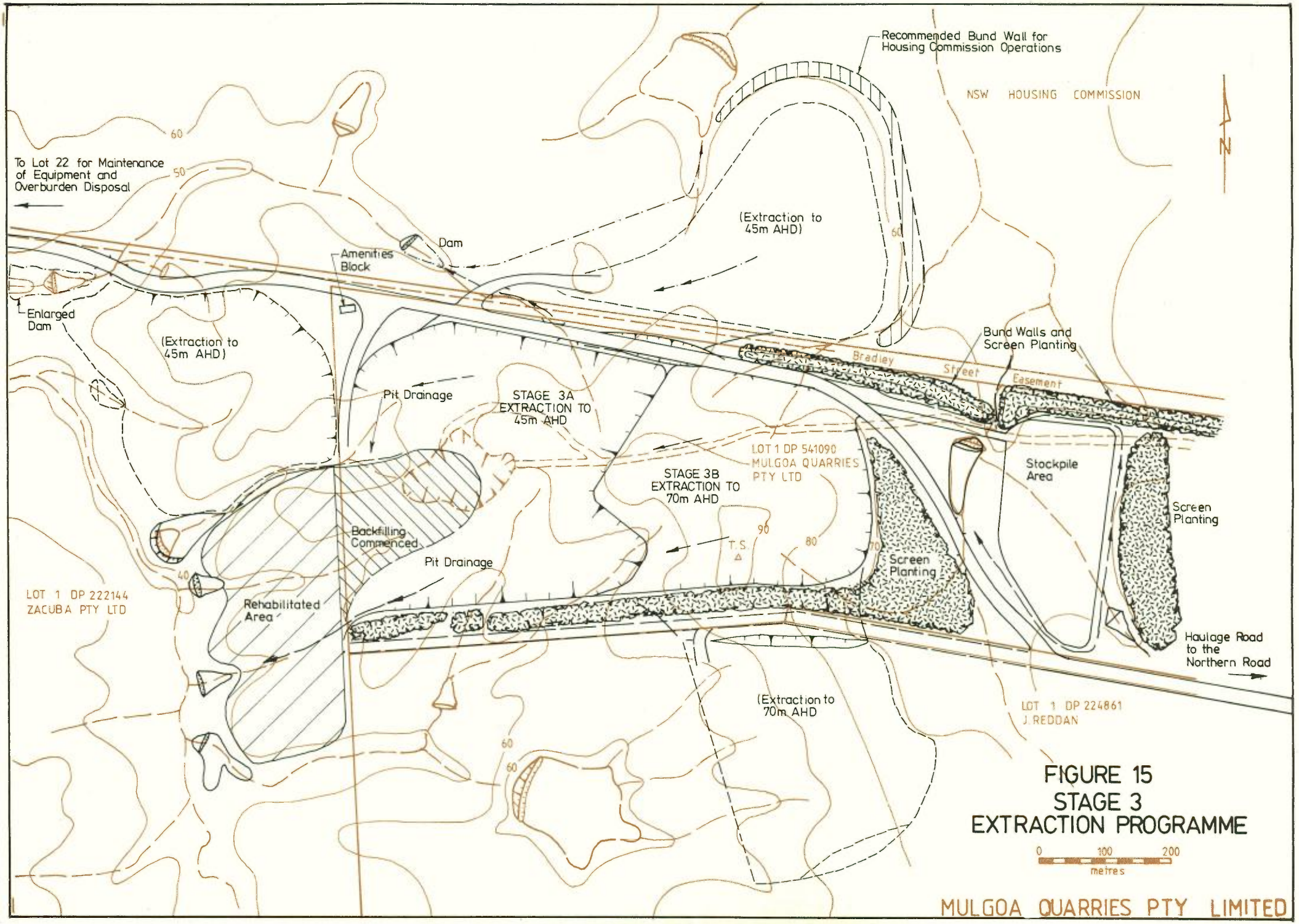


FIGURE 15
STAGE 3
EXTRACTION PROGRAMME

MULGOA QUARRIES PTY LIMITED

of Stage 3B will be provided with a westerly gradient to direct runoff to settling dams *(Figure 15)*.

It is expected that overburden from Stage 3 will be disposed of on lots 21 and 22 and in excavations on the proposed development site. At the completion of the Stage 3A development, progressive backfilling of the excavation with overburden from Stage 3B or stockpiles will commence.

Reserves

Reserves of light-firing material in Stage 3A are expected to be in the order of 1.5 million tonnes with an additional 1 million tonnes of material for disposal as road materials or fill.

Stage 3A has a life of 5 years.

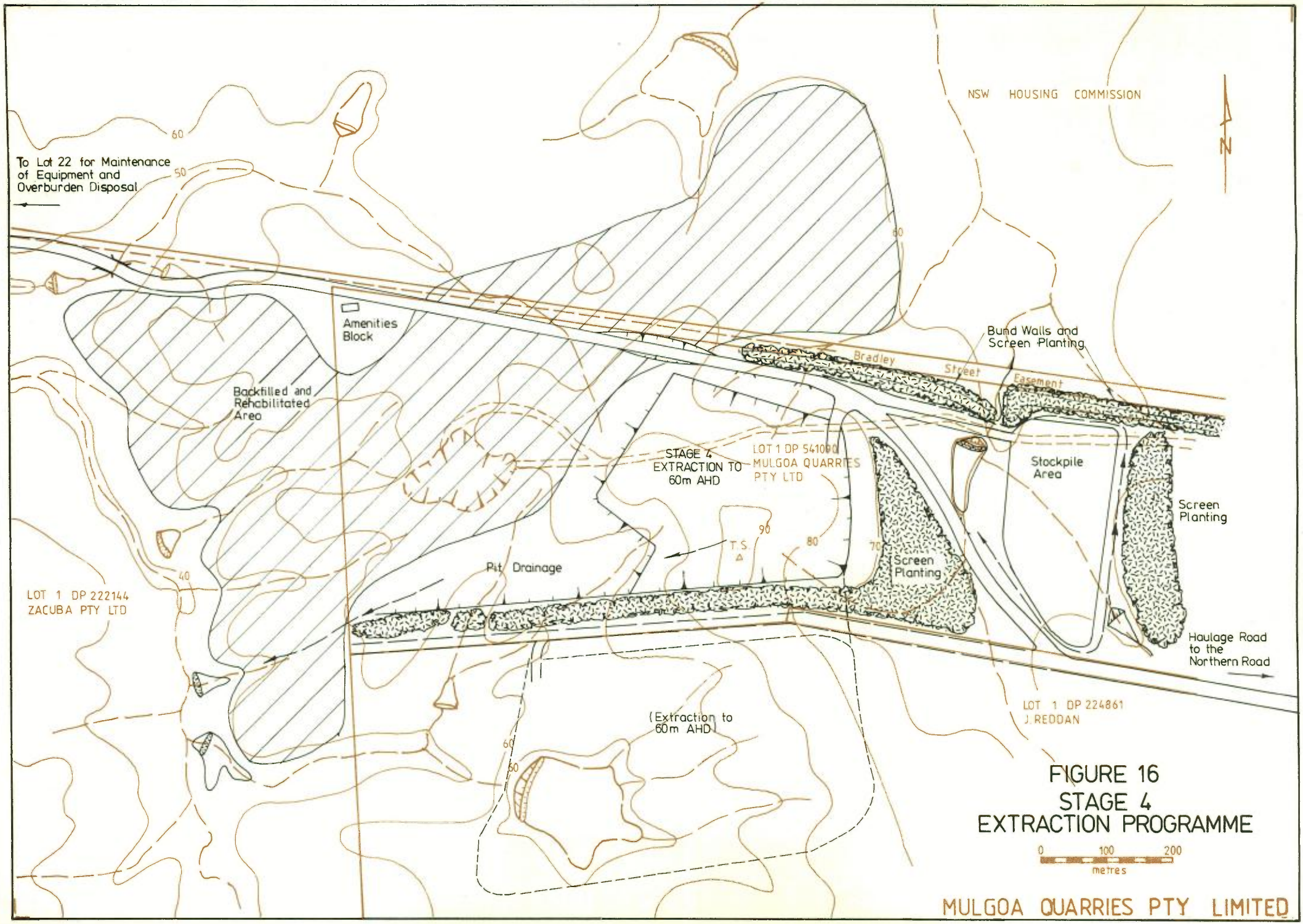
Extraction is expected to commence in Stage 3B 3 years after the commencement of extraction in 3A, and will be completed in 3 years. During this time reserves of 800,000 tonnes of light-firing material will be removed and an additional 1 million tonnes will be utilised for road materials or disposed of in the worked out pits.

STAGE 4

Stage 4 will involve progressive extraction in the area shown on *Figure 16* by removal of material to a depth of 60m AHD.

Stage 4 is proposed to take place about 13 years after the commencement of operations, when planted screens are expected to have reached a relatively mature height to provide a visual barrier.

Drainage will be maintained to the west to sedimentation dams.


NSW HOUSING COMMISSION
N
To Lot 22 for Maintenance of Equipment and Overburden Disposal
60
50
Amenities Block
Backfilled and Rehabilitated Area
Bradley Street Easement
Bund Walls and Screen Planting
STAGE 4 EXTRACTION TO 60m AHD
LOT 1 DP 541000 MULGOA QUARRIES PTY LTD
Stockpile Area
Screen Planting
90
80
70
T.S.
Pit Drainage
Screen Planting
40
LOT 1 DP 222144 ZACUBA PTY LTD
Haulage Road to the Northern Road
(Extraction to 60m AHD)
60
60
LOT 1 DP 224861 J.REDDAN
FIGURE 16
STAGE 4
EXTRACTION PROGRAMME
0
100
200
metres
MULGOA QUARRIES PTY LIMITED

Reserves

Stage 4 will provide in the order of 500,000 tonnes of light-firing material and 900,000 tonnes of overburden and has a life of about 1.7 years.

STAGE 5

In Stage 5, extraction will involve the removal of material from the area shown on *Figure 17* to 45m AHD. Drainage will be to the west to sedimentation dams on Zacuba's property.

Unused material from Stage 5 will be disposed of in worked out excavations.

Reserves

Stage 5 will provide 3 million tonnes of light-firing claystone and 2 million tonnes of overburden and has a life of 10 years.

SUMMARY

The proposed staged extraction programme will provide recoverable reserves in the order of 7.3 million tonnes or 67 per cent of the total indicated resource of 11 million tonnes. About 33 per cent of the resource occurs on the adjoining properties and a proportion cannot be recovered due to the need to provide a stable and usable landform at the completion of extractive operations, economic, and environmental considerations.

An additional 5.7 million tonnes of siltstone, red-firing claystone, laminite and sandstone will be utilised for road materials or disposed of in worked out areas.

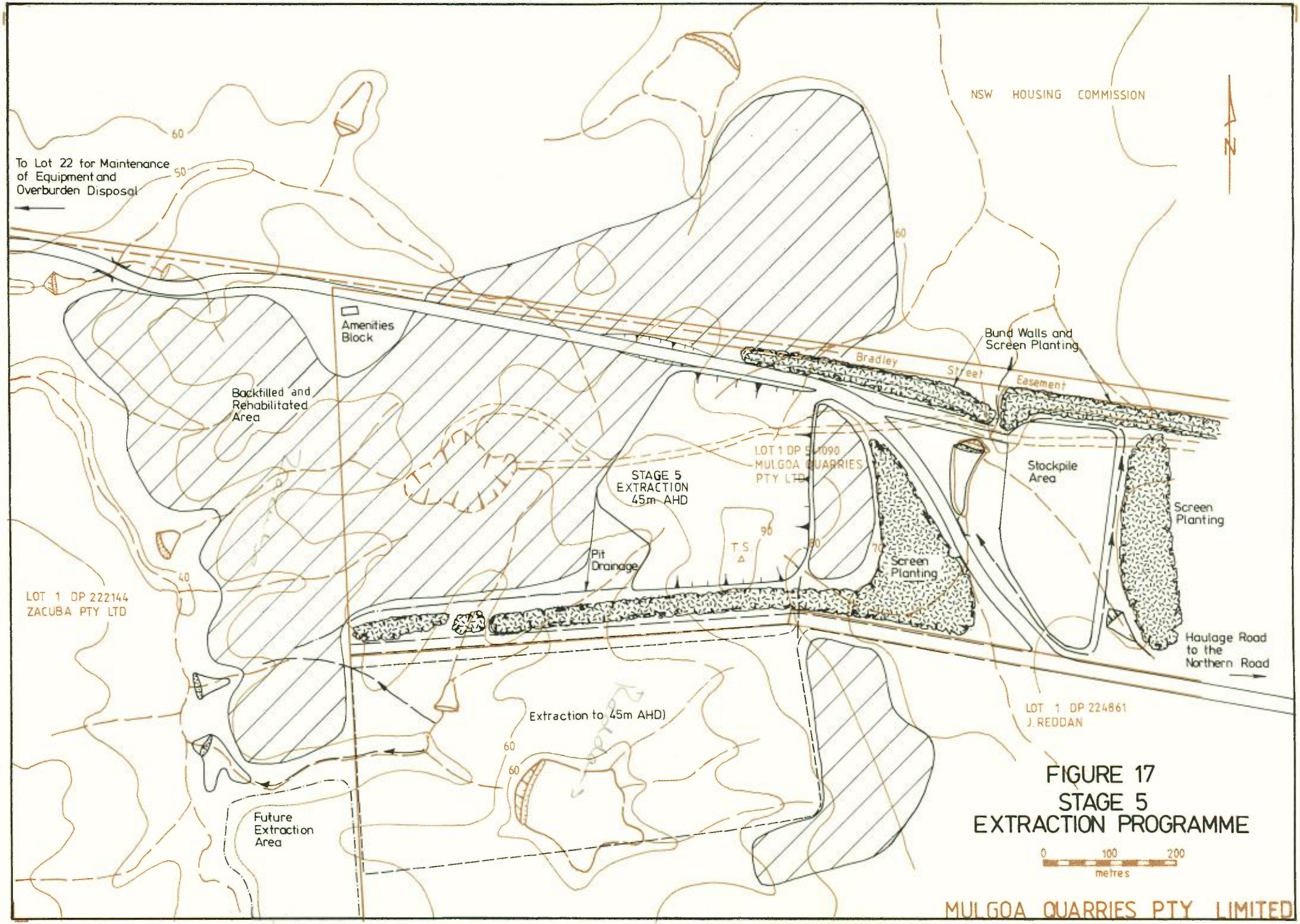
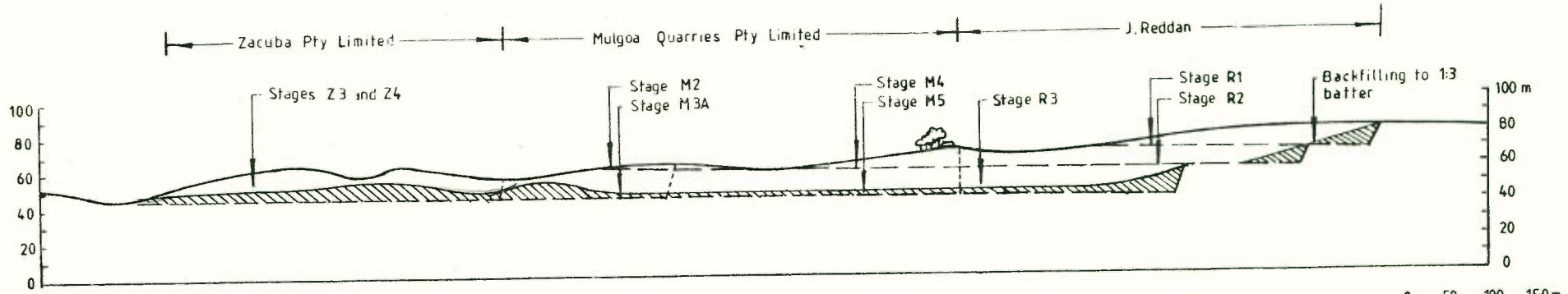


FIGURE 17
STAGE 5
EXTRACTION PROGRAMME

MULGOA QUARRIES PTY LIMITED

SECTION A:A



STAGES

ZACUBA PTY LTD

Z3,Z4	45m AHD

MULGOA QUARRIES PTY LTD

M2	60m AHD
M3A	45m AHD
M4	60m AHD
M5	45m AHD

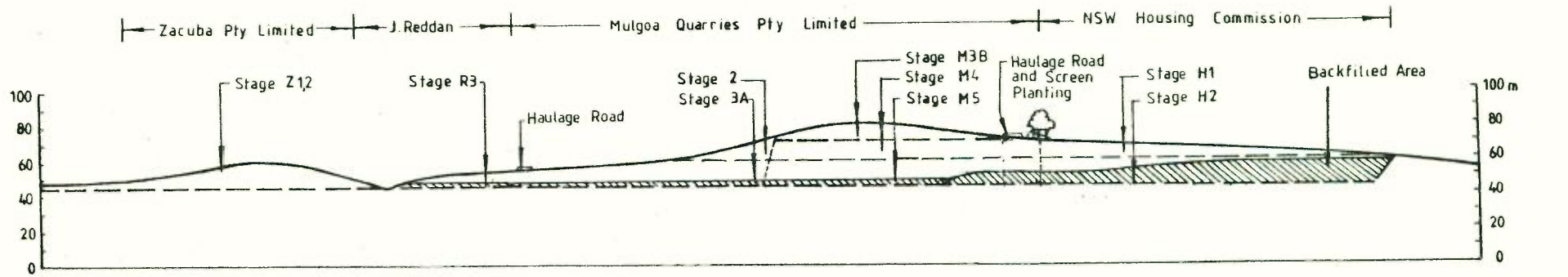
J.REDDAN

R1	70m AHD
R2	60m AHD
R3	45m AHD

Scale : Horizontal 0 50 100 150m

Vertical 0 25 50 75m

SECTION B:B



STAGES

ZACUBA PTY LTD

Z 1,2	45m AHD

J REDDAN

R3	45m AHD

MULGOA QUARRIES

M2	60m AHD
M3A	45m AHD
M3B	70m AHD
M4	60m AHD
M5	45m AHD

NSW HOUSING COMMISSION

H1	60m AHD
H2	45m AHD

Scale : Horizontal 0 50 100 150m

Vertical 0 25 50 75m

FIGURE 18

CROSS SECTIONS AND DETAIL

MULGOA QUARRIES PTY LIMITED

5.2.4 Integration of Possible Adjoining Extractive Operations

The proposed extraction programme has been designed to allow integration of possible extractive operations on the Housing Commission land to the north and J. Reddan's property to the south.

Shown on *Figures 14* to *17* are conceptual plans for the integration of the adjoining operations. Since there are no firm plans for extractive operations on these sites at this stage, details of integration with operations on the proposed development site will be the subject of environmental impact statements accompanying development applications for these two sites.

The plan outlined is a concept for management of the Mulgoa resource which will result in maximum utilisation of the identified resource in an environmentally acceptable manner with the objective of preparing a compatible, stable, and free-draining landform at the completion of extractive operations.

Stage 2

During Stage 2 it is expected that Zacuba Pty Limited will excavate to 45m AHD west of the proposed development area, extending their operations to the common boundary separating the two sites. *(Figure 14)*.

At the same time, removal of clay/shale on the Housing Commission land to 60m AHD working from the north to the south could be integrated with quarrying operations on the northern boundary separating the two sites. Drainage from the Housing Commission area would be to sedimentation dams to the north *(Figure 14)*. A planted bund wall on the northern side of the Housing Commission property *(Figure 13)* would aid in screening these operations from the north.

Stage 3

Stage 3A will commence at the western boundary of the property where Zacuba will have reduced the landform to 45m AHD.

As the Stage 3A excavation proceeds to the northern boundary, extraction to 45m AHD on the Housing Commission property could commence at the boundary and proceed to the north, allowing drainage to the west. Extraction in this direction would allow operations to be shielded from surrounding residential areas by bund walls and the quarry face. *(Figures 13* and *15)*.

Further to the south, extraction on J. Reddan's property by initially excavating to 70m AHD could be integrated with the Stage 3B operations at the property boundaries.

Stage 4

The second stage of extraction on J. Reddan's property to the south would be to reduce the land surface to 60m AHD. These operations could be integrated with Stage 4 of Mulgoa Quarries Pty Limited operations.

Stage 5

Stage 5 will commence at the western boundary where operations conducted by Zacuba Pty Limited will have reduced the land to 45m AHD *(Figure 17)*.

Stage 5 can be integrated with extractive operations on J. Reddan's property by reducing the land surface to 45m AHD maintaining drainage to the west *(Figure 17)*.

5.2.5 Site Clearing

It is proposed to clear only the minimum area necessary at any one time to carry out extractive operations.

Where of sufficient thickness and quality the surface soil will be stripped and stockpiled. Quantities are not expected to be large as soil studies have shown that weathered claystone is less than 1m below the surface over most of the site.

This material will be used in resurfacing worked out areas as they are progressively rehabilitated.

5.2.6 Drilling and Blasting

Drilling and blasting will be carried out to remove competent sandstone and laminite horizons which occur throughout the sequence.

Two types of blasting will be carried out.

Initially, material ahead of the working face will be subject to fragmentation blasting to fracture sandstone units. Thick sequences of various lithologies will be drilled to intersect sandstone units.

To minimise overpressure from fragmentation blasting, delay charges will be set over a relatively large area so that overpressure impact will be absorbed by units above the sandstone, significantly reducing potential blasting impacts.

Fragmentation blasting is expected to be carried out 3 to 4 times per year but this timing is dependent on the incidence of sandstone ahead of the face.

As quarrying proceeds, small scale blasting of sandstone may be necessary to remove minor lenses not intersected during the initial fragmentation blasting. This small scale blasting will involve 62mm diameter holes on a 3m x 3m pattern with stemming to a depth of 0.15 to 0.3m.

5.2.7 Overburden Processing and Utilisation

Sandstone, laminites, red-firing claystone and siltstones removed by blasting and ripping will be utilised, or disposed of within the extraction areas.

Large sandstone units fractured during initial fragmentation blasting will be crushed in a mobile crushing plant temporarily located on the site. This phase of the operation is expected to be carried out by contractors at stages throughout the year when large areas of fractured sandstone are exposed by the quarrying operations. *(Figure 12)*.

Crushed sandstone will be blended with a proportion of laminite or red-firing claystone to improve plasticity and transported from the site for use as road material.

Quantities of material removed during this operation are expected to vary with the geology of the site and may range from 20,000 to 100,000 tonnes per annum.

At the completion of each phase of the crushing operation (3 to 4 weeks, 3 to 4 times per year) the mobile plant will be removed from the site.

5.2.8 Overburden Disposal

Material not utilised for road materials or brickmaking will be disposed of on site.

Several options exist for the disposal of this material:

1. Cover for waste disposed of on lots 21 and 22, should this operation proceed.
2. Fill for the completed quarry on lot 22 to return the land to a usable landform.
3. Fill for rehabilitating extraction sites in the proposed development area.
4. Bund wall and road construction.

Initially it is expected that overburden will be utilised for the construction of roads and bund walls shown on *Figure 13*.

As quarrying proceeds it is proposed that this material will be trucked to lots 21 and 22 and disposed of in the worked out pits. Alternatively the material will be stockpiled for filling excavations in the proposed development area.

Volumes of unwanted material are expected to be high *(Section 5.2.3)* but all material can be accommodated in excavations in the area.

5.2.9 Claystone Removal

Claystone will be selectively extracted from the working face (by dozer) and loaded directly into transport trucks by front-end loader for transport to the brickworks.

Occasionally claystone will be stockpiled for blending with claystone from other parts of the quarry (or lot 28) to provide the required raw material for brickmaking. These stockpiles are short term and sited on the quarry floor. The maximum stockpile height would be 8m.

5.2.10 Equipment

The pool of equipment to be used for earthmoving operations in the proposed development area (and lot 28) are shown in *Table 3*.

TABLE 3

PROPOSED EQUIPMENT

Number	Equipment
4	Front-end loader
3	Dozer
1	Elevator scraper
1	Grader
5	Off Highway haul truck
1	Water Cart
2	Mobile drilling rig
1	Mobile crushing and screening plant
10	Highway trucks

5.2.11 Extraction Rate

It is expected that between 300,000 and 400,000 tonnes of light-firing claystone will be removed annually from this area. This figure may vary with markets and demand, but is not expected to exceed 400,000 tonnes per annum. The production of roadmaking materials will be variable ranging from 20,000 to 100,000 tonnes per annum.

5.2.12 Life of Operations

Assuming that a minimum of 300,000 tonnes of light-firing claystone are removed annually, in situ reserves in the area proposed for quarrying are adequate to supply the brickmaking industry for 25 years.

5.3 FACILITIES

Facilities will be provided for employees in a pre-fabricated portable building housing toilet, shower, and lunch room sited near the extractive operations.

An office/weighbridge complex will be conveniently placed close to the access road at the location shown on *Figure 13*. This complex will be provided with appropriate facilities and will house the site management and monitor all incoming and outgoing traffic.

A small building will be used for the storage of frequently used spares and equipment. It is proposed that most major repairs and maintenance of trucks and equipment will be carried out in the existing maintenance facilities on lot 22. At a later date, when rehabilitation of the quarry on lots 21 and 22 is complete, the maintenance facilities will be relocated to the present site.

Fuel will be stored in a skid mounted portable tanker.

The weighbridge will be a low line facility with 40 tonne capacity.

5.4 WATER SUPPLY AND SEWERAGE

5.4.1 Process Water

Water is used in extractive operations for dust suppression on roads and work areas. Water for this purpose will be derived from strategically located dams at points along the road and near the working quarry. Excess water in sedimentation dams will also be used for dust suppression.

5.4.2 Domestic Water

Water used in facilities will be supplied from tanks attached to the portable buildings.

5.4.3 Sewage Disposal

All waste water from facilities will be disposed of in a septic system designed to the requirements of authorities.

5.5 WASTE DISPOSAL

Wearn Industries Pty Limited has applied to operate a waste facility on lots 21 and 22 for the disposal of non-putrescible wastes in a sanitary landfill operation.

A separate environmental impact statement is currently being prepared for this proposal which will involve the filling of existing worked out pits on lots 21 and 22 with waste and suitable cover material to achieve a final landform suitable for 2 and 10 hectare allotments.

It is proposed that overburden from the proposed development site may be used in part as cover and as fill for these operations. *(Section 5.2.2)*.

No waste disposal operations are proposed for extractive operations on lot 1 DP541090.

5.6 ROAD HAULAGE

5.6.1 Road Options

A number of options have been considered for the haulage of materials from the site, and are discussed further in *Section 8.4*.

Major considerations in the selection of the optimum route were:

(i) Environmental factors such as soil erosion, visual aspects, impacts on flora and fauna, noise, and dust at nearby residences.

(ii) A route that could remain relatively fixed during the life of the extractive operations to take advantage of bund walling and screening.

(iii) A route that would be readily accessible to all proposed extractive operations, for instance, for operations west, north and south of the proposed development site.

(iv) A route that would minimise sterilisation of light-firing claystone deposits.

(v) A route that would provide a single access to a major public transport road.

5.6.2 Optimum Route

The Mulgoa Working Party examined five transport options for the haulage of raw materials to The Northern Road and these are shown on *Figure 19* and discussed further in *Section 8.4*.

The Wearn Group considers that the optimum route for the transport of materials from the site is a combination of the routes designated 4 and 5 by the Working Party. The Housing Commission and J. Reddan have also indicated their agreement that this route appears to be the optimum environmentally for the haulage of materials from the resource areas. The selected route is shown on *Figure 19* and has several economic and environmental advantages.

1. The route provides access to all proposed and possible future extractive operations in the Mulgoa area.
2. It provides access to the existing quarries on lots 21 and 22 for:
   a) Disposal of waste
   b) Haulage of overburden from lot 1 DP541090 to the excavations for disposal and as cover for waste materials (should this proposal proceed)
   c) Access to the maintenance depot on lot 22 for the repair of trucks and equipment.
3. The route traverses land owned by the extracting companies or is a "reserved road". No acquisition of adjoining privately owned land will be necessary.
4. The access along the "reserved road" will be constructed and maintained by the operating companies.
5. The route passes some distance from existing residences on Bradley Street and The Northern Road.

The proposed haulage route passes over land owned or leased by the Wearn Group (Lots 21, 22, 28, and Lot 1 DP541090) and Zacuba Pty Limited (Lot 1 DP222144). Zacuba Pty Limited has agreed to provide access to the

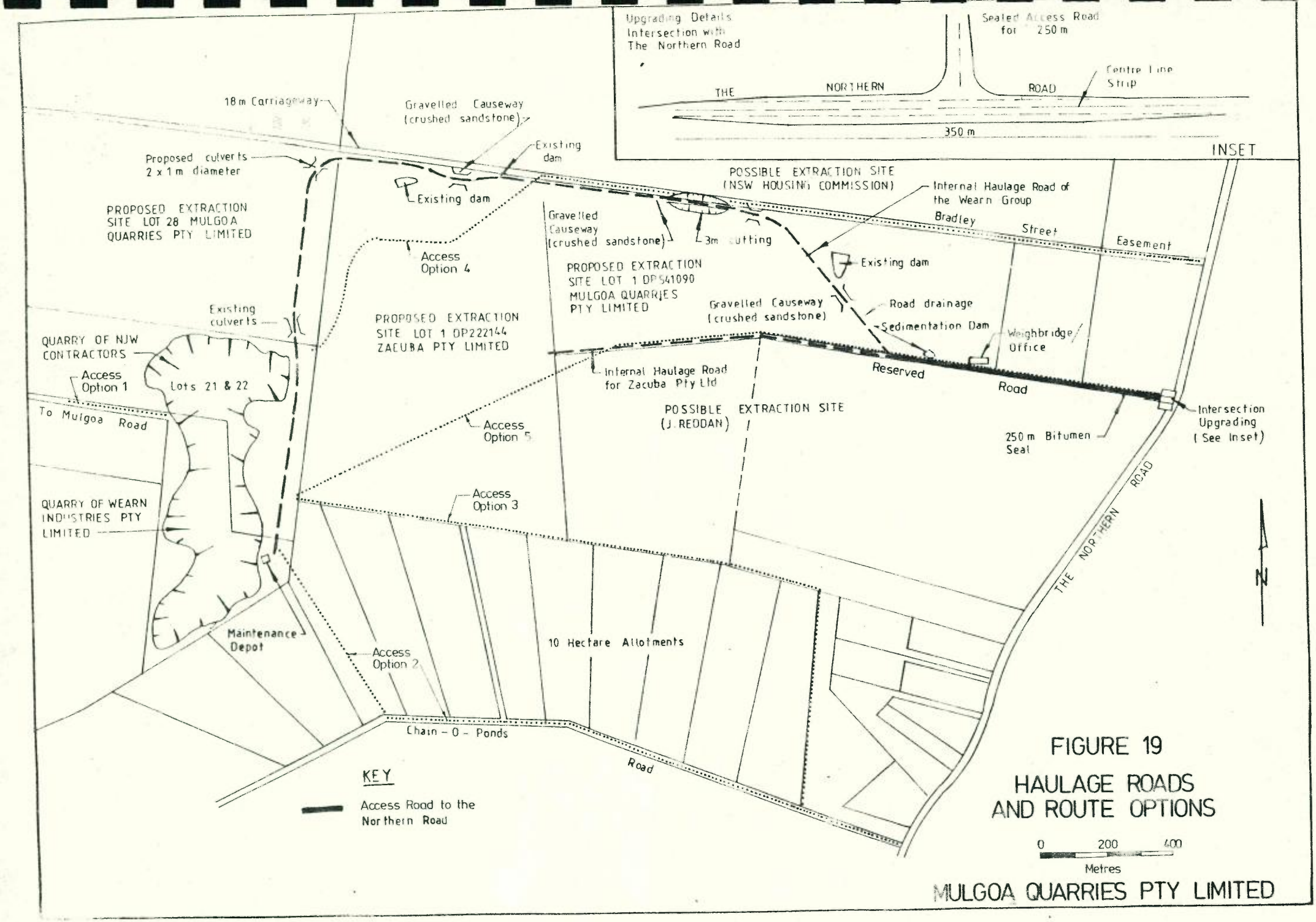


FIGURE 19

HAULAGE ROADS AND ROUTE OPTIONS

0 200 400

Metres

MULGOA QUARRIES PTY LIMITED

Wearn Group across the northern section of Lot 1 DP222144 to enable Wearn Group operations west of the un-named creek to gain access to The Northern Road (confirmed in *R.W. Corkery and Co. Pty Limited, 1982, p22*). In exchange, the Wearn Group has indicated to Zacuba Pty Limited that access along the southern boundary of Lot 1 DP541090 would be available to enable Zacuba Pty Limited direct access to the "reserved road" joining The Northern Road.

It is expected that the common sections of the route, e.g. the "reserved road", would be jointly constructed and maintained by industry and should extractive operations proceed on the Housing Commission and J. Reddan properties, operators on these lands would also be expected to contribute to road maintenance. Individual operators would be responsible for the construction and maintenance of the route where it is used solely by that Company's vehicles.

The route passes along a vacant strip of land of 20m width between Lot 1 (DP224861) and Lots 1, 2 and 7 (DP541090). Investigations by the Land Board Office *(Surveyor-General 23rd December, 1982)* have shown that this strip of land is a "reserved road" under an Old System subdivision and proposed to give access to the various parcels of land in the subdivision, including Lot 1 DP541090. Accordingly, the route can be developed as an access road without any acquisition of privately owned land being necessary.

5.6.3 Road Construction and Upgrading

The intersection of the access road and The Northern Road will be widened and upgraded to cater for the expected traffic. Turning lanes will be provided to allow quarry traffic to turn safely either to the left or right onto this road. Similarly turning lanes will be provided for traffic turning into the quarry access road. It is expected that about 350m of The Northern Road will be upgraded as shown in *Figure 19*. About 250m of the haul road will be sealed from the intersection with The Northern Road.

The access road will have an 18m carriageway constructed to a standard adequate for the expected truck movements. Road materials from the

existing quarry on Lot 22 or other quarry sites will be used in construction and the road will be provided with a suitable grade to reduce noise impacts resulting from ascending trucks.

Causeways and creek crossings will be provided at the locations shown on *Figure 19* to ensure that adequate flows are maintained in all drainage channels.

The construction of the haul route is expected to cost in the order of $450,000 and common parts will be funded by proposed quarry operators.

In-pit haulage roads within the quarry will be progressively relocated during extractive operations to provide suitable access to the main haulage road.

5.7 TRUCK MOVEMENTS

Types of traffic expected to use the access road are:

1. Quarry employee vehicles arriving in the morning and leaving in the afternoon.
2. Highway trucks transporting clay/shale to brickworks and road materials to construction sites.
3. Internal trucks transporting overburden from Lot 1 DP541090 to Lots 21 and 22 for disposal and cover for waste.

During 1980/81, Wearn Industries Pty Limited and N.J.W. Contractors marketed 423,027 tonnes of claystone and 18,081 tonnes of road materials resulting in a maximum of 190 daily truck movements. Current light vehicle movements average 100 per day.

It is expected that as a result of quarrying activities in the proposed development area there will be an average of 120 daily truck movements (based on an average production of 300,000 tonnes/annum claystone and an average of 60,000 tonnes/annum road materials) and 60 daily light vehicle movements.

Additional traffic which will utilise the proposed access road will be vehicles associated with quarrying activities on Lot 28, Zacuba's land, and the Housing Commission property.

It is expected that production on Zacuba's property will be of the order of 140,000 tonnes per annum and on Lot 28, production of 100,000 tonnes per annum is proposed. Assuming additional production of about 50,000 tonnes/annum from the Housing Commission property average daily truck movements would be increased to 110.

In summary, during peak production from all proposed clay/shale quarry sites, daily traffic movements using the access road on weekdays would average 230 trucks and 110 light vehicles.

5.8 MARKETS

Quarry traffic is expected to travel via The Northern Road and Elizabeth Drive to brickworks in the southwest Sydney region and the Western Freeway or The Northern Road/Blacktown Road to plants west and north respectively.

About 60 per cent of brickworks traffic is expected to utilise Elizabeth Drive, and 40 per cent The Northern Road and the Western Freeway.

It is not expected that future demand for light-firing claystone from the proposed development site will exceed 400,000 tonnes per annum.

Future markets for road materials are expected to vary. At the present time major users are the New South Wales Department of Main Roads for local roadworks, private developers of subdivisions, and local Councils such as Liverpool, the Blue Mountains and others. It is estimated that half of present production is used locally and half in areas to the east.

Future demand for materials will depend on Penrith Council's acceptance of the material for roadbase. If the material should be accepted then about 80 per cent of future demand would occur in the Penrith area.

5.9 HOURS OF OPERATION

Extractive operations will be carried out six days per week between the hours of 6:00am and 6:00pm.

5.10 WORKFORCE

Altogether some 40 persons would be employed in quarries operated by Mulgoa Quarries Pty Limited in the Mulgoa area. Approximately 30 of these persons will be employed directly on the proposed development site. Most employees will be derived from the existing quarries on Lots 21 and 22 where some 35 people are currently employed.

SECTION 6

MEASURES TO PROTECT THE ENVIRONMENT

6.0 MEASURES TO PROTECT THE ENVIRONMENT

6.1 WATER MANAGEMENT

Drainage controls have been designed into the proposed quarrying operation to ensure prevention of soil erosion and protection of water quality downstream of the site.

Drainage controls are shown on *Figures 13 to 17* and have been designed for a storm return period of 1 in 10 years.

Generally, the first flush of runoff from disturbed areas contains the majority of suspended solids generated by storm flows. To ensure that these first flushes are contained and treated, controls have been designed for storms of duration equal to the time of concentration of the entire catchment *(Pattison 1977)*.

6.1.1 Runoff Controls

Upslope runoff will be diverted away from areas disturbed by quarrying operations through a series of diversion channels, which will be relocated as quarrying proceeds in accordance with the stages outlined in *Section 5.2.3*.

It is expected that since these channels are located high in the catchments they will have the capacity to convey all expected storm runoff. Any runoff overflow will be collected in the quarry area and diverted to the settling dams.

All channels will be constructed to the following design criteria:

(i) Topsoil will be removed and temporarily stockpiled.

(ii) Channels will be constructed in the impermeable clayey subsoil and will be "V" shaped with batters of 1 in 3 and depth of 0.5m.

(iii) Topsoil will be replaced and the channel grassed.

(iv) The paths from the end of the diversion channels to the existing water courses will be grassed and where necessary provided with channel protection such as rip rap.

(v) Existing farm dams will be retained in the areas shown to provide water for dust suppression on roads and quarry areas.

6.1.2 Soil Erosion Controls

Studies carried out on the existing environment *(Section 4.4)* have shown that the soil has good water retention qualities and is generally stable under grassed or natural vegetation conditions. Where overgrazed and vegetation cover is sparse some sheet erosion or gully scour may occur. The stable pedal structure can also be disrupted by the weight of heavy machinery.

To prevent soil erosion occurring as a consequence of quarrying activities, it is proposed to limit the area stripped ahead of quarrying activities to a minimum. Grazing activities will be curtailed within the proposed development area to give areas not proposed to be disturbed by quarrying activities, the opportunity to regenerate naturally. Supplementary planting will be carried out in the area shown on *Figure 13*.

Heavy traffic will be confined to constructed roads and quarry areas and will not traverse undisturbed areas ahead of the face unnecessarily.

During rain periods, the quarry areas become untrafficable and extractive operations will cease temporarily.

The access road will be provided with drainage channels, causeways and creek crossings as shown on *Figure 19*. These will be designed for the expected flows from upslope areas and stabilised with grass to prevent scouring and rilling.

Rehabilitation of worked out areas will be carried out progressively following extractive operations to ensure a stable landform and to control soil erosion. Runoff controls described in *Section 6.1.1* for the quarrying operation will aid in the control of soil erosion.

6.1.3 Quarry Water Control and Disposal

Runoff from the quarry and working areas will be collected by a system of channels and directed to sedimentation dams for clarification. Following settlement, the water will be used for dust suppression or discharged to the natural drainage system downstream of the site during high flow periods. There will be no dry weather discharge.

These dams, shown on *Figures 13 to 17* will be progressively constructed as quarrying proceeds in stages *(Section 5.2.3)* and will be designed with the retention capacities shown.

Criteria adopted for the design of sedimentation dams are:

(i) Dam sites will be stripped of topsoil and permeable material.

(ii) Walls will be constructed of the clayey subsoil to ensure impermeability.

(iii) The walls will be battered to safe slopes and grassed.

(iv) Spillways will be provided at the edge of the dam wall to convey overflow. These will be protected with rip rap to prevent erosion, and discharges will re-enter the water course away from the base of the dam.

(v) Dams will be constructed with two cells with overflow from one cell to the next providing additional treatment opportunity.

(vi) Straw bales will be provided at the inlet to sedimentation dams to trap any oil washed from trafficked areas. Bales will be regularly changed and disposed of in the waste disposal operation. Dam overflows will be baffled to prevent any oil discharge from the site.

6.1.4 Sewage Disposal

Operator facilities will be provided with a septic system designed to the requirements of authorities for the disposal of waste water.

6.2 OVERBURDEN HANDLING AND DISPOSAL

It is proposed that maximum use will be made of all materials occurring on the site for either brickmaking or as road materials. However, significant quantities of siltstone, claystone, sandstone, and laminite will not meet specifications for these uses and will be utilised for rehabilitating worked out areas.

Excavations will be filled using material derived from the extractive operations to return land in terms of topographic appearance as closely as possible to its original condition.

Overburden will be loaded into off highway dump trucks for cartage to the disposal sites. It is proposed initially to progressively refill pits on lots 21 and 22 using non-putrescible waste and overburden as cover. As quarrying proceeds, unused material from the site will be used to progressively backfill on-site excavations.

Overburden will be compacted by vehicular traffic to a density of about 2.0 tonnes/m^3 and it is expected that there will be sufficient void available for disposal of all unused material in the excavations.

The filled areas will be graded and contoured and improved by tillage and the addition of fertilisers. Several post extraction land use options are possible for the proposed development area.

6.3 DUST CONTROLS

Air quality will be protected by preventing or minimising the quantity of dust produced at potential site generation points.

6.3.1 Access and Haul Roads

The access road will be bitumen sealed for 250m from the intersection of The Northern Road to the crest of the ridge and then gravelled to the extraction area.

The gravelled section is located on the western side of the arcuate ridge away from residences on The Northern Road and Bradley Street.

The access and haul roads will be regularly maintained and watered using a water cart fitted with a spray bar system. Watering will be at the rate of 1.5 times the evaporation rate to allow for the accelerated drying due to traffic. Excessive watering will be avoided to prevent material adhering to truck tyres.

The exhaust from vehicles using the road will be directed away from the ground to prevent dust generation and truck loads will be covered to prevent dust emissions. Speeds will be restricted as far as practicable to below 50kph.

Early planting of quick growing tree species on the eastern side of the access road and on bund walls will entrain any dust that may be generated from this source.

Water for dust suppression will be obtained from the sedimentation dams and farm dams strategically located throughout the area.

6.3.2 Quarrying Operations

Areas of disturbance will be kept to a minimum and worked areas rehabilitated as soon as practicable.

The rig used for drilling blast holes will be fitted with dust collection equipment to minimise dust emissions.

The blasting pattern for fragmenting sandstones *(Section 5.2.5)* will be designed to minimise overpressure and the generation of dust. Blasting will not be undertaken during strong wind periods when potential exists for dust to be conveyed towards residential areas. It is expected that blasting will be carried out 3 or 4 times a year to fragment sandstone and competent laminite horizons and infrequently for the break up of small sandstone lenses.

The quarry face and bund walls will provide protection from prevailing wind directions and shield any stockpiles located on the quarry floor, truck loading operations, and the mobile crushing and screening plant.

The processing equipment will be kept in good condition and regularly maintained.

6.3.3 Stockpiles

Should it be necessary to stockpile overburden in the area shown on *Figure 13*, proposed bund walls and vegetation screens will provide a shield protecting stockpiles from prevailing winds. The planting of grass on stockpiles will also temporarily stabilise and protect the stockpiles until they are required for rehabilitation of extraction sites.

6.4 NOISE AND VIBRATION CONTROL

Safeguards will be incorporated in the project to reduce noise impact.

All access and haul roads will be maintained in good condition and constructed with grades of less than 8.5 per cent. The gentle grades will minimise engine noise generated by laden trucks and by maintaining roads in good condition, noise normally associated with empty trucks will be reduced.

Trucks will not transport materials from the site in convoy and at speeds greater than 50kph as far as practicable. Trucks will be normal road-worthy highway vehicles which will be maintained in good condition and

regularly serviced. All mobile equipment will be fitted with noise reduction equipment on exhausts and shielding around motors to ensure levels do not exceed rated values.

An earthen bund wall will be constructed along the northern perimeter of the property as shown on *Figure 13*. The wall will vary in height up to 6m and together with a 500m buffer zone will reduce noise levels from quarrying and hauling operations at proposed residential areas north of the site.

The quarry face also provides a shield, aiding in reducing noise levels. Attenuation due to distance, topography, and existing and proposed plantings further reduce levels.

Blasting will be carried out during daylight hours and where possible will take place at the same time of day and during suitable weather conditions. Blasting will not be carried out when strong winds are blowing in the direction of residences or when there is likely to be temperature inversions in the area. Prevailing meteorological conditions will be checked before blasting.

The New South Wales Department of Industrial Relations (Mines Inspection Branch) and the State Pollution Control Commission impose limits on overpressure levels and groundborne vibration from blasting. Limits currently being set by these authorities range from 115 to 120dB (lin) for overpressure and 7 to 10 mm/s peak particle velocity for vibration, measured at the property boundary. These levels are well below SAA Explosives Code Australian Standard 2187, Part 2-1979 maximum recommended limit of 20mm/s peak particle velocity for structurally sound buildings (measured at the building).

Using the result of test blasts carried out at the quarry nearby, blasts will be designed to ensure that the limits mentioned above are not exceeded. The use of suitable blasting patterns and delay detonators initiated electrically will ensure that overpressure and vibration levels

are kept to a minimum. Initially and as the quarry progresses from stage to stage, blasting will be monitored and if necessary the blast design modified to ensure that set limits are met.

6.5 BUFFER ZONE

The proposed quarry area is sited on the western third of the property and remote from existing residential areas. A distance of 750m separates the eastern most extremity of the quarry and nearest residences in Bradley Street.

Residences in Chain-O-Ponds Road south of the site are in excess of 750 metres from the proposed quarry site, while to the west residences are greater than 1km distance.

Land to the north of the site is owned by the New South Wales Housing Commission and proposed for future residential development within a 10 year time frame.

To avoid potential land use conflicts resulting from the proximity of housing to quarry developments it is proposed that a minimum buffer zone of 500m be maintained around the quarry area. The quarry has been designed so that operations proceed from north to south away from the proposed residential development. At the same time the buffer zone would be progressively reduced to a minimum of 300m. *(Nagiel 1981)*.

The buffer zone together with the bund wall and tree plantings will reduce noise levels at nearest residences.

6.6 BUND WALL AND TREE SCREENING

6.6.1 Bund Wall

An earthen bund wall will be constructed on the northern side of the proposed access road to shield quarry traffic, reduce noise levels, and to minimise the visibility of the quarrying operations and stockpiles. The wall is shown on *Figure 13*.

Constructed of overburden from the initial extraction area (Stage 2), batter slopes will be relatively steep (1 in 2) in order to achieve the desired height within the area available.

The wall will be hydroseeded with a mixture of stabilising grasses and indigenous trees and shrubs. The bund wall will be provided with adequate drainage at appropriate locations.

It is expected that if extraction takes place on the adjoining land owned by the New South Wales Housing Commission, the wall could be relocated further north. Mulgoa Quarries Pty Limited will co-operate with authorities in siting the bund wall in a suitable location should this be necessary.

6.6.2 Tree Screening

Plantings will be carried out initially to screen the proposed quarry site and access roads. *(Section 5.2.3).*

Tree screening will be established in the area immediately east and south of the quarry site prior to the commencement of quarrying. As operations proceed in an easterly direction across the ridge, (Stage 3B) these trees will have reached a mature height to adequately screen the quarrying operations. (A period of 10 years will elapse from the commencement of quarrying till Stage 3B, when the crest of the ridge will be breached).

A verge of trees will be planted in appropriate locations on the eastern side of the proposed access road to screen stockpiles and the road from the north and northeast. A list of species indigenous to the area and to be used for screening is given in *Table 4.*

An existing verge of trees will partially screen the final 250m of the access road from residences in Bradley Street. *(Figure 13).*

These plantings and bund wall will partially screen the operations from viewing points to the south, north, and northeast.

TABLE 4

SCREEN PLANTING SPECIES

SPECIES	MATURE HEIGHT	COMMON NAME
Trees:-		
+ *Acacia elata*	15m	Cedar Wattle
* *Angophora floribunda*	20m	Rough Barked Apple
Banksia integrifolia	10m	White Honeysuckle
* *Eucalyptus crebra*	30m	Narrow-leafed Ironbark
* *Eucalyptus globoidea*	30m	White Stringybark
* *Eucalyptus pilularis*	40m	Blackbutt
* *Eucalyptus viminalis*	40m	Ribbon Gum
Shrubs:-		
Acacia baileyana	5m	Cootamundra Wattle
Acacia floribunda	4m	White Sally
+ *Acacia longifolia*	6m	Sydney Golden Wattle
Banksia ericifolia	2m	Heath Banksia
Callistemon linearifolius	2m	Narrow-leafed Bottlebrush
Grevillea asplenifolia	3m	-
Grevillea buxifolia	2m	-
Grevillea caleyi	4m	-
Melaleuca armillaris	5m	Bracelet-Honey Myrtle
Melaleuca deanei	3m	
Melaleuca nodosa	3m	

* Indigenous to the Area

\+ Indigenous to the Area and Found on Site

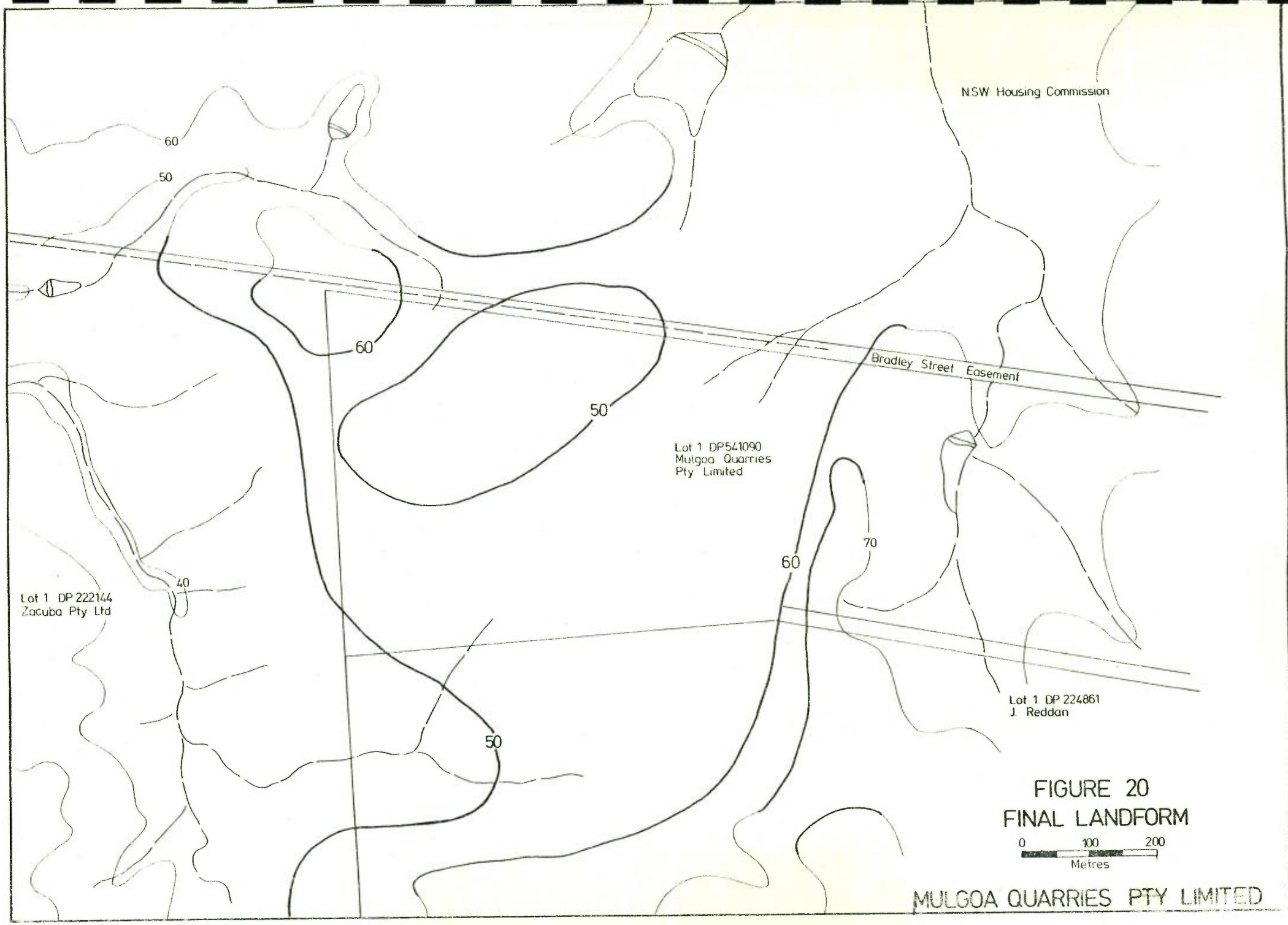

N.S.W. Housing Commission
60
50
60
50
Bradley Street Easement
Lot 1 DP541090
Mulgoa Quarries
Pty Limited
70
60
40
Lot 1 DP 222144
Zacuba Pty Ltd
50
Lot 1 DP 224861
J. Reddan
FIGURE 20
FINAL LANDFORM
0
100
200
Metres
MULGOA QUARRIES PTY LIMITED

FIGURE 21

PROPOSED FINAL LANDUSE

RURAL-RESIDENTIAL

MULGOA QUARRIES PTY LIMITED

6.7 REHABILITATION

Rehabilitation of worked out areas will be carried out progressively during extractive operations.

It is proposed to use overburden to fill excavations on lots 21 and 22 and in the proposed development areas as required.

Lots 21 and 22 may be developed as 2 and 10 hectare subdivisions while a number of post-extraction land use options are possible for the proposed development area.

The material will be compacted to a density of about 2.0 tonnes/m^3. Stockpiled topsoil will be respread and the areas graded and contoured, and improved by tillage and the addition of fertilisers.

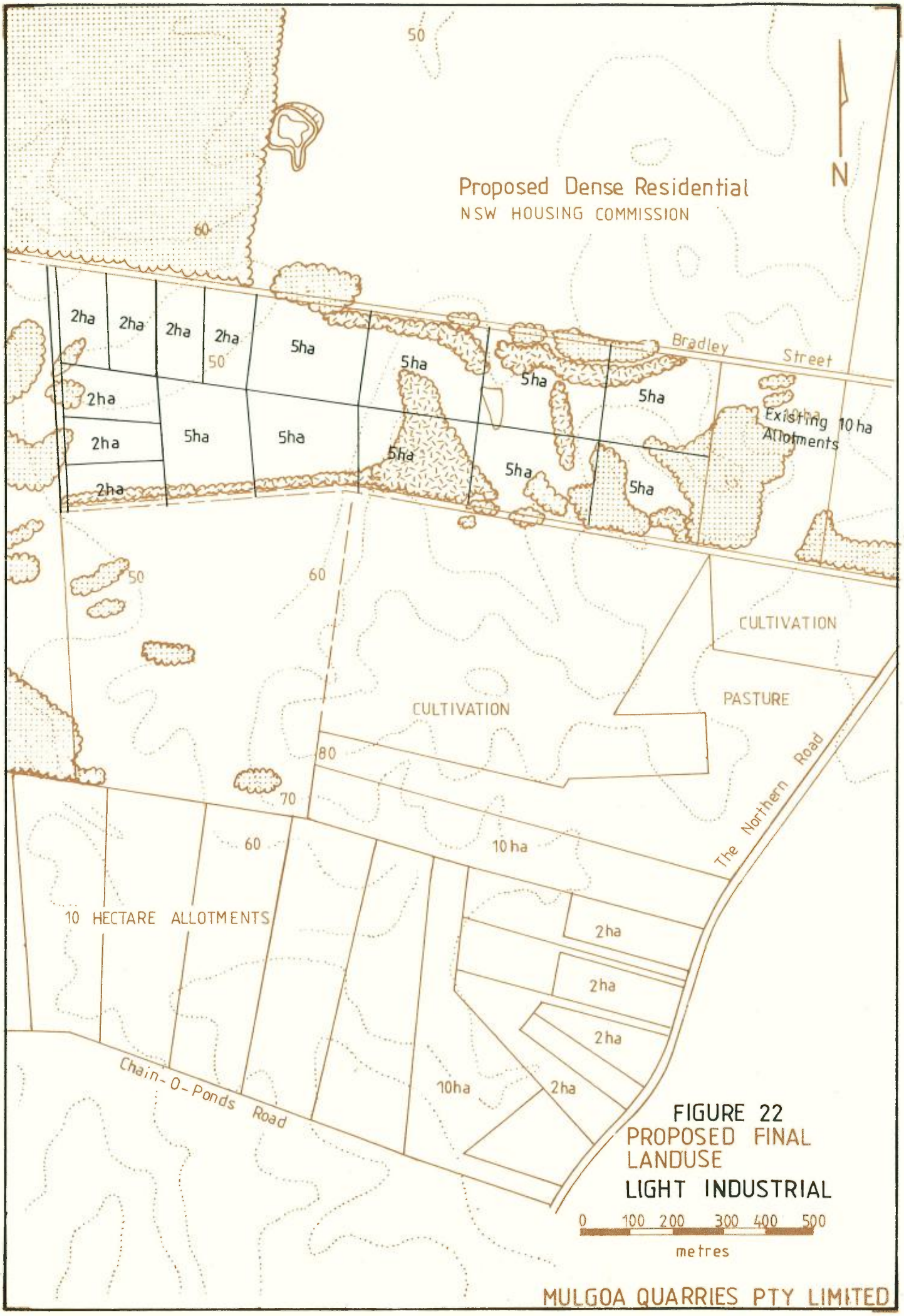
At the end of extractive operations the land will slope gently to the west. The land will be free-draining and suitable for a number of conceptual final land use options which are shown on *Figures 21* to 24. These include:

1. *Residential (Figure 21)*

   The site will adjoin high density residential development to the north and 10 hectare rural allotments to the south and east. The final landform of the site could accommodate either types of development but if high density development is considered a suitable option then a detailed geotechnical study would be necessary to ascertain the suitability of the compacted material for building foundations.

2. *Industrial (Figure 22)*

   A light industrial subdivision would be possible within the area and would require the rezoning of land to permit the proposed use. A similar geotechnical study to 1 above would also be required.


Proposed Dense Residential
NSW HOUSING COMMISSION
N
Bradley Street
Existing 10 ha Allotments
2ha
5ha
50
60
70
80
CULTIVATION
PASTURE
The Northern Road
10 HECTARE ALLOTMENTS
10ha
Chain-O-Ponds Road
0 100 200 300 400 500
metres
FIGURE 22
PROPOSED FINAL LANDUSE
LIGHT INDUSTRIAL
MULGOA QUARRIES PTY LIMITED

3. *Passive Recreation (Figure 23)*

The land could be developed for a passive recreation and/or wildlife refuge. Sited in the valley the adjoining land could be developed as parkland to provide a "greenbelt" between residential development to the north and rural allotments to the south. Barbeque and picnic facilities, walking trails and play areas possibly in some combination with 4 could be considered.

4. *Forestry*

The site is of sufficient size to support a forestry operation based upon high value timber. This development would also serve as a "greenbelt" possibly in combination with land use option 3.

5. *Agriculture (Figure 24)*

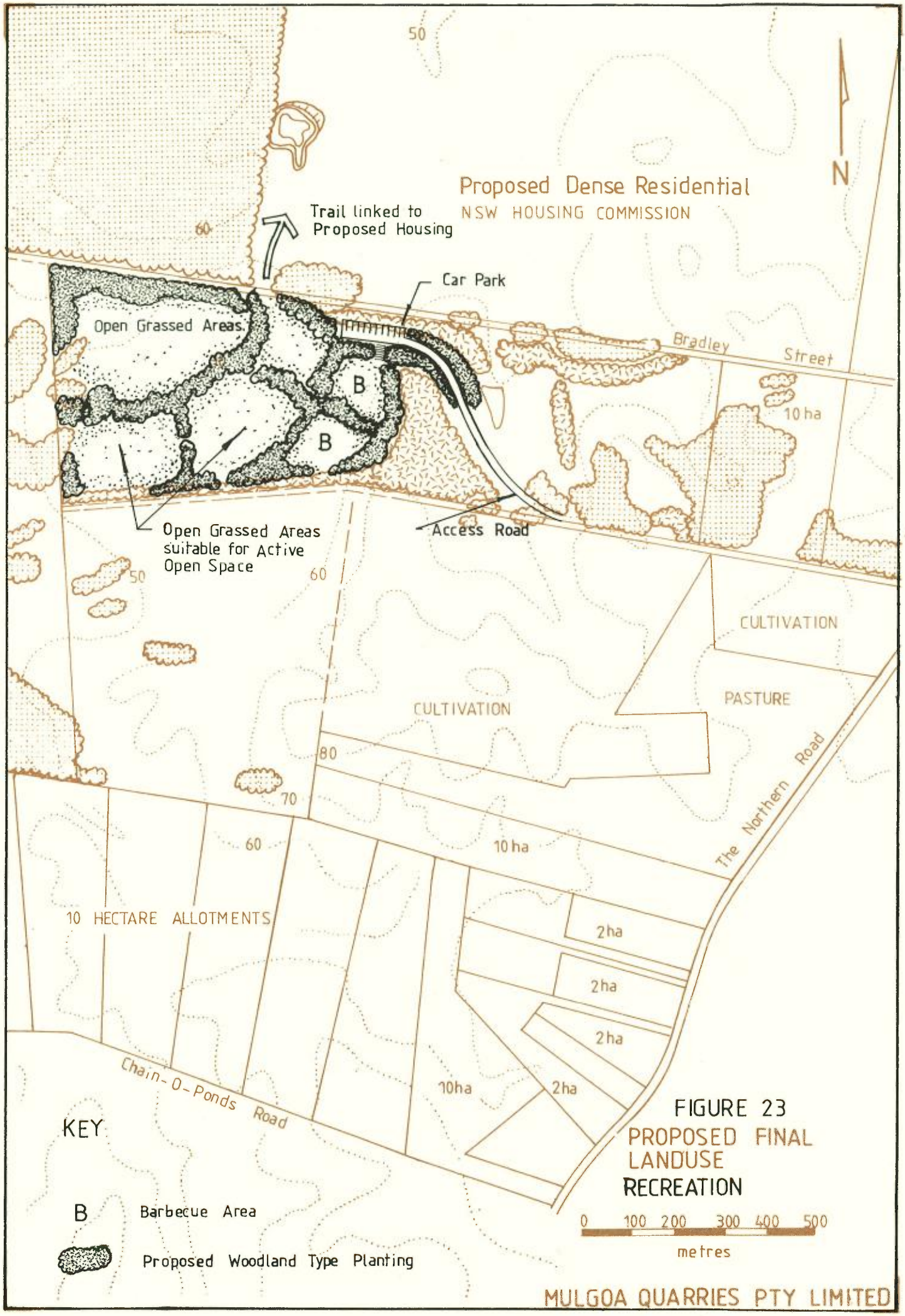
The land could be returned to the pre-extraction land use of grazing/crop cultivation.

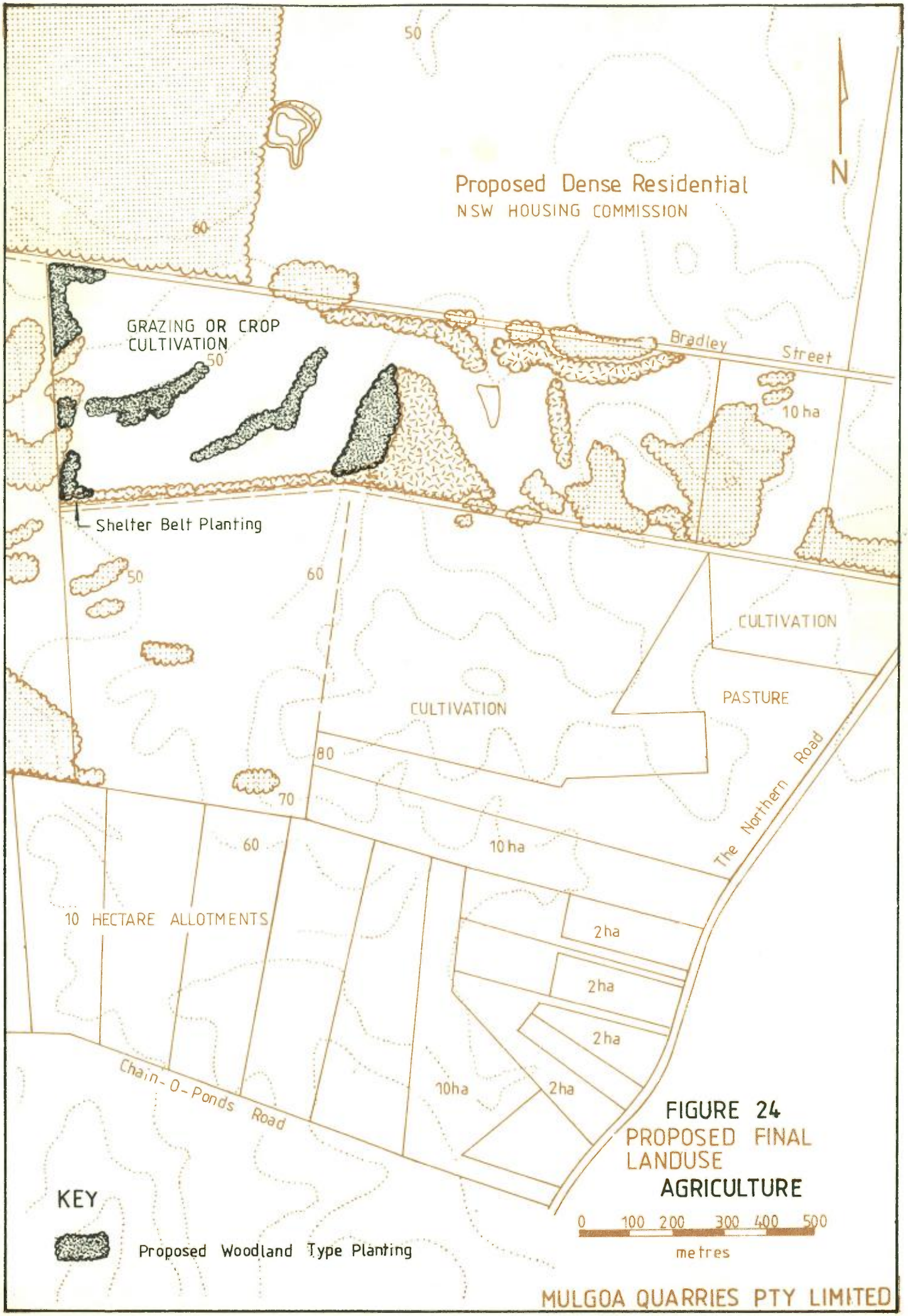
It is acknowledged that during the 25 years of quarrying and rehabilitation on the site, changing circumstances may alter preferences for the final land use. These will be progressively reviewed by the Company in conjunction with Penrith City Council, the local community and relevant Government authorities.

6.8 CONTROLS ON OPERATIONS

The operation will be subject to compliance with conditions imposed by Penrith City Council and licenced with the State Pollution Control Commission.

Regular inspections are made by inspectors from the New South Wales Department of Industrial Relations and Council to ensure compliance with safety regulations and imposed conditions.


Proposed Dense Residential
NSW HOUSING COMMISSION
N
Trail linked to
Proposed Housing
Car Park
Open Grassed Areas
B
B
Bradley Street
10 ha
Open Grassed Areas
suitable for Active
Open Space
Access Road
50
60
CULTIVATION
PASTURE
CULTIVATION
80
70
60
10 ha
The Northern Road
10 HECTARE ALLOTMENTS
2ha
2ha
2ha
10ha
2ha
Chain-O-Ponds Road
KEY
B Barbecue Area
Proposed Woodland Type Planting
FIGURE 23
PROPOSED FINAL
LANDUSE
RECREATION
0 100 200 300 400 500
metres
MULGOA QUARRIES PTY LIMITED


Proposed Dense Residential
NSW HOUSING COMMISSION
N
GRAZING OR CROP CULTIVATION
Bradley Street
10 ha
Shelter Belt Planting
CULTIVATION
PASTURE
CULTIVATION
The Northern Road
10 HECTARE ALLOTMENTS
10 ha
2 ha
2 ha
2 ha
2 ha
10 ha
Chain-O-Ponds Road
50
60
80
70
KEY
Proposed Woodland Type Planting
FIGURE 24
PROPOSED FINAL LANDUSE
AGRICULTURE
0 100 200 300 400 500
metres
MULGOA QUARRIES PTY LIMITED

6.9 ENVIRONMENTAL MANAGEMENT

In conjunction with the high standard of safeguards incorporated in the design of the project, the Company will carry out regular monitoring and reporting of its operations.

(i) Penrith City Council will be provided every two years with a progress report on the stage of operations. The report will be supported by a plan or photograph to illustrate development.

(ii) Water samples will be collected and measured on a regular basis and results made available to relevant authorities.

(iii) Blasting will be regularly monitored by the Company and results made available to authorities.

(iv) A forestry officer will monitor the progress of rehabilitation and screen plantings and provide regular reports on progress. A photographic record will be kept to monitor the effectiveness of the landscaping and rehabilitation programme.

SECTION 7

ANALYSIS OF ENVIRONMENTAL INTERACTIONS & IMPACTS

7.0 ANALYSIS OF ENVIRONMENTAL INTERACTIONS AND IMPACTS

A. NATURAL PHYSICAL ENVIRONMENT

7.1 TOPOGRAPHY AND SLOPES

The proposed quarrying operation will alter the topography of the site by displacing the existing ridge line to the east and lowering the elevation of the ridge by an average of 20m.

A gentle slope to the west will be created.

The final landform is shown on *Figure 20* and will be stable and suitable for a range of landuse options.

7.2 GEOLOGY

The main alteration to the geology will be the removal of part of the lower 65m of *Bringelly Shale* occurring in this area.

The extraction of claystone, laminite, siltstone and sandstone will have a beneficial impact on reserves of light-firing claystone and road materials in the Sydney region. As indicated in *Section 3.0* reserves of clay/shale of this quality are becoming increasingly short in the Sydney region. The site can supply four brickmaking companies currently supplying 29 per cent of the entire Sydney region's brick output with their requirements for light-firing material for 25 years.

7.3 SOIL EROSION

To avoid disruption of the pedal structure of the clay soils, a contributing factor to soil erosion, channels will be constructed to divert clean runoff around disturbed areas, clearing ahead of the face will be restricted, and heavy traffic will be confined as far as practicable to constructed roads.

The safeguards designed into the project for the control of runoff across disturbed areas will ensure that impacts on soil erosion are minimal.

Site management practices such as control of grazing activities and repair of areas subject to gully erosion and rilling will aid in curtailing erosion in the area.

Rehabilitation of worked out areas to create a stable landform will follow extractive operations. It is expected that areas under rehabilitation or temporarily disturbed may be subject to some erosion before vegetation becomes established. These areas will be repaired quickly as part of site management procedures.

7.4 HYDROLOGY

7.4.1 Surface Drainage

The existing flow directions of stream courses will be maintained and only partly modified by quarrying activities. Gradients of streams flowing to the west will be gentle, reducing the incidence of nick point headwalls.

There will be some reduction in flows downstream of the site as a result of on-site water collection and treatment. As existing flows are intermittent and the area contributes only 3.6 per cent of flows to the unnamed creek draining the area, retention of runoff is expected to have insignificant impact on creek flows.

Upslope flows diverted around disturbed areas will rejoin water courses downstream of the site without altering the hydraulic characteristics of the channels. Locations such as discharge points to existing creeks from sedimentation dams will be rip-rapped to prevent scour.

7.4.2 Flooding

Safeguards for the control of runoff from the site will prevent downstream flooding. The site is above known flood levels associated with the Nepean River.

7.4.3 Groundwater

The quarrying activities will not interfere with groundwater aquifers. Some minor flows into the quarry from groundwater sources may occur but these will be collected and treated.

7.4.4 Water Quality

Sedimentation dams constructed downstream of all disturbed areas will ensure that the contribution of suspended solids to flows will be low.

Water quality analyses of samples taken from the floor of the disused quarry show that soluble salts are moderate to high in water on the quarry floor *(Table A4. W4* ≈650mg/ℓ*)* but that levels are quickly reduced downstream through dilution. A farm dam 450m downstream from the disused quarry gave readings of 234mg/ℓ *(W5 Table A4)*. This level indicates low soluble salts which are below the maximum allowable impurity level for drinking water (i.e. total soluble salts 1500mg/ℓ).

There will be no dry weather discharge from settlement dams. Discharge will only be necessary during periods of heavy or prolonged rainfall.

With retention of runoff in sedimentation dams, discharges can be expected to be of better quality than existing runoff.

The impact on water quality downstream will be negligible.

7.5 IMPACT ON AIR QUALITY

Measures proposed in *Section 6.3* for dust control will significantly reduce dust nuisance from the access road and proposed operations.

Prevailing winds are from the northeast to southeast sectors for seven months of the year thus carrying any airborne dust away from the nearest residences on The Northern Road. During these periods of the year the potential for airborne dust being carried toward the proposed Housing Commission development northeast of the site would be minimised by the screening provided by the *E. viminalis - E. pilularis - Angophora subvelutina* closed-forest immediately north of the site.

For five months of the year the prevailing winds are from the northwest to southwest sectors and the likelihood of airborne dust being carried to residences along The Northern Road and proposed Housing Commission development north of the site will be minimised by the natural screening provided by the ridgeline east of the site, the screening and filtering effect of the tree planting programme, and the screening provided by the bund wall and buffer zone north of the site.

With the measures mentioned in *Section 6.3* it is expected that there will be a low impact from dust in an area that is already exposed to a degree of airborne dust from agricultural activities.

The low volumes of traffic associated with the proposed quarry and the open spaces around the site would ensure that vehicle emissions would not have a significant impact on the ambient air quality in the surrounding area.

7.6 IMPACT ON NATIVE VEGETATION

The proposed quarrying operation will have minimal impact on native vegetation communities. The land is predominantly cleared grassland with scattered stands of trees left as shade for grazing animals.

Trees of the *E. viminalis - E. pilularis* closed-forest will be cleared

for the siting of the access road on the eastern side of lot 28 and at the point where the unnamed creek is crossed. No areas of rare or endangered vegetation communities will be cleared and areas containing the protected species *(Casuarina cunninghamiana)* will be avoided.

Removal of vegetation from this area will be an unavoidable impact.

7.7 IMPACT ON WILDLIFE AND HABITATS

The most significant fauna habitats for both mammals and birds are the small patches of dense or mature native forest occurring in creeks, and the farm dams west of the site. *(Section 4.7)*.

The proposed access road will result in the loss of some habitat at the point where it crosses the unnamed creek. As far as practicable an alignment will be chosen which avoids mature "habitat" trees suitable as nesting sites for possums and other dependent fauna.

Only the road alignment will be cleared to minimise the total area to be disturbed. However, some loss of habitat will occur.

The planting of native species as screens and on bund walls will provide additional habitat for animals using the adjacent forested areas.

As with all roads that pass through relatively undisturbed bushland, some road deaths will arise as a result of vehicles using the access roads.

7.8 VISUAL IMPACTS

For the first 10 years, the quarrying operation will be sited on the western side of the ridge where it will be partially screened by ridge lines, bund walls and screen plantings from areas to the north and northeast.

It is expected that as quarrying proceeds to the south and east, the operations will be visible above the tree screen initially planted on the eastern and southern perimeter. Operations will be visible in Penrith South and from The Northern Road near the intersection with Chain-O-Ponds Road during later stages of the operation. It will also be visible to residences on the highland east of the Nepean River (west of Mulgoa Road) and more distant views will be possible from Lapstone and Leonay.

Figure 25 shows lines of site of the proposed quarry from viewing points.

The tree screenings and bund walls will provide a partial shield reducing the overall visual impact.

B. MAN-MADE PHYSICAL ENVIRONMENT

7.9 ABORIGINAL PRE-HISTORY

An extensive archaeological survey of the site resulted in one broken edge ground axe being found. The site was not found to support engravings or rock art, and the clay soil was thought to have been too stiff to have been excavated by Aborigines for burials.

Impacts on archaeological sites are negligible.

7.10 HISTORICAL SITES

The site is remote from historical homes at Mulgoa and Glenmore. Studies conducted by the Mines Inspection Branch of the Department of Industrial Development have shown that these homes are not affected by blasting in the existing quarry.

The proposed development site is more remote from these historical homes and impacts will be minimal.

7.11 PLANNING

7.11.1 Regional Planning

The quarry will have a short term impact on residential developments proposed by the New South Wales Housing Commission on land north of the site. The creation of a buffer zone surrounding the optimum resource area *(Etheridge 1981b)* will restrict the area that can be developed for housing in the short-term.

However, as quarrying proceeds in a southerly direction, the buffer zone will be reduced and further residential development in this area will be possible.

The creation of the buffer zone will have a beneficial impact by eliminating potential land use conflicts that arise when residential development is sited immediately adjacent to quarrying activities.

The claystone resource has been identified as being of significance and importance in the development of regional planning strategies.

7.11.2 Local Planning

The site is located within an area developed for 2 and 10 hectare lots to the south and west and existing quarrying operations to the east.

The extension of quarrying into this area results in these extractive activities being sited together, an aid in local planning. Opportunity exists for the extraction of a valuable claystone resource followed by a post extraction land use which is in keeping with existing surrounding land uses. In this way land is utilised for its highest and best use and resources are not sterilised by urban development.

The proposed activity will have minimal impact on local planning.

7.12 IMPACT ON LAND USE

7.12.1 Agriculture

The proposed quarry will occupy an area of 25 hectares or 33 per cent of land currently used for horse and cattle grazing. It does not cover areas used for crop cultivation. The loss of this small area of grazing land is not expected to have an impact on the availability of grazing land.

All activities associated with the quarry will be confined to the proposed development area and will not affect surrounding agricultural land uses.

7.12.2 Residential

The proposed quarry will prevent the development of housing on the site during the life of the extractive operations.

The quarry site will be 700m from the nearest existing house and at its closest point, 500m from the residential subdivision proposed by the New South Wales Housing Commission. *(Refer Section 7.11.1)*.

The access road has been designed to be about 150m from the nearest residences in Bradley Street and screened by a verge of trees.

Impacts on residential land uses will be low.

7.12.3 Recreational

The development will have minor impact on existing recreational activities in the area, through the loss of grazing land used for horse riding.

The quarry site has potential for a recreational use at the completion of extractive operations.

7.12.4 Special Uses

There will be no impact on the Air Force and Naval establishments or water reservoirs and pipelines. The "Sovereign" trig station will be required to be relocated, possibly to the high point on the ridge 600m to the southeast where it will remain undisturbed.

7.12.5 Mining and Extractive Industries

The development is an extension of quarrying activities currently being carried out on land to the west of the site. The siting of the quarry in this area will result in these activities being located within the one region, and is a beneficial impact.

7.12.6 Natural Areas

The proposed activity will not affect natural areas occurring on or adjacent to the site.

7.13 IMPACT ON PUBLIC UTILITIES

The weighbridge and facilities provided on site for employees will require to be serviced by electricity and telecommunications. Water will be provided from tanks and waste water will be disposed of in a septic system.

It is not expected that there will be any adverse effect on the current supply of these utilities to other users.

7.14 IMPACTS ON ROADS

The proposed haulage route between the quarry and The Northern Road traverses in part land owned by the quarrying Companies and in part a "reserved road". The upkeep of this road will be funded by the quarrying Companies utilising the road.

The intersection of the access route and The Northern Road will be upgraded

for 350m and provided with turning lanes to ensure the safe turning of vehicles. The cost of this upgrading will be borne by the quarrying Companies.

The AADT for The Northern Road has been calculated at 13,500 vehicles or about 8,000 vehicles in a 12 hour day. *(Appendix 2)*. Assuming some 15 per cent of these vehicles are classified as heavy trucks, the number of heavy vehicles (AADT) using this road are of the order of 2,025, or 1,080 in a 12 hour day.

Assuming 40 per cent of heavy traffic originating from the development site travel to the north and 60 per cent to the south *(Section 5.8)*, total traffic levels to the north will increase by 48 vehicles or 0.6 per cent, (4.4 per cent increase in heavy traffic) and to the south between the site and Elizabeth Drive turnoff, levels will increase by 72 vehicles or 0.87 per cent (6.7 per cent heavy traffic).

The Northern Road is a two lane well constructed thoroughfare with good alignment and shoulders. The increase in heavy vehicular traffic is moderate to high but within the capacity of the road. There will be a moderate increase in inconvenience to road users.

Overall, the increase in quarry traffic on Elizabeth Drive is only 1.5 per cent on existing levels. Since the travel distance between the quarry and the brickworks will be considerably shortened by the new route, there will be considerable savings in fuel and a reduction in energy requirements.

7.15 IMPACT ON ENERGY RESOURCES

The proposed quarrying activities will have no impact on coal resources or future underground mining of coal reserves.

Electricity requirements of the weighbridge and facilities will be negligible compared with the total usage of electricity in New South Wales.

Trucks and earthmoving equipment on the proposed development site and lot 28 are expected to consume an average of 16,500 litres of diesel per week and over a 45 week year 743Mℓ will be consumed. This equates with a primary energy requirement of 28.4×10^{12}J per annum.

In comparison, the total non-metallic mineral use of energy in New South Wales has been estimated at 41.4×10^{15}J in 1981-82 *(Department of National Development, 1978)*. Consequently, the development will consume 0.06 per cent of the total energy used by the non-metallic mineral industry in 1981-82.

7.16 IMPACT FROM NOISE AND BLASTING

7.16.1 Noise from the Quarrying Operation

Studies have been undertaken to assess potential noise impacts from the extractive operation on nearby residents. As discussed in *Section 4.16.1* background noise levels vary from 32 to 48dB(A) at various sites around the area.

However the existing background noise level at site N8 is likely to change because of the proposed housing development north of the site. On this basis the background level at N8 is considered inappropriate for assessing the impact of the proposed quarry. In accordance with Australian Standard AS1055-1978, "Noise Assessment in Residential Areas" a calculated background level consistent with the level obtained in residential areas (R1) has been substituted for N8. The relevant calculated background noise levels for R1 are 35dB(A) for weekdays 6.00am to 7.00am, 45dB(A) for weekdays 7.00am to 6.00pm, and 40dB(A) for weekends and public holidays 7.00am to 6.00pm. For purposes of assessing potential impact a calculated background level of 40dB(A) has been determined for site N8.

To predict expected noise levels at surrounding residences from the extraction and transportation operations, typical noise levels for the proposed plant were obtained from previous measurements of similar equipment performing similar operations. These levels are shown in *Table 5*.

TABLE 5

TYPICAL NOISE LEVELS FROM PLANT AND EQUIPMENT

Equipment	Number	Noise Level dB(A) at 1m
Front-end loader	4	110
Dozer	3	115
Elevator Scraper	1	114
Grader	1	109
Off Highway Haul Truck	5	103 (idling) 115 (hauling)
Water cart	1	107
Mobile drilling rig	2	119
Mobile crushing and screening plant	1	119
Highway Truck	10	103 (idling) 111 (hauling)

To determine noise levels at residences surrounding the site the following formula was used:

$$Lp_2 = Lp_1 - 20 \log \frac{r_2}{r_1} - Ae$$

where Lp_1 = sound pressure level at distance r_1 from the source

Lp_2 = sound pressure level at distance r_2 from the source

r_1, r_2 = distances on the same line from the source

Ae = excess attenuation for the distance $r_2 - r_1$

(Beranek 1971)

Values shown in *Table 6* were used to determine the excess attenuation (Ae).

TABLE 6

EXCESS ATTENUATION LEVELS

Source	Level	Reference
Ground absorption - <70m	Nil	Beranek 1971
- >70m	2.5dB(A) per 100m	Croft 1979
	30dB(A) maximum	Beranek 1971
Trees	10dB(A) per 100m	Beranek 1971
Bund wall	10dB(A)	Beranek 1971
Topography (ridges)	15dB(A)	Beranek 1971
Quarry face	20dB(A)	Wilkinson-Murray 1981

To calculate expected noise levels at locations around the site the equipment was divided into three areas or sources, i.e., removal of overburden, in-pit extraction and processing, truck and watercart on access road. Expected noise levels at a location were calculated for each of the three sources and then combined to give an overall noise level.

The results are shown on *Figure 25* as noise contours (lines joining points of equal noise levels). Also shown on *Figure 25* are the existing and calculated background noise levels used to assess noise impact from the quarrying operation.

Noise levels up to 5dB(A) above background are usually considered not significant in Australian Standard AS1055-1978.

From *Figure 25* it can be seen that no existing or known proposed residence should experience noise levels from the quarrying operations more than 5dB(A) above background.

During the construction of the bund wall it is expected that the nearest residences H25 and H26 would experience noise levels up to a maximum of

66dB(A) and 55dB(A) respectively. This would be a short term and unavoidable impact.

7.16.2 Noise from Road Transport

Noise levels from trucks on the access road are expected to peak at 56dB(A) at residence number H23 during the passing of trucks. For those times when vehicles are closest to this residence, some attenuation can be expected from the existing stand of trees. Levels at H22 are expected to peak at 64dB(A). Similar peak levels from traffic on The Northern Road would currently be experienced at these residences.

Research in England has shown that in assessing the impact of traffic noise the L_{10} noise level over an 18 hour day should not exceed 68dB(A) at the facade of a residence. *Table 7* gives unattenuated traffic noise at a distance of 100m from a similar access road based on traffic volumes of 530 light motor vehicle movements and 220 truck movements.

TABLE 7

UNATTENUATED TRAFFIC NOISE ON ACCESS ROAD

Period	5% Grade	10% Grade
18 hour	49dB(A)	50dB(A)
1 hour	53dB(A)	54dB(A)

Source: *Sinclair, Knight and Partners Pty Limited (1978)*

Since the nearest residence to the proposed access road is 150m, the road gradient is expected to be 8 per cent and traffic volumes will be less (60 light vehicle movements and 120 truck movements per day), the expected L_{10} noise level over an 18 hour day at this residence will be well below the 68dB(A) maximum.

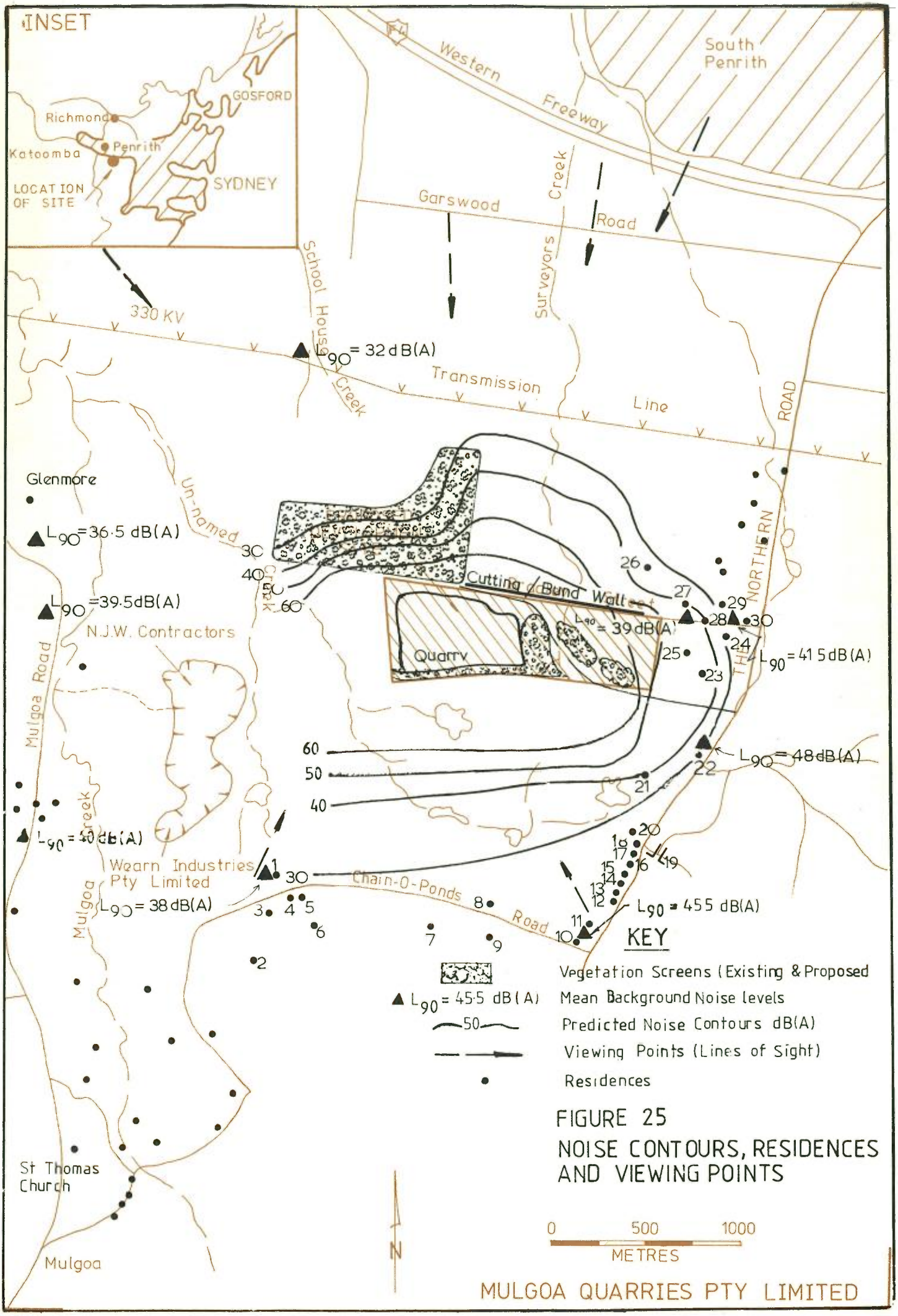


FIGURE 25

NOISE CONTOURS, RESIDENCES AND VIEWING POINTS

MULGOA QUARRIES PTY LIMITED

Background noise levels at residences along The Northern Road are high as a result of existing high traffic volumes. The additional traffic generated by the quarry operation will not significantly add to these levels.

7.16.3 Noise and Vibration from Blasting

As discussed in *Section 6.4* limits on blast overpressure and groundborne vibration will be imposed by Government authorities. These levels are well below those recognised as causing damage to buildings.

Table 8 and *Table 9* show recommended levels and those levels resulting in damage to buildings from overpressure and groundborne vibration.

The results of test blasts carried out at the nearby quarry indicate that these limits will not be exceeded. Details are provided in *Appendix 3*. Residents are expected to be conscious of blasting in the quarry but vibrations and overpressure levels experienced will be well below those specified by authorities and impacts will be minor.

TABLE 8

EFFECTS OF OVERPRESSURE ON ORDINARY STRUCTURES

Overpressure (dB(lin))	Comment
177	All windows break
170	Most windows break
150	Some windows break
140	Some large plate glass windows may break. Dishes and loose windows rattle
136	U.S. Bureau of Mines interim limit
>128	Complaints likely
115-120	Limits currently being imposed by Government authorities in New South Wales

Source: *Siskind and Summers, 1974.*

TABLE 9

DAMAGE BY GROUNDBORNE VIBRATIONS

Peak Particle Velocity (mm/Sec)	Comment
190	50 per cent probability of major plaster damage
110-170	Minor damage - fine plaster cracks, opening of old cracks
70	No noticeable cracks
50	Safe blasting criterion for residential structures recommended by U.S. Bureau of Mines
20	Limit recommended by Australian Standard AS2187, Part 2 - 1979 for structurally sound buildings
7-10	Limits currently being imposed by Government authorities in New South Wales

Source: *Siskind and Summers, 1974.*

C. SOCIAL AND ECONOMIC IMPACTS

7.17 SOCIAL IMPACTS

7.17.1 Population

Given that the direct employment contribution is nil there will be no immediate effects on the population characteristics of the area. However the area remains one of rapid growth in population. If the extraction of light-firing claystone attracts new brickworks to the site or in the vicinity, this growth will accentuate and also service additional expansion.

The expansion of further industry in the area, related to the extraction of the claystone could "balance-out" the youthful nature of the population so that as a whole the population has a lesser ratio of economically dependent persons. Due to the relative dominance of male employment in

extractive and associated industries, the impact of the proposed development, and any associated vertical linkages, on population structure will be limited to a possible increase in the number of single and married males and their families. This sort of growth will not create any problems in the population structure.

7.17.2 Housing and Accommodation

There will be no immediate effects on the housing characteristics of the area as a result of the proposed development.

As no additional labour for the project is derived from outside the region, the direct need for housing units is negligible. Given the existence of unoccupied dwellings in Penrith City no problems are envisaged in the immediate future.

7.17.3 Services and Facilities

Because there is no anticipated increase in employment, particularly "imported" from outside Penrith City, there will be no impact on existing services.

7.18 ECONOMIC IMPACTS

7.18.1 Employment

Direct Employment

The employment level is expected to be 40 persons, most of whom will be transferred from the present quarry site currently being worked by Wearn Industries Pty Limited. It is estimated that 60 per cent of this labour force will be skilled and the remaining 40 per cent semi-skilled workers. All of the workers live within 15km of the new site. Thus while the extraction of claystone from this site will not generate any new direct employment it will not on the other hand, lead to any increased

unemployment in the area. From this point of view there is a beneficial direct employment impact.

Indirect and Induced Employment

The proposed development will stimulate the local, municipal and regional economies. Positive impacts will flow from direct expenditure on capital equipment, from indirect effects generated through use of support services provided by other sectors, and from the induced effects, as the incomes earned filter into consumption in the market place, and through the operation of the multiplier effect.

The extraction of light-firing claystone attracts, and will continue to attract new brickworks to the Western Sydney region with the probability of expanded employment opportunities. The availability of roadbase materials close to Penrith City may also open up employment opportunities in local government.

The magnitude of the indirect and induced effects, together with any direct effects of the proposed investment is a function of a number of factors including the life of the project, the total expenditure on capital and labour, and the magnitude of the appropriate multipliers.

Since all of the direct employment will be local it is fair to assume that a large proportion of the multiplier effect will also be local and regional.

In an area of relatively high unemployment together with a relatively youthful population it is essential to encourage industry and economic growth. With the potential entry of vertically and horizontally linked industry the proposed extractive industry could provide through secondary employment, opportunities for unskilled and unemployed persons in the region.

7.18.2 Industry Output

To date several large brickworks have recently established in the Western Suburbs on the premise that abundant and suitable clay/shale resources are available in the Bringelly Shale. The present extraction operations on lots 21 and 22 have a limited life and unless new operations commence, the availability of the scarce light-firing claystone to dependent brick-works will be extremely limited, necessitating importation of material from much more distant sources. The light-firing claystone remains in strong demand due to the popularity of light coloured bricks and the desire by home buyers for a wide variety of choice in brick colours. In response to this market demand, production of light coloured bricks is expected to continue, although materials may be more costly through higher transport cost components resulting from resources having to be imported from more distant sources.

7.18.3 Income Generation

The project will result in a direct income effect from wages and salaries of probably in excess of $4 million together with an associated multiplier effect in the vicinity of $25 million in the first five years of the operation (assuming a marginal propensity ratio of 0.84 based on national account figures). In addition there is a fixed capital investment resulting from the construction of the access road of approximately $450,000. The project could provide a source of secondary employment and, as such would initiate multiplier effects on income generation in the order of $1.5 million.

Wages and salary bills for indirect and induced employment are more difficult to estimate, but together with local government rate earnings and State and Federal taxes (including payroll tax and income tax) they constitute a significant element of incomes generated.

SECTION 8

ALTERNATIVES

8.0 ALTERNATIVES

A number of alternatives to the proposed extractive operation and transport of materials were considered. These are listed below:

1. Alternative sources of light-firing clay/shale.
2. Alternative materials for the manufacture of bricks.
3. An alternative extraction plan.
4. Alternative transport routes.
5. The alternative of not proceeding.

8.1 ALTERNATIVE SOURCES

Section 3.7 examines alternative sources of light-firing clay/shale in the Sydney region.

Studies conducted by the Geological Survey Branch of the New South Wales Department of Mineral Resources have shown that the Bringelly Shale deposit at Mulgoa constitutes the largest identified resource of light-firing clay/shale in the Sydney Region. *(Etheridge 1981b)*.

While other deposits of light-firing *Bringelly Shale* are known, more than about three quarters of the secured deposits are held by two Companies for use in their own brick manufacturing processes. It has been predicted that most other pits supplying light-firing clay/shale will be worked out by 1990. *(Corkery et al 1980)*.

Light-firing clay/shale can also be obtained from *Hawkesbury Sandstone* shale lenses and Pleistocene clay deposits. Total identified in-situ resources are in the order of 3 million tonnes for *Hawkesbury Sandstone* shale lenses and about 6 million tonnes for Pleistocene clay.

Most of these deposits are in environmentally sensitive areas and subject to economic and environmental constraints. Generally, they are more distant

from markets compared with the proposed site, and consequently, would be subject to higher transport costs (costs which must be passed on to consumers).

Quarrying the proposed development site will result in valuable reserves of economically extractable light-firing claystone being made available to the brickmaking industry. Operations on this site have been designed to ensure that environmental management procedures will minimise impacts and are the optimum to protect the existing environment of the site.

8.2 ALTERNATIVE MATERIALS

Studies of alternative materials suitable for the manufacture of bricks have been undertaken by the New South Wales Department of Mineral Resources *(Corkery et al 1980)* and CSIRO Division of Mineral Chemistry *(Waters 1976)*.

Materials examined include coal washery discard and sand washing tailings.

8.2.1 Coal Washery Discard

It has been found that while coal washery discard has a high clay content it can be used only as an additive to plastic clay/shale, as alone it has poor strength. Its use in brick manufacture would reduce the quantity of fuel used because of the content of carbonaceous material. Fired colour varies from buff to red. Some samples from drewboy sinks (a stage in the gravity separation of coal washery discard) produce moderately light colours when fired *(Main 1978)*.

The CSIRO Division of Mineral Chemistry has studied the use of burnt rejects from the fluidised bed combustion of coal washery discard *(Waters 1976)*. Pilot tests at Glenlee coal washery near Camden indicate that burnt rejects could be suitable for the manufacture of bricks, pipes, and tiles.

Some brick manufacturers in the Sydney area have experimented with coal washery discard using varying proportions with conventional raw materials.

To date, trials have not been very successful, primarily due to the wide variation in the composition of the discard.

8.2.2 Sand Washing Tailings

Clay and silt washed from naturally occurring deposits of sand to produce a construction or industrial quality sand has resulted in the accummulation of large dams of fine grained material known as tailings. In the Sydney area, sand washing tailings have accummulated at Pitt Town, Londonderry, and Elderslie.

Ceramic testing has shown that generally this material has good plasticity, green strength, and fired hardness. Problems however have been experienced in obtaining the desirable moisture content for manufacturing, as some of the materials are difficult to de-water.

It is expected that the use of waste products as raw materials is likely to increase in the future as particular types of naturally occurring clay/ shale become more scarce. However, the New South Wales Department of Mineral Resources has predicted that waste products would supply only a small segment of the total market and not all of this material would be light-firing.

8.3 ALTERNATIVE EXTRACTION PROGRAMME

It is proposed to maximise the resource of light-firing claystone present by excavating to 45m AHD in a joint extraction plan with Zacuba Pty Limited on the common boundary. In this way a free draining site can be maintained at all times.

Alternatively, should extractive operations not proceed on Zacuba's property to the west it is possible to excavate to 45m AHD entirely on lot 1 DP541090 with quarry water being pumped from a sump in the quarry floor to sedimentation dams.

The alternative results in a smaller working area and the sterilisation of about 3 million tonnes of clay/shale. It also results in a water-filled excavation forming part of the final landform.

The alternative however, shows that the Mulgoa Quarries Pty Limited proposal can be operated independently of other quarry proposals on adjoining properties.

The proposed extraction plan detailed in *Section 5.2.3* is considered the optimum for maximum recovery of the light-firing claystone resource and to achieve a free draining landform suitable for a wide range of final land use options.

The simultaneous extraction programme will:

1. Result in additional reserves of light firing claystone being utilised (estimated at 3 million tonnes).
2. Assist in locating the access road so that it can be progressively lowered with the extractive operations.
3. Provide a wide range of post extraction land use options.

In the joint extraction proposal, the land will be excavated to 60m AHD in the proposed development area with sedimentation dams located as shown on *Figure 26*. As excavation on the adjoining land approaches the common boundary, levels on the proposed development site will be progressively reduced to 45m AHD to maintain a free draining site. The sedimentation dams will be progressively relocated below the extraction areas as the land is lowered.

The overburden from the excavations will be disposed of on lots 21 and 22. No filling in the proposed excavations will be necessary. At the completion of extractive operations, the final landform will be a gently sloping hillside to the west (as shown in *Figure 27*) which will be suited for a wide range of final land use options.

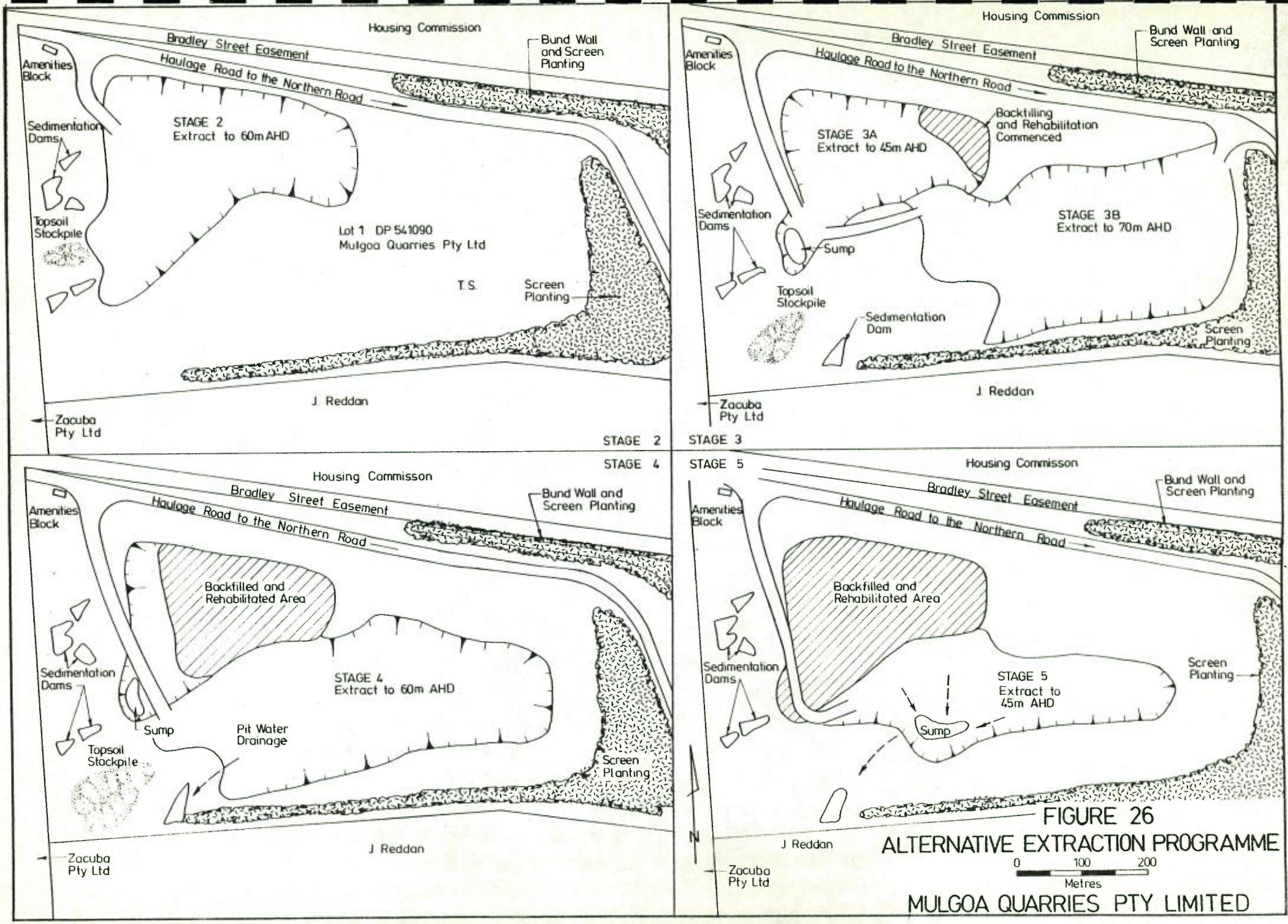


FIGURE 26

ALTERNATIVE EXTRACTION PROGRAMME

MULGOA QUARRIES PTY LIMITED

The proposed extraction programme will be carried out with the close co-operation of all extracting companies and Authorities, and is considered a feasible and acceptable alternative to Mulgoa Quarries Pty Limited.

8.4 ALTERNATIVE TRANSPORT ROUTES

In considering the options for the haulage of materials from the proposed development site to markets the following factors were taken into account:

1. A route that would be readily accessible to all proposed extractive operations, for instance, for operations west or south, and the Housing Commission land to the north, should this proceed.
2. A route that could remain relatively fixed during the life of the extractive operations to take advantage of bund walling and screening.
3. A route that would have the least environmental impact on existing and proposed residential development, flora and fauna, soil erosion, visual impact, noise and dust.
4. A route that was engineeringly sound and could be provided at reasonable cost.
5. A route that would minimise sterilisation of light-firing claystone deposits.
6. A route that would provide access to a major public road constructed to a high engineering standard.
7. A route that could provide a suitable intersection with the selected major road.

The options examined for the haulage of materials are listed below and shown on *Figure 19*.

Route 1: The existing gravel road between Mulgoa Road and the existing quarries on lots 21 and 22.

Route 2: A constructed gravel road over lot 17 Chain-O-Ponds Road owned by Wearn Industries Pty Limited. From there, quarry traffic would use the eastern portion of Chain-O-Ponds Road.

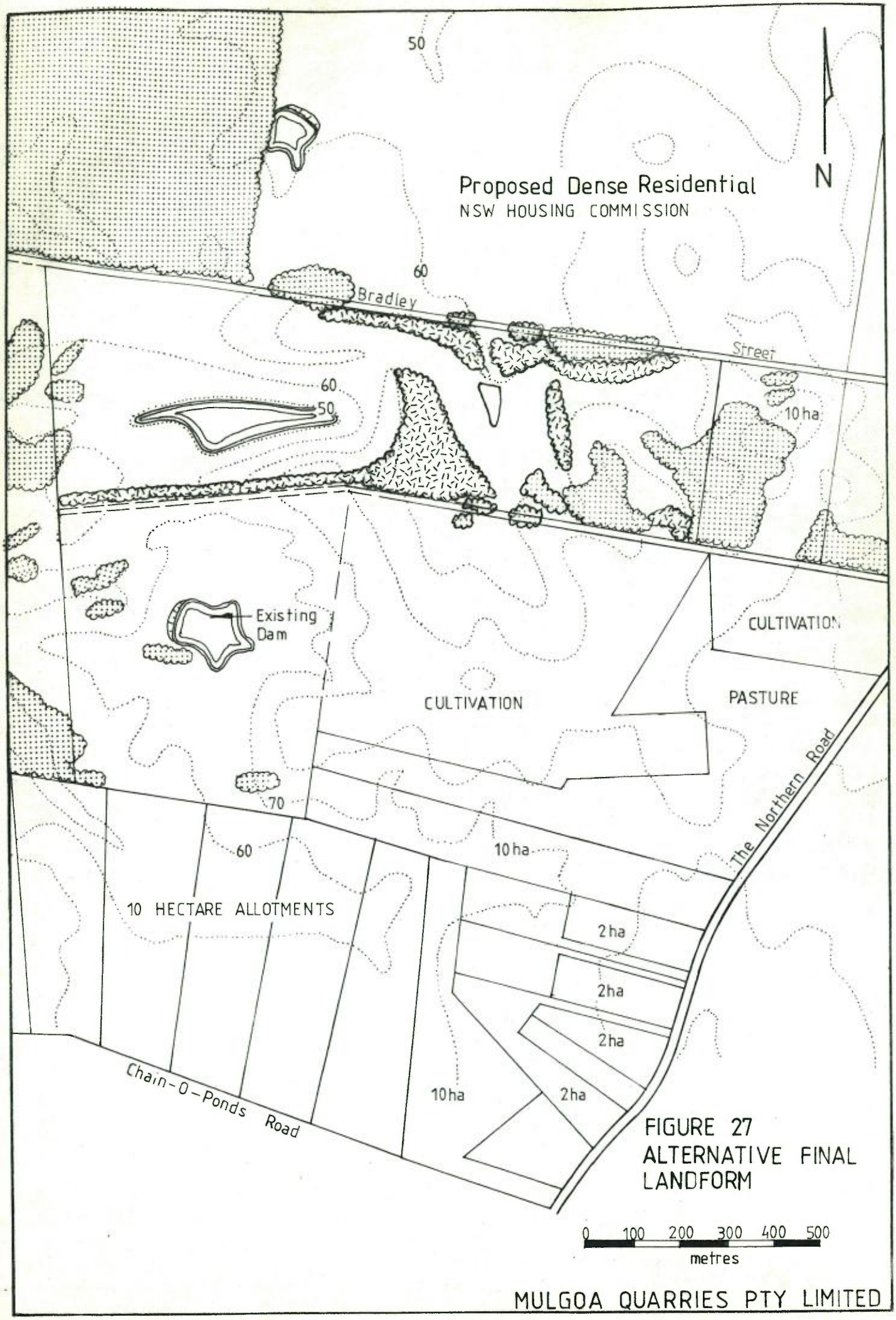


FIGURE 27
ALTERNATIVE FINAL LANDFORM

MULGOA QUARRIES PTY LIMITED

Route 3: Would necessitate the negotiation of a right of way and construction of a roadway along the northern boundaries of 9 properties on Chain-O-Ponds Road and then cross lot 31 to Chain-O-Ponds Road.

Route 4: Crosses lot 1 DP222144 (owned by Zacuba Pty Limited) on a right of way over the northeast of this property which forms an extension to Bradley Street. The route would then necessitate the reconstruction of Bradley Street which would be used to connect to The Northern Road.

In addition to the above, a fifth alternative was examined by the Mulgoa Working Party.

Route 5: Traverses lot 1 DP222144 (Zacuba Pty Limited) to pass along the boundary between lot 4 DP226490 and lot 1 DP 541090 to join with a "reserved road" parallel to Bradley Street.

All of these routes have been examined by the Mulgoa Working Party and considered for this development.

8.4.1 Route 1

Route 1 provides the present access for all heavy vehicles from the extractive operations on lots 21 and 22. The advantages and disadvantages of this route are listed below.

Advantages

* Existing formed access road.
* Maintenance costs for haulage road upkeep about $4,000 per km.
* No impact on flora or fauna or natural systems.

Disadvantages

* Route prone to flooding.
* Bridge over Mulgoa Creek will require replacing if continued use expected. Cost of bridge replacement estimated at $90,000 if central piers of existing bridge could be used. If a complete new bridge was required, costs would be higher.
* Long haulage distance to brickworks, i.e., about 17km longer than a direct route to The Northern Road.
* Route results in heavy vehicles from the quarry site passing through populated areas of Penrith and Regentville and/or villages of Wallacia and Mulgoa.
* Route only services the western areas of the resource. Access to the resource identified by the Department of Mineral Resources would require the construction of a bridge over the two creeks separating lots 21 and 22 from Zacuba, and between Zacuba and the proposed development site.
* Mulgoa Road has poor alignment and pavement in comparison with The Northern Road. Impacts on the condition of the road through continued heavy vehicle use would be high.
* High noise and vehicle emissions in built up areas.
* Fuel and energy use is high.

8.4.2 Route 2

Advantages

* Existing formed access road.
* No impact on flora or fauna or natural systems.
* Maintenance costs for haulage road upkeep about $1,000 per km.
* Grades on Chain-O-Ponds Road are such that noise intrusion at nearby residences would be low.

Disadvantages

* Upgrading and strengthening of Chain-O-Ponds Road required to improve grading and sight distances. Construction of turning and passing lanes at the intersection of Chain-O-Ponds Road and lot 17, and at the intersection of Chain-O-Ponds Road and The Northern Road required in accordance with Department of Main Roads requirements. Estimated cost of roadworks and any alterations to services, etc. - $327,000.
* Route provides access only to clay/shale deposits on the western side of the main creek separating Zacuba's land and the proposed development site. Access to eastern deposits would require the construction of a bridge over this creek.
* Traffic intrusion by heavy vehicles on a low traffic link road, Chain-O-Ponds Road, would be moderately high.
* Dust could be a nuisance at future residences on blocks 15 and 18, Chain-O-Ponds Road, but the route is screened by trees which reduce the spread of dust, and dust nuisance from this route is likely to be minimal.

8.4.3 Route 3

This route involves the use of properties on the northern side of Chain-O-Ponds Road.

Advantages

* Relatively short haul distance.
* Good sight distances at all intersections.
* Route grades satisfactory to minimise noise from haulage trucks in low gear.
* Traffic conflict expected to be minimal.

Disadvantages

* Major capital costs in the construction of the road, and several creek crossings estimated at $433,000. Expected costs are:-

(i) Land acquisition costs together with survey and legal fees.

(ii) Construction of fencing of road reserve.

(iii) Construction of culverts over creeks.

(iv) Earthworks and construction of siltation and erosion control works.

(v) Passing and turning lanes in Chain-O-Ponds Road.

(vi) Road upgrading at the intersection with The Northern Road.

* The proximity of the haul road to properties fronting Chain-O-Ponds Road would have an adverse effect on the amenity of these properties.
* Route places nine properties between roadways on both the northern and southern boundaries.
* Four residences would be affected by short term traffic noise.
* Potential erosion problems and creek siltation during construction and maintenance of haulage road.
* Construction of the haulage road would result in the loss of about 20 mature trees and associated undergrowth.

8.4.4 Route 4

Advantages

* The route provides a relatively short haul distance to brickworks.
* The route is relatively well removed from existing dwellings.
* The route makes partial use of an existing road, Bradley Street.
* Minimal impact on residences on The Northern Road or the condition of The Northern Road.

Disadvantages

* Route does not provide direct access for proposed extractive operations on lot 28 or for possible extraction from Reddan's property.

* Route results in partial sterilisation of clay/ shale reserves occurring on Zacuba's property.
* Route would require construction of a road together with major and minor culverts over two main creeks to join Bradley Street.
* Fencing of road reserve and major earthworks to achieve a reasonable grade without significant noise impacts.
* Widening of the existing road reserve and upgrading of the intersection of Bradley Street and The Northern Road to Department of Main Road specifications.
* Estimated development costs for road works $454,000.
* High noise impacts at two residences in Bradley Street within 25m of the road, and potential noise impacts at future residences in the Housing Commission development to the north, without suitable screening or buffer zone.
* Loss of flora and fauna along waterways crossed by the proposed route.
* Potential noise impacts from the passage of heavy vehicles on steep grades without construction of suitable noise barriers.
* Visual impacts from major earthworks and potential erosion and siltation problems without suitable controls.

8.4.5 Route 5

Advantages

* Minimal traffic conflict.
* Route well removed from existing dwellings with minimal noise impacts.
* The route provides a relatively short haul distance to brickworks.
* The route makes partial use of an existing "reserved road".

Disadvantages

* The route does not provide direct access for possible extractive operations on the Housing Commission land to the north.
* The route passes directly through the optimum resource area identified by the Department of Mineral Resources and sterilises potential light-firing clay/shale resources in this area.
* The route would require major earthworks and creek crossings to be provided.

  This would involve:-

  (i) Construction of major and minor culverts over the main creeks draining the area.

  (ii) Major earthworks with steep grades and erosion control works required along the table drain area.

  (iii) Land clearing along the road reserves.

  (iv) Clearing at the intersection of The Northern Road to provide adequate sight distance.

  (v) Department of Main Roads requirements at the intersection of The Northern Road.

  (vi) Fencing of road reserve.

  (vii) Estimated development costs for road-works $450,000.

* Loss of flora and fauna along water courses and areas traversed by the proposed route.
* High visual impact from dust and traffic movements as the route traverses a high ridge between the proposed development site and Reddan's property to the south.
* Potential noise impacts from the passage of heavy vehicles on steep grades without construction of suitable noise barriers.

8.4.6 Optimum Route

The Mulgoa Working Party formed the view that option 5 was the most desirable transport route followed by route 4. The Working Party noted that an amalgamation of routes 4 and 5 would possibly be more desirable to provide access to all extractive operations, including the Housing Commission land, and to allow careful control and management of all operations.

The optimum route selected for the extraction of raw materials from the proposed development site is an amalgamation of routes 4 and 5 and is shown on *Figure 19*.

The advantages and disadvantages of this route are discussed below.

Advantages

* Route provides ready access to all existing, proposed and possible light-firing clay/shale resources identified in this area, including the Housing Commission land.
* The route minimises sterilisation of light-firing clay/shale deposits.
* The route is well removed from all existing residences including those on Bradley Street.
* The route provides a short haul distance from the resource areas to brickworks minimising impacts on public roads, and reduces vehicle emissions and energy use.
* Through the provision of bund walls, tree screenings, and a buffer zone potential noise and dust impacts on future residential development north of the site is minimised.
* By passing the haul road over the two creeks flowing through the region, at the site shown on *Figure 19*, visual impacts are significantly reduced.
* Bund walling and tree screening will minimise noise impacts from trucks hauling materials on steep grades.
* Route provides access to worked out pits on lots 21 and 22 for the disposal of overburden.
* Route provides access to the existing maintenance depot on lot 22 for the repair of trucks and equipment.
* The route provides direct access to The Northern Road and avoids the townships of Mulgoa, Regentville and Penrith. The Northern Road is in good condition and suited to the expected traffic volumes.
* No land acquisitions necessary.

Disadvantages

* Upgrading of the intersection with The Northern Road, including clearing at the intersection to provide adequate sight distances.
* Loss of flora and fauna along water courses at the point of crossing and partial loss of flora along the "road reserve".
* Earthworks and creek crossings to be constructed, including major and minor culverts as shown on *Figure 19*, and earthworks to achieve a reasonable grade on steeper slopes.
* Erosion control works to minimise siltation and erosion along the route.
* Estimated development costs for roadworks $450,000.

It is considered that economically and environmentally the proposed access route is the optimum for the transport of materials from the proposed development area and adjoining lands to brickworks.

8.5 ALTERNATIVE OF NOT PROCEEDING

Should the proposal not proceed, a significant proportion of the largest identified resource of light-firing clay/shale in the Sydney Region will not be made available to the brickmaking industry.

As a consequence, there will be a severe shortage of light-firing clay/shale material available for brickmaking in the Sydney region. New sources of material will have to be identified if possible or the range of brick types normally produced significantly reduced.

Brickmaking companies dependent on clay/shale from the Mulgoa area have indicated that they would have to modify their current production techniques to accept material from alternative sources and consequently may suffer adverse effects in respect to production costs, output, and quality.

Another indicated that it would have to cease production of some of its current range of bricks.

The brickworks affected produce in excess of 145 million bricks per annum of which about 70 per cent use some percentage of claystone from the Mulgoa area. About 74 million of these bricks are supplied by these companies to the western and southern Sydney regions.

The existing extractive operations provide employment for some 35 persons. At the present time these operations have less than 6 months life.

While a small percentage of these employees could be absorbed into alternative jobs, the high level of unemployment in the western area would result in most joining the ranks of the unemployed when operations cease.

The proposed quarry will provide continued, secure direct employment for these persons over the life of the operation (25 years) with the potential for additional jobs to be created indirectly in the region, thereby absorbing more of the unemployed. *(Section 7.18.1).*

The environmental management procedures to be adopted during extractive operations will ensure that there will be minimal impact on surrounding land uses and residences, and a decision not to proceed with the project does not seem justified.

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APPENDICES

APPENDICES
TABLE OF CONTENTS

LIST OF TABLES

APPENDIX 1

APPENDIX 1

PROJECT TEAM FOR ENVIRONMENTAL INVESTIGATIONS

RESOURCE PLANNING

V. Smith	B.Sc. (Hons) (New'cle) M.Sc. (NSW) AM. Aus. IMM, AMIQ.	* *Project co-ordination and management.* * *Aspects of the existing environment.* * *Project description, safeguards, and controls.* * *Interaction and impact identification and assessment.* * *Report writing and editing.*
K. Renfrew	B. Comm (Hons-Econ) B. Math (New'cle)	* *Social and economic studies.* * *Social and economic impacts.*
P. Dean-Jones	B.A. (Hons-Geomorph) (Mac'q)	* *Soil and erosion studies.* * *Archaeological investigations.*
F. Rice	Met. Cert. AAIM	* *Monitoring programme for air, water and noise.* * *Traffic studies.* * *Impact assessment.*
G. Baxter	B. Nat. Res. (Hons) (UNE)	* *Flora, fauna, and ecological studies.*
J. Henley	B. App.Sc. (Landscape Design) (CAE)	* *Visual analysis.* * *Rehabilitation.* * *Landscaping.*

WEARN INDUSTRIES PTY LIMITED

J. Wearn	General Manager

APPENDIX 2

APPENDIX 2

DESCRIPTION OF THE EXISTING ENVIRONMENT

A. NATURAL PHYSICAL ENVIRONMENT

A2.1 LOCATION AND LAND OWNERSHIP

The proposed development site is 8km south of Penrith in an area primarily used for grazing and crop cultivation and is shown on *Figure 1.* It is accessible from The Northern Road by Bradley Street, a two lane gravel road servicing 10 hectare allotments in this area.

The land is described as Lot 1 DP541090 and covers a total of 75 hectares. The land is being purchased by Mulgoa Quarries Pty Limited from J. and D. Kay.

Throughout the text reference is made to the "proposed development area" which includes the land described above.

Other adjoining lots referred to include lots 21 and 22, the site of the existing pits operated by N.J.W. Contractors and Wearn Industries Pty Limited, lot 28 an area proposed for future extraction, and lot 1 (DP222144); the land owned by Zacuba Pty Limited.

The location of all of these lands are shown on *Figure 4.*

A2.2 TOPOGRAPHY AND SLOPES

The area is moderately undulating with an arcuate ridge forming the main physiographic feature.

Elevations range from 40m AHD in the northeast corner to 92.51m AHD on "Sovereign" Trig Station in the centre of the area. Contours are shown on *Figure 5.*

Slopes are gentle, tending to moderate in the stream gullies. Hillside slopes of 1:20 are common and these are well within the stability limits of shale based slopes in the southwest Sydney Region *(Dunkerly 1972)*.

A2.3 GEOLOGY

A2.3.1 Regional Geology

The proposed development site is located within a sequence of interbedded claystone, siltstone and sandstone known as the Middle Triassic Wianamatta Group, which crops out over a wide area to the west of Sydney. *(Figure 2)*. The group forms the topmost part of the Permo-Triassic sequence which makes up the Sydney Basin sediments.

Throughout the region, the Wianamatta Group is underlain by the Hawkesbury Sandstone and, in the area north of Penrith is overlain by extensive alluvial sediments thought to be Tertiary and younger in age.

The well-known Lapstone Monocline-Nepean Fault System forms a fairly sharp western boundary to the Wianamatta Group, and only thin, elevated erosional remnants exist to the west of this structure.

Within the Wianamatta Group, three distinct formations have been recognised and described in detail in *Herbert (1979)*. These are the Ashfield Shale, and Minchinbury Sandstone, and the Bringelly Shale. These formations are briefly described in *Table A1*.

TABLE A1

WIANAMATTA GROUP

Formation	Description
Bringelly Shale	Topmost unit - claystone, carbonaceous claystone, siltstone, laminite, sandstone, and tuff. Maximum thickness greater than 250m.
Minchinbury Sandstone	Quartz-lithic, fine to medium grained sandstone which separates the underlying Ashfield Shale from the overlying Bringelly Shale. Thickness varies up to 6m.
Ashfield Shale	Basal dark grey to black sideritic siltstone which becomes more sandy towards the top, gradually passing into a laminite (Mulgoa Laminite Member). Thickness varies between 45m and 60m.

A2.3.2 Site Geology

The proposed development site is located on the lower 65m of the Bringelly Shale. The underlying Minchinbury Sandstone and Ashfield Shale crop out to the west of the site.

Bringelly Shale lithologies have been well established by drilling and include claystone, carbonaceous claystone, siltstone, laminite, sandstone, tuff, and rare thin coal. The Cobbitty Claystone Bed, a readily identifiable thin weathered tuff is also found throughout the area, generally less than 5m above the Minchinbury Sandstone.

The ~~most~~ dominant lithologies present are claystone and siltstone with laminite sequences more common towards the base immediately overlying the Minchinbury Sandstone. Sandstone occurs as lenses throughout the sequences. These generally have limited lateral extent and are difficult to correlate even between adjacent boreholes.

Geological cross sections showing lateral lithological variation and interpreted correlations are illustrated on *Figure 7*.

Detailed drilling and logging of the Bringelly Shale sequences have shown that there is a degree of order in the succession of dominant lithologies commencing with a laminite in the lower 15m overlying the Minchinbury Sandstone and passing upwards through alternating sequences of dominant claystone and sandstone.

A total of six lithological or facies types, numbered A to F, have been identified. Their extent and characteristics are shown on *Figures 6* and *7*.

A2.3.3 Resource Potential

Detailed ceramic testing of clay/shale from the area has shown that most claystone horizons are suitable for brickmaking with a high proportion of units being light-firing. As outlined in *Section 3.0*, the deposit constitutes the largest identified resource of light-firing clay/shale in the Sydney Region.

The interbedded sequences of sandstone, siltstone, and laminite, are potentially suitable for road making material and have been utilised successfully in the past for this purpose.

Table A2 summarises the properties and uses of units in the area. *(Etheridge 1981b)*.

A2.3.4 Extractive Industries

Clay/shale is currently extracted from the shale pit of Wearn Industries Pty Limited adjacent to the western boundary of the site as shown in *Figure 1*. In 1980/81, about 300,000 tonnes of clay/shale was extracted from this pit and supplied to four major brickmaking companies for use in a total of six brick plants. In addition, some 18,000 tonnes of sandstone was extracted and used as road material. *Figure 3* shows production of clay/shale and road material from this pit since 1970.

TABLE A2

BRINGELLY SHALE - PROPERTIES AND USES

LITHOLOGY	PROPERTIES AND USES
Clay and highly weathered claystone	Good plasticity, generally contains moderate to high amounts of iron oxide (ferric oxidation state) resulting in salmon/orange and terra cotta fired colours. Suitable for blending with less plastic material for pipe, tile, and brick manufacture.
Claystone (and silty claystone)	Moderate plasticity, contains variable amounts of iron in a reduced form, mainly as nodular siderite (iron carbonate). When fired using a kiln cycle suitable for firing Bringelly Shale material (nominally around 1000-1050^{o}C), claystone containing little siderite fires to produce cream coloured or pale coloured products, whereas claystone with larger amounts of siderite produces light orange to red colours suitable for brick manufacture using modern manufacturing techniques. Pale firing material is suitable for blending with more readily available "red" firing clay/shale for the production of a comprehensive range of brick colours.
Laminite	Generally has a low plasticity and usually contains a high percentage of siderite, both in nodular form and disseminated throughout the siltstone fraction. The material generally fires dark red-brown (at 1000-1050^{o}C). The low plasticity generally makes this material unsuitable for extrusion brick manufacture. It is, however, potentially suitable as a road construction material especially for shouldering and sub-base.

TABLE A2 (CONT'D)

BRINGELLY SHALE - PROPERTIES AND USES

LITHOLOGY	PROPERTIES AND USES
Siltstone	Non-plastic to low plasticity, generally contains a high proportion of nodular and disseminated or granular siderite and hence fires red-brown (at 1000-1050°C). The material is commonly extremely tough and therefore unsuitable for crushing using normal brick manufacturing pre-treatment techniques. The toughness and plasticity make this material unsuitable for brick manufacture. It is potentially suitable, with primary crushing, for use as road construction material.
Sandstone	Generally non-plastic and extremely tough when fresh. Fine-crushed and screened material would be potentially suitable for most road construction applications, possibly as road base material. Blending with small amounts of laminite may be required to introduce some plasticity to the product.

Source: *Etheridge 1981b.*

Reserves of light-firing clay/shale in this pit are nearing depletion.

N.J.W. Contractors Pty Limited also extract clay/shale from a pit adjacent to the northern end of the pit of Wearn Industries Pty Limited. Material is selectively extracted and blended on site and used in two older type brick plants.

As outlined in *Section 3.0*, Wearn Industries Pty Limited has submitted development applications to Penrith City Council to expand operations into adjacent areas, and to dispose of waste materials in the exhausted pits.

A small clay/shale pit was operated in the proposed development area in the mid-1960's-early 1970's by J. and D. Kay. Operations were short term and only small quantities of material were removed.

A2.4 SOILS

A2.4.1 Types and Characteristics

Following *Northcote's (1971)* system of soil description and classification, two main groups of soil have been identified in the proposed development area. These are Uniform (Uf 6.12) and Duplex, including soils from Dr and Db groups. Full descriptions of profiles at the sites shown on *Figure 6* are given in *Table A3*.

The Uniform profiles are very limited in extent and occur only on hilltops. They are thin clay soils grading directly into weathering shale with little or no A horizon. The profile characteristics are due to in situ weathering of claystone/siltstone with erosion of surface material. The ground surface is covered with small remnant claystone/ironstone fragments.

The duplex soil profiles show a combination of in situ weathering, which forms a mottled, highly pedal B horizon, and slow across-slope transport of weathered material which gives a slightly lighter textured (clay loam), but still well structured A horizon. There is little surface accumulation

of organic matter, and no A_2 horizon which suggests that the profiles are well drained.

The horizon boundary between A and B is always sharp and clearly defined in terms of colour, texture, and rock fragment content. The A horizon is not hardsetting and the profiles display a stable aggregate structure and well developed pedality throughout. All soil profiles display an acid pH.

A2.4.2 Topsoil

Studies carried out by the Soil Conservation Service of New South Wales have shown that well structured Duplex soils with moderate clay contents are suitable for stockpiling and for use in rehabilitation if the "topsoil" (A and B horizons) are retained.

The soils of the study area, which consist of stable clay aggregates and well developed primary and secondary peds of moderate consistency would be suitable for stockpiling and use in rehabilitation. Usable "soil" however rarely exceeds 1m in depth and passes quickly into the underlying weathered claystone/siltstone/sandstone units.

A2.4.3 Erosion Potential

The inherent erosion potential of soil material depends primarily on structure and texture which control the moisture absorption and retention capacity of the soil.

All soil profiles in the area are well structured throughout under the prevailing variable soil moisture conditions.

The A horizon generally has major vertical ped faces at 10-15cm intervals. These primary units subdivide readily to peds 4-5cm in diameter, and thence to minor aggregates of approximately 1cm diameter. These units display moderate consistence.

TABLE A3

SOIL PROFILE DESCRIPTIONS

SITE 1	
Dr 5.11	
0-15cm	Light clay loam 10YR6/4 (dull yellow orange) pH 5.5 Structure - major vertical ped faces at 10-15cm intervals, subdivided to rough faced, irregular peds 4-5cm diameter, primary aggregates ½-1cm, moderate consistence, occasional small shale fragments. No surface organic mulch.
15-100cm	Clear, slightly wavy boundary Light clay 5YR5/8 (bright reddish brown) with 10YR6/4 (dull yellow orange) mottle pH 4.5-5 Structure - well defined rough faced peds 4-5cm diameter, polyhedral, breaking to firm aggregates ≃1cm diameter. Contains numerous shale fragments, platy. Particularly common below 70cm.
100cm+	Weathering claystone
SITE 2	
Db 4.11	
0-25cm	Clay loam 10YR5/3 (dull yellowish brown) pH 5.5-6 Structure - irregularly spaced major vertical ped faces, most peds 3cm diameter, rough faced, polyhedral, basic aggregates friable. Occasional small ironstone/claystone fragments. No surface organic mulch.
25-115cm	Clear boundary Light-medium clay 7.5YR6/6 (orange), 10YR7/3 (dull yellow orange) and 5YR5/8 (bright reddish brown) mottle, becoming more strongly mottled with depth. Structure - well developed primary ped faces at 10-15cm intervals, breaking readily to 3cm, polyhedral, rough faced units, and thence to very firm 1cm aggregates. pH 4.5 Abrupt lower boundary to in situ weathering fossiliferous claystone.

TABLE A3 (CONT'D)

SOIL PROFILE DESCRIPTIONS

SITE 3	
Uf 6.12	
0-30cm	Light clay 5YR5/6 (bright reddish brown) Surface scatter of claystone/ironstone fragments pH 6 Structure - major peds at 15cm vertical faces. Bulk of fabric 3-4cm rough faced peds, basic aggregates ½-1cm, moderate consistence.
30cm+	Pedal medium clay interspersed with flat bedded in situ weathering claystone 2.5Y 6/2 (greyish yellow) pH at 1.10m 8

Peds in the B horizon are generally more strongly defined than the A horizon, with primary units being 3-8cm in diameter and secondary units 1cm in diameter with very firm consistency.

In areas where the soil has been ploughed for crops the soil retains a strong pedal character, with the soil texture between clay loam and light-medium clay, i.e., 30-45 per cent clay content. Soils of this texture have good water retention qualities, with moisture moving slowly downslope by seepage.

This well developed structure and clay texture considerably reduces the erosion potential of the soil. Under normal vegetation cover, these soils would be capable of absorbing a high proportion of precipitation by infiltration directly at the surface and along ped faces, thus minimising overland flow. There is some evidence that if vegetation is sparse, as occurs with overgrazing or strip clearing, some sheet erosion and surface scour would occur.

Unformed roads could also be subject to sheet and rill erosion on steeper slopes.

A2.4.4 Evidence of Erosion

Small quantities of sediment from the existing small abandoned quarry is contributed to streams downstream from this site. Most of this material appears to come from the floor of the quarry, since the walls of the quarry are relatively stable, and indicates that although the soils have a well developed, stable pedal structure, this may be disrupted by the weight of heavy machinery. Wash from the abandoned pit does not appear to have been transported greater than 100m. The sediment reaches depths of 30-40cm over this distance.

The wall of the large farm dam shown on *Figure 8* also contributes some sediment to the streams below. This material tends however, to have

retained its pedal structure and its weight reduces the transportation distance to approximately 50m.

Most of the small intermittent streams in the area are currently slightly incised into shallow valley fills which include considerable amounts of charcoal and stratified gravel wash.

Gullying and nick-point retreat are accelerated by land clearance and overgrazing which promotes rapid runoff, but other long term influences, such as climate, aggradational stability of fills, etc., have also contributed.

A2.5 HYDROLOGY

A2.5.1 Catchments

The extent of stream catchments in the vicinity of the proposed development site is shown on *Figure 8*.

Catchment 1 encloses the upper reaches of Surveyors Creek which flows north to join Peach Tree Creek and the Nepean River at Penrith. A total area of 53.4 hectares of this catchment occurs within the proposed development site.

Streams in Catchment 2 also flow north to join Surveyors Creek in the vicinity of Penrith South.

Catchment 3 includes tributaries of an unnamed stream that rises in the vicinity of Kings Hill Road 1.5km south of the area and flows north to join Mulgoa Creek 1km downstream of the site. To point B immediately downstream of the site the stream and its tributaries drain an area of 595 hectares. Only 3.6 per cent of the total catchment (i.e. 21.6 hectares) occurs within the proposed development area.

The area proposed for development falls within parts of catchments 1 and 3.

A2.5.2 Surface Drainage

The drainage pattern within the area is dendritic and all streams are intermittent. Almost all drainage lines are currently incised into shallow pre-existing valley fills. Small nick-point headwalls occur ranging in height from 20cm to 1.5m.

A2.5.3 Flooding

The site is well above known flood levels. High streams flows are generally confined within the well defined channels of main creek systems.

A2.5.4 Groundwater

No significant groundwater flows were recorded during drilling operations and there is no evidence of significant groundwater seepage within existing pits.

The groundwater table is expected to be below areas proposed for excavation.

A2.5.5 Water Quality

Water samples were taken from 7 sites shown on *Figure 8* and analysed in the field for pH and specific conductance using a portable pH/conductivity meter. Samples from sites W1, W2, W3 and W7 were further analysed for a range of chemical parameters.

Samples were taken following a period of rainfall and hence most creeks were flowing.

Results of analyses are given in *Tables A4* and *A5*.

TABLE A4

pH AND SPECIFIC CONDUCTANCE ANALYSES

Site	Description	pH	Specific Conductance* (Micromhos/cm^3)
W1	Farm dam - clear	7.90	650
W2	Creek - flowing, turbid	7.65	440
W3	Farm dam - clear	9.40	355
W4	Disused quarry - still pools	8.70	1,000
W5	Dam - turbid	7.60	360
W6	Dam - clear	7.75	665
W7	Creek - flowing, turbid	7.80	735

TABLE A5

WATER QUALITY ANALYSES (mg/ℓ)

	Site			
Parameter	W1	W2	W3	W7
Filtrable residue* (180°C)	333	242	224	504
Non-Filtrable residue** (105°C)	31	532	15	501
Total Hardness (as $CaCO_3$)	131	63	61	105
Chloride (as Cl)	123	84	69	150
Sulphate (as SO_4)	8	8	4	35
Calcium (as Ca)	22	7	10	11
Magnesium (as Mg)	18	11	9	19
Filtrable Iron	-	0.2	-	0.2

Notes: * Measure of soluble salts, salinity.

** Measure of suspended matter.

The results show that:

(i) Surface waters are slightly alkaline (pH 7.60-8.70) with the water sample W3 being clearly alkaline (pH 9.40). This is probably a result of surrounding cultivation and grazing activities. For water samples W3 (pH 9.40) and W4 (pH 8.70) the pH level exceeded the maximum permissible level of 8.5 specified in the New South Wales Clean Waters Regulations 1970.

(ii) Soluble salts and suspended matter are low to moderate and the water would be suitable for irrigation of most crops.

(iii) The sulphate and chloride levels are below the maximum permissible levels of 250mg/ℓ specified in Schedule 2 of the New South Wales Clean Waters Regulations 1970.

(iv) Total hardness, magnesium and calcium levels are low and the water would be suitable for stock and the irrigation of crops. Hardness levels are below the Australian Water Resources Council's desirable maximum level of 600mg/ℓ for drinking water.

(v) Levels for measured parameters for water samples W1, W2, W4, W5, W6 and W7 are below the maximum allowable impurity level in water for human consumption. For water sample W3, levels for all measured parameters except pH (9.40) are below maximum allowable levels.

A2.6 METEOROLOGY

The Penrith-Mulgoa area lies within a region of temperate climate with rainfall maxima in late summer-early autumn and minima in spring. As could be expected, the area experiences a slightly wider diurnal and annual temperature range and a decreased rainfall compared with coastal locations.

Climatic parameters for the area have been determined from official meteorological records at Richmond air force base and would be relatively indicative of conditions prevailing on the site.

A2.6.1 Temperature and Humidity

Shown in *Table A6* is the mean daily maximum and minimum temperatures for the year together with the 9am and 3pm relative humidity.

TABLE A6

TEMPERATURE AND HUMIDITY

Temperature	J	F	M	A	M	J	J	A	S	O	N	D	Year
Mean Daily Max (°C)	29	28	27	24	20	18	17	19	21	24	27	28	23.7
" " Min (°C)	17	17	16	12	7	5	3	5	8	11	14	16	11.1
Relative Humidity													
Mean 9am (%)	68	75	75	78	79	84	79	73	66	63	59	63	72
" 3pm (%)	47	49	49	47	48	52	45	42	39	42	41	44	45

The mean daily maximum for the year is 23.7°C and minimum 11.1°C. Highest temperatures occur in January (29°C) and lowest in July (3°C).

The mean relative 9am and 3pm humidity readings for the year are 72 per cent and 45 per cent respectively. Overall the range of daily humidity readings show little variation.

A2.6.2 Inversions and Fogs

Due to cold air movement in the Cumberland Basin during night and early morning periods, an inversion layer occurs and is identified by the brown photo chemical fog. This layer is most common during the mid-autumn-winter-early spring seasons.

The duration of the inversion layer is directly proportional to the

prevailing winds and specifically to the heat penetration into the inversion layer in the early morning which tends to diminish the photo chemical smog from about 10am and through the late morning to midday depending upon the cloud cover and prevailing winds. Inversions are generally dissipated by noon in this area.

A2.6.3 Rainfall

The mean monthly rainfall and number of rain days in shown in *Table A7*

Highest falls occur in February (104mm) when rain falls on an average of 16 days per month. Lowest falls occur in September (42mm) on an average of 6 days per month.

The mean rainfall for the year is 812mm.

TABLE A7

RAINFALL

	J	F	M	A	M	J	J	A	S	O	N	D	Year
Mean Rainfall (mm)	97	104	92	63	60	65	35	46	42	69	76	74	812
Raindays (no)	15	16	12	7	8	8	7	8	6	12	14	10	123

A2.6.4 Wind Speed and Direction

Wind roses for each month of the year are shown on *Figure 9*. Strongest winds for all months occur in the afternoon, and hence the 3pm readings are shown.

Southeasterly and easterly winds predominate in the middle summer to early autumn and attain speeds greater than 30km/hr for 1-2 per cent of the time.

April is a transition month when wind directions change from a predominantly southeasterly to westerly.

Throughout winter and early spring the strongest and most frequent winds blow from the west and attain speeds greater than 30km/hr for 5 per cent of the time.

October through to December is unstable with winds originating from both the southeast and western sectors as shown in *Figure 9*.

A2.6.5 Microclimate

The proposed development area will be located on the western slopes of a north-south trending ridge which provides protection from winds from the south and east quadrants.

The site is flanked by east-west spurs extending from the main ridge to the unnamed creek west of the site but is relatively exposed to westerly and southwestly winds.

The ridge crests are "windswept"; winds have higher speeds on the ridge but become more gentle and turbulent in the lee of the hill. This phenomenon is illustrated by results obtained from air quality measurements. A dust station on top of the ridge (D2) recorded lower particulate levels than a station located in the lee of the hill. (D1).

A2.6.6 Air Quality

Four dust monitoring gauges were installed on 19th November, 1981 at the locations shown on *Figure 8* to determine existing levels of particulates in the atmosphere. Samples were collected at monthly intervals (21st

December, 1981 and 21st January, 1982) and analysed for total dust. Results are shown in *Table A8*. As a result of damage only one result was obtained for station 2.

TABLE A8

DUST DEPOSITION RESULTS

		D1	D2	D3	D4	Mean
19/11/81 to 21/12/81	Total Dust (g/m^2/mth)	0.42	-	0.58	0.61	0.53
	Inorganic Fraction (%)	10.8	-	18.4	12.6	13.9
21/12/81 to 21/1/82	Total Dust (g/m^2/mth)	15.5	5.42	2.19	0.72	5.96
	Inorganic Fraction (%)	51.4	36.9	12.3	32.2	33.2

Results show that during the first month an average of 0.53g/m^2/mth of particulates were deposited on the site and during the second month an average of 5.96g/m^2/mth was recorded. To determine the inorganic fraction the samples were ashed at 450°C. The analyses showed that during the first month, the samples contained an inorganic ("dust") level of 13.9 per cent and for the second month the mean "dust" content was 33.2 per cent. The remainder was organic matter such as blown seeding grasses.

During the months of December and January the prevailing winds blow from the northeast to southeast sector across areas used for grazing and cultivation. It is likely that the high results obtained for the second month was as a result of agricultural activities in these areas.

A2.7 NATIVE VEGETATION

A2.7.1 Vegetation Assemblages

The area consists predominantly of cleared grazing land with small areas of native vegetation retained along water courses.

Assemblages have been described following the structural classification of *Specht et al (1974)*, shown in *Table A9*. Species lists are given in *Table A10*.

TABLE A9

STRUCTURAL FORMATIONS OF VEGETATION COMMUNITIES

Life form and height of tallest stratum	Projective foliage cover of tallest stratum		
	Dense (70-100%)	Mid-dense (30-70%)	Sparse (10-30%)
Trees > 30m	Tall closed-forest	Tall open-forest	Tall woodland
Trees 10-30m	Closed-forest	Open-forest	Woodland
Trees 5-10m	Low closed-forest	Low open-forest	Low woodland
Shrubs 2-8m	Closed-scrub	Open-scrub	Tall shrubland
Shrubs 0-2m	Closed-heath	Open-heath	Low shrubland
Herbs	Closed-herbland	Herbland	Open herbland

The areas delineated as "forest" on *Figure 10*, represent small remnants of mature native vegetation, and in some cases, regrowth of new vegetation following clearing. While the structure of the community is best described by the term forest, many areas do not attain the size or diversity normally associated with forests.

1) *E. viminalis, E. pilularis* closed-forest

This assemblage consists predominately of regenerating Eucalypts which provide a dense canopy cover in some places, but do not provide high habitat value due to the low numbers of mature trees.

The understorey is patchy and varies from relatively dense stands of *Acacia* to more open areas of only low understorey species.

TABLE A10

MAJOR PLANT SPECIES

Structural Classification and Title	Dominant Stratum	Mid-Understorey	Low-Understorey	Ground Cover
1) *E. viminalis*, *E. pilularis* closed-forest	*E. viminalis* *E. pilularis* *E. globoidea* occasional *A. floribunda* *A. subvelutina*	*Acacia parramattensis* +*Rosa rubiginosa* *Tieghemopanax sambucifolius*	*Centaurium minus* +*Mypochoeris glabra* +*Erigeron bonariensis* +*Verbena rigida* *Sida rhombifolia*	*Chloris truncata* +*Anagallis arvensis* *Glycine clandestina* *Stipa sp.* *Eragrestis sp.*
2) *A. floribunda* closed-forest	*A. floribunda* occasional *E. saligna*	**Casuarina cunninghamiana* +*B. spinosa* *A. parramattensis*	+*E. bonariensis* *Pteridium esculentum*	*Themeda sp.* *Eragrostis sp.* *Acaena ovina* *G. clandestina* **Adiantum aethiopicum*
3) *E. pilularis* closed-forest with Boxthorn understorey	*E. pilularis*	+*Lycium ferrocissimum*	+*Solanum sodomaeum* +*S. nigrum* +*Erodium moschatum*	+*Urtica incisa* +*P. lanceolata*
4) *E. viminalis*, *E. pilularis* *A. subvelutina* closed-forest with Blackthorn understorey	*E. viminalis* *E. pilularis* *E. globoidea* *A. subvelutina*	+*B. spinosa*	*As for 8*	*As for 8*
5) *Lycium ferrocissimum* closed-scrub	+*L. ferrocissimum*			
6) *Juncus acutus* closed-sedgeland	*Jancus acutus*			*Paspalum paspaloides*
7) *Eucalyptus viminalis*, *Angophora subvelutina* open-forest with Blackthorn understorey	*E. viminalis*, *A. subvelutina*	+*Bursaria spinosa*	+*Solanum nigrum* *Glycine tabacina* *Lepidium hyssopifolium*	*Goodenia glomerata*, +*Anagallis foemina* +*Paspalum dilatatum*
8) *E. viminalis*, *E. crebra*, *A. subvelutina* open-forest with native understorey	*E. viminalis*, *E. crebra*, *A. subvelutina* *E. pilularis*	*Acacia parramattensis*	*Centaurium minus* *Plecanthus parviflorus* *Cotula australis* *Indigofera australis*	*Chloris truncata* *Zornia dyctiocarpa* +*Galium aparine* *Lotus australis* +*A. foemina* *Hardenburgia violaceae* *Wahlenbergia communis* +*Sisyrinchium bermudiana* +*Plantago lanceolata* *Taraxacum officinale* *Themeda sp.*

TABLE A10

MAJOR PLANT SPECIES

Structural Classification and Title	Dominant Stratum	Mid-Understorey	Low-Understorey	Ground Cover
9) *E. globoidea* open-forest	*E. globoidea*	*+B. spinosa*		
10) *Bursaria spinosa* open-scrub	*B. spinosa*			*As for 12*
11) *E. viminalis, E. crebra, A. subvelutina* Woodland	*E. viminalis, E. crebra, A. subvelutina*	*As for 8*	*As for 8*	*As for 8*
12) Closed Herbland (Pasture)	*occasional E. crebra*		*+Cirsium vulgare +Carthamus lanatus C. minus Rumex brownii +R. crispus Senecio lautus*	*+Alophia pulchella +Anagallis arvensis T. officinale Themeda sp. Stipa sp. Eragrostis sp.*

\+ Introduced Species

* Protected Species

2) *Angophora floribunda* closed-forest

This association is confined to the wetter areas and better soils of the gullies in the western portion of the area.

The upper storey is almost completely Rough-barked Apple *(A. floribunda)*. In some places there is no mid-understorey, in others there is a moderately dense layer of *A. parramattensis* and Blackthorn.

The *Acacias* in this association are under severe stress; many are dead. The cause appears to be insect attack, especially borers. This is perhaps due to alteration of surrounding habitat which has reduced the number of *Acacias* available for the insects to feed on.

The canopy cover is dense, in places reaching 80 per cent. This contributes to the production of damp areas on sheltered south facing creek banks. These support relatively dense growth of Common Maidenhair Fern *(Adiantum aethiopicum)* which is a protected plant in New South Wales.

3) *E. pilularis* closed-forest with Boxthorn understorey

Except for the trees, all plants present in this association are introduced weeds. Boxthorn *(Lycium ferrocissimum)* is the dominant shrub and reaches a height of 1.5m. It is a spiny shrub capable of forming dense stands which exclude all other vegetation.

This association is also encouraged by disturbance through grazing and sheltering livestock.

4) *E. viminalis, E. pilularis, A. subvelutina* closed-forest with Blackthorn understorey

This is a relatively large association to the immediate north of the area. The major species are probably representative of the forest type which occupied the proposed development area prior to clearing.

It has been heavily invaded by Blackthorn which reaches a height of around 2m throughout the forest.

5) *Lycium ferrocissimum* closed-scrub

Small patches of Boxthorn growing to a height of around 2-5m and excluding all other vegetation.

6) *Juncus acutus* closed sedgeland

Along some drainage lines there are dense growths of Spiny rush *(Juncus acutus)* and Water couch *(Paspalum paspaloides)*.

7) *Eucalyptus viminalis, Angophora subvelutina* open-forest with Blackthorn understorey

This is the most common association on the grazing land. It consists of a fairly uniform canopy cover of around 50 per cent and a dense mid-understorey of Blackthorn *(Bursaria spinosa)*, which forms almost impenetrable stands up to around 2m. Where breaks in this vegetation occur, other weeds form a large part of the ground cover.

This association occurs where there is constant grazing pressure and disturbance from sheltering livestock which allows opportunist species to establish.

8) *E. viminalis, E. crebra, A. subvelutina* open-forest with native understorey

This is a large association adjoining the grazing land. Whilst still disturbed, this association is host to fewer weed species than the *E. viminalis - A. subvelutina* open-forest and is more diverse.

The assemblage includes a larger number of older trees which are likely to be of greater habitat value for fauna than younger growth. The mid-understorey is relatively sparse in patches and in others it is provided largely by regrowth of tree species.

9) *E. globoidea* open-forest

Comprises small simple patches of forest with White stringy bark *(E. globoidea)* and a regrowth of Blackthorn forming a low sparse understorey.

10) *Bursaria spinosa* open-scrub

Poor management practices has allowed the weed Blackthorn *(B. spinosa)* to infest sections of land previously used for grazing. Shrubs of up to 2m occur in moderately dense stands.

11) *E. viminalis, E. crebra, A. subvelutina* Woodland

This is a less dense structural form of the open-forest assemblage (8).

12) Closed-herbland

This is a general term for the grazed pasture, but excluding the cultivated sections. Occasional, lone Narrow-leaved Ironbark *(E. crebra)* occur in the eastern section of the study area.

A2.7.2 Past and present impacts on local vegetation

The area is almost entirely cleared of native vegetation with only small minor remnants occurring in water courses and as shade trees in grazed areas.

Continuous grazing by horses and cattle, and cultivation of land for crops has prevented regeneration of native species. Only to the west of the area, shown on *Figure 10*, where the site is less intensively grazed is regeneration of native species taking place.

The nearby *E. viminalis - E. pilularis - A. subvelutina* closed-forest, although disturbed by trail-bike riding, logging and rubbish dumping leading to the spread of Blackthorn, would be more indicative of the forest types that occurred on the site prior to clearing.

A2.7.3 Status and Regional Significance

The flora of the area is typical of the vegetation of the western Sydney Region which has been extensively removed by clearing and cultivation

since the early history of Sydney.

No rare or endangered species were identified in the area and two protected species, *Casuarina cunninghamiana* and *Adiatum aethiopicum* in the *Angophora floribunda* assemblage along the course of the unnamed creek were identified.

A2.8 FAUNA AND HABITATS

A2.8.1 Mammals

Trapping for small and arboreal mammals took place in December 1981 and February 1982. On each occasion, trapping was carried out for 112 trap nights with "Elliot Type A" small mammal traps and for eight nights with larger possum traps manufactured by Mascot Wire Works.

One native arboreal mammal, the Brush-tailed Possum *(Trichosurus vulpecula)*, and five individuals of the rodent, the House Mouse *(Mus musculus)* were captured. Two other mammals were sighted. A list of the mammals present on the site and their method of detection is given in *Table A11*.

TABLE A11

MAMMALS FOUND ON STUDY SITE

Common Name	Systematic Name	Method of Detection
Brush-tailed Possum	*Trichosurus vulpecula*	Trapped/Sighted
Ring-tailed Possum	*Pseudocheirus peregrinus*	Sighted
Rabbit+	*Oryctolagus cuniculus*	Sighted
House Mouse+	*Mus musculus*	Trapped

+ Introduced species.

The two native mammals depend on forest trees for shelter and food. The Brush-tailed Possum requires mature trees with hollows for shelter, and spends a large part of its time on the ground feeding on grass. In this

area the availability of nesting hollows would be limiting to the population as there are large areas of grassland surrounded by forests, but relatively few mature trees.

Ring-tailed Possums spend more of their time exclusively in trees and require a dense tall understorey in which to build their dreys (nest). In this case they are probably associated with the stands of *Acacia* and so may be under stress due to the deteriorating viability of this vegetation.

Any disturbance of the forest will disadvantage both these animals. This can be minimised by retaining mature "habitat" trees suitable for nesting, and by avoiding as far as possible forest sections with a dense tall understorey as in the creek gullies.

The other two mammals are introduced. Rabbits require open grassland in which to feed and soil which will support burrows. The clearing of more forest will provide more habitat for these animals which do not penetrate far into native forests.

House mice similarly, do not penetrate far into native forest and are characteristic of disturbed environments. This species is distributed widely in arid and semi-arid pastoral districts. Frequently it is found in the same area and habitat as good populations of smaller native mice *(Frith 1973)*. Even though no native mice were captured their occurrence cannot be discounted.

Simplification of the environment by removal of the forest is likely to favour these animals, at least initially. The degree of disturbance will determine the final balance.

A2.8.2 Birds

Twenty nine species of birds were noted within the study area, of which four are introduced species. A full list of species is given in *Table A12*.

TABLE A12
BIRD SPECIES

Common Name	Systematic Name	Activity		
		Feeding	Perching or on ground	Flying
Galah	*Cacatua roseicapilla*	C	C	C
Sulphur-Crested Cockatoo	*C. galerita*	C	C	C
Eastern Rosella	*Platycercus eximius*		C	C
Red-rumped Parrot	*Psephotus haematonotus*		U	U
White-faced Heron	*Ardea novaehollandiae*	O		
Little pied Cormorant	*Phalacrocorax melanoleucos*			O
White Egret	*Egretta alba*	U		
Swamphen	*Porphyrio porphyrio*	U	U	
Dusky Moorehen and chicks	*Gallinula tenebrosa*	U		
Wood Duck	*Chenonetta jubata*	U	U	
Spur-winged Plover	*Vanellus miles*	C	C	C
Red-capped Dotterel	*Charadrius ruficapillus*		U	
Laughing Kookaburra	*Dacelo gigas*	C		C
Australian Raven	*Corvus coronoides*	C	C	C
Black-shouldered Kite	*Elanus notatus*			U
Pee wee	*Grallina cyanoleuca*	U	U	U
Australian Magpie	*Gymnorhina tibicen*	C	C	C
White Winged Chough	*Corcorax melanorhamphus*	C	C	
Welcome Swallow	*Hirundo neoxena*	C		C
Satin Flycatcher	*Myiagra cyanoleuca*	U		
Noisy Miner	*Manorina melanocephala*	C	C	
Willie Wagtail	*Rhipidura leucophrys*	U	U	
Weebill	*Smicrornis brevirostris*		C	C
Rose Robin	*Petroica rosea*		O	
Australian Pipit	*Anthus novaeseelandiae*	C	C	
House Sparrow+	*Passer domesticus*	C	C	C
Common Starling+	*Sturnus vulgaris*	C		
Indian Myna+	*Acridotheres tristis*	C	C	C
Spotted Turtle Dove+	*Streptopelia chinensis*	U	U	U

C - Common
U - Uncommon
O - One individual only sighted
+ - Introduced species

which also describes the activity of the bird when it was first seen. Birds noted as perching or feeding are definitely using the study area. Those seen only flying may or may not be.

The habitat requirements of these birds differs markedly. *Table A13* gives the number of species in each group.

TABLE A13

BIRD GROUPS PRESENT IN THE STUDY AREA

	Predominant Mode of Life				
	Water Dependent Birds	Birds of Prey	Insect eaters	Seed eaters	Generalists
No. of species	8	1	10	4	6

Three points are evident from the above.

i) A large proportion of the habitat value of the study area, with respect to birds, is due to the presence of relatively large farm dams which are used by a number of water dependent birds.

ii) There are a large number of insectivorous species. It has been suggested by *Kingston (1981)* that such an imbalance may be due to the higher production of plants growing on soils derived from shale. A high rate of production by plants will support a greater insect population. It is also evident that many plant species are under stress through insect attack.

iii) There is a complete lack of strict nectar feeders. This is probably due to the lack of nectar rich vegetation, for example, members of the family *Proteaceae*.

The greatest habitat value for both mammals and birds lies in the patches of native forest, and farm dams.

A2.8.3 Reptiles, amphibians and fish

No reptiles or amphibians were recorded during investigations but a few individuals of the Eastern Water Skink *(Sphenomorphus quoyii)* have been previously recorded near the unnamed creek. *(Kingston 1981)*.

One native species of fish, the Finetailed Gudgeon *(Hypseloetris galii)*, and the introduced Mosquito Fish *(Gambusia affinis)* have been recorded previously in the unnamed creek downstream of the site. *(Kingston 1981)*.

A2.8.4 Status and Regional Significance

No rare or endangered species were recorded in the area.

The avifauna is generally rich considering the extent of clearing and proximity to habitation. This is due to the presence of a few native trees and regrowth of native trees and shrubs in recent years, and the few large farm dams.

A2.9 VISUAL ASPECTS

A2.9.1 Regional Scenery

The site consists predominantly of gently rolling grassed hills with scattered stands of native trees left to provide shelter for grazing stock. To the south, areas are under cultivation with principal crops being sudex, millet and oats. The site is similar to the general Cumberland Basin landscape between Parramatta and Camden of gentle rolling hills utilised for agricultural pursuits.

Sited on the fringe of the urban areas south of Penrith, the surrounding areas have been subdivided into small farmlets (2, 10, and 40 hectare size). The RAAF and Naval depot form a more commercial landscape element.

In contrast, the landscape between the historic buildings of St Thomas Church of England, "The Cottage", and Fernhill in the Mulgoa area is considered to be of very high landscape value *(National Trust of Australia)* having remained essentially unaltered since first described in 1852 by *Colonel Mundy*.
"A handsome stone house overlooks by far the most lovely and extensive landscape - as a home view - I ever met within Australia; and its beauty is much enhanced by the taste and success of the proprietor in weeding out the thinly leafed and unsightly kinds of the gum-tree and preserving only that species of the eucalyptus called the apple-tree, which, with its stout gnarled branches and crisp tufted foliage, is, when standing alone or in clumps on parkish looking ground, by no means a bad representation of the English oak...." *(Mundy 1852)*.

This landscape is concentrated on the drive to "Fernhill" which is a unique example of the adaption of native trees to create a park in the manner of the English Landscape Garden. The National Trust of Australia notes "Not only is this "park" still a most beautiful piece of contrived landscape scenery - natural in appearance yet as artificial as English park scenery - it is a unique piece of evidence of a very rare attitude in the mid 19th century towards the natural environment. Not one exotic is planted along a mile or so of drive."

A2.9.2 Viewing Points

The prominent arcuate ridge is visible from parts of The Northern Road, Chain-O-Ponds Road and the Western Freeway south of Penrith. The ridge can also be seen from the relatively inaccessible high areas immediately east of the Nepean River but is screened from the Blue Mountains west of the river.

B. MAN-MADE PHYSICAL ENVIRONMENT

A2.10 ABORIGINAL PRE-HISTORY

An archaeological survey of the study area was carried out on 9th December, 1981. The survey was intended firstly to locate and record any evidence of

Aboriginal occupation of the proposed development site, and secondly to determine the significance of such sites in terms of the understanding of the prehistoric and pre-European culture of the Aborigines of this area. Finally, to determine the desirability of any site preservation for further investigation.

The survey was carried out on foot. All ridge tops, including ploughed fields and channels, walls and banks of all small streams were examined. Particular attention was paid to creek/gully environs as these seemed the most likely areas for occupation.

Only one relic was found. This was a broken edge ground axe composed of basalt and measuring 10 x 7.2 x 3mm *(Brayshaw 1981)*. The location of this site is shown on *Figure 6*.

The rare sandstone outcrops in gully floors to the west did not display any axe grinding grooves or small engravings. It is possible that this sandstone was not exposed in pre-European times.

The lack of suitable rock outcrop precludes quarry sites or rock art sites, and the clay soil is too stiff to have been excavated by Aborigines for burials.

A2.11 HISTORICAL SITES

Penrith's history dates back to June 1789 when Lieutenant Captain Watkin Tench discovered the river which Governor Phillip later named the Nepean.

Settlement of Penrith and district took place in the early history of the colony, generally resulting from the expansion of settlements in the Richmond area. In fact, early access to and from Sydney was through Richmond.

Penrith became important because of its central position in relation to the Nepean River and the Great Western Highway and later, the Great Western Railway. Cobb and Co used Penrith as a terminal on their western route.

In the Mulgoa area, a group of three individual classified buildings, "Fernhill", St Thomas Church of England, and "The Cottage", retain the original visual relationship to each other and demonstrate the ambitions and changes in wealth and status of an important early colonial family from c.1810 through the prosperity of the 1830's and the financial crises of the early 1840's. *(Figure 11)*.

Originally "The Cottage" was built by William Cox for his sons Henry, George, and Edward on land granted to Edward in 1810.

Dating back to c 1811, "The Cottage" is perhaps the oldest weatherboard house in New South Wales in proportion and roof line. It is the oldest building in the Mulgoa-Wallacia Valley and the oldest surviving "Cox" house.

St Thomas Church of England was considered "their" church and was built from 1836-1838. The hammer beam roof of St Thomas was the first example of a medieval style open timber roof in a New South Wales Church and the building as a whole is the only extant example of a reasonably intact late 1830's Gothic Revival rural Anglican parish church in the state.

"Fernhill" is a single storey stone house completed in 1840 for Edward Cox, a son of William Cox, and was probably one of the last buildings to be completed in the noble Colonial period.

Further towards Penrith along Mulgoa Road is "Glenmore", a rendered brick and stone homestead built in 1825 for Henry Cox. Sold to T.S. Mort in 1851 and in 1854 to J.J. Riley the building was gothicized and enlarged by adding two side wings which bear the Riley Coat of Arms. Classified by the National Trust as a "fine example of a well sited homestead of the 1820's with later sympathetically and interesting Gothic additions".

A2.12 PLANNING

A2.12.1 Regional Planning

The subject area is 8km by road south of Penrith City in an area used primarily for crop cultivation and grazing.

As a result of population growth, Penrith has undergone active urban expansion in the area south of the city towards the western freeway.

Continued growth has lead to pressure for further rezoning and subsequent development of areas for housing further to the south in the Mulgoa area.

Large tracts of land to the north are owned by the New South Wales Housing Commission and Land Commission and proposed for housing as part of a State Government housing and settlement programme. This land extends to the northern boundary of the proposed development site.

A total of 3,000 home building blocks are proposed for this area and it is expected that land as far south as the east-west transmission line *(Figure 11)* will be subdivided by June 1984 and first settled by June 1985.

Residential subdivisions will be extended to the limit of the area within a 6 to 10 year period.

On the eastern side of The Northern Road, the area between Wentworth Road and the Western Freeway are also proposed to be settled in a 10 year period.

All allotments are expected to be 600m^2 size with single detached dwellings. A small percentage of two storey town houses are also proposed.

A2.12.2 Local Planning

Land to the east of The Northern Road is Commonwealth land and the site of the Royal Australian Air Force No. 1 Central Ammunition Depot and Naval Armament Depot/Missile Maintenance establishment.

Land fronting the western side of The Northern Road southeast of the site is subdivided into 2 hectare lots, while 10 hectare lots with frontage to Chain-O-Ponds Road occur further to the south.

Areas between the proposed development site and Mulgoa Road are the sites of the clay/shale extractive operations of Wearn Industries Pty Limited and N.J.W. Contractors. Land owned by Zacuba Pty Limited also occurs in this area.

A2.12.3 Land Zoning

The proposed development site is zoned Rural (A1) in which extractive industries are permitted only with the consent of Penrith City Council.

A2.13 LAND USE

A2.13.1 Agriculture

The area proposed for development has been primarily used for agricultural purposes.

The site to be purchased by Mulgoa Quarries Pty Limited has been used primarily for horse grazing. South of the site the land has been used for the grazing of Hereford cattle and cultivation of crops. Crops include sudax, millet, and oats which are irrigated from dams located on the site. The location of grazing and cultivated land is shown on *Figure 10*.

Lots of 10 hectare and 2 hectare size north and south of the site support "hobby farms", where the land use may be market gardening, cropping, or the grazing of a few domestic animals.

A2.13.2 Residential

Dense urban development occurs south of Penrith and extends to the Western Freeway 2.5km north of the proposed development. South of this area,

residential dwellings are scattered on 40, 10, and 2 hectare allotments fronting major access roads.

The village of Mulgoa occurs 4km to the southwest.

No residences occur within the proposed development site.

Residences on and adjacent to the proposed development site are shown on *Figure 25* and described in *Table A14*.

A2.13.3 Recreational

Two 18 hole golf courses occur to the north and northwest of the site as shown on *Figure 11*. The courses are over 2km from the proposed site. The area is remote from the Nepean River and Blue Mountains National Park and frequented recreational areas.

A2.13.4 Special Uses

Both the Royal Australian Air Force and Navy maintain establishments in the area east of The Northern Road *(Figure 11)*.

A water treatment works and reservoir occur to the east and northeast and the Warragamba-Prospect Water Pipe line 3km to the south.

A2.13.5 Mining and Extractive Industries

Shale quarries currently operated by Wearn Industries Pty Limited and N.J.W. Contractors occur to the west of the area as shown on *Figure 1*.

In the late 1960's - early 1970's, a small shale quarry was operated by J. and D. Kay in the area shown on *Figure 5*.

TABLE A14

RESIDENCES IN PROXIMITY

House No.	Description			
	Walls	Roof	Foundations	Age (yrs) (estimated)
1	Brick	Tile	Pier	<10
2 (Toledo House)	Brick	Tile	?	<10
3	Brick	Tile	Slab	< 5
4	Brick	Tile	Slab	< 5
5	Under Construction			
6	Timber	G.I.	Pier	<20?
7	Brick	Tile	Pier	< 5
8	Fibro	G.I.	Pier	<20
9	Fibro	G.I.	Pier	<20
10	Brick	Tile	Slab	<10
11	Fibro	G.I.	Pier	<20
12	Fibro	G.I.	Pier	<20
13	Fibro	Tile	Pier	<10
14	Fibro	G.I.	Pier	<20
15	Brick	Tile	Pier	10-15
16	Fibro	G.I.	Pier	20
17	Fibro	G.I.	Pier	20
18	Fibro	G.I.	Pier	20
19	Collection of RAAF/RAN homes			
20	Brick	Tile	Slab	<10
21	Brick	Tile	Slab	<10
22	Timber	Tile	?	10?
23	W.B.	G.I.	Pier	20
24	Fibro	G.I.	Pier	20
25	Fibro	G.I.	Pier	20
26	W.B.	Tile	Pier	20
27	Fibro	G.I.	Pier	20
28	Brick	Tile	Slab	< 5
29	Fibro	G.I.	Pier	20
30	Brick	Tile	Slab	< 5

Key: G.I. Galvanised iron
W.B. Weatherboard

Operations were short term with only small quantities of material removed.

A2.13.6 Natural Areas

The area has been primarily cleared for grazing with only small stands of native vegetation occurring within stream courses or left as shade trees in grazing areas.

The most continuous stand of native vegetation occurs to the north of the proposed development area on land owned by the New South Wales Housing Commission and covers a total area of 50 hectares. The stand consists of *E. viminalis - E. pilularis - A. subvelutina* closed-forest and although heavily infested with Blackthorn, represents the largest "natural" area remaining in this region.

The area extends north along the water course of the unnamed creek draining the western portion of the proposed development site.

A2.14 PUBLIC UTILITIES

The area is well serviced with electricity and telecommunications. Water is available in some areas along The Northern Road.

A2.15 ACCESS AND TRANSPORT ROUTES

The proposed development site occurs between two major arterial roads; Mulgoa Road and The Northern Road.

The Northern Road (Route 69) provides the main transport route between Camden and Penrith and connects directly with the Western Freeway. It is a sealed two lane road with good alignment and is maintained by the New South Wales Department of Main Roads.

Table A15 lists the annual average daily traffic (AADT) for this road immediately south of the Western Freeway intersection and north of the Elizabeth Drive turnoff.

TABLE A15

TRAFFIC LEVELS - THE NORTHERN ROAD

The Northern Road (MR154)	1973	1975	1977	1979
Kingswood - south of Western Freeway	6290	6730	8320	10860
Luddenham- north of MR535 - Elizabeth Drive	3240	4800	5370	6770

Source: *New South Wales Department of Main Roads.*

The 1981 AADT has been estimated at 13500 vehicles per day.

The differences between the two locations on the basis of the 1979 figures is 4090 vehicles. Since there are no major road junctions between the locations it is assumed that the majority of these vehicles originate or are destined for, the airforce/naval depot.

A one hour survey of traffic carried out between 8.20am and 9.20am on 24th March, 1982 at the intersection of Bradley Street and The Northern Road showed that of the total of 611 vehicles, 48.8 per cent travelled in a northerly direction, and 51.2 per cent to the south. Of the total number of vehicles, 14.7 per cent were "heavy" vehicles with destinations equally divided to the north and south.

Traffic levels on Mulgoa Road north of St Thomas Road Mulgoa and at Jamisontown are shown on *Table A16*.

TABLE A16

TRAFFIC LEVELS - MULGOA ROAD

Mulgoa Road (MR155)	1973	1975	1977	1979
Mulgoa - North of St Thomas Road	1870	1960	1960	2220
Penrith - South of Jamison Street	4170	4400	4790	6270

Source: *New South Wales Department of Main Roads.*

The figures show that traffic levels at Mulgoa have increased only 18.7 per cent since 1973. At the northern end, levels have increased markedly since 1977 as a result of new subdivisions in the Jamisontown and Regentville areas.

A two lane gravel road (Bradley Street) currently provides access to the proposed development site from The Northern Road. This is joined by a narrow track which formerly provided access to the abandoned shale pit.

A2.16 NOISE AND VIBRATION LEVELS

A2.16.1 Background Noise Levels

Background noise levels were measured at nine sites, N1, N2, N3, N4, N5, N6, N7, N8 and N9 shown on *Figure 11*. Measurements were conducted by Resource Planning during March 1982 and by *Wilkinson-Murray Consulting Pty Ltd* during July and August 1981.

Measurements at all sites except N2 were recorded around the proposed commencement time for extractive operations when noise levels would be most significant, and at various times throughout the day. Only one measurement was recorded at site N2.

Details of measuring equipment are given in *Table A17* and prevailing meteorological conditions in *Table A18*.

TABLE A17

NOISE MEASURING EQUIPMENT

Manufacturer	Type	Model	Serial Number
(a) Resource Planning			
Bruel and Kjaer	Integrating Sound Level Meter	2225	851244
Bruel and Kjaer	Prepolarising Condenser Microphone	4175	852022
Bruel and Kjaer	3m Extension Cable	A00185	
Bruel and Kjaer	Sound Level Calibrator	4230	861507
(b) Wilkinson-Murray Consulting Pty Ltd			
Bruel and Kjaer	Noise Level Analyser	4426	
Bruel and Kjaer	Preamplifier	2619	
Bruel and Kjaer	Condenser Microphone	4165	
Bruel and Kjaer	Sound Level Calibrator	4230	

All measurements were conducted in accordance with Australian Standard 1055-1978. For measurements done by Resource Planning noise levels were read at approximately 5 second intervals over a 5 to 10 minute period. Wilkinson-Murray Consulting Pty Ltd monitored the existing background noise for a 5 to 10 minute period with the Analyser set to sampling rates of 10 per second.

The sound level meters were set at fast response using the 'A' weighted scale which approximates the loudness level sensitivity of the human ear. The data were analysed into L_{eq}, L_{10} and L_{90} classes, where L_{eq} is the equivalent continuous noise level, L_{10} the noise level exceeded for 10 per cent of the time, and L_{90} the noise level exceeded for 90 per cent of the time. According to the State Pollution Control Commission's Noise Control Guide *(Data Sheet N1014)* L_{90} is considered as background. *Table A19* presents a summary of results. Mean background noise levels are shown on *Figure 25*.

TABLE A18

METEOROLOGICAL CONDITIONS

Date	Start Time	Site	Cloud Cover (%)	Temperature (°C)	Humidity (%)	Wind Speed	Wind Direction
14/7/81	4.15pm	N1	37 (3.00pm)	16 (3.00pm)	0 (3.00pm)	Calm-Light	N
	4.30pm	N5	-	-	-	Calm-Light	N
	4.40pm	N6	-	-	-	Calm-Light	N
	4.55pm	N7	-	-	-	Calm-Light	N
	5.10pm	N8	-	-	-	Calm-Light	N
	5.25pm	N4	-	-	-	Calm-Light	N
5/8/81	5.20am	N8	-	-	-	Calm	-
	5.35am	N7	-	-	-	Calm	-
	5.50am	N5	-	-	-	Calm	-
	6.00am	N6	-	-	-	Calm	-
	6.15am	N1	-	-	-	Calm	-
	6.35am	N4	-	-	-	Calm	-
	7.00am	N9	-	-	-	Calm	-
	7.10am	N4	-	-	-	Calm	-
	10.00am	N9	87 (9.00am)	13 (9.00am)	45 (9.00am)	Light-Mod.	SE
	10.30am	N9	-	-	-	Light-Mod.	SE
	10.35am	N4	-	-	-	Light-Mod.	SE
	11.00am	N8	-	-	-	Light-Mod.	SE
	11.30am	N7	-	-	-	Light-Mod.	SE
	11.50am	N6	-	-	-	Light-Mod.	SE
	2.55pm	N1	62 (3.00pm)	18 (3.00pm)	0 (3.00pm)	Light	SE
	3.15pm	N5	-	-	-	Light-Mod.	SE
	4.30pm	N9	-	-	-	Light-Mod.	SE
25/3/82	10.00am	N1	50	22	90 (9.00am)	Calm	-
	10.30am	N2	50	26	-	Calm	-
	10.55am	N3	75	26	-	Calm	-
26/3/82	6.05am	N4	12	18	-	Calm	-
	6.20am	N3	100	18	-	Calm	-
	6.40am	N1	50	18	90 (9.00am)	Calm	-
	11.40am	N4	100	28	-	Calm	-
	11.50am	N1	100	28	60 (3.00pm)	Calm	-

Sources: *RAAF Richmond and Field Observations.*

TABLE A19

BACKGROUND NOISE READINGS (dB(A))

Site	Start Time	Date	L_{10}	L_{eq}	L_{90}	Noise Sources
N1	6.15am *	5/8/81	50	48	40	Quarry, birds, traffic
	6.40am	26/3/82	49.5	47	38.5	Traffic, birds
	10.00am	25/3/82	60	57.5	38.5	Traffic, Jets overhead, birds
	11.50am	26/3/82	41	40.5	36	Traffic, quarry, birds, dog
	2.55pm *	5/8/81	42	39	36	Quarry, birds, light plane overhead
	4.15pm *	14/7/81	42	40	38	Quarry, birds
					—	
	Mean				38	
N2	10.30am	25/3/82	68	64	45.5	Traffic, birds
					—	
	Mean				45.5	
N3	6.20am	26/3/82	80	77	49.5	Traffic
	10.55am	25/3/82	80	78	46	Traffic, birds
					—	
	Mean				48	
N4	6.05am	26/3/82	39.5	38	35.5	Traffic, roosters
	6.35am *	5/8/81	49	46	44	Traffic, birds
	7.10am *	5/8/81	52	49	44	Traffic
	10.35am *	5/8/81	42	40	36	Traffic
	11.40am	26/3/82	45	42.5	34.5	Traffic, birds, light plane overhead
	5.25pm *	14/7/81	47	45	42	Traffic
					—	
	Mean				39	
N5	5.50am *	5/8/81	47	45	35	Traffic, birds, insects
	3.15pm *	5/8/81	63	60	39	Traffic, quarry, light plane
	4.30pm *	14/7/81	62	56	47	Traffic, pump
					—	
	Mean				40	
N6	6.00am *	5/8/81	58	59	33	Traffic
	11.50am *	5/8/81	61	58	42	Traffic
	4.40pm *	14/7/81	62	57	44	Traffic
					—	
	Mean				39.5	
N7	5.35am *	5/8/81	36	33	31	Traffic, insects
	11.30am *	5/8/81	57	53	35	Traffic, helicopter
	4.55pm *	14/7/81	53	51	43	Traffic, birds, dog
					—	
	Mean				36.5	
N8	5.20am *	5/8/81	34	32	30	Traffic, insects
	11.00am *	5/8/81	40	36	32	Birds, quarry
	5.10pm *	14/7/81	38	37	35	Freeway traffic, birds
					—	
	Mean				32	
N9	7.00am *	5/8/81	56	52	47	Traffic, dog
	10.00am *	5/8/81	53	49	38	Traffic, birds, explosions
	10.30am *	5/8/81	52	46	41	Traffic, birds, explosions
	4.30pm *	5/8/81	49	46	40	Traffic
					—	
	Mean				41.5	
	Overall Mean				39	

Notes: * *Wilkinson-Murray Consulting Pty Ltd. (October 1981)*

At sites N2, N3, N4 and N9 traffic on The Northern Road was the most prominent noise source throughout all times of the day. Traffic on Mulgoa Road was most audible at sites N5, N6 and N7 again throughout all times of the day.

Although not consistent, traffic on Chain-O-Pond Road at site N1 was a significant noise source during the morning and traffic on the F4 Freeway produced highest readings at site N8 in the early morning and late afternoon.

At most sites birds, roosters, dogs and insects were also a prominent noise source, and during five measurement periods, light planes, jets and helicopters flying overhead produced high noise readings.

A significant sound during two measurement periods were explosions from the RAAF Central Armament Depot on The Northern Road. Explosions regularly occur at this depot resulting from disposal of old or faulty ammunition or demolition training.

Noise from the existing quarrying operation does not significantly alter the existing background noise levels. At site N1, L_{90} levels of 40dB(A) and 36dB(A) were recorded early in the morning and late morning on a day when the quarry was operating and corresponding L_{90} levels of 38.5dB(A) and 38.5dB(A) on a day when the quarry was not operating.

Mean background readings of 32dB(A) at site N8 and 36.5dB(A) at site N7 are consistent with background levels experienced in rural areas. However, mean background levels of 38dB(A) to 48dB(A) at the other seven sites are high compared with background levels experienced in rural areas, but consistent with those levels experienced in built-up residential areas with low density to medium density through traffic.

A2.16.2 Vibration and Overpressure Levels

Vibration and overpressure levels associated with routine blasting at the nearby quarries have been monitored by the Mines Inspection Branch of the New South Wales Department of Mineral Resources and were found to be below standards set by the Department and well below the maximum particle velocities for buildings contained in Table 11.2 of the SAA Explosives Code AS2187, Part 2-1979 shown in *Table A20*.

Explosions associated with demolition work at the RAAF Central Armament Depot also cause vibration and overpressure in the district.

TABLE A20

MAXIMUM PARTICLE VELOCITY

Type of building	Maximum velocity (Vm) mm/s
Historical buildings, monuments, or ruins	2
Visibly damaged or cracked buildings	10
Structurally sound buildings, e.g. houses or shops	20
Reinforced concrete or steel structures	50

C. SOCIAL AND ECONOMIC ENVIRONMENT

A2.17 POPULATION CHARACTERISTICS

A2.17.1 Sub-Regional

The Western Sydney Subdivision comprises nine local government areas (LGA's) namely Auburn Municipality, Baulkham Hills Shire, Blacktown City, Blue Mountains City, Fairfield City, Holroyd Municipality, Parramatta City, Hawkesbury Shire and Penrith City.

Since 1971 the subregion's rate of growth has been consistently higher than the State average. The average annual rate of growth for the Western Suburbs Statistical Subdivision between 1971 and 1976 was 2.18 per cent and between 1976 and 1979 was 2.85 per cent, whereas comparable growth rates for New South Wales were only 0.98 per cent (1971-76) and 1.25 per cent (1977-79).

This subregion has experienced relatively high rates of natural increase (for 1971-76 an increase of 55,663 persons by natural increase) and also a reasonable net inward migration.

A2.17.2 Penrith City

The population of Penrith City has grown rapidly over the past fifteen years and has exhibited annual growth rates well above those for New South Wales. *(Table A21)*. Between 1966 and 1971 the average annual rate of growth was 5.39 per cent, while from 1971 to 1976 this figure was 5.54 per cent and lastly, from 1976 to 1979 the rate was 5.68 per cent *(Table A22)*. The present population of Penrith City is 107,000 well above estimates predicted by the New South Wales Planning and Environment Commission in 1977.

The age distribution of Penrith City reveals a youthful population, i.e., 34.5 per cent of the population in 1976 was aged between 20 and 39 years while 76.9 per cent were less than 39 years of age *(Table A23)*. Compared with the 1971 population distribution, there had been a proportional increase in the 0-4 years, the 20-29 years and 30-39 years age groups by 1976. In contrast there was a proportional decrease in the 5-14 years, 40-49 years and 50-64 years age groups, again highlighting the "youthful" nature of the population.

This feature is further highlighted by a comparison of Penrith City with New South Wales and the Western Suburbs Statistical Subdivision data at 1976. In comparison with New South Wales, Penrith City exhibited proportionally more persons in the 20-39 years age group and proportionally fewer persons in the 40-65+ years age group. There existed a similar pattern when comparing Penrith with the Western Suburbs in total.

TABLE A21

POPULATION OF PENRITH CITY AND
COMPARISON AREAS 1966-1979

	Year			
	1966	1971	1976 (a)	1979 (b)
New South Wales	4,237,901	4,601,180	4,914,300	5,079,100
Western Suburbs Statistical Subdivision	564,324	693,500	779,700	832,650
Penrith City	46,391	60,316	79,038	94,000

Notes: (a) The 1976 Census is based on sample results.
(b) Estimate A.B.S.

Source: *Derived from A.B.S. (N.S.W.) Handbook of Local Statistics various issues.*

TABLE A22

AVERAGE ANNUAL PERCENTAGE RATES OF
POPULATION GROWTH 1966-1979

	1966-71	1971-76	1976-79
New South Wales	1.7	1.0	1.0
Western Suburbs Statistical Subdivision	4.2	2.2	2.9
Penrith City	5.4	5.5	5.7

Source: *As for Table A21.*

TABLE A23

AGE DISTRIBUTION OF THE POPULATION IN PENRITH CITY AND COMPARISON AREAS 1976

Age Group	Penrith (%)	Western Suburbs (%)	New South Wales (%)
0-4	12.6		
5-9	11.1	30.9	26.3
10-14	10.2		
15-19	8.6		8.8
20-24	8.4		8.0
25-29	11.1		8.3
30-34	8.5	62.9	7.0
35-39	6.5		6.1
40-44	5.0		5.5
45-49	4.5		5.8
50-54	4.0		5.7
55-59	3.0		4.9
60-64	2.3		4.4
65+	3.9	5.8	9.2
Not Stated	0.4	0.5	0.0
Total	100.0	100.0	100.0

Source: *As for Table A21.*

In terms of marital status, the Penrith City again exhibited features differing from those of the Western Suburbs and New South Wales. In particular, there were proportionally more non-married and fewer divorced or widowed persons in Penrith as compared with New South Wales and the Western Suburbs Statistical Subdivision *(Table A24)*. This reflects the age distribution of Penrith City again.

Both Penrith and the Western Suburbs exhibit proportionally fewer Australian-born persons in their population than New South Wales *(Table A25)*. This more "ethnic" characteristic is becoming stronger. In 1971, 77.2 per cent of the population of Penrith City was Australian-born, in 1976 the figure was only 74.7 per cent. The contribution of a migrationary influence is reflected also in the following figures relating to growth of population. For the Western Suburbs 64.6 per cent of the population increase between 1971 and 1976 was contributed by natural increase, while 35.4 per cent was from net migration. In contrast, the corresponding figures for New South Wales were 97.8 per cent and 2.2 per cent, respectively. *(Table A26)*.

In both Penrith City and the Western Suburbs there are approximately equal numbers of males and females. The 1976 figures however reveal a decrease on the expected number of males on the basis of the 1971 figures. Thus, in summary, Penrith City exhibits several features at variance with the larger area of the Western Suburbs Statistical Subdivision. The most significant of these features would be its youthful population.

A2.18 HOUSING AND ACCOMMODATION

A2.18.1 Permanent

Consistent with the growth in the population and its "youthfulness" there has been a rapid growth in the stock of dwellings in Penrith City. *(See Table A27)*. Between 1971 and 1979 the average annual percentage growth rate in the stock of dwellings was 6.6 per cent. In the period

TABLE A24

MARITAL STATUS OF THE POPULATION IN PENRITH CITY AND COMPARISON AREAS-1976

Marital Status	Penrith (%)	Western Suburbs (%)	New South Wales (%)
Never Married	47.5	46.8	44.6
Married	46.1	45.6	45.9
Permanently Separated	1.8	1.8	1.8
Divorced	1.5	1.6	1.9
Widowed	2.7	3.9	5.4
Not Stated	0.4	0.4	0.5
Total	100.0	100.0	100.0

Source: *Derived from data in A.B.S. Characteristics of the Population: Local Government Areas (Preliminary).*

TABLE A25

BIRTHPLACE OF THE POPULATION IN PENRITH CITY AND COMPARISON AREAS-1976

Country of Birth	Penrith (%)	Western Suburbs (%)	New South Wales (%)
Australia	74.7	74.1	77.9
U.K. and Eire	11.5	23.0	6.8
Other	11.2		11.9
Not Stated	2.6	2.9	3.3
Total	100.0	100.0	100.0

Source: *As for Table A24.*

TABLE A26

COMPONENTS OF POPULATION GROWTH IN PENRITH CITY AND COMPARISON AREAS 1971-1976

	Number			Average Annual Rate		
	Natural Increase (a)	Net Migration (b)	Total Increase	Natural Increase (c)	Net Migration (c)	Total Increase (d)
New South Wales	229,685	5,200	234,900	9.54	0.22	0.98
Western Sydney	55,663	30,550	86,200	14.87	8.17	2.37

Notes: (a) Excess of live births over deaths.

(b) Represents the difference between the natural increase and the total increase in population.

(c) Increase per 1,000 of mean population during the period.

(d) Average annual rate of increase per cent.

Source: *A.B.S. (N.S.W.) Population and Migration 1977 to 1979.*

TABLE A27

BUILDING STATISTICS FOR PENRITH CITY

Stock of Dwellings

1971	16,177	1976	23,254
1972	17,816	1977	24,696
1973	19,637	1978	26,296
1974	21,253	1979	28,139
1975	22,603		

Census Data

	June 1971	June 1976
Private Occupied Dwellings	15,630	22,109
Non Private Occupied Dwellings	48	46
Total Occupied Dwellings	15,678	22,155
Unoccupied Dwellings	1,001	1,522
Total Dwellings	16,679	23,677

Total Number of New Dwellings Completed

	1971-72	1972-73	1973-74	1974-75	1975-76
New Houses	1,586	1,649	1,321	929	1,084
Total Dwellings	1,731	1,946	1,760	1,430	1,323

	1976-77	1977-78	1978-79	1979-80
New Houses	n/a	n/a	1,629	n/a
Total Dwellings	1,535	1,647	1,911	2,365

Source: *As for Table A21.*

1976-79 this rate was 6.7 per cent. In comparison with this latter figure, the Western Suburbs recorded a growth in stock of dwellings of only 3.0 per cent. These data are consistent with the respective growths in the number of new dwellings completed. Between 1974-75 and 1979-80 the annual growth rate in Penrith City was 10.6 per cent while, for the same period, the Western Suburbs recorded a rate of 4.1 per cent.

In 1976 there was 1,522 unoccupied dwellings in Penrith City (i.e. 6.4 per cent of total dwellings) and in 1971 there were 1,001 such dwellings (i.e. 6.0 per cent of total dwellings). The corresponding figures for the Western Suburbs were 6.1 per cent and 5.6 per cent respectively. While these figures are reasonably high they are below the New South Wales figures of 9.2 per cent and 8.4 per cent, respectively.

The occupancy ratio for Penrith City of 3.5 persons per dwelling in 1976, and slightly higher at 3.8 in 1971, is consistent with national figures, and reflect the trend to smaller nuclear families. With the existing age distribution and marital status features it seems that there would be less contribution by numbers of single parents in Penrith City.

Total value of buildings approved during 1980 was $116,326,985 an increase of $26,005,643 or 28 per cent over 1979. Penrith City Council area recorded the highest rate of new dwelling construction in the metropolitan area for 1980.

A2.18.2 Temporary

The Penrith area has several motels which provide temporary accommodation. Information on tourist accommodation indicates that there were 13 establishments operating at June 1974 but only 8 at December 1976 and 7 at June 1979, with an associated decline in employment in this field over the same period. The room occupancy rate during the 1978-79 seasons was 53.8 per cent. This rate appears to be comparable with other areas in New South Wales, for example, the comparable figure for the Western Suburbs was 53.9 per cent.

A2.19 COMMUNITY SERVICES AND FACILITIES

A2.19.1 Education

Penrith is adequately supplied with educational facilities. The city contains the Nepean College of Advanced Education, a Technical College and several high schools, primary schools and pre-schools.

At the 1976 Census, 15.2 per cent of the Penrith City's population was aged 5 years or under, whilst 24.3 per cent was of school age. These figures when compared with those for New South Wales (10.6 per cent and 21.0 per cent, respectively) and the Nation (9.1 per cent and 18.2 per cent respectively) again reflect a youthful population.

A2.19.2 Health

Health Services

There are several hospitals in Penrith providing the basis of the health services. These include the Nepean District Hospital, the Jamison Private Hospital and the Governor Phillip Special Hospital. Other health services include an ambulance depot, a baby health centre, community nursing clinics, a Health Commission office and abundant doctors' services. With a population of 94,000 at 30th June, 1979 and approximately 70 doctors practicing, the recommended guideline of 1 doctor for every 2,000 persons is quite well accommodated.

Health Characteristics

Penrith City exhibits a higher statistic for births per 1,000 population than either the Western Suburbs or New South Wales as a whole. In 1978-79 there were 2,095 births in Penrith or 22.3 births per 1,000 population. In contrast the corresponding birth rates were 17.6 births per 1,000 population for Western Suburbs and 15.2 births per 1,000 population for New South Wales in total. These figures again reflect the population trends.

Corresponding data on deaths per 1,000 population reinforce this picture of a "youthful" population. While New South Wales in 1978-79 experienced 7.8 deaths per 1,000 population, Western Suburbs experienced 5.7 deaths per 1,000 population and Penrith only 3.9 deaths per 1,000 population.

In other terms, the contrast is quite striking. Penrith experienced only 176.6 deaths per 1,000 live births, while Western Suburbs had 324.6 deaths per 1,000 live births and New South Wales had 514.8 deaths per 1,000 live births in 1978-79.

A2.19.3 Other Government Services

Penrith is a major centre for services in the western district of Sydney. Located west of Parramatta it is the last major centre before the Blue Mountains city of Katoomba. In particular, all major State Government departments have representation in Penrith. Apart from the Health Commission and the Department of Education, other State Government services provided in the City include the Commonwealth Employment Service, the Departments of Employment and Industrial Relations, Social Security, Labour and Industry, Motor Transport, and Tourism, the Housing Commission and the Public Transport Commission.

Other services include the police, the State Emergency services and civil defence organization, the community youth support scheme, the Dairy industry Authority of New South Wales, probation and parole services, an electoral office and the Army.

A2.19.4 Community Services

The City also provides services in the form of library and swimming pool as well as ovals, parks and other community amenities. With regard to urban facilities, Penrith City Council spends 4.0 per cent of its total expenditure on library facilities, 3.2 per cent on street lighting and 3.6 per cent on town planning. These figures compare favourably with Sydney as a whole where the appropriate proportions are 3.7, 2.4 and 2.7 per cent respectively.

A2.20 EMPLOYMENT

A2.20.1 Employment Ratio

The employment ratio for Penrith in 1971 (i.e. labour force as a proportion of population) was 39.5 per cent which was consistent with other parts of New South Wales. Given the age distribution of Penrith in 1976, it is expected that this figure has increased.

A2.20.2 Unemployment

In 1971 the rate of unemployment in Penrith was 1.8 per cent whereas in June 1977 the Sydney Metropolitan figure was 5.8 per cent, and in July 1979 and May 1980 the figures were 5.6 per cent and 5.6 per cent, respectively. However given the age distribution and marital status characteristics of Penrith City it is estimated that the levels of unemployment would be higher than these Sydney Metropolitan figures. The comparison New South Wales figures were 6.7 per cent, 7.0 per cent and 7.0 per cent respectively.

A2.21 ECONOMIC BASE

A2.21.1 Manufacturing Industry

The predominant industry in Penrith City is manufacturing, and within this category, of major importance is the fabricated retail products and other machinery and equipment classes *(See Table A28)*. In 1971, manufacturing accounted for 30.6 per cent of the persons in the labour force, and over the period 1969-70 to 1977-78 the number of manufacturing establishments had risen significantly[3]. Consistent with trends of labour replacement in the manufacturing of fabricated metal products there had been a consistent decline in the average level of employment per manufacturing establishment from 50.76 per cent in 1969-70 to 31.56 per

TABLE A28

NATURE OF MANUFACTURING ESTABLISHMENTS (a)
IN PENRITH CITY

ASIC Class	June 1975	June 1978
Food, beverages and tobacco	13	11
Textiles	4	7
Clothing and footwear	12	9
Wood, wood products and furniture	12	15
Paper, paper products, printing and publishing	6	13
Chemical, petroleum, and coal products	10	8
Non-metallic mineral products	14	15
Basic metal products	4	4
Fabricated metal products	34	34
Transport equipment	2	2
Other machinery and equipment	24	29
Miscellaneous manufacturing	13	15
Total	148	162

Note: (a) Employing four or more persons.

Source: *As for Table A21.*

TABLE A29

ECONOMIC PRODUCTION
PENRITH CITY

Agricultural Activity	1971-72	1972-73	1973-74	1974-75	1975-76	1978-79
Agricultural Holdings	495	495	524	537	305	186
Total area (hectares)	18,248	17,239	17,531	18,236	15,164	12,656

Manufacturing Activity	1969-70	1971-72	1972-73	1973-74	1974-75	1977-78
Total Establishments	125	145	151	184	199	222
Total Employment	6,345	6,837	7,014	7,815	7,287	7,008
Total Wages and Salaries Paid ($'000)	20,816	26,500	30,451	41,353	48,425	63,178

Retail Establishments	1968-69	1973-74
Total Establishments	537	633
Total Employment	2,998	4,819
Value of Retail Sales ($'000)	46,506	111,945

Source: *As for Table A21.*

cent in 1977-78. *(See Table A29)*

Footnote [3] Regression analysis:

$\hat{Y} = 110 + 13.0714$

t ratios 13.2579 8.33653

$r^2 = .945577$

A2.21.2 Rural Industry

Agriculture has been of only minor significance in the area and has experienced a serious decline over the past decade, both in respect of number of agricultural holdings[4] and total area of agricultural landuse. *(See Table A29)*.

Footnote [4] Regression analysis:

$\hat{Y} = 613.427 - 49.5027\ t$

t ratios 9.12575, - 3.27969

$r^2 = .72893$

A2.21.3 Tertiary Industry

Consistent with world-wide trends, employment in the tertiary sector has increased over the period 1966 to 1976 for this area. The increases are particularly apparent in the Wholesale and Retail Trade. In 1971 this category accounted for 16.7 per cent of persons in the labour force and has experienced growth since that time. For example, data available suggest that the value of retail sales, deflated by appropriate C.P.I., had increased by 74 per cent between 1968-69 and 1973-74. Associated with this increase in the Penrith City area was a 17.9 per cent increase in the number of establishments and a 60.7 per cent increase in employment. *(See Table A29)*. The remaining industries of significance include (in order of importance) construction, community services, public administration and defence, finance and business services, etc., and transport and storage.

APPENDIX 3

APPENDIX 3

VIBRATION AND OVERPRESSURE FROM BLASTING

A3.1 INTRODUCTION

In order to establish the characteristics of the site with respect to the transmission of groundborne vibration and overpressure, a number of production blasts were monitored at the existing Wearn Industries Quarry at Mulgoa.

The results from the blasts were analysed by *Wilkinson-Murray Consulting Pty Ltd* and used for predicting vibration and overpressure levels from the proposed quarry on Lot 1 DP 541090.

Details of the monitored production blasts and the results obtained are given in *Table A31*.

Also shown in *Table A31* are the details and results of monitoring carried out by the Mines Inspection Branch of the Department of Industrial Relations at nearby historic buildings - Fernhill and St Thomas Church of England.

A3.2 VIBRATION AND OVERPRESSURE LIMITS

The New South Wales Department of Industrial Relations (Mines Inspection Branch) and the State Pollution Control Commission impose limits on overpressure levels and groundborne vibration from blasting. Limits currently being set by these authorities range from 115 to 120dB (lin) for overpressure and 7 to 10 mm/s peak particle velocity for vibration, measured at the property boundary. These levels are well below SAA Explosives Code Australian Standard 2187, Part 2-1979 maximum recommended limit of 20mm/s peak particle velocity for structurally sound buildings (measured at the building).

TABLE A31

BLAST DATA AND RESULTS OF MONITORING

Date:	14/7/81	21/7/81	5/8/81	28/1/81	
No of holes	22	23	29	26	
Diameter of holes	62mm	62mm	62mm	70mm	
Depth of holes	5.8m	5.8m	5.8m	6.1m	
Sub-drilling	0.9m	0.9m	0.9m	Nil	
Burden-approximately	2m	2m	2.5m	2.4m	
Spacing-approximately	2m	2m	2m	2.4m	
Stemming depth-nominal	0.15-0.3m	0.15-0.3m	0.15-0.3m	1.8m	
Total Charge Weight (Equivalent to AN60)	240kg	300kg	315kg	180kg	
No of trucklines	3	4	5	-	
Delays (1 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	98kg	330kg	84.5kg	48kg	
Weather	Clear, dry, few clouds	Overcast, drizzle	Clear and dry	-	
Wind	Calm-light NW	Calm	Calm-light SE	-	
Measurement Details:					
Location and distance from blast (approx)	300m SW	600m SE	600m SE	"Fernhill" 1,000m	"St Thomas Church" 1,000m
Overpressure*	125 dBL	129 dBL	118 dBL	88 dBL	-
Vibration**	1.9 mm/s	3.7 mm/s	0.5 mm/s	<1 mm/s	<1 mm/s
	Source: *Wilkinson-Murray Consulting Pty Ltd.*			Source: *Mines Inspection Branch Dept. Industrial Relations*	

The SAA Explosives Code Australian Standard 2187, Part 2-1979 also recommends a maximum peak particle velocity of 2 mm/s for historic buildings.

For this study the following levels were adopted as suitable design criteria for surrounding residences:

vibration	7 mm/s
overpressure	115 dBL

A3.3 ASSESSMENT OF PROPOSED BLASTING

In general, the method of blasting to be used will be the same as that used in the existing quarry at Mulgoa.

Predictions of vibration and overpressure followed methods recommended by *Duvall and Devine* and were based on the type of blast used to produce roadbase (2m x 2m pattern) which has the greatest potential for producing vibration and overpressure.

A3.4 DISCUSSION OF RESULTS

The results show that:

(i) If blasting is restricted to two holes per delay, then vibration and overpressure levels will meet the design criteria at 300m.

Since the nearest existing residence is approximately 700-800 metres from the quarry, vibration and overpressure levels will be below the design criteria at all residences.

(ii) The proposed 500m buffer zone at the southern end of the Housing Commission property will be adequate to ensure that vibration and overpressure levels are acceptable at future Housing Commission residences.

(iii) Since the proposed quarry is further away from Fernhill and St Thomas Church of England than the existing quarry at Mulgoa (which currently does not result in vibration levels exceeding the recommended vibration levels for historic buildings) vibration levels at these buildings will be much less than the 2 mm/s recommended for historic buildings in the SAA Explosives Code Australian Standard 2187, Part 2-1979.

Using the result of test blasts carried out at the quarry nearby, blasts can be designed to ensure that the limits mentioned above are not exceeded. The use of suitable blasting patterns and delay detonators initiated electrically will ensure that overpressure and vibration levels are kept to a minimum. Initially and as the quarry progresses from stage to stage, blasting should be monitored and if necessary the blast design modified to ensure that set limits are met.

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Extraction of materials for brick manufacturing and road making, Mulgoa

Borrower's name	Date	Ext

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