EIS 1482

AA068121

Williamsdale hard rock quarry : environmental impact statement

Totalcare
INDUSTRIES LIMITED

Williamsdale Hard Rock Quarry

Environmental Impact Statement

March 1999

International Environmental
Consultants Pty Limited

L93/0111

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Williamsdale Hard Rock Quarry

Environmental Impact Statement

March 1999

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Form 2

Submission of environmental impact statement (EIS)

prepared under the Environmental Planning and Assessment Act 1979
Section 78A (8)

EIS prepared by

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qualifications	BSc; Grad Dip.Env.Stud; MIBiol;Cbiol
address	International Environmental Consultants Pty Limited Suite 5005 376 Bay Street Brighton-Le Sands NSW 2216
in respect of	

Development Application

Applicant name	Totalcare Industries Ltd
Applicant address	PO Box 777 Fyshwick ACT 2609
land to be developed: address	Oak Vale, Williamsdale, NSW
lot no, DP/MPS, vol/fol etc proposed development	Part Portion 103, 122, 123, 194 (Quarry) Part Portion 121, 120, 119, 84, 9, 177, 28 (Access) LGA Yarrowlumla Council, Parish Burra, County Murray Or ☐ map(s) attached

Lot 1 564594

Lot 1 DP 126279

Lots 21 • 22

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environmental impact statement

☒ an environmental impact statement (EIS) is attached.

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certificate

I certify that I have prepared the contents of this Statement and to the best of my knowledge

- it is in accordance with clauses 54A and 55 of the *Environmental Planning and Assessment Regulation 1994*, and
- it is true in all material particulars and does not, by its presentation or omission of information, materially mislead.

signature R Byrnes
name R.Byrnes
date 29 / 3 / 1999

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1. Executive Summary

1.1 Project Overview

Totalcare propose to establish a premium hard rock quarry on a property located at Williamsdale in New South Wales (NSW), east of the Monaro Highway. The site is immediately adjacent to the Australian Capital Territory (ACT) and NSW border.

The proposed development covers an extraction area of 17.1 ha with a further 32.8 ha processing area containing crushing machinery and product stockpiles. Primary crushed material will be transferred to the processing area for further handling along a 684 m conveyor belt. Quarry products will be transported along a 2.1 km access road to Williamsdale Road and onto the Monaro Highway for delivery to markets.

The quarry operation will produce a range of premium quality, hard rock aggregates, crusher dust/manufactured sand, blended pavement materials, ballast, gabion and other quarry products for sale to public and private sector cliental within the ACT/Queanbeyan areas and south. In addition the proposed development will secure Totalcare a long term source of premium quality hard rock for the production of specified quarry products to supply to public and private sector works in both the ACT and surrounding area.

Quarry planning and assessment of the resultant environmental impact has been based on the assumption of average sales of up to 500,000 tonnes per annum of product, and maximum sales of 630,00 tonnes per annum. However, short term sales are more likely to be more in the order of 200,000 to 300,000 tpa.

The rock will be quarried in benches by drilling and blasting before being loaded either directly to the primary crushing module, or to dump trucks to be subsequently delivered to the primary crusher. From the primary crusher it will be conveyed to a separate processing and stockpiling area via a conveyor belt.

1.2 Environmental Issues and Protection Measures

1.2.1 Water Quality

The proposed development is located on the water shed between two major drainage systems. The waters into which the site flows are not classified waters under the Clean Waters Act, 1970.

The Jerrabomberra Creek system, which drains the northern section of the site, flows north into the Queanbeyan River which flows into Googong Dam, through Lake Burley Griffin and into the Murrumbidgee River. The Lobbs Hole Creek system, which drains the majority of the site and all disturbed areas, flows south west into the Murrumbidgee River which subsequently flows into Burrinjuck Dam. No permanent watercourses flow through the quarry or the processing areas.

Groundwater is commonly used in this area for watering stock, domestic purposes, and irrigation uses, making it an important commodity. The groundwater quality is highly variable in the area, originating from the fractured rock, with no definitive aquifers. The quarry activities have the potential to impact on groundwater in the event of spills of oils and/or lubricants which may seep into the groundwater system; and problems associated with the on-site septic sewerage system and absorption trenches. An impermeable hardstand area surrounded by an impermeable bund wall will be constructed in the processing area to contain any spills and an on-site package sewage treatment system will be installed to minimise the impact of sewage on the groundwater. Consequently, it is not anticipated that activities at the proposed quarry will influence the regional groundwater in the area.

1.2.2 Noise and Blasting

A noise and blasting assessment was undertaken by Atkins Acoustics and Associates Pty Ltd. Ambient noise measurements were recorded at the site and confirmed that the existing noise in the area is typical of rural areas with distant road traffic noise. Noise at the site comes from the Monaro Highway, and local domestic and natural noise elements.

Noise and blast emissions from the proposed quarry were modelled and assessed in terms of continuous noise from the fixed and mobile plant, traffic noise from truck movements, airblast overpressure and ground vibration from blasting using three weather scenarios and five quarry development scenarios. The assessment was undertaken for the existing residential receptors to the south the quarry as well as the rural residential zoned land to the north of the extraction area.

The existing ambient noise is typically rural and influenced by road traffic on the Monaro Highway, local domestic and natural elements such as wind, birds, animals etc. With effective noise controls and management procedures noise from the quarry can be controlled to satisfy the daytime assessment goals for calm weather conditions. Under light north breeze and mild temperature inversion conditions, the predicted noise levels marginally exceed the recommended daytime assessment goals at the nearest residences.

For the majority of the quarry life, there will be no operational noise implications for the rezoned land to the north. However, towards the latter years of quarry extraction, the 35 dB(A) noise contour will encroach into the rural residential area.

The assessment has also shown that during the site development, the noise from the construction activities can be controlled to satisfy the EPA medium term noise assessment goal.

With respect to truck movements to and from the site, noise levels will satisfy the EPA $L_{aeq.\ 1\ hour}$ 50 dB(A) goal. The predicted maximum noise levels meet the relevant criteria at both residences located off the lease area.

The assessment of blast emissions has shown that both ground vibration and airblast overpressure levels can be controlled to satisfy the recommended assessment goals at the nearest residential receptors. Both criteria can be met at a distance of 650 m from each active face. In the later years of quarry extraction, this zone of influence will extend into a small portion of the rural residential zoned land to the north of the extraction area.

1.2.3 Air Quality

Williamsdale is characterised by a temperate climate, with mild summers and cool winters.

There is no existing background data for dust deposition levels for the proposed site. Based on a review of land use, it is likely that the existing levels are low, with emissions generally due to agricultural activities and particulate emissions from the adjacent Monaro Highway, but these will be minimal. Background dust deposition levels are likely to be less than 2 g/m^2/month, and annual average PM_{10} concentrations would be expected to be in the order of 10 $\mu g/m^3$.

Emissions of dust from the site will vary depending on such things as the operation being performed, wind speed, silt and moisture content of the material being moved, as well as other factors. The majority of emissions will come from the processing area and haulage of material off-site. A relatively small fraction (less than 10%) of the total emissions are from operations within the pit. The assessment of impacts has therefore been done on operations at the quarry during Year 30, representing the worst case scenario.

The US EPA short-term $PM_{2.5}$ and PM_{10} goals are not predicted to be exceeded off-site whether the access road is sealed or unsealed. The NSW EPA Interim 24-hour PM_{10} goal is predicted to be exceeded at two nearby residences when the quarry is operating at full production and if the access road is unsealed north of Lobbs Hole Creek. However, the proposed operation is predicted to comply when the road is sealed. During Year 1, when the road is unsealed, the PM_{10} concentrations are expected to remain below all short-term goals.

The proposed development is predicted to comply with all long-term goals for $PM_{2.5}$, PM_{10} and TSP. Increases in dust deposition are also estimated to be below levels which would cause a nuisance impact at the closest residences. Compliance with all long-term goals is not dependant on the access road being sealed. There are no adverse dust implications for the rural residential area to the north of the quarry extraction area.

Since dust generation and deposition due to quarrying activities are below recommended guidelines, no specific mitigation measures are deemed necessary. However, basic dust control measures will be employed to minimise dust generation on site. These will include watering of internal access roads with a water cart; dust control during crushing operations; dust suppression at the head pulleys of all product and transfer conveyors; and dust suppression within the quarry and hardstand areas.

1.2.4 Traffic and Transportation

Transportation of the product and access to the quarry site will be along an access road that intersects with the Monaro Highway. The Monaro Highway will be the route for the transportation of product to markets.

According to the Austroad Traffic Service Assessment Criteria, the Monaro Highway around Michelago is currently providing a good quality of traffic service.

During peak operations of the quarry in the second year, a maximum of 74 vehicles (trucks and personal vehicles) will be generated along the Monaro Highway daily. This will result in an increase in traffic to 3581 vehicles per day while the quarry is operational. This additional traffic will not have a significant effect on traffic in the area and will not affect the quality of service provided by the Monaro Highway, which will continue to offer a good level of service.

No specific mitigation measures are deemed necessary with respect to traffic volumes. However, in order to ensure that the intersections are safely negotiated, it is proposed to upgrade the intersection between Williamsdale Road and the Monaro Highway to allow vehicles on the Monaro Highway to pass trucks turning into Williamsdale Road safely.

1.2.5 Flora

A field survey of the area proposed for the quarry operation was carried out in November 1998. There are four general vegetation communities on the site, being a woodland community dominated by Broad-leaved Peppermint (*E. dives*) and Norton's Long-leaved Box (*E. nortonii*); Yellow Box (*E. melliodora*) and Blakely's Red Gum (*E. blakelyi*) woodland; wetland areas and cleared land. These vegetation communities have previously been subjected to extensive disturbance from logging and grazing.

A number of threatened species have been identified as occurring in the region, however none of these species were observed on the development site, or are considered likely to occur on the site.

The proposed operations of the quarry will result in the removal of native vegetation however, in light of the amount to be removed and the disturbed nature of the vegetation the impacts are not regarded as significant. Rehabilitation of native trees as well as pastures will be undertaken progressively on available areas as part of the rehabilitation process. These mitigation measures will ensure that impacts on the native flora are kept to a minimum.

1.2.6 Fauna

Fauna habitat in the study area can be divided into three broad categories, namely woodland vegetation with an open grassy understorey; dams and wetlands; and cleared land. A number of threatened fauna species have been recorded in the Michelago region, however none of these were observed on the development site.

The clearing of vegetation for the proposed operations will have a minor impact on the fauna habitat available in the Williamsdale area. Since the sites which will be affected have previously been disturbed, they are considered to be of low habitat value and the resulting effect is considered to be insignificant.

Although the effect of clearing vegetation on fauna habitat is deemed insignificant, progressive rehabilitation of native trees and pastures will provide further habitat areas. Due to the potential for disturbance to creek and wetland areas from soil erosion, soil erosion controls and appropriate site management will avoid any significant impact on this habitat.

1.2.7 Visual Impacts

The visual quality of the region is moderate to high, as a result of the rolling topography and the blend of rural landscape characteristics, as well as the contrast between distant vegetated hillslopes and the more open, cleared nature of the grazing landscape.

The Monaro Highway and the railway have a separate visual quality, which is considered of relatively low quality, due to the hard engineered character of the corridor, and the strong visual form that they and their associated infrastructure impose on the landscape.

The quarry will be well hidden from most public viewing points, including the Monaro Highway. The quarry will not be visible to the north, east or west, however it will be visible from Williamsdale Road to the south. Two private residences located along Williamsdale Road will have minor views of the development.

No visual mitigation measures are necessary along the northern, eastern, and western perimeters of the site. The view of the access road and the processing area from the two private residences will be screened by strategically placed visual bunds and vegetation screens. Vegetation planted along spurs and valleys between the residences and the site of the proposed works will effectively screen the views of the quarry activities from these residences.

1.2.8 Archaeology

An archaeology survey was conducted in the area in consultation with the Ngunnawal LALC, occurring within Wiradjuri country.

At the site of the proposed development, a total of 4 sites, 3 areas of potential archaeological deposit (PADs), and 1 isolated artefact (IF) were recorded during the archaeological survey. All sites were open camp sites/isolated finds and were located on, or in the immediate vicinity of creeklines. All sites are likely to be either directly or indirectly impacted by quarrying and associated activity. The significance of all sites has been assessed as low.

No scarred trees were identified, and although there was a large amount of eroding stone material (dacite) on the ridge top area, no evidence of Aboriginal quarrying was noted. There were also no non-indigenous heritage items located in the quarry area.

To effectively manage and minimise the impact of the operation, it is recommended that all sites are avoided. Where sites can be avoided, it is the responsibility of mine management to ensure that all sites and PAD areas are marked and protected during quarrying activity. This protection should include fencing of all sites and PAD areas including a buffer zone of 20 m. All workers must be informed of the location of the sites and PAD areas, and the requirements of the NPWS Act for the protection of these areas.

If sites and PAD areas cannot be avoided, an application should be made to the NPWS for Consent to Destroy Permit for those sites and/or the isolated find. If Consent to Destroy Permits are sought, it will be necessary at some of the sites to collect surface artefacts, and the removal of the top 20 cm of topsoil be monitored by a representative of the Ngunnawal LALC and/or an archaeologist. At the other sites, it is simply recommended that all artefacts be collected and removed from the impact area.

1.2.9 Land Use

The site of the proposed quarry is currently used for grazing, predominantly sheep, as are surrounding areas and neighbouring properties. Land to the north has recently been rezoned for rural residential development purposes and it is anticipated that it will be gradually developed over the next decade. Council has been aware of the potential for the quarry development for some time and has advised verbally that it does not consider the quarry activities to be precluded by the proposed rural residential development nor the rural residential development to be precluded by the quarry.

The proposed development of this site will not have a significant impact on surrounding land uses. Grazing activities will be able to continue around the quarry development area without interruption.

During the initial stages of the quarry development it is not expected that there will be residential dwellings to the immediate north of the quarry. By the time housing has been developed in the area, the quarry operation will be contained within an excavated area below the ridge line which will separate the rural residential dwellings from the quarry operations. Neither visual impacts nor noise impacts are anticipated to be a significant issue for the rural residential dwellings to the north of the quarry area. Occasional noise may be heard during times of temperature inversion and southerly winds however, these impacts are not considered to be major.

The main issue of concern will be ground vibration and airblast overpressure levels. The EPA assessment criteria will be met within 650 m of each active face. In the later years of quarry extraction, this zone of influence will extend into the rezoned land to the north. For planning purposes an appropriate buffer should be established from the outset to ensure that future housing development does not unduly impact on the ultimate development of this regionally significant hardrock resource.

1.3 Conclusion

The proposed quarry development will provide a guaranteed source of premium quality hard rock, which is deemed necessary to overcome the historical problem of variable quality supply from established quarries within the ACT and surrounding regions. However, the proposed development has both positive and negative implications, which have been identified and investigated in detail. A range of mitigation measures are proposed to ensure that the biological integrity of the site is not compromised and that noise, air and water management systems comply with current EPA assessment criteria.

This EIS presents the results of investigations of the likely interactions that the proposed quarry will have on the environment both in the short and long term. These investigations clearly show that the proposed development is environmentally responsible by providing many contributions to controlling impacts and reduction in the potential for offsite impacts.

Potential negative impacts are largely short term and able to be either avoided, mitigated or rectified during the course of extraction. Overall, the impact assessment described in this document strongly favours the development proceeding.

2. Introduction

This section provides background information on the project, the regional setting for the quarry and the proponent. The statutory requirements and environmental approval process are outlined and the consultation undertaken described.

2.1 Outline of Proposed Development

Totalcare propose to establish a premium hard rock quarry on a property located at Williamsdale in New South Wales (NSW), west of the Monaro (see **Figure 2.1**). The site is immediately adjacent to the Australian Capital Territory (ACT) and NSW border.

The proposed development consists of:

- ☐ a 17.1 ha porphyritic tuff quarry producing high quality aggregates and crushed rock for sale to markets based in Canberra and further afield;
- ☐ a 684 m conveyor belt to transfer primary crushed material to the processing area for further handling;
- ☐ a 32.8 ha processing area containing crushing machinery and product stockpiles;
- ☐ a 0.9 km access road to transport equipment and personnel from the quarry to the processing area;
- ☐ a 2.1 km access road to transport the quarry product from the processing area to Williamsdale Road and the Monaro Highway.

2.2 The Proponent

The proponent for the project is Totalcare Industries Limited. Totalcare has a history of providing engineering maintenance services to the ACT and surrounding region. Totalcare has extensive expertise and experience that ensures the quality of their operations, and that standards and approval requirements are met.

2.3 The Project Site and Setting

2.3.1 Regional Setting

The proposed quarry site is located near Williamsdale, which is 35 km south of Canberra on the Monaro Highway. The parcel of land on which the quarry will operate is in the Yarrowlumla Shire, County of Murray, Parish of Burra.

The proposed quarry lease area is in the headwaters of Jerrabomberra Creek and Lobbs Hole Creek. Jerrabomberra Creek feeds the Jerrabomberra Wetlands Nature Reserve which, in turn, flows into Lake Burley Griffin. No disturbed areas feed into the Jerrambomberra Creek system, with all such areas being contained or ultimately discharging into the Lobbs Hole Creek catchment.

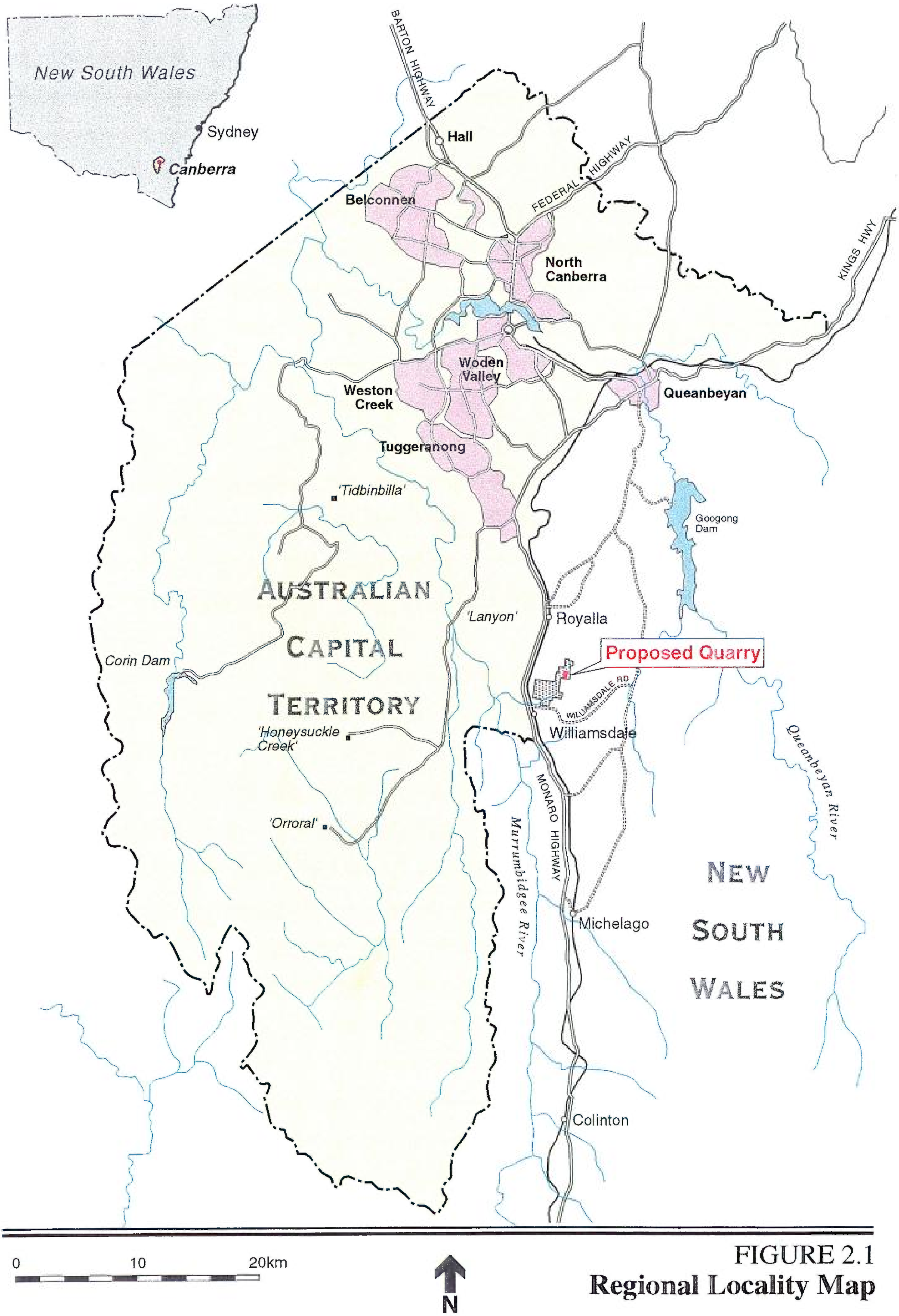


FIGURE 2.1
Regional Locality Map

The area is characterised by undulating country on Silurian volcanics of the Murrumbidgee Valley. Silurian volcanics include the Cappanana Formation and Colinton Volcanics-rhyodaitic and lithic tuff with minor siltstone, sandstone and limestone. Little or no rock outcrop occurs, and waning footslopes are the dominant landform element.

2.3.2 Local Setting

The local area immediately surrounding the proposed quarry site consists of private properties used for primary industry which predominantly consists of sheep and cattle grazing. The area is rural in character, with isolated dwellings located in the midst of open space, and occasional trees and stands of trees located within cleared paddocks. While most of the land has been cleared for grazing, forested areas do occur on ridge tops in the vicinity. The local setting and a general layout of the proposed development within it are shown in **Figure 2.2**.

The closest settlement to the quarry area is the township of Williamsdale, located approximately 4 km south west of the quarry site. The major towns in the area are Michelago, approximately 16 km south of the quarry site, and Queanbeyan, located approximately 22 km north of the proposed quarry.

The Goulburn Bombala Railway line runs in a north south direction, parallel, and immediately to the east of the Monaro Highway. It also lies between the proposed quarry site and the Monaro Highway.

2.3.3 Project Site

The site of the proposed quarry is located on a property with a lease boundary covering approximately 560 ha. The proposed quarry is located on a ridge at an elevation of approximately 965 m, within Portions 103, 122, 123 and 194 of the lease. The proposed access road traverses Portions 21, 22, 84, 119, 120, 121 and 122 of the lease.

2.4 Statutory Requirements

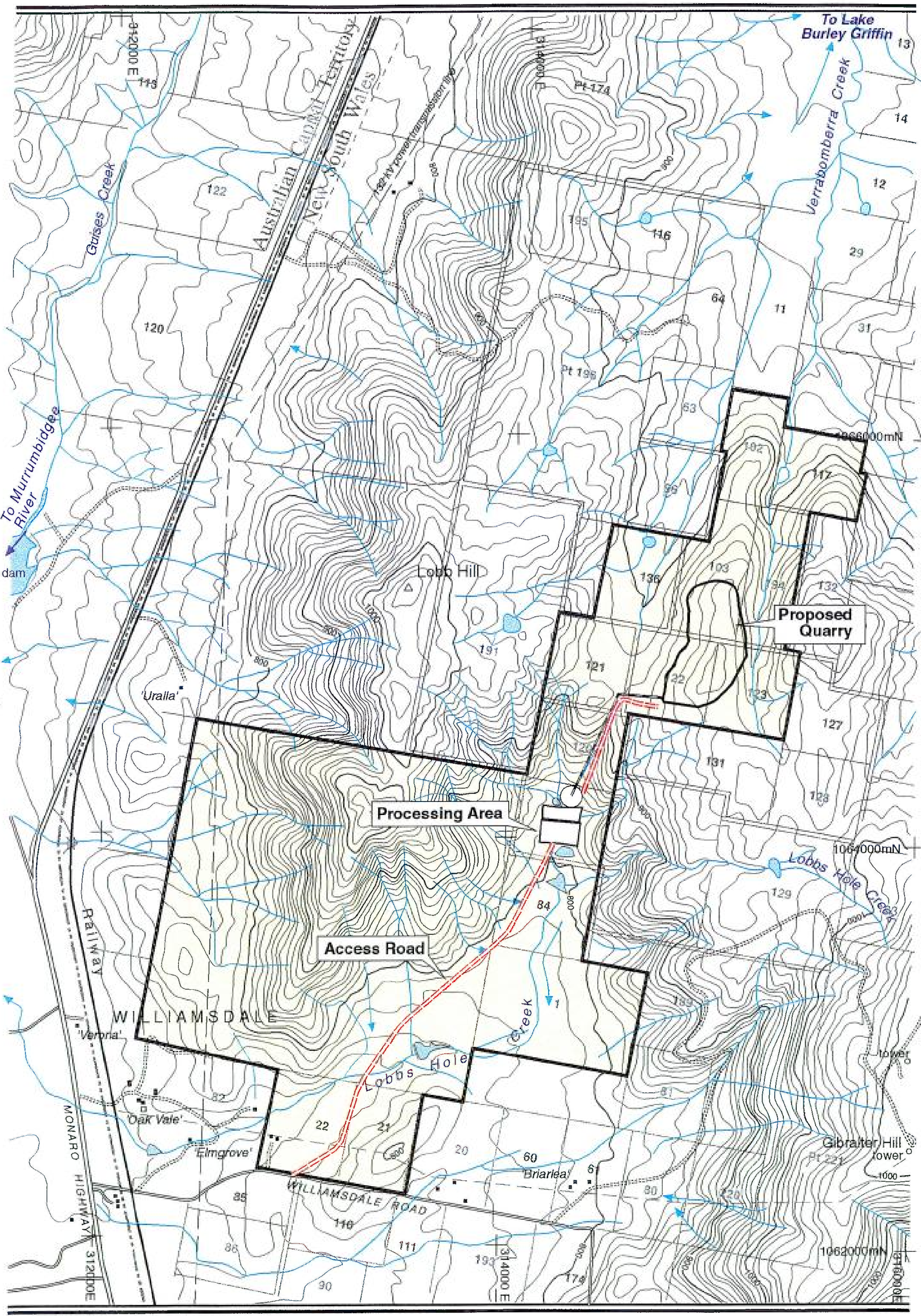
2.4.1 Environmental Planning and Assessment Act

Within New South Wales, development approval and environmental impact assessment procedures are undertaken in accordance with the *Environmental Planning and Assessment Act* (EP&A Act), 1979, as amended. Under the EP&A Act, development approvals are classified into two categories:

☐ Part IV - where development consent is required from Council;

☐ Part V - where a public body or the Minister is responsible for the determination of a proposal and Council consent is not required.

The proposed development of this hard rock quarry and its associated facilities are subject to approvals under Part IV of the EP&A Act.



Topographic map source : Williamsdale 1:25000 8726-4-N
Grid : ISG Zone 55/3

0 500 1000m

1: 25,000

N

FIGURE 2.2
Local Setting and General Layout

2.4.2 Environmental Assessment Procedures

The proposal is classified as a "designated development" under Schedule 3 of the Environmental Planning and Assessment Regulation, 1994. Under Part IV of the EP&A Act 1979, all designated developments require an EIS to be submitted to Council with the development application. In addition, the development is considered to be an integrated development according to clause 91 of the EP&A Act since approvals are required from a number of authorities.

The form and content of this EIS are in accordance with the requirements of clause 54A of the EP&A Regulation. Pursuant to Clause 55 of the Regulation, consultations with the Director of the Department of Planning have been held and the document prepared in accordance with the Director's requirements. In addition, issues raised in correspondence with the various State and local government departments have been considered, including those from the Department of Urban Affairs and Planning (DUAP), Yarrowlumla Shire Council (Council), the Department of Land and Water Conservation (DLWC), the Environment Protection Authority (EPA) and the Roads and Traffic Authority (RTA).

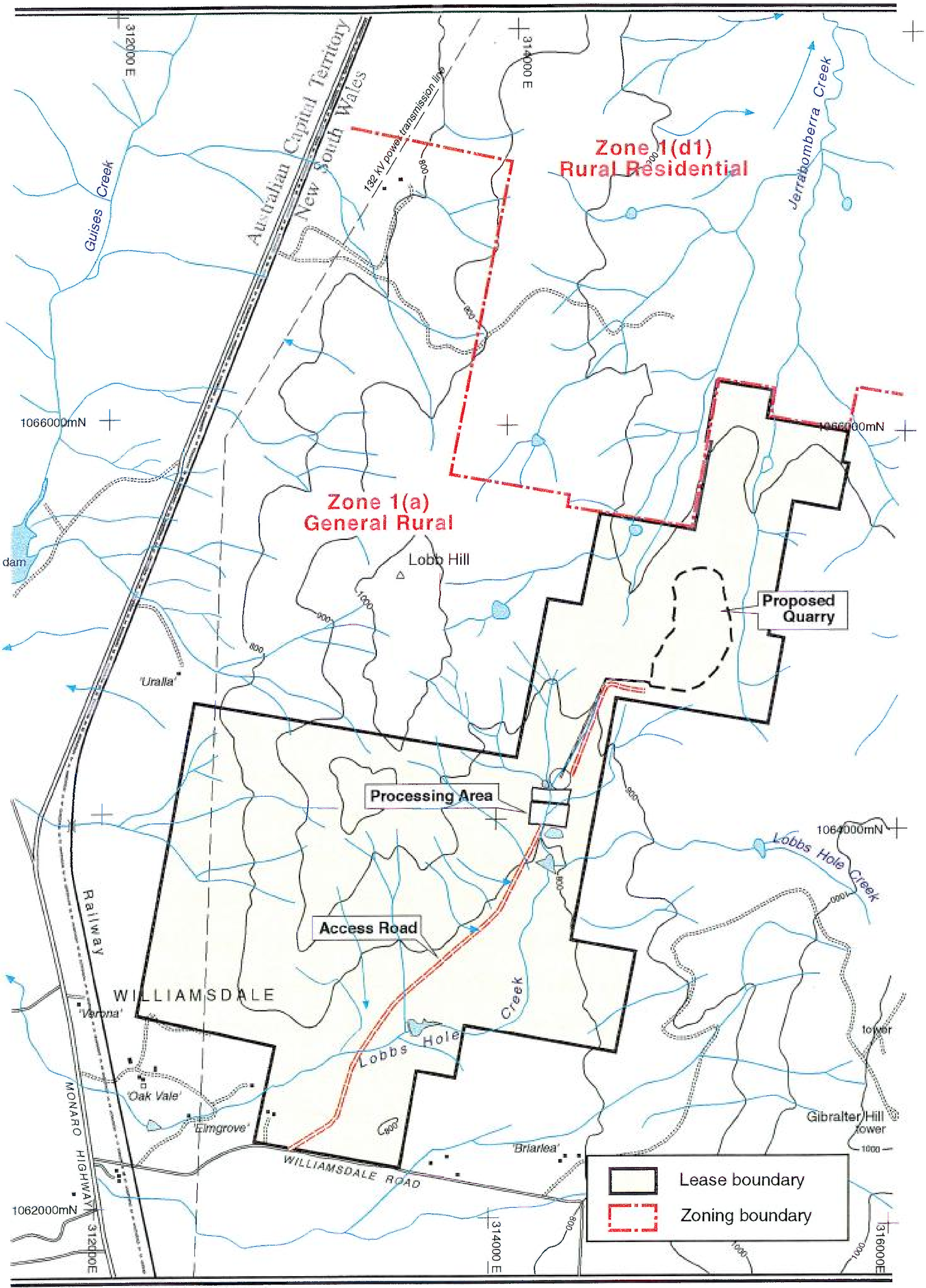
This document will be publicly exhibited and will act as an invitation for comment. Submissions made from the public should be forwarded to Yarrowlumla Council. All submissions will then be forwarded to the Department of Planning for review prior to assessment and ultimate determination by Council.

2.4.3 Zoning

The land on which the proposed quarry is located is zoned General Rural 1(a) under the Yarrowlumla Council Local Environmental Plan, 1993 (see **Figure 2.3**). This land is zoned to protect the agricultural potential of rural land while allowing other land use for appropriate purposes. Extractive industries are permissible under this zone, with development consent.

The zone aims to prevent the fragmentation of rual holdings, and premature and sporadic subdivisions. With respect to the quarry the relevant objective of this zone is to ensure sound management of land which has an extractive or mining industry potential and to ensure that development does not adversely affect the potential of any existing or future extractive industry.

The area to the north of the proposed quarry site has recently been re-zoned Rural Residential 1(d1). The main objective of this zone is to ensure that the local environment is not degraded as a result of activities conducted on the land. This is achieved by ensuring that development is compatible with the environmental capabilities of the land, and encouraging the conservation and enhancement of natural resources by means of appropriate land management techniques.



Topographic map source : Williamsdale 1:25000 8726-4-N
Grid : ISG Zone 55/3

FIGURE 2.3
Zoning

2.4.4 Scope of the Development Application

The Development Application accompanying this EIS covers the proposal to quarry premium hard rock from the lease area described above. Approval is sought for a 30 year operation consisting of:

- ☐ resource extraction from the hard rock quarry with an average quarry production of 500,000 tpa and an upper production figure of 630,000 tpa;
- ☐ access roads from the quarry to the processing area and from the processing area to Williamsdale Road and the Monaro Highway;
- ☐ a processing area including stockpiles for the product;
- ☐ associated works and infrastructure required for the proposed operation;
- ☐ transportation of the product to markets.

Even though a 30 year planning consent is being sought at this time, it must be recognised that the operation will continue for many years and therefore subsequent planning consents will be required in the future.

2.5 Authority Consultation

The planning legislation controlling developments likely to have a significant effect on the environment in NSW is the Environmental Planning and Assessment (EP&A) Act, 1979. In accordance with the EP&A Act, the Director General of the Department of Urban Affairs and Planning (DUAP) was consulted regarding the form and content of the EIS. A copy of the letter from the Director General is provided in **Appendix A**.

This EIS has been prepared in accordance with Part 4 of the Environmental Planning and Assessment (EP&A) Act 1979. The EP&A Regulation (1994) outlines matters that must be considered in preparing a Part 4 EIS. Clause 54A sets out matters which should be included in this EIS as outlined in Schedule 2 of the Regulations to the Act. **Table 2.1** shows the requirements of Schedule 2 and indicates where each requirement is addressed in the EIS.

Table 2.1 - EIS Statutory Requirements

Matters to be considered in the EIS Under Schedule 2 EP&A Regulation 1994	EIS Section
1 A summary of the environmental impact statement.	Section 1
2 A statement of the objectives of the development or activity.	Section 3.1.2
3 An analysis of any feasible alternatives to the carrying out of the development or activity, having regard to its objectives, including:	
(a) the consequences of not carrying out the development or activity: and	Section 4.3
(b) the reasons justifying the carrying out of the development or activity.	Section 4.1 & 4.2
4 An analysis of the development or activity, including:	

Table 2.1 - EIS Statutory Requirements

Matters to be considered in the EIS Under Schedule 2 EP&A Regulation 1994	EIS Section
(a) a full description of the development or activity; and	Section 3
(b) a general description of the environment likely to be affected by the development or activity, together with a detailed description of those aspects of the environment that are likely to be significantly affected; and	Sections 5 & 6
(c) the likely impact on the environment of the development or activity, having regard to:	
(i) the nature and extent of the development or activity	Section 5, 6 & 7
(ii) the nature and extent of any building or work associated with the development or activity	Section 5, 6 &7
(iii) the way in which any such building or work is to be designed, constructed and operated; and	Section 5, 6 & 7
(iv) any rehabilitation measures to be undertaken in connection with the development or activity; and	Section 3, 5, 6, & 7
(d) a full description of the measures proposed to mitigate any adverse effects of the development or activity on the environment.	Section 5, 6, 7 & 8
5 The reasons justifying the carrying out of the development or activity in the manner proposed, having regard to biophysical, economic and social considerations and the principles of ecologically sustainable development.	Section 4
6 A compilation (in a single section of the environmental impact statement) of the measures referred to in item 4(d).	Section 8.1
7 A list of any approvals that must be obtained under any other Act or law before the development or activity may lawfully be carried out.	Section 8.2
8 For the purposes of Schedule 2, the principles of ecologically sustainable development are as follows:	Section 7.7
(a) The precautionary principle - namely that if there are threats of serious or irreversible environmental damage, lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation.	Section 7.7.1
(b) Inter-generational equity - namely, that the present generation should ensure that the health, diversity and productivity of the environment is maintained or enhanced for the benefit of future generations.	Section 7.7.2
(c) Conservation of biological diversity and ecological integrity.	Section 7.7.3
(d) Improved valuation and pricing of environmental resources.	Section 7.7.4

A number of requirements were made by NSW Agriculture for the preparation of this EIS. These requirements and where they have been addressed in the EIS are summarised in **Table 2.2** and are provided in full in **Appendix A**.

Table 2.2 - NSW Agriculture Requirements

Environmental Issue to be Addressed	EIS Section
☐ Agricultural land classification	Section 6.2
☐ The impact of the proposal on sustainable agricultural production including adjoining properties.	Section 6.1.1
☐ Assess any perceived conflict with adjoining land holders and the proposed mitigation measures.	Section 6.1.1
☐ Proposed buffers.	Section 6
☐ Note current and proposed rehabilitation including plans for top soil stockpiles.	Section 3.13
☐ Fencing of areas to prevent entry of cattle.	Section 3
☐ An assessment of impact to remnant vegetation on the land and details of proposed clearing.	Section 3.3.1, 3.3.5 & 6.5.5
☐ An assessment of any risk to endangered species of flora and fauna.	Section 6.5.4 & 6.6.4
☐ An assessment of the impact on ground and surface water.	Section 5.3 & 5.4
☐ Sediment and erosion control measures.	Section 3.13
☐ Impacts to local traffic.	Section 6.4.3

Requirements of the Environment Protection Authority (EPA) and the EIS section in which they have been addressed are summarised in **Table 2.3**.

Table 2.3 - EPA Requirements

Environmental Issue to be Addressed	EIS Section
☐ Impacts on surface and groundwater.	Section 5..3 & 5.4
☐ Wastewater treatment.	Section 5.5
☐ Air quality issues, including dust control.	Section 5.1
☐ Noise and blasting.	Section 5.2
☐ Soil and erosion control.	Section 3.13.2
☐ Rehabilitation and environmental monitoring.	Section 3.13 & 8.4
☐ Broader environmental issues.	Section 5 & 6

Specific requirements proposed by the Department of Land and Water Conservation and the sections in which they are addressed are presented in **Table 2.4**.

Table 2.4 - Department of Land and Water Conservation

Environmental Issue to be Addressed	EIS Section
☐ Locality issues, including maps, land tenure.	Section 2.3
☐ Planning Issues including compatibility with surrounding land uses	Section 6.1
☐ Description of resources, geology, size and quality.	Section 3.2
☐ Site layout.	Section 3.3
☐ Extraction methods.	Section 3.3.7
☐ Stockpiles of overburden, tailings	Section 3.3.6
☐ Transport on site.	Section 3.9
☐ Storage of fuels and chemicals.	Section 3.6
☐ Sanitary and waste disposal.	Section 3.10.1
☐ Sediment dams and drains.	Section 5.5.2
☐ Environmental management and rehabilitation plan.	Section 8.3 & 8.5
☐ Rehabilitation.	Section 8.5
☐ Impacts during the establishment of the quarry.	Section 5, 6 & 7
☐ Erosion control.	Section 3.13
☐ Power.	Section 3.14.1
☐ Flooding.	Section 5.5
☐ Water requirements.	Section 3.7

Table 2.4 - Department of Land and Water Conservation

Environmental Issue to be Addressed	EIS Section
☐ Proposed life of the quarry.	Section 3.1
☐ Water quality issues.	Section 5.3. 5.4 & 5.5

The Department of Mineral Resources also provided a copy of their requirements for the preparation of and EIS. These are summarised in **Table 2.5**.

Table 2.5 - Department of Mineral Resources

Environmental Issue to be Addressed	EIS Section
☐ The amount of material to be extracted and the methods to be employed	Section 3.2.4 & 3.3.7
☐ Characteristics of the material to be extracted and quality.	Sectio3.2
☐ Anticipated annual production. staging and life of the quarry.	Section 3.3.4
☐ Alternative sources.	Section 4.3
☐ Transport routes.	Section 3.9
☐ Disposal of wastes.	Section 3.10.1
☐ Assessment of noise. vibration. dust and visual impacts and proposed mitigation measures.	Section 5
☐ Rehabilitation.	Section 8.5
☐ Justification for the project.	Section 4

NPWS also provided a copy of their requirements for the preparation of EIS documents. These requirements are summarised in **Table 2.6** and are provided in full in **Appendix A**.

Table 2.6 - NPWS Requirements

Environmental Issue to be Addressed	EIS Section
☐ Mapping the location and description of all native fauna habitats, vegetation communities and plant species that will, or are likely to be impacted by the development.	Section 6.5 & 6.6
☐ Mapping of the location and description of Aboriginal sites and relics within the area to be impacted and identification of any areas of high archaeological potential.	Section 6.8
☐ Assessment of the significance of the above attributes.	Section 6.5. 6.6 & 6.8
☐ Prediction of the likely impact of the proposal on the above attributes.	Section 6.5. 6.6 & 6.8
☐ Assessment of measures available to minimise the impact of the proposal on these attributes.	Section 6.5. 6.6 & 6.8
☐ Management controls. including fire management. erosion and sedimentation. increased traffic effects, increased noise and dust, removal of habitat. introduction and spread of pests species.	Section. 3.13. 5.1. 5.2. 6.4. .6.5. 6.6 & 6.9

Although the proposed quarry site does not fall within the boundaries of the ACT, it is in an area adjacent to the border in the south-east. Consequently, the ACT Government Department of the Environment Land and Planning were contacted. They proposed a number of general requirements for the EIS. These are generally in regard to the extraction, treatment and wastes, and transport. Full details of their requirements are presented in **Appendix A**.

The Yarrowlumla Shire Council was also consulted with regard to requirements for the EIS. The main area of concern was the effects of the proposed quarry on an area of land immediately to the north of the proposed quarry site. This area was recently rezoned from 1(a) General Rural to 1(d1) Rural residential. Consequently, the EIS addresses the potential impacts of the proposed quarry on future rural residential development of this area.

The aim of the EIS is to enable members of the public, the determining authority and DUAP to properly understand the environmental consequences of the proposal.

2.6 Community Consultation

This quarry has had a previous approval and consequently, the community have been aware of the development for many years. Totalcare have carried out consultation with landowners directly affected by the development and discussions will continue.

2.7 Study Participants

Participants involved in the preparation of the EIS included personnel at Totalcare, several independent sub-consultants, and International Environmental Consultants. These personnel and their role are stated below.

Totalcare

Manager Engineering Maintenance	Neal Smith
Quarry Manager	Darryl Knowles

International Environmental Consultants

Project Director	Robert Byrnes
Project Manager	Margot Jamieson
Environmental Scientist	Julie Gander
Graphics	Dean Oliver
Subconsultants	
Noise and Blasting	Atkins Acoustics
Dust Assessment	Nigel Holmes
Archaeology	R Mills and Associates
Flora/fauna	Roger Lembit

3. Description of the Proposed Development

3.1 Outline of the Quarry Proposal

3.1.1 Principal Elements of the Proposed Development

The major components of the proposed quarry development are outlined in the following table:

Table 3.1 - Principal Elements of the Development

Element	Purpose and Description
Quarry	Development comprises: - clearing and mulching of vegetation; - removal and stockpiling of topsoil for use in rehabilitation; - stripping and disposal of weathered rock overburden (using drilling and blasting, hydraulic excavators, dump trucks etc); - development of quarry benches by drilling and blasting (as per detailed quarry plans); - production drilling and blasting and subsequent loading and haulage of blasted rock to primary crusher.
Quarry Roads	Main quarry access road to be constructed to link Williamsdale Road to the process plant and truck loading area. Existing farm track will be upgraded to link the designated process and quarry areas. Quarry access roads to be developed 'in-pit' to link quarry benches to primary crusher.
Primary Crusher and Overland Conveyor	The primary crusher is to be initially located at natural RL935 adjacent to the quarry rim (at RL940) with crushed rock to be conveyed 684 m downhill to a 40,000 tonne 'surgepile' located before secondary and tertiary process plant. The primary crusher will be re-located inside the quarry itself once 'in-pit' crushing is operationally viable.
Secondary and Tertiary Processing Area	The secondary and tertiary process plant, product stockpiles and quarry infrastructure (office, weighbridge, workshop, amenities etc) are to be located on split level pads to be cut and filled over a 3 ha area at the head of the valley opening up to Williamsdale Rd. Processing plant will be located on the upper (RL813) pad and will comprise conventional crushing, screening, blending and materials handling plant to produce a range of premium quality quarry products.
Stockpiles and Loading Area	Product will be stockpiled on the RL810 pad adjacent to process plant. The pad area will be 'hardstanded' to minimise contamination and support heavy vehicle traffic. All product will be weighed at a computer linked weigh bridge before dispatch.
Visual/Acoustic Bunds	These will be designed and constructed to minimise visual and noise impacts from the quarry and transport operations. Bunds locations are shown on site development plans with the main bund located immediately down-valley of the process plant and stockpiling area.
Transportation	The quarry access road will sealed, signposted and speed limited to minimise potential impacts. The main road will be altered in consultation

Table 3.1 - Principal Elements of the Development

Element	Purpose and Description
	with appropriate road authorities to ensure the safety of the intersections.
Water Management Structures	To be designed to catch and contain stormwater, provide necessary site water, prevent pollution of the Lobbs Hole Creek and assist in the prevention of soil erosion.

3.1.2 Objectives of the Proposed Development

The overall objective of the proposed development is to secure Totalcare a long term source of premium quality hard rock for the production of specified quarry products to supply to public and private sector works in both the ACT and surrounding area. The availability of a guaranteed source of premium quality hard rock is deemed necessary to overcome the historical problem of variable quality rock supply from established quarries within the ACT and surrounding regions.

Principal objectives for the quarry development itself were that:

- ☐ it be located as close as possible (preferably within 30km) to central ACT markets;
- ☐ it be located in proximity to one of the major roads or highways servicing the ACT;
- ☐ the resource comprise a minimum of 25 years reserves of 'quarriable', premium quality hard rock;
- ☐ quarry planning be undertaken to optimise the resource with minimum environmental impact;
- ☐ the process plant be designed to incorporate state-of-the-art crushing, screening and handling plant to ensure product quality; and that
- ☐ the quarry be developed in a cost effective manner to enable it to compete with private sector operations, particularly those operating in the ACT and surrounding region.

3.2 Geology

3.2.1 Regional Geology

Regional geology is shown on the Canberra *1:250,000 Geological Series Sheet* SI/55-16 and described in the accompanying *Explanatory Notes* published by the Australian Government Publishing Service, Canberra.

The 1:250,000 sheet shows the quarry site lying on the western side of a belt of undifferentiated porphyritic rocks extending approximately 30 km along a north-south axis. These are mapped as Un-named Silurian Porphyries (Sp) and described in the

1979 notes as quartz-feldspar porphyries generally comprising 'altered, welded tuff and ash flows'.

The 1:250,000 sheet shows the quartz-feldspar porphyries as being bounded by foliated volcanics and metasediments of the Colinton Volcanics on their western, northern and southern flanks. To the east, the porphyritic unit is bounded by older metasediments of Ordovician age and Silurian sediments and volcanics belonging to the Canberra Formation. All of these units have been deformed with the older rocks being intensely folded and faulted.

More recent geological mapping is available for the northern portion of the geological unit mapped as undifferentiated porphyries on the 1:250,000 sheet. The Bureau of Mineral Resources (BMR) have published a *1:100,000 Geological Series Sheet* that extends to London Bridge, some 7 km north of the proposed quarry site. The BMR sheet is dated 1992 and subdivides the geology previously mapped as Un-named Silurian Porphyries (Sp) into a number of units comprising the Collinton Volcanics (Svc, Svc_3 etc). The principal unit (Svc) is geologically described as 'dark green dacitic ignimbrite with minor volcaniclastic sediments'.

3.2.2 Site Geology

Representative drill cuttings and drill core have been petrographically examined for the proponent by Dr B.J.Barron and described as essentially similar in all cases. The rock is described by Dr Barron as an *'unsorted, crystal / once-vitric tuff derived from a coarsely quartz-plagioclase-K feldspar-biotite porphyritic acidic (rhyodacitic) volcanic source'*. For the purposes of this report the rock is hereafter referred to as porphyritic tuff.

Dr Barron notes that because the porphyritic tuff is a pyroclastic rock and not a volcanic flow rock, it may have a variable composition due to variable proportions of primary volcanic lithic and crystal fragments. The rock has undergone strong but mainly selective alteration principally during deposition. Pyroclastic rock can be defined as:

> *'pertaining to fragmental rock materials formed by volcanic explosion or aerial ejection from a volcanic vent.' (Source – Collins 'Dictionary of Geology – 1990)*

The proposed quarry site was identified by Guideline Pty Ltd in 1982 and confirmed by Coffey Partners International in December 1984 as being 'the most suitable for hard rock quarry development within the Canberra region'. The conclusion is included within Coffey's Report No. S5281/2/3 and attached as **Appendix B**. Coffey's prepared the report for Leighton Contractors Pty Ltd in response to a brief from Leightons to locate 'a suitable site within the Canberra region for the development of a hard rock quarry capable of supplying high quality dense natural aggregates'.

The initial brief was provided to Coffey Partners by Leightons in 1983 and gave precedence to a number of geological, commercial, engineering and environmental search criteria. These included rock quality, site location and access (relative to ACT markets and main roads), hard rock reserves, resource 'quarriability' and minimal potential for environmental impact.

The site was originally identified by Coffeys for Leightons from reconnaissance geological mapping. It comprises two main adjacent north-south trending ridges of which the western ridge was selected as the preferred quarry development site on the basis of site topography and access.

Once identified the prospective quarry location was investigated in some detail by Coffeys in March to May 1984 with details of exploration, testing and conclusions incorporated within Report S5281/2/2 dated February 1985. Work undertaken and reported by Coffeys included:

☐ aerial photo interpretation of structural features of the quarry area;

☐ geological mapping of the area intended for quarry development and now in the vicinity of the area to be initially quarried under the current proposal;

☐ the diamond drilling of four core holes (three to 30 m and one to 24 m depth) all of which were located within the area to be initially quarried under the current proposal;

☐ the drilling and blasting of four test pits within fresh rock exposed at the surface;

☐ the excavation of six backhoe pits to determine depth of overburden, all within the currently proposed quarry area;

☐ bulk sampling of trial blasted and cored rock for subsequent laboratory analysis;

☐ estimates of reserves within the originally delineated quarry area;

☐ the formal reporting of work undertaken and conclusions drawn.

The Coffey's report concluded that the rock was 'suited for [production of] all types of aggregate requirements' particularly ready mix concrete. It also reported 'indicated' reserves of 9 million tonnes of quarriable rock within the northern half of the ridge proposed for quarry development'. The report includes site maps (showing drill hole and test pit locations etc), detailed drill logs and photos, laboratory reports etc, and is attached as **Appendix C**.

The significance of the Williamsdale site is also now recognised by the Department of Mineral Resources (DMR). Correspondence dated 9 June 1998 confirms the subject site a an 'identified [quarry] resource' and nominates that

> *'The Department would object to any proposed change in zoning which may restrict or prohibit mining or extraction on areas shown by the striped hatching (blue) on the enclosed plans'*

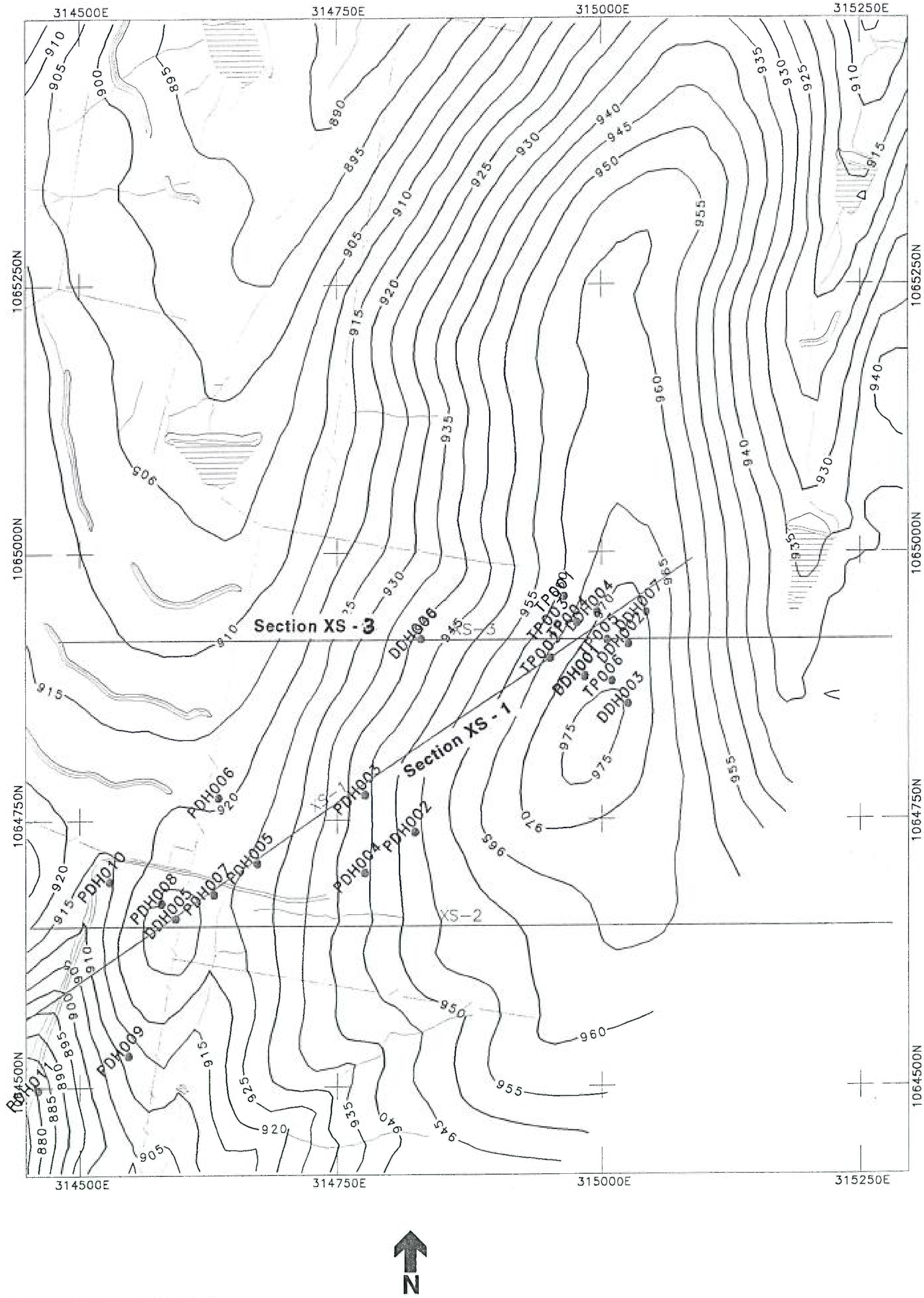
The DMR correspondence (including the referred plan) is attached as **Appendix D**. The area to be quarried under the current proposal is significantly larger than that investigated by Coffey Partners in 1984. For this reason, the proponent has undertaken additional drilling, sampling and testing of rock with the objective of confirming the presence of at least 12.5 million tonnes of premium quality material within the designated quarry area. This work was completed during the period October 1998 to February 1999 and has been monitored by specialist extractive industry consultants Don Reed & Associates (DRA). The work undertaken by the proponent and monitored by DRA consisted of the following:

- ☐ air and ground survey of the proposed quarry and process plant areas (and surrounding properties);
- ☐ the generation of a computer based topographic model (at ECS International) for subsequent geological modelling, extraction scheduling and quarry planning;
- ☐ the drilling of 11 percussion drill holes to depths of between 20 and 21.6 metres to confirm the depth of overburden and weathered rock in the area between the proposed quarry development and the main secondary and tertiary process plant;
- ☐ the diamond drilling of three core holes (DDHs 5, 6 and 7) to depths of 45, 55 and 63 metres depth respectively, at strategic locations to determine geology within both the main quarry ridge and the smaller ridge immediately west, between the quarry and the process plant;
- ☐ petrographic analysis of drill cuttings and drill core to positively identify rock type and potentially deleterious materials, as well as to predict the mechanical properties of the rock;
- ☐ the sampling and laboratory testing of drill core to confirm mechanical properties and rock quality.

Drill hole locations are shown in **Figure 3.1** prepared by ECS under DRA supervision. Figure 3.1 is based on current and detailed survey information provided by Geospectrum. Survey data has been used to create a three dimensional geological model incorporating drill log data and used to generate the geological cross sections included as **Figures 3.2** and **3.3**. These figures provide sectional representation of drill coverage and representation over the proposed quarry site.

Figures 3.2 and **3.3** show logged data from vertical and inclined drill holes superimposed over the final quarry profile. They show that DDH6 and DDH7 have been drilled down to RL 902 and RL 918 respectively, these levels being ±8m of the final quarry floor level of RL 910m.

Detailed drill logs of diamond holes are included within **Appendix E**. Drilling results are summarised within **Table 3.2**:



Source : ECSI Mining Consultants

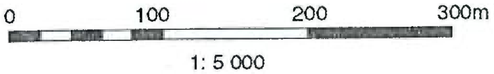
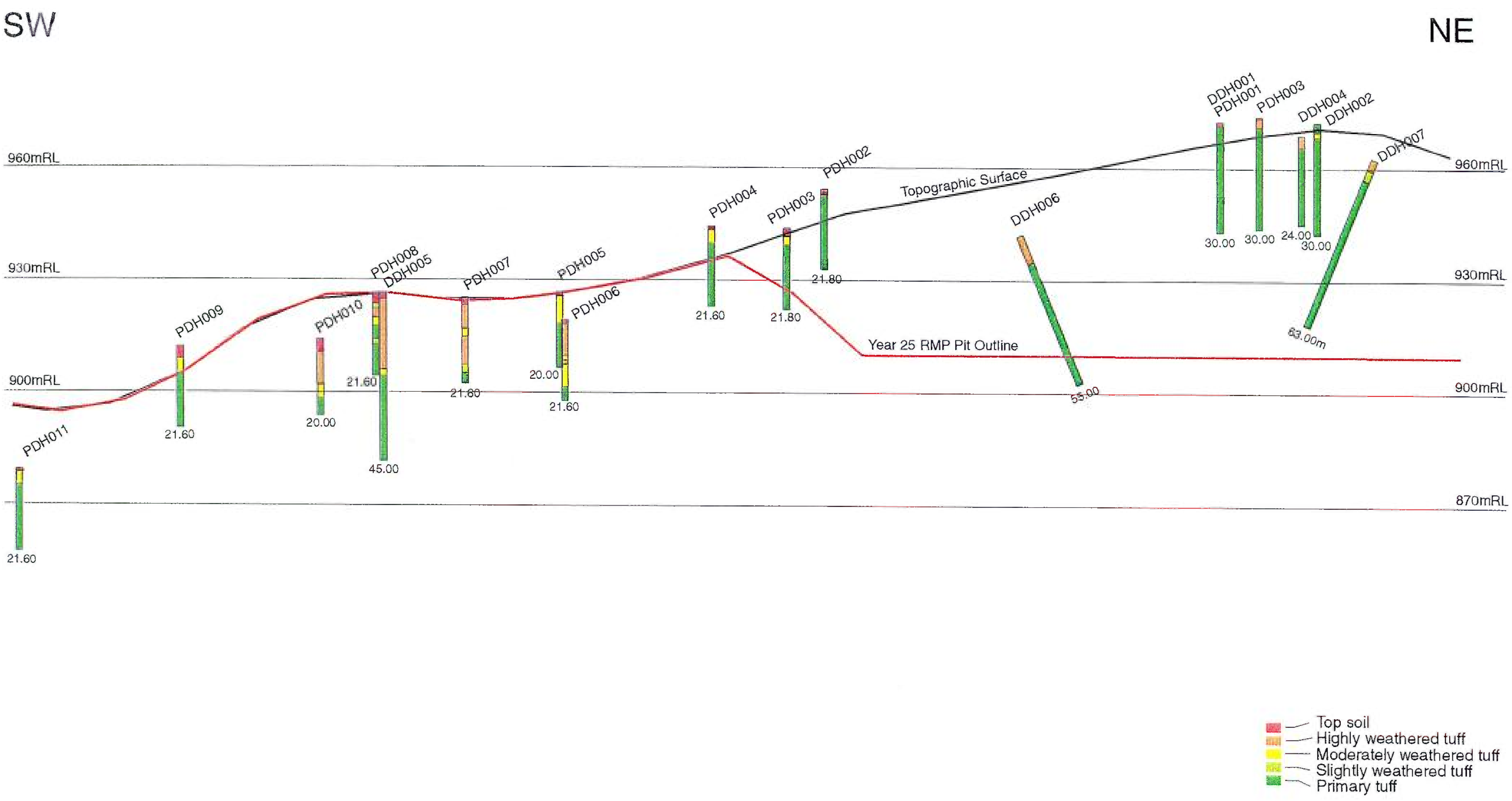


FIGURE 3.1

Drillhole Locations and Cross Sections

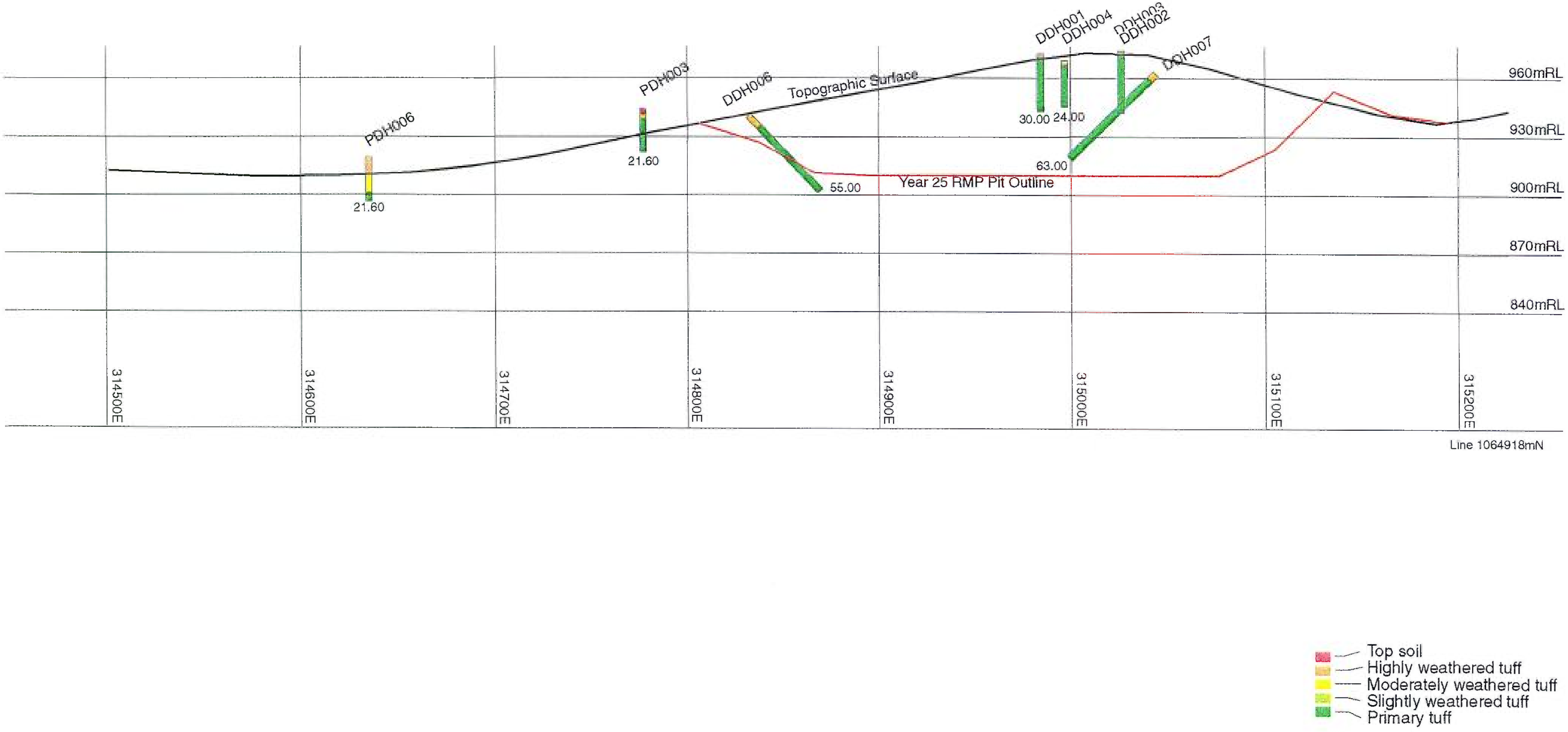


Source : ECSI Mining Consultants XS-1-1.CGM

Note : Cross section and drillhole locations shown on Figure 3.1

N

FIGURE 3.2
Geological Cross Section 1



Note : Cross section and drillhole locations shown on Figure 3.1

Source : ECSI Mining Consultants XS-3-1.CGM

N

FIGURE 3.3
Geological Cross Section 3

Table 3.2 - Drill Log Summary

Hole No	Depth of Overburden (m)	Total Linear Metres Drilled (m)	Total Metres Fresh Rock (m)	Metres Fresh but H.Altered Rock (m)	Metres Fresh Mod.Altered Rock (m)	% Fresh Mod.Altered Rock (%)
Diamond Drill Holes						
DDH1	0.3	30	29.7	0	29.7	100%
DDH2	4.9	30	25.1	0	25.1	100%
DDH3	3.6	30	26.4	0	26.4	100%
DDH4	3	24	21	0	21	100%
DDH5	12.2	45	32.8	32.8	0	0%
DDH6	10	50	45	10.4	34.6	77%
DDH7	8.1	63	54.9	5.9	49	89%
Percussion Drill Holes						
PDH1	3.6	20.4	16.8			
PDH2	4.8	21.6	16.8			
PDH3	4.8	21.6	16.8			
PDH4	6	21.6	15.6			
PDH5	9.6	20	10.4			
PDH6	19.2	21.6	2.4			
PDH7	20.4	21.6	1.2			
PDH8	9.6	21.6	12			
PDH9	8.4	21.6	13.2			
PDH10	16.8	20	3.2			
PDH11	4.8	21.6	16.8			

Conclusions to be drawn from the above-tabled drill holes include as follows:

- The depth of weathered rock overburden within the nominated quarry area has been determined from DDH's 1-4, 6 & 7 and PDH's 1-4. It ranges 0.3m to 10m and averages 4.9m. The bulk of this material appears suitable for selective quarrying and blending for the production of road pavement materials.

- Diamond drill holes 1, 2, 3, 4, 6 and 7 were all drilled within the delineated quarry area. Logs for the six holes show that 202.1m of core has been described as fresh (Fr) porphyritic Tuff. Of this figure only 16.3m or approximately 8% has been logged as heavily altered and of lesser quality. This material can be either:

  - selectively loaded and dumped (or blended into road materials or other); or

  - crushed (with a percentage of weaker material being reduced to dust) and diluted within overall aggregate production.

- The remainder of the fresh [selectively altered] core has been logged as strong, competent and an apparently suitable for the production of premium quality aggregates and associated quarry products. Such comment is made on the basis of visual observation in the field and petrographic analysis of representatively sampled core. Confirmation of rock quality however is reliant on extensive laboratory testing, the results of which are reported in Section 3.2.3 below.

☐ Field observation of drill core and trial blasted rock has also indicated that the rock can be expected to have good to excellent blasting and crushing characteristics.

Representative drill core from percussion drill holes and DDH's 5 and 6 has been petrographically examined by Dr Jane Barron who previously worked as the senior petrologist for the NSW Department of Mineral Resources (DMR). Representative core from DDH 7 has been examined by Janet McNulty who is the Principal of Applied Petrographic Services (APS) for confirmatory opinion and an expanded view on the expected engineering properties of the rock.

Reports prepared by Dr Barron and APS are included with this document as **Appendix F**. Major conclusions to be drawn from those reports are as follows:

☐ The resource comprises a generally massive deposit of pyroclastic rock described by Barron as an unsorted crystal / once vitric tuff derived from a coarsely quartz feldspar and biotite-porphyritic acidic volcanic source.' That source was probably rhyodacitic.

☐ The deposit shows signs of localised folding and faulting although no dominant structures have been identified at this stage and the rock appears relatively homogeneous and increasingly massive at depth.

☐ Although variably altered, all of the samples examined are described by Barron as having similar lithology, ie, 'the samples show remarkably similar primary mineralogy, with moderate to intense but selective alteration.'

☐ Secondary minerals principally comprise illite (10-20%), chlorite (5-10%) along with minor carbonates and zeolites. This secondary mineralogy is generally described by Barron as being contained, ie:

> *'very fine grained illite is selectively located in plagioclase crystal sites, partly clouds the once glassy rock matrix and defines the weak, wavy tectonic foliation'*
>
> *'chlorite is selectively developed in sparse once-phenocrystic sites, and also forms small patches in the foliated rock matrix fraction.'*
>
> *'minor granular calcite fills tension microfractures and coats sparse planar joint surfaces. Calcite is an accessory secondary phase that is also 'contained' within feldspar and mafic crystal sites.'*

☐ Overall the rock type (lithology) is described by Barron as apparently 'tough and compact due to an abundant, very fine grained quartzofeldspathic rock matrix fraction , in spite of the contained presence of contained illite and patchy chlorite. Barron goes on to note that the rock should mechanically break along calcite infilled joints and fractures.

Comment on the expected engineering/mechanical properties of the rock is provided by APS and summarised within **Section 3.2.3** below.

3.2.3 Rock and Product Quality

Product quality has been nominated by Totalcare as the fundamental reason for the proposed new quarry development at Williamsdale. The corporation is seeking a reliable source of high quality hard rock capable of yielding premium quality aggregates, road pavement materials and other <u>construction materials able to meet relevant specifications at all times</u>. Totalcare management advise that this required consistency of product quality has not been historically available from quarries located within the ACT and immediate surrounds.

Product quality is primarily reliant on the mechanical and chemical properties of the rock quarried. Mechanical properties are principally dependant on rock mineralogy, texture and freshness. Problems faced by existing hard rock quarries in the Canberra region are to a large degree related to the variability of the rock types being quarried.

Assessment of the quality of the Williamsdale porphyritic tuff has been essentially fourfold, comprising:

- ☐ initial, physical assessment of outcrop, trial blasted spalls, percussion drill cuttings and diamond drill core by DRA and ECS geologists in the field;
- ☐ petrographic analysis of drill cuttings and core (by Barron and APS) to confirm rock type, identify potentially deleterious mineralogy and predict probable engineering properties of the rock;
- ☐ chemical analysis (by Sydney Analytical Laboratories and CTS) to test for potential reactivity (sulphides, alkalis etc) and potential contaminants such as sugar;
- ☐ comprehensive laboratory analysis (at CTS and Boral Greystanes) to confirm the strength, durability and overall competence and quality of the rock as a source of premium quality quarry materials.

Field Inspection

Physical assessment of the Williamsdale resource has been undertaken by senior geologists from Coffey and Partners (1984/85) and Don Reed and Associates (DRA) during the period October 1998 to February 1999. The rock outcrops extensively along the quarry ridge where it has been trial blasted at several locations for bulk sampling and subsequent laboratory testing. Whilst selectively altered the rock appears generally massive (tightly jointed) and homogeneous, strong and competent.

Trial blasted rock exhibits excellent blasting and crushing characteristics (fragmentation, shape etc) and is reported to have reacted well to laboratory [jaw] crushing. Fresh rock also exhibits excellent drilling characteristics (penetration rates, cuttings shape etc) and yields an apparently high quality drill dust.

Diamond drill core is increasingly massive at depth yielding unbroken core lengths of three to five metres. It has a characteristically fragmental, porphyritic texture and a strong metallic ring. In excess of 90% of core from DDH's 6 and 7 has been logged as relatively homogeneous, selectively altered, strong, competent and apparently suitable for the production of premium quality aggregates. That 'apparent suitability' has been subsequently confirmed by comprehensive laboratory testing.

Petrographic Analysis

Rock type, mineralogy, texture, homogeneity, alteration and genesis are commented on in detail by Barron whose conclusions are summarised in **Section 3.2.2** above and whose reports are attached as **Appendix F**. Barron's basic conclusions are confirmed by APS whose report is also included in **Appendix F**.

APS are used by the quarry industry to petrographically inspect rock samples for potentially deleterious mineralogy and/or, contaminants. The standard reporting format used by APS for all these clients is that presented as **Appendix F**. APS's principal conclusions in relation to the Williamsdale material (DDH7) can be summarised as follows:

☐ ***Rock type*** is a relatively "homogeneous crystal / vitric tuff";

☐ ***Rock mineralogy*** comprises 22-23% quartz, 53-54% feldspar, 17-18% chlorite/clay minerals, 1-5% carbonates and minor opaques and accessory minerals;

☐ ***Rock texture*** is detrital, poorly sorted, coarse to very fine grained and mainly consisting of crystal fragments in a very fine grained felsic and chlorite / clay mineral matrix. Indistinct bedding is defined by elongate detrital quartz and biotite;

☐ The presence of moderate to minor amounts of heavily strained quartz or fine chert or microcrystalline quartz indicates potential for Alkali Aggregate Reactivity (AAR);

☐ Potential ***Alkali Silica Reactive*** materials were not detected;

☐ Stain testing indicated that minor amounts of the chlorite / clay minerals in the rock may be expansive and that X Ray diffraction analysis would be required.

It needs be stressed that petrographic analysis is used to identify the presence of potentially reactive materials such as strained quartz or expansive clays. It cannot in itself confirm or quantify Alkali Aggregate Reactivity. Chemical analysis [modified CSIRO test] has in fact shown tested aggregate to be non-reactive. Further testing is scheduled to confirm the result reported in **Table 3.3** below.

As a result of the recommendations included in the APS report, X Ray diffraction testing was commissioned to check for the presence / absence of expansive clays. Testing was undertaken by Dr Ervin Slansky, School of Geology, University of NSW and concluded that '*no expansive clays not even in traces, were found in the fine fraction of the samples.*' Slansky's report is attached as **Appendix G**.

Chemical Analysis

Tests for chemical properties have been carried out by Sydney Analytical Laboratories at Seven Hills and [the modified mortar bar expansion test] by Boral Laboratory at Greystanes. Initial tests were completed during the second half of 1998 on trial blasted 'spall' material with chemical testing having been undertaken in order to assess:

- ☐ the potential for alkali aggregate reactivity (AAR) in concrete manufacture; and
- ☐ the potential for the rock to contain sulphide mineralisation (pyrite or other) at sufficient level to be of concern for the potential generation of acid by oxidation.

A summary of the tests conducted and the results obtained follows:

Table 3.3 - Chemical and Potential Reactivity Test Results (1998 & 1999)

Test	Result
Water Soluble Sulphate (% SO_4)	0.003
Acid Soluble Sulphate (% SO_4)	0.004
Total Sulphur (% S)	0.008
Total Oxidisable Sulphur (% S)	0.007
Acid Neutralising Capacity (% $CaCO_3$)	1.300
Net Acid Generating Potential (Kg H_2SO_4 per tonne)	-12.800
Sugar Contamination	nil

Principle conclusions to be drawn from chemical tests are that:

- ☐ levels of oxidisable sulphur are extremely low and net acid generating potential is negative;
- ☐ the crushed rock will readily comply with the ACT Government's 1997 limit of no more than 0.05% sulphur in crushed rock for road pavement material; and that
- ☐ crushed rock aggregates will similarly comply with the stringent requirements of the CSIRO modified test that mortar bar expansion not exceed 0.1% at 21 days.

Laboratory (Geotechnical) Analysis

A bulk sample of rock spalls obtained from the trial blast adjacent DDH1 was tested by Canberra Testing Services on the 13 July 1998. Results of those tests are presented in the **Table 3.4**.

Table 3.4 Laboratory Test Results (1998)

Test	Specified Limit	Result (1998)
Point Load Strength (Mpa)		7.8
SSD Particle Density (kg/m^3) (+4.75 mm aggregate)	> 2100	2680
Water Absorption %	< 2	0.5
Wet Strength (kN)	> 100	339
Dry Strength (kN)		390
Wet/Dry Variation %	< 25 (severe) < 35 (moderate)	13
Sodium Sulphate Soundness Weighted Percent Loss %	< 6	0.1
Los Angeles Abrasion B Grading %	< 30	11
Polished Aggregate Friction Value	Note (1)	54
Stripping %		nil
Initial Adhesion Stripping %		nil

Note (1) that the RTA seeks PAFV results of >48 for premium quality sealing aggregates in the ACT and 50 or more on major state roads. A PAFV of 54 is regarded excellent for road building and maintenance purposes.

Confirmation of rock durability comes from testing of crushed drill core from DDH6 and DDH7. In both cases, drill core was representatively sampled, crushed (by laboratory jaw crusher) and tested for wet / dry strength variation and Los Angeles Abrasion. Results are summarised in **Table 3.5** below.

Table 3.5 - Laboratory Test Results (1999)

Drill Core Depth Sampled	DDH6 15-30m	DDH6 30-60m	DDH7 10–30m	DDH7 30-60m
Dry Strength (KN)	400	385	328	352
Wet Strength (KN)	354	308	293	308
Wet / Dry Strength Variation (%)	12	20	12	14
Los Angeles Value	12	13	15	13

It is noted that only one wet/dry strength variation has been measured >14. It is widely recognised within the quarry industry that lower wet/dry strength variations will be derived from the testing of better shaped aggregates than those produced by laboratory jaw crushing. This is because quarry produced aggregates will be more cubically shaped after closed circuit and impact crushing. Better shaped aggregates have substantially lower wet/dry strength variations than the more elongated and flakily shaped aggregates produced by laboratory jaw crushers.

The principle attribute of premium grade aggregate is rock durability which is quantified by testing for; Wet / Dry Strength Variation, Los Angeles Value and Sodium Sulphate Soundness. The above tabled results confirm that representatively sampled spalls and drill core have tested extremely durable.

Results also allow the rock to be categorised as relatively impermeable and 'very strong ' to 'extremely strong'. Furthermore the high Polished Aggregate Friction Value (PAFV), coupled with rock strength and durability, suggests that the Williamsdale quarry will prove to be an excellent source of sealing aggregate whilst the 'nil stripping' results indicate it will prove of equally good quality for asphalt pavement manufacture.

Laboratory results appear to confirm Barron's conclusion that the bulk of the potentially deleterious secondary minerals (chlorite and illite) are 'locked up' within the rock fabric. Where aggregated in more heavily altered rock, these secondary minerals may need to be handled with some care (via selective quarrying) however it is anticipated that a high proportion of this weaker material will be either scalped or reduced to crusher dust, during normal crushing and screening operations.

Conclusions Relative to Rock and Product Quality

On the basis of the geological exploration work completed to date and the results of subsequent petrographic, chemical and geotechnical testing, it appears that the Williamsdale resource will yield a range of premium quality, quarry products.

3.2.4 "Quarriable" Reserves

Quarriable reserves are defined in this report as those able to be quarried from the subject / western ridgeline, in an operationally and commercially viable manner, to produce premium quality quarry products. These reserves can be sub-divided into 'proven reserves' and 'inferred reserves'. Such categorisation has been adopted by some sectors of the quarry industry from the mining industry.

Within the quarry industry the term 'proven reserve' is used to describe a resource where reserves and quality of the rock have been confirmed by an adequately qualified geologist. The term is used to reflect the level of confidence held by geologists in the light of the technical and economic investigations undertaken and results obtained.

Based on all available data, the reserves within the proposed quarry development area of 17.1 hectares can be substantially categorised as proven. Based on the quarry planning presented within this EIS, those substantially proven reserves have been quantified (down to RL910m) as:

Substantially 'proven' reserves

☐ fresh porphyritic tuff	=	15 530 000 tonnes (at 2.68 t / bcm)
☐ weathered rock overburden	=	2 055 000 tonnes (at 2.40 t / bcm)

Additional, inferred reserves are contained within the quarry ridge to the north of the proposed quarry development area. They lie within the area bounded by the RL940 topographic contour. Reserves within that additional 12 hectares have not been drilled but are inferred (by virtue of deposit structure, surface outcrop and a trial blast) as:

Additional inferred reserves

☐ fresh porphyritic tuff	=	13 025 000 tonnes (at 2.68 t / bcm)
☐ weathered rock overburden	=	1 500 000 tonnes (at 2.40 t / bcm)

Thus the total figure for proven and inferred reserves of quarriable fresh rock within the main quarry ridge (ie, within the RL940 contour down to RL910) has been quantified at ***28.555 million tonnes***. Additional reserves of potentially quarriable hard rock are present within surrounding ridges and below the planned quarry floor, that is below RL910.

3.2.5 Product Range

The quarry operation will produce a comprehensive range of premium quality, hard rock aggregates, crusher dust / manufactured sand, blended pavement materials, ballast, gabion and other quarry products for sale to public and private sector cliental within the ACT/Queanbeyan areas and south. Totalcare's internal demand will underpin future quarry production, with the anticipation that additional markets will be secured.

Quarry products will also be supplied to regional Councils, road contractors, concrete producers, asphalt producers, builders, resellers, landscape gardeners and so on.

The competitiveness of the Williamsdale quarry product will be primarily tied to:

- ☐ product quality; and
- ☐ delivered price.

Delivered price and other market forces are considered within Section 4 of this EIS.

3.3 Quarry Planning and Operation

3.3.1 Initial Site Development / Quarry Access

During the development of the site a number of works need to be carried out to improve traffic access and instigate environmental control systems.

The access road to the site, including Williamsdale Road and the railway crossing on Williamsdale Road will be upgraded. Associated with the work on the service road to the site will be the construction and installation of drainage and sediment ponds, silt stop fencing etc. which will protect the environment from specific harm associated with the works.

Culverts will be installed wherever creek crossings are required.

Development of the process/stockpile area will involve earthworks and construction of areas of hardstand, creating approximately 3 ha of space for the process/stockpile area.

During the development of the quarry , the existing farm track linking the proposed process plant area to the proposed quarry area will be upgraded to cater for site development and subsequent quarry operations. Earthworks associated with the development of actual quarry benches will be undertaken concurrently with other developmental works and will involve the clearing of a limited number of trees, the stripping of overburden, and the creation of two or more initial quarry benches.

An 'in-pit' quarry access road will link the quarry benches with the primary crushing station. Associated drainage works and pollution control measures will be developed prior to or at the same time as the initial stages of quarry development.

3.3.2 Quarry Planning and Design

Quarry plans have been prepared for the extraction of the hard rock resource at Williamsdale. Planning has been supervised by DRA in consultation with Totalcare representatives and management. Plans have been computer generated by ECS Mining Consultants, Bowral. They are based on aerial photography and survey data (from December 1998) and the 3 dimensional, geological modelling referred to above.

Plans have been prepared to show the quarry development at years 1, 2.5, 5, 10, 15, 25 and [end] 'life of quarry. They are presented in this report as **Figures 3.4a** to **3.4g**. Time intervals have been chosen to show the extent of quarry development after the removal of 0.5, 1.25, 2.5, 5.0, 7.5, 12.5 and 15.8 million tonnes of hard rock.

The staged quarry plans included as **Figures 3.4a** to **3.4g** clearly demonstrate the full extent of the quarry development over time. They allow assessment of visual and other impacts on existing residents to the south and possible future developments to the north and north west. Plans can be viewed in graphic [3D] presentation from any viewing point nominated. Oblique views are available on Power Point presentation.

The quarry will be developed from the top of the ridge downwards, with the upper [RL970m] bench being initially cleared, stripped and quarried to allow the subsequent development of lower benches. Total volumes of material to be quarried under the proposed quarry design are nominated within **Table 3.6**.

Key elements of quarry design are as follows:

- ☐ all quarry development to be contained within the RL940m contour;
- ☐ quarry access roads to be developed within the confines of the quarry rim, ('in-pit');
- ☐ access road width to be 12m (plus shoulders) with a maximum gradient of 10%;
- ☐ face heights set at 15m to optimise quarry operational efficiencies within DMR guidelines,
- ☐ face orientations to be a nominal 15° from the vertical; and
- ☐ final bench widths to be 10 metres.

3.3.3 Extraction Schedule

Quarry planning and assessment of the resultant environmental impact has been based on the assumption of sales of up to 500 000 tonnes per annum of product. This is despite the fact that short term sales may be more in the order of 150 000 – 300 000 tpa. Scheduling of quantities to be quarried and subsequent product yield have been based on the following assumptions:

- ☐ in situ density of fresh rock quarried = 2 680 kg/bcm

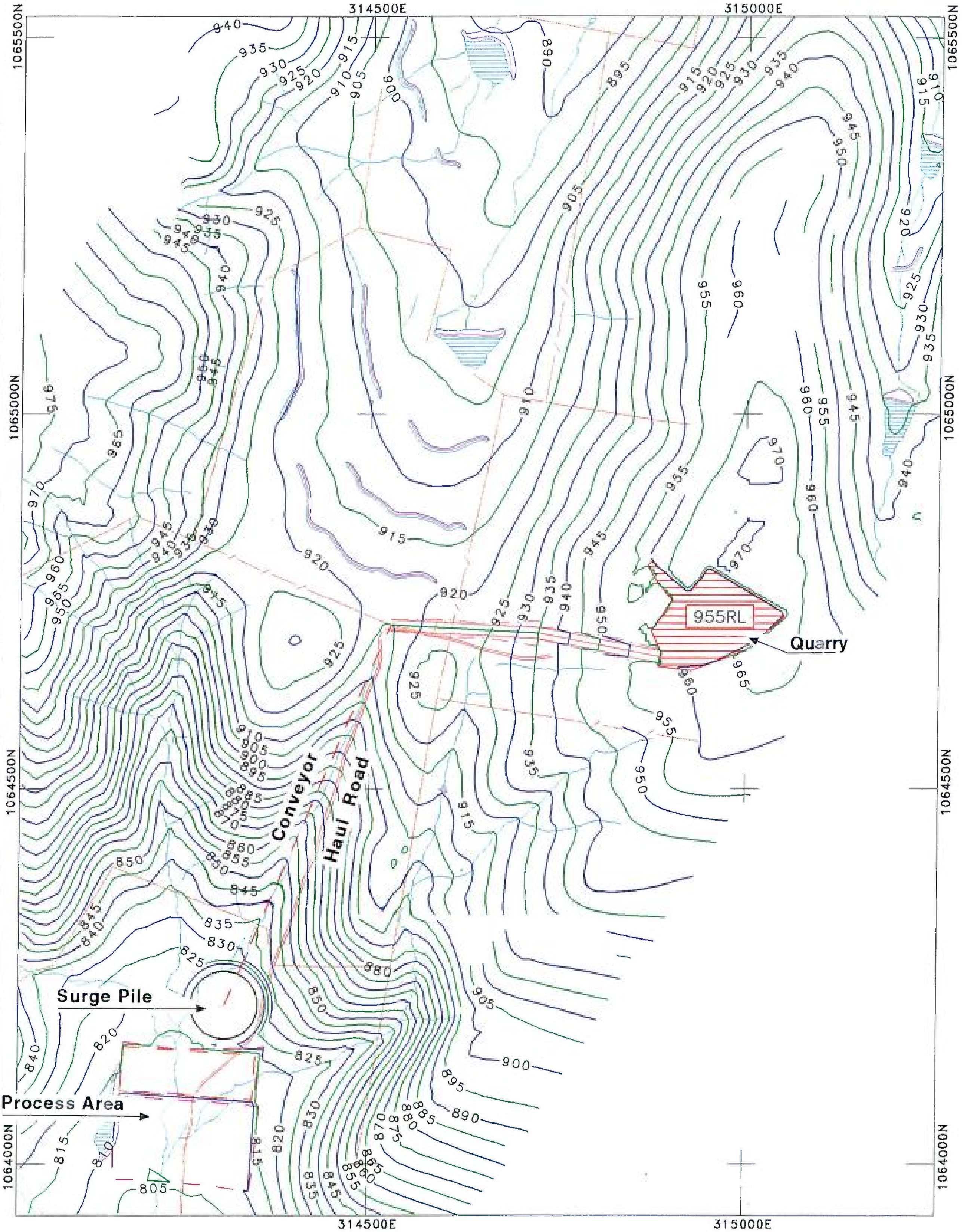


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FIGURE 3.4a

Staged Quarry Development - Year 1

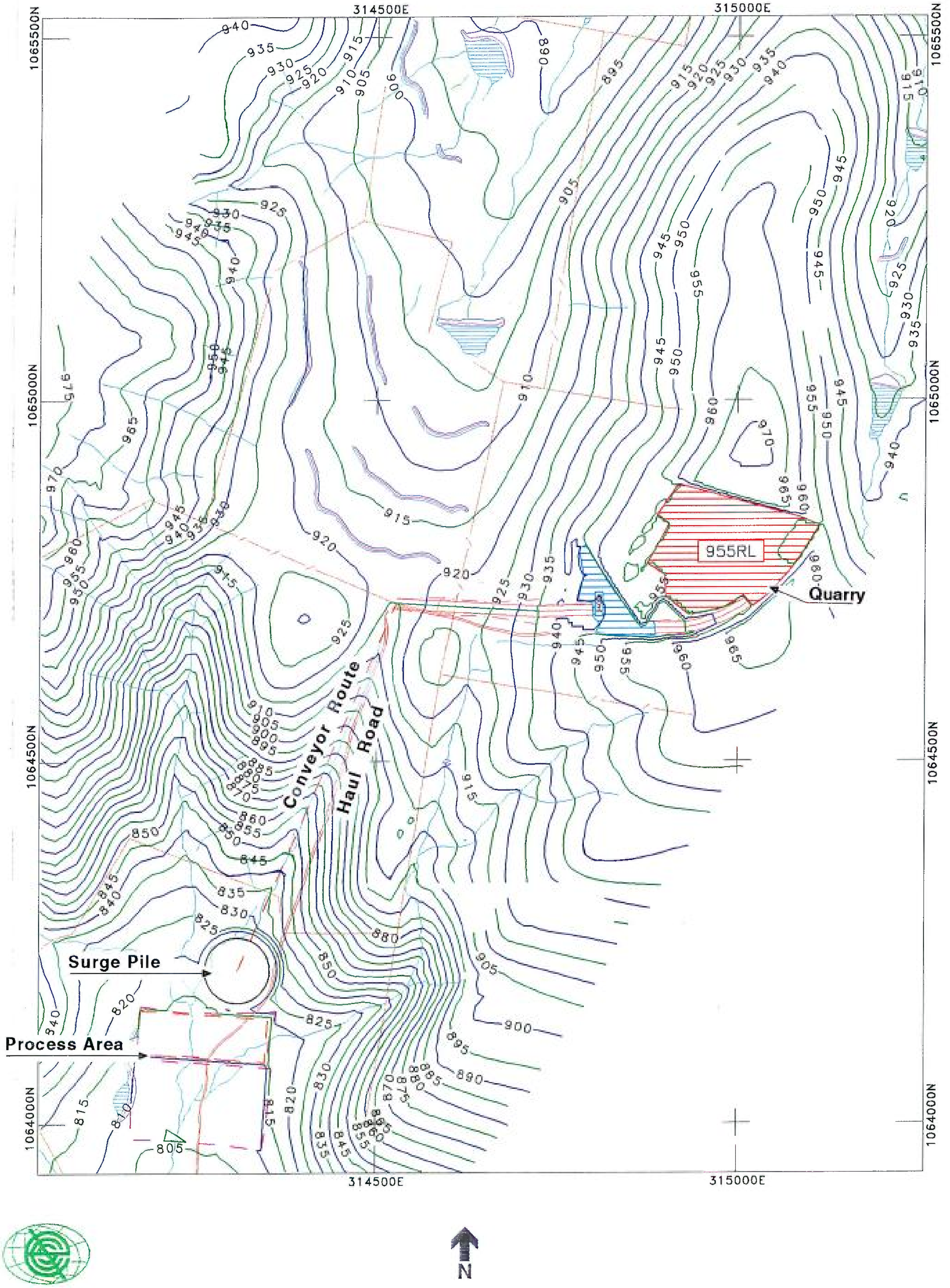

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FIGURE 3.4b

Staged Quarry Development - Year 2.5

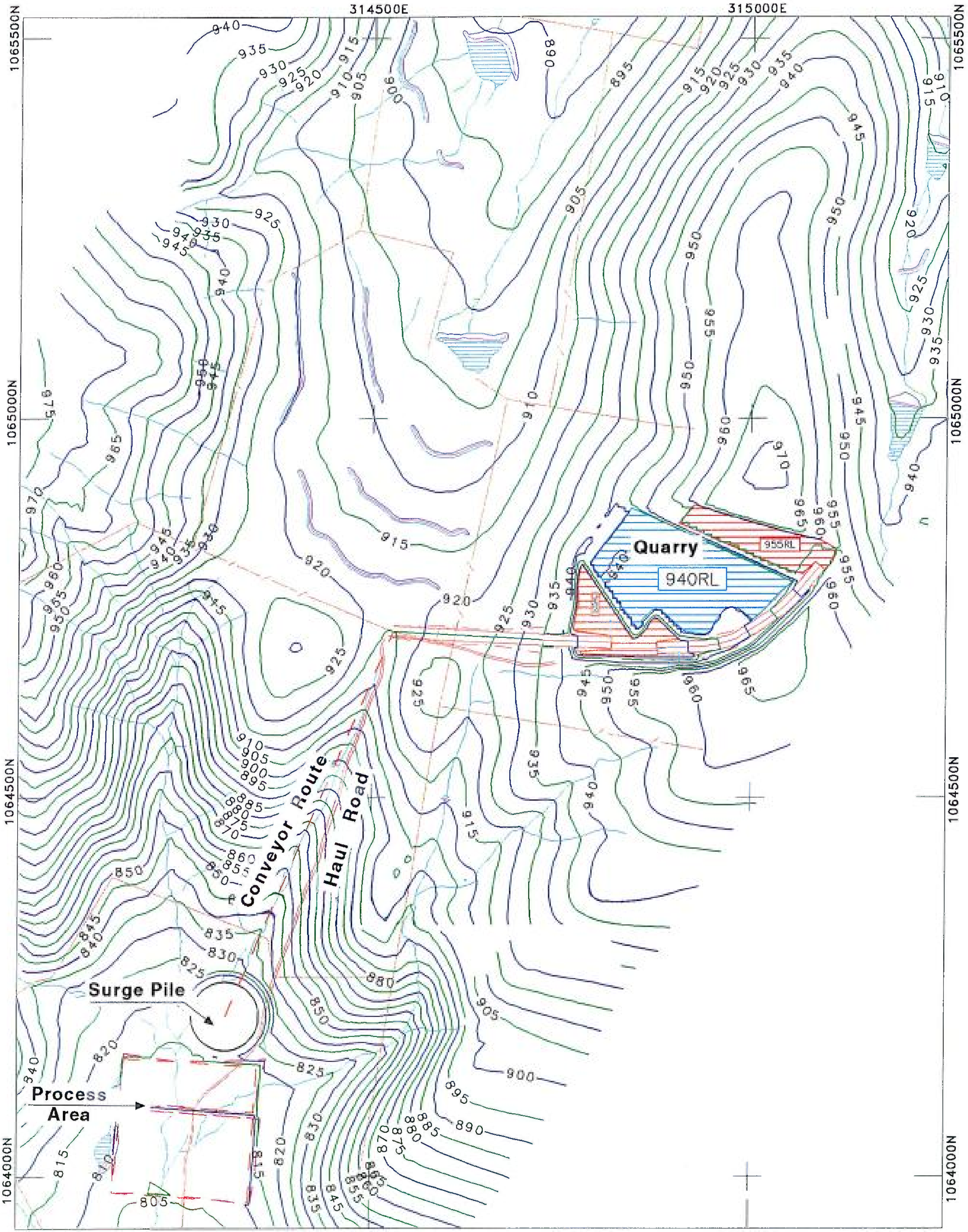

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FIGURE 3.4c

Staged Quarry Development - Year 5

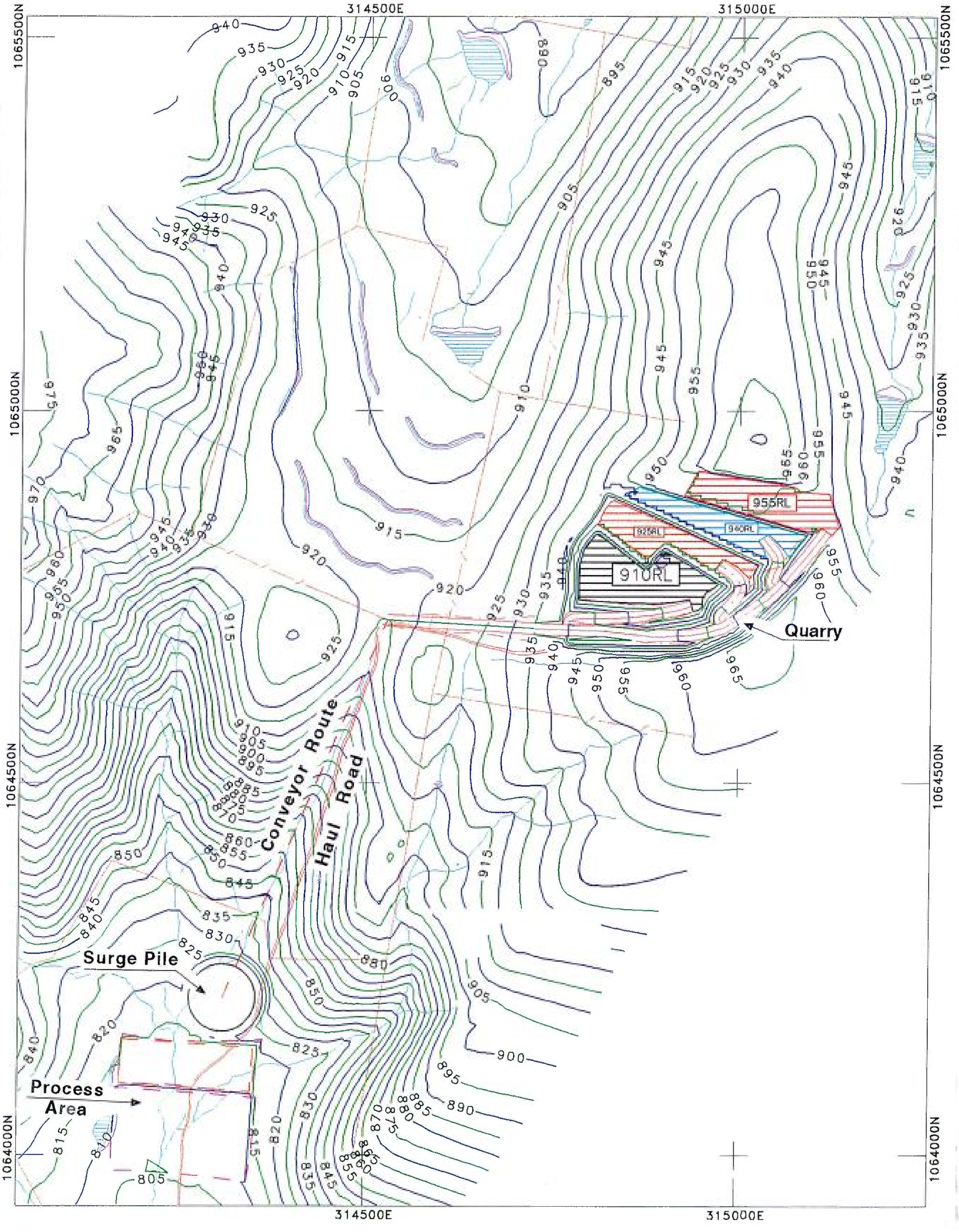

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FIGURE 3.4d

Staged Quarry Development - Year 10

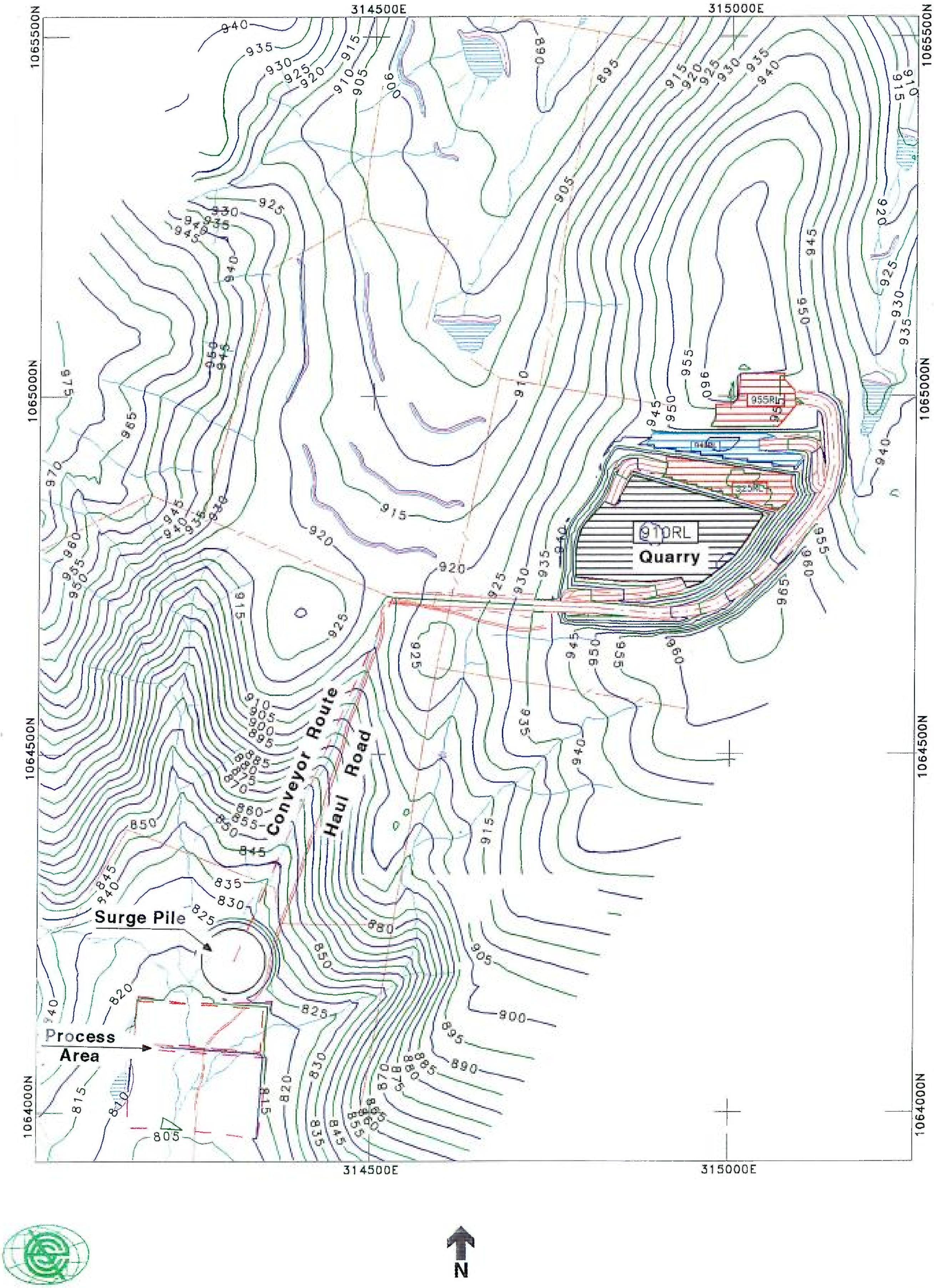

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FIGURE 3.4e

Staged Quarry Development - Year 15

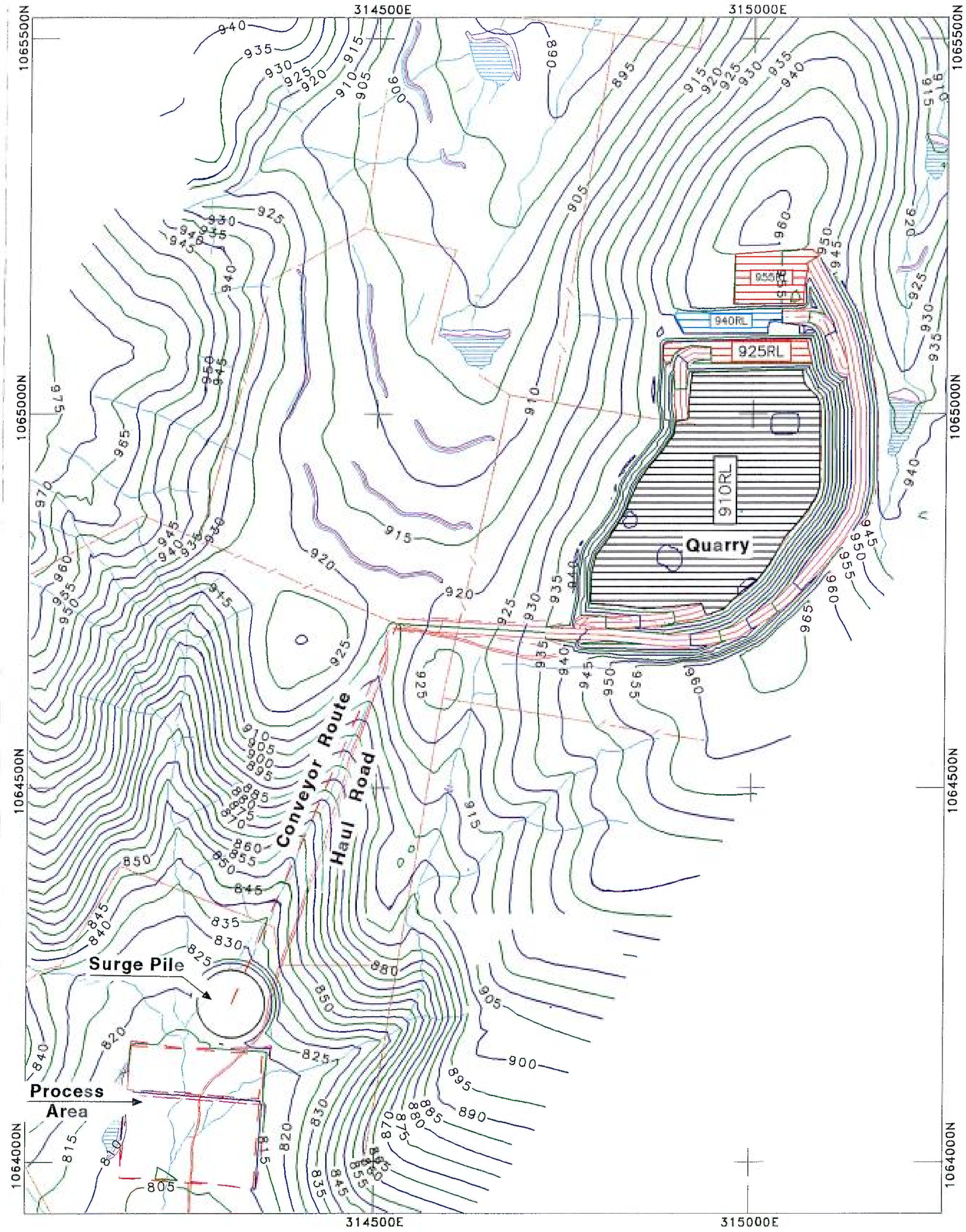

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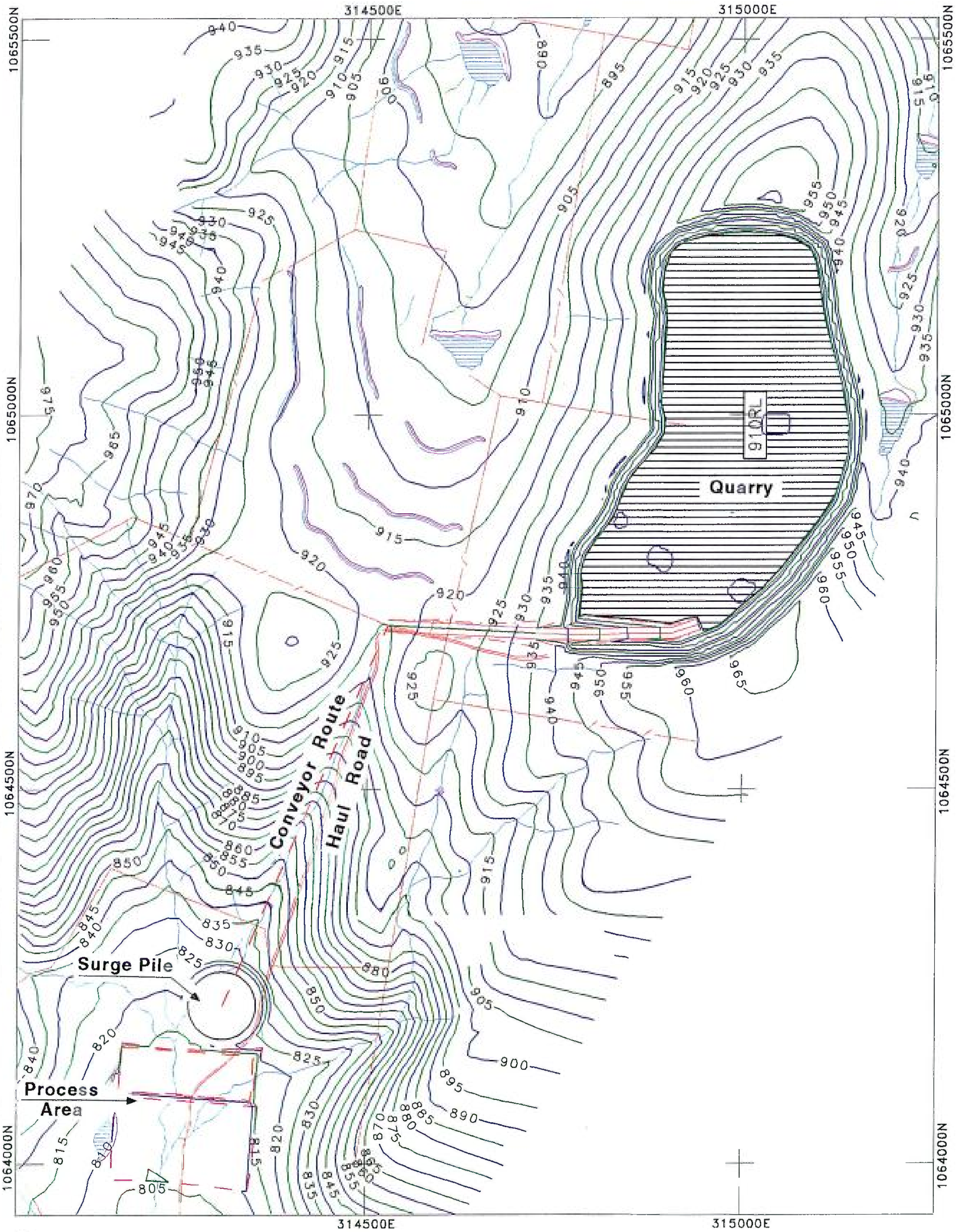
FIGURE 3.4f

Staged Quarry Development - Year 25



Source : ECSI Mining Consultants

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FIGURE 3.4g
Staged Quarry Development - Year 31

- in situ density of weathered rock = 2 400 kg/bcm
- product yield / bcm quarried = 90%
- depth of overburden (range) = 1-12m
- average depth of overburden = 6m

The assumption of 90% yield allows that 10% of material quarried will be lost as 'scalps' during processing. Scalped material will theoretically comprise weathered rock from upper benches and a percentage of the more 'heavily altered' tuff. In fact, scalping ratios should decrease substantially on lower benches which will be developed entirely within fresh rock. It is also anticipated that a high percentage of scalped material will be blended back into road pavement materials and sold as product. Thus the 90% figure is considered conservative.

Allowance for 1-12m overburden (6m average) is expected to prove similarly conservative as the average depth of overburden within the 10 holes drilled within the delineated quarry area is 4.9 metres.

Total volumes and quantities to be quarried, processed and sold have been assumed by ECS to be as follows:

Table 3.6 - Quarry Extraction Schedule

Year	1	2.5	5	10	15	25	LOQ(1)
Overburden (bcm)	45 754	120 094	197 991	237 898	341 665	696 787	855 822
Tonnes Quarried	555 000	1 388 900	2 777 800	5 555 600	8 333 400	13 889 000	17 530 000
Tonnes Produced	500 000	1 250 010	2 500 020	5 000 040	7 500 060	12 500 100	15 777 012

Note (1) LOQ = Life of quarry (ie total reserves from final quarry shell)

3.3.4 Forecast Production & Sales – Plant Production Capacity & Operation

The plant has been designed to process an average 500 000 tpa in normal operational hours, ie:

- 'in-pit' primary crushing plant capacity has a design capacity of 450 tph; whilst
- secondary and tertiary crushing and screening plant has a design capacity of 300 tph.

Under these circumstances, normal annual production capacity can be calculated as 300 tph x 9 hrs x 5 days x 45 weeks x 83% production factor, ie approximately 500,000 tpa.

Such production lies well within the upper production figure of 630,000 tpa, as assessed in this environmental impact statement. There may be times however when market demand from one or more major projects (such as the VFT, International

Airport or Canberra-Nowra Highway) may require production of more than 500 000 - 630 000 tpa. To meet such extraordinary demand, production could be increased to around 800 000 tpa by working additional hours, ie: 300 tph x 12 hrs x 5.5 days x 48 weeks x 85% prod. factor, ie. approximately 800 000 tpa.

Under these circumstances, Council would need to be consulted in relation to assessment and approval of any additional impact. It needs be stressed that in the interests of operational and cost efficiency, processing plant has been designed to meet 'forecast maximum demand' within 'normal operating hours'.

Dependant on the balance achieved between production and sales during the first two to three years of quarry operation, it is expected that stocks of aggregates and blended road materials will be built up to (and maintained) at between 120 000 and 150 000 tonnes.

The quarry industry is effectively market driven with sales tied to demand from the construction industry, product quality and sales price at point of delivery. Under these circumstances (and particularly in a market like Canberra) it is deemed critical that any new quarry be designed to afford maximum flexibility of operation to its owners. For this reason, process plant at Williamsdale will be both modular and semi-mobile. This will allow a number of operational options, for example the Williamsdale plant will be able to be operated:

☐ 40 hrs/week x 44-49 weeks per annum to produce 450 000 – 500 000 tpa; or
☐ 40 hrs/week x 30-44 weeks per annum to produce 300 000 – 450 000 tpa; or
☐ 40 hrs/week x 15-30 weeks per annum to produce 150 000 – 300 000 tpa; etc

Only the first of these three scenarios require a full time/fully manned quarry operation at Williamsdale. Although quarry management will at all times operate at least one sales loader and the weighbridge at Williamsdale, the second and third production scenarios will not require full time quarry operation. Under these circumstances the quarry workforce and/or process plant to be periodically transferred to other project sites. The concept of 'campaign' quarry operation is becoming increasingly common within the quarry industry.

The key to planning the proposed Williamsdale quarry operation has been essentially twofold, ie:

☐ to ensure the long term availability of premium quality quarry products for construction purposes whilst at the same time;

☐ designing the quarry and quarry plant to be operated either full time or on a campaign basis to cater for fluctuating conditions of market demand.

3.3.5 Quarry Site Preparation

The proposed quarry area is covered primarily with grazing pastures and farm access tracks are in place. A small area of low regrowth eucalypt and associated native species will be cleared in the southern portion of the quarry area.

The existing access track linking the proposed processing and quarry areas (between RL 810/813 and RL940), will be upgraded and widened to cater for a range of traffic ranging from low loaders and 50 tonne dump trucks to water carts, fuel tankers and four wheel drive vehicles. The upgraded 'quarry service road' will be will be 900 m long.

Where it occurs, existing vegetation within the designated quarry area and access track will be progressively removed before quarrying activities commence. Wherever possible, cleared vegetation will be mulched and transported directly to rehabilitation areas in the process area or visual screen planting for respreading. In the event that there are no areas available for rehabilitation at the time, cleared vegetation will be windrowed for future burning and spreading.

All clearing and revegetation works will be done in consultation with the relevant authorities, the DLWC in particular. An Erosion and Sediment Control Plan will be prepared as part of the Environmental Management Plan. The plan will detail works to be undertaken prior to any surface disturbance such as the clearing of vegetation and subsequent stripping of overburden. Such works are outlined in Section 3.13.3 and will include:

☐ sedimentation control dams;

☐ revegetation works on exposed batters formed during construction;

☐ use of hay bales or sand bag check dams in roadside drains and minor watercourses to retard runoff flow and trap sediments; and

☐ erection of silt stop fencing at key drainage points.

All sediment traps will be regularly maintained (and/or upgraded) to ensure effective control of runoff from disturbed areas. For the extended quarry development, all erosion and sediment controls will discharge into further dams in the lease area and Lobbs Hole Creek, then downstream off the lease area. All of the measures described (ie, in relation to site clearing, drainage and sedimentation control) will be adopted as part of standard operating procedure on in the quarry.

Further information on erosion control systems is provided as part of the proposed short and long term rehabilitation works.

3.3.6 Topsoil and Overburden Stripping

Topsoil in the quarry area mainly consists of shallow, rapidly drained lithosols and shallow earths, with rock outcrops occurring across the area. They are relatively infertile and are subject to sheet erosion. The 'stripping' of topsoil and underlying weathered rock will precede drilling and blasting in the development of upper quarry benches. Weathered rock will be removed separately to be used to be either:

☐ dumped as overburden;

☐ used in bund wall and/or road construction; or preferably,

☐ blended into road base products.

All topsoil will be stripped and loaded to trucks for transport to rehabilitation or stockpiling areas. If possible, overburden will be stripped, transported, dumped and respread in one operation however, it is more likely that topsoil will be stored for some time. This will be done in accordance with the preferred DLWC policy in order to sustain as much of the biological content of the soil as possible. The main stockpile will be located at the base of the processing area and will be shaped in the form of a visual/noise bund. On conclusion of quarrying activities, the bund will no longer be needed and used in the final rehabilitation of the site.

Overburden removal will occur either using in house equipment or by use of contractors. Equipment employed will be finally determined by sub-surface geology but is expected to include bulldozers (Cat D11 - D9 or equivalent), scrapers (40 - 60t), hydraulic excavators (40 - 60t) and two or more 35 - 50 tonne dump trucks.

3.3.7 Extraction Methodology – Drilling and Blasting

Once stripped of overlying topsoil and heavily weathered rock, underlying rock will be quarried in benches by drilling and blasting before being loaded and transported to the primary crusher. These benches have been designed to be 15 metres high and inclined at about 15° from the vertical, ie, 75° from the horizontal. Drill and blast design has been primarily determined by the following:

☐ site topography;

☐ site geology;

☐ material production and market demand;

☐ size of the primary jaw crusher;

☐ environmental and safety constraints.

The development of 15 metre benches has been selected in order to:

☐ maximise blasting efficiencies;

☐ minimise inter-bench movements of mobile equipment;

☐ minimise the number of drill movements;

☐ minimise the number of inter-bench access roads;

☐ adhere to industry practice in relation to safety standards.

Drilling and blasting will be undertaken to develop the quarry benches shown in staged quarry plans shown as **Figures 3.4a - 3.4g**. While final drill hole size and blast patterns will need to be left somewhat flexible (in order to cater for changing geological circumstances and evolving blast technology) it is anticipated that initial blast hole size will range between 90 and 125mm, with 102mm adopted in initial modelling. Drilling and blasting may be done in-house but will probably be carried out under contract.

Drill rigs will be equipped with sound suppression and dust collection systems, as required. They will be chosen and configured to match the production and environmental requirements of the job at any given time. During the initial years of the quarry development, it is likely that drilling will be carried out by contractors who may operate pneumatic, hydraulic or air/hydraulic units with either towed or on board compressors. Smaller percussion rigs might equate to an Ingersoll Rand CM 351 air track with a VHP 700 (200 psi) air compressor. Contractors are expected to employ either standard drifter, or down the hole units.

Once the quarry moves to larger production tonnages, drilling will be carried out with larger capacity hydraulic percussion rigs with on board compressors. In today's market a typical rig produced by Gardner Denver might range from a SCH 2500 (with 150 cfm compressor) through to a SCH 4500 (with 350 cfm compressor). Drill units will be fitted with silence packs, dust suppression and/or dust collectors and pre-cleaners.

Quarry planning has been based on the extraction of up to 630,000 tpa with an average production of 500,000 tpa of finished product. Actual production however will be market driven and is more likely to be in the order of 200,000 to 350,000 tpa (from 220,000 – 390,000 tonnes quarried), during the first years of quarry operation. Figures set out in the following table provide essential data in relation to blast size, frequency and scheduling for the drilling and blasting of between 200,000 and 660,000 tpa of hard rock at the proposed Williamsdale quarry.

The number of holes drilled per blast will depend on blast size, drill hole diameter and the type of explosive employed. A number of explosive types and initiation systems are available on the market today. Modelling has been undertaken assuming the use of either ANFO or variable strength slurry explosives initiated by state of the art, high explosives and detonators. Initial blasts will be initiated using non-electric (Nonel) detonators with staggered delays employed along and between, blast 'rows'.

Table 3.7 Blast Size, Schedule and Frequency

Target Production (TPA)	Tonnes Blasted (TPA)	Volume Blasted (BCM)	Mean BCM per Blast	Blast Frequency (wks)	Blasts per annum
100 000	110 000	41 000	3 416	4.33	12
200 000	220 000	82 000	4 555	2.88	18
300 000	330 000	123 000	5 125	2.16	24
400 000	440 000	164 000	6 833	2.16	24
500 000	550 000	205 000	8 542	2.16	24
600 000	660 000	246 300	10 262	2.16	24

The critical issue to predicting blast impact (measured as airblast overpressure and ground vibration) is nomination of maximum instantaneous charge or MIC. Assuming 15 m bench heights, the mass of conventional explosives (ANFO) may range from:

❒ 95 kg/hole for a 90mm diameter hole with 13m explosive column; to

❒ 108 kg/hole for a 102mm diameter hole with a 13m explosive column; to

❒ 132 kg/hole for a 125mm diameter hole with a 13m explosive column.

MIC's will be determined by bench height (nominal 15m with 13m explosive column), hole diameter (nominal 102mm for initial blasts), and the number of holes detonated instantaneously. At this stage it has been determined that EPA criteria can be readily met by blasting on the upper bench with an MIC of 265 kgs which would allow 2 x 125 m holes to be initiated on the same delay. Final drill and blast design will be determined by:

❒ EPA imposed criteria in relation to airblast over-pressure and ground vibration;

❒ rock fragmentation; and

❒ cost per tonne of rock on ground.

MIC's and other drilling and blasting controls will be finally determined to ensure they meet current EPA guidelines. Blast options range from fortnightly (approximately. 27,500 tonnes per blast x 24 blasts per year) to monthly (9,000 tonnes per blast x 12 blasts per year). It should be noted however, that weekly or even twice weekly blasting may be required during the quarry development stages, under adverse weather conditions and/or while working in tight sections of the quarry.

Initial blasts will be extensively monitored to confirm predicted impacts at potentially affected residences. Future blast design will be determined on the basis of monitored results and other above-listed criteria. MIC and other blast factors will always be stringently controlled and monitored to ensure compliance with EPA guidelines. Standard quarry practise will include the following:

❒ blasting to be conducted between the hours of 9am and 3pm, wherever possible;

❒ details of blast dates and approximate times to be displayed (at least 24 hours before blasting) on an appropriately sized sign located at the intersection of Williamsdale Road and the quarry access road;

❒ liaison with aviation authorities will be maintained on a blast by blast basis;

❒ blasting to be avoided in adverse meteorological conditions wherever possible;

❒ generation of fly rock to be minimised / eliminated by adequate stemming of drill holes (using 14mm crushed aggregate) and by careful monitoring of the drilled 'burden' to avoid substantial cracks, fissures and other face conditions that may allow premature fragmentation and consequent escape of explosive energy.

Quarry practices such as deck loading will be employed (where necessary) to avoid such weaknesses;

- ground vibration will be minimised by paying particular attention to such critical factors as:
  - the confinement of the explosive charge;
  - the detonation efficiency of the charge; and
  - the degree of water saturation in the ground at the time.

- air-blast overpressure will be similarly controlled with particular attention being paid to:
  - blast hole diameter;
  - explosive strength;
  - concentration in blast holes; and
  - the use of air decks etc.

  It is noted that the highest levels of over-pressure relate to gas venting (either through the face or stemming ejection) and that these sources can be completely eliminated without loss of control over fragmentation.

- Secondary breakage of oversized rock in the quarry will normally be undertaken with a hydraulic rock breaker although there may be times where explosives may be necessary.

Drilling and blasting will be carried out in accordance with relevant regulations and monitored by the Regional Mines Inspector and the EPA. All blasts will be self-monitored to provide air-blast over-pressure and ground vibration data on a blast by blast basis. The handling and storage of explosives will be controlled by contractors and/or the quarry operator, under licence from the Mines Inspectorate branch of the Department of Mineral Resources (DMR).

Optimal drilling and blasting results will be achieved by quarry face surveys and careful monitoring of face geology, profile and structure. Modifications to drilling and blasting practices will be made on a blast by blast basis in accordance with these factors.

3.3.8 Face Loading & Delivery of Blasted rock to the Primary Crusher

Blasted rock will be loaded from the quarry floor either:

- direct to the primary crushing module; or
- to dump truck to be delivered to the primary crusher.

Rock will be loaded by either a front end loader (CAT. 988 or equivalent) or 45-65 tonne hydraulic excavator. Mobile, face loading plant will be either owned by be company or owned and operated by a contractor.

Where haulage distances are greater than 50 metres, dump trucks will be used to haul blasted rock from quarry faces to the primary crushing module. Dump trucks will be 35 - 50 tonne machines (CAT 769 - 773 or equivalent). Quarry design caters for either direct loading of an in-pit primary crusher module or dump truck haulage from the various benches to the primary crusher located at RL925 (refer below). In-pit, access road design has been based on road widths of 12m and maximum road gradients of 10%.

3.3.9 In-Pit Primary Crushing

The primary crusher module will be mobile or semi-mobile in configuration and will comprise:

- ☐ a 50 tonne receiving hopper;
- ☐ vibrating grizzly feeder;
- ☐ jaw crusher (48"x42" or larger);
- ☐ an integrated diesel fuelled generator / power source;
- ☐ control cabin with PLC & CCTV link to secondary & tertiary plant; and
- ☐ dust suppression at truck and crushed rock discharge points.

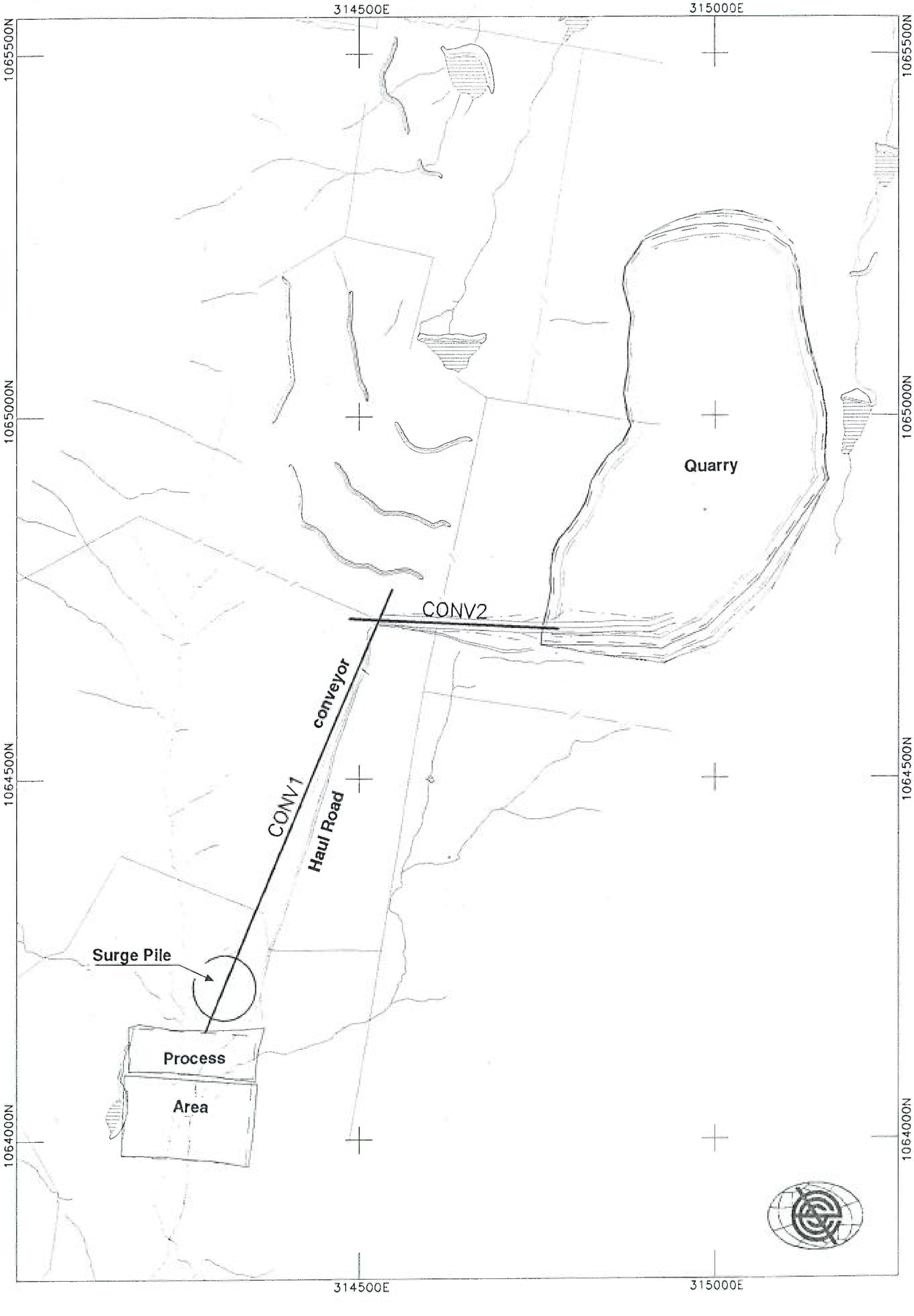
The module will be initially located on the main quarry access road at natural RL135, approximately 100 metres west of the long term quarry rim at RL940. The operating strategy of the quarry will always be to retain the option of being able to match the size of the primary crusher with blasted rock size and production requirements. Whilst the initially installed primary jaw crusher will be sized at 48" x 42" it is probable / possible that larger crushers will be employed in the longer term.

It is the intention of the quarry operator to move the primary crushing station into the confines of the quarry (ie within the RL140 rim) as feasible. Relocation will be possible once the RL925 bench is developed to sufficient size to allow blasting and plant loading operations to be conducted in a safe and operationally viable manner. Quarry plans indicate that such circumstances will be created after the removal of about three million tonnes of resource.

Primary crushed rock will be delivered by overland conveyors to a surgepile located immediately uphill of secondary and tertiary processing plant as shown in **Figure 3.5**. The proposed conveyor routes are shown on **Figures 3.6** and **3.7**. The two conveyors will initially cover a distance of approximately 755 metres from the tail pulley at RL15 to the downhill discharge point at RL845. Dust suppression will be provided adjacent the head pulleys on conveyor transfer and discharge points.

The use of overland conveyors averts any need to use dump trucks outside of the quarry and immediate confines. In particular it averts the impact of operating dump trucks at the head of the valley in which the secondary and tertiary crushing and screening plant is located.

The surgepile location and profile are shown in **Figures 3.8**. The 40,000 tonne surgepile has been designed to stockpile primary crushed rock prior to secondary and tertiary crushing and screening. It allows independent operation of quarrying and



Source : ECSI Mining Consultants

FIGURE 3.5
Section Location Plan

Source : ECSI Mining Consultants

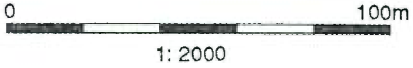
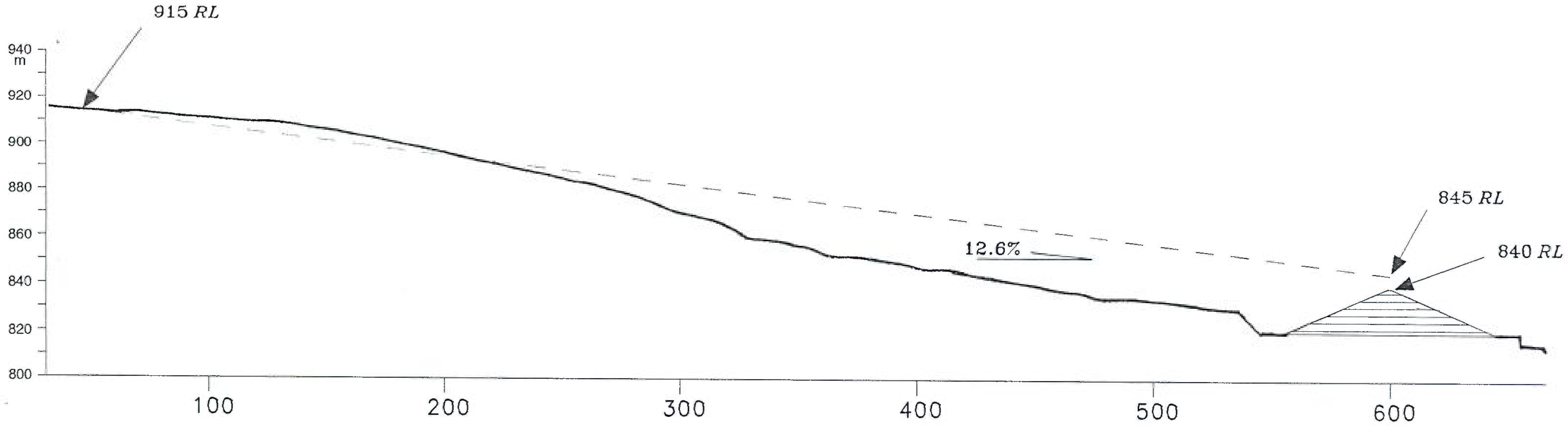


FIGURE 3.6

Section along Conveyor Path from Initial Crusher to Transfer Point



Source : ECSI Mining Consultants

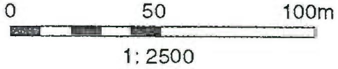
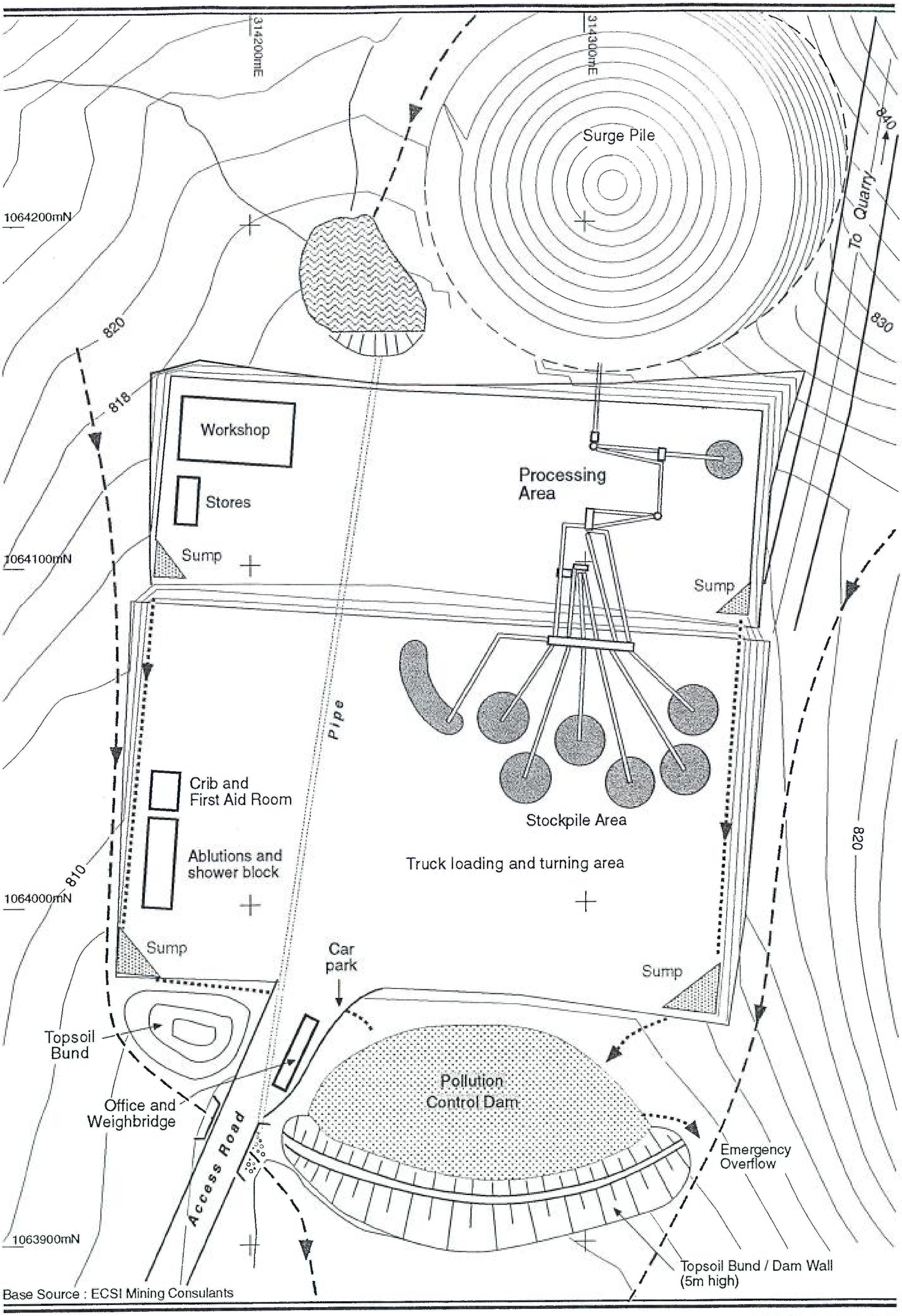


FIGURE 3.7
Section along Conveyor Path from Transfer Point to Surge Pile



Base Source : ECSI Mining Consulants

FIGURE 3.8
Layout of Process and Stockpile Area

processing operations at Williamsdale. It has been designed with a minimum 'live' capacity of 10,000 tonnes to ensure raw feed availability during short / long term interruptions to quarry production.

Primary crushed rock will be transported to secondary and tertiary processing plant via a variable speed conveyor installed within an Armco or concrete tunnel underlying the surgepile. That conveyor will be fed by at least two variable speed feeders installed along the tunnel roof. Surgepile and conveyor delivery avoids the impacts of alternate dump truck or loader delivery.

3.4 Materials Processing – Secondary & Tertiary Crushing and Screening

3.4.1 Processing Area – Site Preparation

The processing area is located at the head of the north-south oriented valley shown in **Figure 3.8** and is currently cleared for grazing. Site preparation of the processing area will involve:

☐ clearing the few stands of existing vegetation located in the area;
☐ removal of existing fencing;
☐ removal and spreading or stockpiling of topsoil;
☐ installation of drainage and water catchment infrastructure;
☐ bulk earthworks to create the split level processing and stockpiling pads;
☐ hardstanding of these same areas for heavy vehicle usage and minimisation of potential for product contamination.

The area selected for the processing and stockpiling of quarry product totals approximately three hectares (excluding the surgepile) and is shown in **Figure 3.8**. The few trees that need to be cleared will be mulched and the material used in rehabilitation works in the processing area.

Topsoil in the designated processing and product stockpiling areas consists of a moderately deep (<0.30 m), moderately drained brownish black massive loam / sandy clay loam. This material is of a better quality than topsoil to be stripped from the actual quarry area and will be stripped prior to any subsequent earthworks or construction at the site. Stripped topsoil overburden will be either:

☐ transported to short term rehabilitation areas; or
☐ stockpiled for future rehabilitative purposes.

Topsoil stockpiles will be constructed in accordance with the preferred DLWC policy in order to sustain as much of the biological content of the soil as possible. The main stockpile will be located at the base of the processing area and will be shaped in the form of a visual/noise bund. On conclusion of quarrying activities, the bund will no longer be needed and used in the final rehabilitation of the site.

Soil conservation measures will be carried out to ensure that the area is not subject to uncontrolled erosion.

The surge pile area will be excavated/constructed (by cut and fill) at approximate RL820. The material will be excavated using hydraulic excavators and a bulldozer. The material excavated will be loaded to dump trucks and used in the construction of the access road and for hardstand on the process and stockpile areas.

The main plant and stockpile pads will be re-graded by cut and fill operations, then hardstanded to create a split level site comprising:

- an 'upper level' pad covering approximately 1 Ha for process plant and associated infrastructure (workshop, storage area and possible laboratory); and
- a 'lower level' pad covering approximately 2 Has for stockpiling of quarry product and the location of remaining quarry infrastructure (weighbridge, office, amenities etc).

These two areas are shown in **Figure 3.8**.

Cut material will be obtained from areas located on the north eastern hillslope of the designated plant area. The final processing area will have a ground slope of 3%, sloping to the south west , towards the sedimentation control structure. Dust suppression will be achieved through the use of a water cart spraying water on pads, access roads and other disturbed areas. Sediment and water control structures will be constructed to include diversion banks and sedimentation / settling ponds.

3.4.2 Secondary and Tertiary Crushing and Screening Plant

The secondary crushing and screening plant will incorporate pre-scalping facilities to remove weathered and otherwise altered material (nominally -14mm) from the primary crushed rock. Scalped material will be either blended back into road pavement material, sold as a stand-alone product, and/or used in the maintenance of internal access roads and quarry floors.

The major components of the secondary and tertiary crushing and screening plant will be as follows:

- a 9 tonne surge bin;
- a 54" Rollercone, secondary cone crusher;
- a 6'x 20' triple deck, horizontal screen;
- a 2100 Cedar Rapids, tertiary vertical shaft impact (VSI) crusher;
- 2 (7'x 20') triple deck, horizontal product screens;
- 6 x 35 tonne product / blending bins;
- product conveyors / radial stackers;
- all connecting conveyors, chute work, supporting structures;
- a bitumen precoat plant;
- a 125 tph pug mill;
- 1 x 500 kVA and 1 x 800 kVA, integrated, diesel powered 'gensets'; and
- a fully enclosed operator facility with PLC and CCTV process control.

Crushing and screening plant modules will be wheel mounted (mobile) for delivery and relocation but will be hydraulically raised on 1 metre high stands for normal operation. The layout of process plant, associated infrastructure and stockpiles is shown in **Figure 3.8**.

Dust, noise and visual control will be afforded by:

- ☐ cloth enclosure of the three screens;
- ☐ cloth enclosure of selected conveyors;
- ☐ dust suppression at all conveyor head pulleys and/or;
- ☐ dust suppression at all crusher feed and discharge points;
- ☐ erection and operation of plant behind product stockpiles and the main visual bund.

The design capacity of the first stage secondary and tertiary crushing and screening plant is 300 tonnes per hour (tph). Crushed and screened product will be conveyed to overhead bins for aggregate storage, blending and either:

- ☐ direct loading to delivery trucks; or
- ☐ transfer to major product stockpiles.

3.4.3 Stockpiling and Loading of Crushed and Screened Product

Products to be generated by the quarry operation include a range of single sized and blended aggregates, blended road bases, crusher dust, ballast and gabion. Blending will be achieved either through use of a conveyor located underneath individual bins directing product to a pug mill, or through the use of a FEL (Cat 980 or equivalent). The mill would be used for blending and stabilising product transported by conveyor.

Facilities will be installed to enable sealing aggregates to be pre-coated with emulsion on site and stockpiled prior to being transported off site. Aggregates will be placed on stockpiles via a ground conveyor (transporting product from blending bins) for subsequent stockpiling or truck loading by FEL.

Blended materials will be similarly ground stockpiled and loaded by FEL. The total tonnage of product stored in stockpiles will be set at minimum of 120,000 tonnes and a maximum of 150 000 - 200,000 tonnes. All loaded material will be weighed prior to leaving the site over a computer linked, 60 tonne weigh bridge.

3.5 Associated Infrastructure

There will be provision for an explosives magazine, a detonator storage area and a flammable liquid area on site in accordance with EPA, mines inspector and work cover standards. Flammable products stored on site will include at least two 10,000 L diesel storage tanks and one 4 500 L storage tank.

Telephone lines to and from the site will need to be established.

During the site development stages there will be demountable office facilities transported to the site for use by quarry personnel.

Other on site infrastructure to be constructed as part of the proposed development will include:

- an oil and lubricant storage shed;
- workshop facilities including storage areas for tools and spares;
- a materials testing laboratory;
- an amenities block including showers and toilets (chemical toilets) etc.;
- a weigh bridge and office;
- a truck wash down area;
- a truck, staff and visitor areas;

Trees will be planted around the amenities area to improve the area and reduce dust generation in the vicinity. Security measures will also be employed to avoid stock entering any area controlled by the quarry operators.

3.6 Fuels and Lubricants

Fuel will be stored in above ground diesel tanks within a bunded area on an impermeable hardstand. Diesel will be pumped directly from delivery tanks into the above ground storage tanks in the process area. The bund will be sufficiently large to contain 110% of the volume of the largest tank within the bund in accordance with AS 1940. Hose couplings will be located within the bund wall and there will be no pipework constructed through the wall. This will contain any spillage and prevent associated soil and groundwater contamination.

Lubricants will also be stored in a designated bunded area with a concrete base. Oil will be delivered to the site in drums which will be unloaded and laid on their sides (to prevent the ingress of water) in the bunded area. When required, oil drums will be placed on a lube and workshop truck and oil will be transferred to equipment using portable pumps.

Inspections of the tanks and the bunded areas will be carried out regularly and fuel supplied will be reconciled with fuel stored to ensure that leakage is not occurring.

Waste oil will be stored for periodic collection and recycling by a local waste contractor. In the event of a spillage, the oils will be contained within the bunded area and pumped to drums for recycling. Residual oil will be absorbed using an appropriate material, and disposed of appropriately. Any spills occurring outside the bunded areas will be cleaned up by excavation of the material and appropriate disposal.

3.7 Water Consumption Requirements

The quarry will use water for the following activities:

- ☐ domestic water supply (potable);
- ☐ dust control during crushing operations (non-potable);
- ☐ dust suppression at the head pulleys of conveyors transferring material of 5 mm or smaller (non-potable);
- ☐ dust suppression within the quarry and hardstand areas (non potable);
- ☐ internal access roads and access road dust control (non potable);
- ☐ fire fighting.

3.7.1 Potable Water

Potable water for drinking and staff amenities will be required at the quarry processing area. Demand for potable water has been estimated at 20 L/person/day. With an estimated maximum workforce of 31 people (including truck delivery fleet), potable water demand will be approximately 620 L per day. Additional water will be provided as required.

Potable water will be trucked to site by a small tanker and stored in an above ground tank (up to 22,500 L) located adjacent to the main office and amenities area. Rain water from roofs of on site buildings will be caught and held for domestic use.

3.7.2 Non-Potable Water

The vast majority of water demand will be for dust suppression. Dust suppression in the quarry area and on the internal road network will be achieved through the use of a water truck, which will spray water as required to minimise dust generation. The water tanker used will hold approximately 25,000 L of water and will be used as required to suppress dust on the site. During dry weather, it is estimated the tanker may be used for up to 4 hours per day, and will need filling about twice per day.

Dust suppression in stockpile areas will be achieved through the use of sprays connected to conveyor head pulleys which transport material of 5 mm or less, during operating hours, delivering a mist spray over the stockpiles and key material handling areas.

Water requirements for dust suppression for the site are anticipated to be in the order of 40 000 to 60 000 L/day, depending on weather conditions.

3.8 Site Water Sources

Raw water will be sourced from the main 3 ML water supply dam, which will be supplemented where necessary from existing farm dams. Water will also be sourced from smaller pollution control structures located around the processing area (shown on **Figure 5.4**).

3.9 Transportation and Access

Access to the quarry site will be obtained via the Monaro Highway, Williamsdale Road and a access road from the junction with Williamsdale to the quarry site (see **Figure 3.10**). Trucks will be limited to 60 km/hr on Williamsdale Road and will adhere to the 100 km/hr speed limit on the Monaro Highway.

The bulk of trucks to be used for the transportation of quarry material off site will be tri-axle trailers with 30 tonne gross loads. It is expected that these will constitute over 90% of the pick up vehicles. The remainder of product will be loaded to, and delivered by, 6 and 8 wheeler rigid trucks, with or without trailers.

It is anticipated that some 32 to 64 loads of product will be transported daily (64-128 truck movements). Projected maximum truck movements would be in the order of 176 per day. Trucks will be loaded directly from the stockpiles by front end loaders or from ground bins and conveyor belts.

Before entering the stockpile area and following loading, trucks will cross the weighbridge which will determine the tare and gross weight of each transportation load.

3.9.1 Access Road

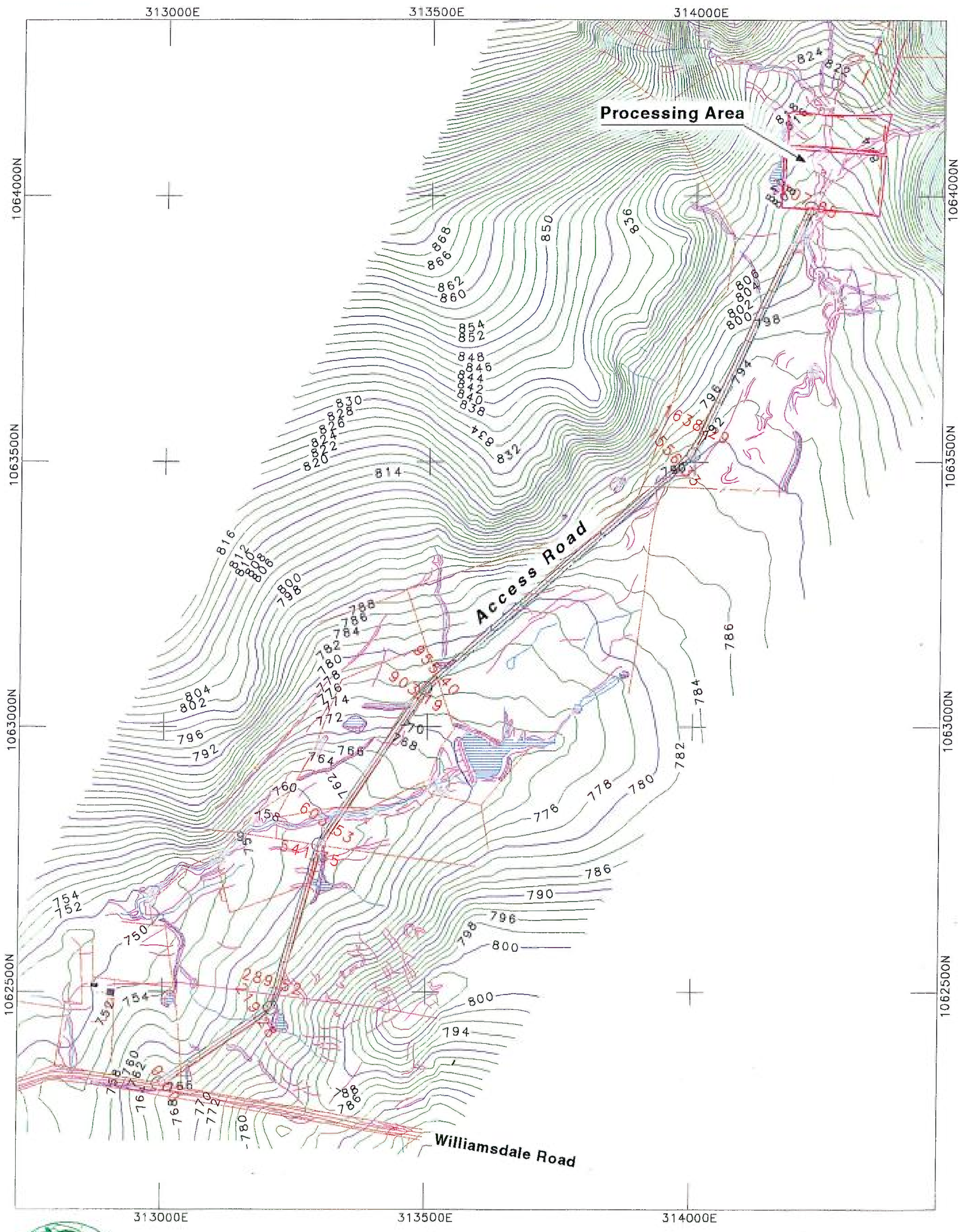
The access road will be designed and constructed as an all-weather unsealed road with the first section to Lobbs Hole Creek being sealed in the first year (see **Figure 3.9**). The remainder of the road will be sealed using quarry produced sealing aggregates when available. It is anticipated that the entire road will be sealed prior to average production of 500,000 tpa being reached. The adopted design speed of the road is 60 km/hr.

The proposed access road will generally follow the route of the existing access track with variations in alignment and grading to accommodate the requirements set by the adopted design speed criteria.

The alignment of the access road will deviate from that of the existing access track from Williamsdale Road, predominantly to allow the construction of the intersection at a location where the best sight distance can be provided.

The access road will feature a 6.4 m wide pavement with 9.0 m total trafficable surface. In addition, 1.0 m wide table drains will be provided as required in road cuttings. Typical batter slopes will be 2 horizontal to 1 vertical. Pavement construction will be in accordance with Council specifications. It is anticipated that all pavement materials will be sourced from the site.

Intersection of Access Road with Williamsdale Road - The layout proposed for the intersection of the Williamsdale Road with the Monaro Highway will consist of a



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Source : ECSI Mining Consultants

0 100 200 300 400 500 m

1: 10 000

FIGURE 3.9
Plan of Access Road

standard type A terminating intersection. The alignment will be angled slightly to facilitate trucks entering and leaving the access road. There is sufficient sight distance and trucks will be required to give way to vehicles already travelling on Williamsdale Road.

Intersection of Williamsdale Road with the Monaro Highway - The existing intersection is an AUL layout (for through traffic only). A composite AUR/AUL layout has also been considered but because conflict is unlikely and this layout may encourage undesirable overtaking, the AUL layout is considered to be the most appropriate treatment for the intersection. This is also supported by the fact that the current Williamsdale Road intersection is infrequently used and the peak transport requirements of the quarry is well within the carrying capacity of the current intersection. It is therefore expected that intersection performance and turning times will be unaffected by the proposed quarry development.

If found necessary within the life of the quarry development, a deceleration lane for south bound traffic on the Monaro Highway turning left into Williamsdale Road will be provided.

Railway Level crossing over Williamsdale Road Although the railway line is not currently in use it is proposed to strengthen the crossing by replacing the existing asphalt pavement with 100 mm hotmix. This will minimise potential impact on the rail line from trucks.

3.9.2 Road Design

Drainage structures will be constructed at natural drainage points along the access road to handle normal runoff. These drainage structures will be designed for an average recurrence interval (ARI) of 100 years, in accordance with Australian Rainfall and Runoff (1987).

Deep shoulder drains, able to be maintained by grader, will be constructed to protect the road pavement.

3.10 Infrastructure

3.10.1 Sewage Treatment Facilities

It is proposed to install an Envirocycle package treatment plant using biological processes to treat the sewage.

Effluent from Envirocycle package aerobic treatment plants contain less polluting organic material and significantly less bacteria than septic tank effluent. Effluent quality requirements for such plants are:

- ☐ Biochemical oxygen demand (BOD_5) 20 mg/L
- ☐ Suspended solids (SS) 30 mg/L

☐ Faecal coliforms (FC) 30 per 100 ml.

These units are circular with five annular segments in series and two centre compartments. The annular segments comprise two primary sedimentation sections and three aeration sections. The centre compartments comprise one clarifier and one disinfection tank. Sludge from the clarifier is returned to the first primary sedimentation tank. Aeration is achieved by a diffused air system and disinfection by chlorine.

Treated effluent will be used to irrigate landscaped and other revegetated areas. Spray irrigation areas will be licensed by the EPA.

3.10.2 Power

Power will be provided by two Diesel Generators (1 x 800 kVA and 1x 500 kVA). The diesel to run these generators will be sourced from a 4,500 litre above ground diesel storage tank that is fully bunded. These two generators will provide power for all requirements at the Processing area including domestic and industrial needs, as well as the conveyor drives.

3.11 Production and Hours of Operation

3.11.1 Project Schedule

It is anticipated that the quarry could be in commercial production within 12 weeks of development consent being granted. Exact scheduling of the development will however, depend upon the time of receipt of development approval and necessary licences and permits, availability of suitable equipment and contractors for both construction and initial quarry operation.

3.11.2 Construction

Construction activities will commence following of development approval, and is expected to last for approximately 12 weeks. A detailed engineering design will be undertaken once development consent has been granted. This work will take into account any requirements in conditions of consent applying to the project.

Contractors will be engaged to carry out the majority of construction activities, with contractors being drawn primarily from the local area. The construction workforce will comprise a combination of skilled, semi-skilled and unskilled labour. There will be a small component of specialist contract labour as well as staff from the proponent's or associated companies who may have to be brought into the area.

Since most of the construction contractors will be locally based, it will not be necessary to establish construction camps on site.

3.11.3 Operation

It is anticipated that activities at the quarry associated with product processing, loading and dispatch will operate 24 hours a day. This is necessary to optimise delivery cycle times and meet customer requirements located across NSW. The actual quarrying activities however, will be restricted to daylight hours, typically from 6.30 am to 6.00 pm. Quarry operations will not normally occur on Sundays or public holidays.

Normal hours of operation have been calculated on the basis of 9.6 hours per day, 5½ days per week, 48 weeks per annum, with 240 tonnes per hour being processed. Normal hours of operation for individual quarry activities will be as follows:

- ☐ quarry development will occur in daylight hours only (nominally 6.30 am to 6 pm), 5½ days per week;
- ☐ the in-pit/quarry operation will occur for approximately 5 - 6 hours per day during daylight hours (ie. 5-6 hours between 6.30 am to 6pm), 5½ day per week;
- ☐ secondary/tertiary processing will take place during a single daily shift (ie. 8 hours plus 2 hours overtime) but on occasion may be required to be double shifted, 5½ days per week;
- ☐ while the majority of truck loading and dispatch will occur during daylight hours, 5½ days per week, the operation will need to be available 24 hours a day, 7 days a week to provide flexibility for transportation requirements;
- ☐ plant maintenance

  - where possible, preventative maintenance will generally be undertaken during production hours. In the event that this is not possible, maintenance will occur after production hours with limited overtime;

  - breakdown maintenance may be required up to 24 hours per day during production stoppages, as per normal quarry practice.

3.12 Workforce

3.12.1 Construction

During the construction period a significant number of contractors will be employed on site. These will include supervisors, surveyors, engineers, drill and blast contractors, electrical, civil, landscape and earthworks contractors. Earthworks contractors will employ operators for dozers, scrapers, graders, excavator, rollers and sealing units at various stages of the construction period.

3.12.2 Operation

During the operation of the quarry the on-site workforce is expected to consist of the following:

- ☐ 1 x driller/shot firer (in house or contracted);
- ☐ 1 x face loader operator (in house or contracted);

☐ 1 x 50 tonne dump truck operator (in house or contracted);

☐ 1 x plant operator;

☐ 1 x relief operator/plant operator;

☐ 1 x sales loader operator;

☐ 1.5 - 2 x weigh bridge operators;

☐ 1 x quarry foreman;

☐ 1 x quarry manager;

☐ 1 x salesman/sales manager(as dictated by market conditions).

All other maintenance and relief staff will be contracted as required.

The quarry operation is expected to support a truck delivery fleet of an average 15-20 vehicles, the bulk of which will be subcontracted.

3.13 Rehabilitation and Erosion Control

3.13.1 Rehabilitation Objectives

Temporary and permanent rehabilitation strategies have been developed for the site, with the primary aim being to maximise surface stability during both the construction phase and establishment of the final landform. The temporary rehabilitation works will be conducted concurrently with temporary erosion and sedimentation controls.

The rehabilitation strategy will be developed to achieve the following objectives:

☐ to produce a final "walk away" landform which is stable and aesthetically consistent with surrounding landforms, yet as far as possible does not preclude possible future land uses;

☐ to minimise the environmental impact of the quarry. This will best be achieved by shaping and revegetating surfaces as soon as possible, consistent with constraints imposed by the operation of the quarry and associated infrastructure. In addition careful use of spoil and topsoil piles will minimise noise and visual impacts;

☐ to ensure that available topsoil resources are optimised while establishing the suitability of alternative topdressing material in the course of the quarry design;

☐ to ensure that the drainage systems at the site will remain stable and functional under extreme rainfall events.

3.13.2 Temporary Erosion Control Systems

Prior to any construction work on site, including clearing of vegetation, soil stripping or access road construction, temporary erosion and sedimentation control structures will be put in place. The primary objective of the proposed erosion and sedimentary control systems is to safeguard against soil loss and consequently, minimise the risk of water quality impacts in downstream areas. The type of systems to be used are described below.

Silt Fences

A series of silt fences will be erected downstream of critical drainage locations in order to contain sediment generated during construction and prior to the stabilisation of surfaces by revegetation works.

The filter fabric used in the silt fences will have a permeability coefficient of 0.02 cm/s, allowing sufficient flow during minor storm events without water build up. Each fence will have a silt retention efficiency of at least 75%, however the overall retention efficiency will be increased by having the two fences in parallel.

Road Batters

Road batters will be constructed to minimise exposed areas and consequent soil erosion. In addition, batters will be topsoiled and revegetated as quickly as possible following disturbance. The batters will be stabilised with grasses to hold the topsoil on site.

If necessary, hydromulching will be used to protect underlying fill material from wind and water erosion, thereby minimising sediment loss. The hydromulching application typically consists of straw, bitumen or polymer binder, seed and fertiliser. The value of the mulch application is that it provides instant protection of the surface soil from erosion and well as protects seeds, improves water holding capacity and germination, and is biodegradable decomposing to form an organic humus.

Drainage Culverts

Additional erosion and sedimentation control systems will be used during construction of causeways or other activities near waterways. Silt traps will be constructed downstream of each crossing and will remain during the life of the quarry.

Drainage beneath each causeway will be provided by a series of precast concrete pipes. The combined cross-sectional area of the pipes will be sufficient to cater for all flows up to a 1 in 100 year, critical duration storm event.

3.13.3 Initial Rehabilitation Works

Rehabilitation works will be conducted on all exposed batters including access roads, quarry process area, the outer face of the dams, construction areas and material stockpiles. These works will be conducted as soon as possible, to stabilise surfaces and prevent erosion.

Topsoil removed from the processing and surge pile areas will be stored in a bund constructed downslope of the processing area. This bund will store the topsoil for the duration of the project and will also provide visual screening and noise shielding for the two residences on Williamsdale Road. It will be approximately 5 m high and will have batters no steeper than 1:2 (V:H).

The topsoil stockpile will be seeded with grasses as soon as construction has been finalised (subject to suitable weather conditions) to stabilise the soil. In addition, shrubs will be planted along the top of the stockpile to further stabilise the pile and to provide additional visual screening of the processing area.

Rehabilitation works may include a spray application of straw mulch material to the ground surface immediately following formation of exposed slopes or topsoiling. The mulch would consist of a mixture of straw, bitumen, fertiliser and seed mix. The primary purpose of this application is to provide immediate surface soil stability to minimise erosion potential while at the same time sowing grass seed and fertiliser.

An appropriate grass seed mix will be based on recommendations made by the Soil Conservation Service now part of the Department of Land and Water Conservation, consisting of a mixture of fast growing, short lived species; slower growing, more hardy grass species; and nitrogen fixing legumes. An example of the type of grass seed mix for different growing seasons in provided in **Table 3.5**.

Table 3.5 - Generalised Seed and Fertiliser Applications

Season	Species	Rate (kg/ha)	Fertiliser *	Rate (kg/ha)
Autumn/Spring	Phalaris (Sirosa) *Phalaris aquatica*	1 - 2		
	Red Clover *Trifolium pratense*	2 - 3	Grower 11	400
	White Clover *Trifolium repens*	1	Starter 15	400
	Subterranean Clover *Trifolium subterraneum*	4		
	Murex Medic *Medicago murex*	2 - 4		
	Cocksfoot *Dactylis glomerata*	1 - 2		
	Tall Fescue *Festuca arundinacea*	3 - 6		
	Tall Wheatgrass *Thinopyrum elongatum*	3 - 10		

The hay mulching present in the spray mixture promotes slow runoff velocities, reducing scour potential. However, even with such a surface sealing, runoff from larger storm events will have the potential to erode steeper batter slopes. The erosion potential will reduce once vegetation is established.

The fertiliser application is likely to be either "Starter 15" or "Grower 11" at a rate of 400 kg/ha. Gypsum may also be applied to improve the soil structure and water infiltration, however this will be determined in consultation with the Soil Conservation Service prior to revegetation works.

Once the areas have been sown they will be regularly watered to maximise germination and sustained growth. Once the final revegetation works are complete and self-regenerating native vegetation communities are established, maintenance requirements will be substantially reduced.

3.13.4 Final Rehabilitation Works

In most areas the final rehabilitation works will be a natural progression and continuation of the initial rehabilitation works. The final "walk away" landform will however, require additional earthworks prior to revegetation, and assume no further quarrying activities after the 30 year development plan covered by this EIS.

Until such time as the quarry has ceased active extraction, rehabilitation will be peripheral only, and will not include the processing area or the quarry itself. This means that rehabilitation will be limited to site landscaping and vegetation works located around the roadways and the processing area.

Areas requiring long term stability will be seeded with a mixture of native tree and shrub species in the initial sowing. Advice will be sought from both the Soil Conservation Service and the National Parks and Wildlife Service for an appropriate species list. It is also proposed to undertake some tree planting in the early stages of the project so that by the time the quarrying operations have reached an advanced stage, these tree screens will be well established and form part of the final landform.

Assuming that no further quarrying activities occur after the 30 year life of the quarry currently proposed, or at such time as the quarry operators intend closure of the quarry, the final void will be secured in a manner acceptable to the Department of Mineral Resources. In order to shield the rural residential community to the north from views of the quarry faces, it is not proposed to throw blast the northern sides of the quarry which would expose the quarry area. A bund will be constructed around the top of the quarry some distance from the face and fencing will be constructed around the pit to limit access to the site. The final grade of the landform will depend on the extent of the quarry operation at the time of intended closure.

Once operations have been completed, all buildings, infrastructure and stockpiles will be removed from the processing area and the area will be shaped and ripped where necessary to prepare it for topsoiling. It is anticipated that only minor regrading will be required for these areas to return the landform to its pre-existing condition. Following shaping and ripping, topsoil from the bund wall will be spread to a depth of

10-20 cm across the processing area and surge pile area and the area revegetated with grasses, shrubs and trees.

Surface preparation prior to rehabilitation works will generally include:

- ☐ contour ripping in advance of normal cultivation and sowing operations to increase moisture infiltration and thus improve and prolong the available moisture for establishing vegetation. This will also aid in reducing surface runoff and subsequent erosion hazard while promoting tree root penetration. These works will be carried out in consultation with an experienced geotechnical engineer in order to avoid potential slope instability;
- ☐ application of gypsum at a rate of approximately 8 tonnes/ha may be required to improve the structure of the material and avoid surface sealing;
- ☐ prior to cultivation fertilisers may be applied to encourage early root development.

Revegetation works will be monitored in order to fine tune rehabilitation methodologies and ensure that a suitable vegetation community is established in the quarry area.

The main water supply dam will remain to collect runoff from the processing area. Runoff waters will contain sediment until final revegetation works are established. Once revegetation works are established, the dam will serve as a valuable water storage for subsequent land uses such as stock grazing.

3.13.5 Final Land Use

The principal objective of the rehabilitation plan is to create a stable landform that poses no long-term environmental hazard. When determining the final land use of the site, a number of other factors need to be taken into consideration, including:

- ☐ land use of surrounding areas;
- ☐ physical limitations of the area;
- ☐ soil availability or suitability of alternative top dressing materials;
- ☐ visual implications and landscape compatibility;
- ☐ existing ecological values;
- ☐ existing land capability for the site and surrounding areas; and
- ☐ requirements of state and local authorities and community organisations.

The final landform of the processing area and surge pile will be similar to that currently existing. The site will be suitably revegetated for agricultural grazing activities and will be reafforested to reflect vegetation communities that naturally occur in the area.

The final void will be treated in accordance with requirements at the time of the mine closure. In addition to ensuring that the site is stable, it is likely that some revegetation of benching will occur. It is important however, to keep final land use options open. During the course of rehabilitation, further opportunities may arise which could influence the final use of the land. Such land uses may be identified from input from local organisations, agencies and community groups.

3.14 Energy Statement and Greenhouse Emissions

3.14.1 Energy Statement

The principal sources of energy to be used in the quarry are electricity and diesel. It is recognised that energy conservation is an important issue in all areas of the quarry operations, and the most energy efficient processes available will be used. At this stage however, it is not possible to accurately define the total energy use, given that at least some of the initial quarry development activities will be undertaken on a contract basis.

3.14.2 Greenhouse Emissions

The use of diesel powered equipment on the site will lead to emissions of carbon dioxide. A number of strategies will be used to minimise greenhouse gas generation. These include:

☐ minimising vehicle usage where possible, and

☐ maintaining vehicles so that fuel efficiency is maximised.

All vehicles and equipment will meet standard emission criteria and will be serviced regularly to optimise fuel consumption and minimise the generation of green house gases. These strategies will be implemented as part of the National Greenhouse Strategy.

4. Project Justification and Alternatives

This Section justifies the project in terms of the supply and demand for quarry materials. How the proposed Williamsdale Quarry will fit into Totalcare's overall operations is also explained and alternatives discussed.

4.1 General

Justification for the proposed quarry development is nominated by the proponent as being essentially twofold, ie:

- ☐ to allow Totalcare Engineering Maintenance to develop a fully integrated business structure to compete for future public and private sector contracts on an equal footing with private sector entities; and
- ☐ to ensure that the Corporation has long term access to a reliable source of premium quality aggregates, road pavement materials and other construction materials able to meet relevant specifications, at a competitive price, at all times.

These two strategic objectives are considered by Totalcare management to be critical to the long term commercial viability of their core business activities in engineering maintenance services. The realisation of the two objectives relies on approval of the Development Application for which this EIS has been prepared.

4.2 Company Background

Totalcare Industries Limited (Totalcare) was incorporated on 28 November 1991 and commenced operations on 1 January 1992. The company is wholly owned by the ACT Government, incorporated as an unlisted company and operates subject to the provisions of the Territory Owned Corporations Act. The company is managed through a highly experienced Board of Directors.

The company's original functions comprised a commercial linen service, incineration of clinical wastes, sterilising of surgical instruments, building maintenance and transport services for health care and hospital sectors. The ACT Government transferred a number of additional functions to Totalcare on 1 January 1997. These included project directorship of building and infrastructure construction, property management, engineering maintenance service, fleet management services and an expanded building maintenance service.

The expertise, skills and professionalism of a diverse range of business units are now amalgamated into the five divisions of Projects, Engineering Maintenance, Fleet, Facilities Management, and Mitchell Processing Facilities. A corporate group supports these divisions.

Totalcare Industries Limited provides services to both government and private sectors. The company achieved sales revenue of $87.579 million in 1997/98 through a workforce of 650 employees and a large capital equipment base. Employee skills cover a wide spectrum of professional, technical, trade and administrative competencies. Also, Totalcare has effectively and reliably built a strong contractor and subcontractor network, which enables Totalcare to assemble a strong team to meet any challenge.

Totalcare is a company managing the delivery of capital and maintenance works to government agencies and private sector clients on a competitive basis. An essential component of its business strategy is a continuous improvement philosophy aimed at developing a commercially viable and customer focused organisation. It is the intention of the business units within Totalcare to comply with their customer's requirements by providing services in the most efficient and effective manner. This includes conforming to statutory and regulatory requirements as well as giving consideration to community needs, environmental issues and safety requirements.

4.2.1 Totalcare Engineering Maintenance

Totalcare Engineering Maintenance is a division of Totalcare Industries Limited. This division was born out of previous Commonwealth and ACT Government identities that have provided the roads and stormwater maintenance service for the ACT over many decades. In more recent years this service has been extended to the ACT surrounding regions, including work for local councils, RTA, other government agencies and private clients.

The National Competition Policy of Commonwealth, State and Territory agreements has resulted in significant changes within government for the delivery of services to the community. Governments have been systematically opening up services that were previously provided by an in-house workforce, for public tender to ensure the best value for money service is delivered to the community. Many government in-house providers of services have been shifted into company structures and are required to operate under the same conditions as private sector counterparts to ensure a level playing field in the event of a public tender for those services. Hence the formation of Totalcare Engineering Maintenance.

Totalcare Engineering Maintenance is a local business with a permanent workforce of 100 and additional seasonal personnel of up to 25. It is a dedicated team of people who are building a total roads and stormwater maintenance business to serve its community. The business achieved sales revenue of $22.8 Million in 1997/98. The business must grow and diversify its revenue base to ensure its longterm viability. One area of growth is in the supply of quarry materials to supplement its road construction and maintenance activities.

4.2.2 Integrated Business Structure

The principal reason for the corporatisation was to streamline operations and allow the new entity to compete with the private sector in tendering for future civil and engineering contracts in the ACT and surrounding areas. This strategic planning is in accord with the Federal Government's 'National Competition Policy' designed to ensure a level playing field for competitive tendering.

In order to be competitive when tendering for roads maintenance contracts, Totalcare Engineering Maintenance have determined that they need similar resources and capabilities as their counterparts within the private sector. Such philosophy is considered particularly critical when tendering for turnkey projects. These private sector counterparts are vertically integrated with their own quarries, concrete, asphalt and road maintenance plants.

4.3 Project Justification

The main reasons why Totalcare wish to develop the Williamsdale Quarry can be summarised as follows:

☐ A general shift is occurring throughout Australia towards performance based roads maintenance contracts offered for up to 10 year terms. A similar trend is projected within the ACT and surrounding region. To effectively compete for these contracts a business will need a fully integrated service capable of satisfying the performance contract requirements. Only a few large national companies are currently capable of meeting this demand. The level playing field is tilted in their favour. This situation has the potential to increase the road maintenance costs without increasing quality for local communities.

☐ Totalcare Engineering Maintenance needs to position itself to be competitive with these national companies or become increasingly non competitive. Therefore it is developing a fully integrated business that can give existing and potential clients a "turn key" service for roads and stormwater maintenance requirements. This includes asset inspections, pavement management, maintenance designs/strategies, project and contract management, routine and planned maintenance/construction, emergency response works, supply of materials and the supply of plant and equipment. The proposed Williamsdale Quarry is part of this business development.

☐ The ACT regional market for quarry aggregates is virtually controlled by two national companies. Totalcare as a third player with the Williamsdale Quarry will improve competition and result in gains for the local community.

☐ All aggregates used in road spray sealing are currently transported into the ACT region. The significant truck transport costs are passed on to the local community. The availability of product at Williamsdale Quarry will reduce cartage distances by over 100 km and approximately $10 per tonne.

☐ Shortages have occurred in the previous two years for the supply of spay seal aggregates. This has an effect on the completion of work that can only be conducted over the months of December to March due to temperature requirements. The supply and quality of the spray sealing aggregate from the Williamsdale Quarry will provide a local reliable supply and overcome this problem.

☐ Many roads are failing before their design life. This increases the demand for the scarce roads maintenance dollars available. Specification for road building materials are becoming more stringent to maximise the life of a road. The Williamsdale Quarry will produce a very high grade of aggregate that will satisfy these specifications.

- The proposed Very Fast Train (VFT) will require high quality ballast material. Very few quarries will be able to satisfy the stringent specifications for ballast. A considerable volume of material will be required for construction of the high speed rail line. The Williamsdale Quarry product will satisfy the VFT requirements.
- The development of an International Airport will also require materials that may be provided by the development of the Williamsdale Quarry.

The project is justified on the basis of Totalcare's business objectives and the high quality of the rock that will be obtained on a consistent basis which will enable Totalcare to meet its business objectives. As summary of rock quality considerations is provided below.

4.4 Rock and Product Quality

As nominated in the opening paragraph of Section 3.1.2 - the overall objective of the proposed development is for Totalcare to secure a long term source of premium quality hard rock for the production of specified quarry products for supply to public and private sector works in both the ACT and surrounding areas. In order to be competitive any such source would need to be:

- independent of vertically integrated competitors;
- located as close as possible to ACT markets;
- accessible by major roads;
- large enough to ensure long term supply – say 20 years or more;
- able to be developed and operated at competitive cost.

The only three operational hard rock quarries located within a 60km radius of central ACT markets are owned and operated by Boral and CSR at Mugga Rd, Hall and Cooma Rd Queanbeyan.

Totalcare has a substantial data base on the quality of product from ACT and regional quarries. Based on the geotechnical data available it is asserted that aggregates and other premium quality products from the proposed Williamsdale quarry will be stronger, more durable, sounder and less porous than that available from the three 'ACT quarries'. It is also believed that the proposed quarry will yield a superior sealing aggregate for road construction and maintenance. These conclusions are based on a comparison of test results for:

- Dry Strength (KNs);
- Wet / Dry Strength Variations (%s)
- Los Angeles Values;
- Water Absorption; and
- Polished Aggregate Friction Values.

The massive, homogeneous nature of the Williamsdale resource will to yield aggregates and other quarry products of a consistently high quality. The availability of such guaranteed source of premium quality hard rock is deemed necessary to overcome the historical problem of variable quality supply from established quarries within the ACT and surrounding regions.

Totalcare management strongly believe that better quality raw materials translate to better quality roads, bridges and other civil works. Better quality infrastructure will generally have a longer life and require less maintenance. With all other factors being equal, Totalcare assert that the taxpayer can expect better value for money spent on civil projects when superior quality raw materials (starting with quarry products) are utilised without any substantial cost penalty.

The cost of quarry products at point of use comprises both:

☐ the ex-bin price; and
☐ transport costs.

Ex-bin price represents the value of product at the point of dispatch from the quarry and is generally determined by market forces of supply and demand. Transport costs are principally determined by the cartage distance from the quarry to the point of delivery. Transport costs are generally in the order of $0.10 - $0.15 per tonne per km travelled. Thus every 10km travelled will add something in the order of $1.00 - $1.50 to the delivered cost of materials.

Despite the higher costs involved, Totalcare and others have been importing aggregates and other product from quarries located between 115 km and 160 km from the ACT. Totalcare has incurred these additional costs in order ensure a consistent supply of premium quality quarry materials for specified projects. Resultant, additional costs would not need to be incurred if similar, premium quality product had been available from the 'ACT' quarries.

4.5 Market Areas

The ACT and surrounding regional market for hard rock quarry products is estimated to range from 0.8 to 1.8 million tonnes per annum (mtpa). The reason for the large spread relates primarily to the industries reliance on major projects. If average demand is assumed as 1.2 mtpa then their impact of the proposed Totalcare quarry can be assessed as shown in **Table 4.1**.

Table 4.1 Potential Market Share for Proposed Williamsdale Quarry

Total Market	800,000	1,200,000	1,800,000
Totalcare Prod. TPA			
200,000	25%	17%	11%
350,000	44%	29%	19%
500,000	63%	42%	28%

It is envisaged that the quarry would ultimately capture 20 – 25% of ACT-regional market for hard rock quarry products. The high quality of the rock and the fact that Totalcare demand will underpin production ensures the viability of the quarry.

4.6 Alternatives of the Project

A number of alternatives to the quarry project have been considered including the 'no development' option, alternative quarry sites and alternative quarry plans. These are discussed below.

4.6.1 No Development Alternative

The 'no development' option would potentially sterilise a regionally important quarry resource whose development is considered environmentally viable and commercially desirable. Without development of the resource in the near future, the potential for rural residential encroachment on the area is high, which would limit the future development of the resource.

The consequences of adopting such an option would include the loss of economic benefits to the region (in the form of job creation and financial investment) and significant financial loss to Totalcare who would have to obtain product from elsewhere, often involving substantial haulage.

In the event that the quarry does not go ahead, Totalcare Engineering Maintenance will not be able to achieve their aim of developing a fully integrated business structure to compete for future contracts on an equal footing with the private companies. They will also lose the ability to access a reliable source of premium quality aggregate at all times. This will have the effect of increasing longterm road maintenance costs, particularly the sealing of roads without increasing the quality of roads for local communities. The increased maintenance costs must ultimately be passed on to the general public. Totalcare must be competitive to remain in the market place, so an operation such as the proposed quarry is essential to their future business growth.

In addition, a 'no development' option would not encourage competition in the region and the community would not obtain the resulting benefits.

4.6.2 Off-site Development Options

High quality alternative resources outside the area have been considered and are either limited in quantity (due to resources being exhausted), limited in quality or require additional costs to Totalcare, associated with long distance haulage of material. These alternatives are described below.

Royalla Prospect

The quality of rock underlying the "Black Flat" property of Michelago, approximately 4 km north of Williamsdale was assessed in 1983. The rock was found to be medium grained porphyritic dacitic tuff with a well developed foliation striking generally 005° to 020° and dipping about 80° to the east.

The site was assessed as having less potential than the currently proposed Williamsdale Quarry for two main reasons:

- ☐ the rock at the Williamsdale site is of higher quality than that at Royalla; and
- ☐ the Royalla Prospect site could be seen from the Monaro Highway, with visual screening doing little to reduce the visual impact.

Other Areas

The suitability of the general area stretching from Canberra to Goulburn for the quarry was assessed. It was generally found that reserves in the north western area were unsuitably located in terms of access to road networks, the tourist feature of the Ginninderra Falls would be impacted, and the vegetation and topography (cleared and undulating land) together with the proximity and density of residential developments would result in unacceptable visual impacts.

The central area was also considered to be affected by poor visual amenity, was likely to be affected by future impositions of 1 km residential zone restrictions, and may also contain significant quantities of pyrite and metamorphic textures that may be detrimental to the aggregate suitability of the rocks.

The eastern half of the area was characterised by deep and slightly weathered to fresh corestones commonly being distributed throughout the material, and the durability of the medium and coarse grained granitoid rocks is generally either too low for use as concrete aggregate or is inferior to that of volcanic rocks.

The southern area contains the Royalla Prospect and Williamsdale areas already discussed.

4.6.3 Quarry Planning Alternatives

Alternative quarry plans and locations have been considered in detail within the Williamsdale lease area. Alternative sites for the quarry are limited by the existence and the extent of the hard rock on site in relation to the overburden present across the area. The proposed quarry plan optimises resource recovery and environmental factors associated with the operation.

4.6.4 Conclusion

Detailed attention has been given to the design of the proposed development to ensure that the project can be carried out in an environmentally acceptable manner. The proposed development, as detailed in Section 3, is considered to be the best development alternative having regard to environmental factors, economic considerations and resource utilisation.

5. Emissions and Environmental Effects

This chapter describes the existing air and noise environment of the site and surrounding areas, details the expected air and noise emissions from the operation and outlines the anticipated net effects on the environment. Mitigation measures required to meet EPA assessment criteria are also described and form part of the proposed development.

5.1 Air Quality

Air quality issues associated with the proposed development will be associated with both the construction and the operational phases of the proposed quarry operations.

5.1.1 Climate

Williamsdale is characterised by a temperate climate, with mild summers and cool winters. Data on the climate of the region was obtained from the Bureau of Meteorology Canberra station, which is located approximately 28 km north of Williamsdale. Additional climatic data obtained from the Bureau of Meteorology station at Tuggeranong is contained within the air quality report contained in **Appendix H**.

❐ Temperature

The mean daily maximum and minimum temperature for each month are presented in **Table 5.1**. Highest daily temperatures occur during the summer months of December, January, and February. Peaks in daily temperature of 27.7 ° occur in January. Minimum daily temperatures occur in the winter months of June, July, and August. The minimum daily temperatures occur in July, averaging -0.2°C.

Table 5.1 - Average Monthly Temperatures recorded at Canberra (1939-1998).

Month	Mean Daily Max Temperature (°C)	Mean Daily Min Temperature (C°C)
January	27.7	13.0
February	27.0	12.9
March	24.4	10.6
April	19.8	6.6
May	15.3	3.2
June	12.1	0.9
July	11.2	-0.2
August	12.9	1.0
September	15.9	3.1
October	19.2	6.0
November	22.5	8.5
December	26.0	11.2

Source: Australian Bureau of Meteorology.

☐ Frosts and Fogs

On average, frosts occur during every month of the year, except February. There is an annual average of 99 days with frost. Frosts are most common during the winter months of June, July and August (refer to **Table 5.2**).

Fog typically occurs during the entire year, however fogs are most common in May, June and July. The annual average number of days with fogs occurring is 44.5.

Table 5.2 - Average Monthly Occurrence of Frosts and Fog at Canberra.

Month	Mean number of Days with Frost	Mean number of Days with Fog
January	0.1	1.1
February	-	0.8
March	0.5	2.4
April	5.0	3.9
May	13.4	7.5
June	18.3	8.1
July	21.1	7.7
August	18.6	4.9
September	13.3	3.8
October	6.4	2.7
November	2.0	1.2
December	0.3	0.6

Source: Australian Bureau of Meteorology.

☐ Rainfall

The mean annual rainfall in the area is 630.3 mm, with rainfall occurring on an average of 105.9 days. The greatest amount of precipitation occurs in October, with 65.1 mm of rain, however the month with the greatest number of rainy days is August. The lowest amount of precipitation occurs in the month of June, and the month with the least number of rainy days is February. The mean monthly and yearly rainfall data, together with the mean number of days with rain are presented in **Table 5.3**.

Table 5.3 - Mean Rainfall Data from Canberra (1939-1998).

Month	Mean Monthly Rainfall (mm)	Mean Number of Days with Rain
January	61.8	7.7
February	54.3	6.6
March	52.5	7.1
April	49.8	7.5
May	48.8	8.4
June	40.1	9.2
July	42.6	9.8
August	47.0	11.2
September	51.8	10.2
October	65.1	10.5
November	63.6	9.8
December	52.8	7.9

Source: Australian Bureau of Meteorology.

❒ Wind Speed and Direction

Wind speed and direction recorded at Canberra indicate that winds tend to predominate from the north-west during the morning and afternoon. There is no seasonal shift in wind direction, with winds predominating from the north-west throughout the entire year. Winds tend to be stronger in the afternoon, particularly from July to October (refer to **Table 5.4**).

Table 5.4 - Wind Speed and Directional Data recorded at Canberra (1939-1998).

	9.00 am		3.00 pm	
	Wind Speed and Direction	Calm	Wind Speed and Direction	Calm
January	11 nw	43	26 nw	6
February	12 se	47	23 nw	10
March	14 se	51	24 nw	12
April	13 nw	55	32 nw	14
May	16 nw	57	34 nw	18
June	18 nw	55	34 nw	17
July	21 nw	56	41 nw	14
August	23 nw	48	41 nw	7
September	22 nw	43	42 nw	7
October	23 nw	37	40 nw	6
November	20 nw	38	34 nw	6
December	18 nw	37	29 nw	5

Source: Australian Bureau of Meteorology.
Note: Figures that appear in the above table relate to % occurrence of wind in the dominant direction.

5.1.2 Air Quality Assessment Criteria

To assess the air quality impacts of dust associated with the proposal, it is necessary to be able to refer to objective air quality standards that can be used for comparison against existing, or predicted future air quality. For the purposes of this report, the criteria used are those adopted by the NSW EPA.

To adequately assess impacts, it is necessary to have criteria for both long term (annual) and short term (24 hour) averaging periods. For long term averages, it is necessary to consider both the deposition of dust - that is, the number of grams of dust deposited per square metre per month ($g/m^2/month$), and the concentration of dust in the air - that is, the number of micrograms of dust per cubic metre of air ($\mu g/m^3$). For short term averages, it is usually adequate to consider the concentration of dust in the air, as there are no short term criteria for dust deposition rates.

The NSW EPA has historically noted air quality goals for particulate matter determined by the US EPA and the NHMRC. These, together with other goals referred to in the US, are listed in **Table 5.5**.

It should be noted that the National Environment Protection Council (NEPC) has determined a new set of quality goals for adoption at a national level, which are part of the National Environment Protection Measures (NEPM). These are currently being considered by Federal Parliament and are likely to be adopted by the NSW EPA when they are gazetted. In its recent publication "Action for Air" (EPA, 1998) the NSW EPA has adopted the 50 $\mu g/m^3$ NEPM 24 hour standard for particulate matter less than 10 μm in diameter (PM_{10}) as an interim goal, as well as a new long term reporting goal of 30 μg/m³.

Table 5.5 - Air Quality Standards/Goals for Particulate Matter Concentrations

Pollutant	Standard	Agency
Total Suspended Particulate	90 μg/m³ (annual mean)	NHMRC
Particulate matter < 10 μg (PM_{10})	50 μg/m³ (annual mean)	US EPA
	30 μg/m³ (annual mean)	NEPM
	150 μg/m³ (24 hour period)	US EPA
	50 μg/m³ (24 hour period)	NEPM
	50 μg/m³(24 hour period)	NSW EPA Interim
Particulate matter < 2.5 μg ($PM_{2.5}$)	15 μg/m³ (annual mean)	US EPA
	65 μg/m³ (24 hour period)	US EPA

Concentration

In the following discussion reference is made to three classes of dust, $PM_{2.5}$, PM_{10} and Total Suspended Particulate matter (TSP). $PM_{2.5}$ refers to dust in the fine particle size range 0 to 2.5 μm. PM_{10} dust relates to particles less than 10 μm aerodynamic size and TSP relates to all suspended particles (which are usually in the size range 0 to 50 μm, larger particles settling out too rapidly to be considered a significant air quality issue).

In Australia, the NEPC has proposed a 24 hour PM10 goal of 50 μg/m³ which is part of the NEPM being reviewed by Parliament. The EPA now adopts the NEPM 24 hour standard of 50 μg/m³ as an interim goal and refer to a new annual average of 30 μg/m³ as a long term reporting goal. The NSW EPA Interim goals are designed as regional goals and are therfore not intended to apply at the boundary of any particular development (EPA, 1998). In assessing the impacts of the current proposal it is therefore more appropriate to use the US EPA goals at the lease boundary (ie. 24 hour standard of 150 μg/m³ and an annual average standard of 50 μg/m³ for PM_{10}) in conjunction with their $PM_{2.5}$ goals of 65 μg/m³ (24 hour) and 15 μg/m³ (annual mean).

The NSW EPA also continues to note the NHMRC's 90 μg/m³ annual average goal for total suspended particulate matter (TSP).

The aim of the primary standard is to protect the public against adverse health effects and is not to be exceeded more than once a year. The secondary standard is designed to protect against "known or anticipated adverse effects of a pollutant" and is also not to be exceeded more than once per year.

Deposition

In the past, the EPA has considered that residential areas would begin to experience dust related nuisance impacts when annual average dust deposition levels exceed 4 g/m²/month, and the dust impacts would be at unacceptable levels when they reached 10 g/m²/month. However, these have been refined and it is now considered that perceptible degradation of air quality occurs as a result of a specific project, if the project results in dust deposition levels increasing by a certain margin. The increment in fallout levels before the nuisance level is reached depends on the existing dust fallout levels. **Table 5.6** summarises the criteria.

Table 5.6 - General Criteria for Dust Deposition

Existing dust level (g/m²/month)	Maximum acceptable dust level increase above existing level (g/m²/month)	
	Residential Suburban	**Other**
2	2	2
3	1	2
4	0	1

The criteria for dust fallout levels are set to protect against nuisance impacts and they are not relevant for interpreting the significance of dust in quarry working areas.

5.1.3 Existing Air Quality

Details of the existing air quality are provided in Appendix H.

There are no existing dust deposition or high volume sampling data for the proposed site. Based on a review of land use, it is likely that the existing levels are low, with emissions generally due to agricultural activities such as harvesting and ploughing of fields, or movement of livestock. There will also be particulate emissions from the adjacent Monaro Highway but these will be minimal.

Background dust deposition levels are likely to be less than 2 g/m^2/month, and annual average PM_{10} concentrations would be expected to be of the order of 10 $\mu g/m^3$. Maximum 24-hour PM_{10} concentrations will depend on the presence of nearby sources of particulate matter such as bushfires or remote sources such as dust storms from inland areas to the west. There is no reason to suppose that worst-case conditions for the quarry will correlate with the highest concentrations produced from other sources.

5.1.4 Dust Emissions

Emissions of dust from the site will vary depending on such things as the operation being performed, wind speed, silt and moisture content of the material being moved, as well as other factors. The mine plan and operations of the quarry during Year 30 has been used for modelling the worst case scenario.

Details of how emissions for each operation have been calculated can be found in the full report in **Appendix H**, and are summarised in **Table 5.7**. The majority of emissions come from the processing area and haulage of material off-site. A relatively small fraction (less than 10%) of the total emissions are from operations within the pit. This is important to note since the in-pit activities are closest to the rezoned land to the north of the site.

Table 5.7 - Estimated Dust Emissions

Operation / Activity	TSP emission rate (kg/y)
Drilling	1,152
Blasting	11,008
Front-end-loaders loading dump trucks	3,015
Hauling rock to primary crusher	17,640
Dumping rock to crusher hopper	3,015
Primary crushing	8,820
Conveyer stacking surge pile	2,872
Screening	48,000
Secondary crushing	8,400
Tertiary crushing	55,800
Conveyer stacking stockpiles	2,872
Front-end-loaders loading sales trucks	2,872
Hauling product off-site	126,666
Wind erosion from the pit	13,251
Wind erosion from the stockpile area	4,417
TOTAL	309,800
Ratio of extraction rate to TSP emissions	0.49

5.1.5 Impacts

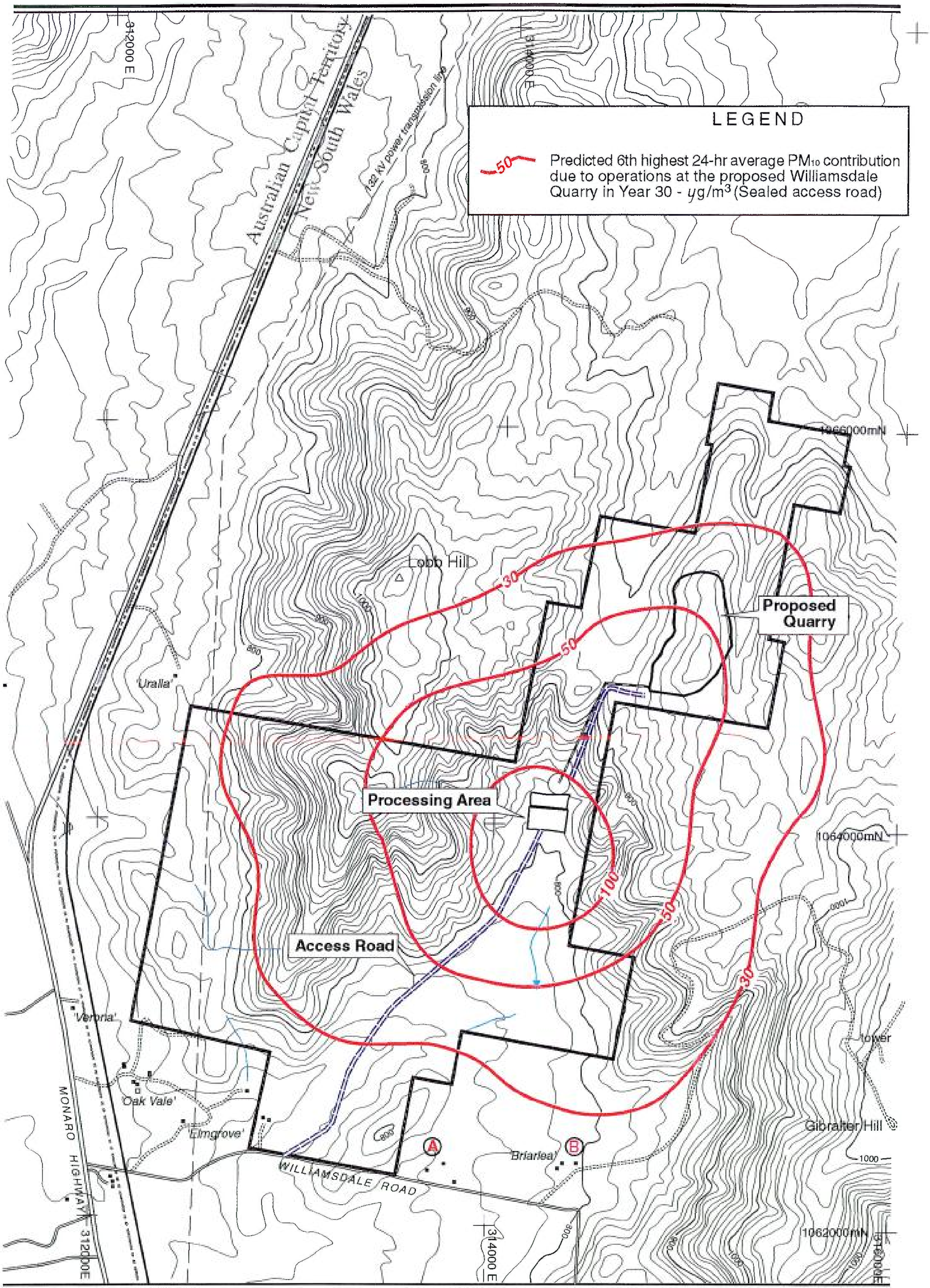
Short-term concentration

The predicted maximum 24-hour $PM_{2.5}$ concentrations due to operations at the quarry in Year 30, are shown in full report in **Appendix H.** Predicted levels at all residences and the rezoned land to the north are expected to be below 15 µg/m^3. This is well below the short-term US EPA goal of 65 µg/m^3, even when a conservative background of 10 µg/m^3 is added.

Consideration of the predicted maximum 24-hour PM_{10} concentration in the area around the proposed site indicates that the US EPA short-term goal of 150 µg/m^3 is not exceeded at either residence investigated, nor is it predicted to be exceeded on any of the land to the north of the site which has been rezoned. Background concentrations would need to be of the order of 100 µg/m^3 or more for the US EPA short-term PM_{10} goal to be exceeded. The NSW EPA's Interim goal of 50 µg/m^3 is predicted to be exceeded at both residences and also on a small fraction of the rezoned land adjacent to the site. However, the more appropriate goal for this assessment is the US EPA 150 µg/m^3 goal.

The NEPM 24-hour goal on which the EPA's Interim goal is based, allows an exceedance of 50 µg/m^3 on five occasions per year. It is anticipated that some areas located around the site will exceed the 24-hour NEPM goal more than five times per year if the access road is not sealed and more than 300 000 tonnes of product is quarried annually. These areas include both residences investigated, but not the rezoned land to the north. This is a conservative estimate of background conditions but one which may not be uncommon close to farming activities on dry windy days.

The largest source of dust emission is due to haulage of product off-site. Sealing the access road north of Lobbs Hole Creek will reduce these emissions from 124,444 kg/y to 2,222 kg/y. **Figure 5.1** shows the sixth highest 24-hour PM_{10} concentrations for



Topographic map source : Williamsdale 1:25000 8726-4-N
Grid : ISG Zone 55/3

0 500 1000m

1: 25,000

N

FIGURE 5.1
Dust Impacts

Year 30 if the road was sealed. Predicted concentrations at the southern residences are less than 30 $\mu g/m^3$ during year 30 if the road is sealed. The quarry is therefore predicted to comply with the NEPM 24-hour goal if the access road is sealed north of Lobbs Hole Creek.

If the road is to be sealed during the first year of operation it is not expected that the short-term PM_{10} goals would be exceeded at any time after that year. There is still the potential then, for the goal to be exceeded sometime during Year 1 when the majority of the access road is unsealed. However, assuming a production rate at or below 300,000 t/y and an unsealed access road during the first year, it is expected that the proposed operation will comply with the NEPM standard during Year 1, with an unsealed access road.

Long-term concentration

Predicted annual average $PM_{2.5}$ levels are well below the US EPA goal of 15 $\mu g/m^3$. This is the case for both residences, as well as for the rezoned land to the north of the site. In addition, the predicted PM_{10} levels due to the proposed operations are expected to remain well below the US EPA annual goal of 50 $\mu g/m^3$, at all residences outside the lease boundary. The NSW EPA's long-term reporting goal is also not expected to be exceeded.

The two residences studied are predicted to experience increases in annual TSP concentration of approximately 15 $\mu g/m^3$ at Year 30 of the quarry operation. If an annual TSP background concentration of 30 $\mu g/m^3$ is assumed, the net TSP concentration would be 45 $\mu g/m^3$. This is below the NHMRC annual goal of 90 $\mu g/m^3$.

Deposition

Assuming that existing levels are of the order of 2 g/m^2/month, no residences are predicted to experience dust deposition levels at or above the NSW EPA's 4 g/m^2/month level. In other words, increases in annual average dust deposition at all residences are predicted to be less than 2 g/m^2/month. This is the case for both the existing residences and also the rezoned land to the north.

5.1.6 Mitigation Measures

The dust impacts of the proposed development on nearby residences and rezoned land are not predicted to cause any adverse impacts off-site. The proposed development is predicted to comply with both the US EPA and NHMRC long-term goals for $PM_{2.5}$, PM_{10} and TSP. Increases in dust deposition are also estimated to be below levels which would cause a nuisance impact at the closest residences.

Since dust generation and deposition due to quarrying activities are below recommended guidelines, no specific mitigation measures are deemed necessary. However, basic dust control measures will be employed to minimise dust generation on site. These will include watering of internal access roads with a water cart; dust control during crushing operations; dust suppression at the head pulleys of all product and transfer conveyors; and dust suppression within the quarry and hardstand areas.

Dust suppression in the quarry area and on the internal road network will be achieved through the use of a water truck, which will spray water as required to minimise dust generation. During dry weather, it is estimated the tanker may be used for up to 4 hours per day, and will need filling about twice per day.

Dust suppression in stockpile areas will be achieved through the use of sprays connected to each of the conveyor head pulleys, during operating hours delivering a mist spray over the stockpiles and key material handling areas.

5.2 Noise and Blasting

A noise and blasting assessment was undertaken by Atkins Acoustics and Associates Pty Ltd, a copy of which is contained in full as **Appendix I**. The study included measurement of ambient background noise levels and an assessment of the impacts of the proposed development both during the construction and the operational phases of the project. A summary of the study and findings is presented below.

5.2.1 Existing Acoustic Environment

Existing ambient noise levels prevailing in the Williamsdale area were measured at selected reference locations in the vicinity of the proposed quarry site from 15 December to 22 December 1998. The locations selected for the measurements were rural residences near the proposed quarry operations. These sites are considered representative of residential dwellings located in remote areas and are in close proximity to existing traffic noise on Williamsdale Road.

The measurement procedures adopted for the assessment were in accordance with the recommendations of the relevant Australian Standards and the normal requirements of the EPA.

The instrumentation selected for the measurements comprised 2 x RTA Technology Environmental Noise Loggers. Details of the instrumentation are found in **Appendix I**.

Ambient noise levels are measured and assessed as percentile A-weighted sound levels. The parameters regarded as being the most important amongst these, are the L_{A1}, or the A-weighted sound level exceeded for 1% of the sample period and referenced as the "maximum noise level", the L_{A10}, or the level exceeded for 10% of the sample period (the average maximum noise level); the L_{A90}, the level exceeded for 90% of the sample period and referenced as the "background or average minimum noise level"; and the L_{Aeq}, which is the A-weighted energy equivalent continuous (constant) sound level.

The ambient noise levels were recorded at two locations as described below:

- ☐ Lot 21 (Lobbs Hole) referred to as R1, and

☐ Lot 22 (Elmgrove Shearing Shed) referred to as R2.

The ambient noise levels recorded at the two sites confirm that the existing noise in the area is typical of rural areas with distant road traffic noise. Noise at the site comes from the Monaro Highway, and local domestic and natural noise elements.

The ambient background noise measurements at both locations are presented in **Table 5.8**, and are below 30 dB(A) during day and night time periods. As outlined in the EPA Environmental Noise Control Manual (ENCM), where the existing background noise level is less than 30 dB(A), then 30 dB(A) should be assumed to be the background noise level.

Table 5.8 - Ambient Background (L_{A90}) Noise Measurements

Location	Time Period		
	Day 6.00 am - 6.00 pm	Evening 6.00 pm - 10.00 pm	Night-time 10.00 pm - 6.00 am
R1	29	29	29
R2	29	29	28

5.2.2 Noise and Blasting Assessment Criteria

For the assessment of noise emissions from quarry operations, it is accepted practice to assess the likely noise in terms of acoustic planning goals for the area, the existing ambient noise levels prevailing, and blast emissions as recommended in the Environmental Noise Control Manual (ENCM) set out by the Environment Protection Authority (EPA).

Operational Noise

For the assessment and evaluation of noise in rural areas, the EPA, Environmental Noise Control Manual (ENCM) recommends that noise emissions from a source should not exceed the background noise level by more than 5 dB(A), providing that the resultant L_{A90} noise level does not exceed the recommended planning level for the area.

In terms of planning goals, the EPA, ENCM (Chapter 21) recommends the background noise levels set out in **Table 5.9**.

Table 5.9 - Recommended Outdoor Background Noise Levels

Zone of Measurement Area	Predominant Land use of Measurement area	Time Period	L_{90} background noise level dB(A)	
			Acceptable Limit	Extreme Limit
Rural	Residential	Day	45	50
		Evening	40	45
		Night	35	40

Based on the EPA guidelines and the existing background noise levels, **Table 5.10** presents the operational noise goals recommended for the quarry proposal.

Table 5.10 - Operational Noise Goals

Assessment Location	Time Period		
	Day 6.00 am - 6.00 pm	Evening 6.00 pm - 10.00 pm	Night-time 10.00 pm-6.00 am
R1	35	35	33
R2	35	35	33

Road Traffic Noise

The noise goals for low traffic flows in rural areas are $L_{Aeq.\ 1\ hour}$ 50dB(A) for new developments, $L_{Aeq.\ 1\ hour}$ 55dB(A) for existing developments and for night time operations the L_{Amax} level should not exceed the background (L_{A90}) level by more than 15dB(A) when measured at any residential building (ENCM).

From the background noise measurements results (30dB(A)), the goals proposed to assess the truck noise from the access road are $L_{Aeq,1hr}$ 50dB(A)and L_{A1} 45dB(A).

Blast Emissions

The EPA ENCM recommend that airblast overpressure and ground vibration when measured at any affected residence should no exceed the goals summarised in **Table 5.11**.

Table 5.11 - Blast Emission Goals

Time of Blast	Airblast Overpressure (dB(lin))	Ground Vibration peak particle velocity (mm/sec)
Monday - Saturday 9.00 am - 3.00 pm	115	5
Monday - Saturday 6.0 am - 9.00 am 3.00 pm - 8.00 pm	105	2
Sunday & Public Holidays 6.0 am - 8.00 pm Any day 8.00 pm - 6.00 am	95	1

It is accepted however, that these levels may be exceeded on infrequent occasions and should be limited to no more than 5% of the total number of blasts and should not exceed 120 dB(lin) at any time. The EPA also accept that in regard to ground vibration the 5 mm/sec goal can be exceeded by no more than 5% of the total number of blasts with a limit of 10 mm/sec at any time.

Construction Noise

The EPA, ENCM guidelines for the assessment of noise impacts for a construction period greater than 4 weeks and less than 26 weeks state that the $L_{A10,\ 15\ min}$ noise level from the construction activities should not exceed the background noise level by more than 10 dB(A). This means that the recommended construction noise goal is 40 dB(A).

5.2.3 Major Noise Sources from the Proposal

Noise and blast emissions from the proposed quarry have been modelled and assessed in terms of continuous noise from the fixed and mobile plant, traffic noise from truck movements, airblast overpressure and ground vibration from blasting.

Quarry Operations

The main quarrying plant of acoustical significance that will be operated on the site will consist of loaders, quarry trucks, a primary crusher, rock breaker, generator, conveyors and a hydraulic drill. For the assessment of noise emissions from this plant, the following sound power levels have been established from previous field measurements.

Table 5.12 - Quarry Plant Sound Power Levels

Plant Description	Sound Power Level dB(A)								
	dBA	63	125	250	500	1k	2k	4k	8k
Primary Crusher	115	113	108	112	110	110	108	107	102
Loader	111	89	91	99	101	106	106	103	98
Rock Breaker									
Conveyors (2 off)	100	96	100	96	92	89	91	93	87
Generator									
Hydraulic Drill	110	110	113	107	109	104	103	96	92
50 ton Haul Truck	112	102	104	104	108	107	106	103	94

Processing Plant

The main processing quarry plant of acoustical significance that will be operated on the site will consist of crushers, screens and conveyors. In terms of mobile plant, the loaders, and quarry trucks are the main items of plant that have been considered. For the assessment of noise emissions from this plant, the following sound power levels have been adopted.

Table 5.13 - Plant Sound Power Levels

Plant Description	Sound Power Level dB(A)								
	dBA	63	125	250	500	1k	2k	4k	8k
Secondary Crusher	115	113	108	112	110	110	108	107	102
Tertiary Crusher	111	89	91	99	101	106	106	103	98
Pug Mill	112	95	94	99	102	110	108	105	99
Screens	112	95	98	102	108	106	107	103	97
Conveyors (2 off)	100	96	100	96	92	89	91	93	87
Loader (Cat 988)	104	101	112	101	102	99	96	91	86
Generator									
Quarry Truck	106	96	98	98	102	101	100	97	88

Transient/Intermittent Truck Noise Sources

Transient/intermittent noise from the quarry is associated with truck movements. **Table 5.14** presents a summary of the sound power levels adopted for the assessment of the truck noise levels.

Table 5.14 - Truck Noise Sound Power Levels

Plant Description	Sound Power Level dB(A)							
	dB(A)	63	125	250	500	1K	2K	4K
Truck (SEL)	114	109	110	112	111	109	106	104
Truck (T_{amax})	110	100	101	100	99	110	96	91

SEL - Sound exposure level

Blast Design

For assessing the likely effects from the quarry blasts, significant detail has been provided within **Section 3.4.5** in relation to blast design options, monitoring and forecast impacts.

5.2.4 Predicted Impact Assessment

Noise emissions from the site operations were modelled using three weather scenarios:

☐ calm (no wind, relative humidity of 50%, air temperature of 20°C)

☐ wind enhanced (1m/sec north wind, relative humidity of 50%, air temperature of 20°C)

☐ default temperature inversion conditions (temperature gradient 5°C/100 m, 50% relative humidity, air temperature of 20°C).

In addition, five quarry development scenarios were considered:

☐ Stage I - Before any substantial worked faces are established drilling on exposed areas of the quarry;

☐ Stage II - Year 5 - with quarry faces established. Drilling on higher benches (RL965) with quarrying at lower level (RL955). Processing plant operating (RL81-813);

☐ Stage III - Year 10 - with extended quarry faces established. Drilling on higher benches (RL965) with quarrying at lower level (RL940). Processing plant operating (RL810-813)

☐ Stage IV - Year 25 - with extended quarry faces established. Drilling on higher benches (RL960) with quarrying at lower level (RL955). Processing plant operating (RL810-813)

☐ Stage V - Year 30 - with extended quarry faces established. Drilling on higher benches (RL955) with quarrying at lower level (RL910). Processing plant operating (RL810-813)

The assessment is based on the assumption that all fixed and mobile plant is operating simultaneously, representing the worst case scenario.

The predicted noise levels at each residential assessment location under calm weather conditions is given in **Table 5.15** and **Figures 5.2** and **5.2a**, where it can be seen that under such conditions no criterion are exceeded.

Table 5.15 - Predicted Noise Levels during Calm Weather

Assessment Location	Scenario Stage I	Stage II	Stage III	Stage IV	Stage V
R1	25	28	28	28	28
R2*	< 25	< 25	< 25	<25	<25
R3	25	28	26	26	26

* - Residence associated with quarry proposal

The noise predictions made under conditions that incorporate changes in wind and temperature are provided in full in **Appendix I**. In summary, both down wind and temperature inversion effects result in an increase in noise levels of between 10 - 12 dB(A).

Considering the recommended noise controls and given that the predicted exceedances are under limited climatological conditions, the opinion is held that the operation of the quarry is not likely to result in an unacceptable noise impact at existing residential dwellings.

In the later years of quarry operations, operational noise will extend further north. By Year 30, the 35 dB(A) contour extends slightly into the rezoned area to the north, however the 40 dB(A) which would represent a constraint to housing development, remains within the proponents land holding. Until noise monitoring data confirms or otherwise the predictions made in this EIS, it would be prudent to avoid housing development within the 35 dB(A) contour.

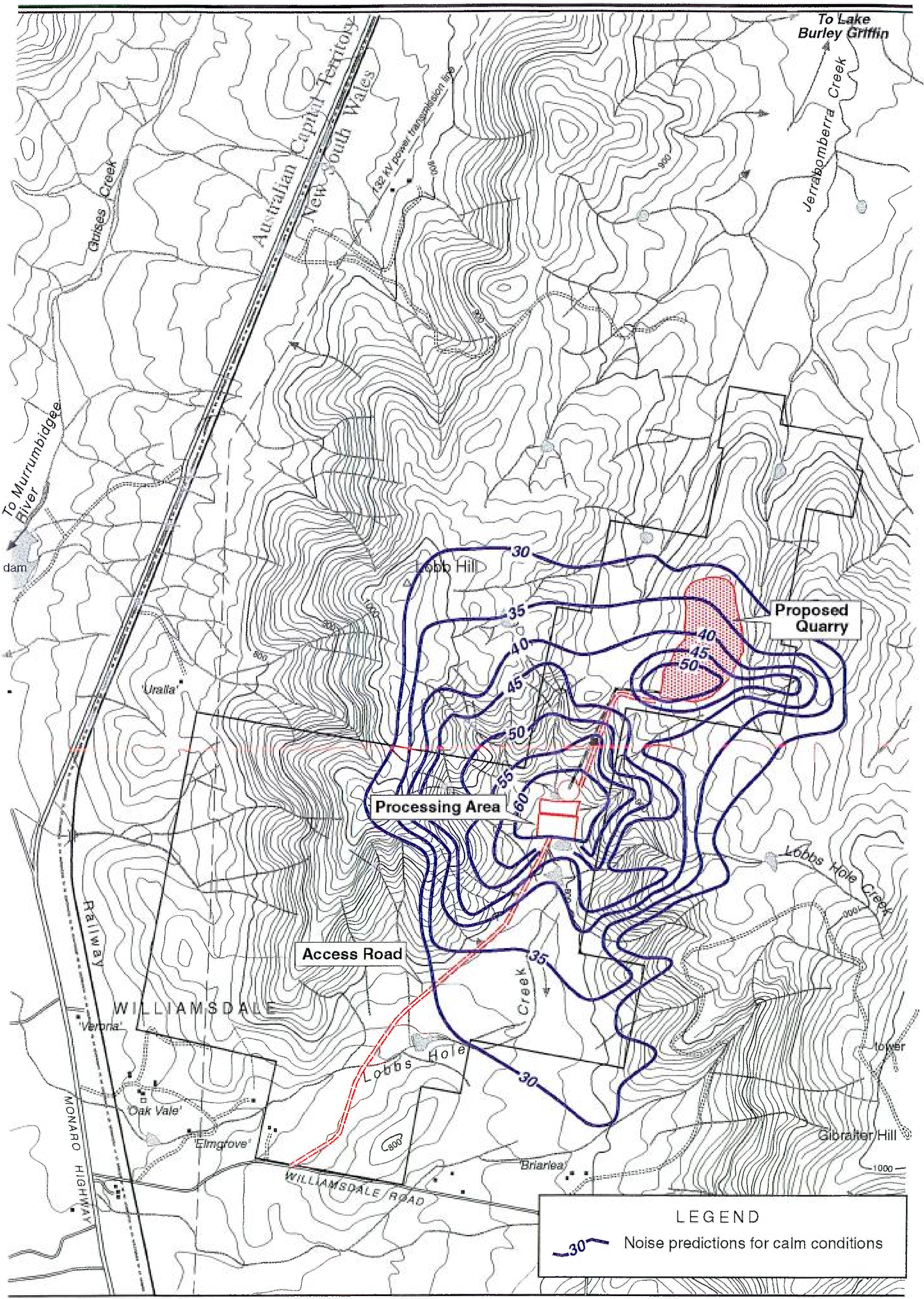
Road Traffic Noise

For the evaluation of truck noise on the site access road, the assessment has considered Single Event Sound Power Level (SEL) from a typical truck to be 114 dB(A) and generation of up to 20 truck movements per hour with regard to the following relationship:

$$L_{Aeq,1hour} = SEL + 10\log(N) - 10\log(3600) - 20\log(r) - 8$$

where:
SEL = Sound Exposure Level
N = number of events per hour
3600 = number of seconds in 1 hour
r = distance from road
8 = constant for converting sound power levels to sound pressure levels.

The predicted noise levels from the projected truck movements are summarised in **Table 5.16**. These results confirm that the noise from trucks on the site access road satisfy the EPA $L_{aeq.\ 1\ hour}$ 50 dB(A) goal.



Topographic map source : Williamsdale 1:25000 8726-4-N
Grid : ISG Zone 55/3

FIGURE 5. 2
Noise Contours

❒ Wind Speed and Direction

Wind speed and direction recorded at Canberra indicate that winds tend to predominate from the north-west during the morning and afternoon. There is no seasonal shift in wind direction, with winds predominating from the north-west throughout the entire year. Winds tend to be stronger in the afternoon, particularly from July to October (refer to **Table 5.4**).

Table 5.4 - Wind Speed and Directional Data recorded at Canberra (1939-1998).

	9.00 am		3.00 pm	
	Wind Speed and Direction	**Calm**	**Wind Speed and Direction**	**Calm**
January	11 nw	43	26 nw	6
February	12 se	47	23 nw	10
March	14 se	51	24 nw	12
April	13 nw	55	32 nw	14
May	16 nw	57	34 nw	18
June	18 nw	55	34 nw	17
July	21 nw	56	41 nw	14
August	23 nw	48	41 nw	7
September	22 nw	43	42 nw	7
October	23 nw	37	40 nw	6
November	20 nw	38	34 nw	6
December	18 nw	37	29 nw	5

Source: Australian Bureau of Meteorology.
Note: Figures that appear in the above table relate to % occurrence of wind in the dominant direction.

5.1.2 Air Quality Assessment Criteria

To assess the air quality impacts of dust associated with the proposal, it is necessary to be able to refer to objective air quality standards that can be used for comparison against existing, or predicted future air quality. For the purposes of this report, the criteria used are those adopted by the NSW EPA.

To adequately assess impacts, it is necessary to have criteria for both long term (annual) and short term (24 hour) averaging periods. For long term averages, it is necessary to consider both the deposition of dust - that is, the number of grams of dust deposited per square metre per month ($g/m^2/month$), and the concentration of dust in the air - that is, the number of micrograms of dust per cubic metre of air ($\mu g/m^3$). For short term averages, it is usually adequate to consider the concentration of dust in the air, as there are no short term criteria for dust deposition rates.

The NSW EPA has historically noted air quality goals for particulate matter determined by the US EPA and the NHMRC. These, together with other goals referred to in the US, are listed in **Table 5.5**.

It should be noted that the National Environment Protection Council (NEPC) has determined a new set of quality goals for adoption at a national level, which are part of the National Environment Protection Measures (NEPM). These are currently being considered by Federal Parliament and are likely to be adopted by the NSW EPA when they are gazetted. In its recent publication "Action for Air" (EPA, 1998) the NSW EPA has adopted the 50 $\mu g/m^3$ NEPM 24 hour standard for particulate matter less than 10 μm in diameter (PM_{10}) as an interim goal, as well as a new long term reporting goal of 30 μg/m^3.

Table 5.5 - Air Quality Standards/Goals for Particulate Matter Concentrations

Pollutant	Standard	Agency
Total Suspended Particulate	90 μg/m^3 (annual mean)	NHMRC
Particulate matter < 10 μg (PM_{10})	50 μg/m^3 (annual mean)	US EPA
	30 μg/m^3 (annual mean)	NEPM
	150 μg/m^3 (24 hour period)	US EPA
	50 μg/m^3 (24 hour period)	NEPM
	50 μg/m^3(24 hour period)	NSW EPA Interim
Particulate matter < 2.5 μg ($PM_{2.5}$)	15 μg/m^3 (annual mean)	US EPA
	65 μg/m^3 (24 hour period)	US EPA

Concentration

In the following discussion reference is made to three classes of dust, $PM_{2.5}$, PM_{10} and Total Suspended Particulate matter (TSP). $PM_{2.5}$ refers to dust in the fine particle size range 0 to 2.5 μm. PM_{10} dust relates to particles less than 10 μm aerodynamic size and TSP relates to all suspended particles (which are usually in the size range 0 to 50 μm, larger particles settling out too rapidly to be considered a significant air quality issue).

In Australia, the NEPC has proposed a 24 hour PM10 goal of 50 μg/m^3 which is part of the NEPM being reviewed by Parliament. The EPA now adopts the NEPM 24 hour standard of 50 μg/m^3 as an interim goal and refer to a new annual average of 30 μg/m^3 as a long term reporting goal. The NSW EPA Interim goals are designed as regional goals and are therfore not intended to apply at the boundary of any particular development (EPA, 1998). In assessing the impacts of the current proposal it is therefore more appropriate to use the US EPA goals at the lease boundary (ie. 24 hour standard of 150 μg/m^3 and an annual average standard of 50 μg/m^3 for PM_{10}) in conjunction with their $PM_{2.5}$ goals of 65 μg/m^3 (24 hour) and 15 μg/m^3 (annual mean).

The NSW EPA also continues to note the NHMRC's 90 μg/m^3 annual average goal for total suspended particulate matter (TSP).

The aim of the primary standard is to protect the public against adverse health effects and is not to be exceeded more than once a year. The secondary standard is designed to protect against "known or anticipated adverse effects of a pollutant" and is also not to be exceeded more than once per year.

Deposition

In the past, the EPA has considered that residential areas would begin to experience dust related nuisance impacts when annual average dust deposition levels exceed 4 g/m^2/month, and the dust impacts would be at unacceptable levels when they reached 10 g/m^2/month. However, these have been refined and it is now considered that perceptible degradation of air quality occurs as a result of a specific project, if the project results in dust deposition levels increasing by a certain margin. The increment in fallout levels before the nuisance level is reached depends on the existing dust fallout levels. **Table 5.6** summarises the criteria.

Table 5.6 - General Criteria for Dust Deposition

Existing dust level ($g/m^2/month$)	Maximum acceptable dust level increase above existing level ($g/m^2/month$)	
	Residential Suburban	Other
2	2	2
3	1	2
4	0	1

The criteria for dust fallout levels are set to protect against nuisance impacts and they are not relevant for interpreting the significance of dust in quarry working areas.

5.1.3 Existing Air Quality

Details of the existing air quality are provided in Appendix H.

There are no existing dust deposition or high volume sampling data for the proposed site. Based on a review of land use, it is likely that the existing levels are low, with emissions generally due to agricultural activities such as harvesting and ploughing of fields, or movement of livestock. There will also be particulate emissions from the adjacent Monaro Highway but these will be minimal.

Background dust deposition levels are likely to be less than 2 $g/m^2/month$, and annual average PM_{10} concentrations would be expected to be of the order of 10 $\mu g/m^3$. Maximum 24-hour PM_{10} concentrations will depend on the presence of nearby sources of particulate matter such as bushfires or remote sources such as dust storms from inland areas to the west. There is no reason to suppose that worst-case conditions for the quarry will correlate with the highest concentrations produced from other sources.

5.1.4 Dust Emissions

Emissions of dust from the site will vary depending on such things as the operation being performed, wind speed, silt and moisture content of the material being moved, as well as other factors. The mine plan and operations of the quarry during Year 30 has been used for modelling the worst case scenario.

Details of how emissions for each operation have been calculated can be found in the full report in **Appendix H**, and are summarised in **Table 5.7**. The majority of emissions come from the processing area and haulage of material off-site. A relatively small fraction (less than 10%) of the total emissions are from operations within the pit. This is important to note since the in-pit activities are closest to the rezoned land to the north of the site.

Table 5.7 - Estimated Dust Emissions

Operation / Activity	TSP emission rate (kg/y)
Drilling	1,152
Blasting	11,008
Front-end-loaders loading dump trucks	3,015
Hauling rock to primary crusher	17,640
Dumping rock to crusher hopper	3,015
Primary crushing	8,820
Conveyer stacking surge pile	2,872
Screening	48,000
Secondary crushing	8,400
Tertiary crushing	55,800
Conveyer stacking stockpiles	2,872
Front-end-loaders loading sales trucks	2,872
Hauling product off-site	126,666
Wind erosion from the pit	13,251
Wind erosion from the stockpile area	4,417
TOTAL	309,800
Ratio of extraction rate to TSP emissions	0.49

5.1.5 Impacts

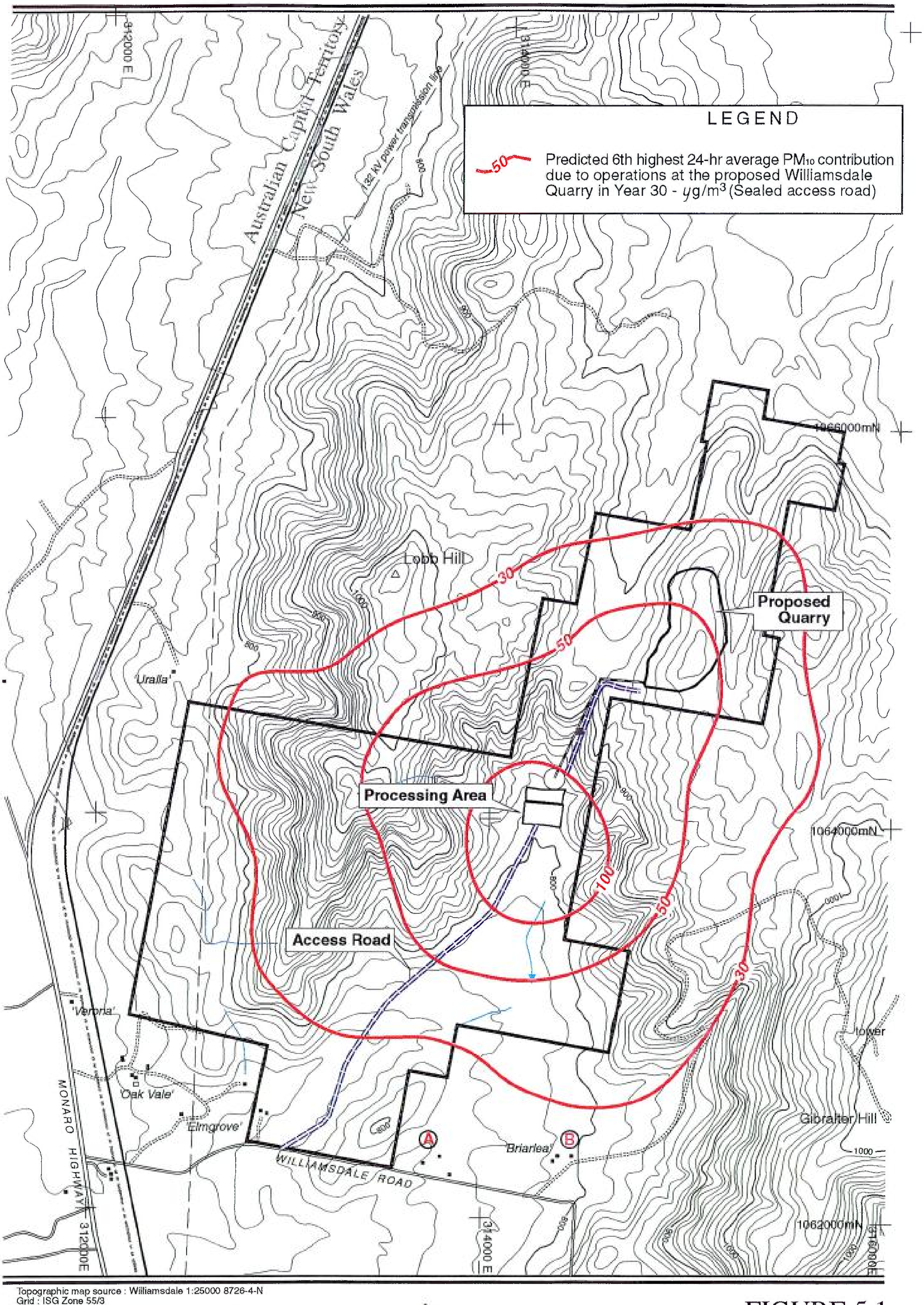
Short-term concentration

The predicted maximum 24-hour $PM_{2.5}$ concentrations due to operations at the quarry in Year 30, are shown in full report in **Appendix H.** Predicted levels at all residences and the rezoned land to the north are expected to be below 15 $\mu g/m^3$. This is well below the short-term US EPA goal of 65 $\mu g/m^3$, even when a conservative background of 10 $\mu g/m^3$ is added.

Consideration of the predicted maximum 24-hour PM_{10} concentration in the area around the proposed site indicates that the US EPA short-term goal of 150 $\mu g/m^3$ is not exceeded at either residence investigated, nor is it predicted to be exceeded on any of the land to the north of the site which has been rezoned. Background concentrations would need to be of the order of 100 $\mu g/m^3$ or more for the US EPA short-term PM_{10} goal to be exceeded. The NSW EPA's Interim goal of 50 $\mu g/m^3$ is predicted to be exceeded at both residences and also on a small fraction of the rezoned land adjacent to the site. However, the more appropriate goal for this assessment is the US EPA 150 $\mu g/m^3$ goal.

The NEPM 24-hour goal on which the EPA's Interim goal is based, allows an exceedance of 50 $\mu g/m^3$ on five occasions per year. It is anticipated that some areas located around the site will exceed the 24-hour NEPM goal more than five times per year if the access road is not sealed and more than 300 000 tonnes of product is quarried annually. These areas include both residences investigated, but not the rezoned land to the north. This is a conservative estimate of background conditions but one which may not be uncommon close to farming activities on dry windy days.

The largest source of dust emission is due to haulage of product off-site. Sealing the access road north of Lobbs Hole Creek will reduce these emissions from 124,444 kg/y to 2,222 kg/y. **Figure 5.1** shows the sixth highest 24-hour PM_{10} concentrations for



Topographic map source : Williamsdale 1:25000 8726-4-N
Grid : ISG Zone 55/3

0 500 1000m

1: 25,000

N

FIGURE 5.1
Dust Impacts

Year 30 if the road was sealed. Predicted concentrations at the southern residences are less than 30 $\mu g/m^3$ during year 30 if the road is sealed. The quarry is therefore predicted to comply with the NEPM 24-hour goal if the access road is sealed north of Lobbs Hole Creek.

If the road is to be sealed during the first year of operation it is not expected that the short-term PM_{10} goals would be exceeded at any time after that year. There is still the potential then, for the goal to be exceeded sometime during Year 1 when the majority of the access road is unsealed. However, assuming a production rate at or below 300,000 t/y and an unsealed access road during the first year, it is expected that the proposed operation will comply with the NEPM standard during Year 1, with an unsealed access road.

Long-term concentration

Predicted annual average $PM_{2.5}$ levels are well below the US EPA goal of 15 $\mu g/m^3$. This is the case for both residences, as well as for the rezoned land to the north of the site. In addition, the predicted PM_{10} levels due to the proposed operations are expected to remain well below the US EPA annual goal of 50 $\mu g/m^3$, at all residences outside the lease boundary. The NSW EPA's long-term reporting goal is also not expected to be exceeded.

The two residences studied are predicted to experience increases in annual TSP concentration of approximately 15 $\mu g/m^3$ at Year 30 of the quarry operation. If an annual TSP background concentration of 30 $\mu g/m^3$ is assumed, the net TSP concentration would be 45 $\mu g/m^3$. This is below the NHMRC annual goal of 90 $\mu g/m^3$.

Deposition

Assuming that existing levels are of the order of 2 g/m^2/month, no residences are predicted to experience dust deposition levels at or above the NSW EPA's 4 g/m^2/month level. In other words, increases in annual average dust deposition at all residences are predicted to be less than 2 g/m^2/month. This is the case for both the existing residences and also the rezoned land to the north.

5.1.6 Mitigation Measures

The dust impacts of the proposed development on nearby residences and rezoned land are not predicted to cause any adverse impacts off-site. The proposed development is predicted to comply with both the US EPA and NHMRC long-term goals for $PM_{2.5}$, PM_{10} and TSP. Increases in dust deposition are also estimated to be below levels which would cause a nuisance impact at the closest residences.

Since dust generation and deposition due to quarrying activities are below recommended guidelines, no specific mitigation measures are deemed necessary. However, basic dust control measures will be employed to minimise dust generation on site. These will include watering of internal access roads with a water cart; dust control during crushing operations; dust suppression at the head pulleys of all product and transfer conveyors; and dust suppression within the quarry and hardstand areas.

Dust suppression in the quarry area and on the internal road network will be achieved through the use of a water truck, which will spray water as required to minimise dust generation. During dry weather, it is estimated the tanker may be used for up to 4 hours per day, and will need filling about twice per day.

Dust suppression in stockpile areas will be achieved through the use of sprays connected to each of the conveyor head pulleys, during operating hours delivering a mist spray over the stockpiles and key material handling areas.

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A noise and blasting assessment was undertaken by Atkins Acoustics and Associates Pty Ltd, a copy of which is contained in full as **Appendix I**. The study included measurement of ambient background noise levels and an assessment of the impacts of the proposed development both during the construction and the operational phases of the project. A summary of the study and findings is presented below.

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The measurement procedures adopted for the assessment were in accordance with the recommendations of the relevant Australian Standards and the normal requirements of the EPA.

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☐ Lot 21 (Lobbs Hole) referred to as R1, and

☐ Lot 22 (Elmgrove Shearing Shed) referred to as R2.

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Operational Noise

For the assessment and evaluation of noise in rural areas, the EPA, Environmental Noise Control Manual (ENCM) recommends that noise emissions from a source should not exceed the background noise level by more than 5 dB(A), providing that the resultant L_{A90} noise level does not exceed the recommended planning level for the area.

In terms of planning goals, the EPA, ENCM (Chapter 21) recommends the background noise levels set out in **Table 5.9**.

Table 5.9 - Recommended Outdoor Background Noise Levels

Zone of Measurement Area	Predominant Land use of Measurement area	Time Period	L_{90} background noise level dB(A) Acceptable Limit	 Extreme Limit
Rural	Residential	Day	45	50
		Evening	40	45
		Night	35	40

Based on the EPA guidelines and the existing background noise levels, **Table 5.10** presents the operational noise goals recommended for the quarry proposal.

Table 5.10 - Operational Noise Goals

Assessment Location	Time Period		
	Day 6.00 am - 6.00 pm	Evening 6.00 pm - 10.00 pm	Night-time 10.00 pm-6.00 am
R1	35	35	33
R2	35	35	33

Road Traffic Noise

The noise goals for low traffic flows in rural areas are $L_{Aeq.\ 1\ hour}$ 50dB(A) for new developments, $L_{Aeq.\ 1\ hour}$ 55dB(A) for existing developments and for night time operations the L_{Amax} level should not exceed the background (L_{A90}) level by more than 15dB(A) when measured at any residential building (ENCM).

From the background noise measurements results (30dB(A)), the goals proposed to assess the truck noise from the access road are $L_{Aeq,1hr}$ 50dB(A)and L_{A1} 45dB(A).

Blast Emissions

The EPA ENCM recommend that airblast overpressure and ground vibration when measured at any affected residence should no exceed the goals summarised in **Table 5.11**.

Table 5.11 - Blast Emission Goals

Time of Blast	Airblast Overpressure (dB(lin))	Ground Vibration peak particle velocity (mm/sec)
Monday - Saturday 9.00 am - 3.00 pm	115	5
Monday - Saturday 6.0 am - 9.00 am 3.00 pm - 8.00 pm	105	2
Sunday & Public Holidays 6.0 am - 8.00 pm Any day 8.00 pm - 6.00 am	95	1

It is accepted however, that these levels may be exceeded on infrequent occasions and should be limited to no more than 5% of the total number of blasts and should not exceed 120 dB(lin) at any time. The EPA also accept that in regard to ground vibration the 5 mm/sec goal can be exceeded by no more than 5% of the total number of blasts with a limit of 10 mm/sec at any time.

Construction Noise

The EPA, ENCM guidelines for the assessment of noise impacts for a construction period greater than 4 weeks and less than 26 weeks state that the $L_{A10.\ 15\ min}$ noise level from the construction activities should not exceed the background noise level by more than 10 dB(A). This means that the recommended construction noise goal is 40 dB(A).

5.2.3 Major Noise Sources from the Proposal

Noise and blast emissions from the proposed quarry have been modelled and assessed in terms of continuous noise from the fixed and mobile plant, traffic noise from truck movements, airblast overpressure and ground vibration from blasting.

Quarry Operations

The main quarrying plant of acoustical significance that will be operated on the site will consist of loaders, quarry trucks, a primary crusher, rock breaker, generator, conveyors and a hydraulic drill. For the assessment of noise emissions from this plant, the following sound power levels have been established from previous field measurements.

Table 5.12 - Quarry Plant Sound Power Levels

Plant Description	Sound Power Level dB(A)								
	dBA	63	125	250	500	1k	2k	4k	8k
Primary Crusher	115	113	108	112	110	110	108	107	102
Loader	111	89	91	99	101	106	106	103	98
Rock Breaker									
Conveyors (2 off)	100	96	100	96	92	89	91	93	87
Generator									
Hydraulic Drill	110	110	113	107	109	104	103	96	92
50 ton Haul Truck	112	102	104	104	108	107	106	103	94

Processing Plant

The main processing quarry plant of acoustical significance that will be operated on the site will consist of crushers, screens and conveyors. In terms of mobile plant, the loaders, and quarry trucks are the main items of plant that have been considered. For the assessment of noise emissions from this plant, the following sound power levels have been adopted.

Table 5.13 - Plant Sound Power Levels

Plant Description	Sound Power Level dB(A)								
	dBA	63	125	250	500	1k	2k	4k	8k
Secondary Crusher	115	113	108	112	110	110	108	107	102
Tertiary Crusher	111	89	91	99	101	106	106	103	98
Pug Mill	112	95	94	99	102	110	108	105	99
Screens	112	95	98	102	108	106	107	103	97
Conveyors (2 off)	100	96	100	96	92	89	91	93	87
Loader (Cat 988)	104	101	112	101	102	99	96	91	86
Generator									
Quarry Truck	106	96	98	98	102	101	100	97	88

Transient/Intermittent Truck Noise Sources

Transient/intermittent noise from the quarry is associated with truck movements. **Table 5.14** presents a summary of the sound power levels adopted for the assessment of the truck noise levels.

Table 5.14 - Truck Noise Sound Power Levels

Plant Description	Sound Power Level dB(A)							
	dB(A)	63	125	250	500	1K	2K	4K
Truck (SEL)	114	109	110	112	111	109	106	104
Truck (T_{amax})	110	100	101	100	99	110	96	91

SEL - Sound exposure level

Blast Design

For assessing the likely effects from the quarry blasts, significant detail has been provided within **Section 3.4.5** in relation to blast design options, monitoring and forecast impacts.

5.2.4 Predicted Impact Assessment

Noise emissions from the site operations were modelled using three weather scenarios:

- calm (no wind, relative humidity of 50%, air temperature of 20°C)
- wind enhanced (1m/sec north wind, relative humidity of 50%, air temperature of 20°C)
- default temperature inversion conditions (temperature gradient 5°C/100 m, 50% relative humidity, air temperature of 20°C).

In addition, five quarry development scenarios were considered:

- Stage I - Before any substantial worked faces are established drilling on exposed areas of the quarry;
- Stage II - Year 5 - with quarry faces established. Drilling on higher benches (RL965) with quarrying at lower level (RL955). Processing plant operating (RL81-813);
- Stage III - Year 10 - with extended quarry faces established. Drilling on higher benches (RL965) with quarrying at lower level (RL940). Processing plant operating (RL810-813)
- Stage IV - Year 25 - with extended quarry faces established. Drilling on higher benches (RL960) with quarrying at lower level (RL955). Processing plant operating (RL810-813)
- Stage V - Year 30 - with extended quarry faces established. Drilling on higher benches (RL955) with quarrying at lower level (RL910). Processing plant operating (RL810-813)

The assessment is based on the assumption that all fixed and mobile plant is operating simultaneously, representing the worst case scenario.

The predicted noise levels at each residential assessment location under calm weather conditions is given in **Table 5.15** and **Figures 5.2** and **5.2a**, where it can be seen that under such conditions no criterion are exceeded.

Table 5.15 - Predicted Noise Levels during Calm Weather

Assessment Location	Stage I	Stage II	Scenario Stage III	Stage IV	Stage V
R1	25	28	28	28	28
R2*	< 25	< 25	< 25	<25	<25
R3	25	28	26	26	26

* - Residence associated with quarry proposal

The noise predictions made under conditions that incorporate changes in wind and temperature are provided in full in **Appendix I**. In summary, both down wind and temperature inversion effects result in an increase in noise levels of between 10 - 12 dB(A).

Considering the recommended noise controls and given that the predicted exceedances are under limited climatological conditions, the opinion is held that the operation of the quarry is not likely to result in an unacceptable noise impact at existing residential dwellings.

In the later years of quarry operations, operational noise will extend further north. By Year 30, the 35 dB(A) contour extends slightly into the rezoned area to the north, however the 40 dB(A) which would represent a constraint to housing development, remains within the proponents land holding. Until noise monitoring data confirms or otherwise the predictions made in this EIS, it would be prudent to avoid housing development within the 35 dB(A) contour.

Road Traffic Noise

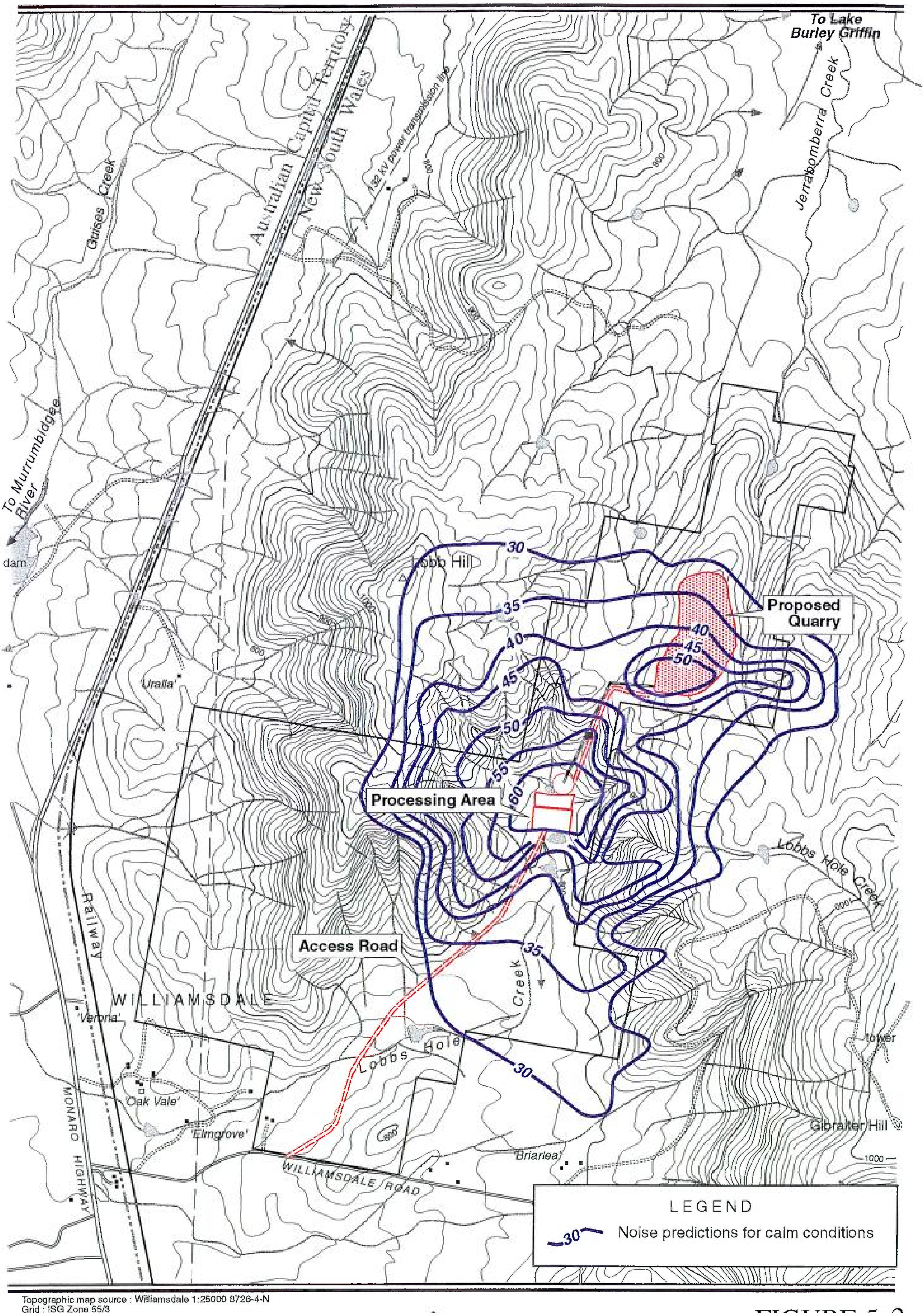
For the evaluation of truck noise on the site access road, the assessment has considered Single Event Sound Power Level (SEL) from a typical truck to be 114 dB(A) and generation of up to 20 truck movements per hour with regard to the following relationship:

$$L_{Aeq,1hour} = SEL + 10\log(N) - 10\log(3600) - 20\log(r) - 8$$

where:

SEL = Sound Exposure Level
N = number of events per hour
3600 = number of seconds in 1 hour
r = distance from road
8 = constant for converting sound power levels to sound pressure levels.

The predicted noise levels from the projected truck movements are summarised in **Table 5.16**. These results confirm that the noise from trucks on the site access road satisfy the EPA $L_{aeq,1\,hour}$ 50 dB(A) goal.

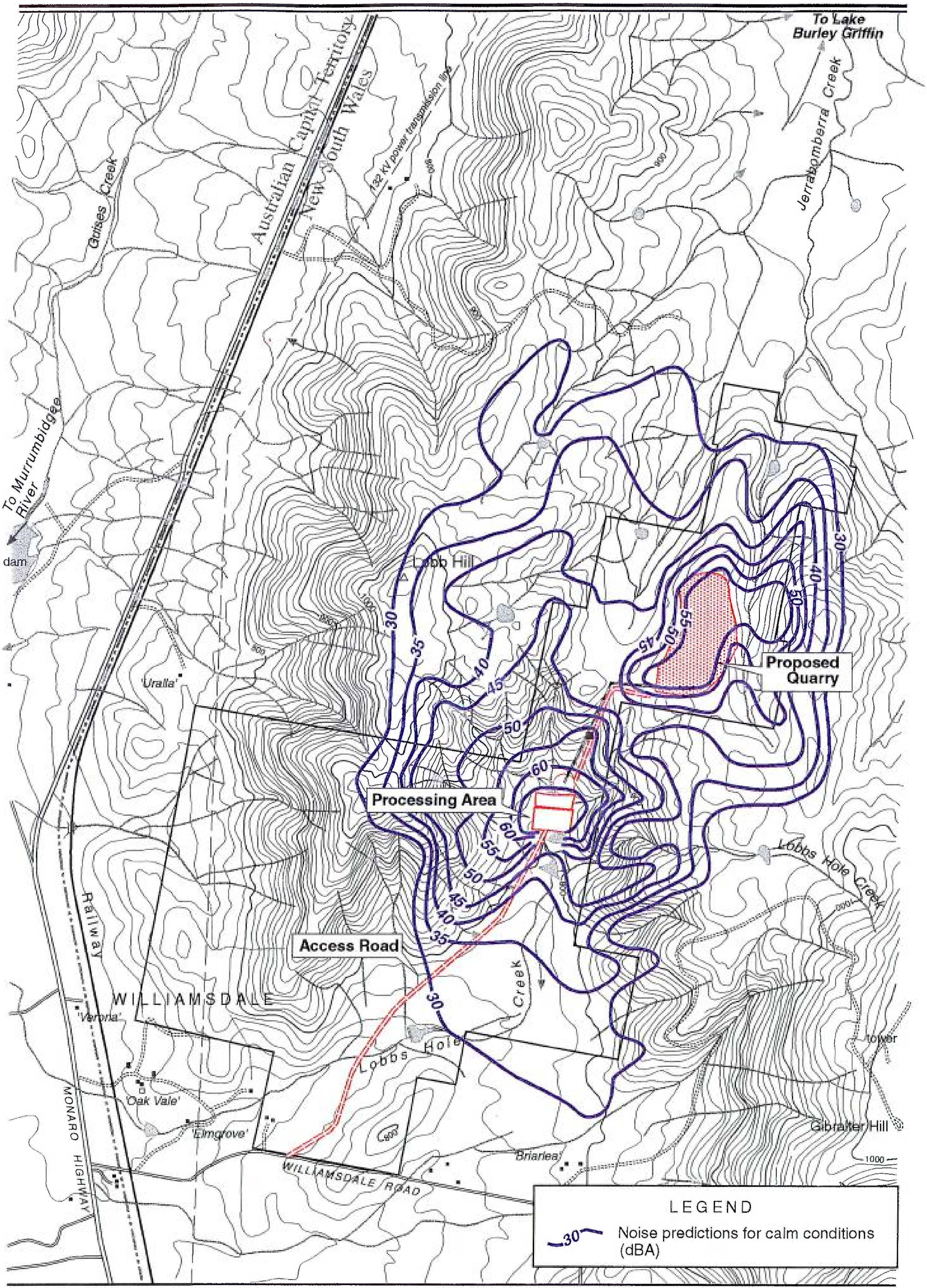


Topographic map source : Williamsdale 1:25000 8726-4-N
Grid : ISG Zone 55/3

0 500 1000m
1: 25,000

N

FIGURE 5. 2
Noise Contours



Topographic map source : Williamsdale 1:25000 8726-4-N
Grid : ISG Zone 55/3

0 500 1000m
1: 25,000
N

FIGURE 5.2a

Noise Contours Calm Weather - Year 30

Table 5.16 - Predicted Truck Noise Levels

Location	Distance (m)	Sound Pressure Level $L_{aeq, 1 hour}$
R1	1150	22
R2*	250	35
R3	600	23

* Residence associated with quarry proposal

Intermittent Truck Noise Sources

In regard to maximum noise levels generated from trucks on the site access road, the noise modelling has shown that the noise contributions (**Table 5.17**) satisfy the assessment goals at locations R1 and R3, and exceed the assessment goal at location R2.

It should be noted however, that the residence at site R2 isa residence associated with the quarry. Elevated noise levels at this particular location are considered to be acceptable to the occupiers of the residence, therefore the fact that noise assessment goals may not be met at this particular residence is of minor importance when considering the noise impacts on the surrounding environment.

Table 5.17 - Intermittent Transient Noise Sources

Plant Description	Sound Pressure Levels L_{A1} dB(A)
Location R1	
Truck Noise	41
Location R2*	
Truck Noise	54
Location R3	
Truck Noise	42

* Residence associated with quarry proposal

Prediction of Blast Vibration and Airblast Overpressure

The results of the modelling for both ground vibration and airblast overpressure are presented in **Table 5.18**. This has shown that the levels satisfy the assessment goals.

Table 5.18 - Summary of Blast Emissions

Reference Location	Predicted Range Ground Vibration mm/sec	Predicted Airblast Overpressure dB(lin)	Assessment Goal Ground Vibration mm/sec	Assessment Goal Airblast Overpressure dB(lin)
Location R1	0.2 - 0.4	101	5	115
Location R2	0.2 - 0.3	99	5	115
Location R3	0.2 - 0.4	100	5	115

The results of the modelling for both ground vibration and airblast overpressure have shown that the levels satisfy the assessment goals.

The impact of blast vibration and airblast overpressure was also assessed in the rezoned area to the north. It is anticipated that the EPA criteria of 5 mm/sec vibration and 115 dB(lin) overpressures will be met at a distance of 500 m and 650 m respectively.

Housing development within the rezoned area to the north should not be located at a distance of less than 650 m from the ultimate quarry boundary in order to avoid unacceptable levels of blast vibration and airblast overpressure. This buffer area could be reduced following the results of noise and blast monitoring, however, at this stage it would be prudent to maintain an adequate buffer around the quarry.

Construction Noise

The envisaged construction activities will include preliminary site works, earthworks, foundation/floor construction, steel erection, building cladding and plant installation. To evaluate noise emissions from the site during construction, these activities have been considered.

A summary of the range of noise levels predicted for the worst case scenario at each of the residential properties being assessed is provided in **Table 5.19** . The noise modelling has shown that the noise from the envisaged construction activities satisfies the EPA medium term noise assessement goal.

Table 5.19 - Predicted Construction Noise Levels

Location	Sound Pressure Levels				
	Preliminary Site Works	Earthworks	Concrete Floors/ Footings	Building Erection	Plant Installation
R1	29	32	31	29	27
R2	26	30	28	26	24
R3	29	32	31	29	27

5.2.5 Noise Mitigation

The noise modelling has shown that with the selection of appropriate plant and the implementation of effective noise controls outlined below, the quarry can be operated to satisfy the recommended assessment goals at all the residences identified as being potentially exposed to the quarry operations.

With respect to trucks transportingmaterials from the site, the assessment has shown that the prioposal will not result in an exceedance of the recommended $L_{\text{aeq. 1 hour}}$ 50 dB(A) goal.

Noise controls and mitigation measures include:

❒ the construction of 4.5 - 5.0 metre high earth mounding on the southern side of the site processing area;

❒ all fixed external plant and equipment should be selected and installed to satisfy a noise specification of less than 85 dB(A) at 1 m;

❒ where practical all fixed internal plant and equipment should be selected and installed to satisfy a noise specification of less than 85dB(A) at one (1) metre;

☐ where practical any plant or equipment installed on the site exceeding a sound pressure level of 85d(A) at one (1) metre should be evaluated in terms of secondary noise controls/enclosures/rooms;

☐ all inloading and building conveyor systems should be belt type conveyors;

☐ all screens should be installed to minimise the transfer of structural borne vibration to building structures;

☐ all dust collection and control systems should be selected on acoustic performance, and without tonal or impulsive noise characteristics;

☐ where practical all permanent site mobile plant shall be fitted with secondary/residential grade noise controls and acoustic treated engine enclosures;

☐ where practical audible alarms will be replaced with flashing lights or a similar system;

☐ as part of the quarry Environmental Management Plan (EMP) a Noise Management Plan (NMP) should be implemented with noise monitoring being conducted during initial stages of quarry development to confirm noise levels and where required assess the practicability of additional noise controls. Subsequent annual noise audits should be undertaken if considered necessary to ensure that all noise control measures are installed and maintained, and that the environmental noise criteria are satisfied. The program should incorporate a complaint management protocol that facilitates investigation and actioning of noise related complaints.

Blast control and mitigation measures include:

☐ MIC of initial blasts be limited to a maximum of 265 kg;

☐ where practical blasting will be conducted between 9.30 am and 5.00 pm;

☐ as part of the quarry EMP a "Blast Management Plan" (BMP) should be implemented with blast monitoring being conducted during initial stages of quarry development to confirm ground vibration and airblast overpressure and where required assess the practicability of additional controls. Subsequent blast monitoring should be undertaken in the initial quarry development to ensure that all blasts are controlled and satisfy EPA requirements. The program should incorporate a complaint management protocol that facilitates investigation and actioning of blast related complaints.

To control noise levels during the construction phase it is recommended that:

☐ As part of the quarry EMP a "Environmental Noise Management Plan" (ENMP) should be prepared and implemented to present the details and procedures that will be employed to minimise construction noise impacts. Noise monitoring should being conducted during initial stages of development to confirm noise levels and where required assess the practicability of additional noise controls. The program should incorporate a complaint management protocol that facilitates investigation and actioning of noise related complaints.

5.3 Surface Water Hydrology

The proposed development is located on the water shed between two major drainage systems as shown in **Figure 5.3**. The waters into which the site flows are not classified waters under the Clean Waters Act, 1970.

The Jerrabomberra Creek system, which drains the northern section of the site, flows north into the Queanbeyan River which flows into Googong Dam, through Lake Burley Griffin and into the Murrumbidgee River. The Lobbs Hole Creek system, which drains the majority of the site, flows south west into the Murrumbidgee River which subsequently flows into Burrinjuck Dam. Entrance to the quarry site is through the valley of the Lobbs Hole Creek which flows from the quarry site in a south-westerly direction.

The headwaters of Lobbs Hole Creek rise in a series of steep narrow ephemeral watercourses which flow from the spurs of Lobb Hill to the north and Gibraltar Hill in the east. These ephemeral watercourses discharge into the relatively flat, broad valley through which Lobbs Creek meanders before discharging into Guises Creek and then into the Murrumbidgee River approximately 3 km east of the site.

No permanent watercourses flow through the quarry area or the processing area. Both the Lobbs Hole and Jerrabomberra Creek systems have been impacted by timber clearing and the construction of dams. Overflow from the dams has created some minor gully and sheet erosion typical of open grazing land. The creek banks have been damaged by stock gaining access to water.

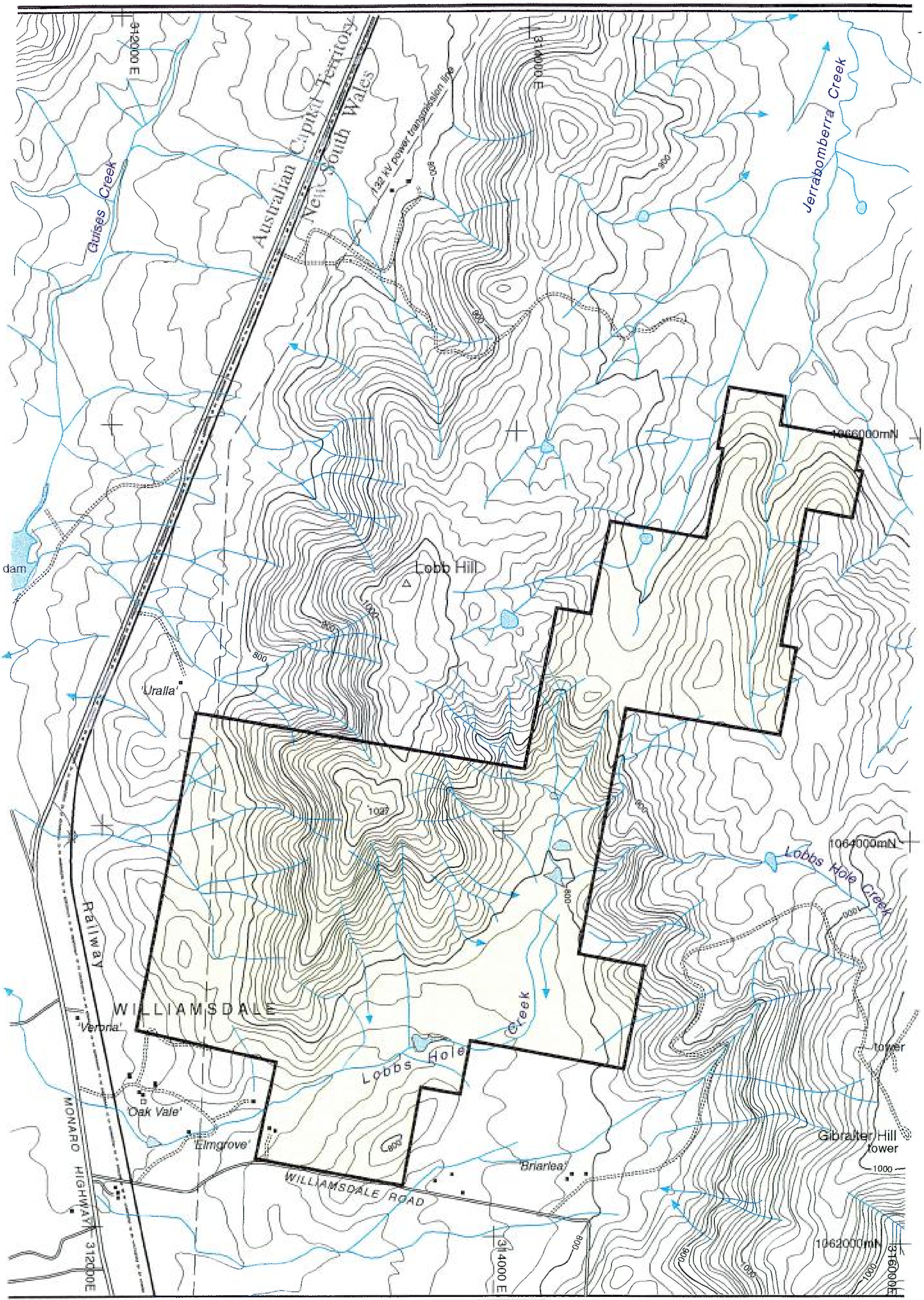
5.4 Groundwater

Groundwater is commonly used in this rural area for watering stock, domestic purposes, and irrigation uses, making it an important commodity. Searches were conducted on the Water Resources records for existing bore data, and an assessment of quarry activities on the groundwater in the area was made. This is presented below, along with recommendations for mitigation measures to protect the groundwater quality of the area.

5.4.1 Criteria for Assessment

Under the provisions of the Water Act, 1912, the Water Administration Act, 1986, and the Clean Waters Act, 1970, groundwater resources in New South Wales are controlled by the Crown.

The Water Act (1912) prohibits interference with the flow and quality of groundwater and requires that licences be obtained for any bores not installed by the Crown. The Water Act can make demands regarding pollution control for groundwater resources.



Topographic map source : Williamsdale 1:25000 8726-4-N
Grid : ISG Zone 55/3

FIGURE 5.3
Drainage Network

Under the provisions of the Water Administration Act, 1986, the control of, and right to use sub-surface water, was placed in the control of the Water Corporation operating through Water Resources.

The Clean Waters Act, 1970 is administered by the EPA and is designed to control pollution of groundwaters.

5.4.2 Hydrogeology and Groundwater

The area has the potential to provide groundwater supplies to rural residential allotments via bores. The main groundwater resource in the area generally occurs below 15 m (Yarrowlumla Council, 1996).

Hydrological conditions are not complex and yields of 0.2 to 0.5 L/sec can generally be expected from bores drilled into fractured rock. There are currently 39 registered bores in the Parish of Burra, and one surface water licence. The bores are licensed for stock and domestic use and typical yields are less than 0.5 L/sec with highest yields being obtained from bores sunk into valley floors.

The groundwater quality is highly variable in the area, originating from the fractured rock, with no definitive aquifers. Water quality measured from one bore in the area appears to be of good quality, while bores located just a couple of hundred metres away are quite saline. Groundwater salinities to the north in the Royalla area were found to be less than 500 mg/L with higher salinities of over 1000 mg/L possibly occurring beneath the lower slopes and valley floors of the main drainage lines.

5.4.3 Impacts and Recommendations

The quarry activities have the potential to impact on groundwater in the event of:

☐ spills of oils and/or lubricants which may seep into the groundwater system; and
☐ problems associated with the on-site septic sewerage system and absorption trenches.

In the event of oil and fuel spills the following mitigation measures will be taken to ensure that groundwater resources are not contaminated by the quarry activities:

☐ an impermeable hardstand area surrounded by an impermeable bund wall will be constructed in the quarry processing area. This will contain spills and prevent groundwater contamination from fuel spillage or oil leakage occurring beneath the process area;

☐ an on-site package sewage treatment system (Envirocycle or similar), will be installed to minimise the impact of sewage on the groundwater.

Thus, to prevent contamination of any deeper groundwater resource in the area all fuel storage tanks will be fully bunded. Any spills will therefore be fully contained and not permitted to seep into the groundwater systems. This will prevent groundwater contamination from fuel spillage and oil leakage occurring around the processing and plant areas.

With these mitigation measures in place, it is not anticipated that activities at the proposed quarry will influence the regional groundwater in the area. The extraction area represents the top of a prominent hill with no adjoining surface or subsurface catchment. During extensive drilling within and surrounding the proposed extraction area, little water was intercepted. None of that encountered would constitute groundwater but was rather recent rainwater infiltration. The resource is uniform and no separate aquifers will be encountered during the life of the quarry. Groundwater resources are therefore unlikely to be affected.

5.5 Water Management Plan

5.5.1 Drainage

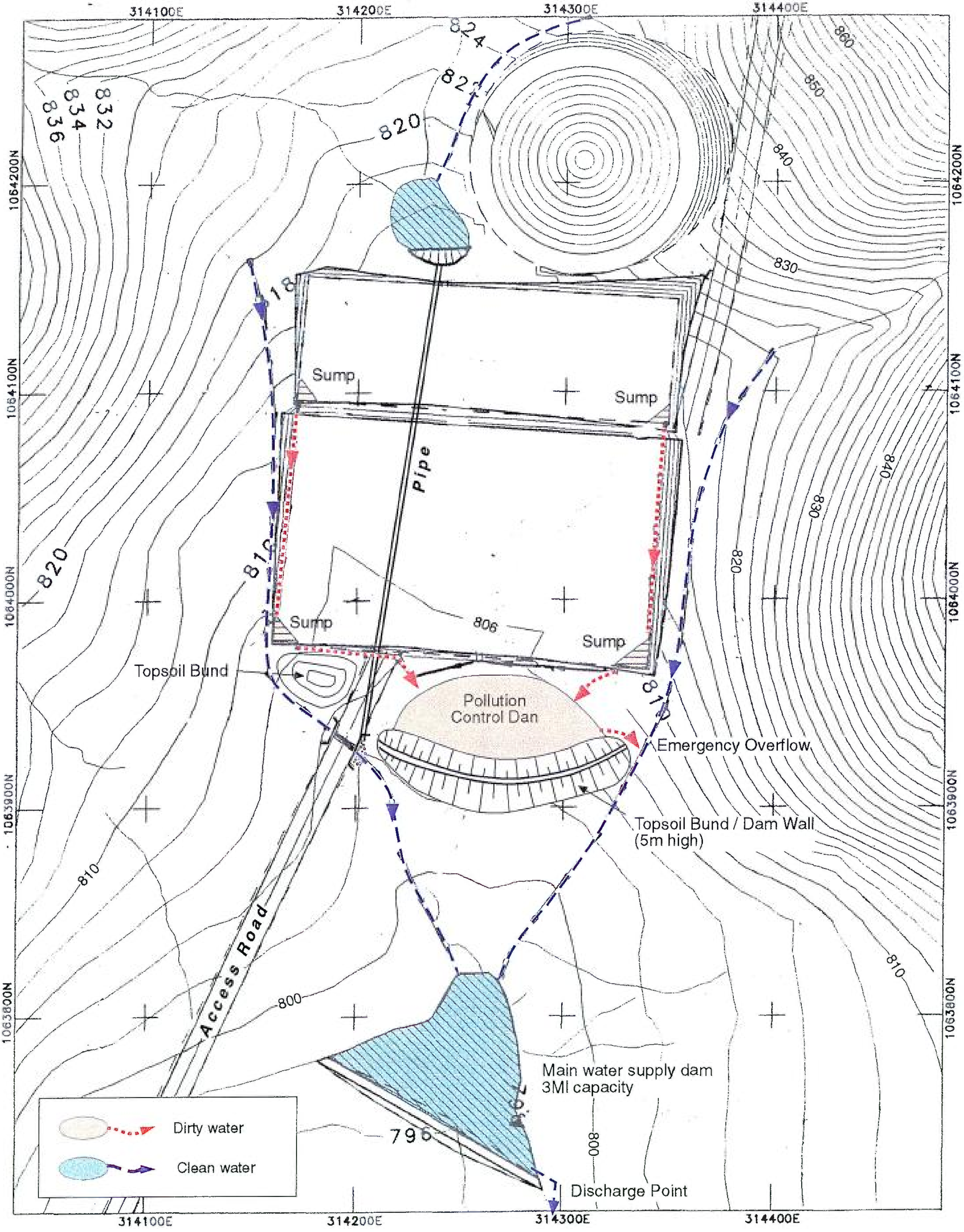
The primary objective of the Water Management Plan is the separation of clean and dirty water systems and the provision of sufficient pollution control facilities to ensure that any site discharges will meet water quality objectives. Since the quarry extraction area is located on top of a hill with effectively no upstream catchment, the dirty water system will be the quarry itself. Some minor diversion works will be required in the early years until the crest of the hill is reached. All rainwater inflows will be contained within in pit sumps which will be used for dust suppression purposes.

The drainage system for the processing area is shown on **Figure 5.4**. Clean water will be separated both around and beneath the hardstand area. Clean surface water to the north of the processing area will be directed into a small catch dam which will feed into an underground pipe which passes the water under the processing area to discharge into the Main Water Supply Dam at the southern end of the site. Clean water from the eastern and western slopes will be directed via diversion channels designed to cater for the peak discharge of a 1 in 100 year, 72 hour storm event. Small energy dissipaters will be installed at the outlets of the main clean water diversion channels. The outlets will also be rock lined for scour protection.

Graded channels will be provided when crossing contours and will generally require erosion protection such as jute meshing or rock armour. The majority of the clean water diversion system will consist of contour channels and will generally have lower grades. However, should flow velocities during the design storm event be greater than 2.5 m/s, erosion control measures such as rock armour or jute meshing will be used.

A dirty water channel will be constructed within the processing area which will direct contaminated water into four sumps. These sumps will be lined and constructed with a concrete ramp suitable for a bobcat to enter for cleaning purposes. From the sumps the water will then be passed into the Pollution Control Dam located adjacent to the southern end of the processing area. Water contained within the Pollution Control Dam will be preferentially used as the raw water source in order to maximise stored volume, however, during storm events, treated water will pass into the Main Water Supply Dam.

5.5.2 Pollution Control Structures



Base Source : ECSI Mining Consulants

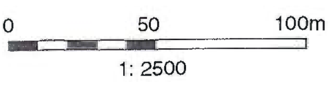


FIGURE 5.4
Water Management Plan

All dirty water generated within the processing area will pass through at least two separate settlement processes prior to entering the Main Water Supply Dam. Should discharges occur from the Main Water Supply Dam, there is an additional and substantial existing farm dam located within the property, downstream of the quarry.

There is approximately 63 ha of clean catchment to the north of the processing area. In a 1 in 100 year storm event of critical duration, that is, when the time of concentration equals the duration of the storm, a peak runoff volume of 9.5 m^3/s will need to be safely passed beneath the process area. Runoff will first be collected in a small 0.4 ML catch dam which will enable water to be directed into the 1,200 mm diameter concrete pipe running beneath the processing area. This pipe will discharge into the Main Water Supply Dam via an energy dissipater and open grassed channel.

The principle function of the Main Water Supply Dam is to harvest clean water from the catchment surrounding the quarry site, which is then used as the main source of water for the quarry. The dam has a holding capacity of 3 ML and will be fed primarily by the clean water diversion system. The total catchment of this dam is approximately 210 ha.

The dirty water catchment includes the surge pile and the hardstand area, approximately 4.2 ha in total. Each of the four internal sumps will have a capacity of approximately 300 m^3 which combined with the 1.3 ML Pollution Control Dam will provide a total dirty water storage capacity of 2.5 ML. This is sufficient to contain all runoff emanating from a 1 in 10 year, 72 hour storm event.

As previously mentioned, overflow water may also enter the Main Water Supply Dam from the Pollution Control Dam. However, this overflow water will have been treated within the concrete sumps and Pollution Control Dam and is expected to be of sufficient quality for offsite discharge. The fact that it enters the Main Water Supply Dam for re-use does not affect the integrity of the overall pollution control performance of the operation but rather represents an added safeguard against sediment leaving the site.

Furthermore, the mixing of clean and dirty water at this point does not represent an environmental hazard, since the water will be fully contained in the Main Water Supply Dam where it is anticipated the water level will remain below the maximum capacity of the dam due to its role as the main source of water for the quarry.

In the event of high volumes in the Main Water Supply Dam, water will overflow at the southern spillway into a channel that feeds directly into a farm dam located on Lobbs Hole Creek where the water will be contained. An EPA licence will be required for any discharges off site and water quality will be monitored prior to any off site discharges in accordance with licence conditions.

6. Land Use and Environmental Effects

This chapter provides details of the surrounding land uses of the development area including soils, land capability, flora, fauna and archaeology and provides details of expected impacts and proposed mitigation measures. Traffic and transportation issues are also described and assessed.

6.1 Surrounding Land Uses

The site of the proposed quarry is currently used for grazing, as are surrounding areas and neighbouring properties. The dominant land use is sheep grazing.

Land to the north has recently been rezoned for rural residential development purposes and it is anticipated that it will be gradually developed over the next decade. Development may commence in approximately a year though no specific dates are available as yet. As the land becomes progressively developed, there will be additional rural residential dwellings located to the north of the proposed quarry site. This area of land to the north that has recently been rezoned can be seen in **Plate 2**.

Council has been aware of the potential for the quarry development for some time and do not consider the quarry activities to be precluded by the proposed rural residential development nor the rural residential development to be precluded by the quarry. The Development Control Plan (Yarrowlumla Council, 1998) places some constraints on development in the rezoned area. Of particular note, physical development other than light agricultural grazing or low impact recreation is not permitted within 400 m of Jerrabomberra Creek. In addition, house sites may not be located on lands steeper than 15%. Consequently, substantial portions of the land to the immediate north of the proposed quarry will not be used for housing.

6.1.1 Potential Impacts

The proposed development of this site will not have a significant impact on surrounding land uses. Grazing activities will be able to continue around the quarry development area without interruption.

During the initial stages of the quarry development there will not be rural residential dwellings to the north of the area. By the time housing has been developed in the area, the quarry operation will be contained within an excavated area below the ridge line which will separate the rural residential dwellings from the quarry operations. Neither visual impacts nor noise impacts are anticipated to be a significant issue for the rural residential dwellings to the north of the quarry area. Occasional noise may be heard during times of temperature inversion and southerly winds however, these impacts are not considered to be major.

The visual and noise impacts on the two residences to the south east of the site will be mitigated by appropriate treatments to minimise the effect of the operation on the residents. These treatments will ensure that the land use on the surrounding properties is not compromised by the development.

6.2 Land Capability

The land capability of an area refers to its ability to support a particular intensity of urban development without serious erosion and sedimentation problems occurring during the construction phase, as well as in the long term. The rural capability of an area refers to its ability to sustain regular agricultural and pastoral production without permanent damage.

The Department of Land and Water Conservation (DLWC) has classified the land in this area according to its capability for agricultural use. The classification depends on a number of factors including slope and soil fertility. Eight classes are identified and a brief description of each of these is provided below.

Class I	Suitable for a wide variety of uses, with the highest potential for agriculture.
Class II	High potential for agricultural use, but with increasing limitation.
Class III	Generally fair to good agricultural land.
Class IV	Not generally suitable for cultivating on a regular basis; comprises the better classes of grazing land.
Class V	Not suitable for cultivation; production generally lower than for grazing land in Class IV.
Class VI	Comprises the least productive grazing land.
Class VII	Generally comprises areas of steep slopes with shallow soils; clearing of timber not recommended.
Class VIII	Land unusable for agricultural or pastoral purposes; preservation of the natural vegetation recommended.

Under the DLWC's classification, the area affected by the development is classified as Classes IV, V and VI. The land is largely unsuitable for cultivation but is suitable for grazing purposes. Class IV land is found on the lower slopes in the area while Class VI land is found on areas of steep slopes, shallow soils, rocky outcrops and water logging.

The Williamsdale area is generally considered to have high limitations for urban development, due to waterlogging being common and subsequent problems with septic effluent disposal. In addition, land with steeper slopes ($>20^0$) is regarded as too steep for development (Yarrowlumla Council, 1996).

A local environmental study was carried out by Yarrowlumla Council in relation to the rezoning of the land to the north of the quarry lease area (1996). Following this, a Development Contol Plan (No.6) was prepared in 1998. These documents state that physical development other than light agricultural grazing or low impact recreation is not to occur within 400 m of Jerrabomberra Creek to minimise water quality degradation and soil erosion. In addition, Class 1, 2 and 3 agricultural land in the area (generally corresponding with the land adjacent to Jerrabomberra Creek) is not be compromised. Thus the development to the north will be limited by environmental parameters and as a result will be more compatible with the quarry operations.

6.2.1 Future Land Use

It is important to keep final land use options open, however, in keeping with current local land use and zoning of the area, it is anticipated that the future land use of the quarry site will also be predominantly grazing activities. The activities of the proposed quarry will not limit future land uses of the area surrounding the quarry site. The quarry area itself will consist of an open void to which access will be prohibited.

6.3 Soils

6.3.1 Existing Soils

Soils in the proposed project area fall into two broad categories - Colluvial Landscapes of Campbell, and Transferral Landscapes of Williamsdale (DLWC, 1993). The soils and their capabilities are described separately below and the information has been drawn from the DLWC (1993) report.

Colluvial Landscape

A number of different soil classes are found in this area, varying in depth generally according to their location within the landscape. Rapidly drained Lithosols (<30 cm) and shallow Earths occur on crests and near rock outcrops. Red Podzolic Soils and Yellow Podzolic Soils are moderately deep (<70 cm) and moderately well-drained. Along drainage lines are soils of variable depths (usually 60-120 cm) which are imperfectly drained Solodic Soils or Solonetzic Soils and Gleyed Podzolics.

The shallow and poorly drained soils occurring in the landscape are of low to medium suitability as a growth medium. The other soils are moderately suitable, and are generally considered reasonable for pasture species and most trees.

The topsoils in the area generally have a good water holding capacity with a high organic content and moderate acidity. However, limitations such as very low available phosphorus, low clay content, very low nutrient storage capacity and moderate sodicity occur. The subsoils may have high clay content and a moderate nutrient storage capacity, but are very low in available phosphorus and organic matter. Calcium and potassium deficiencies also occur.

Transferral Landscape

The soils in Transferral Landscape are typically moderately deep and moderately well drained Yellow Podzolic Soils on the higher areas of the landscape, with a total depth of less than 100 cm. On flat areas and lower rises the soils tend to be moderately to very deep, poorly to imperfectly drained Solodic Soils and Solodised Solonetz Soils, with a total depth generally 80-120 cm but they may be deeper.

The soil material has a moderate to low suitability as a growing medium. The topsoil has only moderate water retention capacity, with high organic content and is reasonably acidic. There is typically a low clay content, and a low capacity for nutrient storage with very low available phosphorus. The lower subsoils also have very low nutrient storage capacity and very low phosphorus, as well as low organic matter content. Seasonal waterlogging is a limitation, along with a moderate to high wind erosion hazard.

The poorly drained Solonetz Soils and Solodic Soils on the lower flat areas have low suitability as a growth medium, however the Yellow Podzolic Soils on the upper ridges are moderately suitable for plant growth. Soil volumes are adequate for root penetration of pasture species and most trees.

6.3.2 Potential Impacts and Safeguards

Based on the capability scheme devised by the Department of Land and Water Conservation (previously the Soil Conservation Service) the soils in the area have a low to moderate soil erosion hazard, and are subject to moderate to severe sheet, rill and gully erosion. If disturbed the valleys are subject to gully erosion and will require erosion control measures to ensure that erosion does not degrade the site. Consequently, soil conservation management techniques will be implemented during construction and operation to protect the site.

Soil erosion will be controlled by appropriate land management practices, including vegetative practices and structural soil conservation measures. Erosion and sedimentation controls covering the access road, the processing area and the quarry site are detailed in **Section 3.13.2**. The provision of these measures and the proposed involvement of the Department of Land and Water Conservation during the construction phase of the project will ensure that adverse sedimentation impacts on the local rivers will be avoided and that erosion problems do not develop on the property.

6.4 Traffic and Transportation

Transportation of the product and access to the quarry site will be along an access road that intersects with the Monaro Highway. The Monaro Highway will be the route for the transportation of product both north and south towards markets in Canberra, Queanbeyan and further afield.

The Monaro Highway is a sealed, wide two lane road that is currently in good condition. Visibility through the area is generally considered to be good. Traffic flow volumes along the Monaro Highway running through Michelago (approximately 16 km south of Williamsdale) were obtained from the RTA and are presented in **Table 6.1**.

Table 6.1 - Monaro Highway Annual Average Daily Traffic (AADT), Michelago

	1990	1994	1997
AADT	3,689	4,010	3,433

Source: Roads and Traffic Authority, NSW.
Data based on axel pairs, or car equivalents.

6.4.1 Traffic Generation

All product leaving the quarry will be by truck. This means that truck movements will be directly dependant on sales. Given the nature of the market, daily truck movements can vary substantially, particularly in the case of "one off" construction projects.

It is estimated that in the first year of operation of the quarry, 250,000 tpa of product could be generated over a 48 week period. This will be moved off site by trucks with a carrying capacity of 30 tonnes. This corresponds to a total of 5,210 tonnes of product being moved per week, requiring 32 trucks (64 movements) per day, operating for 5.5 days per week.

During the second year of operation, it is estimated that up to 500,000 tpa of product will be generated. On a weekly basis, this represents 10,400 tonnes per week, which will require 64 trucks (126 movements) per day, over 5.5 days per week. It is further estimated that the maximum number of trucks required through the life of the quarry will be 88 trucks per day (176 movements).

At any time during the operation of the quarry, a maximum of 10 personal light vehicles (20 movements) per day is expected.

6.4.2 Assessment Criteria

Assessment of the expected level of service of the roads is based on the design and formation as set out by the Austroad Traffic Assessment Criteria provided in **Table 6.2**.

Table 6.2 - Austroad Traffic Service Assessment Criteria

Road Stereotype	Quality of Traffic Service		
	Poor (vpd)	Fair (vpd)	Good (vpd)
Unsealed			
Natural Surface	over 100	61 to 100	up to 60
Formed	over 100	61 to 100	up to 60
Gravel one lane (up to 4.5m)	over 100	61 to 100	up to 60
Gravel one land (up to 4.5m)	over 150	61 to 150	up to 60
Sealed Undivided			
One lane (up to 4.5m)	over 300	151 to 300	up to 150
Narrow two lane (4.6 to 6.4m)	over 4 000	1 001 to 4 000	up to 1 000
Wide two lane (6.5 to 9.1m)	over 6 000	4 001 to 6 000	up to 4 000
Three lane (9.2 to 11.6m)	over 10 000	6 001 to 10 000	up to 6 000
Four lane (over 11.6m)	over 15 000	10 001 to 15 000	up to 10 000
Divided			
Four lane (up to 9.1m x 2)	over 30 000	15 001 to 30 000	up to 15 000

vpd = vehicles per day

6.4.3 Impacts of the Proposal

According to the Austroad Traffic Service Assessment Criteria, the Monaro Highway around Michelago is currently providing a good quality of traffic service.

During peak operations of the quarry in the second year, a maximum of 74 vehicles (trucks and personal vehicles), corresponding to 148 vehicular movements will be generated along the Monaro Highway daily. Based on the 1997 Annual Average Daily Traffic, traffic along the Monaro Highway will increase to 3581 vehicles per day while the quarry is operational.

The additional traffic created by the quarry along the Monaro Highway will not have a significant effect on traffic in the area and will not affect the quality of service provided by the Monaro Highway, which will continue to offer a good level of service.

6.4.4 Safeguards and Mitigation Measures

Since proposed operations at the quarry will have no significant effect on the operation of the roads with respect to traffic volumes in the area, no mitigation measures are deemed necessary specifically with respect to traffic volumes.

In order to ensure that the intersections are safely negotiated, it is proposed to upgrade the intersection between Williamsdale Road and the Monaro Highway to allow vehicles on the Monaro Highway to pass trucks turning into Williamsdale Road safely. In consultation with the National Capital Authority and the Department of Urban Services Roads and Stormwater, it is proposed to upgrade the intersection to a Type B (BAL) intersection to ensure its continued safe operation.

A BAL (basic left turn treatment) will be constucted on Williamsdale Road and the Monaro Highway for vehicles turning onto the Monaro Highway from Williamsdale Road and vehicles turning left from the Monaro Highway into Williamsdale Road. The intersection will have a single radius return, auxiliary lanes are not orovided, and the layout is not channelised. Signage will be installed as required.

These layouts are suitable in rural areas where high speed, low volume traffic occurs, yet the volume of turning traffic is sufficient to make a conflict likely.

6.5 Flora

6.5.1 Introduction

The proposed quarry site currently supports vegetation that has previously been subjected to extensive disturbance from logging and grazing. A flora survey and environmental impact assessment was conducted by Roger Lembit during November 1998 and is presented in **Appendix J**.

6.5.2 Methodology

A field survey of the area proposed for the quarry operation was carried out in November 1998 and involved recording the dominant plant species present, the nature and composition of canopy, shrub and ground layer strata, and the level of disturbance to the vegetation. Detailed searches were also made for rare or threatened species of flora likely to occur in the area.

6.5.3 Plant Communities on Site

The field survey identified four general vegetation communities, which are summarised below and mapped on **Figure 6.1**.

Broad leaved Peppermint - Box Woodland

The site of the proposed quarry and nearby hills support a woodland community dominated by Broad-leaved Peppermint (*E. dives*) and Norton's Long-leaved Box (*E. nortonii*). Associated species include Yellow Box (*E. melliodora*) and Inland Scribbly Gum (*E. rossii*). On an exposed north-facing hill the most common woodland tree is Inland Scribbly Gum.

The native shrub layer is very sparse, however species present include A*cacia mearnsii*, Native Indigo (*Indigofera australis*) and Blackthorn (*Bursaria spinosa*). A more dense shrub layer occurs in a gully to the proposed site extraction, and is dominated by Blackthorn.

The ground layer is usually dominated by introduced pasture species and other exotic species. Common exotic ground layer plants include Hop Clover (*Trifolium campestris*), Rat's Tail Fescue (*Vulpia bromoides*), Catsear (*Hypochaeris radicata*), Hare's Foot Clover (*Trifolium arvense*), Soft Brome (*Bromus mollis*), *Bromus diandra*, Cocksfoot (*Dactylis glomeratus*) and Perennial Ryegrass (*Lolium perenne*).

Common native ground layer species include *Geranium solanderi*, Prickly Starwort (*Stellaria pungens*), *Wahlenbergia stricta*, *Galium gaudichaudii*, *Ranunculus lappaceus*, Tussocky Poa (*Poa labillardieri*), Sheep's Burr (*Acaena ovina*), Redanther Wallaby Grass (*Chionochloa pallida*) and *Cheilanthes austrotenuifolia*.

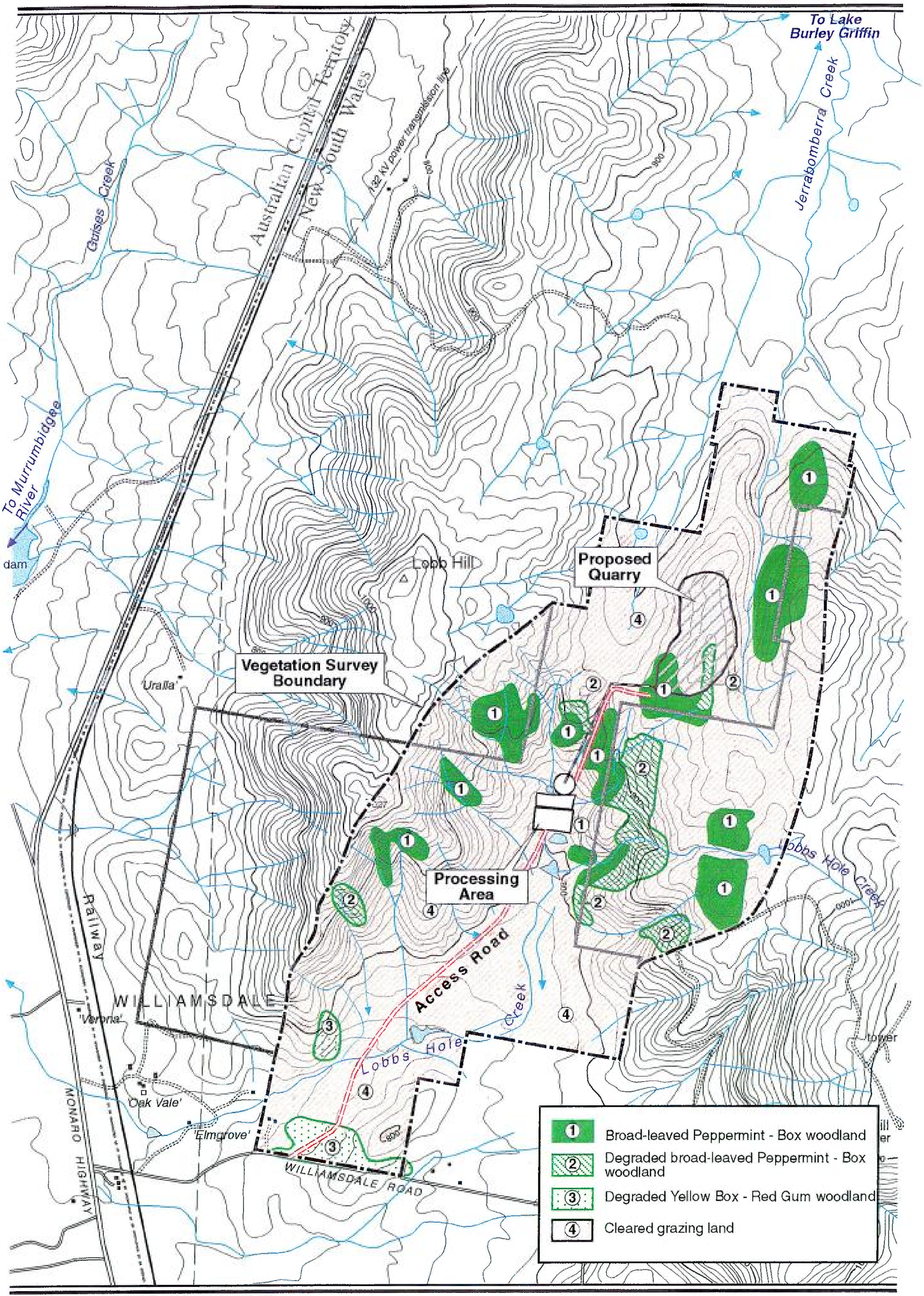
Yellow Box - Red Gum Woodland

Stands of Yellow Box (*E. melliodora*) and Blakely's Red Gum (*E. blakelyi*) trees occur on sites of higher fertility and deeper soils, however past clearing and a long history of agricultural disturbance in the area mean that the area no longer supports viable remnants of the original vegetation. Associated tree species may include Apple Box (*E. bridgesiana*).

The proposed access road would traverse areas which support stands of these trees with the more dense stands of trees occurring along Williamsdale Road.

Wetland

Wetland vegetation occurs in flat valleys with impeded drainage to the north of the proposed access road, in the middle of paddocks used extensively for grazing. High proportions of exotic species are present. Native plant species which remain in the wetter parts include *Carex gaudichaudii*, *Carex appressa* and *Juncus* spp.



Topographic map source : Williamsdale 1:25000 8726-4-N

0 500 1000m

1: 25,000

N

FIGURE 6.1
Vegetation Communities

Cleared Land

Most of the land in the area has been cleared in the past for agriculture. Much of this land now supports improved pasture. Common species include Cocksfoot (*Dactylis glomeratus*) and Perennial Ryegrass (*Lolium perenne*), as well as a range of clovers.

6.5.4 Threatened Plant Species

The Atlas of NSW Wildlife maintained by the National Parks & Wildlife Service identifies only two threatened flora species for the Michelago 1 : 100 000 map sheet. These are *Gentiana bredboensis* and *Eucalytpus pulverulenta*.

Yarralumla Council's *Upper Jerrabombera Creek - Royalla Local Environmental Study* (1996) lists another three species which may occur in the area; Small Purple Pea (*Swainsona recta*), Button Wrinklewort (*Rutidosis leptorhynchoides*) and Austral Toadflax (*Thesium australe*). These species are normally associated with native grasslands where they occur in the vicinity of Canberra. The Council's Development Control Plan No.6 for its Rural Residential Zone also lists a Leek Orchid (*Prasophyllum petilum*) and a daisy (*Ammobium craspedioides*), as species which require consideration. The Leek Orchid is another species associated with native grasslands, while *Ammobium craspedioides* is found in forest, woodland and roadsides mainly around the Yass district (Harden, 1992).

No evidence was found that these species occur in the study area. Given the level of disturbance to the native vegetation in the study area it is considered highly unlikely that populations of these species remain in the area.

None of the threatened species described above were observed in the area and are not likely to be affected by the proposal. It is considered highly unlikely that any of the species occur in the area.

The following 8 part test has been prepared to provide guidance for an assessment of the proposed development on threatened species.

a) in the case of threatened species, whether the life cycle of the species is likely to be disrupted such that a viable local population of the species is likely to be placed at risk of extinction,

Development of the proposed quarry will result in the clearing of some vegetation. During the initial years of development, minimal amounts of vegetation will be removed. Larger areas will be cleared during later years, however as the quarry progresses all available areas will be rehabilitated with species the same as those that originally occurred.

No populations of the threatened species identified as occurring in the region were observed in the study area. With no local populations present in the area where impact will occur, the life cycle of these species is not likely to be disrupted or placed at risk of extinction.

b) in the case of an endangered population, whether the life cycle of the species that constitutes the endangered population, is likely to be disrupted such that the viability of the population is likely to be significantly compromised,

No endangered population as defined in the Threatened Species Conservation Act occurs in the area affected by the proposed development.

c) in relation to the regional distribution of the habitat of a threatened species, population or ecological community, whether a significant area of known habitat is to be modified or removed,

The habitat of *E. pulverulenta* is dry woodland on poor soils. Some areas of dry woodland will be removed as part of the operations at the quarry, however given the area covered by dry woodland in the region, the area to be destroyed is not considered to be significant.

The habitat of *G. bredboensis* is on margins of very wet seepage zones of pastures on granitic soils. This habitat type is not present on the study site, therefore the proposed operations will not result in the loss of significant habitat.

d) whether an area of known habitat is likely to become isolated from currently interconnecting or proximate areas of habitat for a threatened species, population or ecological community,

There are no areas of known habitat for threatened species in the area of the proposed quarry. Consequently, no areas of known habitat will become isolated from any interconnecting or proximate areas of habitat as a result of the development.

e) whether critical habitat will be affected,

No areas of critical habitat as defined in the Threatened Species Conservation Act occur in the study area.

f) whether a threatened species, population or ecological community, or their habitats, are adequately represented in conservation reserves (or other similar protected areas) in the region,

According to Briggs and Leigh (1996), none of the threatened species identified as occurring in the region are represented in a conservation reserve.

g) whether a development or activity proposed is of a class of development or activity that is recognised as a threatening process,

The development is not of a class of development which is recognised as a threatening process as listed in Schedule 3 of the Threatened Species Conservation Act.

h) whether any threatened species, population or ecological community is at the limit of its known distribution.

The distribution range for *E. pulverulenta* is from Bathurst to Bomballa (Central and Southern Tablelands). The closest population occurs south of the site in the hills north-east of Cooma.

G. bredboensis occurs only in small section along the Bredbo River. If it was to occur on the site it would be a disjunct population at its northern limit.

6.5.5 Flora Impacts

Given the poor quality of the vegetation due to previous disturbances, and the absence of any threatened flora species in the area, it is considered that the impact of the proposal will be insignificant.

The proposed operations of the quarry will result in the removal of native vegetation however, in light of the amount to be removed and the disturbed nature of the vegetation the impacts are not regarded as significant. In addition, the operations of the proposed quarry could contribute to the spread of exotic weeds which already exist in the area. Of particular concern are patches of Sweet Briar (*Rosa rubiginosa*) in the vicinity of the proposed process/stockpile area.

6.5.6 Mitigation Recommendations

Control of Sweet Briar around the proposed process/stockpile and quarry areas will be undertaken to prevent spread of the weed on the property and further afield.

As quarrying is to take place sequentially over a long period of time, it will be possible to re-establish vegetation in areas where operations have been completed. Rehabilitation of native trees as well as pastures will be undertaken as part of the rehabilitation process. These mitigation measures will ensure that impacts on the native flora are kept to a minimum.

6.6 Fauna

6.6.1 Introduction

A fauna survey on the site of the proposed quarry works was undertaken by Roger Lembit in November 1998 and included an assessment of fauna habitat in the area. The survey was conducted in November 1998, and is presented in **Appendix J**.

6.6.2 Methodology

Fauna observations were made through actual sightings, and were complemented by information obtained via signs such as scats and burrows, and bird and frog calls. Information derived from the Atlas of NSW Wildlife maintained by the NSW National Parks and Wildlife Service was also used.

6.6.3 General Survey Results

Fauna habitat in the study area can be divided into three broad categories, as summarised below.

Woodland Vegetation with an Open, Grassy Understorey

Previous disturbances to these areas mean that they of limited value as wildlife habitat. The bird fauna is dominated by species which favour open woodland and grasses, with few small birds present due to the lack of shrubs. Higher proportions of small birds are found in the gully to the south of the proposed extraction area supporting a greater density of shrubs, however this area is relatively small in size.

Dams and Wetlands (including Sedgeland)

Wetland vegetation occurs along the creek to the east of the proposed access road and to the south of the proposed quarry site. Whilst disturbed by past land uses these areas have some habitat value for aquatic birds, bats and frogs. Frogs were heard calling in the creek at the time of the field survey of the land.

Pastures (Cleared Land)

These areas have been highly disturbed in the past. This means that they are generally of poor habitat value for native fauna, and consequently are dominated by introduced or common native species. Some of the remnant trees in the pastures do have tree hollows suitable for fauna habitation.

6.6.4 Endangered Fauna known in the Vicinity

A number of threatened fauna species have been recorded in the Michelago area. In addition, Yarrowlumla Council's 'Upper Jerrabombera Creek - Royalla Local environmental Study' (1996) lists additional fauna species which may occur in the Upper Jerrabombera Creek - Royalla area. These include 1 frog, 3 reptile, 3 bird, and 2 mammal species as shown in **Table 6.3**.

A number of other threatened fauna species are listed in Yarrowlumla Council's Development Control Plan No.6 for the Rural Residential Zone to the north. These additional species are: *Polytelis swainsonii* (Superb Parrot), *Synemon plana* (Golden Sun Moth), *Suta flagellum* (Little Whip Snake), *Malacorhynchus membranaceus* (Pink Eared Duck), *Calyptorhynchus lathami* (Glossy Black Cockatoo), *Lathamus discolor* (Swift Parrot), *Miniopterus australis* (Blue Billed Duck), *Litoria aurea* (Green and Golden Bell Frog), *Granitella picta* (Painted Honeyeater) and *Varanus rosenberi* (Rosenbergs Goanna).

The extent of vegetation clearance on the land is small in relation to this habitat type in the region. The vegetation has already been severely disturbed by a long history of agricultural use.

Table 6.3 - Threatened Fauna Species Recorded in the Area

Scientific Name	Common Name	Status
Frogs		
Heleioporus australiacus	Giant burrowing frog	V
Reptiles		
Delma impar	Striped legless lizard	V
Aprasia parapulchella	Pink-tailed legless lizard	V
Tympanocryptis lineats pinguiolla	Southern lined earless dragon	E
Birds		
Ninox connivens	Barking owl	V
Xanthornyza phrygia	Regent honeyeater	E
Pachycephala olivacea	Oliver whister	V
Mammals		
Dasyrus maculatus	Tiger quoll	V
Phascolarctos cinereus	Koala	V

E = Endangered
V = Vulnerable

The following 8-part test has been prepared to provide guidance for an assessment of the proposed development on threatened species.

a) in the case of threatened species, whether the life cycle of the species is likely to be disrupted such that a viable local population of the species is likely to be placed at risk of extinction,

No threatened species were found to occur in the area of the proposed quarry and the area has been severely disturbed by agricultural land use. Accordingly it is highly unlikely that any part of the life cycle of a threatened species will be disrupted.

b) in the case of an endangered population, whether the life cycle of the species that constitutes the endangered population, is likely to be disrupted such that the viability of the population is likely to be significantly compromised,

No endangered population as defined in the Threatened Species Conservation Act 1995 occurs in the area affected by the proposed development.

c) in relation to the regional distribution of the habitat of a threatened species, population or ecological community, whether a significant area of known habitat is to be modified or removed,

Three types of fauna habitat have been identified as occurring on the site of the proposed development. The proposed quarry site lies predominantly on pasture (cleared land) which is not likely to be prime habitat for any threatened fauna species.

Only one species of vulnerable frog, *Heleioporus australiacus*, has been identified as occurring in the region. This species was not found on the study site although creeks on the land may provide suitable habitat. Siting of development will avoid the flatter reaches of Lobbs Hole Creek where suitable habitat is more likely to occur. The impact of the proposed development on dams and wetlands will be minimal provided adequate erosion control measures are put in place. The proposed quarry development will not result in modification of a significant area of known habitat.

The proposed quarry will result in the clearing of a small area of native vegetation. No threatened species were found to occur in this area, and consequently it is not believed that the area represents habitat for any threatened species. In terms of the value of the woodland vegetation on a regional scale, the area to be cleared is relatively small and has been disturbed and so does not represent a significant modification of habitat.

d) whether an area of known habitat is likely to become isolated from currently interconnecting or proximate areas of habitat for a threatened species, population or ecological community,

The habitat areas occurring on the site consist of disjunct pockets of woodland, occasional farm dams and creeks, already isolated from other habitat areas. There were no threatened species observed in the study area suggesting that the pockets of habitat present are not habitat for threatened species. No area of known habitat will become isolated from other habitat areas of threatened species, populations or ecological communities.

e) whether critical habitat will be affected,

No areas of critical habitat as defined in the Threatened Species Conservation Act occur in the study area.

f) whether a threatened species, population or ecological community, or their habitats, are adequately represented in conservation reserves (or other similar protected areas) in the region,

The Giant Burrowing Frog (*Heleioporus australiacus*) is present in several conservation reserves in the Sydney area as well as Morton National Park.

There are no records of the Striped Legless Lizard (*Delma impar*), Pink-tailed Legless Lizard (*Aprasia parapulchella*), or the Southern Lined Earless Dragon (*Tympanocryptis lineata pinguiolla*) occurring in the Tinderry Range Nature Reserve (NPWS Atlas of NSW Wildlife, 1998).

The range of the Barking Owl (*Ninox connivens*) is extensive across Australia (Pizzey, 1980) and is likely to occur in a number of conservation reserves. The Regent Honeyeater (*Xanthomyza phrygia*) is present in a number of conservation reserves through its range, but is a nomadic species seeking out flowering ironbarks. The Olive Whistler (*Pachycephala olivacea*) is present in a number of conservation reserves through its range. Locally present in Brindabella National Park and Tinderry Nature Reserve.

The Tiger Quoll (*Dasyrus maculatus*) is present in a number of conservation reserves throughout its range. The Koala (*Phascolarctos cinereus*) has been recorded in a large number of conservation reserves through the range of the species.

g) **whether a development or activity proposed is of a class of development or activity that is recognised as a threatening process,**

The development is not of a class of development which is recognised as a threatening process as listed in Schedule 3 of the Threatened Species Conservation Act.

h) **whether any threatened species, population or ecological community is at the limit of its known distribution.**

The only threatened species that would be near the limit of its known distribution if it was found to occur in the study area is the Southern Lined Earless Dragon (*Tympanocryptis lineata pinguiolla*). It is restricted to the area between Canberra and Cooma. If present in the study area it would be approaching its northern limit.

6.6.5 Potential Impacts of the Development

The clearing of vegetation for the proposed operations will have a minor impact on the fauna habitat available in the Williamsdale area. Since the sites which will be affected have previously been disturbed, they are considered to be of low habitat value and the resulting effect is considered to be insignificant.

The creek and wetland present on the land support populations of frogs. The clearing of land and operations at the site may result in some soil erosion, potentially impacting on these habitat areas.

6.6.6 Mitigation Measures

Although the effect of clearing vegetation on fauna habitat is deemed insignificant, progressive rehabilitation of native trees and pastures will provide further habitat areas.

Due to the potential for disturbance to creek and wetland areas from soil erosion, soil erosion controls (as described in **Section 3.14.2**) and appropriate site management will avoid any significant impact on this habitat.

6.7 Visual Assessment

Following an inspection of the area, an evaluation of the visual landscape resources and qualities in the area was made and an assessment of the impact of the quarry on the visual character of the area determined. A strategy has been designed to ameliorate the predicted visual impacts as outlined below.

6.7.1 Existing Visual Character

The proposed quarry site lies approximately 4 km north-east of Williamsdale, which is approximately 35 km south of Canberra along the Monaro Highway.

The local area consists of a rural landscape, with rolling hills having moderate to steep slopes. There are also narrow ridge tops, which give way to broad, gently sloping valleys. The valleys in the vicinity of the proposed quarry are generally orientated in a north-south direction. Most of the vegetation in the surrounding valleys has been cleared, however much of the vegetation on the ridge tops remains.

The proposed site of the quarry covers a ridge top at an elevation of approximately 965 m. Surrounding ridge tops are generally higher than the site of the proposed quarry, such as Lobb Hill (elevation approximately 1044m) to the west, and Gibraltar Hill (elevation of approximately 1,120m) to the south.

In general terms, the visual character of the landscape can be divided into a number of natural visual units, as shown in **Plates 1** and **2**:

- ☐ the Monaro Highway and railway line corridor
- ☐ valley floors;
- ☐ side slopes;
- ☐ ridgetops.

The **Monaro Highway/Railway Corridor** is a dominating visual element within the landscape. It consists of a 2 lane sealed asphalt road. This wide thoroughfare transports reasonable volumes of fast moving traffic through the area. Its linear form is a strong, continuous feature of the landscape. The railway running alongside the Monaro Highway also provides a linear visual element to the landscape. Views from the highway contain all the various visual elements within the region.

Valley Floors consist of broad areas which are flat to undulating. They are generally good for grazing and consequently are cleared of trees and shrubs with the exception of occasional stands of eucalypts. The areas are grassed and generally hold sheep and/or cattle. In addition, rural residential dwellings frequently occur in this visual element.

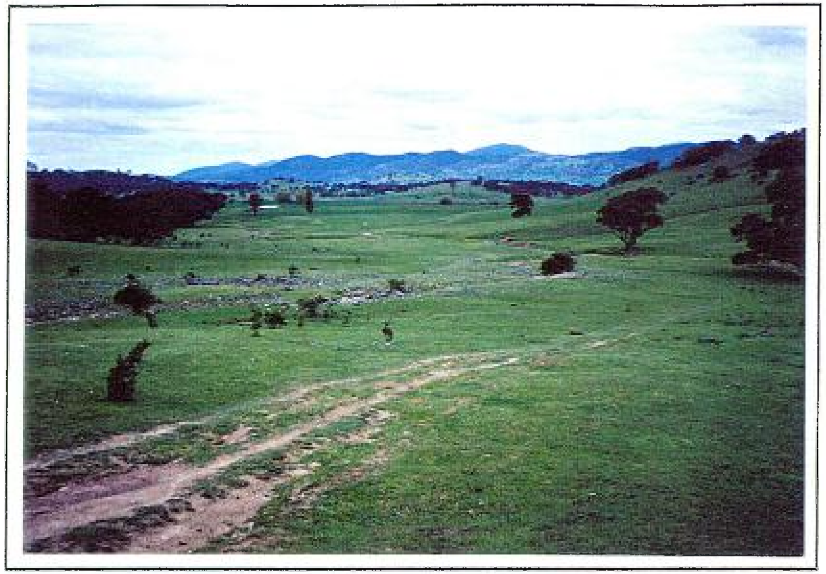
The **Side Slopes** in the area vary in steepness from moderate to steep. Generally the gentler slopes are cleared for grazing and have similar characteristics to the grazed valley floors. The steeper slopes are usually vegetated with native vegetation, consisting of dark green/grey, medium height eucalypt species.

The **Ridges** in the landscape consist of rounded hill tops which are visually prominent in the landscape. They may be vegetated with local eucalyptus species or cleared for grazing. The surface of these areas may also be covered with stony areas where the soils are skeletal.

6.7.2 Assessment Criteria

In assessing the visual impacts of the proposed quarry, the visual catchment around the quarry was evaluated according to the visual sensitivity of the areas within the catchment. The visual effect of the proposed quarry is the result of a complex combination of factors including:

- ☐ the existing visual environment;
- ☐ final visual characteristics of the proposed quarry;
- ☐ viewing distance from the quarry;



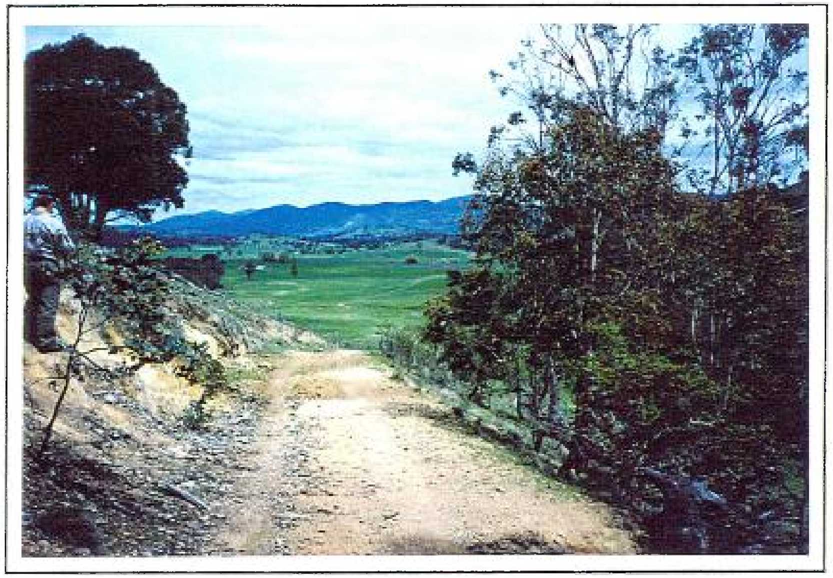
View from processing area towards Williamsdale Rd showing cleared valley floor, currently used for grazing.

Cleared lower slopes and vegetated steeper slopes typical of the area.

Ridge top typical of the area, showing native vegetation and stony surface.

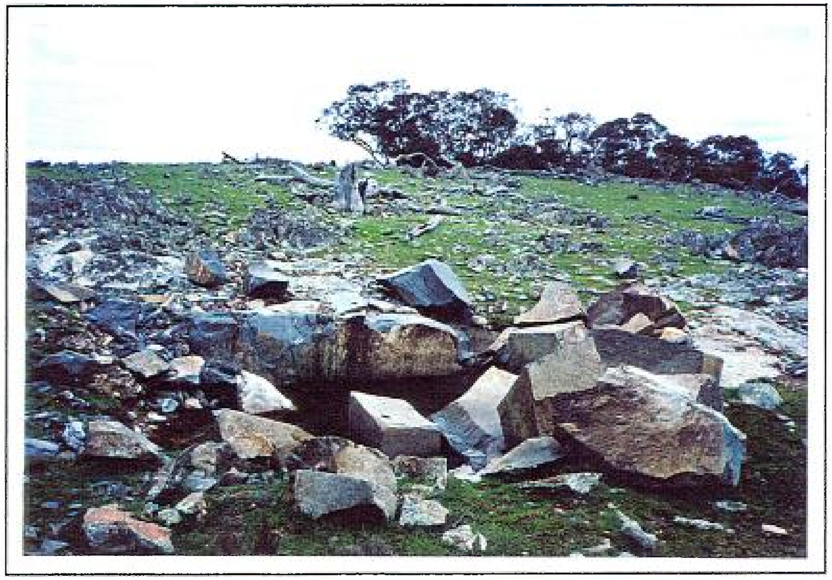
Processing Area. Conveyor will be located in the gully in the centre of the photo.

PLATE 1

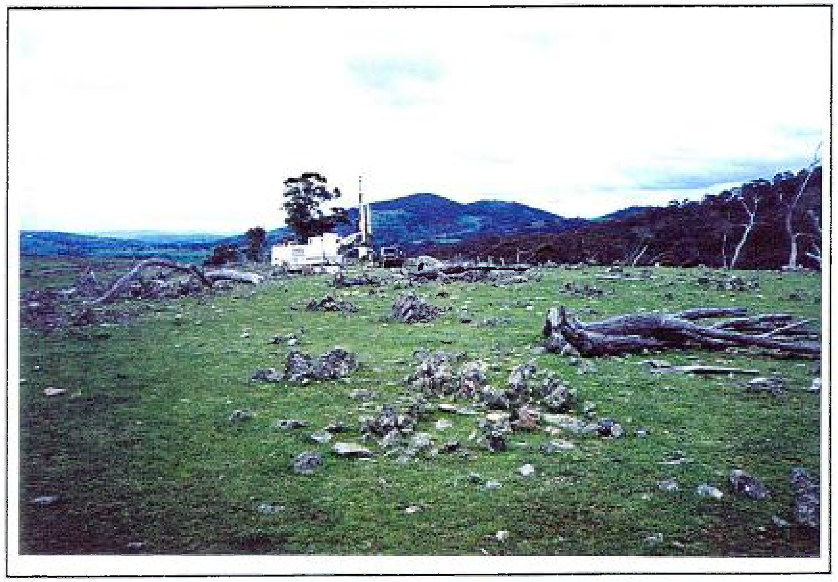


View toward south from existing access track.

View from crest of hill to the north looking towards the area recently zoned "Rural Residential".



Hard rock on ridge top. Rock to be quarried will consist of similar material.



Drill rig on the ridge top - view to the north.

PLATE 2

- ☐ intervening topography;
- ☐ intervening vegetation cover;
- ☐ visual contrast generated;
- ☐ number of viewers;
- ☐ duration of view;
- ☐ angle of view;
- ☐ visual sensitivity.

Existing visual elements - the nature of the existing visual characteristics of the landscape is an important element in considering the impacts of the proposed upgrading works.

Visually, the most significant impacts occur where the quarry is directly visible for long periods of time from numerous residences immediately adjacent to the site. The visual impacts decrease with increasing distance, shorter viewing times, screening effects of intervening vegetation and topography, and fewer number of viewers.

Visual characteristics of proposed quarry - The proposed quarry will create a separate visual element within the locality, influencing the visual character in the immediate vicinity of the quarry. The light colour of the rock will provide a strong contrast with the darker native vegetation and the grazing grasses in the region. The visual character of the quarry will be more similar to the Monaro Highway than the rural characteristics of the majority of the surrounding area.

Distance - In terms of the visual impact, areas closest to a the quarry are subject to the highest degree of visual impact. The further a viewer is from the quarry, the lower the visual impact will be. Within the visual catchment view lengths may be categorised into foreground (0-1 km), within which the quarry forms a prominent feature in the landscape, middle ground (1-3 km), within which the quarry can be readily seen but would not be as highly prominent, and background (>3 km), within which the quarry is less prominent in the landscape, even when there is a direct line of site to the quarry.

No residents or public roads are located with a foreground view of the quarry or the production area or access roads. Two residents and Williamsdale road are located some 2 km to the south of the quarry processing area, and from these areas aspects of the proposed activity will be visible in the middle ground. Due to intervening topography, no significant distance views of the quarry will be available.

Topography

Vegetation cover - the amount and nature of existing vegetation in the landscape is very important when determining the visual impact of a transmission line. If the landscape is cleared, the line can be visible for considerable distances. In this case the visual impacts will be high close to the line but will still lessen with distance.

Where scattered vegetation occurs, the impacts are generally low, since scattered vegetation can both camouflage and screen the transmission line. This is also true of sites where the transmission line crosses banana or other plantations.

If clearing is required for the transmission line in an area of dense vegetation, the visual impacts will be high, as a result of the introduction of a highly contrasting element (ie. the transmission line corridor) into the landscape.

Number of viewers affected - when determining the visual impacts of a transmission line the number of viewers the line will have is taken into consideration. Visual impacts are regarded as higher when a greater number of people are affected by the line.

Duration of view - the duration of viewing also contributes to the visual impacts of a transmission line. Static views (ie. from residences, recreational areas and tourist lookouts) are regarded as more important than transitory views (ie. from roads).

Angle of view - Visual impacts also depend on the locations and angles from which the line is viewed. The greater proportion of given vista the transmission line occupies the greater the impact. This is determined by the angle of view and the distance of the line from the viewer.

Visual Sensitivity - visual sensitivity is a measure of the perceived visual impacts on the visual environment, or the ability of an area to absorb the visual impacts of a development. For example, the following environments would be regarded as having different visual sensitivities even though actual impacts may not vary greatly - industrial areas and wilderness areas. The proposed line will have the greatest potential visual impact in areas of high visual sensitivity.

6.7.3 Visual Quality

The visual quality of the region is moderate to high, as a result of the rolling topography and the blend of rural landscape characteristics. The contrast between distant vegetated hill slopes and the more open, cleared nature of the grazing landscape.

The Monaro Highway and the railway have a separate visual quality, which is considered of relatively low quality, due to the hard engineered character of the corridor, and the strong visual form that they and their associated infrastructure impose on the landscape.

6.7.4 Impact Assessment

The visual impact of the proposed development has been assessed in terms of permanent views for nearby residents and transient views for motorists on public roads.

The quarry will be well hidden from most public viewing points, including the Monaro Highway. The quarry will not be visible to the north, since the quarry will not cut through the ridge to the north. Views of the quarry from the Monaro Highway to the west will be prevented by Lobb Hill. The quarry will not be visible to the east since it will be shielded by the existing ridge which will not be breached by the quarry activities.

The main passage of traffic through the area is along the Monaro Highway. Lobb Hill is located between the Monaro Highway and the quarry site, so the site will not be visible to the wider community using the highway.

Consequently, the only direction from which the quarry will be visible will be the south, from the direction of Williamsdale Road.

The two private residences situated along Williamsdale Road will have views of parts of the quarry operations. Direct views of the quarry itself will be limited by the ridge tops surrounding the quarry, however these two residences will have minor views of the access roads used by the quarry and one house will also have views of the processing area. The residences are located 2 km away from the processing area and currently views of the area are possible due to a lack of intervening vegetation.

Traffic along the Williamsdale Road will limited to intermittent views of the quarry access roads and the processing area which will be located over 2 km from the public road. Intermittent views of these features will be possible for approximately 1 km along Williamsdale Road.

6.7.5 Visual Safeguards and Mitigation Measures

With no visual impacts on the general community along the Monaro Highway, no visual mitigation measures are necessary along the western perimeter of the site. Similarly, views from the north and east need no mitigation since the proposed quarry will not be visible from these directions.

The view of the access road and the processing area from the two private residences will be screened by strategically placed visual bunds and vegetation screens. Vegetation planted along spurs and valleys between the residences and the site of the proposed works will effectively screen the views of the quarry activities from these residences. The visual bund will be located directly below the processing area and will be established during the construction period for the project. This bund will be grassed and shrubs will be planted along the top of it to further minimise visual impacts. The vegetation screens will be located further to the south of the processing area and will take some 3-10 years to provide full screening.

Such vegetation planting has been incorporated into the quarry design to mitigate the visual impact of the quarry on these houses. The vegetative screens will include native shrubs and trees and specific species to be established as part of this visual barrier will be determined in consultation with the DLWC and the local residents.

6.8 Aboriginal Archaeology and European Heritage

An archaeological survey was conducted in December 1998 to assess potential impacts of the proposed development on Aboriginal relics and non-indigenous heritage items in the area. Key findings are summarised below, and the full report is presented in **Appendix K**.

The survey area is within Wiradjuri country and in the Ngunnawal LALC area. Prior to commencing the survey work, the Land Council was informed and they were consulted during the work and represented during the field survey. Recommendations made at the conclusion of the survey were confirmed with the Land Council who have been provided with a copy of the final report.

6.8.1 Existing Archaeological Information

There is little early, reliable information about Aborigines in the Canberra/Queanbeyan district available. However, a study of clan boundaries from ethno-historic and linguistic evidence (see **Appendix K**) indicated that Queanbeyan included the clan or tribal and linguistic boundaries of three groups: the Ngunnawal, Ngarigo and Walgalu.

These records indicate a rapid reduction in numbers and disintegration of tribal life in the district after European settlement, probably accelerated by the introduction of European diseases. Numbers were estimated at around 400-500 Aboriginal people living a traditional lifestyle in the 1850's, however this was reduced to just five or six in 1872. The traditional Aboriginal economy was replaced by an economy based on European rations in the 1850's and by the final decade of the 1800's, the region's indigenous culture and economy was centred on white settlements and support by sympathetic farmers (**Appendix K**).

A number of studies have been conducted in the area, providing additional details of aboriginal activities in the region, and summaries of these are presented in **Appendix K**.

6.8.2 Field Investigation Results and Impacts

Initial investigations carried out prior to commencement of the field survey included site and archival searches of the NPWS site data base and the register of the National Estate, Canberra. In addition, a desk top study of the survey area landform and archaeological land systems was conducted. Ten sites have previously been located within 10 km of the proposed development area. All ten of these sites are open camp sites. Limited archaeological research has been conducted in the area, which may bias the distribution pattern of the sites found, however it appears that the sites are located adjacent to reliable water sources.

As a result of this work, a model of site prediction and sensitivity was developed in conjunction with a strategy for survey area coverage. The sites identified as most likely to occur in the area were:

- ☐ open camp sites which are most likely to be associated with water resources and bog areas;
- ☐ isolated artefacts which could be located across the quarry site;
- ☐ stone arrangement which would most likely be confined to high ground on hill tops or spurlines;

☐ scarred trees which could occur wherever old timber is present.

It was predicted that most archaeologically sensitive micro-landform units in the study area would be creek lines, swamp and bog areas, raised flat or gently sloping ground in the vicinity of a reliable water source.

A combined 'on foot' and vehicle survey strategy was adopted for all areas directly and indirectly impacted by quarrying and associated activities. This involved a series of on-foot transects, approximately 15 m wide across all sensitive landform units within the impact area (ie. ridge crests, hill crests, spurlines, creeklines and water courses).

At the site of the proposed development, a total of 4 sites, 3 areas of potential archaeological deposit (PADs), and 1 isolated artefact (IF) were recorded during the archaeological survey. The location of each site is shown on **Figure 6.2**. This survey did support previous distribution patters in that all sites were open camp sites/isolated finds and were located on, or in the immediate vicinity of creeklines. All sites are likely to be either directly or indirectly impacted by quarrying and associated activity. The significance of all sites has been assessed as low.

A statement of significance was prepared for each site and a discussion of the findings at each site is provided below.

Site WR-OS-1 and associated PAD 1

Site WR-OS-1 is located approximately 230m north of the Williamsdale Road, on the northern side of an ephemeral drainage line which flows into a small dam to the east of the woolshed. Artefacts are exposed across an area 10 m long by 2 m wide on the eroded northern bank of the drainage line. The area has been heavily eroded by grazing animals, ploughing and cultivation and the excavation of a contour bank on the western side of the site. Although the exposed artefacts do not appear to be in situ, the raised area to the north of the site has been identified as PAD 1 (an area of potential archaeological deposit). This PAD area has been heavily disturbed by ploughing, clearance and grazing. A total of 5 artefacts were recorded at this site. These included 4 flakes and one block fracture fragment. Raw materials included chert (4) and quartz (1).

The scientific value of the site in terms of its site integrity is poor, due to disturbance of the A soil horizon. The artefacts are in a fair state of preservation although there has been some damage to artefacts from grazing animals. The site is not unique and is a poor representative of its type. This site is considered to be of low significance, and the potential sensitivity of the PAD is moderate.

Site LHC-OS-1 and associated PAD 2

This open camp site is located in the southern bank of Lobbs Hole Creek. A light scatter of artefacts extends along the length of the southern bank of the creek west of the fence line, for a distance of 180 m x 5 m. No artefacts were located on the northern bank.

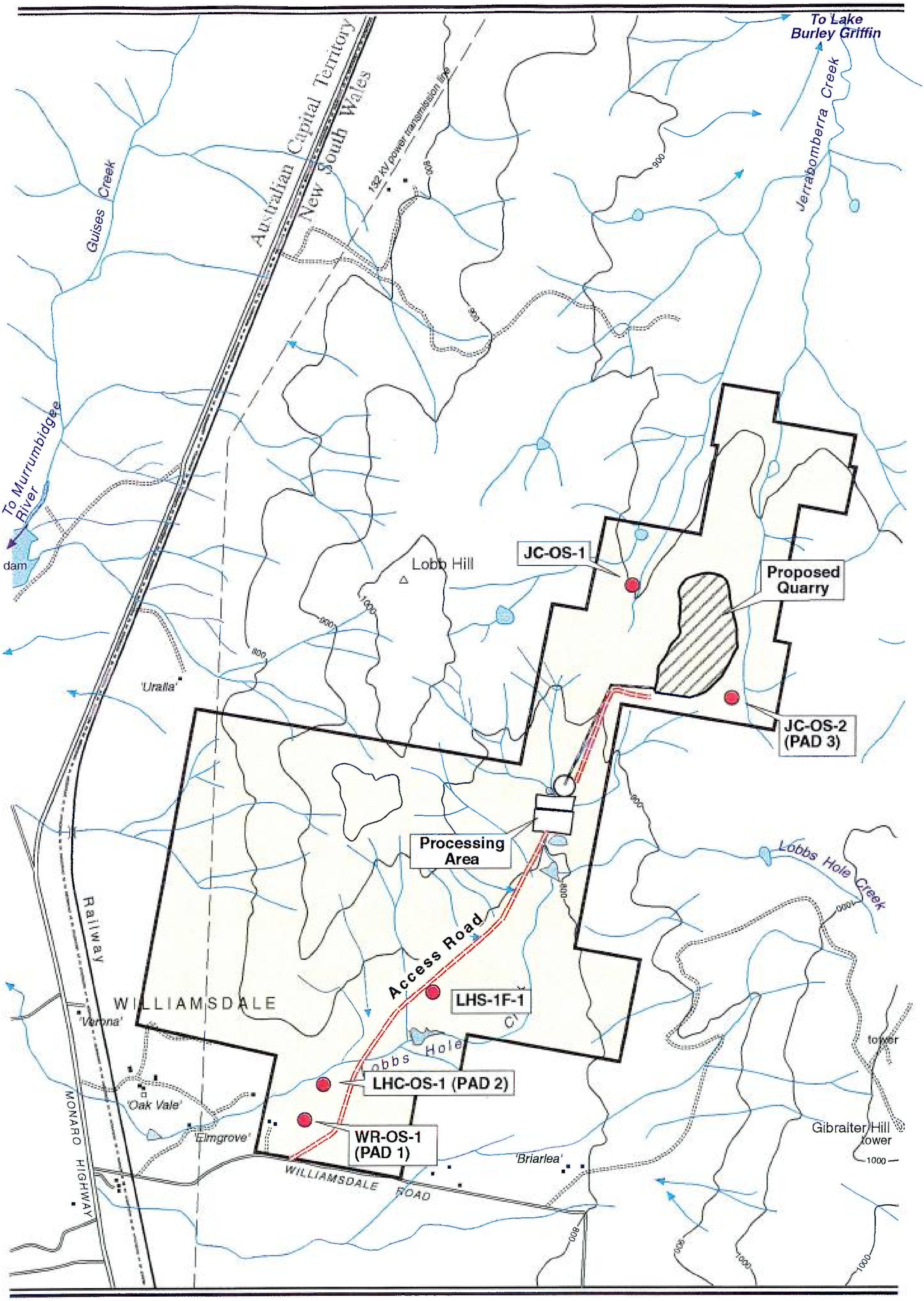


FIGURE 6.2

Archaeological Sites

The density of artefacts on the southern, creek bank is low (8 over a distance of 180 m x 10 m). A highly disturbed PAD area was identified south of the creek bank for a distance of 20 m. The PAD has been heavily disturbed by ploughing, clearance and grazing. Although artefactual material may be present within the PAD area, it is likely to be in-situ.

This site is also of low scientific value and has a poor level of site integrity. It has been highly disturbed by erosion, however the artefacts are in a fair state of preservation. This site is a poor example of its type, and offers little educational value. The potential for the PAD to contain data which would be useful for future scientific research has been assessed as low.

LHC-IF-1

This isolated find was located approximately 80 m south of the proposed access route to the east of the old homestead site. The isolated find, a hammerstone, was located on a track which runs through swampy ground at the base of a steep hill slope. The hammerstone was a circular quartzite river pebble with abrasion consistent with use as a hammerstone around the central edge and a shallow, possible anvil mark on one flat side. No other artefacts or PAD areas were identified in the vicinity. Therefore it is concluded that this was a drop site, and the significance of this isolated artefact is low.

Site JC-OS-1

Site JC-OS-1 was located below a dam which has been constructed across the ephemeral head waters of the Jerrabomberra Creek to the west of the main quarry area. The natural flow of the creekline has been terminated by the dam however it appears that water still flows through the creekline in times of high water levels. There was considerable erosion in the area caused in part by water but also by the construction of contour banks and ditches. Visibility across the site area was high, greater than 80%. The artefacts were located on the top of what appeared to be the original creek banks. The site extended across an area approximately 25 m x 10 m. No in situ artefacts were present at the site and no PAD areas identified. The whole area had been heavily disturbed.

This site has been highly disturbed, however the artefacts are in a good state of preservation. This site is also a poor representative of its type, and so has low potential as an educational resource to the general community.

Site JC-OS-2 and associated PAD 3

Site JC-OS-2 was located in the south-eastern corner of the main quarry spur line approximately 100 m up from the headwaters of the Jerrabomberra Creekline. The artefacts were located over a distance of 28 m x 5 m, on a sheep pad to the south of a vehicle track along the eastern side of the crest of the spur. The artefacts were below a saddle between the southern and northern section of the quarry spurline and appeared to have moved down slope in eroded material. This movement was the result of water gully erosion and tracks caused by animal erosion. A PAD area was identified to the west of the site, however the depth of soil in the PAD area was shallow (less than 5 cm) and the area had been heavily disturbed.

This site is a poor example of its type with little scientific value, being highly disturbed, however the artefacts are in a good state of preservation.

Discussion of Survey Results: Lobbs Hole Creek and its associated alluvial valley was identified as potentially the most archaeologically sensitive area in the survey area. This was in fact the case, however the creekline area had been heavily eroded and disturbed by clearing, past farming activity and flooding. The survey area is approximately 2km east of the Murrumbidgee River which would have provided a permanent water supply and a rich riverine environment for water birds, fish, shell fish and mammals and would therefore be a more likely place for large camp sites.

No scarred trees were identified for two reasons, the majority of old growth timber had been removed and those old growth trees remaining were stringy barks and ironbarks which were not favoured by Aboriginal people for bark removal.

Although there was a large amount of eroding stone material (dacite) on the ridge top area, no evidence of Aboriginal quarrying was noted. All the eroded stone material had been softened by weathering and was unsuitable for the manufacture of stone axes etc. The top of the ridge line was relatively level with no outstanding topographical features which may have encouraged ceremonial or spiritual activities.

Aside from Lobbs Hole Creek, no other permanent creeklines were present within the survey area, although the soak and wetland areas associated with the western and eastern headwaters of the Jerrabomberra Creek may have provided sufficient water for animals and visiting groups of hunters passing through the area. It is however, unlikely to have been an area used intensively by Aboriginal people in the past. The location of sites JC-OS-1 and JC-OS 2, would support the scenario that these tracks were used as access routes through the area.

There were no non-indigenous heritage items located in the quarry area. The site of the original homestead on the northern side of Lobbs Hole Creek was identified by the presence of several pine trees and remnants of an orchard, however the homestead had been removed to a site adjacent to the Monaro Highway by the current owners.

6.8.3 Recommendations

Under the National Parks and Wildlife Act 1974 and the NSW Heritage Act 1985, Totalcare has an obligation to determine if their proposed quarry development will impact upon indigenous heritage and where required, take ameliorative action. The following recommendations have been made.

Recommendation 1

The location of the sites and PAD areas should be marked in some way so that their locations are known to mine management. Workers should also be informed of the sensitivity of these areas.

Recommendation 2

It is recommended that all sites are avoided. Where sites can be avoided, it is the responsibility of mine management to ensure that all sites and PAD areas are marked and protected during quarrying activity. This protection should include fencing of all sites and PAD areas including a buffer zone of 20 m. All workers must be informed of the location of the sites and PAD areas, and the requirements of the NPWS Act for the protection of these areas.

If sites and PAD areas cannot be avoided, Totalcare should apply to the NPWS for Consent to Destroy Permit for those sites and/or the isolated find. If Consent to Destroy Permits are sought for WR-OS-1 and PAD 1, LHC-OS-1 and PAD 2, JC-OS-2 and PAD 3, it is recommended that all surface artefacts be collected, and the removal of the top 20 cm of topsoil be monitored by a representative of the Ngunnawal LALC and/or an archaeologist. Where Consent to Destroy Permits are sought for site JC-OS-1 and LHC-IF-2 it is recommended that all artefacts be collected and removed from the impact area.

Recommendation 3

All sites found in the field survey are highly disturbed and the artefacts are not in situ, therefore no recording of artefact distribution across the site is recommended. The collection of all surface artefacts should be carried out by a qualified archaeologist and/or representative of the Ngunnawal LALC.

6.8.4 Legal Requirements and Obligations

All non-indigenous heritage items are protected by the NSW Heritage Act (1975 and the EP & A Act (1979). All indigenous relics (sites and objects), other than those made for sale, are protected under the New South Wales National Parks and Wildlife Act 1967 (amended 1974). Archaeological sites are a non renewable resource, valued for the information they can provide on the lifestyles of people in the past, and are also valued by local communities who maintained cultural links with the past through these sites and places.

It is illegal to damage or destroy a site or relic without the prior consent of the Director of NSW NPWS and/or DUAP. Any such disturbance requires a permit from the Director. The NPW Act requires the relics recovered under such a permit come under the custody of the Australian Museum in Sydney or the LALC if an application has been made by that group for a Care and Control Permit.

6.9 Fire Prevention

Advice will be sought from the Local Bushfire Brigade regarding appropriate bushfire prevention measures that should be incorporated into the proposed quarry development.

Given the extensive clearing of vegetation in the area and on neighbouring properties, the risk of bushfire and resulting damage to the operations of the proposed quarry are considered to be low. Nevertheless, standard fire prevention measures will be implemented at the site. These will be undertaken in accordance with the requirements of the NSW Fire Brigades. They will include the provision of dedicated fire water storage and pumping facilities, isolation of all fuel storage areas and explosives from potential ignition sources and provision of fire extinguishers at the main office, workshop and crusher area. If considered necessary by the Bush Fire Brigade, fire breaks will be installed around the relevant areas.

7. Social and Economic Effects

This Chapter provides data on the social and economic factors of the Yarrowlumla Local Government Area, as relevant to the proposed development. Potential impacts on the community, and mitigation measures are discussed.

7.1 Introduction

The proposed quarry is located near Williamsdale, which is approximately 35 km south of Canberra. Williamsdale falls under the Yarrowlumla Local Government Area. Population information for the Yarrowlumla Local Government Area was obtained from the Australian Bureau of Statistics, 1996 Census, and is summarised below.

7.2 Community Characteristics

The total population of the Yarrowlumla area is 9,186, with 4,626 males and 4,560 females. The largest age groups are young children and teenagers of school age (0-19 years), and the middle ages from 30 to 54 years. There are relatively few aged members of the population within the area (>60 years), and the median age is 35 years. The median weekly individual income is in the range of $400-$499.

7.3 Employment Characteristics

The total workforce in the area consists of 4,926 persons which is 54% of the population. The total number of people unemployed is 271, which is approximately 6% of the total workforce. Of those unemployed, 174 were male, and 97 were female.

The main source of employment for both males and females in the area is in Government Administration and Defence, which is not surprising, considering the close proximity to Canberra. This is followed by the construction industry for males, and health and community services for females. The largest occupational group in the Yarrowlumla Local Government area are professionals, comprising approximately 27% of the workforce.

7.4 Community Services

The Yarrowlumla Local Government area is serviced by a number of schools (including pre-schools and the Bungendore School of Arts), public halls/community centres, libraries, recreation grounds and buildings, swimming pools, and a Community Health Centre.

A number of community programs are run in the area. These include environmental initiatives such as developing community awareness in terms of pollution problems, noxious plants, tree preservation orders, and participation in clean up Australia Day. There is a multi-cultural service that aims at improving the skills of non-English speaking members of the community. Home and Community Care Services are also available to help frail and elderly people. The Council also encourages employees to enhance their skills and knowledge by providing opportunities for training and education in various areas of science, business, first aid, as well as a number of practical workshops.

7.5 Recreation and Tourism

The Yarrowlumla Shire has a number of tourist attractions. These include scenic drives between the townships of Bungendore, Braidwood and Yass. Attractions include cottage industries, numerous cafes, and the Woodworks at Bungendore, with a world-wide reputation for their hand crafted wood products.

The main attractions in the area are the numerous wineries, along with national parks, such as Namadgi National Park, and the Tinderry Nature Reserve.

7.6 Impact of the Proposal

7.6.1 Workforce and Economy of the area

The proposed quarry will employ a number of workers both during the construction and operational phases. As discussed in **Section 3.13**, a variety of skilled and unskilled labour will be required during the construction phase of the project consisting mainly of specialist contractors. It is anticipated that during the operational phase of the project there will be up to 11 workers employed full-time, supplemented by a truck delivery fleet of between 15 and 20 people (sub-contracted) and other contractors.

The workforce for the quarry will be readily available locally, as evidenced by the high proportion of unemployed people in the region. Consequently, with the exception of some management staff it is expected that project employment can be mainly satisfied from the surrounding region with little or no in-migration.

Skilled and semi-skilled workers will be drawn primarily from the local communities. In addition to those employed directly by the quarry, drivers employed to transport quarry materials will be used by the developer, providing work to this sector of the community also.

Consequently, the project will have a positive impact on the employment in the area, and though the numbers to be employed are not regarded as particularly great, the period of employment for the workers will be long term.

Housing for the proposed workforce will be obtained in the local area, since it is anticipated that the workforce will be drawn form the area and will already be established there. It is not proposed to provide separate accommodation for either the construction or permanent workforce associated with the proposal. The proposed employment levels for the quarry will not require further infrastructure works or the expansion of residential areas. It is considered that existing residential developments within the region would easily cater for any minor increases in population caused by the proposed quarry development. No difficulty with housing is anticipated as a result of the proposed quarry.

7.6.2 Indirect and Induced Employment

The quarry will employ up to 11 people who will be involved in the extraction of the hard rock, processing, administration and management. In addition, personnel will be employed in the transportation of quarry product to markets. It is anticipated that contractors will be employed to transport the material and that on average, some 15-20 operators will be involved in trucking at any one time.

As production increases, further employment opportunities will be available. There will also be additional transport operators and subcontractors used as sales increase.

With the current level of unemployment in the Burra area, it is expected that the majority of new employees could easily be drawn from the local labour market with little or no in-migration. The work available will include professional, skilled and semi-skilled categories.

The quarry operation will also generate indirect employment benefits in the local and regional economies. Factors for indirect employment generation vary according to the type of industry and location. For mining and extractive industries, an employment multiplier of 1.46 has been previously used and is considered appropriate in this case.

On this basis, total indirect employment will be in the order of 45 people. This figure includes employment generated by transport operations and other associated contractors. In addition, there are several other areas where activities at the quarry have a direct bearing on local industries. For example, the quarry will supply cost effective products to the building and construction industries and materials for road pavement.

7.6.3 Impact of the Proposal on Tourism and Recreation

The major tourist attractions in close proximity to the proposed quarry are the wineries and small cottages and cafes in the local townships. The proposed development will have no negative impact on these attractions. Similarly, National Parks and Nature Reserves in the surrounding area will not be impacted by the proposed quarry, and so no negative effects are expected on tourism in the area.

7.7 Ecologically Sustainable Development Principles

Sustainability is essentially about developing a system which is not self-destructive and does not take from the world's future, but which takes account of social, environmental and economic factors in the decision making process. By integrating conservation practices and principles into the development process, a sustainable balance can be achieved between environmental and economic objectives.

7.7.1 Precautionary Principle

The precautionary principle, as defined by the EP&A Regulation, dictates:

> *.....that if there are threats of serious or irreversible environmental damage, lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation.*

The hard rock extraction proposal has integrated the precautionary principle in the operation, along with adopting mitigation measures to prevent environmental degradation associated with the project.

The studies undertaken prior to and during the preparation of this EIS have not indicated any threats of serious or irreversible environmental damage. However, where risk of potential degradation has been identified, mitigation measures have been developed to ensure that significant adverse impacts do not occur. Consistent with the requirements of the precautionary principle, the mitigation measures incorporated into the proposed development form an integral component of the operation.

7.7.2 Intergenerational Equity

Under the EP&A Regulation, the principle of intergenerational equity requires:

> *...that the present generation should ensure that the health, diversity and productivity of the environment is maintained or enhanced for the benefit of future generations.*

The Rio Declaration on Environment and Development (Agenda 21) also adopted the principle that:

> *...the right to development must be fulfilled so as to equitably meet developmental and environmental needs of present and future generations.*

The principle of intergenerational equity identifies a need to ensure that the requirements of the present generation can be met without precluding options for future generations. The extraction project will not prejudice future extraction projects or local planning in the area.

Mitigation measures to ensure that the environmental impacts associated with the operation are minimised are also required under the principle of intergenerational equity. Protection of the air, water, biological and noise environment of the area will contribute to meeting the requirements of intergenerational equity, protecting the quality of the environment for both the existing and future generations. Such mitigation measures will help ensure that the land following mining activities will be left in a manner that enables other land uses to be carried out.

Totalcare will develop an Environmental Management System based on ISO 14,000 for the Williamsdale hard rock quarry. Once implemented the system will assist in maintaining current best practice in environmental management in accordance with the company's Environmental Policy.

7.7.3 Conservation of Biological Diversity and Ecological Integrity

There is a need to maintain the biological diversity and ecological integrity of the region within which the operation is located. Conservation of ecological integrity requires that natural processes in the area continue to function. The proposed development incorporates measures to minimise potential impacts on vegetation communities and habitat value.

Rehabilitation initiatives which form part of the project will also assist in maintaining the biological diversity and ecological integrity of the area.

A range of specific management initiatives have been proposed to minimise the disturbance to existing natural resources of the site. These and other measures discussed in the EIS will assist in conservation of ecological integrity.

7.7.4 Improved Valuation and Pricing of Environmental Resources

The proposed operation by its very nature, will allow a valuable resource to be extracted without permanent degradation of existing environmental resources. The use of the hard rock will result in a cost effective use of a potential resource that has been marked for development.

8. Environmental Monitoring and Impact Verification

8.1 Summary of Mitigation Measures

This EIS has documented a range of mitigation measures that will ensure that the ongoing operation continues to meet current pollution control standards and assessment criteria. A summary of the ameliorative measures outlined in this EIS is provided below in **Table 8.1**.

Table 8.1 - Summary of Proposed Mitigation Measures

Issue	Proposed Mitigation Measures
Dust	It is predicted that air quality criteria will be met, therefore no specific mitigation measures are proposed. However, general measures will be taken on site to reduce dust generation, including watering of internal access roads and access roads when necessary; dust control during crushing operations; and dust suppression at the head pulleys of all product and transfer conveyors.
Noise	A number of noise mitigation measures have been proposed. Around the southern side of the site processing area a 5 m high earth mounding will be constructed. Fixed external and internal (where practical) plant and equipment will be selected and installed to satisfy a noise specification of less than 85dB(A) at 1 m. If any plant or equipment installed on site exceeds these specifications it will be evaluated in terms of secondary noise controls. All inloading and building conveyor systems should be belt type conveyors. All screens will be installed to minimise the transfer of structural borne vibration. Dust collection and control systems will be selected on acoustic performance. Where practical permanent site mobile plant will be fitted with secondary/residential grade noise controls and audible alarms will be replaced with flashing lights or a similar system. MIC initial blasts will be limited to a maximum of 265 kg and blasting conducted between 9.30 am and 5.00 pm. A blast management plan will be implemented as part of the EMP.
Hydrogeology & Groundwater	An impermeable hardstand area surrounded by an impermeable bund wall will be constructed around the processing area and fuel storage tanks. An on-site sewage treatment system will be installed to minimise the impact of sewage on the groundwater.
Surface Water	Clean and dirty water will be kept separate around the site through a series of drains and channels. All dirty water will pass through at least 2 settlement processes prior to entering the Main Water Supply Dam. In the event of discharge from the Main Water Supply Dam the water will be contained in a farm dam located downstream along Lobbs Hole Creek. Silt fences will be used to contain sediment and prevent it entering the waterways.
Land Use	It is not anticipated that the quarry will have a significant impact on future land uses in the area, subsequently no mitigation measures are proposed.
Soils	A minimum area will be disturbed at any one time and rehabilitation will occur progressively. Soil resources will be protected by erosion control works to protect against uncontrolled runoff and maintain existing soil materials.
Roads and Traffic	It is anticipated that there will be no significant effect on traffic volumes in the area, therefore no specific mitigation measures have been formulated with respect to traffic volumes. There may be an upgrading of the intersection between the Monaro Highway and Williamsdale Road.
Flora	Control of weeds, particularly Sweet Briar will be undertaken to prevent further spread. Re-establishment of native vegetation will take progressively in areas where operations are complete.

Table 8.1 - Summary of Proposed Mitigation Measures

Issue	Proposed Mitigation Measures
Fauna	Progressive rehabilitation of vegetation will be conducted to replace any lost fauna habitat. Soil erosion controls will be implemented to minimise the impact on creeks and wetlands which represent valuable fauna habitat.
Visual Characteristics	With no significant impact identified, no visual mitigation measures are proposed along the western, northern and eastern perimeters of the site. View of the quarry from the residences to the south will be mitigated by screened bunds with native vegetative cover.
Archaeology	The location of all sites and PAD areas will be marked and the location known to site personnel. All sites will be avoided with a 20 m buffer zone and fenced. Consent to Destroy will be sought from NPWS for areas that cannot be avoided. Collection of surface artefacts will be by a qualified archaeologist and/or representative of the Ngunnawal LALC.
Fire Control	Advise will be sought from the local bushfire brigade. Standard fire prevention measures will be implemented, including dedication of fire water storage and pumping facilities, isolation of fuel storages and explosives from potential ignition sources, and provision of fire extinguishers. Fire breaks will be provided if necessary.
Rehabilitation	A preliminary rehabilitation strategy has been developed incorporating temporary and permanent programs in order to maximise surface stability during construction activities and establishment of the final landforms. Erosion and sedimentation control measures include installing diversion drains and banks to divert runoff from undisturbed areas upslope around the site; installing silt fences to reduce sediment content of runoff from disturbed areas; stabilising and revegetating steep batters as they are created; and revegetating, fertilising and watering rehabilitated areas. Any exposed areas where erosion hazards exist will be controlled to avoid sedimentation impacts on downstream waterways. Systems to be used include parallel silt fences, revegetating road batters using matting, topsoiling and spray seeding, drainage culverts, silt traps, and energy dissipaters.

8.2 Approvals and Licences Required

The principal approval required for the project is the development consent which will be sought from Yarrowlumla Council.

In addition, Pollution Control Approval (under the Pollution Control Act, 1970, s17I) will be obtained prior to commencement of construction from the EPA. A Pollution Control Licence (under the Pollution Control Act, 1970, s17A) will be sought prior to operation of the quarry from the EPA.

While these are not anticipated to be required, in the event that any Aboriginal sites need to be disturbed Consent to Destroy approvals will be sought from the NPWS.

8.3 Environmental Management System

It is important that a basis for ongoing environmental management be implemented to ensure continual compliance with existing and future requirements and community expectations.

The following sections provide an outline of the Environmental Management System (EMS). The key feature of the EMS is adaptability enabling it to be flexible enough to cater for future changes in environmental legislation and community expectations.

8.3.1 Objectives of the EMS

An EMS is a structured approach to managing the environmental aspects of a company's operations. An EMS is a quality assurance system which enables a company to establish, and assess the effectiveness of, environmental policy and objectives, achieve conformance with them and demonstrate that conformance to regulatory authorities. The aim of such a system is to support environmental protection and prevention of pollution in balance with socio-economic needs.

An integral component of the EMS is the Environmental Management Plan (EMP). The EMP provides a system of reporting and monitoring which can be used to review the company's operations against established environmental performance indicators. It provides Totalcare management with an improved view and control of the operation's environmental performance. An EMS incorporating the EMP provides the following benefits:

☐ assistance in compliance with regulatory authorities;
☐ demonstration of due diligence;
☐ reduction in environmental liability;
☐ effective planning for future environmental and rehabilitation costs.

8.3.2 Outline of the EMS Components

Specifically, the EMP outlines the quarry plan for each year, monitoring results, the rehabilitation program and incorporates requirements of EPA licences and approvals and planning consent conditions.

In addition to the normal reporting requirements of the EPA and Council, the following records and data will be held on site:

☐ details of all trucking movements generated by the operation;

☐ monitoring results;

☐ complaints register and details of any additional mitigation measures incorporated or changes to normal practices as a result;

☐ details of areas which are shaped but not rehabilitated, sowed, completed and self sustaining. All data will include total areas to date and incremental annual areas for each given year.

Environmental monitoring results will be obtained in accordance with the program outlined in **Section 8.3**. Copies of all relevant documentation will be kept on site including licenses, permits, approvals and planning consents. The EMP will report on the status of these documents and requirements.

8.4 Environmental Monitoring

The environmental constraints associated with the development of this quarry have been identified in this EIS. Mitigation measures have been formulated to control and limit the negative impacts of the quarrying operations on the environment.

A detailed environmental monitoring program will be established in the areas of noise and blasting, water quality and dust generation. Monitoring of these areas will verify the predicted impacts presented in this document, as well as allow the environmental performance of the operation to be assessed and the necessary adjustments made.

8.4.1 Noise and Blasting Monitoring

A noise monitoring system will be established to monitor the noise levels emanating from the quarry at a point in between the two nearest residences. The monitoring program will cover both day and night time periods. Background (L_{90}) and maximum (L_{10}) noise levels will be monitored.

Measurements will be taken during the commissioning phase in order to verify design performance specifications and the achievement of EPA assessment criteria. Further noise monitoring will be carried out annually to check on maintenance and long-term performance. Following the installation of any new plant or equipment, additional noise monitoring will be done during that period.

Initial blasts will also be monitored for both air blast and ground vibration in order to check blast design. Adjustments will be made to blast design to achieve EPA assessment criteria.

8.4.2 Water Quality

Water quality monitoring will be undertaken in accordance with any licence requirements. It is anticipated that monitoring will occur during discharge events and two monitoring sites have been identified, one immediately downstream of the water supply dam and one at the lease boundary (see **Figure 8.1**). Samples will be taken and analysed for total suspended solids, total dissolved solids, turbidity and pH. Analyses in the surrounding water courses will be taken to establish current background water quality.

Rainfall records will also be kept for the site. If necessary this data will be compared with nearby weather stations in order to ascertain variability caused by topographic shielding.

8.4.3 Dust Monitoring

Dust monitoring will be conducted at two locations, namely near the lease boundary to the north of the quarry site, and at the lease boundary between the processing area and the two residences located on Williamsdale Road, as shown in **Figure 8.1**.

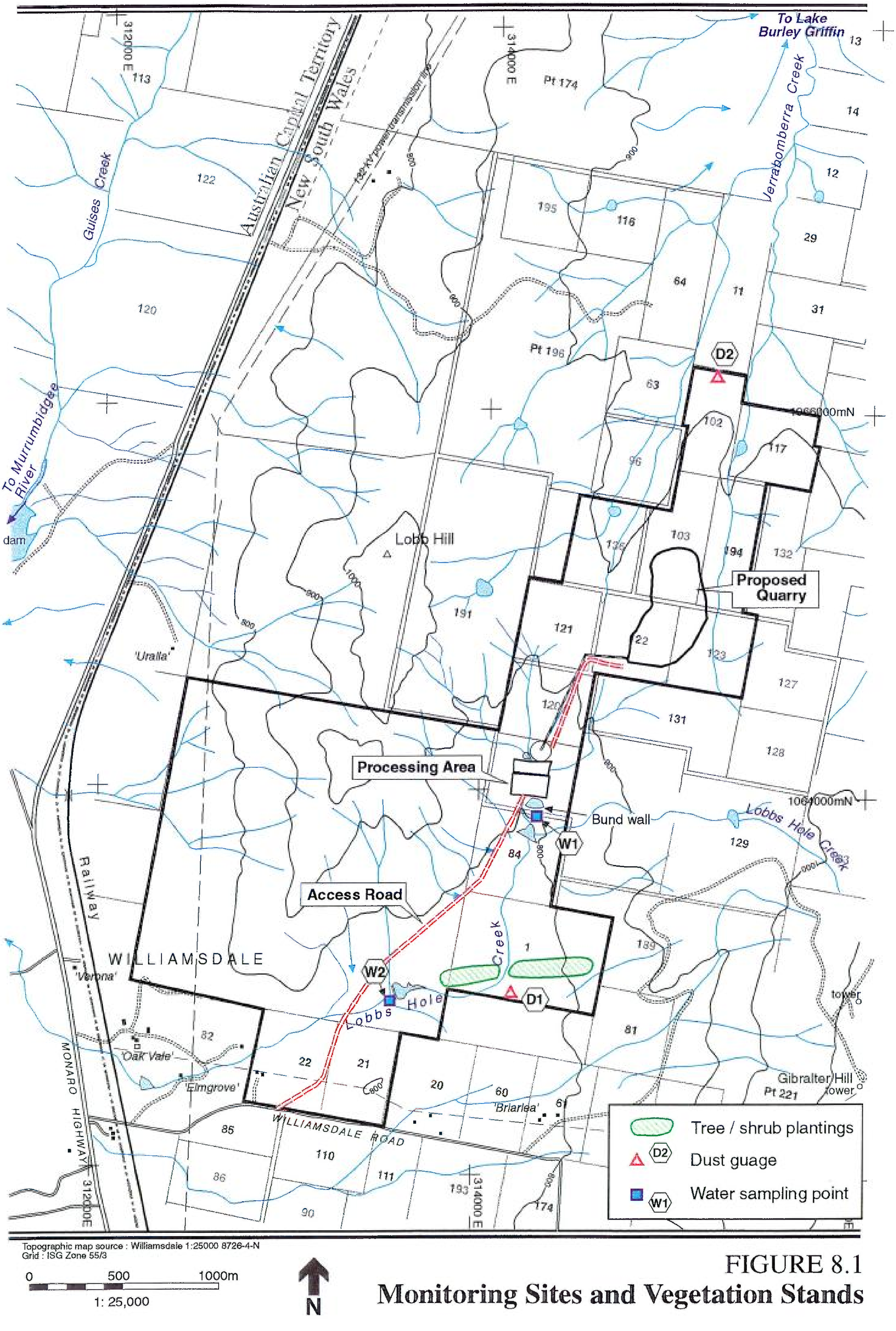


FIGURE 8.1
Monitoring Sites and Vegetation Stands

It is envisaged that monthly readings of dust deposition will be recorded. Records will be taken prior to construction activities commencing, and for a finite period once the quarry commences operation.

The monitoring period will be determined by the EPA and will most likely continue for a two year period or until such time as the EPA are satisfied that dust levels are satisfactorily controlled.

8.5 Rehabilitation

It is proposed to monitor rehabilitation progress throughout the life of the quarry, whenever rehabilitation works are underway. Data to be collected and held on site includes:

- ☐ total area disturbed;
- ☐ area shaped to final contours;
- ☐ area topdressed and sown;
- ☐ details of vegetation plantings;
- ☐ topsoil volumes stripped and stockpiled.

A photographic record may also be useful to record each stage of the rehabilitation as it progresses. This would valuable when analysing different rehabilitation techniques and relative success.

8.6 Environmental Reporting

An annual report will be prepared that summarises the data obtained in the monitoring programs. The report will be based on the financial year in line with other management reporting requirements. The report will include the raw data collected as well as statistical analyses. Details of all activities undertaken during the reporting period relevant to the environmental performance of the project will be provided.

The report will be used to facilitate improved management of the project, to minimise the negative impacts of the quarrying activities on the environment.

References

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Appendix A - Director General's Requirements and Authority Responses

New South Wales Government
Department of Urban Affairs and Planning

Mr. Weeks White
Coffey Geosciences Pty Ltd
PO Box 152
FYSHWICK ACT 2609

Contact:	Chris Ritchie
Our Reference:	Q98/00057/Pt1
Your Reference:	

Proposed Hard Rock Quarry "Oak Vale" Williamsdale, Yarrowlumla

Dear Mr White,

Thank you for your letter of 8th September 1998 seeking consultation with the Director-General for the preparation of an environmental impact statement (EIS) for the above development.

Under clause 55 of the *Environmental Planning and Assessment Regulation 1994* (the Regulation), the EIS should consider the issues that have been outlined in the attached letters from the Department of Land and Water Conservation (dated 26th October 1998), the Environment Protection Authority (dated 28th October 1998) and Roads and Traffic Authority (dated 11th November 1998).

Attachment No. 1 outlines the statutory matters that must be included in any EIS under clauses 54 and 54A of the Regulation.

The Department's EIS Guideline '**Extractive Industries – Quarries**' contains the type of information most likely to be relevant to your proposed development. Not all the matters it contains may be appropriate for consideration in your EIS; equally, it is not exhaustive. The Guideline is available for purchase from the Department's Information Centre, 1 Farrer Place, Sydney or by calling (02) 9391 2222.

You should consult with Yarrowlumla Shire Council and take into account any comments Council may have in the preparation of the EIS. The EIS should also address other issues that emerge from consultations with relevant local, State and Commonwealth government authorities, service providers and community groups.

As you have identified that a license may be required from some agencies if development consent is granted, the proposal is likely to be "integrated development". Consequently, 2 copies of the EIS and supporting documents should also be submitted with each of the relevant approval bodies (including a fee of $250) at the same time that you lodge them with the Council.

Please contact Chris Ritchie on (02) 9391 2085 if you require any further information regarding the Director-General's requirements for the EIS.

Yours sincerely,

David Mutton 16/11/98
Acting Director
Development and Infrastructure Assessment
As Delegate for the Director-General

Governor Macquarie Tower
1 Farrer Place, Sydney 2000
Box 3927 GPO, Sydney 2001

Telephone: (02) 9391 2000
Facsimile: (02) 9391 2111

DEPARTMENT OF URBAN AFFAIRS AND PLANNING

Attachment No. 1

STATUTORY REQUIREMENTS FOR THE PREPARATION OF AN ENVIRONMENTAL IMPACT STATEMENT UNDER PART 4 OF THE ENVIRONMENTAL PLANNING AND ASSESSMENT ACT 1979

In accordance with the *Environmental Planning and Assessment Act 1979* (the Act), an environmental impact statement (EIS) must meet the following requirements.

Content of EIS

Pursuant to Schedule 2 and clause 54A of the *Environmental Planning and Assessment Regulation 1994* (the Regulation), an EIS must include:

1. A summary of the environmental impact statement.
2. A statement of the objectives of the development or activity.
3. An analysis of any feasible alternatives to the carrying out of the development or activity, having regard to its objectives, including:
   (a) the consequences of not carrying out the development or activity; and
   (b) the reasons justifying the carrying out of the development or activity.
4. An analysis of the development or activity, including:
   (a) a full description of the development or activity; and
   (b) a general description of the environment likely to be affected by the development or activity, together with a detailed description of those aspects of the environment that are likely to be significantly affected; and
   (c) the likely impact on the environment of the development or activity, having regard to:
      (i) the nature and extent of the development or activity; and
      (ii) the nature and extent of any building or work associated with the development or activity; and
      (iii) the way in which any such building or work is to be designed, constructed and operated; and
      (iv) any rehabilitation measures to be undertaken in connection with the development or activity; and
   (d) a full description of the measures proposed to mitigate any adverse effects of the development or activity on the environment.
5. The reasons justifying the carrying out of the development or activity in the manner proposed, having regard to biophysical, economic and social considerations and the principles of ecologically sustainable development.
6. A compilation, (in a single section of the environmental impact statement) of the measures referred to in item 4(d).
7. A list of any approvals that must be obtained under any other Act or law before the development or activity may lawfully be carried out.
8. For the purposes of Schedule 2, the principles of **ecologically sustainable development** are as follows:
   (a) The precautionary principle - namely, that if there are threats of serious or irreversible environmental damage, lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation.
   (b) Inter-generational equity - namely, that the present generation should ensure that the health, diversity and productivity of the environment is maintained or enhanced for the benefit of future generations.
   (c) Conservation of biological diversity and ecological integrity.
   (d) Improved valuation and pricing of environmental resources.

Note

The matters to be included in item (4)(c) might include such of the following as are relevant to the development or activity:

(a) the likelihood of soil contamination arising from the development or activity;
(b) the impact of the development or activity on flora and fauna;

(c) the likelihood of air, noise or water pollution arising from the development or activity;
(d) the impact of the development or activity on the health of people in the neighbourhood of the development or activity;
(e) any hazards arising from the development or activity;
(f) the impact of the development or activity on traffic in the neighbourhood of the development or activity;
(g) the effect of the development or activity on local climate;
(h) the social and economic impact of the development or activity;
(i) the visual impact of the development or activity on the scenic quality of land in the neighbourhood of the development or activity;
(j) the effect of the development or activity on soil erosion and the silting up of rivers or lakes;
(k) the effect of the development or activity on the cultural and heritage significance of the land.

An environmental impact statement referred to in Section 78A(8) of the Act shall be prepared in written form and shall be accompanied by a copy of Form 2 of the Regulation signed by the person who has prepared it.

Procedures for public exhibition of the EIS are set down in clauses 57 to 61 of the Regulation.

Attention is also drawn to clause 115 of the Regulation regarding false or misleading statements in EISs.

Note

If the development application to which the EIS relates is not exhibited within 2 years from the date of issue of the Director-General's requirements, under clause 55(7) of the Regulation the proponent is required to reconsult with the Director-General.

◆

Goulburn Office

NSW Agriculture

PO Box 389
NSW Government Offices
159 Auburn Street
GOULBURN NSW 2580

Telephone: (02) 48230616
Facsimile: (02) 48223261

http://www.agric.nsw.gov.au

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Your File: C6521/1-AD

Our Ref: AD:ad
Our File: 4E 2/14 COFFEY.DOC

Coffey Geosciences Pty Ltd
PO Box 152
FYSHWICK ACT 2609

Attention: Weeks White

29 September, 1998

Dear Weeks

EIS for Proposed Hard Rock Quarry
Williamsdale NSW

The EIS should address the following regarding impacts to agriculture.

1. The agricultural land classification of the proposed site and current land use.
2. The impact the proposal will have on any sustainable agricultural production including adjoining properties. Note any expectations for further expansion of the quarry.
3. Assess any perceived conflict with adjoining land holders and the proposed mitigation for those conflicts. Evasion of weeds, dust and noise onto adjoining property and visual impact can be sources for conflict.
4. Proposed buffers between quarry activities and adjoining land holders.
5. Note current rehabilitation success and proposed rehabilitation for new site. Note management plans for top soil stockpile to avoid erosion and leaching of nutrients.
6. Fencing of the extraction face and haul road to stop cattle from straying into the quarry's activities.
7. An assessment of impact to remnant vegetation on the land and details of any proposed clearing (DLWC).
8. An assessment of any risk to endangered species of flora and fauna (NPWS).
9. An assessment of the impact the development will have on the surface and ground water resources (DLWC).
10. Sediment and erosion control for roads and quarry (DLWC).

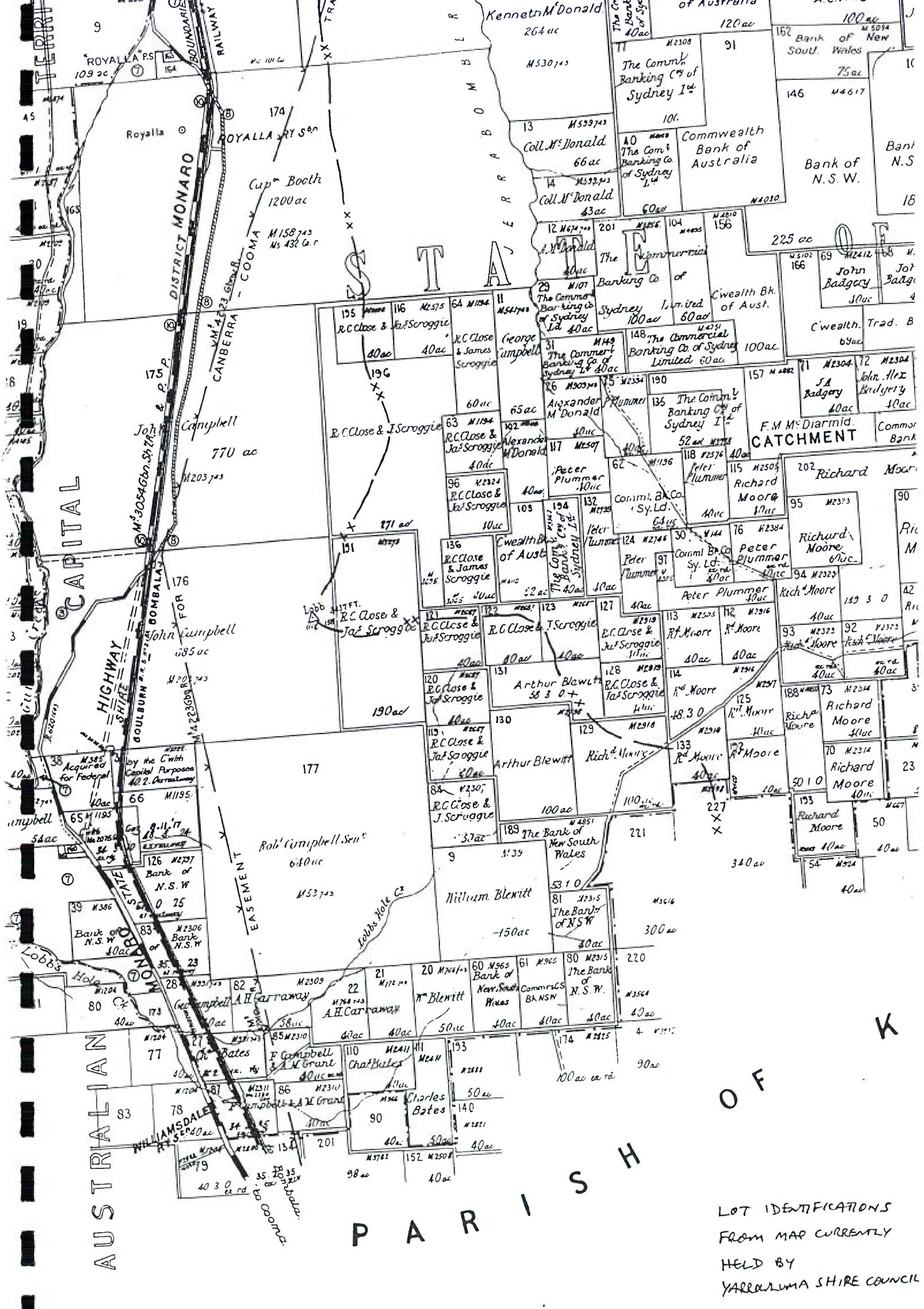
11. Impacts to local traffic (RTA).

NSW Agriculture would be keen to review the Environmental Impact Statement when completed.

Should you require further information, please contact Andrew Docking at the Goulburn Office on (02) 48230735.

Yours sincerely,

Andrew Docking
A/Agricultural Environment Officer



LOT IDENTIFICATIONS
FROM MAP CURRENTLY
HELD BY
YARRALUMA SHIRE COUNCIL

PRELIMINARY
RESPONSE

EPA

Environment
Protection
Authority
New South Wales

Suite 4
Robert Lowe Building
30 Lowe Street
PO Box 622
Queanbeyan
NSW 2620

Telephone .06. 299 3330
Facsimile .06. 299 3525

Mr W White
Coffey Geosciences Pty Ltd
PO Box 152
FYSHWICK ACT 2609

Our Reference: QU149/03 (QUF430)

Your Reference: C6521/1-AG

Dear Mr White

Proposed Hard Rock Quarry – Williamsdale

Reference is made to your letter dated 8 September 1998 regarding the Environment Protection Authoritys' (EPA) requirements for the preparation of an Environmental Impact Statement (EIS) for the above matter.

The provisions of the Environmental Planning and Assessment (Amendment) Act 1979 have recently been amended to introduce "Integrated Development Assessment" (IDA) and includes a process for preparation and assessment of development applications that require approval from multiple government agencies. In this regard, the proposal you have described is likely to fall into the IDA category.

Under the Protection of the Environment Operations Act 1997, soon to be commenced, an EPA licence is required for any extractive industry that obtains more than 30000 cubic metres of material per year. This limit is consistent with the definition of designated development in the Environmental Planning and Assessment (Amendment) Act 1997, which requires the preparation of an EIS.

The EPA has a formal role in providing its requirements for matters to be addressed in the EIS through the Director General of the Department of Urban Affairs and Planning (DUAP), together with requirements of other relevant agencies. As such, you should contact the regional office of DUAP to request this information. The main issues which the EPA wishes to see included in the EIS are:

- impacts on water (surface and groundwater);
- wastewater treatment;
- dust control and minimisation;
- soil and erosion control;
- noise impacts and potential for nuisance;
- operational considerations;

- air, topographical and meteorological details; and
- broader environmental issues (eg. cleaner production principles, ecologically sustainable development principles).

A number of publications and guidelines are available which discuss these issues, including the attached checklist for new developments, DUAP EIS Guidelines for Extractive Industries, and ANZECC Guidelines (Technical Basis for Guidelines to Minimise Annoyance Due to Blasting Overpressure and Ground Vibration).

To further assist with identifying potential impacts of the proposal, the EPA recommends that an on site meeting be held with the applicant, Council and all relevant government agencies. Future problems and site specific requirements can then be addressed in the application and EIS prior to lodgement, rather than during the assessment period.

Should you have any further enquiries regarding this matter or wish to arrange a site meeting, please contact Cathy Trindall of this office on (02) 6299 3330.

Yours sincerely

Nigel Sargent
Head Regional Operations Unit
Southern Tablelands
for **Director General**
16/9/98

Attachment 1 - EPA generic check-list for new developments.

Many environmental impacts and costly add-on pollution controls can be avoided by careful planning and design. The following checklist will assist in minimising environmental impacts and will help achieve more environmentally and financially sustainable development.

Water

What design measures are included to ensure that stormwater leaving the site is clean?
How can water consumption be minimised?
Are there opportunities to re-use waste water?
What design measures can be applied to minimise erosion and sedimentation?

Air

What design features are included to minimise energy use?
Can the number and length of vehicle trips generated by the development be minimised?

Waste

Will the development minimise resource consumption and waste?
Is the development able to facilitate re-use or recycling of any waste generated?
Are there any neighbouring developments that can use waste products created by this development and/or whose waste products this development can use?

Land use conflicts

What design features can be used to minimise the noise generated by the development and the impact of noise on surrounding land uses?
What odour impacts on surrounding land uses will result from the development and how can these be minimised?

Hazards

Can the development minimise the use and/or generation of toxic or hazardous products?
What are the hazards associated with this development? For example contaminated land, lead, acid sulphate soils, asbestos, flooding, fire, chemical storage.

Overall management

What additional measures are needed to minimise environmental impacts at the demolition and construction phase?
What can be done to compensate for the environmental impacts of my development?
What systems are proposed to monitor and improve environmental performance?
Could the development adopt cleaner production techniques and the ISO 14000 international environmental standards?
Does the development make a net positive contribution to the communities' environmental goals?

ATTACHMENT A
ENVIRONMENT PROTECTION AUTHORITY REQUIREMENTS FOR ENVIRONMENTAL IMPACT STATEMENT

Impacts on Surface and Groundwater

The proponent must be able to demonstrate that regional surface water and groundwater will be protected from the operation and rehabilitation of the quarry. Appropriate sediment, erosion and environmental management plans should be prepared as part of the EIS process.

The EIS needs to establish the basis for a coherent Soil and Water Management Plan for the quarry which will outline erosion and sediment control strategies for the mitigation of the impact on water quality of sediment sources such as the extraction area, the crushing and processing area, stockpiles and infrastructures such as roads as well as other pollutants including bulk fuel and oils and greases. The EIS should also include a description of the condition of any natural waterbodies or wetlands and drainage and sediment management systems.

The concept Soil and Water Management Plan should include a Site Plan which locates all Water Pollution Controls such as water diversion and collector banks, sumps, sedimentation basins and outlets for banks and basins. The EIS should list the design criteria for these structures and demonstrate how principles such as the separation of clean and dirty water and the major/ minor design concept has been incorporated in the design of the structures.

The specifications for all water pollution control structures should be listed in the EIS and shall include the following:

- **Banks-** longitudinal bed slope, base width of channel, depth of design flow, side slopes, design discharge, maximum velocity of flow.
- **Sedimentation basins -** design volume, effective stilling depth, surface area
- **Outlets to banks and Basins -** width of sill (level spreader) and slope below outlet

Recommendations shall be made for the quality of any water discharged from sedimentation basins to waters as defined by the parameters pH, Suspended Solids (mg/L) and Oils and Greases.

The EIS should make commitments as to the management of water pollution controls. For example, sedimentation basins need to be managed so to maintain capacity after runoff events, monitoring of structures should be programmed for after rain events etc. These management and monitoring strategies need to be detailed in the Rehabilitation and Environmental Management Plan.

Wastewater treatment

Wastewater storages must be designed to ensure protection of surface waters and groundwaters.

The treatment and disposal of domestic effluent, including from any proposed infrastructure must be documented within the EIS.

Air quality issues

The EIS should identify the sources of air pollution at the quarry such as dust from processing plant, stockpiles, roads etc. and detail methods for mitigating the production and emission of dust. Predictions should be made as to dust deposition rates and Total Suspended Particulate and these predictions should be compared with SPCC guidelines for acceptable rates of dust deposition for the affected receptors, including meteorologocal conditions under which nearby residences are likely to be affected.

Management strategies for the mitigation of air pollution and the monitoring of air quality should be detailed in a Rehabilitation and Environmental Management Plan.

Noise and Blasting

The EIS should establish noise planning levels for affected residences for both the on site operations at the quarry and quarry traffic.

The methodology used in the assessment of noise should use the comparative assessment of the source noise (L_{A10}) and background noise (L_{A90}) within existing meteorological conditions as the measure for audibility of the quarry's operations (and hence the potential for offensive noise complaints). Background noise levels should be measured in the absence of any extraneous noises such as wind, rain etc., using data loggers in line with EPA methodology for measuring backgrounds as outlined in the Environmental Noise Control Manual. Alternatively, a level of 30 dBA may be used to represent the background noise level for a rural area.

The anticipated effect of increase in vehicle movements should be predicted using the Leq 1hr measurement to assess the increased road noise.

Noise sources at the site should be listed and proposed noise mitigation methods should be detailed. These noise mitigation methods may include strategies such as machinery modifications, orientation of extraction benches and management considerations such as recommended hours of operation, hours for maintenance of plant and vehicle management.

Proposals for the monitoring of noise in the future should be detailed in the Rehabilitation and Environmental Management Plan for the Quarry.

The EIS should define the typical blast design and the frequency of blasting proposed for the extraction activities. The impact of blasting should be defined in terms of the blast overpressure and ground vibration. The proposed hours of blasting should also be detailed.

The EPA has adopted the ANZECC guideline titled "Technical Basis for Guidelines to Minimise Annoyance due to Blasting Overpressure and Vibration". The EIS should demonstrate that the proposed blasting program is in compliance with these guidelines.

Rehabilitation and Environmental Management Plan

The plan should provide ongoing management strategies to mitigate the environmental impacts of the operation of the quarry. This includes operational techniques for extraction and processing as well as the operation and maintenance of formal pollution controls.

The plan should outline management strategies relevant to the stages of construction, extraction and then rehabilitation. Monitoring strategies relevant to these stages should also be detailed and recording and reporting systems need to be put in place. The monitoring program needs to list monitoring techniques, frequency of monitoring, reporting and limit conditions.

The rehabilitation plan needs to be progressive and integrated into the extraction plan for the quarry. The plan should indicate the final landuse of the site and demonstrate how the rehabilitation techniques detailed in the plan will facilitate this landuse. A site plan of the rehabilitated site should be presented which indicates the staged rehabilitation of the site and final contours of the land surface.

The EIS should demonstrate how the rehabilitation of the site would ensure that ongoing environmental impacts have been prevented.

Other Issues

The EIS should include an assessment of broader environmental issues such as cleaner production principles, ecologically sustainable development, cumulative impacts and integration of land use planning.

DUAP Guidelines

In addition to the above specific requirements, the Department of Urban Affairs and Planning (DUAP) EIS Guidelines for Extractive Industries nominate a number of issues which should be addressed in the EIS that are relevant to both the EPA and other government agencies involved in the assessment process.

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Mr D Mutton - Acting Director
Development and Infrastructure Assessment
Department of Urban Affairs and Planning
GPO Box 3927
SYDNEY NSW 2001

Our Reference: 290496A1 (QUF491)

Your Reference:

FAXED 28/10/98

Dear Mr Mutton

Proposed Hard Rock Quarry - "Oak Vale", Williamsdale, Shire of Yarrowlumla

I refer to your request for the Environment Protection Authority's (EPA) requirements for the environmental impact statement (EIS) in regard to the above proposal received by the EPA on 22 October 1998.

The EPA emphasises the importance of ensuring that it is provided with all necessary information essential to its determination of the proposal and preparation of general terms of approval and appreciates the opportunity of providing its information requirements for the subject proposal.

The EPA has considered the details of the proposal as provided by the Department of Urban Affairs and Planning (DUAP) and accordingly, has formulated its requirements for the EIS. The EPA provides full detail of the information it requires in Attachment 'A'. In summary, the EPA requires information in regard to the following aspects of the proposal:

1. Impacts on surface and groundwater
2. Wastewater treatment
3. Air quality issues
4. Noise and blasting
5. Rehabilitation and environmental monitoring
6. Broader environmental issues.

Based upon the information provided to the EPA, the applicant will require an environment protection licence to construct and operate the extractive industry if the Protection of the Environment Operations (POEO) Act 1997 has commenced at the time of determination. However, prior to implementation of the POEO Act a pollution control approval to construct pollution control works and pollution control licence to operate under the Pollution Control Act 1970 will be required.

To assist the EPA in assessing the EIS once it has been lodged with the consent authority, it is suggested that the format of the EIS follow the format of DUAP's EIS guidelines and the specific EIS requirements as outlined in Attachment A. The EPA would like to receive 6 copies of the final EIS for assessment purposes.

Should you have any further enquiries regarding this matter please contact Cathy Trindall of this office on (02) 6299 3330.

Yours sincerely

Nigel Sargent
Head Regional Operations Unit
Southern Tablelands
for **Director General**
28/10/98

cc
Coffey Geosciences Pty Ltd
PO Box 152
FYSHWICK ACT 2609

Yarrowlumla Shire Council

"A Community Working Together to Achieve the Best in Rural Living"

Dougle for info

Neil 23/11

File: P5170.209
Contact: J Wright
Your ref: C6521/1-AJ

COFFEY GEOSCIENCES
PTY LTD
RECEIVED
13 NOV 1998
CANBERRA

11 November 1998

Mr W White
Coffey Geosciences Pty Ltd
PO Box 152
FYSHWICK 2609

Dear Mr White

RE ENVIRONMENTAL IMPACT STATEMENT – HARD ROCK QUARRY, WILLIAMSDALE, NSW

I refer to your letter of 8 September 1998 concerning the above matter. The delay in replying to your letter is regretted.

As discussed in your recent telephone conversation with John Wright, an area of land immediately to the north of the proposed quarry site has been recently rezoned from 1(a) General Rural to 1(d1) Rural residential. The EIS should examine the potential impacts of the proposed quarry on future rural residential development of this area.

A copy of the amendment is enclosed for your information.

If you wish to discuss this matter please contact John Wright of Council's Environment and Development Division on (02) 6297 6113.

Yours sincerely

John W

f. D R Rouse
Director Environment and Development

YARROWLUMLA SHIRE COUNCIL is the corporate name of YARROWLUMLA COUNCIL
ADMINISTRATION OFFICE: 11 Farrer Place Queanbeyan 2620
POSTAL ADDRESS: PO Box 112, Queanbeyan NSW 2620
TELEPHONE: (02) 6297 1311 • FAX: (02) 6297 5854
Web Site: http://www.yarrowlumla.nsw.gov.au • Email: records@yarrowlumla.nsw.gov.au

LTR jw Coffey quarry

ENVIRONMENTAL PLANNING AND ASSESSMENT ACT 1979

YARROWLUMLA LOCAL ENVIRONMENTAL PLAN 1993

(AMENDMENT No. 14)

I, the Minister for Urban Affairs and Planning, in pursuance of section 70 of the Environmental Planning and Assessment Act 1979, make the local environmental plan set out hereunder. (Q95/00117)

CRAIG KNOWLES MP

Minister for Urban Affairs and Planning.

Sydney, 10 March, 1998.

Citation

1. This plan may be cited as Yarrowlumla Local Environmental Plan 1993 (Amendment No. 14).

Aims, objectives etc.

2. This plan aims to encourage the orderly and economic use of the land to which the plan applies by rezoning certain land from Zone No. 1(a) (General Rural) to Zone No. 1(d1) (Rural Residential) under Yarrowlumla Local Environmental Plan 1993 for the purpose of providing land suitable for rural residential development in the Royalla area.

Land to which plan applies

3. This plan applies to land in the vicinity of Royalla, as shown edged heavy black on the map marked "Yarrowlumla Local Environmental Plan 1993 (Amendment No. 14)" deposited in the office of Yarrowlumla Council.

Relationship to other environmental planning instruments

4. This plan amends Yarrowlumla Local Environmental Plan 1993 in the manner set out in clause 5.

Amendment of Yarrowlumla Local Environmental Plan 1993

5. Yarrowlumla Local Environmental Plan 1993 is amended by inserting at the end of the definition of "the map" in clause 6(1) the following words:

Yarrowlumla Local Environmental Plan 1993 (Amendment No. 14)

LAND & WATER
CONSERVATION

Coffey Geosciences Pty Ltd
P O Box 152
Fyshwick ACT 2609

ATTENTION: Weeks White

Dear Mr. White,

Environmental Impact Statement, Proposed Hard Rock Quarry
Williamsdale,NSW

This Department would like to see the issues listed below addressed in the Environmental Impact Statement. The list of issues is a generalised one based on requirements which the Department provides to development proponents. Some of these issues may not be relavant to your proposal.

1. Locality Issues

* Map clearly identifying location of proposal and the position of:
  - surrounding roads, adjoining communities or dwellings and any land use likely to be affected by the development
  - utilities including transmission lines, pipelines, cables or easements
  - watercourses, water storage, drinking water catchments
  - watertable and the relationship with the maximum excavation depth; groundwater bores within 1 kilometre
  - prevailing wind and rainfall
  - surface contours/topography
  - sight lines from residences or public places such as roads.

* Title details and land tenure, owners consent.

* Identify any Crown Land and give details of:
  - status of Crown Land
  - proposals for occupation and use of Crown Land
  - impact of operation on any adjoining Crown Land.

2. Planning Issues

* Compatibility of the proposal with any regional strategy for extractive industries in the area and with the provisions of any State Environmental Planning Policy, Regional and Local Environmental Plans for existing and proposed development.

* Compatibility with existing land uses including forestry, agricultural, viticulture, horticulture, residential or residential areas and with any environmental protection areas. Identify the agricultural land capability of the areas to be disturbed.

3. Description of Quarry Proposal

* Characteristics of the resource; its geology, size and quality.

* Quantity and types of material to be extracted and processed; depth of overburden and of topsoil.

* Site layout map showing:
- maximum extent to be extracted and proposed staging
- area to be cleared, identifying major vegetation communities and any features of conservation value
- plant including washing, screening, blending, crushing, cutting or other processing, loading, transporting or handling of materials
- storage areas for overburden, extractive material and tailings, waste, fuels, chemicals and explosives
- drainage network, bunding, sedimentation dams
- landscaping
- parking, queuing and turning areas, weighbridge, truck wash-down areas.

* Proposed extraction methods and plan of operation including removal of overburden and staging of extraction; number of benches; slope, height, depth and width of benches; depth of excavation.

* Rate of extraction; estimated daily, weekly and annual volumes of the material to be extracted and transported.

* Details including location and quantities of overburden, tailings and extractive material to be stockpiles or stored.

* Methods of loading and transport of material within the site and from the site; access roads, any conveyors, loaders, etc.

* Quantities and method of storage of fuels and chemicals including explosives on the site; security and bunding arrangements.

* Sanitary and waste disposal requirements.

* System of sediment dams and drains.

* Proposed life of the quarry; any proposal for future expansion including staging and proposed timing.

4. Previous Operations on the Site

* History of previous extraction from the site; review of past environmental performance including the impacts of the operation on the environment and the effectiveness of any site rehabilitation.

- * Previous controls which applied on the site.
- * Integration of the proposed development with operations previously carried out.
- * Restoration or rehabilitation works proposed for the areas previously disturbed and the integration of these works into rehabilitation plans for the proposed operations.

5. Infrastructure Requirements

- * Electricity supply lines.
- * Water requirements, proposed supply or storage; if water is to be drawn from a stream or river; outline the potential impacts on downstream users; identify recycling and reuse options.
- * Waste disposal requirements; proposed methods and location of disposal.
- * Impacts on any existing infrastructure.
- * Proposals to protect any easements, cables, pipelines which may be impacted by the proposal.

6. Flooding Issues

- * Flooding status. If flood liable, direction of flood flow and potential impacts from inundation.
- * Means to prevent breakthrough during floods from any pits, slimes or settlement ponds into adjacent waterways.
- * Any likely effects of the operation on flood liability of surrounding lands.
- * Any future proposed flood mitigation schemes that may influence the impact of the proposal on the environment.

7. Water Quality Issues

- * Identification of any natural or artificial water bodies or wetlands, or environmentally sensitive areas which could affect the site or be impacted by:
    - any change in the surface or groundwater hydrology as a result of the proposal, or
    - any changes in the water quality leaving the site
    - dust from the quarry or traffic.

* Description of potential sources of water pollution such as:
- stockpile leachate, haul roads, disturbed areas
- sewerage
- workshop, vehicle wash facilities, plant and equipment, fuel storage
- increased turbidity due to sediment loss and erosion.

* Site drainage system
- to divert uncontaminated surface water including stormwater or streams around or away from the quarry and other disturbed areas
- to prevent adverse impacts on the water quality from process water and contaminated stormwater. This should include the segregation of contaminated water from non-contaminated water on site to minimise amount to be collected or treated; measures to collect and treat any contaminated water
- to prevent contamination of water from accidental spillages of petroleum products or other chemicals.

* Design criteria of sedimentation dams to contain runoff from the quarry or any processing area including reference to management of water from storm events and the non-filterable residues from stormwater overflows. Likely turbidity as a result of the geological characteristics. Any proposals to treat (including chemically) the water, if necessary, to achieve the required level of fines within a few days of rainfall event. The facilities should incorporate a stormwater by-pass to direct further flows around the dam; proposed maintenance works including method of dewatering slimes or fines ponds; proposal to store sludge, fines or slimes and use of the area.

* A range of temporary sediment controls including a carefully planned sequence of sediment traps and filters to effectively allow for increased retention time of drainage water particularly during construction to maximise settling time of sediment laden runoff.

* Water balance on the site including wastewater storage and reuse demonstrating ability to avoid dry weather discharge. Outline strategy of water use and reuse so that:
- the poorest quality stored water is reused first, and
- the water level is reduced in the dam to restore its capacity as quickly as possible, including irrigation of landscaping, truck wash down, dust control, etc.

* Proposed clean water storage volumes, locations, licencing requirements.

* Proposed new dams, numbers, locations etc.

* Proposed new bores, locations, licencing requirements.

* Potential impacts on groundwater quality, quantity or depth of the watertable,

including:

- any adverse effects on any groundwater recharge areas
- if extraction is below the watertable:
    - when dewatering proposed to facilitate extraction, any effects on the local or regional watertable
    - adequacy of measures to ensure no contamination of the watertable during and after extraction because of the final reuse of the area.
    - impact on the aquifer intake area and the adequacy of the protection of this area.

* Potential impact downstream drainage lines in terms of channel stability, sedimentation and flooding.

* A plan for ongoing maintenance and monitoring of sediment and water controls to ensure their correct installation and effectiveness.

* Potential impact on localised saline discharges and water table heights.

8. Erosion Control

* Knowledge of physical and chemical soil characteristics of the area to determine the erosion potential and suitability for rehabilitation.

* Measures to minimise the area denuded at any one time.

* Location of buffer zones along drainage lines and sensitive areas; include widths, fencing details and management.

* An integrated system of measures to control water flow within the impacted area to minimise the volume, slope and speed of water flow and the transmission of sediment including the construction and maintenance of sediment ponds, and traps.

* Appropriate system to stabilise and maintain banks of cut areas and open drains to prevent erosion.

* Selection of appropriate techniques that minimise erosion for stripping topsoil and subsoils before extraction.

* Program to control wind and water erosion from stockpiles; identification of time of the year when prevailing wind speed and direction or rainfall would warrant additional control measures.

9. Stability

* Identification of any areas where the slope exceeds 18 degrees.

* Structural stability of quarry walls and stockpiles.

* Methods to prevent subsidence or slip.

10. Impacts During the Establishment of the Quarry

* Site preparation, clearing including any burning, chipping or mulching, removal and storage of overburden, and construction of access roads.

* Does the proposed quarry site have any land identified as Protected Land under the Native Vegetation Conservation (NVC) Act 1997 ?

  Under Section 12 Part F of the NVC Act, a designated development has exemption from the need to apply for clearing as long as the EIS assesses the vegetation on site, and considers the vegetation issues in the overall development plans of the site.

  The above exemption does not exclude your requirements under the National Parks and Wildlife Act 1974, Pollution Control Act 1970, etc. (Section 23, Part 2).

* Any works within 40 metres of a major drainage line or water course, may require a permit under Part 3A of the Rivers and Foreshores Improvement Act, 1938.

11. Rehabilitation

* Assess the general suitability for rehabilitation and the need for supplementary rehabilitation treatment such as fertiliser addition.

* Physical and chemical properties of the topsoil; storage of topsoil, including measures to separate less fertile subsoil overburden from more fertile topsoil.

* Identify soil which would be suitable as surface material in rehabilitation either additional to or in substitute for original soil material.

* Identify stockpile surface stabilisation measures such as mulching or temporary vegetation of any stockpiles to prevent erosion; stockpile batter grades recommended one less than 3 to 1 (H:V) with a 2 to 3 metre rounded crest.

* Identify topsoil and overburden stockpile locations.

* Proposed rehabilitation of cut and fill batters and culverts on the access roads.

* Details of reshaping of area to create a stable landform aesthetically compatible with surrounding area.

* Revegetation plan including surface preparation, replacement of overburden and

topsoil, sowing techniques, species, rates and staging of the rehabilitation program, requirement of fertiliser, need to temporary vegetation, fence locations to control stock and vehicle movements, is required.

* Maintenance program of the rehabilitated area.

* Rehabilitation procedures during and after completion of the extractive operation; final land formation plan including any sedimentation dams; consideration of final drainage patterns; provision for fencing; progressive erosion control strategy during and after rehabilitation; identify volume and types of material required to achieve any reshaping and the proposed source of the material; proposed use of any waste from the operation in land formation.

* Proposed final use of the site:
  - compatibility of the proposed use with the surroundings.
  - if landfill, materials recycling facility or contaminated soil treatment works are proposed; then consideration of the suitability of the site in relation to groundwater; permeability of soil, type of waste to be disposed or processed; identify any constricts in the suitability of the site for this purpose and the final landform, landscaping and use.
  - if recreation lake is proposed, then consideration of the appropriateness of the grading of the slopes, potential groundwater impacts, potential water quality issues because of the catchment or soil types.
  - abandonment plan, providing details of rehabilitation of the area in the event of the operation being temporarily or permanently suspended.

12. Environmental Management and Rehabilitation Plan

The environmental management plan should include a comprehensive plan for managing or mitigating any environmental impacts for the life of the quarry.

The overall management plan should integrate strategies for sound environmental practice during the construction, operation and decommissioning of the site including:

- energy and water conservation
- management of impacts including air, blasting, noise, water, erosion, flora and fauna, heritage, traffic and road, bushfire, visual and hazards
- transportation issues
- waste management issues
- rehabilitation and reuse of the site.

The plan should include a monitoring program to include all key impacts on the environment and appropriate reporting procedures to relevant authorities and if appropriate to the consent authority.

The monitoring program should include:

- monitoring locations, intervals and duration
- the key information that will be monitored, its criteria and reasons for monitoring
- reporting procedures to internal management and relevant authorities.

Annual environmental reports should be considered which address performance, compliance with consent conditions, progress with operations and rehabilitation, actions on complaints etc. This report should be sent to relevant authorities.

The plan should identify all government licensing and approval requirements and demonstrate how the plan will facilitate compliance with these requirements.

Additional reference material can be found in the Department of Urban Affairs and Planning EIS Requirements Document, 1996.

For further information or technical assistance please contact John Scown on (02) 6226 1433.

Yours faithfully

JScown

J. T. SCOWN
Resource Officer, Yass
for GEOFF FISHBURN
Regional Director
MURRUMBIDGEE REGION

22 September, 1998

MINERAL RESOURCES

NSW DEPARTMENT OF MINERAL RESOURCES
Minerals and Energy House, 29-57 Christie Street
(P.O. Box 536), St Leonards, NSW 2065, Australia
Phone (02) 9901 8888 · Fax (02) 9901 8777
DX 3324 St Leonards

Coffey Geosciences Pty Ltd
PO Box 152
Fyshwick ACT 2609

Attention: Mr W White

2 8 SEP [illegible]
CANBERRA

Our Ref: L98/0354
Your Ref: C6521/1-AI

Dear Sir,

Environmental Impact Statement Requirements for
Proposed Hard Rock Quarry
Williamsdale, NSW

I refer to your letter of 8th September, 1998 seeking this Department's requirements for an environmental impact statement (EIS) to be prepared for the abovementioned proposal.

Hard rock (rhyolite) is not a prescribed mineral under the Mining Act, 1992. Therefore, the Department of Mineral Resources has no statutory authority over the extraction of this commodity, apart from its role under the Mines Inspection Act, 1901 (as amended) with respect to safe operation of mines and quarries.

The resources which are the subject of this proposal were identified as a potential resource in "Construction Material resources of the A.C.T. & Subregion" by G.P. MacRae: Unpublished Report GS1993/018: Geological Survey of New South Wales.

Notwithstanding the above, this Department is the principal government authority responsible for assessing the State's resources of construction materials and for advising State and local government on their planning and management.

With regard to the requirements of the Department of Mineral Resources concerning issues which should be addressed in environmental impact statements, the following are considered essential:

1. The amount of material to be extracted and the method or methods used to determine this amount (e.g. drilling, trenching, geophysical methods). Supporting information, summarising this data, including plans and cross-sections showing locations of drillholes, geology etc, and area proposed for extraction should be included. Other relevant supporting data should be appended or referenced.

2. Characteristics of the material to be produced. For hard rock aggregate proposals information such as grainsize and mineralogy, nature and extent of weathering or alteration, and amount and type of deleterious minerals, if any, should be indicated. Details of tests carried out to determine the characteristics of the material should be appended.

3. An assessment of the quality of the material and of its suitability for the anticipated range of applications should be provided.

4. Anticipated annual production, staging (if any), and life of the operation.

5. Alternative sources to the proposal and their availability.

6. Transport routes.

7. Disposal of waste products and the location and size of stockpiles.

8. Assessment of noise, vibration, dust and visual impacts, and proposed measures to minimise these impacts.

9. Proposed rehabilitation procedures during, and after completion of, extraction operations, and proposed final use of site.

10. Justification for the proposal in terms of local and, if appropriate, regional context.

If you have any queries on this matter please contact Mr Alan Ferguson of the Geological Survey on (02) 9901 8367.

Yours faithfully,

S.R. Lishmund
for **Director-General**
24/9/98

NSW
NATIONAL
PARKS AND
WILDLIFE
SERVICE

The General Manager
Coffrey Geosciences Pty Ltd
PO Box 152
Fyshwick ACT 2609

Attention: Mr Denis Byrne

9[illegible] October 1998

Our reference: *ZF0081/FK/sn98/231*
Your reference: *C6521/1-AE*

Dear Sir,

RE: Environmental Impact Statement - Proposed Hard Rock Quarry Williamsdale, NSW

Reference is made to your letter of 8 September 1998 in which you consult with the National Parks and Wildlife Service (NPWS) on the features to be incorporate into the above proposal. Thank you for the opportunity to comment, in future all correspondence on planning issues should be addressed to;

Environmental Planning Manager
NPWS
PO Box 2115
Queanbeyan NSW 2620 Tel: (02) 6298 9701 Fax: (02) 6299 4281

The NPWS is responsible for the care, control and management of all areas dedicated as national parks, Aboriginal areas, historic sites, nature reserves and game reserves. In addition, the NPWS is responsible for the protection of native fauna and native plants throughout NSW and with the protection and care of the State's Aboriginal sites and relics.

The NPWS has an interest in the potential impacts of the proposal on the following:

- areas of native vegetation,
- areas of potential value as habitat for native fauna, and
- areas of archaeological potential.

It is recommended that detailed surveys be undertaken to determine the significance of the site for these features.

In particular, the matters recommended to be addressed in the Environmental Impact Statement are as follows;

- Mapping of the location and description of all native fauna habitats, vegetation communities and plant species that are within the area to be impacted and which are likely to be of local, regional or state conservation significance.
- Mapping of the location and description of Aboriginal sites and relics within the area to be impacted and identification of any areas of high archaeological potential.
- Assessment of the significance of the above attributes.
- Prediction of the likely impact of the proposal on the above attributes.

Southern Zone
6 Rutledge Street
Queanbeyan NSW
2620 Australia
PO Box 2115
Queanbeyan 2620
Fax: (02) 6299 4281
Tel: (02) 6298 9700

Head Office
43 Bridge Street
Hurstville NSW
Australia
PO Box 1967
Hurstville 2220
Fax: (02) 9585 6555
Tel: (02) 9585 6444

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- Assessment of measures available to minimise the impact of the proposal on these attributes.

Flora and Fauna Issues

As the actual size and scope for the proposed quarry has not yet been defined the following comments are based on what the EIS should endeavour to address. The quarry should be examined in terms of its potential impacts on the native fauna and flora, including all infrastructure that will support the quarry. Therefore, a fauna and flora survey should be included in the EIS. When conducting the survey reference should be made to the Giant Burrowing Frog *Heleioporus australiacus* which has recently (1995) been recorded nearby in an area of similar habitat conditions. There are other threatened species that have been recorded in the surrounding area, such as koalas, tiger quolls and bats. Since it is possible for threatened species to be found in the proposal area, the potential impact of the activity should be considered by carrying out an 8 part test of significance.

When conducting the survey the NPWS would like to note that there are particular times when surveying for fauna and flora species is likely to be more effective. Best time to survey for fauna is when the weather is warming up, particularly amphibians and bats are best surveyed on mild balmy nights just before or after it has rained when there is plenty of insect activity.

When collecting information on flora and fauna species that might be present, searching through literature and reviewing past surveys will provide you with a basis for the EIS. The "Wildlife Atlas is a NPWS GIS database which identifies registered site recordings of fauna species in NSW and may provide information of use to you in your study. The Atlas is not a definitive database and the EIS should encompass other research and surveys that may have been conducted in the area. The same can be said of the second database which is the "ROTAP database" of rare or threatened plants. Material from these databases is available upon written application and the receipt of the appropriate fee. Information on this service may be obtained by contacting Data Licensing Officer, Geographical Information Systems Division, NPWS, PO Box 1967, Hurstville NSW 2220 or on (02)9585-6684.

Cultural Heritage

There are Aboriginal camp sites recorded just south of the Williamsdale area. The topography of the suggested proposal area shows undulating peaks and valleys with creek lines and plenty of water. It is in these areas that Aboriginal camp sites are located and there is potential for more sites and artefacts to be found. Under s.90 of the *National Parks and Wildlife Act* 1979 it is an offence to knowingly disturb, damage or destroy relics, including moving without the prior permission of the Director-General of the NPWS.

For the archaeological inspection NPWS would recommend using the *'Aboriginal Cultural Heritage Standards and Guidelines Kit'* at a fee of $70.00 when conducting the full survey. This is available from the Cultural Heritage Unit, Southern Zone by contacting Jackie Taylor on (02) 6298-9707.

The third GIS database is the Aboriginal Sites Register. Once again, material from this database is available upon written application and the receipt of the appropriate fee. Information on this service may be obtained by contacting Aboriginal Sites Registrar, Cultural Heritage Services Division, NPWS, PO Box 1967, Hurstville NSW 2220 or on (02) 9585-6471.

Management prescriptions

The EIS needs to examine potential direct and indirect impacts and devise controls to protect against detrimental impacts. Some of the controls that are to be implemented in the management plan of the quarry and addressed in the EIS are: fire management, erosion and sedimentation, the effects of increasing traffic into the area, increased noise and dust, removal of habitat, and possible introduction and spread of pest species.

Recommendations

Issues that need to be addressed in the EIS for the hard rock quarry are;

- The 8 part test of significance for threatened species will need to be included in the flora and fauna study. This should include all areas proposed for disturbance including all infrastructure that will support the quarry.
- Management Controls that need to be addressed in the EIS are; fire management, erosion and sedimentation, the effects of increasing traffic into the area, increased noise and dust, removal of habitat, and possible introduction and spread of pest species.
- An archaeological survey needs to be conducted by an appropriately qualified archaeologist or Aboriginal representative.

If you have any questions concerning this matter, please contact Frances Knight, Environmental Planning Officer, on (02) 6298 9711.

Yours sincerely,

Michael Hood
Manager, Environmental Planning Unit,
Southern Zone

c:\fmk\scope\quarry_williamsdale

ACT GOVERNMENT
DEPARTMENT OF THE ENVIRONMENT LAND AND PLANNING
JOHN OVERALL OFFICES 220 NORTHBOURNE AVE BRADDON ACT 2601
GPO BOX 1908 CANBERRA ACT 2601
TEL [illegible]
FAX

ACT Planning Authority

RECEIVED
15 APR 1993
Connell Wagner
9 8 7 6 5

Connell Wagner (NSW) Pty Ltd
PO Box 538
Neutral Bay
NSW 2089

Dear Mr Paterson,

Re: Proposed Oak Vale Quarry, Williamsdale
Environmental Impact Statement

Thank you for your letter dated 9 March, in regard to the proposed quarry site at Oak Vale, Williamsdale.

Whilst the proposed quarry site does not fall within the boundaries of the ACT, it is an area adjacent to the border in the south-east. There are a few aspects of the quarry - the extraction, treatment and wastes, and transport that we would like considered in relation to any possible impact (direct or in-direct) on the local environment in the ACT. The impacts need to be assessed for the various stages of the operation: the construction of the quarry and access road; the operation span of the quarry and the heavy traffic use of the access road and Monaro Highway; and the rehabilitation of the site when quarrying ceases. Measures to be taken to mitigate any impacts should be addressed.

The proposed location is at the headwaters of Jerrabomberra Creek that feeds the Jerrabomberra Wetlands Nature Reserve which, in turn, flows into Lake Burley Griffin. An assessment of any cumulative impact on both the wetland and the lake by the quarry upstream of these areas should be carried out. Aspects to study are a possible alteration to flow/flood regime, siltation, pollution, turbidity and any affects on aquatic invertebretes.

It is also important that the quarry operation and access road do not alter the Jerrabomberra Ck floodplain through erosion and/or siltation thus altering the flow regime.

The proposed access road will intersect with the Monaro Highway and the transport route to Canberra will be along the Monaro Highway. Traffic impacts such as noise, hazards and road damage should be considered.

Also, any possible problems caused by dust from the operation and the access road (if unsealed); any visual impact of the quarry or access road; and the proposed procedures for waste removal need to be investigated.

If you have any queries in relation to any of these points, please contact Gary Richards (telephone 06.207.5661) in the Environmental Planning and Assessment Section.

Yours sincerely,

for George Tomlins
8th April, 1993

Appendix B - Coffey Report No. S5281/2/3

Leighton Contractors Pty. Ltd.

QUARRY INVESTIGATION
CANBERRA, A.C.T.

Report No. S5281/2/3 Dec. 1984

COFFEY

Coffey & Partners Pty Ltd

Consulting Engineers
in the geotechnical sciences

CTS2292
23 November 1998

This is a full reproduction copy of Coffey and Partners Pty Ltd report:

S5281/2/3
Leighton Contractors Pty Ltd
Quarry Investigation, Canberra, ACT
December 1984

It has been produced for Totalcare Industries Ltd following authority given by our original client, Leighton Contractors Pty Ltd by facsimile dated 17 November 1998 (copy attached).

For and on behalf of
COFFEY GEOSCIENCES PTY LTD

DENIS BYRNE

265 Canberra Avenue Fyshwick
ACT 2609 Australia
PO Box 152 Fyshwick
ACT 2609 Australia
Telephone +61 2 6280 4732
Facsimile +61 2 6280 6650
Email cgeocanb@coffey.com.au

Coffey Geosciences Pty Ltd ACN 056 335 516

LEIGHTON

Leighton Contractors
Pty Limited
A.C.N. 000 [illegible]

5 Queens Rd
Melbourne Vic 3004
Australia
Telephone (03) 6285800
Facsimile (03) 6662870

Facsimile Cover Sheet

To: Chris Turner
Company: Coffey Partners Int. Pty Ltd
From: John Bartolotta
Fax. No. : (02) 6280 6650
Date: 17th Nov 1998
Phone No. : (03) 9228 7707
Subject: **REALEASE DOCUMENTS RE WLLIAMSDALE**

Dear Chris,

Total Care Industries has approached Ian Luck (General Manager, Southern Region, Leighton Contractors Pty Ltd) for the purchase of documents relating to Oakdale Quarry, Williamsdale.

Authority is hereby given for the release of the above mentioned documents.

Regards,

John Bartolotta
Administration Manager Southern Region

C P Thorne [illegible]
B C Burman [illegible]
I R Birch [illegible]
C F R Fitzhardinge [illegible]
G K Spencer [illegible]
P C Thomson
M G Philp [illegible]
R Fell [illegible]
M C Ervin [illegible]
T D Sullivan [illegible]
I L McKenzie [illegible]
J P MacGregor [illegible]
P J N Pells [illegible]
Special Consultant
C O Brawner [illegible]

COFFEY

Coffey & Partners Pty Ltd

Soil and rock engineering
engineering geology
groundwater hydrology
foundation engineering
mining geotechnics
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computer applications
construction control & monitoring

Consulting Engineers
in the geotechnical sciences

Incorporated in Queensland

12 Waterloo Road
North Ryde Sydney

PO Box 125
North Ryde New South Wales
Australia 2113

Telex Coffey AA22650
Telephone (02) 888 7444

your reference
our reference S5281/2/3 JPM:AP
date 14th December, 1984

The Manager,
Leighton Contractors Pty. Ltd.,
30 Botany Street,
PHILLIP. A.C.T. 2606.

ATTENTION: MR. P. COOPER

Dear Sir,

RE: QUARRY INVESTIGATION - CANBERRA, A.C.T.

We have pleasure in presenting our report on the current status of the search for quarry sites in the Canberra region. It is intended to be used as a support document for the Oak Vale Quarry - Environmental Impact Statement (see our Report S5281/2/1) and summarises the search parameters and areas covered during the field evaluation of potential quarry sites.

This supplements our letter of 20th December, 1983.

If you have any questions or require further information, please do not hesitate to contact the undersigned.

Yours faithfully,
COFFEY & PARTNERS PTY. LTD.

per J.P. MacGREGOR

TABLE OF CONTENTS

LIST OF FIGURES

1.0 INTRODUCTION

Coffey & Partners Pty. Ltd. was commissioned by Leighton Contractors Pty. Ltd. to find a suitable site within the Canberra region for the development of a hard rock quarry capable of supplying high quality dense natural aggregates.

In late 1983, an office evaluation of the regional geology ranked the stratigraphic units in terms of their quarry prospects. The results of this study, which did not include the stratigraphy of the Australian Capital Territory, were presented in our letter of 20th December, 1983.

The investigation for a suitable quarry site was subsequently initiated based on this listing in conjunction with economic and environmental search parameters.

The non-geologic considerations were established during consultations with Leighton Contractors Pty. Ltd. (Mr. P. Cooper), the Yarrowlumla Shire Council (Mr. D. Rouse) and the Department of Environment and Planning (Ms. L. Gray) whereas the limitations relating specifically to the A.C.T. are based on discussions with Leighton Contractors Pty. Ltd. (Mr. P. Cooper), the Department of Housing and Construction (Mr. G. Knight), the Department of Territories and Local Government (Mr. G. Vachenko) and the National Capital Development Commission (Messrs. K. Storey and G. Scott).

Three potential sites have been examined in some detail with one site (on the Oak Vale property) being chosen as the most suitable for quarry development. The proposed development and operation of this quarry is the subject of an Environmental Impact Statement (see Coffey & Partners Pty. Ltd. Report No. S5281/2/1).

2.0 GENERAL SEARCH PARAMETERS

A number of environmental and economic search parameters are common to both N.S.W. and the A.C.T. These are:-

* the quarry site must be no closer than 1 km to any residence;

* the quarry must be capable of supplying at least 500,000 tonnes of high quality concrete aggregate; and

* the visual impact of the quarry must be kept to a minimum.

In addition to these considerations, guidelines were adopted for the comparative evaluation of potential sites. These include:-

* the quarry site should be as close as possible to suitable road networks;

* the quarry site should be as close as possible to Canberra;

* the quarry site should have the potential for long-term operation and expansion;

- the topographic situation of the site should be such that quarrying activities will result in a self-draining pit; and
- the potential impact of the quarry operations on the environment should be minimised.

In view of the limited number of Murrumbidgee River crossings available to heavy traffic, the quarry seach has been restricted to areas east of the Murrumbidgee River.

3.0 AUSTRALIAN CAPITAL TERRITORY

3.1 Statutory Siting Constraints

The development and operation of a quarry within the A.C.T. is affected by three Commonwealth authorities:-

- the National Capital Development Commission (N.C.D.C.);
- the Department of Housing and Construction (D.H.C.); and
- the Department of Territories and Local Government (D.T.L.G.).

The N.C.D.C. reportedly has no clear policy on quarrying in the A.C.T. and treats each quarry application on its own merit (K. Storey, pers. comm.).

The Commission appears to be primarily concerned with the design and siting of a quarry and infrastructure as far as it affects the wider environment.

The D.H.C. is responsible for formulating the ordinances related to noise, air and water discharge standards. Although these statutes have yet to be enacted, we understand that they will, as far as quarry operations are concerned, be in line with the Clean Air, the Clean Waters and the Noise Control Acts of N.S.W. (G. Knight, pers. comm.).

Any application for the development and operation of a quarry in the A.C.T. must be directed through the D.T.L.G. which is responsible for granting and maintaining any lease in the Territory. The D.T.L.G. will reportedly co-ordinate evaluation of the proposal and, after consultation with other authorities, will nominate conditions for approval of a lease. These prescriptions may or may not include assessment of the environmental impact of the proposal. If such an assessment is required, it will likely be along the lines of a N.S.W. Environmental Impact Statement (G. Vachenko, pers. comm.).

3.2 Environmental Siting Constraints

The N.C.D.C.'s main concern for the operation of a quarry relates to minimising its visual impact on the national capital's 'open space' which accounts for some 72% of the A.C.T. It appears desirable that where the proposed development is within 'open space', it is sited such that its visual impact is minimised.

Areas which are reportedly unavailable for development include:-

- declared nature reserves;
- urban areas; and
- any area within sight of the Parliamentary zone.

Some other areas of particular concern to the N.C.D.C. are:-

- the self-draining nature of the quarry pit;
- the quality and quantity of drainage from the quarry if it is into the Canberra lakes or main rivers;
- the design and siting of quarry buildings;
- the developer's working plan for progressive restoration of the quarry; and
- the developer's operation programme for the quarry (e.g. over a 3 or 5 year period).

3.3 Areas Investigated

The constraints listed above effectively preclude quarry development in the A.C.T., and as a suitable quarry site had been located in N.S.W. in the early stages of the study no site in the A.C.T. has been investigated in detail.

4.0 NEW SOUTH WALES

4.1 Environmental Planning Instrument Zonings

Search radii of 30km from the proposed Gungahlin development area and Tuggerong in the A.C.T. were adopted for the present study. It is noted that much of the area beyond the Gungahlin search radius has been covered in the investigations for aggregate sources for use on the Hume Highway reconstruction projects and the Federal Highway Collector bypass (Canberra Job No. C.2942).

A large part of the search area is within the jurisdiction of the Yarrowlumla Shire Council which has issued an environmental planning instrument in the form of Interim Order No. 1 (1966). The zoning restrictions on the development of quarries contained in the Order are shown on Figure 2.

4.2 Environmental Considerations

Extractive industry in N.S.W. is treated as Designated Development within the meaning of Schedule 3 of the Environmental Planning and Assessment Regulation, 1980. As such, an Environmental Impact Statement (E.I.S.) must accompany any development application. The content and form of an E.I.S. is nominated in the above Regulation which is enforced by the Department of Environment and Planning.

Prior to the field work, the Department was informally consulted regarding any emphasis that it might place on features affecting the search area. Ms. L. Gray of the Department advised that it was policy to object to any development where the proposed development encroached upon the visual catchment of a highway.

Sensitive geographic areas suggested by Ms. Gray as likely to attract close scrutiny of any development proposal include:-

* the escarpment of the Lake George Fault; and

* the Murrumbidgee River.

The search therefore, was generally restricted to areas which are:-

* not in view of a highway;

* not in view of a urban development;

* not in view of a rural subdivision area (e.g. Burra Valley and Mac's Reef); and

* not associated with the Lake George Fault or Murrumbidgee River.

4.3 Areas Investigated

4.3.1 Royalla Prospect

In late 1983, Mr. V. Drew of 'Black Flat', Michelago, approached Coffey & Partners Pty. Ltd. to assess the aggregate suitability of rock underlying part of his property located some 4 km north of Williamsdale, N.S.W. (see Figure 3). With the concurrence of Mr. Drew, Leighton Contractors Pty. Ltd. were contacted to fund such a study.

Coffey & Partners Pty. Ltd. were subsequently commissioned by Leighton Contractors Pty. Ltd. to assess the quarry potential of the site which was informally named the Royalla Prospect by virtue of its proximity to the Royalla railway siding some 2 km north.

The rock cropping out over the site comprises medium grained porphyritic dacitic tuff which has a well developed foliation striking generally 005^{o} to 020^{o} and dipping about 80^{o} to the east. It is assigned to the mid-Silurian Colinton Volcanics, which consist of tuff, crystal tuff and dacite with shale, sandstone and limestone lenses.

In 1974 the southern part of the prospect had been investigated and assessed as containing a 'rock type suitable for the production of high quality crushed rock aggregate'. Qualifying comments, however, related to the unfavourable results of the particle shape and potential reactivity determinations (see Coffey & Partners Pty. Ltd. Report No. S5281).

Field inspection of the site on 15th December, 1983 revealed that the well developed foliation is found throughout the area and, furthermore, that numerous fault and shear zones may cross the area. These observations initiated the current regional study by which Leighton Contractors Pty. Ltd. sought assurance that the Royalla prospect was the optimum quarry site for their regional use.

Following the discovery and sampling of the Oak Vale prospect, some two km to the south east, rock from the central and northern parts of the Royalla prospect were sampled for trial crushing and laboratory testing (see Figure 4).

Two drill sites were selected on the basis of available access and each was drilled with a track mounted Gardner-Denver 3100 'Airtrak' rotary-percussion rig on 6th March, 1984. Six holes, each 3m deep, were drilled at each site. All were inclined between 50^{o} and 70^{o} from the horizontal and were arranged in opposing pairs.

The two sites were blasted with ANFO and nitroglycerine on 6th March, 1984. The resultant blast products were generally irregular in shape and ranged from metre sized blocks to fine gravels. Many of the gravel and cobble sized fragments exhibited marked flakiness in shape (see photographs 1 to 6, Appendix A). The rock type in each site appeared to be the same as that sampled in 1974.

From each site approximately 70 kg of 100mm size rock fragments were collected for crushing and testing. The two samples were crushed in the BMI Laboratory, Sydney, but no tests were undertaken on the aggregate as the Oak Vale prospect was assessed to be a more favourable site for the development and operation of a hard rock quarry.

The factors affecting this assessment include:-

* the Royalla site is within sight of the Monaro Highway and the planned highway realignment whereas the Oak Vale site is not (see photograph 7, Appendix A; and Figure 3);

* additional screening of the Royalla site would be unlikely to reduce its visual impact; and

* the rock occurring over the Oak Vale prospect, on visual inspection appears to be of higher quality than that found on the Royalla prospect.

* the rock from the present Royalla appears to have similar engineering properties to the area previously examined (see S5281).

4.3.2 Oak Vale Prospect

The Oak Vale prospect was identified on 17th January, 1984, during reconnaissance geological mapping. It is located wholly within the Oak Vale property, some 16 km south of Tuggeranong, Canberra, and comprises two adjacent north-south trending ridges. The western of the two ridges was selected by Leighton Contractors Pty. Ltd. as the preferred quarry site on the basis of topography and access.

The ridges contain significant extractable volumes of medium grained porphyritic dacite which, on the basis of laboratory test results and qualitative assessment of the drill cores, appears to be suitable for use as high quality concrete aggregate (see Coffey & Partners Pty. Ltd. Report No. S5281/2/2). Deformation of the rock is markedly less than in the dacitic tuff of the Royalla prospect.

The site was selected using the following criteria:-

* the distribution of the most suitable undifferentiated porphyry unit (see our letter of 20th December, 1983);

* the visual catchment of the Monaro Highway;

* the 1 km limit to any residence;

* the visual catchment of the Burra Valley rural subdivision;

* the environmental planning instrument zonings; and

* the proximity to a suitable road network (viz. the Monaro Highway and Williamsdale Road).

Figure 3 shows that the site of the Oak Vale prospect is as close to Canberra as the Monaro Highway's visual catchment permits. The topographic situation and the geological setting produce a favourable site for a quarry operation with reserves in excess of 500,000 tonnes.

4.3.3 Federal Highway - Sutton Prospect

This prospect is located close to the Federal Highway some 3.9 km east off the Sutton Road intersection (see Figure 2). Unlike the two prospects described above, which comprise volcanic rock of Silurian age, this prospect is within older, more highly deformed Ordovician sediments and metasediments.

Although this stratigraphic unit had been assessed as 'unprospective' in the initial study, detailed assessments of the area were commissioned by Leighton Contractors Pty. Ltd. under a share arrangement with Mr. G. Schmidt who reportedly had first option on the area. The field investigations included numerous field traverses, nine rotary-percussion boreholes and two costeans (Canberra Job No. C2977, see letters of 22nd March and 7th May, 1984).

Although extremely high strength rock occurs over the prospect, it is interbedded with less durable rock and does not crop out in significant thicknesses. The lack of uniformity in conjunction with the apparent structural complexity of the Ordovician sediments and metasediments has confirmed the initial 'unprospective' evaluation and led to the recommendation that no further work be carried out at this site.

4.3.4 Other Areas

The assessed prospectivity of the regional stratigraphy is given in Tables 1 and 2 and is shown in Figure 5. For the purpose of this exercise, prospectivity has been ranked in four categories corresponding to the following:-

* Category 1: Most prospective;
* Category 2: Prospective;
* Category 3: Prospective, but not as prospective as Category 2; and
* Category 4: Unprospective.

A general relation between rock type and potential is:-

* Category 1: Volcanic rocks;
* Category 2: Predominantly volcanic rocks with some sedimentary rocks;
* Category 3: Predominantly sedimentary rocks with some volcanic rocks; and
* Category 4: Sedimentary and intrusive granitoid rocks.

As can be seen from Figure 5, the 'most prospective' units occur in the northwest, centre and south of the search area along with 'prospective' stratigraphic units assigned to Categories 2 and 3. 'Unprospective' sediments generally occupy the eastern half of the region.

Reconnaissance of these areas was limited to road traverses in order to assess the environmental suitability of potential quarry sites. This reconnaissance did not identify an acceptable quarry location.

The following comments relate to the northwestern area:-

* the 'most prospective' Douro Volcanics (Smd) are, when compared to the Oak Vale Prospect, unfavourably sited with respect to suitable road networks;

* the tourist feature of the Ginninderra Falls occurs within the 'most prospective' undifferentiated Porphyry (Sp); and

TABLE 1

CANBERRA 1:250,000 GEOLOGICAL SERIES SHEET

Unit Symbol	Age	Unit Name	Rock Types	Category
Qa	Quaternary		Soil, clay, silt, sand, gravel	4
Cza	Tertiary		Gravel, sand, clay, lignite, silcrete	4
gbu	Silurian/ Devonian	Urialla Granite	Biotite granite	4
gbd	Silurian/ Devonian	Greenwood Granite	Biotite granite	4
gbs	Silurian/ Devonian	Sutton Granite	Biotite granite	4
g	Silurian/ Devonian		Granite	4
Sp	Silurian		Porphyry	1
Sv	Silurian		Mainly acid volcanics	2
Sud	Late Silurian	Deakin Volcanics	Rhyodacite, rhyolite, dacitic and rhyodacitic tuff, tuff, minor agglomerate, ashstone, tuffaceous sandstone, shale	2
Sug	Late Silurian	Glenesk Formation	Acid volcanics, volcanic breccia, slate	2
Suf	Late Silurian	Captian's Flat Formation	Interbedded slate and lithic tuff, thin basalt and dacite, sandstone	3
Suw	Late Silurian	Carwoola Beds	Siltstone, shale, argillaceous sandstone	4
(Smc)	Middle Silurian	Copper Creek Shale and Rutledge Quartzite	Siltstone, graphitic slate, tuff, limestone lenses, quartzite	3
Smo	Middle Silurian	Colinton Volcanics	Tuff, crystal tuff, dacite, shale, sandstone, limestone lenses	2
Smw	Middle Silurian	Walker Volcanics	Dacite, rhyodacite, rhyolite, calcareous shale, limestone, sandstone	2
Smh	Middle Silurian	Hawkins Volcanics	Dacite, dacitic crystal tuff, agglomerate, quartz andesite, minor shale, tuff	2
Sma	Middle Silurian	Ainslie Volcanics	Dacite, agglomerate, quartz andesite, minor andesite, rhyolite, tuff, shale	2
Smy	Middle Silurian	Glen Bower Beds	Thin bedded sandstone, slate, thin limestone	4
Smd	Middle Silurian	Douro Volcanics	Coarse tuff, quartz porphry	1
Smc	Middle Silurian	Canberra Formation	Siltstone, mudstone, limestone, slaty shale, minor argillaceous and tuffaceous sandstone, ashstone, quartz andesite, tuff, dacite, calcareous sandstone	3
Slm	Early Silurian	Murrumbateman Creek Formation	Slate, interbeds of quartz sandstone	4
S	Silurian		Sediments and volcanics	3
Os	Ordovician		Greywacke, sandstone, slate, chert, limestone, quartzite	4
Oup	Late Ordovician	Picaree Formation	Greywacke, slate, carbonaceous slate, sandstone, siltstone, chert	4
Omp	Middle to Late Ordovician	Pittman Formation	Quartz sandstone, feldspathic sandstone, greywacke, micaceous siltstone and shale, radiolarian chert, phyllite	4

TABLE 2

GOULBURN 1:250,000 GEOLOGICAL SERIES SHEET

Unit	Age	Unit Name	Rock Types	Category
Qa	Quarternary		Sand, clay, gravel	4
Cza	Tertiary		Gravel, sand, clay, claystone, sandstone	4
Smd	Middle Silurian	Douro Volcanics	Dacite, andesite, coarse and fine crystal tuff, tuffaceous sandstone, shale, limestone	2
Os	Ordovician		Silty sandstone, micaceous siltstone, phyllite, shale, slate, quartzite, minor porphyry	4

* the potential for establishing a quarry site which complies with the environmental siting guidelines is limited by the cleared and undulating nature of the countryside. In conjunction with the density of residential development this commonly adversely effects the visual amenity of the area.

In the central area the quarry potential appears to be affected by poor visual amenity and the following considerations:-

* the proximity to the proposed Gungahlin development area in the A.C.T. introduces the possibility of future impositions of 1 km residential zone restrictions which would limit the operations of a quarry; and

* the 'most prospective', and 'prospective', Ainslie Volcanics (Sma) reportedly contain significant quantities of pyrite and metamorphic textures that may be detrimental to the aggregate suitability of the rocks.

The southern area has effectively been covered in the sections on the Royalla and Oak Vale Prospects whereas the comments relating to the 'unprospective' sediments and metasediments of the Federal Highway-Sutton Prospect can, in general, be applied to the 'unprospective' eastern half of the search area.

Intrusive granitoid rocks have been included as Category 4 units of this study for the following reasons:-

* the nature and depth of the weathered zone is characteristically deep with slightly weathered to fresh corestones commonly being distributed throughout; and

* the durability of the medium and coarse grained granitoid rocks is generally either too low for use as concrete aggregate or is inferior to that of volcanic rocks.

The presence of significant proportions of poor quality material within the rock mass indicates that quarrying granitoid rocks for use as concrete aggregate is unlikely to be cost effective.

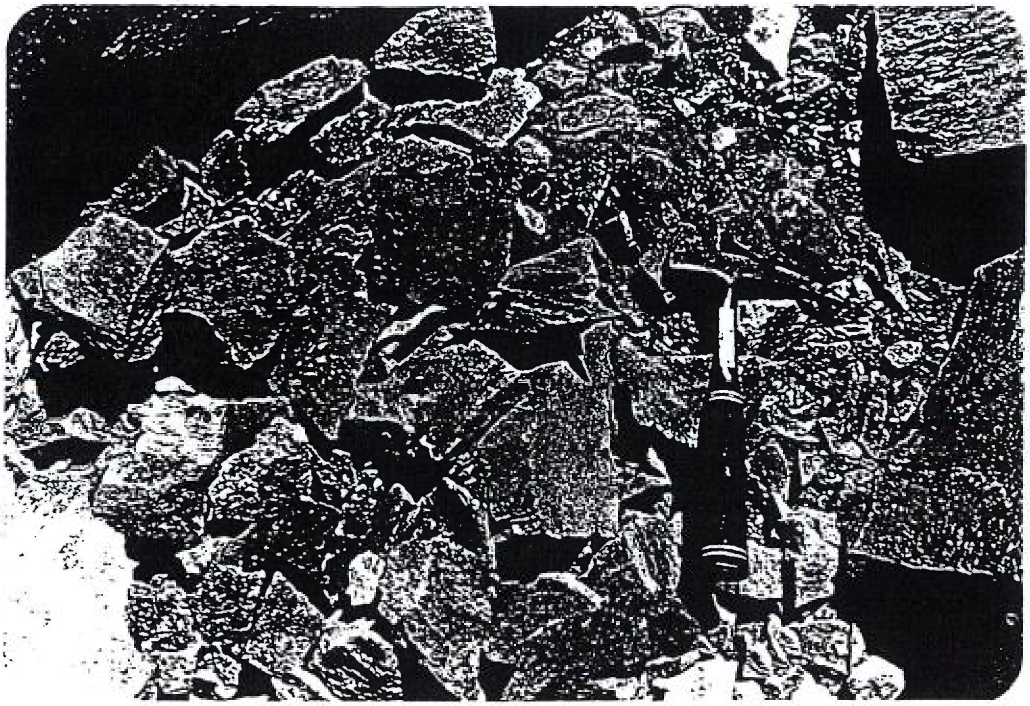
APPENDIX A

PHOTOGRAPH 1

ROYALLA PROSPECT. SAMPLE SITE A. Before drilling

PHOTOGRAPH 2

ROYALLA PROSPECT. SAMPLE SITE A. After blasting

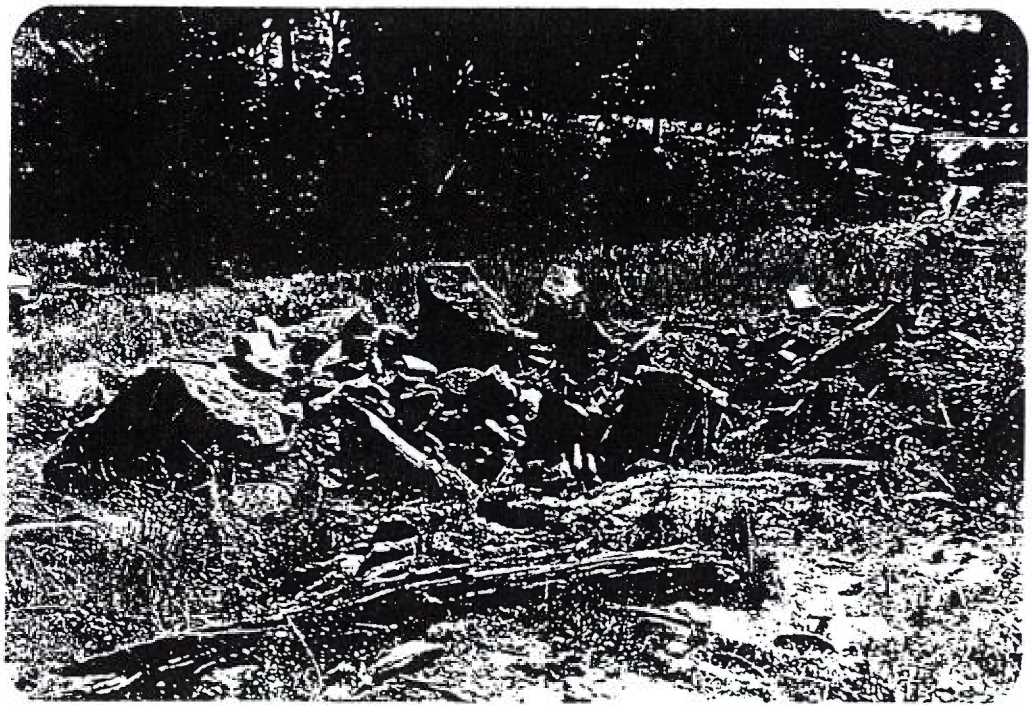


PHOTOGRAPH 3

ROYALLA PROSPECT. SAMPLE SITE A. Close-up of blast rubble

PHOTOGRAPH 4

ROYALLA PROSPECT. SAMPLE SITE B. Before drilling

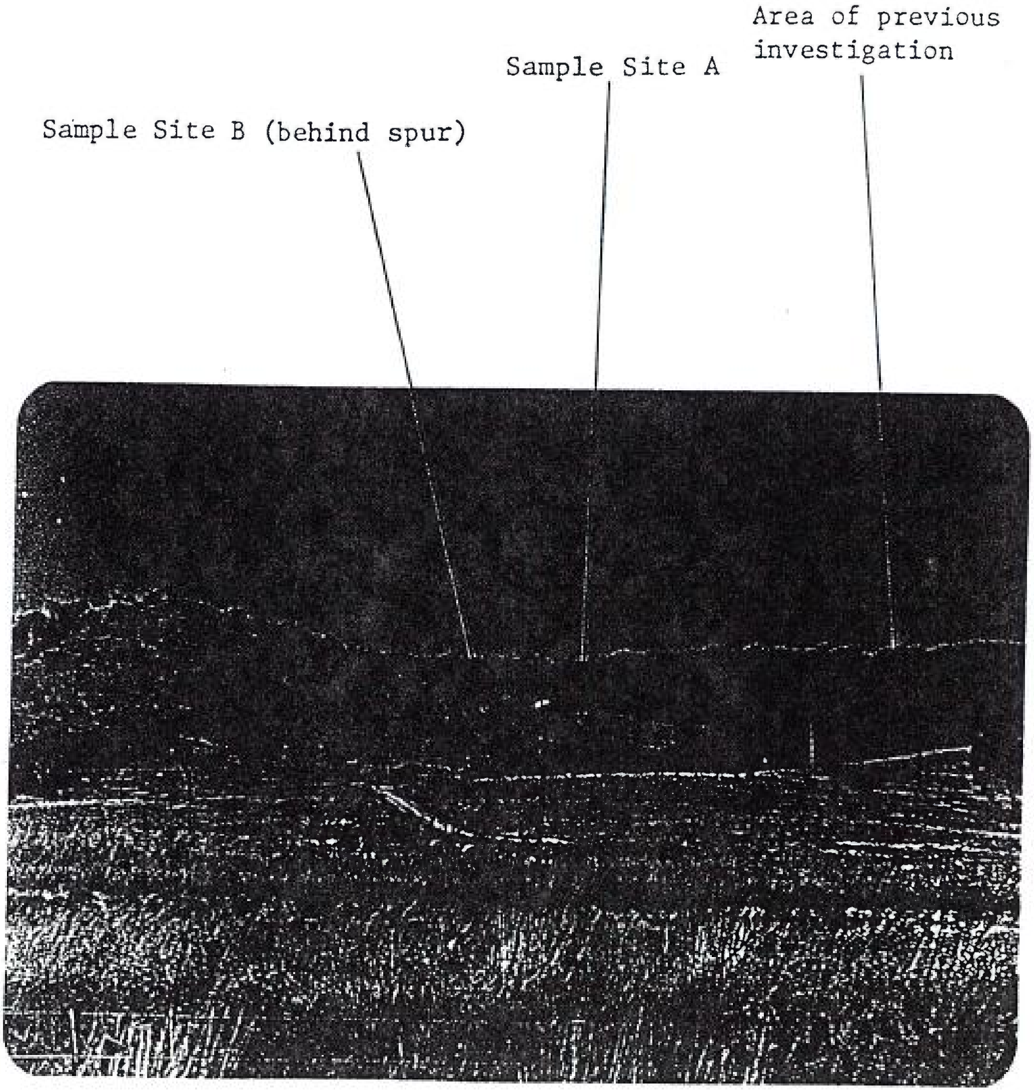


PHOTOGRAPH 5

ROYALLA PROSPECT. SAMPLE SITE B. After blasting

PHOTOGRAPH 6

ROYALLA PROSPECT. SAMPLE SITE B. Close-up of blast rubble



PHOTOGRAPH 7

ROYALLA PROSPECT. View looking eastwards from the Monaro Highway

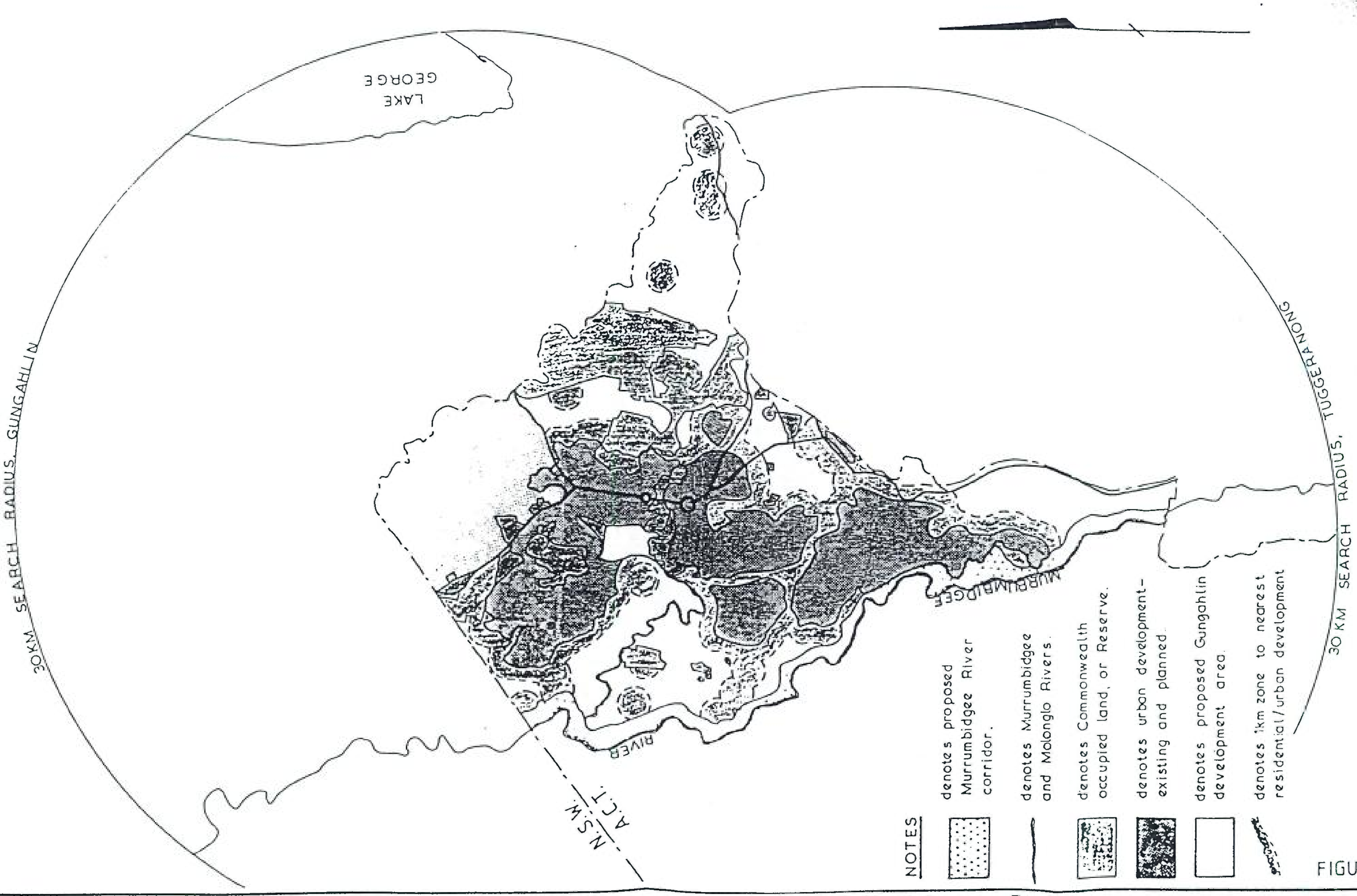


FIGURE 1

Coffey & Partners Pty Ltd Consulting Engineers in the geotechnical sciences

0 5 10
Scale (km)
1 : 250,000

revision	description	drawn	approved	date

drawn H.E.H.
approved G.K.S.
date 22 8 84

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QUARRY INVESTIGATION,
CANBERRA ACT
RESTRICTIONS TO QUARRY DEVELOPMENT IN ACT

COFFEY

drawing no S.5281/2/3-1
job no S 5281/2/3

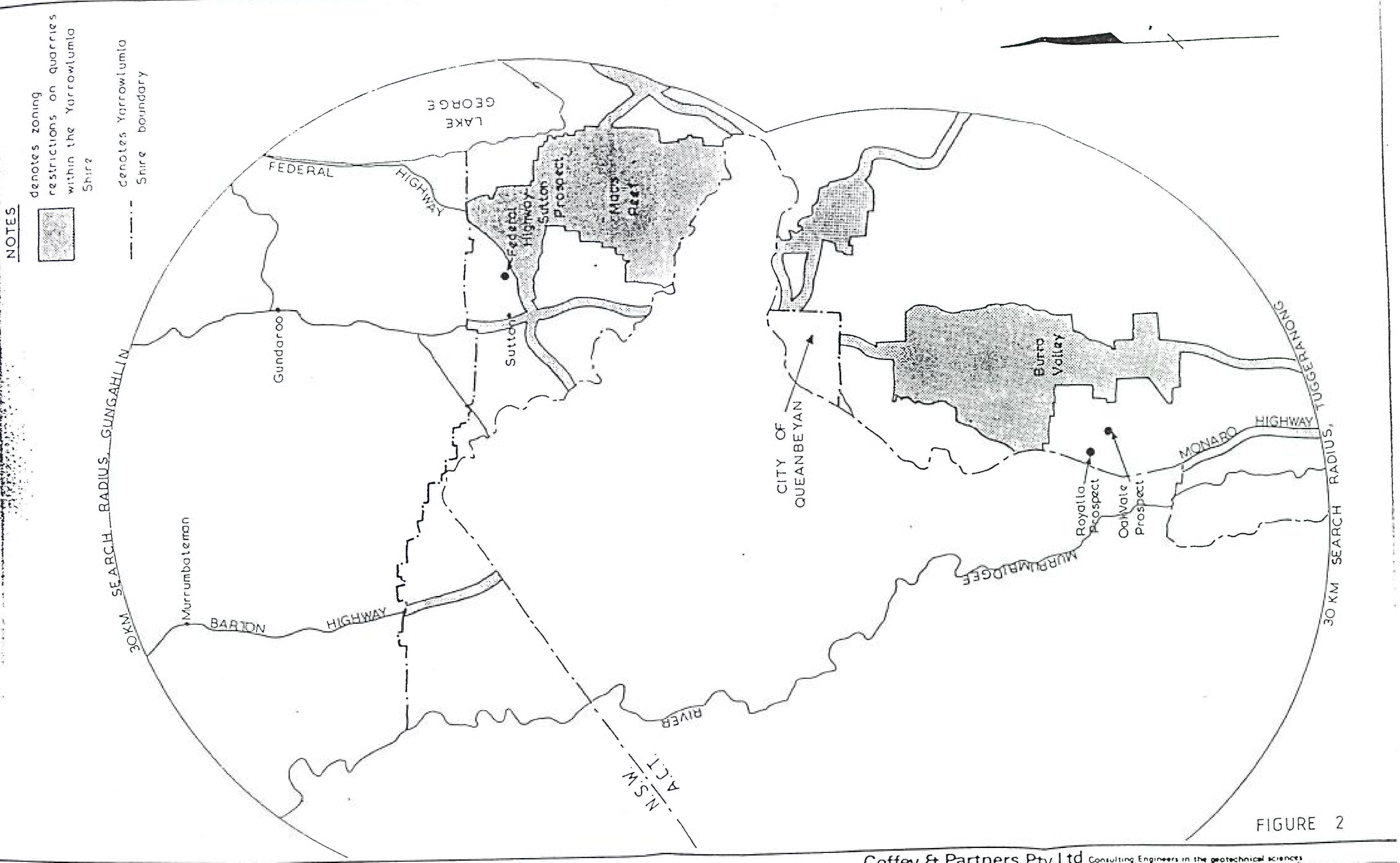

FIGURE 2

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0 5 10
scale (km)
1: 250,000

revision	description	drawn	approved	date

drawn H.E.H
approved G.K.S
date 22 8 84

LEIGHTON CONTRACTORS PTY LTD

QUARRY INVESTIGATION,
CANBERRA ACT
RESTRICTIONS TO QUARRY DEVELOPMENT
YARROWLUMLA SHIRE

COFFEY

drawing no S 5281/2/3-2

job no S 5281/2/3

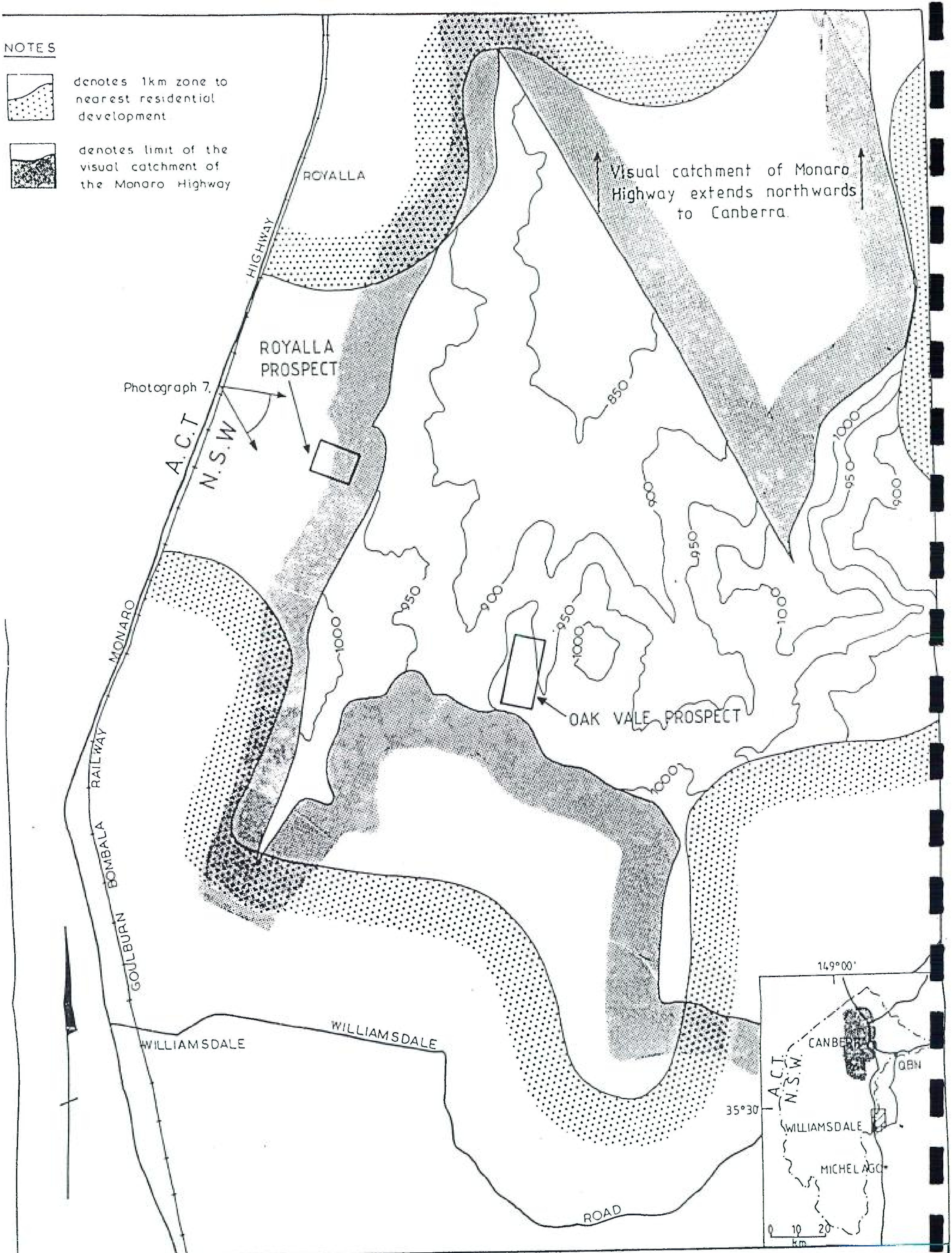

FIGURE 3

Coffey & Partners Pty Ltd Consulting Engineers in the geotechnical sciences

0 500 1000 scale (metres)	drawn	H.E.H.	LEIGHTON CONTRACTORS PTY. LTD.	COFFEY	drawing no S.5281/2/3-3
	approved	G.K.S.	QUARRY INVESTIGATION CANBERRA ACT LOCATION OF ROYALLA & OAKVALE PROSPECTS		job no S.5281/2

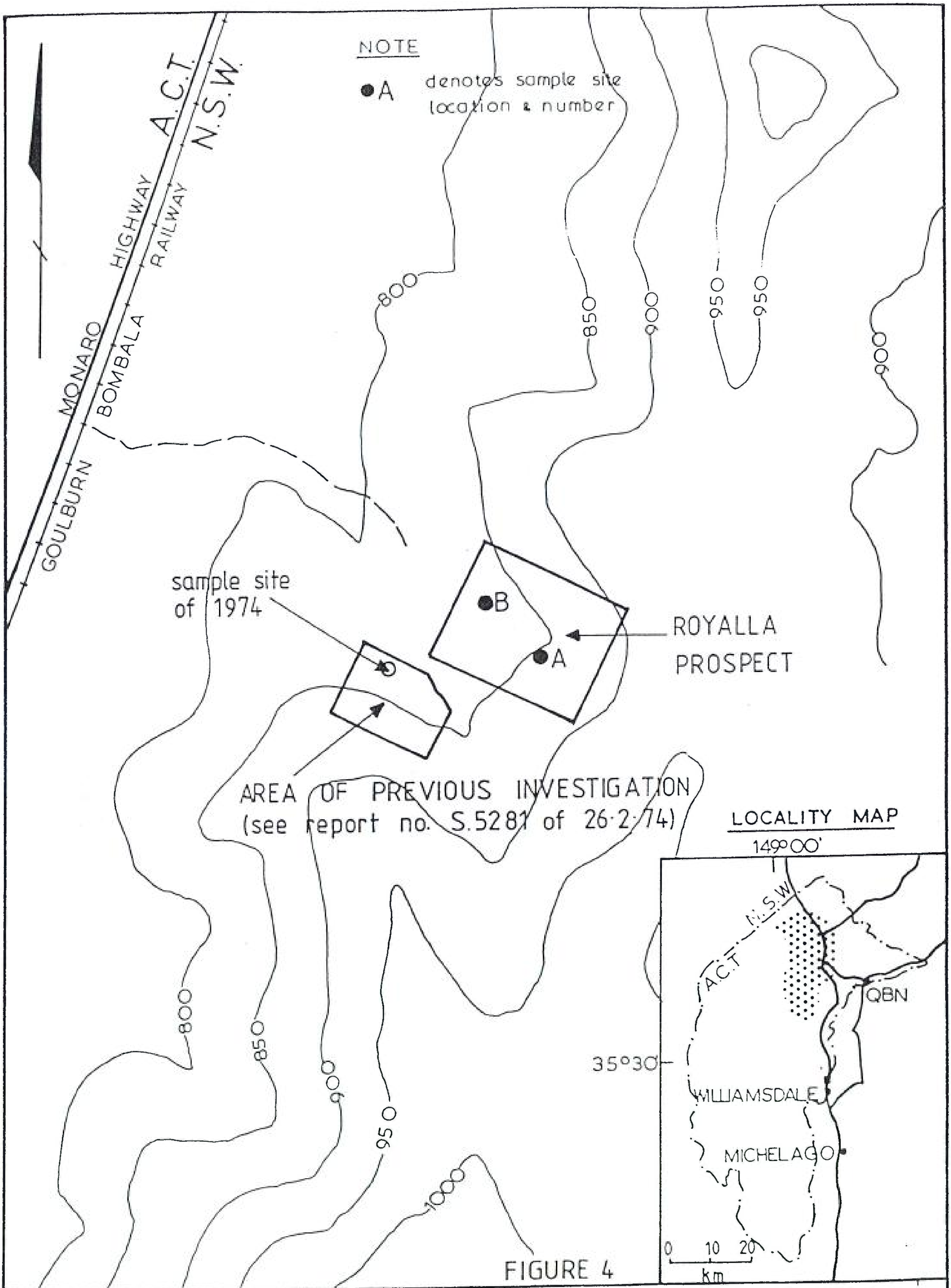

FIGURE 4

Coffey & Partners Pty Ltd Consulting Engineers in the geotechnical sciences

drawn	H.E.H.	LEIGHTON CONTRACTORS PTY. LTD.	drawing no:
approved	G.K.S.	QUARRY INVESTIGATION, CANBERRA ACT ROYALLA PROSPECT	S.5281/2/3-4
date	2·10·84		
scale	1:10,000		job no. S.5281/2

Appendix C - Coffey Report No. S5281/2/2

LEIGHTON CONTRACTORS PTY. LTD.

OAK VALE QUARRY SITE
ASSESSMENT OF RESERVES

REPORT NO. S5281/2/2 FEB. 1985

COFFEY

Coffey & Partners Pty Ltd

CTS2292
23 November 1998

This is a full reproduction copy of Coffey and Partners Pty Ltd report:

S5281/2/2
Leighton Contractors Pty Ltd
Oak Vale Quarry Site
Assessment of Reserves
February 1985

It has been produced for Totalcare Industries Ltd following authority given by our original client, Leighton Contractors Pty Ltd by facsimile dated 17 November 1998 (copy attached).

For and on behalf of
COFFEY GEOSCIENCES PTY LTD

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Facsimile Cover Sheet

To: Chris Turner
Company: Coffey Partners Int. Pty Ltd
From: John Bartolotta
Fax. No. : (02) 6280 6650
Date: 17th Nov 1998
Phone No. : (03) 9228 7707
Subject: **REALEASE DOCUMENTS RE WLLIAMSDALE**

Dear Chris,

Total Care Industries has approached Ian Luck (General Manager, Southern Region, Leighton Contractors Pty Ltd) for the purchase of documents relating to Oakdale Quarry, Williamsdale.

Authority is hereby given for the release of the above mentioned documents.

Regards,

John Bartolotta
Administration Manager Southern Region

C P Thorne [illegible]
B C Burman [illegible]
I R Birch [illegible]
C F R Fitzhardinge [illegible]
G K Spencer [illegible]
P C Thomson
M G Philp [illegible]
R Fell [illegible]
M C Ervin [illegible]
T D Sullivan [illegible]
I L McKenzie [illegible]
J P MacGregor [illegible]
P J N Pells [illegible]
Special Consultant
C O Brawner [illegible]

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your reference
our reference ARC:AH - S.5281/2/2
date 20th February, 1985

The Manager,
Leighton Contractors Pty.Ltd.,
30 Botany Street,
PHILLIP. A.C.T. 2606.

Attention: Mr. P. Cooper

Dear Sir,

We enclose our assessment of the potential of the Oak Vale quarry site, Williamsdale, N.S.W.

If you have any questions or require further information, please do not hesitate to contact this office.

Yours faithfully,
COFFEY & PARTNERS PTY.LTD.

J.P. MacGREGOR
Principal Engineering Geologist.

ACEA

Offices and NATA Registered Laboratories
Adelaide
Albury-Wodonga
Ballina
Brisbane
Canberra
Darwin
Gladstone
Melbourne
Moruya
Newcastle
Orange
Perth
Sydney
Townsville
Wagga Wagga
Woodridge
Rangoon Burma
Mandalay Burma

TABLE OF CONTENTS

1. INTRODUCTION

At the request of Mr. Phil Cooper of Leighton Contractors Pty.Ltd., Coffey & Partners Pty.Ltd. has investigated the potential reserves of the proposed aggregate quarry site at Oak Vale, north-west of Williamsdale, N.S.W.

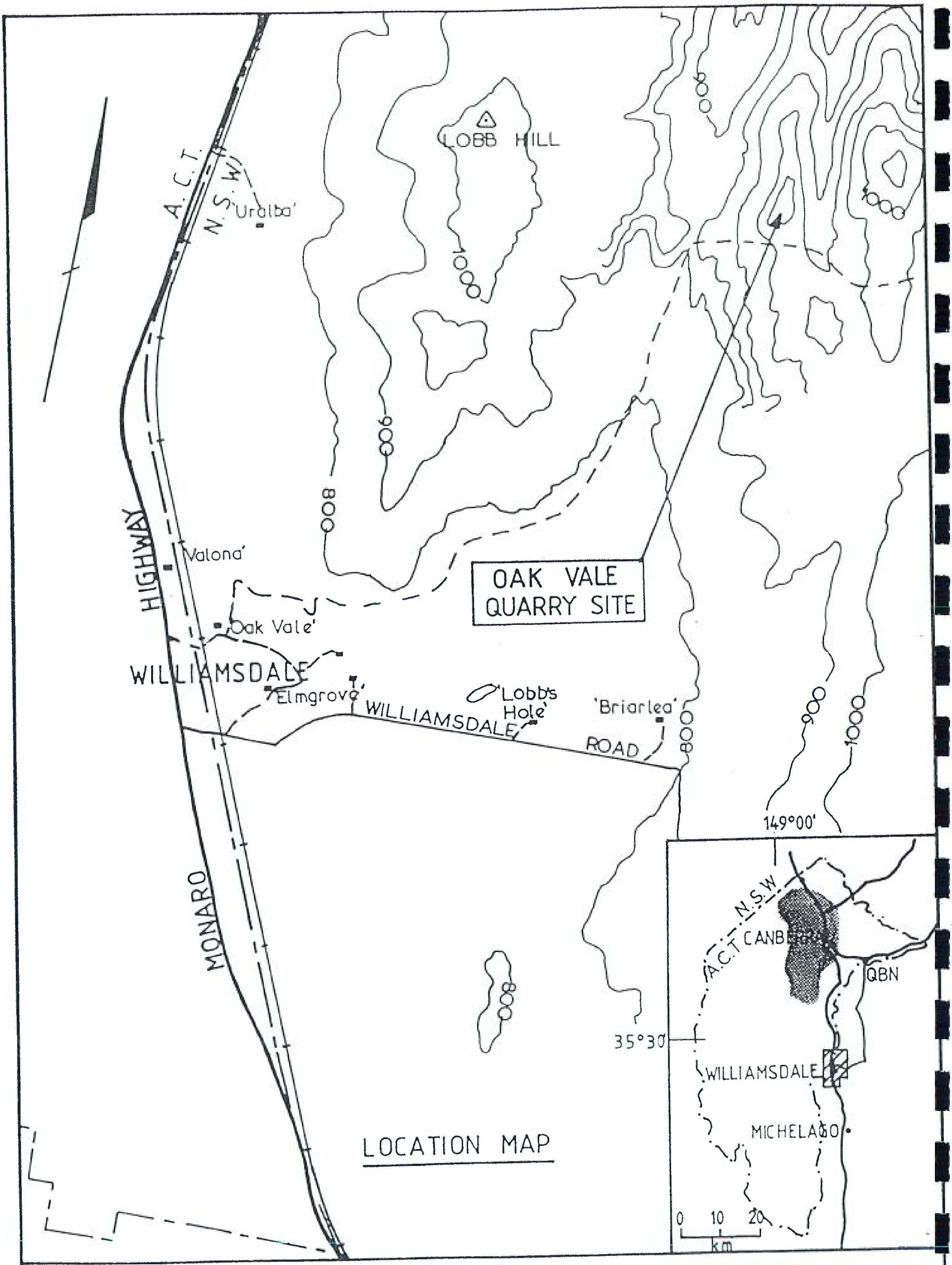
The investigation has included examination of the quality and quantity of material available in the deposit. This report presents the detailed results of the field and laboratory investigations together with our assessment of the potential of the deposit.

2. LOCATION AND BACKGROUND

The Oak Vale quarry site is located within portions 103, 122, 123 and 194 of the Oak Vale property, some 16 km south of Tuggeranong, Canberra, A.C.T. Although located in N.S.W., access to the site is from the Monaro Highway at Williamsdale, within the A.C.T. (see Figure 1).

The general location of the proposed quarry site was established during reconnaissance geological mapping by Coffey & Partners Pty.Ltd. In this area, two adjacent north-south trending ridges appear to contain high strength uniform rock with potential for development of a hard rock quarry. This potential was assessed in terms of rock-type, geological structure, topographic situation and distance from the nearest residence.

The western of the two ridges was selected by Leighton Contractors Pty.Ltd. as the preferred site on the basis of topography and access. The current study has involved the investigation of the general rock quality underlying the ridge by bulk sampling at four locations and the detailed examination of 1 hectare tentatively selected by Leighton Contractors Pty.Ltd. as the site for initial quarry development.



LOCATION MAP

Coffey & Partners Pty Ltd Consulting Engineers in the geotechnical sciences

drawn	H.E.H.	LEIGHTON CONTRACTORS PTY. LTD.	COFFEY	drawing no:
approved	G.K.S.	GEOLOGICAL INVESTIGATION OF THE OAKVALE QUARRY SITE, WILLIAMSDALE. N.S.W.		FIGURE 1
date	9·5·84			job no: S.5281/2
scale	1:25000			

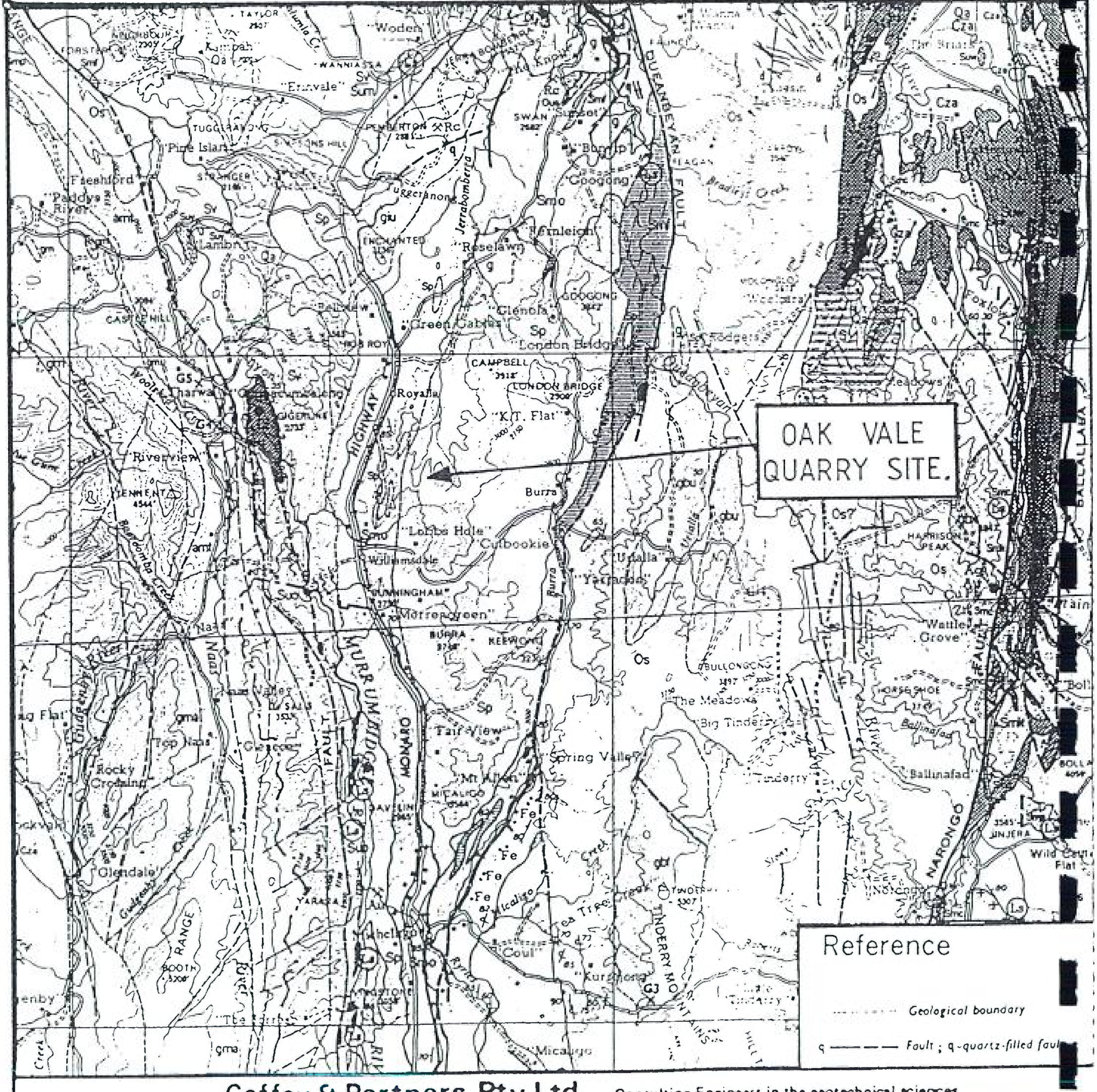
3. REGIONAL GEOLOGY

The quarry site lies on the western side of a belt of undifferentiated porphyritic rocks believed to be of Silurian age. Foliated volcanics and metasediments of the mid-Silurian Colinton Volcanics bound the western, northern and southern edges of this 30 km long porphyry unit. Older sediments and metasediments of Ordovician age occur to the east along with some Silurian sediments and volcanics belonging to the Canberra Formation (see Figure 2). All of these rocks have been deformed with the older rocks being intensely folded and faulted.

SILURIAN TO DEVONIAN

SILURIAN TO DEVONIAN		g	Granite
		Sp	Porphyry
		Sv	Mainly [illegible]
SILURIAN	Colinton Volcanics	Smo	Tuff, crystal tuff [illegible] shale, sandstone, limestone lenses Dacite Tuff Limestone Shale
	Canberra Formation Mt Pleasant Porphyry St Johns Beds, London Bridge Formation	Smf	Calcareous shale, limestone, sandstone, tuff, porphyry, altered acid lav Limestone
ORDOVICIAN		Os	Greywacke, sandstone, slate, chert, limestone, quartzite

Taken from Canberra 1:250,000 Geological Series Sheet SI 55-16 (2nd Ed.)



Coffey & Partners Pty Ltd Consulting Engineers in the geotechnical sciences

drawn	H.E.H.	LEIGHTON CONTRACTORS PTY. LTD.	drawing no:
approved	G.K.S.	GEOLOGICAL INVESTIGATION OF	FIGURE 2
date	18·7·84	THE OAK VALE QUARRY SITE,	
scale	1:250,000	WILLIAMSDALE. N.S.W.	job no: S.5281/2

4. SITE INVESTIGATION

4.1 BULK SAMPLING

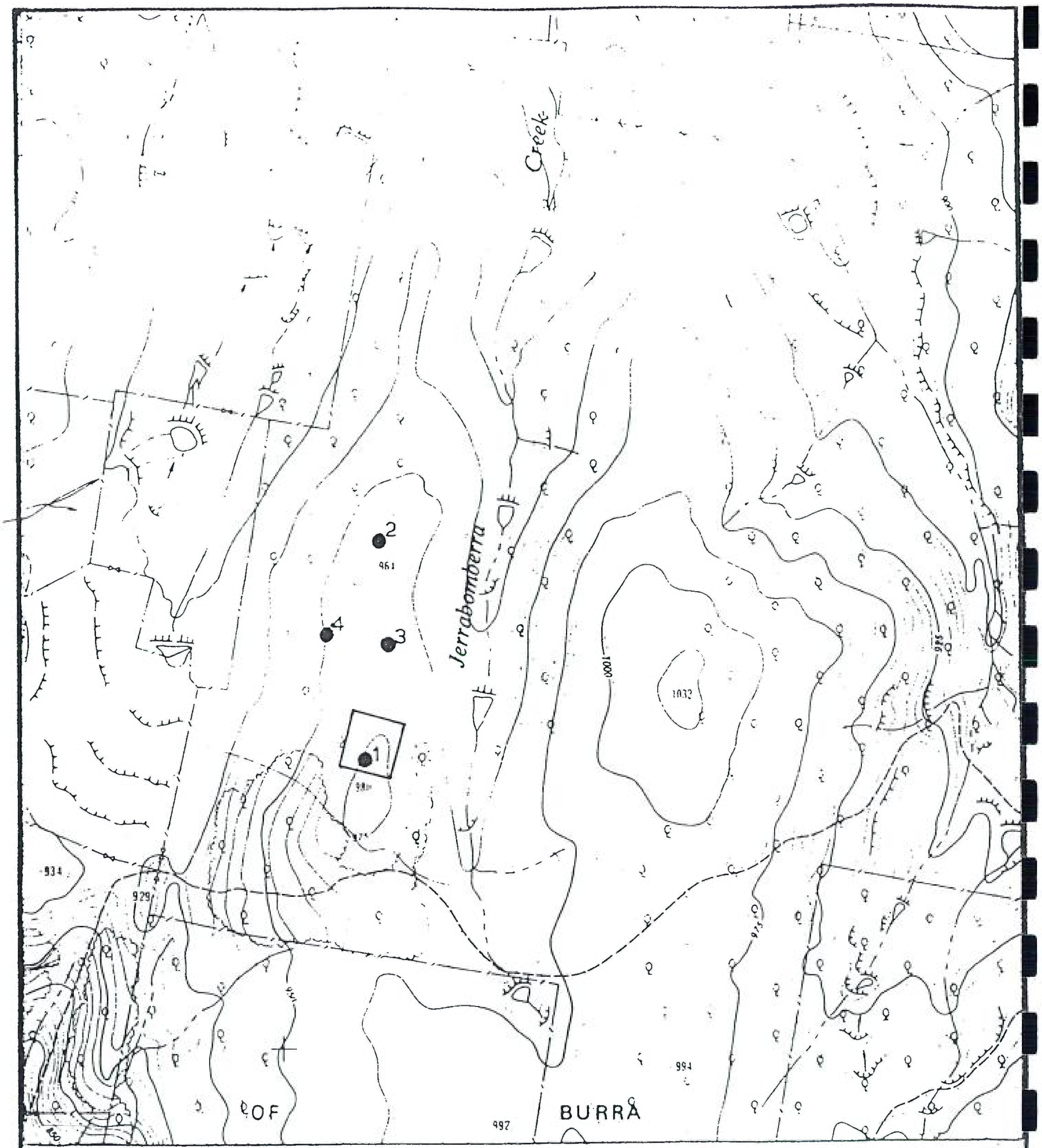
Four sites were selected to obtain bulk samples for trial crushing and laboratory testing (see Figure 3). The sites were selected following examination of outcrops based on range of materials with Site 1 the apparently highest quality and Site 4 the lowest quality (see photographs 1 to 4, Appendix A).

Each site was drilled with a track-mounted Gardner-Denver 3100 "Airtrak" rotary-percussion rig on 1st March, 1984, and blasted with ANFO and nitroglycerine on 2nd March, 1984.

The number of holes per site ranged from four to six and were inclined between 50° and 70° from the horizontal and arranged in opposing pairs. The resultant blast products ranged from metre sized blocks to fine gravels. The defect spacings appeared to be the controlling factors for block size and geometry.

From each site, approximately 70 kg of 100 mm size rock fragments were collected for crushing and testing.

The rock type in each site appeared to be the same.



Base map from A.C.T. 1:10,000 Planning Series 208–570, First Edition.

NOTES

☐ denotes location & orientation of the 1 ha surveyed grid.

●1 denotes sample site location & number.

SAMPLE SITE LOCATION MAP

Coffey & Partners Pty Ltd Consulting Engineers in the geotechnical sciences

drawn	H.E.H.	LEIGHTON CONTRACTORS PTY. LTD.	drawing no:
approved	G.K.S.	GEOLOGICAL INVESTIGATION OF	FIGURE 3.
date	8·6·84	THE OAK VALE QUARRY SITE,	
scale	1:10,000	WILLIAMSDALE. N.S.W.	job no: S.5281/2

4.2 GEOLOGICAL MAPPING

Following the sampling programme, an area of 1 hectare round Site 1 was geologically mapped at a scale of 1:200 based on a 25 m grid pegged by surveyors from Leighton Contractors Pty.Ltd.

Drawings S.5281/2/2-1 and S.5281/2/2-2 show the location of rock outcrops, their geometry and defect spacings.

4.3 DRILLING

Between 10th April and 24th May, 1984, four cored diamond boreholes (B.H.1 to B.H.4) were drilled at the quarry site as shown on Drawings S.5281/2/2-1 and S.5281/2/2-2.

Borehole B.H.1 was drilled to 21.00 m with a truck-mounted Pioneer P160L rotary rig using a 3 m triple tube and a 3 m double barrel. The remainder of B.H.1 and the other holes were drilled with a truck-mounted Longyear 34 rig using a 3 m TNW double barrel.

Almost 100% recovery was obtained in a total of 114.20 m of 'H' size drilling. The logs of B.H.1 to B.H.4 are included in Appendix B.

4.4 TEST PITTING

Six test pits (T.P.1 to T.P.6) were sunk on 10th May, 1984, with a John Deere 400 backhoe to determine soil type and depths in areas of the quarry site with no outcrop (see Drawings S.5281/2/2-1 and S.5281/2/2-2).

The logs of these pits are included in Appendix B.

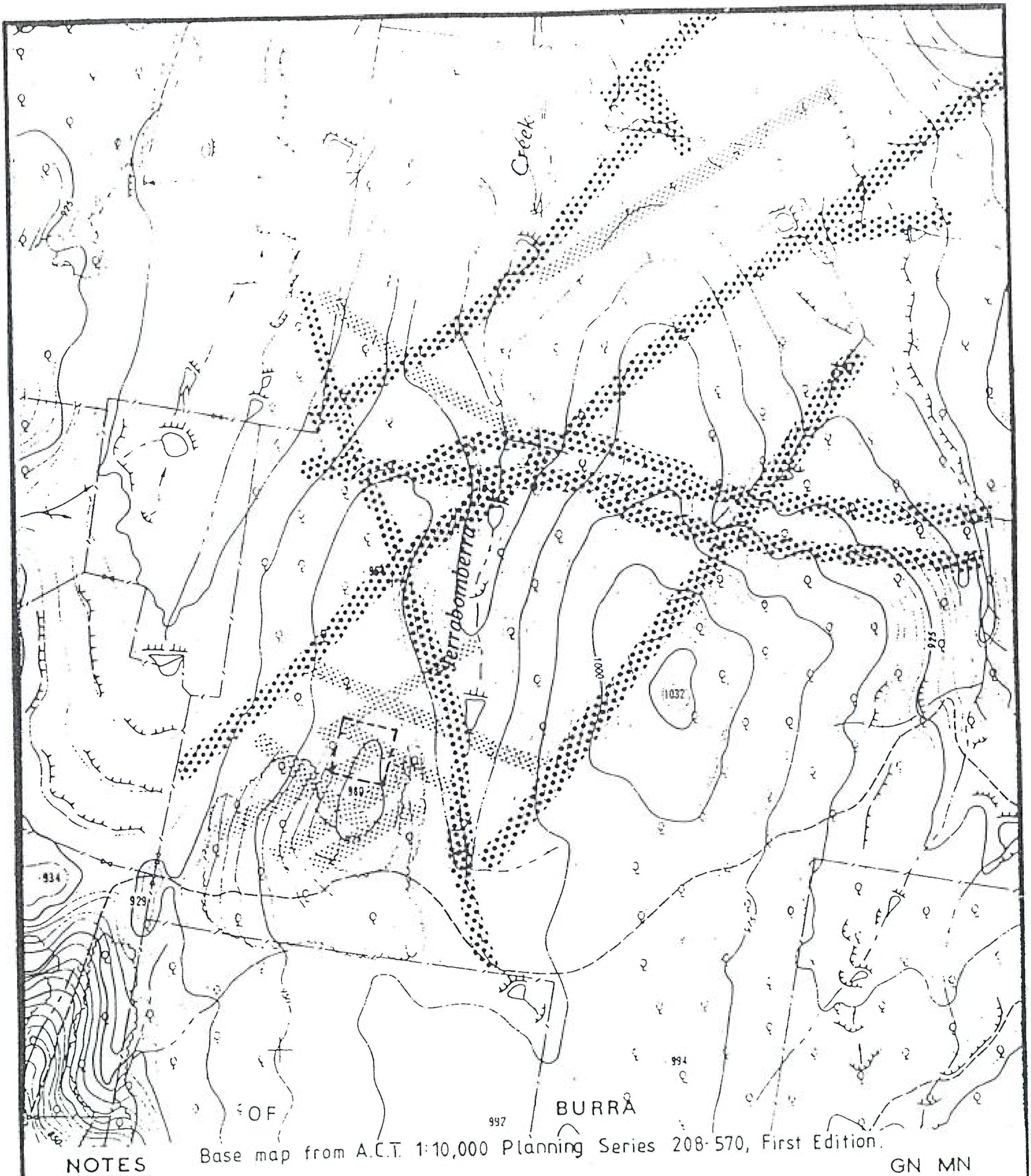
4.5 PHOTOINTERPRETATION

In Figure 4 linear features near the quarry site which are apparent on aerial photographs are located. These features may indicate zones of strongly foliated or weak rock.

4.6 LABORATORY TESTING

4.6.1 AGGREGATE

Samples of 70 kg of 100 mm size rock were collected at each of the four sample sites and were forwarded to Coomo Mining and Construction Equipment Pty.Ltd. for separate crushing by a no. 1 Kumbee impact crusher.



Base map from A.C.T. 1:10,000 Planning Series 208-570, First Edition.

NOTES

⬚	denotes location & orientation of the 1 ha surveyed grid
▓	denotes strong photolineament.
░	denotes weak photolineament.

PHOTOINTERPRETATION

GN MN

Coffey & Partners Pty Ltd Consulting Engineers in the geotechnical sciences

drawn	H.E.H.	LEIGHTON CONTRACTORS PTY. LTD.	drawing no:
approved	G.K.S.	GEOLOGICAL INVESTIGATION OF	FIGURE 4
date	8.6.84	THE OAK VALE QUARRY SITE,	S 5281/2

The crushed sample grading from each of the sample sites was, however, not representative of the grading likely to result from full scale crushing operations.

In order to ensure adequate sample quantities in the -19.0 mm +13.2 mm and -13.2 mm +9.5 mm size fractions, samples from site no's. 1 and 3 were combined for laboratory analysis. The grading, bulk density and water absorption of the coarse aggregate, 10% fines wet/dry variation, the Los Angeles 'B' value and sodium sulphate soundness were determined in the Sydney laboratory of Coffey & Partners Pty.Ltd. The test results are given in Appendix C.

4.6.2 PETROGRAPHIC DESCRIPTION

A hand specimen from the blast rubble of sample site no. 1 was examined petrographically by Mr. G.E. Halford of the Geology Department, Australian National University. The petrographic description is included in Appendix C.

5. RESULTS

5.1 GEOLOGY

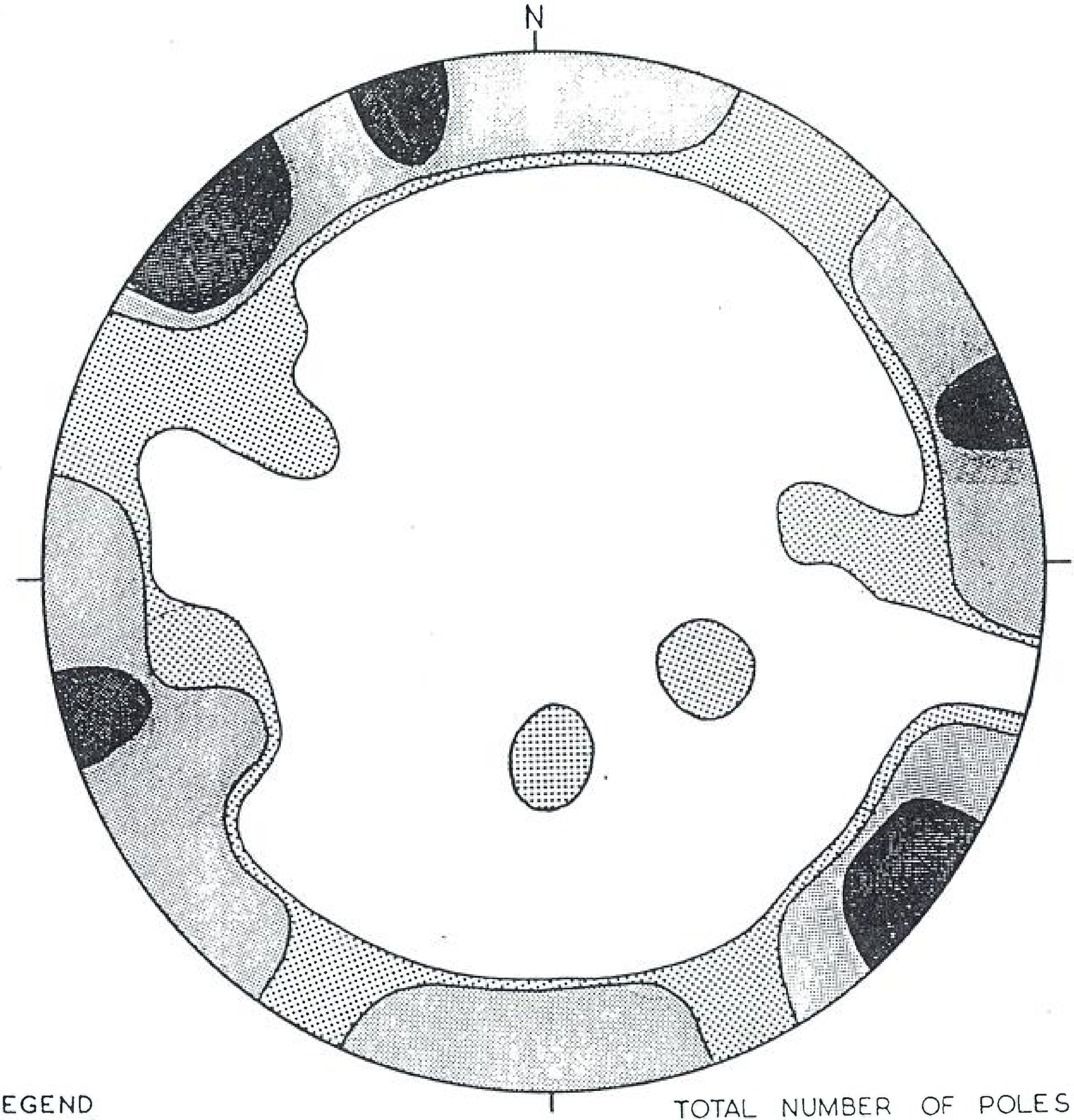
Rock crops out over approximately one third of the surveyed area with half of the outcrops having relief greater than 150 mm. The western and south-eastern flanks of the quarry site are relatively devoid of surface rock and the more massive rock exposures occur to the west of the ridgeline.

Drawing S.5281/2/2-1 shows the distribution and surface expression of this surficial rock.

Defects are usually planar rough, or subordinate undulose rough, joints. Defect spacings of 100 mm to 300 mm or less are commonly associated with elongate outcrops and weak to moderate foliations over the eastern slopes of the quarry area.

The orientation of these features is 030° to 040°. A contour plot of poles to the 318 joints measured shows a north-easterly orientation for the preferred joint direction. There is a weaker joint set around 345° (see Figure 5).

As the photolineaments identified in Figure 4 are also oriented in these directions the major and minor structural features are related.



LEGEND

▓	>3%
░	2% – 3%
▒	1% – 2%
☐	< 1%

TOTAL NUMBER OF POLES TO JOINTS = 318.

CONTOUR PLOT OF POLES TO JOINTS.

Coffey & Partners Pty Ltd Consulting Engineers in the geotechnical sciences

drawn H.E.H.
approved G.K.S.
date 12·6·84

LEIGHTON CONTRACTORS PTY. LTD.
GEOLOGICAL INVESTIGATION OF
THE OAK VALE QUARRY SITE
WILLIAMSDALE N.S.W.

COFFEY

drawing no: FIGURE 5
job no S.5281/

In the drill core the presence of calcite and quartz veneered defects cut by zeolite and minor calcite veneered joints indicate several periods of joint formation. These defects occur in zones ranging in apparent thickness from about 1 m to 3 m. Slickensides are also associated with some of these features.

Shear zones in all four boreholes are steeply dipping and appear to be related to the zones of zeolite veneered fractures. In borehole B.H.2 between 18.5 m and 20.0 m, a quartz infilled crushed zone contains relatively well developed epidote crystals. On either side of this zone, feldspar phenocrysts are commonly kaolinised and altered to zeolite and minor amounts of fine pyrite is associated with thin veins of fluor-apatite, calcite, quartz and epidote.

Apart from the shear zones (which represent less than 10% of the core recovered) the core from all four boreholes is of very high to extremely high strength with most defects tight. During drilling, core was commonly unfractured and had to be broken during boxing. The RQD (rock quality designation) values for fresh rock core are above 97%.

Examination under the microscope indicates that the rock is a dacite with porphyritic texture (Appendix C). This is apparent also in hand specimen. The soil cover over the quarry site generally comprises:-

- leached slopewash soils of moist, medium dense, clayey-silty sand of low plasticity, to depths ranging from 0.15 m to 0.5 m, underlain by
- slopewash soils of moist, stiff, sandy clay of low and low to medium plasticity, to depths of 0.5 to 1.5 m, overlying
- extremely to highly weathered dacite of extremely low to low strength.

The drilling indicates that fresh rock occurs within 4 m of the natural surface.

Several damp areas reflect seepage from joints through the leached and slopewash soils at the soil/rock interface.

5.2 ROCK QUALITY

The laboratory test results and the petrographic analysis on samples selected during geological mapping as representative of the site indicates that the rock is suited for all types of aggregate requirements (Appendix C).

The following comments relate to its suitability as concrete aggregate as specified in the Australian Standard Specification for Dense Natural Aggregates for Concrete (A.S. 1465-1974).

- BULK DENSITY:

  The bulk density of the coarse fraction is 2680 kg/m³ which is above the minimum specification of 2300 kg/m³ (as expressed on a dry basis).

- UNIT MASS:

  The test results of 1760 kg/m³ is well above the specified limit of not less than 1200 kg/m³.

- WATER ABSORPTION:

  The laboratory water absorption determination of 0.8% for the coarse aggregate is below the 5% limit for site placed concrete and the 2½% limit for precast concrete.

- MATERIAL FINER THAN 75 um:

  The crushing did not produce a significant quantity of material finer than 75 um.

- DELETERIOUS MATERIALS:

  Secondary minerals chlorite, epidote and kaolin, noted in the petrographic analysis, are not presented in sufficient quantities to detrimentally affect the aggregate quality. Although veins of quartz, and quartz, epidote and minor zeolite have been observed in outcrops and drill core, they are unlikely to affect material quality. The pyrite in the dacite is present in amounts estimated to be less than 1% and, on the basis of the lack of reaction of the pyrite with lime water, appears to be of the non-reactive type. Friable particles, light particles, material finer than 2µm, organic impurities and alkali-reactive materials are unlikely to be present in significant quantities.

* RESISTANCE OF ABRASION:

The Los Angeles Abrasion value (B grading) of 14% is well under the maximum limit of 30%.

* AGGREGATE CRUSHING VALUE:

This has not been determined but is assessed at about 15% to 20% which is within the specified limit of 25%.

* 10% FINES VALUE:

The laboratory measured dry strength of 327 kN for the aggregate is well above the nominated minimum strength of 50 kN. Similarly, the wet/dry strength variation of 23% as defined in the Australian Standard Methods for Sampling and Testing Aggregate (A.S. 1141-1974, 1980) is acceptable for concrete aggregate.

* PARTICLE SHAPE:

Based on observation, the percentage of misshapen particles is anticipated to be favourable for quality concrete aggregate. The possible effect of the zones of rock having weak to moderate foliation on the shape of the particles is expected to be minimal.

* GRADING:

The grading produced by a small crusher is not representative of full scale conditions. It is considered that suitable gradings would be produced by the correct selection of crushing equipment.

5.3 RESERVE ESTIMATION

Based on an area of 1 ha and with exploration taken to a depth of 30 m, the confirmed reserves of fresh rock are estimated at 700 000 tonnes.

Indicated reserves available by extraction from northern half of the ridge above the valley floor are estimated to be 9 000 000 tonnes.

6. CONCLUSIONS

Present surface and subsurface data indicate that significant extractable volumes of a uniform, durable, extremely high strength dacitic rock occur at the Oak Vale quarry site and adjacent ridge.

The rock quality appears to be suitable for all concrete requirements.

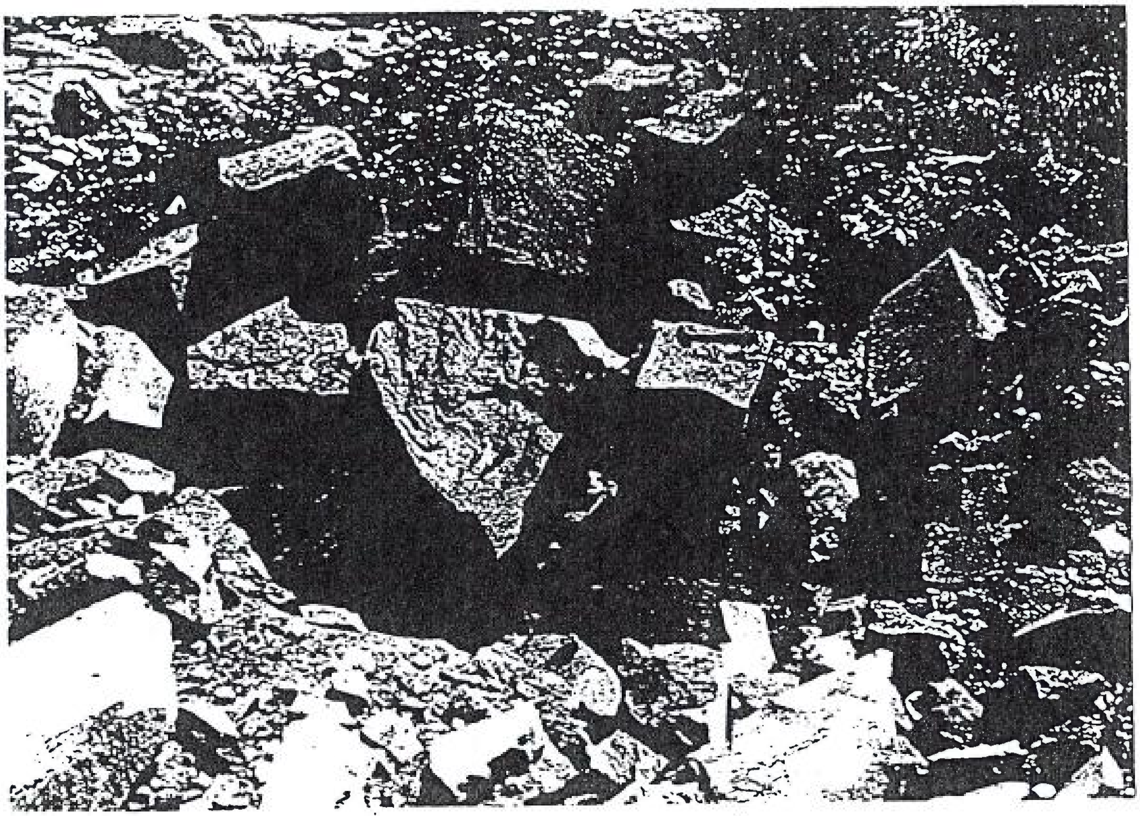
Structural features, such as shear zones, tend to be aligned around 035° and 345°. These features should be considered during detailed planning of the quarry operations.

COFFEY & PARTNERS PTY. LTD.

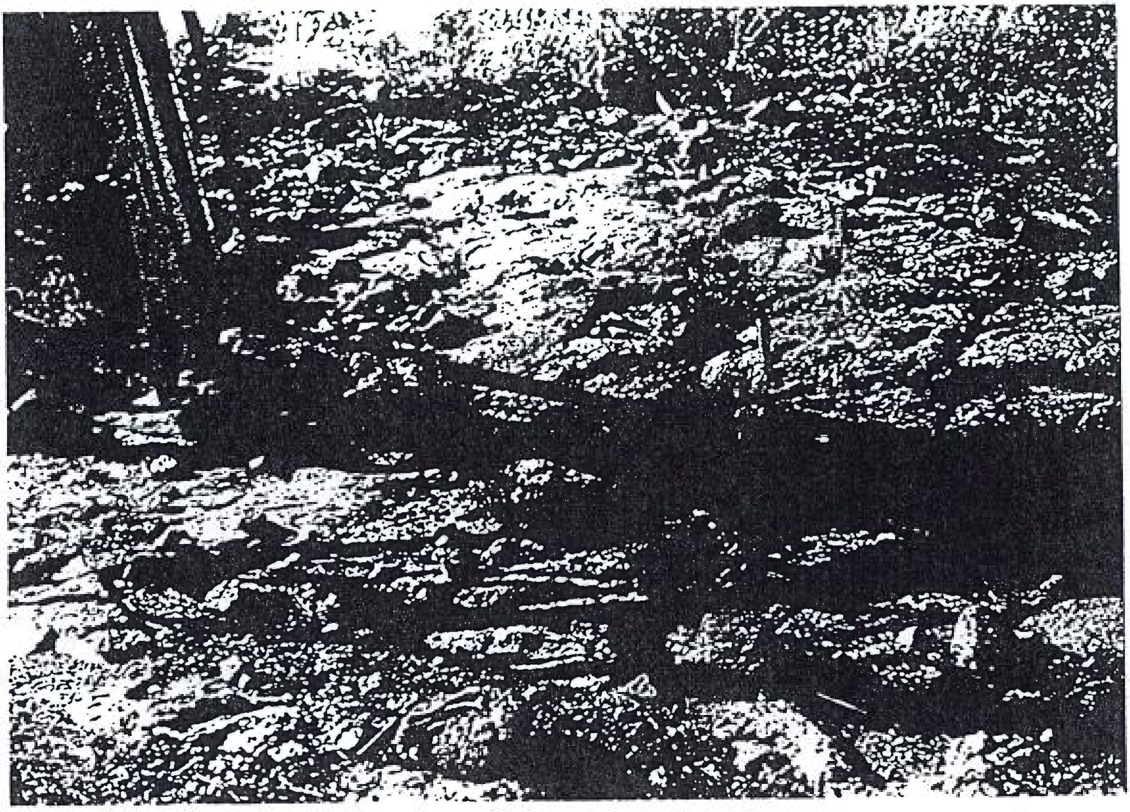
APPENDIX A

APPENDIX A

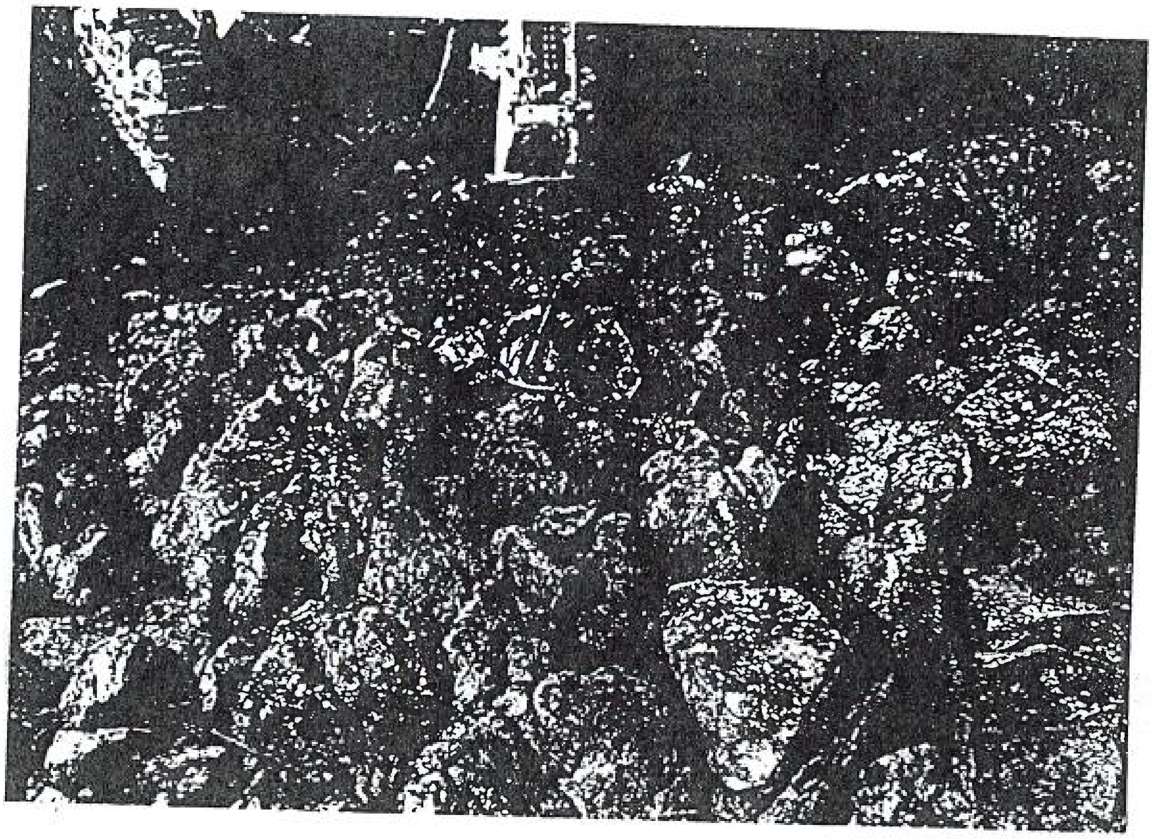
SITE PHOTOGRAPHS



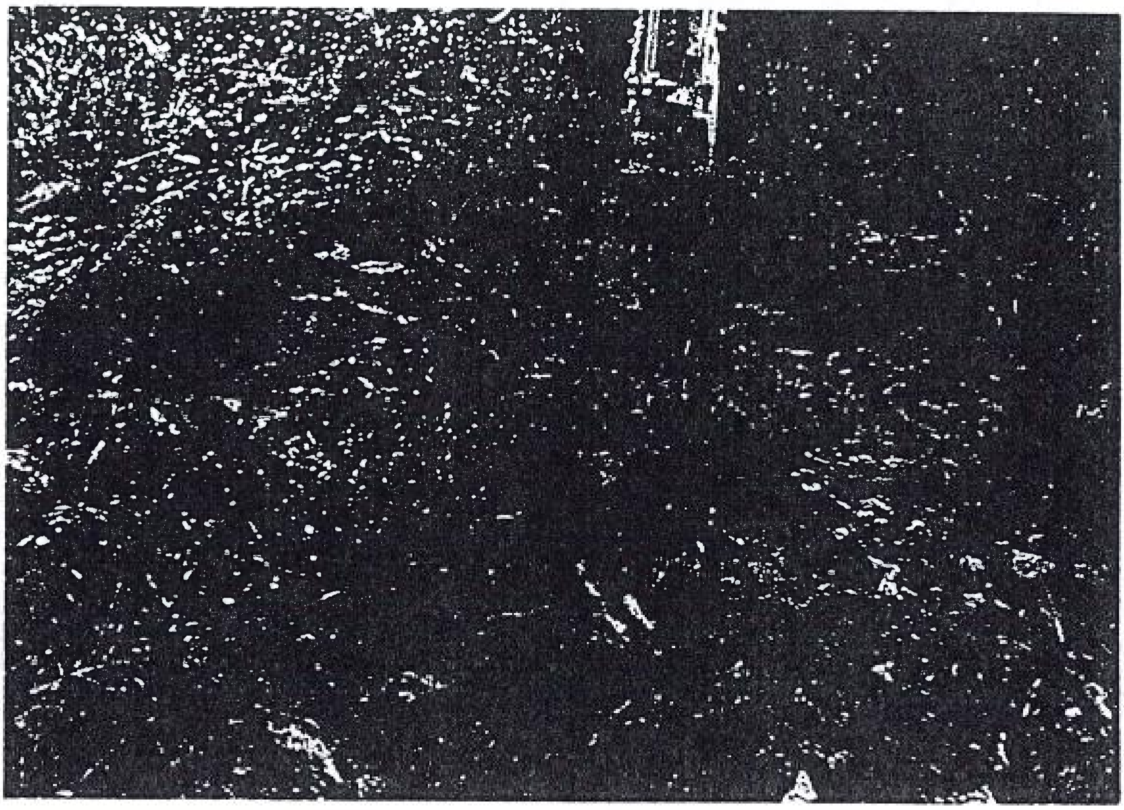
PHOTOGRAPH 1: SAMPLE SITE NO. 1. Although no pre-blast photograph is available, the outcrop pattern is discernable in upper left corner of photograph.



PHOTOGRAPH 2: SAMPLE SITE NO. 2



PHOTOGRAPH 3: SAMPLE SITE NO. 3



PHOTOGRAPH 4: SAMPLE SITE NO. 4

APPENDIX B

APPENDIX B

RESULTS OF FIELD INVESTIGATIONS

Coffey & Partners Pty. Ltd.

COFFEY

Explanation
Sheet 1

descriptive terms soil and rock

SOIL DESCRIPTIONS

Classification of Material based on Unified Classification System (refer SAA Site Investigation Code AS1726–1975 Add No. 1 Table D1).

Moisture Condition based on appearance of soil

dry	Looks and feels dry: cohesive soils usually hard, powdery or friable, granular soils run freely through hands.
moist	Soil feels cool, darkened in colour; cohesive soils usually weakened by moisture, granular soils tend to cohere, but one gets no free water on hands on remoulding.
wet	Soil feels cool, darkened in colour; cohesive soils weakened, granular soils tend to cohere, free water collects on hands when remoulding.

Consistency based on unconfined compressive strength (Qu) (generally estimated or measured by hand penetrometer).

term	very soft		soft		firm		stiff		very stiff		hard
Qu kPa		25		50		100		200		400	

If soil crumbles on test without meaningful result, it is described as **friable**.

Density Index (generally estimated or based on penetrometer results).

term	very loose		loose		medium dense		dense		very dense
density index I_D %		15		35		65		85	

ROCK DESCRIPTIONS

Weathering based on visual assessment

term	criterion
Fresh:	Rock substance unaffected by weathering.
Slightly Weathered:	Rock substance affected by weathering to the extent that partial staining or partial discolouration of the rock substance usually by limonite has taken place. The colour and texture of the fresh rock is recognisable; strength properties are essentially those of the fresh rock substance.
Moderately Weathered:	Rock substance affected by weathering to the extent that staining extends throughout whole of the rock substance and the original colour of the fresh rock is no longer recognisable.
Highly Weathered:	Rock substance affected by weathering to the extent that limonite staining or bleaching affects the whole of the rock substance and signs of chemical or physical decomposition of individual minerals are usually evident. Porosity and strength may be increased or decreased when compared to the fresh rock substance, usually as a result of the leaching or deposition of iron. The colour and strength of the original fresh rock substance is no longer recognisable.
Extremely Weathered:	Rock substance affected by weathering to the extent that the rock exhibits soil properties - i.e. it can be remoulded and can be classified according to the Unified Classification System, but the texture of the original rock is still evident.

Strength based on point load strength index, corrected to 50 mm diameter - Is(50) (refer I.S.R.M., Commission on Standardisation of Laboratory and Field Tests, Suggested Methods for Determining the Uniaxial Compressive Strength of Rock Materials and the Point Load Strength Index, Committee on Laboratory Tests Document No. 1). (Generally estimated: x indicates test result).

classification	extremely low		very low		low		medium		high		very high		extremely high
Is (50) MPa		0.03		0.1		0.3		1		3		10	

Defect Spacing measured at right angles to planes of defects of same set.

classification	extremely close		very close		close		medium		wide		very wide		extremely wide
spacing m		0.03		0.1		0.3		1		3		10	

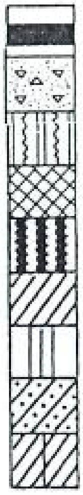
Defect description uses terms contained on AS1726 table D2 to describe nature of defect (fault, joint, crushed zone, clay seam (etc.) and character (roughness, extent, coating etc.).

Coffey & Partners Pty. Ltd.

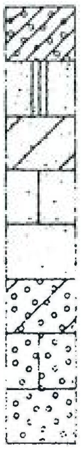
Explanation
Sheet 2

graphic symbols soil and rock

SOIL

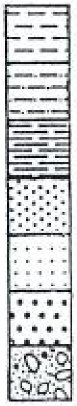


- Asphaltic Concrete or Hotmix
- Concrete
- Topsoil
- Fill
- Peat, Organic Clays and Silts (Pt, OL, OH)
- Clay (CL, CH)
- Silt (ML, MH)
- Sandy Clay (CL, CH)
- Silty Clay (CL, CH)

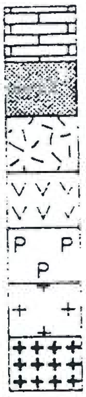


- Gravelly Clay (CL, CH)
- Sandy Silt (ML)
- Clayey Sand (SC)
- Silty Sand (SM)
- Sand (SP, SW)
- Clayey Gravel (GC)
- Silty Gravel (GM)
- Gravel (GP, GW)

ROCK



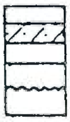
- Claystone (massive)
- Siltstone (massive)
- Shale (laminated)
- Sandstone (undifferentiated)
- Sandstone, fine grained
- Sandstone, coarse grained
- Conglomerate



- Limestone
- Coal
- Dolerite, Basalt
- Tuff
- Porphyry
- Granite
- Pegmatite

- Schist
- Gneiss
- Quartzite
- Talus
- Alluvium

SEAMS



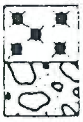
Seam >0.1 m thick
(on a scale 1:50)

Seam 0.01 m to 0.1 m thick
(on a scale 1:50)

INCLUSIONS

(Special purposes only)

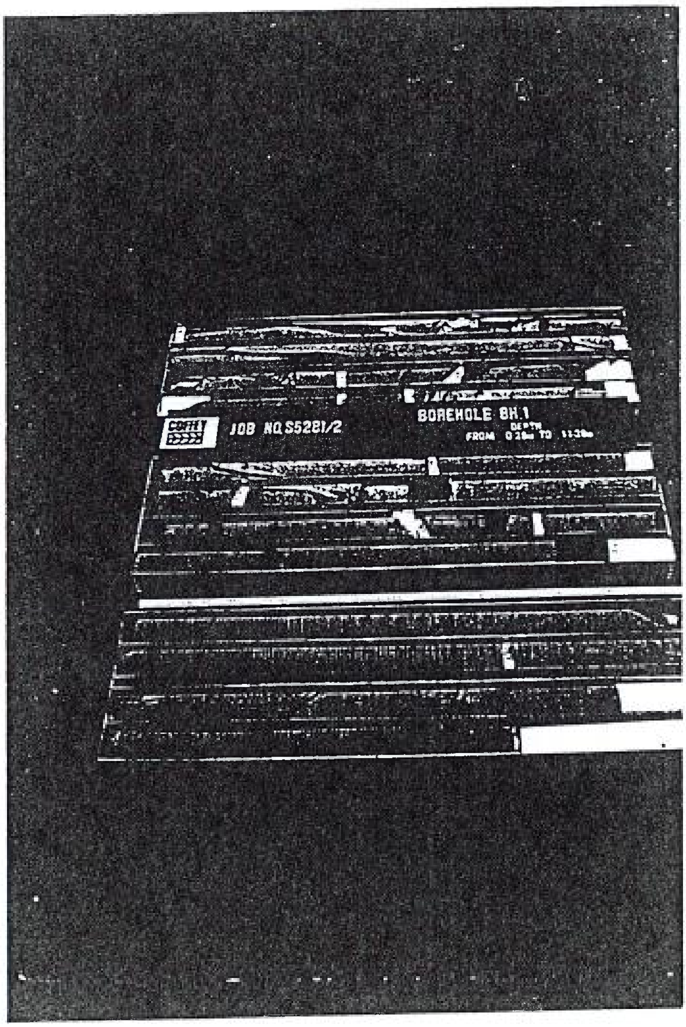
- Rock Fragments
- Swamp



- Ironstone Gravel Laterite
- Shale Breccia in Sandstone

Water Level ▼

Surfaces ——————— Known Boundary | — — — Probable Boundary | —— ? —— ? Possible Bounda


COFFEY
JOB NO.S5281/2
BOREHOLE BH.1
DEPTH
FROM 0.28m TO 11.30m

Coffey & Partners Pty Ltd

COFFEY

engineering log – cored borehole

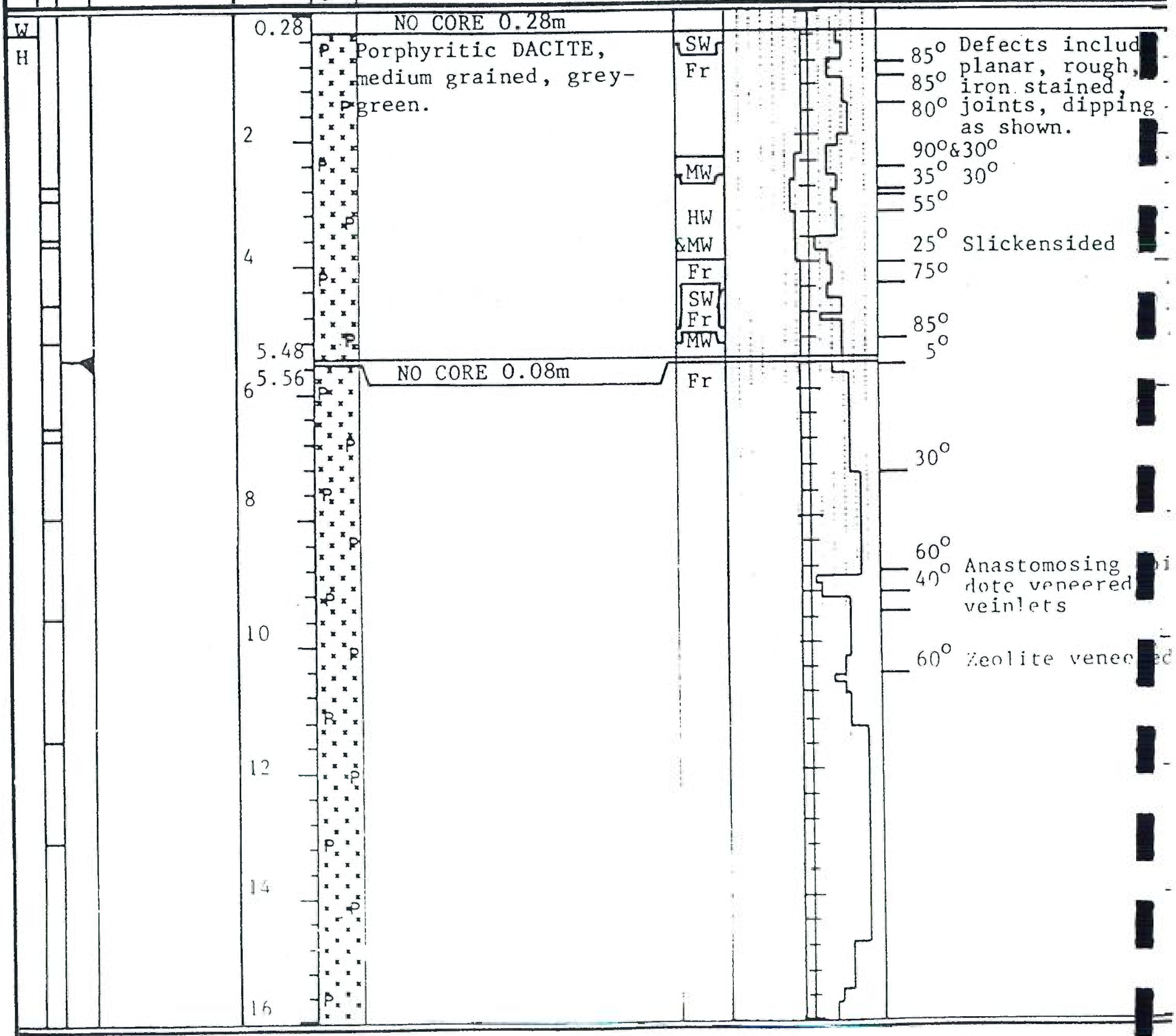
borehole no. BH1
sheet 1 of 2

office job no. SYDNEY S5281/2

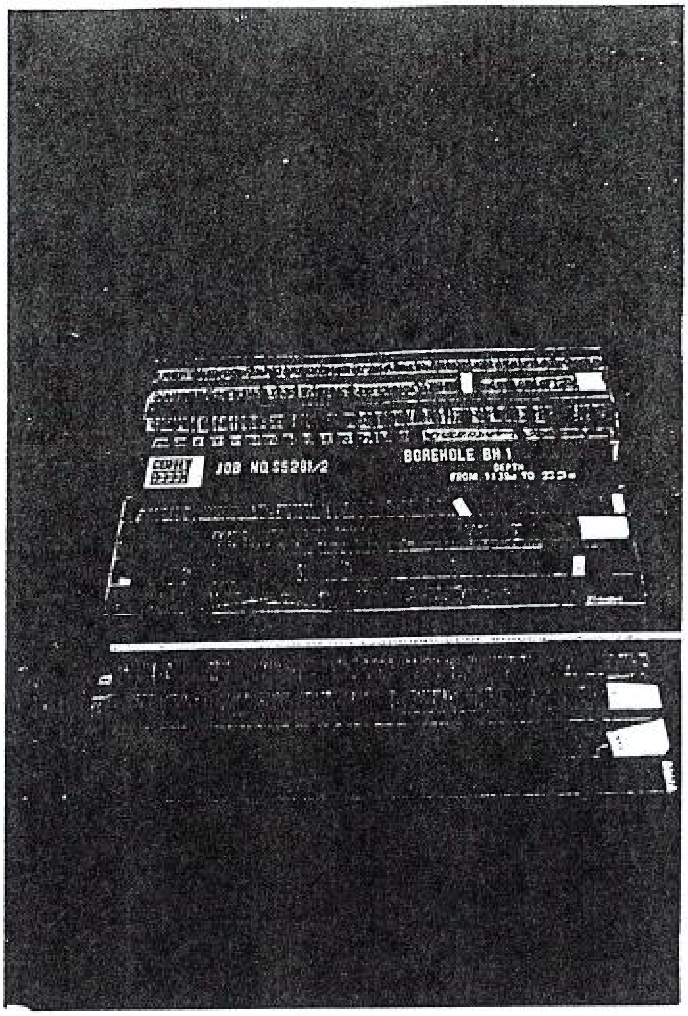
client LEIGHTON CONTRACTORS PTY. LTD.
project OAK VALE QUARRY SITE ASSESSMENT OF RESERVE
borehole location 43E; 30N OF THE SURVEYED GRID

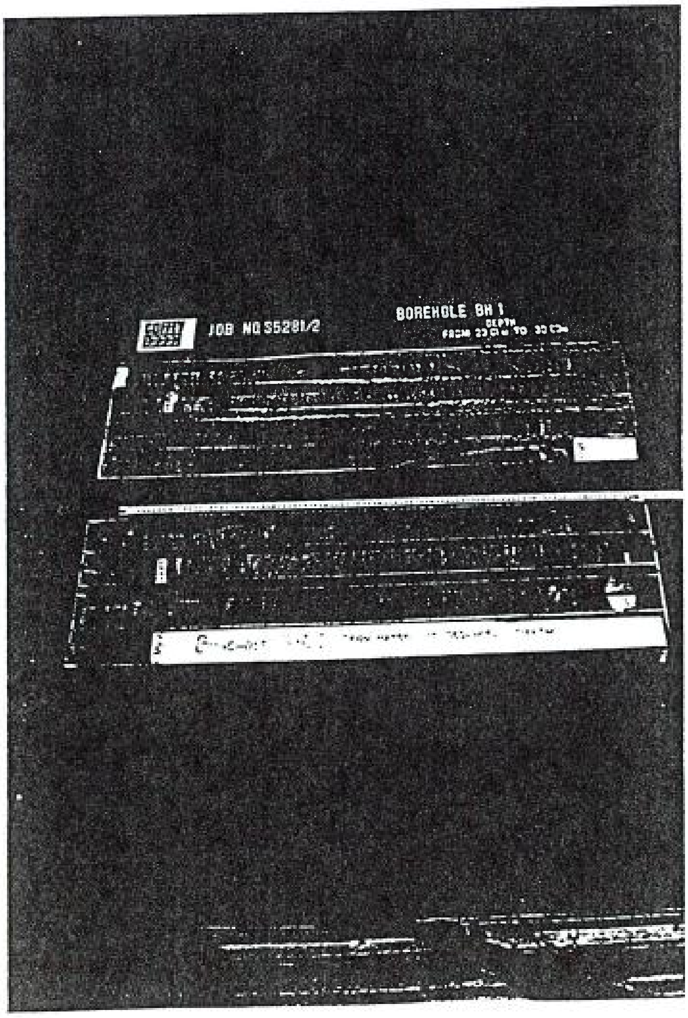
hole commenced 10.3.84
hole completed 3.5.84
supervised by ARC
log checked by JPM

drill model and mounting: PIONEER P160-L TRUCK, LONG YEAR 34 TRUCK
slope 90 deg
barrel type and length: 3mTT/3mTNW
fluid WATER
bearing – deg.
R.L. surface ESL m
datum



method	R.L. depth metres	substance description (rock type: grain characteristics, colour, structure, minor components)	weathering	defect description (thickness, type, inclination, planarity, roughness, coating) particular / general
W	0.28	NO CORE 0.28m		
H		Porphyritic DACITE, medium grained, grey-green.	SW Fr	85° 85° 80° Defects includ planar, rough, iron stained, joints, dipping as shown. 90°&30° 35° 30° 55°
			MW HW &MW	25° Slickensided
			Fr	75°
			SW Fr MW	85° 5°
	5.48–5.56	NO CORE 0.08m		
			Fr	30° 60° 40° Anastomosing dote veneered veinlets 60° Zeolite venee


JOB NO S5281/2
BOREHOLE BH 1
DEPTH
FROM 13.30m TO 23.0m


JOB NO S5281/2
BOREHOLE BH 1
DEPTH
FROM 23.0m TO 33.0m

engineering log – cored borehole

COFFEY

borehole no BH1
sheet 2 of 2

office and job no. SYDNEY S5281/2

LEIGHTON CONTRACTORS PTY. LTD.

project OAK VALE QUARRY SITE ASSESSMENT OF RESERVE

borehole location 43E; 30N OF THE SURVEYED GRID

hole commenced 10.3.84

hole completed 3.5.84

supervised by ARC

log checked by JPM

drill model and mounting PIONEER P160-L TRUCK, LONG YEAR 34 TRUCK

slope 90 deg

R L surface ESL m

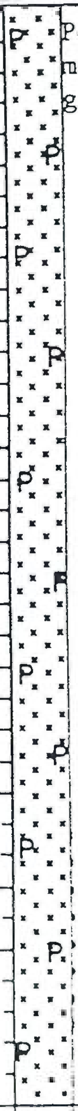
barrel type and length 3mTT/3mTNW

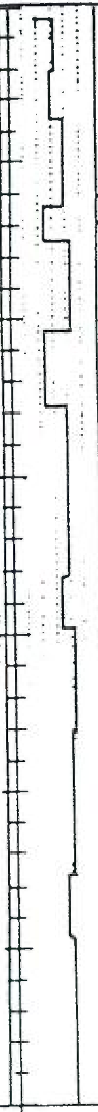
fluid WATER

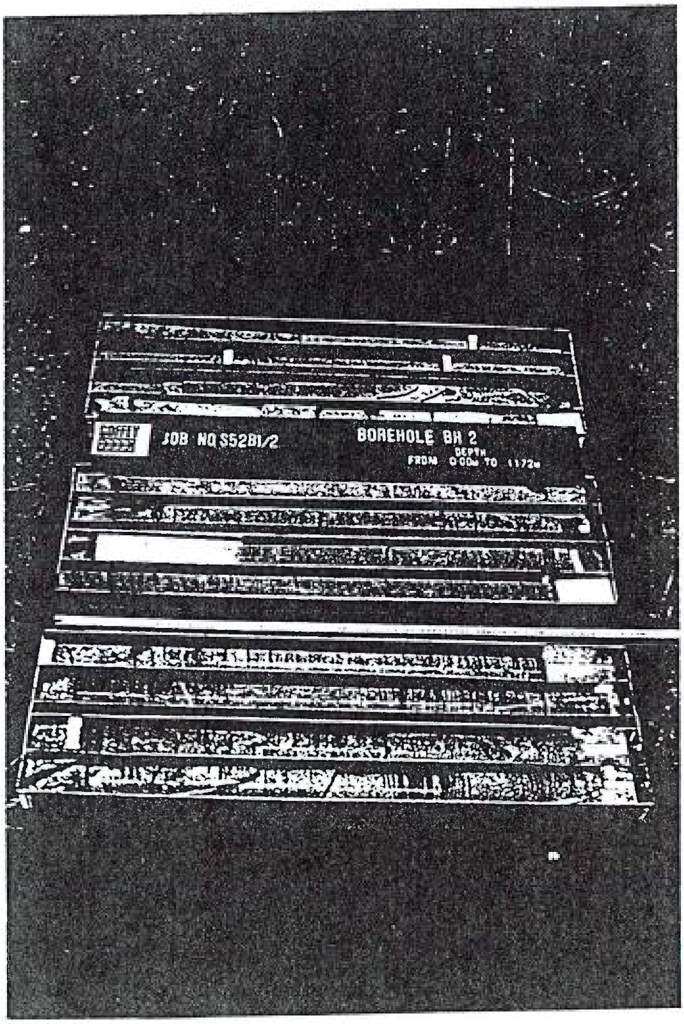
bearing _ deg

datum

drilling information					rock substance				rock mass defects		
method	case-lift	water		R L depth metres	graphic log core loss	substance description rock type: grain characteristics, colour, structure, minor components	weathering	strength Is (50) EL VL L M H VH EH	defect spacing mm 30 100 300 1000 3000	defect description thickness, type, inclination, planarity, roughness, coating particular	general
H						Porphyritic DACITE, medium grained, grey-green.	Fr				
				18						80° 80° slickensided	
				20							
				22							
				24							
				26						85° 20° zeolite veneered	
				28						30°	
				30		BH1 TERMINATED AT REQUIRED DEPTH.					






JOB NO S5281/2
BOREHOLE BH 2
DEPTH
FROM 0.00m TO 11.72m

engineering log – cored borehole

COFFEY

borehole no. BH2
sheet 1 of 2

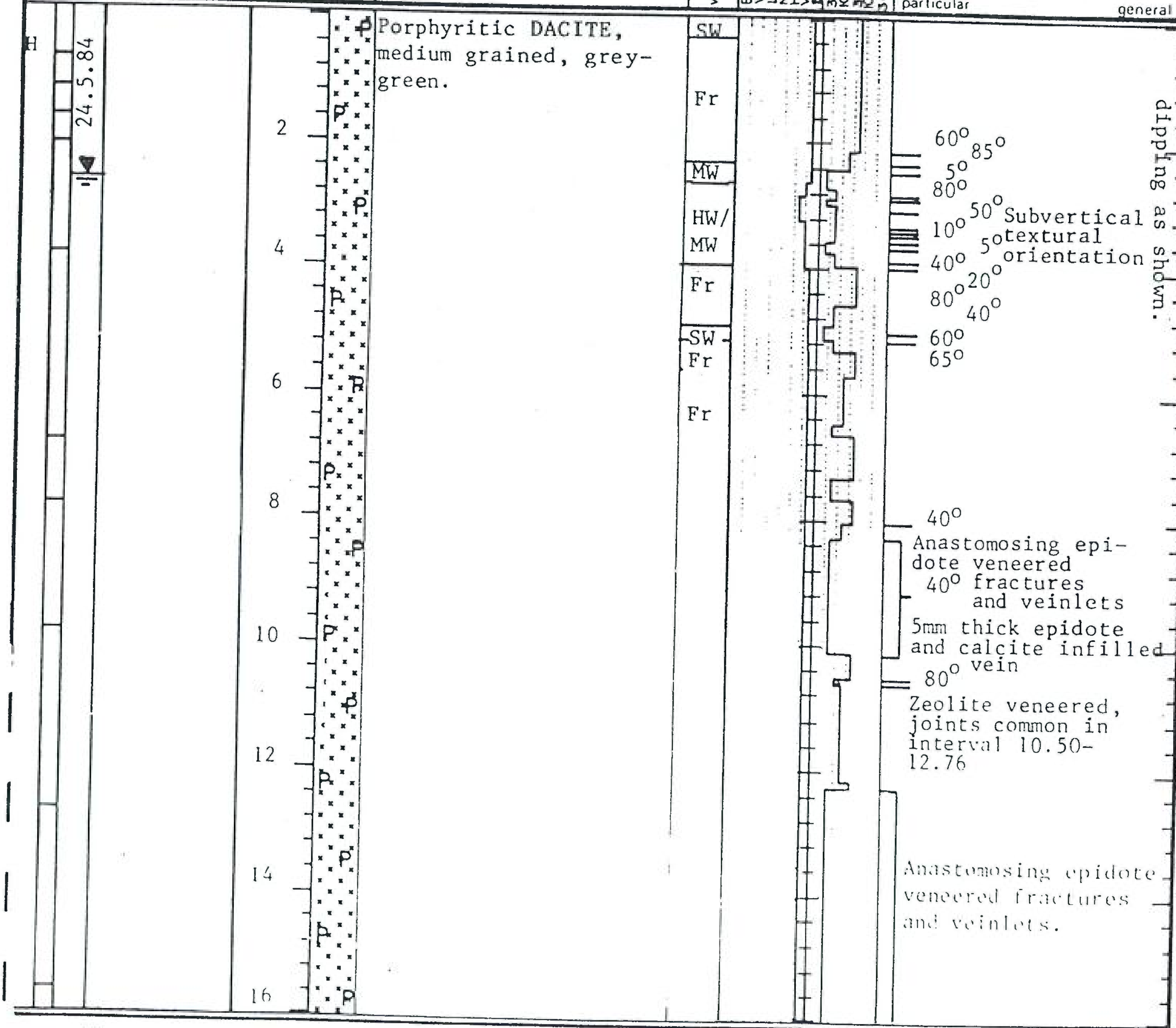
office and job no. SYDNEY S5281/2

client: LEIGHTON CONTRACTORS PTY. LTD.
project: OAK VALE QUARRY SITE ASSESSMENT OF RESERVE
borehole location: 78E; 71N OF THE SURVEYED GRID

hole commenced: 8.5.84
hole completed: 14.5.84
supervised by: ARC
log checked by: JPM

drill model and mounting: LONG YEAR 34 TRUCK
slope: 90 deg
R.L. surface: ESL m
barrel type and length: 3mTNW
fluid: WATER
bearing: – deg.
datum:

drilling information					rock substance				rock mass defects	
method	case-lift	water		R.L. depth metres	graphic log core loss	substance description rock type, grain characteristics, colour, structure, minor components	weathering	strength Is (50) EL VL L M H VH EH	defect spacing mm 30 100 300 1000 3000	defect description thickness, type, inclination, planarity, roughness, coating. particular general



Porphyritic DACITE, medium grained, grey-green.

Subvertical textural orientation

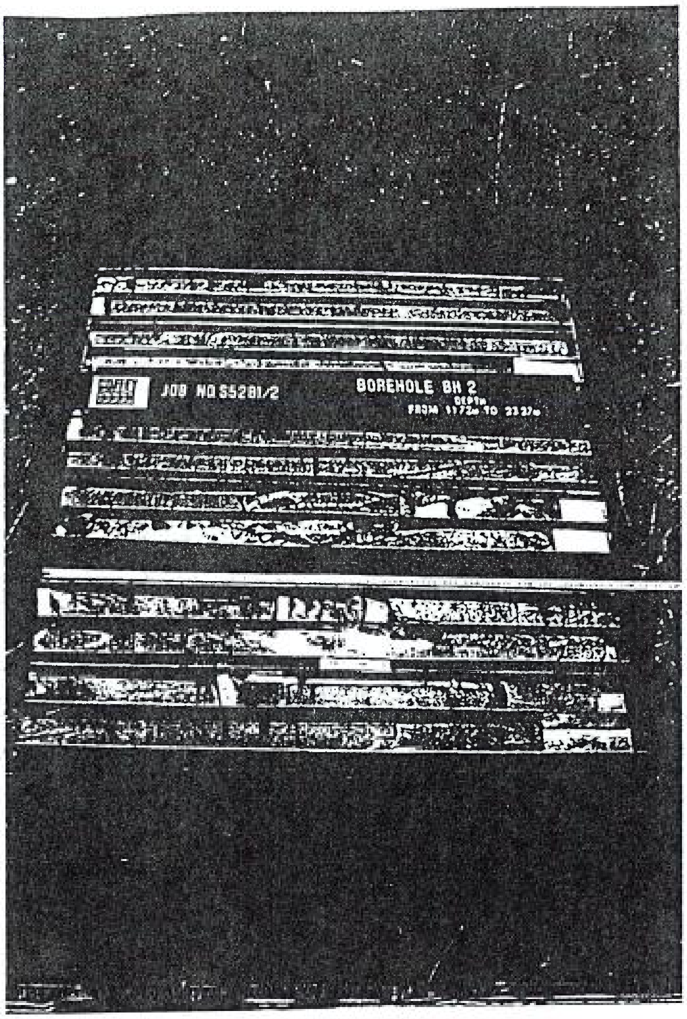
Anastomosing epidote veneered fractures and veinlets

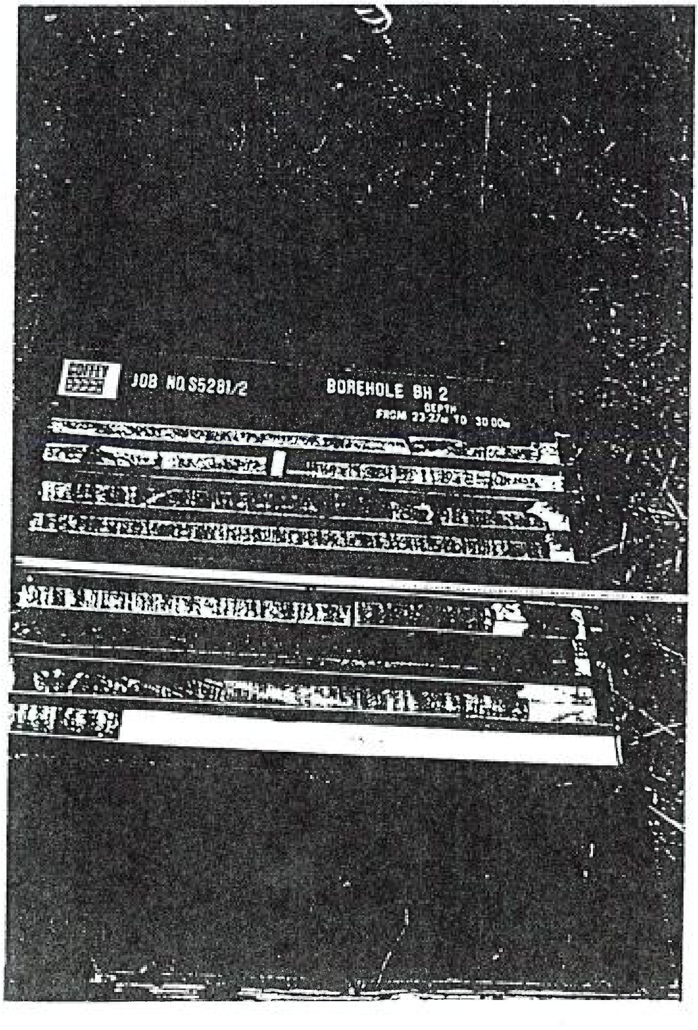
5mm thick epidote and calcite infilled vein

Zeolite veneered, joints common in interval 10.50-12.76

Anastomosing epidote veneered fractures and veinlets.

Defe[illegible] are [illegible]tl[illegible] ana[illegible]ou[illegible] joi[illegible] e[illegible]te [illegible]ca[illegible]e v[illegible]red dipping as shown.


JOB NO S5281/2
BOREHOLE BH 2
DEPTH
FROM 11.72m TO 23.27m


JOB NO S5281/2
BOREHOLE BH 2
DEPTH
FROM 23.27m TO 30.00m

engineering log – cored borehole

COFFEY

borehole no. BH2

sheet 2 of 2

office and job no. SYDNEY S5281/2

LEIGHTON CONTRACTORS PTY. LTD.

hole commenced 8.5.84

hole completed 14.5.84

project OAK VALE QUARRY SITE ASSESSMENT OF RESERVE

supervised by ARC

borehole location 78E; 71N OF THE SURVEYED GRID

log checked by JPM

drill model and mounting LONG YEAR 34 TRUCK

slope 90 deg

R L surface ESL m

barrel type and length 3mTNW

fluid WATER

bearing – deg

datum

drilling information					rock substance				rock mass defects		
method	case-lift	water		R L depth metres	graphic log core loss	substance description rock type: grain characteristics, colour, structure, minor components	weathering	strength Is (50) EL VL L M H VH EH	defect spacing mm 30 100 300 1000 3000	defect description thickness, type, inclination, planarity, roughness, coating particular	general
H					P	Porphyritic DACITE, medium grained, grey-green.	Fr			80°	
				18	P						Crushed and sheared zone with quartz, veins to 100mm thick with epidote veins a crystal intergrowths feldspars commonly altered. Minor pyrite and fluor-apati associated with calcite
			D	20 20.10	P					70°	infilled fractures
										85°	Subvertical textural orientati .
				22	P					85°	Minor slickensided dipping 10°.
				24	P					80°	
					P					85°	
										60°	10mm thick anas tomosing epidot vein
				26	P						
				28	P						Anastomosing epidote veneered fractures and veinlets.
					P					70°	
				30		BH2 TERMINATED AT REQUIRED DEPTH.					


BOREHOLE BH 3
JOB NO S5281/2
DEPTH
FROM 0·00m TO 12·65m

Coffey & Partners Pty Ltd

engineering log – cored borehole

COFFEY

borehole no. BH3

sheet 1 of 2

office and job no. SYDNEY S5281/2

LEIGHTON CONTRACTORS PTY. LTD.

hole commenced 15.5.84

hole completed 18.5.84

project OAK VALE QUARRY SITE ASSESSMENT OF RESERVE

supervised by ARC

borehole location 93E; 17N OF THE SURVEYED GRID

log checked by JPM

drill model and mounting LONG YEAR 34 TRUCK

slope 90 deg

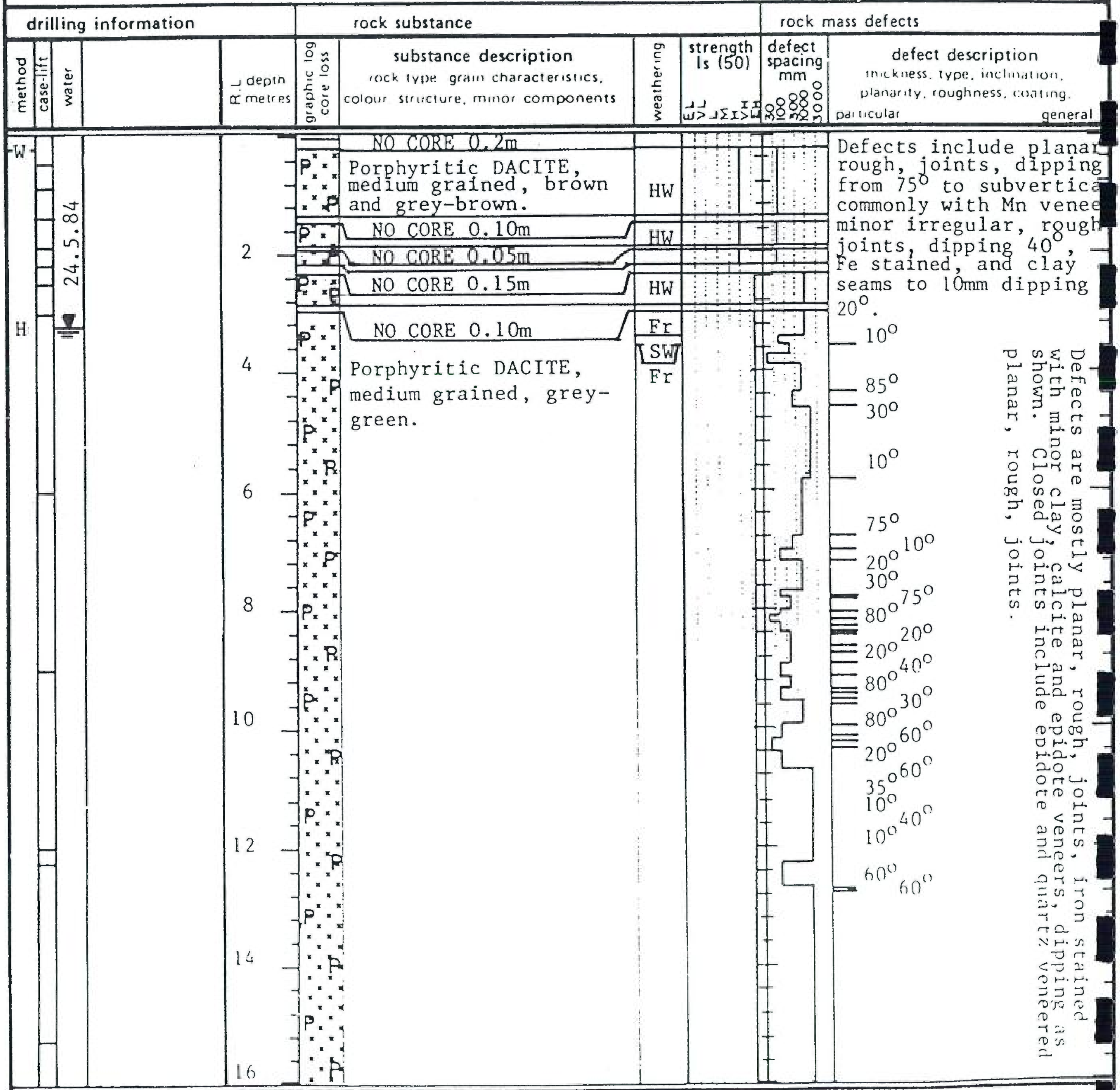
R.L. surface ESL m

barrel type and length 3mTNW

fluid WATER

bearing – deg

datum

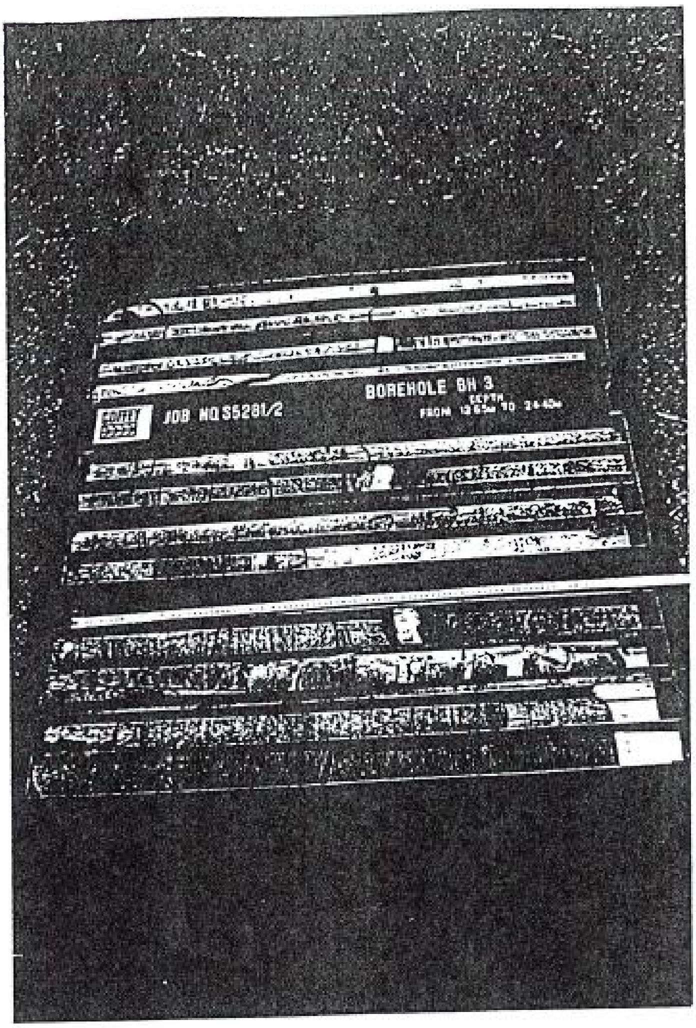


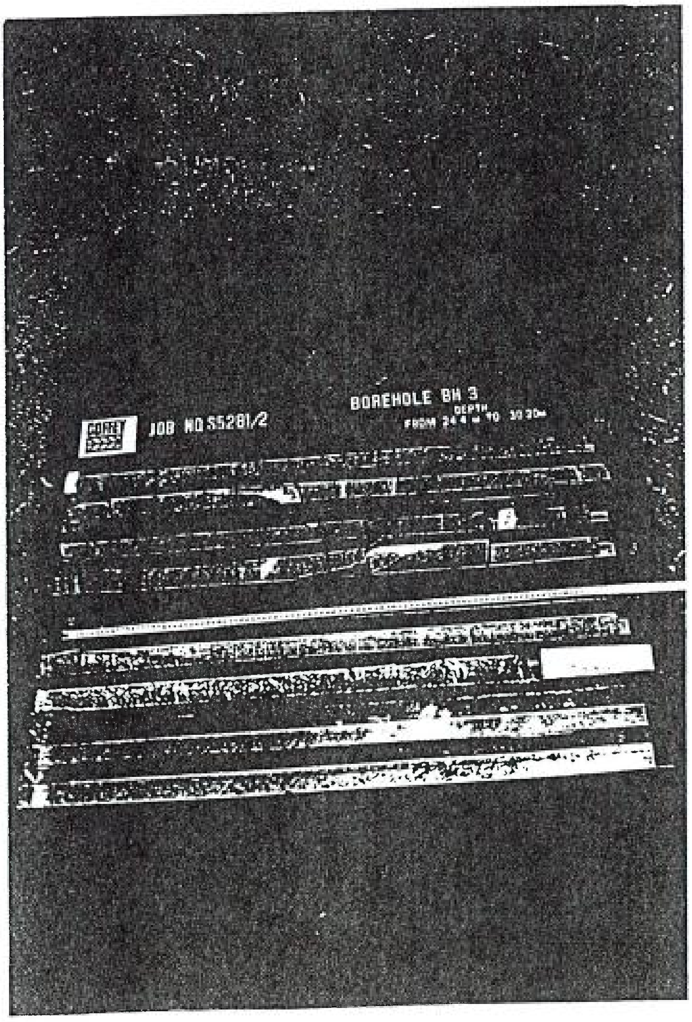
substance description (rock type, grain characteristics, colour, structure, minor components)	weathering
NO CORE 0.2m	
Porphyritic DACITE, medium grained, brown and grey-brown.	HW
NO CORE 0.10m	HW
NO CORE 0.05m	
NO CORE 0.15m	HW
NO CORE 0.10m	Fr
Porphyritic DACITE, medium grained, grey-green.	SW Fr

defect description (thickness, type, inclination, planarity, roughness, coating)

Defects include planar rough, joints, dipping from 75° to subvertical commonly with Mn veneer, minor irregular, rough joints, dipping 40°, Fe stained, and clay seams to 10mm dipping 20°.

Defects are mostly planar, rough, joints, iron stained with minor clay, calcite and epidote veneers, dipping as shown. Closed joints include epidote and quartz veneered planar, rough, joints.


JOB NO S5281/2
BOREHOLE BH 3
DEPTH
FROM 12.65m TO 24.40m


JOB NO S5281/2
BOREHOLE BH 3
DEPTH
FROM 24.4 m TO 30.30m

Coffey & Partners Pty Ltd

engineering log – cored borehole

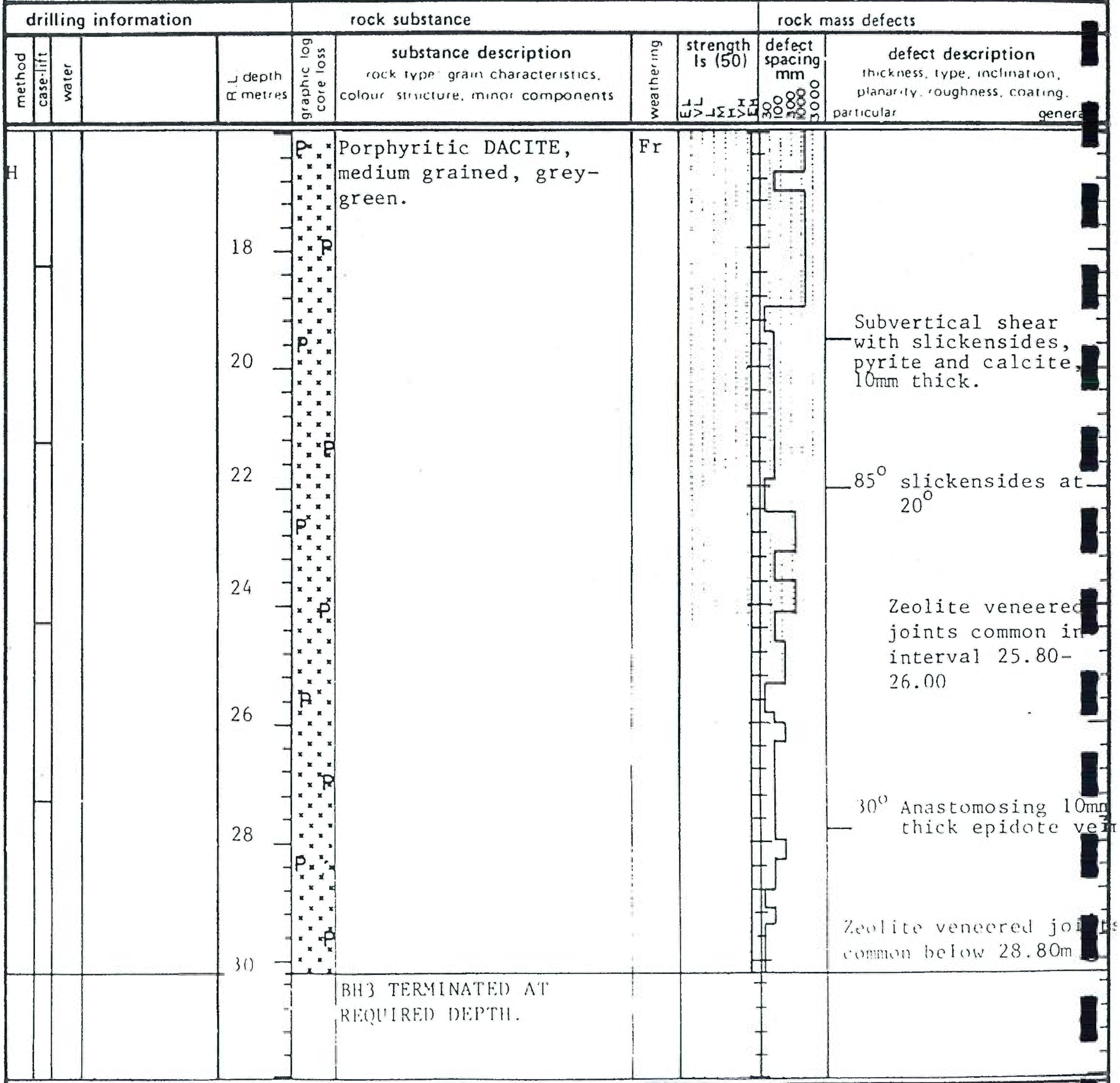
COFFEY

borehole no. BH3
sheet 2 of 2

office and job no. SYDNEY S5281/2

LEIGHTON CONTRACTORS PTY. LTD.
hole commenced 15.5.84
hole completed 18.5.84
project OAK VALE QUARRY SITE ASSESSMENT OF RESERVE
supervised by ARC
borehole location 93E; 17N OF THE SURVEYED GRID
log checked by JPM

drill model and mounting LONG YEAR 34 TRUCK
slope 90 deg
R.L. surface ESL m
barrel type and length 3m TNW
fluid WATER
bearing – deg
datum



Porphyritic DACITE, medium grained, grey-green.

Fr

Subvertical shear with slickensides, pyrite and calcite, 10mm thick.

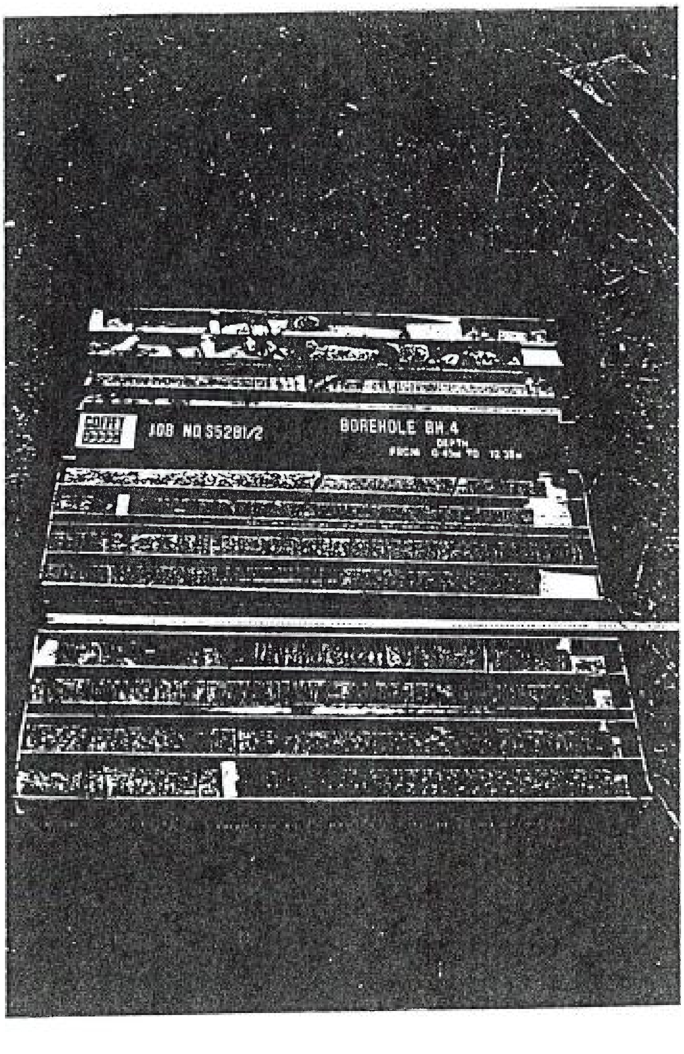
85° slickensides at 20°

Zeolite veneered joints common in interval 25.80-26.00

30° Anastomosing 10mm thick epidote vei

Zeolite veneered joi common below 28.80m

BH3 TERMINATED AT REQUIRED DEPTH.


JOB NO S5281/2
BOREHOLE BH.4
DEPTH
FROM 0.45m TO 12.38m

Coffey & Partners Pty Ltd

COFFEY

borehole no BH4
sheet 1 of 2

engineering log – cored borehole

office and job no SYDNEY S5281/2

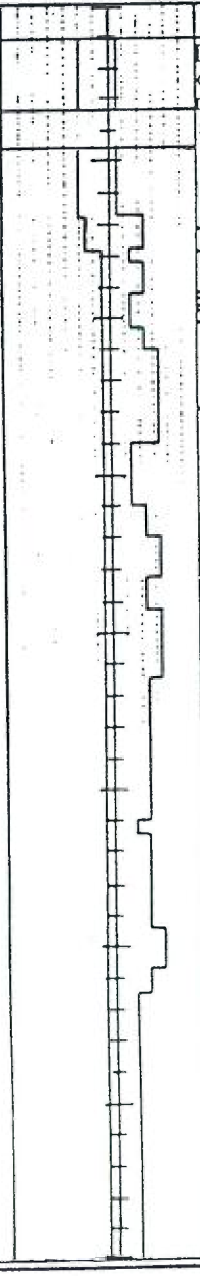
client LEIGHTON CONTRACTORS PTY. LTD.
project OAK VALE QUARRY SITE ASSESSMENT OF RESERVE
borehole location 41E; 92N OF THE SURVEYED GRID

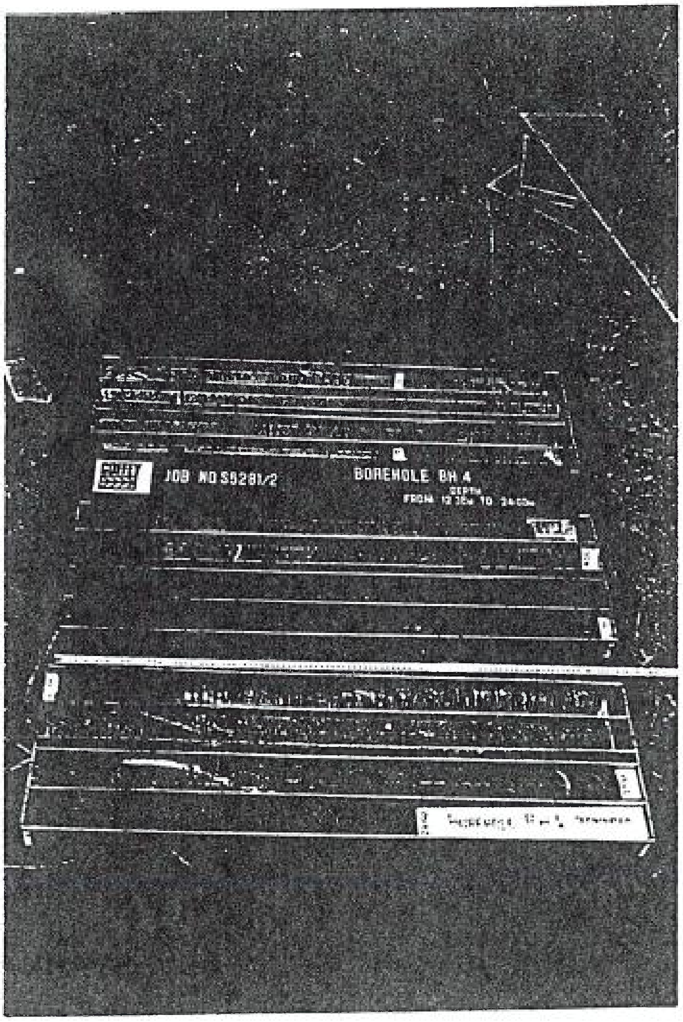
hole commenced 21.5.84
hole completed 23.5.84
supervised by ARC
log checked by JPM

drill model and mounting LONG YEAR 34 TRUCK slope 90 deg
barrel type and length 3m TNW fluid WATER bearing – deg.
R L surface ESL m
datum

method	case-lift	water	depth metres	substance description (rock type, grain characteristics, colour, structure, minor components)	weathering	defect description (particular)
W						
				Porphyritic DACITE, medium grained, brown and green-brown.	HW	Defects include thin clay and planar, rough, manganese and iron stained, joints.
				NO CORE 0.50m		
H		24.5.84	2	Porphyritic DACITE, medium grained, grey-green.	HW/ MW MW SW	85° 20° 30° 25° 5° 30° 10° 30°
			4	Porphyritic DACITE, medium grained, grey-green.	Fr	30°
			6			
			8			40° Epidote, quartz and (?) calcite vein 5mm thick 40° vein as above
			10			25°
			12			
			14			5° Anastomosing epidote veneered fractures & veins, minor sub-vertical textural orientation.
			16			

general: Defects are mostly planar, rough, joints, epidote and quartz and calcite veneered, dipping as shown, iron stained, joints common to depth of 13.5m.




JOB NO S5281/2
BOREHOLE BH 4
DEPTH
FROM 12.30m TO 24.00m

engineering log – cored borehole

COFFEY

borehole no. BH4
sheet 2 of 2

SYDNEY S5281/2

LEIGHTON CONTRACTORS PTY. LTD. 21.5.84
23.5.84
project OAK VALE QUARRY SITE ASSESSMENT OF RESERVE ARC
borehole location 41E; N OF THE SURVEYED GRID JPM

drill model and mounting LONG YEAR 34 TRUCK slope 90 deg R.L. surface ESL
barrel type and length 3m TNW fluid WATER bearing – deg datum

drilling information				rock substance				rock mass defects	
method	case-lift	water	depth metres	graphic log core loss	substance description rock type, grain characteristics colour, structure, minor components	weathering	strength Is (50)	defect spacing mm	defect description thickness, type, inclination, planarity, roughness, coating particular general
H				P	Porphyritic DACITE, medium grained, grey-green.	Fr			
			18	P					Anastomosing epidote veneered fractures and veinlets. Minor sub-vertical textural orientation.
			20	P					
		◀		P					5° Slickensided, clay veneered, planar, rough, joint. Some zeolite veneered joints in the interval 21.50 to 24.10m
			22	P					
			24	P					30° Quartz and epidote vein 10mm thick
					BH4 ABANDONED AT 24.00 DUE TO REPORTED LOSS OF CIRCULATION AND EXCESSIVE BIT WEAR.				

Coffey & Partners Pty Ltd

engineering log
excavation

COFFEY

pit no TP1
sheet 1 of 1

office and job no SYDNEY S5281/2

client	LEIGHTON CONTRACTORS PTY. LTD.	pit commenced	10.5.84
		pit completed	10.5.84
project	OAK VALE QUARRY SITE ASSESSMENT OF RESERVE	supervised by	ARC
pit location	06E; 97N OF THE SURVEYED GRID	checked by	JPM

equipment type and model JOHN DEERE 400 BACKHOE
R.L. surface ESL m
excavation dimensions 2.5 m long. 0.6 m wide
datum

method	penetration 1 2 3	support	water	notes samples, tests, etc.	depth metres	graphic log	classification symbol	material soil type plasticity or particle characteristics colour secondary and minor components	moisture condition	consistency/density index	hand penetrometer kPa 100 200 300 400	structure and additional observations
B H		NIL	NONE ENCOUNTERED				SC/SM	CLAYEY SILTY SAND, dark grey, low plasticity, sand fine to coarse, trace of fine gravel.	M	MD		rootlet zone
							SC/SM	CLAYEY SILTY SAND, light grey, low plasticity, sand fine to coarse, some gravel to 50mm as quartz and HW & MW dacite.	M	MD/D		leached zone
					1		CL	SANDY CLAY, yellow-brown, orange-brown and light grey mottled, low plasticity, sand fine to coarse, trace of fine gravel.	M	St/VSt		SLOPEWASH SOIL
						P		Porphyrite DACITE, medium grained, yellow-brown, brown and light gray, HW and MW, ELS and LS.	M/D			EW and HW ROCK

TP1 TERMINATED AT BACKHOE REFUSAL.

key

method
N natural exposure
X existing excavation
BH backhoe bucket
B bulldozer blade
R ripper

support
T timbering
penetration 1 2 3
no resistance
ranging to
refusal

water
10 Jan 78 water level on date shown
water outflow
water inflow

notes samples and tests
U50 undisturbed sample 50 mm diameter
D disturbed sample
N standard penetration test figure = result
N* SPT + sample
Nc cone penetrometer

classification symbols and soil description
based on unified classification system

moisture
D dry
M moist
W wet

consistency/density index
VS very soft
S soft
F firm
St stiff
VSt very stiff
H hard
Fb friable
VL very loose
L loose
MD medium dense
D dense
VD very dense

Coffey & Partners Pty Ltd

engineering log excavation

COFFEY

pit no: TP2
sheet 1 of 1

office and job no SYDNEY S5281/2

	LEIGHTON CONTRACTORS PTY. LTD.	pit commenced	10.5.84
		pit completed	10.5.84
project	OAK VALE QUARRY SITE ASSESSMENT OF RESERVE	supervised by	ARC
pit location	07E; 70N OF THE SURVEYED GRID	checked by	JPM
equipment type and model	JOHN DEERE 400 BACKHOE	R.L. surface	ESL m
excavation dimensions	2.5 m long 0.6 m wide	datum	

method	penetration 1 2 3	support	water	notes samples, tests, etc.	R.L. depth metres	classification symbol	material soil type, plasticity or particle characteristics colour, secondary and minor components	moisture condition	consistency/density index	hand penetrometer kPa	structure and additional observations
BH		NIL	NONE ENCOUNTERED			sc/sm	CLAYEY SILTY SAND, dark brown, low plasticity, sand fine to coarse, trace of fine gravel.	M	MD		rootlet zone
						SC/SM		M	MD		leached zone
						CL	CLAYEY SILTY SAND, light grey-brown, low plasticity, sand fine to coarse.	M	St		SLOPEWASH SOIL
					1		SANDY CLAY, yellow-brown, orange-brown and grey, low plasticity, sand fine to coarse, trace of fine gravel.	M/D			EW & HW ROCK
							Porphyritic DACITE, medium grained, yellow-brown, orange-brown and grey, EW and HW, ELS and LS.				
							TP2 TERMINATED AT BACKHOE REFUSAL.				

key

method
N natural exposure
X existing excavation
BH backhoe bucket
B bulldozer blade
R ripper

support
T timbering

penetration 1 2 3
no resistance
ranging to
refusal

water
▼ 10 Jan 78 water level on date shown
◀ water outflow
▶ water inflow

notes samples and tests
U50 undisturbed sample 50 mm diameter
D disturbed sample
N standard penetration test figure = result
N* SPT + sample
Nc cone penetrometer

classification symbols and soil description
based on unified classification system

moisture
D dry
M moist
W wet

consistency/density index
VS very soft
S soft
F firm
St stiff
VSt very stiff
H hard
Fb friable
VL very loose
L loose
MD medium dense
D dense
VD very dense

Coffey & Partners Pty Ltd

engineering log
excavation

COFFEY

pit no TP3
sheet 1 of 1

office and job no SYDNEY S5281/2

LEIGHTON CONTRACTORS PTY. LTD.
project OAK VALE QUARRY SITE ASSESSMENT OF RESERVE
pit location 09E; 38N OF THE SURVEYED GRID

pit commenced 10.5.84
pit completed 10.5.84
supervised by ARC
checked by JPM

equipment type and model JOHN DEERE 400 BACKHOE
excavation dimensions 3.0 m long. 0.6 m wide
R.L. surface ESL m
datum

method	penetration 1 2 3	support	water	notes samples, tests etc.	RL depth metres	graphic log	classification symbol	material soil type: plasticity or particle characteristics colour, secondary and minor components	moisture condition	consistency/density index	hand penetrometer kPa 100 200 300 400	structure and additional observations
BH		NIL	SLOW SEEPAGES				SC/SM	CLAYEY SILTY SAND, dark grey-brown, low plasticity, sand fine to coarse trace of fine to coarse gravel and cobbles to 100mm.	M/W	MD		rootlet zone
							SC/SM	CLAYEY SILTY SAND, light grey, low plasticity, sand fine to coarse, some gravel to 50mm as quartz and HW & MW dacite.	W	MD		leached zone
					1		CL	SANDY CLAY, yellow-brown, orange-brown and light grey, low and medium plasticity, sand fine to coarse.	M/W	St		SLOPEWASH SOIL
								DACITE, medium grained, grey, orange-brown and yellow brown, EW & HW, ELS & VLS.	M/D			EW & HW ROCK
								TP3 TERMINATED AT BACKHOE REFUSAL.				

key

method

... exposure
... excavation

support
T timbering

penetration 1 2 3
no resistance
ranging to
refusal

water
10 Jan 78 water level on date shown
water outflow
water inflow

notes	samples and tests
U50	undisturbed sample 50 mm diameter
D	disturbed sample
N	standard penetration test figure = result
N*	SPT + sample
Nc	cone penetrometer

classification symbols and soil description
based on unified classification system

moisture
D dry
M moist
W wet

consistency/density index

VS	very soft
S	soft
F	firm
St	stiff
VSt	very stiff
H	hard
Fb	friable
VL	very loose
L	loose
MD	medium dense
D	dense
VD	very dense

Coffey & Partners Pty Ltd

engineering log
excavation

COFFEY

pit no TP4
sheet 1 of 1

office and job no SYDNEY S5281/2

client	LEIGHTON CONTRACTORS PTY. LTD.	pit commenced	15.5.84
		pit completed	10.5.84
project	OAK VALE QUARRY SITE ASSESSMENT OF RESERVE	supervised by	ARC
pit location	25E; 79N OF THE SURVEYED GRID	checked by	JPM

equipment type and model JOHN DEERE 400 BACKHOE
excavation dimensions 3.0 m long 0.6 m wide
R L surface ESL m
datum

method	penetration 1 2 3	support	water	notes samples, tests, etc.	RL depth metres	graphic log	classification symbol	material soil type: plasticity or particle characteristics colour, secondary and minor components	moisture condition	consistency/density index	hand penetrometer kPa 100 200 300 400	structure and additional observations
BH		Nil	NONE ENCOUNTERED		0.10		sc/sm	CLAYEY SILTY SAND, dark grey, low plasticity, sand fine to coarse, trace of fine gravel.	M	MD		rootlet zone
					0.30		SC/SM		M	MD/D		leached zone
					0.80		CL	CLAYEY SILTY SAND, light grey, low plasticity, sand fine to coarse, some gravel to 50mm as quartz and HW & MW dacite.	M	St		SLOPEWASH SOIL
					0.90	P		SANDY CLAY, brown and orange-brown, minor yellow-brown, mottled, low to medium plasticity, sand fine to coarse, trace of fine gravel. Porphyrite DACITE, medium grained, brown and yellow-brown, EW & HW, ELS & LS.	M/D			EW & HW ROCK

TP4 TERMINATED AT BACKHOE REFUSAL.

key

method
N natural exposure
X existing excavation
BH backhoe bucket
B bulldozer blade
R ripper

support
T timbering

penetration 1 2 3
no resistance
ranging to
refusal

water
10 Jan 78 water level on date shown
water outflow
water inflow

notes	samples and tests
U50	undisturbed sample 50 mm diameter
D	disturbed sample
N	standard penetration test figure = result
N*	SPT + sample
Nc	cone penetrometer

classification symbols and soil description
based on unified classification system

moisture
D dry
M moist
W wet

consistency/density index	
VS	very soft
S	soft
F	firm
St	stiff
VSt	very stiff
H	hard
Fb	friable
VL	very loose
L	loose
MD	medium dense
D	dense
VD	very dense

Coffey & Partners Pty Ltd

engineering log
excavation

COFFEY

pit no: TP5
sheet 1 of 1

office and job no SYDNEY S5281/2

LEIGHTON CONTRACTORS PTY. LTD.

project OAK VALE QUARRY SITE ASSESSMENT OF RESERVE
pit location 57E; 69N OF THE SURVEYED GRID

pit commenced 10.5.84
pit completed 10.5.84
supervised by ARC
checked by JPM

equipment type and model JOHN DEERE 400 BACKHOE
excavation dimensions 2.0 m long 0.6 m wide

R.L. surface ESL m
datum

method	penetration 1 2 3	support	water	notes samples, tests, etc.	RL depth metres	graphic log	classification symbol	material soil type plasticity or particle characteristics colour, secondary and minor components	moisture condition	consistency/density index	hand penetrometer kPa 100 200 300 400	structure and additional observations
BH		NIL	NONE		0.20		SC/SM	CLAYEY SILTY GRAVELLY SAND, dark brown, low plasticity, sand fine to coarse, gravel fine to boulder size comprising quartz and dacite.	M	MD		rootlet zone
					0.50		SC/SM	CLAYEY SILTY GRAVELLY SAND, light grey-brown, low plasticity, sand fine to coarse, gravel fine to coarse, cobbles and boulders to 250mm comprising dacite and quartz.	M	MD/D		SLOPEWASH SOIL leached zone
					0.60	R		Porphyritic DACITE, medium grained, grey-green, minor brown, EW & MW, ELS & VHS.	M/D			EW/MW ROCK

TP5 TERMINATED AT BACKHOE REFUSAL.

key

method

N	natural exposure
E	existing excavation
BH	backhoe bucket
B	bulldozer blade
R	ripper

support

T timbering

penetration 1 2 3

resistance ranging to refusal

water

▼ 10 Jan 78 water level on date shown

◀ water outflow

▶ water inflow

notes samples and tests

U50	undisturbed sample 50 mm diameter
D	disturbed sample
N	standard penetration test figure = result
N*	SPT + sample
Nc	cone penetrometer

classification symbols and soil description

based on unified classification system

moisture

D	dry
M	moist
W	wet

consistency/density index

VS	very soft
S	soft
F	firm
St	stiff
VSt	very stiff
H	hard
Fb	friable
VL	very loose
L	loose
MD	medium dense
D	dense
VD	very dense

Coffey & Partners Pty Ltd

engineering log
excavation

COFFEY

pit no: TP6
sheet 1 of 1

office and job no SYDNEY S5281/2

LEIGHTON CONTRACTORS PTY. LTD.

project	OAK VALE QUARRY SITE ASSESSMENT OF RESERVE
pit location	72E; 33N OF THE SURVEYED GRID
pit commenced	10.5.84
pit completed	10.5.84
supervised by	ARC
checked by	JPM
equipment type and model	JOHN DEERE 400 BACKHOE
excavation dimensions	2.0 m long. 0.6 m wide
R.L. surface	ESL m
datum:	

method	penetration 1 2 3	support	water	notes samples, tests, etc.	R.L. depth metres	graphic log	classification symbol	material soil type: plasticity or particle characteristics colour, secondary and minor components	moisture condition	consistency/density index	hand penetrometer kPa 100 200 300 400	structure and additional observations
BH		NIL	NONE		0.15		SC/SM	CLAYEY SILTY SAND, dark brown, low plasticity, sand fine to coarse, trace of gravel to 50mm.	M	MD		Rootlets zone Leached zone SLOPEWASH SOIL
					0.50		CL	SANDY CLAY, light brown and light yellow-brown, low plasticity, sand fine coarse gravel, cobbles and boulders to 250m.				
								TP6 TERMINATED AT BACKHOE REFUSAL ON MW/SW DACITE.				

key

method

N	natural exposure
E	existing excavation
BH	backhoe bucket
B	bulldozer blade
R	ripper

support

T timbering

penetration 1 2 3

no resistance ranging to refusal

water

▼	10 Jan 78 water level on date shown
◀	water outflow
▶	water inflow

notes	samples and tests
U50	undisturbed sample 50 mm diameter
D	disturbed sample
N	standard penetration test figure = result
N*	SPT + sample
Nc	cone penetrometer

classification symbols and soil description

based on unified classification system

moisture

D	dry
M	moist
W	wet

consistency/density index

VS	very soft
S	soft
F	firm
St	stiff
VSt	very stiff
H	hard
Fb	friable
VL	very loose
L	loose
MD	medium dense
D	dense
VD	very dense

APPENDIX C

APPENDIX C

RESULTS OF LABORATORY TESTING

S.5281/2/2 - February 1985.

PETROGRAPHIC DESCRIPTION OF ROCK SAMPLE FROM SAMPLE SITE NO. 1, OAK VALE QUARRY SITE, WILLIAMSDALE, N.S.W.

HAND SPECIMEN

A massive, dark grey rock with visible phenocrysts of glassy quartz, pink and greenish feldspar and scattered sulphides.

THIN SECTION

Modal percentages were estimated on the average of 10 random counts.

A. PHENOCRYSTS: 36.2%

1. Plagioclase (20.1%)

   Subhedral and fractured crystals up to 2 mm in size are extensively altered to sericite and carbonate. Some zoning is present and, where multiple twinning is preserved, the composition ranges between An_{26} and An_{32} (oligoclase/andesine).

2. Quartz (10.6%)

   Rounded and embayed crystals of β-quartz are accompanied by angular pieces of fractured crystals. They are up to 4.5 mm in size and have undulose extinction.

BMI Limited

Materials Laboratory

Administration Centre
Greystanes Road
South Wentworthville
Sydney

Telephone 02 6360000
DX 1277 Sydney

Post Office Box 42
Wentworthville NSW 2145
Australia

Telex AA22751
Cables Beml

Test Report

CLIENT: Coffey & Partners Pty. Ltd. FILE NO: 33/84

PROJECT: Los Angeles Abrasion Value Wet/Dry Strength Variation

DESCRIPTION: Crushed Aggregate DATE RECD: 2/3.5.84

Test Method	Laboratory Sample No:	1584	[redacted]
	Field sample No:	S5281/2	[redacted]
	Date sampled:	-	[redacted]
AS1141.22	Dry Strength (kN)	327	[redacted]
	Wet Strength (kN)	252	[redacted]
	Wet/Dry Strength Var. (%)	23	[redacted]
AS1141.23	Los Angeles Abrasion Value 'B' Grading	14	[redacted]

Mr. T. O'Brien
File, MF

Authorised Signatory P.J. Clarke

Date 15th May 1984 Serial No. [illegible]

Appendix D - Correspondance

General Manager
Yarrowlumla Shire Council
P.O Box 112
QUEANBEYAN NSW 2622

9th June 1998 Our ref: L95/0232

Dear Sir,

RE: MINERAL AND EXTRACTIVE RESOURCES WITHIN YARROWLUMLA LOCAL GOVERNMENT AREA.

SECTION 117(2) (EP & A ACT 1979) DIRECTION

I refer to our previous correspondence of 17th November 1995 regarding the Section 117(2) Direction No. G28 advice sent to you by the Department of Mineral Resources.

This advice has been recently revised by the Department. Some sites have been deleted and others modified. Attachment 1 and the enclosed plans show these amendments. This advice replaces all previous advice sent to you.

The Department would object to any proposed change in zoning which may restrict or prohibit mining or extraction on areas shown by the striped hatching (blue) on the enclosed plans. These areas contain existing quarries/mines and identified resources.

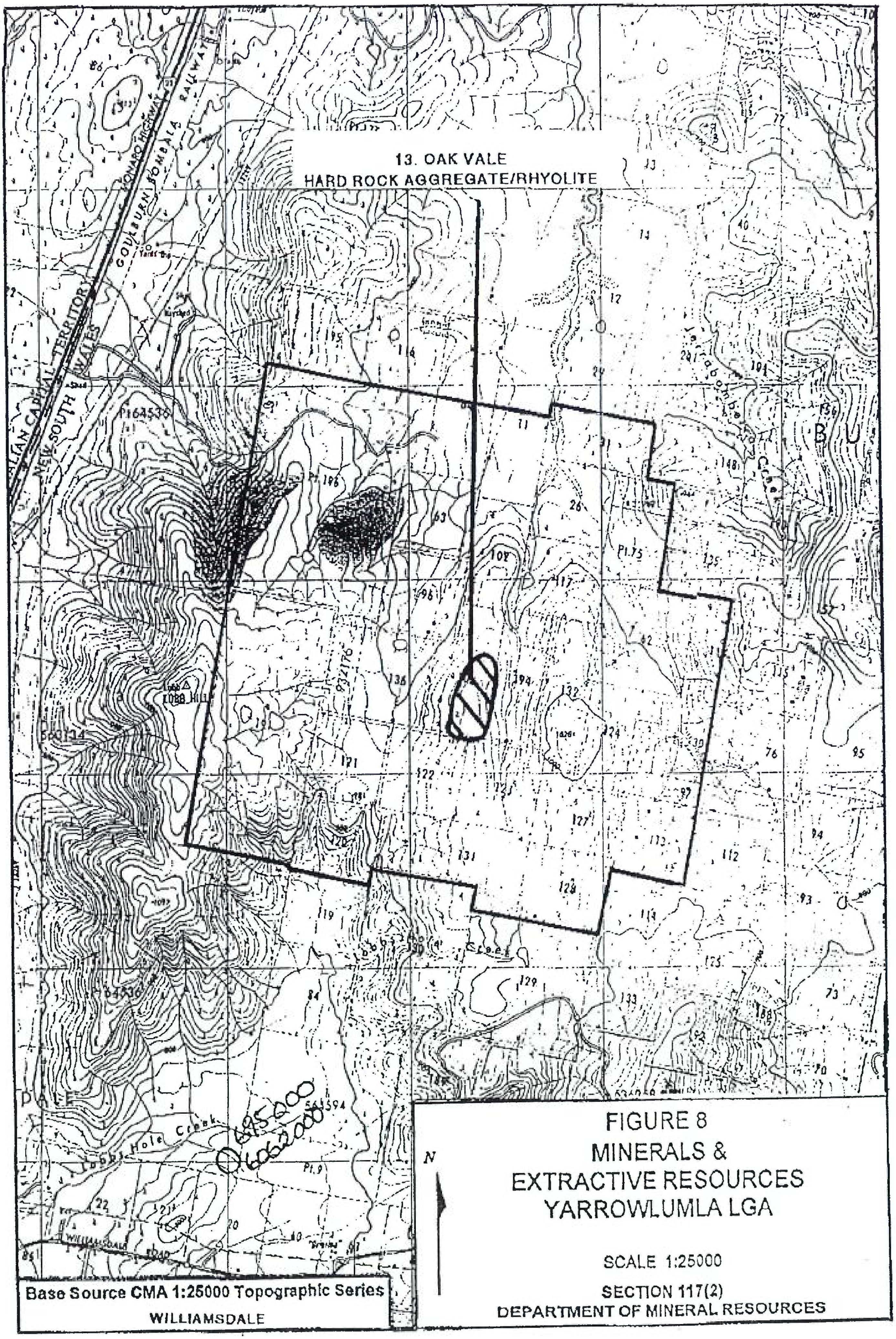
Within areas shaded pink, it is essential for Council to forward to the Department for comment any proposed LEPs which propose a change of zoning which may restrict or prohibit mining/extraction. Development within these areas could adversely affect or be affected by future quarrying/mining operations.

The Department will endeavour to ensure that Council is kept informed of mineral and extractive resource developments in the district. Further advice is likely in future to notify Council of additional resources or to delete others and separate advice may also be provided in respect of coal and petroleum resources.

If you have any queries in reference to this please contact Mr Jyrki Piemmunne of the Geological Survey on (02) 9901 8369.

Yours faithfully,

S.R. Lishmund
for Director-General



13. OAK VALE
HARD ROCK AGGREGATE/RHYOLITE

FIGURE 8
MINERALS &
EXTRACTIVE RESOURCES
YARROWLUMLA LGA

SCALE 1:25000

SECTION 117(2)
DEPARTMENT OF MINERAL RESOURCES

Base Source CMA 1:25000 Topographic Series
WILLIAMSDALE

Appendix E - Drill Holes

Canberra Testing Service
A DIVISION OF DANIELAY PTY LTD
A.C.N 065 481 209

1/1

CTS

265 Canberra Avenue, Fyshwick, ACT, 2609, Ph: (06) 280 4261, Fax: (06) 280 6650

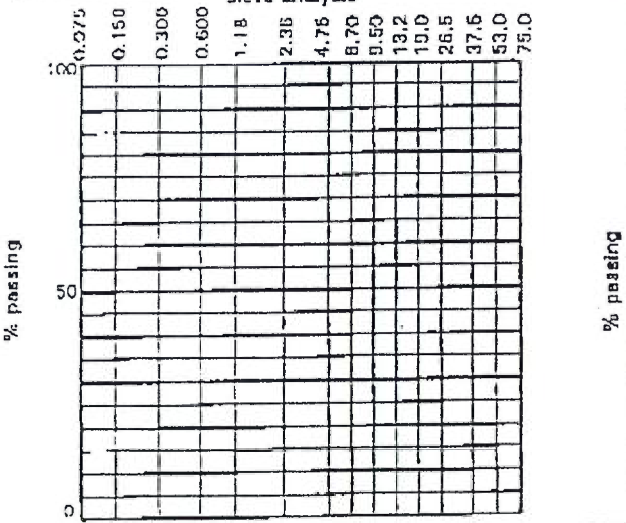
aggregate test results

client : *TOTALCARE INDUSTRIES LIMITED*
principal : *ACT GOVERNMENT*
project : *PROPOSED OAKVALE HARDROCK QUARRY*
location : *WILLIAMSDALE, NSW*

job no : *CTS2154*
laboratory : *CTS, CANBERRA*
report date : *10/02/99*
test report : *99/60491*

test procedure : *AS1141.22-1996 & .23,table2, grading B -1995*
test date : *3.2.99 - 4.2.99*

sample no: *60491*
aggregate source: *Oakvale Hardrock Quarry*
material description: *Crushed Rhyodacite, Diamond Drill Hole no.6 , 15 - 30 m*

AS1141 section	test description		range tested	test result	limits
4	bulk density:	kg/m^3			
5	particle density and water absorption of fine aggregate	particle density (dry) kg/m^3			
		apparent particle density kg/m^3			
		particle density (SSD) kg/m^3			
		absorption %			
6	particle density and water absorption of coarse aggregate	particle density (dry) kg/m^3			
		apparent particle density kg/m^3			
		particle density (SSD) kg/m^3			
		absorption %			
11	sieve analysis 		75.0mm		
			53.0mm		
			37.5mm		
			26.5mm		
			19.0mm		
			13.2mm		
			9.50mm		
			6.70mm		
			4.75mm		
			2.36mm		
			1.18mm		
			600µm		
			300µm		
			150µm		
			75µm		
12	material finer than 75um				
14	particle shape - mis-shapen particles				
22	dry strength	KN	*-19.0 + 9.5mm*	*400*	
22	wet strength	KN	*-19.0 + 9.5mm*	*354*	*min.100*
22	wet/dry strength variation	%	*-19.0 + 9.5mm*	*12*	*max.35*
23	los angeles value		*-19.0 + 9.5mm*	*12*	*max.20*
24	soundness (by use of sodium sulphate solution)				
31	light particles				
32	friable particles				
33	clay and fine silt (by volume)				
34	organic impurities other than sugar				

remarks: *The crushed rock sample was delivered to CTS on 1.2.99 .*

NATA

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Authorised Signature
NATA Reg. No. 613

11/2/99

Form Number LJ 081 Version 1.1

Canberra Testing Service
A DIVISION OF DANPLAY PTY LTD
A.C.N. 065 481 203

CTS

265 Canberra Avenue, Fyshwick, ACT, 2609, Ph: (06) 280 4261, Fax: (06) 280 6650

1/1

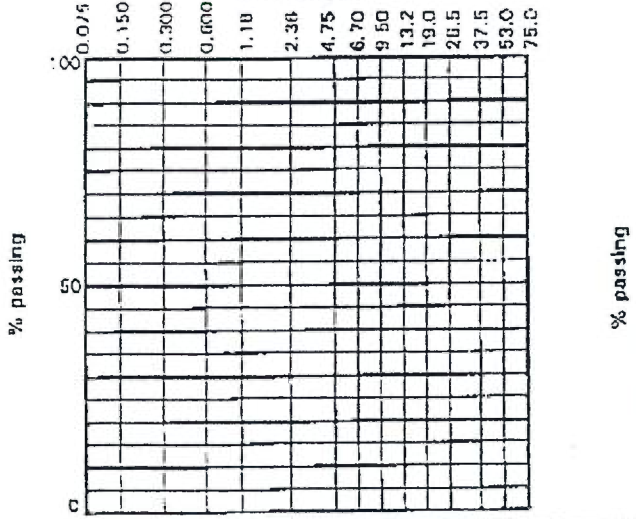
aggregate test results

client : *TOTALCARE INDUSTRIES LIMITED*
principal : *ACT GOVERNMENT*
project : *PROPOSED OAKVALE HARDROCK QUARRY*
location : *WILLIAMSDALE, NSW*

job no : *CTS2154*
laboratory : *CTS, CANBERRA*
report date : *10/02/99*
test report : *99/60492*

test procedure : *AS1141.22-1996 & .23, table2, grading B-1995.*
test date : *3.2.99 - 4.2.99*

sample no: *60492*
aggregate source: *Oakvale Hardrock Quarry*
material description: *Crushed Rhyodacite, Diamond Drill Hole no.6 , 30 - 60 m*

AS1141 section	test description		range tested	test result	limits
4	bulk density:	kg/m ^{3}			
5	particle density and water absorption of fine aggregate	particle density (dry) kg/m ^{3}			
		apparent particle density kg/m ^{3}			
		particle density (SSD) kg/m ^{3}			
		absorption %			
6	particle density and water absorption of coarse aggregate	particle density (dry) kg/m ^{3}			
		apparent particle density kg/m ^{3}			
		particle density (SSD) kg/m ^{3}			
		absorption %			
11	sieve analysis 		75.0mm		
			53.0mm		
			37.5mm		
			26.5mm		
			19.0mm		
			13.2mm		
			9.50mm		
			6.70mm		
			4.75mm		
			2.36mm		
			1.18mm		
			600µm		
			300µm		
			150µm		
			75µm		
12	material finer than 75um				
14	particle shape - mis-shapen particles				
22	dry strength	KN	*-19.0 + 9.5mm*	*385*	
22	wet strength	KN	*-19.0 + 9.5mm*	*305*	*min.100*
22	wet/dry strength variation	%	*-19.0 + 9.5mm*	*20*	*max.35*
23	los angeles value		*-19.0 + 9.5mm*	*13*	*max.20*
24	soundness (by use of sodium sulphate solution)				
31	light particles				
32	friable particles				
33	clay and fine silt (by volume)				
34	organic impurities other than sugar				

remarks: *The crushed rock sample was delivered to CTS on 1.2.99 .*

Authorised Signature
NATA Reg. No. 610

10/2/99

Canberra Testing Service
A DIVISION OF CANPLAY PTY LTD
A.C.N. 065 491 203

1/1

CTS

265 Canberra Avenue, Fyshwick, ACT, 2609. Ph: (06) 280 4261, Fax: (06) 280 6650

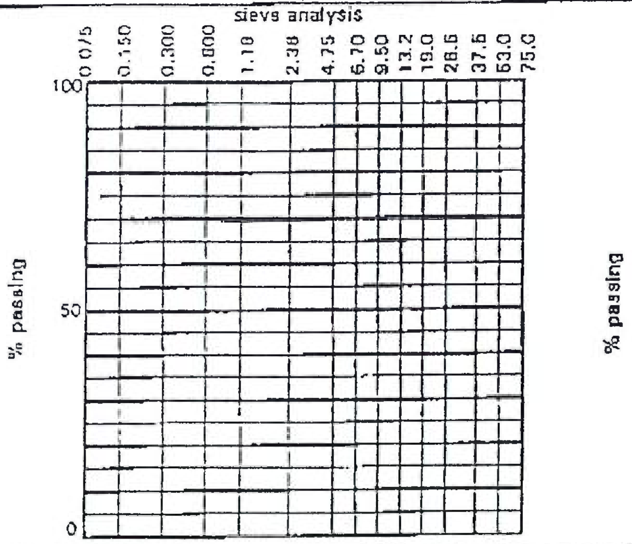
aggregate test results

client : *TOTALCARE INDUSTRIES LIMITED*
principal : *ACT GOVERNMENT*
project : *PROPOSED OAKVALE HARDROCK QUARRY*
location : *WILLIAMSDALE, NSW*

job no : *CTS2154*
laboratory : *CTS, CANBERRA*
report date : *10/02/99*
test report : *99/60493*

test procedure : *AS1141.22-1996 & .23.table2, grading B -1995*
test date : *5.2.99 - 6.2.99*

sample no: *60493*
aggregate source: *Oakvale Hardrock Quarry*
material description: *Crushed Rhyodacite, Diamond Drill Hole no.7 , 10 - 30 m*

AS1141 section	test description		range tested	test result	limits
4	bulk density:	kg/m³			
5	particle density and water absorption of fine aggregate	particle density (dry) kg/m³			
		apparent particle density kg/m³			
		particle density (SSD) kg/m³			
		absorption %			
6	particle density and water absorption of coarse aggregate	particle density (dry) kg/m³			
		apparent particle density kg/m³			
		particle density (SSD) kg/m³			
		absorption %			
11			75.0mm		
			53.0mm		
			37.5mm		
			26.5mm		
			19.0mm		
			13.2mm		
			9.50mm		
			6.70mm		
			4.75mm		
			2.36mm		
			1.18mm		
			600µm		
			300µm		
			150µm		
			75µm		
12	material finer than 75um				
14	particle shape - mis-shapen particles				
22	dry strength	KN	*-19.0+9.5mm*	*328*	
22	wet strength	KN	*-19.0-9.5mm*	*233*	*min.100*
22	wet/dry strength variation	%	*-19.0+9.5mm*	*12*	*max.35*
23	los angeles value		*-19.0+9.5mm*	*15*	*max.20*
24	soundness (by use of sodium sulphate solution)				
31	light particles				
32	friable particles				
33	clay and fine silt (by volume)				
34	organic impurities other than sugar				

remarks: *The crushed rock sample was delivered to CTS on 4.2.99 .*

NATA

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Authorised Signature
NATA Reg. No. 613

11/2/99

Canberra Testing Service
A DIVISION OF DANPLAY PTY LTD
A.C.N. 055 481 209

1/1

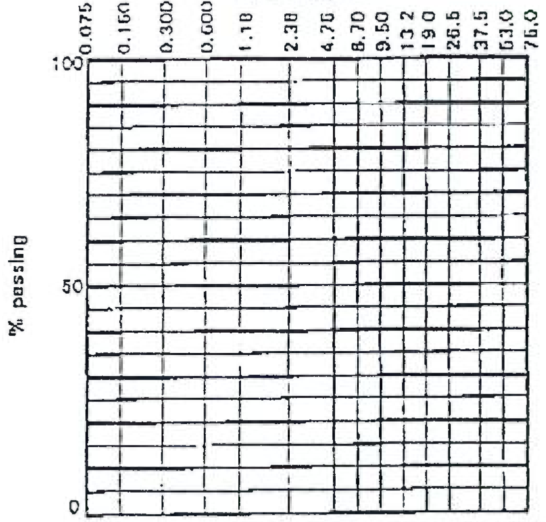
CTS

265 Canberra Avenue, Fyshwick, ACT, 2609, Ph: (06) 280 4261, Fax: (06) 280 6650

aggregate test results

client :	*TOTALCARE INDUSTRIES LIMITED*	job no :	*CTS2154*
principal :	*ACT GOVERNMENT*	laboratory :	*CTS, CANBERRA*
project :	*PROPOSED OAKVALE HARDROCK QUARRY*	report date :	*10/02/99*
location :	*WILLIAMSDALE, NSW*	test report :	*99/60494*
test procedure :	*AS1141.22-1996 & .23,table2, grading B -1995*	test date :	*5.2.99 - 6.2.99*
sample no:	*60494*	aggregate source:	*Oakvale Hardrock Quarry*

material description: *Crushed Rhyodacite, Diamond Drill Hole no.7 , 30 - 60 m*

AS1141 section	test description		range tested	test result	limits
4	bulk density:	kg/m ^{3}			
5	particle density and water absorption of fine aggregate	particle density (dry) kg/m ^{3}			
		apparent particle density kg/m ^{3}			
		particle density (SSD) kg/m ^{3}			
		absorption %			
6	particle density and water absorption of coarse aggregate	particle density (dry) kg/m ^{3}			
		apparent particle density kg/m ^{3}			
		particle density (SSD) kg/m ^{3}			
		absorption %			
11	sieve analysis 	% passing	75.0mm		
			53.0mm		
			37.5mm		
			26.5mm		
			19.0mm		
			13.2mm		
			9.50mm		
			6.70mm		
			4.75mm		
			2.36mm		
			1.18mm		
			600µm		
			300µm		
			150µm		
			75µm		
12	material finer than 75um				
14	particle shape - mis-shapen particles				
22	dry strength	KN	*-19.0+9.5mm*	*352*	
22	wet strength	KN	*-19.0+9.5mm*	*308*	*min.100*
22	wet/dry strength variation	%	*-19.0+9.5mm*	*14*	*max.35*
23	los angeles value		*-19.0+9.5mm*	*13*	*max.20*
24	soundness (by use of sodium sulphate solution)				
31	light particles				
32	friable particles				
33	clay and fine silt (by volume)				
34	organic impurities other than sugar				

remarks: *The crushed rock sample was delivered to CTS on 4.2.99 .*

NATA

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Authorised Signature
NATA Reg. No 613

11/2/99

Appendix F - Petrographic Reports

DR B.J. BARRON
Petrologist

7 Fairview Avenue
ST IVES NSW 2075
AUSTRALIA
Tel/Fax: (02) 9449.5839

Our ref: R7/90/1126
Your ref: Pers. comm.

Petrological examination of three drill core samples DDH 6 16.1 m, 28.3 m and 53.8 m, from Williamsdale, NSW.

Report No: R7/90/1126

4 February, 1999

For: Don Reed & Associates Pty Ltd.

J. Barron
Dr B.J. Barron
Consulting Petrologist

SUMMARY and CONCLUSIONS

Drill core samples from DDH 6 represent the three levels 16.1 m, 28.3 m and 53.8 m. These sample are a similar lithology to those in DDH 5 since they comprise unsorted crystal/once-vitric tuff derived from a coarsely quartz, feldspar and biotite-porphyritic acidic volcanic source.

The two samples DDH 6 16.1 m and 28.3 m contain a slightly smaller and less abundant crystal fraction than DDH 6 53.8 m. Nevertheless, the samples show remarkably similar primary mineralogy, with moderate to quite intense but selective alteration.

The secondary mineralogy locally is 'contained' within certain crystal sites, defines a weak tectonic foliation, and also is characteristic in finer narrow branching veins or planar joints.

Illite is the most abundant hydrous secondary phase that accounts for up to ~ 15% - 20% of samples DDH 6 16.1 m and 28.3 m, but only about 10% - 15% of DDH 6 53.8 m. Very fine grained illite is selectively located in plagioclase crystal sites, partly clouds the once-glassy rock matrix, and defines the weak, wavy tectonic foliation.

Chlorite is selectively developed in sparse once-phenocrystic biotite sites, and also forms small patches in the foliated rock matrix fraction.

Minor granular calcite fills tension microfractures and coats sparse planar joint surfaces. Calcite is an accessory secondary phase that is also 'contained' within feldspar and mafic crystal sites.

Zeolites are not present in these mainly tough and compact K-feldspar-rich samples.

Sample No.	DDH 6 16.1 m
Rock Type	Partly selectively altered, weakly foliated (deformed), unsorted crystal/once-vitric tuff, containing material from a coarsely quartz-plagioclase-K-feldspar-biotite porphyritic acid-volcanic source.

Hand Specimen A rather massive, fine grained mottled pale to mid green-grey sample that contains abundant medium to rather coarse grained crystals of quartz and diffuse pale grey feldspar. Sparse feldspar crystals are pale pink. K-feldspar staining gave strong positive results for the abundant rock matrix fraction and also for sparse subhedral crystal sites. The sample is moderately to quite well foliated and is cut by a network of branching narrow veinlets that are only partly foliation-controlled. These pale grey veinlets react strongly with cold dilute HCl, indicating calcite.

Thin Section This is an unsorted crystal/lithic fragmental volcaniclastic (tuffaceous) rock that contains material from a coarsely porphyritic acid volcanic source. Broken crystal fragments of previous phenocrysts account for about 30% of the present section area, while poorly defined outlines of fine grained volcanic lithic fragments possibly account for a further 20% of the section area. The crystal fragments vary up to 3.5 mm grain size, while altered and deformed fine grained lithic fragments are less than 4 mm across. The fine grained rock matrix fraction most likely once contained glass shards and fragments that are now obscured by foliation and alteration.

The crystal fraction contains almost equal major proportions of quartz and feldspar with subordinate sites of deformed and altered biotite. The abundant once-phenocrystic quartz forms subhedral crystals that are deeply resorbed, as well as anhedral crystals that are distinctly magmatically rounded. Smaller quartz crystals are angular broken chips. The quartz shows strong strain shadows ± narrow deformation twins. It encloses ubiquitous dusty solid and some fluid inclusions. Abundant plagioclase crystal sites are intensely deformed and altered to albite that is heavily clouded with wispy fine grained illite ± traces of carbonate. Subordinate K-feldspar cleavage fragments, on the other hand, are relatively free of the abundant illite but are distinctly perthitic enclosing irregular patches of albite. Some of these crystals show hematite clouding that is most likely responsible for the pink colour of this phase in the hand specimen. Medium to coarse grained sites of deformed ragged biotite flakes are converted to aggregates of green chlorite, interlayer illite-sericite and abundant elongate trails of sphene granules ± lenses of carbonate and granular epidote. Accessory crystal fragments are apatite, zircon, sphene-leucoxene altered oxide crystal sites and sparse late-formed euhedral pyritic sulphides up to 0.7 mm grain size.

The poorly defined volcanic lithic fragments commonly are themselves fragmental, with broken phenocryst sites set throughout a fine grained once-?glassy ?shard-rich fragment matrix. This matrix fraction now is converted to mottled aggregates of microgranular K-feldspar ± quartz, throughout which wispy fine grained illite defines a wavy foliation direction.

The rock matrix fraction is exceptionally fine grained (mainly < 0.01 mm) and comprises a K-feldspar-rich mosaic (see staining of offcut), throughout which is developed a wavy foliation marked by wispy illite. The wispy illite forms discontinuous and branching narrow lenses that bend around more competent coarse crystal fragments.

The sample is cut by branching narrow tension fractures with zones of microbreccia that grade into carbonate-rich veins. The carbonate mainly is calcite (since there is strong reaction with cold dilute HCl). The carbonate is intergrown with minor granular quartz, later crosscutting discontinuous narrow veinlets (< 0.2 mm across) contain abundant prehnite.

This sample comprises a partly selectively altered, weakly foliated (deformed), unsorted crystal/once-vitric tuff, containing material from a coarsely quartz-plagioclase-K-feldspar-biotite porphyritic acid-volcanic source.

Sample No.	DDH6 28.3 m
Rock Type	Selectively altered, moderately foliated and deformed, unsorted crystal/once vitric tuff that lacks significant veins, but contains minor tension fracture-located carbonate.

Hand Specimen A rather compact and massive but weakly foliated, mid green-grey sample that contains moderately abundant pale grey feldspar and dark grey quartz crystal sites with fewer dark green-grey mafic crystal sites. K-feldspar staining gave strong positive results for the abundant fine grained rock matrix fraction and also for sparse medium grained feldspar crystal sites. Unlike the previous sample, the present sample lacks conspicuous veins except for a coarse grained carbonate coating developed on a more or less planar joint surface, along which the drill core has broken. The carbonate reacts strongly with cold dilute HCl indicating calcite.

Thin Section Crystal/?vitric fragmental texture once again is characteristic of this unsorted volcaniclastic (most likely tuffaceous) rock. Selective alteration and foliation largely obscures finer relict textures, particularly in the rock matrix fraction. Angular crystal fragments comprise at least 30% of the present section area with poor outlines of fine grained lithic fragments accounting for a further 15% of this lithic type. The unsorted angular fragments are set in the fine grained poorly defined once ?glassy K-feldspar-rich rock matrix fraction.

The crystal fraction has a variable grain size up to about 3 mm in the present section and once again contains approximately equal major proportions of quartz and feldspar with sparse large altered biotite flakes up to 2 mm grain size. The once-phenocrystic quartz mainly is broken and angular, but some larger crystals retain subhedral partial outlines that are deeply magmatically embayed. They contain characteristic trails of solid and fluid inclusions, some are deformed and show narrow parallel deformation twin lamellae. Smaller quartz grains are again angular and broken chips. As in the previous sample DDH 6 16.1 m, albitised plagioclase dominates the feldspar fraction. The plagioclase cleavage fragments again are heavily clouded with abundant dusty illite and minor carbonate. Sparse cleavage fragments of K-feldspar are relatively unaltered except for partial fine grained clay ± red-brown hematite clouding. The K-feldspar is quite strongly perthitic. Sites of sparse ragged biotite flakes reach almost 2 mm grain size and are distinctly deformed and altered to chlorite, patchy sphene-leucoxene ± epidote ± illite. Accessory phases are apatite, allanite, zircon and sparse titanian oxides partly converted to sphene-leucoxene.

Poorly defined lithic fragments commonly contain degraded feldspar crystal sites set in a mottled ?devitrified feldspathic fraction that was almost certainly once glassy. The once glassy groundmass or matrix fraction is clouded with wispy illite, epidote granules and minor chlorite. Elsewhere are poor outlines of lithic fragments that are flattened and drawn out parallel to the foliation. These are again fine grained mottled and devitrified but contain broken feldspar cleavage fragments and once could have been tuffaceous.

Recognisable crystal and lithic fragments are set throughout an exceptionally fine grained rock matrix fraction that contains abundant K-feldspar (see staining of offcut), with an average grain size of < 0.01 mm. This microgranular felsic matrix is intergrown with abundant wispy illite which forms local dense foliated aggregates that bend around the more competent crystal and lithic fragments. Small elongate patches of chlorite are accessory, and this fraction contains abundant small clusters (< 0.1 mm across) of dusty sphene granules replacing previous titanian oxides.

The sample contains accessory narrow discontinuous vein-like patches of carbonate mainly located in strain shadow domains adjacent to large crystal fragments. Apart from these local tensional domains, the sample lacks significant veins in the present section.

The sample is a selectively altered, moderately foliated and deformed, unsorted crystal/once vitric tuff that lacks significant veins, but contains minor tension fracture-located carbonate.

Sample No.	DDH 6 53.8 m
Rock Type	Partly selectively altered, foliated and deformed, unsorted crystal-rich and once-vitric tuff of acidic volcanic primary composition. It is cut by narrow tension fracture-located veinlets and sparse joints filled with carbonate ± chlorite while others contain mainly illite.

Hand Specimen A compact fine grained mid green-grey sample that contains very abundant medium and coarse grained mid and pale grey quartz and feldspar crystal sites, as well as sparse fine grained mid green-grey lithic clasts, one of which is subrounded and reaches more than 2 cm long. K-feldspar staining gave strong positive results for the fine grained rock matrix fraction and for sparse medium and coarse grained crystal sites. The drill core is cut by a prominent planar fracture or joint coated with white calcite that reacts strongly with cold dilute HCl.

Thin Section In this unsorted crystal/vitric tuff, the crystal fraction accounts for about 45% of the section area, and is unusually coarse grained compared with previous samples. Many crystals reach more than 3 mm grain size. Subordinate lithic fragments are poorly defined, since most were once glassy and similar to the abundant rock matrix composition.

The crystal fraction once again comprises approximately equal major proportions of quartz and feldspar with sparse sites of equally coarse grained, deformed and altered biotite flakes. Some large subhedral quartz crystals are deeply magmatically embayed while others are magmatically rounded and embayed. Most shows complex strain shadows and narrow strain lamellae, while others are cut by abundant microfractures. Some could have been shattered in situ. Smaller quartz grains mainly are angular chips. Subhedral plagioclase prisms and cleavage fragments retain some relict islands of moderately calcic plagioclase that are relatively clear of the ubiquitous illite clouding in most grains. Plagioclase crystals contain minor carbonate and traces of chlorite, as well as abundant fine grained illite. Large deformed biotite flakes now are converted to green chlorite intergrown with patchy epidote and trails of fine grained sphene granules. Patches of secondary red-brown allanite are accessory. Primary accessory phases are zircon, apatite and titanian oxides partly converted to clouded sphene-leucoxene.

Poorly defined lithic fragments now are marked by a mottled mosaic of granular devitrified feldspar (most likely enriched in K-feldspar), throughout which are sparse sites of albitised plagioclase and chlorite-altered once phenocrystic biotite. In rare lithic fragments there are vague outlines of possible cuspate glass shards. These are marked by distribution of dusty titanian oxides now converted to sphene-leucoxene.

The recognisable crystal and minor lithic fragments are set throughout an exceptionally fine grained rock matrix that is once again dominated by K-feldspar (see staining of offcut). This fraction has a grain size of < 0.01 mm and is moderately to heavily dusted with fine grained illite that forms a lensed and wavy discontinuous foliation. Therefore the illite has a rather uneven distribution.

The sample has undergone minor brittle fracture and development of narrow joints marked by patchy granular carbonate ± subordinate chlorite ± illite. Narrow tension microfractures also are filled with granular carbonate. Still other narrow discontinuous microfractures are dominated by aggregates of extremely fine grained illite.

The sample may be identified as a partly selectively altered, foliated and deformed, unsorted crystal-rich and once-vitric tuff of acidic volcanic primary composition. . It is cut by narrow tension fracture-located veinlets and sparse joints filled with carbonate ± chlorite while others contain mainly illite.

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Petrological examination of four percussion chip samples from holes 1, 9, 10 and 11, near Williamsdale, NSW.

Report No: R7/90/1113

4 November 1998

For: Don Reed and Associates Pty Ltd

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SUMMARY and CONCLUSIONS

Four samples of drill chips from percussion drill holes 1, 9, 10 and 11 represent material for a proposed hard rock quarry at Williamsdale, NSW.

This rock type is essentially similar in all four drill holes. It is an unsorted crystal/?vitric tuff that contains material from a coarsely quartz-plagioclase-K-feldspar-biotite porphyritic acidic (?rhyodacitic) volcanic source. (It is not a rhyodacite volcanic flow rock as described in a previous report). Because it is a pyroclastic rock and not a volcanic flow rock, it may have a variable composition due to variable proportions of primary volcanic lithic and crystal fragments.

The rock has undergone strong but mainly selective alteration. Primary plagioclase is albitised and clouded with abundant fine grained illite (finer grained than sericite). It also contains a rather variable proportion of matrix-located illite that defines a wavy foliation (produced by moderate tectonic deformation).

The samples also contain patchy chlorite, most of which selectively replaces previous phenocrystic biotite. Chlorite also is a minor component in the fine grained rock matrix fraction. Minor patchy alteration is to carbonate, epidote and sphene. In addition, traces of sulphides are preserved.

The rock chips are cut by narrow discontinuous veins, as well as fracture- or joint-located veinlets. It is difficult to ascertain from the present rock chip samples, the density of veining throughout the rock mass. The present four samples show variation in vein mineralogy. All are cut by veins of quartz- carbonate with variable proportions of zeolite (a mineral that degrades readily). Minor epidote is present within some veins of PDH 1 (base), and PDH10, while prehnite also is developed in PDH 10.

In spite of about 35% of hydrous secondary minerals, particularly illite and chlorite, as well as patchy carbonate, the rock chips in all four samples are tough and compact. The reason for this is likely to be the presence of fine grained (microgranular) K-feldspar (see staining of rock chip offcuts), together with albite ± quartz throughout the exceptionally fine grained rock matrix fraction. The trails of fine grained illite, particularly defining the wavy foliation, generally are 'contained' within this felsic fraction. In addition, chlorite also is 'contained' mainly within selectively altered, once-phenocrystic biotite crystal sites. The wavy discontinuous foliation is not penetrative, and the rock does not necessarily split along the foliation direction.

An overall very approximate average mineralogy for all the rock chip samples could be as follows; quartz 30%; albite 20%; K-feldspar 12%; illite 20%; chlorite 12%; carbonate 3%; sphene-leucoxene 3%; and accessory oxide apatite, zircon, sulphides, zeolite, hematite and prehnite.

SUMMARY TABLE

SAMPLE NUMBER	ROCK TYPE	PRIMARY MINERALOGY	SECONDARY MINERALOGY	VEIN MINERALOGY
PDH 1 (Base)	Partly selectively altered and weakly foliated (deformed), unsorted crystal/?vitric tuff that contains material from a coarsely quartz-plagioclase-K-feldspar-biotite porphyritic acidic volcanic source.	Qtz, pl, Kfs, bi, ox, zr, ap.	Ab, ill, cc, chl, sp-lx, ep, ill-chl and/or sm.	Qtz, cc, ?Kfs.
PDH 9	Selectively altered, partly deformed and foliated, unsorted crystal/?vitric tuff that contains material from a coarsely quartz-plagioclase-K-feldspar-biotite porphyritic acidic volcanic source.	Qtz, pl, Kfs (bi), ox, zr, ap.	Ab, ill, chl, sp, (ill-chl) cc, he, (More ill than PDH 1), sp-lx, (minor sulphides) (ep).	Qtz, cc, he, ze, ± Kfs. Cc, qtz.
PDH 10	Selectively altered, weakly foliated and deformed, unsorted crystal/?vitric tuff that is cut by irregular narrow veins and vein-like patches.	Qtz, pl, Kfs (bi), ox, zr, ap.	Ab, chl, ill, cc, ep, sp-lx.	Qtz, pr, cc, ep ± Kfs ± ze.
PDH 11	Selectively altered, foliated and veined unsorted crystal/?vitric tuff, that contains material from a coarsely quartz-plagioclase-K-feldspar-biotite porphyritic acidic volcanic source.	Qtz, pl, Kfs, (Kfs-qtz intergrowth) (bi), ox, ap, zr.	Ab, ill, chl, cc, ep, sp-lx.	Qtz, cc, ze, Cc, qtz.

Abbreviations: ab = albite, ap = apatite, bi = biotite, cc = carbonate, chl = chlorite, ep = epidote, he = hematite, ill = illite, Kfs = K-feldspar, lx = leucoxene, ox = oxide, pl = plagioclase, pr = prehnite, qtz = quartz, sm = smectite, sp = sphene, ze = zeolite, zr = zircon.

Sample No. PDH 1 (Base)

Rock Type Partly selectively altered and weakly foliated (deformed), unsorted crystal/?vitric tuff that contains material from a coarsely quartz-plagioclase-K-feldspar-biotite porphyritic acidic volcanic source.

Hand Specimen This is a drill chip sample in which most chips lie within the size range 2 mm up to 8 mm and are narrow and platy. They comprise a fine grained pale to mid grey lithology with conspicuous medium to rather coarse grained mid to dark grey crystal sites. K-feldspar staining gave moderate to patchy strong positive results for sparse crystal sites and also for patches of fine grained rock matrix fraction (?fragments within the drill chips).

Thin Section The drill chips represented in this section comprise a single lithology. It is an unsorted crystal/vitric tuff that contains ~ 20% of mainly broken and angular once-phenocrystic fragments, some of which reach 3 mm grain size. Poorly defined fine grained (once glassy) and porphyritic volcanic lithic fragments account for at least another 30% of the relevant section area. The recognisable crystal- and lithic fragments are set throughout a poorly defined, exceptionally fine grained rock matrix fraction, that once could have contained much finer grained, once-glassy volcanic lithic fragments and ?shards. Primary mineralogy is partly- to entirely obscured by selective alteration, moderate deformation and some veining.

The crystal fraction comprises ~ 30% quartz, 40% plagioclase, 20% K-feldspar, and 10% of altered mafic phases and oxides.

The quartz grains invariably are medium to coarse grained and retain some magmatically rounded and embayed shapes, but are mainly angular and broken and even shattered in situ. They show strain shadows, curving narrow fractures filled with fine grained illite-carbonate and some contain trails of fluid inclusions. They also enclose sparse, small inclusions of chlorite-altered ?biotite, rare unaltered biotite and rare traces of ?sulphides. Plagioclase cleavage fragments generally are < 1.5 mm grain size and invariably are converted to albite that is moderately to heavily dusted with fine grained illite and patchy carbonate. A little primary calcic plagioclase could remain. The once-phenocrystic K-feldspar forms sparse crystals up to 2 mm that are quite strongly perthitic. These contain areas of homogeneous feldspar that are still high temperature sanidine, (low negative optic axial angle). Mafic crystal sites are dominated by ragged biotite flakes that are now deformed and converted to chlorite-illite with clouded sphene-leucoxene marking previous cleavage traces. These sites also contain traces of epidote. Accessory oxide granules also are converted to aggregates of fine grained sphene-leucoxene, while relict small crystals of apatite and zircon are accessory primary phases.

Poorly defined volcanic lithic fragments reach ~ 5 mm in the present section and some are coarsely plagioclase porphyritic, with a mottled and devitrified, once ?glassy groundmass fraction. The mottled granular devitrification reaches 0.2 mm grain size, and now comprises irregular interlocking domains of K-feldspar ± albite, that is heavily dusted with exceptionally fine grained illite. Other lithic fragments are themselves fragmental.

The angular and broken crystal- and lithic fragments are set throughout an exceptionally fine grained (< 0.01 mm) rock matrix fraction, that comprises patchy microgranular K-feldspar ± ?albite (see staining of offcut), that is moderately to very heavily clouded with illite, subordinate chlorite, and minor patchy carbonate. It also contains irregularly distributed clusters of sphene-leucoxene granules that replace previous titanian oxides. Some of the alteration could comprise interlayer illite-chlorite or smectite. In some domains illite-smectite ± chlorite define a rather wavy discontinuous lensed foliation.

The sample is cut by narrow veinlets (generally < 0.5 mm) that are irregular and discontinuous and also occupy planar joints or fractures. The contain granular quartz, carbonate and minor ?K-feldspar ± epidote. One carbonate vein that reaches 2 mm across, contains coarse granular carbonate and minor fine grained aggregates of prismatic ?zeolite (up to 0.3 mm long prisms) that are developed along one margin of the vein.

Rock chips in this sample comprise partly selectively altered and weakly foliated (deformed), unsorted crystal/?vitric tuff that contains material from a coarsely quartz-plagioclase-K-feldspar-biotite porphyritic acid volcanic source.

Sample No.	PDH 9
Rock Type	Selectively altered, partly deformed and foliated unsorted crystal/?vitric tuff that contains material from a coarsely quartz-plagioclase-K-feldspar-biotite porphyritic acid volcanic source.

Hand Specimen Pale to mid grey fine grained drill chips comprise this sample that are mainly very angular and < 8 mm long. The drill chips contain conspicuous medium to coarse grained pale grey feldspar crystal sites and glassy quartz. K-feldspar staining gave strong patchy positive results, mainly for the rock matrix fraction of many chips, and also for sparse medium grained crystal sites.

Thin Section This sample basically is the same lithology as sample PDH 1 (Base). It is an unsorted crystal/vitric tuff that contains material from a strongly quartz-plagioclase-K-feldspar-biotite porphyritic acidic volcanic source. Unsorted crystal fragments once again account for ~ 20% of the relevant section area and vary from fine grained angular chips up to almost 3 mm grain size. Very poorly defined once ?glassy volcanic lithic fragments once could have account for a further 40% of the relevant sample and the remainder comprises a fine grained rock matrix fraction of smaller broken crystal- and lithic-fragments, as well as ?glass shards, none of which are preserved.

The broken phenocrystic fraction comprises ~ 30% quartz, 50% plagioclase, 10% K-feldspar and ~ 10% of degraded biotite flakes.

Some quartz crystals retain clear magmatically rounded and resorbed shapes, but most are angular and broken, or else shattered in situ. Large crystals (one of which reaches 3 mm), show strong strain shadows, and curving narrow microfractures filled with illite-chlorite. Plagioclase cleavage fragments, again are albitised with moderate to intense clouding with fine grained illite, patchy carbonate and minor red-brown dusty hematite. Development of fine grained illite appears to be more intense in this sample than the previous sample PDH 1 (Base). Sparse angular cleavage fragments of K-feldspar are weakly perthitic and variously clouded with dusty hematite. Sites of sparse biotite flakes mainly are < 1 mm, but one of these reaches nearly 3 mm. No primary igneous biotite remains as such, and these sites now are converted to green chlorite and clouded fine grained sphene-leucoxene, as well as ?hematite developed along previous cleavage traces. Clouded sphene-leucoxene also marks sites of previous accessory oxide microphenocrysts and granules throughout the rock matrix fraction. Apatite-zircon and traces of sulphides are accessory.

Outlines of angular fine grained (once glassy) volcanic lithic fragments reach > 3 mm grain size. They are marked by a devitrified granular felsic mosaic with a variable grain size from 0.1 mm up to 0.4 mm. They comprise mosaics of dominant quartz with minor K-feldspar, all of which are dusted with fine grained illite, while elsewhere are fragments that are dominantly feldspar that are equally heavily dusted with illite. The fragments are variously quartz-feldspar-biotite porphyritic.

The abundant fine grained rock matrix fraction in the rock chips retains poor outlines of very fine grained angular feldspathic and once glassy lithic material that is now very heavily clouded with fine grained illite with minor chlorite and dusty granular sphene. Very fine grained illite is more abundant in the rock chips of this sample than in the previous sample PDH 1, where it defines a distinct but wavy and irregular foliation that bends around crystal and lithic fragments. Small aggregates of accessory epidote are an accessory secondary phase.

Several rock chips are cut by substantial veins (mainly < 2 mm across). One of these is a hydrothermal deposit of subhedral prismatic quartz (up to 0.9 mm grain size) with subordinate patchy interstitial carbonate and dusty hematite-clouded zeolite and/or K-feldspar. Elsewhere are discontinuous veins of granular carbonate, intergrown with quartz, or else almost monomineralic quartz that shows partial fine grained recrystallisation and strain shadows.

The sample is a selectively altered, partly deformed and foliated, unsorted crystal/?vitric tuff that contains material from a coarsely quartz-plagioclase-K-feldspar-biotite porphyritic acid volcanic source.

Sample No.	PDH 10
Rock Type	Selectively altered, weakly foliated and deformed, unsorted crystal/?vitric tuff, that is cut by irregular narrow veins and vein-like patches containing assemblages amongst quartz, carbonate, prehnite, zeolite ± K-feldspar ± epidote.

Hand Specimen A rock chip sample that comprises fine grained, mid to pale grey and some yellow-brown oxidised rock chips, that contain medium to coarse grained pale grey and mid grey (feldspar and quartz) crystal sites. K-feldspar staining gave patchy positive results for most rock chips in the fine grained rock matrix fraction and for sparse small crystal sites. The rock chips in this sample are angular and some reach 1 cm long.

Thin Section This is a selectively altered, weakly foliated and veined sample that comprises rock chips of a similar lithology to those characteristic in PDH 1 (Base), and PDH 9. In the present rock chips, there are again developed unsorted angular crystal- and volcanic-lithic-fragments from a coarsely quartz- and feldspar-porphyritic and biotite-microporphyritic acidic volcanic source. Angular crystal fragments vary mainly within the size range 0.15 mm up to 2 mm, but with some crystals reaching > 3 mm grain size. Recognisable lithic fragments also are angular and generally < 3 mm in the present rock chips. The recognisable crystal fraction accounts for ~ 20% of most rock chips but in some the crystal fraction reaches ~ 40%. Angular lithic fragments account for up to 60% of rare rock chips, but mainly comprise < 40%.

The crystal fraction (broken phenocrystic debris), comprises ~ 30% quartz, 50% plagioclase cleavage fragments, 10% K-feldspar cleavage fragments and a further 10% of altered mafic crystal sites and oxides.

Once again phenocrystic quartz is present as angular fragments, as well as some irregularly rounded and magmatically embayed grains. Aggregates (up to 2 mm across) of shattered quartz fragments could represent phenocrysts that are shattered in situ. The coarse grained angular quartz shows distinct strain shadows and curving fractures filled with chlorite ± illite ± carbonate. Plagioclase cleavage fragments are albitised and quite heavily dusted with fine grained illite ± patchy fine grained epidote. Cleavage fragments of K-feldspar are mottled and moderately perthitic. Once again phenocrystic biotite forms ragged deformed flakes that are converted to patchy chlorite ± epidote and clouded sphene-leucoxene. Minor oxide microphenocryst sites also are largely converted to clouded sphene-leucoxene. Small crystals of apatite and zircon are accessory.

Poorly preserved angular lithic fragments comprise some material that is felsic, mottled and devitrified. Irregular interlocking 0.2 mm grains of quartz ± feldspar are quite heavily clouded with dusty illite ± carbonate. These also enclose abundant fine granules of sphene-leucoxene. Elsewhere, recognisable lithic fragments are themselves fragmental, enclosing poorly defined angular albitised plagioclase cleavage fragments subordinate perthitic K-feldspar and small quartz chips. These fragments are heavily clouded with illite, patchy epidote ± sphene.

The rock matrix fraction in most rock chips is not well defined. It has lost finer relict textures, but most likely contained smaller lithic fragments and ?glassy shards. It is now marked by an exceptionally fine grained felsic mosaic (< 0.01 mm grain size), throughout which very fine grained wispy illite forms a wavy foliation. Also present are patches of chlorite, minor epidote and dusty sphene.

The rock chips in this sample are cut by narrow irregular veinlets and fracture-located veins (mainly < 0.8 mm across) that contain granular quartz and aggregates of fine grained prehnite ± carbonate ± epidote. Some veins also contain minor K-feldspar ± zeolite.

The rock chips in this sample may be identified as selectively altered, weakly foliated and deformed, unsorted crystal/?vitric tuff, that is cut by irregular narrow veins and vein-like patches containing assemblages amongst quartz, carbonate, prehnite, zeolite ± K-feldspar ± epidote.

Sample No.	PDH 11
Rock Type	Unsorted crystal/?vitric tuff that contains material from coarsely quartz-plagioclase-K-feldspar-biotite porphyritic

acidic volcanic source. The rock chips show substantial but mainly selective alteration and weak to moderate development of a foliation defined by fine grained illite. Some rock chips are cut by narrow veinlets.

Hand Specimen Rock chips in this sample are fine grained, pale- to mid grey and contain abundant medium to coarse grained, mid to dark grey sites of quartz and feldspar. K-feldspar staining gave patchy positive results for most of the fine grained rock matrix fraction and also for sparse medium grained crystal sites. The angular platy rock chips reach 1 cm long.

Thin Section As in previous samples the present rock chips comprise unsorted crystal/?vitric tuff from a coarsely quartz-feldspar- and biotite-porphyritic acid volcanic source. The coarse broken phenocrysts and poorly defined angular once-glassy volcanic lithic fragments have an uneven distribution, and are set throughout an abundant fine grained, altered and weakly foliated rock matrix fraction. The crystal fragments have a variable grain size that reaches more than 3 mm across but mainly crystal fragments are < 1.5 mm across. Barely recognisable once glassy but now devitrified and altered volcanic lithic fragments, also reach > 3 mm across.

The crystal fraction of these rock chips comprises ~ 40% quartz, 40% plagioclase, 10% K-feldspar, and 10% of degraded mafic crystal sites, oxides and accessory apatite and zircon.

Quartz again forms sparse very large crystals (up to 4 mm across in the present section), that retain some subhedral and magmatically rounded and embayed crystal shapes, but mainly angular and broken chips are present. Some larger crystals are shattered in situ with distinct strain shadows and some fine recrystallisation along incipient microfractures. Some irregular narrow fractures are filled with illite ± chlorite ± carbonate. Cleavage fragments of plagioclase invariably are albitised and quite heavily dusted with fine grained illite ± carbonate. Rare patches of fine grained granular epidote are accessory. Subordinate K-feldspar cleavage fragments are mottled and perthitic and rarely form micrographic intergrowths with quartz. Deformed and degraded sites of previous ragged biotite flakes now contain aggregates of chlorite, patchy clouded sphene-leucoxene, and epidote ± carbonate.

Volcanic lithic fragments are poorly defined and some are flattened parallel to the weak foliation. Several retain mottled textures of granular devitrification in which interlocking irregular but equant felsic domains commonly reach ~ 0.06 mm across. This felsic, once-glassy material is clouded with abundant fine grained wispy illite. Some poorly defined, once-glassy volcanic lithic fragments are themselves fragmental.

The rock matrix fraction again is exceptionally fine grained (< 0.01 mm grain size), and forms a microgranular mosaic with somewhat variable K-feldspar (see staining of offcut). This fraction is moderately to heavily clouded with exceptionally fine grained illite, which in some domains forms a wavy foliation that bends around the relatively coarse broken crystal and lithic fragments. The rock matrix fraction also contains small patches of chlorite, carbonate, clouded epidote and sphene-leucoxene granules.

Some rock chips in this sample are cut by ?hydrothermal veins up to ~ 0.8 mm across. These are dominated by partly recrystallised granular quartz with minor interstitial carbonate and zeolite. Elsewhere are narrow (~ 0.2 mm across) veinlets containing fine granular carbonate and minor quartz, while still other veinlets (~ 0.3 mm across) contain almost equally abundant prismatic to granular quartz, interstitial carbonate and minor interstitial zeolite (this reaches 0.3 mm grain size). Unlike the previous sample, there is no vein-located prehnite.

The rock chips in this sample, as in the previous samples, comprise unsorted crystal/?vitric tuff that contains material from coarsely quartz-plagioclase-K-feldspar-biotite porphyritic acidic volcanic source. The rock chips show substantial but mainly selective alteration and weak to moderate development of a foliation defined by fine grained illite. Some rock chips are cut by narrow veinlets.

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Petrological examination of three drill core samples from DDH5, near Williamsdale, NSW.

Report No: R7/90/1120

3 January, 1999

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SUMMARY and CONCLUSIONS

Three drill core samples from DDH5 represent material at 17.5 m, 18.5 m and 34.2 m. The three samples comprise unsorted crystal/once-vitric tuff that contains material from a very coarsely quartz-porphyritic and medium to coarsely plagioclase-K-feldspar-biotite-porphyritic acidic volcanic source.

The samples show only minor variation in primary mineralogy. A very approximate overall average modal mineralogy is as follows; quartz ~ 25%-30%; albite 15%-20%; K-feldspar 5%-10%; illite 10%-20%; chlorite 5%-10%; carbonate 1%-3%; zeolite 0%-3%; sphene-leucoxene ~ 3%; and accessory apatite, zircon, and hematite.

The samples have undergone strong selective alteration, similar to that described for previous samples from percussion drill holes 1, 9, 10 and 11. Primary plagioclase is albitised and clouded by fine grained illite. Illite also is developed in the abundant fine grained rock matrix fraction where it defines a distinct wavy foliation due to moderate tectonic deformation.

Chlorite selectively replaces once-phenocrystic biotite flakes, and therefore forms discrete patches that are essentially 'contained' in the fine grained feldspathic and illite-rich rock matrix fraction. Minor chlorite also forms fine grained foliated patches in the rock matrix fraction. Carbonate, that is mainly calcite, partly fills microfracture-located veinlets.

Fracture-located veinlets are characteristic in all samples, and vein-located calcite is most abundant in DDH5 17.5, where it accounts for almost 5% of the section area. Zeolite-bearing joint- or fracture-located veins are present in DDH5 18.5 m and particularly 34.2 m. In the latter, a branching zeolite-(carbonate) vein reaches 0.6 mm across, and accounts for about 2%-3% of the present section area.

The previous report, R7/90/1113, indicates that this lithology is tough and compact due to an abundant, very fine grained quartzofeldspathic rock matrix fraction, in spite of the presence of contained illite and patchy chlorite.

Nevertheless, the present samples show variable, but minor, microfracture-located calcite and zeolite, that would degrade readily under normal conditions of near-surface weathering. The rock also should mechanically break along joints and fractures marked by the zeolite-calcite-bearing veins.

Sample No. DDH5 17.5 m

Rock Type Partly selectively altered, distinctly foliated (deformed), unsorted crystal/once-vitric tuff, that contains material from a coarsely quartz-plagioclase-K-feldspar-biotite porphyritic acid volcanic source.

Hand Specimen A fine grained, mid green-grey drill core sample that contains abundant medium and coarse grained pale grey quartz, and fewer pale brown ?feldspar crystal sites. The sample is cut by several narrow branching pale grey microfractures and discontinuous veinlets. One discontinuous white veinlet reaches 5 mm across and reacts strongly with cold dilute HCl, indicating calcite. Staining for K-feldspar gave positive results for sparse crystal sites and rare patches and gives patchy positive results for the fine grained rock matrix fraction.

Thin Section This unsorted volcaniclastic rock contains abundant medium and coarse grained broken crystal fragments and clearly is tuffaceous. It contains at least 30% of angular crystal fragments that vary from < 0.2 mm up to > 4 mm grain size. Subordinate lithic fragments possibly account for about 15% of the section area and rarely reach more than 4 mm across. The remaining fine grained rock matrix fraction possibly contained glassy shards and fragments that are now obscured by alteration foliation and veining.

The crystal fraction is almost equally dominated by quartz and feldspar with sparse coarse sites of altered and deformed, once-phenocrystic biotite flakes. Phenocrystic quartz invariably is coarse grained, distinctly magmatically rounded and embayed. Some crystals are shattered in situ and most show brittle fracture, strain shadows and narrow zones of fine grained recrystallisation due to deformation. Most quartz grains retain trails of fluid and dusty solid inclusions. Plagioclase cleavage fragments dominate the feldspar and invariably are converted to albite that is moderately to heavily dusted with fine grained illite and traces of carbonate. K-feldspar cleavage fragments are fractured but relatively little-altered. They are strongly perthitic and quite heavily dusted with hematite which is responsible for the red-brown colour of the hand specimen. Sites of ragged deformed biotite flakes reach more than 3 mm grain size. These are converted to chlorite that is partly oxidised, and intergrown with aggregates of sphene granules. Apatite and zircon are accessory. Also accessory are oxide granules that are converted to aggregates of fine grained sphene-leucoxene, indicating a titanian parent.

Poorly defined <u>volcanic lithic fragments</u> up to 4 mm across, commonly comprise glomeroporphyritic aggregates of illite-clouded albitised plagioclase and chlorite-altered biotite flakes, set in a meagre matrix of foliated illite-sericite.

The exceptionally fine grained (< 0.01 mm) <u>rock matrix fraction</u> now is finely recrystallised and distinctly foliated. The wavy foliation bends around coarse crystal and lithic fragments, and is defined by branching trails of wispy illite ± oxidised chlorite. The fine grained illite is intergrown with equally fine grained albite ± K-feldspar and trails of dusty sphene granules.

The sample has undergone later tensional brittle fracture in several different directions. Some narrow tension-fracture located <u>veinlets</u> of granular carbonate-quartz are discontinuous, and terminated against narrow vein-like fracture zones also containing fine grained granular recrystallised quartz and partly recrystallised carbonate. These zones are typically stained by limonitic oxides. Upon crushing this rock should break along fracture-located veinlets.

The sample comprises partly selectively altered, distinctly foliated (deformed), unsorted crystal/once vitric tuff, that contains material from a coarsely quartz-plagioclase-K-feldspar-biotite porphyritic acid volcanic source.

<u>Sample No.</u>	DDH5 18.5 m
<u>Rock Type</u>	Selectively altered, partly deformed and foliated, unsorted crystal/once-vitric tuff, that contains material from a coarsely quartz-plagioclase-K-feldspar-biotite porphyritic acid volcanic source. It is cut by a network of late branching narrow fracture-located veinlets that contain granular zeolite (mainly laumontite).

Hand Specimen A fine grained mid- to pale green-grey drill core sample that contains abundant poorly defined medium and coarse grained pale grey and mid grey crystal sites. The sample is cut by sets of conspicuous narrow ?brittle-fracture located veinlets that are pale pink (?zeolite-bearing). K-feldspar staining gave strong positive results for sparse crystal sites, and patchy positive results for the fine grained rock matrix fraction.

Thin Section This sample is a similar lithology to that described in the previous sample DDH5 17.5 m. It is also an unsorted crystal/once-vitric tuff, that contains material from a coarsely quartz-plagioclase-K-feldspar biotite porphyritic acidic volcanic source. Broken crystal fragments have a variable grain size up to 6 mm across, and these account for about 35% of the present section area. Shadowy outlines of altered once-glassy volcanic lithic fragments, could account for a further 15% of the section area. These mainly are < 1 mm grain size.

The crystal fraction is dominated by exceptionally coarse grained quartz phenocrysts that retain subhedral and deeply magmatically embayed (resorbed) shapes. Most coarse grained crystals are broken, while finer grained quartz comprises angular chips. The quartz grains show distinct strain shadows, narrow fractures and zones of recrystallisation. Most quartz crystals contain trails of dusty solid and fluid inclusions. Subordinate and smaller feldspar crystal sites are dominated by albitised cleavage fragments of plagioclase that are quite heavily dusted with fine grained illite and patchy carbonate. Sparse cleavage fragments are strongly perthitic K-feldspar that is partly clouded by dusty hematite ± carbonate. Biotite is not preserved in ragged deformed sites of flakes that are now converted to partly oxidised chlorite, together with small clusters of sphene granules. Small crystals of apatite and zircon are accessory. Also accessory are sparse sites of titanian oxides now converted to dense aggregates of fine grained sphene-leucoxene.

Once-glassy volcanic lithic fragments, with sparse albitised plagioclase phenocrysts, now are converted to mottled devitrified aggregates of clouded albite and abundant illite.

The fine grained rock matrix fraction once could have been glassy, but now comprises a felsic mosaic that is heavily dusted with and cut by branching trails of illite that define the wavy foliation. Local patches of carbonate and sphene are also developed.

The sample is cut by sparse narrow discontinuous tension fractures mainly filled with carbonate (calcite) and subhedral vein quartz. Later fractures and veins, however, are the pale pink branching and discontinuous ?fracture-located veins of the hand specimen. One of these, represented in the present section, reaches 0.7 mm across. It comprises a granular aggregate of zeolite (most likely laumontite), with an average grain size of about 0.2 mm. The laumontite is moderately to quite heavily dusted with red-brown hematite, which is responsible for the pink colour of these veins in the hand specimen. The laumontite is also intergrown with minor patchy carbonate and quartz.

The sample is a selectively altered, partly deformed and foliated, unsorted crystal/once-vitric tuff, that contains material from a coarsely quartz-plagioclase-K-feldspar-biotite porphyritic acid volcanic source. It is cut by a network of late branching narrow fracture-located veinlets that contain granular zeolite (mainly laumontite).

Sample No.	DDH5 34.2 m
Rock Type	Selectively altered, foliated and deformed, unsorted crystal/once-vitric tuff that is cut by narrow tension-fracture-located veinlets of granular quartz-carbonate, and later narrow joint- or fracture-located veinlets containing abundant zeolite ± carbonate ± quartz.

Hand Specimen A fine grained mid green-grey drill core sample, that contains sparse coarse grained pale grey ?quartz crystal sites and rare pink-brown feldspar crystal sites. The sample is cut by several discontinuous branching pale grey veinlets that react with cold dilute HCl indicating calcite. The drill core is broken along somewhat planar ?joint or fracture-located veins that contain abundant pale pink zeolite.

K-feldspar staining gave positive results for some coarse crystal sites, and also for abundant diffuse patches in the fine grained rock matrix fraction.

Thin Section Unsorted crystal/once-vitric fragmental texture once again is characteristic in this tuffaceous rock. It has undergone selective alteration, weak foliation and veining that largely obscures finer relict textures and mineralogy. Angular crystal fragments account for about 30% of the present section area, and vary from < 0.1 mm up to more than 4 mm grain size. Poorly defined lithic fragments reach 2 mm across, and comprise once-porphyritic and once-glassy but now mottled and devitrified once-glassy volcanic material. The poorly defined fine grained once-glassy rock matrix fraction now is altered and foliated.

The unsorted crystal fraction comprises approximately equal major proportions of quartz and feldspar. The once phenocrystic quartz is broken and angular with some intact subhedral and magmatically rounded or embayed outlines. The once phenocrystic quartz shows distinct strain shadows and brittle fractures with zones of local fine recrystallisation. The quartz encloses conspicuous trails of dusty solid and fluid inclusions. Abundant cleavage fragments of albitised plagioclase are very heavily dusted with fine grained illite. Sparse phenocrystic K-feldspar, on the other hand, lacks illite clouding but is distinctly perthitic with patches of dusty hematite clouding. Deformed and selectively altered mafic crystal sites retain shapes of previous biotite flakes. These are converted to chlorite and oxidised chlorite with patches of microgranular sphene. Accessory crystal sites are fine grained apatite, zircon and titanian oxides, also converted to fine grained clouded sphene-leucoxene.

The sample contains poorly defined once glassy volcanic lithic fragments, mainly < 2 mm across. Although once glassy, these are now converted to a mottled quartz-bearing felsic mosaic that is clouded with dusty illite. Some of the poorly defined lithic fragments enclose angular cleavage fragments of albitised plagioclase, suggesting that some lithic fragments are themselves fragmental (tuffaceous).

The poorly defined rock matrix fraction is fine grained felsic and contains abundant illite that defines the weak foliation and forms wavy trails around coarse crystal and lithic fragments.

The sample is cut by several sets of discontinuous veinlets. A set of subparallel narrow discontinuous tension microfractures contains aggregates of granular quartz with minor K-feldspar and carbonate. These are cut at a high angle by a somewhat wider (up to 0.4 mm) discontinuous veins that also contain granular quartz and carbonate (mainly calcite). Still later ?joint or fracture-located veins (the pink veinlets of the hand specimen), contain granular zeolite (once again ?laumontite), together with carbonate (calcite), and minor quartz.

The sample may be described as a selectively altered, foliated and deformed, unsorted crystal/once-vitric tuff that is cut by narrow tension-fracture-located veinlets of granular quartz-carbonate, and later narrow joint- or fracture-located veinlets containing abundant zeolite ± carbonate ± quartz.

Applied Petrographic Services
2a Railway Avenue, Stanmore, NSW 2048, Australia
P.O.Box 257
Strawberry Hills 2012
Ph/Fax (02) 9516 4808

CLIENT: TOTAL CARE ENGINEERING MAINT.
255 CANBERRA AVENUE
FYSHWICK, ACT 2609
APS REPORT NO.: M 1209
DATE: 20.2.99
ATTENTION: DARRYL KNOWLES
SAMPLE DETAILS: WILLIAMSDALE QUARRY, DDH 7; 18.0 metres

PETROGRAPHIC ANALYSIS

MINERAL	FORM	VOL. %
QUARTZ	Poorly sorted. Coarse grained, some medium, fine and very coarse (max. 4.5mm, average approx. 0.8mm) detrital crystal fragments, and as very fine grained anhedra in the matrix (0.03mm). Some crystal fragments are rounded, some strongly embayed, but also some very angular grains. Generally slightly to distinctly elongate. Most grains show intense strain shadows, are frequently fractured, some mylonitised.	23
PLAGIOCLASE	Medium to coarse grained, rounded to angular detrital crystal fragments up to 2.5mm, average approx. 0.5mm. Also as very fine grained anhedra in the matrix. Generally moderate alteration.	30
K FELDSPAR	Medium to coarse grained detrital crystal fragments, and as very fine grained anhedra in the matrix.	23
OPAQUES	Mainly fine grained TiO_2, minor partly leucoxenised ilmenite, and <1% pyrite.	1
CHLORITE/ CLAY MINERALS	Very fine grained flakes in the matrix, also partly altering plagioclase, and aggregates (up to 2mm) pseudomorphing biotite flakes.	18
ACCESSORY MINERALS	Very fine grained crystals of zircon, apatite, and epidote.	<1
CARBONATES	Fine grained, generally elongate secondary crystals in pressure shadows, and altering plagioclase.	5

Number of points counted: 508
Date counted: 18.2.99

ROCK TEXTURE: Detrital. Poorly sorted, coarse to very fine grained. Mainly consisting of crystal fragments in a very fine grained felsic and chlorite/clay mineral matrix. Also rare sandstone fragments. An indistinct bedding is defined by elongate detrital quartz and biotite. Slight grain size and compositional variations in the matrix define shapes suggesting that this may originally have contained volcanic glass, later devitrified to very fine grained felsics/clays.

ROCK TYPE: CRYSTAL/?VITRIC TUFF

J. McNULTY
PETROLOGIST

CLIENT: TOTAL CARE ENGINEERING MAINT.
255 CANBERRA AVENUE
FYSHWICK, ACT 2609

APS REPORT NO.: M 1209

DATE: 20.2.99

ATTENTION: DARRYL KNOWLES

SAMPLE DETAILS: WILLIAMSDALE QUARRY, DDH 7; 18.0 metres

ALKALI SILICA REACTIVE MATERIALS
AS LISTED IN THE JOINT PUBLICATION
CEMENT & CONCRETE ASSOCIATION OF AUSTRALIA T47
& STANDARDS AUSTRALIA HB79-1996

Section 2.4 Evaluation of Reaction Potential by Petrology

Potential for Substantial AAR

Minor amounts of siliceous glass, opal, chalcedony, cryptocrystalline quartz, tridymite, or cristobalite	NOT DETECTED
Moderate amounts of heavily strained quartz or fine chert or microcrystalline quartz within acid rock	**Quartz shows intense strain shadows**
Major amounts of moderately strained quartz	NOT DETECTED

Further testing should be undertaken to verify this classification

Potential for Mild or Slow AAR

Rare siliceous glass, opal, chalcedony, cryptocrystalline quartz, tridymite, or cristobalite	NOT DETECTED
Minor amounts of heavily strained quartz or fine chert or microcrystalline quartz within acid rock	**3% microcrystalline quartz in the matrix**
Minor to moderate amounts of moderately strained quartz	NOT DETECTED

Further testing should be undertaken to verify this classification

The rock contains moderate amounts of heavily strained quartz (and minor microcrystalline quartz). This has the potential for substantial AAR. Further testing is necessary to confirm this.

J. McNULTY
PETROLOGIST

CLIENT: TOTAL CARE ENGINEERING MAINT.
255 CANBERRA AVENUE
FYSHWICK, ACT 2609

APS REPORT NO.: M 1209

DATE: 20.2.99

ATTENTION: DARRYL KNOWLES

SAMPLE DETAILS: WILLIAMSDALE QUARRY, DDH 7; 18.0 metres

PETROGRAPHIC ANALYSIS FOR ALKALI REACTIVITY
METHOD: ASTM C295-90 (By thin section and point count)

ALKALI SILICA REACTIVE MATERIALS

OPAL	NOT DETECTED
CHERT	NOT DETECTED
TRIDYMITE/CRISTOBALITE	NOT DETECTED
MICROCRYSTALLINE QUARTZ	**3%**
STRAINED/METAMORPHOSED QUARTZ	**MODERATE AMOUNTS PRESENT**
MYLONITISED QUARTZ	**SOME PRESENT**
ACID TO INTERMEDIATE GLASSY TO CRYPTOCRYSTALLINE ROCKS	NOT DETECTED
SYNTHETIC GLASS	NOT DETECTED
SILICA RICH ROCKS	**23% QUARTZ**

ALKALI SILICATE REACTIVE MATERIALS

GREYWACKE/ARGILLITE/PHYLLITE	NOT DETECTED
ZEOLITES	NOT DETECTED

ALKALI CARBONATE REACTIVE MATERIAL

ARGILLACEOUS DOLOMITIC LIMESTONE	NOT DETECTED
CALCAREOUS DOLOMITE	NOT DETECTED

J. McNULTY
PETROLOGIST

CLIENT: TOTAL CARE ENGINEERING MAINT.
255 CANBERRA AVENUE
FYSHWICK, ACT 2609

APS REPORT NO.: M 1209

DATE: 20.2.99

ATTENTION: DARRYL KNOWLES

SAMPLE DETAILS: WILLIAMSDALE QUARRY, DDH 7; 18.0 metres

PETROGRAPHIC EXAMINATION FOR DELETERIOUS MATERIALS
METHOD: ASTM C295-90 (By thin section and point count)

SOLUBLE SULPHATES	NOT TESTED
SULPHIDES	**<1% PYRITE**
EXPANSIVE CLAY MINERALS	NOT TESTED*
ALTERED / WEATHERED MATERIAL	**ALTERATION OF PLAGIOCLASE**
ORGANIC MATERIAL	NOT DETECTED
CINDERS/CLINKER/COAL ASH	NOT DETECTED
MAGNESIUM OXIDE	NOT DETECTED
CALCIUM OXIDE	NOT DETECTED
FLAKY (CRUSHED) PARTICLES	NOT DETECTED
MICA	NOT DETECTED
ZEOLITES	NOT DETECTED

***Staining indicated that minor amounts of the chlorite/clay minerals in the rock may be expansive. X-ray diffraction would be required to confirm this.**

J. McNULTY
PETROLOGIST

CLIENT: TOTAL CARE ENGINEERING MAINT.
255 CANBERRA AVENUE
FYSHWICK, ACT 2609

APS REPORT NO.: M 1209

DATE: 20.2.99

ATTENTION: DARRYL KNOWLES

SAMPLE DETAILS: WILLIAMSDALE QUARRY, DDH 7; 42.6 metres

PETROGRAPHIC ANALYSIS

MINERAL	FORM	VOL. %
QUARTZ	Poorly sorted. Coarse grained, some medium, fine and very coarse (max. 4.5mm, average approx. 1mm) detrital crystal fragments, and as very fine grained anhedra in the matrix (0.03mm). Some crystal fragments are rounded, some strongly embayed, but also some very angular grains. Generally slightly to distinctly elongate. Most grains show intense strain shadows, are frequently fractured, some mylonitised.	23
PLAGIOCLASE	Medium to coarse grained, rounded to angular detrital crystal fragments up to 3.5mm, average approx. 0.8mm. Also as very fine grained anhedra in the matrix. Generally moderate alteration.	33
K FELDSPAR	Medium to coarse grained detrital crystal fragments, and as very fine grained anhedra in the matrix.	21
OPAQUES	Mainly fine grained TiO_2, minor partly leucoxenised ilmenite, and <1% pyrite.	2
CHLORITE/ CLAY MINERALS	Very fine grained flakes in the matrix. also partly altering plagioclase, and aggregates (up to 3mm) pseudomorphing biotite flakes.	17
ACCESSORY MINERALS	Very fine grained crystals of zircon, apatite, and 1% epidote.	1
CARBONATES	Fine grained, generally elongate secondary crystals in pressure shadows, thin veins, and altering plagioclase.	3

Number of points counted: 519

Date counted: 18.2.99

ROCK TEXTURE: Detrital. Poorly sorted, coarse to very fine grained. Mainly consisting of crystal fragments in a very fine grained felsic and chlorite/clay mineral matrix. An indistinct bedding is defined by elongate detrital quartz and biotite. Slight grain size and compositional variations in the matrix define shapes suggesting that this may originally have contained volcanic glass, later devitrified to very fine grained felsics/clays.

ROCK TYPE: CRYSTAL/?VITRIC TUFF

J. McNULTY
PETROLOGIST

CLIENT: TOTAL CARE ENGINEERING MAINT. **APS REPORT NO.:** M 1209
255 CANBERRA AVENUE
FYSHWICK, ACT 2609 **DATE:** 20.2.99
ATTENTION: DARRYL KNOWLES
SAMPLE DETAILS: WILLIAMSDALE QUARRY, DDH 7; 42.6 metres

ALKALI SILICA REACTIVE MATERIALS
AS LISTED IN THE JOINT PUBLICATION
CEMENT & CONCRETE ASSOCIATION OF AUSTRALIA T47 & STANDARDS AUSTRALIA HB79-1996

Section 2.4 Evaluation of Reaction Potential by Petrology

Potential for Substantial AAR

Minor amounts of siliceous glass, opal, chalcedony, cryptocrystalline quartz, tridymite, or cristobalite	NOT DETECTED
Moderate amounts of heavily strained quartz or fine chert or microcrystalline quartz within acid rock	**Quartz shows intense strain shadows**
Major amounts of moderately strained quartz	NOT DETECTED

Further testing should be undertaken to verify this classification

Potential for Mild or Slow AAR

Rare siliceous glass, opal, chalcedony, cryptocrystalline quartz, tridymite, or cristobalite	NOT DETECTED
Minor amounts of heavily strained quartz or fine chert or microcrystalline quartz within acid rock	**2% microcrystalline quartz in the matrix**
Minor to moderate amounts of moderately strained quartz	NOT DETECTED

Further testing should be undertaken to verify this classification

The rock contains moderate amounts of heavily strained quartz (and minor microcrystalline quartz). This has the potential for substantial AAR. Further testing is necessary to confirm this.

J. McNULTY
PETROLOGIST

CLIENT: TOTAL CARE ENGINEERING MAINT.
255 CANBERRA AVENUE
FYSHWICK, ACT 2609

APS REPORT NO.: M 1209

DATE: 20.2.99

ATTENTION: DARRYL KNOWLES

SAMPLE DETAILS: WILLIAMSDALE QUARRY, DDH 7; 42.6 metres

PETROGRAPHIC ANALYSIS FOR ALKALI REACTIVITY
METHOD: ASTM C295-90 (By thin section and point count)

ALKALI SILICA REACTIVE MATERIALS

OPAL	NOT DETECTED
CHERT	NOT DETECTED
TRIDYMITE/CRISTOBALITE	NOT DETECTED
MICROCRYSTALLINE QUARTZ	**2%**
STRAINED/METAMORPHOSED QUARTZ	**MODERATE AMOUNTS PRESENT**
MYLONITISED QUARTZ	**SOME PRESENT**
ACID TO INTERMEDIATE GLASSY TO CRYPTOCRYSTALLINE ROCKS	NOT DETECTED
SYNTHETIC GLASS	NOT DETECTED
SILICA RICH ROCKS	**23% QUARTZ**

ALKALI SILICATE REACTIVE MATERIALS

GREYWACKE/ARGILLITE/PHYLLITE	NOT DETECTED
ZEOLITES	NOT DETECTED

ALKALI CARBONATE REACTIVE MATERIAL

ARGILLACEOUS DOLOMITIC LIMESTONE	NOT DETECTED
CALCAREOUS DOLOMITE	NOT DETECTED

J. McNULTY
PETROLOGIST

CLIENT: TOTAL CARE ENGINEERING MAINT. **APS REPORT NO.:** M 1209
255 CANBERRA AVENUE
FYSHWICK, ACT 2609 **DATE:** 20.2.99
ATTENTION: DARRYL KNOWLES
SAMPLE DETAILS: WILLIAMSDALE QUARRY, DDH 7; 42.6 metres

PETROGRAPHIC EXAMINATION FOR DELETERIOUS MATERIALS
METHOD: ASTM C295-90 (By thin section and point count)

SOLUBLE SULPHATES	NOT TESTED
SULPHIDES	**<1% PYRITE**
EXPANSIVE CLAY MINERALS	NOT TESTED*
ALTERED / WEATHERED MATERIAL	**ALTERATION OF PLAGIOCLASE**
ORGANIC MATERIAL	NOT DETECTED
CINDERS/CLINKER/COAL ASH	NOT DETECTED
MAGNESIUM OXIDE	NOT DETECTED
CALCIUM OXIDE	NOT DETECTED
FLAKY (CRUSHED) PARTICLES	NOT DETECTED
MICA	NOT DETECTED
ZEOLITES	NOT DETECTED

***Staining indicated that minor amounts of the chlorite/clay minerals in the rock may be expansive. X-ray diffraction would be required to confirm this.**

J. McNULTY
PETROLOGIST

CLIENT: TOTAL CARE ENGINEERING MAINT. **APS REPORT NO.:** M 1209
255 CANBERRA AVENUE
FYSHWICK, ACT 2609 **DATE:** 20.2.99
ATTENTION: DARRYL KNOWLES
SAMPLE DETAILS: WILLIAMSDALE QUARRY, DDH 7; 56.3 metres

PETROGRAPHIC ANALYSIS

MINERAL	FORM	VOL. %
QUARTZ	Poorly sorted. Coarse grained, some medium, fine and very coarse (max. 5.5mm, average approx. 1mm) detrital crystal fragments, and as very fine grained anhedra in the matrix (0.03mm). Some crystal fragments are rounded, some strongly embayed, but also some very angular grains. Generally slightly to distinctly elongate. Most grains show intense strain shadows, are frequently fractured, some mylonitised.	22
PLAGIOCLASE	Medium to coarse grained, rounded to angular detrital crystal fragments up to 3mm, average approx. 0.8mm. Also as very fine grained anhedra in the matrix. Generally moderate alteration.	32
K FELDSPAR	Medium to coarse grained detrital crystal fragments, and as very fine grained anhedra in the matrix.	21
OPAQUES	Mainly fine grained TiO_2, minor leucoxenised ilmenite, and <1% pyrite.	1
CHLORITE/ CLAY MINERALS	Very fine grained flakes in the matrix, also partly altering plagioclase, and aggregates (up to 2mm) pseudomorphing biotite flakes.	17
ACCESSORY MINERALS	Rare very fine grained crystals of zircon and apatite, and 6% secondary epidote.	6
CARBONATES	Fine grained, generally elongate secondary crystals in pressure shadows, thin veins, and altering plagioclase.	1

Number of points counted: 514 Date counted: 18.2.99

ROCK TEXTURE: Detrital. Poorly sorted, coarse to very fine grained. Mainly consisting of crystal fragments in a very fine felsic and chlorite/clay mineral matrix. An indistinct bedding is defined by elongate detrital quartz and biotite. Slight grain size and compositional variations in the matrix define shapes suggesting that this may originally have contained volcanic glass, later devitrified to very fine grained felsics/clays.

ROCK TYPE: CRYSTAL/?VITRIC TUFF

J. McNULTY
PETROLOGIST

CLIENT: TOTAL CARE ENGINEERING MAINT.
255 CANBERRA AVENUE
FYSHWICK, ACT 2609

APS REPORT NO.: M 1209

DATE: 20.2.99

ATTENTION: DARRYL KNOWLES

SAMPLE DETAILS: WILLIAMSDALE QUARRY, DDH 7; 56.3 metres

ALKALI SILICA REACTIVE MATERIALS
AS LISTED IN THE JOINT PUBLICATION
CEMENT & CONCRETE ASSOCIATION OF AUSTRALIA T47
& STANDARDS AUSTRALIA HB79-1996

Section 2.4 Evaluation of Reaction Potential by Petrology

Potential for Substantial AAR

Minor amounts of siliceous glass, opal, chalcedony, cryptocrystalline quartz, tridymite, or cristobalite	NOT DETECTED
Moderate amounts of heavily strained quartz or fine chert or microcrystalline quartz within acid rock	**Quartz shows intense strain shadows**
Major amounts of moderately strained quartz	NOT DETECTED

Further testing should be undertaken to verify this classification

Potential for Mild or Slow AAR

Rare siliceous glass, opal, chalcedony, cryptocrystalline quartz, tridymite, or cristobalite	NOT DETECTED
Minor amounts of heavily strained quartz or fine chert or microcrystalline quartz within acid rock	**2% microcrystalline quartz in the matrix**
Minor to moderate amounts of moderately strained quartz	NOT DETECTED

Further testing should be undertaken to verify this classification

The rock contains moderate amounts of heavily strained quartz (and minor microcrystalline quartz). This has the potential for substantial AAR. Further testing is necessary to confirm this.

J. McNULTY
PETROLOGIST

CLIENT: TOTAL CARE ENGINEERING MAINT.
255 CANBERRA AVENUE
FYSHWICK, ACT 2609

APS REPORT NO.: M 1209

DATE: 20.2.99

ATTENTION: DARRYL KNOWLES

SAMPLE DETAILS: WILLIAMSDALE QUARRY, DDH 7; 56.3 metres

PETROGRAPHIC ANALYSIS FOR ALKALI REACTIVITY
METHOD: ASTM C295-90 (By thin section and point count)

ALKALI SILICA REACTIVE MATERIALS

OPAL	NOT DETECTED
CHERT	NOT DETECTED
TRIDYMITE/CRISTOBALITE	NOT DETECTED
MICROCRYSTALLINE QUARTZ	**2%**
STRAINED/METAMORPHOSED QUARTZ	**MODERATE AMOUNTS PRESENT**
MYLONITISED QUARTZ	**SOME PRESENT**
ACID TO INTERMEDIATE GLASSY TO CRYPTOCRYSTALLINE ROCKS	NOT DETECTED
SYNTHETIC GLASS	NOT DETECTED
SILICA RICH ROCKS	**22% QUARTZ**

ALKALI SILICATE REACTIVE MATERIALS

GREYWACKE/ARGILLITE/PHYLLITE	NOT DETECTED
ZEOLITES	NOT DETECTED

ALKALI CARBONATE REACTIVE MATERIAL

ARGILLACEOUS DOLOMITIC LIMESTONE	NOT DETECTED
CALCAREOUS DOLOMITE	NOT DETECTED

J. McNULTY
PETROLOGIST

CLIENT: TOTAL CARE ENGINEERING MAINT.
255 CANBERRA AVENUE
FYSHWICK, ACT 2609

APS REPORT NO.: M 1209

DATE: 20.2.99

ATTENTION: DARRYL KNOWLES

SAMPLE DETAILS: WILLIAMSDALE QUARRY, DDH 7; 56.3 metres

PETROGRAPHIC EXAMINATION FOR DELETERIOUS MATERIALS

METHOD: ASTM C295-90 (By thin section and point count)

SOLUBLE SULPHATES	NOT TESTED
SULPHIDES	**<1% PYRITE**
EXPANSIVE CLAY MINERALS	NOT TESTED*
ALTERED / WEATHERED MATERIAL	**ALTERATION OF PLAGIOCLASE**
ORGANIC MATERIAL	NOT DETECTED
CINDERS/CLINKER/COAL ASH	NOT DETECTED
MAGNESIUM OXIDE	NOT DETECTED
CALCIUM OXIDE	NOT DETECTED
FLAKY (CRUSHED) PARTICLES	NOT DETECTED
MICA	NOT DETECTED
ZEOLITES	NOT DETECTED

***Staining indicated that minor amounts of the chlorite/clay minerals in the rock may be expansive. X-ray diffraction would be required to confirm this.**

J. McNULTY
PETROLOGIST

Appendix G - X-Ray Testing Report

REPORT PREPARED ON BEHALF
OF XSEARCH

on

X-RAY POWDER DIFFRACTION ANALYSIS OF TWO SAMPLES OF CRYSTAL/?VITRIC TUFF from Williamsdale Quarry

By

Dr Ervin Slansky

School of Geology
The University of New South Wales

For

Applied Petrographic Services

March 1999

X-RAY POWDER DIFFRACTION ANALYSIS OF TWO SAMPLES OF CRYSTAL/?VITRIC TUFF
from Williamsdale Quarry

Introduction

Two samples of drill core labeled

DDH 7, 42.6m and
DDH 7, 56.3m

were submitted for mineral analysis by X-ray powder diffraction with a request to confirm a low amount of expansive clays.

The analysis was carried out by monochromatized CuKα radiation examining the sample as received and as an oriented aggregate of the fine fraction obtained by sedimentation from water suspension of the samples. The oriented specimens were examined air dry, after ethylene glycol solvation and after heating to 400°C for one hour, a procedure that is standard for the identification of clay minerals.

The data from the natural (as received) powdered specimen were processed by computer; a search match program WINPlot (CSIRO, Division of Soils) was used for the identification of mineral phases. The program uses the ICCD (International Centre for Diffraction Data) powder diffraction file (sets 1 – 47).

Analytical Data

The results of the X-ray powder diffraction analysis of the natural (as received) as well as the oriented sample are given in Table 1. The letters D, A, M, S, T denote semi-quantitative estimates of mineral percentages:

D = dominant (>60%)
A = abundant (60 - 40 %)
M = moderate (40 - 20%)
S = small (20 - 5%)

T = traces (<5%)

The diffractometer traces obtained in the course of the examination are attached (see Figures 1 to 3).

Comment

The data obtained by examining **samples as received** confirmed the mineral composition established by optical microscopy, with the exception of accessory minerals, which fall below the detection limit of XRD analysis. *Quartz*, *feldspars* (both alkali feldspar and plagioclase), *chlorite* and *mica* are the principal minerals. Mica appears to be dioctahedral of the muscovite/sericite type. If there is a trioctahedral mica present, its occurrence is masked by the former.

No expansive clays, not even in traces, were found in the **fine fraction** of the samples. The diffractometer traces of the fine fraction show essentially the same mineral composition as the traces of natural (as received) samples. The subsequent treatment of oriented air-dry specimens (glycolation, heating) did not produce any observable changes of the patterns.

Dr Ervin Slansky
March 4, 1999

Table 1

Mineral Composition of Samples
(data for samples as received and fine fraction combined)

Mineral	*DDH 7 42.6m*	*DDH 7 56.3m*
Quartz	A	A
Feldspars	A	A
Chlorite	M	M
Mica	S	S
Epidote	?T	T
Apatite	?	T
Calcite	T	T

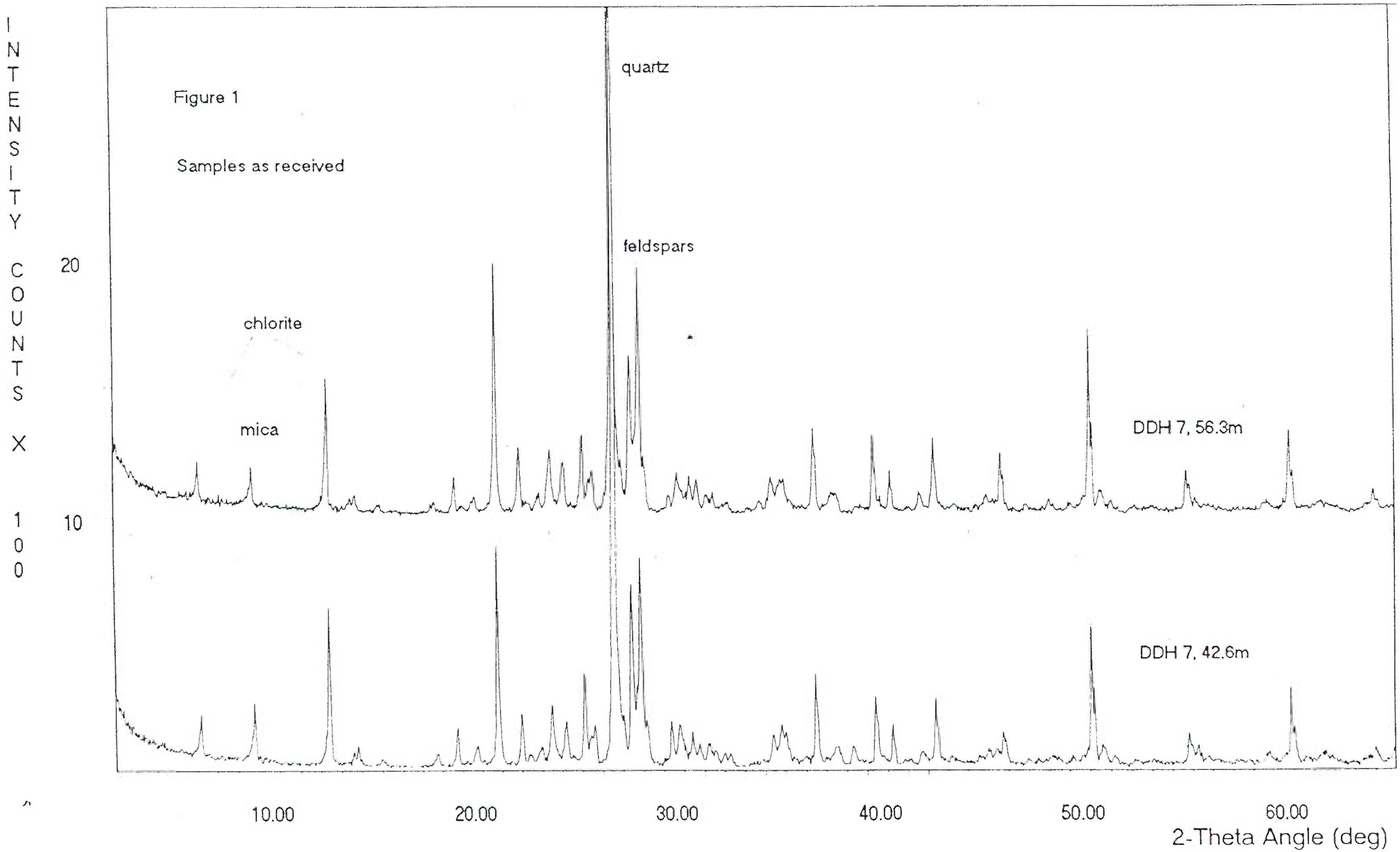
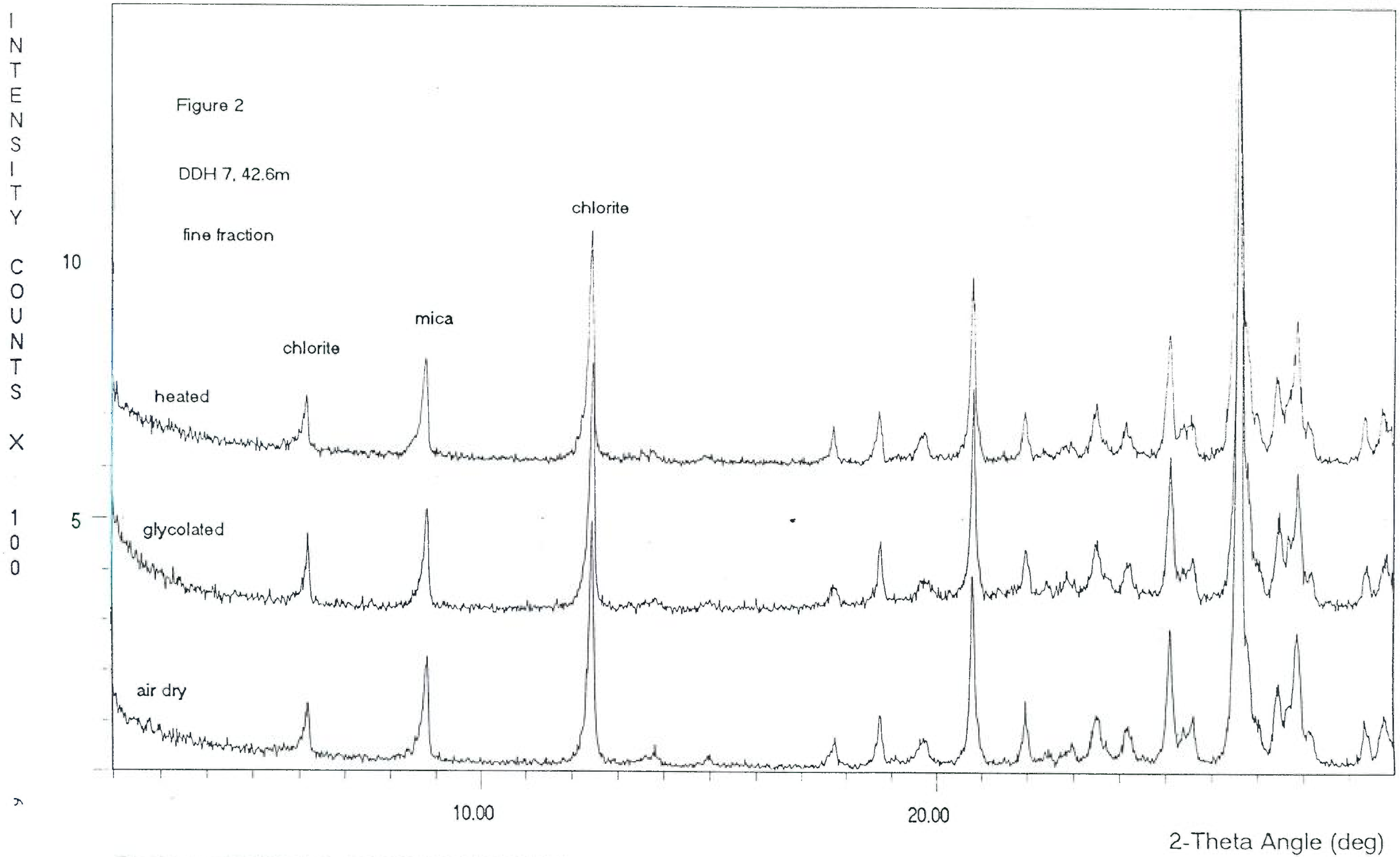


Figure 1

Samples as received

File Name: a:\990023ar.rd a:\990024ar.rd

Figure 2



File Name: a:\990023ad.rd a:\990023g.rd a:\990023h.rd

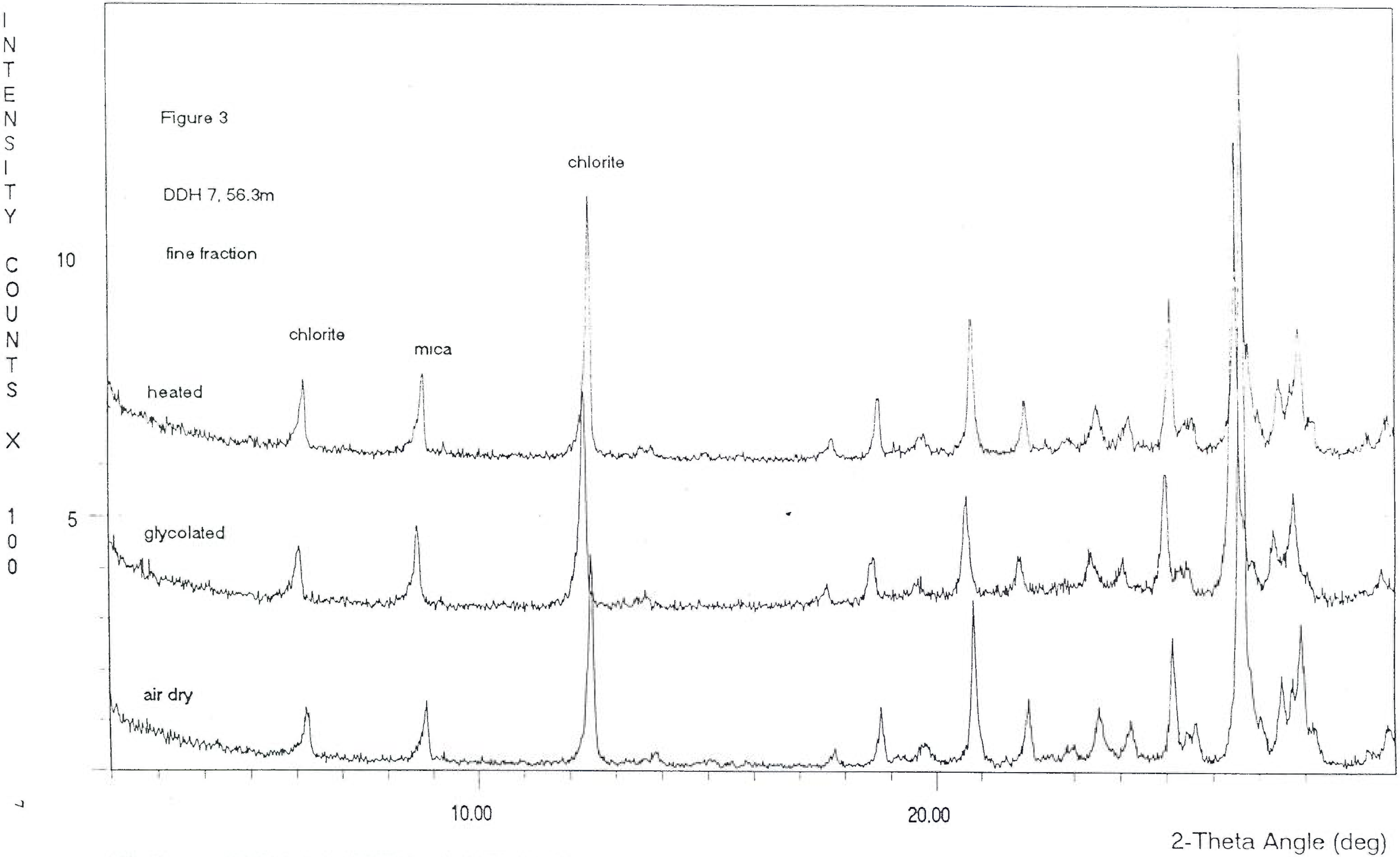


Figure 3

DDH 7, 56.3m

fine fraction

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Appendix H - Air Quality Report

AIR QUALITY IMPACT ASSESSMENT

PROPOSED EXTRACTION OPERATIONS
WILLIAMSDALE QUARRY, NSW

26 February, 1999

Prepared
for
International Environmental Consultants Pty Ltd

by

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FIGURES

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1. INTRODUCTION

This report has been prepared by Holmes Air Sciences for International Environmental Consultants Pty Ltd. It forms a supporting document to be included in the Environmental Impact Statement (EIS) for the proposed extraction operations at Williamsdale Quarry in southern NSW. The purpose of the report is to assess the dust impacts due to proposed operations at the site.

Dust impacts have been assessed by comparing estimated dust concentrations and fallout levels with relevant air quality criteria. These estimates have been made using the US EPA's short-term industrial source complex model known as ISCST3 (**US EPA, 1995**).

2. LOCAL SETTING AND PROJECT DESCRIPTION

The proposed quarry is located approximately 20 km south of Tuggeranong, near the village of Williamsdale. The site is north of Williamsdale Road which intersects with the Monaro Highway at the NSW/ACT border. **Figure 1** shows the location of the proposed quarry which lies near the northern end of the lease boundary. The local terrain is undulating, with the site itself located on an area of raised terrain falling away to the south (**Figure 2**).

There are a number of single residences to the west and south of the site, and the land adjacent to the north of the lease had recently been zoned rural residential indicating the potential for further development in this area. At this stage there are no residences to the north of the proposed site.

The quarry operation will produce a comprehensive range of premium quality hard rock aggregates, crusher dust, manufacture sand and blended pavement materials for sale to the public and private sector within the ACT/Queanbeyan areas. It is anticipated that the proposal will produce a maximum of 600,000 t/y of product, from a total excavation of 630,000 t/y. All material will be drilled and blasted requiring approximately 32 blasts per year. Fractured rock will then be transferred into 50 t dump trucks using front-end-loaders and hauled to the primary crusher just outside the pit. Primary crushed rock will then be conveyed to a surge pile. The rock will be reclaimed from the surge pile and fed into the process area where it will be crushed and screened and loaded into different stockpiles. The product will be loaded into 27 t sales trucks and hauled off-site via the access road to Williamsdale Road. The proposal will operate between 6am and 6pm, 5.5 days per week.

3. AIR QUALITY ISSUES

3.1 Preamble

This section discusses air quality goals which currently apply in NSW. These goals are used to assess air quality impacts, but they are not formal standards in NSW; that is, they are not legally binding standards. The health issues on which the goals are based are also discussed.

The NSW Environmental Protection Authority (EPA) has historically noted air quality goals for particulate matter determined by the United States Environment Protection Agency (US EPA) and the National Health and Medical Research Council (NHMRC). These, together with other goals referred to in the US, are listed in **Table 1**.

It should be noted that the National Environment Protection Council (NEPC) has determined a new set of air quality goals for adoption at a national level, which are part of the National Environment Protection Measures (NEPM). These are currently being considered by Federal Parliament and are likely to be adopted by the NSW EPA when they are gazetted. In its recent publication "Action for Air" (**EPA, 1998**) the NSW EPA has adopted the 50 $\mu g/m^3$ NEPM 24-hour standard[2] for particulate matter less than 10 μm in diameter (PM_{10}) as an interim goal, as well as a new long-term reporting goal of 30 $\mu g/m^3$.

Table 1 - Air quality standards/goals for particulate matter concentrations

POLLUTANT	STANDARD	AGENCY
Total suspended particulate matter (TSP)	90 $\mu g/m^3$ (annual mean)	NHMRC
Particulate matter < 10 μm (PM_{10})	50 $\mu g/m^3$ (annual mean) 30 $\mu g/m^3$ (annual mean) 150 $\mu g/m^3$ (24-hour)[1] 50 $\mu g/m^3$ (24-hour)[2] 50 $\mu g/m^3$ (24-hour)	US EPA NEPM US EPA NEPM NSW EPA Interim
Particulate matter < 2.5 μm ($PM_{2.5}$)	15 $\mu g/m^3$ (annual mean) 65 $\mu g/m^3$ (24-hour)[3]	US EPA US EPA

Air quality impacts from dust emissions occur in a number of ways. Firstly there is the potential for dust deposition to soil surfaces such as washing, motor vehicles, the outsides of buildings, swimming pools and to lead to a build up of sediment in rainwater tanks which collect water from roofs. These are referred to as effects on amenity. These effects would occur in the absence of the quarry and it is the extent to which the effects are worsened that determines the acceptability or otherwise of dust emissions from the proposal. Secondly, air borne dust has the potential to cause health effects.

The effects of dust on amenity and health can be assessed by comparing dust deposition rates and dust concentrations with recognised air quality criteria established as a result of research both in New South Wales and overseas. To cover the full range of possible adverse impacts it is necessary to make reference to criteria for both long-term (annual means) and short-term (24-hour) periods and for dust within a range of particle sizes.

3.2 Concentration

In the following discussion reference will be made to three classes of dust, $PM_{2.5}$, PM_{10} and Total Suspended Particulate matter (TSP). $PM_{2.5}$ refers to dust in the fine particle size range 0 to 2.5 μm. This dust can be inhaled into the deepest areas of the lung. PM_{10} dust relates to particles less than 10 μm aerodynamic size and TSP relates to all suspended particles (which are usually in the size range 0 to 50 μm, larger particles settling out too rapidly to be considered a significant air quality issue). TSP concentration measurements therefore include PM_{10} particles and PM_{10} particles included $PM_{2.5}$ particles. Particles in the $PM_{2.5}$ and PM_{10} size range have recently become the focus of considerable scientific attention because of the strong correlation between excess mortality and fine particle concentration that has been noted in the Six Cities Study undertaken by **Dockery et al. (1993)** in the United States. The correlation is weaker with TSP concentrations, presumably because a substantial fraction of TSP particles are too large to enter the sensitive areas of the respiratory system.

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[1] 99th percentile averaged over three years
[2] At regional monitors – can be exceeded five times per year
[3] 99th percentile averaged over three years

PM_{10} particle concentrations are of interest because these particles can reach the lower parts of the respiratory system by inhalation and can have health impacts as well as nuisance impacts. $PM_{2.5}$ particles are those that show the strongest association with health effects and it is possible that in the future the air quality goals for the protection of human health will be expressed in terms of the concentrations of $PM_{2.5}$ rather than PM_{10} or TSP concentrations. The US EPA has recently reformulated its air quality standards for particulate matter to include concentration limits for $PM_{2.5}$.

In Australia, the NEPC has proposed a 24-hour PM_{10} goal of 50 µg/m^3, which is part of the NEPM being reviewed by Federal Parliament. The NSW EPA has historically noted the US EPA 24-hour standard of 150 µg/m^3 and an annual average standard of 50 µg/m^3 for PM_{10}. It will now adopt the NEPM 24-hour standard of 50 µg/m^3 as an interim goal and refer to a new annual average of 30 µg/m^3 as a long-term reporting goal. The NSW EPA Interim goals are designed as regional goals and are therefore not intended to apply at the boundary of any particular development (**NSW EPA, 1998**). In assessing the impacts of the current proposal it is perhaps then more appropriate to use the US EPA goals at the lease boundary, in conjunction with their $PM_{2.5}$ goals of 65 µg/m^3 (24-hour) and 15 µg/m^3 (annual mean). All goals will be discussed in **Section 7**.

The NSW EPA also continues to note the NHMRC's 90 µg/m^3 annual average goal for total suspended particulate matter (TSP). This level is recommended as the maximum permissible level in urban environments.

$PM_{2.5}$ particles in the atmosphere are generally the result of combustion processes in motor vehicles, bushfires and industrial processes. Some $PM_{2.5}$ particles are generated by evaporation of sea-spray and from vegetation. Most quarrying dust is composed of coarser particles with a tendency to cause nuisance effects rather than pose a threat to human health. Work undertaken on behalf of the **SPCC (1983)** shows that close to dust sources on open cut mines the mass fraction of the $PM_{2.5}$, and PM_{10} in the TSP fraction of dust is approximately 6 per percent and 40 to 50 per cent respectively. This will be similar for quarrying operations.

3.3 Deposition

The EPA consider that residential areas begin to experience dust related nuisance impacts when annual average dust (insoluble solids) deposition levels exceed 4 g/m^2/month, and that dust impacts would be at unacceptable levels when they reached 10 g/m^2/month (**SPCC 1983**). In the early 1990s the EPA (**Dean et al., 1990**) refined these criteria. They are now expressed in terms of an acceptable increase in dust deposition over the existing background. **Table 2** shows the maximum acceptable increase in dust deposition over the existing dust levels.

Table 2 - EPA criteria for dust fallout

Existing dust fallout level (g/m^2/month)	Maximum acceptable increase over existing fallout levels (g/m^2/month)	
	Residential	Other
2	2	2
3	1	2
4	0	1

For example, in residential areas with annual average deposition levels of between 0 and 2 g/m^2/month, an increase of up to 2 g/m^2/month would be permitted before it is considered that degradation of air quality has occurred.

The criteria for dust fallout levels in **Table 2** are set to protect against nuisance impacts and they are not relevant for interpreting the significance of dust in quarry working areas.

4. DISPERSION METEOROLOGY AND EXISTING AIR QUALITY

This section describes the dispersion meteorology, general climate and air quality in the study area. It also provides information on prevailing wind patterns, historical data on temperature, humidity and rainfall are presented to give a more complete picture of the local climate.

The computer-based dispersion model used to predict dust deposition and concentration levels requires data on wind speed, wind direction, atmospheric stability[4] class and mixed-layer height[5]. The data base used and the way in which it has been used to derive the parameters required for dispersion modelling are discussed below.

4.1 Wind data for Tuggeranong

The meteorological data used in this study has been compiled from data obtained from the Bureau of Meteorology. Hourly temperature, wind speed and wind direction data was recorded at an automatic weather station (AWS) at Tuggeranong, approximately 20-25 km north of the study area. Cloud cover data are not available at that site and so in order to determine stability class it was necessary to use cloud cover data from the Bureau's Canberra station. Contemporaneous three-hourly cloud cover data were obtained from Canberra and an interpolating program used to compile these data into a one-hourly file. The two data sets were then combined and Turner's method (**Turner, 1964**) was used to calculate stability class.

Figure 3 shows the annual and seasonal windroses compiled from the Tuggeranong and Canberra data. It shows a high frequency of winds from the northwestern quadrant in all seasons. Summer and autumn also appear to have a high percentage of winds from the northeastern quadrant. The annual average wind speed is 2.78 m/s.

It is important to note that the meteorological data used for this study is not site-specific and may not represent all features of wind flow in the local area. This question is expanded in the following paragraphs.

Geostrophic[6] wind patterns are likely to be similar for the two areas since they are only 20-25 km apart, but differences in terrain will affect the local wind patterns. The topography affects the movement of air in two ways. One is the way in which the wind is deflected by terrain features which steer, or channel the wind. The more stable the atmosphere the greater the

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[4] In dispersion modelling stability class is used to categorise the rate at which a plume will disperse. In the Pasquill-Gifford stability class assignment scheme (as used in this study) there are six stability classes, A through to F. Class A relates to unstable conditions, such as might be found on a sunny day with light winds. In such conditions plumes will spread rapidly. Class F relates to stable conditions, such as occur when the sky is clear, the winds are light and an inversion is present. Plume spreading is slow in these circumstances. The intermediate classes B, C, D and E relate to intermediate dispersion conditions.

[5] The term mixed-layer height, refers to the height above the ground through which ground-based emissions will eventually be dispersed once a plume has been thoroughly mixed. An elevated plume, initially above the mixed-layer height will remain isolated from the ground until such time as the mixed-layer height reaches the height of the plume. In general the mixed-layer height will increase during the day as the sun causes convection to deepen the turbulent layer of the atmosphere close to the ground. Mixed-layer height will also increase if the wind speed increases because higher wind speeds will increase turbulence as the wind blows over the rough ground.

[6] Geostrophic winds flow parallel to the isobars, due to the balance achieved between the pressure gradient force and the Coriolis force. The geostrophic wind is far enough away from the earth's surface so as not to be affected by features such as local terrain and surface roughness.

effect. The terrain can also affect the movement of air by generating so-called katabatic, or drainage flows. These are usually generated at night when the wind is light and the skies are clear. Under these conditions the ground will cool by radiating heat to space. The cooled ground will then chill the air close to it making that air denser than the air further from the ground. If the ground is sloping then the air close to the ground will be denser than the nearby air at the same height above sea level, but a different height above the ground. The result will be that the dense air close to the surface will begin to drift down the slope.

As shown in **Figure 2**, the ground to the south of the quarry site slopes away more rapidly than to the north. It is not unreasonable then that there may be drainage flows towards the lower ground to the south. This is particularly true for the process area which is located towards the bottom of this lower area to the south. **Figure 3** shows that the majority of light winds are from the northern sector. The estimates of dust impacts for residences A and B (**Figure 1**) to the south, are therefore likely to be conservative due to the high frequency of winds from the north in the data file. Predictions to the north however, where the adjacent land has been rezoned as rural residential, could be underestimated. The wind patterns at the site could indeed be represented by the Tuggeranong data, but without on-site measurements that cannot be determined to any degree of accuracy.

4.2 Temperature, humidity and rainfall

Table 3 presents the temperature, humidity and rainfall data for Queanbeyan, north of the site (**Bureau of Meteorology World Wide Web site**). Humidity data consist of monthly averages of 9 am and 3 pm readings. Also presented are monthly averages of maximum and minimum temperatures. Rainfall data consist of mean monthly rainfall and the average number of raindays per month.

From temperature data recorded over 47 years, the annual average maximum and minimum temperatures experienced are 20.6°C and 6.4°C, respectively. The maximum monthly average temperature is recorded in January at 29.0°C. July is the coldest month, with an average minimum temperature of -0.2°C.

The annual average humidity reading from 47 years of data collected at 9 am is 71%. The months with the highest 9 am humidity on average are June and July with 81%.

Rainfall data collected over 125 years show that October is on average the wettest month, with a mean rainfall reading of 61 mm. The average number of raindays for October is 7. July is the driest month with an average rainfall of 40 mm. The average annual rainfall is 595 mm and the average number of raindays is 74.

Table 3 - Temperature, humidity and rainfall data for Queanbeyan
(Station Number 070072 Latitude 35 Deg 22 Min S Longitude 149 Deg 14 Min E Elevation 580 m)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
9 am Mean Temperatures (C) and Relative Humidity (%) (47 years of record)													
Dry-bulb	19.9	19.3	16.6	12.2	7.8	4.9	4.0	5.6	9.5	13.4	16.9	19.2	12.4
Wet-bulb	15.9	15.8	13.6	10.0	6.3	3.7	2.8	4.0	7.3	10.4	13.0	14.9	9.8
Humidity	64	68	70	74	79	81	81	76	72	65	62	61	71
Daily Maximum Temperature (C) (47 Years of record)													
Mean	29.0	28.5	25.6	20.6	15.9	12.5	11.8	13.7	17.3	20.7	24.4	27.6	20.6
Rainfall (mm) (125 Years of record)													
Mean	57.0	48.7	52.1	45.7	46.3	43.2	39.8	43.4	46.7	60.7	57.8	53.9	595
Median	52.4	41.7	33.0	39.1	35.4	34.0	34.2	40.7	42.0	52.3	51.7	46.0	571
Raindays (Number) (108 Years of record)													
Mean	6	5	5	5	6	7	7	7	7	8	7	6	74

*Source : **www.bom.gov.au***

5. EXISTING AIR QUALITY

There are no existing dust deposition or high volume sampling data for the proposed site. Based on a review of land use, it is likely that the existing levels are low, with emissions generally due to agricultural activities such as harvesting and ploughing of fields, or movement of livestock. There will also be particulate emissions from the adjacent Monaro Highway but these will be minimal. Background dust deposition levels are likely to be less than 2 g/m^2/month, and annual average PM_{10} concentrations would be expected to be of the order of 10 $\mu g/m^3$. Maximum 24-hour PM_{10} concentrations will depend on the presence of nearby sources of particulate matter such as bushfires or remote sources such as dust storms from inland areas to the west. There is no reason to suppose that worst-case conditions for the quarry will correlate with the highest concentrations produced from other sources.

For the purposes of assessing impacts it is the level of the background that applies when the contribution from the quarry is greatest that is important. This level cannot be determined by any rigorous scientific process and for the purpose of assessment it has been taken to be 10 $\mu g/m^3$ – that is, the same as the estimated annual average PM_{10} concentration.

6. ESTIMATED EMISSIONS

Emissions of dust from the site will vary depending on such things as the operation being performed, wind speed, silt and moisture content of the material being moved, as well as other factors. During the 30 year life of the project it is estimated that the maximum extraction rate will be 630,000 t/y, of which 600,000 t/y will be product. By Year 30, the extraction activities such as drilling and blasting, will be closest to the rezoned area adjacent to the northern lease boundary, and the quarry will be operating at a production rate of 600,000 t/y. For this reason, Year 30 has been chosen as a worst case and will be the year assessed.

Details of how emissions for each operation have been calculated can be found in **Appendix A**, and are summarised in **Table 4**. The majority of emissions come from the processing area and haulage of material off-site. A relatively small fraction (less than 10%) of the total emissions are from operations within the pit. This is important to note since the in-pit activities are closest to the rezoned land to the north of the site.

Table 4 - Estimated dust emissions from the proposed Williamsdale Quarry

Operation / Activity	TSP emission rate (kg/y)
Drilling	1,152
Blasting	11,008
Front-end-loaders loading dump trucks	3,015
Hauling rock to primary crusher	17,640
Dumping rock to crusher hopper	3,015
Primary crushing	8,820
Conveyer stacking surge pile	2,872
Screening	48,000
Secondary crushing	8,400
Tertiary crushing	55,800
Conveyer stacking stockpiles	2,872
Front-end-loaders loading sales trucks	2,872
Hauling product off-site	124,444
Wind erosion from the pit	13,251
Wind erosion from the stockpile area	4,417
TOTAL	***307,578***
Ratio of extraction rate to TSP emissions	***0.51***

7. ASSESSMENT OF IMPACTS

In this report the assessment of dust concentrations and deposition rates have been made over an area of 6 km by 6 km, using ISCST3, the US EPA's Industrial Source Complex model. Predictions have also been made residences A and B (**Figure 1**) to determine whether or not the EPA's short-term PM_{10} goals are met. Dust deposition has been averaged over the year and expressed as monthly deposition levels. Results are presented in **Figures 4** to **13** and discussed with reference to the individual goals. Since it is not known at this stage exactly when the access road will be sealed, Year 30 has been initially assessed with an unsealed road to represent a worst-case scenario. Further modelling was done with the road sealed and those results are also presented in this section.

7.1 Concentration

7.1.1 Short-term concentration

The predicted maximum 24-hour $PM_{2.5}$ concentrations due to operations at the quarry in Year 30, are shown in **Figure 4**. Predicted levels at all residences and the rezoned land to the north are expected to be below 15 $\mu g/m^3$. This is well below the short-term US EPA goal of 65 $\mu g/m^3$, even when a conservative background of 10 $\mu g/m^3$ is added.

Figure 5 shows the predicted maximum 24-hour PM_{10} concentration in the area around the proposed site. It can be seen that the US EPA short-term goal of 150 $\mu g/m^3$ is not exceeded at Residences A and B, nor is it predicted to be exceeded on any of the land to the north of the site which has been rezoned. Background concentrations would need to be of the order of 100 $\mu g/m^3$ or more for the US EPA short-term PM_{10} goal to be exceeded. The NSW EPA's Interim goal of 50 $\mu g/m^3$ is predicted to be exceeded at both residences and also on a small fraction of the rezoned land adjacent to the site. However, as discussed in **Section 3** the more appropriate goal for this assessment is the US EPA 150 $\mu g/m^3$ goal.

The NEPM 24-hour goal on which the EPA's Interim goal is based, allows an exceedance of 50 $\mu g/m^3$ on five occasions per year. **Figure 6** shows the predicted sixth highest 24-hour PM_{10} concentration due to Year 30 operations. In other words, those locations inside the 50 $\mu g/m^3$ contour are predicted to exceed the 24-hour NEPM goal more than five times per year. Both Residences A and B lie just within this contour, while levels in the rezoned land to the north are less than 50 $\mu g/m^3$. **Figure 7** shows a time series of 24-hour average PM_{10} concentrations at both residences, indicating that the majority of predicted levels are below 50 $\mu g/m^3$. If a background of 20 $\mu g/m^3$ was added to the predicted PM_{10} concentrations however, the NSW EPA / NEPM 24-hour goal would be exceeded on many occasions throughout the year. This is a conservative estimate of background conditions but one which may not be uncommon close to farming activities on dry windy days.

7.1.2 Long-term concentration

Predicted annual average $PM_{2.5}$ levels are shown in **Figure 8**, to be well below the US EPA goal of 15 $\mu g/m^3$. This is the case for both Residences A and B, as well as for the rezoned land to the north of the site.

Figure 9 shows that predicted PM_{10} levels due to the proposed operations are expected to remain well below the US EPA annual goal of 50 $\mu g/m^3$, at all residences outside the lease boundary. Annual average background levels at Residences A and B would have to be of the order of 35 $\mu g/m^3$, which is unlikely in the study area. The NSW EPA's long-term reporting goal is also not expected to be exceeded.

Figure 10 shows the predicted annual average TSP concentrations due to emissions from the quarry in Year 30. Residences A and B are predicted to experience increases in annual TSP concentration of approximately 15 µg/m³. If an annual TSP background concentration of 30 µg/m³ is assumed, the net TSP concentration would be 45 µg/m³. This is below the NHMRC annual goal of 90 µg/m³.

7.2 Deposition

Figure 11 shows the predicted increase in annual dust deposition levels. Assuming that existing levels are of the order of 2 g/m²/month, no residences are predicted to experience dust deposition levels at or above the NSW EPA's 4 g/m²/month level. In other words, increases in annual average dust deposition at all residences are predicted to be less than 2 g/m²/month. This is the case for both the existing residences and also the rezoned land to the north.

7.3 Sealing the access road

As discussed in **Section 7.1.1**, the USEPA 24-hour PM_{10} goal of 150 µg/m³ is not expected to be exceeded at any of the existing residences or rezoned land. However, the NSW EPA's 50 µg/m³ goal is predicted to be exceeded on more than five occasions per year at Residences A and B. **Table 4** shows that the largest source of dust emission is due to haulage of product off-site. Sealing the access road north of Lobbs Hole Creek will reduce these emissions from 124,444 kg/y to 2,222 kg/y. **Figure 12** shows the sixth highest 24-hour PM_{10} concentrations for Year 30 if the road was sealed. Predicted concentrations at the southern residences are less than 30 µg/m³. The quarry is therefore predicted to comply with the NEPM 24-hour goal if the access road is sealed north of Lobbs Hole Creek.

It is not known at what stage the access road will be sealed north of Lobbs Hole Creek, but before quarrying begins it will be sealed to the south. If the road were to be sealed during the first year of operation it is not expected that the short-term PM_{10} goals would be exceeded at any time after that year. There is still the potential then, for the goal to be exceeded sometime during Year 1 when the majority of the haul road is unsealed. A modelling exercise was therefore carried out to estimate PM_{10} concentrations expected during Year 1, assuming a production rate of 300,000 t/y and an unsealed access road. **Figure 13** shows the predicted concentrations for this scenario. It can be seen that the sixth highest PM_{10} concentration is less than 35 µg/m³ at Residences A and B. It is therefore expected that the proposed operation will comply with the NEPM standard during Year 1, with an unsealed access road.

8. CONCLUSIONS

The dust impacts of the proposed development on nearby residences and rezoned land, have been assessed. Operations at the proposed quarry site are not predicted to cause any adverse impacts off-site when the access road is sealed.

The US EPA short-term $PM_{2.5}$ and PM_{10} goals are not predicted to be exceeded off-site for either the sealed, or unsealed access road scenarios. The NSW EPA Interim 24-hour PM_{10} goal is predicted to be exceeded at Residences A and B when the quarry is operating at full production and if the access road is unsealed north of Lobbs Hole Creek. However, the proposed operation is predicted to comply when the road is sealed. During Year 1, when the road is unsealed, the PM_{10} concentrations are expected to remain below all short-term goals.

The proposed development is predicted to comply with all long-term goals for $PM_{2.5}$, PM_{10} and TSP. Increases in dust deposition are also estimated to be below levels which would cause a nuisance impact at the closest residences. Compliance with all long-term goals is not dependant on the access road being sealed.

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APPENDIX A
ESTIMATED DUST EMISSIONS

YEAR 30 DUST EMISSIONS

Introduction

The dust emission inventory has been estimated using the emission factors and the quarry design information provided below. Emission factors have been developed using emission factor equations provided in the **US EPA (1985)** (and subsequent updates) publication referred to as AP-42 and from factors determined by **NERDDC (1986)**.

Estimated emissions are presented for all significant dust generating activities associated with the development of the quarry.

It has been assumed that all quarrying activities occur between the 12 hour period 6 am to 6 pm. Dust from wind erosion is assumed to occur over 24 hours per day, but wind erosion is also assumed to be proportional to the third power of wind speed. Generally, this will mean that most wind erosion occurs in the day when wind speeds are highest.

Drilling (US EPA, 1985, Table 8.24-4)

In Year 30 approximately 630,000 t (242,300 bcm) of material will be blasted. This will require the drilling of 1,920 holes (32 blasts/y 60 holes/blast). It is assumed that 0.6 kg of dust will be generated in drilling each hole **(US EPA, 1985)**. The total number of holes is 1,920 and so the total annual dust emission is estimated to be 1,152 kg. [1,920 holes x 0.6 kg/hole].

Blasting (US EPA, 1985, Table 8.19-2)

A number of equations are available to estimate dust emissions from blasting. The most useful, in the sense that it explicitly shows how the area, depth and moisture content of the blast takes affect the dust emission is **Equation 1**.

The TSP emission factor equation for blasting is given by:

Equation 1

$$E_{TSP} = 344 \times \left(\frac{A^{0.8}}{M^{1.9} \times D^{1.8}} \right) \quad \text{- kg/blast}$$

where,

A = blast area (m^2)

M = moisture content (%)

D = depth of blast holes (m)

The other widely used equation only relates the dust emission to the area of the blast. Assuming a moisture content of approximately 1%, a hole depth of 16 m and blast area of approximately 513 m^2, the emission factor (E_{TSP}) is calculated to be approximately 344 kg/blast.

A total of approximately 32 blasts is envisaged for Year 30. The total emissions from blasting will therefore be 11,008 kg/y [354 kg/blast x 32 blasts/y].

Loading fractured rock to dump trucks

In Year 30, approximately 630,000 t of material will be loaded into trucks and transported to the primary crusher hopper. Each tonne of material loaded will generate a certain amount of dust, depending on the wind speed and the moisture content. **Equation 2 (US EPA, 1995, 13.2.4-3)** shows the relationship between these variables.

Equation 2

$$E_{ore} = k \times 0.0016 \times \left(\frac{\left(\frac{U}{2.2} \right)^{1.3}}{\left(\frac{M}{2} \right)^{1.4}} \right)$$

where,

$k = 0.74$

U = wind speed (m/s)

M = moisture content (%)

[where $0.25 \leq M \leq 4.8$]

Assuming a moisture content of 1% for the fractured rock, the total emission for Year 30 is therefore given by;

$$E_{total} = 630{,}000 \times 0.00312 \times \left(\frac{U}{2.2} \right)^{1.3}$$

A "wind speed factor", [that is the $(U/2.2)^{1.3}$ part of Equation 3], will vary from hour to hour. This factor has been calculated for each hour in the meteorological data file and an annual average determined to be approximately 1.532. The total emissions from loading rock to trucks will therefore be approximately 3,015 kg/y [630,000 x 0.00312 x 1.532].

Hauling material to crusher hopper

Approximately 630,000 t of material will be hauled to the crusher in Year 30, using 50 t trucks. Assuming a return travel distance of 0.7 km, dust generation rate of 4 kg/VKT and 50% control of dust by watering of the haul road, the total dust generated is expected to be 17,640 kg/y [(630,000 t / 50 t) x 0.7 km x 4 kg/km x 50/100].

Dumping fractured rock to crusher hopper (US EPA, 1985, Table 8.19.2-2)

In Year 30 approximately 630,000 t of material will be dumped from at the crusher hopper. Each tonne of rock dumped will generate dust at the rate determined by **Equation 2** (where M is 1%).

The total emission for Year 30 is therefore given by;

$$E_{total} = 630{,}000 \times 0.00312 \times \left(\frac{U}{2.2} \right)^{1.3}$$

The emissions from this process will vary from hour to hour depending on the wind speed and in the model this is how the emission is represented. However, the annual emission is also of interest. Using the annual average "wind speed factor" of 1.534 (as determined previously), the total emissions from loading waste to trucks will be approximately 3,015 kg/y [630,000 x 0.00312 x 1.534].

Primary crushing (US EPA, 1985, Table 8.19.2-1)
In Year 30 approximately 630,000 t of material will be crushed. Each tonne of material crushed will generate approximately 0.014 kg of dust [0.140 kg/t reduced by 90% when enclosed]. The total dust generated by primary crushing in Year 30 will therefore be 8,820 kg/y [630,000 t/y x 0.014 kg/t].

Conveyer stacking surge pile (US EPA, 1985 Table 8.19.1-1)
Approximately 600,000 t of material will be conveyed to the surge pile. Each tonne of rock stacked will generate dust at the rate determined by **Equation 2** (where M is 1%).

The total emission for Year 30 is therefore given by;

$$E_{total} = 600{,}000 \times 0.00312 \times \left(\frac{U}{2.2}\right)^{1.3}$$

The emissions from this process will vary from hour to hour depending on the wind speed and in the model this is how the emission is represented. However, the annual emission is also of interest. Using the annual average "wind speed factor" of 1.534 (as determined previously), the total emissions from loading waste to trucks will be approximately 2,872 kg/y [600,000 x 0.00312 x 1.534].

Screening (US EPA, 1985, Table 8.19.1-1)
Dry screening will take place in the process area. Approximately 600,000 t of material will be screened in Year 30. Each tonne of material will generate approximately 0.08 kg of dust. The total amount of dust generated from screening will therefore be approximately 48,000 kg/y [600,000 t/y x 0.08 kg/t].

Secondary and tertiary crushing (US EPA, 1985, Table 8.19.2-1)
Approximately 600,000 t of material will be crushed using secondary and tertiary crushers. Each tonne of material crushed in the secondary crushing stage will generate approximately 0.014 kg of dust [0.140 kg/t reduced by 90% when enclosed]. The total dust generated by secondary crushing in Year 30 will therefore be 8,400 kg/y [600,000 t/y x 0.014 kg/t].

Tertiary crushing has a higher emission rate of 0.930 kg/t, which can be reduced by 90% if the crusher is enclosed. The total dust generated in Year 30 by enclosed tertiary crushing will therefore be approximately 55,800 kg/y [600,000 t/y x 0.093 kg/t].

Conveyer stacking stockpiles
Approximately 600,000 t of product material will be stacked into stockpiles. Each tonne of rock stacked will generate dust at the rate determined by **Equation 2** (where M is 1%).

The total emission for Year 30 is therefore given by;

$$E_{total} = 600{,}000 \times 0.00312 \times \left(\frac{U}{2.2}\right)^{1.3}$$

The emissions from this process will vary from hour to hour depending on the wind speed and in the model this is how the emission is represented. However, the annual emission is also of interest. Using the annual average "wind speed factor" of 1.534 (as determined previously), the total emissions from loading waste to trucks will be approximately 2,872 kg/y [600,000 x 0.00312 x 1.534].

Loading product to trucks
In Year 30, approximately 600,000 t of product material will be loaded into trucks and transported off-site. Each tonne of product loaded will generate dust at the rate determined by **Equation 2** (where M is 1%).

The total emission for Year 30 is therefore given by;

$$E_{total} = 600{,}000 \times 0.00312 \times \left(\frac{U}{2.2}\right)^{1.3}$$

The emissions from this process will vary from hour to hour depending on the wind speed and in the model this is how the emission is represented. However, the annual emission is also of interest. Using the annual average "wind speed factor" of 1.534 (as determined previously), the total emissions from loading waste to trucks will be approximately 2,872 kg/y [600,000 x 0.00312 x 1.534].

Hauling product off-site
Approximately 600,000 t of product will be hauled off-site in Year 30, using 50 t trucks. The road will be unsealed until it crosses Lobbs Hole Creek, and sealed from the creek to Williamsdale Road. A dust generation rate of 2 kg/VKT is assumed on unsealed roads (allowing for 50% control by watering), and a rate of 0.1 kg/VKT is assumed for sealed roads. Return travel distances of 2.8 km is assumed on unsealed roads and 1 km on sealed roads. On unsealed roads the total dust generated is expected to be 124,444 kg/y [(600,000 t / 27 t) x 2.8 km x 2 kg/km]. On sealed roads the total dust generated is expected to be 2,222 kg/y [(600,000 t / 27 t) x 1 km x 0.1 kg/km].

Wind erosion from pit
The US EPA (1985) emission factor equation for wind erosion is:

Equation 4

$$E_{TSP} = 1.9 \times \left(\frac{s}{1.5}\right) \times \left(\frac{365-p}{235}\right) \times \left(\frac{f}{15}\right) \quad \text{- kg/ha/y}$$

where,

s = silt content (%),

p = number of raindays per year (dimensionless), and

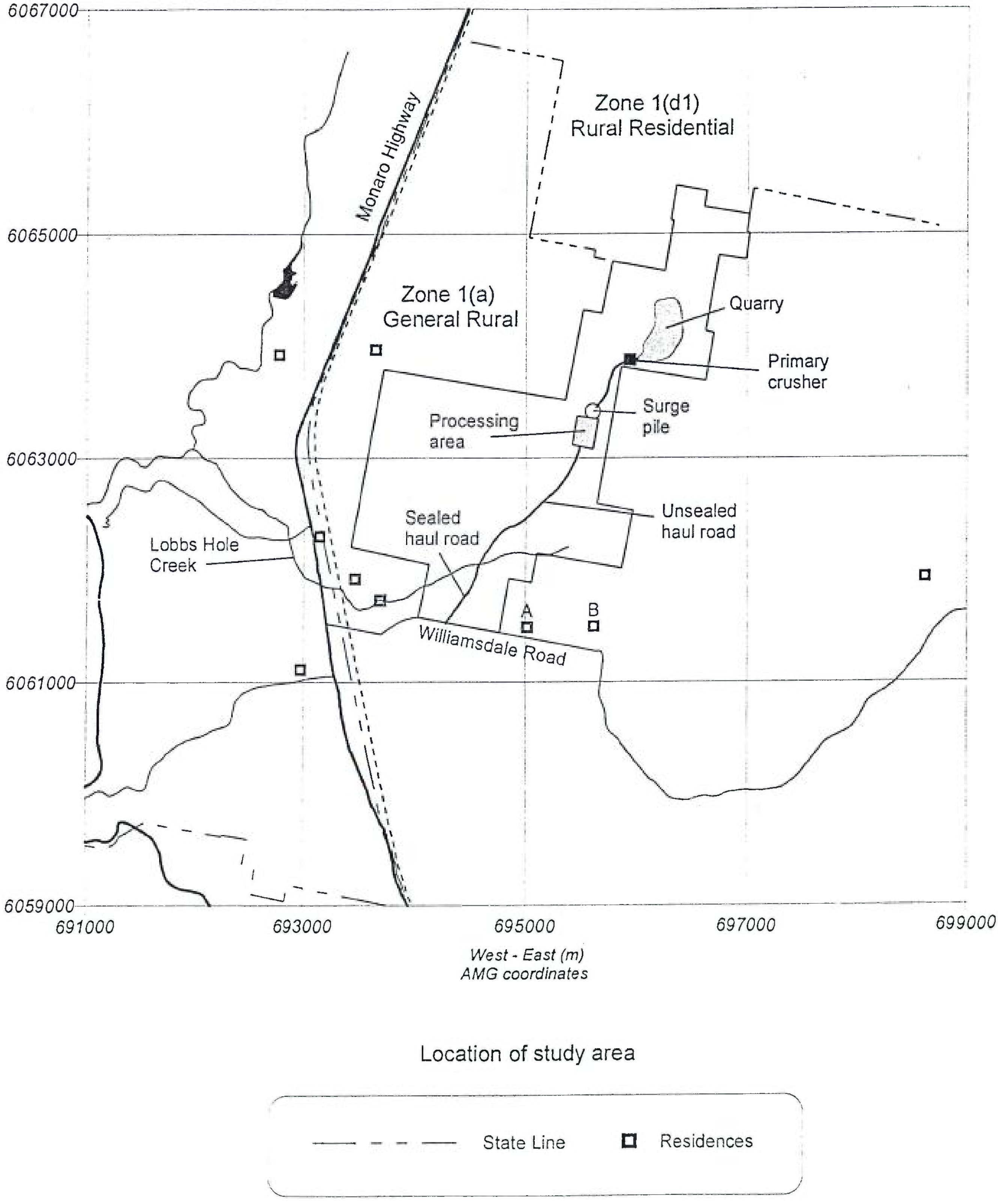
f = the percentage of time the wind speed is above 5.4 m/s.

The equation gives a TSP emission factor of 12.1 kg/ha/day (4,417 kg/ha/year) for s=10% (US **EPA 1995, Table 13.2.2-2**), p=107 and f=13%. Assuming that the disturbed area of pit is 3 ha in Year 30, the annual dust emission will be 13,251 kg/year [4,417 kg/ha/y x 3 ha].

Wind erosion from stockpile area

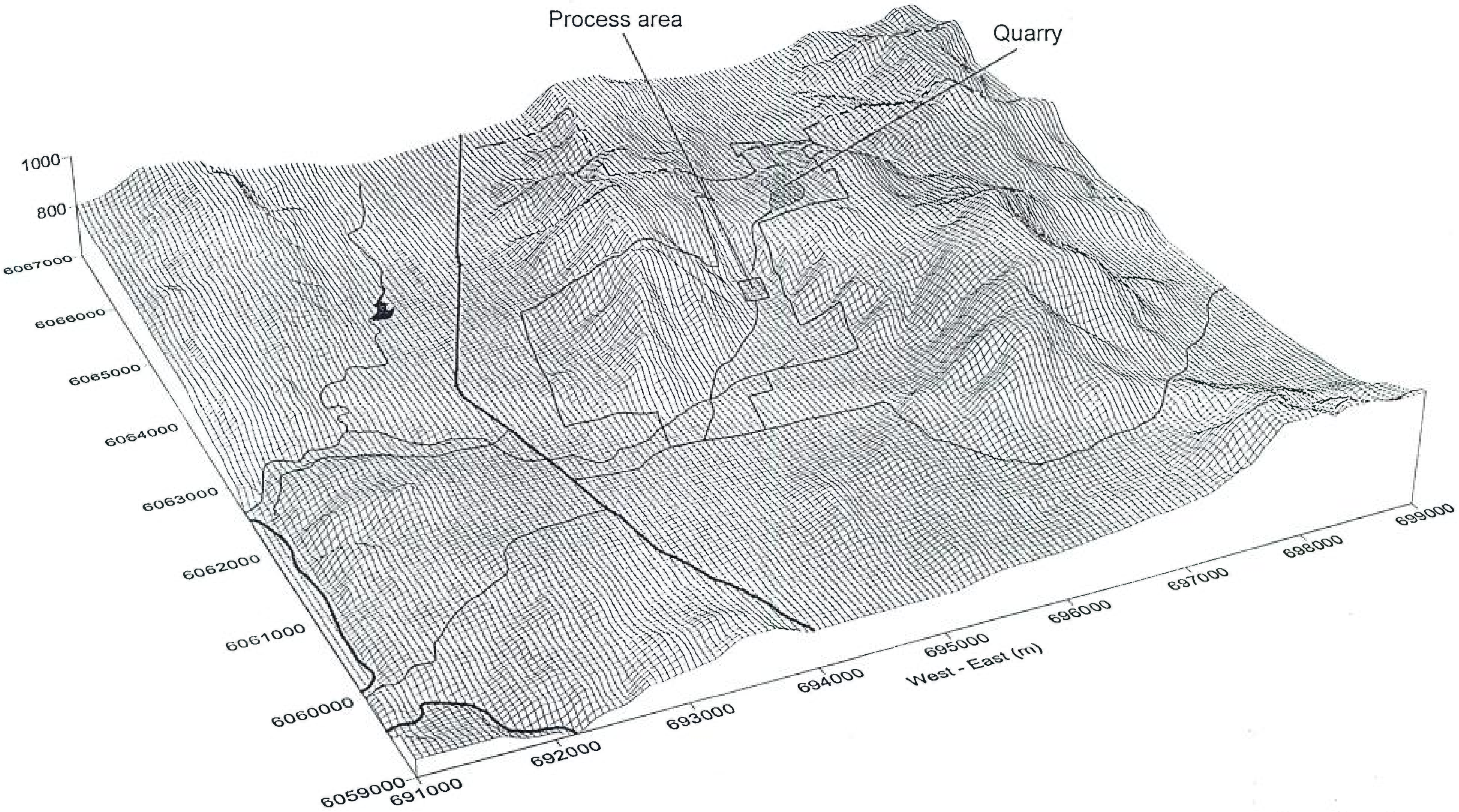
Assuming that the stockpile area is approximately 1.5 ha in Year 30 the annual dust emission will be 4,417 kg/year [6,625 kg/ha/y x 1.5 ha].

FIGURES



Location of study area

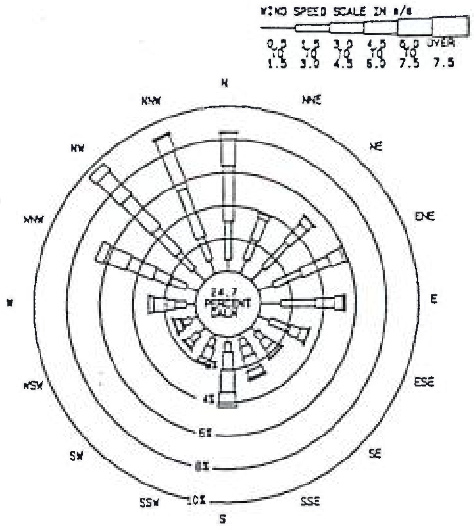
FIGURE 1



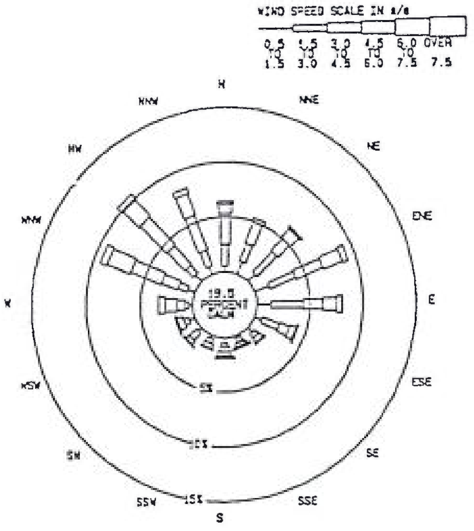
Pseudo three-dimensional plot of local terrain

FIGURE 2

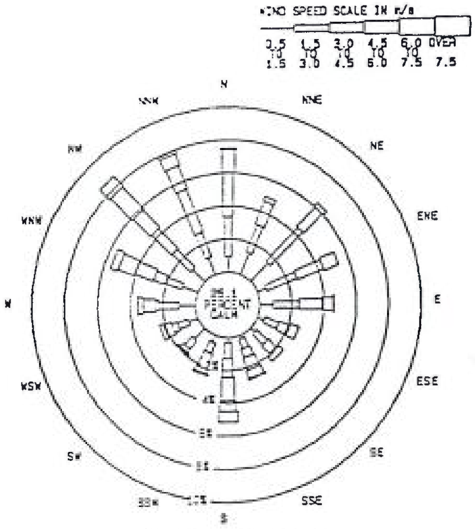
ANNUAL AND SEASONAL WINDROSES FOR TUGGERANONG – 1998



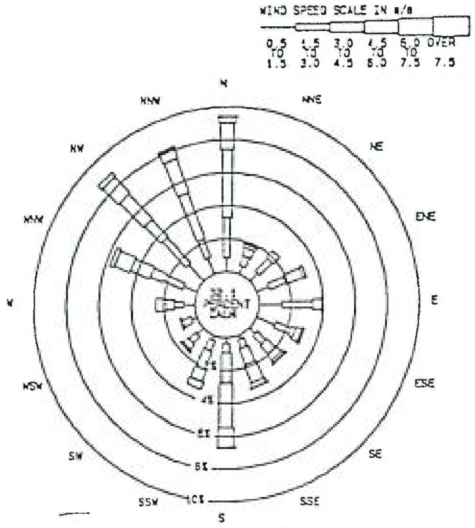
DISTRIBUTION OF WINDS
FREQUENCY OF OCCURRENCE IN PERCENT
Tuggeranong - Annual 1998



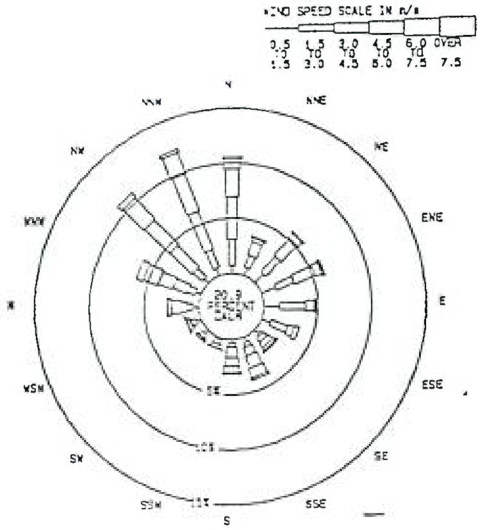
DISTRIBUTION OF WINDS
FREQUENCY OF OCCURRENCE IN PERCENT
Tuggeranong - Summer 1998



DISTRIBUTION OF WINDS
FREQUENCY OF OCCURRENCE IN PERCENT
Tuggeranong - Autumn 1998

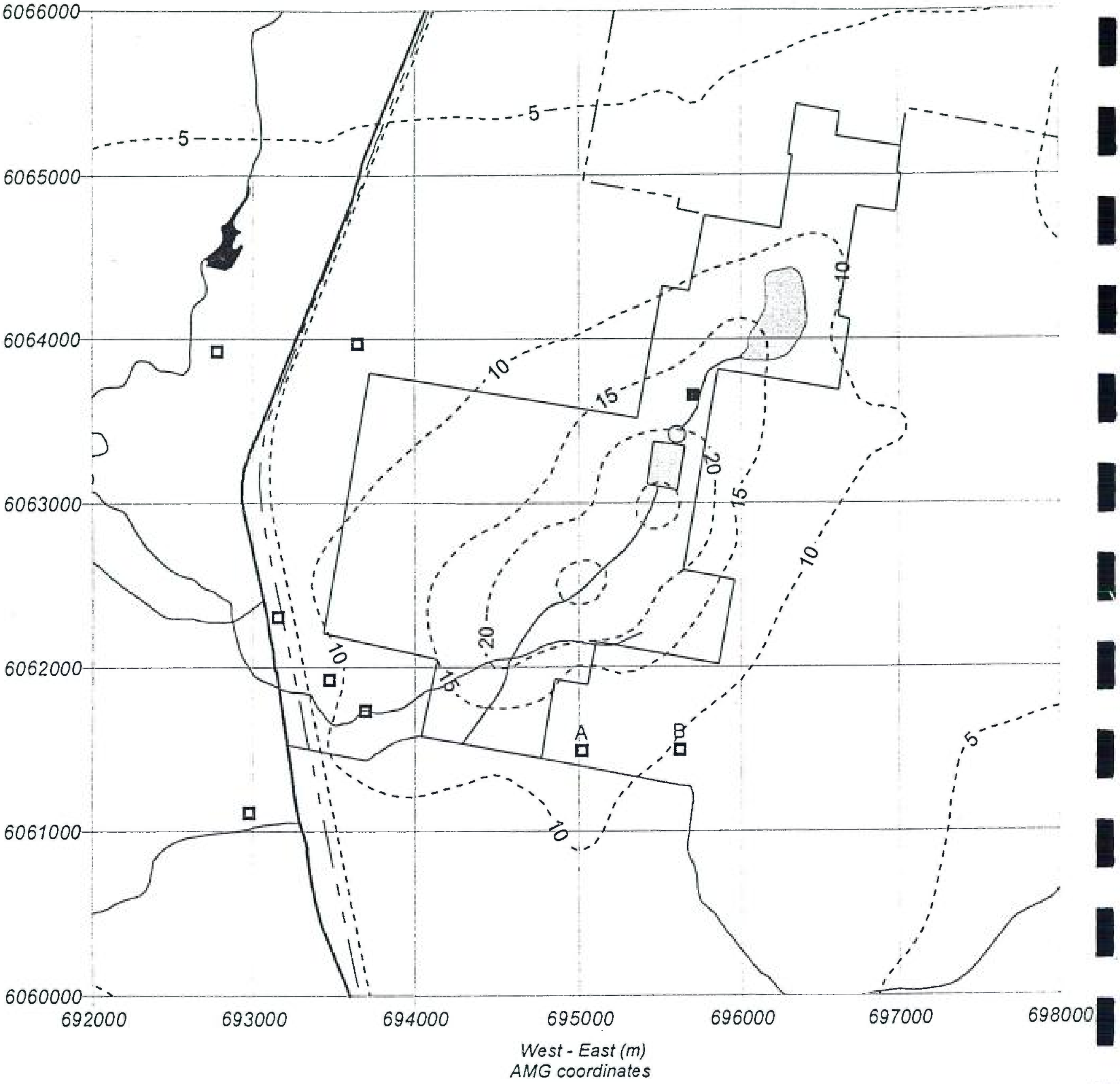


DISTRIBUTION OF WINDS
FREQUENCY OF OCCURRENCE IN PERCENT
Tuggeranong - Winter 1998



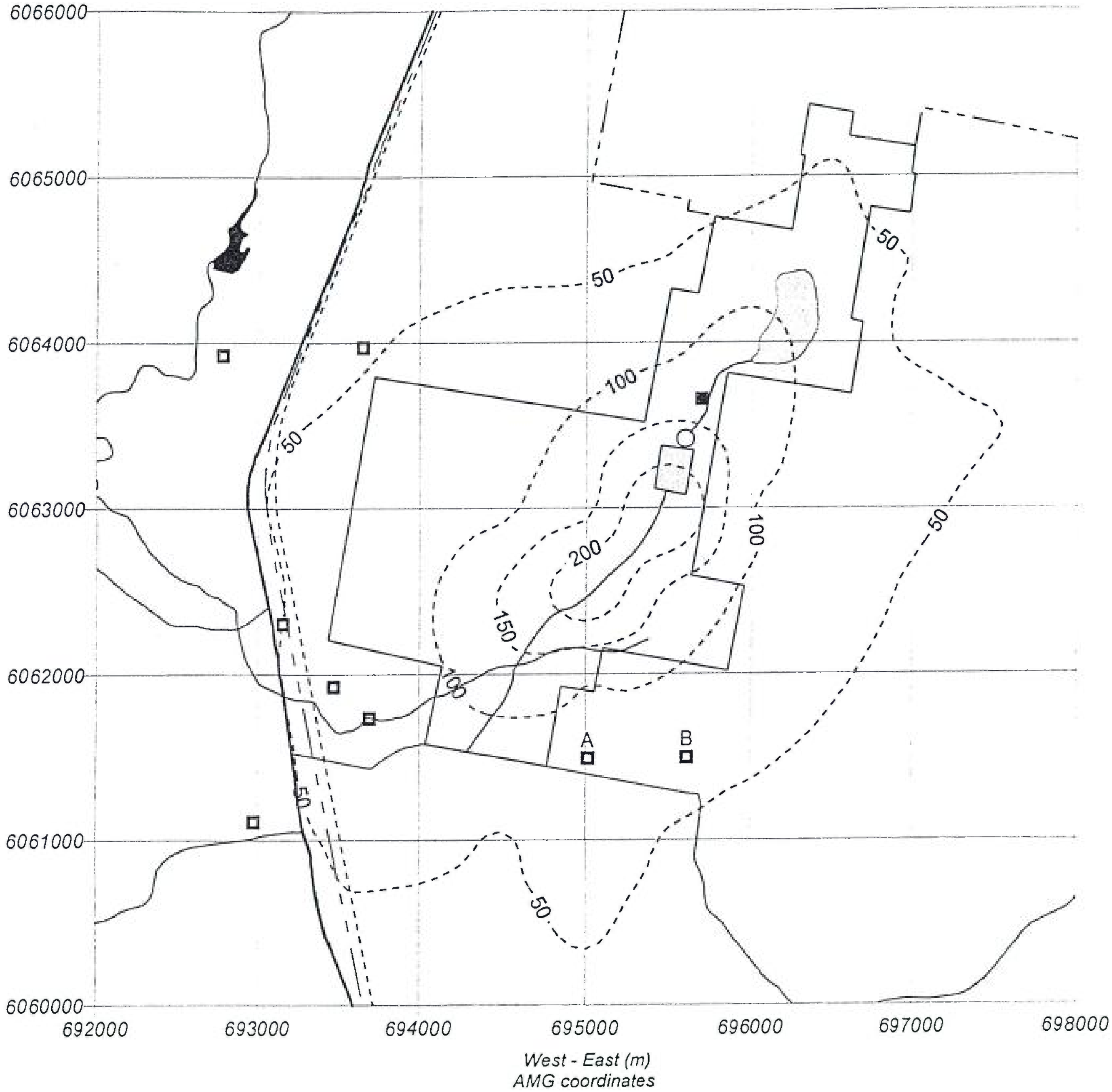
DISTRIBUTION OF WINDS
FREQUENCY OF OCCURRENCE IN PERCENT
Tuggeranong - Spring 1998

FIGURE 3



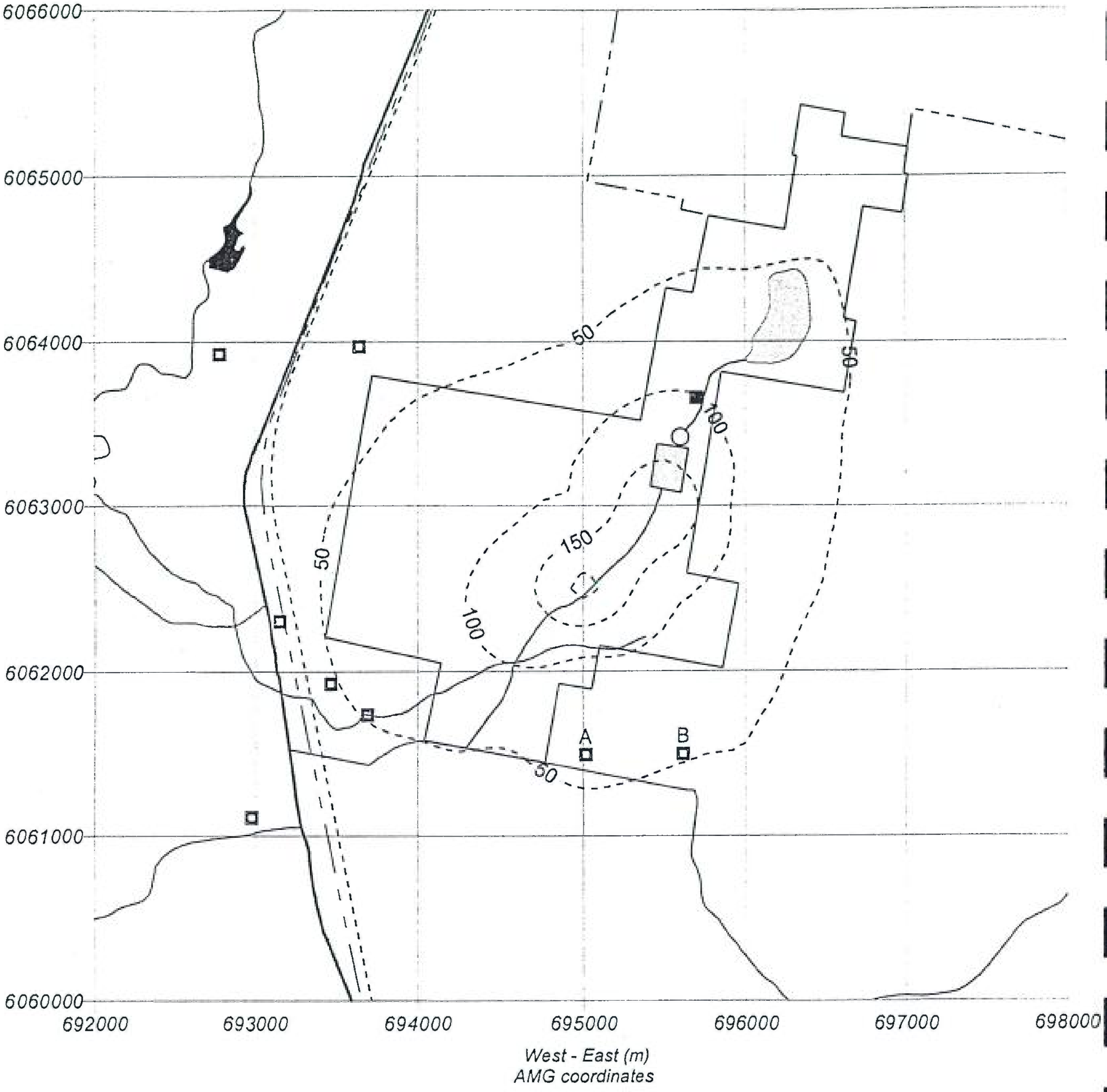
Predicted maximum 24-hour average $PM_{2.5}$ concentration due to operations at the proposed Williamsdale Quarry in Year 30 - µg/m³ (unsealed access road)

FIGURE 4



Predicted maximum 24-hour average PM_{10} concentration due to operations at the proposed Williamsdale Quarry in Year 30 - µg/m^3 (unsealed access road)

FIGURE 5



Predicted 6th highest 24-hour average PM_{10} concentration due to operations at the proposed Williamsdale Quarry in Year 30 - $\mu g/m^3$ (unsealed access road)

FIGURE 6

Time series of predicted 24-hour PM_{10} concentrations for Residences A and B

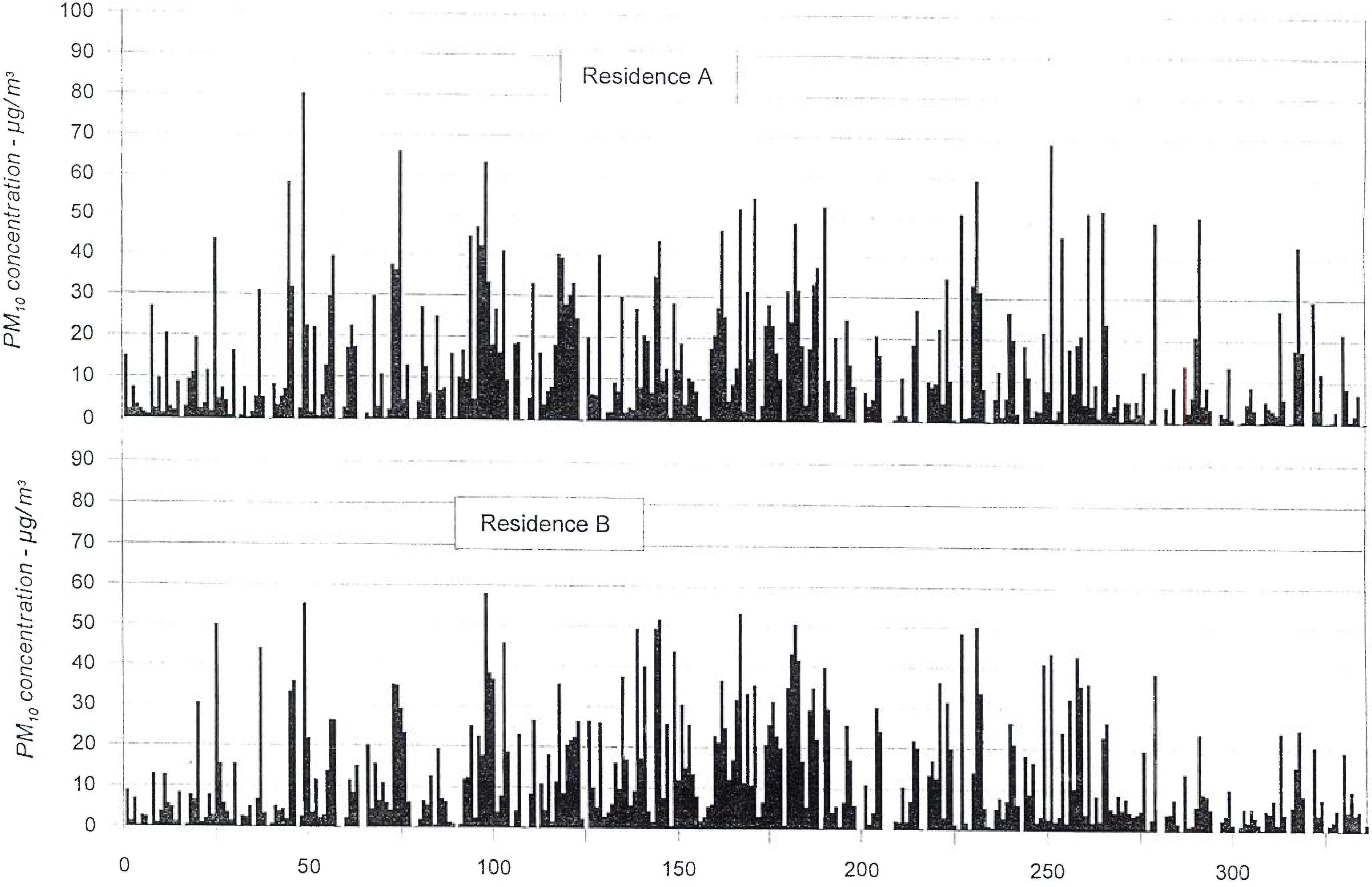
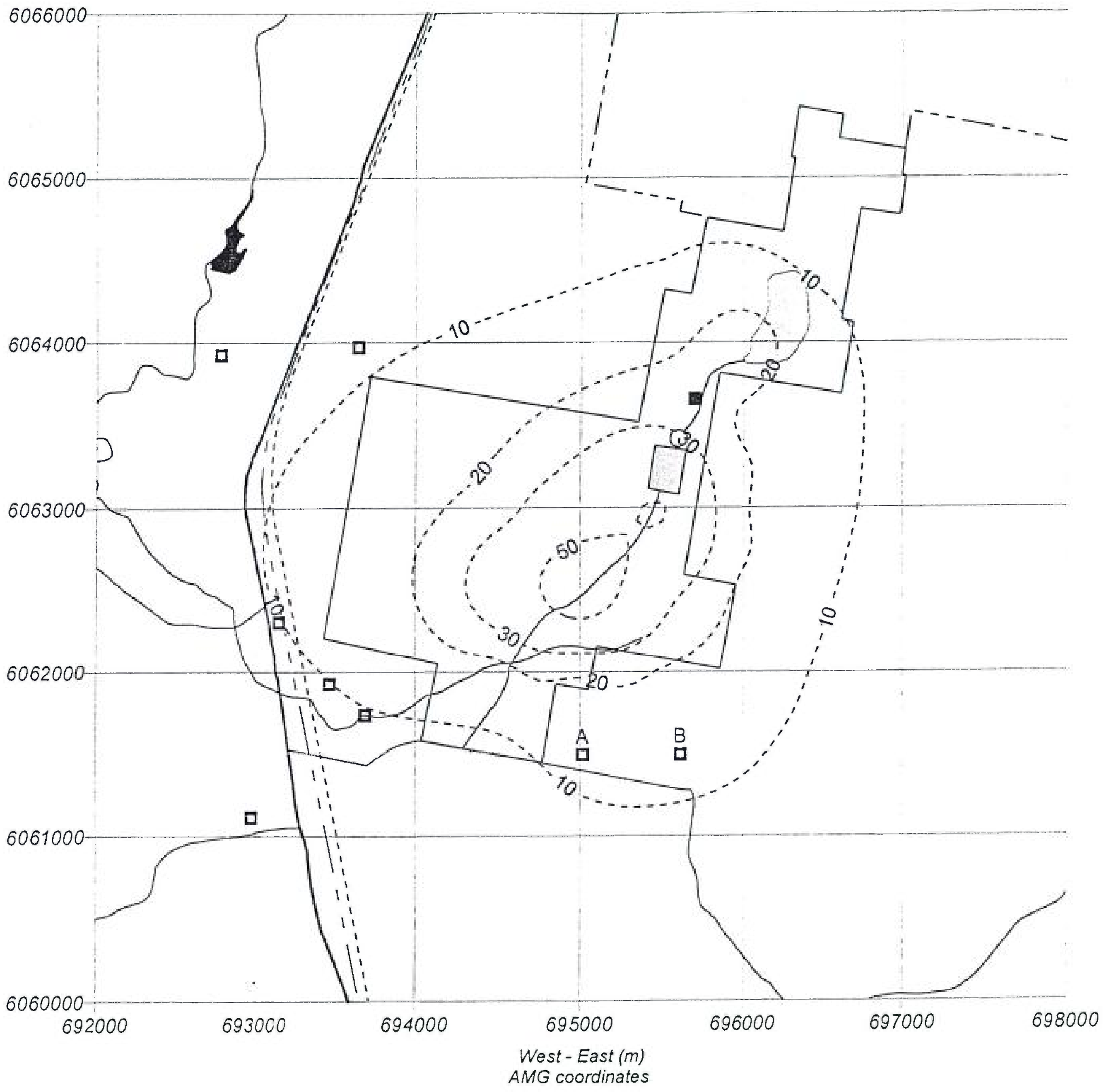


FIGURE 7

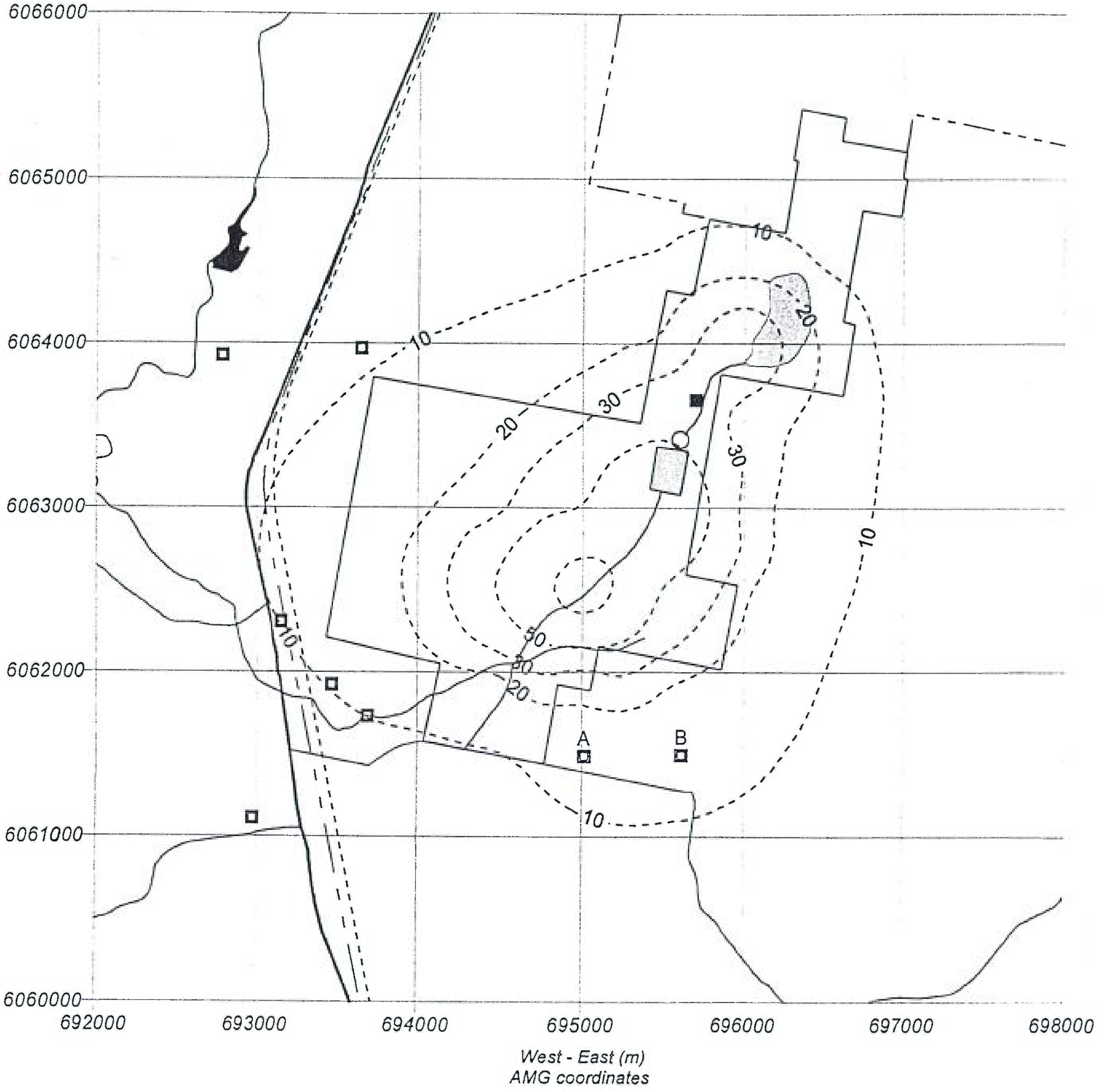
Predicted annual average $PM_{2.5}$ concentration due to operations at the proposed Williamsdale Quarry in Year 30 - µg/m³ (unsealed access road)

FIGURE 8



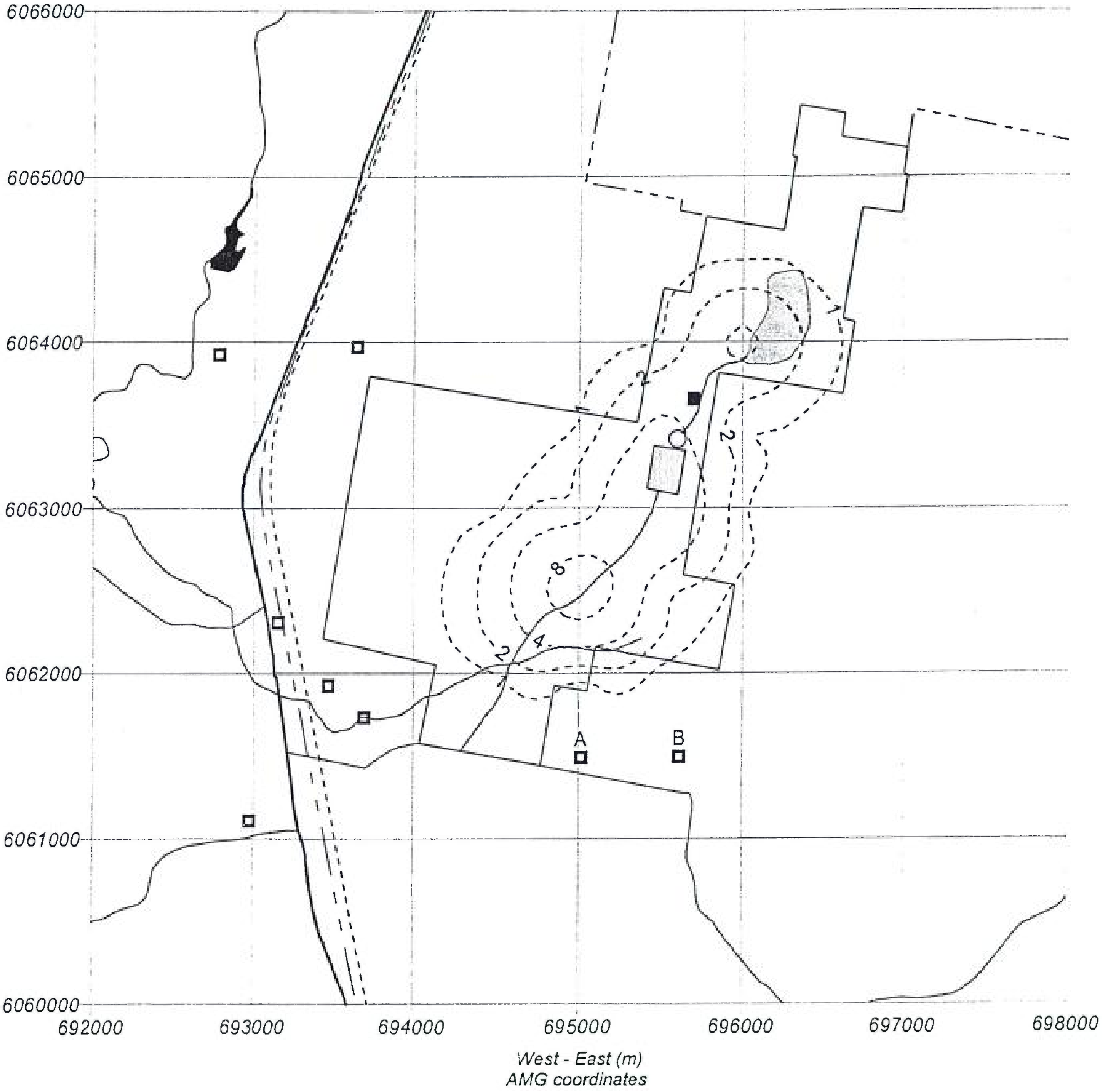
Predicted annual average PM_{10} concentration due to operations at the proposed Williamsdale Quarry in Year 30 - µg/m³

FIGURE 9



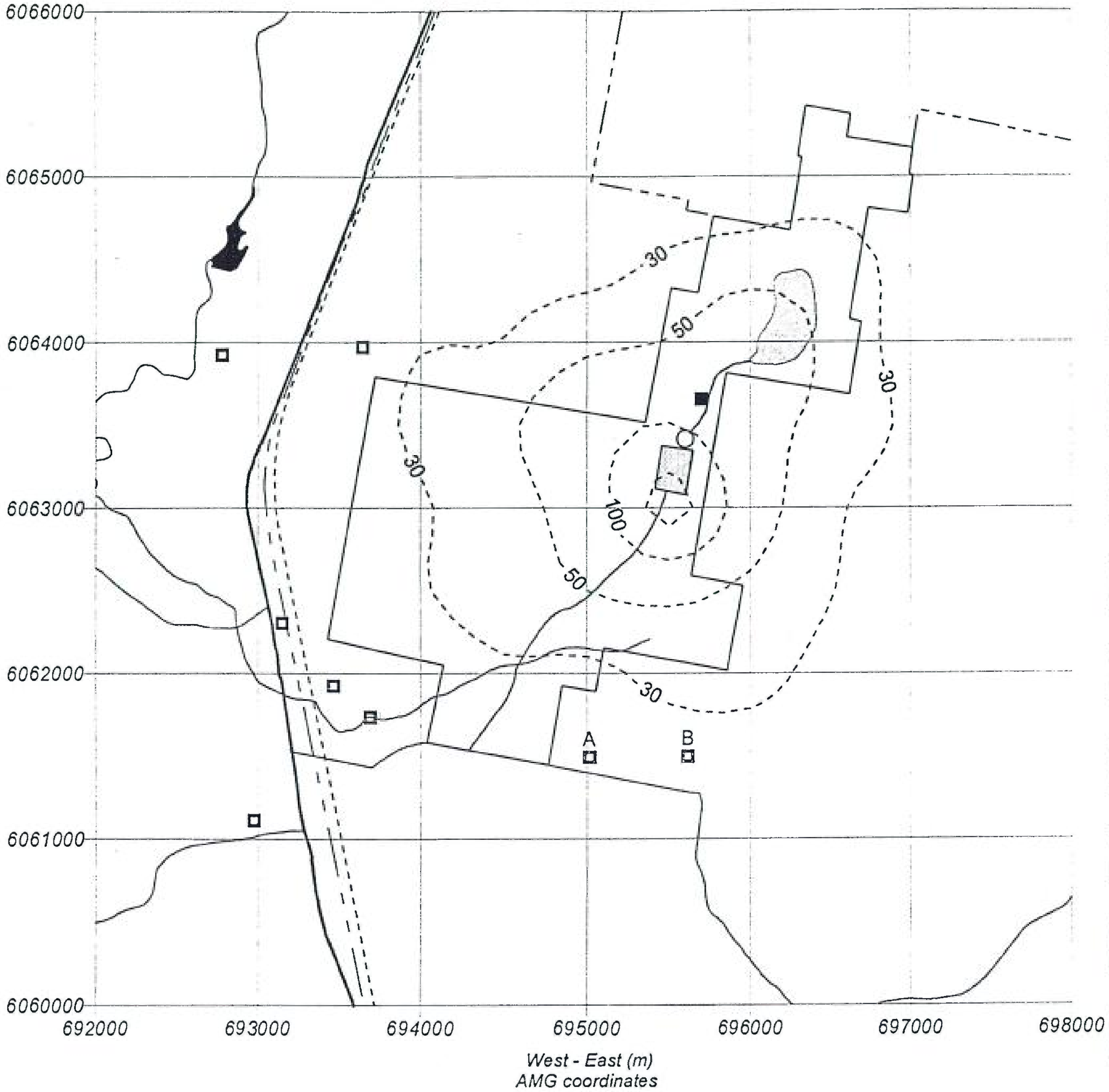
Predicted annual average TSP concentration due to operations at the proposed Williamsdale Quarry in Year 30 - µg/m³

FIGURE 10



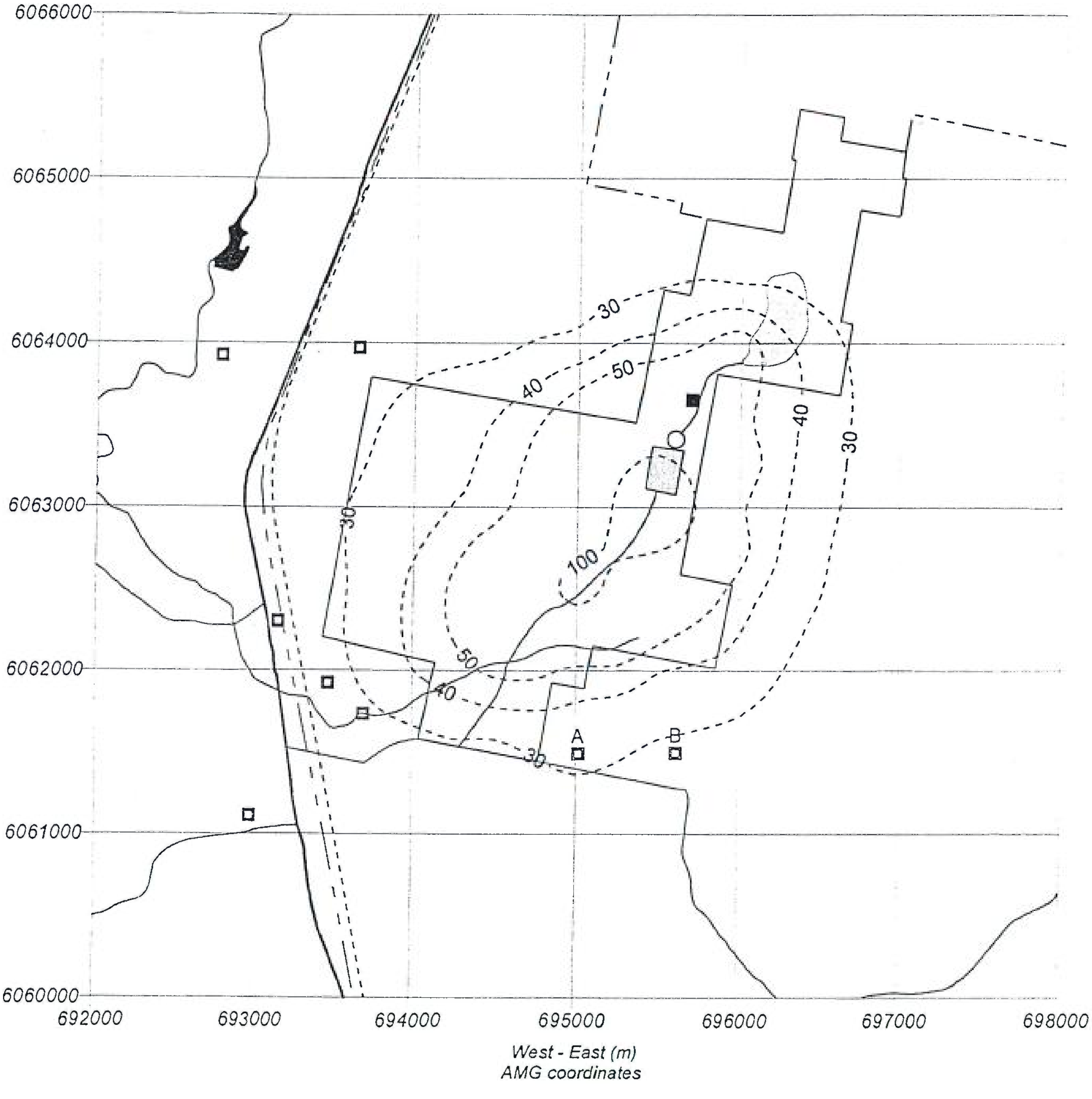
Predicted annual average dust deposition due to operations at the proposed Williamsdale Quarry in Year 30 - g/m²/month (unsealed access road)

FIGURE 11



Predicted 6th highest 24-hour average PM_{10} concentration due to operations at the proposed Williamsdale Quarry in Year 30 - $\mu g/m^3$ (Sealed access road)

FIGURE 12



Predicted 6th highest 24-hour average PM_{10} concentration due to operations at the proposed Williamsdale Quarry in Year 1 - µg/m^3 (unsealed access road)

FIGURE 13

Appendix I - Noise and Blasting Report

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NOISE AND BLAST
IMPACT ASSESSMENT
WILLIAMSDALE HARD ROCK QUARRY
WILLIAMSDALE

29.4875.R1:GA108
Rev 01

Prepared for: International Environmental Consultants
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March 1999

CONTENTS

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LIST OF TABLES

APPENDICES

1.0 INTRODUCTION

Atkins Acoustics and Associates was commissioned by International Environmental Consultants Pty Ltd. to conduct a noise and blast impact assessment of the proposed Williamsdale hard rock quarry.

This report presents the results, findings and recommendations of the noise and blast assessment. The main aims of the study were to;

- ☐ inspect the site and identify nearby residential dwellings potentially exposed to the noise and blast emissions from the proposal,
- ☐ measure, review and comment on the existing ambient background noise level prevailing in the vicinity of the site,
- ☐ recommend noise and blast assessment goals,
- ☐ identify and quantify the main noise sources associated with the proposal,
- ☐ predict and evaluate the likely range of noise and blast emissions,
- ☐ assess the noise and blast impacts,
- ☐ prepare noise contour plots for the quarry operations under varying climatological conditions, and
- ☐ recommend ameliorative noise and blast control measures where practical and cost effective.

The information presented in this report has been prepared for the particular investigation described herein, and should not be used in any other context or for any other purposes.

2.0 SITE DESCRIPTION AND PROPOSAL

2.1 The Site

The proposed quarry will be located approximately two point five (2.5) kilometres west of the Monaro Highway (Fig 1) and two point six (2.6) kilometres north of Williamsdale Road. The quarry processing plant will be located approximately one point seven (1.7) kilometres north of Williamsdale Road. The quarry will be located within Lots 122, 123, 103 and 194, the processing plant is on Lot 119.

2.2 Description of Proposal

It is proposed to quarry an area of approximately seventeen (17) hectares. The first stage quarry and plant development will produce an average production of 500,000 tpa with a maximum production rate of 630,000 tpa. The primary processing plant will be designed to produce 450 - 500 tph, the secondary/tertiary plant will be designed to initially produce approximately 250 tph.

Provision will be made in plant design to increase the capacity of the secondary/ tertiary plant from 300 tph to 400 tph at some time in the future if market demand is sufficient to justify additional investment.

2.3 Site Development

As part of the site establishment;

☐ Williamsdale Road and the existing railway crossing will be upgraded.

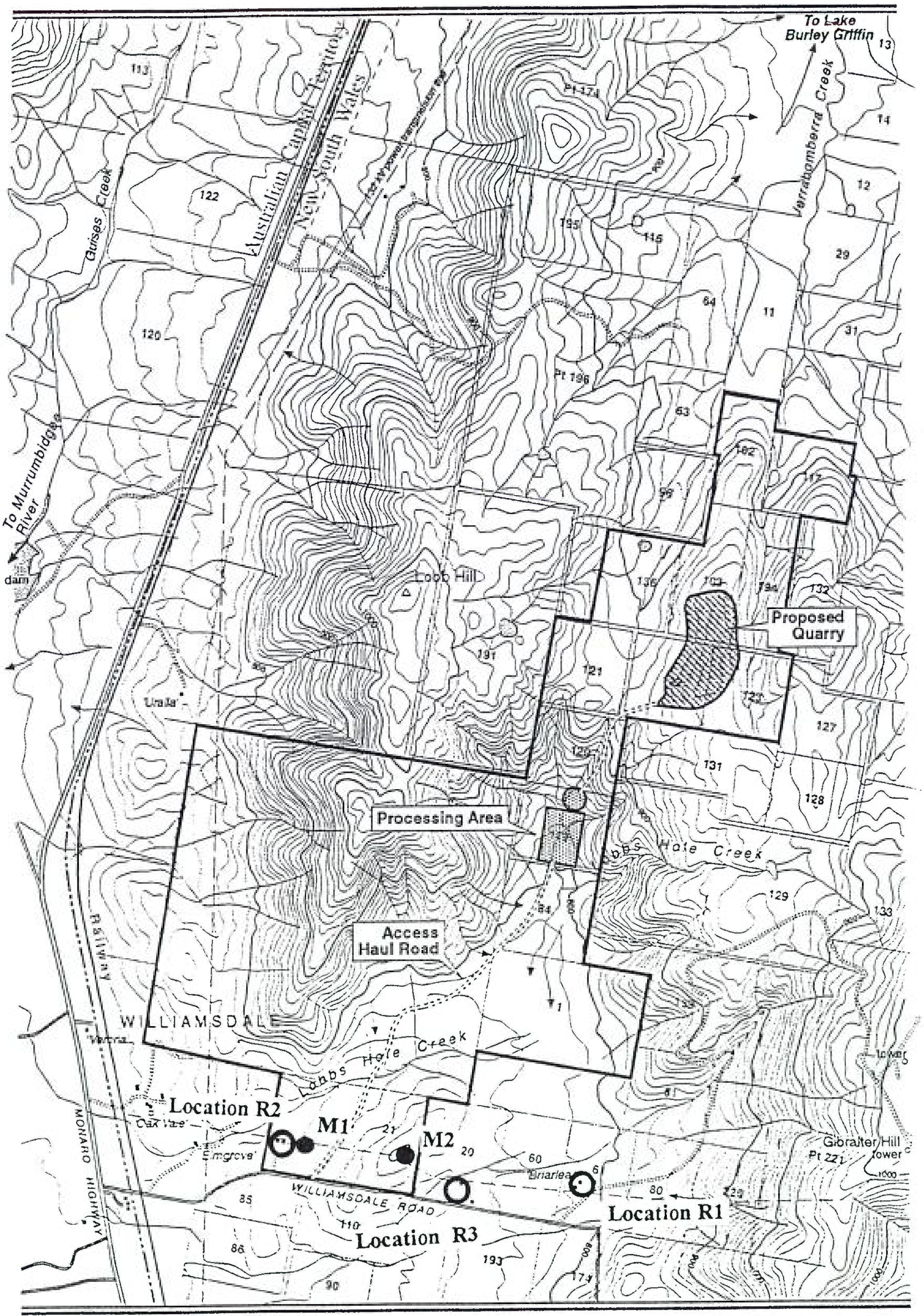
☐ a site access road will be constructed from Williamsdale Road.

☐ a working area will be prepared to construct the processing plant and stockpile areas.

☐ a service road linking the processing plant with the quarry (bench by bench) will be constructed.

☐ stripping of overburden will be undertaken to expose working faces to create two or more quarry working benches within the designated quarry boundaries.

Figure 1: Site Location



Topographic map source Williamsdale 1 25000 8726-4-N

0 500 1000m

1: 25,000

N

Local Setting and Proposed Layout

2.4 Quarry Development

ECSI Mining Consultants have established a thirty (30) year mining plan for the quarry. The plan basically involves the following:

2.4.1 Stripping

- ongoing stripping (preceding drilling and blasting) to remove soil overburden and weathered rock overburden.

- overburden removal using probably a 40-60 tonne excavator and two or three 15-30 tonne "off-highway" trucks.

2.4.2 Drilling and Blasting

The drilling and blast plan will generally involve;

- drilling and blasting faces as shown in the quarry plans, noting that development will be top to bottom. The quarry design will generally be based on 15m bench heights and minimum 15m bench widths.

  The final drill and blast design will be determined by:
  - cost per tonne of rock on ground
  - environmental impact (ground vibration and over pressure/MIC's etc)
  - rock fragmentation

- Hydraulically powered rigs with necessary sound suppression/dust collection, etc will undertake drilling.

- secondary breakage of oversized rock in the quarry will normally be undertaken with a hydraulic rock breaker, although there may be times where explosives will be used.

2.4.3 Face Loading

The quarried materials will be loaded by front end loader (FEL) or face shovel from quarry floors at the base of 15 m faces to either;

- a primary crusher and/or
- into 50 tonne dump truck/s and transported to the primary crusher

2.4.4 In-Pit Primary Crushing

The primary crusher will be located as shown on the quarry plans within approximately 400 m of the main processing plant. The capacity of the plant will be 460 tonne per hour.

2.5 Secondary and Tertiary Process Plant

2.5.1. Crushing and Screening

The first stage secondary and tertiary crushing and screening plant capacity will be approximately 250 tph. The plant will comprise secondary cone crusher/s and tertiary impact (vertical shaft crusher/s) and all associated screens, conveyors etc.

Crushed and screened product will be conveyed up to overhead bins (approximately 35 tonnes) for aggregate storage, blending, truck loading etc.

Diesel fuel generator located at central point and adjacent to secondary and tertiary plant will power the plant.

2.5.2 Product Stockpiling and Outloading

Finished products produced from the quarry will include a range of single sized and blended aggregates, blended road bases, crusher dust, and other (gabion, ballast, etc)

Blending will be achieved by a conveyor running underneath individual bins to a pug mill (for blending and stabilisation of product) and/or by front-end loader.

Aggregates will be stockpiled by ground a conveyor (ex blending bins) for subsequent loading to the sales trucks by front-end loader. The blended materials will be similarly ground stockpiled and loaded by front-end loader.

Total stockpiles of ground stored material to be set at minimum 100 000 tonnes, and maximum 300 000 tonnes.

2.6 Mobile Plant and Equipment Schedules

Plant and equipment that will be used to win, load, and cart the rock will typically comprise:

2.6.1 Quarry Face

☐ Gardner Denvor 3500 hydraulic drill rig or equivalent.
☐ 2 x 50 tonne dump trucks (Cat 773) or equivalent
☐ Face Loader (Cat 988 FEL) or equivalent
☐ Water Truck
☐ Diesel Generator (500 kVA)

2.6.2 Processing Plant

☐ Sales Loader (Cat 972 G FEL) or equivalent
☐ Diesel Generator (800kVA)

2.7 Hours of Operation

The hours of operation for the quarry will be principally governed by the market demand for raw material and the site's ability to meet that demand.

Construction Phase - 7.00am to 7.00pm Monday to Friday
- 7.00am to 5.00pm Saturday, plus Sunday if possible
- 12 week construction program

Operational Phase:

Quarry Extraction - 6.30am to 6.00pm Monday to Friday.
Processing Plant - 6.30am to 6.00pm Monday to Friday, 7.00am to 1.00pm Saturday
Maintenance - Scheduled for Sunday 7.00am to 1.00pm but could occur anytime in emergencies.
Truck Dispatch - 6.30am to 6.00pm Monday to Friday with approval for up to 24hrs/day.
Drilling - correspond to quarry extraction hours.
Blast Frequency - 1.5 to 2.5 weeks, blast design to be confirmed.

2.8 Truck Movements (Internal Haul Road)

For the predicted annual tonnage (100,000-300,000 tpa) there will be an average of between 9-27 loads of rock per day which equates to between 18-54 truck movements on the internal haul road per day, the average movements per hour will be between 4 to 5.

2.9 Extraction Methodology

The stripped hard rock will be quarried in benches by drilling and blasting. The drill and blast design has been (and will continue to be) primarily determined by the following:

- ☐ site topography
- ☐ site geology
- ☐ material production and market demand
- ☐ size of primary jaw crusher
- ☐ environmental and safety constraints.

Drilling will be carried out by hydraulic equipment. The drill rig employed at the quarry will be chosen and configured to match the production and environmental requirements of the job at any given time.

Blast monitoring will be conducted on all blasts as a matter of standard practice. MIC and other blast factors will be controlled to ensure compliance with EPA guidelines. Standard quarry practice will include the following:

- ☐ blasts will be conducted between the hours of 9.00 am and 3.00 pm, wherever possible.

- ☐ nearby residences will be advised of blast times as will the times be displayed on a board at Williamsdale Road boundary gate

- ☐ blasting will be avoided in adverse meteorological conditions wherever possible fly rock will be minimised/eliminated by adequate stemming of drill holes (using 14 mm crushed aggregate) and by careful monitoring of the drilled burden to avoid substantial cracks, fissures, and other face conditions that may allow premature fragmentation/escape of explosive energy. Quarry practices such as deck loading will be utilised to avoid such weaknesses.

☐ Ground vibration will be minimised by paying particular attention to critical factors such as:

- the confinement of the explosive charge
- the detonation efficiency of the charge, and
- the degree of water saturation in the ground at the time.

☐ Airblast overpressure will be similarly controlled with particular attention being paid to:

- blast hole diameter
- explosive strength
- concentration in blast holes
- the use of air decks etc.

☐ Secondary breakage of oversized rock is expected to be done mechanically (by hydraulic rock breaker), as opposed to secondary blasting.

With regard to explosive type and initiation system a number of options are available to ensure maximum control. Three (3) basic options will be trialed as bulk explosive these being ANFO, Handibulk dry and Handibulk wet (or equivalent). Final selection will relate to fragmentation, environmental impact and cost.

It is initially intended to use non-electric (or Nonel) detonation system using 9 and 17 ms delays along rows and 42 and 65 ms delays between rows. All holes will be primed using 200-500 ms Nonel detonation and appropriate primers.

Initial blasts will be monitored to provide air blast overpressure and ground vibration data which will allow confirmation of blast design.

3.0 EXISTING AMBIENT NOISE LEVELS

For the noise assessment, the existing ambient background noise levels were measured and recorded from Tuesday 15 December to Tuesday 22 December 1998.

The instrumentation selected for the measurements comprised two (2) RTA Technology Environmental Noise Loggers. Each logger was set to fast response with a fifteen minute sampling period. The reference level of each instrument was checked prior to and after the measurements with a Bruel & Kjaer Sound Level Calibrator Type 4230, and remained within ±0.5dB(A).

The ambient noise levels were measured and assessed as percentile A-weighted sound levels. The parameters regarded as being the most important amongst these, are the "L_{A1}", or the A-weighted sound level exceeded for 1% of the sample period and referenced as the "maximum noise level", the "L_{A10}", or the level exceeded for 10% of the sample period (the "average maximum noise level"), the "L_{A90}", the level exceeded for 90% of the sample period and referenced as the "background or average minimum noise level", and the "L_{Aeq}", which is the A-weighted energy equivalent continuous (constant) sound level.

The locations selected to acquire the ambient noise data are identified as;

1. Lot 22 (Elmgrove Shearing Shed)
2. Lot 21 (Lobbs Hole)

The locations are shown on Figure 1.

3.1 Results

The site audits and ambient noise measurements confirmed that the existing noise in the area is typically rural with distant road traffic noise (Munro Highway), local domestic and natural elements such as wind, birds, animals, etc.

The results of the ambient noise measurements are presented in graphic form in Appendix 1, to show the trend in the daily noise levels over twenty-four (24) hour periods.

Table 1 presents a summary of the background (L_{A90}) noise levels determined as the lowest repeatable for the day, evening and night periods.

Table 1: Ambient Background (L_{A90}) Noise Measurement Results
dB(A) re: $20x10^{-6}$ Pa

Assessment Location	Time Period		
	Day 6.00am - 6.00pm	Evening 6.00pm-10.00pm	Night-time 10.00pm-6.00am
Location M1	29	29	29
Location M2	29	29	28

Notes:

(i) The EPA,ENCM (Chapter 19) states that where the existing background noise level is less than 30dB(A), then 30dB(A) should be assumed to be the background noise level.

4.0 NOISE and BLAST ASSESSMENT GOALS

For the assessment of environmental noise and blast emissions from a new quarry proposal, it is accepted practice to evaluate the noise in terms of the existing ambient noise level, noise planning goals, and blast emission goals recommended in the Environment Protection Authority (EPA), Environment Noise Control Manual (ENCM).

4.1 Operational Noise

4.1.1 EPA Assessment Goals

For the assessment of quarry noise emissions, the EPA, Environmental Noise Control Manual recommends that the noise should not exceed the background noise level by more than 5dB(A), and that the resultant background noise should not exceed the recommended planning levels. Where the background plus 5dB(A) approach results in an exceedance of the acceptable planning level the procedures of the EPA,ENCM (Chapter 20) should be considered to control "creeping" background noise.

In terms of planning goals, the EPA, ENCM (Chapter 21) recommends the following background noise levels.

Table 2: Recommended Outdoor Background Noise Levels

R 0 W	Zoning of noise receiver area	Predominant land use of Receiver area	Time Period	L_{90} background noise level dB(A)	
				Acceptable Limit	Extreme Limit
(a)	Rural (approx R1 AS1055)	Residential, church, hospital	Day Evening Night	45 40 35	50 45 40

4.1.2 Recommended Operational Noise Assessment Goals

Based on the EPA guidelines and the existing background noise levels, Table 3 presents the operational noise goals recommended for the quarry proposal.

Table 3: Operational Noise Goals
L_{A10} dB(A) re: $20x10^{-6}$ Pa

Assessment Location	**Time Period**		
	Day 6.00am - 6.00pm	**Evening 6.00pm-10.00pm**	**Night-time 10.00pm-6.00am**
Location M1	35	35	33
Location M2	35	35	33

4.2 Road Traffic Noise

Where traffic flow is continuously low as for the proposal, the EPA recommend the use of the L_{Aeq} and L_{Amax} descriptors.

From the EPA, ENCM $^{(Chapter\ 157)}$ the noise goals for low traffic flows in rural areas are $L_{Aeq.\ 1\ hour}$ 50dB(A) for new developments, $L_{Aeq.\ 1\ hour}$ 55dB(A) for existing developments and for night time operations the L_{Amax} level should not exceed the background (L_{A90}) level by more than 15dB(A) when measured at any residential building.

From the background noise measurements results (30dB(A)), the goals proposed to assess the truck noise from the access road are $L_{Aeq,1hr}$ 50dB(A)and L_{A1} 45dB(A).

4.3 Blast Emissions.

For the assessment of the blast emissions in terms of human discomfort, the EPA, ENCM recommend that airblast overpressure and ground vibration when measured at any affected residence should not exceed the goals summarised in Table 4.

In the application of the EPA goals, it is accepted that there could be some exceedances of the airblast overpressure goals of 115dB(lin) on infrequent occasions. This should be limited to not more than 5% of the total number of blasts and should not exceed 120dB(lin) at any time. In regard to ground vibration, the EPA accept that the 5mm/sec goal can be exceeded, by no more than 5% of the total number of blasts with a limit of 10mm/sec at any time.

Table 4: Blast Emission Goals

Time of Blast	Airblast Overpressure (dB(lin))	Ground Vibration peak particle velocity (mm/sec)
Monday - Saturday 9.00am - 3.00pm	115	5
Monday -Saturday 6.00am -9.00am 3.00pm - 8.00pm	105	2
Sunday / Public Holiday 6.00am - 8.00pm Any day 8.00pm - 6.00am	95	1

4.4 Construction Noise

For the assessment of construction noise impacts during the quarry preparation (approx 12 weeks), the following EPA, ENCM(Chapter 171) goals have been considered;

1. **Construction periods of 4 weeks and under**
   The $L_{A10,15min}$ noise level from the construction activities should not exceed the background level by more than 20dB(A).

2. **Construction periods greater than 4 weeks and less than 26 weeks**
   The $L_{A10,15min}$ noise level from the construction activities should not exceed the background noise level by more than 10dB(A).

From the ambient noise measurements the recommended construction noise goals are summarised in Table 5.

Table 5: Construction Noise Goals
L_{A10} dB(A) re: $20x10^{-6}$ Pa

Construction Period	Sound Pressure Level L_{A10} dB(A) re: 20×10^{-6} Pa
	7.00am - 7.00pm
4 weeks and under	50
between 4 - 26 weeks	40

5.0 SITE PLANT AND EQUIPMENT

Noise and blast emissions from the proposed quarry have been modelled and assessed in terms of continuous noise from the fixed and mobile pant, traffic noise from truck movements, airblast overpressure and ground vibration from blasting.

5.1 Quarry Operations

The main quarrying plant of acoustical significance that will be operated on the site will consist of loaders, quarry trucks, a primary crusher, rock breaker, generator, conveyors and a hydraulic drill. For the assessment of noise emissions from this plant, the following sound power levels have been established from previous field measurements.

Table 6: Quarry Plant Sound Power Levels

Plant Description	Sound Power Level dB(A) re: 10^{-12} Watts								
	dBA	63	125	250	500	1k	2k	4k	8k
Primary Crusher	115	113	108	112	110	110	108	107	102
Loader	111	89	91	99	101	106	106	103	98
Rock Breaker	116	111	114	114	111	106	111	107	100
Conveyors (2 off)	100	96	100	96	92	89	91	93	87
Generator	105	97	103	102	101	100	98	89	86
Hydraulic Drill	110	110	113	107	109	104	103	96	92
50 tn Haul Truck	112	102	104	104	108	107	106	103	94

5.2 Processing Plant

The main processing quarry plant of acoustical significance that will be operated on the site will consist of crushers, screens and conveyors. In terms of mobile plant, the loaders, and quarry trucks are the main items of plant that have been considered. For the assessment of noise emissions from this plant, the following sound power levels have been adopted.

Table 7: Plant Sound Power Levels

Plant Description	Sound Power Level dB(A) re: 10^{-12} Watts								
	dBA	**63**	**125**	**250**	**500**	**1k**	**2k**	**4k**	**8k**
Secondary Crusher	115	113	108	112	110	110	108	107	102
Tertiary Crusher	111	89	91	99	101	106	106	103	98
Pug Mill	112	95	94	99	102	110	108	105	99
Screens	112	95	98	102	108	106	107	103	97
Conveyors (2 off)	100	96	100	96	92	89	91	93	87
Loader (Cat 988)	104	101	112	101	102	99	96	91	86
Generator	105	97	103	102	101	100	98	89	86
Quarry Truck	106	96	98	98	102	101	100	97	88

5.3 Transient/ Intermittent Truck Noise Sources

It is envisaged that the quarry could generate on average up to eighty-eight (88) off site truck movements per day, or up to twelve (12) movements per hour. The projected maximum number of movements is one hundred and seventy six (176) per day or twenty (20) per hour.

Transient/intermittent noise from the quarry is associated with truck movements. Table 8 presents a summary of the sound power levels adopted for the assessment of the truck noise levels.

Table 8: Truck Noise Sound Power Levels
dB(A) re: 10^{-12} Watts

Plant Description	Sound Power Level dB(A)							
	dB(A)	**63**	**125**	**250**	**500**	**1K**	**2K**	**4K**
Truck (SEL)	114	109	110	112	111	109	106	104
Truck (L_{Amax})	110	100	101	100	99	110	96	91

5.4 Blast Design

For assessing the likely effects from the quarry blasts, it has been assumed that the following blasting pattern would be employed during the initial blasts.

Table 9: Initial Blast Design

Description	Material	Design
Number of holes per blast		60
Number of Rows		5
Subdrilling (1/3 burden)		1m
Total depth of holes (face height + 1m sub drilling		16m
Bulk explosives density	ANFO Handibulk dry Handibulk wet	0.8 kg/m^3 1.0 kg/m^3 1.2 kg/m^3
Stemming	ANFO Handbulk	2.5m 3.0m
Explosives Column	ANFO Handbulk	13.5 m 13.0 m
Explosives mass per hole	ANFO Handbulk dry Handbulk wet	88 kg 106 kg 127.5 kg
Powder Factors	ANFO Handbulk dry Handbulk wet	0.69 kg/m^3 0.83 kg/m^3 0.99 kg/m^3
Rock yield per hole		128 bcm
Rock yield per m drilled		8.5 bcm
Explosive Mass/blast	ANFO Handbulk dry Handbulk wet	5280 kg 6360 kg 7650 kg
Preliminary MIC	ANFO (3 holes) Handbulk dry (2 holes) Handbulk wet (2 holes)	265 kg 212 kg 255 kg

6.0 SITE NOISE EMISSIONS

6.1 Quarrying Operations

Noise emissions from the site operations were modelled with the EPA approved Environmental Noise Model (ENM) computer model. The model considers attenuation factors such as distance, shielding from working faces, ground coverage, atmospheric absorption, topographical features of the area and building structures.

The noise model input data for the Williamsdale quarry has been based on noise measurements at similar quarries, manufactures specifications, ground contours plotted from 1:25000 topographical maps, ground contour intervals of 10 metres, a grassed ground coverage, shielding provided by the quarry faces and the proposed building structures.

For the computer noise modelling, three (3) weather scenarios were considered;

☐ calm, ie, no wind, relative humidity of 50%, and air temperature of 20 ° C;

☐ wind enhanced, ie., 1m/sec north wind, relative humidity of 50%, and air temperature of 20 ° C;

☐ default temperature inversion conditions, ie., temperature gradient 5°C/100 metres, 50% relative humidity and an air temperature of 20 °.

The quarry development scenarios (Appendices 2, 3, 4, 5 and 6) considered in the noise modelling included:

☐ Stage I -	Before any substantial worked faces are established drilling on exposed areas of the quarry.
☐ Stage II -	Year 5 - with quarry faces established. Drilling on higher benches (RL965) with quarrying at lower level (RL955). Processing plant operating (RL81--813)
☐ Stage III -	Year 10 - with extended quarry faces established. Drilling on higher benches (RL965) with quarrying at lower level (RL940).

Processing plant operating (RL810-813)

☐ Stage IV - Year 25 - with extended quarry faces established. Drilling on higher benches (RL960) with quarrying at lower level (RL955). Processing plant operating (RL810-813)

☐ Stage V - Year 30 - with extended quarry faces established. Drilling on higher benches (RL955) with quarrying at lower level (RL910). Processing plant operating (RL810-813)

The above scenarios generally cover the envisaged situations throughout the life of the quarry. They were selected to present the range of activities, situations and noise levels likely to be emitted from the site.

The assessment was based on the assumption that all the fixed and mobile plant was operating simultaneously. Whilst this working situation will not occur all of the time, for the purpose of the noise assessment the worst case scenario has been presented. Table 10 presents a summary of the predicted noise levels to the following residential assessment locations (Figure 1) for calm weather conditions.

Table 10: Predicted Noise Levels During Calm Weather
dB(A) re: 20 x 10^{-6} Pa

Assessment Location	**Scenario**				
	Stage I	*Stage II*	*Stage III*	*Stage IV*	*Stage V*
Location R1	25	28	28	28	28
Location R2*	<25	<25	<25	<25	<25
Location R3	25	28	26	26	26

* Residence associated with quarry proposal

Perusal of the results summarised in Table 10 will show that during calm weather conditions no criterion exceedances occur.

In assessing the above noise predictions, consideration should be given to the effects of wind and temperature inversions. The two (2) effects warrant comment; light northerly wind, and temperature inversions.

The results of the Stage III quarry noise modelling under the influence of calm, wind and temperature inversion conditions are presented as noise contours in Appendices 7, 8 and 9. The modelling has shown that both down wind and temperature inversion effects result in an increase in noise levels of between 10-12dB(A).

Considering the recommended noise controls and given that the predicted exceedances are under limited climatological conditions, in our opinion the operation of the quarry is not likely to result in an unacceptable noise impact at residential dwellings.

6.2 Road Traffic Noise

For the assessment of truck noise, previous studies undertaken by Atkins Acoustics have established that the single event sound power level (SEL) from a typical truck is 114dB(A).

For the evaluation of truck noise on the site access road, the assessment has considered the above SEL, the assumption that the proposal could generate up to twenty (20) truck movements per hour and the following relationship:

$$L_{Aeq,1hour} = \mathbf{SEL+10\log(N) - 10\log(3600) - 20\log(r) - 8}$$

where:
SEL = sound exposure level
N = number of events per hour
3600 = number of seconds in 1 hour
r = distance from road
8 = constant for converting sound power levels to sound pressure levels.

The predicted noise levels from the projected truck movements are summarised in Table 11.

Table 11: Predicted Truck Noise Levels

Reference Location	Distance (m)	Sound Pressure Level $L_{Aeq,1hour}$
Location R1	1150	22
Location R2*	250	35
Location R3	600	23

* Residence associated with quarry proposal

The results in Table 11 confirm that the noise from trucks on the site access road satisfy the EPA $L_{Aeq,1hour}$ 50dB(A) goal.

6.4 Intermittent Truck Noise Sources

In regard to maximum noise levels generated from trucks on the site access road, the noise modelling has shown that the noise contributions (Table 12) satisfy the assessment goals at locations R1 and R3, and exceed the assessment goal at location R2.

Table 12: Intermittent Transient Noise Sources
L_{Amax} dB(A) re: $20x10^{-6}$ Pa

Plant Description	Sound Pressure Levels L_{A1} dB(A)
Location R1	
Truck Noise	41
Location R2*	
Truck Noise	54
Location R3	
Truck Noise	42

* Residence associated with quarry proposal

6.5 Prediction of Blast Vibration and Airblast Overpressure

For the assessment of the range of blast ground vibration and airblast overpressure levels, the modelling has been based on blast data and prediction models previously developed by Atkins Acoustics.

Ground vibration levels are established by determining scaled distances, ie, by dividing the distance from the blast to the reference assessment location by the square root of the maximum instantaneous charge, and calculating the resultant level. With respect to airblast overpressure the scaled distance is calculated by dividing the distance from the blast by the cubed root of the maximum instantaneous charge.

For the Williamsdale quarry the following blast predictive models have been adopted for average and hard rock conditions.

Ground Vibration

$$\mathbf{PPV} = 1140 \times (D/MIC^{0.5})^{-1.6}$$ .....(average rock conditions) . ...**Equation I**

$$\mathbf{PPPV} = 500 \times (D/MIC^{0.5})^{-1.6}$$ .....(hard rock condition)...............**Equation II**

Airblast Overpressure

$$\mathbf{dBL} = 165 - 24(\log_{10} D - 0.3 \log_{10} MIC)$$ ....**Equation III**

where: PPV is the peak particle velocity (mm/s);
dBL is the airblast overpressure (dBL);
D is the distance between the blast and monitoring site (m);
MIC is the weight of explosive per delay (kg).

It is normal practice in the planning of quarry blasts to design the blast utilising time delays to control the maximum instantaneous charge (MIC). For the modelling of the Williamsdale quarry blast a MIC of 265 Kg has been adopted. Based on a 265 Kg MIC and the closest point of the quarry to the nearest residence being 2400 metres, the predicted range of ground vibration levels are between 0.17mm/sec. and 0.38mm/sec., with an airblast overpressure level of 101dB(lin). Both calculations are conservative, as no allowances for shielding from topography or excess ground attenuation from the local geology have been allowed.

For evaluating the predicted blast emissions at the other reference locations, Table 13 presents a summary of the results.

Table 13: Summary of Blast Emissions

Reference Location	Predicted Range Ground Vibration mm/sec	Predicted Airblast Overpressure dB(lin)	Assessment Goal Ground Vibration mm/sec	Assessment Goal Airblast Overpressure dB(lin)
Location R1	0.2 - 0.4	101	5	115
Location R2	0.2 - 0.3	99	5	115
Location R3	0.2 - 0.4	100	5	115

The results of the modelling for both ground vibration and airblast overpressure have shown that the levels satisfy the assessment goals. We also confirm that the blast configuration may be varied or adjusted during the life of the quarry operation if blast monitoring confirms that the measured overpressure and ground vibration levels are less than the recommended levels.

7.0 CONSTRUCTION NOISE

7.1 Overview

The envisaged construction activities will include preliminary site works, earthworks, foundation/floor construction, steel erection, building cladding and plant installation. To evaluate noise emissions from the site during construction, the following activities have been considered.

7.1.1 Preliminary Site Works

The preliminary site works involve the erection of security fencing, the relocation of services and access adjustments to the internal roads. It is envisaged that trucks and an excavator could be used to move materials during the site establishment works.

7.1.2 Earthworks/ Foundations

The main construction activities during this phase of the project could involve excavation, levelling and compaction. During the site works, trucks, an excavator, a grader, a compactor and a front-end load could be used.

7.1.3 Concrete Footings/Floors

The main construction activities envisaged during this phase of the works would involve concrete trucks and a concrete pump.

7.1.4 Steel/Building Erection

The main plant and equipment envisaged during the building construction period would involve trucks and a crane.

7.1.5 Plant Installation

The main plant and equipment envisaged during this phase of the works would involve trucks and a crane.

7.1.6 Typical Construction Schedules

Table 14 presents a summary of the likely construction plant and schedules that have been considered for the construction noise modelling and assessment.

Table 14: Construction Plant Schedule

Operation	Proposed Plant	No. Required (Av max)	Duration (weeks)
Preliminary Site Works	Truck	1	2
	Excavator	1	2
Earthworks / Foundation	Trucks	2	4
	Excavator/Loader	1	4
	Compactor	1	3
	Grader	1	2
Concrete Floor/footings	Concrete trucks	2	2
	Concrete pump	1	2
	Trucks	2	2
Building Erection	Trucks	2	6
	Crane	1	6
Plant Installation	Truck	1	5
	Crane	1	5

7.2 Construction Hours

To minimise potential noise impacts during construction, the main activities would be restricted to between 7.00am and 7.00pm, Monday to Friday, and 7.00am to 5.00pm on Saturday. However, with prior notification to exposed residents and with the approval from the EPA, construction outside these hours could be undertaken provided the construction noise did not give rise to an unreasonable nuisance or disturbance to the occupiers of residential dwellings.

7.3 Construction Plant and Equipment Noise Levels

For the assessment of the noise emissions from the construction activities, the sound power levels summarised in Table 15 have been established from data presented in Australian Standard AS2436-1981 and previous studies conducted by Atkins Acoustics.

Table 15: Construction Plant and Equipment Sound Power Levels
L_{A10} re: 10^{-12} Watts

Plant Description	Plant Type	Sound Power Level	Comments
Front End Loader	Wheeled	110	continuous
Grader		108	intermittent
Compactor	Caterpillar 825	110	2-3 days
Water Cart		106	continuous
Excavator	Kato 750	107	continuous
Truck		106	continuous
Crane	truck mounted	110	1 day
Compressor	600 CFM	100	intermittent
Backhoe		108	7 days
Concrete Truck		108	2 days
Concrete Pump		109	2 days
Concrete Vibrators		105	2 days

7.4 Predicted Noise Levels from Construction Activities

Considering the construction schedules and scenarios described earlier, construction noise levels have been predicted for identified residential properties.

Table 16 presents a summary of the range of noise levels predicted for the envisaged worst case scenario.

Table 16: Predicted Construction Noise Levels
L_{A10} re: 20×10^{-6} Pa

Reference Location	Sound Pressure Levels dB(A) re: 20×10^{-6} Pa				
	Preliminary Site Works	Earthworks	Concrete Floors/Footings	Building Erection	Plant Installation
R1	29	32	31	29	27
R2	26	30	28	26	24
R3	29	32	31	29	27

7.5.1 Assessment of Noise from Construction Activities

The noise modelling has shown that the noise from the envisaged construction activities satisfies the EPA medium term noise assessment goal (background plus 10dB(A)).

8.0 FINDINGS AND RECOMMENDATIONS

The noise modelling has shown for calm weather conditions the noise and blast emissions from the quarry can be controlled to satisfy the recommended assessment goals. To satisfy the requirements of our assessment, it will be necessary to implement and maintain noise controls on some plant and equipment, and to implement a blast monitoring program to control blast emissions.

With respect to trucks transporting materials from the site, the assessment has shown that the proposal will not result in an exceedance of the recommended $L_{Aeq, 1 hour}$ 50dB(A) goal..

8.1 Preliminary Noise and Blast Control Recommendations

The findings of the noise and blast assessment are based on the sound power data presented in Tables 6, 7, 8, and 9, and the preliminary control measures summarised below being incorporated into the proposal. As part of any development application for the proposal, a detailed assessment will be undertaken to confirm and detail the final acoustic requirements for the development.

Operational Noise Control Recommendations

☐ the construction of 4.5 - 5.0 metre high earth mounding on the southern side of the site processing area.

☐ all fixed external plant and equipment should be selected and installed to satisfy a noise specification of less than 85dB(A) at one (1) metre.

☐ where practical all internal plant and equipment should be selected and installed to satisfy a noise specification of less than 85dB(A) at one (1) metre.

- where practical any plant or equipment installed on the site exceeding a sound pressure level of 85dB(A) at one (1) metre should be evaluated in terms of secondary noise controls/enclosures/rooms.

- all inloading and building conveyor systems should be belt type conveyors.

- all screens should be installed to minimise the transfer of structural borne vibration to support structures.

- all dust collection and control systems should be selected on acoustic performance, and without tonal or impulsive noise characteristics.

- where practical all permanent site mobile plant shall be fitted with secondary/residential grade noise controls and acoustic treated engine enclosures.

- where practical audible alarms should be replaced with flashing lights or a similar system.

- as part of the quarry EMP a "Noise Management Plan" (NMP) should be implemented with noise monitoring being conducted during initial stages of quarry development to confirm noise levels and where required assess the practicability of additional noise controls. Subsequent annual noise audits should be undertaken if considered necessary to ensure that all noise control measures are installed and maintained, and that the environmental noise levels (criteria) are satisfied. The program should incorporate a complaint management protocol that facilitates investigation and actioning of noise related complaints.

Blast Control Recommendations

The following blast controls are recommended for the quarry operation:

- ☐ the MIC of initial blasts will be limited to a maximum of 265 kgs
- ☐ where practical blasting will be conducted between 9.30am and 5.00pm
- ☐ as part of the quarry EMP a "Blast Management Plan" (BMP) should be implemented with blast monitoring being conducted during initial stages of quarry development to confirm ground vibration and airblast overpressure and where required assess the practicability of additional controls. Subsequent blast monitoring should be undertaken in the initial quarry development to ensure that all blasts are controlled and satisfy EPA requirements. The program should incorporate a complaint management protocol that facilitates investigation and actioning of blast related complaints.

Construction Noise Control Recommendations

- ☐ As part of the quarry EMP a "Environmental Noise Management Plan" (ENMP) should be prepared and implemented to present the details and procedures that will be employed to minimise construction noise impacts. Noise monitoring should being conducted during initial stages of development to confirm noise levels and where required assess the practicability of additional noise controls. The program should incorporate a complaint management protocol that facilitates investigation and actioning of noise related complaints.

9.0 CONCLUSION

It is proposed to establish a hard rock quarry with an area of approximately seventeen (17) hectares on a greenfield site at Williamsdale. The quarry proposal is located approximately two point five (2.5) kilometres west of the Monaro Highway (Fig 1) and two point six (2.6) kilometres north of Williamsdale Road. The quarry processing plant will be located approximately one point seven (1.7) kilometres north of Williamsdale Road.

The results of ambient noise monitoring and environmental noise audits conducted in the area have confirmed that the existing ambient noise is typically rural and influenced by road traffic on the Monaro Highway, local domestic and natural elements such as wind, birds, animals, etc.

The findings of the noise modelling for the proposal have shown that with effective noise controls and management procedures, noise from the quarry can be controlled to satisfy the daytime assessment goals for calm weather conditions. Under light north breeze and mild temperature inversion conditions, the predicted noise levels marginally exceed the recommended daytime assessment goals at the three reference assessment locations.

In regard to truck movements to and from the site, the modelling has shown that the noise satisfies the EPA $L_{Aeq,1hour}$ 50dB(A) goal. The modelling has also shown that the predicted maximum noise levels from truck movements on the site access road exceed the nighttime EPA goal at location R2. Location R2 is located on the development site.

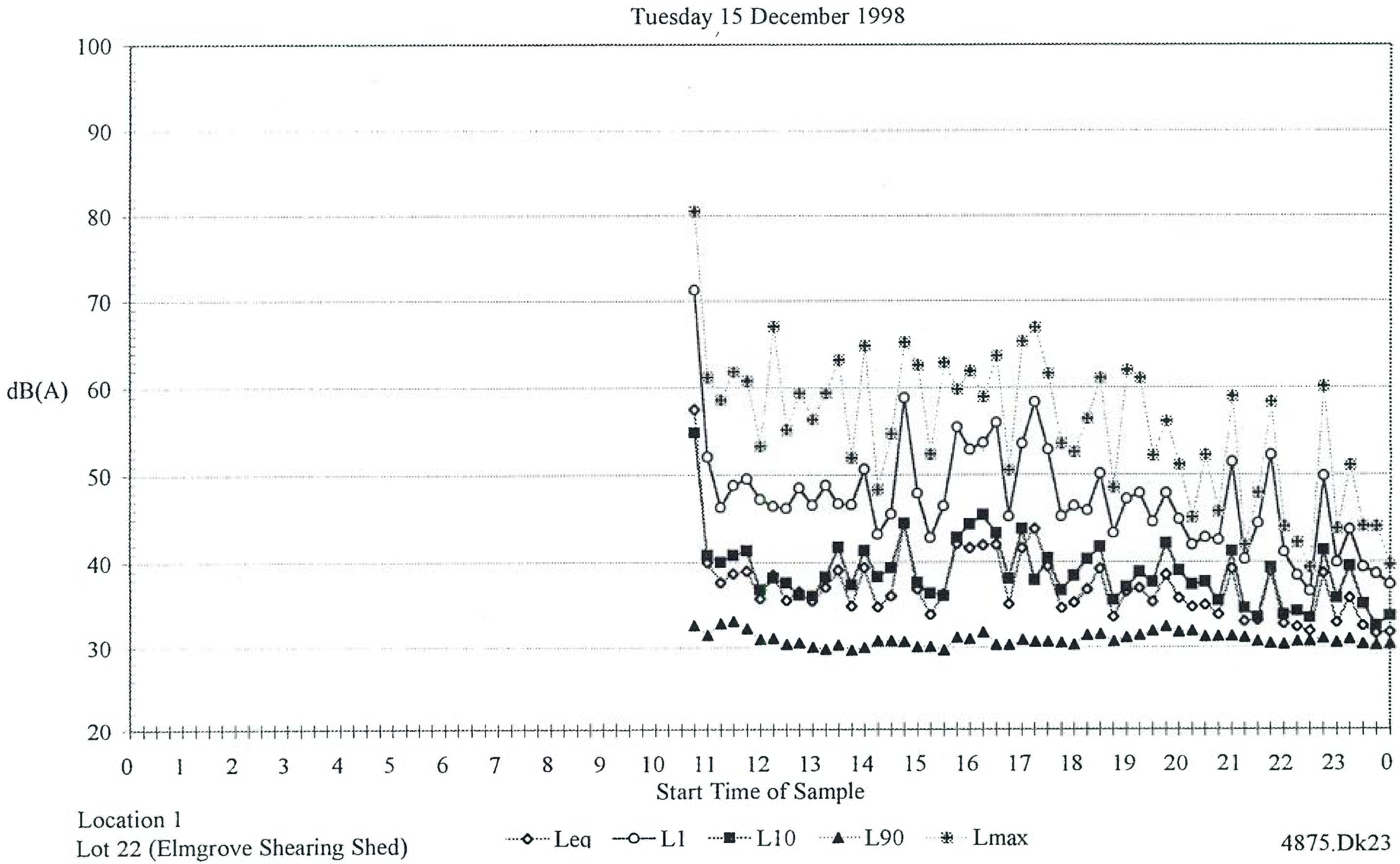
With respect to blast emissions, the assessment has shown that both ground vibration and airblast overpressure levels can be controlled to satisfy the recommended assessment goals. It is acknowledged that the blast configuration could be varied or adjusted during the life of the quarry operation if blast monitoring confirms that the measured overpressure and ground vibration levels are less than the recommended levels.

Based on the findings of the assessment and as part of the Noise Management Plan for the site it is recommended that noise and blast monitoring be conducted during initial stages of mine development to confirm the above findings and establish the practicability of additional noise and blast controls where required.

The assessment has also shown that during the site development, the noise from the envisaged construction activities can be controlled to satisfy the EPA medium term noise assessment goal (background plus 10dB(A)).

APPENDIX 1: AMBIENT BACKGROUND SOUND PRESSURE LEVELS

Ambient Sound Pressure Levels

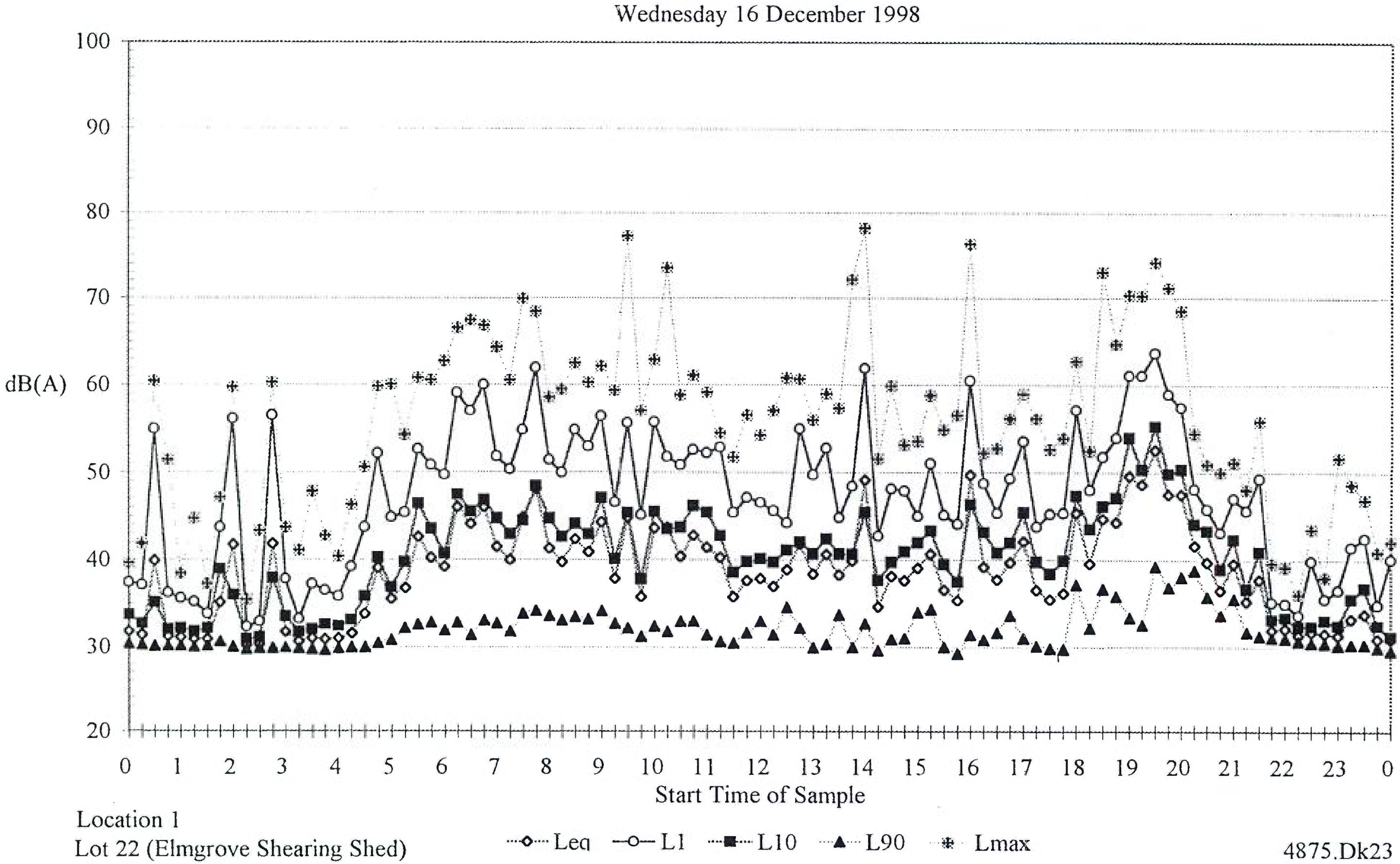


Location 1
Lot 22 (Elmgrove Shearing Shed)

4875.Dk23

4875a.XLS

Ambient Sound Pressure Levels

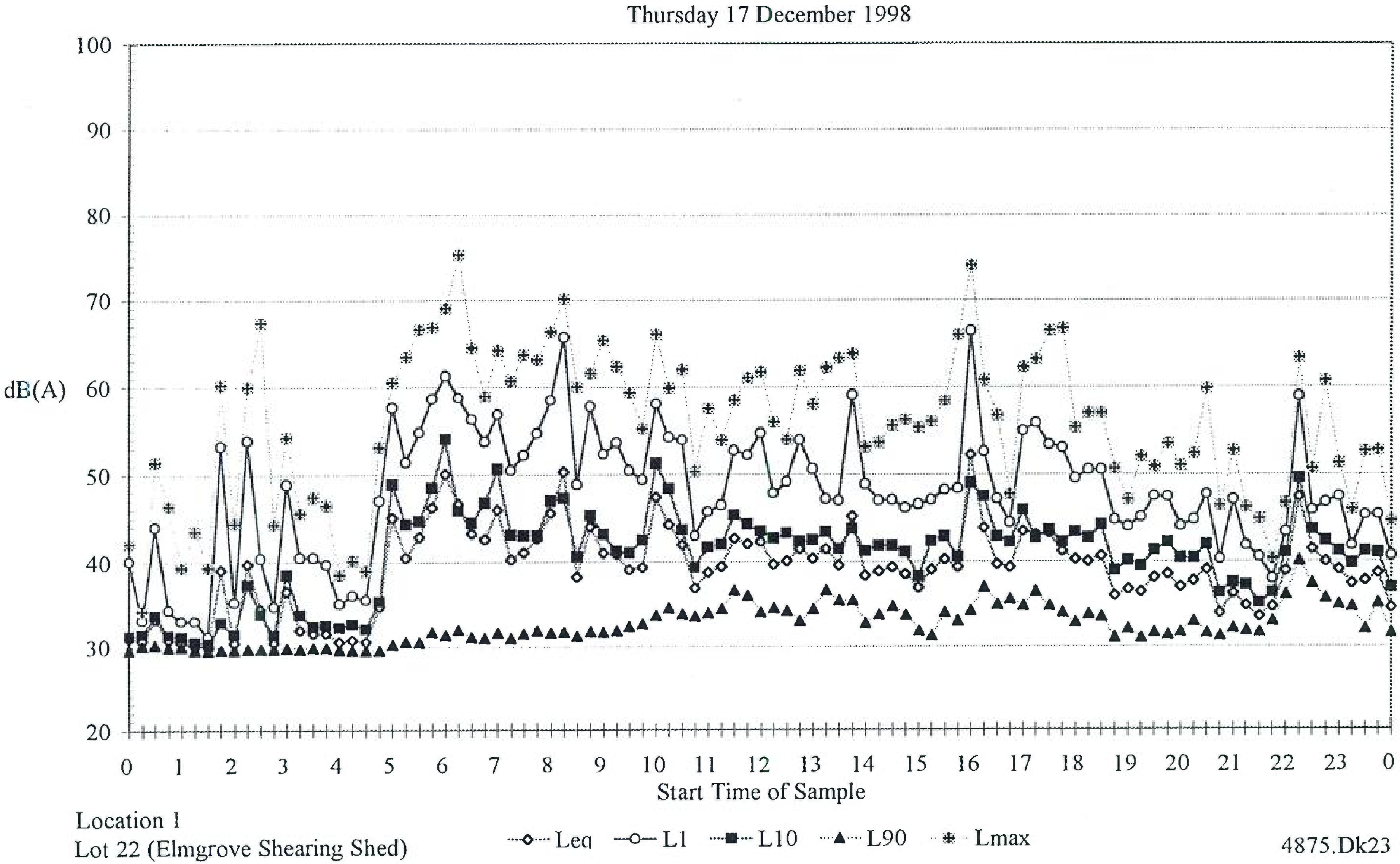


Location 1
Lot 22 (Elmgrove Shearing Shed)

4875.Dk23

4875a.XLS

Ambient Sound Pressure Levels

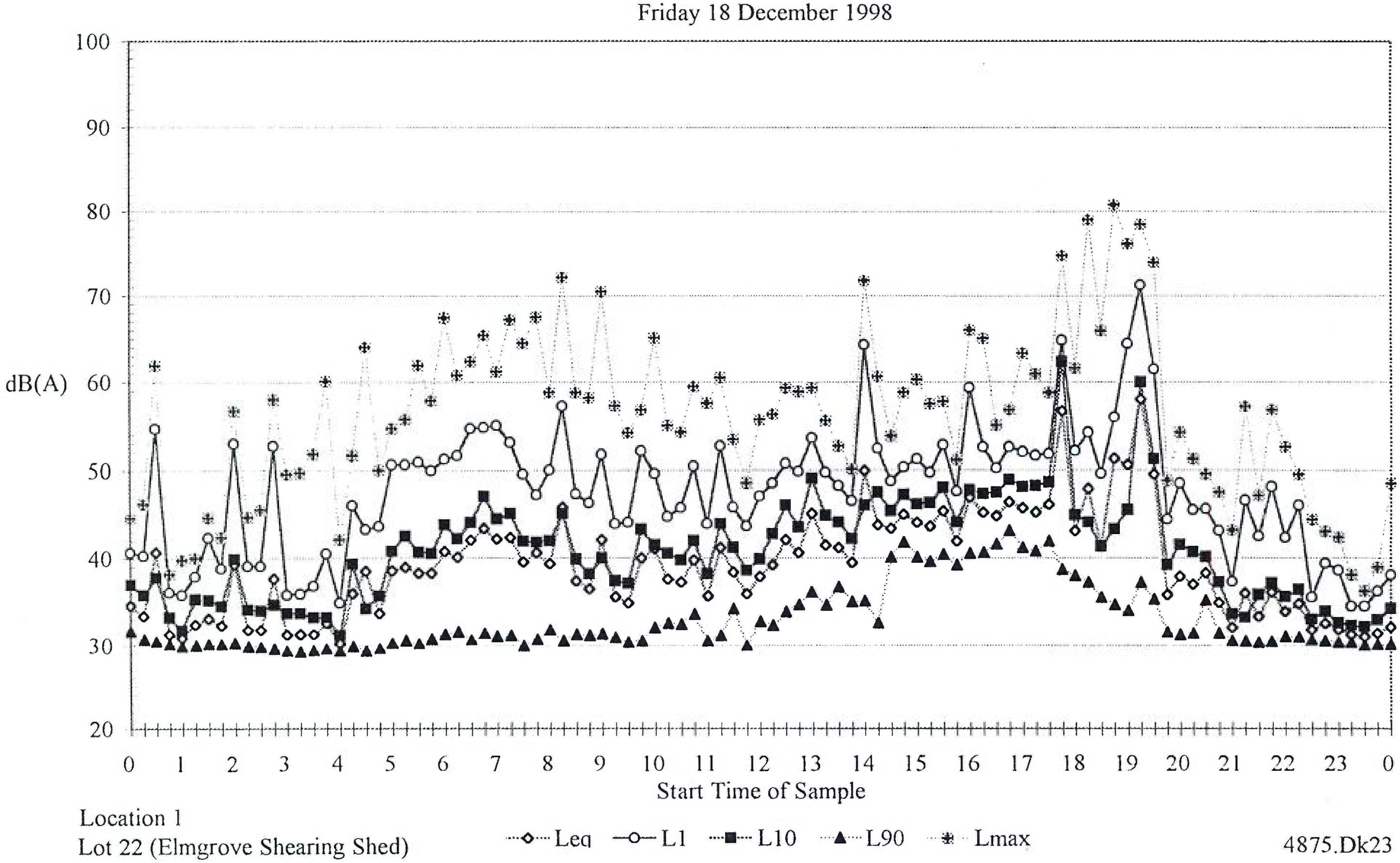


Location 1
Lot 22 (Elmgrove Shearing Shed)

4875.Dk23

4875a.XLS

Ambient Sound Pressure Levels



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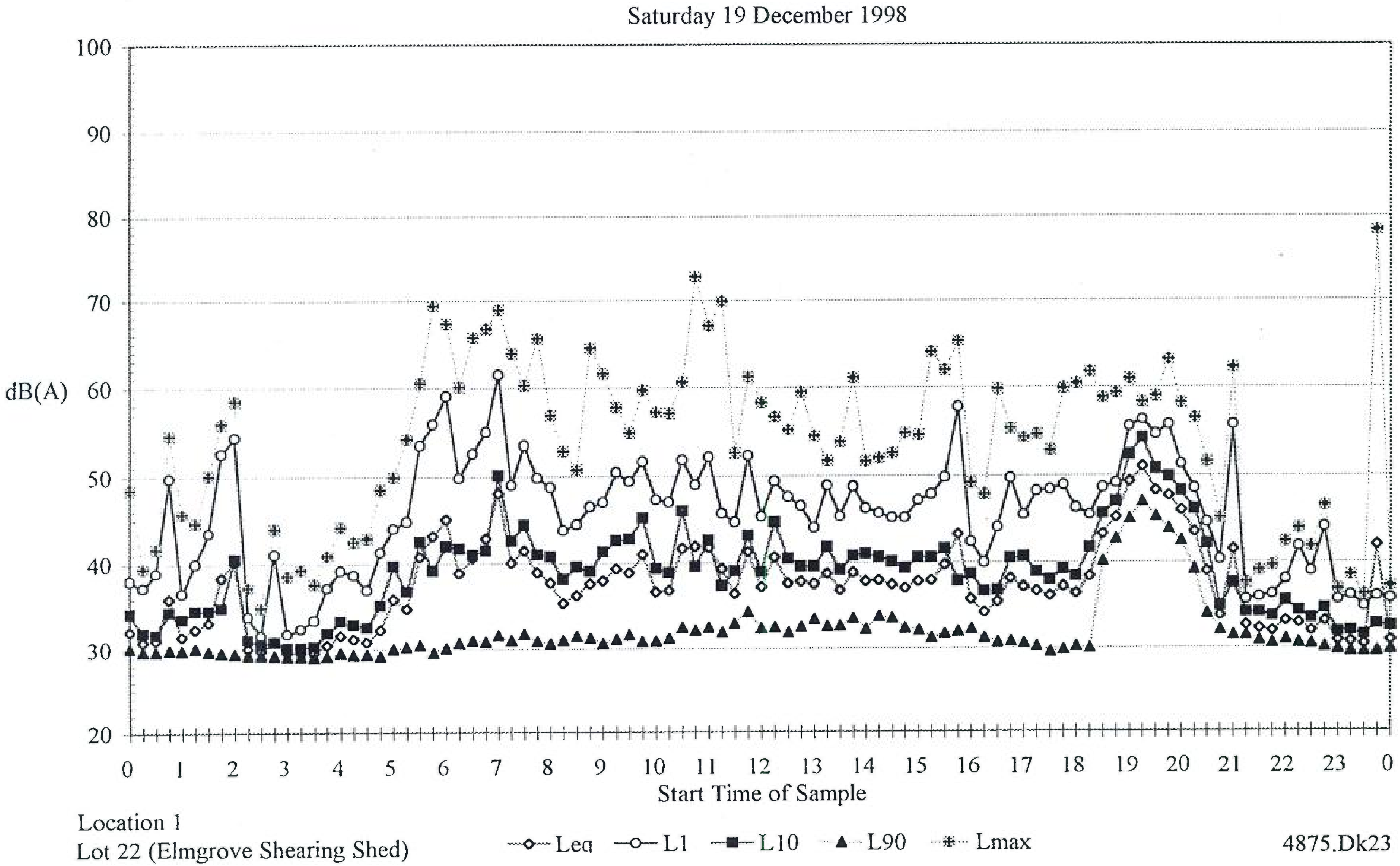
Ambient Sound Pressure Levels



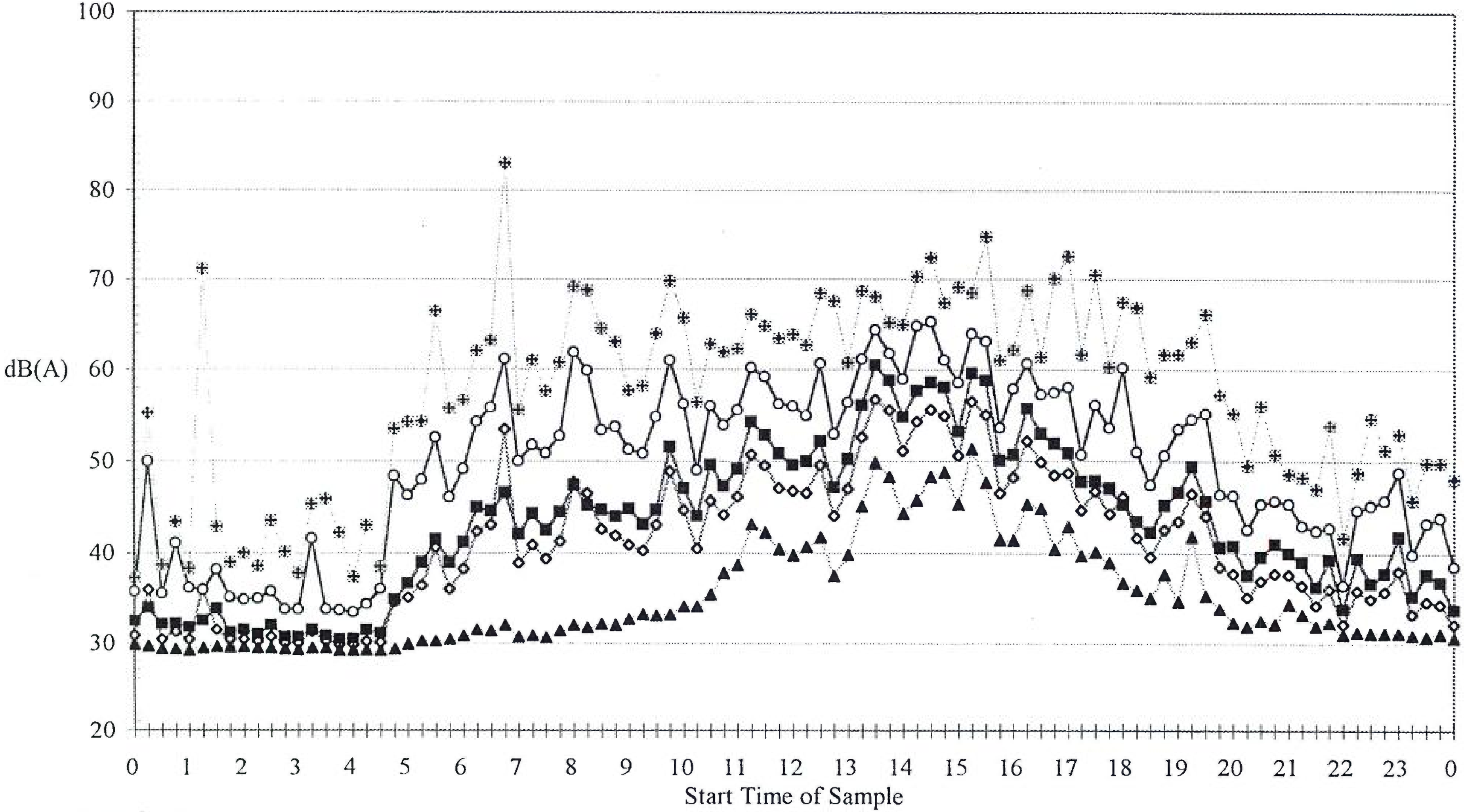
Saturday 19 December 1998

Location 1
Lot 22 (Elmgrove Shearing Shed)

4875.Dk23

Ambient Sound Pressure Levels

Sunday 20 December 1998



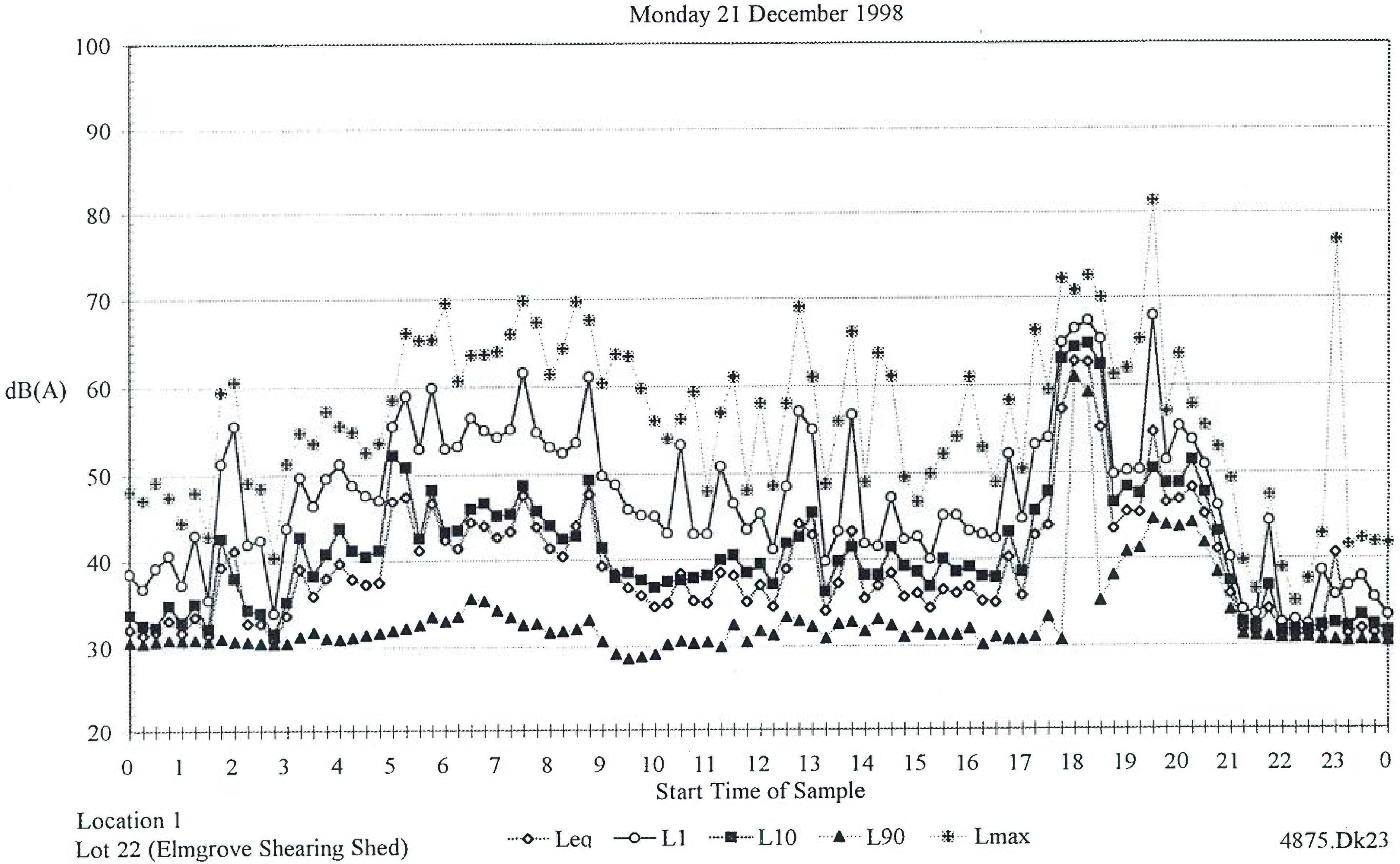
Location 1
Lot 22 (Elmgrove Shearing Shed)

◇ Leq ○ L1 ■ L10 ▲ L90 ✱ Lmax

4875.Dk23

4875a.XLS

Ambient Sound Pressure Levels



Monday 21 December 1998

Location 1
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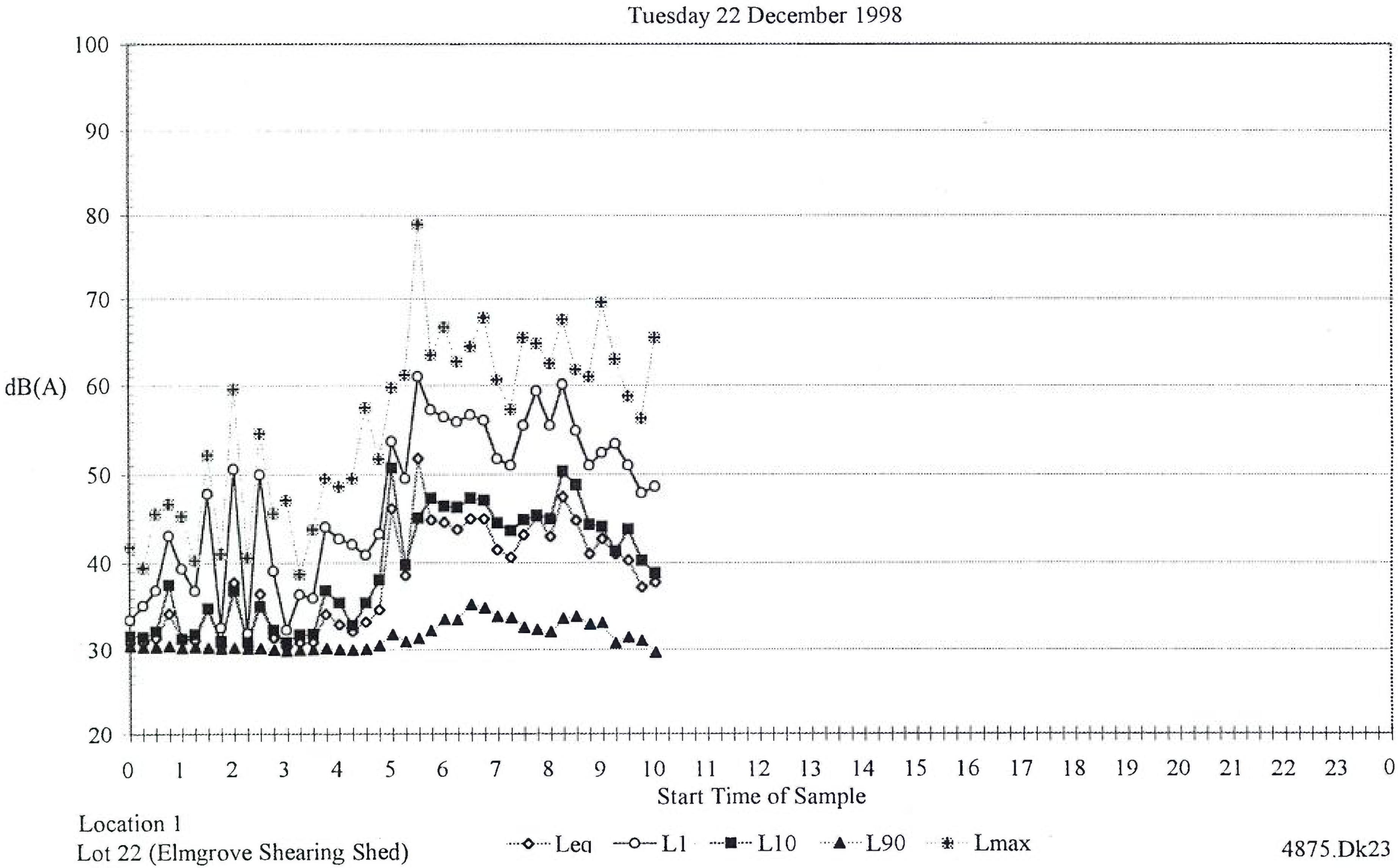
4875.Dk23

4875a.XLS

Ambient Sound Pressure Levels

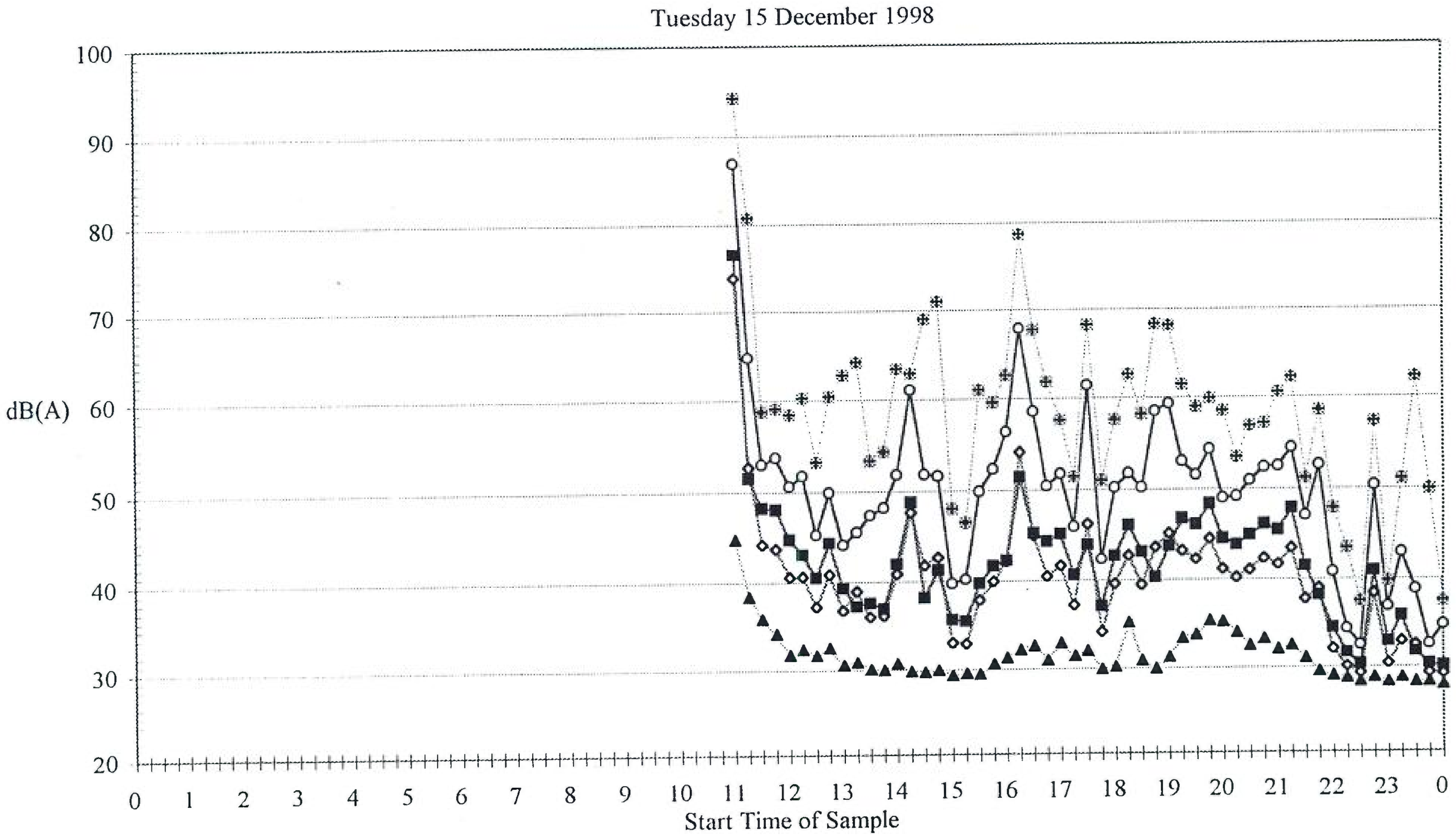


Location 1
Lot 22 (Elmgrove Shearing Shed)

4875.Dk23

4875a.XLS

Ambient Sound Pressure Levels

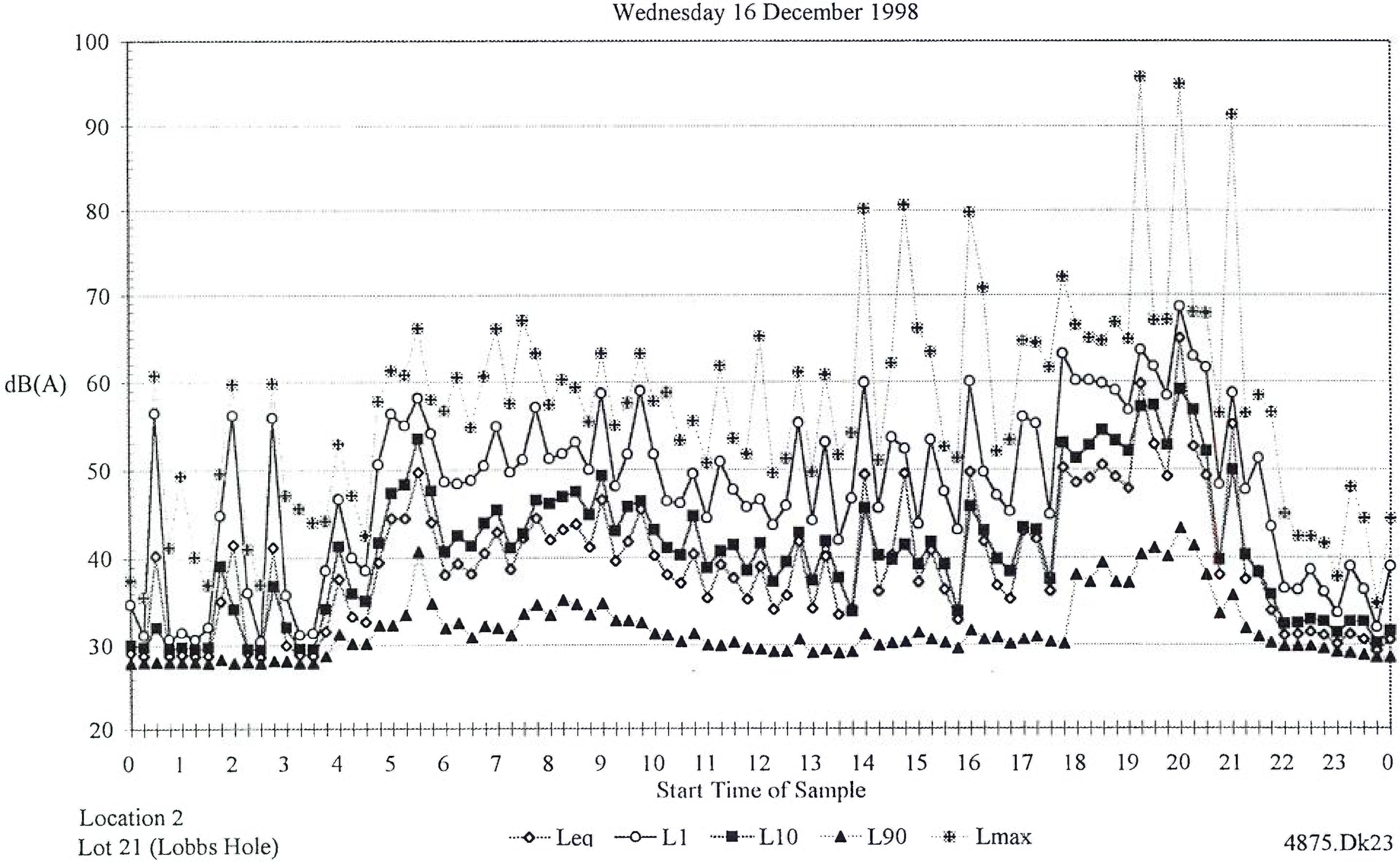


Location 2
Lot 21 (Lobbs Hole)

4875.Dk23

4875b.XLS

Ambient Sound Pressure Levels

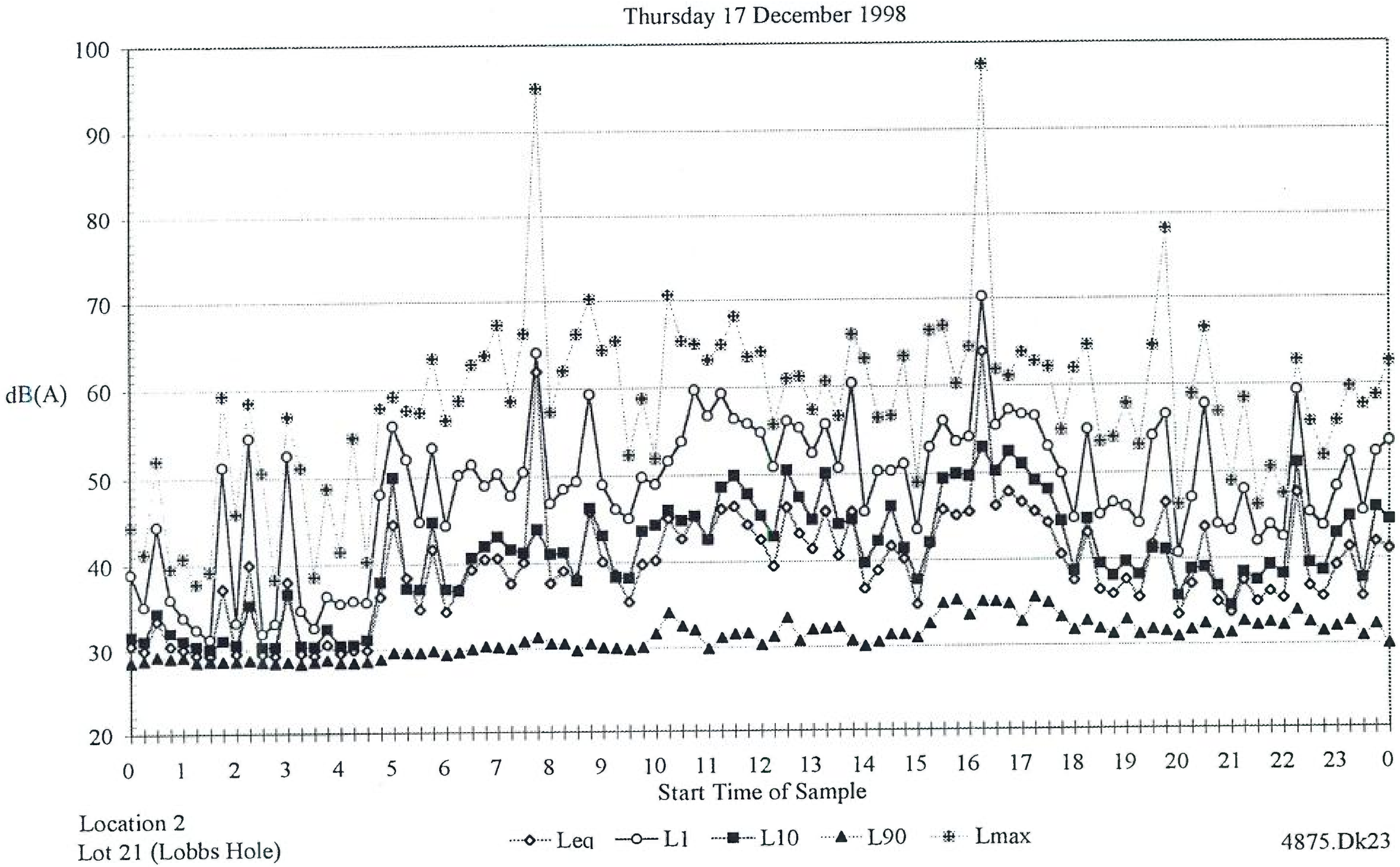


Location 2
Lot 21 (Lobbs Hole)

4875.Dk23

4875b.XLS

Ambient Sound Pressure Levels



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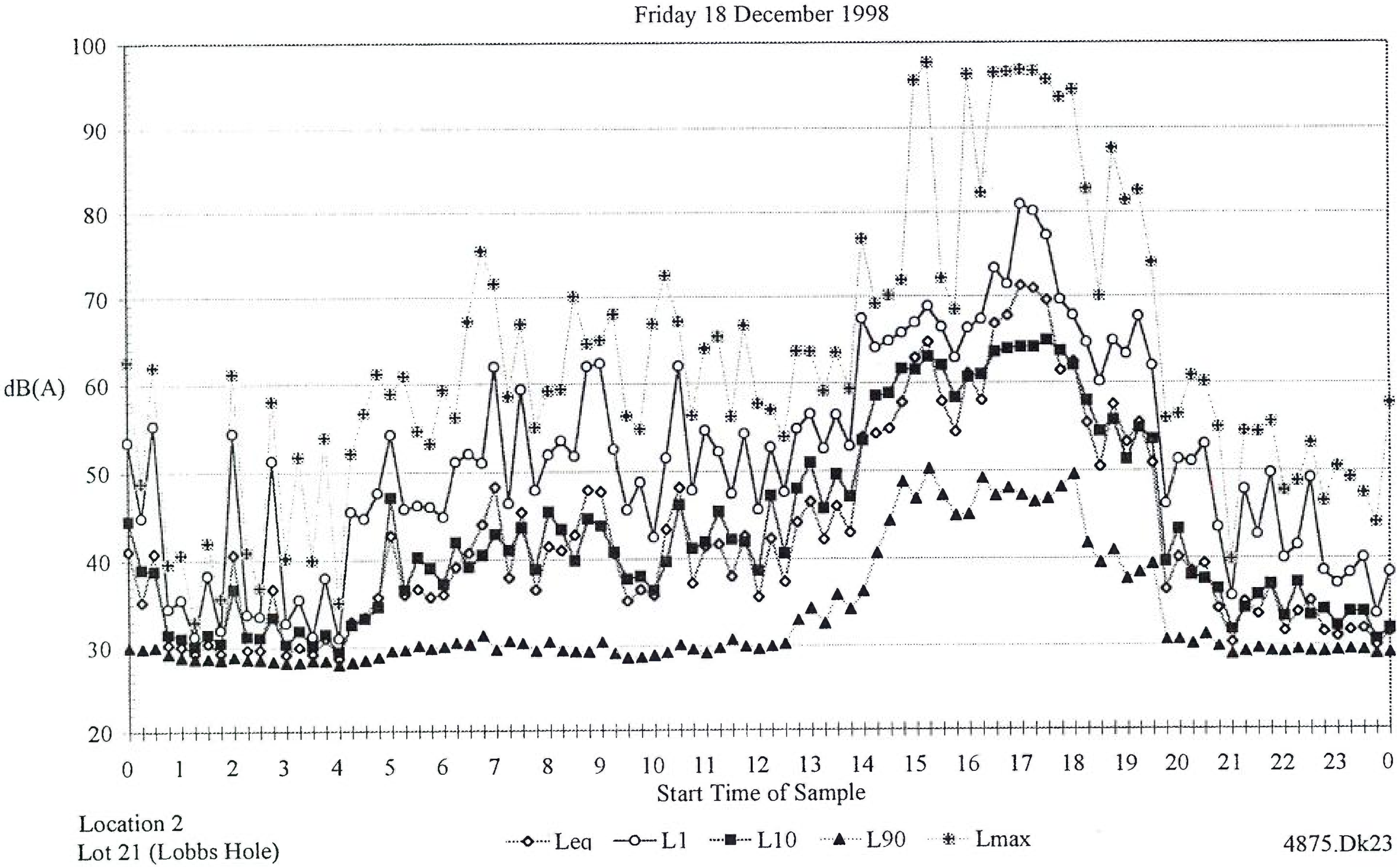

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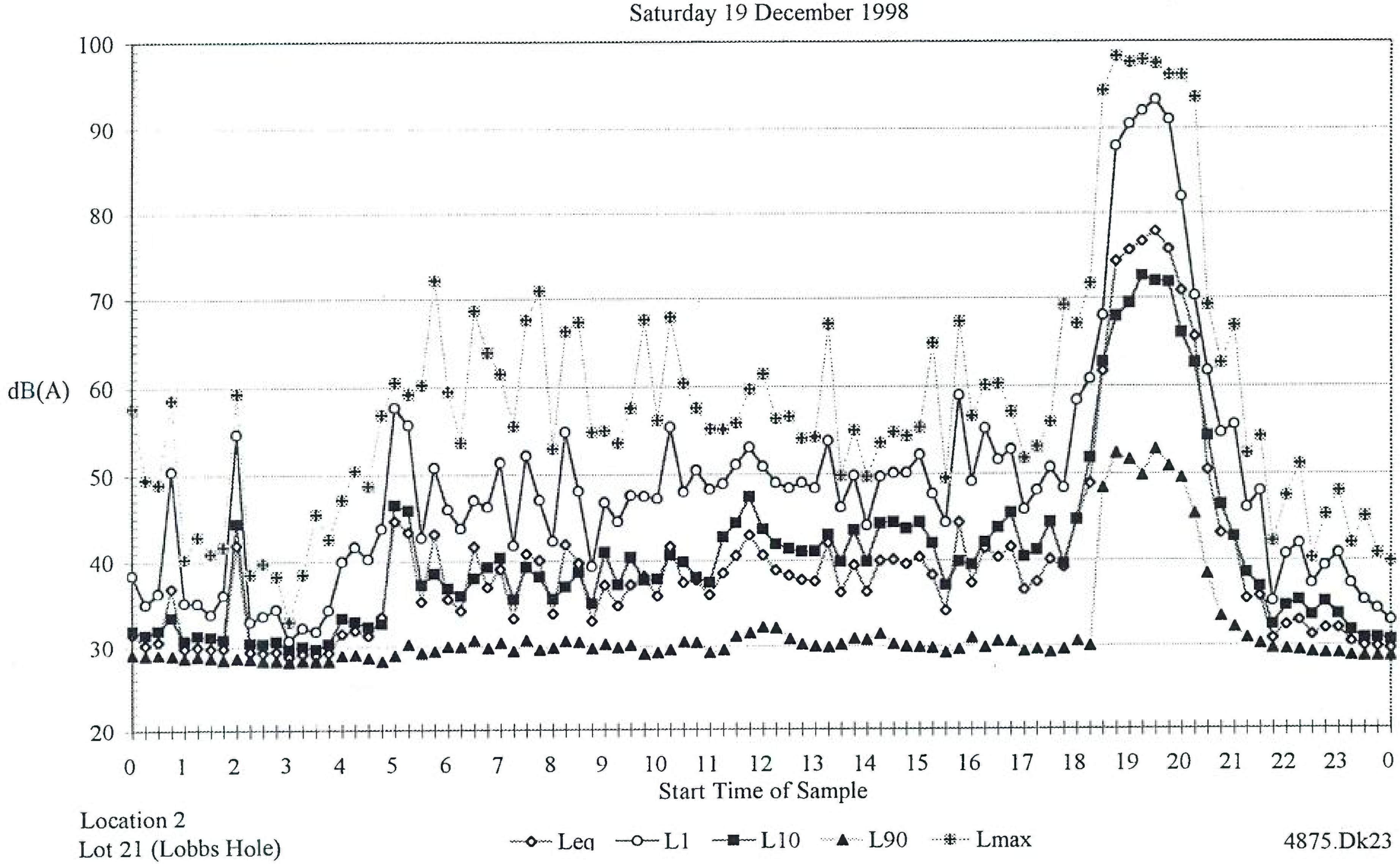

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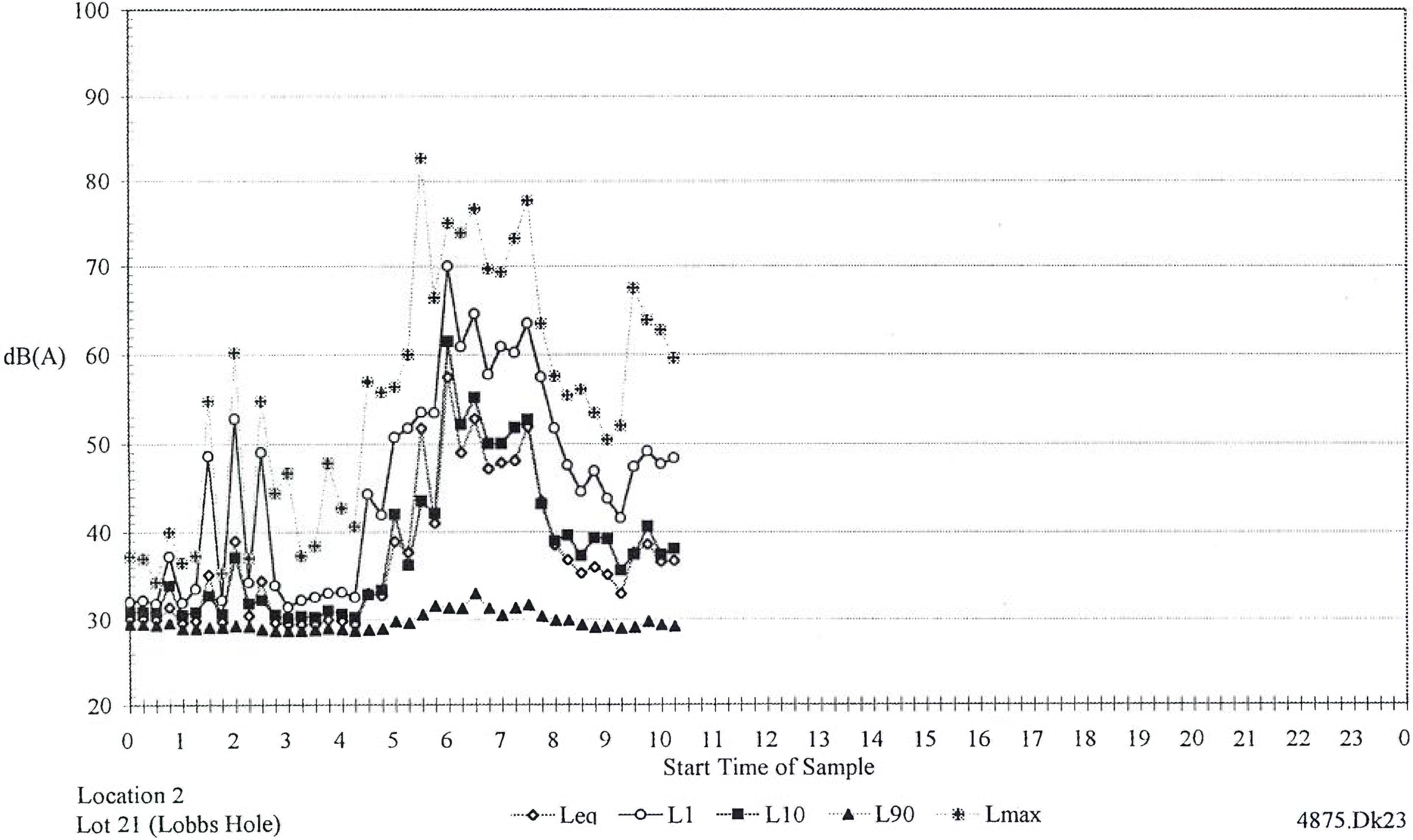
Ambient Sound Pressure Levels

Tuesday 22 December 1998



Location 2
Lot 21 (Lobbs Hole)

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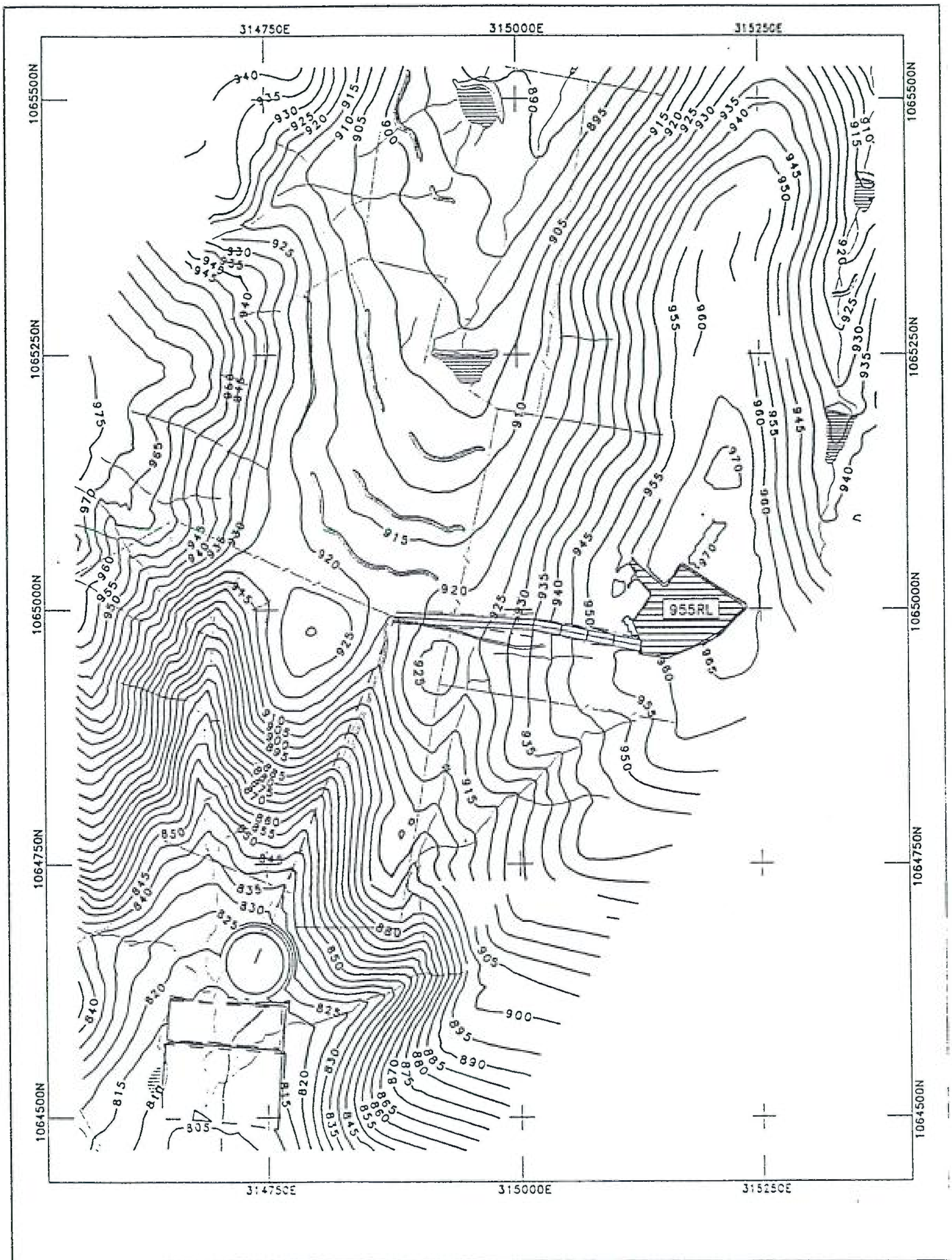
APPENDIX 2: STAGE I. QUARRY DEVELOPMENT



ECSI
MINING CONSULTANTS

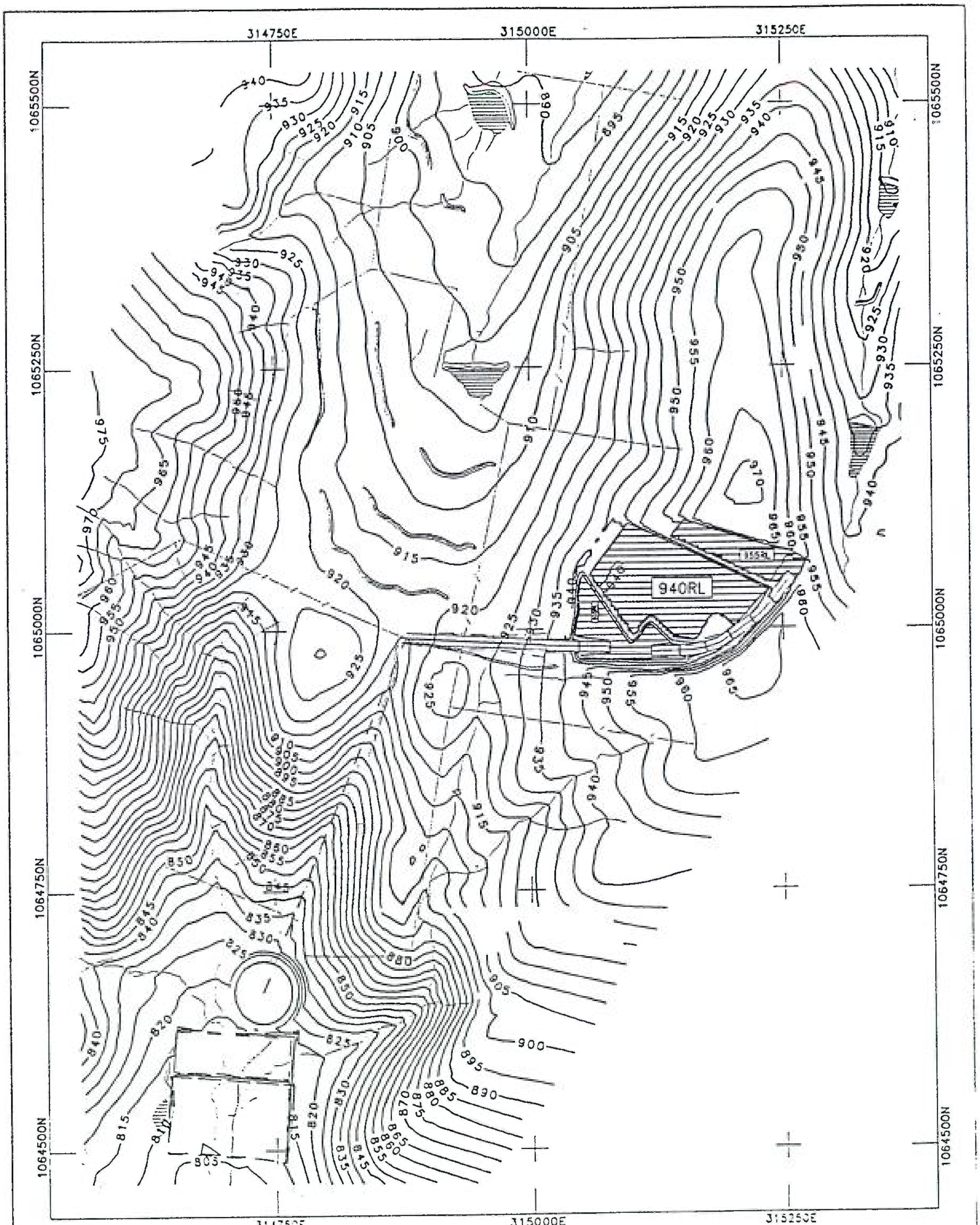
WILLIAMSDALE QUARRY

Scale : 1:7500
Drawn: ECS
Approved:
Revision:
CGM File:

STAGED PIT – YEAR 1
SHOWING RAMP ACCESS, PROCESS PAD
AND SURFACE FEATURES

FIGURE

APPENDIX 3: STAGE II. QUARRY DEVELOPMENT



ECSI
MINING CONSULTANTS

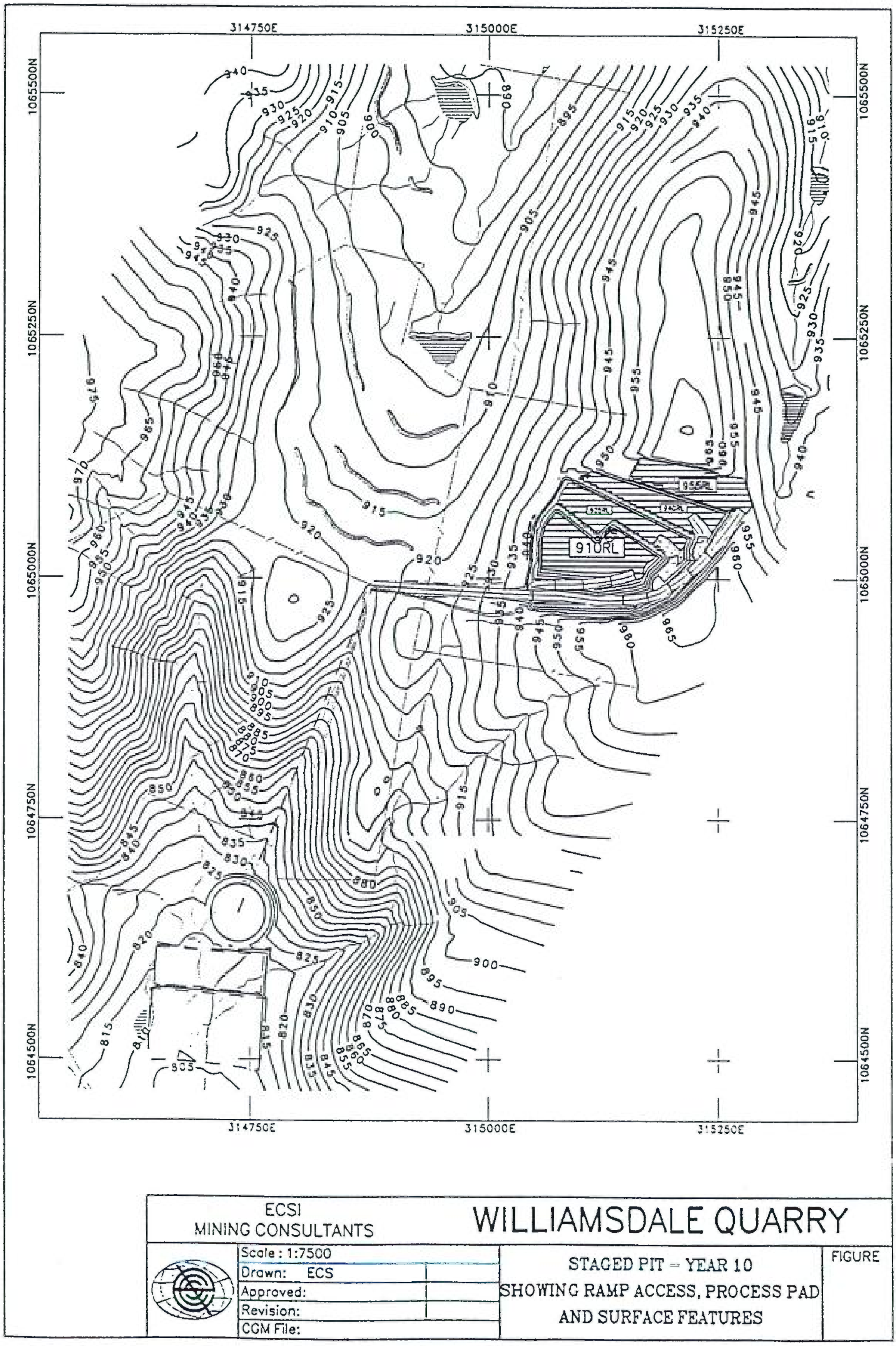
WILLIAMSDALE QUARRY

Scale : 1:7500
Drawn: ECS
Approved:
Revision:
CGM File:

STAGED PIT – YEAR 5
SHOWING RAMP ACCESS, PROCESS PAD
AND SURFACE FEATURES

FIGURE

APPENDIX 4: STAGE III. QUARRY DEVELOPMENT



ECSI
MINING CONSULTANTS

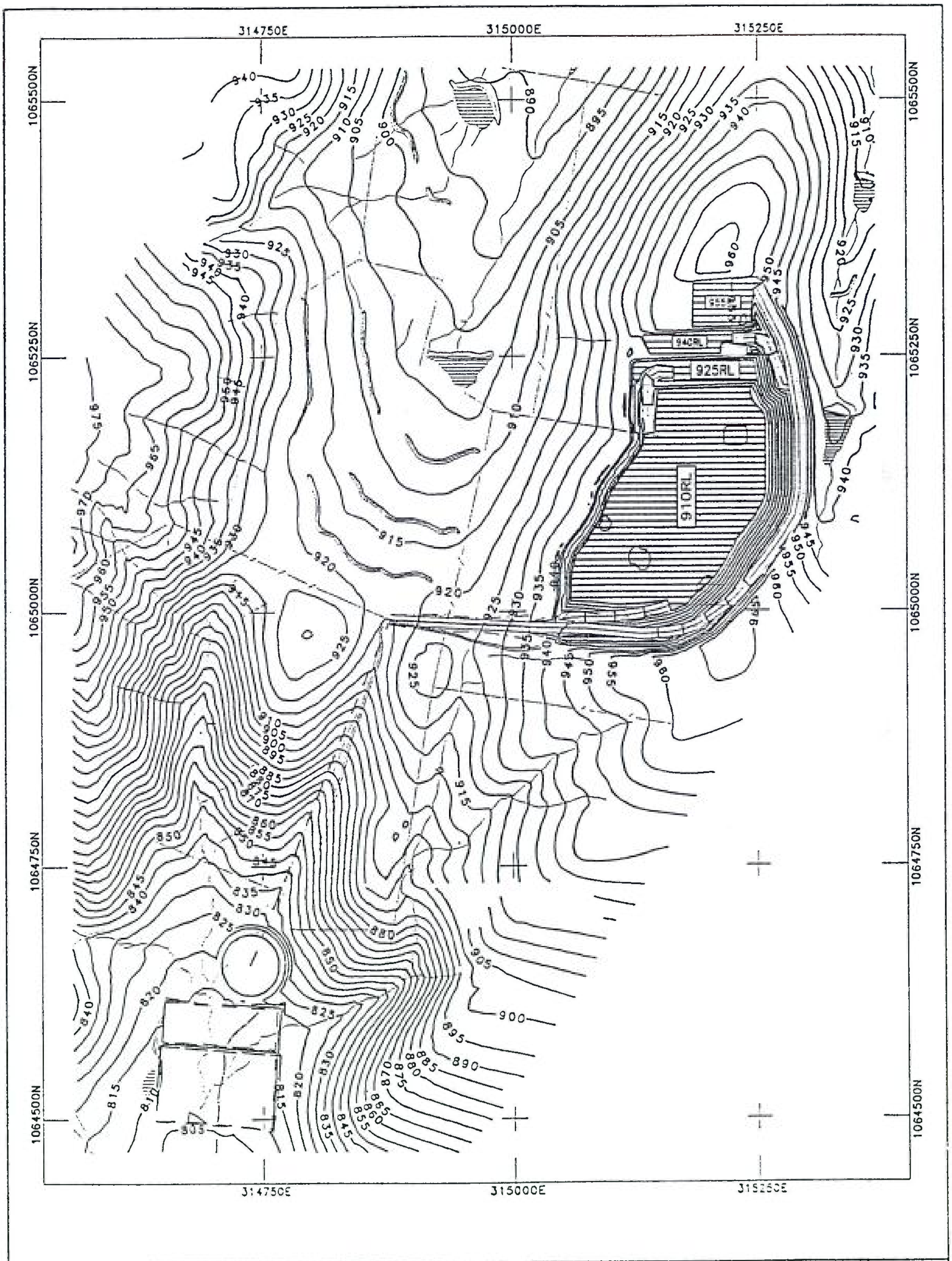
WILLIAMSDALE QUARRY

Scale : 1:7500
Drawn: ECS
Approved:
Revision:
CGM File:

STAGED PIT - YEAR 10
SHOWING RAMP ACCESS, PROCESS PAD
AND SURFACE FEATURES

FIGURE

APPENDIX 5: STAGE IV. QUARRY DEVELOPMENT



ECSI
MINING CONSULTANTS

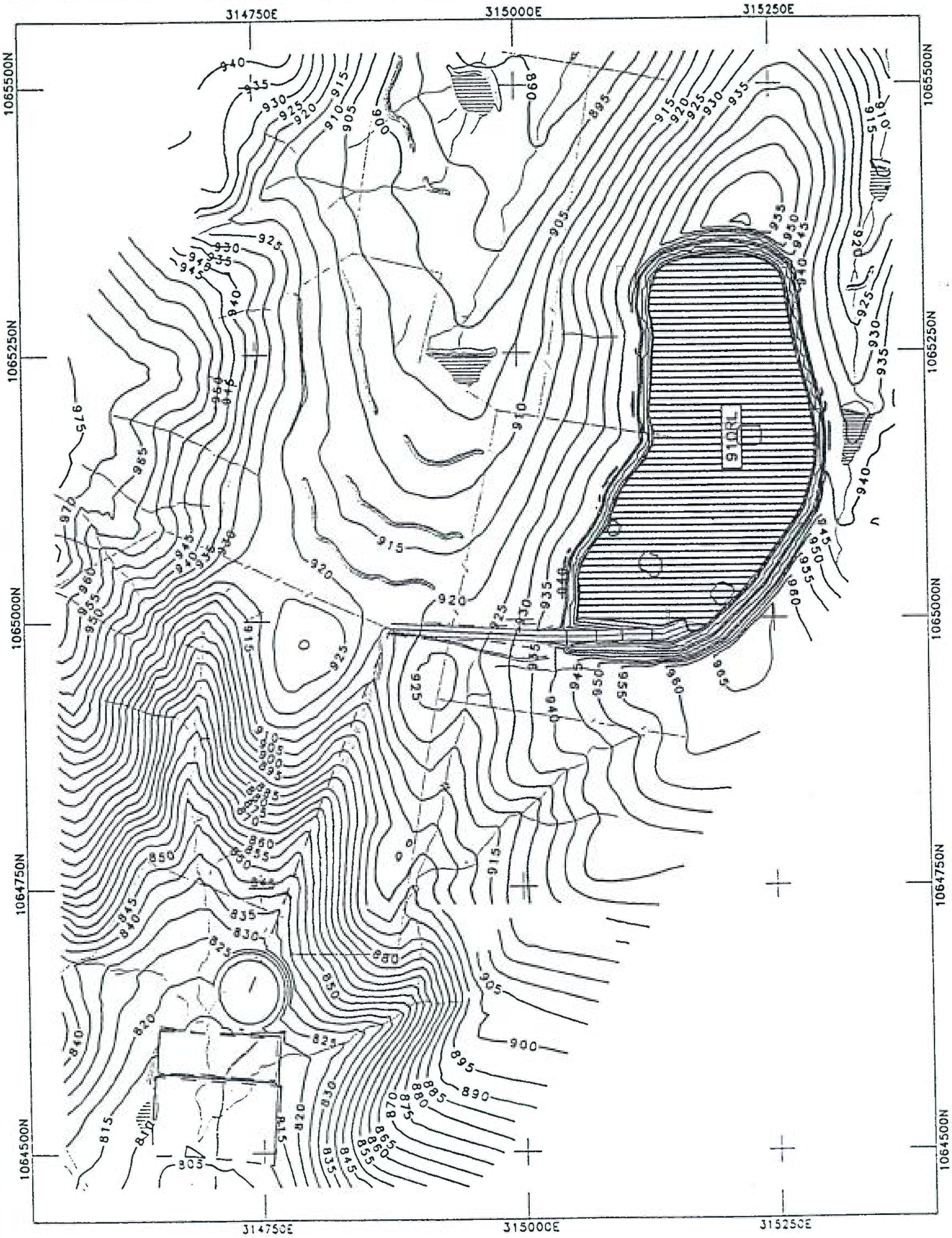
WILLIAMSDALE QUARRY

Scale : 1:7500
Drawn: ECS
Approved:
Revision:
CGM File:

STAGED PIT – YEAR 25
SHOWING RAMP ACCESS, PROCESS PAD
AND SURFACE FEATURES

FIGURE

APPENDIX 6: STAGE V. QUARRY DEVELOPMENT



ECSI
MINING CONSULTANTS

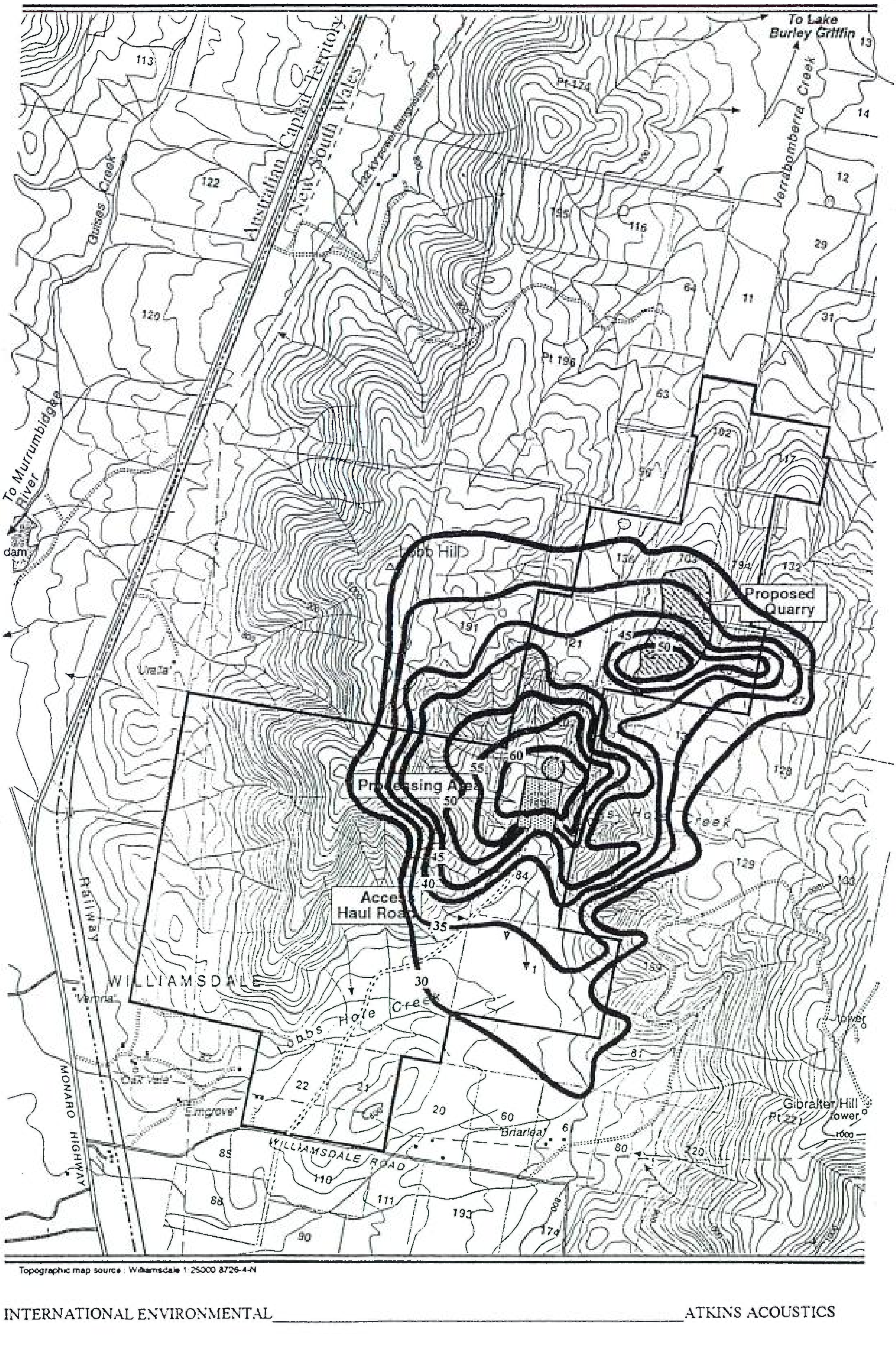
WILLIAMSDALE QUARRY

Scale : 1:7500
Drawn: ECS
Approved:
Revision:
CGM File:

STAGED PIT – YEAR 31
SHOWING RAMP ACCESS, PROCESS PAD
AND SURFACE FEATURES

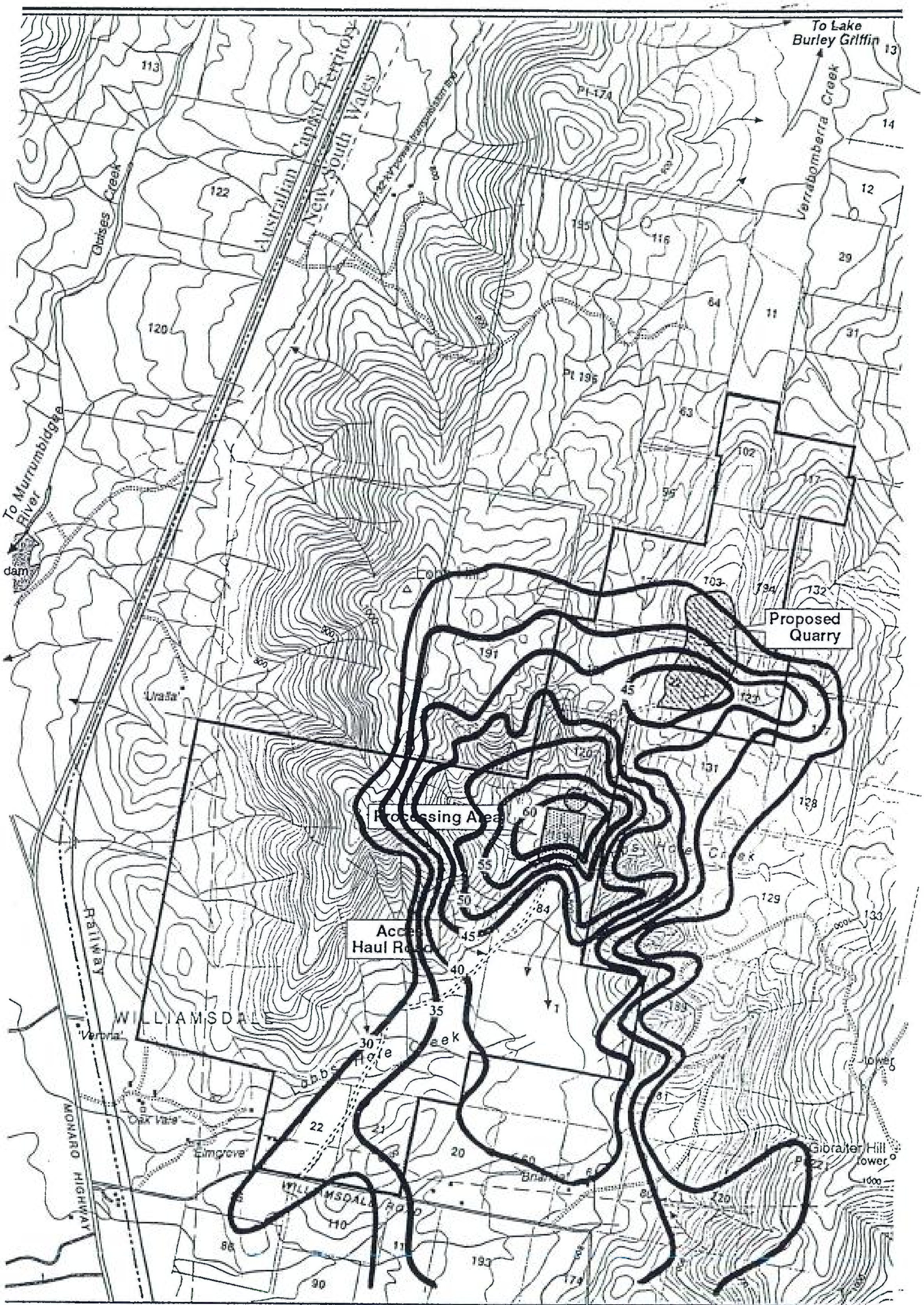
FIGURE

APPENDIX 7: STAGE III QUARRY NOISE PREDICTIONS
(Calm Conditions)



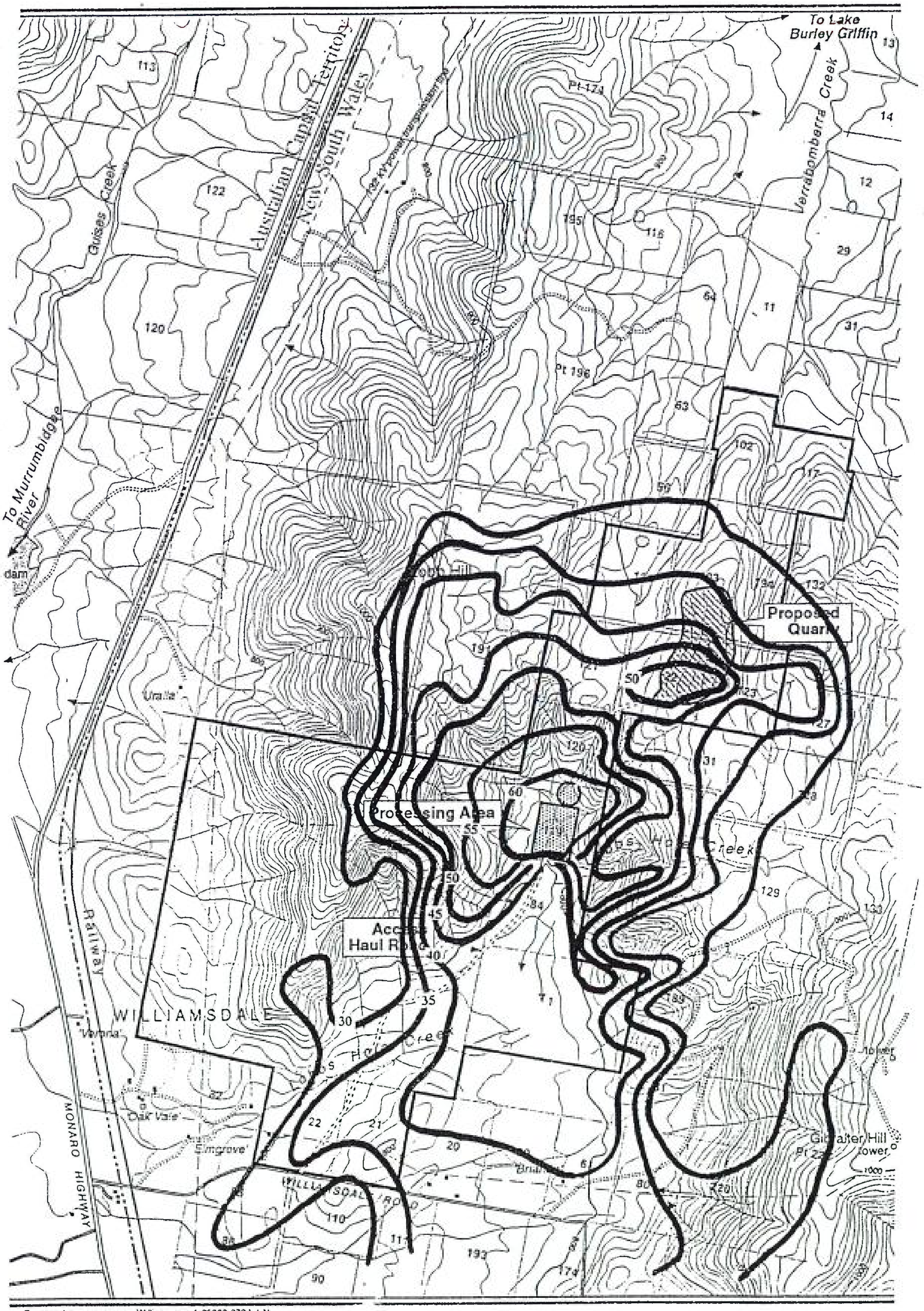
Topographic map source : Williamsdale 1:25000 8726-4-N

APPENDIX 8: STAGE III QUARRY NOISE PREDICTIONS
(North Breeze 1m/sec)



Topographic map source : Williamsdale 1:25000 8726-4-N

APPENDIX 9: STAGE III QUARRY NOISE PREDICTIONS
(Temperature Inversion)



Topographic map source : Williamsdale 1:25000 8726-4-N

APPENDIX 10: DEFINITION OF TERMS

Term	**Definition**
A-weighted :	See dB(A)
Ambient noise :	The all-encompassing noise associated within a given environment. It is the composite of sounds from many sources, both near and far.
Assessment period :	The period in a day over which assessments are made: day (0700-0800hrs), evening (1800-2200 hrs) or night (2200-0700 hrs).
Background Noise :	The underlying level of noise present in the ambient noise, excluding the noise source under extraneous noise is removed. This is described using the L_{A90} descriptor.
Cumulative noise level :	Refers to the total level of noise from all sources.
Day :	The period between 0700 and 1800 hrs (Monday-Saturday) and 0800-1800 (Sunday and Public Holidays).
dB :	Abbreviation for decibel- a unit of sound measurement. Given sound pressure to a reference pressure.
dB(A) :	Unit used to measure 'A-weighted sound pressure levels. A-weighting is an adjustment made to sound level measurement to approximate the response of the human ear.
Default parameters :	In assessing meteorological enhancement of noise, refers to set values for weather parameters, such as wind speeds and temperature gradients, to be used in predicting source noise levels.
Equivalent Continuous : *Noise Levels :*	The level of noise equivalent to the energy average of noise levels occurring over a measurement period.
Evening :	Refers to the period between 1800-2200hrs.
Extraneous Noise :	Noise resulting from activities that area. Atypical activities might include construction, traffic generated by holiday periods and by special events such as concerts or sporting events. Normal daily traffic is not considered to be extraneous.

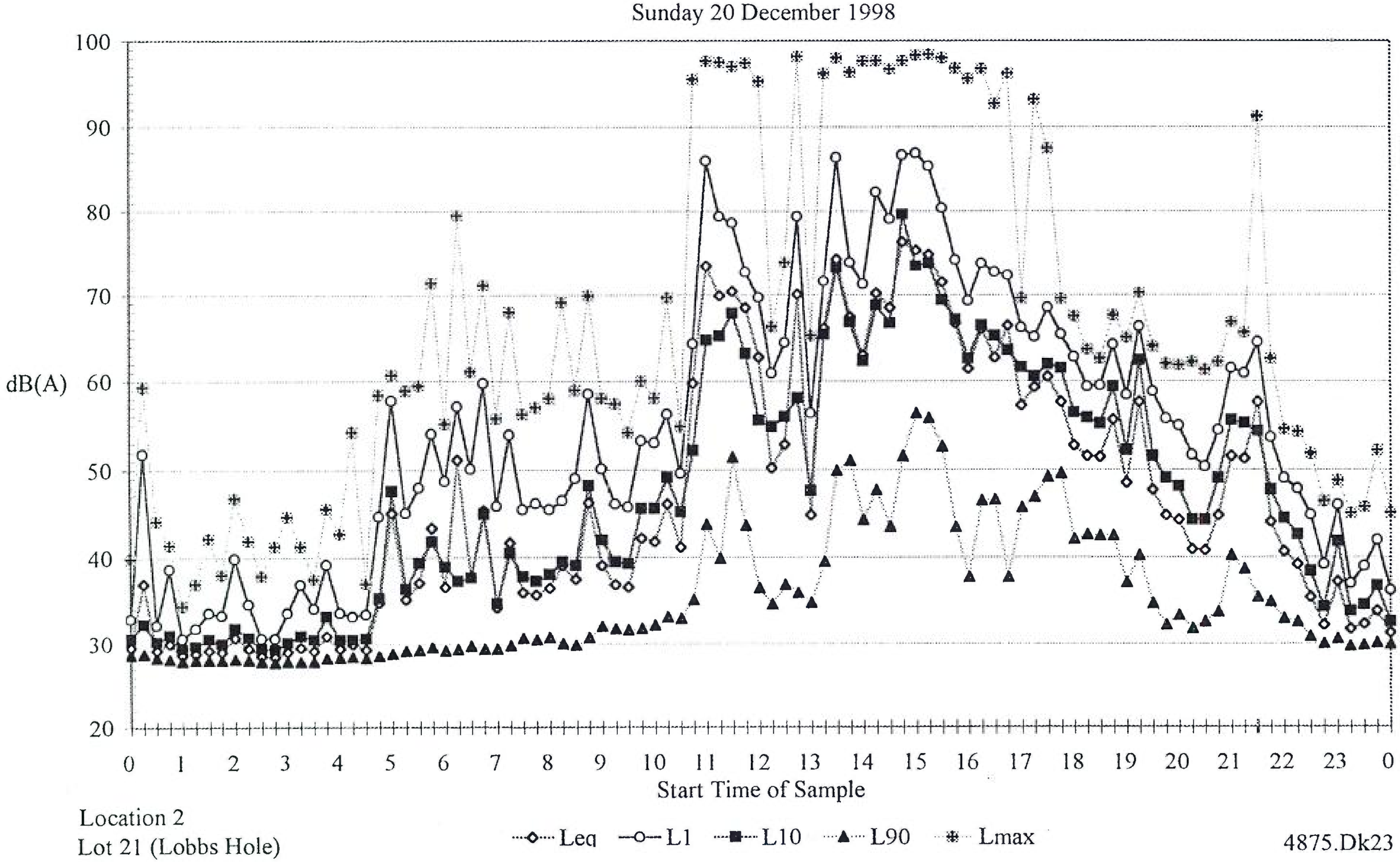
APPENDIX 10: DEFINITION OF TERMS. Cont'd.

Term	**Definition**
Fluctuating Noise :	Noise that varies continuously and to an appreciable extent over the period of observation.
Greenfield site :	Undeveloped land.
Impulsive Noise :	Noise having a high peak of short duration, or a sequence of such peaks. A sequence of such impulses in rapid succession is termed 'repetitive impulsive noise'.
Intrusive Noise :	Refers to noise that intrudes above the background level by more than 5 decibels.
L_{A90} :	The A-weighted sound pressure level that is exceeded for 90% of the time over which a given sound is measured. This is considered to represent the background noise.
L_{Aeq} :	The equivalent continuous noise level - the level of noise equivalent to the energy average of noise levels occurring over a measurement period.
Long-term annoyance :	Prolonged annoyance over months and years.
Meteorological conditions :	Wind and temperature inversion conditions.
Most affected location(s) :	Locations that experience (or will experience) offensive noise from the noise source under consideration. In determining these locations, one needs to consider existing background levels, exact noise source location(s), distance from source (or proposed source) to receiver, and any shielding between source and receiver.
Night :	The period between 2200 and 0700 hrs (Monday-Saturday) and 2200-0800 (Sunday and Public Holidays).
Performance-based goals :	Goals specified in terms of the outcomes/performance to be achieved, but not in terms of the means of achieving them.
Receiver :	The noise-sensitive land use at which noise from a delopment can be heard.

APPENDIX 10: DEFINITION OF TERMS. Cont'd.

Term	Definition
Stationary noise sources :	Sources that do not generally move from place to place, eg. industrial or commercial sources. In general, these include: **Individual stationary sources such as:** - heating, ventilating and air conditioning (HVAC) equipment, - rotating machinery; - impacting mechanical sources; - other mechanical equipment and machinery such as conveyors; **Mobile sources confined to particular location such as draglines and haul trucks.** **Facilities, usually comprising many sources of sound, including;** - industrial premises; - extractive industries; - commercial premises; - warehousing facilities; - maintenance and repair facilities. - (In this case, the stationary source is understood to encompass all the activities taking place within the property boundary of the facility).
Temperature inversion :	An atmospheric condition where temperature increases with height above the ground.

Ambient Sound Pressure Levels

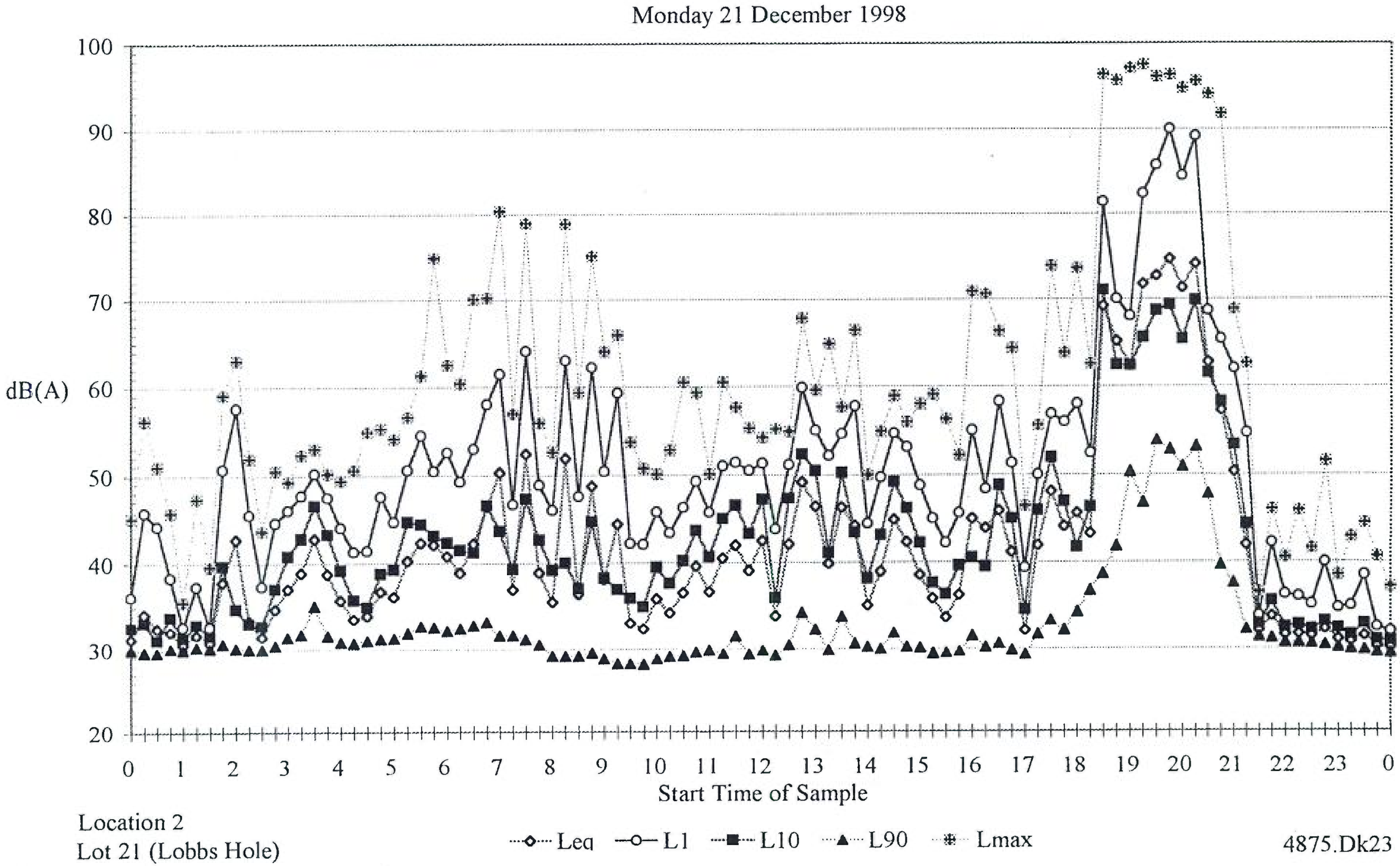


Location 2
Lot 21 (Lobbs Hole)

4875.Dk23

4875b.XLS

Ambient Sound Pressure Levels



Location 2
Lot 21 (Lobbs Hole)

4875.Dk23

4875b.XLS

Appendix J - Flora and Fauna Report

WILLIAMSDALE QUARRY

FLORA & FAUNA ASSESSMENT

1.0 Introduction

This report discusses the results of a flora and fauna assessment for a proposed hard rock quarry. The location of the proposed Oakvale Quarry is close to Williamsdale, south of Canberra. The land is within New South Wales, close to the border with the Australian Capital Territory.

The land on which the quarry is proposed is on a ridge to the east of the Monaro Highway about 2km north-east of Williamsdale.

An Environmental Impact Statement covering a proposed quarrying operation on the land was prepared in 1986. The EIS does not provide detailed information on the flora and fauna of the area as it was believed at that time that impacts would be minimal due to the distrubed nature of the land.

The current development proposal is different in a number of respects from the earlier proposal and environmental legislation has changed since 1986. Accordingly a further assessment of flora and fauna on the land was commissioned. This report and the field survey undertaken as part of the assessment seeks to provide a description of the flora and fauna occuring on the land and seeks to address the requirements of the Threatened Species Conservation Act, 1995.

This assessment covers land proposed for quarrying, the site of the proposed processing plant and the access road to the quarry.

2.0 Methods

A field inspection of the land was undertaken in November 1998. During the field survey records were made of the dominant plant species present, the nature and composition of canopy, shrub and ground layer strata and the level of disturbance to vegetation. Searches were made for rare or threatened plant species considered likely to occur in the area.

Observations of fauna were also made including actual sightings, signs such as scats & burrows and bird and frog calls. These observations were supplemented with information from the Atlas of NSW Wildlife and information in Yarrolumla Council's 'Upper Jerrabombera Creek - Royalla Local Environmental Study (1996).

3.0 Vegetation

Broad leaved Peppermint - Box Woodland

The site of the proposed quarry and nearby hills support a woodland community dominated by Broad-leaved Peppermint (*E. dives*) and Norton's Long-leaved Box (*E. nortonii*). Associated species include Yellow Box (*E. melliodora*) and Inland Scribbly Gum (*E. rossii*). On an exposed north-facing hill the most common woodland tree is Inland Scribbly Gum.

The understorey has been disturbed by a long history of grazing and pasture improvement. The native shrub layer is very sparse. The native ground layer flora is more diverse and in a few locations approaches 50% of the total ground layer plant cover.

The ground layer flora is usually dominated by introduced pasture species and other exotic species. Common exotic ground layer plants include Hop Clover (*Trifolium campestris*), Rat's Tail Fescue (*Vulpia bromoides*), Catsear (*Hypochaeris radicata*), Hare's Foot Clover (*Trifolium arvense*), Soft Brome (*Bromus mollis*), *Bromus diandra*, Cocksfoot (*Dactylis glomeratus*) and Perennial Ryegrass (*Lolium perenne*).

Native shrub species present include *Acacia mearnsii*, Native Indigo (*Indigofera australis*) and Blackthorn (*Bursaria spinosa*).

Common native ground layer species include *Geranium solanderi*, Prickly Starwort (*Stellaria pungens*), *Wahlenbergia stricta*, *Galium gaudichaudii*, *Ranunculus lappaceus*, Tussocky Poa (*Poa labillardieri*), Sheep's Burr (*Acaena ovina*), Redanther Wallaby Grass (*Chionochloa pallida*) and *Cheilanthes austrotenuifolia*.

A gully to the south of the proposed site of extraction supports vegetation with a more dense shrub layer. The dominant shrub species in this gully is Blackthorn.

Yellow Box - Red Gum Woodland

Sites of higher fertility and deeper soils in the area support stands of Yellow Box (*E. melliodora*) and Blakely's Red Gum (*E. blakelyi*) trees. In these areas the original vegetation would have been a woodland dominated by these species. Clearance of the native vegetation and a long history of agricultural use of the land mean that the area no longer supports viable remnants of the original vegetation. Associated tree species may include Apple Box (*E. bridgesiana*).

The proposed access road would traverse areas which support stands of these trees with the more dense stands of trees occurring along Williamsdale Road.

Wetland

Flat valleys with impeded drainage to the north of the proposed access road support wetland vegetation. This vegetation occurs in the middle of paddocks which have a long history of grazing and the vegetation includes a high proportion of exotic species due to this disturbance. Native plant species which remain in the wetter parts include *Carex gaudichaudii*, *Carex appressa* and *Juncus* spp.

Cleared Land

Most of the land in the area has been cleared in the past for agriculture. Much of this land now supports improved pasture. Common species include Cocksfoot (*Dactylis glomeratus*) and Perennial Ryegrass (*Lolium perenne*), as well as a range of clovers.

3.1 Threatened Flora Species

The Atlas of NSW Wildlife maintained by the National Parks & Wildlife Service identifies only two threatened flora species for the Michelago 1 : 100 000 map sheet. These are *Gentiana bredboensis* and *Eucalytpus pulverulenta*.

Yarrolumla Council's 'Upper Jerrabombera Creek - Royalla Local Environmental Study (1996) lists another three species which may occur in the area; Small Purple Pea (*Swainsona recta*), Button Wrinklewort (*Rutidosis leptorhynchoides*) and Austral Toadflax (*Thesium australe*). These species are normally associated with native grasslands where they occur in the vicinity of Canberra. The Council's Development Control Plan No. 6 for its Rural Residential Zone also lists a Leek Orchid (*Prasophyllum petilum*) and a daisy, *Ammobium craspedioides*, as species which require consideration. The Leek Orchid is another species associated with native grasslands, whilst *Ammobium craspedioides* is found in forest, woodland and roadsides mainly around the Yass district (Harden 1992).

No evidence was found that these species occur in the study area. Given the level of disturbance to the native vegetation in the study area it is considered highly unlikely that populations of these species remain in the area.

None of the threatened species described above were observed in the area likely to be affected by the proposal and it is considered highly unlikely that any of the species occur in the area. However, the following 8-part test has been prepared to provide guidance for an assessment of the proposed development on threatened spcies.

a) in the case of threatened species, whether the life cycle of the species is likely to be disrupted such that a viable local population of the species is likely to be placed at risk of extinction,

Development of the proposed quarry will result in the clearing of some vegetation. During the initial years of development, minimal amounts of vegetation will be removed. Larger areas will be cleared during later years, however as the quarry progresses all available areas will be rehabilitated with species the same as those that originally occurred.

No populations of the threatened species identified as occurring in the region were observed in the study area. With no local populations present in the area where impact will occur, the life cycle of these species is not likely to be disrupted or placed at risk of extinction.

b) in the case of an endangered population, whether the life cycle of the species that constitutes the endangered population, is likely to be disrupted such that the viability of the population is likely to be significantly compromised,

No endangered population as defined in the Threatened Species Conservation Act occurs in the area affected by the proposed development.

c) in relation to the regional distribution of the habitat of a threatened species, population or ecological community, whether a significant area of known habitat is to be modified or removed,

The habitat of *E. pulverulenta* is dry woodland on poor soils. Some areas of dry woodland will be removed as part of the operations at the quarry, however given the area covered by dry woodland in the region, the area to be destroyed is not considered to be significant.

The habitat of *G. bredboensis* is on margins of very wet seepage zones of pastures on granitic soils. This habitat type is not present on the study site, therefore the proposed operations will not result in the loss of significant habitat.

d) whether an area of known habitat is likely to become isolated from currently interconnecting or proximate areas of habitat for a threatened species, population or ecological community,

There are no areas of known habitat for threatened species in the area of the proposed quarry. Consequently, no areas of known habitat will become isolated from any interconnecting or proximate areas of habitat as a result of the development.

e) whether critical habitat will be affected,

No areas of critical habitat as defined in the Threatened Species Conservation Act occur in the study area.

f) whether a threatened species, population or ecological community, or their habitats, are adequately represented in conservation reserves (or other similar protected areas) in the region,

According to Briggs and Leigh (1996), none of the threatened species identified as occurring in the region are represented in a conservation reserve.

g) whether a development or activity proposed is of a class of development or activity that is recognised as a threatening process,

The development is not of a class of development which is recognised as a threatening process as listed in Schedule 3 of the Threatened Species Conservation Act.

h) whether any threatened species, population or ecological community is at the limit of its known distribution.

The distribution range for *E. pulverulenta* is from Bathurst to Bomballa (Central and Southern Tablelands). The closest population occurs south of the site in the hills north-east of Cooma.

G. bredboensis occurs only in small section along the Bredbo River. If it was to occur on the site it would be a disjunct population at its northern limit.

4.0 Fauna

4.1 Fauna Habitats

Three broad habitat types can be recognised in the study area. These are:

- woodland vegetation with an open, grassy understorey
- dams and wetlands (including sedgeland), and,
- pastures (cleared land).

The value of the study area as a habitat for wildlife has been severely compromised by a long history of agricultural use of the land. The bird fauna is now largely restricted to species which favour open woodland and grasses with the lack of shrub cover meaning that the woodland is of low value to small birds which require shelter. The gully to the south of the proposed extraction area supports higher populations of small birds due to the increased shrub cover, however its relatively small size limits its value as a wildlife habitat.

Wetland vegetation occurs along the creek to the east of the proposed access road and to the south of the proposed quarry site. Whilst disturbed by past land uses these areas have some habitat value for aquatic birds, bats and frogs. Frogs were heard calling in the creek at the time of the field survey of the land.

The pastures are severely disturbed habitats which provide little in the way of structural or floristic diversity. They are generally inhabited by introduced or common native species adapted to modified environments. Some of the remnant trees in the pastures do have tree hollows suitable for fauna habitation.

4.2 Threatened Fauna Species

A number of threatened fauna species have been recorded for the Michelago map sheet. In addition Yarrolumla Council's "Upper Jerrabombera Creek - Royalla Local Environmental Study (1996) lists additional fauna species which may occur in the upper Jerrabombera Creek - Royalla area. Table 1 provides a list of these species and their conservation status.

Table 1. Threatened Fauna Species Recorded for Michelago, Upper Jerrabombera Creek and Royalla areas

Scientific Name	Common Name	Status
Frogs		
Heleioporus australiacus	Giant Burrowing Frog	V
Reptiles		
Delma impar	Striped Legless Lizard	V
Aprasia parapulchella	Pink-tailed Legless Lizard	V
Tympanocryptis lineata pinguiolla	Southern Lined Earless Dragon	E
Birds		
Ninox connivens	Barking Owl	V
Xanthomyza phrygia	Regent Honeyeater	E1
Pachycephala olivacea	Olive Whistler	V
Mammals		
Dasyrus maculatus	Tiger Quoll	V
Phascolarctos cinereus	Koala	V

Notes:

E Endangered
V Vulnerable

A number of other threatened fauna species are listed in Yarrolumla Council's Development Control Plan No. 6 for its Rural Residential Zone. These additional species are; *Polytelis swainsonii* (Superb Parrot), *Synemon plana* (Golden Sun Moth), *Suta flagellum* (Little Whip Snake), *Malacorhynchus membranaceus* (Pink Eared Duck), *Calyptorhynchus lathami* (Glossy Black Cockatoo), *Lathamus discolor* (Swift Parrot), *Miniopterus australis* (Common Bent Wing Bat), *Strictonetta naevosa* (Freckled Duck). *Oxyura australis* (Blue Billed Duck), *Litoria aurea* (Green and Golden Bell Frog), *Granitella picta* (Painted Honeyeater) and *Varanus rosenbergi* (Rosenbergs Goanna).

The value of the study area as a habitat for wildlife has been severely compromised by a long history of agricultural use of the land. Further the extent of clearance of the woodland vegetation is insignificant in relation to this habitat type in the region and much of the vegetation to be cleared has been severely disturbed by agricultural land use. In addition the area does not provide suitable habitat for a large number of the species listed above.

The following 8 part test has been prepared to provide guidance for an assessment of the proposed development on threatened species.

a) **in the case of threatened species, whether the life cycle of the species is likely to be disrupted such that a viable local population of the species is likely to be placed at risk of extinction,**

No threatened species were found to occur in the area of the proposed quarry and the area has been severly disturbed by agricultural land use. Accordingly it is highly unlikely that any part of the life cycle of a threatened species will be disrupted.

b) **in the case of an endangered population, whether the life cycle of the species that constitutes the endangered population, is likely to be disrupted such that the viability of the population is likely to be significantly compromised,**

No endangered population as defined in the Threatened Species Conservation Act 1995 occurs in the area affected by the proposed development.

c) **in relation to the regional distribution of the habitat of a threatened species, population or ecological community, whether a significant area of known habitat is to be modified or removed,**

Three types of fauna habitat have been identified as occurring on the site of the proposed development. The proposed quarry site lies predominantly on pasture (cleared land) which is not likely to be prime habitat for any threatened fauna species.

Only one species of vulnerable frog, *Heleioporus australiacus*, has been identified as occurring in the region. This species was not found on the study site although creeks on the land may provide suitable habitat. Siting of development will avoid the flatter reaches of Lobbs Hole Creek wehre suitable habitat is more likely to occur. The impact of the proposed development on dams and wetlands will be minimal provided adequate erosion control measures are put in place. The proposed quarry development will not result in modification of a significant area of known habitat.

The proposed quarry will result in the clearing of a small area of native vegetation. No threatened species were found to occur in this area, and consequently it is not believed that the area represents habitat for any threatened species. In terms of the value of the woodland vegetation on a regional scale, the area to be cleared is relatively small and has been disturbed and so does not represent a significant modification of habitat.

d) **whether an area of known habitat is likely to become isolated from currently interconnecting or proximate areas of habitat for a threatened species, population or ecological community,**

The habitat areas occurring on the site consist of disjunct pockets of woodland, occasional farm dams and creeks, already isolated from other habitat areas. There were no threatened species observed in the study area suggesting that the pockets of habitat present are not habitat for threatened species. No area of known habitat will become isolated from other habitat areas of threatened species, populations or ecological communities.

e) whether critical habitat will be affected,

No areas of critical habitat as defined in the Threatened Species Conservation Act occur in the study area.

f) whether a threatened species, population or ecological community, or their habitats, are adequately represented in conservation reserves (or other similar protected areas) in the region,

The Giant Burrowing Frog (*Heleioporus australiacus*) is present in several conservation reserves in the Sydney area as well as Morton National Park.
There are no records of the Striped Legless Lizard (*Delma impar*), Pink-tailed Legless Lizard (*Aprasia parapulchella*), or the Southern Lined Earless Dragon (*Tympanocryptis lineata pinguiolla*) occurring in the Tinderry Range Nature Reserve (NPWS Atlas of NSW Wildlife, 1998).

The range of the Barking Owl (*Ninox comnivens*) is extensive across Australia (Pizzey, 1980) and is likely to occur in a number of conservation reserves. The Regent Honeyeater (*Xanthomyza phrygia*) is present in a number of conservation reserves through its range, but is a nomadic species seeking out flowering ironbarks. The Olive Whistler (*Pachycephala olivacea*) is present in a number of conservation reserves through its range. Locally present in Brindabella National Park and Tinderry Nature Reserve.

The Tiger Quoll (*Dasyrus maculatus*) is present in a number of conservation reserves throughout its range. The Koala (*Phascolarctos cinereus*) has been recorded in a large number of conservation reserves through the range of the species.

g) whether a development or activity proposed is of a class of development or activity that is recognised as a threatening process,

The development is not of a class of development which is recognised as a threatening process as listed in Schedule 3 of the Threatened Species Conservation Act.

h) whether any threatened species, population or ecological community is at the limit of its known distribution.

The only threatened species that would be near the limit of its known distribution if it was found to occur in the study area is the Southern Lined Earless Dragon (*Tympanocryptis lineata pinguiolla*). It is restricted to the area between Canberra and Cooma. If present in the study area it would be approaching its northern limit.

5.0 Assessment of Impacts

The proposed quarrying operation is planned to extend across an area of 17 hectares, including 3 hectares to be used as a process/stockpile area. Extraction would occur sequentially over the quarry area.

Vegetation and soil will be progressively removed as the operation proceeds. This will result in the loss of disturbed native vegetation from the quarry site.

The loss of vegetation will have a minor impact on the fauna habitat available in the Williamsdale area as the sites which will be affected have been significantly disturbed and are of low habitat value.

As quarrying is to take place sequentially over a long period of time it will be possible to re-establish vegetation in areas where operations have been completed.

The creek and wetland present on the land support populations of frogs. Application of soil erosion controls and appropriate site management should avoid any significant impact on this habitat.

It is also possible that the operations could contribute to the spread of exotic weeds which already exist in the area. For instance, there are patches of Sweet Briar (*Rosa rubiginosa*) in the vicinity of the proposed process/stockpile area.

6.0 Impact Mitigation Recommendations

Rehabilitation of the land will take place sequentially as quarrying progresses. Re-establishment of native trees as well as pastures should be undertaken as part of the rehabilitation process.

Control of Sweet Briar around the proposed process/stockpile and quarry areas should be undertaken to prevent spread on the property and further afield.

Roger Lembit B.Sc.Agr.
Environmental Consultant
December 1998

Reference

Yarrolumla Council (1996) *Upper Jerrabomberra Creek - Royalla Local Environmental Study* Environment and Development Division, Yarrolumla Council.

Appendix K - Archaeological Report

An Archaeological Survey for the Proposed Hard Rock Quarry at Oak Dale, Williamstown near Queanbeyan, NSW.

Commissioned by International Environmental
Consultants Pty Ltd for Totalcare

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January, 1999

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Photo 11: Artefacts from Site JC-OS-2
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Photo 13: Creekline on the eastern side of the spur
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Photo 16: Western side of the quarry site looking east across the extraction site.

5. Copy of Statement of Involvement of Aboriginal Community and record of consultation with LALC.

6. Gazetteer of previously recorded sites and associated reports from NPWS Sites register

7. Copies of NPWS Site Forms for recorded sites and field notes.

Executive Summary

International Environmental Consultants Pty Ltd commissioned Robynne Mills, archaeological consultant, to conduct an archaeological survey of the proposed Oak Dale Hard Rock Quarry. The archaeological study was designed to identify potential impacts of the proposed development on Aboriginal relics ('relics' as defined by the New South Wales National Parks and Wildlife Act 1974) and non-indigenous heritage items as defined by the NSW Heritage Act and the Environmental Planning and Assessment Acts of 1975 and 1979 respectively.

The field component of the study was conducted by Robynne Mills and Jim Kelton, archaeological consultants from Tuesday 15th to Thursday 17th December, 1998. Ngunnawal Local Aboriginal Land Council (LALC) was represented during the survey by Joe House. Details of LALC consultation and a *Statement of Involvement in the field survey* from Ngunnawal LALC are included as Appendix 5.

This report provides details of local environmental observations relevant to the archaeological sensitivity of the study area. It maps all known archaeological sites in the vicinity of the study area as recorded in the site register of the National Parks and Wildlife Service (NPWS) and the Heritage schedules of Queanbeyan Council. Survey methods, results and significance assessments are made according to NPWS guidelines. Where appropriate, the report recommends site management options to minimise impact on heritage sites, places and items within the study area.

The survey identified 4 sites, 1 isolated artefact (IF) and 3 areas of potential archaeological deposit (PAD). Sites WR-OS-1, LHC-OS-1 are in the vicinity of the proposed access route to Williamsdale Road. Site JC-OS-1 is within the proposed creekline area to the west of the quarry site where silt traps will be required. Site JC-OS-2 is located in the south-east corner of the proposed quarry sites. The isolated artefact is to the east of the proposed access road on the northern side of the Lobbs Hole Creek. The PAD area is located on the southern bank of Lobbs Hole Creek in association with Site LHC-OS-1.

It is recommended that Mine management be made aware of the locations of all sites and the PAD area and of their responsibilities under the NPW Act to protect these sites. The exact location of all proposed mining activities including access routes and the impact of these activities on the sites located in this survey should be determined. Where possible sites should be avoided and protected. Sites which cannot be avoided by the proposed development are protected by the NPW Act and Totalcare would be required to apply to the NPWS for a Consent to Destroy Permits for each sites prior to the development proceeding. A condition of this permit would be the collection of surface artefacts from all sites and monitoring of the identified PAD area. No non-indigenous heritage sites were identified in the survey.

Provided the recommendations in Section 8 of this report are implemented, there is no objection on archaeological grounds to the project proceeding as proposed. These recommendations are made on the basis of the National Parks and Wildlife Act of 1974 (as amended), whereby it is illegal to damage, deface or destroy an Aboriginal relic without the written permission of the Director. Should any further relics be encountered during the course of the development, officers of the National Parks and Wildlife Service should be informed without delay.

1. Details of the Development Proposal and Consultancy Brief.

1.1 Development Proposal

Totalcare proposes to develop a hard rock quarry at Williamsdale, near Queanbeyan. The development includes the quarry site, a crushing plant, a conveyor system from the quarry to the crushing plant, water catchment and siltration ponds and a series of access roads.

1.2 Consultancy Brief

The consultant was commissioned to:

- consult with the Ngunnawal LALC prior to the survey, to identify any areas of special significance to the Aboriginal community eg sacred or ceremonial areas and identify issues of Community concern.
- arrange for a representative of Ngunnawal LALC to participate in the field work to ensure Aboriginal community representation in discussions relating to the significance, protection and management of all relics identified in the archaeological survey.
- examine the proposed development area for indigenous and non-indigenous heritage items, sites and places which could be impacted upon either directly or indirectly by the proposed development.
- assess the significance of heritage sites/items/places recorded and make recommendations for the protection and management of these items.
- prepare a report on the heritage investigation which meets the requirements of the NPWS and DUAP.

1.3 Impacts

Sections of the proposed development area have been subject to considerable impacts from past and present mining and land use practices.

1.3.1 Previous impacts to the proposed development area

The major impacts to the development area have been associated with:

- Clearance of timber and the construction of access tracks
- Cattle and sheep grazing

1.3.2 Impact of current proposal

The degree of impact of the proposed development on indigenous and non-indigenous heritage items will vary greatly across the development area.

- **High impact areas** include those areas directly associated with the hard rock extraction, infrastructure including stockpile areas, hardstand area, office, conveyor areas, parking areas, electricity sub-station, water supply tanks and minor access roads.
- **Low or nil impact** will occur in those sections of the study area where no mining activity or mining infrastructure is planned (Map 3).

2. Aboriginal Community Consultation (Appendix 5)

The survey area is within Wiradjuri country and in the Ngunnawal LALC area. Initial contact with the LALC occurred with a phone call on the 4th November, 1998 to inform the LALC of the proposed survey. A fax on the 2ndth December, 1998 formally advised the LALC of the pending field survey, and requested LALC involvement. LALC was asked to provide, following the field survey, a *Statement of Involvement*, detailing the level of LALC involvement and any concerns that the LALC might have regarding the development proposal. This is provided as Appendix 5. After the completion of the field survey, a summary document was sent to the LALC on 6th January, 1999 confirming the results of the archaeological survey. The LALC was advised that it would be provided with a copy of the final report.

3. Study Area.

3.1 Location

The development site is located approximately 29km south of Queanbeyan and 3-5km north-east of Williamsdale (Map 1). The proposed development site is located east of the Goulburn-Bombala Railway which delineates the boundary of the Australian Capital Territory. All of the proposed development is within the State of NSW.

3.2 Environmental Observations.

3.2.1 Topography

The development area contains two major creekline systems. The Jerrabomberra Creek system which flows north into the Queanbeyan River and the Lobbs Hole Creek system which flows south west into the Murrumbidgee River. Entrance to the quarry site is through the valley of the Lobbs Hole Creek which flows from the quarry site in a south-westerly direction. The headwaters of Lobbs Hole Creek rise in a series of steep narrow ephemeral watercourses which flow from Lobbs Hill to the north and Gibraltar Hill in the south. These ephemeral watercourses discharge into the relatively flat, broad valley through which Lobbs Creek meanders to discharge into Guises Creek and thence into the Murrumbidgee River approximately 3km east of the site. The valley floor has been heavily impacted by the clearance of timber, cropping and grazing. The creek banks have been damaged by stock gaining access to water.

The quarry site is approximately 3km east, up Lobbs Hole Creek Valley where the hill slopes rise steeply from the valley floor in a series of narrow ridge lines and spurs at heights of approximately 1000 ft. These ridges are separated by steep, narrow valleys which form the headwaters of the Jerrabomberra Creek system which flows on both the eastern and western sides of the quarry site (Photo 16). Little old growth timber remains in the quarry area.

The major topographic areas identified within the development area are:

- **Lobbs Hole and Jerrabomberra Creek systems** which have been impacted by timber clearance, construction of dams the overflow from which has created some gully and sheet erosion.

- **steep hill slope areas** (Map 5, Photos 7, 16) which are base rock covered in some places by a thin layer of topsoil which has little resistance to erosion once the surface vegetation is damaged. The soils are shallow and skeletal and much of the surface is strewn with outcrops of volcanic tuff and dacite. Vegetation in the area is native sclerophyll woodland from which old growth trees had been logged. Many edible plants were noted in this area and there was evidence of large numbers of wallabies and wombats.

- **ridge crest and spurs** (Map 5, Photo 14, 15, 16**).** The hill and ridge crests are covered with outcrop of eroding dacite. Topsoil is shallow and tree cover sparse.

4. Archaeological Context

4.1 Sites identified in the area from NPWS Sites Register.

A search of NPWS records was conducted prior to commencement of the field survey. This search revealed a total of 10 sites within 10km of the proposed development area (Map 2). Of these, 3 sites are to the west adjacent to the Murrumbidgee River, one site to the south on a tributary of Waterhole Creek and the remaining 6 are to the south- west on Cassidy's Creek. All sites are open camp sites. This site distribution pattern may be somewhat biased as a result of limited archaeological investigations carried out in the area, however it does appear that sites area located adjacent to reliable water sources.(Map 2)

Sites identified in the vicinity of the development area:

#57-5-0015	Royalla	Open Camp Site
#57-5-0016	Royalla	Open Camp Site
#57-5-0017	Royalla	Open Camp Site
#57-5-0026	Michelago	Open Camp Site
#57-5-0027	Williamsdale	Open Camp Site
#57-5-0051	Margaret's Creek	Open Camp Site
#57-5-0052	Margaret's Creek	Open Camp Site
#57-5-0053	Cassidy's Creek	Open Camp Site
#57-5-0054	Cassidy's Creek	Open Camp Site
#57-5-0055	Cassidy's Creek	Open Camp Site

4.2 Archaeological data and models from previous studies in the area.

4.2.1 Ethno-historic Data

Little early, reliable direct information about Aborigines in the Canberra/Queanbeyan district is available (Flood 1980). A study of clan boundaries from ethno-historic and linguistic evidence by Flood (1980), based on Tindale (1940). Indicated that Queanbeyan included the clan or tribal and linguistic boundaries of three groups: the Ngunnawal, Ngarigo and Walgalu (Kuskie 1989:120).

Records do indicate a rapid depopulation and a disintegration of tribal life in the Canberra/Queanbeyan District after European settlement (Officer 1989). This rapid reduction in population was probably accelerated by the impact of European diseases such as the smallpox epidemic of 1830, influenza and a severe measles epidemic in the 1860's. (Flood 1980, Butlin 1983).

William Davis Wright, a collector of early information about the plight of Aboriginal people in the Queanbeyan area, states that there were between 400-500 Aboriginal people living a tribal, nomadic lifestyle in the Queanbeyan area in the 1850's. By 1856 the local "Canberra Tribe" were reported to number around seventy (Schumack 1967) and by 1872 this number had been reduced to only five or six (Goulburn Herald 9th November, 1872). In 1873 one "pure blood" member remained, known to the white community as Nelly Hamilton or "Queen Nellie".

By the 1850's the traditional Aboriginal economy had been largely replaced by an economy based on European rations. Reduced population, isolation of the people from their traditional lands and the destruction of traditional social networks meant that by the final decade of the 1800's the region's indigenous culture and economy was centred on white settlements and support by sympathetic farmers (Officer 1989).

Frequently only "pure blood" individuals were considered "Aboriginal or Tribal" by European observers, thus making possible the assertion that local tribes were "extinct". In reality "Koori" and tribal identify remains integral to the descendants of the nineteenth century Ngunnawal people, some of whom live in the Canberra -Queanbeyan-Yass districts. (Navin Officer 1995: p 5)

4.2.2 Academic Research

There have been several academic studies carried out in the area to the north of the present study area. These include Flood (1973), Read (1983) and White and Cane (1986)

Flood concludes from her investigations that this region was unsuitable for permanent Aboriginal occupation before 10,000 years ago. She points out that the palaeo-climate would have been peri-glacial (cold, dry and windy). The character of the climate in the last 10.000 years has been similar to today except for an identified cold spell from about 3000 to 15000 years ago. Flood's study concludes that while the immediate Canberra area was very important by late pre-historic and early contact times (on the basis of a range of ethnographic and archaeological evidence which she cites) there is little evidence of occupation prior to 1600 BC (Flood 1973:302). Subsequent work has found considerable evidence both to support this thesis and considerably extend this period into the past. There is now archaeological evidence that Aboriginal people were in the Canberra area at least 20,000 years ago, however the bulk of known sites date from the last 4000 yrs (Bartz no date :8). It has been noted by Flood (1973) that the most important food resource for the Aboriginal inhabitants of this area was the Bogong moths which gather in high granite mountains to the west for 3-4 months every spring. During this period the moths provided a staple food of sufficient quantity not only for the local inhabitants but for large ceremonial gatherings. Except for these periodic gatherings, the population of the Southern Tablelands appears to have been low when compared with coastal NSW or the Riverine Plains of Western NSW, despite an adequate year round food supply (eg fish, crayfish, vegetable foods, and birds and mammals). Ethnographic evidence indicates that the territory of each group or clan included a variety of ecological zones giving access to all available food resources.(Barz no date: p9). Feary and Bell (1983) found evidence in the Gudgenby Valley of large camp sites, quarry sites and a range of art and ceremonial sites which support a more extensive occupation pattern for the highland areas than the itinerant or seasonal patterns suggested by Flood.

Read (1983) compiled a history of the Wiradjuri people from 1883 to 1869. White and Cane (1986) undertook an in depth study of the Aborigines of the Yass District from contact to present.

From the results of a broad study of bog areas across the tablelands including Jackson's Bog and Calabash Creek to the south of the study area, Hiscock argued that swamp areas were a significant resource zone to past Aboriginal inhabitants of the region. The presence of backed blades at many sites indicated a date for Aboriginal occupation in the region in the vicinity of 4000 years BP.

4.2.3: Archaeological investigations related to D A's and EIA studies.

A number of archaeological investigations associated with DA applications, REFs and EIA studies have been carried out in the vicinity of the current study area. These include Barz (1970s), Paton (1985), Navin and Officer (1993, 1995A, 1995b), Kuskie (1989)

Barz carried out a survey of a route from Canberra to Royalla for the NSW Electricity Commission. The southern section of this survey crosses the Murrumbidgee to the west of the current development site. Barz identified 10 open camp sites of which three are within 2km of the current development area. These are sites #57-5-0015,-0016, -0017. All sites are located on high ground adjacent to the Murrumbidgee River. Raw materials at the sites included quartz, silcrete, quartzite and river pebbles

Paton (1985) also conducted a survey for the Electricity Commission of NSW. His survey was from Cooma to Royalla (ie to the south of the current development area) This survey was through three major landform areas; steep hill slopes and crests, foot slopes and river valleys. A total of fifteen sites were located in this survey. They included 14 open camp site's and one quarry site. Two of these sites #57-5-0027 and #57-5-0026 were located approximately 6km south of the current development site. These sites were both open camp sites containing low density of artefacts (4 at each site) of quartzite, quartz and silcrete. Both sites were located on raised, flat areas adjacent to creeklines and no in situ artefacts were identified. Paton makes the following conclusions as to landscape sensitivity. He identifies steep undulating terrain as having very low potential for sites; gently to moderately sloping terrain is identified as low but flat areas adjacent to intermittent creeks within this general landscape unit, is assessed as having high potential for sites to occur. However river valleys are identified as the areas of highest potential.

Kuskie's research (1989, 1990) in the vicinity of the Queanbeyan River and Jumping Creek, to the north of the current study area identified a relatively high site density in areas immediately adjacent to the River. Within a 100ha area at Jumping Creek, a total of twenty sites were identified. Kuskie interpreted these sites in terms of site complexes rather than individual items and as such considered them to be regionally significant. The predominant raw materials at all sites were silcrete, quartzite, chert, volcanic rock and jasper. Site distribution indicated that large, dense artefact scatters were concentrated around creek confluences and extending back to the river flats and lower slopes in the nearby vicinity. Smaller and less dense sites occurred on the ridges and lower slopes within the area.

Navin and Officer have carried out two surveys in the vicinity of the development area. Both surveys were development related. Navin (1993) was a survey of the Readymix Development at Cooma Road Quarry. This site is approximately 20km north of the current development on the watershed between the Jerrabomberra Creek and the Queanbeyan River. The topography is similar to that of the current study area and is characterised by steep sided slopes, narrow creek valleys, incised drainage lines and narrow sloping crest lines. No Aboriginal artefacts or sites were located in this survey. Navin attributes this absence of sites to the fact that the study area consisted of low sensitive areas where bedrock was at or near the ground surface, and the majority of slopes, crests and saddles were littered with rock in the form of pebbles, cobbles and boulders. Slopes were steep, creeks were steep sided with no adjacent flat, well drained areas suitable for Aboriginal campsites. Unlike the adjacent areas which have been the subject of archaeological investigation such as the Queanbeyan River, Jumping Creek and Jerrabomberra Creed, there are no major water courses or particularly exploitable resources within the study area to act aa a foci for Aboriginal activity (Navin 1993: 11)

Navin (1995). It appears from the site register print out that a survey of the Eastern Gas Pipeline was carried out by Navin in 1995. No copy of this report was available from NPWS (see print out). From the identification of site types and locations it would appear that all sites are located in the vicinity of Cassidy's Creekline. Two are open camp sites and two isolated artefacts. This site distribution pattern would appear to support Navin, Paton and Barz assertion that creekline/riverine landscapes have a high potential for sites to occur.

Kelton, (1996, 1998) conducted two surveys to the south of the proposed quarry for Telstra. Kelton 1996 identified a single Aboriginal scarred tree and the second survey (Kelton 1998) identified no sites.

4.3 Development of a predictive model for site type and distribution within the study area.

It is reasonable to expect that site types represented in the development area will be similar in type and distribution patterns to those identified in studies carried out by Bartz, Navin, Paton, Hiscock and Kuskie. The most likely site types will be:

- open camp sites which are most likely to be associated with water resources and bog areas
- isolated artefacts which could be located across the quarry site
- stone arrangements which will most likely be confined to high ground on hill tops or spurlines
- scarred trees which could occur wherever old timber is present

4.4 Predicted Archaeological Sensitivity

Based on the results of previous archaeological investigations in the region and a study of the topography within the study area, it was predicted that the most archaeologically sensitive micro-landform units in the study area will be creek lines, swamp and bog areas, raised flat or gently sloping ground in the vicinity of a reliable water source.

5. Field Survey Methods

5.1 Pre-field Survey Investigation

Initial investigations carried out prior to commencement of the field survey included site and archival searches of the NPWS site data base, and the Register of the National Estate, Canberra. Consultation also took place with Ngunnawal LALC.

5.2 Pre-Field Survey Assessment

Prior to the commencement of the field survey, a desk top study of the survey area landform and archaeological land systems was conducted. As a result of this pre-field work assessment, a model of site prediction and sensitivity was developed (Section 4.4) in conjunction with a strategy for survey area coverage (Section 5.4).

5.3 Landscape Classification

Archaeological land systems correspond with landform units (Section 3.2). These differing landform units within the study area include the creek lines, gentle hill slopes, steep hill slopes and hill crests and ridge lines/spurs (Map 5, Photos 3, 5, 7, 812, 1316).

5.4 Field Survey Strategy

Initial reconnaissance of the survey area was conducted by vehicle. During this reconnaissance, areas of direct impact from the proposed development were identified and representative samples of landform units within the study area, but not in the zone of direct impact, were selected for on foot examination. Highly disturbed areas, areas with high surface visibility and areas of potential archaeological sensitivity were also identified and the following survey strategies adopted.

A combined 'on foot' and "vehicle" survey strategy was adopted for all areas directly and indirectly impacted by quarrying and associated activities (Map 4). This involved a series of on-foot transects, approximately 15m wide across all sensitive landform units within the impact area (ie ridge crests, hill crests, spurlines, creeklines and water courses). ***A 'vehicle survey"*** was conducted over all low sensitivity landform areas. This vehicle survey involved the driving of 10m transects across steep hill slope areas and the examination of all old growth trees for evidence of scarring.

Creek lines, swamp areas: Three transects, approximately 15m wide, were walked on each side of Lobbs Hole Creek and all ephemeral creeklines. Tracks, table drains and scour areas were thoroughly examined. Visibility over this landform unit varied from 80% on exposed eroded bank areas to less than 10% in adjacent grassed areas.

Steep Hill slopes were covered in a series of vehicle transects Areas sampled in these topographic units are identified in Map 5.

Ridge crests, spurlines and knolls were surveyed on foot in 10m wide transects (Map 4)

5.5 Field Recording Methods

The field survey was conducted using the Williamsdale 8726-IV-N topographic map and maps and aerial photographs of the proposed development supplied by International Environmental Consultants. The site manager took the consultants on a tour of the site and identified all areas which would be impacted by the proposed development. Where sites were present, site details, landform and environmental conditions relating to the detectability of sites were recorded on data sheets developed for the survey. Copies of site/artefact recording forms are provided in Appendix 7 where they occur as field notes attached to copies of all NPWS site forms completed during the field survey. Photographs were taken of all sites

5.6 Field Survey Methods and Coverage Data

- **The total lease area** has been assessed from development plans supplied by International Environmental Consultants as approximately 9 kilometres ^{2} or 900ha.

- **The area of direct impact** from quarrying and associated infrastructure including crushing plant, conveyor system, road access etc has been assessed as:
    - quarry site area and creekline modification for filtration traps 600m x 1.5km = 90ha
    - access to quarry and conveyor belt installation 400m x 200m =8ha
    - crushing plant area 600x x 500m = 30ha
    - road access from Williamsdale Rd 2km x 50m = 10ha
    - Total of 138ha

- **Areas where no proposed impacts** were identified by the client totalled 762ha. This area was not included in the survey.

It is important to attempt to quantify the effectiveness of coverage of these varying impact zones. *'Effective coverage'* for the areas surveyed using a total coverage strategy, a sample coverage strategy and a vehicle reconnaissance strategy are set out in Table 1.

Table 1: Effective Coverage tables
Table 2: Effective Coverage

Landform Unit	Sample Unit area in hectares	Coverage method	% visibility	Effective Coverage of Landform unit areas	% area effect surveyed
Ridge/hill tops	**102ha**	on foot	80%	81.6ha	59.1
Steep Hill slopes	**13ha**	vehicle	10%	1.3ha	0.9
creeklines/ valley floor swampy areas	**23ha**	on foot	20%	4.6ha	3.3
Totals	**138ha**			87.5ha	**63.3**

Site detectability varied over the survey area and was determined by factors such as surface visibility (see Table 2), geomorphology, the size of the survey team and the type of sites present (whether present ie whether the sites are obtrusive or unobtrusive). The measurement of site detectability is difficult given the range of factors which may influence site detection, some of which are mentioned above. Effective coverage assessment can be determined by the interpreted accuracy of a field investigation (Witter 1990b). For the current study, a method of coverage analysis where effective coverage can be reasonably accurately calculated, was adapted from Witter (cited Bonhomme 1993:50) where the following applies:

Survey Coverage Assessment formula (Boot 1996 pers Com)
L x W x % of visible ground surface = effective survey coverage
where L is the length of the of the survey area/unit/transect in metres, W is the width of the survey unit/area/transect in metres. Therefore the total survey area was approximately ha of which will be directly impacted;. Tables 1 indicates that approximately 63.3% of the area was effectively surveyed.

5.7 Surface visibility

Surface visibility within an archaeological context generally refers to the degree of impediments on the surface which might obstruct surface observation of archaeological material. The main factor to affect visibility is vegetation cover, although features such as rock outcrops and other natural or man-made obstructions on the landscape can also affect surface visibility. Surface visibility can be expressed as a percentage of the surface which is visible (Bonhomme 1986:11). Table 2 provides a basis for surface visibility assessment.

During this survey 100% visibility conditions prevailed on a network of tracks cut through the area. This network of tracks extended through all landform units and provided a representative sample of all archaeological units within the development area. There were also extensive areas of high visibility associated with areas of surface erosion. As a result of the skeletal soils and absence of vegetation cover, the ridge crest areas also had relatively high surface visibility. In the Lobbs Hole Creek area, visibility was confined to tracks and areas of surface erosion along the edges of the banks.

Table 2: Surface Visibility Criteria

a	Nil soil visibility	0-5%
b	Occasional glimpses of bare ground	5-10%
c	Frequent patches of bare ground	20-50%
d	Approximately 50% bare surface	50-70%
e	>70% bare surface	75-100%

Surface visibility varies within and between different landform areas and these differences are shown in Table 1. The generally low levels of surface visibility prevailing during this archaeological survey allowed for only a limited level of archaeological assessment of some landscape areas.

5.8 Surface Exposure

Surface exposure of archaeological sites is linked with visibility but should not be confused with surface visibility, in that exposure usually refers to the results or the effects of geomorphic processes on archaeological deposits. The major cause of surface exposure at this site was erosion caused by water flowing into water courses and grazing cattle (Photos 1, 3, 8, 10).

5.9 Definition of Sites and establishing site boundaries

For the purposes of surface archaeological surveys, site boundaries are most frequently determined by the presence of Aboriginal cultural material. NPWS report writing guidelines indicate that a site may be determined by the presence of two artefacts located within 50m of each other. However, Witter (pers coms 16/5/96) describes a cultural site as ..."*a place identified as such by an observer (including someone listening to oral accounts)...a site should be a unit of management*". This statement infers that an archaeological 'site' may be a place where physical evidence of past Aboriginal occupation has occurred, eg open camp sites, stone arrangements, while other site types may be determined by the presence of a single artefact (eg a scarred tree) or even by the presence of a recognised significant area based upon anecdotal information and often occurring with no visible artefacts (eg places of ceremonial or religious significance such as natural geological formations).

The extent of a site, particularly in the case of open camp sites, is often difficult to assess, owing to the effects of the geomorphic processes which may have impacted on a particular area and its archaeological deposits. However, surface deposits of archaeological material are usually, but not always a reliable guide to site locations. It should be acknowledged that EIA related studies do have their limitations and where the archaeologist believes there is a potential for the presence of sub-surface archaeological deposit, the issue should be raised and steps taken to accommodate that potential within a management framework. That framework might include a recommendation for further archaeological investigations or else simply taking into account the likelihood of sub-surface deposits during the development of management recommendations.

6. Survey Results and Discussion

A total of four (4) sites, three associated PADs and one (2) isolated artefact were recorded during the archaeological survey. These sites were all open campsites (Map 2, Tables 3, 4, Sketches 1-5)). No non-indigenous sites were identified in this survey. Based on the current quarry planning it is anticipated that only one site will be impacted by the quarry development. All other sites will be protected during the operation of the quarry.

6.1 Site WR-OS-1 and associated PAD 1

Site WR-OS-1 is located approximately 230m north of the Williamsdale Road (Map 2, Tables 3, Sketches 1, Photos 1, 2). The site is on the northern side of an ephemeral drainage line which flows into a small dam to the east of the woolshed. Artefacts are exposed across an area 10m long by 2m wide on the eroded northern bank of the drainage line. The area has been heavily eroded by grazing animals, ploughing and cultivation and the excavation of a contour bank on the western side of the site. Although the exposed artefacts do not appear to be in situ, the raised area to the north of the site has been identified as PAD 1 (an area of potential archaeological deposit). This PAD area has been heavily disturbed by ploughing, clearance and grazing. A total of 5 artefacts were recorded at this site (Table 4). These included 4 flakes and one block fracture fragment. Raw materials included chert (4) and quartz (1).

6.2 Site LHC-OS-1 and associated PAD 2

This open camp site is located in the southern bank of Lobbs Hole Creek (Map 2, Table 3, Sketch 2, Photos 3, 4). A light scatter of artefacts extends along the length of the southern bank of the creek west of the fence line, for a distance of 180m x 5m,. No artefacts were located on the northern bank. The creek banks are steep (Photo 3) and the soil in the creekline area is light, friable, sandy, alluvial gravels deposited over the years by wash from the ridge lines and hill slopes. The creek banks have been heavily eroded by water and animals gaining access to the creekline to drink.

The density of artefacts on the southern, creek bank is low (8 over a distance of 180m x 10m). Visibility on the top and sides of the bank was high, between 70-100%. However this high visibility did not extend more than 5m from the edge of the creek bank. A highly disturbed PAD area was identified south of the creek bank for a distance of 20m. The PAD has been heavily disturbed by ploughing, clearance and grazing. Although artefactual material may be present within the PAD area, it is likely to be in-situ.

6.3 LHC-IF-1

This isolated find was located approximately 80m south of the proposed access route to the east of the old homestead site (Map 2, Tables 2, 4, Sketch 3, Photos 5, 6). The isolated find, a hammerstone, was located on a track which runs through swampy ground at the base of a steep hill slope. The hammerstone was a circular quartzite river pebble with abrasion consistent with use as a hammerstone around the central edge and a shallow, possible anvil mark on one flat side. No other artefacts or PAD areas were identified in the vicinity. Therefore it is concluded that this was a drop site.

6.4 Site JC-OS-1

Site JC-OS-1 was located below a dam which had been constructed across the ephemeral head waters of the Jerrabomberra Creek to the west of the main quarry area (Map 2, Sketch 4, Table 4, Photos 8, 9). The natural flow of the creekline has been terminated by the dam however it appears that water still flows through the creekline in times of high water levels. There was considerable erosion in the area caused in part by water but also by the construction of contour banks and ditches. Visibility across the site area was high, greater than 80%. The artefacts were located on the top of what appeared to be the original creek banks. The site extended across an area approximately 25m x 10m. No in situ artefacts were present at the site and no PAD areas identified. The whole area had been heavily disturbed.

6.5 Site JC-OS-2 and associated PAD 3

Site JC-OS-2 was located in the south-eastern corner of the main quarry spur line approximately 100m up from the headwaters of the Jerrabomberra Creekline (Map 2, Table 3, 4, Sketch 5, Photos 10, 11). The artefacts were located over a distance of 28m x 5m, on a sheep pad to the south of a vehicle track along the eastern side of the crest of the spur. The artefacts were below a saddle between the southern and northern section of the quarry spurline and appeared to have moved down slope in eroded material. This movement was the result of water gully erosion and tracks caused by animal erosion. Visibility along the vehicle track and the sheep pad was high, in excess of 80%, however immediately off the tracks visibility was less than 5%. Topsoil at the site was shallow and friable and the area had been heavily eroded. A PAD area was identified to the west of the site, however the depth of soil in the PAD area was shallow (less than 5cm) and the area had been heavily disturbed.

6.6 Discussion of survey results

Non-indigenous Heritage

There were no non-indigenous heritage items located in the quarry area. The site of the original homestead on the northern side of Lobbs Hole Creek was identified by the presence of several pine trees and remnants of an orchard, however the homestead had been removed to a site adjacent to the Monaro Highway by the current owners who said that the mosquitoes made life on the creekline most unpleasant.

Indigenous Heritage

From the study of distribution patterns of known sites in the broader region, the most sensitive landscape areas identified were all creekline and valley floor areas and ridge crests. It was anticipated that open camp sites may be located on creeklines and valley floor areas; quarry sites in the exposed rock outcrops on the ridge tops and scarred trees in any remaining areas of old growth timber. This survey did support previous distribution patterns in that all sites were open camp sites/ isolated finds and were located on, or in the immediate vicinity of creeklines.

Lobbs Hole Creek and its associated alluvial valley was identified as potentially the most archaeologically sensitive area in the survey area. This was in fact the case, however the creekline area had been heavily eroded and disturbed by clearing, past farming activity and flooding. The survey area is approximately 2km east of the Murrumbidgee River which would have provided a permanent water supply and a rich riverine environment for water birds, fish, shell fish and mammals and would therefore be a more likely place for large camp sites.

No scarred trees were identified for two reasons, the majority of old growth timber had been removed and those old growth trees remaining were stringy barks and ironbarks which were not favoured by Aboriginal people for bark removal.

Although there was a large amount of eroding stone material (dacite) on the ridge top area (Photos 14 and 15), no evidence of Aboriginal quarrying was noted. All the eroded stone material was had been softened by weathering and was unsuitable for the manufacture of stone axes etc. The top of the ridge line was relatively level with no outstanding topographical features which may have encouraged ceremonial or spiritual activities.

Aside from Lobbs Hole Creek, no other permanent creeklines were present within the survey area, although the soak and wetland areas associated with the western and eastern headwaters of the Jerrabomberra Creek may have provided sufficient water for animals and visiting groups of hunters passing through the area. It is however, unlikely to have been an area used intensively by Aboriginal people in the past. The location of sites JC-OS-1 and JC-OS 2, would support the scenario that these tracks were used as access routes through the area.

7. Significance assessment of indigenous sites and PAD areas

7.1 Criteria for Significance Assessment

A statement of significance has been prepared for all sites and PAD areas identified during this survey. The assessment of significance for individual sites is determined by a number of criteria, which in their broadest terms and under NPWS guidelines, include consideration of a site's scientific and educational value as well as giving consideration to the value of a site to the Aboriginal community.

Scientific Significance: requires an assessment of the site's integrity, preservation, contents, location, uniqueness, representativeness and potential for future scientific research.

Educational Value/Public significance: assesses the potential of the site as an educational resource. It is important to acknowledge that this potential will not be the same for all groups which will include: educational institutions, general public and Aboriginal communities.

Aboriginal Value: The Aboriginal community places a range of values on sites. Aboriginal values can often vary from those held by the non-Aboriginal community. In some instances, the archaeological significance of a site is considered by an Aboriginal community to be a secondary consideration when assessing a site's significance. The Aboriginal community may place a greater emphasis on the socio-cultural significance of a site, or upon its educational value, (particularly for teaching community members about the lifestyles of their ancestors) and the value of a site in providing a 'link' with living community members and their ancestors. It appears that in many cases, Aboriginal communities tend to place far greater significance on sites relating to contemporary Aboriginal Heritage and historic events, for example mission sites and fringe camp sites. However the reverence for burial or sacred sites is never compromised.

7.2 Significance assessment and discussion.

7.2.1 Sites WR-OS-1 and PAD 1

- **Site WR-OS-1:** The significance of this site has been assessed as low and the potential sensitivity of the PAD as moderate
  Scientific Value:
    Site integrity: poor
    The integrity of these sites has been destroyed by the disturbance of the A soil horizon. This disturbance is associated with surface and creekline erosion and damage by grazing animals. The artefacts are not in situ.
    Preservation: fair
    Artefacts are in a fair state of preservation although there has been some damage to artefacts from grazing animals
    Contents: conforms to predictive model
    The contents of this site conform to the predictive model for other sites in this landform unit (Barz (1979), Paton (1985), Navin (1993, 1995). There are no unusual characteristics associated with the stone assemblage.

    Location: conforms to predictive model
    The location of this site (ie on the raised area adjacent to a creekline)

conforms with the predictive model for site location developed for this survey; supports the creekline model of site distribution and reinforces the statements of the sensitivity of creek line terrace areas.

Uniqueness: Nil

Representativeness: poor example of this site type

Potential for future scientific research: Nil .

Educational Value:

This site is a poor example of this site type and as such has low potential as an educational resource to the general community.

Aboriginal Community Value:

All sites are valued by the Aboriginal Community. Statements as to the relative value of this site for the Aboriginal community has been assessed by the LALC in their report (Appendix 5)

- **Associated PAD 1:** PAD 1 to the north of site WR-OS-1 has been identified as having the potential to produce data relevant to site WR-OS-1. However this PAD area has been disturbed and the integrity of the material contained within it may have been compromised by ploughing, construction of contour banks and grazing animals.

7.2.2 Site LHC-OS-1 and PAD 2

- **Site LHC-OS-1:** The scientific significance of this site has been assessed as low.

Scientific Value:

Site integrity: poor

This site has been highly disturbed by erosion associated with the erosion and subsequent collapse of the creek banks. This situation has been exacerbated by the animals accessing drinking water. Artefacts on the surface are not in situ as the topsoil has been either disturbed or removed by erosion.

Preservation: fair

Artefacts are in a fair state of preservation however there is evidence of post depositional damage from grazing cattle.

Contents: The artefact density is extremely low along the creek bank and no areas of high artefact concentration were noted. This could be the result of the erosion of much of the site area into the creek or it may indicate a generally low use pattern along the creekline. There are no unusual characteristics associated with the stone assemblage.

Location: The location of this site conforms with the expected pattern of site distribution as stated in Section 4.4 of this report.

Uniqueness: Nil

Representativeness: poor example of this site type

Potential for future scientific research: Nil

Educational Value: This is a poor example of this site type and as such has low potential as an educational resource to the general community.

Aboriginal Community Value:

All sites are valued by the Aboriginal Community. Statements as to the relative value of this site for the Aboriginal community has been assessed by the LALC in their report (Appendix 5)

- **PAD 2**: is located to the south of Site LHC-OS-1. The PAD area has the potential to contain additional artefactual material similar to that identified at Site LHC-OS-1. However the whole PAD area as been heavily disturbed by ploughing, cropping and grazing, so the potential for the PAD to contain data which would be useful for future scientific research has been assessed as low.

7.2.3 LHC-IF-1

The significance of this isolated artefact has been assessed as low.

7.2.4 Site JC-OS-1

The scientific significance of this site has been assessed as low

Scientific Value:

Site integrity: This site has been highly disturbed as a result of the damming of the ephemeral creekline and surface erosion at the site. The artefacts are not in situ.

Preservation: good

Artefacts at the site are in a good state of preservation

Contents: The artefact density at this site is low (2 artefacts across an area of high visibility 30m x 50m). The contents of this site conform with the contents of other sites recorded in the area.

Location: The location of this site conforms with the expected pattern of site distribution as stated in 4.4 of this report.

Uniqueness: Nil

Representativeness: poor example of this site type

Potential for future scientific research: Nil

Educational Value: This is a poor example of this site type and as such has low potential as an educational resource to the general community.

Aboriginal Community Value:

All sites are valued by the Aboriginal Community. Statements as to the relative value of this site for the Aboriginal community has been assessed by the LALC in their report (Appendix 5)

7.2.5 JC-OS-2 and PAD 3

- **Site JC-OS-2:** The significance of this site has been assessed as low.

Scientific Value:

Site integrity: This site has been highly disturbed as a result of the surface erosion caused by grazing animals. The artefacts are not in situ.

Preservation: good

Artefacts at the site are in a good state of preservation

Contents: The contents of this site conform with the contents of other sites recorded in the area.

Location: The location of this site conforms with the expected pattern of site distribution as stated in 4.4 of this report.

Uniqueness: Nil

Representativeness: poor example of this site type

Potential for future scientific research: Nil

Educational Value: This is a poor example of this site type and as such has low potential as an educational resource to the general community.

Aboriginal Community Value:

All sites are valued by the Aboriginal Community. Statements as to the relative value of this site for the Aboriginal community has been assessed by the LALC in their report (Appendix 5)

- **PAD 3:** is located to the west of Site JC-OS-2. The PAD area is approximately 20m x 10m and has the potential to contain additional artefactual material similar to that identified at Site JC-OS-2. However the topsoil deposit is shallow (less than 10cm) across the whole PAD area. The PAD are has been heavily disturbed by sheet erosion and grazing animals so the potential for the PAD to contain data which would be useful for future scientific research has been assessed as low.

8. Site Management Recommendations for sites and PAD areas identified by the survey.

Totalcare, as a developer, has an obligation under the National Parks and Wildlife Act 1974 and the NSW Heritage Act 1985, to determine if their proposed quarry development will impact upon indigenous heritage and where required, take ameliorative action. The following recommendations have been developed to minimise the potential impact of the development on heritage items and places and to ensure that the proposed development is accommodated within a management framework that is endorsed by NPWS and includes consultation with the Ngunnawal LALC.

Recommendation 1:

Totalcare should be made aware of the locations of all sites and PAD areas and of their responsibilities under the NPW Act to protect these sites. This protection extends to all sites which will be impacted by the current proposed development.

Recommendation 1.1: Management issues to be considered in relation to the protection of these sites should include:

- marking of the location of these sites and PAD areas in some way so that their locations are known to mine management
- informing workers of the sensitivity of these areas

Recommendation 2:

Avoidance of all sites is recommended.

Recommendation 2.1

If sites can be avoided, then it is the responsibility of mine management to ensure that all sites and PAD areas are protected during quarrying activity. This protection should include:

- fencing off of all sites and PAD areas, including a buffer zone of 20m around each site and PAD area.
- informing all workers of the location of the sites and PAD areas and the requirements of the NPWS Act for the protection of these areas.
- prior to the implementation of any protective work on site, discussions should be held with Ngunnawal LALC

Recommendation 2.2

If sites and PAD areas cannot be avoided and Totalcare wish to proceed with the quarrying development as planned, then Totalcare should apply to the NPWS for Consent to Destroy Permit for all sites and the isolated find.

Recommendation 2.3

The following conditions for Consent to Destroy Permits for sites **WR-OS-1 and PAD 1, LHC-OS-1 and PAD 2, JC-OS-2 and PAD 3** are recommended to NPWS for their consideration.

- all surface artefacts should be collected and monitoring of the removal of the top 20cm of topsoil from the site area and associated PAD areas should be conducted by a representation of the Ngunnawal LALC and/or an archaeologist. The monitored removal of the topsoil layer should take place prior to work commencing so that if additional sites are located or more investigation is required, work can stop and appropriate management strategies can be implemented for the area.

Recommendation 2.4

The following conditions for Consent to Destroy Permits for site JC-OS-1 and LHC-IF-2 are recommended to NPWS for their consideration.

- Isolated find LHC-IF-1 should be collected and removed from the impact area. No further investigation is recommended for this area.
- Site JC-OS-1: all surface artefacts should be collected from this site. No further investigation is recommended at this site.

Recommendation 3

The following recommendations are made for the collection of surface artefacts:

- All sites are highly disturbed and the artefacts are not in situ therefore no recording of artefact distribution across the site is recommended.
- The collection of all surface artefacts should be carried out by a qualified archaeologist and/or a representative of the Ngunnawal LALC
- If the Ngunnawal LALC wish to retain the artefacts collected from these sites then LALC should make application to NPWS for a Care and Control Permit. This application should be lodged with NPWS concurrently with the LALC comments on the proposed Consent to Destroy applications.

9. Legal Requirements and Obligations

All non-indigenous heritage items are protected by the NSW Heritage Act (1975 and the EP & A Act (1979). All indigenous relics (sites and objects), other than those made for sale, are protected under the New South Wales National Parks and Wildlife Act 1967 (amended 1974). Archaeological sites are a non renewable resource, valued for the information they can provide on the lifestyles of people in the past, and are also valued by local communities who maintained cultural links with the past through these sites and places.

It is illegal to damage or destroy a site or relic without the prior consent of the Director of NSW NPWS and/or DUAP. Any such disturbance requires a permit from the Director. The NPW Act requires the relics recovered under such a permit come under the custody of the Australian Museum in Sydney or the LALC if an application has been made by that group for a Care and Control Permit.

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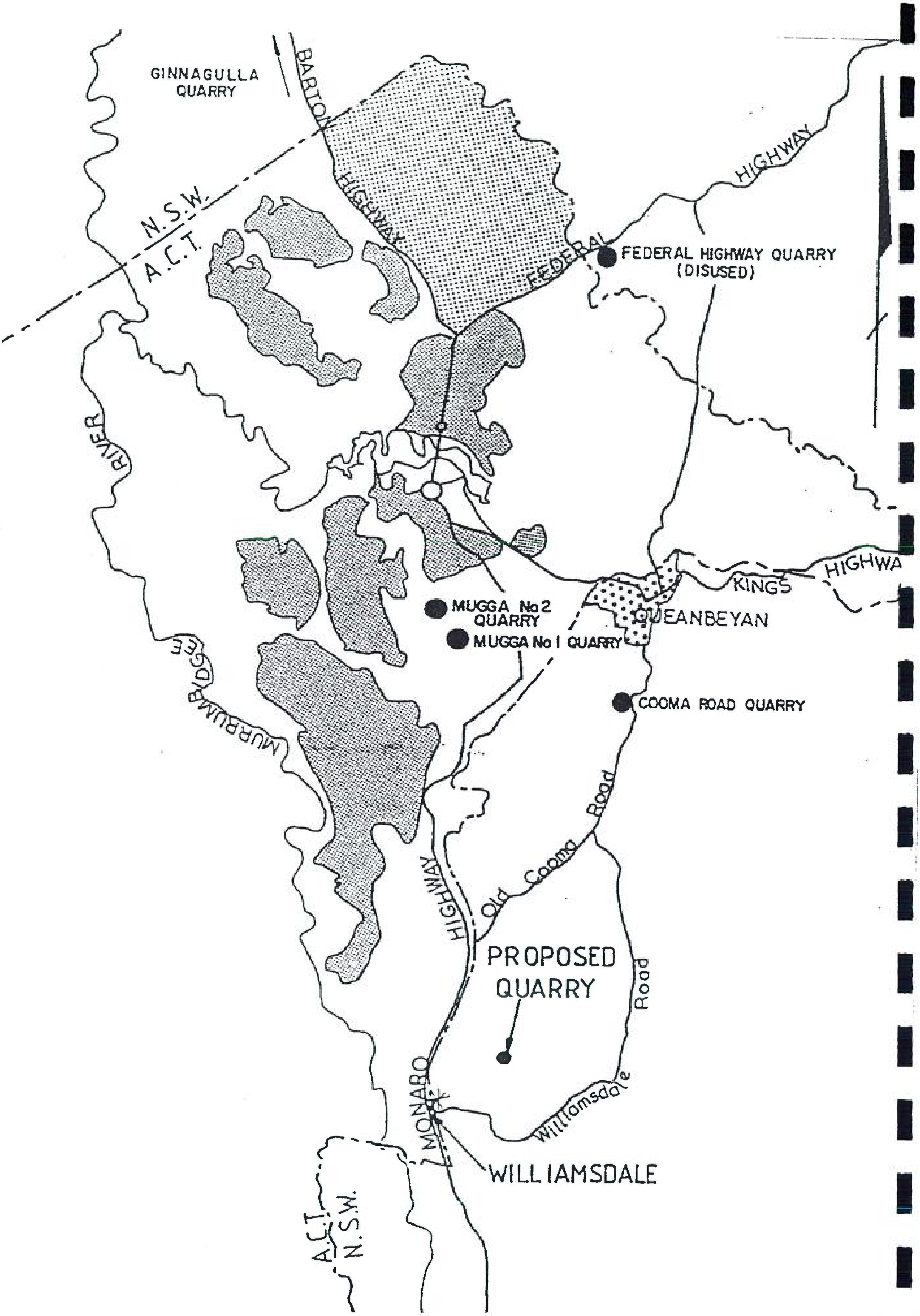
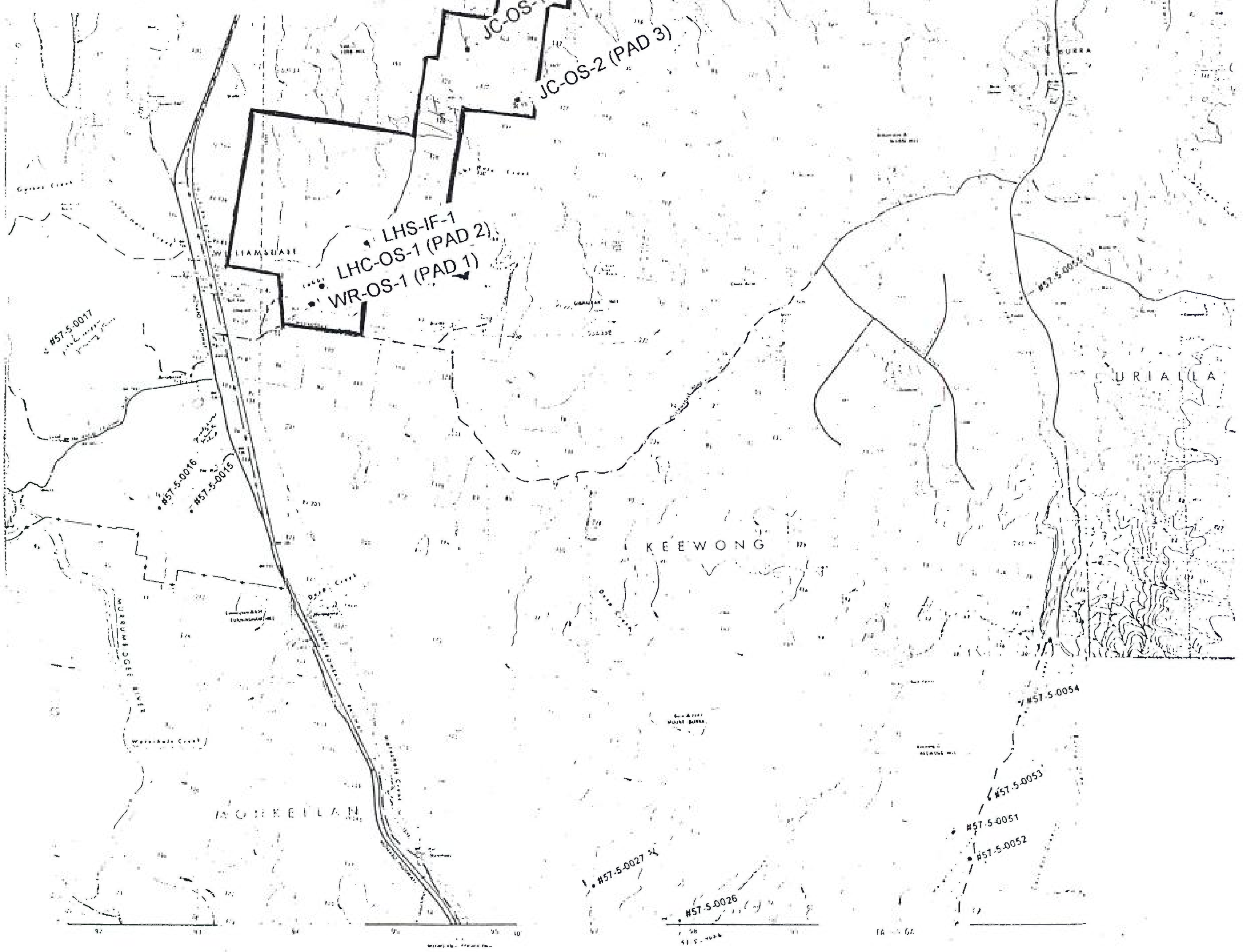
Appendix 1: Maps

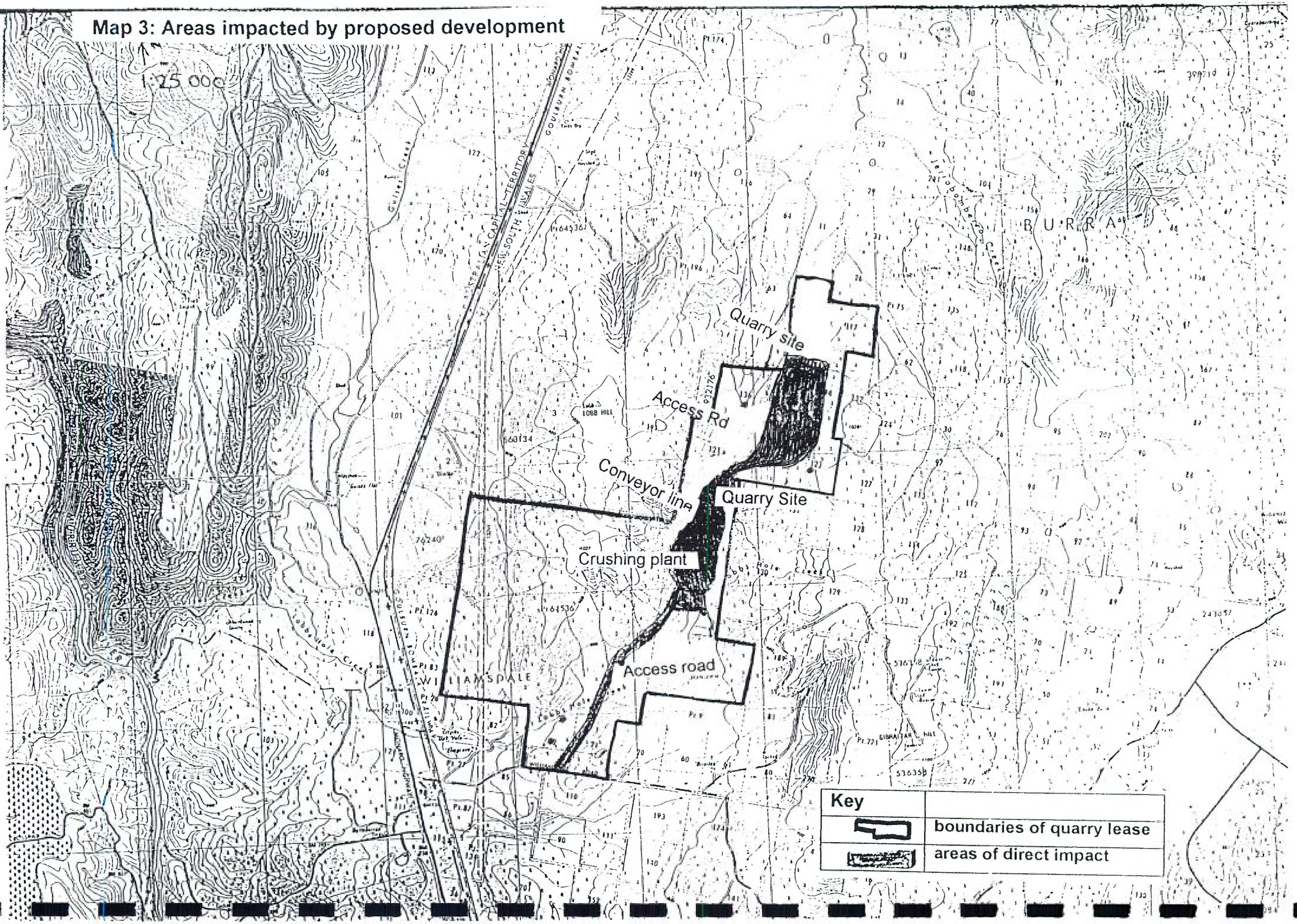
Map 1: Locality map



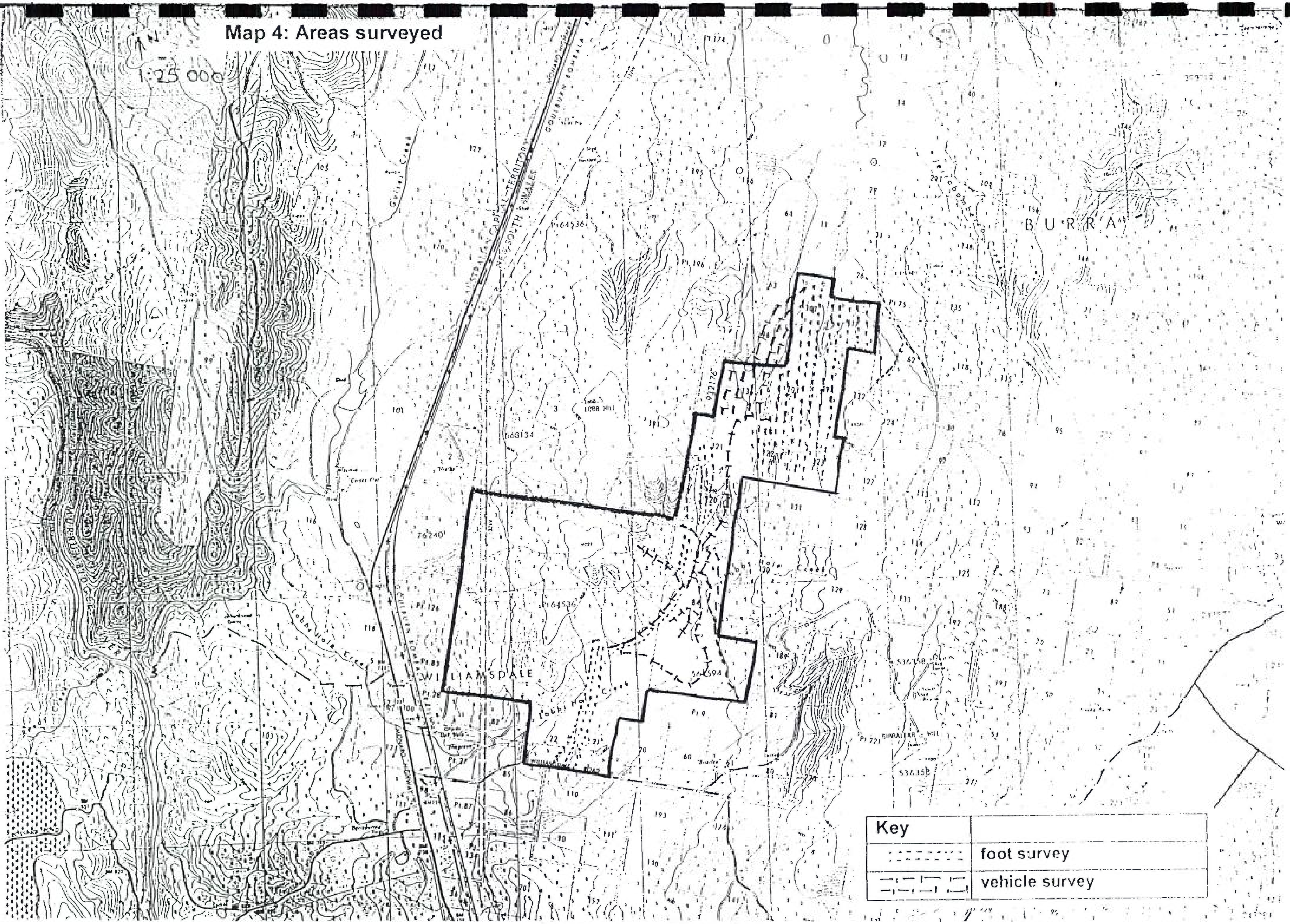
Map 2: Boundaries of the Lease area, known sites and sites recorded during the survey.



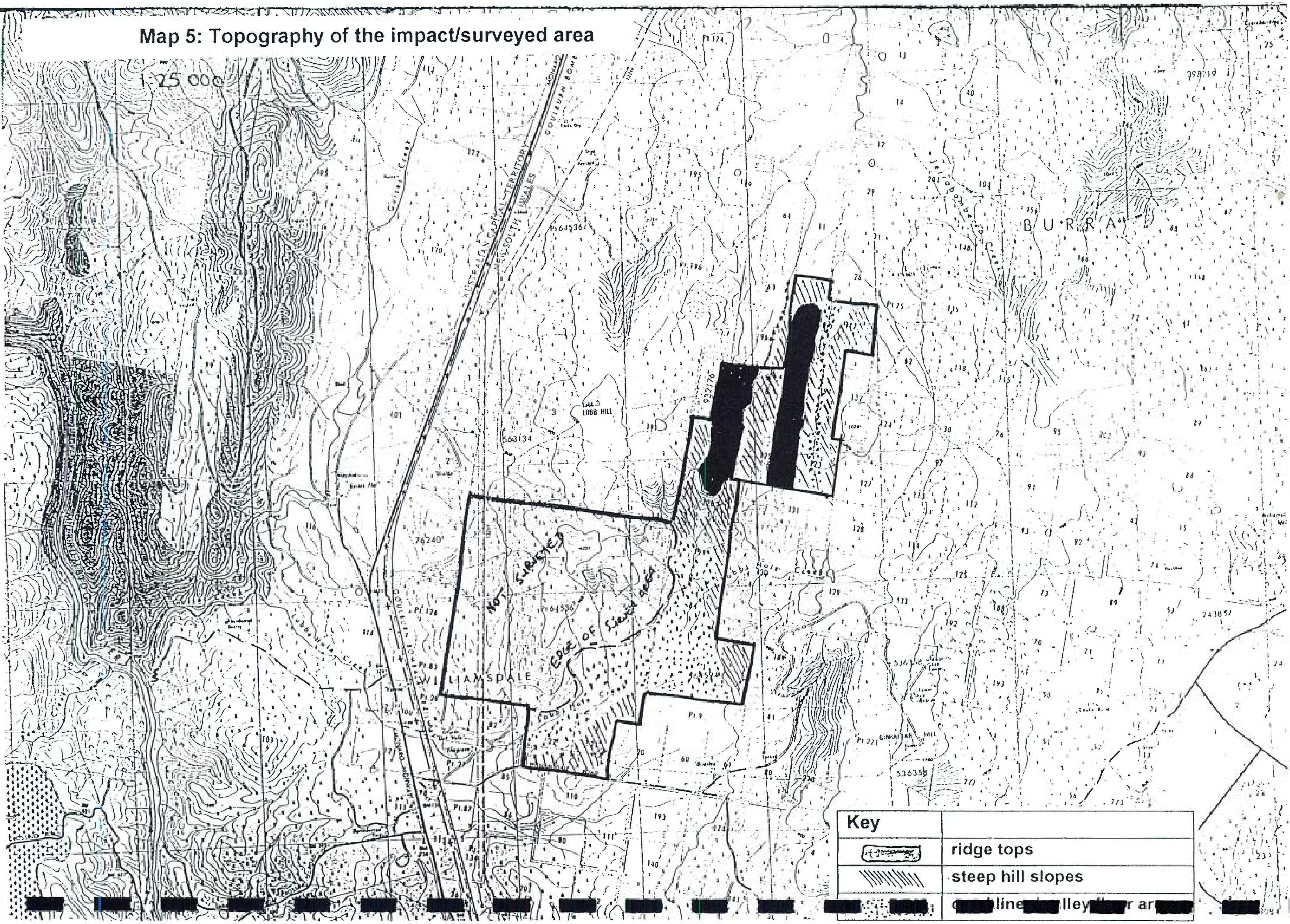
Map 3: Areas impacted by proposed development



Map 4: Areas surveyed



Map 5: Topography of the impact/surveyed area



Appendix 2: Tables

Tables 1 and 2 in text

Table 3: Summary Description of Open Sites and Isolated Artefacts

Site Name	Site Type	Grid Ref	Land form	Site Dimensions	Surf. Visib.	Contents	Artefact density per sq m.	Remarks	Degree of Impact from development
WR-OS-1	Open camp site	694494E 6061963N	Creek line	10m x 2m	70%	Sample 5 stone artefacts	<1 art.	PAD present	Nil
LHC-OS-1	Open camp site	694689E 6062190N	Creek Bank	100m x 20m	80%	sample 10 stone artefacts	<1 art	PAD present but heavily disturbed	Direct impact
LHC-IF-1	Drop site IF	694867E 6062480N	Flood plain		100%	1 stone artefact	<1 art	No PAD identified	Nil
JC-OS-1	Open camp site	695993E 6064446N	Creek line	5m x 2m	100%	2 stone artefacts	<1 art	No PAD identified	Direct impact
JC-OS-2	Open camp site	696349E 6063908N	saddle	28m x 5m	100%	12 stone artefacts	<1 art	PAD present disturbed, shallow deposit	Direct impact

Table 4: Artefact Details from sites recorded in the survey

Site name	Artefact type	Raw material	Colour	Dimensions (mm)			Cortex	Comments
				Leng.	Broad	Thick		
WR-OS-1	flake	mudstone/ chert	brown/red	32	17	3	nil	unifacial platform focal, PFI, euralia scar, plat. modified, neg flk scar from platform dorsal ridge margin along 50% of the flake, bulb, ripples term. Snapped. Transverse flk scar on dorsal surface
	flake	chert	grey/brown	21	10	4	nil	unifacial, broad platform with crushing, PFI, bulb, termination absent snapped, dorsal ridge, working from original platform preparation along both lateral margins.
	Flake	chert	grey/brown	10	12	4	nil	Platform, slight lip, bending fracture, block termination, dorsal ridge
	flake fragment	chert	brown	15	9	2.5	nil	platform snapped, dorsal ridge, plunge termination
	block fracture fragment	quartz	milky white	12	6	1.5	nil	high energy fractured surfaces
LHC-OS-1	flake	quartzite	brown	27	21	6	nil	unifacial broad platform, PFI, lip on platform ventral margin, bending fracture, feather term. Post dep. damage
	flake	chert	brown/grey	9	12	2	nil	platform narrow, PFI, bending fracture, feather term. Neg flk scar dorsal surface, radiating pressure linest
	flake	quartz	milky white	25	22	7	nil	unifacial, focal platform, bulbed ventral surface, radiating pressure lines from PFI, bending fracture, post dep. damage to platform

Site name	Artefact type	Raw material	Colour	Dimensions mm			Cortex	Comments
				Leng.	Broad	Thick		
	block fractured fragment (BFF)	chert	grey	15	6	2	nil	dorsal ridge, snapped terminal and proximal ends, ripple lines on one flat surface, possible dorsal ridge
	Block fracture piece	silcrete	pink	23	20	6	nil	2 neg flk scars on one flat surface
	Block fracture piece	silcrete	pink	35	25	4	nil	2 high energy fractured surfaces, 1 possible neg. flk scar
	BFF	quartz	milky white	20	17	4	nil	possible PFI
	BFF/ lamellate	quartz	milky white	24	5	2	nil	high energy fracture one flat surface
	BFF	quartz	milky white	6	5	1	nil	association with BF quartz
	Hammer-stone	quartzite	grey/brown	55dia.		30	95% ww	abrasion to one end, possible use as a millstone
LHC-IF-1	hammer-stone	quartz	milky white	23	48	30	60% ww	5 neg flk scars water worn pebble
JC-OS-1	manuport	quartzite	grey	110	63	51	30% ww	Broken river pebble. No evidence of use
	flake	silcrete	red	40	24	9	nil	unifacial platform broad, PFI, radiating pressure lines, neg flk scar across dorsal ridge, bulb present, bending fracture. Secondary scar on one lateral, termination feather
JC-OS-2	flake fragment	chert	black/grey	19	25	8	nil	platform absent, pressure ripples, plunge termination
	block fracture	chert	black	19	18	15	nil	3 high energy fractured surfaces, 2 neg. flk scars

Site name	Artefact type	Raw material	Colour	Dimensions (mm)			Cortex	Comments
				Leng.	Broad	Thick		
JC-OS-2 (cont)	Block fracture frag.	Quartzite	black/grey	8	16	2	nil	nil
	core (producer)	chert	cream/ brown	31	41	28	nil	possible source Gungahlin (LALC pers com) multi-platform, platform reduced, rotated, 6 neg flk scars, possible bi-polar, 3 platforms
	flake	quartz	milky white	12	7	3	nil	narrow platform, bending fracture, term snapped
	flake	quartz	milky white	29	23	13	nil	platform, PFI, slight dorsal ridge, possible reduction on platform dorsal margin, term. Feather
	flake	quartz	milky white	14	22	12	nil	platform, dorsal ridge, lip on dorsal margin of platform, bending fracture, block termination
	Block fracture	quartz	milky white	27	18	14	nil	1 high energy fracture on one flat surface
	Block fracture	quartz	milky white	22	12	11	nil	1 high energy fracture on one flat surface
	Block fracture	quartz	milky white	17	22	10	nil	crushing along one lateral margin
	flake	quartz	milky white	11	18	6	nil	PFI, dorsal ridge, lip on ventral margin of platform, plunge term.
	Core	quartz	milky white	34	49	21	nil	uni-platform, 2 neg. flk scars

Appendix 3: Sketches

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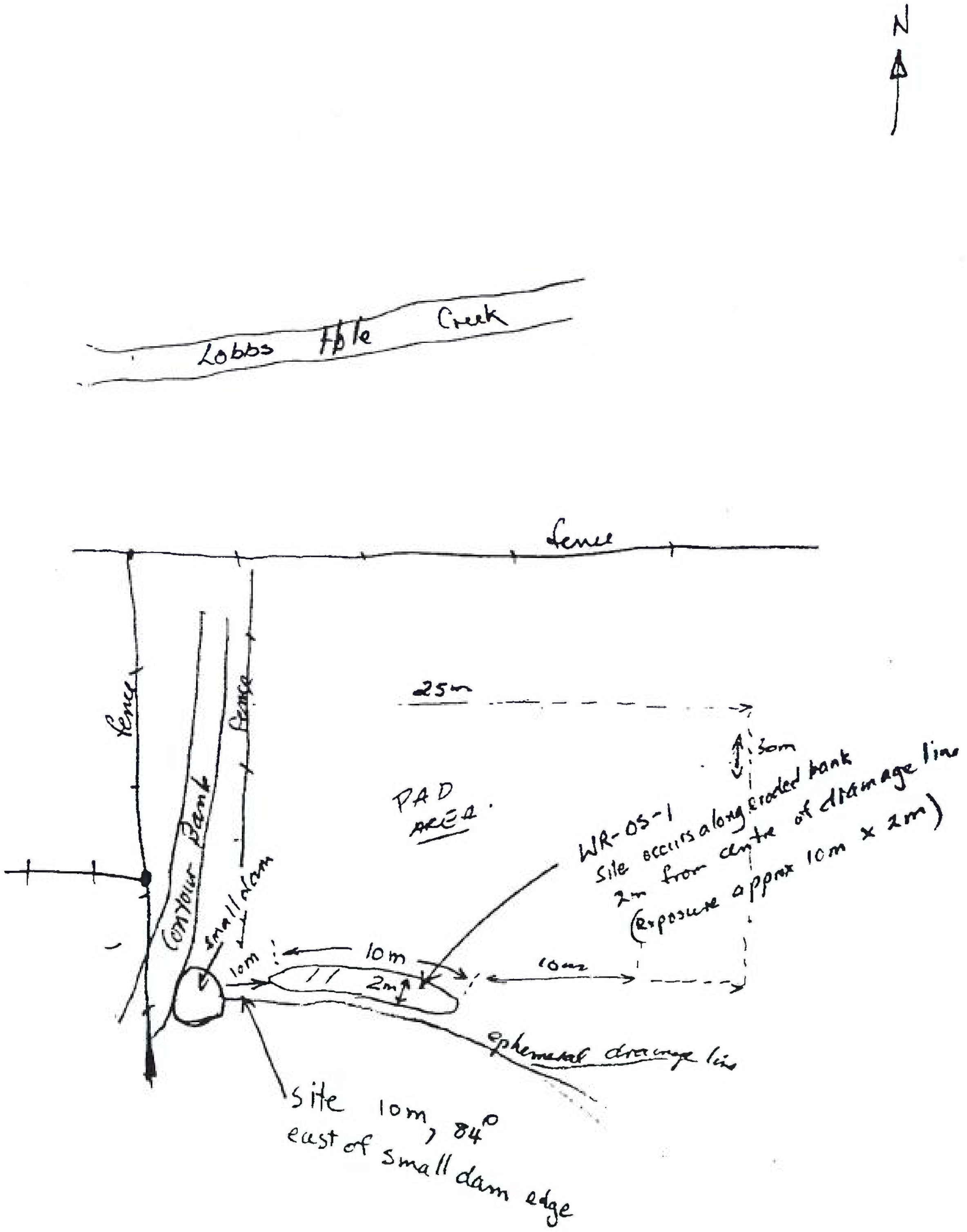
Sketch 1: Location of Site WR-OS-1 and PAD 1

WR-OS-1



WR-OS-1
Site occurs along eroded bank
2m from centre of drainage line
(Exposure approx 10m x 2m)

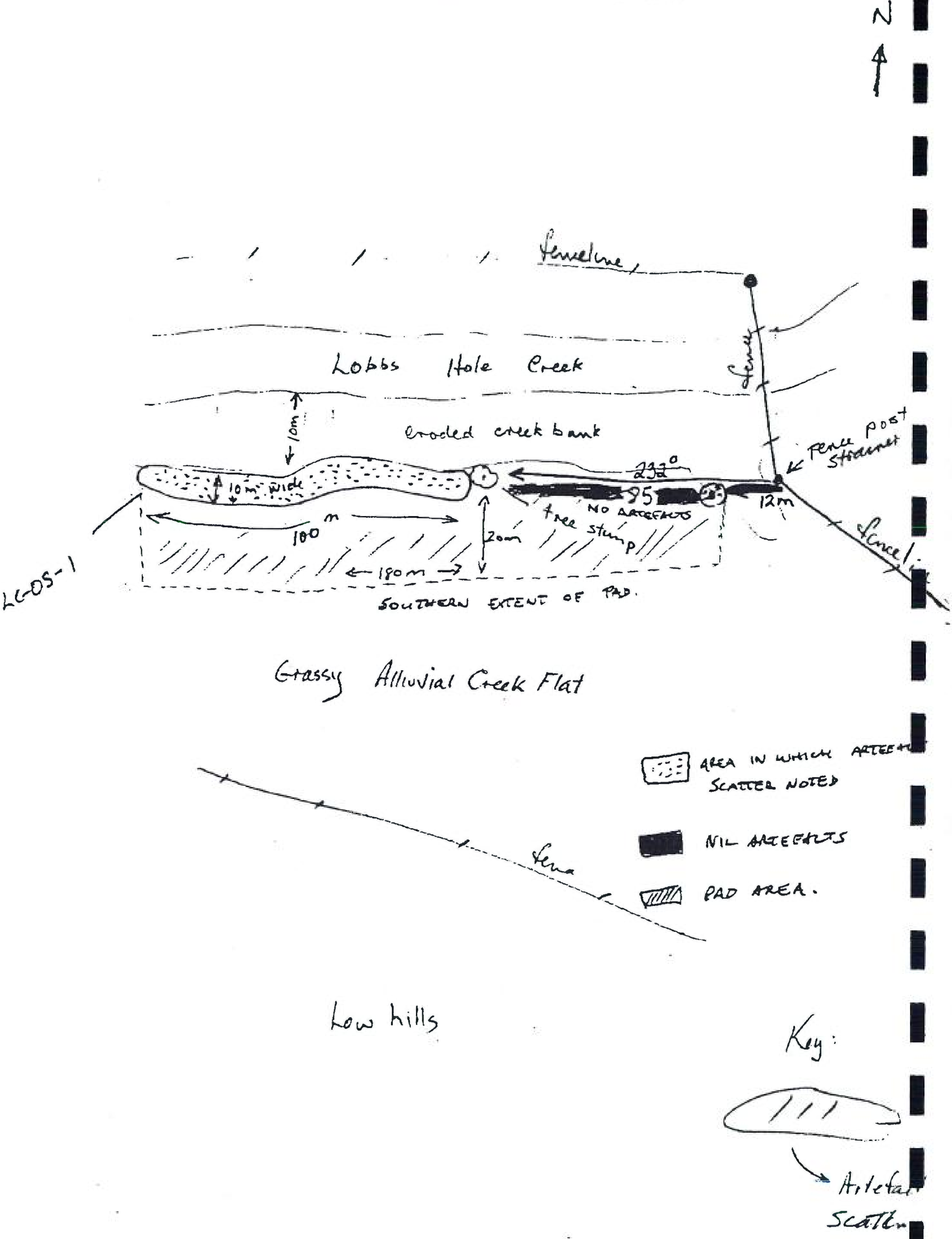
site 10m, 84°
east of small dam edge

Sketch 2: Location of Site LHC-OS-1 and PAD 2

16.12.0

Location Sketch

694689
606219



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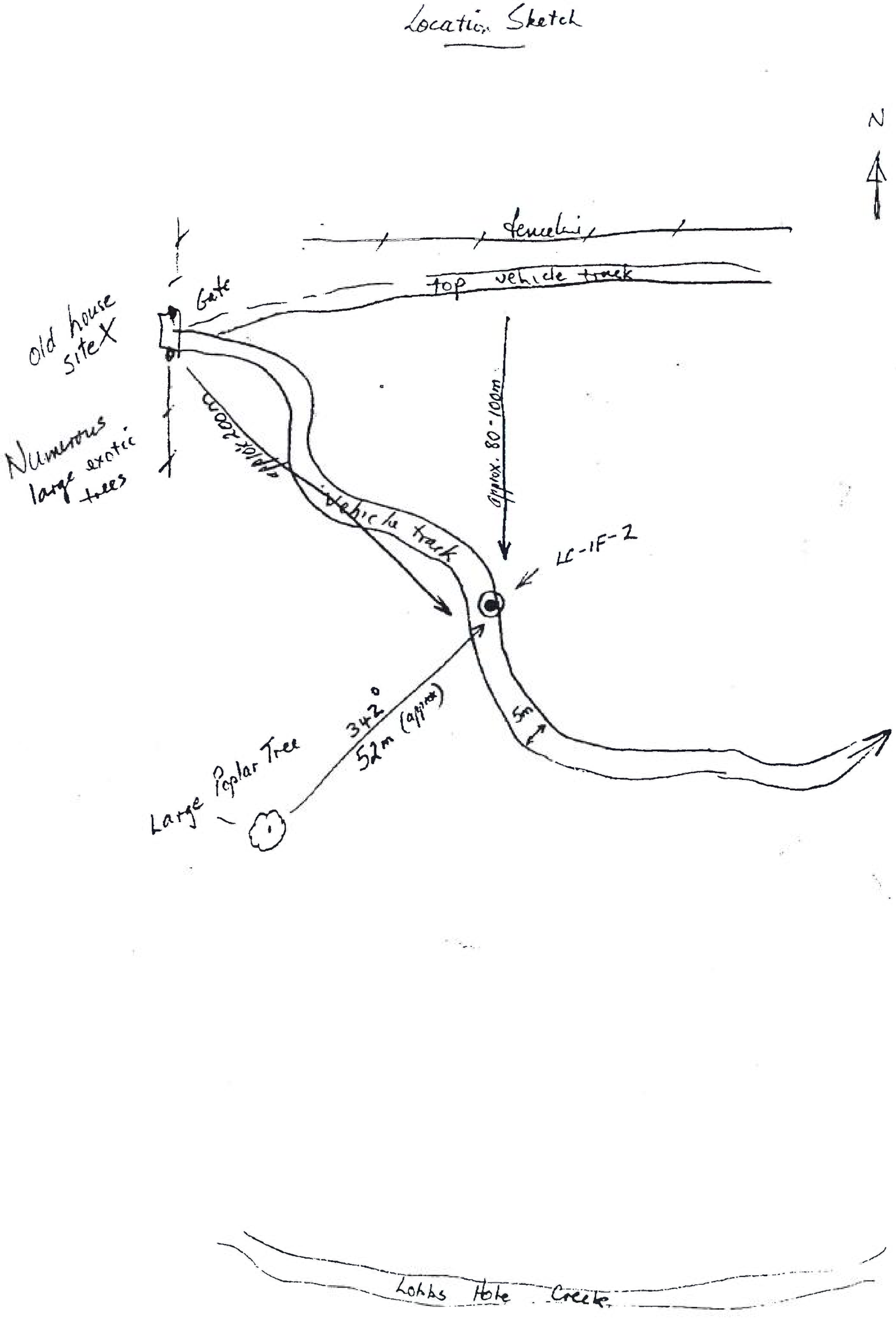
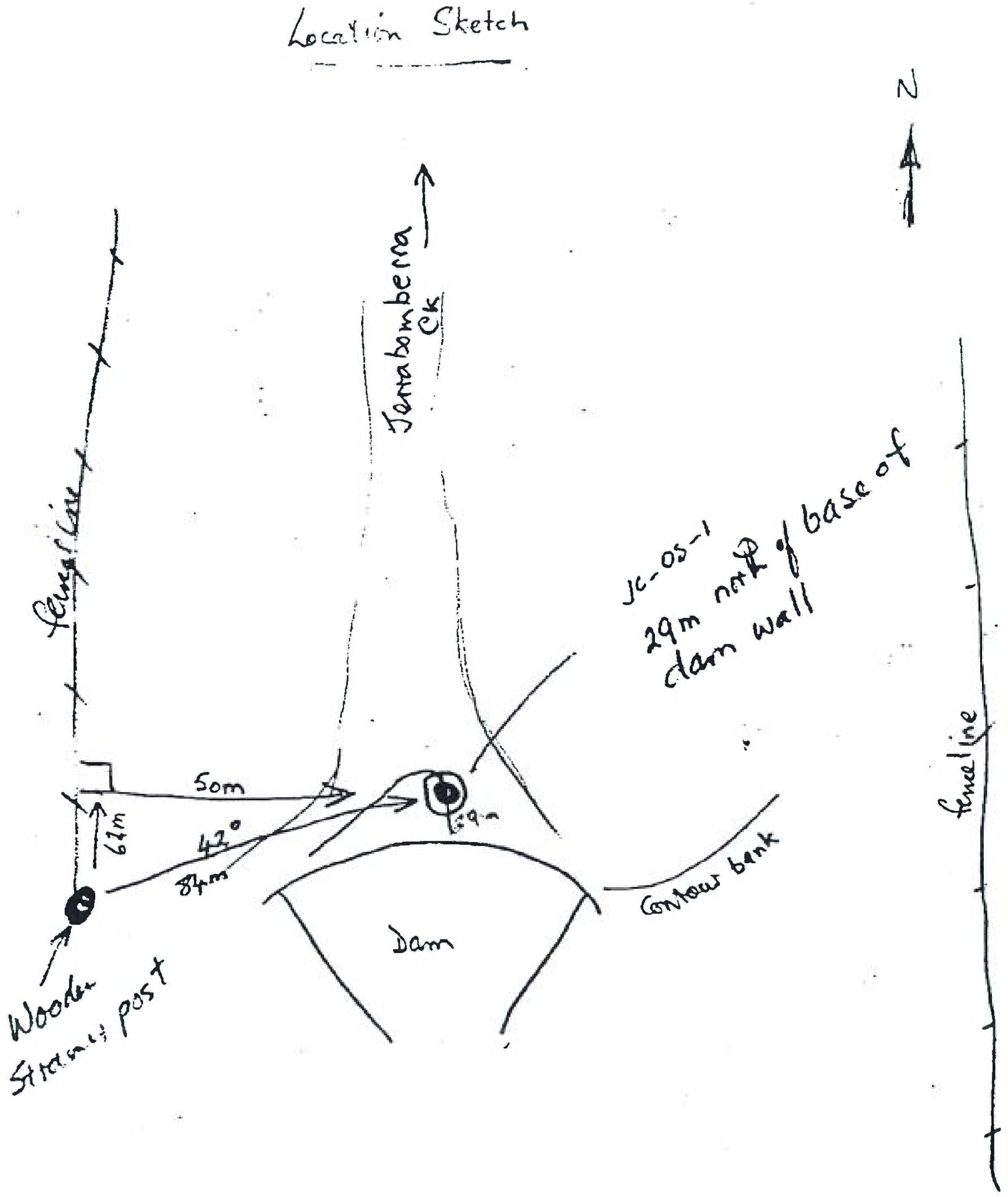
Sketch 3: Location of LHC-IF-1



Sketch 4: Location of Site JC-OS-1



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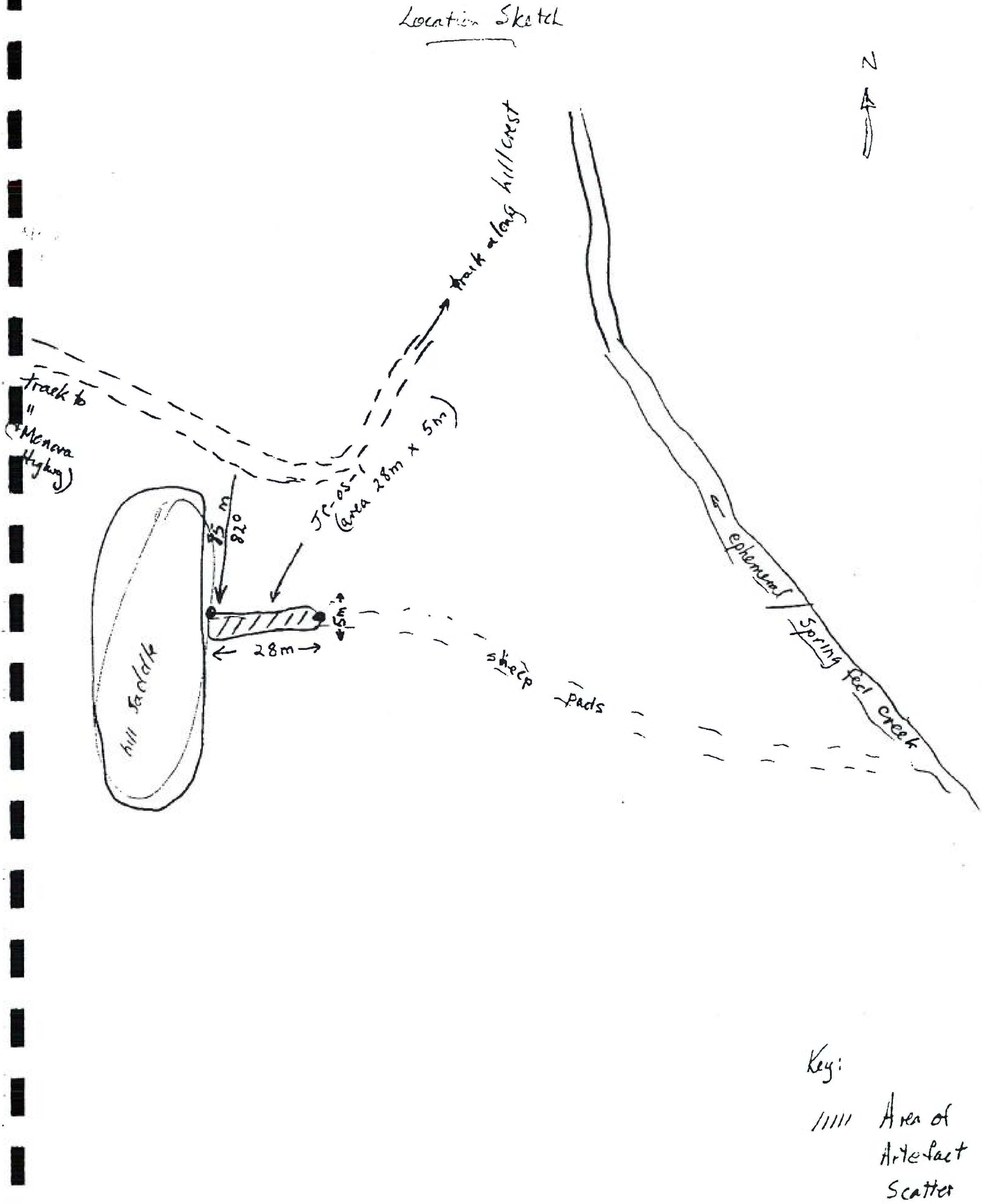
Sketch 5: Location of Site JC-OS-2



Appendix 4: Photographs

Photo 1: Site WR-OS-1

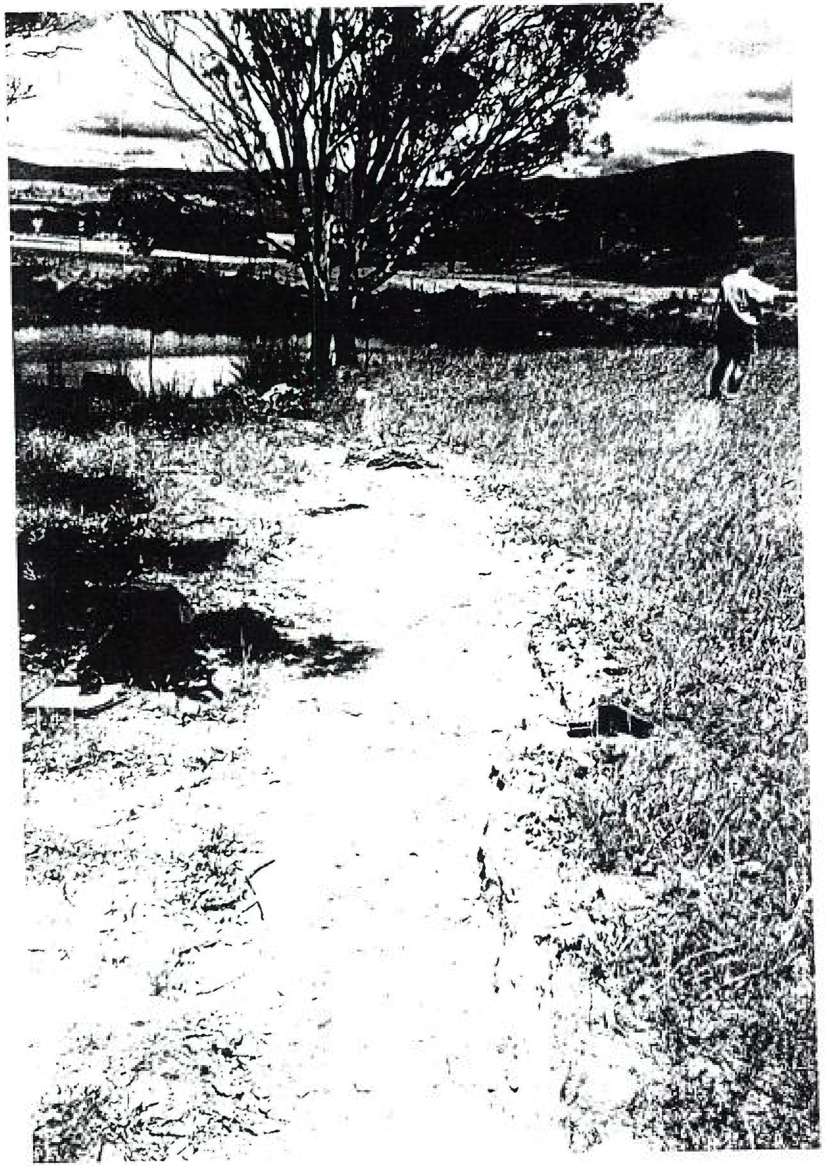


Photo 2: Artefacts from WR-OS-1

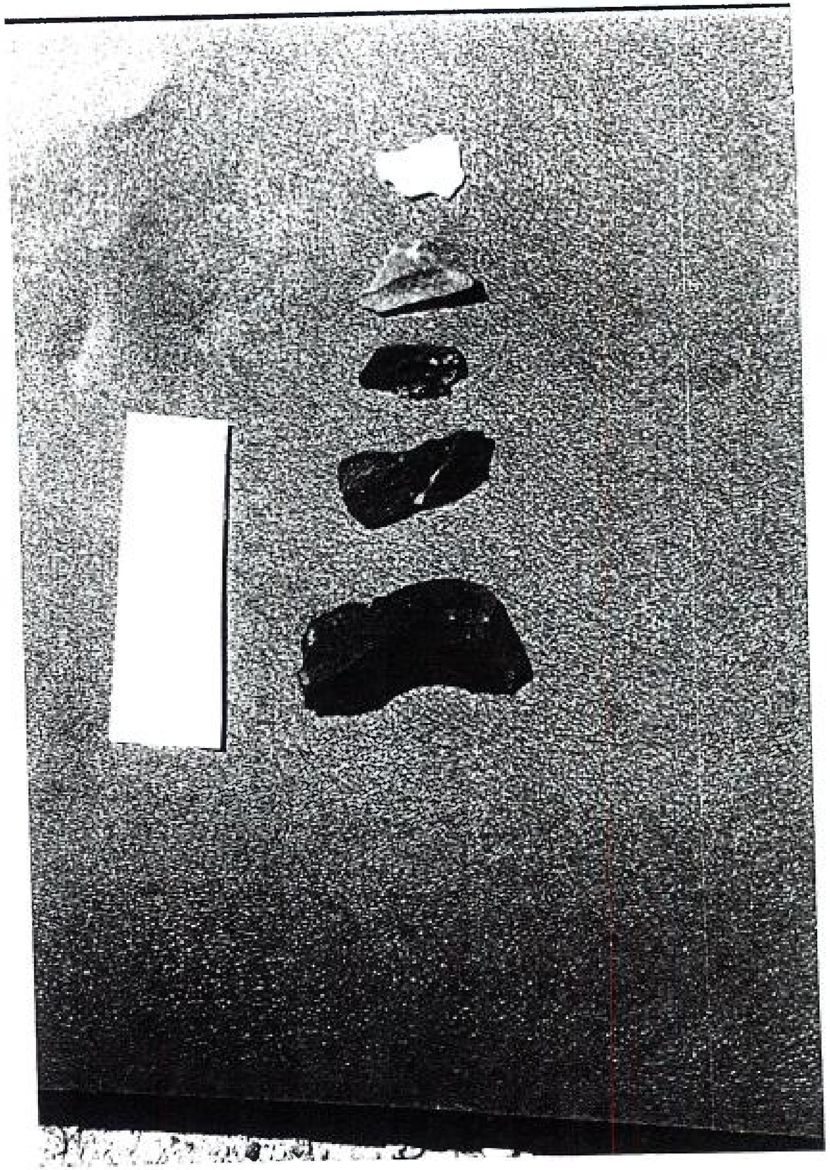


Photo 3:Site LHC-OS-1

Photo 4: Artefacts from Site LHC-OS-1

Photo 5: Location of LHC-IF-1

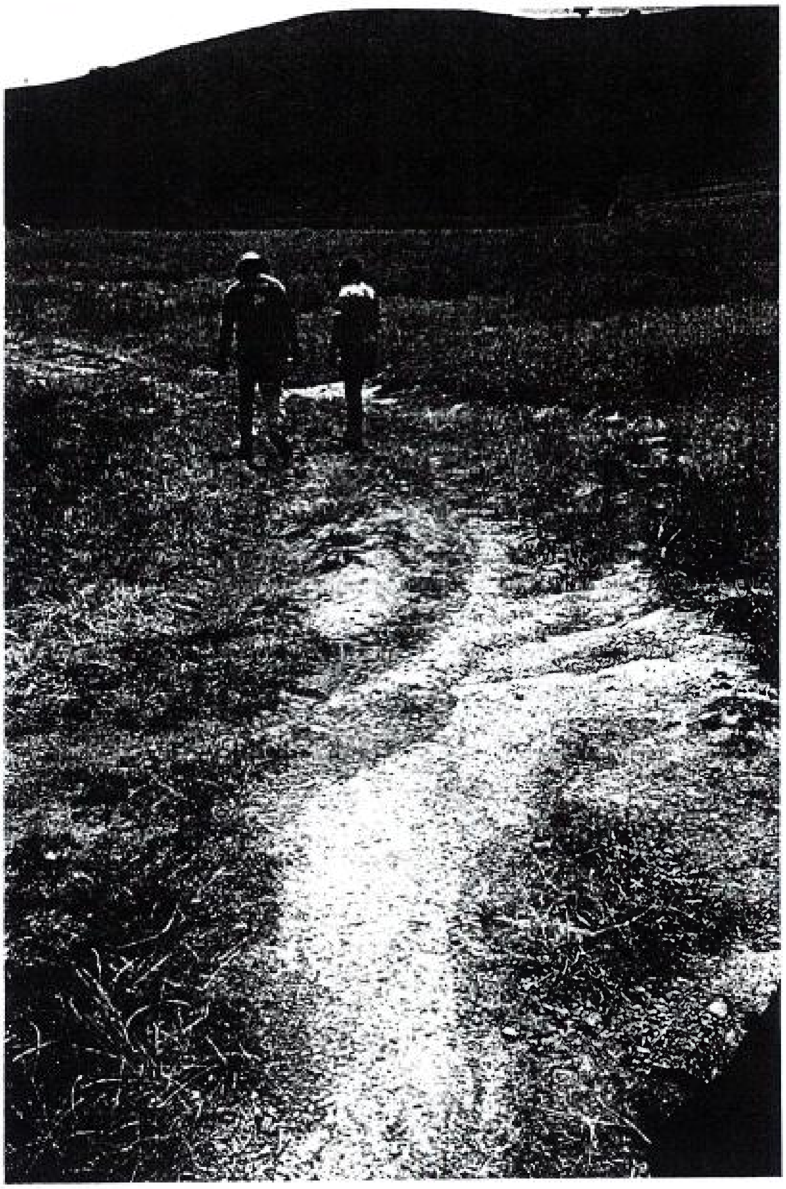


Photo 6: LHC-IF-1

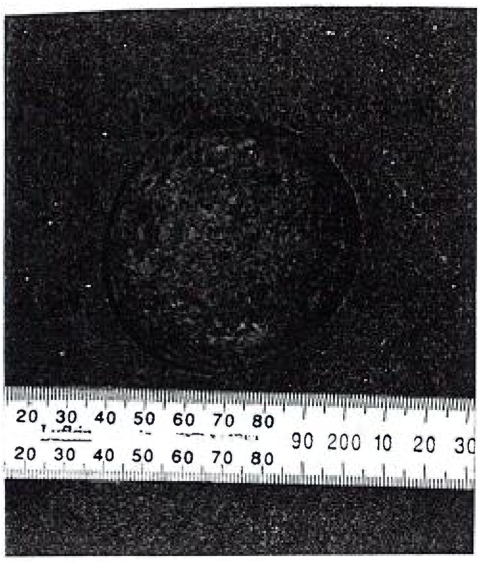


Photo 7: Site of crushing plant and conveyor

Photo 8: Site JC-OS-1

Photo 9: Artefacts from JC-OS-1

Photo 10: Site JC-OS-2

Photo 11: Artefacts from Site JC-OS-2

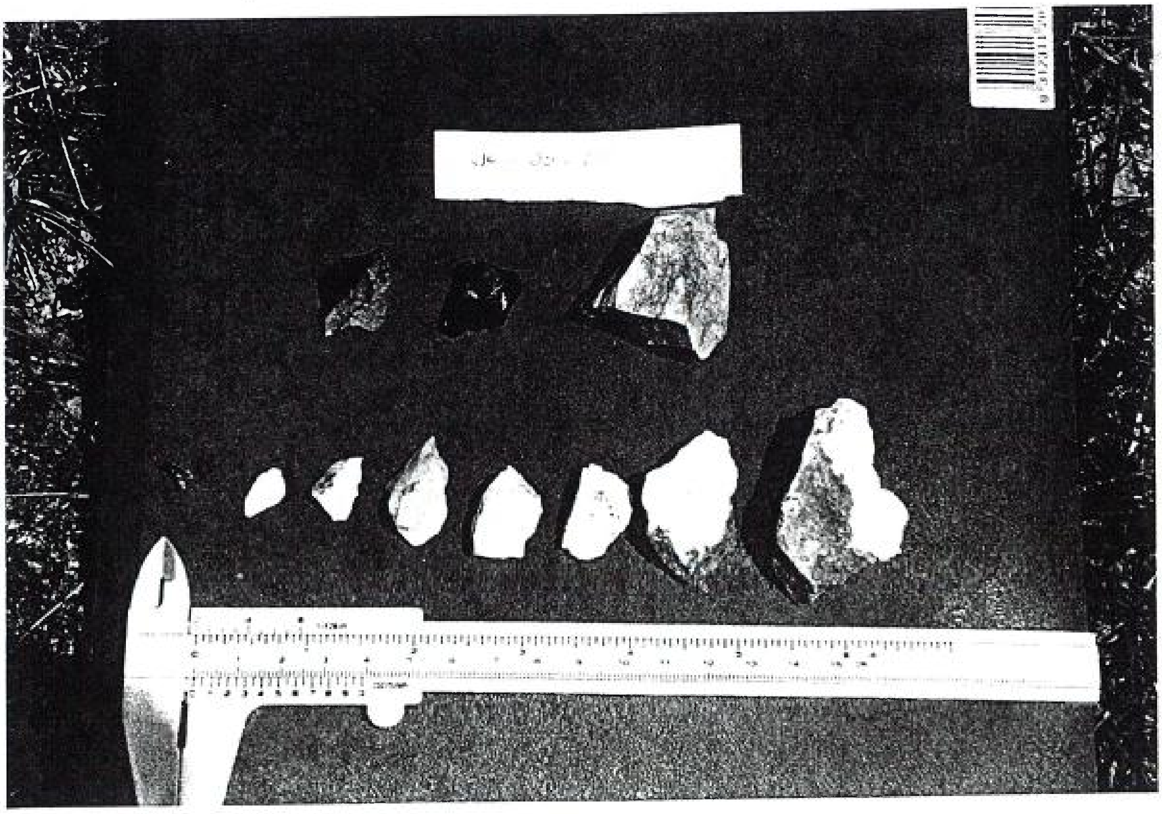


Photo 12: Eastern Side of the proposed quarry spur

Photo 13: Creekline on the eastern side of the spur

Photo 14: Eroding dacite deposit on the crest of the spur

Photo 15: Eroding dacite deposit on the crest of the spur

Photo 16: Western side of the quarry site looking east across the extraction site.

Appendix 5:

Copy of Statement of Involvement of Aboriginal Community and record of consultation with LALC.

FAX

Robynne Mills
Archaeological and Heritage Services
60 Watkin Street
Newtown 2042
Ph: (02) 95171413
Fax: (02) 95179860

****

To: Queanbeyan LALC
Attention: Arnold and Tony
Date: 5th November, 1998

****

Message: Re survey of quarry site off Monaro Highway at Old Cooma Road

Just a note to confirm our phone conversation. We will carry out the survey at the Quarry site on Williamsdale Road on Wednesday 16th and Thursday 17th December. We will meet at the junction of Williamsdale Road and Monaro Highway at 8.30 on Wednesday morning.

Many thanks,

Robynne.

Robynne

****

FAX

Robynne Mills
Archaeological and Heritage Services
60 Watkin Street
Newtown 2042
Ph: **(02) 95171413**
Fax: **(02) 95179860**

****

To: Queanbeyan LALC
Attention: Arnold and Tony
Date: 2nd December, 1998

****

Message: Re survey of quarry site off Monaro Highway at Old Cooma Road

Just a note to confirm the survey of the Quarry at Queanbeyan. Sorry I have not been in touch but the client has been changing his mind about locations etc and I have been unable to get maps to use for the survey.

If possible I would like to carry out the survey on Thursday 18th and Friday 19th December. Please give me a call if these days don't suit but I would like to get the survey over before Christmas.

All being well I will meet at the junction of the Monaro Highway and Williamsdale Road at 8.30 on Thursday19th (see attached map).

Many thanks,

Robynne

****

FAX

Robynne Mills
Archaeological and Heritage Services
60 Watkin Street
Newtown 2042
Ph: (02) 95171413
Fax: (02) 95179860

****

To: Queanbeyan LALC
Attention: Arnold and Tony
Date: 5th November, 1998

****

Message: Re survey of quarry site off Monaro Highway at Old Cooma Road

International Environmental Consultants have commissioned me to carry out a survey of the area shown on the accompanying map.

As we discussed in our phone call earlier today I would like to carry out the survey on Monday 16th and Tuesday 17th November. I will contact you next week to finalise details of where we will meet etc.

I would appreciate it, if the LALC could discuss the proposed development with Aboriginal Elders and Community members who may be able to identify areas or places of special importance for the Community within the proposed development area and identify any issues which the Community would like to raise in relation to the proposed development. Then these places and/or issues can be incorporated within the management framework.

Many thanks,

Robynne.

Robynne

Appendix 6:

Gazetteer of previously recorded sites and associated reports from NPWS Sites register

FAX

Robynne Mills
Archaeological and Heritage Services
60 Watkin Street
Newtown 2042

Ph (02) 95171413
Fax (02) 95179860
Email: robynnemills@ozemail.com.au

****

To: NPWS Site Register
Attention: Paul
Fax No:
Number of pages:1

****

Dear Paul,

Could you please carry out the following site search:

Name of Company: International Environmental Consultants
Nature of Development: Quarry

Map Title: Williamsdale

Grid References for site: 69000-703000E
6055000-606800N

I need the results of this search by Friday 12th for a survey scheduled for Monday 15th December, 1998.

Many thanks,

Robynne

Robynne

ASR Site Search Criteria

SiteID (like): ☐ Zone: 55 District: ☐
AMGE: 690000 to 703000 SiteType1: ☐
AMGN: 6055000 to 6068000 SiteType2: ☐
Name(like): ☐ SiteType3: ☐
Recorder: ☐ SiteType4: ☐
Date from: ☐ to ☐ SiteType5: ☐
LGA: ☐
Local ALC: ☐

ASR Standard Site List - 5573

9/12/98 15:17:09

SiteID:	SiteName:	Location:	Zone:	AMGE:	AMGN:	Check Method:	Site Type:	Recorder:	Record Date:	Assoc. Report:
✓57-5-0015	Royalla;CR15;		55	693000	6059800		Open Camp Site	Barz, K.	4/01/84	C-57
✓57-5-0016	Royalla;CR14;		55	692700	6059800		Open Camp Site	Barz, K.	4/01/84	C-57
✓57-5-0017	Royalla;CR13c;		55	691600	6061400		Open Camp Site	Barz, K.	4/01/84	C-57
✓57-5-0026	RC14;Michelago;		55	697900	6055100		Open Camp Site	Paton, R.	22/12/84	C-1033
✓57-5-0027	RC15;Williamsdale;		55	697000	6055800		Open Camp Site	Paton, R.	30/12/84	C-1033
✓57-5-0051	EGP 2-47;Margarets Creek 8;Eastern Gas Pipline;		55	700600	6056320		Open Camp Site	Navin, K.	14/07/95	?
✓57-5-0052	EGP 2-48;Margarets Creek 9;Eastern Gas Pipline;		55	700750	6056000		Open Camp Site	Navin, K.	14/07/95	?
✓57-5-0053	EGP 2-49;Cassidys Creek 1;Eastern Gas Pipline;		55	700990	6056660		Isolated Find	Navin, K.	14/07/95	?
✓57-5-0054	EGP 2-50;Cassidys Creek 2;Eastern Gas Pipline;		55	701300	6057660		Isolated Find	Navin, K.	14/07/95	?
57-5-0055	EGP 2-51;Cassidys Creek 3;Eastern Gas Pipline;		55	701400	6061570		Open Camp Site	Navin, K.	14/07/95	?

Appendix 7:

Copies of NPWS Site Forms for recorded sites and field notes.

Open Sites / Isolated Artefacts / Middens

Site Name: WR-05-1

Date: 16-11-98.

Grid Reference 694494 E
6061963 N

1. Landform Unit: Creek terrace adj to creek
(hill slope, ridge top, floodplain etc)

2. Nature of deposit: fine gravelly loam
(sandy, gravely, clay etc)

3. Erosion - On Site: [✓ Sheet] [✓ Rilling] Gully

- Environment:

4. Site Exposure / Extent: 10 x 2m m. Area m^2
(artefacts visible)
PAD area identified 30m x 25m.

4. Surface Visibility (est.): <5% 5-10% 20-50% 50-70% [✓ 75-100%]
100% on scoured area

5. Present Landuse: pasture grazing dam installation nearby

6. Type of Archaeological Material Present: stone tools

7. Artefacts in situ ? Erosion.
(erosion occurring etc)

8. Artefact Density: / m^2 (average) /m^2 (Max.)

9. Total Number of artefacts: ⑤

Estimated Number of artefacts: 50-100 100-200 <500 >500

10. Raw Material %s: silcrete, quartz, chert

11. Site complex characteristics:
(associated hearths, knapping floors, ST's etc) Nil.

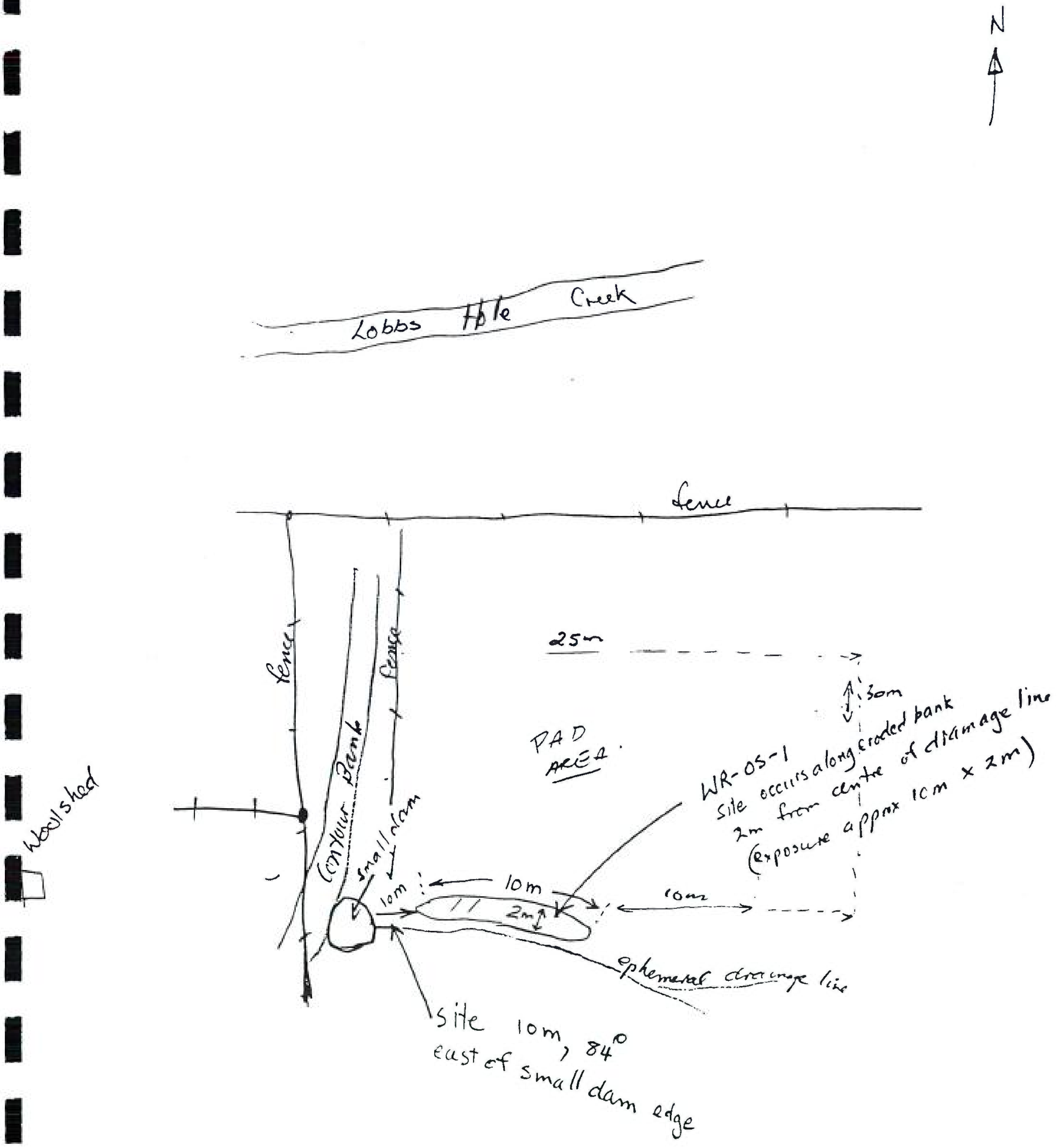
Artefact Details: Open Camp Site (OS), ~~Midden (M), Isolated Artefact~~ (IF)

Site Field Name: WR-OS-1 Date: 16 · 12 - 98 Grid Reference:

Artefact Type	Raw Material	Colour	Dimensions			Cortex	Comments
flake unmodified deb.	fine grained mudstone/ chert	brown reddy	32	17	3	NIL CORTEX	unifacial platform focal, PFI, eraillure scar, platform mod neg flake scar from platform dorsal ridge margin 50% of flake bulb, ripples [illegible] snapped Neg flake scar transverse ~ dorsal surface
flake	chert	grey, brown	21	10	4	NIL CORTEX	unifacial broad platform, crushing on platform PFI, bul platform absent snapped dorsal ridge, [illegible] along dorsal ridge working from original platform preparation (lateral dorsal margin
flake unmodified debitage	chert	grey/brown	10	12	4	Nil	Platform, slight lip (bending fracture) black laminations dorsal ridge
flake frag.	chert	brown	15	9	2.5	NIL	platform snapped dorsal ridge, plunge term
block fracture fragment	quartz	milky white	12	6	1.5	NIL	high energy fracture surfaces

16.12.98

WR-05-1



Open Sites / Isolated Artefacts / Middens

Site Name: LHC-OS-1 **Date:** 16-12-98

Grid Reference: 694-689
6062-019

1. Landform Unit: Creek Bank
(hill slope, ridge top, floodplain etc)

2. Nature of deposit: Alluvial deposit, fine sandy silt
(sandy, gravely, clay etc)

3. Erosion - On Site: Sheet [✓ Rilling] [✓ Gully]
Erosion associated with sheep grazing on edges of bank plus root erosion

- Environment: light scatter of artefacts along exposed edge of creek 20m wide

4. Site Exposure / Extent: ....x..........m. Area ....m²
(artefacts visible)

4. Surface Visibility (est.): <5% 5-10% 20-50% [✓ 50-70%] 75-100% associated [illegible] erosion area

5. Present Landuse: Cultivation

6. Type of Archaeological Material Present: stone - Potential PAD

7. Artefacts in situ ? NO much of deposit eroded
(erosion occurring etc)

8. Artefact Density: ..../ m² (average) ..../m² (Max.)

9. Total Number of artefacts: ⑤ over the length of the site 100 m.

Estimated Number of artefacts: 50-100 100-200 <500 >500

10. Raw Material %s:

11. Site complex characteristics:
(associated hearths, knapping floors, ST's etc)

Sheet 1/2

Artefact Details: Open Camp Site (OS), Midden (M), Isolated Artefact (IF)

Site Field Name: LHC-OS-1 Date: 16-12-98 Grid Reference:

Artefact Type	Raw Material	Colour	Dimensions			Cortex	Comments
flake unmodified deb	quartzite fine grained	brown	27	21	6	NIL	unifacial broad scatter PFI, lip on platform ventral margin (bending fract) post dep. damage dorsal margin dorsal ridge, feather terminati
flake unmodified deb.	chert	brown grey	9	12	2	Nil	platform narrow PFI bending fracture. feather term neg flk. scar dosal surface, radiating line
flake	quartz	milky white	25	22	7		unifacial platform focal, post dep. damage to platform. Bulbed ventral surface radiating line PFI (bending fracture)
block fractured fragment	chart	grey	15	6	2	NIL	dorsal ridge, snapped term top/bottom ripple lines one flat sface, possible dorsal ridge ?
block fracture	silcrete	pink	23	20	6	NIL	2 neg flk scars one flat surface.
block fracture	silcrete pink	pink	35	25	12	NIL	2 high energy fracture surfaces, 1 possible neg flk scar
BFF	quartz	milky white	20	17	4		possible PFI
BFF/lamellate	quartz	milky white	24	5	2		high energy fracture one flat surface

Sheet 2 of 2

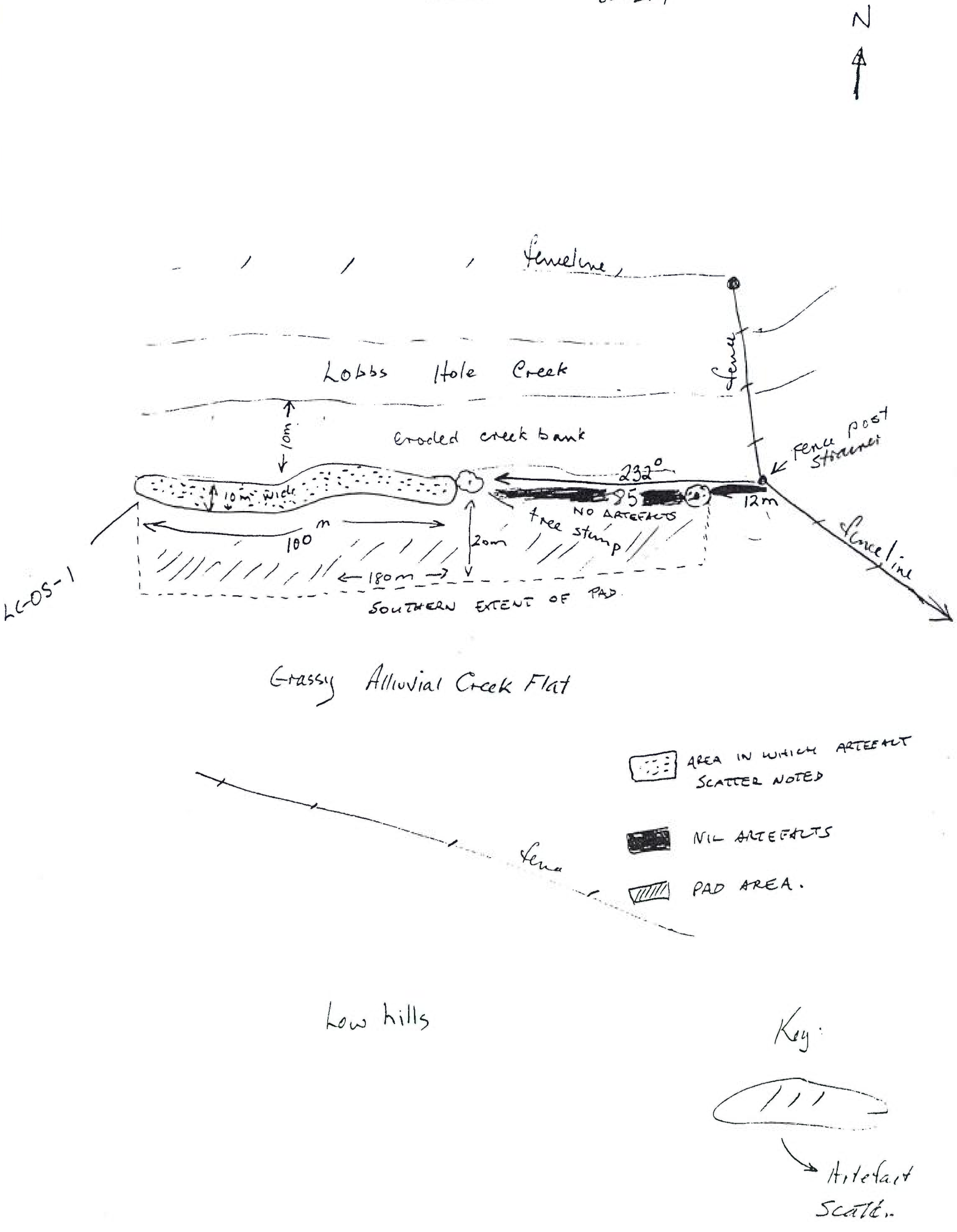
Artefact Details: Open Camp Site (OS), Midden (M), Isolated Artefact (IF)

Site Field Name: Date: Grid Reference:

Artefact Type	Raw Material	Colour	Dimensions			Cortex	Comments
BFF	quartz	milky white	5	6	1	NIL	association with BF quartz.
Hammerstone	quartzite	grey	55	[illegible] Round.	30	95% hw	frag. broken abrasion on one end. Split pebble impact abrasion. Possible use as millstone on flat surface

16.12.98

Location Sketch 694689
606219



Open Sites / Isolated Artefacts / Middens

Site Name: LHC - IF - 1

Date: 16-12-95

Grid Reference 194867 E
6062480 N

1. Landform Unit: CREEK PLAIN
(hill slope, ridge top, floodplain etc)

2. Nature of deposit: GRAVELLY CLAY / ALLUVIAL LOAM.
(sandy, gravely, clay etc)

3. Erosion - On Site: [✓ Sheet] Rilling Gully
ASSOCIATED WITH TRACK

- Environment: foot of steep slope

4. Site Exposure / Extent: — x — m. Area — m²
(artefacts visible)

4. Surface Visibility (est.): <5% 5-10% 20-50% [✓ 50-70%] 75-100%

5. Present Landuse: grazing

6. Type of Archaeological Material Present: Stone

7. Artefacts in situ ? NC (camp site)
(erosion occurring etc)

8. Artefact Density: — / m² (average) — /m² (Max.)

9. Total Number of artefacts: ① Hammerstone

Estimated Number of artefacts: 50-100 100-200 <500 >500

10. Raw Material %s:

11. Site complex characteristics: NIL.
(associated hearths, knapping floors, ST's etc)

Artefact Details: Open Camp Site (OS), Midden (M), Isolated Artefact (IF)

Site Field Name: LHC-IF-1 Date: 16-12-78 Grid Reference: 694867 E.
6062480 N

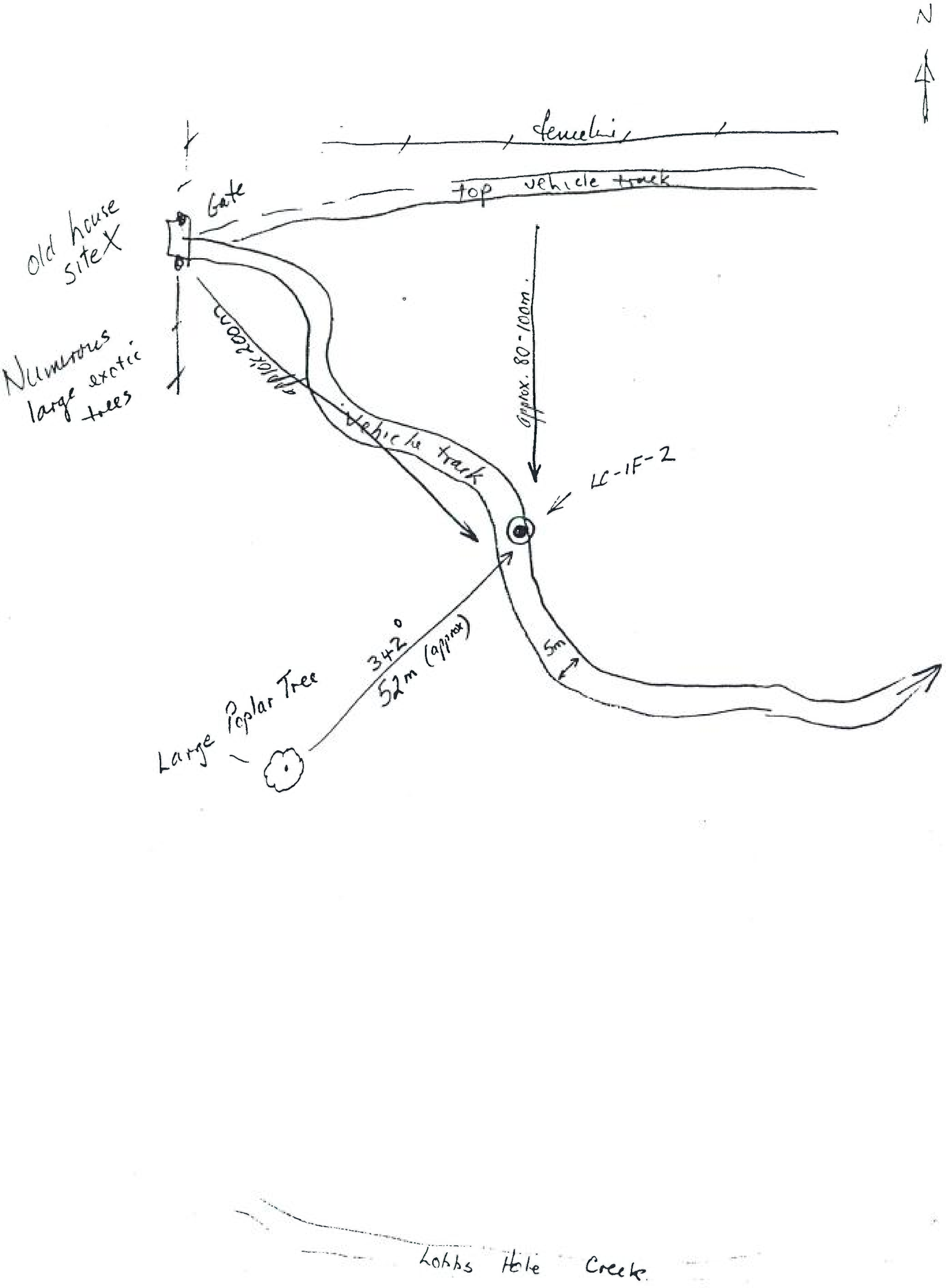
Artefact Type	Raw Material	Colour	Dimensions	Cortex	Comments
HAMMERSTONE	QUARTZITE	PINK/BROWN	CIRCULAR 65 diameter 40 thick	100% WW	Abrasion consistent with hammer stone around edge (central) one large ~~cho~~ [illegible] anvil mark shallow one side

682 910

16.10.13

LHC_IF_1

Location Sketch



Open Sites / Isolated Artefacts / Middens

Site Name: JC - [illegible] - 1

Date: 16-12-98

Grid Reference 695993 E
6064446 N

1. Landform Unit: JERRABOMBERRA CK HEADWATERS. EPHEMERAL CREEK — SOAK AREA ORIGINALLY.
(hill slope, ridge top, floodplain etc)

2. Nature of deposit: SANDY LOAM
(sandy, gravely, clay etc)

3. Erosion - On Site: [✓ Sheet] Rilling [✓ Gully]

- Environment: OPEN GRASSLAND.

4. Site Exposure / Extent: 10 x 25m m. Area ....m ^{2}
(artefacts visible)

4. Surface Visibility (est.): <5% 5-10% 20-50% [✓ 50-70%] 75-100%

5. Present Landuse: GRAZING - DAMS

6. Type of Archaeological Material Present: STONE

7. Artefacts in situ ? NO.
(erosion occurring etc)

8. Artefact Density: ..../ m ^{2} (average) ..../m ^{2} (Max.)

9. Total Number of artefacts: ②

Estimated Number of artefacts: 50-100 100-200 <500 >500

10. Raw Material %s: QUARTZITE SILCRETE.

11. Site complex characteristics: NIL.
(associated hearths, knapping floors, ST's etc)

Artefact Details: Open Camp Site (OS), Midden (M), Isolated Artefact (IF)

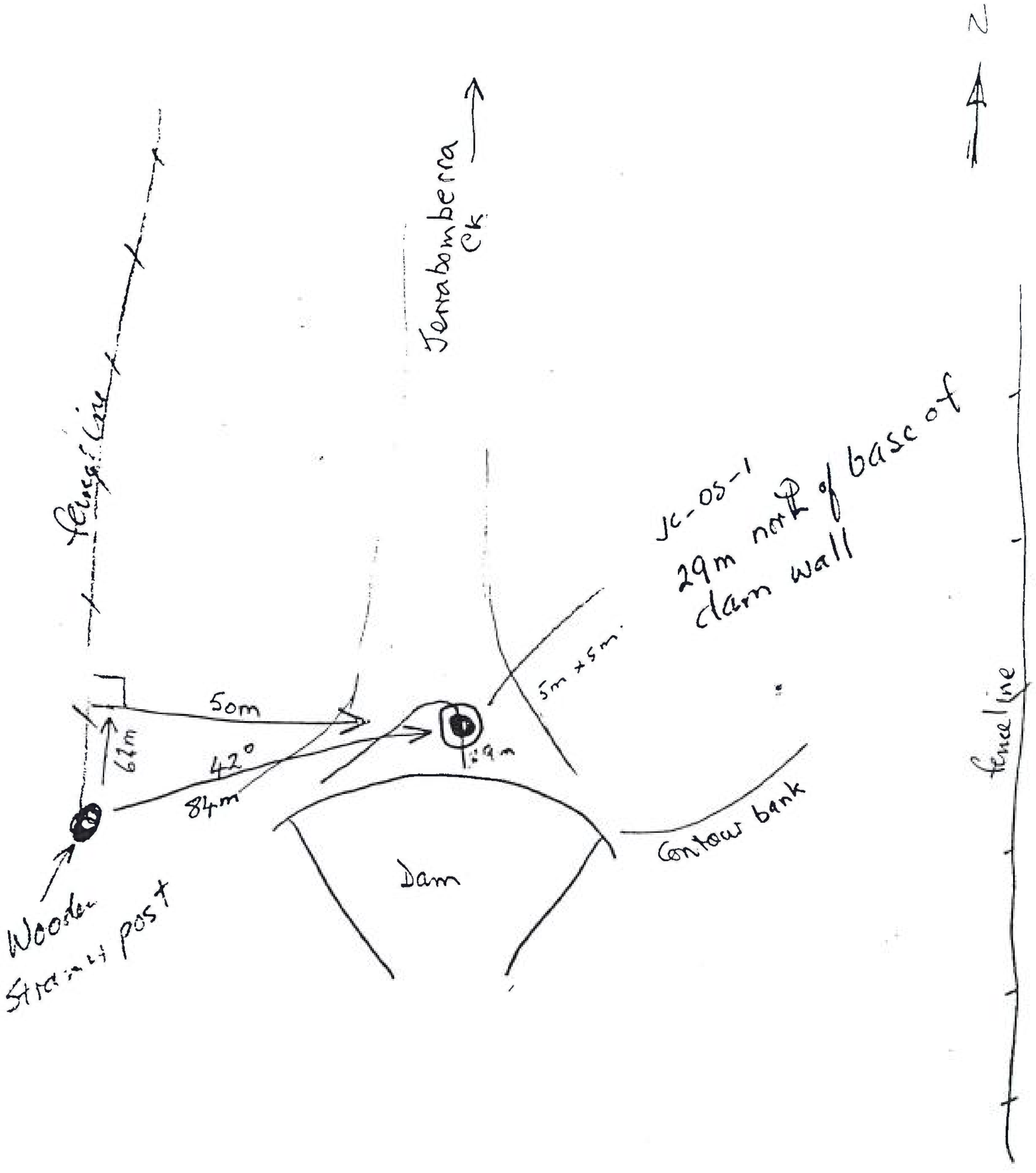
Site Field Name: JC-05-1 Date: 16-12-98 Grid Reference:

Artefact Type	Raw Material	Colour	Dimensions			Cortex	Comments
MANUPORT RIVER PEBBLE	Quartzite	Grey	110	63	51	30%? n/a	Broken river Pebble Broken. No Evidence
FLAKE	RED ~~Shale~~ SILTSTONE MUDSTONE (CHERT)	RED	40	24	9		Unifacial Platform broad. Radiating [illegible] line Neg flk scar dorsal ridge, bulb, bending flake. Secondary flake scar on lateral term feather.

JC-OS 1

16 12 98

Location Sketch



Open Sites / Isolated Artefacts / Middens

Site Name: JC-OS-2 (East Trib)

Date: 17-12-98.

Grid Reference: 696349 E
6063908 N.

1. Landform Unit: Saddle up from Jerralandero Ck (east Tri
(hill slope, ridge top, floodplain etc)

2. Nature of deposit: sandy loam
(sandy, gravely, clay etc)

3. Erosion - On Site: Sheet [✓ Rilling] [✓ Gully]
erosion associated with track

- Environment: open woodland - cleared with regrowth Timber.

4. Site Exposure / Extent: ....x..........m. Area ....m 2
(artefacts visible)

4. Surface Visibility (est.): <5% 5-10% 20-50% 50-70% [✓ 75-100%]
on track - adjacent area 20-50%.

5. Present Landuse: grazing

6. Type of Archaeological Material Present: stone open camp site

7. Artefacts in situ ? No washed down slope
(erosion occurring etc)

8. Artefact Density: ..../ m 2 (average) ..../m 2 (Max.)

9. Total Number of artefacts: 10

Estimated Number of artefacts: 50-100 100-200 <500 >500

10. Raw Material %s: 7/10 quartz 2 black chert 1 cream chert

11. Site complex characteristics:
(associated hearths, knapping floors, ST's etc) NIL.

Jerrambarra Creek East Side

Artefact Details: Open Camp Site (OS), Midden (M), Isolated Artefact (IF)

Site Field Name: JC - OS - 2

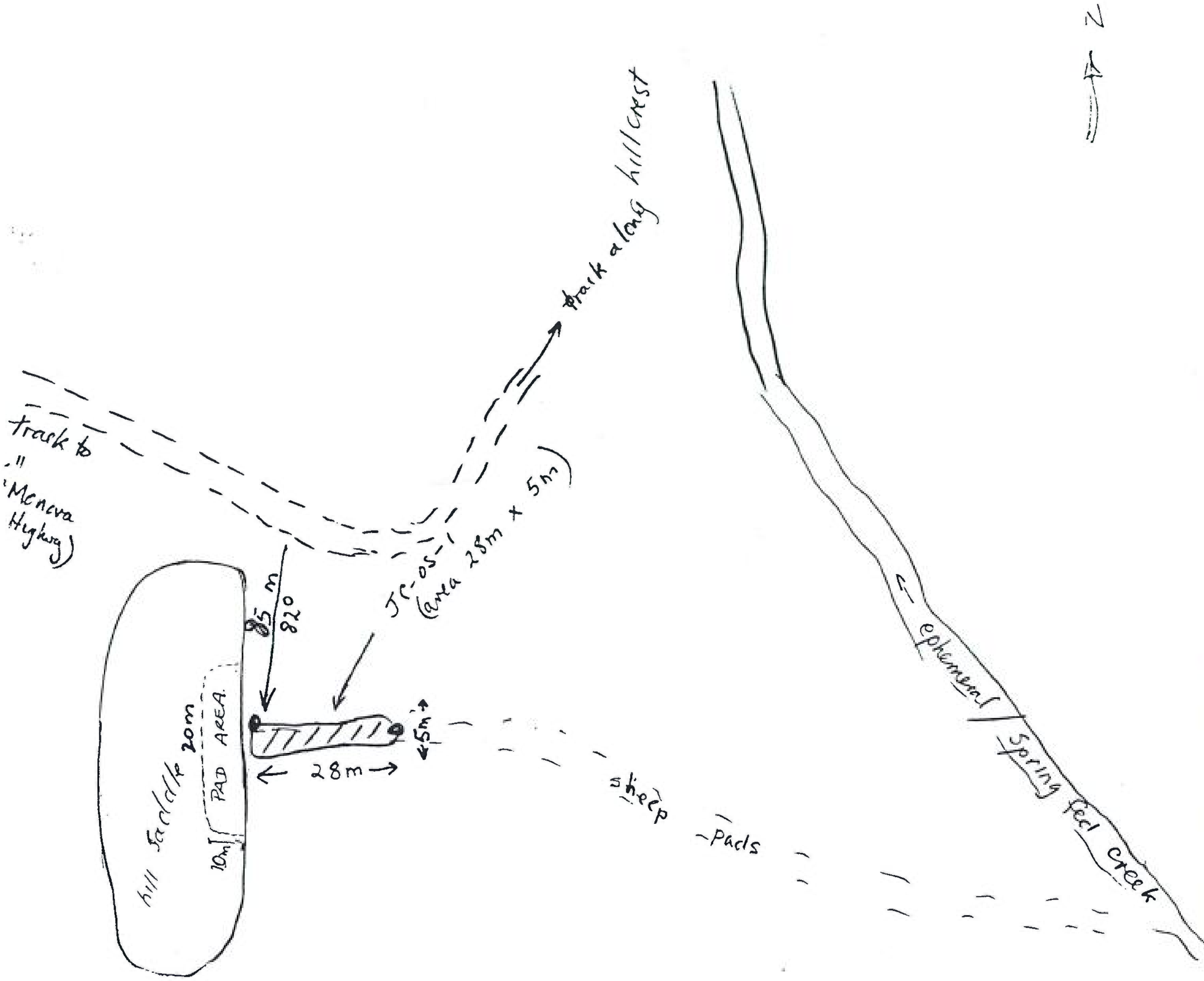
Date: 17-12-98

Grid Reference: 693649 E 6063908 N

Artefact Type	Raw Material	Colour	Dimensions			Cortex	Comments
Flake fragment deb. unmod.	chert	black/grey	19	25	8	NIL	plat. absent snapped ripples. plunge term
block fracture	chert	black/grey	19	18	15	NIL	3 high energy fractured surfaces 2 neg flake scars.
BFF unmodif deb.	Quartzite	black/grey	8	16	2	NIL	
CORE (producer)	chert	cream/brown grey	31	41	28	NIL	possible source fragmentation, multi platform reduced, rotated, 6 neg flk scars. possible bi-polar platforms 3.
Fractured quartz present artefact by association							
flake	quartz	milky white	12	7	3	NIL	~~[illegible]~~ narrow platform bending fracture feather termination
flake	"	"	29	23	13	NIL	platform, PF1, slight dorsal ridge, possible retouch on platform dorsal margin from [illegible]
flake	"	"	14	22	12	NIL	platform, dorsal ridge lip on dorsal margin bending fracture, abrupt term.
BF	"	"	27	18	14		1 high energy flat fracture
BF			22	12	11		crushing along one edge
BF	"	"	17	22	10	NIL	PF1, dorsal ridge, lip on ventral margin plat.
~~BF~~ flake	"	"	11	18	6	NIL	plunge term
core	"	"	34	49	21	NIL	uni platform 2 neg flk scars

JC-05-2 17-12-9

Location Sketch



Key:

///// Area of Artefact Scatter

[ ] New recording [ ] Additional Info

National Parks and Wildlife Service

Box 1967, Hurstville NSW 2220. Tel: (02) 9585 6444
Standard Site Recording Form Revised 5/88

NPWS Code

1:250,000 map sheet:

AMG Grid reference (250K / 25K)
Full reference - please include leading digits

6 9 6 3 5 0 mE 6 0 6 3 9 1 0 mN (5/6)

Scale of map used for grid reference
Please use largest scale available
[ ] 25K, 50K (preferred) [ ] 100K [ ] 250K

[✓ 1:25K] 50K, 100K map name: WILLIAMSDALE 8726-IV-N

HEAD OFFICE USE ONLY:

NPWS Site no:

Site types:

Accessioned by: Date:

Data entered by: Date:

Owner/Manager

Address:

Site name: JC-OS-2

Locality/property name:

NPWS District: QUEANBEYAN

Region:

Reason for investigation

PROPOSED HARD ROCK QUARRY

Portion no:

Parish:

Photos taken? YES

How many attached? IN REPORT.

How to get to the site (refer to permanent features, give best approach to site eg. from above, below, along cliff (Draw diagram on separate sheet)

THROUGH PRIVATE PROPERTY (OAK DALE) EAST OF MONARO HIGHWAY 30KM SOUTH OF QUEANBEYAN AND 100M NORTH OF WILLIAMSDALE.

Other sites in locality? YES

Are sites in NPWS Register? YES

Site Types include: CAMP SITES, IFS. SCARRED TREE.

Have artefacts been removed from site? NO

By whom?

When?

Deposited where? /

Is site important to local Aborigines?

Give contact(s) name(s) + address(es) JOE HOUSE NGUNNAWAL LALC.

Contacted for this recording?

(Attach additional information separately) If not, why not?

Verbal/[✓ written] reference sources (including full title of accompanying report)

NPWS Report Catalogue #

Checklist
surface visibility
damage/disturbance/
threat to site

Condition of site

HIGHLY DISTURBED.

Recommendations for management & protection (attach separate sheet if necessary) AVOID.

IF NOT POSSIBLE CONSENT TO DESTROY WITH COLLECTION & MONITORING.

Site recorded by:
Address/institution

Robynne Mills
60 Watkin Street
Newtown NSW 2042

Date 11/1/99.

SITE POSITION & ENVIRONMENT

OFFICE USE ONLY: NPWS site no:

1. Land form a. beach/hill slope/ridge top, etc:

b. site aspect:

c. slope:

d. mark on diagram provided *or* on your own sketch the position of the site:

e. Describe briefly:

f. Local rock type:

g. Land use/effect:

2. Distance from drinking water:

Source:

3. Resource Zone associated with site (estuarine, riverine, forest etc):

4. Vegetation:

5. Edible plants noted:

6. Faunal resources (include shellfish):

7. Other exploitable resources (river pebbles, ochre, etc):

Site type:

OPEN CAMPS SITE

DESCRIPTION OF SITE & CONTENTS.

Note state of preservation of site & contents. Do **NOT** dig, disturb, damage site or contents.

6.5 Site JC-OS-2 and associated PAD 3

Site JC-OS-2 was located in the south-eastern corner of the main quarry spur line approximately 100m up from the headwaters of the Jerrabomberra Creekline (Map 2, Table 3, 4, Sketch 5, Photos 10, 11). The artefacts were located over a distance of 28m x 5m, on a sheep pad to the south of a vehicle track along the eastern side of the crest of the spur. The artefacts were below a saddle between the southern and northern section of the quarry spurline and appeared to have moved down slope in eroded material. This movement was the result of water gully erosion and tracks caused by animal erosion. Visibility along the vehicle track and the sheep pad was high, in excess of 80%, however immediately off the tracks visibility was less than 5%. Topsoil at the site was shallow and friable and the area had been heavily eroded. A PAD area was identified to the west of the site, however the depth of soil in the PAD area was shallow (less than 5cm) and the area had been heavily disturbed.

CHECKLIST TO I

length, width, dep

height of site, she

deposit, structure

element eg. tree s

grooves in rock.

DEPOSIT: colour,

texture, estimated

depth, stratigrapl

contents-shell, bo

stone, charcoal, c

& distribution of

stone types, artef

types.

ART area of surfa

decorated, motifs

colours, wet, dry

pigment, techniqu

engraving, no. of

figures, sizes,

patination.

BURIALS: number & condition of bone, position, age, sex, associated artefacts.

TREES number, alive, dead, likely age, scar shape, position, size, patterns, axe marks, regrowth

QUARRIES rock type, debris, recognisable artefacts, percentage quarried.

OTHER SITES EG. structures (fish traps, stone arrangements, bora rings, mia mias), mythological sites, rock holes, engraved groove channels, contact sites (missions massacres cemeteries) as appropriate

Attach sketches etc. eg. plan & section of shelter, show relation between site contents, indicate north, show scale.

Attach annotated photos (stereo where useful) showing scale, particularly for art sites.

[ ] New recording [ ] Additional Info

National Parks and Wildlife Service

Box 1967, Hurstville NSW 2220. Tel: (02) 9585 6444

Standard Site Recording Form Revised 5/88

NPWS Code

1:250,000 map sheet: ______

AMG Grid reference (Full reference - please include leading digits): 695990 mE (250K / 25K) 6064460 mN (250K / 5/6 / 25K)

Scale of map used for grid reference (Please use largest scale available): [ ] 25K, 50K (preferred) [ ] 100K [ ] 250K

1:25K, 50K, 100K map name: WILLIAMSDALE 8726-IV-N

HEAD OFFICE USE ONLY:

NPWS Site no: ______

Site types:

Accessioned by: ______ Date: ______

Data entered by: ______ Date: ______

Owner/Manager

Address.

Site name: JC-OS-1

Locality/property name:

NPWS District: QUEANBEYAN

Region:

Reason for investigation

PROPOSED HARD ROCK QUARRY

Portion no:

Parish:

Photos taken? YES

How many attached? IN REPORT.

How to get to the site (refer to permanent features, give best approach to site eg. from above, below, along cliff
(Draw diagram on separate sheet.)

THROUGH PRIVATE PROPERTY (OAK DALE) EAST OFF MONARO HIGHWAY 30 KM SOUTH OF QUEEBEYAN AND 400 m NW OF WILLIAMSDALE.

Other sites in locality? YES

Are sites in NPWS Register? YES

Site Types include: CAMP SITES, IFs, SCARRED TREE.

Have artefacts been removed from site? NO.

By whom?

When?

Deposited where?

Is site important to local Aborigines?

Give contact(s) name(s) + address(es) JOE HOUSE NGUNNAWAL LALC.

Contacted for this recording?

(Attach additional information separately) If not, why not?

Verbal/ [✓ written] reference sources (including full title of accompanying report)

NPWS Report Catalogue #

AN ARCH. SURVEY FOR THE PROPOSED HARD ROCK QUARRY, OAK DALE WILLIAMSDALE SOUTH OF QUEANBEYAN

Checklist
surface visibility
damage/disturbance/
threat to site

Condition of site

HIGHLY DISTURBED.

Recommendations for management & protection (attach separate sheet if necessary) AVOID.

IF NOT POSSIBLE CONSENT TO DESTROY APPLICATION WITH COLLECTION.

Site recorded by

Address/institution

Robynne Mills
60 Watkin Street
Newtown NSW 2042

Date: 11/1/99.

SITE POSITION & ENVIRONMENT

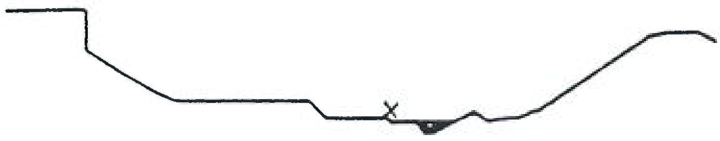
OFFICE USE ONLY: NPWS site no

1. Land form a. beach/hill slope/ridge top, etc:

b. site aspect:

c. slope:

d. mark on diagram provided or on your own sketch the position of the site:



e. Describe briefly:

ADJACENT TO NORTHERN HEADWATERS OF JERRABOMBERRA CK.

f. Local rock type: DACITE / TUFF.

g. Land use/effect: GRAZING.

2. Distance from drinking water: JERR. CK. EPHEMERAL

Source: MURRUMBIDGEE RIVER 5 km.

3. Resource Zone associated with site (estuarine, riverine, forest etc): OPEN FOREST / SWAMP (MAY BE RECENT AS A RESULT OF DAMMING)

4. Vegetation: NIL NATIVE

5. Edible plants noted: NIL

6. Faunal resources (include shellfish): WALLABIES

7. Other exploitable resources (river pebbles, ochre, etc): NIL

Site type:

OPEN CAMP SITE

DESCRIPTION OF SITE & CONTENTS.

Note state of preservation of site & contents. Do NOT dig, disturb, damage site or contents.

CHECKLIST TO HELP:
length, width, d
height of site, sh
deposit, structu
element eg. tree
grooves in rock.
DEPOSIT: colou
texture, estimate
depth, stratigrap
contents-shell, b
stone, charcoal,
& distribution of
stone types, arte
types.
ART area of surf
decorated, motif
colours, wet, dry
pigment, techniq
engraving, no. of
figures, sizes,
patination.
BURIALS: number & condition of bone, position, age, sex, associated artefacts.
TREES. number, alive, dead, likely age, scar shape, position, size, patterns, axe marks, regrowth
QUARRIES. rock type, debris, recognisable artefacts, percentage quarried.
OTHER SITES EG. structures (fish traps, stone arrangements, bora rings, mia mias), mythological sites, rock holes, engraved groove channels, contact sites (missions massacres cemeteries) as appropriate

6.4 Site JC-OS-1

Site JC-OS-1 was located below a dam which had been constructed across the ephemeral head waters of the Jerrabomberra Creek to the west of the main quarry area (Map 2, Sketch 4, Table 4, Photos 8, 9). The natural flow of the creekline has been terminated by the dam however it appears that water still flows through the creekline in times of high water levels. There was considerable erosion in the area caused in part by water but also by the construction of contour banks and ditches. Visibility across the site area was high, greater than 80%. The artefacts were located on the top of what appeared to be the original creek banks. The site extended across an area approximately 25m x 10m. No in situ artefacts were present at the site and no PAD areas identified. The whole area had been heavily disturbed.

Attach sketches etc. eg. plan & section of shelter, show relation between site contents, indicate north, show scale.
Attach annotated photos (stereo where useful) showing scale, particularly for art sites.

[ ] New recording [ ] Additional Info

National Parks and Wildlife Service

Box 1967, Hurstville NSW 2220. Tel: (02) 9585 6444
Standard Site Recording Form Revised 5/88

1:250,000 map sheet: NPWS Code

AMG Grid reference (Full reference - please include leading digits): 694870 mE 6062480 mN

Scale of map used for grid reference (Please use largest scale available): [ ] 25K, 50K (preferred) [ ] 100K [ ] 250K

1:25K, 50K, 100K map name: WILLIAMSDALE 8726-IV-N

HEAD OFFICE USE ONLY:
NPWS Site no:
Site types:
Accessioned by: Date:
Data entered by: Date:

Owner/Manager
Address

Site name: LHS-IF-1
Locality/property name:
NPWS District: QUEANBEYAN
Region:

Reason for investigation

PROPOSED HARD ROCK QUARRY

Portion no:
Parish:

Photos taken? YES
How many attached? IN REPORT.

How to get to the site (refer to permanent features, give best approach to site eg. from above, below, along cliff (Draw diagram on separate sheet)

ENTRANCE THROUGH PRIVATE PROPERTY — MONARO HIGHWAY 100m NORTH OF WILLIAMSDALE.

Other sites in locality? YES
Are sites in NPWS Register? YES
Site Types include: CAMP SITES IF, SCARRED TREE.

Have artefacts been removed from site? NO.
By whom?
When?
Deposited where?

Is site important to local Aborigines?
Give contact(s) name(s) + address(es) JOE HOUSE NGUNNAWAL LALC.
Contacted for this recording?
(Attach additional information separately) If not, why not?

Verbal/[✓ written] reference sources (including full title of accompanying report)
NPWS Report Catalogue #

AN ARCH. SURVEY FOR THE PROPOSED HARD ROCK QUARRY, OAK DALE WILLIAMSDALE SOUTH OF QUEANBEYAN.

Checklist
surface visibility,
damage/disturbance/
threat to site

Condition of site

DROP SITE

Recommendations for management & protection (attach separate sheet if necessary) CONSENT TO DESTROY COLLECTION.

Site recorded by
Address/institution
Robynne Mills
60 Watkin Street
Newtown NSW 2042

Date 11/1/99.

SITE POSITION & ENVIRONMENT

OFFICE USE ONLY: NPWS site no:

1. Land form a. beach/hill slope/ridge top, etc:

b. site aspect:

c. slope:

d. mark on diagram provided or on your own sketch the position of the site:

e. Describe briefly:

RAISED AREA IN LOBBS HOLE CREEK FLOODPLAIN.

f. Local rock type: DACITE / TUFF

g. Land use/effect: GRAZING. (PLOUGHING.)

2. Distance from drinking water: LOBBS HOLE CK. 200m Source: MURRUMBIDGEE RIVER. 2KM.

3. Resource Zone associated with site (estuarine, riverine, forest etc): RIVERINE

4. Vegetation: NIL NATURAL

5. Edible plants noted: NIL

6. Faunal resources (include shellfish): NIL

7. Other exploitable resources (river pebbles, ochre, etc): NIL

Site type:

OPEN CAMP SITE.

DESCRIPTION OF SITE & CONTENTS.

Note state of preservation of site & contents. Do NOT dig, disturb, damage site or contents.

6.3 LHC-IF-1

This isolated find was located approximately 80m south of the proposed access route to the east of the old homestead site (Map 2, Tables 2, 4, Sketch 3, Photos 5, 6). The isolated find, a hammerstone, was located on a track which runs through swampy ground at the base of a steep hill slope. The hammerstone was a circular quartzite river pebble with abrasion consistent with use as a hammerstone around the central edge and a shallow, possible anvil mark on one flat side. No other artefacts or PAD areas were identified in the vicinity. Therefore it is concluded that this was a drop site.

CHECKLIST T
length, width, c
height of site, s
deposit, structu
element eg. tre
grooves in rock

DEPOSIT: colou
texture, estimat
depth, stratigra
contents-shell,
stone, charcoal,
& distribution o
stone types, art
types.

ART area of surface decorated, motifs, colours, wet, dry pigment, technique of engraving, no. of figures, sizes, patination.

BURIALS: number & condition of bone, position, age, sex, associated artefacts.

TREES. number, alive, dead, likely age, scar shape, position, size, patterns, axe marks, regrowth

QUARRIES. rock type, debris, recognisable artefacts, percentage quarried.

OTHER SITES EG. structures (fish traps, stone arrangements, bora rings, mia mias), mythological sites, rock holes, engraved groove channels, contact sites (missions massacres cemeteries) as appropriate

Attach sketches etc. eg. plan & section of shelter, show relation between site contents, indicate north, show scale.

Attach annotated photos (stereo where useful) showing scale, particularly for art sites.

[ ] New recording [ ] Additional Info

National Parks and Wildlife Service

Box 1967, Hurstville NSW 2220. Tel: (02) 585 6444

Standard Site Recording Form Revised 5/88

1:250,000 map sheet: NPWS Code

AMG Grid reference 694690 mE 6062020 mN

Full reference - please include leading digits

Scale of map used for grid reference [ ] 25K, 50K (preferred) [ ] 100K [ ] 250K

Please use largest scale available

1:25K, 50K, 100K map name: WILLIAMSDALE 8726-IV-N

HEAD OFFICE USE ONLY:

NPWS Site no:

Site types:

Accessioned by: Date:

Data entered by: Date:

Owner/Manager:

Address:

Site name: LHC-08-1

Locality/property name: OAK DALE

NPWS District: QUEANBEYAN

Region:

Reason for investigation

PROPOSED HARD ROCK QUARRY DEVELOPMENT

Portion no:

Parish:

Photos taken? YES

How many attached? IN REPORT.

How to get to the site (refer to permanent features, give best approach to site eg. from above, below, along cliff. (Draw diagram on separate sheet.)

SEE ATTACHED MAP, SKETCH. ACCESS THROUGH PRIVATE PROPERTY NORTH OF WILLIAMSDALE RD., WILLIAMSDALE (SOUTH OF QUEANBEYAN).

Other sites in locality? YES

Are sites in NPWS Register? YES

Site Types include: OCS, IF, SCARRED TREE.

Have artefacts been removed from site? By whom? NO

When? Deposited where? /

Is site important to local Aborigines?

Give contact(s) name(s) + address(es) JOE HOUSE NGUNNAWAL LALC.

Contacted for this recording?

(Attach additional information separately) If not, why not?

Verbal/written reference sources (including full title of accompanying report).

NPWS Report Catalogue #

AN ARCH. SURVEY FOR THE PROPOSED HARD ROCK QUARRY ~~AT~~ OAK DALE WILLIAMSDALE NEAR QUEANBEYAN

Checklist: surface visibility, damage/disturbance/ threat to site

Condition of site:

HIGHLY DISTURBED.

Recommendations for management & protection (attach separate sheet if necessary):

APPLICATION FOR CONSENT TO DESTROY WITH COLLECTION & MONITORING.

Site recorded by:

Address/institution:

Robynne Mills
60 Watkin Street
Newtown NSW 2042

Date: 11/1/99.

SITE POSITION & ENVIRONMENT

OFFICE USE ONLY: NPWS site no:

1. Land form a. beach/hill slope/ridge top, etc:

b. site aspect:

c. slope:

d. mark on diagram provided or on your own sketch the position of the site:

e. Describe briefly: BANK OF LOBBS HOLE CREEK.

f. Local rock type: DACITE / TUFF

g. Land use/effect: GRAZING.

2. Distance from drinking water: LOBBS CK. 10m

Source: MURRUMBIDGEE RIVER 21km.

3. Resource Zone associated with site (estuarine, riverine, forest etc): RIVERINE

4. Vegetation: NIL NATIVE.

5. Edible plants noted: NIL

6. Faunal resources (include shellfish): NIL

7. Other exploitable resources (river pebbles, ochre, etc): NIL

Site type:

CAMP SITE.

CHECKLIST TO H
length, width, dep
height of site, shel
deposit, structure
element eg. tree s
grooves in rock.
DEPOSIT: colour,
texture, estimatec
depth, stratigraph
contents-shell, bc
stone, charcoal, c
& distribution of t
stone types, artef
types.
ART: area of surfa
decorated, motifs,
colours, wet, dry
pigment, techniqu
engraving, no. of
figures, sizes,
patination.
BURIALS: numbe
condition of bone
position, age, sex,
associated artefacts.
TREES: number, alive,
dead, likely age, scar
shape, position, size,
patterns, axe marks,
regrowth
QUARRIES, rock type,
debris, recognisable
artefacts, percentage
quarried.
OTHER SITES EG.
structures (fish traps,
stone arrangements,
bora rings, mia mias),
mythological sites, rock
holes, engraved groove
channels, contact sites
(missions massacres
cemeteries) as
appropriate

DESCRIPTION OF SITE & CONTENTS.
Note state of preservation of site & contents. Do **NOT** dig, disturb, damage site or contents.

6.2 Site LHC-OS-1 and associated PAD 2

This open camp site is located in the southern bank of Lobbs Hole Creek (Map 2, Table 3, Sketch 2, Photos 3, 4). A light scatter of artefacts extends along the length of the southern bank of the creek west of the fence line, for a distance of 180m x 5m,. No artefacts were located on the northern bank. The creek banks are steep (Photo 3) and the soil in the creekline area is light, friable, sandy, alluvial gravels deposited over the years by wash from the ridge lines and hill slopes. The creek banks have been heavily eroded by water and animals gaining access to the creekline to drink

The density of artefacts on the southern, creek bank is low (8 over a distance of 180m x 10m). Visibility on the top and sides of the bank was high, between 70-100%. However this high visibility did not extend more than 5m from the edge of the creek bank. A highly disturbed PAD area was identified south of the creek bank for a distance of 20m. The PAD has been heavily disturbed by ploughing, clearance and grazing. Although artefactual material may be present within the PAD area, it is likely to be in-situ.

Attach sketches etc. eg. plan & section of shelter, show relation between site contents, indicate north, show scale.
Attach annotated photos (stereo where useful) showing scale, particularly for art sites.

[ ] New recording [ ] Additional Info

National Parks and Wildlife Service

Box 1967, Hurstville NSW 2220. Tel: (02) 585 6444
Standard Site Recording Form Revised 5/88

NPWS Code

1:250,000 map sheet: ______

AMG Grid reference (Full reference - please include leading digits): 694490 mE 6061960 mN

Scale of map used for grid reference (Please use largest scale available): [ ] 25K, 50K (preferred) [ ] 100K [ ] 250K

[✓ 1:25K] 50K, 100K map name: WILLIAMSDALE 8726-IV-N.

HEAD OFFICE USE ONLY:

NPWS Site no:

Site types:

Accessioned by: Date:

Data entered by: Date:

Owner/Manager:

Address:

Site name: WR-05-1

Locality/property name: OAK DALE

NPWS District: QUEANBEYAN

Region:

Reason for investigation

PROSED HARD ROCK QUARRY DEVELOPMENT

Portion no:

Parish:

Photos taken? YES

How many attached? IN REPORT.

How to get to the site (refer to permanent features, give best approach to site eg. from above, below, along cliff. (Draw diagram on separate sheet.)

TURN OFF THE MONARO HIGHWAY TO WILLIAMSDALE. SITE NORTH OF WILLIAMSDALE RD. APPROX. 1 Km FROM TURN OFF (SEE ATTACH.

Other sites in locality? YES

Are sites in NPWS Register? YES

Site Types include: OCS, IF, SCARRED TREE.

Have artefacts been removed from site? By whom? NO.

When? Deposited where? /

Is site important to local Aborigines? Give contact(s) name(s) + address(es)

JOE HOUSE
NGUNNAWAL LALC

Contacted for this recording?

(Attach additional information separately) If not, why not?

Verbal/[✓ written] reference sources (including full title of accompanying report).

NPWS Report Catalogue #

AN ARCH. SURVEY FOR THE PROPOSED HARD ROCK QUARRY AT OAK DALE, WILLIAMSDALE NEAR QUEANBEYAN

Checklist: surface visibility, damage/disturbance/ threat to site

Condition of site: HIGHLY DISTURBED.

Recommendations for management & protection (attach separate sheet if necessary): : AVOIDANCE

IF IMPACTED BY DEVELOPMENT THEN CONSENT TO DESTROY APPLICATION TO NPWS. WITH COLLECTION / MONITORING. NO SUB-SURFACE INVESTIGATION RECOMMENDED.

Site recorded by: Robynne Mills

Address/institution:
60 Watkin Street
Newtown NSW 2042

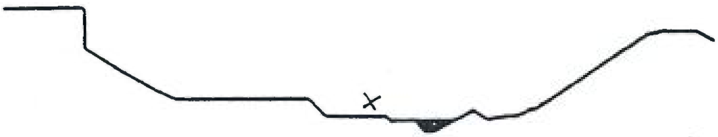
Date: 11/1/99.

SITE POSITION & ENVIRONMENT

OFFICE USE ONLY: NPWS site no:

1. Land form a. beach/hill slope/ridge top, etc: b. site aspect: c. slope:

d. mark on diagram provided *or* on your own sketch the position of the site:



e. Describe briefly:

RISE IN FLOOD PLAIN OF LOBBS HOLE CREEK

f. Local rock type: DACITE / TUFF

g. Land use/effect: GRAZING.

2. Distance from drinking water: 2 km

Source: MURRUMBIDGEE RIVER

3. Resource Zone associated with site (estuarine, riverine, forest etc): RIVERINE

4. Vegetation: NIL NATIVE - SOWN GRASSES

5. Edible plants noted: NIL

6. Faunal resources (include shellfish): NIL

7. Other exploitable resources (river pebbles, ochre, etc): NIL

Site type:

CAMP SITE

DESCRIPTION OF SITE & CONTENTS.
Note state of preservation of site & contents. Do **NOT** dig, disturb, damage site or contents.

6.1 Site WR-OS-1 and associated PAD 1

Site WR-OS-1 is located approximately 230m north of the Williamsdale Road (Map 2, Tables 3, Sketches 1, Photos 1, 2). The site is on the northern side of an ephemeral drainage line which flows into a small dam to the east of the woolshed. Artefacts are exposed across an area 10m long by 2m wide on the eroded northern bank of the drainage line. The area has been heavily eroded by grazing animals, ploughing and cultivation and the excavation of a contour bank on the western side of the site. Although the exposed artefacts do not appear to be in situ, the raised area to the north of the site has been identified as PAD 1 (an area of potential archaeological deposit). This PAD area has been heavily disturbed by ploughing, clearance and grazing. A total of 5 artefacts were recorded at this site (Table 4). These included 4 flakes and one block fracture fragment. Raw materials included chert (4) and quartz (1).

CHECKLIST T
length, width, c
height of site, s
deposit, structi
element eg. tre
grooves in roc
DEPOSIT: col
texture, estima
depth, stratigr
contents-shell
stone, charco
& distribution
stone types, a
types.
ART: area of s
decorated, motifs, colours, wet, dry pigment, technique of engraving, no. of figures, sizes, patination.
BURIALS: number & condition of bone, position, age, sex, associated artefacts.
TREES: number, alive, dead, likely age, scar shape, position, size, patterns, axe marks, regrowth
QUARRIES: rock type, debris, recognisable artefacts, percentage quarried.
OTHER SITES EG. structures (fish traps, stone arrangements, bora rings, mia mias), mythological sites, rock holes, engraved groove channels, contact sites (missions massacres cemeteries) as appropriate

Attach sketches etc. eg. plan & section of shelter, show relation between site contents, indicate north, show scale.
Attach annotated photos (stereo where useful) showing scale, particularly for art sites.