HERNE HILL QUARRY RELOCATION

Public Environmental Review

Pioneer

September 1990

DAMES & MOORE

Proposed Relocation of Pioneer Quarry, Herne Hill

Public Environmental Review

PUBLIC COMMENTS INVITED

Pioneer Concrete (WA) Pty Ltd proposes to relocate its quarrying and asphalt production facilities from their current position at Lot 11 Neuman Road, Herne Hill to a new area on Pioneer property approximately 1.5km east of the present site.

A Public Environmental Review (PER) regarding the proposal has been prepared by Dames & Moore in accordance with Western Australian Government procedures. The PER describes the proposal, examines the likely environmental impacts and discusses proposed environmental management procedures.

The PER will be available for public review between 1st September and 27th October 1990.

Copies of the report will be available for examination at the following locations:

Environmental Protection Authority – 1 Mount Street. Perth
The Environment Centre – 794 Hay Street, Perth
Midlands Public Library – The Crescent, Midland
State Reference Library – Alexander Library Building, Perth Cultural Centre
Shire of Swan – Great Northern Highway
Guildford Public Library – James Street, Guildford

Copies of the PER may be purchased for the sum of $10.00 each (including postage and handling) from:

Pioneer Concrete (WA) Pty Ltd
123 Burswood Road, VICTORIA PARK, WA 6100

Interested persons and organisations wishing to comment on the environmental impact of the proposal or on the content of the PER are invited to make written submissions by 27th October 1990 to:

THE CHAIRMAN
ENVIRONMENTAL PROTECTION AUTHORITY
1 Mount Street, PERTH WA 6000
Attention: Mr R Griffiths

If you have any queries about preparing your submission or the assessment process please telephone the EPA on (09) 222 7000.

West. Australian 1.9.90

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PUBLIC ENVIRONMENTAL REVIEW
HERNE HILL QUARRY RELOCATION

for

Pioneer Concrete (WA) Pty Ltd

Dames & Moore Job No. 14890-008-071

September 1990

PUBLIC ENVIRONMENTAL REVIEW
HERNE HILL QUARRY RELOCATION

The Environmental Protection Authority (EPA) invites people to make a submission on this proposal.

The Public Environmental Review (PER) for the proposed relocation of the Herne Hill Quarry has been prepared by Pioneer Concrete (WA) Pty Ltd in accordance with Western Australian Government procedures. The report will be available for comment for 8 weeks, beginning on 1 September 1990 and finishing on 27 October 1990.

Comments from Government agencies and from the public will assist the EPA to prepare an Assessment Report in which it will make recommendation to Government.

Following receipt of comments from Government agencies and the public, the EPA will discuss these comments with Pioneer and may ask for further information. The EPA will then prepare an assessment report with recommendations to Government, taking into account issues raised in the public submissions.

WHY WRITE A SUBMISSION?

A submission is a way to provide information, express your opinion and put forward your suggested course of action including any alternative approach. It is helpful if you indicate any suggestions you have to improve the proposal.

All submissions received will be acknowledged.

DEVELOPING A SUBMISSION

You may agree or disagree, or comment on, the general issues discussed in the PER or with specific proposals. It helps if you give reasons for your conclusions, supported by relevant data.

You may make an important contribution by suggesting ways to make the proposal environmentally more acceptable.

- clearly state your point of view;
- indicate the source of your information or argument if this is applicable; and
- suggest recommendations, safeguards or alternatives.

POINTS TO KEEP IN MIND

By keeping the following points in mind you will make it easier for your submission to be analysed.

Attempt to list points so that the issues raised are clear. A summary of your submission is helpful. Refer each point to the appropriate section, chapter or recommendation in the PER. If you discuss different sections of the PER keep them distinct and separate, so there is no confusion as to which section you are considering.

Attach any factual information you wish to provide and give details of the source. Make sure your information is accurate.

Please indicate whether your submission can be quoted, in part or in full, by the EPA in its Assessment Report.

REMEMBER TO INCLUDE; YOUR NAME, ADDRESS, DATE.

THE CLOSING DATE FOR SUBMISSIONS IS: 27 October 1990

SUBMISSIONS SHOULD BE ADDRESSED TO:

The Chairman
Environmental Protection Authority
1 Mount Street
PERTH WA 6000
Attention: Mr Robert Griffiths

Executive Summary

EXECUTIVE SUMMARY

Pioneer Concrete (WA) Pty Ltd has for 30 years operated a hard rock quarry and associated crushing and screening plant at Lot 11 Neuman Road, Herne Hill, in the Shire of Swan.

The existing operation (Pioneer No.1) occupies an area of about 50 hectares. Lot 11 has a total area of 800 hectares, all owned freehold by Pioneer.

Changing population trends in the Swan Valley, and greater environmental awareness by the general public, the Shire of Swan and Pioneer, have caused Pioneer to review its operations. As a result Pioneer has formulated a proposal to relocate its works to another part of its property (Pioneer No.2) about 1.5km further east and located in a valley beyond the main ridge of the Darling Escarpment. This will involve the development of a new pit and the erection of a completely new crushing and screening plant with stockpiling and administrative facilities. The Pioneer asphalt plant will also be relocated to this area.

It is expected that Pioneer No.2 will be operational within three years of the date that all necessary approvals have been obtained. Once Pioneer No.2 is working, operations at Pioneer No.1 will cease.

It is proposed to remove all structures and equipment from the Pioneer No.1 area and to landscape and rehabilitate it using predominantly indigenous plants. The existing quarry area has been the subject of an extensive planting and rehabilitation programme over the last three years, with excellent results. This will continue until all visible areas are revegetated.

The purpose of this Public Environmental Review is to present this proposal for examination and comment by the general public, the Shire of Swan and the Environmental Protection Authority.

The advantages of the proposal and the area chosen are:

(a) It conforms to the recommendations of the Basic Raw Materials committee of the Metropolitan Region Planning Authority for future quarry operations in Perth;
(b) It has minimal visual impact. The quarry and process works will be out of public view;

(c) The buffer zone to any major habitation is increased by about 1.5km (3km from URBAN zoning) and the escarpment ridge protects the Swan Valley from sight and sound;

(d) In building a completely new crushing plant, Pioneer has the opportunity to update its equipment, installing the latest technology available for noise and dust control;

(e) All access to and from the works will be directly via Toodyay Road; and

(f) There are no significant environmental or social problems peculiar to the site.

The proposed site for Pioneer No.2 is located on the south slope of a steep-sided valley. Susannah Brook, a small, semi-permanent stream, runs through the centre of the valley. A mosaic of lateritic and granite-derived soils hosts a mixture of native scrub and heath vegetation. Most of this vegetation (95% of the Pioneer land holding) will remain undisturbed by the proposed quarry and will act as a buffer against noise, dust and visual impacts from the quarry.

An investigation has identified the major potential adverse impacts which may arise from the proposal as landscape restructuring, water quality effects on Susannah Brook, damage to vegetation, and air emissions including noise, dust and odours. Other potential impacts include the loss of fauna habitat, introduction of dieback disease, visual impact and effects on adjoining land users.

These potential impacts have been addressed by Pioneer, and strategies have been developed to avoid or minimise them.

Landscape restructuring associated with the development of Pioneer No.2 will be balanced by the rehabilitation of a larger area at Pioneer No.1 following its closure.

The water quality of Susannah Brook and other watercourses will be protected by the construction of sedimentation basins to trap runoff from disturbed areas. Most runoff will be recovered and used for dust suppression watering of roads and stockpiles.

Botanical studies have shown that the areas to be disturbed by the Pioneer No.2 quarry (40 ha in total) contain vegetation types which are mostly represented elsewhere on the Pioneer property. The few species which are present only in the

Project Area are well-represented in other areas including John Forrest National Park, approximately 4km south of the Pioneer No.2 site.
The impact of noise, dust and odours from the new quarry is expected to be much less than currently exists at Pioneer No.1, due to the greater distance of Pioneer No.2 from any residences and the presence of a large, undeveloped buffer zone.

The visual impact of Pioneer No.2 will be minimal, as the quarry has been designed to be visible only from within Pioneer property.

The risk of introduction of dieback disease will be managed by quarantine procedures including the washing down of vehicles entering from disease-risk areas and the use of only uncontaminated material for landfill or other purposes.

Effects on adjoining land owners will be minimal, as the quarry will be surrounded by a generous buffer on all sides. All of this buffer is either owned freehold by Pioneer or zoned for extractive industry.

In summary, Pioneer considers that this proposal offers an acceptable solution to the various social and environmental issues which have arisen at the existing quarry site, whilst ensuring the continued long-term operation of an essential enterprise which contributes significantly to the economic well being of Western Australia.

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PUBLIC ENVIRONMENTAL REVIEW
HERNE HILL QUARRY RELOCATION

1.0 INTRODUCTION

1.1 THE PROPOSAL

Pioneer Concrete (WA) Pty Ltd ("Pioneer") operates a hard rock quarry at Lot 11 Neuman Road, Herne Hill. Pioneer proposes to relocate this operation to another area on the same property (as shown on Figure 1), and subsequently to close and decommission the existing works. Throughout this document, the existing quarry is referred to as "Pioneer No.1", and the proposed new quarry as "Pioneer No.2".

1.1.1 Background

Pioneer No.1 has been operating since 1961, and has developed as the major source of crushed granite and diorite in the northern Perth metropolitan area. Since 1977 an asphalt plant has operated on the same site, using crushed stone from the quarry as feedstock. The asphalt plant is operated by Pioneer Asphalts Pty Ltd.

In recent years a number of factors have changed the environment in which the quarry operates. Most of these are related to increased population density in the surrounding areas, with consequent increases in the intensity of land use. Greater regulation of land use by local and state governments has resulted, with land being zoned into rural, residential, and industrial areas. Although the Pioneer landholding pre-dates these zonings and Pioneer is therefore not legally bound by them in continuing its operations, pressure has grown for the quarry to be closed or relocated.

In 1985 the State Government released a blueprint for future development of the Swan Valley entitled the Swan Valley Policy (SVP) which identified housing, viticulture, recreation and tourism as major land uses in the Swan Valley. The primary objectives of the Policy were:

- To improve the viability and competitiveness of the Valley's viticulture industry;
- To promote the development of tourism to its fullest potential while retaining the unique character and appeal of the Swan Valley and adjacent areas; and
- To conserve and enhance the Swan Valley's resources, particularly its rural character and amenity, its natural and built environments, and its clay deposits.

Although the Pioneer No.1 quarry is outside the area addressed by the Swan Valley

Policy, its continued existence at the present site is seen by some to be incompatible with the objectives of the Policy.

As a consequence of continuing residential development in the local area, the number of people living in close proximity to the quarry has increased. As a result, numerous public complaints have been made to Pioneer during recent years concerning noise, dust and odours emanating from the quarry and asphalt plant. Pioneer has, over the years, made considerable efforts to address these complaints and has outlaid several millions of dollars in installing noise and dust suppression measures and in changing operational procedures. As a result of these measures, the level of complaint has dropped dramatically. It is recognised, however, that no industry such as this can be completely free from noise, dust, odours and visual impact, and that the most effective way of eliminating undesirable social impacts is to relocate the entire operation to a more remote site surrounded by a generous buffer zone. The proposed location of Pioneer No.2 fulfills this requirement.

In recent years the Shire of Swan has made a number of demands of Pioneer linked with the issuing of an extractive industry licence. Despite maintaining that it is not legally bound to observe these demands, Pioneer has met them and this has resulted in the Shire agreeing to a one year licence, renewable over a period of five years subject to certain conditions.

Despite the fact that for the time being Pioneer is meeting community expectations Pioneer recognises that (a) community standards are constantly changing; (b) the character of the Swan Valley is likely also to change; and (c) it is commercially and environmentally unsatisfactory for planning to be limited to such a short term as five years.

Accordingly, Pioneer has looked for a solution that would guarantee it long-term community acceptance (and with that, long-term licensing approvals) and enable it at the same time to commit to significant capital expenditure based on that long-term security and planning.

The present proposal is for a quarry that currently exceeds community expectations and is capable of use for at least 100 years, during which time Pioneer will be able to secure a number of long-term licensing approvals, subject to Pioneer continuing its responsible environmental policies.

1.1.2 Objectives

Pioneer hopes, through the proposed relocation, to fulfil several related objectives. These are:

1. To relocate the present operations to an area sufficiently remote from current and future urban development so that undesirable social effects arising from noise, dust, odours and visual impact are eliminated or minimised.

2. To use an area which contains sufficient reserves of high grade, economically-recoverable resource to sustain the operations into the foreseeable future, and an area which has been designated as a source of rock under the State Planning Commission's Basic Raw Materials Resource Protection Strategy.

3. To earn sufficient income from the new location to fund a comprehensive, ongoing programme of rehabilitation of the existing and proposed quarries.

4. To secure state and local government licences to operate in that location for at least sufficient time to make the relocation an economic proposition. Pioneer considers the No.2 quarry to contain sufficient reserves for at least a 100-year operation.

1.1.3 Scope

The proposal involves the relocation of all of Pioneer's activities currently carried on at Pioneer No.1 to the new area. These include the quarrying operation itself, the screening, crushing and other processing facilities, workshops, offices, stockpiles, despatch facilities and the asphalt plant. Services such as SECWA power supply, water and telephones would be reconnected at the new site.

1.1.4 Timing

It is expected that Pioneer No.2 will be operational within 3 years of the date that all necessary approvals have been obtained. Pioneer No.1 and Pioneer No.2 will operate together for a short period until production at Pioneer No.2 is sufficient for market supplies. Rehabilitation of Pioneer No.1 will continue after operations have ceased until the rehabilitation is well established.

1.2 LOCATION

Figure 1 shows air photograph coverage of the Herne Hill region showing the general location of Pioneer No.1 and Pioneer No.2, in relation to surrounding land uses.

The locations of Pioneer No.1 and Pioneer No.2 are shown in Figure 2. This figure shows the boundary of Pioneer's property and the locations and proximity of the nearest sites of habitation east of the proposed quarry. It can be seen from the figure that Pioneer No.2 is more than 1km distant from any present human habitation. The closest possible future intensive residential development under current zoning regulations is approximately 3km from the Pioneer No.2 site (see Section 5.1.1.2). By contrast, Pioneer No.1 is approximately 0.75km distant from the nearest houses to the west and a similar distance from possible future intensive residential development.

1.3 THE PROPONENT

The proponent for the proposal is Pioneer Concrete (WA) Pty Ltd, a subsidiary of Pioneer International Ltd, an Australian-owned public company. Pioneer Concrete operates its quarrying activities through its quarrying division. The head office of Pioneer Concrete (WA) Pty Ltd is located at:

123 Burswood Road, Victoria Park WA 6100.

In addition to its operations at Herne Hill, Pioneer operates quarries at Byford, Broome, Bunbury, Karratha and Exmouth. The company also operates concrete plants at numerous metropolitan and country locations. Pioneer also owns or holds interests in quarrying, concrete and asphalt manufacture and supply in other states of Australia and overseas, including Hong Kong, USA, United Kingdom, Spain, West Germany, Singapore and Fiji.

1.4 RESPONSIBLE AUTHORITIES

The existing and proposed operations at Herne Hill are the subject of regulation and/or interest by a number of state and local government authorities. The main interested bodies, and their areas of interest, are described below.

1.4.1 Shire of Swan

The Swan Shire Council makes regulations regarding the zoning of land within the Shire for uses such as residential, industrial, rural and so on. The council also issues extractive industries licences to quarries operating within the Shire boundaries and building licences for new buildings.

1.4.2 Department of Planning and Urban Development (DPUD)

This department is responsible for administering State Government regulations and policies including the Swan Valley Policy (SVP).

The Department, under its previous name of State Planning Commission (SPC), also released the Draft Basic Raw Materials Resource Protection Strategy for the Metropolitan Region. This Strategy identified areas of key natural resources to be protected from interference by other developments.

1.4.3 Department of Mines

The Department of Mines in Western Australia controls the activities of extractive industries by the provisions of the Mines Regulation Act 1946-1974 regarding mining activities and related issues including occupational health and safety.

1.4.4 Environmental Protection Authority (EPA)

The EPA has primary responsibility for environmental protection and regulation in Western Australia through the powers of the Environmental Protection Act 1986. EPA assessment is required for any proposed new development (including this proposal) which has the potential to adversely affect the biological or social environment. The EPA also has powers to license and regulate any industry which produces air or water emissions such as smoke, gases, dust and noise.

1.4.5 Water Authority of Western Australia (WAWA)

The Water Authority may exercise control over any industry which has the potential to affect public water supplies, certain groundwater resources and drainage. The Authority has an interest in the Herne Hill area due to the presence of the Swan Groundwater Area on the coastal plain to the west of Pioneer No.1.

Groundwater Area on the coastal plain to the west of Pioneer No.1.

The Water Authority is also responsible for the provision of public water supplies to the existing and proposed quarries.

1.5 ENVIRONMENTAL INTERACTION WITH OTHER DEVELOPMENTS

The Pioneer No.2 quarry is not expected to have any significant impact upon any other existing land use in the nearby area. Existing and planned housing areas (see Section 5.1.1) are sufficiently far from the Pioneer No.2 site to receive minimal impact and, in most cases, are further from Pioneer No.2 than from Pioneer No.1.

The potential cumulative impacts of Pioneer No.2 and one or both of two other proposed rock quarries in the nearby area are examined in Section 8.13. These are the "Red Hill Proposal" (located approximately 1km east of the Pioneer No.2 site) and the "Scarp Proposal" (located 1.5km north of Pioneer No.1). Both of these possible quarries have been at the early proposal stage for several years.

1.6 LEGISLATIVE CONSIDERATIONS

Pioneer No.1 was established prior to the institution of local or regional Town Planning regimes for the land. Under both the current Town Planning Scheme No.9 of the Shire of Swan, and the Metropolitan Region Scheme, the present quarry has existing use rights.

The consequence of these rights is that the Proponent is entitled to continue to use the present workings for quarrying, to extend them up to the title boundary, to replace, relocate and introduce new equipment at any location on the land, to continue operating its asphalt plant and to increase production from both the quarry and the asphalt plant without any requirement for planning permission.

The Proponent is obliged to obtain an Extractive Industries licence under the Extractive Industries Bylaws 1982 made by the Shire of Swan pursuant to the Local Government Act.

Extractive Industries licences have been issued by the Council on a yearly basis and

have been made subject to conditions. There is no authority in the Act for such conditions to be imposed by the issue of a licence.

The Proponent is obliged to observe the pollution and noise control provisions of the Environmental Protection Act 1986.

The quarry is also a mine for the purpose of the Mines Regulation Act 1946-1974 which has a regime of control over the operations of the quarry, principally directed to occupational health and safety.

There are various agencies involved with the assessment of hard rock quarries in Western Australia. These include:

Department of Mines
Local Government Authority (Shire of Swan in this case)
Department of Planning and Urban Development (DPUD)
Environmental Protection Authority (EPA)
Water Authority of Western Australia (WAWA)
Department of Conservation and Land Management (CALM)
Western Australian Museum

Operation Standards and Regulations concerning the Herne Hill quarry operations include:

Mines Regulation Act 1946-1974
Local Government Act 1960
Town Planning and Development Act 1928
Metropolitan Region Town Planning Scheme Act 1984
Environmental Protection Act 1986
Noise Abatement (Neighbourhood Annoyance) Regulations 1979
Water Authority Act 1984
Metropolitan Water Supply, Sewerage and Drainage Act 1909
Soil and Land Conservation Act 1945-1982
Aboriginal Heritage Act 1972-1980

1.7 ENVIRONMENTAL IMPACT ASSESSMENT

Three levels of formal assessment exist under the Western Australian Environmental Protection Act (1986). These are:

Consultative Environmental Review (CER)
Public Environmental Review (PER)
Environmental Review and Management Programme (ERMP).

In March 1990 the Environmental Protection Authority determined that the appropriate level of assessment for the Herne Hill quarry relocation proposal was Public Environmental Review. The Environmental Impact Assessment process is shown in Figure 3.

1.7.1 Public Environmental Review (PER)

As its name implies, a PER is designed to document the significant information regarding a development proposal in a publicly-available, easily-understood report with the aim of encouraging public discussion as to the merits and environmental costs of the proposal. The report also serves as the means by which the EPA formally assesses the environmental acceptability of the proposal and recommends to the Minister for the Environment whether the project should or should not proceed. The final decision on approval is made by the Minister. During the assessment process, public submissions are invited for a period of eight weeks and are taken into account by the EPA when making recommendations.

2.0 NEED FOR THE PROPOSAL

Quarries are an essential part of the economy. The cost of raw materials is incurred at such a basic level in the economy that any increase in their cost is reflected and multiplied many times over in the cost of living in the community. Any direct increases in costs of construction are passed on through rates, housing and rental into all forms of goods and services.

Rock quarries, including Pioneer No.1, form an integral part of the complete industrial environment. Quarry materials are essential for the building and construction industries, being used in:

- Concrete
- Asphalt
- Stone Masonry/Monumental Stone
- Pre-cast concrete
- Dam construction
- Marinas/Harbour works
- Road construction (sub-base and sealing)
- Road drainage
- Landscaping/Gardening
- Erosion protection (rip rap and rock mattresses)
- Sporting facilities
- Rail ballast

2.1 PERTH'S ROCK SUPPLY

2.1.1 Resources

Extensive deposits of hard rock suitable for quarrying occur on the Darling Plateau within 50km of Perth. While the total reserves are large, planning constraints on development, economics and environmental considerations severely restrict the areas available for quarrying. No alternatives to the Scarp resources exist close to Perth.

2.1.2 Future Demands

At present, demand from the metropolitan region for hard rock is met by four major companies operating five quarries. A further three potential quarries have progressed to the stage of initial planning.

Demand for aggregate in the Perth region fluctuates with the activity of the building industry but is generally between 2 - 3 million tonnes per annum. Reliable predictions of future demand are difficult because of the number of parameters that may have an influence. However, the Basic Raw Materials Committee of the former State Planning Commission (SPC) suggested that overall demand for hard rock quarry products can be related to the number of new dwellings constructed using a factor of 190 tonnes per dwelling.

Using this as a basis, an estimate of future demand can be made. Two scenarios are considered:

- Scenario 1: housing for 2 million people
- Scenario 2: housing for 2.9 million people

Based on present demand of 2.5 million tonnes per year, the estimated future demand for Scenario 1 is 84.6 million tonnes and Scenario 2 would require 137.5 million tonnes.

Currently-estimated growth rates for Perth would see Scenario 1 being reached by the year 2022. On this basis, demand for aggregate would remain at 2.5 million tonnes/year and there would be sufficient combined hard rock reserves in the established quarries to serve the existing and projected markets for at least 100 years (SPC, 1986).

2.1.3 Competition

In the Perth metropolitan area there are two major factors affecting the cost of hard rock:

1. The distance of quarries from their market, and
2. The presence of four major suppliers to that market in strong competition with each other.

Pioneer is one of these four and, by virtue of its proximity to the fast-growing northern suburbs, is able to be very competitive in those areas. Pioneer's largest competitor operates at the southern end of the scarp and is thus able to be extremely competitive in that area. Between the two the entire metropolitan area benefits from a competitive price established by each in their local area.

Pioneer No.1 supplies more than 700,000 tonnes of rock per annum to the Perth market, which represents approximately 30% of the total Perth hard rock market.

There would be a severe effect on a regional basis were the Herne Hill rock resource not to be utilised. The resulting decrease in competition, coupled with increased transport distances for rock supplied to the northern Perth area, would be very likely to result in considerable cost increases for rock in that area.

2.2 SOCIAL ISSUES

2.2.1 Background

Pioneer has developed this proposal to relocate its operations as a long-term solution to various social and legislative pressures.

Since operations began in 1961, complaints received about the operation and management of the Herne Hill quarry have aided in identifying the main environmental issues.

A register of public complaints has been kept by the Shire of Swan since October 1985. A register of complaints received directly from the public has also been maintained by Pioneer. Figure 4 summarises the monthly incidence of complaints received between October 1985 and May 1990, and identifies the main public issues concerning Pioneer's operations at Pioneer No.1. As can be seen from Figure 4, the incidence of public complaints against the quarry has declined dramatically since 1985. This is seen as a reflection of the amount of effort which Pioneer has put into addressing the issues raised by those complaints.

Following the release of a draft Environmental Management Report (EMR) for the quarry in 1986, the Shire of Swan requested public submissions before the issuing of an excavation licence for continued operations at Pioneer No.1 quarry.

A breakdown of the 28 submissions received, identifying the key issues, is presented in Table 1.

TABLE 1

KEY ISSUES IDENTIFIED BY PUBLIC SUBMISSIONS
ON THE 1986 DRAFT EMR - PIONEER NO.1 QUARRY

ISSUE	NUMBER OF REFERENCES
Total submissions = 28	
Swan Valley Area and Policy Document	12
Asphalt Plant (Emissions, closeness to residences)	11
Quarry (General objection, expansion)	11
Rehabilitation	11
Visual scar/Aesthetic value	10
Refusal of Licence renewal	9
Wind data	8
Additional quarries in area	7
Relocation/discontinuation of quarry activity	7
Air quality/dust	7
Environmental parameters (improvements on-site)	7
Water resources	7
Population increase/Rural lifestyle	6
Relocation of asphalt plant	6
Quarry management	5
Flora/fauna and native bushland	5
Planning issues	3
Non-compliance with Licence conditions	3
Noise	3
Blasting	3
Report (distorted, misinformative)	3
Monitoring	2
Employment	2
Community health	2
Property damage	2
Traffic	2
Land values	1

Note: Most of the issues identified in this table will be resolved with the proposed relocation of the quarry.

2.2.2 Response to Complaints

All complaints received by Pioneer, either directly or through the Shire of Swan, concerning operations at Pioneer No.1 have been investigated promptly and corrective action taken where necessary. Following investigation, Pioneer has taken one or more of the following actions:

- Defend the complaint – Some complaints have been regarded by Pioneer to be unfounded, such as complaints regarding blasting noise on days when no blasting was conducted by Pioneer.

- Request further information – Many complaints have been months old or contain insufficient detail to be verified or acted upon. In the absence of information regarding time of day or even the date, it has not been possible for Pioneer to investigate these complaints and take any remedial action. Unfortunately, many complaints have historically fallen into this category.

- Acknowledge the complaint – Where the complaint is considered to be legitimate, Pioneer has and will continue to investigate the problem and undertake remedial action where appropriate. Over the years, this has resulted in several millions of dollars being spent by Pioneer at Herne Hill on the installation and upgrading of dust and odour suppression equipment, the changing of operating procedures for blasting, processing and asphalt production and, finally, the proposed relocation of the entire quarry operations.

2.2.3 Shire of Swan Zoning Regulations

The Shire of Swan Town Planning Scheme No.1 was gazetted on 18 June 1974 (Government Gazette, W.A. 19.6.74 pp 2012-2029) under Section 7 of the Town Planning and Development Act 1928. Under Scheme No.1, quarrying was a "P" use for land in a "Rural Zone" (that is, a use that is permitted in principle). On 9 July 1985 Scheme No.1 was revoked and Swan Town Planning Scheme No.9 was gazetted. The quarry land was rezoned "General Rural". Under Scheme No.9 development approval is required to carry out or continue quarrying which is classed as an AA ("Industry (extractive)") use, unless it enjoys existing use rights pursuant to Clause 2.4 of the Scheme.

Clause 2.4.1.1 of the Scheme provides that:

> "No provision of the Scheme shall prevent - (a) the continued use of any land or building for the purposes for which it was being lawfully used at the time of coming into force of the Scheme if that use was lawful under the provisions of the earlier Scheme".

At the time of promulgation of Swan Town Planning Scheme No.9 the quarry was in operation and the area of land upon which the quarry was situated was in lawful use for the purpose of excavation under Clause 2.4 of Town Planning Scheme No.9.

Similarly, the quarry is within the Metropolitan Region and therefore comes under the regulations of the Metropolitan Region Scheme 1962. The provisions concerning approvals for development are identical to those of the Swan Shire's Scheme. The rationale behind Pioneer's exemption from these requirements for approvals are also based upon a prior lawful land use principle as in the case of Swan Town Planning Scheme No.9.

The consequences of these existing land use rights within the terms of Swan Town Planning Scheme No.9 are as follows:

- Pioneer may continue to use the present workings for the purposes of quarrying;
- Pioneer can extend the quarry workings up to the title boundary of the land described in Certificate of Title Volume 153 Folio 568;
- Existing plant and equipment may be replaced or relocated and new plant and equipment introduced at any location on the land;
- Production may be increased; and
- The Planning Authority (either Swan Shire or Planning and Urban Development) cannot impose conditions regulating the conduct of these operations and cannot enforce the conditions of development approvals that may be current.

2.2.4 Swan Valley Policy

While neither the existing nor the proposed quarry sites are within the Swan Valley Policy Area identified by the State Government in 1985, Pioneer No.1 is immediately to the east of the Policy Area. The relocated quarry operations are less likely to influence the viticulture, tourism and recreation, and conservation and planning objectives for the Policy Area.

2.3 BENEFITS OF RELOCATION

The benefits of quarry relocation for the local community will be in the areas of visual impact, noise impacts and dust impacts. As shown in Figure 2, the planned relocation site of the quarry is remote from residential areas and other community facilities.

2.3.1 Economic Benefits

2.3.1.1 Introduction

The benefits to the state and the local area of the proposal will be substantial, and will include continuation of:

- o A competitive pricing structure for hard rock;
- o Significant capital expenditure; and
- o Direct, indirect and induced employment opportunities.

2.3.1.2 Employment

Pioneer No.1 directly employs 34 personnel, with another 16 full-time subcontractors. Most of these people live in the Swan Shire. Pioneer expects the existing workforce to be largely sufficient for the transfer of operations to Pioneer No.2 and the continued operations at that site, although some extra work will be generated for contractors and subcontractors in the construction phase.

2.3.1.3 Capital Expenditure

Pioneer currently spends around six million dollars per year, much of it in the local area. This represents a major annual injection of capital into the economy. Pioneer expects the proposed relocation to involve initial capital expenditure of approximately $12 million, and total developmental capital expenditure for the new quarry is expected to be $30 million over ten years.

2.3.1.4 Indirect and Induced Benefits

In addition to the direct benefits of such a large injection of capital into the economy there will be substantial indirect and induced benefits.

Firms supplying goods and services to Pioneer will continue to benefit indirectly from quarrying operations. Additional benefits would be associated with construction activities.

High levels of expenditure by Pioneer, along with wages expenditure by the direct and indirect labour forces, will generate economic activity and employment opportunities. These induced benefits will be felt in both the local area and the metropolitan region.

Pioneer is also a substantial ratepayer in the Shire of Swan, and participates or contributes to many local community activities.

3.0 EVALUATION OF ALTERNATIVES

3.1 INTRODUCTION

In a second Environmental Management Report (EMR) submitted in November 1987 (Dames & Moore, 1987), Pioneer, subject to certain conditions, proposed to:

- o cease quarrying the Eastern face of the existing quarry and concentrate extractive operations on the Northern face in order to reduce visual impact; and
- o within 5-6 years, move the existing crushing plant and stockpiles approximately 500m east into the confines of the quarry, thereby removing these operations from public view and reducing noise and dust. This proposal, became Alternative No.1 in subsequent considerations.

Pioneer has since ceased operations on the Eastern face of Pioneer No.1 and is presently quarrying the Northern face.

3.2 ALTERNATIVE No.1

Closer examination of Alternative No.1 revealed the following deficiencies:

- o The immediate area in use and proposed for quarrying (the North face) contained sufficient rock reserves for only fifteen years from 1987. Assuming a lag of five years to establish the new plant Pioneer would be forced to open a new face within ten years. This face would have to be located either:
  - on top of the escarpment; although screened from view this would entail a very large overburden removal operation and was considered environmentally unacceptable; or
  - east of the escarpment ridge; this would also be out of sight and offered low overburden and few environmental problems.

  Either of these locations would require a connection by surface haul road or tunnel to the plant located on the Pioneer No.1 quarry floor;

- The proposed quarry floor location might not achieve the long-term acceptance by the community that Pioneer was hoping for, although it would be a significant improvement; and

- The Basic Raw Materials Committee of the State Planning Commission had designated the Pioneer No.1 site as a "Priority Extraction Area" for quarrying (Figure 5). However, that designation had a limited life of ten years and would be unlikely to be renewed.

3.3 ALTERNATIVE NO.2 (PREFERRED SITE)

The SPC study identified about another 35% of the Pioneer landholding as a long-term "Priority Resource Area" for quarrying (Figure 5). Investigation of this area by Pioneer identified considerable reserves of economic, high-grade rock suitable for quarrying, and gave rise to the Pioneer No.2 quarry proposal. For this and other reasons the Pioneer No.2 site became the preferred alternative.

3.3.1 Reasons for Selection

It was found that this site had many advantages:

- it conformed to SPC long-range planning, as a Priority Resource Area for hard rock quarrying;
- visual and noise impacts would be practically eliminated, with a large increase in buffer zone distance to any future urban development;
- overburden was comparatively shallow;
- construction of the new plant could be completed without interference to existing operations;
- rock reserves were adequate for many years; and
- plant and stockpile areas could be located with easy access to Toodyay Road but still hidden from view.

The disadvantage of Pioneer No.2 is the necessity to develop a new quarry face immediately. This could possibly present some production bottlenecks in the early years and will involve considerably more capital expenditure in the short term. However, Pioneer considers the extra expenditure to be justified, provided that it is able to secure appropriate long-term government permits that will assure its ongoing activities on the condition that it meets certain standards.

The Existing Environment

4.0 Physical Environment

5.0 Socio-Economic Environment

6.0 Biological Environment

4.0 PHYSICAL ENVIRONMENT

4.1 REGIONAL SETTING

The proposed Pioneer No.2 quarry lies within the Shire of Swan on freehold, rural zoned land approximately 20km north-east of Perth city centre. The land is owned and managed by Pioneer Concrete Pty Ltd. The total land area is 800ha and supports mostly native vegetation typical of the Darling Scarp and Plateau.

Land to the east of Pioneer's land holding consists of 556ha owned by Midland Brick and is subject to extractive industry activities (Figure 1).

The Swan Valley, an important area for agriculture, recreation and tourism, is located to the west of the site. Current land use in the area includes hobby farming (especially vineyards and livestock grazing), rural "lifestyle" properties and parks and recreation (e.g. John Forrest National Park).

4.2 GEOLOGY AND GEOMORPHOLOGY

The proposed quarry site is located on the Darling Scarp and Plateau, 20km north-east of Perth city. The Darling Plateau consists primarily of Archaean rocks and has an average elevation of 240m above sea level. The Archaean rocks of the Plateau are blanketed by a layer of laterite which tends to mask variations in the bedrock topography. Iron oxides are concentrated in near-surface horizons, giving a red-brown colour and leading to the development of a flat, hard duricrust or "cap rock". This relatively flat erosional surface is referred to as a peneplain and surrounds the area of the proposed quarry.

The Darling Scarp/Swan Coastal Plain interface is approximately 3km west of the proposed quarry and represents the western edge of the Darling Plateau. The Scarp in the vicinity of Herne Hill rises to over 200m above the level of the Swan Coastal Plain.

The geology of the Project Area is typical of the edge of the Darling Scarp. A lateritic plateau, a remnant of the peneplain, occurs on the ridges. The Scarp face is of granite-gneiss rock in various stages of erosion, ranging from boulder or massive outcrops to highly weathered gneiss or pallid-zone clay exposures. Bands of diorite

rock strike across the granite-gneisses, generally varying from 2-30m wide. The strike is usually north-south trending. Pegmatite and quartz veins also occur as bands from a few centimetres to 5 - 10m wide and penetrate through the gneiss and diorite but do not enter the laterite, which is geologically much younger.

There are no known fossil deposits in the Project Area. Some geological features exposed in Pioneer No.1 may be of scientific and educational interest following decommissioning, and are worth preserving.

4.3 SOILS

The Darling Scarp and Plateau are characterised by three primary soil associations:

- The western part of the Darling Plateau contains lateritic gravels and block laterite. The chief soils are ironstone gravels with sandy and loamy matrices which overlie duricrusts comprising re-cemented ironstone gravels, vesicular laterite and/or mottled[1] or pallid zone material.
- Gravelly yellow earths are found downslope from granite outcrops. Yellow sands and loams occupy the floors of shallow valleys in the west.
- Along the Darling Scarp and in deeply incised valleys massive rock outcrops are a feature and soils are mainly acid red earths. Soils associated with outcrops are frequently shallow and skeletal. This association dominates the Project Area.

Soil formation in the Project Area is influenced by the laterite mantle on ridges and the plateau, and valleys which show considerable variation depending on the amount of local relief, degree of stripping of the weathered mantle and the geological nature of the substrate.

The soils of the lateritic plateau are mostly iron-rich silty clays or loams with a high proportion of laterite pebbles. They are generally moderately well drained and slopes are mostly less than 2^{o}.

Soils on laterite uplands have formed from weathering of the laterite duricrust, have been transported downslope by colluvial action and are free of salts and calcium

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[1] The mottled soils have duplex profiles and are otherwise described as hard-setting loamy soils with red, yellow or mottled clayey subsoils.

carbonate. Quaternary colluvium has accumulated on the lower slopes of the Darling Scarp and in the incised watercourses. This material consists of scree and rock fragments in a variable matrix of clays, silts and sands and is lateritised in places.

Generalised soils descriptions for the Project Area are given in Appendix A. In the Project Area, the soil patterns on the valley slopes are complex: the underlying rock types, slope, moisture and degree of weathering give rise to a variety of soils.

Within the steep valley slopes around Susannah Brook, there are basically two types of soils: those on granite-gneiss substrates and those on diorite substrates. The granitic soils are frequently coarse or sandy and vary from sandy grits in skeletal situations to sandy loams, clay loams and heavy clays in weathered pallid-zone exposures. The soils range from grey-brown to orange-brown in colour. All are moderately drained and occur on slopes of 5^{o} to 20^{o}. Diorite-derived soils are all medium clays, red-brown in colour and poorly to moderately drained. Slopes are mostly less than 5^{o}.

Erosion Hazard

The erosion hazard rating is a subjective assessment derived from an interaction between soil texture, water and wind erodibility (i.e. the power of water and wind to erode), the steepness and length of slope, vegetative cover and land use management of the site.

The lateritic plateau, found above the proposed quarry, is least prone to erosion as the soils are very gravelly and have a high proportion of bedrock exposure or coarse rock which reduces surface sheet flow of water. All of the remainder of the Project Area consists of highly erodible soils with erodibility at any given location dependent mostly on slope. Thus, the relative risk of erosion after soil disturbance can largely be determined by direct reference to the slope as indicated by a contour map. The closer the contours, the higher the erosion risk.

The majority of soils, even on the steepest slopes, are stable until disturbed. Any form of disturbance, but especially vehicles and site clearing, can rapidly destabilise the slopes and lead to sheet erosion, gully erosion or slumping.

There are two types of erosion occurring within the Project Area: natural and accelerated. Natural erosion is the detachment and removal of particles which occurs under natural conditions. Accelerated erosion is the detachment, transport and

deposition of material at a faster rate in disturbed areas. Under current management practices most of the Project Area is undisturbed, except where fire damage has removed substantial amounts of vegetation cover.

Development or operations of any type that may disturb the soil surface have potential to erode directly or to create erosion problems. The location of the proposed quarry is within the catchment of Susannah Brook and will require careful erosion control management to minimise potential impacts on Susannah Brook.

4.4 HYDROLOGY

The slope and runoff characteristics of the Darling Scarp are such that many major watercourses have their origins within this landform. The rivers lose their moderately steep gradient when they enter the plain and consequently drop their sediments. Salinity and sediment transport have major implications for river and catchment water quality impacting on downstream users. Causes of these problems are largely unchecked erosion and land clearing within the stream catchments.

Susannah Brook, 1km to the north, is the major drainage unit of the Project Area (Figure 2). Susannah Brook flows into the Swan River near Herne Hill.

There are numerous ephemeral streams and brooks which flow following rain and arise in the vicinity of the proposed quarry site. The First-Order Streams outlined in Appendix A are examples of these. It should be noted that these streams are tributaries of Susannah Brook. Thus, quarry activities near the First-Order stream may impact on water quality downstream in Susannah Brook.

Groundwater resources of the Darling Scarp are limited. Some springs and soaks exist on the surface, usually at the junction of weathered and unweathered profiles. Small amounts of water from bores are provided for use by orchardists or private premises from the shallow water table in laterite. However, there is limited potential to develop this groundwater resource for use by the proposed quarry.

4.5 TOPOGRAPHY

The proposed quarry site is located east of the Darling Scarp at an elevation of up to 260m on a slope of between 5^{o} and 40^{o}. It is bounded by the Darling Plateau, an

erosional peneplain with a slope of less than 5^{o} and an average elevation of about 240m.

The quarry site occupies the southern side of a steep valley, through the centre of which flows Susannah Brook. The plant and infrastructure site is located on the plateau above the valley. Plates 1 to 5 depict views of the Pioneer No.2 area.

4.6 DRAINAGE

The major drainage feature of the Project Area is Susannah Brook, a small semi-permanent watercourse which flows through the centre of the valley. Susannah Brook originates on the Darling Plateau near Stoneville Road (8km east of Herne Hill) and follows a steeply-incised valley down the Scarp to the coastal plain, where it joins the Swan River. The catchment of Susannah Brook above the Herne Hill quarry is approximately 29.5km^2 in area, and consists mostly of moderately steep, forested and partly-cleared land. The flow rate in Susannah Brook varies markedly in response to short-lived, high intensity rainfall events in its catchment.

Numerous small, well-defined streams and drainage gullies originate in the higher parts of the Project Area and drain into Susannah Brook. Two of these streams drain the proposed quarry pit areas in Pioneer No.2. The natural drainage of the Project Area is shown in Figure 6.

A high percentage of rain which falls in the Project Area contributes directly to runoff, especially on the exposed granite slopes. Estimated coefficients of runoff in the area during short-term, high-intensity rainfalls range from 90% on granite outcrops to 30% on wooded slopes. Flow in the small streams is thus rapid and short-lived, and occurs only after high-intensity rainfall. There is no groundwater contribution from the Project Area to the flow in the small streams or in Susannah Brook, although small amounts of seepage would occur on steep slopes underlain by granite.

4.6.1 Susannah Brook

4.6.1.1 Flow Patterns

The flow rate in Susannah Brook is highly variable and depends on rainfall in the

catchment of the brook. Of a total catchment area of 29.5km^2, only about 37.5ha (less than 1.4%) will be affected by the Pioneer No.2 operations.

The mean annual flow rate in Susannah Brook has been estimated by Hammond & Mauger (1985) at 5 x 10^6 m^3. The annual discharge from the area of the proposed Pioneer No.2 quarry, assuming similar rainfall and runoff characteristics as the Susannah Brook catchment, is likely to be in the order of 70,000m^3.

4.6.1.2 Sediment Loads in First-order Streams

The small, ephemeral streams which drain the project area are the primary means of transport of water and sediments from the project area to Susannah Brook. It is proposed to utilise these streams as part of the sediment trapping system by diverting their flow into a large sedimentation basin (see Section 8.2) before releasing the runoff to Susannah Brook.

4.6.1.3 Sediment Loads in Susannah Brook

The concentration of suspended sediments in Susannah Brook varies greatly between low and high flows.

Previously-collected data (Dames & Moore, 1989b) show that Total Suspended Solids (TSS) concentration in Susannah Brook below the proposed quarry site may vary from as little as 1mg/l during low flows to more than 4600mg/l at high flows. These data illustrate the high erosion potential which presently exists in the Susannah Brook catchment during periods of heavy rain.

The implication of this for the proposed quarry operation is that, during periods of heavy rain and high flows, the sediment loads in Susannah Brook are already heavy and any increased sediment loads originating from the very small catchment of the quarry are likely to be insignificant.

Pioneer intends to ensure that the concentration of suspended sediments in water entering Susannah Brook from the area of the proposed Pioneer No.2 quarry will be comparable to that of water already in the Brook.

4.7 WATER RESOURCES

4.7.1 Surface Water

None of the surface water features in or around the Project Area are currently utilised for public water supply.

A number of small man-made surface water storages exist around the Project Area, many of which occupy disused borrow pits. One of these storages is proposed to be developed by Pioneer to supplement the process water for Pioneer No.2 but the bulk of process water will continue to be drawn from the existing water storage in Pioneer No.1.

4.7.2 Groundwater

Due to the elevation and geology of the Project Area, there are no significant available groundwater resources close to the proposed quarry.

Large quantities of shallow groundwater exist on the coastal plain west of the project area, and these are tapped by numerous private bores. None of this groundwater will be used or affected by the proposed quarry.

4.7.3 Water Authority Zonings

The Water Authority of Western Australia controls groundwater usage in the area west of Campersic Road. Under the Rights in Water and Irrigation Act 1914-1981, this area is proclaimed as part of the Swan Groundwater Area.

The Water Authority is also understood to be considering a proposal to establish a "Proclaimed Catchment" status over a part of the Susannah Brook catchment for possible use as a pipehead storage reservoir. This proposal has not been formalised and the boundaries of the proposal have not been established (P. Moore, WAWA, 1990 pers. comm.). However, the area concerned is believed to be upstream of the Pioneer landholding.

Neither of these zonings is expected to be affected in any way by the Pioneer No.2 quarry.

4.8 METEOROLOGY

The Bureau of Meteorology has been recording climatic data since 1957 at the Upper Swan Research Station, approximately 4km north-west of Pioneer No.1. This site is considered close enough to the Project Area to be used directly in this study.

The climate at the proposed quarry site is characterised by a temperate mediterranean climate experiencing warm, dry summers and mild, wet winters.

4.8.1 Rainfall and Evaporation

Average monthly rainfall and evaporation records are summarised in Figure 7. Average evaporation exceeds rainfall for eight months of the year, and annual average evaporation (1609mm) exceeds annual average rainfall (728mm) by 881mm.

The predominance of winter rainfall is clearly indicated in Figure 7, with 58% of the annual average rain falling between June and August. The summer season, from November to March, receives only 9% of the average annual rainfall.

4.8.2 Temperature

Figure 7 shows average monthly maximum and minimum temperatures at the Upper Swan Research Station. The lowest temperatures are normally experienced in August, when the average minimum and maximum temperatures are 7°C and 18°C respectively. The highest temperatures typically occur in February, when the average minimum temperature is 16°C and the average maximum temperature is 34°C.

4.8.3 Wind

Seasonal windroses based on data recorded at the Upper Swan Research Station are shown in Figure 8. The most common winds are south-westerlies, which are particularly common in spring and summer (30% to 40% at 3.00pm). During summer approximately 55% of the winds are easterlies at 9.00am, but only 25% at 3.00pm. Prevailing winds tend to be easterly in the morning and south-westerly in the afternoons. Data from the Bureau of Meteorology also shows the preponderance of winds from the western quadrant, on a monthly basis.

An ongoing programme of wind monitoring has been established as part of the planning for the proposed relocation. This programme will produce detailed information on wind speed and direction at both the highest part of the Project Area and in the Susannah Brook valley at the bottom of the Project Area. The results of this monitoring will provide a picture of the wind patterns in the Project Area and will assist in the minimisation of dust and noise emissions from Pioneer No.2.

5.0 SOCIO-ECONOMIC ENVIRONMENT

5.1 ADJACENT LAND USES

5.1.1 Residential

At present, low-density residential areas exist both on the Darling Scarp and on the Swan Coastal Plain around Pioneer's land holding at Herne Hill. No significant urban residential areas occur within 4km of the Project Area. The existing housing to the west and north of Pioneer's property consists mainly of hobby farm blocks and "lifestyle" properties.

5.1.1.1 Existing Housing

Most housing in the vicinity of the proposed quarry (see Figure 2) is located on "Rural Living" zoned land on average block sizes of 4ha. Some housing also exists on the Darling Scarp on "General Rural" land of a minimum 40ha lot size. Only two areas of "Urban" (R20) zoned land occur in the area. Both of these are located more than 4km west of the Pioneer No.2 site and are thus not considered to interact significantly with the proposed quarry.

5.1.1.2 Future Housing

Two possible areas of future housing may be located in the vicinity of the proposed quarry. The first, the Stratton Development, has advanced to the planning stage. It is situated west of Talbot Road, Herne Hill. The development consists of small block sizes (most are less than $450m^2$) and is a joint venture between a private developer and the Urban Concepts branch of Homeswest. It would provide homes for 6,000 to 7,000 people. The other potential area of urban residential development is located west of Campersic Road, east of the railway, north of Toodyay Road and south of Cathedral Avenue. This land was recommended for urban development in the State Planning Commission's review of the 1970 Corridor Plan (SPC, 1987). The plan for urban development of this area is supported by the Swan Shire and some preliminary studies have been carried out (Swan Shire, pers. comm.). The area is presently used largely for hobby farming including vineyards and livestock grazing. Both areas are more than 3km from Pioneer No.2.

5.1.2 Recreational

Several formal and informal recreation areas are located in the vicinity of the Pioneer property. The Red Hill Pits picnic site is located on the southern side of Toodyay Road, next to a waste disposal site and an off-road vehicle area (Figure 1). Swan View Equestrian Centre is located on Pechey Road (not illustrated), about 3km south of the Project Area. Much of the foothills and Darling Scarp area is used, in some cases illegally, for horse riding.

Major recreational activities in the area include driving of off-road vehicles, picnicking, bush walking and horse riding.

5.1.3 Reserves

The closest reserve to the Pioneer No.2 site is the Red Hill Pits Picnic Area, as shown in Figure 1. A large area zoned "Parks and Recreation" is located south of the proposed quarry and Toodyay Road (Figure 1). Immediately south of this reserve, and approximately 4km south of Pioneer No.2, lies the largest reserve in the area, John Forrest National Park (not shown). The proximity of John Forrest to Perth and its long history make it one of the most popular parks for Perth Metropolitan visitors. Other smaller areas of regional open space and parks also exist although none is in close proximity to the proposed quarry.

5.1.4 Historical, Archaeological and Ethnographic Sites

Although the Swan Valley area has a long history of European settlement, no items of European heritage value occur in the Project Area.

Two sites of Aboriginal cultural significance were found during an ethnographic survey of the Pioneer landholding in May 1990. Arrangements for dealing with issues raised by these sites are detailed in Section 6.10.

5.2 LAND USE PLANNING

Current land uses for the area in the vicinity of the proposed quarry are shown in Figures 1 and 10. Major land uses in the area are as follows:

- Vineyards;
- Rural (horse grazing);
- Rural (partly cleared);
- Wineries;
- Extractive industries (including operational clay and gravel pits); and
- Recreation and conservation.

In 1986 the State Planning Commission (now Department of Planning and Urban Development) released the Draft Basic Raw Materials Resource Protection Strategy for the Perth Metropolitan region. The aim of the Strategy was to identify significant sources (actual or potential) of basic raw materials such as rock, sand and clay, and to enable their protection from competition from other land uses. The strategy zoned resource areas in a number of categories; the three which are of relevance to the Herne Hill area are described below, and shown in Figure 5.

Priority Extraction Areas

These are areas currently in use by extractive industry which have "important attributes in repect to quality, quantity and/or location and where extraction is considered to be the priority land use. These areas may require protection in the relevant town planning scheme." (Survey & Mapping Group, 1987).

The Pioneer No.1 site is classified as a "Priority Extraction Area" for hard rock extraction. This designation has a life of ten years and is due to expire in 1996.

Priority Resource Areas

These are areas of proven resources of regional significance "within which extraction is considered a priority land use. Land use changes or new development which may jeopardise extraction options, will not be permitted in these areas." (Survey & Mapping Group, 1987).

The Pioneer No.2 site has been designated a "Priority Resource Area" for hard rock quarrying with an indefinite lifetime.

Key Areas

These are "areas of regional significance as a source of raw material, which must be protected in the relevant town planning scheme." (Survey & Mapping Group, 1987).

An area east of the Pioneer No.2 site, owned by Midland Brick Pty Ltd, has been designated a "Key Area" for clay extraction. This classification also applies to a smaller area south of the Pioneer No.2 site.

The significance of these zonings is that the Pioneer No.2 site is recognised as an important rock resource and, under State Government policy, quarrying is the preferred land use for the site. Hence Pioneer, in proposing to relocate its operations to that site, is acting in accordance with stated Government policy.

5.2.1 Shire Zoning

Most of the area around Herne Hill is zoned rural; west of the foot of the Darling Scarp is zoned "General Rural" (including land currently being quarried) and consists of large lots in excess of 40ha. To the west the zoning is designated as "Rural Living" with average lots of 4ha. A large area south of Pioneer's land holding is zoned "Parks and Recreation" and includes John Forrest National Park. Small areas of "Urban (R20) zoned land occur to the west of the Project Area. However, these are at least 4km from Pioneer No.2. If proposed new housing subdivisions proceed, considerably larger areas of "Urban" zoned land will exist, but in any event not closer than 3km from the quarry.

5.3 ABORIGINAL HERITAGE

An archaeological survey for Aboriginal sites was undertaken in April 1990 by Quartermaine Consultants. No sites of Aboriginal archaeological significance were found either in the Project Area or on the greater Pioneer landholding. One artefact (a single quartz flake) was found during the site visit. It is an offence under the Aboriginal Heritage Act 1972-1980 to disturb, either knowingly or unknowingly, any site without prior permission from the Department of Aboriginal Sites.

Ethnographic studies of traditional associations of Aborigines with the Project Area were undertaken by McDonald Hales & Associates. These studies showed that the

Swan Valley and Darling Scarp areas are rich in sites of mythological and ceremonial significance. The traditional owners of the area around the proposed quarry are the Nyungar people.

Two areas of significance were noted in the Project Area, both associated with the Waugal myth:

- Susannah Brook is believed to be part of the Dreaming Track of the Waugal (Rainbow Serpent) and is therefore considered to be of great significance. This applies only to Susannah Brook, and not to any tributaries such as the ephemeral streams which drain the Project Area.

- A white "ochre" deposit (actually kaolinite clay) exists near the proposed tertiary crusher/infrastructure site, and is associated with a larger deposit on the opposite side of Toodyay Road. The "ochre" is of very high quality and, despite its mythological significance, is regarded as an exploitable resource by the local Nyungar community.

Aboriginal concerns over these two sites were focussed on the protection of Susannah Brook from interference and the availability of the ochre for ceremonial purposes. To these ends Pioneer proposes to:

- maintain a minimum buffer of 50m between Susannah Brook and any development activities at the No.2 quarry;
- take steps to prevent any silt or other contamination reaching Susannah Brook from the quarry; and
- consult with representatives of the Aboriginal community with a view to making ochre from the deposit available to them, either by permitting periodic access to the site or by removing and stockpiling the ochre in a suitable location.

In line with current practice, a full report of the archaeological and ethnographic surveys has been lodged with the Registrar of Aboriginal Sites at the W.A. Museum.

5.4 EUROPEAN HERITAGE

Despite the long history of European settlement of the Swan Valley and surrounding areas, no items or sites of European heritage value have been identified in or near the Project Area.

5.5 EXISTING QUARRIES

Shire of Swan records list only three licensed and operating excavations in the Herne Hill area, apart from Pioneer No.1. Two of these are located in Lennard Street, Herne Hill and are not expected to have any environmental interaction with the Pioneer No.2 quarry.

The third of these excavations, and the only one likely to have any interaction with Pioneer No.2, is a clay quarry located approximately 750m east of the proposed tertiary crusher/despatch facility site. This quarry is operated by Midland Brick Pty Ltd.

The Midland Brick Operations are within the catchment of Susannah Brook and probably contribute some sediment to the Brook – this would consist mainly of clay particles and fine silt (refer Section 4.6.1.3). The quarry surrounds are currently undergoing rehabilitation, and the amount of sediment discharge should decrease as this rehabilitation proceeds.

In addition to the above, there exist a number of disused excavations and borrow (gravel) pits in the area. These are not expected to have any environmental interaction with Pioneer No.2.

5.6 FUTURE QUARRIES

The Shire of Swan has advised that there are two current proposals for the development of hard rock quarries in the Herne Hill area, in addition to Pioneer No.'s 1 and 2.

The site for the first of these proposals (The "Red Hill Proposal") is located north of Toodyay Road at Red Hill (see Figure 1). This proposal was submitted in August 1985 by Midland Brick Pty Ltd, which owns 556 hectares of land adjoining Pioneer's eastern boundary. The Midland Brick land is used as a source of clay and, according to that Company's submission, will continue to be used in that manner for some seventy years. This activity will ensure the maintenance of a substantial buffer zone to the East and South of both Pioneer No.2 and Red Hill.

The second proposal (the "Scarp Proposal") is located on the scarp face 1.5km north of Pioneer No.1 between the 132kV transmission lines to the north of Pioneer No.1 and Susannah Brook. This location is approximately 2.5km north-west of the proposed Pioneer No.2 (see Figure 1).

The cumulative effect of the proposed Pioneer No.2 and one or both of these other proposals is discussed in detail in Section 8.12 and will be dependent upon a number of factors, viz:

- the scale of relevant operations;
- the distance between the operations;
- the ability or otherwise of an observer to view more than one of the operations; and
- the siting of the operations, in respect of the hydrological environment.

5.7 ACCESS AND TRANSPORT ROUTES

5.7.1 Existing Access

The current quarry is located at Lot 11 Neuman Road. Access is via Great Northern Highway and Toodyay Road, which are under the control of the Main Roads Department, to Neuman Road for which Swan Shire is responsible.

5.7.2 Future Access

Following decommissioning of Pioneer No.1, it is proposed that access to Pioneer No.2 would be directly from Toodyay Road. This would eliminate the use of Neuman Road by haulage vehicles. Access within Pioneer's land holding would be on existing tracks which would be upgraded where necessary.

5.7.3 Traffic Density on Toodyay Road

Traffic levels for Toodyay Road are available for sections east of Great Northern Highway (4190 vehicles for Average Annual Weekday Traffic (AAWT), 1988/89), at the railway crossing (9740 for AAWT in 1988/89) and north of Talbot Road at the bridge (6219 for AAWT in February 1990).

6.0 BIOLOGICAL ENVIRONMENT

6.1 VEGETATION

General Vegetation

Havel (1979) describes four major environmental factors influencing the vegetation of the Darling Scarp and Plateau. The first factor controlling species distribution on the plateau relates to topography. Upland sites tend to have not only drier soils but also soils with greater proportions of gravel and sand and lower levels of nutrients than lowland sites. The second major factor concerns available moisture and is influenced both by the absolute amount of rainfall and the texture of the soil - conditions which exhibit a strong east-west gradient.

The third environmental factor controlling the jarrah forest flora involves the degree of soil leaching and the resulting acidity. Low-lying areas tend to be acidic, wet and highly-leached. A number of habitats and vegetation complexes are contained in the well-drained, neutral and moderately fertile soils which represent the end of several environmental gradients in the Darling Range. The fourth factor affecting species distribution involves soil fertility. The concentration of particular nutrients, especially nitrogen and phosphorous, is important, as are the cation exchange capacity of the soil and the percentage of saturation of that capacity. These factors, in combination, control the distribution of the plant communities.

Five principal plant community types occur on the Darling Scarp and Plateau edge (Heddle and Marchant, 1983), as follows:

o	Open Forest of jarrah-marri: (also with Fraser's Sheoak and Bull Banksia)	on lateritic gravels
o	Woodland of wandoo-marri: (also with Christmas Tree and Powderbark Wandoo)	on deeper and younger, red, clayey soils (often over diorite)
o	Low Woodland of Rock Sheoak: (heath and herbland species)	on skeletal soils associated with granitic outcrops
o	Heath, ranging from Closed to Open	on granitic outcrops
o	Herblands, including Borya, ferns, mosses and lichens	on granitic outcrops

The status of the native vegetation on the Darling Scarp varies significantly. In many instances only remnants of the original plant communities now exist.

The Project Area

Plant communities of the immediate quarry and crushing plant areas can be grouped into eight associations:

- Marri-Wandoo Low Woodland;
- Marri-Jarrah Low Woodland;
- Marri Low Woodland;
- First-Order Stream - Marri;
- First-Order Stream - Wandoo;
- Heath;
- Lithic complex; and
- Revegetation area.

Detailed descriptions of natural vegetation associations and the part of the site which has been revegetated are presented in Appendix A, and a vegetation map is shown in Figure 9.

Marri-Wandoo Low Woodland

This vegetation type is common and occurs on the hilltops and on the deeper soils of the hillsides. The woodland is dominated by Eucalyptus calophylla and E. wandoo, with E. accedens on the diorite-derived soils. Also common were Banksia grandis and Nuytsia floribunda on the hill tops. Below this were many species of shrubs and herbs (see Appendix A, Plate A1 - a).

Marri-Jarrah Low Woodland

This vegetation type occurred between Toodyay Road and the proposed crushing plant, extending into the lower eastern corner and further east. The tree canopy was composed equally of Eucalyptus calophylla and E. marginata; both appeared to be uniform regrowth. Below this were many species of low shrubs and herbs.

Marri Low Woodland

Narrow belts (to 10m wide) of deeper soils on granite slopes of the quarry site are dominated by Eucalyptus calophylla and Xanthorrhoea acanthostachya. Also common were Macrozamia reidlei, and many species of low shrubs and herbs (See Appendix A, Plate A1 - b). These areas were burnt in late 1988 and showed vigorous regrowth in January 1990.

First-Order Stream - Marri

One ephemeral First-Order Stream with Marri was recorded in the area, draining from the southern part through the centre of the West Pit area. The shallow gully supported Eucalyptus calophylla woodland over mixed low scrub over low heath and open herbs (see Appendix A, Plate A2 - a).

First-Order Stream - Wandoo

One First-Order Stream with Wandoo was recorded in the area, draining from the southern part through the centre to the north of the East Pit area. The shallow gully supported Eucalyptus wandoo low forest over mixed low scrub over low heath and open herbs.

Heath

This vegetation type was common in and to the north of the primary and secondary crushing plant site. Mixed open scrub is dominated by occasional patches of dense Calothamnus rupestris and emergent Xanthorrhoea acanthostachya, over mixed low heath. Occasional patches of very shallow soil had a cover of mixed herbs, mainly Borya sphaerocephala. Granite boulders (to 2m diameter) were also present (Appendix A, Plate A2 - b).

Lithic Complex

This vegetation type was common in the West Pit area and extended to the north-west. The lithic complex comprised Marri Low Woodland (described above), open heath and herblands, depending on soil depth. Open heath was dominated by infrequent dense patches of Calothamnus rupestris and scattered Xanthorrhoea acanthostachya over a many species of shrubs. On the shallow soils herbs were dominant, consisting mainly of annual grasses and Asteraceae with Borya sphaerocephala also occurring. Bare granite boulders and pavements covered 10% of the West Pit area (Appendix A, Plate A3 - b). The area was burnt late in 1988, resulting in many remnant dead shrubs and a reduced canopy coverage.

Revegetation Area

Most of the vegetation of the proposed crushing plant site is rehabilitation vegetation, covering areas that were previously cleared and had surface alterations. The understorey of this vegetation largely comprises weedy alien annual grasses, clovers, Lotus sp. and Patterson's Curse. Native vegetation of Marri-Wandoo woodland and granitic heath border the rehabilitation on the south and north respectively.

The relationship between each of these vegetation types and the landform is obvious and consistent. As a consequence, the vegetation of the Project Area is highly mosaic; the type of vegetation cover depends on drainage, slope and location. In general, the Open Forest of Marri-Jarrah occurs on the lateritic remnant peneplain on a small area of hill top in the Project Area, the Woodlands of Wandoo-Marri occur on granitic slopes with deeper soils, especially diorite soils and heavy clays, and Heath and Herbfields occur on shallow soils over granite rock. The creekline vegetation is basically an extension of the three granitic types, depending on soil depth and type.

The structural vegetation types of the Project Area are common and widespread on the Darling Plateau and Scarp. Recent fires have selectively impacted on parts of the Project Area, with creekline vegetation seemingly the most affected. On the whole, however, the vegetation is in good condition.

6.2 FLORA

6.2.1 General

The large variety of landforms and soils on the Darling Scarp supports a specialised and characteristic flora. Although many species also occur in adjacent areas, available records show that at least 10 plant species are restricted to the Darling Scarp (Heddle and Marchant, 1983). Many more occur as outliers of populations in other areas.

A complete list of the flora of the Darling Scarp and Plateau is most difficult to compile, but the "Flora of the Perth Region" (Marchant et al., 1987) generally notes which species occur on the Scarp. Bell and Heddle (1989) prepared an account of the species for which the "Flora" included mention of habitats and locations within the confines of the jarrah forest, designations such as "Darling Range" or "Scarp", or

indications of predominance on lateritic soils. Using this crude technique, Bell and Heddle determined that the jarrah forest (in the broad sense) contains at least 784 species of plants, with the most common families being the Proteaceae, Papilionaceae and Myrtaceae, with 70, 68 and 63 species respectively. The most common family of the monocotyledons was the Orchidaceae, with 51 species.

6.2.2 The Project Area

All species recorded during the survey are listed in Appendix A, and significant species found are discussed in Section 6.2.3.

6.2.3 Significant Flora

Appendix B contains a discussion of the meaning of "significant flora" and provides a background to consideration of the issue. It also contains a listing from the Dames & Moore Rare Flora Database of rare or significant species likely to occur in the Project Area.

No Declared Rare Flora (DRF) were observed in the Project Area. However, seven species of significant flora were identified in the Project Area, namely Beaufortia purpurea, Calothamnus rupestris, Darwinea pimelioides, Hakea cristata, Synaphea acutiloba, S. pinnata and Tetratheca pilifera.

Beaufortia purpurea is an erect or spreading shrub to 1m tall. Marchant et al. (1987) record the distribution of the species as the Darling Scarp east of Perth, extending east just outside the Perth Region, but with a very geographically restricted distribution. The usual habitat is rocky slopes. The species was observed in the West Pit area.

This species was observed from several other locations on the Pioneer landholding outside the Project Area. It grew in open woodlands where it was the dominant understorey species. However these were isolated occurrences on rocky areas. Within the Project Area it was recorded from Marri-Wandoo Low Woodland and the First-Order Streams type vegetation. In both cases it dominated the understorey in infrequent patches no more than 5m across.

Calothamnus rupestris, a Priority 5 species (see Appendix B), is a shrub 1m to 3m tall with similar spread, forming dense thickets. Marchant et al. (1987) describe the habitat as being restricted to watercourses and associated with granite slopes on the Darling Scarp and Range, with a distribution from Toodyay Road to east of Jarrahdale. The only known location outside the Perth Region is at Boyagin Rock. Several populations of this species were observed within the Pioneer landholding outside the Project Area, restricted to 2nd order streams and granite outcrops. Populations within the Project Area were recorded from Marri-Wandoo Low Woodland, First-Order Streams, Heath and Lithic complex types of vegetation, in all cases associated with granite outcrops. C. rupestris occurred at both the West Pit and primary crushing plant sites.

Darwinea pimelioides, a Priority 2 species, is a small open shrub to 0.4m tall with a similar spread. Marchant et al. (1987) record the species as endemic to the Perth Region from a small area near Perth on the Darling Scarp and Range, usually occurring along watercourses in association with D. citriodora. It has been recorded from Darlington to Walyunga.

This species was observed along Susannah Brook and along both First-Order Streams in the Project Area. A scattered population of 10-15 plants was noted on the granite slopes adjacent to the First-Order Stream in the West Pit area and 3-5 plants adjacent to the First-Order Stream in the East Pit area.

Hakea cristata is an erect shrub up to 3m tall and with a spread of 2m. Briggs and Leigh (1988) record this species as rare, with a range of less than 100km. Marchant et al. (1987) record the species as endemic to the Perth Region, known only from the Darling Range east of Perth on granite or laterite soils, associated with either Jarrah or Wandoo. The species' distribution ranges from Kalamunda and Wooroloo to Red Hill.

This species was observed in several locations in the Pioneer land holding, outside as well as within the Project Area. Particular habitats noted were Jarrah woodlands on top of hills and associated with granite outcrops. It occurred as widely separated individuals. Within the Project Area it was recorded from heath, lithic complex and the First-Order stream vegetation types. H. cristata was observed at the West Pit, East Pit and primary crushing plant sites.

Petrophile biloba is an erect shrub to 2m tall, with a spread of 0.5m. Leigh, Boden and Briggs (1984) record the species as "vulnerable", with a range of less than 100km. Marchant et al. (1987) record the distribution from Canning River to Wannamal on the Darling Range on lateritic or granitic soils.

This species was observed in several locations on the Pioneer land holding outside the Project Area, where it was growing in small colonies on granite slopes similar to the West Pit site. Within the Project Area it was locally common in Marri-Wandoo Woodland and on lithic complex. In both these vegetation types it occurred on shallow soils associated with granite outcrops. P. biloba was observed at the West Pit, East Pit and primary crushing plant sites.

Synaphea acutiloba, a Priority 3 species, is an undershrub to 0.6m tall with a spread to 0.5m. Marchant et al. (1987) record the species as endemic to the Perth Region and occurring along and adjacent to the Darling Scarp from Millendon to Gosnells.

This species was observed on several granite slopes within the Pioneer landholding outside the Project Area. These were observed as individuals or in small groups as undershrubs. Within the Project Area it was uncommon, being restricted to lithic complex and Marri Low Woodland vegetation and favouring sheltered locations. S. pinnata was observed in both the West Pit and East Pit sites.

Tetratheca pilifera, a Priority 3 species, is a small slender sub-shrub to 0.2m tall. Marchant et al. (1987) record the species from gravelly soils in the Darling Scarp and Range between Perth, Toodyay and Lancelin.

Two plants of this species were observed in the West Pit site but nowhere else in the Pioneer land holding. Both plants grew in Marri Low Woodland.

6.2.4 Plant Diversity

The hillside where the West Pit is to be located extends several hundred metres to the north. This continuation experiences a north-easterly aspect while the Project Area experiences a south-easterly aspect. This difference produces sufficient differences in habitat to result in considerable changes in the species composition.

Granite hillsides are not uncommon along the Darling Scarp. However, the species present on each may vary considerably. For example, a study of John Forrest National Park (Armstrong and Muir, 1988), located approximately 5km to the south of the project area, found large differences in the species composition between four visually similar granite hillsides.

There were three plant species observed in the Project Area but not recorded during an intensive seven-year survey of John Forrest National Park (Armstrong & Muir, unpublished data). These species were Convolvulus erubescens, Darwinea pinifolia and Pelargonium littorale. This gives some indication of the patchy distribution of some species along the Darling Scarp. Marchant et al. (1987) describe the distribution of these as: C. erubescens occurring on or near the Darling Scarp from Perth to Bunbury, extending through the Murchison, Gascoyne and Goldfields, south west and Eucla divisions; D. pinifolia occurring near Perth, in winter-wet sites on the Darling Scarp, extending north to Badgingarra; P. littorale occurring from the North of the Perth Region (Gingin) south to the extreme southwest coast and along the south coast to Cape Arid.

From the above distributions, all three species could be expected to occur in John Forrest National Park. However, they were not recorded during the seven year study. There is a strong possibility of other species occurring in the Project Area which do not occur in John Forrest National Park or were not observed due to the timing of the survey. In late January and late April, when this survey was undertaken, most annual and other species that die off over summer are not evident. The presence of additional, as yet undetected species would increase the diversity of the area and hence its conservation value.

From the above it can be concluded that, while granite hillside vegetation is unevenly distributed along the Darling Scarp, most of the species identified within the Project Area are known to occur in other areas including John Forrest National Park. Of the seven "Significant Species" identified in the Project Area, all are represented in John Forrest National Park. All but two are also represented on Pioneer property outside the Project Area. The three species observed in the Project Area but not in John Forrest National Park are considered to be well-represented elsewhere.

6.2.5 Weed Species

The following list of weed species were identified in or near the Project Area.

- o Conzia sp.
- o Dittrichia graveolens
- o Gladiolus undulatus
- o Gladiolus caryophyllaceus
- o Homeria sp.
- o Ursinia anthemoides
- o Watsonia ? bulbillifera.

Two of these species were particularly prevalent, Ursinia anthemoides and Watsonia ? bulbillifera. The former was common, but never dominant, throughout most of the Project Area. However, W. ? bulbillifera formed a monoculture along sections of Susannah Brook and other wet areas of the Pioneer land holding. This species is known to be a problem in wet areas of the Darling Scarp where it will invade and exclude the native species.

The results of an extensive survey of John Forest National Park produced a list of 98 weed species, presented in Appendix C (Armstrong & Muir, unpublished data). Many of these species are potential invaders of the Project Area due to the great similarity of habitat types.

6.3 FAUNA

6.3.1 Invertebrates

Very few systematic studies of invertebrate fauna have been undertaken on the Darling Scarp. Bunn and Stoddart (1983) reviewed the biogeographic affinities of the freshwater aquatic fauna of the south-west and concluded that the distinctiveness of the local aquatic fauna results largely from isolation from the original tropical elements and the absence of some habitat types. Edward and Bunn (1983) highlighted the fact that some elements of the aquatic fauna are unnamed and some are rare, ancient and relictual and have great biogeographical significance. Studies by Streamtec (1989) in the Collie region have indicated that increased sediment loads in streams of the Darling Range can have profound detrimental effects on freshwater invertebrates.

No formal invertebrate studies have been undertaken in the Project Area. During the field surveys, several freshwater triclad Turbellarians (flatworms) were noted in the First-Order Streams which dissect the Project Area. Planarian flatworms were common under granite exfoliations in the Lithic Complex as well as many millipedes of the monotypic genus Dinocambala ingens, scorpions (Urodacus novaehollandiae), Assassin Bugs (Reduviidae), three unidentified species of centipede, native snails (Bothryembryon sp.) and several species of ants (Campanotus spp.). Moth caterpillars were frequently seen feeding on the moss fields on granite. Earthworms were common in the revegetated areas and feral bee hives were recorded in Wandoo woodland along the First-Order Stream. In addition, Marron (Cherax tenuimanus) are known to occur in Susannah Brook upstream of the Project Area from the evidence of exoskeletal remains. Other remains were found on the edge of a flooded claypit within the revegetated portion of the Project Area.

In general, few management conclusions can be reached from these studies except that increased sediment loads in streams, too-frequent burning and the presence of dieback disease may alter invertebrate ecosystems.

6.3.2 Vertebrates

A detailed survey of the vertebrate fauna of the Project Area was undertaken by Ninox Wildlife Consulting in July 1990. The data collected were augmented, where appropriate, by the results of a previous survey conducted by Ninox in the same area in 1986. A full report of the findings of these surveys is presented in Appendix D.

6.3.2.1 Species Present

The 1986 and 1990 surveys recorded 46 species of birds, 6 species of mammals and 12 species of amphibians and reptiles as occurring in the Project Area. In addition, examination of the published literature produced a further 39 species of birds, 23 species of mammals and 42 species of amphibians and reptiles which would be expected to occur in the habitats present within the Project Area. This gives a total possible species listing for the Project Area of 85 species of birds, 29 species of mammals and 54 species of amphibians and reptiles.

No rare or endangered vertebrates have been recorded in the Project Area. Of the species which would be expected to occur in the area, four are considered rare or endangered: the Peregrine Falcon (Falco peregrinus), the Chuditch (Dasyurus geoffroii), Dell's Skink (Ctenotus delli) and the Carpet Python (Morelia spilota imbricata). Of these four, the Chuditch and the Carpet Python may be affected by the Pioneer No.2 Quarry. This is likely to be confined to, at most, territorial disruption to a few individuals. The Peregrine Falcon and Dell's Skink are unlikely to be affected as they are not dependent upon the habitat types found in the area to be disturbed.

6.3.2.2 Habitats

The Pioneer landholding is a significant area of relatively undisturbed wildlife habitat in the Perth region, as are all remaining areas of native bushland on the Darling Scarp. Two areas of particular significance were noted within the Project Area. These were the two First-Order Streams which bisect the sites of the proposed quarry pits. Riparian (creekside) habitats are considered important because of their relative rarity, their vulnerability and their generally higher biological productivity, which benefits specialised fauna such as the Yellow-footed Antechinus or Mardo (Antechinus flavipes) and the Southern Brown or Short-nosed Bandicoot (Isoodon obesulus). Another significant habitat identified in the Project Area was the Lithic Complex containing areas of exfoliated granite slab, which is important for the Ornate Rock Dragon (Ctenophorus ornatus) and several species of Geckos.

In conclusion, the proposed development of the Pioneer No.2 quarry will have an impact on fauna habitats which are declining in area in the Perth region. There will, however, be no significant impact on the habitats of any rare or endangered fauna species.

6.4 DIEBACK DISEASE

The northern Jarrah forest is being radically altered by dieback disease caused by the root-rot fungus Phytophthora cinnamomi. This is a soil-borne pathogen that can be carried on the mudguards, wheels and tracks of vehicles, and probably in mud on the feet of animals and humans. Once introduced to a site, the fungus spreads slowly through the soil and among root systems of susceptible species. It may also be washed down-slope with the soil water flow during rainfall. In south-western

Australia, the disease is most devastating to plants on poorly drained sites, particularly in the high rainfall areas and in vegetation dominated by myrtaceous and proteaceous species.

The widespread use of bulldozers, graders and loaders for road making and forestry operations has undoubtedly resulted in extensive artificial spread of the disease in the northern Jarrah forest. Dieback disease alters the forest environment in the following ways:

- it can kill many of the highly susceptible dominant tree species, such as Jarrah and Banksia sp., together with many species in the understorey vegetation;
- it may indirectly degrade other forest values, such as water quality (in salinity sensitive areas), fauna habitats and aesthetics;
- it increases water production in catchments by reducing plant-intercepted precipitation, thus increasing surface run-off and reducing infiltration.

The Department of Conservation and Land Management (CALM) is currently engaged in programmes of surveying and mapping the incidence and spread of dieback disease in State Forests. The Department is also studying the behaviour of the disease and potential methods for controlling its spread. Research carried out during the last decade indicates that fire intensity may have direct effects on dieback spread (Underwood and Christensen, 1981). Low-intensity fires promote regeneration of species of Proteaceae which are particularly sensitive to attack by the fungus, while high-intensity fires favour leguminous plants, some of which tend to be resistant or even, in a few cases, antagonistic to the pathogen.

Recent research has demonstrated variations in disease impact over time. The degree of impact depends upon landscape position and vegetation type (Havel 1975a, 1979), drainage characteristics and host susceptibility. Low impact sites are those where only some susceptible plants in the understorey are killed by dieback disease. Conversely, high impact sites are those where most susceptible understorey plants, and over half the overstorey (e.g. Jarrah) are either dead or dying from the disease. The Project Area is susceptible to the disease and any activity likely to cause introduction or spread of the disease is of concern.

No Phytophthora cinnamomi dieback disease was visually recorded within the Project Area. This is probably due to the general lack of disturbance to the area or the effects of the recent burning.

The risk of introduction of dieback to the woodlands and heaths is, however, high. Dieback introduction is most likely to occur as a result of accidental spread by vehicles using tracks which run along the contour. The disease will spread downslope from such a source.

While soil erosion should be controlled by using access tracks which run along the contour, dieback disease can be partly controlled by using tracks which run across the contour. These contradictions in management requirements can be partly ameliorated by careful track selection and design, and by appropriate management. Management measures for the dieback hazard are detailed in Section 8.5.2.

6.5 FIRE

Early records in south-western Australia indicate that fires were common in the northern jarrah forest before European settlement in 1829. They occurred naturally as a result of lightning strikes. Fire was also deliberately used by Aborigines for hunting, cooking and to improve access.

According to Hallam (1975), these fires were probably periodic and covered large areas. It is questionable whether they reached the frequency which followed forest utilisation and land development.

Advances in the fire suppression capacity of CALM and Local Government Authorities have realised a marked reduction in the severity of wildfires and incidence of high intensity fires. These include aerial detection systems and efficient fire fighting equipment.

The primary factors likely to influence flora and fauna conservation values are fire intensity, area of burn, the length of fire-free intervals, season of burn, and past frequency of burning, e.g. over the last 50 years.

Ecological responses to fire are extremely complex and interrelated. For almost every positive ecological response from any fire regime an opposite negative response can be demonstrated, often in a completely different part of the biota. For example, an intense fire may burn and cause hollow butts in some trees, thus damaging their wood production potential and degrading appearance and vigour. At the same time, however, burnt out trees provide useful breeding hollows for bats and reptiles.

Although no particular attempt has been made to define in detail the fire history of the Project Area, examination of the aerial photograph (Figure 1) indicates several old fire patterns. Fires are known to have occurred within the Project Area during the last few years and their impacts remain obvious. It is apparent that fire has occurred fairly regularly and no doubt will continue to occur. Management must therefore aim to balance the needs of conservation of the land not affected by the quarry with the need to protect life and property. This can best be achieved by periodic controlled burning under carefully pre-determined weather conditions and time of year, and careful fire prevention at other times.

Description of the Proposal

7.0 Description of Proposal

7.0 DESCRIPTION OF THE PROPOSAL

7.1 LOCATION OF STRUCTURES

7.1.1 Existing Structures

There are no man-made structures in the Pioneer No.2 area at present, apart from two meteorological monitoring stations. One of these stations is shown in Plate 5b.

7.1.2 Planned Structures

The approximate layout of the Pioneer No.2 workings is shown in Figure 11. This figure shows the proposed locations of the quarry pit, primary and secondary crusher, conveyor, tertiary crusher/infrastructure area and asphalt plant. The layout shown is of necessity general, as planning for Pioneer No.2 is still in its early stages and the details of many elements have yet to be finalised. However, the major features will be confined within the boundaries shown in Figure 11.

The position of the asphalt plant has been selected so as to create the lowest possible visibility while allowing the stack gases to exit into the air at the highest possible elevation, to assist in the elimination of odours from the plant.

All workshops, offices, stockpiles and loading facilities will be located in the tertiary crusher/infrastructure area. These elements will be sited and designed to minimise visibility.

The position of the sedimentation basin in the valley below the quarry is conceptual and will be finalised after detailed hydrological and engineering studies aimed at determining the optimum design and location of the basin.

Views of the proposed locations of the quarry pits, crushing plant and infrastructure sites are shown in Plates 1 to 5.

7.2 QUARRYING

A general overview of the quarry operations is provided in Figure 12.

7.2.1 Handling of Overburden

One of the points in favour of the proposed Pioneer No.2 Quarry is that it is located in an area with very little overburden. Preliminary drilling has indicated overburden depths of between zero and 6m, necessitating the removal of about 400,000 cubic metres over a 25-year period. Pioneer recognise the value of the topsoil and overburden on the proposed site. Prior to quarrying, topsoil and overburden will be separately stripped. Overburden will initially be used to construct and extend screening and drainage bunds. Topsoil will be used in vegetating these bunds.

In later years, overburden and topsoil will be stockpiled and grassed to be reclaimed for future use in rehabilitation works.

7.2.2 Drilling and Blasting Techniques

The drilling and blasting undertaken to establish the quarry face and to extract rock at Pioneer No.2 will be similar to techniques used at Pioneer No.1.

A percussion drill powered by a diesel-driven compressor will be used to prepare 100mm diameter holes up to 15m deep in a predetermined pattern, which will take into consideration the bench profile, rock characteristics, and the amount and size of broken rock required. The holes will be packed with explosives mixed on site and will be fired with millisecond delay electric detonators. The charges will be fired in a planned sequence to ensure that, using the minimum amount of explosives, the required amount of rock is broken to a size suitable for loading into the primary crusher. Such sequential blasting minimises noise, vibration, air blast and flyrock.

Blasting will be undertaken approximately six to seven times per month, which is a similar frequency to that which occurs at the Pioneer No.1 quarry.

The drilling will be undertaken with modern drilling machinery equipped with efficient mufflers and dust extraction systems. Drilling and blasting will only occur during daylight hours.

It is inevitable that some rocks will be too large to be accepted by the primary crusher. Such rocks will be stored on the quarry bench until there are sufficient to warrant bringing in a mechanical rock breaking machine. This will avoid the need for secondary blasting or "popping".

7.2.3 Haulage

The quarried rock will be loaded by front-end loader and hauled to the primary crusher in two 50 tonne capacity off-highway dump trucks. The internal haul roads will be watered in order to minimise dust generation. Any dust resulting from dumping into the crusher will be controlled by water sprays over the receiving hopper or chute.

All vehicles will be equipped with efficient mufflers, and gradients on the haul roads will be as low as is practicable.

7.2.4 Quarrying Schedule

Quarrying activities at Pioneer No.2 will follow a similar schedule to those at Pioneer No.1, and will generally be a daylight operation.

7.3 CRUSHING

7.3.1 Crushing Method

Quarried rock will be crushed in a crushing and screening plant. All screens and crushers will be fitted with dust suppression equipment, and conveyors carrying any fine-grained material will have side wind guards or covers to minimise dust.

Material below the output size for the primary jaw crusher will be screened off from the feeder mechanism to bypass this plant. This material will be screened and any residual soil and weathered material will drop out into a scalps stockpile. The scalps would not normally meet specifications for concrete aggregate, asphalt paving material or other similar uses, and will be disposed of locally as road base materials or stored for future rehabilitation purposes if necessary.

Output from the primary crusher will be stored in a large surge stockpile. The capacity of the primary crusher and the stockpile area will be sized to enable this system to process the daily output from the quarry during daylight hours. Use of a surge stockpile of broken rock has advantages for production, such as enabling a uniform feed to the secondary and tertiary crushers and the ability to continue operation if breakdowns occur in the quarry operations or primary crusher.

Stone from the surge stockpile will be placed on a conveyor, and fed over screens to a cone crusher. Screen undersize and crusher product will be screened again and oversize passed back to the cone crusher. Screen fines and the smallest screened stone will pass separately to final sets of screens for separation into different products. Screen oversize and coarse screened material will pass through separate crushers and back to the product screens.

7.3.2 Crushing Schedule

The crushing schedule will be similar to that of the present operations at Pioneer No.1.

7.4 DESPATCH

7.4.1 Stockpiling and Truck Loading

Product from the final screens will be stored in stockpiles. A front-end loader will take product from the stockpiles and load it directly into trucks. Water sprays installed over the transfer points will prevent most of the dust and noise that arises from loading operations. Dust suppression methods are detailed in Section 8.7.

7.4.2 Haulage Routes

Trucks operating now from Pioneer No.1 traverse Neuman Road for about 300 metres before entering Toodyay Road. At Pioneer No.2 there will be two driveways directly connecting Pioneer property with Toodyay Road. These driveways, located about 2km east of Neuman Road, will be separate "in" and "out" points resulting in a one-way traffic system. The two driveways will be separated by about 500 metres.

There will be no haulage traffic using Neuman Road.

7.5 ASPHALT PRODUCTION

7.5.1 Raw Materials

Raw materials for the asphalt process are aggregate, bitumen and hydrated lime. The aggregate is mined, crushed to less than 20mm diameter and stockpiled on site prior

to utilisation. The majority of aggregate comprises granite stone with some asphalt mixes requiring a small proportion of diorite and gravel.

Bitumen is a residue from the distillation of crude oil and is stored in two 50 tonne kettles. Hydrated lime is occasionally used to improve the affinity between the aggregate and bitumen to produce a stiffer mix. It is stored in powder form in a vertical steel silo.

7.5.2 Production Process

Aggregate retrieved from the on-site stockpile is dumped into cold feed bins which are computer controlled to proportion the correct weight of various sized aggregate particles onto a cold feed conveyor belt. The conveyor belt ends at the dry drum mixer where the aggregate is deposited. A gas burner produces hot air which is drawn through the drum to remove any moisture from the aggregate and increase its temperature to between 140-165^{o}C. Halfway through the drum, hot bitumen is added via sprays and mixing occurs as the asphalt passes down the drum where it is eventually discharged onto a hot elevator and deposited into one of four hot storage bins. A general overview of the asphalt production process is shown in Figure 13.

7.5.3 Disposal of Wastes

Liquid wastes derived from waste drains in the workshops and washdown areas will be directed to an oil/water separator. The collected oil and grease will be placed and sealed in drums and disposed of in an approved manner, either by recycling or by disposal at a Council-approved liquid waste disposal site.

The dust-laden water derived from the scrubber system in the exhaust stack will be piped into one of three dust sedimentation ponds, each having a capacity of approximately 50,000L, located on the site. Mud from the settling ponds will be removed and disposed of in a solid waste disposal site located on Pioneer property west of the proposed West Pit site, as shown in Figure 2. This site is situated on heavy, impermeable clay soils and is bunded to prevent erosion and leaching.

Water from the sedimentation ponds will be recycled through the scrubber system.

7.5.4 Control of Odours

The two main sources of odours associated with the asphalt plant are the bitumen kettles and the dryer drum. The bitumen kettles will be fitted with hydrocarbon filters to absorb any gases released during normal ventilation and during expulsion and refilling of the kettle. An elevator extraction pipe will remove the gases from the asphalt as it passes from the drum mixer to the hot storage bins. This gas as well as the gas released during the mixing phase itself will be directed through the wet scrubbing system in the exhaust stack. This system is very effective in trapping unburnt hydrocarbons.

Investigations at Pioneer No.1 over the past three years have shown that odours emanating from the asphalt plant are generally detectable only within a short radius. Pioneer do not anticipate any problems with odours because the proposed location of the new plant is about 2.5km from the nearest residents. To ensure the control of odours Pioneer has installed equipment at the Pioneer No.2 site which continually monitors wind direction and speed. Data collected from this monitoring will help to increase Pioneer's understanding of wind patterns and odour dispersal on the site. Pioneer is also committed to investigating, both Australia-wide and overseas, any new developments in odour control technology.

7.5.5 Operating Hours

The asphalt plant will normally operate from Monday to Friday between the hours of 6am and 5pm. In some special circumstances, such as when the asphalt is being transported to distant markets in country towns, or when asphalt must be supplied for night time roadworks, the plant may be required to start early or to operate at night. Due to the nature of asphalt, it is not possible to stockpile the finished product for more than a few hours.

7.6 INFRASTRUCTURE

7.6.1 Electricity

Electrical power is supplied to Pioneer No.1 from the SECWA grid. A similar supply will be required at the proposed Pioneer No.2 quarry. Arrangements will be made with SECWA at an appropriate time to connect power supplies to the new site and to terminate supplies to Pioneer No.1.

A 132KV SECWA main crosses the Pioneer landholding from east to west, as shown on Figure 2. This line will not be affected by the proposed relocation of quarrying.

7.6.2 Water Supplies

7.6.2.1 Process Water

Pioneer currently obtains most of its process and dust suppression water for Pioneer No.1 from a storage basin in the quarry pit. This source is occasionally augmented by scheme water during prolonged dry periods.

Pioneer proposes to continue to use the storage basin at Pioneer No.1 for water supply to Pioneer No.2, and to supplement this supply by enlarging an existing reservoir located on Pioneer land to the south-west of the proposed quarry. This reservoir is shown in Figure 6. Other supplies will come from water recycled from the sedimentation basin and from the Pioneer No.2 quarry pit itself. No water supplies will be drawn from Susannah Brook.

Pioneer estimates that its process water consumption at Pioneer No.2 will be similar to usage at Pioneer No.1. On-site water storage has been sufficient to meet process water needs at Pioneer No.1 quarry during 1988 and 1989, and Pioneer expects this situation to continue.

7.6.2.2 Potable Water

Potable water for the proposed quarry will be drawn from Water Authority supplies. This is expected to be similar to the amount currently consumed at Pioneer No.1.

Arrangements will be made with the Water Authority at the appropriate time to terminate water supplies to Pioneer No.1 and establish supplies to Pioneer No.2.

7.6.3 Gas Supply

Natural gas supplied by the State Energy Commission of WA (SECWA) is used for process heating in the asphalt plant at Pioneer No.1. Arrangements will be made with SECWA at an appropriate time to terminate this supply, and to connect supplies at Pioneer No.2.

7.6.4 Telephone Lines

Arrangements will be made with Telecom Australia at the appropriate time to transfer telephone services from Pioneer No.1 to Pioneer No.2.

7.6.5 Roads

Relocation of the Pioneer quarry will bring benefits to the local area in terms of reduction of traffic noise and traffic density.

Current access to Pioneer No.1 is from Toodyay Road via Neuman Road. Access to Pioneer No.2 will be directly from Toodyay road via dual private driveways which will be constructed to Main Roads Department specifications for heavy vehicles access and designed so as to minimise noise from gear-changing, acceleration and bumps. The driveways will be located in an area where there are few nearby dwellings. There will be no alternative access to the quarry.

7.6.6 Sewerage

Sewage disposal will be by means of septic tanks, as is the case at Pioneer No.1. The nature of the soils in the area, and the distance from any water resources, will ensure that there are no adverse impacts resulting from this practice.

7.6.7 Drainage

Drainage will be an integral part of the design of Pioneer No.2, and will be designed to achieve the following aims:

- Prevent flooding of the quarry pits, plant and infrastructure areas;
- Minimise erosion of the quarry surrounds;
- Prevent the release of sediment-laden waters to Susannah Brook;
- Prevent the contamination of surface waters with oils, chemicals or other substances; and
- Maximise the re-use of runoff water for process water supply.

A detailed description of drainage control measures to be employed in the quarry pits is given in Section 8.2. These measures are illustrated in Figure 6.

All surface runoff from the plant and infrastructure sites will be directed by means of bunds and drains to storage or sedimentation basins and, where practicable, re-used for processing or dust suppression.

Runoff from areas likely to give rise to oil contamination, such as equipment workshops, will be directed to drainage via sumps and oil traps where appropriate, to allow removal of oils. These oil traps will be periodically cleaned out and the recovered oils disposed of at a Council-approved liquid waste disposal site or sent for recycling.

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Environmental Impacts and Management

8.0 ENVIRONMENTAL IMPACTS AND MANAGEMENT

The major potential environmental impacts of the proposed quarry have been identified as landscape restructuring, water quality effects on Susannah Brook, damage to vegetation, and air emissions including noise, dust and odours. Other potential impacts include loss of fauna habitat, visual impact, traffic effects on Toodyay Road, and effects on adjoining land uses.

These potential impacts and the proposed management measures are discussed in this section.

8.1 LANDSCAPE RESTRUCTURING

8.1.1 Impact

The landscape in the quarry area will be altered by the development over time of the open quarry pits and by the construction of haul roads, crushers, stockpiles and associated infrastructure. This restructuring will be permanent in the case of the quarry pits but temporary (albeit long-term) for the other elements.

The landscape restructuring has consequent potential impacts in terms of changes to drainage patterns, erosion, loss of vegetation and fauna habitat and visual impact. These potential impacts are discussed in detail later in this Section.

8.1.2 Management

Changes to the landscape are unavoidable in a quarrying operation. However, improved quarrying techniques will result in the area of disturbance at Pioneer No.2 being significantly less than at Pioneer No.1 (5% of total landholding over 40 years for Pioneer No.2, compared to 7% over 30 years for Pioneer No.1).

An ongoing rehabilitation programme will operate at Pioneer No.2 as detailed in Section 8.10 to ensure that, where possible, the landscape is restored to a near-natural condition following quarrying. This, coupled with the planned rehabilitation of Pioneer No.1, will mean that the total area of land disturbed by quarrying on Pioneer's property at Herne Hill will actually decrease.

Management measures for erosion, vegetation, fauna habitat, visual and other impacts are detailed in the following sections.

8.2 DRAINAGE AND WATER QUALITY

8.2.1 Impact

The main concern with regard to drainage is the maintenance of water quality in Susannah Brook, and the minimisation of sediment output from the quarry. As Susannah Brook flows into the Swan River, any adverse effects on Susannah Brook have the potential to impair the water quality in the Swan River.

The main potential water quality impact of the quarry on Susannah Brook is the potential for transport of sediment in runoff into the brook. A minor issue is the potential for contamination of the brook by hydrocarbons (oils etc) from workshop areas or the asphalt plant.

8.2.2 Management

The proposed drainage control measures are schematically represented in Figure 6.

First-Order Streams in Quarry

As described previously (Section 4.6), the main drainage of the Project Area is by means of two first-order streams which drain the West and East Pit areas. These streams are ephemeral and flow briefly after heavy rain in their catchments.

The western stream has a catchment area of approximately 36ha which includes all 16.5ha of the proposed West Pit. The catchment area of the eastern stream is approximately 19ha, including approximately 7ha of the proposed East Pit's total area of 10.5ha.

These streams will form an integral part of the runoff control strategy. Flow from the quarry areas via the streams will be diverted into a sedimentation basin to be constructed downstream of the quarry pits. Runoff from any disturbed areas outside the quarry pits will be diverted into the sedimentation basin by means of bunds. Runoff from undisturbed areas will be diverted by bunds, where possible, around the pits.

Susannah Brook

There will be no physical interference with Susannah Brook as a result of the operations. All runoff from the quarry pit areas, apart from that which is recycled for process use, will eventually enter Susannah Brook via the sedimentation basin shown in Figure 6. Thus the proposed quarry operation will have no significant effect on the flow characteristics of Susannah Brook.

Water Quality

The great difference in catchment size between Susannah Brook and the Pioneer No.2 Project Area will mean that water draining from the Project Area will be greatly diluted upon entering Susannah Brook. Nevertheless, Pioneer intends to ensure that water leaving the quarry site will be treated to a quality which is comparable to that of water draining from undisturbed areas.

Measures for minimising sediment runoff from the quarry are described in detail in Section 8.3. The result of these measures will be that water entering the brook from the quarry will generally contain a similar amount of sediment to water already in the brook. Measures for minimising the potential for hydrocarbon contamination of Susannah Brook are described in Section 8.3. No chemicals or refuse will be allowed to enter the brook.

In summary, the proposed quarry development is expected to have no significant deleterious effects on the water quality of Susannah Brook.

Effects on Groundwater

There is no shallow groundwater in the Project Area except for small amounts of seepage around granite outcrops. The potential for adverse effects on groundwater is therefore considered to be negligible. The groundwater resources of the Swan Coastal Plain west of the scarp will not be affected in any way by the quarry.

8.3 EROSION AND SEDIMENTATION

8.3.1 Impact

Any bare soil areas or areas disturbed by machinery during the construction and operation of Pioneer No.2 will be susceptible to erosion. This erosion produces management problems associated with erosion gullies and also an increase in sediment loads in runoff from the site.

8.3.2 Management

Maintenance of Soil Stability

In areas of steep slope and high runoff coefficient such as the proposed quarry site, the potential for soil erosion depends heavily on the stability of the soil. For this reason, Pioneer are committed to preserving the stability of the soil as much as possible. Strategies for achieving this will include:

- Minimising the area of disturbance of the natural vegetation cover (by careful surveying and close supervision of personnel employed in development activities);
- Re-establishing vegetation on disturbed areas as soon as possible;
- In those areas which must remain bare, such as the quarry pit, roads and plant sites, sealing of the ground surface with asphalt or similar, and trapping of runoff by means of bunds and/or sediment ponds.

Prevention of Run-on

Because the quarry and processing/infrastructure areas extend into the upper parts of the catchments of the First-order streams which drain the site, run-on is not expected to be a major problem. Nevertheless, particularly in the early developmental stages, upslope bunding of the quarry pits and other denuded areas will assist in reducing the amount of soil erosion in those areas and will help minimise the volume of sedimentation basin required. This bunding will be carried out wherever it is seen to be beneficial.

Treatment of Runoff

On a steep site where the soil has a high run-off coefficient, drainage control is of paramount importance to ensure that excessively silt-laden water does not contaminate off-site areas.

A conservative approach to conceptual design has been adopted to ensure that all silt-laden run-off from the quarry operations can be stored and that suspended particles have sufficient time for settlement.

The design of the sedimentation basin (Figure 6) has been based on the 1-in-10 year storm. A 24-hour retention time has been allowed for, necessitating the ability to store 22,000m^3 of storm run-off. During larger storms with a recurrence interval of

greater than 10 years, the amount of silt-laden water running off other parts of the Susannah Brook catchment will produce such a high dilution factor that any sediment entering the brook from the quarry site will not be significant.

It is proposed to construct an adequately designed and protected bund wall downhill of the quarrying operations to channel storm run-off into a sedimentation basin to be located above the 50 metre buffer zone around Susannah Brook downstream (north-west) of the quarry pits. This basin, capable of holding 22,000m^3 for 24 hours, will be designed to allow complete draining for sediment removal and will be cleaned when its storage capacity has been reduced by 30-40 percent.

The Tertiary Crusher and Despatch area will eventually be entirely asphalt paved. The area will be bunded and graded so that run-off can be directed by pipelines and silt traps to the south-west and north-east. The use of existing storage dams as sedimentation traps will require upgrading of each facility to ensure inflow does not cause scouring and that an adequate emergency spillway exists. Regular inspections of silt build-up and sediment removal will be undertaken.

8.4 VEGETATION

8.4.1 Impacts

The construction of the quarry pits and plant will require the removal of up to 40ha of natural and rehabilitated vegetation over 100 years.

8.4.2 Management

Vegetation damage will be confined to the smallest possible area, and will be partly compensated for by the rehabilitation of the Pioneer No.1 quarry, which will give emphasis to the re-establishment of restricted plant species. Seed of the geographically-restricted plants Hakea myrtoides, Petrophile biloba, Beaufortia purpurea, Synaphea acutiloba, Thomasia glutinosa and Calothamnus rupestris will be collected for propagation from areas to be disturbed, and seedlings planted out in appropriate locations on-site.

Fire will be strictly controlled in the quarry area and surrounding land.

8.5 FLORA

8.5.1 Impacts

For the purposes of impact assessment the area of each potential quarry pit and the tertiary crusher site were divided into one of three categories: Upland lateritic plateau, Granitic slopes and Diorite dykes. The area of each of these geomorphological types as a percentage of the total area was calculated from stereo aerial photographs using a planimeter. Results of these calculations are shown below in Table 2.

TABLE 2

PERCENTAGE OF GEOMORPHOLOGICAL TYPES AT PROPOSED QUARRY PIT SITES AND THE TERTIARY CRUSHER

SITE	UPLAND LATERITIC PLATEAU (percentage)	GRANITE SLOPES (percentage)	DIORITE DYKES (percentage)
West Pit	20	78	2
East Pit	0	98	2
Tertiary Crusher	13	87	*
Total Land Holding	28	68	4.4

*None observed.

Most of the significant and geographically restricted species in the Darling Scarp occur primarily on granite slopes. Therefore, the site for the East Pit has a potentially greater impact than that of the West Pit and both sites contain a greater percentage of granite slopes than does the total Pioneer land holding. The tertiary crusher site occurs largely in a rehabilitation area and thus landform types at that site do not adequately reflect vegetation associations.

The development of Pioneer No.2 will involve the destruction of some populations of geographically restricted and Priority plant species. However, no gazetted flora are known to occur at the site and the vegetation populations are widespread throughout the surrounding lands (see Section 6.1; Appendix A).

A further concern relates to the possibility of introducing exotic weed species or plant diseases such as Dieback (caused by the fungus Phytophthora cinnamomi) into the area.

8.5.2 Management

There is currently no known occurrence of dieback disease on the Pioneer landholding despite 30 years of occupation by Pioneer. Although a number of weed species are already present in or near the Project Area (see Section 6.2.5), great care will be exercised to reduce the potential of introducing additional weed species into the area.

The risk of introduction of both weed species and dieback disease will be minimised by the following measures:

- all machinery and vehicles entering the site from possibly contaminated areas will be thoroughly cleaned of soil before entry;
- all fill brought into the site will be obtained from uncontaminated sources;
- vegetation will be monitored to detect and treat any local outbreaks of dieback disease; and
- vehicular access to other parts of the Pioneer landholding will be discouraged.

Pioneer is currently propagating and planting rare species during the revegetation programme for Pioneer No.1 and will continue this practice during the operation of Pioneer No.2.

8.6 FAUNA

8.6.1 Impacts

Loss of habitat is known to have resulted in the widespread decline of mammal species throughout the south-west. European settlement and the fragmentation of natural vegetation has adversely affected the passerines (song birds), most of which have declined dramatically in the Darling Scarp as they are heavily dependent on riparian (creekside) vegetation.

The proposed quarry will result in a further eventual loss of 40ha of habitat over 100 years, some of which is riparian or contains exfoliated granite slab. This will be partly balanced by the rehabilitation of the Pioneer No.1 site.

There are four species of vertebrate fauna which are classified as "rare or otherwise in need of special protection" and which may be present in the Project Area. These are the Peregrine Falcon (Falco peregrinus), the Western Native Cat or Chuditch (Dasyuris geoffroii), the Dell's Skink (Ctenotus delli) and the Carpet Python (Morelia spilota imbricata). Of these four, only the Chuditch and the Carpet Python are likely to be affected in any way by the Pioneer No.2 Quarry, and this is likely to be confined to, at most, territorial disruption to a few individuals. The Peregrine Falcon and Dell's Skink are unlikely to be affected as they are not dependent upon the habitat types found in the area to be disturbed.

Adverse impacts have been noted when water quality or quantity decreases. Thus, any impacts on Susannah Brook would have implications for invertebrates and fish.

Fauna which is slow-moving (e.g. some invertebrates) or territorial (e.g. reptiles) will be destroyed should the proposed quarry be established. Other mobile but territorial fauna such as birds and some mammals may also be affected by the project as suitable habitat declines on the Darling Scarp. Most fauna, however, is both common and mobile and will probably migrate when disturbance commences.

8.6.2 Management

Pioneer recognises the decline in available habitat within the Darling Scarp and is keen to preserve the extensive buffer zone around the quarry in as pristine condition as possible. This includes limiting activity to the proposed quarry locations described in this report and by preventing unauthorised access to that part of the buffer zone which is owned by Pioneer.

The measures employed for protection of vegetation will also serve to minimise the damage to fauna habitats in the Project Area.

8.7 DUST

8.7.1 Impact

The existing and proposed operations consist of drilling and blasting of rock, loading and haulage to crushing facilities, screening and reduction, transport to stockpiles, loading and transport off-site of the final product. All these phases of the operation produce dust.

At sufficiently high concentrations, dust can reduce the amenity of an area for living, farming or other activities. The specific effects contributing to the degradation of amenity include a reduction in visibility, damage to or soiling of materials and, at very high concentrations, damage to vegetation or interference with normal agricultural activities.

While health guidelines for dust are relatively clearly defined and recognised, the criteria for assessing the nuisance value of dust are much less clear. The nuisance value depends on many factors including dust concentration in air, dust fallout rates, the colour of the dust, the size of the particles, the average rate of dust fallout, the period of exposure, the frequency of high dust fallout episodes and the sensitivity of the receptor.

There may have been short-term episodes of strong easterly-sector winds during blasting operations at Pioneer No.1 when dust deposition could cause annoyance at residences within 1km of the blast site. The proposed Pioneer No.2 quarry is nearly twice as far from the nearest residences as Pioneer No.1 and, given the rapid fall-off in dust deposition with distance, this is expected to greatly reduce the dust impact of the quarry operations.

The nearest residence to the Pioneer No.2 quarry area is approximately 1.75km to the east of the tertiary crusher and stockpile area. The intervening area comprises mostly scattered timber and scrub. The nearest cultivated acreage is approximately 2.5km to the west. There are no residences within at least 2.5km to the north, west or south. This compares favourably with Pioneer No.1, where the nearest residences are less than 1km to the south-west of the crushing plant.

8.7.2 Management

Pioneer recognises its responsibility to control the level of dust from its operations and to this end will continue to employ a number of control measures including watering of roads and aggregate stockpiles, wetting of material during transfer operations in the processing plant, spraying of loads leaving the site and the restriction of blasting, where possible, to periods when prevailing winds are away from residential areas. All these measures will afford a percentage control over fugitive dust.

In addition, the Pioneer No.2 operations will emit significantly less dust than Pioneer No.1, due to:

- o use of an enclosed conveyor for transporting rock from the secondary to the tertiary crusher;
- o enclosure of all crushing and screening plants;
- o bitumenisation, where practical, of all roads on the site; and
- o improvements in the design of stockpiles and despatch facilities.

8.7.2.1 Quarrying

The major source of dust in the quarrying operation is blasting.

All blasting operations will create dust. The amount of dust generated from a blast depends on several factors, the main ones being the type of rock and the amount of explosive used in breaking the ground.

The proponent will endeavour to minimise the impact of dust from blasting by:

- o using good blasting practice – i.e. only using sufficient explosive to do the work required; and
- o whenever possible, restricting blasting to days when the prevailing wind is in a favourable direction.

Both of these measures should reduce the impact of dust; firstly by minimising the amount of dust created, and secondly by allowing the dust to disperse away from residences.

8.7.2.2 Crushing Plant

The crushing and screening plant to be installed at the new quarry will incorporate state-of-the-art technology to reduce dust emissions. Specific measures will include:

- o mechanical filtration of exhausted air from the plant;
- o provision of water sprays within the plant;
- o enclosure of conveyor belts; and
- o continuous monitoring of dust emissions with immediate investigation in the event of a serious malfunction in any of the dust suppression equipment.

8.7.2.3 Stockpiles and Loading Facility

Stockpiles will be regularly watered by automatic, tower-mounted sprinklers. This system has been in operation at the present quarry for some time and has been shown to be very effective in controlling dust from this source. Truck loads of product will be damped by water sprays prior to leaving the site, to minimise dust generation during transport.

8.7.2.4 Roads

All unsealed roads and other bare areas will be watered by specially-equipped water trucks as often as is necessary to prevent dust generation. The compact nature of the proposed layout at Pioneer No.2 will permit all major truck movement areas to be sealed, with the only unsealed operational areas being the quarry benches and floor which will be watered as necessary. Vehicle speeds within the quarry will be restricted to further reduce dust generation.

8.7.2.5 Other Areas

It is intended to keep earthworks and stripping of overburden to the minimum necessary to achieve immediate operational requirements. Overburden stripping from the quarry pit area will be carried out progressively throughout the life of the workings. The retention of existing vegetation for as long as possible, and the ongoing revegetation of bare areas no longer required for operations, will minimise the generation of fugitive dust.

8.7.2.6 Occupational Health Considerations

Occupational health matters relating to dust exposure come under the jurisdiction of the Ventilation Board of the Department of Mines.

Pioneer has a strong commitment to minimising the exposure of workers to dust hazards, and all machinery and plant at the new quarry will incorporate the latest in occupational dust protection measures.

Pioneer will monitor occupational dust and submit the results to the Ventilation Board of the Department of Mines.

8.8 NOISE

8.8.1 Noise Modelling

Noise modelling studies were carried out by an independent consultant (Herring Storer Acoustics, 1990) as part of the preparation of this PER. The report of this study is included in Appendix H. The study consisted of two main parts. The first part involved taking measurements of noise levels from the Pioneer No.1 operations, computer modelling of noise levels in the surrounding area using these readings, and cross-checking the model results against actual measurements of noise level at two locations west of the quarry (Appendix H, Figure 1).

The second part involved transferring the noise emission data from Pioneer No.1 to the Pioneer No.2 site, and modelling noise levels in the area surrounding that site. Weather conditions at the time of measurement, and those used in modelling, were fine with a temperature of 25°C, relative humidity of 29% and a strong north-easterly breeze of 7m/s (25km/h). Both measurement locations shown in Appendix H, Figure 1 are directly downwind of Pioneer No.1 under these conditions.

Results

The first part of the modelling study suggested that the two measurement locations would experience noise levels from processing operations at Pioneer No.1 of approximately 30-35 dB(A) and 40-45 dB(A). The actual noise levels recorded at these sites were 40 db(A) and 49 dB(A), respectively.

In the second part of the modelling study based on Pioneer No.2, the noise levels predicted at these same locations were both below 30 dB(A) (below ambient levels). These results are fully reported in Appendix H and shown in Figure 14.

In addition to the above study, data on blasting noise levels gathered over several years of monitoring near Pioneer No.1 were used to predict blast noise levels in areas surrounding the proposed Pioneer No.2 quarry.

8.8.2 Impacts

To assist in the assessment of noise impacts, Table 3 has been provided to illustrate average noise levels for selected scenarios.

TABLE 3

CLASSIFICATION OF ACOUSTIC ENVIRONMENTS

SOUND LEVEL (dB)	EXAMPLE	SUBJECTIVE EVALUATION
140	Near jet engine	deafening
130	Threshold of pain	deafening
100	Loud auto horn	very loud
90	Noisy urban street	very loud
85	Noisy factory	very loud
80	School cafeteria with untreated surfaces	loud
70	Stenographic room	loud
60	Near highway auto traffic	moderate
50	Average office	moderate
40	Soft radio waves in an apartment	moderate
30	Average residence without stereo playing	faint
20	Average whisper	very faint
10	Rustle of leaves in wind	very faint

Source: Department of Employment and Industrial Relations (1983).

8.8.2.1 Processing Noise

Permissible noise levels are regulated by the Environmental Protection Act 1986 and Regulations. Under the regulations the maximum permitted continuous outdoor noise levels in residential areas (Category A2) such as that along Campersic Road are:

0700 - 1900 hrs	45 dB(A)
1900 - 2200 hrs	40 dB(A)
2200 - 0700 hrs	35 dB(A)

Proposed changes to the regulations cite the following as the maximum acceptable noise levels:

0700 - 1900 hrs Mon to Sat	50 dB(A)
2200 - 0700 hrs	40 dB(A)
Any other time	45 db(A)

Under either the existing or proposed regulations, it can be seen from Appendix H, Figure 2 that noise levels in residential areas near Campersic Road resulting from Pioneer No.1 are likely to be at or near maximum permissible levels for much of the time. By contrast, the noise levels in these areas emanating from Pioneer No.2 are predicted to be below the lowest night-time noise criterion at all times (Figure 14).

This clearly shows that the proposed relocation of quarrying will result in considerably reduced noise impacts on the main residential areas in Herne Hill, particularly that along Campersic Road. Further substantial reductions in processing noise levels will be achieved by specific design improvements at the Pioneer No.2 quarry, as described in Section 8.8.3.

It can be seen that reduction of processing noise levels will be a major benefit of the proposed relocation.

8.8.2.2 Blasting Noise

Blasting noise levels are regulated in Western Australia by the Environmental Protection Authority. The standard adopted by the EPA for licensing purposes of prescribed premises states that 90% of blasts should be at, or below 115dB Peak (Lin), while up to 10% of blasts may be permitted up to a maximum level of 120dB Peak (Lin).

Eighty-three blasts at Pioneer No.1 have been measured since 12 August 1986. The measurements have been made at locations in Campersic Road and Padbury Avenue, Herne Hill. Seven blasts have exceeded the 115dB Peak (Lin) level which means that blasting operations at Pioneer No.1 are within the required levels.

Due to the remote location of Pioneer No.2 and the muffling effects of the intervening topography, noise impacts from blasting at the Pioneer No.2 quarry are expected to be significantly less than those from Pioneer No.1. Airblast levels at the distance of the nearest residences are expected to be well below the draft standard.

The highest noise levels from blasting will occur during the early developmental stages of Pioneer No.2 when blasting must take place at or near the ground surface in weathered material. As the quarry pit develops, blasting will take place on developed benches and in unweathered rock. This will result in further substantial reductions in blast noise levels.

8.8.3 Management

Blasting Techniques

Blasting operations will be conducted under the jurisdiction of the Mines Regulation Act. All blasting at the quarry will be recorded on-site in a blasting report book. This report book will be inspected periodically by the Department of Mines to review blasting practices. The report book will outline the time of the blast, blast design, number of holes fired, amounts of explosive used, and other relevant information.

Over the years, Pioneer has introduced a number of changes to its blasting techniques at Pioneer No.1. This has been done to improve efficiency and to reduce environmental impact.

In 1982, secondary blasting ceased at the quarry. Mechanical methods were introduced to break down oversized rocks.

In order to improve blast efficiency and reduce environmental effects, new explosive products have been trialled as they have become available from manufacturers.

Blast design has been modified. In an effort to further reduce airblast levels, changes to the amount of explosive fired in any one instant have been implemented, and delays between detonations have been increased.

All of these noise suppression measures will be continued and further developed at the new quarry. Pioneer will also take the necessary steps to ensure that the guidelines described in Section 8.8.2 are met or improved upon.

Blasting Schedule

Blasting will be conducted eight or nine times a month, usually in the afternoon. This time has been chosen because the prevailing winds at that time of the day usually have a westerly component. This will aid in reducing any possible noise and dust impact from the blasting.

Crushing Plant Noise

All crushing and screening plants will be fully enclosed to limit the propagation of noise. The plant itself will incorporate design measures aimed at minimising the generation of noise. These measures will include the use of rubber or polypropylene components instead of metal ones where possible. These measures will ensure that the crushing and screening operations at Pioneer No.2 will be considerably quieter than those at Pioneer No.1. The noise emissions will be further reduced by the greater distance of Pioneer No.2 from the nearest residences.

Vehicle Noise

Vehicle noise will come from two sources. The first will be the use of haul trucks and earthmoving machinery in the quarrying operation. The second will be delivery trucks entering and leaving the despatch area.

Both of these sources will generate noise levels in the immediate vicinity similar to those occurring at Pioneer No.1. However, the greater buffer zone around Pioneer No.2 means that this noise will be reduced to near background levels by the time it reaches the nearest residences. The problem of noise from unladen delivery vehicles at Pioneer No.1, which has given rise to some complaints, is not expected to occur at Pioneer No.2, due to the greater distance from residences and the design of the driveways.

Occupational Noise Levels

Occupational noise levels in the quarrying industry are regulated by the Mines Regulation Act 1946-74. This Act, administered by the Department of Mines, sets standards for permissible exposure of workers to noise. All operations at the Pioneer No.2 quarry will comply with the provisions of the Act.

8.9 ODOURS

8.9.1 Impacts

There are no odours associated with the operation of the quarry pits and crushing plant. The asphalt plant emits bitumen odours within its immediate vicinity. These odours have been the subject of complaints directed at the Pioneer No.1 quarry.

8.9.2 Management

Pioneer has addressed complaints relating to asphalt plant odours at the Pioneer No.1 Quarry by installing state-of-the-art gas scrubbing and filtering equipment in the plant in order to remove hydrocarbons from the exhaust gases. The proposed Pioneer No.2 asphalt plant will incorporate similar equipment to minimise hydrocarbon emissions. Details of the odour control systems to be installed are given in Section 7.5.4. In addition, the greater distance of the Pioneer No.2 site from the nearest residences will further reduce the effect of odours on residents.

Investigations over the past three years have shown that except on very rare occasions complaints of odour have not emanated from a distance greater than 1km from the asphalt plant.

These occurrences have proved to be of relatively short duration and of an extremely intermittent nature. The offensive odour is not continuous. This has also been confirmed by independent Local Government and State Government inspectors.

Pioneer believes that most odours occur during the transfer of bitumen being delivered to the plant and even then weather and wind conditions must be such as to trap and convey the odours to our neighbours. The deliveries generally occur daily and transfer takes about one hour which would explain the short-lived and intermittent nature of the complaints.

In proposing the relocation of the asphalt plant Pioneer considers that the new site by virtue of its increased buffer zone, which places it 3km from Campersic Road, and the topography of the intervening terrain will eliminate the odour problem for our neighbours.

The expected reduction in odour problems associated with the asphalt plant is seen as a major benefit of the proposed relocation. Pioneer will continue to closely monitor research being conducted by oil companies into the reduction of asphalt plant odours, and will investigate the viability of incorporating any new developments into the design of the asphalt plant.

8.10 REHABILITATION

8.10.1 Aim of the Rehabilitation Programme

The Rehabilitation Programme will be carried out in an orderly and progressive manner with the aims of:

- reducing visual impact;
- restoring soil and soil-based organisms;
- restoring vegetation cover;
- reducing erosion;
- restoring habitat for fauna; and
- reducing noise and dust arising from the quarry operation.

These aims will be achieved by restoring, to all available areas, plant cover that is as close to the indigenous vegetation as is practicable.

In practice, restored vegetation will vary from indigenous patterns because the environmental factors influencing it (soils, light availability, etc.) will have changed. At the outset, a high proportion of native legumes (Acacia, Kennedia, Hardenbergia spp. etc.) and a small proportion of non-native grasses and herbaceous legumes (medics and clovers) will be introduced. The purpose of this will be to establish rapid cover to stabilise loose soil surfaces, to fix nitrogen and to commence production of ground litter which will add humus to the soil. Other indigenous shrubs and groundcovers including, wherever available, representatives of geographically-restricted species, will be planted at the same time.

Great care will be taken to plant upper storey trees of only truly indigenous species, since this is the component of the vegetation that gives the area its characteristic appearance when viewed from a distance.

In this way, while the understorey varies from the indigenous for environmental and practical reasons, the overall appearance of revegetated areas will in time be very similar to their surroundings.

8.10.2 Priorities

The immediate rehabilitation at Pioneer No.2 will be directed to vegetation of screening and drainage bunds constructed as part of the quarry establishment process. This vegetation establishment will commence in the first planting season after completion of those bunds, and before the plant is commissioned. Any other areas which are unavoidably disturbed during construction will receive attention as soon as is practicable.

Strict controls will be exercised during construction to minimise ground disturbance. These measure will include:

- o Surveying and flagging of areas to be cleared;
- o Briefing of all contractors and personnel on clearing procedures, and strict supervision of clearing by Pioneer personnel; and
- o Continuation of the Pioneer policy, currently practised at Pioneer No.1, of giving a high priority to bushland preservation.

8.10.3 Landscaping of the Pioneer No.2 Quarry Pits

The method for landscaping of the Pioneer No.2 Quarry pits will generally follow techniques established during rehabilitation of Pioneer No.1. Improvements will be made in the areas of topsoil and overburden management and the final form of quarried rock benches to make the landscaping more effective and at the same time more economical.

Rehabilitation will involve the following tasks:

1. Wherever possible, strip and store topsoil, including existing vegetation cover. Seed of geographically-restricted plant species will be collected at this stage for propagation.

2. Strip and separately store overburden. Most overburden will be utilised for construction of screening and drainage bunds within the Project Area. Excess overburden will be stockpiled for later use in rehabilitation. For both topsoil and overburden, storage will be in stockpiles not more than 1.5m deep. If storage is for longer than twelve months, a cover crop will be established over the surface of the stockpiles to prevent erosion and maintain biological activity within the stored material.

3. Twelve months prior to rehabilitation of each section of the quarry, orders will be placed for the propagation of the required nursery stock. Seed will be ordered three months prior to rehabilitation.

4. Where practicable, particularly on the upper levels, benching will be carried out in such a manner as to allow placement of a soil profile to cover the vertical face backing each bench.

   Blasting of the forward edge of each bench may be carried out to place a core of rock fill on the bench below, to fracture the rock of the blasted bench to encourage moisture and root penetration, and to "blur" the otherwise straight edge of the bench.

5. Tip, from bench above, stockpiled overburden followed by stockpiled topsoil. This phase of the work will be completed as close as possible to the commencement of winter rains (i.e. mid-May).

6. Commence planting and seeding when the soil profile has become saturated to a depth of 300mm (i.e. late May - early June). Complete planting and seeding by the end of June.

   Seedlings and plants will be fertilised at the time of planting. They will not receive any irrigation, relying on natural rainfall for establishment and survival.

8.10.4 Landscaping of Pioneer No.2 Plant and Infrastructure Sites

Landscape works to the Plant and Infrastructure sites will be in the form of earthworks, soil preparation and planting prior to and immediately following construction, to serve the purposes of screening the sites from view, reducing noise, dust and soil erosion.

It is proposed to construct mounds on the north and south sides of the plant site to screen it from any possible views from the Swan Valley and Toodyay Road, prior to construction of the plant. These will be vegetated by seeding and planting of nursery stock with the intention of establishing cover prior to commissioning of the plant.

The other major area of planting will be to disturbed areas of the road system, particularly at points of access from Toodyay Road to ensure full screening of the site.

Planting to screen mounds and roadways will be carried out in the same manner as rehabilitation within the quarry and will not be irrigated.

Amenity planting will be provided around the Plant and Infrastructure site, to improve its appearance and to provide a pleasant working environment. This planting will be irrigated over an establishment period.

The general layout of landscaping works planned for the Pioneer No.2 site is illustrated in Figure 15.

8.10.5 Rehabilitation of Pioneer No.1 Quarry

Past, present and proposed rehabilitation efforts at Pioneer No.1 are illustrated in Figure 16.

8.10.5.1 Timetable for Rehabilitation

It is expected that operations at the Pioneer No.1 quarry will be progressively phased out in conjunction with the development of Pioneer No.2. Rehabilitation of the upper quarry faces and stockpile areas has already commenced, and will proceed along with the phasing out of operations. Pioneer expects to cease all operations at Pioneer No.1 apart from rehabilitation work, and to have removed all plant and equipment from the site, within approximately three years after the start of production of Pioneer No.2. Pioneer No.1 will continue to be used as a source of water for Pioneer No.2 after that time. It is not possible to predict a time when all rehabilitation at Pioneer No.1 will be completed, as this depends on the rate of successful establishment of vegetation on the site, but this objective will be vigorously pursued.

8.10.5.2 Current Rehabilitation Efforts

To date, rehabilitation of the Pioneer No.1 quarry has been concentrated on the east and south quarry faces and the new screening mound being constructed across the western throat of the quarry.

Prior to 1987 approximately 8,000 trees and shrubs were planted at Pioneer No.1. Between 1987 and 1989, approximately 60,000 nursery stock plants and 66kg of native seed were planted. The plants are spaced at approximately $1/m^2$ and seed is sown at the rate of approximately 10kg/ha, with the aim of achieving total vegetation cover.

This technique has resulted in the complete revegetation of the 210m and 225m quarry benches along the east face of Pioneer No.1, as shown in Plate 6, and substantial revegetation of parts of the western mound, the south quarry face and the south-eastern quarry face. In 1990, a further 9450 plants and 22 kg of native seed will be planted.

Expertise is being built up in the techniques of hydro-seeding, which have the potential for achieving rapid and economical vegetative cover over inaccessible areas.

8.10.5.3 Final Rehabilitation Strategy

The Pioneer No.1 Quarry has been undergoing progressive rehabilitation for several years with very successful results. The immediate aim of the rehabilitation work has been to eliminate the visual impact of the quarry. To this end, work has concentrated on:

(a) The Eastern Face down to within 50m of the quarry floor;
(b) The Western Mound, which will close off the entrance to the quarry and screen the remainder of the Eastern Face from public view; and
(c) The Southern Face.

Only the Northern Face will be worked for the remaining period of operations at Pioneer No.1. When quarrying ceases, the Northern Face will be terraced and revegetated. The quarry floor will remain as a water catchment area for Pioneer No.2, with extra planting being done to achieve an aesthetically-pleasing landscape.

The areas currently occupied by stockpiles, plant and infrastructure below the quarry will be redeveloped and revegetated in a manner that is compatible with existing landscapes along the face of the Scarp.

8.10.5.4 Options for Subsequent Use of Site

Pioneer foresee no options for the subsequent use of Pioneer No.1 other than to maintain the area as a buffer zone and as water storage for Pioneer No.2.

8.10.6 Monitoring of Rehabilitation

The practice since 1987 has been that rehabilitation works are monitored by Pioneer staff and consultants employed by them. Successes and shortcomings are noted and the information used to progressively improve rehabilitation techniques. Areas requiring further work have been retreated as necessary. This system has been very successful to date and results achieved have been outstanding. Pioneer proposes to continue this successful practice.

8.10.7 Responsibility for Rehabilitation

Pioneer will continue to assume responsibility for rehabilitation until all necessary areas have been restored to self-maintaining condition.

8.10.8 Timing of Rehabilitation

Rehabilitation of the Pioneer No.1 quarry is already well under way as noted above. It is expected that the final rehabilitation measures will be commenced by the time the quarry relocation is completed. Rehabilitation efforts will continue for some time after that date.

Rehabilitation at the Pioneer No.2 quarry will, as much as possible, be progressive. Areas disturbed during the development phase but which are no longer used will be rehabilitated as they become redundant. Rehabilitation of the upper levels of the quarry pit will be undertaken as the pit deepens. This rehabilitation will be a long-term, ongoing process and will be an integral part of the quarry operations.

8.11 WASTE DISPOSAL

8.11.1 Impact

Solid and liquid wastes, including stormwater, have the potential to impact on the water quality of both surface and groundwater resources.

8.11.2 Management

Solid Wastes

Non-toxic solid wastes, such as domestic waste, will be disposed of in an approved council landfill site, as is currently the practice at Pioneer No.1.

Liquid Wastes

Liquid wastes from the quarry operations will consist mainly of slurry from dust suppression equipment in the processing plant, and oils and solvents from the workshops.

Inert slurry will continue to be disposed of in the solid waste disposal site located on Pioneer property west of the proposed West Pit site, as shown on Figure 2.

Waste oils and solvents will be collected and stored in drums before being removed from the site either for recycling or disposal in a council-approved liquid waste disposal site.

Stormwater

Stormwater at Pioneer No.1 is directed by bunds and drains into two sedimentation basins (Figure 6) before being released to watercourses. Runoff from workshop areas where oil contamination is likely to occur is directed into sumps which separate the oils from the water. The sumps are periodically cleaned out and the recovered oil stored for recycling.

Stormwater at the Pioneer No.2 site will be directed into storage impoundments, to be used for dust suppression or processing. Any runoff likely to contain oil contamination will be treated as described above.

The net result of these drainage control measures will be that no untreated runoff from any disturbed area of the Pioneer No.2 site will be permitted to enter any watercourse.

8.12 ADJACENT LAND USES

8.12.1 Impacts

Residential Areas

The impact of the proposed development on residential land use will be negligible. Quarrying itself will be restricted to a small area within the proponent's land holding and consequently will not affect land use on adjacent or nearby properties. Other potential impacts, such as dust, reduced water quality and noise are expected to be insignificant due to the large buffer between residential areas and Pioneer No.2.

Reserves

There are no expected impacts on reserves in the area of the proposed quarry. The site is well concealed and restricted to a small area. All the reserves are more than 1km from the quarry and John Forrest National Park is approximately 4km from the proposed quarry at its closest point.

Recreation Areas

None of the recreational areas identified in Section 5.1.2 will be significantly affected by operations at the quarry. The Red Hill Pits picnic site (see Figure 1) is the closest of these areas to the quarry. This site will experience continuous daytime noise levels of less than 25dB(A) from the quarry, which is less than normal outdoor ambient levels and which would probably be less than the noise level it already receives from Toodyay Road, the adjacent refuse disposal site and off-road vehicle area. In addition, the picnic area will experience occasional noise from blasting. Given the occasional and short-lived nature of this noise, it is not expected to significantly degrade the amenity of the picnic area. The picnic site may experience a marginal increase in traffic noise due to the use of Toodyay Road by trucks carrying rock from the quarry but, as Toodyay Road is already used by many heavy vehicles, this increase in not seen as significant.

Other recreation areas are sufficiently far from the proposed quarry to suffer no adverse effects from its operations.

Planned Developments

There are no other major planned developments for the area in the vicinity of the proposed quarry, apart from those associated with the housing developments.

A proposal exists to upgrade Toodyay Road to form part of the proposed National Highway (the "Orange Route" proposal) which would involve widening of the road to form a dual carriageway. However, this upgrading is expected to be confined to the existing Toodyay Road Reserve and would have minimal interaction with the Pioneer proposal.

8.13 CUMULATIVE IMPACT OF QUARRIES

The cumulative effects considered are those which are known to be of significance in respect of Pioneer No.1 and associated operations. Items that are of particular interest in determining the cumulative impact are:

- the distance between the locations of the proposals,
- the scale of the proposed operations, and
- the environmental management procedures of the proposals.

As indicated in Sections 5.5 and 5.6, the two proposed quarries are located 1.5km and 2.5km respectively from the existing Pioneer operations, at a separation of approximately 3km. The Red Hill proposal is for an annual production of around 200,000 tonnes, and it is assumed that the Scarp proposal would be similar in size. This figure may be compared to recent annual production at Pioneer No.1 of 650,000 tonnes. It is assumed that environmental management practices for the two proposals will be such that all relevant regulations will be adhered to.

In view of the distances separating the proposed Pioneer No.2 operations and the other proposed developments, the planned and assumed environmental management practices at the three sites, and particularly in view of the proposed and assumed small scale of operations of the new proposals when compared to the Herne Hill quarries, the overall cumulative effect of an additional one or two quarries in the Herne Hill area will be slight to moderate.

The most significant effects would be:

- o the additional visual impact of a new quarry development (Scarp proposal) on the Scarp face in the Herne Hill area;
- o the increased frequency of blasting noise in the Swan Valley resulting from development at the Scarp Proposal site;
- o possible deleterious effects on Susannah Brook if the Pioneer, Red Hill and Scarp proposals were all to proceed - all are located close to the Brook itself; and
- o an increase in traffic in the Herne Hill area, which would be proportional to the scale of the operations (i.e. an increase of 30% to 70% when compared to traffic generated by the Pioneer No.1 operations). The Scarp Proposal would inject considerable traffic onto Campersic Road, whereas the Pioneer No.2 and/or Red Hill proposals would use Toodyay Road.

8.14 ACCESS AND TRANSPORT ROUTES

The number of heavy vehicles using Toodyay Road will not be affected by the proposed quarry relocation. Pioneer traffic on Toodyay Road will remain at its present density of about 110 movements each way per working day. This is likely to change over the years in proportion to any increase or decrease in the market for Pioneer's products. Any such changes are expected to be of a very gradual nature. The movement of heavy vehicles away from the smaller Neuman Road is seen as beneficial.

8.15 EFFECT ON EXISTING SERVICES

Electricity, Gas, Water and Telephone Services

The relocation of the Pioneer quarry will necessitate the redirection of electricity, gas, water and telephone services to the new site. Arrangements for these will be made with the relevant bodies at the appropriate time. The requirements for these services at Pioneer No.2 are expected to be similar to the requirements at Pioneer No.1.

The 132kV power transmission line which traverses the Pioneer landholding in the vicinity of the proposed Pioneer No.2 will not be affected by the quarry relocation.

No water or gas mains or telephone lines will require relocation as a result of the establishment of Pioneer No.2.

Sewerage

Sewage at the Pioneer No.2 site will be disposed of by means of septic tanks, as is the practice at Pioneer No.1. The soil types present in the Project Area will ensure that no adverse effects are felt by Susannah Brook or other watercourses as a result of this practice.

Roads

The proposed relocation will have no significant effect on roads in the local area, as both Pioneer No.1 and No.2 quarries have their sole access directly from Toodyay Road. The access to Pioneer No.2 will be situated approximately 3.5km further east on Toodyay Road than that for No.1, in an area more remote from residences.

8.16 EXISTING COMMUNITY FACILITIES

The relocated quarry is not expected to have an impact on existing recreational areas or other community facilities.

8.17 WORKFORCE

Construction

The relocation of quarrying from Pioneer No.1 to the No.2 site will take place as part of Pioneer's ongoing operations, and will not involve a significantly increased construction workforce. Some additional contractors will be employed during the relocation, and this will have an economic benefit to the local community.

Operation

Pioneer expects its workforce at the Pioneer No.2 quarry to be about the same as that currently employed at Pioneer No.1. The workforce will progressively transfer to the No.2 site as development proceeds and as operations at Pioneer No.1 are wound down.

8.18 CONTINGENCY PLANNING, SAFETY AND EMERGENCY SERVICES

The effect of the relocation of quarrying to the Pioneer No.2 site will have no significant effects on services such as ambulance, police and the State Emergency Service. Bushfire fighting services will benefit from the relocation, as access to the eastern end of Pioneer's landholding will be improved. The fire hazard at the Pioneer No.2 operations will be no greater than that at Pioneer No.1.

8.19 VISUAL IMPACTS

8.19.1 Impacts

Close-range Visibility

Close-range visibility is defined as the visual impact that the proposed quarry will have within the land owned by Pioneer. It is only from within Pioneer property that the quarry workings will be visible once screening bunds and vegetation are established. Since the quarry is located on freehold land, the short-range visual impact is of no public significance. The proposed quarry has been sited to eliminate visual impacts to Swan Valley residents and the general public.

Long-range Visibility

A computer assessment of long-range visibility taking into account the surrounding topography and vegetation, in conjunction with site visits, has determined that the proposed quarry and plant will not be visible outside of Pioneer property when the proposed bunds and screening vegetation are established. Studies including computer-generated perspectives of the proposed quarry (Figure 17) have shown that the quarry operations will not be visible at all from the Swan Valley.

With the planned rehabilitation of Pioneer No.1, the overall visual impact of Pioneer's activities at Herne Hill will be greatly reduced.

8.19.2 Management

Quarry

As previously discussed, the pits will be easily visible only from within Pioneer property. Screening trees will be planted along the spur north-west of the quarry to further reduce visibility.

Plant and Infrastructure Sites

The plant and infrastructure sites will be hidden from public view by the topography, screening bunds and vegetation. The main infrastructure site, including the tertiary crusher and stockpile areas, will be hidden from Toodyay Road by embankments and screening trees. These embankments will be designed and vegetated so as to blend in with the surrounding environment. The asphalt plant will likewise be invisible from Toodyay Road.

The primary and secondary crushers will not be visible from major vantage points outside Pioneer property.

Roads

Roads will connect the different parts of the quarry operations, including haul roads from the pits to the primary crusher. Road building will be kept to a minimum and the roads will not be visible from outside Pioneer property except at the entry and exit points on Toodyay Road.

8.20 POST-QUARRYING LAND USE

Pioneer intends ultimately to return much of the No.1 quarry site to a near-natural state by landscaping and planting of trees and shrubs. For an indefinite period of time, the central quarry pit will continue to be used by Pioneer as a source of water for the No.2 quarry operations. The final end-use of the quarry will be the use of the quarry for a buffer zone and as a source of water.

The Pioneer No.2 site contains sufficient rock reserves for approximately 150 years' quarrying at the present rate. Considering this time scale, it is inappropriate at this stage to consider what the end use of the quarry might be.

Options for Subsequent Use of the Site

Pioneer does not consider it appropriate to discuss subsequent uses of the Pioneer No.2 site at this stage, as it is intended to use the site for quarrying into the foreseeable future. Options for end use commensurate with its status as freehold land will be considered at an appropriate time.

The suitability of the site for other uses will remain largely intact after quarrying, as the only permanent legacy of quarrying will be the existence of the quarry pits.

Final Rehabilitation

Final rehabilitation of the proposed quarry will comprise complete revegetation of quarried and otherwise disturbed areas in accordance with techniques outlined in 8.10, which have produced excellent results to date.

The areas occupied by plant and infrastructure will also be revegetated to complete cover of native vegetation using similar techniques, since in their proposed location they do not form part of a pasture/woodland landscape pattern.

9.0 MONITORING

9.1 OBJECTIVES OF THE MONITORING PROGRAMME

The results of the monitoring programme will be used to assess Pioneer's performance in terms of environmental protection, rehabilitation and public acceptance, to rectify any problems at an early stage and to develop long-term strategies for environmental management of the quarry.

9.2 AIR QUALITY MONITORING

Previous Dust Monitoring

High-volume dust monitoring surveys were carried out by the Pollution Control Division of the EPA on three sites west and north of Pioneer No.1 in 1986-87, following complaints about dust nuisance allegedly originating in the quarry.

The results showed that the projected annual mean dust concentration at each of the three sites would be less than 90 ug/m^3, which is the air quality goal recommended by the National Health and Medical Research Council (NHMRC). At worst, dust of probable quarry origin made up 50 to 60 percent of the total dust collected on a day on which blasting took place, at a site approximately 500m directly west of the quarry throat (EPA, 1987). The average composition of dust at Site 2, the dustiest of the sites, included 77 percent of non-quarry material and 23 percent material of possible quarry origin.

Proposed Monitoring Programme

A comprehensive air quality monitoring programme will be established at the Pioneer No.2 site. The programme will take four main parts:

1. A meteorological monitoring station will be maintained on the site (see Plate 5b) to measure rainfall, wind speed and direction. The results of this monitoring will be used in conjunction with other monitoring results to predict dust, noise and odour dispersion.

2. Continuous static (deposit) and directional dust gauges will be sited at locations around the quarry to measure airborne dust emissions, particularly from blasting.

3. Particulate emissions will be continuously monitored at the asphalt plant stack.

4. Visual monitoring by Pioneer management of the crushing and other processing plants will be made to detect any leakage of dust.

9.3 NOISE MONITORING

Pioneer has carried on a programme of blast noise monitoring at Pioneer No.1 since 1985. During that time, a number of changes have been made to blasting practices at the quarry, including changes to the type and amount of explosive used, cessation of secondary blasting of oversized rocks, and the insertion of delay periods into blasting sequences. These changes have resulted in a substantial reduction in blasting noise levels since the commencement of monitoring.

Pioneer is committed to maintaining an ongoing programme of monitoring of blasting and processing noise at the Pioneer No.2 quarry. The results of this monitoring will be made available to the EPA on a regular basis. These results will also be used by Pioneer in its endeavours to bring about further reductions in all noise emissions from the Pioneer No.2 quarry.

Occupational noise levels will be monitored within the workings to ensure compliance with statutory noise limits for workers.

9.4 WATER QUALITY MONITORING

Regular samples will be taken from Susannah Brook at sites upstream and downstream of the Pioneer No.2 quarry, and will be analysed for suspended solids and hydrocarbons. In addition, rising stage samplers and peak level recorders will be installed in Susannah Brook to give more detailed information regarding water quality and flow rates in the brook. The information on flow rates will be used to optimise the runoff control measures in use at the quarry.

9.5 VISUAL IMPACT MONITORING

The Pioneer No.2 operation has been designed to have no visual impact outside Pioneer property, and the requirement for monitoring will be low. Photographic monitoring points have been established on Pioneer land near the proposed quarry to record visual changes around the quarry with time.

9.6 VEGETATION MONITORING

The area of vegetation disturbed by the quarry will be monitored to ensure that it is kept to a minimum and that unused areas are rehabilitated as early as possible. The area surrounding the quarry will be visually monitored to detect any outbreaks of dieback disease or weed infestations.

9.7 PUBLIC OPINION MONITORING

Pioneer will continue to keep a record of public comments and complaints regarding its operations and will respond individually to each complaint.

The Shire of Swan will be encouraged to maintain its register of public submissions regarding Pioneer's operations and to promptly pass them on to Pioneer for action, if necessary.

9.8 MONITORING OF REHABILITATION

The rehabilitation programmes in place at the Pioneer No.1 quarry and proposed for Pioneer No.2 are designed to require a minimum of maintenance or monitoring. In the early stages of vegetation establishment, regular monitoring will take place to gauge the success of individual planting programmes and to enable remedial plantings to be carried out if necessary.

9.9 REPORTING OF MONITORING RESULTS

The results of the monitoring programmes will be reported annually to the Environmental Protection Authority and the Shire of Swan in a summary report.

10.0 COMMITMENTS

Pioneer Concrete (WA) Pty Ltd makes the following specific commitments regarding environmental protection and management at the proposed Pioneer No.2 Quarry.

Quarry Development and Operation

10.1 Access to the Pioneer No.2 site will be direct from Toodyay Road. Accessways will be designed to minimise noise generation and disruption to other traffic, and will be constructed to the satisfaction of the Main Roads Department.

10.2 Topsoil, vegetation and overburden will be stripped from areas to be developed. These will be used for the building of bunds and for rehabilitation purposes.

10.3 No physical interference with Susannah Brook will be permitted at any stage during the development or operation of the quarry. To this end, a minimum 50 metre buffer zone will be maintained each side between the Brook and any quarrying activity, and allowing a total 100 metre buffer zone around the Brook.

10.4 Regional water mains, power, gas and telephone services will not be adversely affected by the development of the Pioneer No.2 site.

10.5 Process water supplies will be drawn from the existing water storage in the Pioneer No.1 Quarry and from the other surface storages's on Pioneer property, with possible occasional augmentation by Water Authority supplies. No water will be drawn from Susannah Brook. There is currently no planned use of groundwater in the proposed development, consequently there will be no effect on groundwater resources.

10.6 Drilling and blasting will be conducted only during daylight hours. Blast design will be aimed at achieving the required breakage of rock with minimum generation of noise, vibration and dirt.

10.7 Following the completion of development of Pioneer's No.2 pit and crushing plant, processing operations at Pioneer No.1 will cease and the plant will be dismantled.

Protection of Vegetation

10.8 Site clearance and vegetation removal will be minimised by survey control and supervision of personnel engaged in clearing activities.

10.9 All vehicles entering the site from regions identified as potentially contaminated areas with dieback disease, will be thoroughly washed to remove adhering soil and weed seeds. All fill or soil used on the site will be obtained from uncontaminated sources.

10.10 Where appropriate, seeds of geographically-restricted plant species will be collected from the site and propagated for later use in rehabilitation.

10.11 Fire prevention measures as per relevant Shire and Brigade regulations will be enforced within the project area and on the rest of Pioneer's land holding.

10.12 Unauthorised vehicular access to the Pioneer land holding will not be permitted and the current practice of using security guards to patrol the area will be continued.

10.13 Pioneer will monitor the vegetation on its property to detect any outbreaks of dieback disease. If any is detected, Pioneer will consult with the Department of Conservation and Land Management to determine a suitable treatment strategy.

10.14 The remainder of Pioneer's property outside the Project Area will be maintained as a buffer zone for the Quarry.

Noise, Dust and Odours

10.15 All emissions of noise, dust and odours from the operations will be within limits laid down in licence conditions by the Environmental Protection Authority or set out in the Environmental Protection Act 1986.

10.16 Pioneer will endeavour to further reduce emissions by a number of means including enclosure of crushing and screening plants, watering of roads, stockpiles and product transfer points, careful design of blasting, and the use of extraction systems and wet scrubbers in the asphalt plant.

10.17 Pioneer or its agents will monitor noise levels from blasting and processing, dust deposition, odours and occupational noise and dust. The results of this monitoring will be made available on an annual basis.

10.18 Occupational noise and dust levels will be monitored and the results reported to the Department of Mines. Pioneer will take any action necessary to ensure that the levels of occupational noise and dust comply with the provisions of the Mines Regulation Act 1946-1974.

Drainage and Water Quality

10.19 Pioneer will endeavour to minimise disruption to drainage patterns in areas outside those directly affected by quarrying activities. Rainfall runoff to disturbed areas will will be prevented by the use of bunds and drains where necessary. Careful attention will be paid to the minimisation of erosion.

10.20 No untreated runoff from disturbed areas of the Project Area will be permitted to enter any watercourse. All such runoff will first be treated by means of sedimentation basins or silt traps to remove excess suspended sediments. Any runoff likely to contain oil contamination will be treated to remove such contaminants.

10.21 The quality of water leaving the Project Area will be monitored by regular sampling.

Visual Impact

10.22 The Pioneer No.2 operations will not be visible from ground level outside Pioneer property once screening bunds and vegetation are established. Screening vegetation will be established around the Pioneer No.2 infrastructure site and north-west of the quarry pits to screen the operations from view.

Aboriginal Interests

10.23 Discussions will be held with representatives of the local Nyungar Aboriginal community regarding the protection of Susannah Brook and the future of the white "ochre" deposit in the vicinity of the tertiary crusher/stockpile site. Pioneer will take steps to ensure that quantities of the "ochre" are made available to Aborigines for their use.

Waste Disposal

10.24 Solid wastes, such as domestic waste, will be disposed of at an approved Council landfill site.

10.25 Oils and grease separated from contaminated runoff in the area of the workshops and asphalt plant will be collected and removed from the site, either for recycling or for disposal in a Council-approved liquid waste disposal site.

10.26 Inert slurry originating from dust suppression sprays in the crushing, screening and asphalt plants will be disposed of in the solid waste disposal site located on Pioneer property. This site is situated on a near-impermeable clay base and is bunded to prevent runoff.

10.27 Sewerage facilities will be designed so as to prevent impacts on ground or surface waters in the area, and will conform to Health Department regulations.

Rehabilitation

10.28 A programme currently underway at Pioneer No.1 will continue.

10.29 Pioneer will continue to take responsibility for rehabilitation and will investigate new developments in rehabilitation methods in order to optimise the rehabilitation of the Pioneer No.1 and No.2 Quarries.

10.30 The progress reports on rehabilitation works at the Pioneer Quarries will be made available to the Environmental Protection Authority as required.

Community Liaison

10.31 Pioneer will continue to maintain a register of public complaints against its quarrying operations at Herne Hill and will respond promptly and individually to each complaint received.

Management, Monitoring and Reporting

10.32 Prioneer will continue to monitor meteorology, noise, dust, odours, water quality, vegetation and public opinion at the Pioneer No.2 quarry site, the results of this monitoring will be used by Pioneer to optimise its environmental management procedures at the Pioneer No.2 Quarry. these results will be available on an annual basis.

10.33 Pioneer will continue to monitor research, both within Australia and overseas, into new developments in blasting technology, noise, dust and odour control in the operations of the quarry and the asphalt plant.

11.0 CONCLUSIONS

This Public Environmental Review describes what the proponent believes to be a practical and acceptable solution to the questions of economics, basic resource availability, public acceptance and planning which have arisen concerning Pioneer's quarrying operations at Herne Hill.

The proposal offers substantial benefits to the local and wider communities in terms of economics, the elimination of noise, dust and visual impacts in residential areas, and the opportunity to rehabilitate the Pioneer No.1 quarry.

The potential environmental impacts of the proposal have been set out in this PER. Pioneer believes that the measures it has proposed will result in these impacts being eliminated or kept within acceptable levels.

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13.0 GLOSSARY AND ABBREVIATIONS

13.1 GLOSSARY

Absorption	The intake of one substance into another.
Adsorption	The concentration or suspension of one substance on the surface of another.
Aggregate	Small even sized rock fragments used as a general building material.
Alluvium	A deposit of detritus and sediment laid down by water. Also see colluvium.
Anthropology	Science of the study of man and society, especially primitive man.
Aquatic	Of or relating to water as distinct from land or air.
Aquifer	A permeable rock formation which stores and transmits sufficient groundwater to yield quantities to wells, bores or springs.
Archaeology	Study of antiquities, especially of the prehistoric period.
Association	A group of plants with a characteristic form, structure and dominant species.
Attenuation	(Applied to Sound) - reduction or tapering off.
Australia Height Datum (AHD)	The national basis for describing the elevation above sea level of land features and structures
Batter	Slope resulting from cutting and filling.
Benches	A name applied to ledges of all kinds of rock that are shaped like steps or terraces.
Biology	The study of living things.
Biota	The totality of plants and animals of a specified area.
Bund	An earth or rock wall constructed to prevent the inflow or outflow of liquids.
Catchment	An intake area and all parts of the drainage basin which drain into it.

Clay	A fine grained sediment composed primarily of clay-sized particles (2 microns). Characterised by high plasticity and a considerable content of clay and subordinate amounts of other fine grained minerals such as quartz.
Colluvium	Material of loose and incoherent deposits usually at the foot of a slope of a cliff and laid down primarily by gravity. Also see alluvium.
Community	Ecological term for any naturally occurring group of different organisms inhabiting a common environment, interacting with each other, especially through food relationships, and relatively independent of other groups.
Contour	A line connecting points of equal value on a map.
dB(A)	The management of sound pressure level in which the amplitude of the sound signal is negatively weighted in frequencies below 1000Hz in accordance with a weighing scale known as the "A" weighing scale. This scale was established to closely simulate human perception of the relative level of pure tone sounds. The dB(A) scale is most commonly used to measure sound levels which will affect human beings.
Dieback	An exotic plant disease caused by the fungus Phytophthora cinnamomi.
Dilution factor	The ratio of dilution which occurs between the discharge and receiving waters.
Dominant species	The most abundant species in the tallest or most important stratum of a plant association.
Drainage pattern	The pattern formed by drainage lines, gullies, streams and rivers.
Ecology	Study of the relations of animals and plants, particularly of animal and plant communities, to their surroundings.
Ecosystem	A community of organisms, interacting with one another, plus the environment in which they live and with which they also interact. An ecosystem is usually defined by its dominant vegetation and plants species or by the habitat in which it occurs.
Effluent	Liquid industrial waste.
Environmental Impact Assessment (EIA)	The process of determining the likely impacts of some particular project or action on the environment.

Ephemeral stream	A stream that flows briefly only in direct response to precipitation in the immediate locality and whose channel is at all times above the water table.
Ethnography	Scientific description of the races of man.
Evaporation	Transfer of water from liquid to vapour from soil, vegetation and water bodies.
Exotic Species	Not native, usually implying an unacclimatised introduction by human agency.
Fault	A fracture in the earth's crust along which there has been some displacement of the sides relative to one another.
Fauna	The species of animals present within a community or vegetation of a geographic area.
Flora	The species of plants present within a community or vegetation of a geographic area.
Formation	The ordinary unit of geological mapping consisting of a large and persistent stratum of some one kind of rock.
Geology	The study of the earth as a whole, its origin, structure, composition and history and the nature of the processes which have given rise to its present state.
Geomorphology	The description and interpretation of land forms.
Gravel	Fragments of rock worn by the action of air and water, larger and coarser than sand.
Groundwater	Underground water contained within a saturated zone or rock (aquifer).
Habitat	A place where species or populations of plants and animals live. A habitat contains a system of components which satisfies the requirements of the organism and includes both living and non-living features.
Hard Rock	Rock with a hardness of 5 or greater according to the relative scale devised by Moh.
Hydromulching	The process of coating erodible soil surfaces with a medium such as paper pulp or bark pulp to facilitate plant growth.
Impermeable	Describing a rock mass that will not allow the transmission of water under the head differences ordinarily found in groundwater.

Indigenous	Native to a particular area, not introduced.
Infrastructure	The supporting installations and services that supply the needs of the project.
Landform	The shape, form and nature of a specific feature of the earth's land surface.
Laterite	Iron-rich material which hardens on exposure to the atmosphere and is associated with deeply weathered profiles.
Leachate	The liquid that has percolated through the soil or other medium.
Macroinvertebrate	Animals without backbones e.g. protozoa, koonac, insects, spiders, worms, etc., are known as invertebrates. Macroinvertebrates are the larger invertebrates such as insects, etc., which can be studied without using microscopic techniques.
Meteorology	The science of climate.
Multiplier	A number used to calculate the indirect effects generated as a consequence of project construction and operation.
Organic	Being, containing, or relating to carbon compounds, especially in which hydrogen is attached to carbon whether derived from living organisms or not.
Outcrop	The part of a rock formation which appears at the surface of the ground.
Overburden	Material which overlies a deposit of useful materials or ores.
Particulate matter	Occurring as minute particles.
Passerines	A member of the Passeriformes, a group of birds. A perching bird, with large first toe directed back, other three toes forward.
Perennial	A plant that continues its growth from year to year.
Permeability	Capacity for transmitting fluid.
pH	A measure of acidity or alkalinity of soil or water. pH 7.0 is neutral, pH 0-6.9 is acid and pH 7.1-14 is alkaline.
Piezometer	A small diameter cased bore used for water level measurements.
Potable	Drinkable.

Predator	An animal which subsists by the capture and killing of other animals.
Quartz	A crystallised silicon dioxide.
Quartzose	Sands, sandstone and grits essentially composed of quartz, or containing quartz as a principal ingredient.
Rehabilitation	Processes necessary to return disturbed land to a predetermined surface, land use or productivity.
Reservoir	Opening in the ground in which water is stored.
Sediment	Solid material settled from suspension in a liquid.
Seepage	A quantity of a fluid that has seeped through porous material.
Skeletal soil	A thin veneer of soil overlying bedrock. Often comprised of rock fragments rather than truly weathered soil.
Species diversity	A number which relates the density of organisms of each species present in a habitat.
Species richness	A botanical term indicating a measure of the number of species of plants occurring in a given area.
Topography	The physical features of a region (land or sea) such as are represented on maps, taken collectively; especially relief and contour.
Topsoil	The general term applied to the surface portion of the soil including the average plow depth or the A-horizon where this is deeper.
Total Dissolved Salts (TDS)	Amount of dissolved salts in a given quantity of water.
Understorey	That vegetation less than 1m tall.
Upperstorey	The dominant tall strata (also usually the species by which the community is named).
Weathered	Changed by long exposure to atmospheric conditions.
Wetlands	Lakes, pools, rivers, streams and swamps and their associated, moist margins.
Windrose	A diagram summarising the frequencies of winds of different strengths and directions as measured at a specific point over an extended period of time.

13.2 ABBREVIATIONS

AHD	Australian Height Datum
CALM	Department of Conservation and Land Management
dB(A)	Decibels "A" weighted
E	East
EMP	Environmental Management Plan
EPA	Environmental Protection Authority
ERMP	Environmental Review and Management Programme
g	gram
ha	hectare
h	hour
kg	kilogram
km	kilometre
kV	kilovolt
L	litre
LGA	Local Government Authority
m	metre
ML	megalitre
mg	milligrams
mm	millimetre
Mt	million tonnes
Mtpa	million tonnes per annum
m^3	cubic metres
N	North
NH&MRC	National Health and Medical Research Council
S	South
s	second
SECWA	State Energy Commission of Western Australia
SIA	Socio-economic Impact Assessment
sp.	species (singular)
spp.	species (plural)
t	tonnes
TDS	Total Dissolved Salts
tpa	tonnes per annum
TSP	total suspended particles
ug	microgram
W	West
^oC	degree Celsius

ATTACHMENT 1

EPA GUIDELINES FOR THE
PUBLIC ENVIRONMENTAL REVIEW

GUIDELINES FOR THE PUBLIC ENVIRONMENTAL REVIEW (PER)
ON THE PROPOSAL BY PIONEER CONCRETE (WA) PTY LTD
FOR THE RELOCATION OF THE HERNE HILL QUARRY OPERATIONS

The PER should facilitate public review of the key environmental issues by expressing the main body of the text in terms understandable to the general public, and placing technical detail in appendices.

SUMMARY

The PER should contain a brief summary of:

- salient features of the proposal;
- alternative sites and technologies considered;
- description of the receiving environment and analysis of potential impacts and their significance;
- environmental monitoring and management programmes, safeguards and commitments; and
- conclusions.

1. INTRODUCTION

The PER should include an explanation of the following:

- identification of the proponent and responsible authorities;
- background and objectives of the proposal;
- brief details of the scope and timing of the proposal;
- environmental interaction with other developments (present and future);
- relevant statutory requirements and approvals; and
- brief description of the environmental impact assessment process and the scope, purpose and structure of the PER.

2. NEED FOR THE PROPOSAL

This section presents an opportunity for the proponent to describe in a general way the broad costs and benefits of the project to the Company and the community. These should be described at local, and State levels.

3. EVALUATION OF ALTERNATIVES

A description should be given of how the project has developed and the degree to which development alternatives, including the 'no development' option, have been examined.

Each site considered should be described sufficiently to provide an appreciation of its salient characteristics. The criteria used to evaluate sites should be described and the relative advantages and disadvantages of each site given, including environmental considerations.

The criteria used in the evaluation of alternative technologies to achieve the objectives of the proposal should be given. Where options in process or technology exist these should be explained and compared in terms of the selection criteria. Environmental consequences of the alternative technology options available should be discussed.

When alternatives are rejected, the factors which led to their rejection should be clearly identified.

The aim of this section is to lead the reader through the thought processes which led to the desired proposal, and to outline the factors which control its present form.

4. PROPOSED LOCATION

The proposed location is to be described including:

- cadastral, land use planning and zoning information;
- adjacent land uses, including:
  - the location of any nearby residences;
  - recreational land use;
  - reserves;
  - historical, archaeological or ethnographic sites;
- topography;
- natural drainage and downstream destinations;
- water resources;
- flora and fauna;
- meteorology, especially the prevailing winds;
- location of existing structures, and structures to be built on the site; and
- provision of services, including power, gas, telephone road and rail access, water and drainage.

5. DESCRIPTION OF THE PROPOSAL

In this section the processes involved in the operation of the proposed quarry should be explained. The inputs, outputs and by-products of each process should be explained. Materials handling procedures should be described and an indication of gross quantities given. Transport arrangements should also be described.

6 EXISTING ENVIRONMENT

This section should provide an overall description of the environment and an appraisal of the physical and ecological systems likely to be affected by all aspects of the proposal, but should concentrate on the significant aspects of the environment subject to potential impact from the development. Only the habitats, resources and potential resources which could be influenced by the project should be described. Excessive descriptions which are irrelevant to the impact of the proposal tend to detract from the document.

7 ENVIRONMENTAL IMPACTS

The proposal will impact on some aspects of the environment, and it is necessary to discuss the individual impacts and then synthesize these so as to show the overall effect on the total environment. This is necessary for two reasons: firstly to allow the reader of the document to draw conclusions on whether the proposal is environmentally acceptable, and secondly, to show that operative management, ameliorative and monitoring programmes can be devised to manage potential impacts.

Consideration should be given to both the long term and short term effects of the project development and operation at the various locations where the project and associated activities may significantly impact on the environment.

A thorough evaluation of the hydrological, geomorphological and botanical impacts of the proposal should be provided. Discuss effects of the project on the existing environment, including any archaeological, enthnographic and heritage aspects and the existing local population.

This section should show the overall effect on the total ecosystem and surroundings of the area. It will be necessary to address the impacts on the individual environmental components before a final overall synthesis can be made. In all cases where an assessment is made the criteria employed to assess impacts should be clearly stated. Wherever possible, effects should be quantified and uncertainties highlighted. The synthesis should also include an assessment of the significance and timing of the various impacts identified. For example:

- it may be useful to examine mine site impacts separately from plant impacts;
- construction impacts separately from operational and decommissioning impacts; and
- some of the infrastructure elements (such as the power supply) will have little or no ongoing interaction with the environment once they are established.

The following potential environmental impacts should be included:

- effects on geomorphology, land stability and landscape
- effects on drainage and water quality (surface and ground)
- effects on biota
- effects of emissions (air and noise)
- management of solid and liquid wastes and stormwater
- impact on adjacent land uses including any conservation and recreation aspects
- effects on access and transport systems
- effects on existing services including power, water, gas and telephone
- effects on existing community facilities
- impacts of construction and operational workforces
- effects on existing contingency planning, safety and emergency services
- visual impact.

It should be noted that air and noise emissions, and visual impact are likely to be key issues and therefore should be addressed in considerable detail.

Predicted noise emissions should indicate the likely presence of special characteristics (eg tonal or pressure components) which may affect the level of annoyance generated by the noise.

"Worst case" scenarios should be described, with the rate of occurrence of these conditions being indicated.

The discussion of air and noise emissions should make specific reference to the way in which seasonal wind patterns are likely to modify the impacts of those emissions.

Impacts should be quantified where possible, and criteria for making assessment of their significance should be outlined. Compliance with relevant standards and statutes should be demonstrated.

A brief and general land capability analysis of the affected land after quarrying for the range of uses considered should be provided.

8 ENVIRONMENTAL MANAGEMENT

An environmental management programme should be described on the basis of (and cross-referenced to) the synthesis of environmental impacts previously outlined. The objectives, the scope and details of the programme should be described. Assignment of responsibility for environmental management structure should also be stated and commitments given.

Discuss the mechanism proposed to ensure that environmental management commitments are met through fluctuating economic conditions.

Specific commitments should be given to all components and procedures of the environmental management programme.

The PER should include an indication of the likely life of the project and preliminary plans for decommissioning the plant and rehabilitating the mine site.

Emphasis should be given as to how the environmental management programme will be adapted in response to results from the monitoring programme.

Discuss the plans for decommissioning of the existing site including; timing, methods for rehabilitation of the mine site and plant site, and likely final land use for the site.

9 MONITORING

The systems for the treatment and control of air, noise and water pollution will require monitoring to ensure that they are operating efficiently and the receiving environment will require monitoring to ensure that environmental impacts are constrained to an acceptable level.

The specification of a monitoring programme should be given and responsibility for the operation of that system should be assigned, Emphasis should be placed on how the environmental management programme and plant operations will be adapted where necessary in the light of monitoring or auditing results.

Procedures should be outlined for reporting the results of the monitoring of environmental impacts to the appropriate authorities.

10 CONCLUSION

Conclusions of the overall impact of the proposal (including the role of ameliorative measures) should be stated together with an assessment of the environmental acceptability of the project.

11 COMMITMENTS

A list of commitments made by the proponent in the PER should be given.This would be best placed in the document as an Appendix.

12 REFERENCE (BIBLIOGRAPHY/ABBREVIATIONS)

12.1 GLOSSARY

Provide definitions of technical terms used. Also define and explain units of measurement which may not normally be understood by the interested layman.

12.2 GUIDELINES

Guidelines which have been approved by the EPA should be reproduced in the document.

12.3 APPENDICES

These may be produced as separate volumes or incorporated in the back of the document.

WESTERN AUSTRALIA
ENVIRONMENTAL PROTECTION AUTHORITY

Information to be supplied with an application for Works Approval/Licence

Air Pollution Control

Where relevant:

A1 The Company name as registered with the Corporate Affairs Department and a brief description of the nature of the project.

A2 A locality plan showing the location of the site, relevant lot boundaries and processing plant, and providing details of surrounding land uses (e.g. industrial, rural, residential, etc).

A3 Description of the proposed installation, modification or replacement or alteration of the type of materials or fuel used in the process.

A4 A site plan showing the layout of the processing plant and details of emission points of gaseous wastes with regard to location and height. The site plan should be at a scale of between 1:250 and 1:2500. A diagram showing the elevation and general arrangement of the various plant components.

A5 Quantity of products to be produced annually (tonnes).

A6 Details of the process generating the gaseous wastes.

A7 General arrangement drawings and/or piping and instrumentation drawings of plant affected.

A8 Details of proposed air pollution control equipment complete with arrangement drawings and specifications if possible.

A9 Details of the gaseous wastes to be emitted both before and after treatment, with regard to the following items, where applicable:

(a) Chimney stack height
(b) Volumetric flow rate
(c) Temperature
(d) Composition
(e) Concentration of particulate matter and size range
(f) Proposed outlet velocity
(g) Humidity

A10 Details of buildings and structures within a 30m radius of the emission points and at a greater distance where an effect on the dispersion characteristics of any emission point or stack is possible.

P.T.O.

Continued:

A11 Details of hydrocarbons and/or organic solvents, likely to be emitted by or used in the process, with regard to the following items:

(a) Type of solvents or hydrocarbons
(b) Consumption rates

A12 Details of any odours likely to be emitted by the processes and of control measures proposed. Advise odour threshold value of materials handled in the process where known.

It is not a requirement for the above information to be presented in a professionally drafted form, however, all information must be clear, unambiguous and suitable for an understanding of the treatment and control methods. Calculations, dimensions, construction details, levels etc, will not be checked for accuracy and the full responsibility for implementation of these schemes remains with the owner or applicant.

Should there be concern that the works is of a controversial nature, it should be discussed with officers of the Water Authority and the Environmental Protection Authority prior to a detailed submission.

Any queries associated with liquid waste management related to the application should be directed to Mr Peter Ryan (Ph: 09 420 2431) at the Water Authority in Perth. Any queries associated with air and noise pollution should be directed to the Receptionist at the Pollution Control Division of the Environmental Protection Authority on (Ph: 09 222 7122) for transfer to the appropriate officer.

Z:INFO:sc

ATTACHMENT 2

STUDY TEAM AND AUTHORITIES CONTACTED

ATTACHMENT 2

STUDY TEAM AND AUTHORITIES CONTACTED

This report has been prepared by a Task Force established by Pioneer to address the environment and social issues associated with the Herne Hill operations. The Task Force has been operating since 1986 and consists of the following members:

Mr George Purdy	–	Chairman
Mr John Blake	–	Manager, Pioneer Concrete (WA) Pty. Ltd.
Mr Ted Fowles	–	State Manager, Pioneer Concrete (WA) Pty. Ltd.
Mr Con Rimpas	–	State Manager, Pioneer Asphalts Pty. Ltd.
Mr Tony Pignot	–	Manager (Herne Hill), Pioneer Quarries
Mr Ed Boucaut	–	Environmental Scientist, Dames & Moore
Mr Phil Palmer	–	Landscape Architect, P. & M. Tooby
Mr Peter Foss	–	Lawyer, Mallesons Stephen Jaques
Ms Jan Hope	–	Public Relations

The following consultants were used to prepare sections of the report:

P. & M. Tooby	–	Rehabilitation
Ninox Wildlife Consultants	–	Vertebrate Fauna
Herring Storer Acoustics	–	Noise Modelling
Dames & Moore	–	Vegetation and Flora
McDonald, Hales & Associates	–	Ethnography
Quartermaine Consultants	–	Archaeology
Airblast Technology	–	Blast Monitoring

Authorities contacted during the preparation of the PER include:

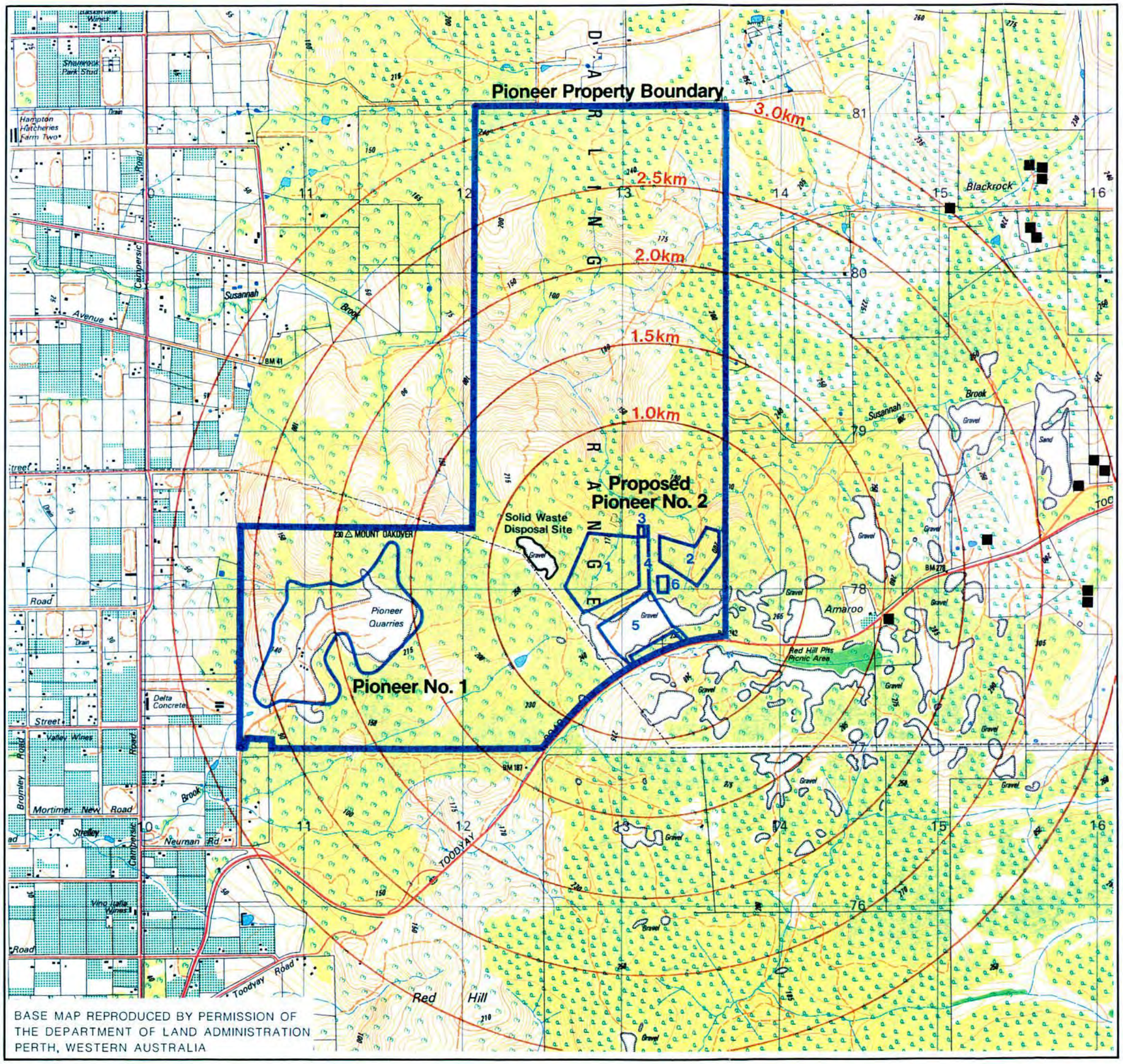
The Shire of Swan;
The Environmental Protection Authority;
The Department of Planning and Urban Development;
The Western Australian Water Authority; and
The Mines Department.

Figures

AIRPHOTO MOSAIC
HERNE HILL REGION

DAMES & MOORE

FIGURE 1



BASE MAP REPRODUCED BY PERMISSION OF THE DEPARTMENT OF LAND ADMINISTRATION PERTH, WESTERN AUSTRALIA

PIONEER No. 2 — LEGEND

1 WEST PIT

2 EAST PIT

3 PRIMARY & SECONDARY CRUSHERS

4 CONVEYOR

5 TERTIARY CRUSHER/ INFRASTRUCTURE AREA

6 ASPHALT PLANT

■ EXISTING RESIDENCES EAST OF PIONEER NO. 2

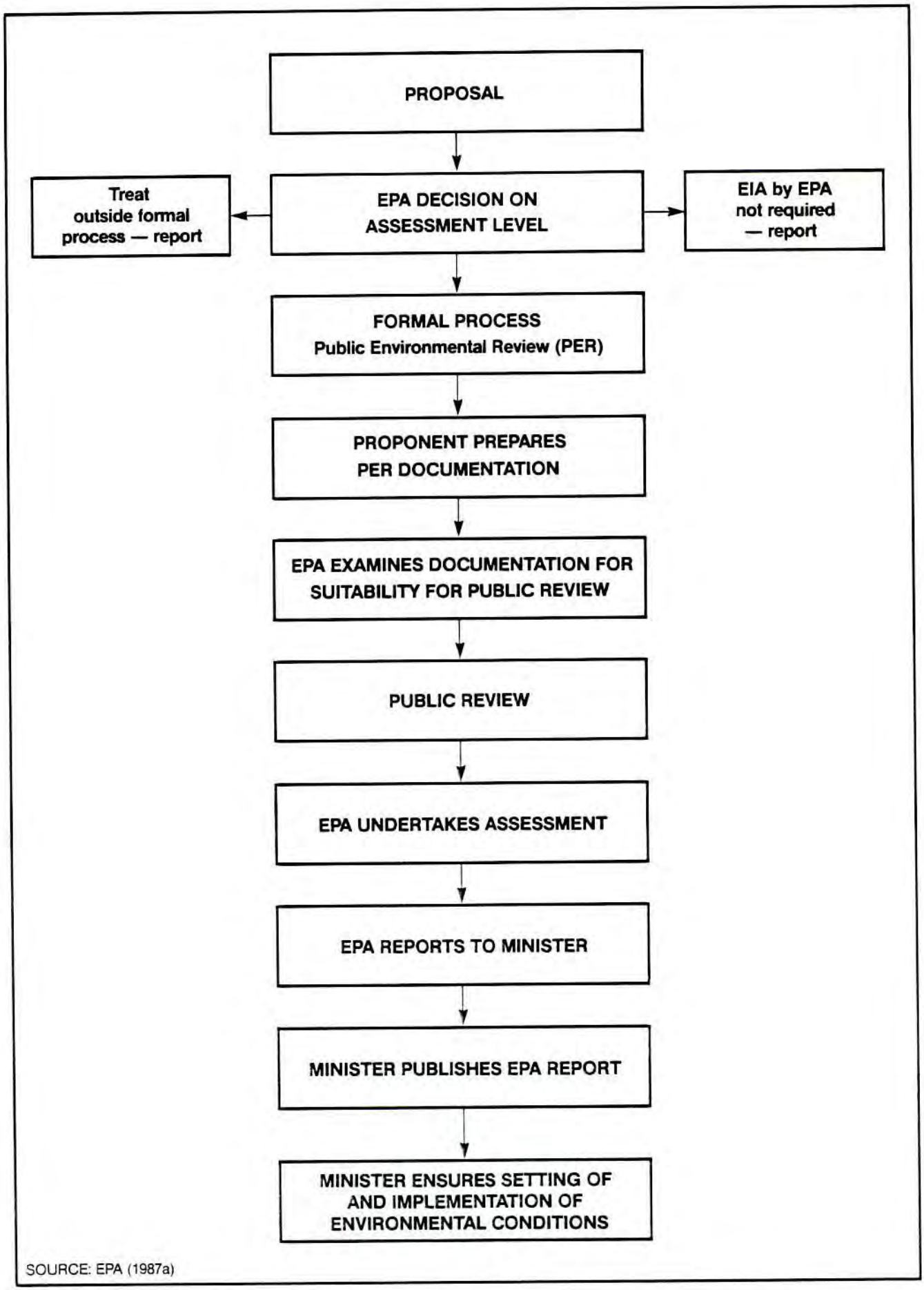
0 0.5 1km

SCALE 1 : 25 000

LOCATION OF THE PROJECT

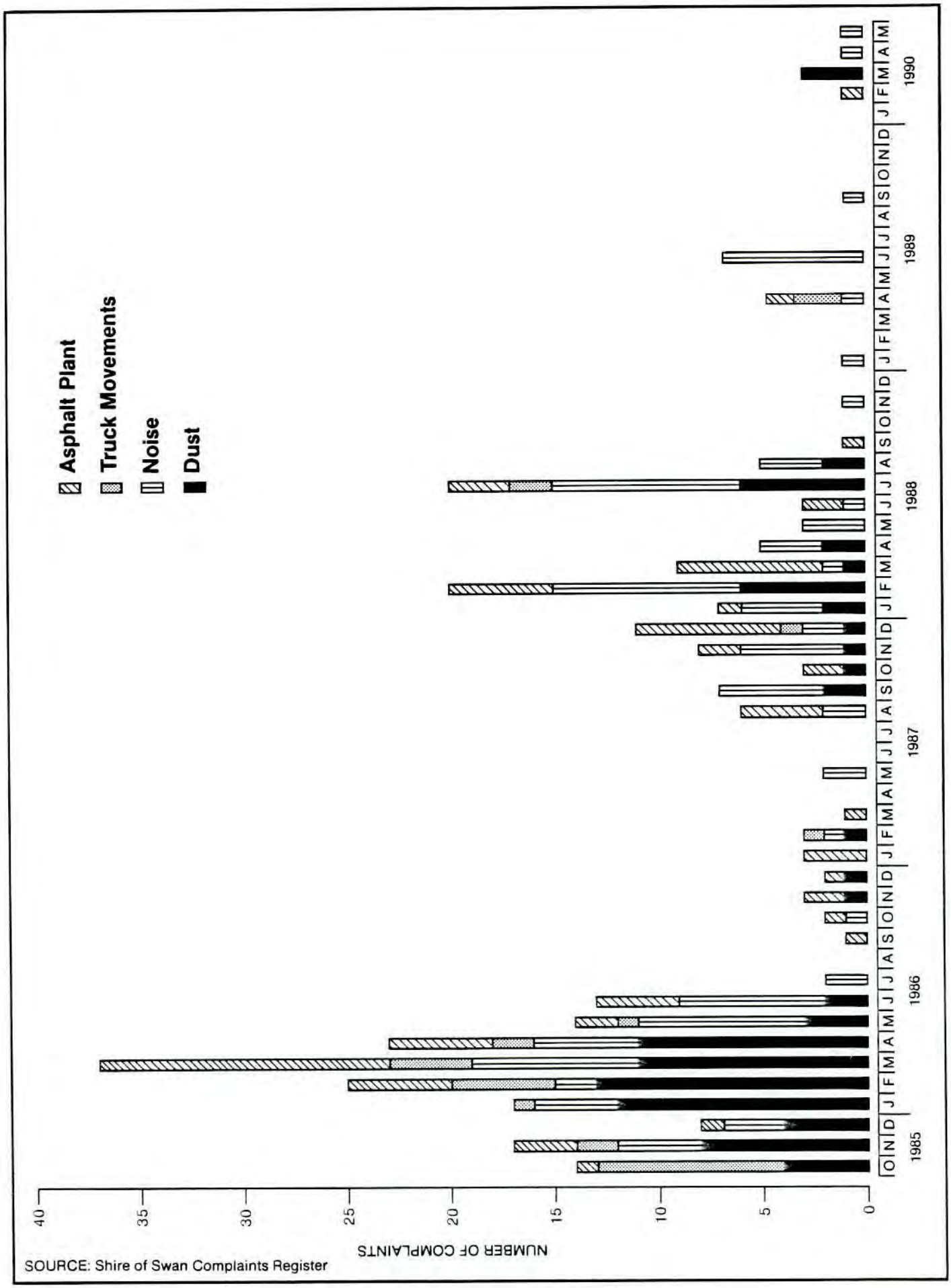
DAMES & MOORE

FIGURE 2



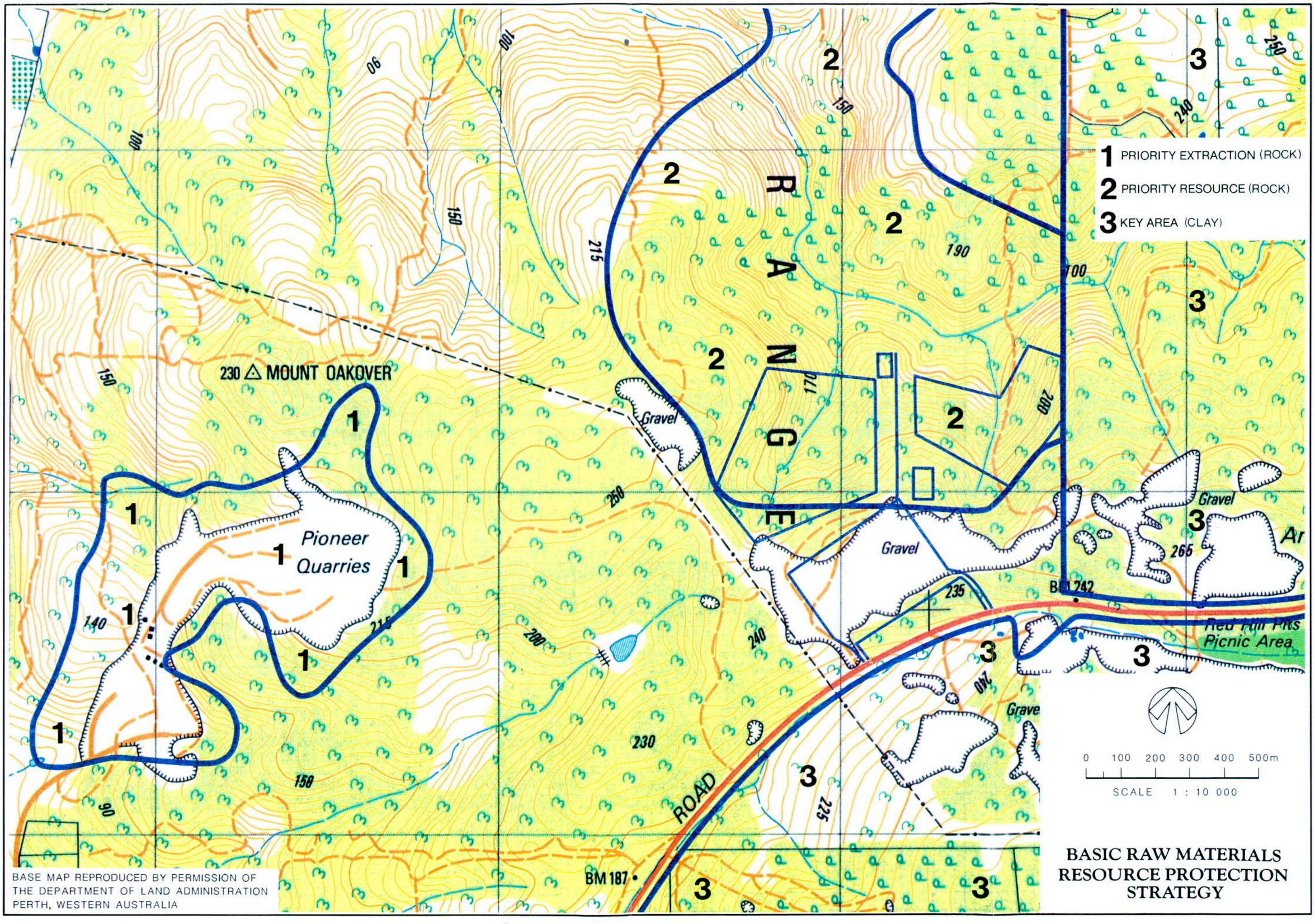
SOURCE: EPA (1987a)

ENVIRONMENTAL IMPACT ASSESSMENT PROCESS



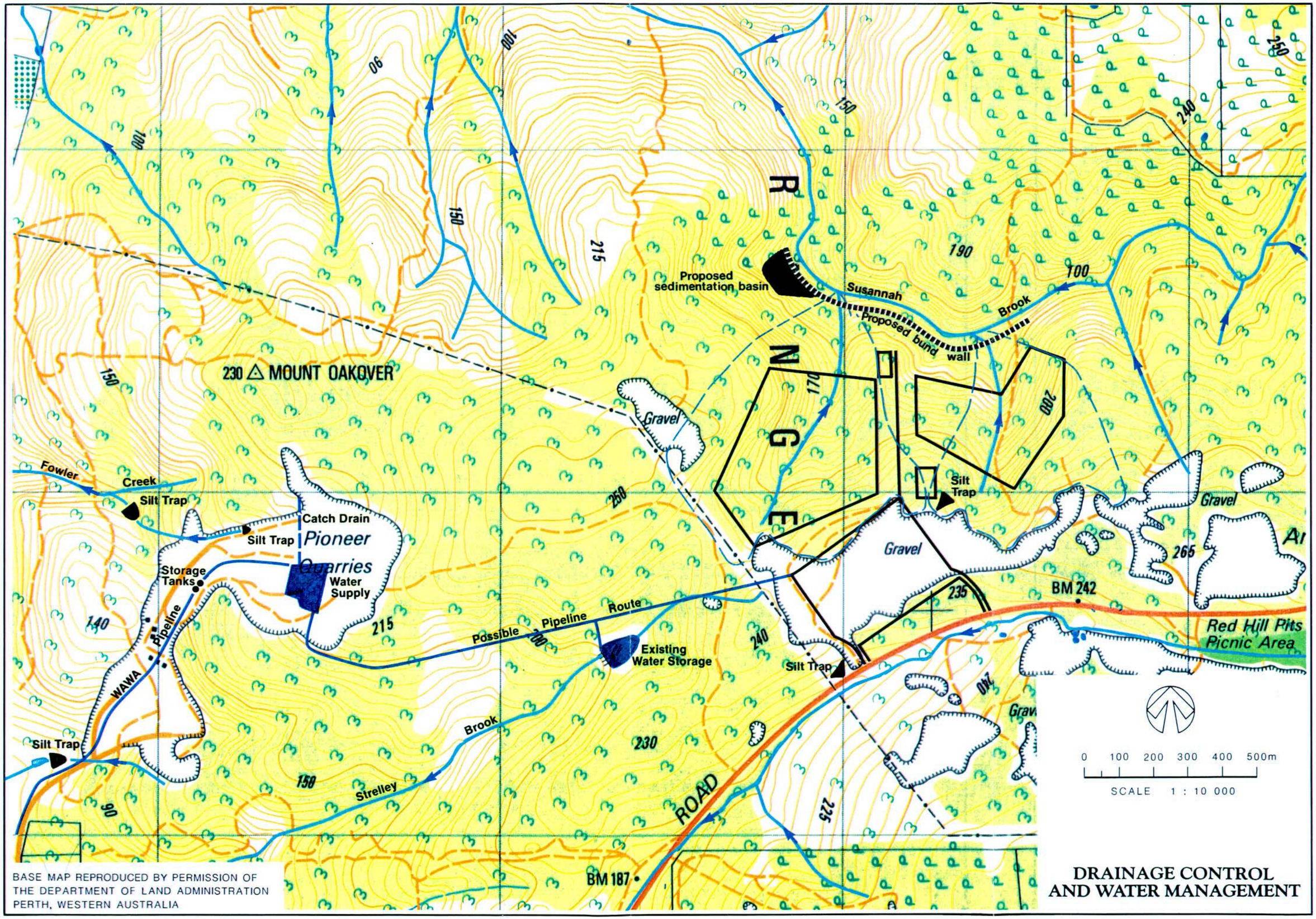
SOURCE: Shire of Swan Complaints Register

COMPLAINTS SUMMARY
PIONEER No. 1 QUARRY



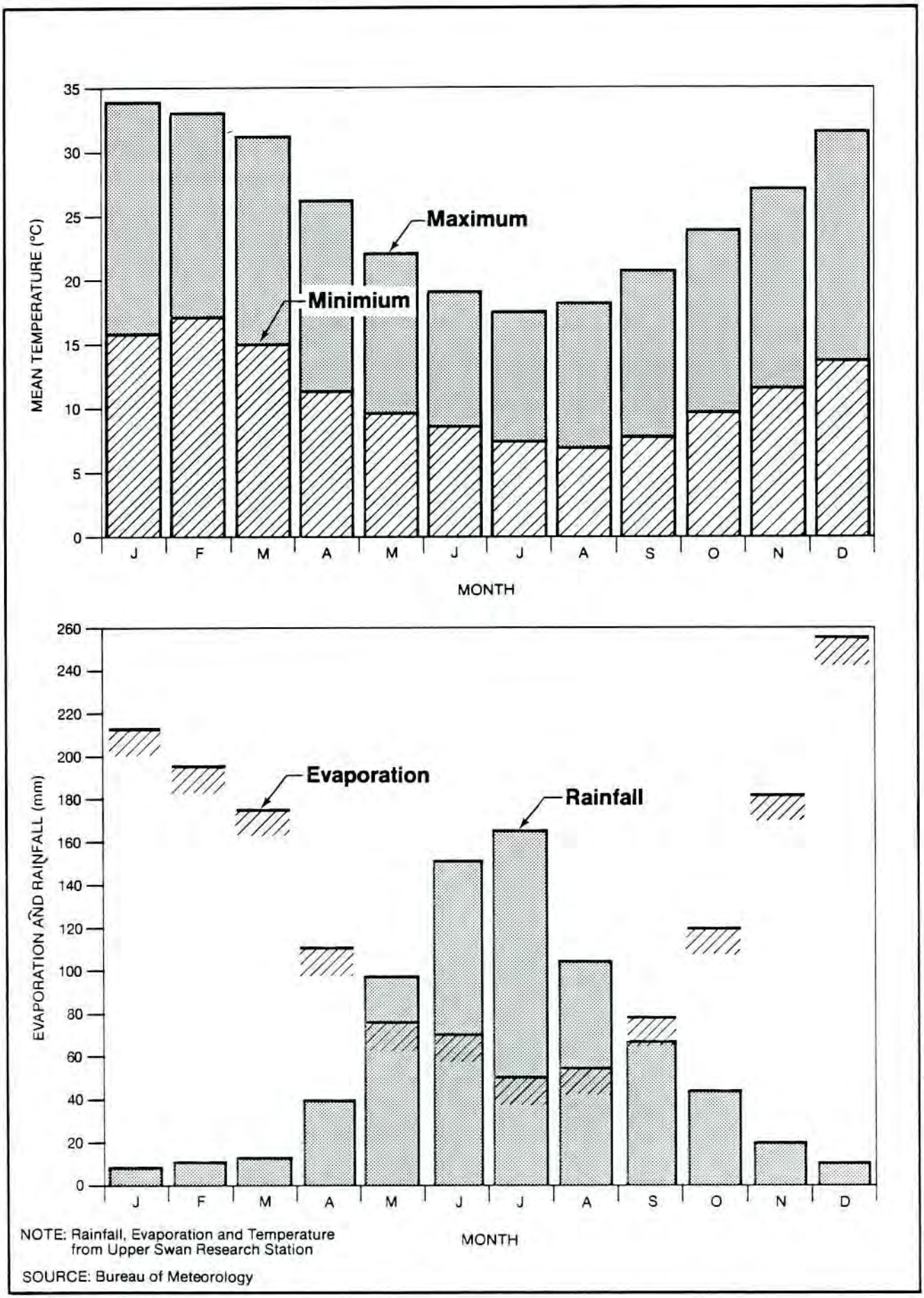
DAMES & MOORE

FIGURE 5



BASE MAP REPRODUCED BY PERMISSION OF THE DEPARTMENT OF LAND ADMINISTRATION PERTH, WESTERN AUSTRALIA

DRAINAGE CONTROL AND WATER MANAGEMENT

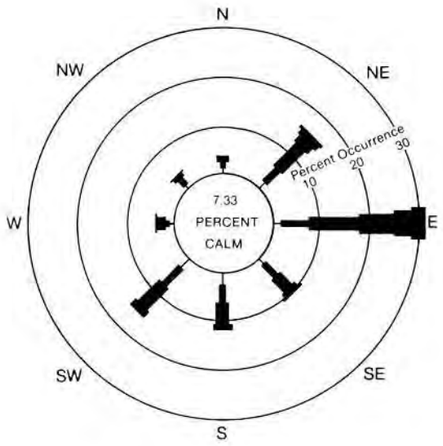


NOTE: Rainfall, Evaporation and Temperature from Upper Swan Research Station

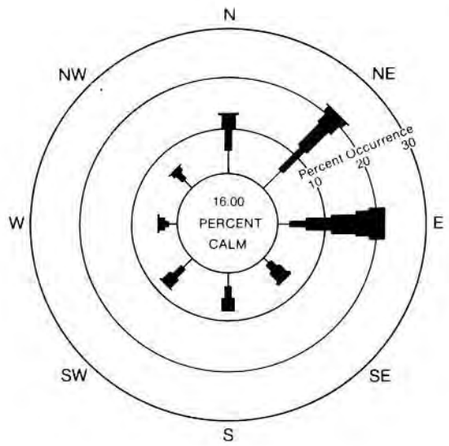
SOURCE: Bureau of Meteorology

MONTHLY TEMPERATURE, RAINFALL AND EVAPORATION

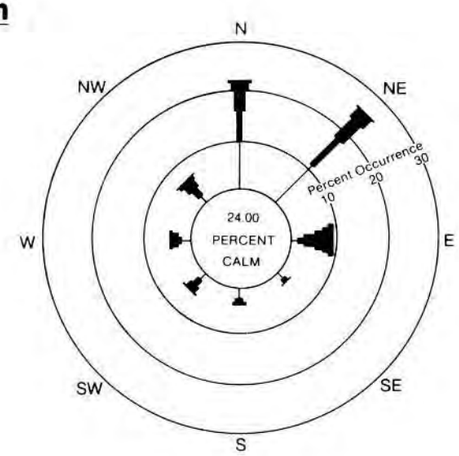
9.00am



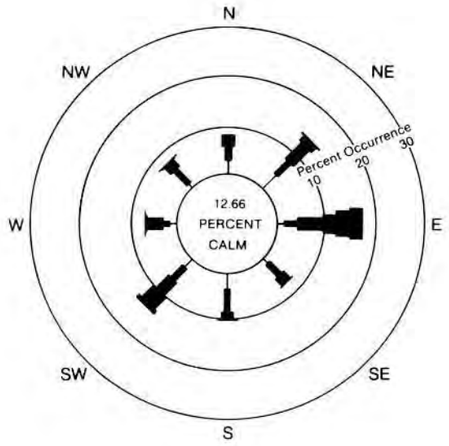
SUMMER



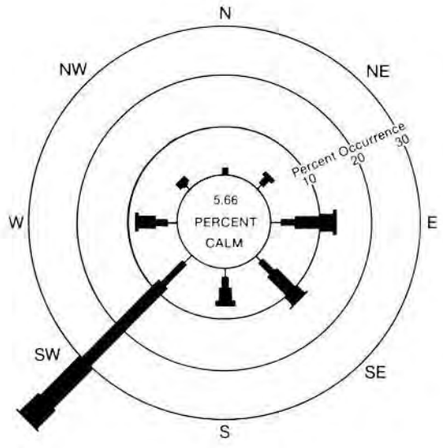
AUTUMN

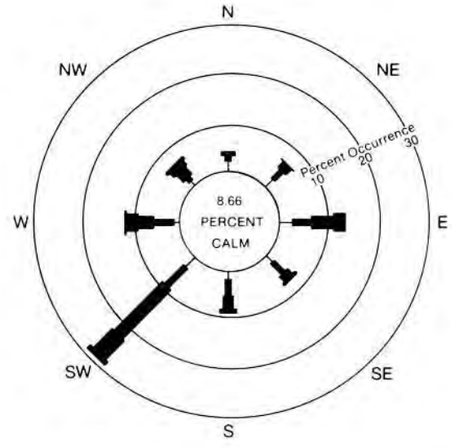


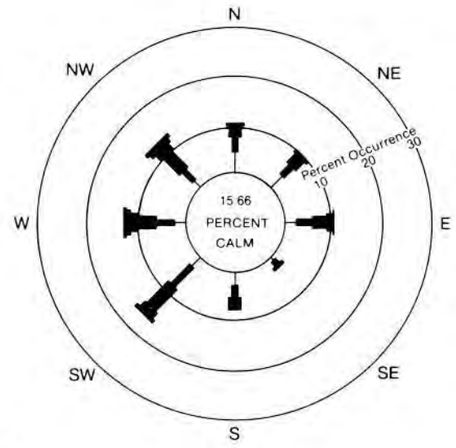
WINTER

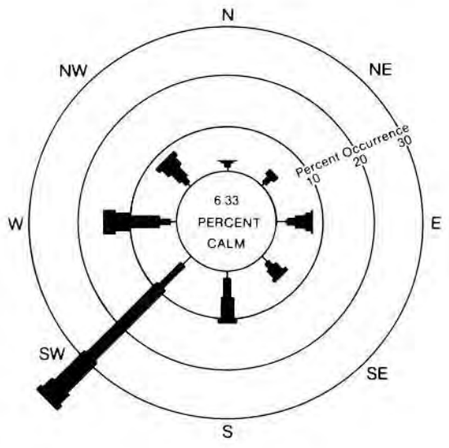


SPRING









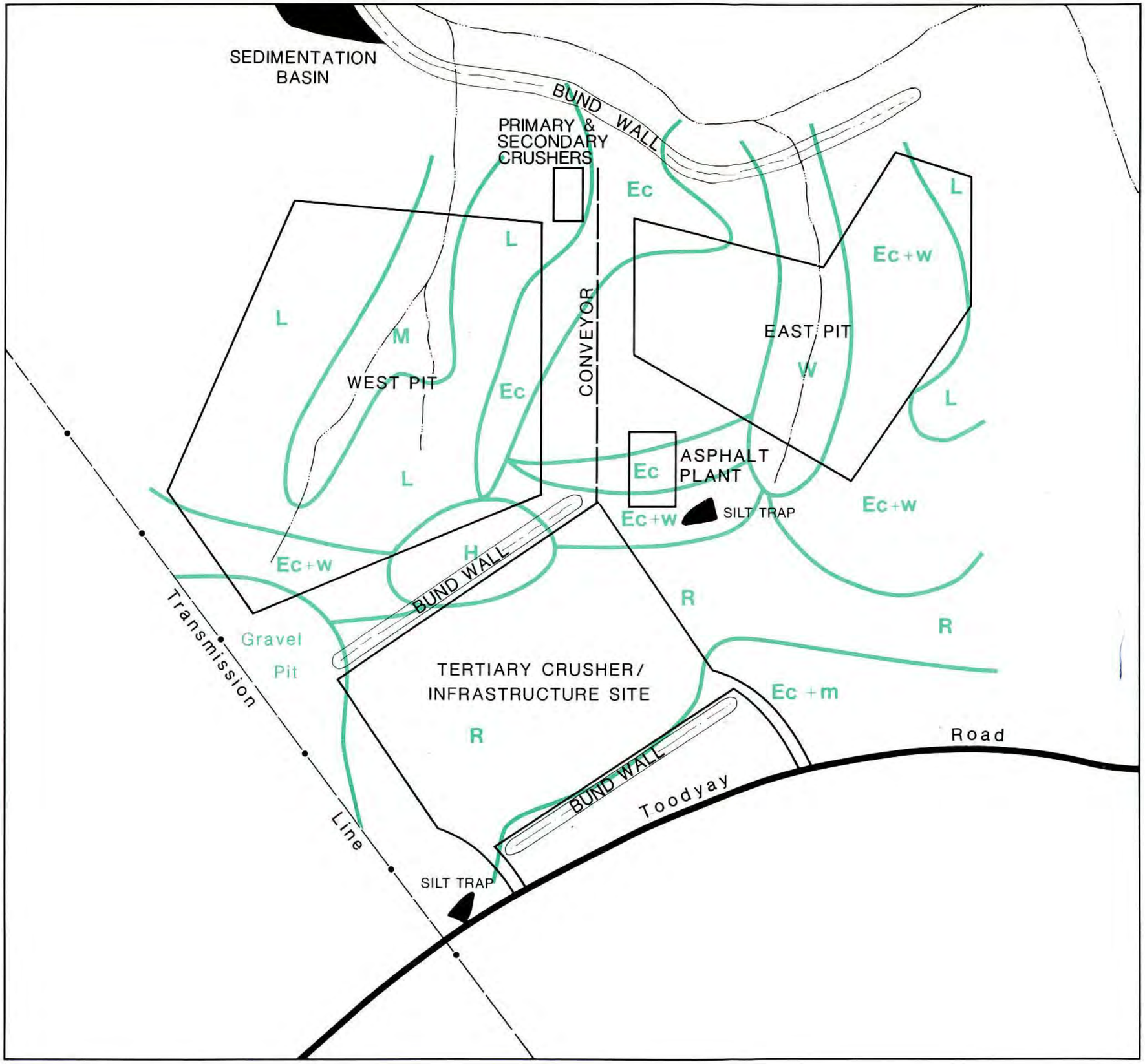
3.00pm

WIND SPEED RANGE
(km/hour)

1 - 5
8 - 10
11 - 20
21 - 30
31 - 40
over 40

SOURCE: Bureau of Meteorology

SEASONAL WINDROSES
UPPER SWAN
RESEARCH STATION



H	HEATH
L	LITHIC
R	REVEGETATION AREA
M	1st ORDER STREAM MARRI
W	1st ORDER STREAM WANDOO
Ec	MARRI LOW WOODLAND
Ec+w	MARRI — WANDOO LOW WOODLAND
Ec+m	MARRI — JARRAH LOW WOODLAND

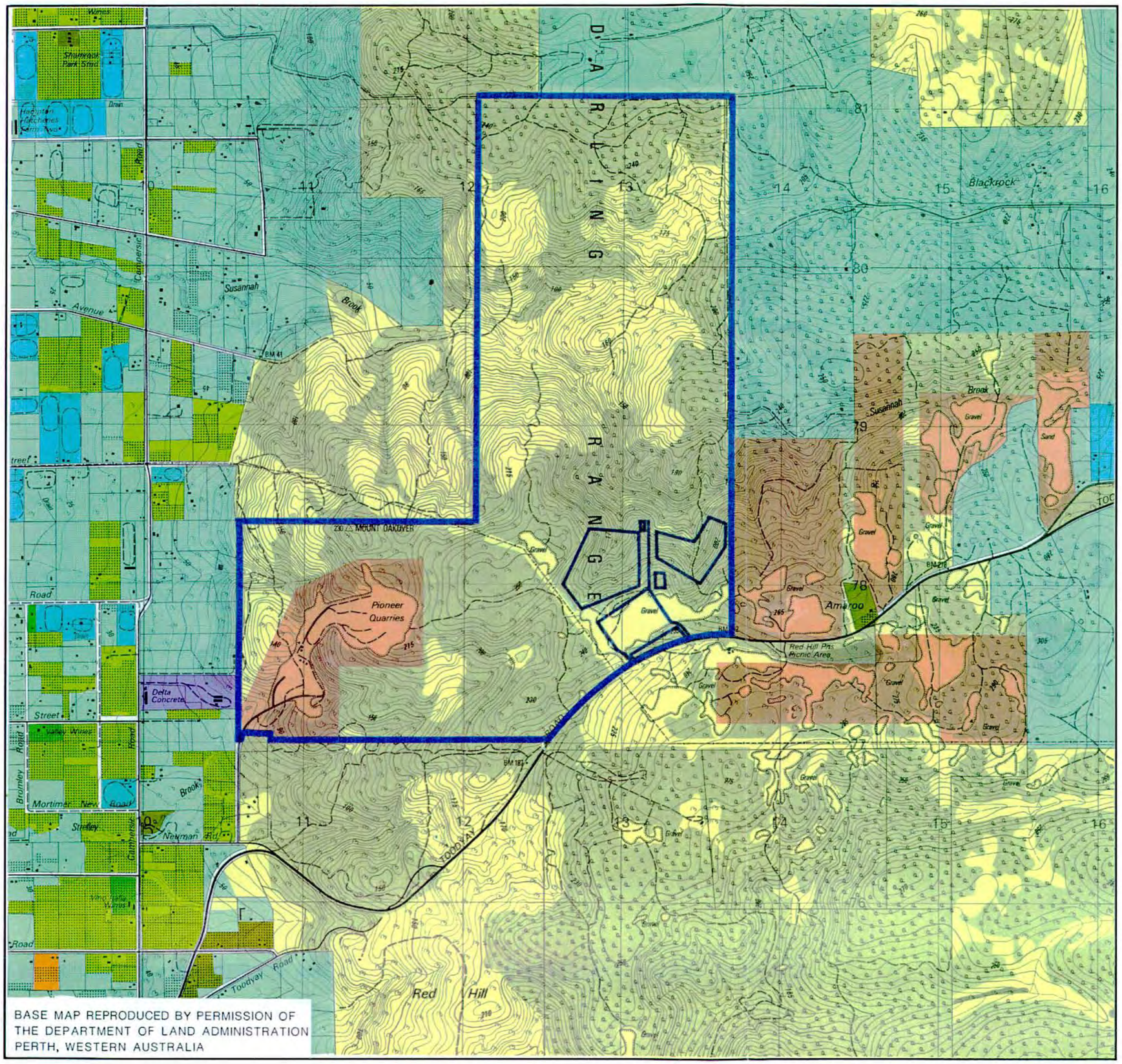
0 100 200m

SCALE 1 : 5000

EXISTING VEGETATION
PIONEER No. 2 SITE

DAMES & MOORE

FIGURE 9



SOURCE: SHIRE OF SWAN

- RURAL — CROPPING, LAND GRAZING
- UNDEVELOPED
- EXTRACTIVE INDUSTRY
- VINEYARD
- WINERY/VINEYARD
- RURAL — HORSE GRAZING
- ORCHARD
- GENERAL INDUSTRY
- MARKET GARDEN

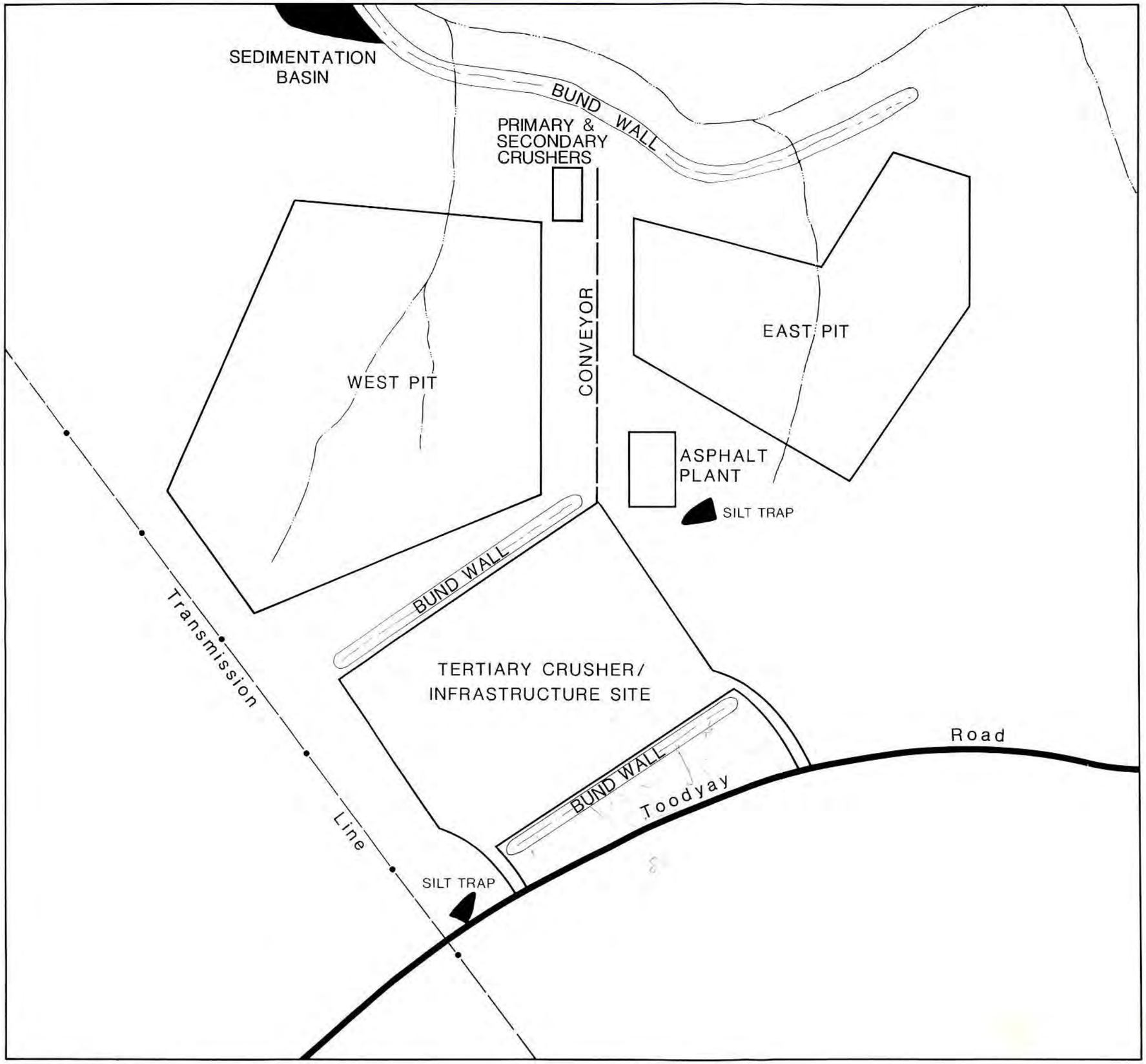
0 0.5 1km

SCALE 1 : 25 000

LAND USE

DAMES & MOORE

FIGURE 10



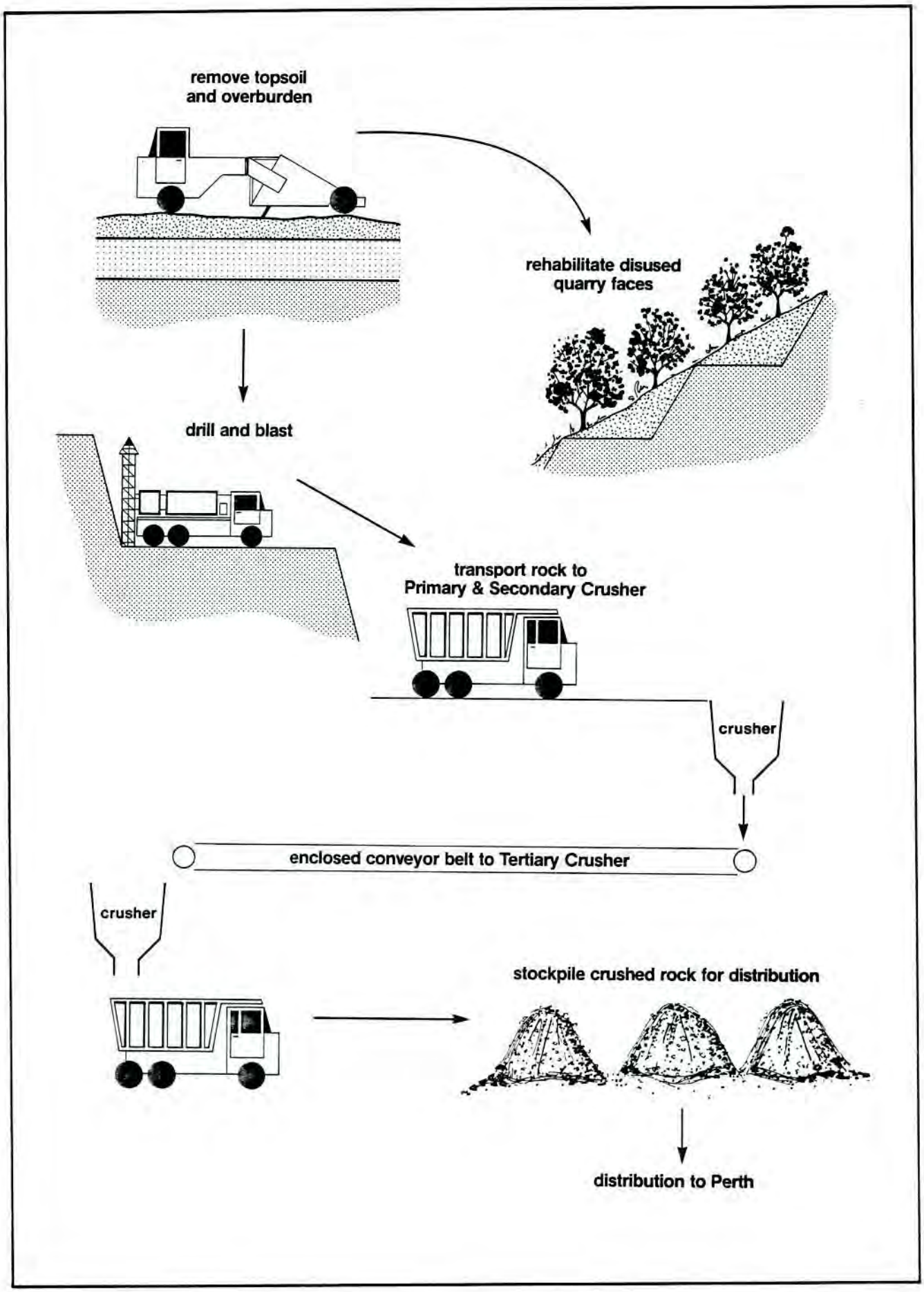
0 100 200m

SCALE 1 : 5000

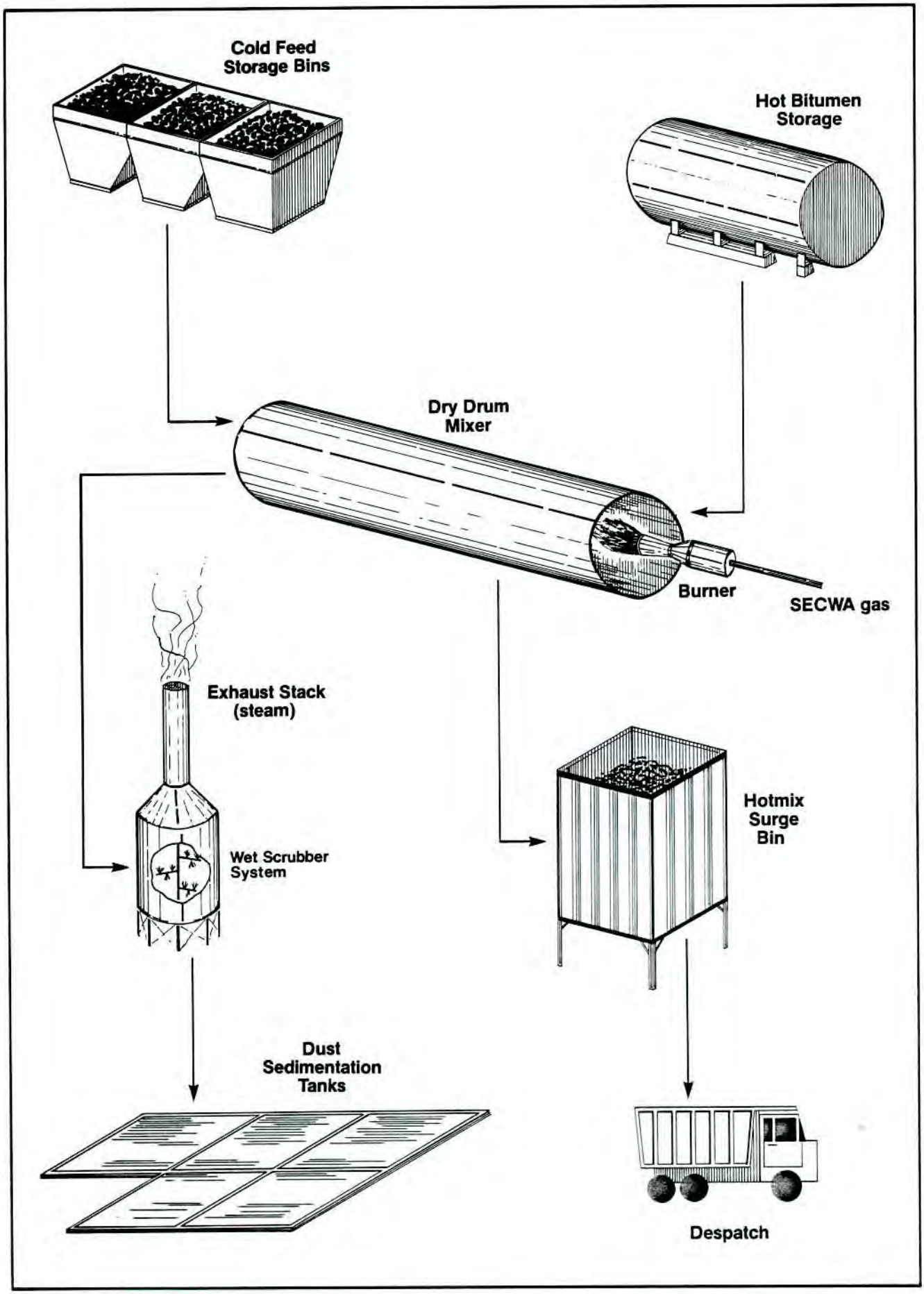
SITE LAYOUT
PIONEER No. 2 SITE

DAMES & MOORE

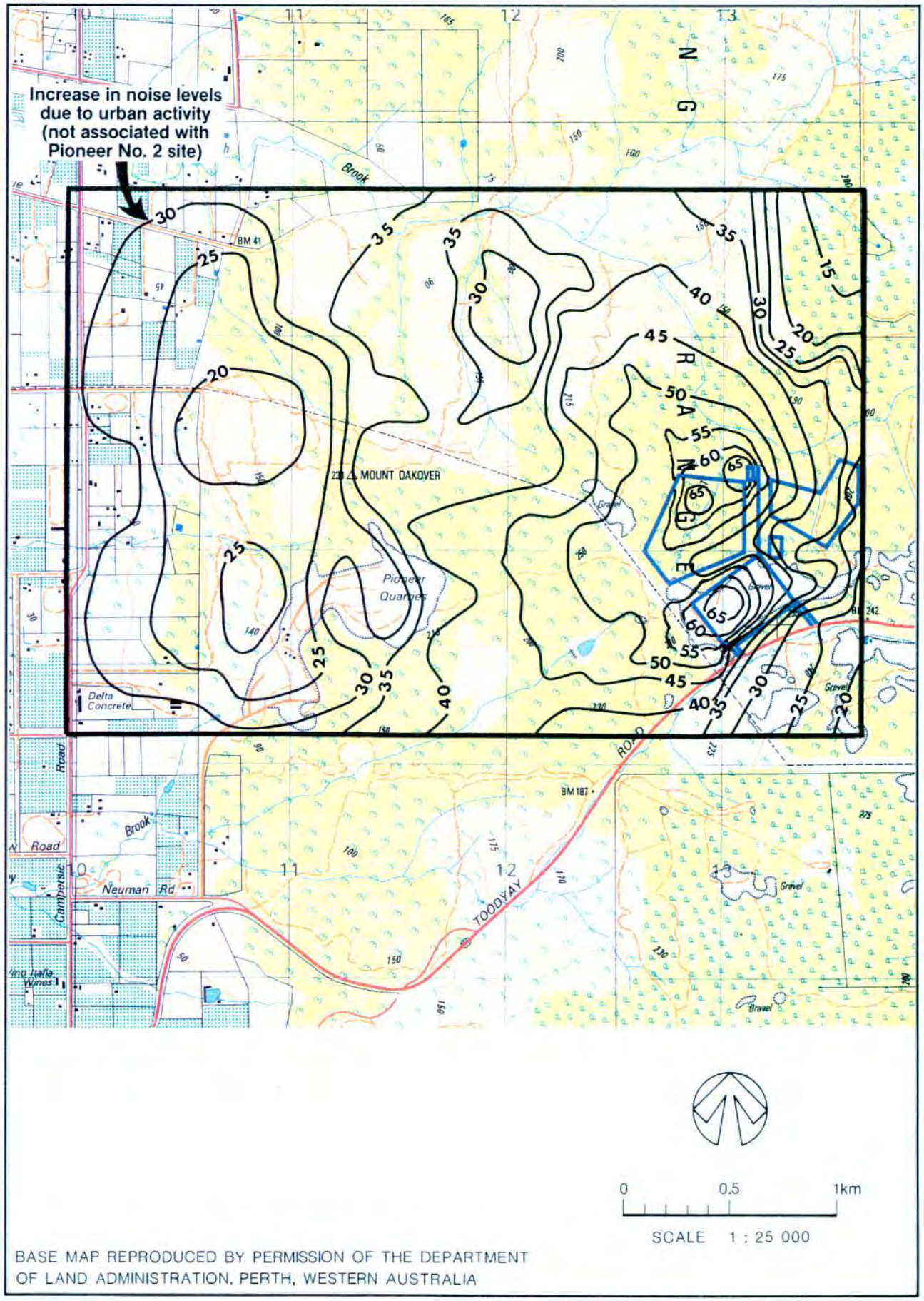
FIGURE 11



QUARRYING PROCESS

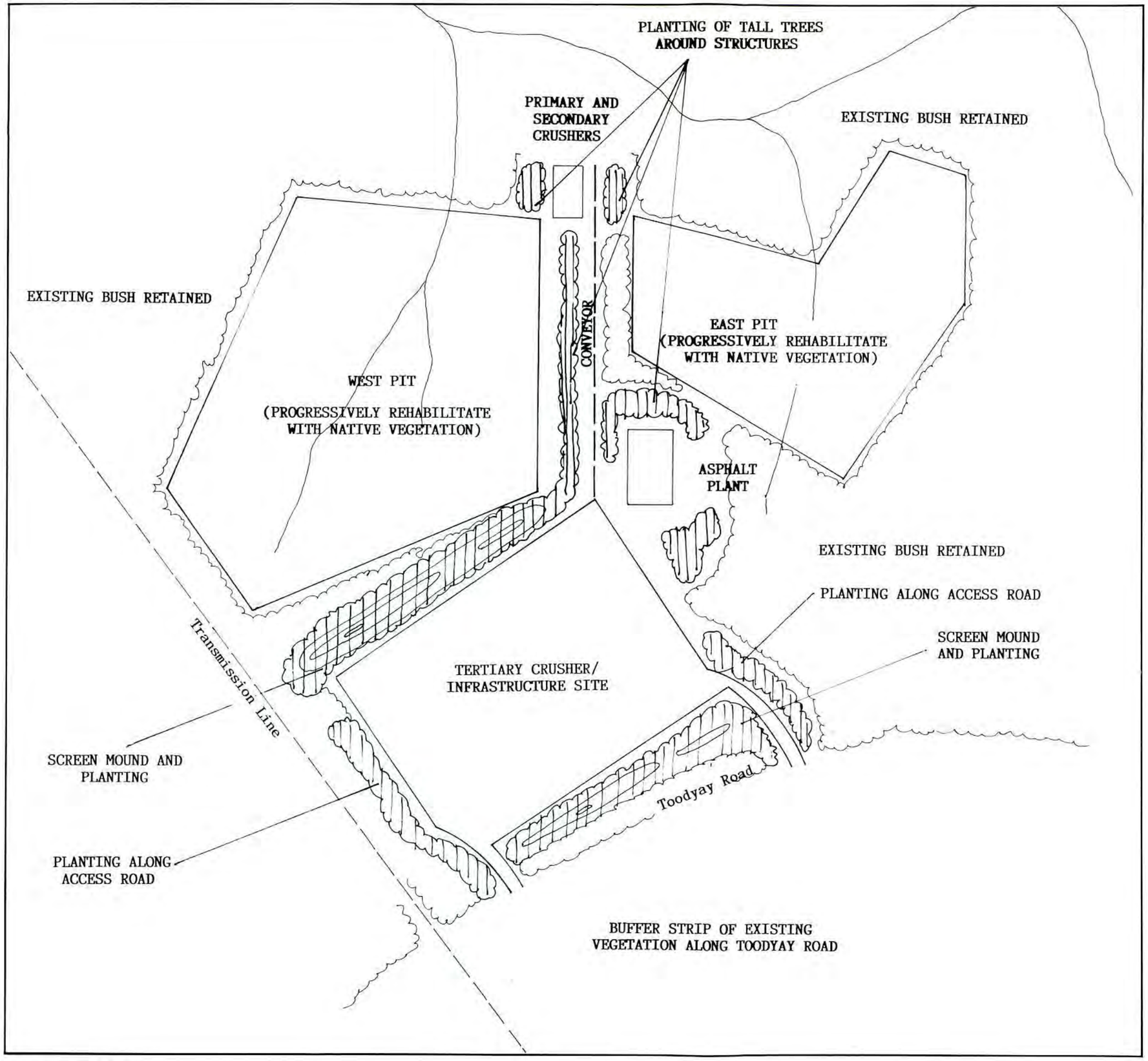


ASPHALT PRODUCTION PROCESS



BASE MAP REPRODUCED BY PERMISSION OF THE DEPARTMENT OF LAND ADMINISTRATION, PERTH, WESTERN AUSTRALIA

PROCESSING NOISE PREDICTIONS PIONEER No. 2 SITE



KEY

EXISTING BUSH RETAINED

PROPOSED SCREEN MOUND

PROPOSED AREAS OF
MAJOR PLANTING
(CONCEPTUAL LAYOUT)

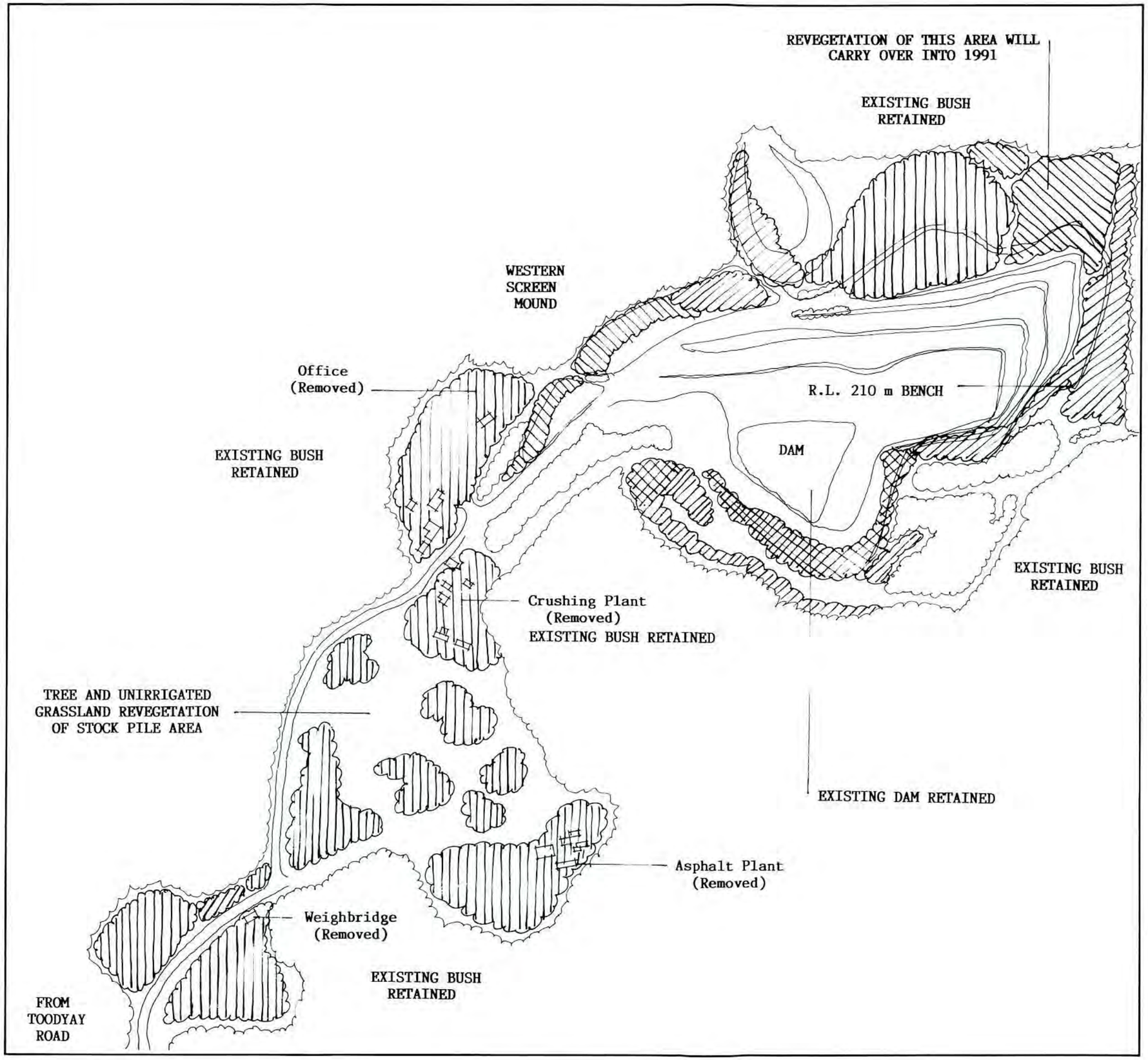
P&M Tooby (1984) Pty. Ltd.
Landscape Architects
2/11, Richardson St,
South Perth W.A. 6151
(09) 474 1010

SCALE 1 : 5000
Approx.

LANDSCAPE PLAN
PIONEER No. 2 SITE

PREPARED BY T & M TOOBY

FIGURE 15



KEY

EXISTING BUSH RETAINED

REVEGETATION

COMPLETED BY 1989

CURRENTLY BEING IMPLEMENTED (1990)

PROPOSED ULTIMATE

P & M Tooby (1984) Pty. Ltd
Landscape Architects
2/11 Richardson St,
South Perth W.A. 6151
(09) 474 1010

SCALE 1 : 5000
Approx.

REHABILITATION PLAN
PIONEER No. 1 SITE

PREPARED BY T & M TOOBY

FIGURE 16

Location of Perspective View

AREAS FROM WHICH QUARRY WOULD BE VISIBLE I.E. OBSERVER WOULD HAVE TO BE STANDING IN AREA SHOWN IN RED TO SEE PROPOSED QUARRY PIT.

PROPOSED QUARRY

EXISTING QUARRY

COMPUTER GENERATED PERSPECTIVE VIEW OF PIONEER No. 1 & No. 2 SITES FROM SWAN COASTAL PLAIN (LOCATION SHOWN ON PLAN)

0 0.5 1km

SCALE 1 : 25 000

BASE MAP REPRODUCED BY PERMISSION OF THE DEPARTMENT OF LAND ADMINISTRATION PERTH, WESTERN AUSTRALIA

VISUAL IMPACT ASSESSMENT PIONEER No. 2 SITE

DAMES & MOORE

FIGURE 17

Plates

A. Pioneer No. 2 — Proposed Quarry Site (West Pit)
looking across site to southwest.

B. Pioneer No. 2 — Proposed Quarry Site (West Pit)
close-up view to southwest.

A. Pioneer No. 2 — Proposed Site for Toodyay Road Screening Bund view along bund to southwest.

B. Pioneer No. 2 — Proposed Tertiary Crusher/Infrastructure Site view to southwest.

A. Pioneer No. 2 — Proposed Tertiary Crusher/Infrastructure Site looking east across site.

B. Pioneer No. 2 — Proposed Tertiary Crusher/Infrastructure Site looking west across site.

A. Pioneer No. 2 — Proposed Primary/Secondary Crusher Site looking east across site, June 1990.

B. Pioneer No. 2 — Proposed Primary/Secondary Crusher Site looking west across site, June 1990.

A. Pioneer No. 2 — Proposed Primary Crusher Tip Point looking south across site, June 1990.

B. Meteorological Monitoring Station Proposed Tertiary Crusher/Infrastructure Site.

A. Pioneer No. 1 — Rehabilitation of Quarry Face June 1990 (Rehabilitation started in 1988).

B. Pioneer No. 1 — Close-up of rehabilitated vegetation (approx. 1-3m high).

Appendix A

APPENDIX A

DETAILED VEGETATION DESCRIPTIONS

APPENDIX A

DETAILED VEGETATION DESCRIPTIONS

MARRI-WANDOO LOW WOODLAND (See Plate A1 - a)

Vegetation:

Mixed Eucalyptus woodland 6-15m tall, 10-30% canopy cover, dominated by E. calophylla, with E. wandoo common and E. accedens locally common on diorite derived soils. Below this stratum were mixed open low woodlands 3-6m tall, with 2-10% canopy cover, comprising Banksia grandis and Nuytsia floribunda. A lower-middle stratum comprised mixed open low scrub, 1.0-2.0m tall, with 2-10% canopy cover, dominated by Xanthorrhoea acanthostachya with occasional Hakea lissocarpha, H. trifurcata, H. undulata and Macrozamia riedlei. The lower shrub stratum consisted of low heath to 0.5m tall, with 30-70% canopy cover, dominated by Dryandra nivea, Hibbertia hypericoides and Lepidosperma angustatum. There was a ground layer of open herbs to 0.3m tall, with 2-10% canopy cover, including remnant annual grasses and Asteraceae.

Laterite Residue Soil:

Silty clay, weakly pedal, brown, 80-90% laterite pebbles, substrate laterite over granite at depth, moderately well-drained, slope 2^{o}, minimal runoff, no existing erosion but with a slight erosion potential. The upper slopes of lithic complex vegetation which occur near the plateau were also noted to have laterite residues.

Diorite Soil:

Silty clay, pedal, red-brown. Diorite boulders outcrop along ridge at an average 30% cover, moderately drained, slight runoff, slope $<5^{o}$, minimal existing erosion, potential erosion slight to moderate. Diorite occurs as intrusions in granite.

MARRI LOW WOODLAND (See Plate A1 - b)

Vegetation:

Eucalyptus calophylla woodland to 10-15m tall, with 10-30% canopy cover. Below this were mixed scrub to low scrub 1-3m tall, with 10-30% canopy cover with Xanthorrhea acanthostachya dominating, and with Hakea cristata and Macrozamia riedlei common. Below this was a mixed low heath to 1.0m tall, and 30-70% canopy cover, dominated by Hibbertia hypericoides, H. commutata, Hakea lissocarpha, Daviesia horrida, Dryandra armata and D. nivea. Below this were mixed open herbs to 0.3m tall, with 10-30% canopy cover, including remnant annual grasses and Asteraceae.

Soil:

Silty clay, friable, grey-brown, some grits, quartz pebbles on ground surface. Ground surface with 15% (average) cover of granite boulders. Skeletal soil over substrate of granite-gneiss, poorly drained, slope 5^{o} to 10^{o}, minimal to moderate existing erosion, moderate sheet run-on and run-off, erosion potential severe when disturbed.

1ST ORDER STREAM - MARRI

Vegetation:

Eucalyptus calophylla woodland, 10-18m tall, 10-30% canopy cover, with occasional Nuytsia floribunda to 4m tall. Below this was mixed open low scrub 1-2m tall, with 2-10% canopy coverage, comprising Calothamnus rupestris (in dense patches), Hakea undulata and Xanthorrhoea acanthostachya. Below this was a low heath stratum to 1.0m tall, with 30-70% canopy cover, dominated by Allocasuarina humilis, Beaufortia purpurea, Dryandra armata, D. nivea and Hakea lissocarpha. A ground layer consisted of mixed open herbs to 0.5m tall, with 2-10% canopy cover, including remnant annual grasses and Asteraceae.

Soil:

Sandy loam, orange-brown, 30% grit, with grey-brown organic matter at the surface. Granite-gneiss substrate, moderately drained, slope 5^{o} - 20^{o}, moderate existing gully erosion, moderate run-on and run-off, severe erosion potential if disturbed, high nutrient holding capacity (high iron content).

Sedimentation and high volume water runoff are potential problems as this stream is a tributary of Susannah Brook.

FIRST ORDER STREAM - WANDOO (See Plate A2 - a)

Vegetation:

Eucalyptus wandoo low forest 8-15m tall, 30-70% canopy cover. Below this were mixed low scrub 1-2m tall, with 10-30% canopy cover with Xanthorrhoea preissii dominating, and with Hakea trifurcata, H. cristata both common, below this was a mixed low heath to 0.5m tall, and 30-70% canopy cover, dominated by Hibbertia hypericoides. Below this were mixed open herbs to 0.3m tall with 10-30% canopy cover, with no species dominant.

Soil:

Sand, coarse, light yellow-brown, gritty with 20% pebbles, colluvial in origin, moderately to well drained, slope $<5^{o}$, moderate gully erosion, erosion potential severe in creekline and moderate on slopes.

Sedimentation and pollution are potential water quality issues as the stream is a tributary of Susannah Brook.

MARRI-JARRAH LOW WOODLAND

Vegetation:

Mixed Eucalyptus low woodland 6-10m tall, 30-70% canopy cover, comprising equally of E. calophylla and E. marginata. Below this stratum were mixed dwarf open to open low scrub to 0.5-1.5m tall, with 2-10% canopy cover with Hakea undulata dominating. Below this were mixed low heath to 0.5m tall, with 30-70% canopy cover with Hibbertia hypericoides and Xanthorrhoea preissii dominating. Below this were mixed open herbs, low grasses and low sedges all to 0.5m tall, with 10-30% canopy cover.

Soil:

Silty clay, weakly pedal, brown, 80-90% laterite pebbles, substrate laterite over granite at depth, moderately drained, slope 2^{o}, minimal runoff, no existing erosion but with a slight erosion potential. The upper slopes of lithic complex vegetation which occur near the plateau were also noted to have laterite residues.

HEATH (See Plate A2 - b)

Vegetation:

Mixed open scrub 1-2m tall, with 2-10% canopy cover, dominated by dense patches of Calothamnus rupestris and isolated Xanthorrhoea acanthostachya. Below this was mixed low heath to 1.0m tall, with 30-70% canopy cover, no species dominated. Below this on shallow soils were open herbs to 0.3m tall, with 10-30% canopy cover, dominated by Borya sphaerocephala, Conostylis androstemma, Cryptandra arbutiflora, Jacksonia alata and Pimelea imbricata.

LITHIC COMPLEX (See Plate A3 - b)

Vegetation:

Lithic complex of mixed low open scrub 1-3m tall, with 2-10% canopy cover, dominated by Xanthorrhea acanthostachya with occasional dense patches of Calothamnus rupestris. Below this was mixed open dwarf scrub to 1.0m tall, with 2-10% canopy cover, dominated by Calothamnus quadrifidus. Ground layer consisted of open herbs to 0.3m tall, 10-30% canopy cover, dominated by remnant annual grasses and Asteraceae. Boulders 0.5-3.0m diameter covered 20% of the area.

REVEGETATION AREA

Mixed open low woodland 5-10m tall, with 2-10% canopy cover, comprising planted Acacia pycnantha and Eucalyptus platypus. Below this was open dwarf scrub to 0.5m tall, with 2-10% canopy cover, dominated by colonising Oxylobium cuneatum. Below this were open herbs to 0.2m tall, with 10-30% canopy cover, dominated by introduced species including annual grasses, Lotus sp. and Trifolium sp.

Table A1. Proposed Pioneer Herne Hill quarry flora species listing.

Species	Marri and Wandoo Low Woodland	Marri Low Woodland	First Order Stream Marri	Heath	Lithic Complex	First Order Stream Wandoo	Marri and Jarrah Low Woodland
o Acacia pulchella	x	x	x	x	x	x	x
o Acacia saligna					x		
o Acacia urophylla		x					
o Acacia willdenowiana							x
o Actinotus leucocephalus				x	x		
o Agrostocrinum scabrum					x		
o Allocasuarina humilis	x			x	x		
o Andersonia lehmanniana	x						
o Anigozanthos manglesii			x				
o Arthropodium capillipes		x					
o Astroloma pallidum	x			x	x		
o Baeckea camphorosmae	x	x		x	x		
o Beaufortia purpurea	x						
o Boronia cymosa	x						
o Boronia ovata	x		x		x		x
o Borya sphaerocephala				x	x		
o Bossiaea eriocarpa	x						
o Bossiaea ornata			x				
o Burchardia umbellata	x						
o Calothamnus quadrifidus		x	x	x		x	
o Calothamnus rupestris	x						
o Calothamnus sanguineus	x			x			
o Calytrix (?) glutinosa				x			
o Cheilanthes sieberi					x		
o Chorizema dicksonii	x			x			
o Conospermum glumaceum					x		
o Conospermum huegelii					x		
o Conostylis androstema					x		
o Convolvulus erubescens					x		
o Cryptandra arbutiflora				x	x		
o Cymbopogon obtectus					x		
o Dampiera linearis							x
o Darwinia citriodora					x		
o Darwinea pimelioides					x		
o Darwinea pinifolia			x		x		
o Daviesia decurrens	x						
o Daviesia (?) hakeoides		x					
o Daviesia horrida					x	x	
o Dioscorea hastifolia		x					
o Diplopeltis huegelii		x			x		
o Dryandra armata	x			x			
o Dryandra bipinnatifida	x						
o Dryandra nivea	x			x	x	x	x
o Eucalyptus accedens	x						
o Eucalyptus calophylla	x	x	x				x

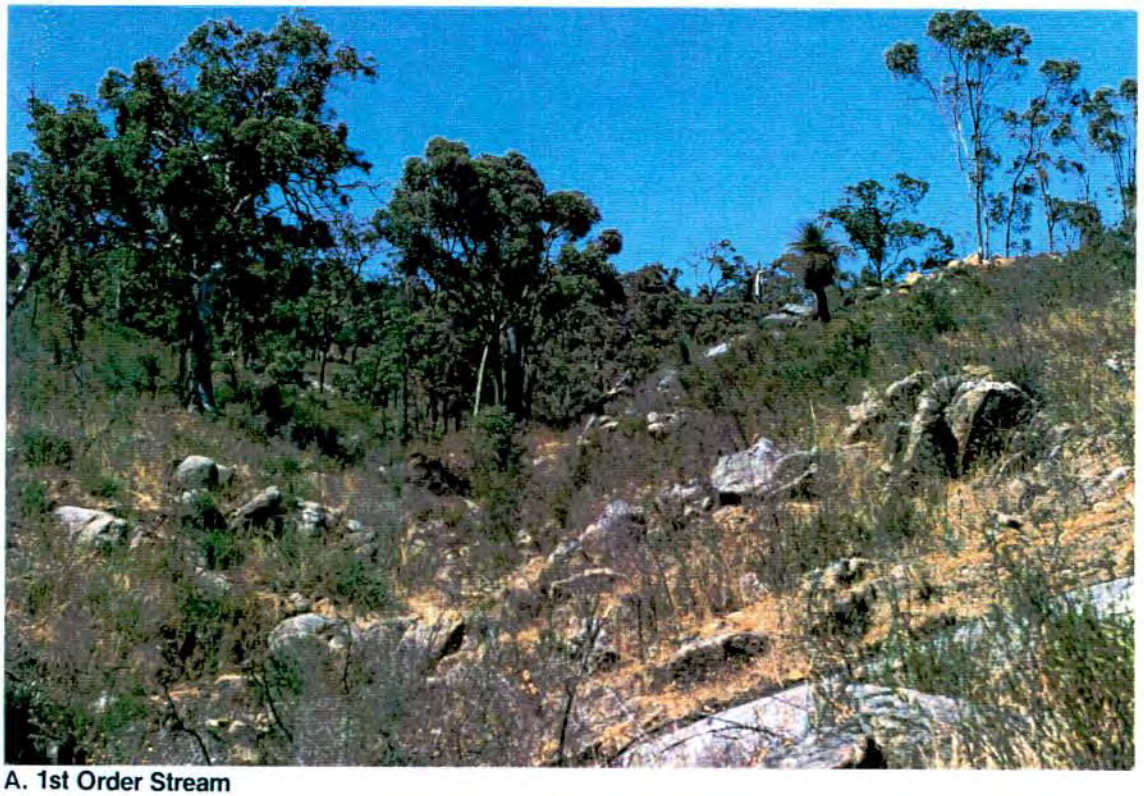
Species	Marri and Wandoo Low Woodland	Marri Low Woodland	First Order Stream Marri	Heath	Lithic Complex	First Order Stream Wandoo	Marri and Jarrah Low Woodland
o Eucalyptus marginata							x
o Eucalyptus wandoo	x					x	
o (?) Eriostemon							x
o Gompholobium marginatum		x				x	
o Gonocarpus cordiger	x			x	x		
o Grevillea bipinnatifida		x		x	x	x	x
o Grevillea endlicheriana				x	x		
o Grevillea synapheae							x
o Haemodorum laxum		x		x	x	x	x
o Haemodorum spicatum		x					
o Haemodorum (?) simulans				x	x		
o Hakea cristata				x	x	x	
o Hakea cyclocarpa							x
o Hakea lissocarpha		x		x			x
o Hakea petiolaris					x		
o Hakea stenocarpa			x	x			
o Hakea trifurcata					x	x	
o Hakea undulata				x	x		x
o Halgania corymbosa	x	x			x		
o Hemiandra pungens			x	x	x		
o Hemigenia incana			x		x		
o Hibbertia commutata	x	x					x
o Hibbertia hypericoides				x	x	x	x
o Hibbertia pachyrrhiza		x					
o Hibbertia subvaginata	x			x			
o Hovea chorizemifolia							x
o Hovea pungens						x	
o Hypocalymma angustifolia	x	x		x			
o Isopogon asper	x			x			
o Isopogon dubius					x		
o Kennedia coccinea	x						x
o Kennedia stirlingii		x			x		
o Kennedia prostrata					x		
o Lechenaultia biloba	x			x	x		x
o Lepidosperma sp.			x		x		x
o Leptospermum erubescens				x			
o Lobelia alata			x				
o Lobelia heterophylla	x	x					
o Logania campanulata				x			
o Lomandra sp.	x						x
o Macrozamia reidlei					x		
o Melaleuca radula	x	x			x	x	
o Melaleuca scabra	x	x		x			
o Mesomelaena tetragona				x	x		x
o Mirbelia spinosa				x	x		
o Muehlenbeckia adpressa		x	x		x	x	
o Nicotiana rotundifolia					x		
o Nuytsia floribunda	x				x		

Species	Marri and Wandoo Low Woodland	Marri Low Woodland	First Order Stream Marri	Heath	Lithic Complex	First Order Stream Wandoo	Marri and Jarrah Low Woodland
o Olearia paucidentata	x	x		x	x	x	
o Opercularia echinocephalus	x					x	
o Orthrosanthus laxus		x					
o Patersonia juncea					x		
o Patersonia rudis	x						
o Pelargonium littorale					x		
o Petrophile biloba	x				x		
o Pentopeltis peltigera							x
o Phyllanthus calycinus		x	x			x	x
o Pimelea imbricata			x				
o Pimelea sp						x	
o Pithocarpa corymbulosa			x				
o Platysace juncea				x			
o Prasophyllum sp. (1m tall)				x			
o Pronaya fraseri					x		
o Ptilotus declinatus					x		
o Ptilotus drummondii		x					
o Pultenaea ericifolia			x				
o Rulingia cygnorum		x			x	x	
o Santalum accuminatum					x		
o Scaevola fasciculata		x			x		
o Scaevola glandulifera	x	x	x		x		
o Scaevola pilosa		x					
o Spiculea ciliata					x		
o Stylidium affine	x						
o Stylidium repens					x		
o Stylidium sp.				x			
o Stypandra glauca				x	x	x	
o Synaphea acutiloba	x		x	x	x		
o Synaphea pinnata		x			x		
o Templetonia biloba	x						
o Tetratheca pilifera		x					
o Thomasia (?) glutinosa	x						
o Thysanotus sparteus			x				
o Trachymene caerulea	x	x			x		
o Trymalium ledifolium					x		
o Verticordia huegelii				x			
o Waitzia paniculata	x				x		
o Waitzia suaveolens		x		x	x		
o Xanthorrhoea acanthostachya	x	x		x	x		
o Xanthorrhoea preissii				x	x	x	x
o Xanthosia candida		x	x	x	x		
Total	43	37	21	38	72	21	24

A. Marri — Wandoo Low Woodland

B. Marri Low Woodland

WOODLAND VEGETATION



A. 1st Order Stream

B. Heath

1st ORDER STREAM AND HEATH VEGETATION

A. Granite slope with Marri Xanthorrhoea bands and Marri — Wandoo on ridge

B. Lithic Complex

VEGETATION OF GRANITE SLOPES

Appendix B

APPENDIX B

RARE, ENDANGERED AND RESTRICTED FLORA

APPENDIX B

RARE, ENDANGERED AND RESTRICTED FLORA

Introduction

Before one can evaluate the importance of an area for rare plant species, it is necessary to understand the term "rare", how this term originated, and how the significance of a rare species is determined. The following discussion is necessary to put the findings in the Study Area into perspective.

In 1975 Western Australia's Fauna Conservation Act was retitled as the Wildlife Conservation Act, and in 1979 the Act was amended to provide protection for specified flora as well as for fauna. The first plant species to be declared by the Minister as protected rare flora under the Act were listed in the WA Government Gazette on 14 November 1980. Periodically, the Minister publishes notices in the Government Gazette deleting and adding species to the list of protected flora. While a species, or other taxon, is gazetted as protected no-one is allowed to "gather, pluck, cut, pull up, destroy, dig up, remove or injure" a plant belonging to a wild population of that species without special written consent of the Minister (Rye and Hopper 1981). Fines may be imposed for breaching provisions of the Act.

The first list of gazetted flora comprised 100 species. The current list, printed in the WA Government Gazette on 14 July 1989, comprises 238 species. Some of the species first gazetted in 1980 are absent from the current list, because they have been found to be more abundant or wide-ranging than previously indicated by collections and records, or because they appear to be well-protected in nature reserves and national parks.

In general, species are gazetted or declared as rare flora not only because they are rare (i.e. because fewer than a few thousand reproductively mature plants of the species are known to exist in the wild) or geographically restricted but also because their continued, long-term survival in the wild is believed to be threatened.

Gazetted rare species (usually referred to as Declared Rare Flora - DRF) are not the only Western Australian plants that are rare, geographically restricted, threatened or vulnerable. In fact, they probably constitute only a small proportion of such species.

For example, Marchant and Keighery (1979) listed more than 2,000 species that were rare or poorly collected or were geographically restricted to a range of less than 160 kilometres. This section discusses such species, particularly ones that are gazetted as declared rare flora (DRF), and have been recorded in the Northern Forest Region.

Published Lists of Rare, Restricted and Poorly Collected Species

Australia-wide treatments of rare, geographically restricted and endangered species by Specht, Roe and Boughton (1974), Hartley and Leigh (1979), Leigh, Briggs and Hartley (1981) and Briggs and Leigh (1988) also contain Western Australian lists, which are based upon publications or other information provided by botanists in the various states. They cover presumably rare or threatened plants but do not deal with the adequacy of collection of any species.

"Extinct and Endangered Plants of Australia", by Leigh, Boden and Briggs (1984), lists endangered and presumably extinct species and the presumed threats to their survival. The book also describes and illustrates many endangered and extinct species, discusses the inconsistent use of terms to indicate various degrees of threat and rarity, and describes the binary system developed by Hartley and Leigh (1979) to classify rare, restricted and threatened species.

The first western Australian publication on rare and restricted flora, by Marchant and Keighery (1979), is based upon the numbers of specimens of each native Western Australian species lodged in the Western Australian Herbarium and the geographical range of the collections for each species. Marchant and Keighery classify most of their 2,022 listed species as geographically restricted, presumably rare or poorly collected.

Four reports dealing with rare, restricted and threatened species have been published by the Department of Fisheries and Wildlife. One, by Rye (1982), lists geographically restricted south-western plants, and another, by Rye, Hopper and Watson (1980), is concerned with the distribution and conservation status of commercially exploited native plants. The first two lists of gazetted rare Western Australian flora are presented and the listed species are described and illustrated in Rye and Hopper (1981) and Patrick and Hopper (1982).

"Significant Species"

The term 'significant species' as used in this report refers to species that are:

- rare, geographically restricted or apparently rare or restricted because they are poorly collected or recorded,
- at the limits of their ranges or in areas outside their normal ranges or habitats,
- particularly susceptible or vulnerable to environmental changes, especially ones caused either directly or indirectly by humans,
- diminishing significantly in abundance or geographical range due to clearing and other environmental changes associated with agriculture, mining, recreation, urbanisation and provision of services, or
- poorly represented in secure conservation reserves.

The term 'significant' is used in this report instead of 'vulnerable', 'sensitive', 'threatened', 'depleted' or 'endangered' because these terms either are too limited in their scope or implications or, as Leigh, Boden and Briggs (1984) put it, "have become highly emotive through popular usage, making it difficult to develop objective criteria for use in ascribing species to various categories". Leigh, Boden and Briggs discuss appropriate terminology in more detail.

All of the species in the lists appended to this report are significant species. Some significant species are gazetted as DRF; most are not.

The accuracy of most lists of significant Western Australian species is limited by the fact that they are incomplete. They do not contain varieties, subspecies or undescribed species, some of which are also rare, and the intensity, uniformity and seasonal coverage of collecting and systematic surveying have been insufficient to distinguish between genuinely rare (and restricted) species and species which only appear to be rare (or restricted) because they have been poorly collected. Systematic surveying and collecting by Western Australian Wildlife Research Centre (WAWRC) botanists, and others, are slowly correcting this deficiency.

In some cases, significant species are found in areas where they were not previously known to occur. For instance, Villarsia submersa, a small water-lily type plant, was believed to be restricted to a few small seasonal ponds between Bunbury and

Busselton until recent years, when it was found near Denmark, west of Manjimup and, in 1989, in a few ponds in the Metropolitan Region. Synaphea pinnata and Stachystemon axillaris are plant species previously gazetted as rare (Government Gazette, 14 November 1980) which have since been found to be more common or widespread than previously believed and are no longer gazetted.

In other cases, species are no longer found in areas where they have been previously recorded, often due to habitat destruction or alteration. However, there are many species which emerge and flower for only one or a few years after fire, then disappear until after the next burn. For example, a population of the gazetted orchid Drakaea jeanensis recorded in the metropolitan area a few years ago has not been found recently.

Other sources of incompleteness and ambiguity in distribution and abundance information are:

- o insufficient locality information given on the labels which accompany herbarium specimens,
- o inaccurate identification of specimens, and
- o treatment of groups of species as single species.

So little is known about the abundance, distribution and taxonomy of nonvascular plants that few, if any, such species are gazetted as rare flora or are included in lists of rare species, although many of them may also be rare or geographically restricted.

Gazetted Rare Species

The first list of declared rare flora, gazetted in 1980, was based upon assessment of the Marchant and Keighery (1979) list, addition of newly described species and local botanists' knowledge of species distributions and abundance. Gazettal of a species is now generally preceded by relatively detailed searches made in the field to locate populations of the species proposed as rare.

The gazetted list of DRF does not include all, or probably even a majority of, rare species. The current list (14 July 1989) concentrates on the south-western part of Western Australia and particular groups of species, which have, in general, been studied in greater detail than others. For example, members of the families Proteaceae, Myrtaceae, Leguminosae and Orchidaceae account for more than 150, well over half, of the DRF on the July 1989 list. It is likely that in the south-west alone there are many more ungazetted rare and restricted species than gazetted ones.

The two lists of DRF in Rye and Hopper (1981) and Patrick and Hopper (1982) comprise about 150 species, and the 1989 list contains about 250 species, probably only a small proportion of Western Australian plants that could be considered as rare. Another list, in Rye (1982), contains 527 species of southern Western Australian flowering plants that are geographically restricted and includes most, if not all, of the species gazetted at that time as rare. The Rye list is based upon investigation of collections upon which the Marchant and Keighery (1979) list was based, taxonomic publications and rare plant records of the WAWRC.

Since the early 1980s WAWRC botanists have been compiling lists, descriptions, illustrations and records of significant species throughout Western Australia on a regional basis. The lists were originally compiled from herbarium records of the species listed in Rye (1982) and Marchant and Keighery (1979) and from taxonomic literature. These lists and records, along with relevant taxonomic studies, provide the basis for the lists of species proposed for gazettal and being considered for gazettal.

The WAWRC now has continuing programmes of research and, in addition to the list of gazetted species, has five unofficial priority lists of rare and restricted species for each of the eleven management regions into which CALM has divided the state:

- Priority One (P1) Species - species known from only a few localities, which are on lands under immediate threat, and are in urgent need of further survey work;
- Priority Two (P2) Species - species known from only a few localities, which are on lands not under immediate threat, and are in urgent need of further survey work;
- Priority Three (P3) Species - species known from several localities, some of which are on lands not under immediate threat, and are in need of further survey work;

- Priority Four (P4) Species - species presumed to be extinct; and
- Priority Five (P5) Species - species considered to have been adequately surveyed and are not endangered or in need of special protection but could be if circumstances change.

These lists are modified and updated as relevant information and results of survey work become available. Priority One, Two and Three species are under consideration for declaration as rare flora, pending the outcome of further survey work.

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Appendix C

APPENDIX C

WEED SPECIES OF JOHN FORREST NATIONAL PARK

APPENDIX C

WEED SPECIES OF JOHN FORREST NATIONAL PARK

Acacia decurrens
Acacia podalyrifolia
Acacia pycnantha
Aira cupaniana
Anagallis arvensis
Arctotheca calendula
Arundo donax
Asparagus asparagoides
Avena fatua
Bellardia trixago
Briza maxima
Briza minor
Bromus diandrus
Callitriche stagnalis
Centaurium erythraea
Cerastium glomeratum
Cicendia filiformis
Conyza albida
Crassula natans
Cyperus polystachyus
Cyperus tenellus
Cytisus proliferus
Dittrichia graveolens
Echium plantagineum
Ehrharta calycina
Ehrharta longiflora
Eragrostis curvula
Erodium botrys
Ficus carica
Filago gallica
Freesia aff. leichtlinii
Fumaria muralis
Galium divaricatum
Genista linifolia
Gladiolus caryophyllaceus

Gladiolus undulatus
Gomphocarpus fruticosus
Hedypnois rhagadioloides
Homeria flaccida
Homeria miniata
Hypochaeris glabra
Isolepis prolifera
Ixia polystachya
Juncus capitatus
Kickxia elatine
Lavandula stoechas
Lepidium africanum
Linum trigynum
Lolium perenne
Lupinus cosentinii
Lythrum hyssopifolia
Medico polymorpha
Misopates orontium
Monadenia bracteata
Monopsis simplex
Oenothera stricta
Phoenix dactylifera
Ornithopus compressus
Orobanche minor
Osteospermum cladestinum
Oxalis corniculata
Oxalis glabra
Oxalis pes-caprae
Oxalis purpurea
Parentucellia latifolia
Parentucellia viscosa
Paspalum dilatatum
Pennisetum setaceum
Pentaschistis airoides
Petrorhagia velutina
Physalis peruviana
Plantago lanceolata

Pseudognaphalium luteo-album
Raphanus raphanistrum
Rhynchelyteum repens
Ricinus communis
Romulea rosea
Silene gallica
Sisymbrium orientale
Solanum nigrum
Sonchus oleraceus
Sparaxis pillansii
Spergula arvensis
Stachys arvensis
Trachynia distachya
Trifolium angustifolium
Trifolium campestre
Trifolium dubium
Trifolium glomeratum
Trifolium hirtum
Trifolium subterraneum
Ursinia anthemoides
Verbascum virgatum
Volpia bromoides
Wahlenbergia capensis
Watsonia bulbillifera
Watsonia leipoldtii
Zantedeschia aethiopica

APPENDIX D

VERTEBRATE FAUNA SURVEY OF PIONEER NO.2 SITE

1.0 INTRODUCTION

The primary objectives of the vertebrate fauna assessment were to:

- produce an inventory of the vertebrate fauna recorded during a field appraisal and prepare a provisional list of unrecorded migratory or cryptic species expected to be present;

- relate the fauna recorded to the major vegetation types of the area; o compare faunal habitats, i.e. vegetation and soil types, in terms of their fauna species richness and abundance;

- assess the significance of the fauna on a regional and local basis; o give particular consideration to species classified as "rare, or otherwise in need of special protection";

- assess the long term survival prospects of the fauna particularly in relation to rehabilitation of mined areas.

The field assessment of the proposed quarry extensions took place on July 8, 1990 using four skilled field observers with wide experience in the Darling Range. A total of 24 field/hours were spent within the quarry site and adjacent land conducting foot and vehicle transects throughout the proposed area of operations. Opportunistic sampling was conducted throughout the area and a series of six intensive sampling sites were established within each of its major vegetation communities. These sites were subjected to intensive hand-foraging for amphibians and reptiles and all birds were noted. Active mammals were recorded as were signs such as tracks, scats, diggings and nests. An appraisal of habitat quality and critical resources was carried out. This latter aspect included an assessment of the number of tree-hollows, the frequency of logs on the ground, the capacity of the soil to support burrows, the density of flowering shrubs, the occurrence of exfoliating granite, the level of disturbance and the frequency of fires.

The Project Area was previously surveyed by the authors of this report for three days in February 1986 and all sampling areas were re-visited during this current assessment indicating that good coverage of the site has been obtained. A total of over five 10 hour personnel/days has therefore been spent assessing the fauna. In addition, recent and historical records of fauna from the general area were obtained from the W.A. Museum records and a list of provisional species likely to be present within the Project Area was constructed (Appendices D-F) from the above and following sources: Alcoa of Australia and Dames and Moore (1978); Dell (1983); Dell and How (1988); Wellington and Dell (1989); Nichols and Muir (1989); Dunlop et al. (1987); Ninox Wildlife Consulting (1988, 1989); Sedgwick (1944) and Serventy and Whittell (1976). The assumption behind the provisional list of species is that if several seasonal surveys which included detailed bird transect sampling, mist netting, bat trapping, pit, cage and Elliott trapping and nocturnal sampling were carried out, all of the listed species would eventually be recorded.

Geographic distribution patterns and taxonomy follow Blakers et al. (1984); Strahan (1983); Storr et al. (1981, 1983, 1986, 1990) and Tyler et al. (1984).

Vertebrate habitats were defined using the information on the eight major vegetation associations provided in Section 6.1. The three mixed Low Woodlands have been combined as one faunal unit since, apart from a small, select group of specialised animals, they can be regarded as a continuum with very little faunal definition between them. In many cases vertebrate communities cannot be readily assigned to individual vegetation types or their permutations, each with an unique range of animals, since even at the extremes of vegetation structure, topography and substrate within this small study area, most associations will have at least 80% of their vertebrates in common (Appendices D-F) and, on occasions, an even greater proportion due to seasonal movements in response to breeding activity or the availability of food and water. Apart from the group of specialised animals adapted to specific features which are considered in detail in following sections of this report, the major difference between vegetation types will be changes in abundance of species common to most associations, rather than definitive suites of habitat-specific vertebrates.

2.0 BIRDS

Dell (1983) considered that the Darling Scarp supported 100 species of bird, but more recent estimates (Nichols and Muir, 1989) suggest that the number potentially present could go as high as 150.

Some species of birds are seasonal in the Darling Scarp. The White-winged Triller (Lalage sueuri) is sometimes a common breeding species in the Wandoo woodlands. Honeyeaters are known to undertake nomadic seasonal movements searching for areas of suitable flowering plants. The importance of the Scarp in providing food for these species, some of which are not normally found in the Jarrah forest, requires detailed study.

During the field survey 36 native and one introduced bird were recorded; a further nine species were noted in February 1986 bringing the total known from the site to 46. With the addition of unrecorded, rarer, migratory or nomadic species, the habitats of the Project Area are expected to support a total of 85 species of bird (Appendix D).

Based on the results of the field assessment and other source information for the Project Area and its environs it is considered that the First Order Stream Wandoo (79 species) is the most productive habitat followed by the First Order Stream Marri (75 species), Revegetation Area (70 species), Low Mixed Woodlands (68 species), Lithic Complex (53 species) and Heath (44 species). The Revegetation Area has an unusually high potential because of its density, structural complexity and high diversity of flowering shrubs and trees. The presence of wetlands within this area also contributes to its potential. Heaths have been assessed as having a relatively low species richness but because of their diversity of flowering shrubs are seasonally expected to far exceed all other associations in terms of their abundance of individual birds, especially Honeyeater species.

3.0 MAMMALS

Twenty-three native mammals are known from the Darling Scarp (Dell, 1983). In the Jarrah forest as a unit, Nichols and Muir (1989) have recorded 29 species.

The Yellow-footed Antechinus (Antechinus flavipes) and Southern Brown Bandicoot (Isoodon obesulus) are predominantly inhabitants of dense riparian vegetation. More information is needed on habitat requirements before a fire-management strategy can be devised to favour these species. Dell (1971) has drawn attention to the effects of fire on the Southern Brown Bandicoot and the need for plant litter required for nest construction. Sawle (1979) has noted similar requirements for the Yellow-footed Antechinus. The effects of regular burning of the forest heath understorey on the Western Pygmy-possum (Cercartetus concinnus) and the Honey Possum (Tarsipes rostratus) also need to be ascertained (Dell, 1983).

Two native and three introduced mammals were observed during the field assessment of the Project Area with a further species recorded in February 1986, thus giving a total of six recorded species from the area. With the inclusion of the species listed in Appendix E, the total expected from the proposed quarry site and adjacent land is 22 native mammals (including nine species of bat) and 7 introduced or feral species.

In terms of potential species richness, the vegetation communities of the Project Area can be ranked as follows: First Order Stream Zones (20 native species each); Mixed Low Woodlands (19 species); Lithic Complex and Heath (17 species each); Revegetation Area (13 species).

4.0 FROGS AND REPTILES

Currently, 51 species (10 frogs, 1 tortoise, 7 geckos, 6 legless lizards, 2 dragon lizards, 11 skinks, 3 monitors, 3 blind snakes, 2 pythons and 6 elapid snakes) are known to occur on the Scarp in the vicinity of Perth (Dell, 1983). Seventeen species were recorded during a study near Lesmurdie in June 1984 and July 1985 (Wellington and Dell, 1989).

Three frogs and six reptiles were recorded during the assessment with a further four reptiles noted in February 1984 giving a total of 13 known species from the site. Distribution patterns and the available habitats of the Project Area indicate that a possible 10 frogs and 44 reptiles will be present (Appendix F). Using this actual and provisional list the vegetation associations of the Project Area can be ranked as follows in terms of their species richness: First Order Streams (49 species); Low mixed Woodlands (40 species); Lithic Complex (37 species); Heath (35 species); Revegetated Area (28 species).

5.0 FISH

One species of native fish, the Western Minnow (Galaxias occidentalis), was observed in a flooded claypit within the revegetated area near the proposed crusher plant. There have been few methodical or comprehensive surveys of the current status and distribution of freshwater fishes in the streams of the Darling Scarp. Chubb et al. (1979) list only 4 indigenous species in the Swan-Avon system, viz Western Minnow, Freshwater Cobbler, Nightfish and Pygmy Perch. They list at least 6 species of introduced fishes in the same river system. Attention is drawn by Chubb et al. (1979) to the effects of damming, the consequent drying-up of long stretches of stream, eutrophication and run-off from agricultural land.

The high level of importance of crustaceans and freshwater insects in the diet of freshwater fishes can be judged from an analysis of diet by Sarti and Allen (1978). Studies need to be undertaken into the ecology of freshwater fishes before management plans can be devised for their conservation based on these types of findings.

Consideration should also be given to changes to water quality and of changes in the volume of water flowing from the Scarp to the Coastal Plain. These changes will affect populations of freshwater fish in the Coastal Plain adjacent to the Scarp. Although there are no semi-permanent streams in the Project Area, and hence no stream fish populations, changes to the ephemeral streams could ultimately affect fish downstream in watercourses such as Susannah Brook.

6.0 FERAL FAUNA

Four species of feral or introduced vertebrates have been recorded within the Project Area during the field surveys. A further four species are expected to occur (Appendix D and E).

The legacy of European settlement in south-western Australia has been the gradual introduction and spread of feral (introduced) animals. The more common species include cats, pigs, foxes, grazing animals (e.g. goats, donkeys), rabbits, mice, rats, aquatic fauna (trout, Redfin Perch) and birds (e.g. Kookaburras, Sulphur-crested Cockatoos, Senegal Doves).

Of this list, pigs, foxes and cats appear to represent major environmental threats. Pigs are thought to spread jarrah dieback disease, transmit exotic diseases to livestock and humans, and pollute streams (Feral Pig Committee, 1985). Foxes have been shown be Christensen (1980) to significantly predate on medium-sized (0.15 to 5kg body weight) native fauna. Populations of Southern Brown Bandicoots (Isoodon obesulus), Chuditch (Dasyurus geoffroii), Brush-tailed Possums (Trichosurus vulpecula), Woylies (Bettongia penicillata), Tammars (Macropus eugenii) and Numbats (Myrmecobius fasciatus) are thought to be affected by the existence of the fox.

7.0 RARE OR ENDANGERED SPECIES

No rare or endangered fauna were recorded during this or the 1986 field survey of the study area. However, three vertebrates classified as "rare, or otherwise in need of special protection" are potentially present and are listed below with annotations.

Peregrine Falcon (Falco peregrinus)

Status: Schedule 2 - in need of special protection.

Habitats: All vegetation types.

Comments: A highly mobile bird with little apparent habitat specificity. Unlikely to be affected by the proposed quarry extensions and, in fact, may be advantaged by the potential nesting sites provided by abandoned quarry faces.

Chuditch (Dasyurus geoffroii)

Status: Schedule 1 - likely to become extinct.

Habitat: All vegetation types, but more common in forests and woodlands.

Comments: The proposed extensions and associated works are likely to cause localised territorial disruption to a few resident individuals of this native marsupial carnivore but will not seriously affect local populations.

Dells Skink (Ctenotus delli)

Status: Schedule 1 - likely to become extinct.

Habitat: Laterites and clays in damper valleys.

Comments: This species will be locally distributed in the immediate vicinity of Susannah Brook and is therefore unlikely to be affected to any extent given that that this area will not be part of the quarry.

Carpet Python (Morelia spilota imbricata)

Status: Schedule 2 - in need of special protection.

Habitat: Most vegetation types with a preference for rocky areas and heaths.
Comments: One or two individuals may be disadvantaged by the quarry extensions. Survey work in the Darling Range has shown this species to be more common than originally thought, especially when areas are subjected to intensive seasonal assessments (Worsley Alumina, 1985).

8.0 SIGNIFICANT HABITATS

In reality, all remaining areas of natural bushland in the Darling Range, and in particular those along the highly developed metropolitan portion of the Scarp, are of significance regardless of the type of country represented or its relative conservation value. This is a product of the amount of broad-scale clearing which has taken place since European settlement.

However, within the area covered by the proposed quarry extensions and adjacent areas, two habitats in particular stand out as having special significance: the First Order Stream zones which traverse portions of the Project Area. Riparian habitats are considered to be important for the following reasons:

- stream zones are of critical importance to the life cycles of several species of amphibians, fish and aquatic invertebrates;
- the deeper loamy soils favour species of reptiles which have burrowing rather than surface habits, or are dependent on deep litter;
- the dense vegetation, higher humidity, and overall productivity advantage specialised fauna such as the Yellow-footed Antechinus (Antechinus flavipes) and Southern Brown Bandicoot (Isoodon obesulus); and
- in comparison to other habitats, stream zones are poorly represented per unit area, vulnerable to silting and wildfires and have undergone more adverse changes than any other habitat in the Darling Range (Dell, 1983).

Of the two types of First Order Streams found in the Project Area, the Wandoo low forest example which bisects the proposed East Pit is the more significant. Mature Wandoo forest is the one of the richest habitats on the Scarp for birds and is particularly significant because of the number of hollow branches and trunks which act as important breeding sites and refuges for many species of birds, mammals and reptiles. Some species of vertebrate are mainly restricted to Wandoo associations on the Scarp, with species such as the Reticulated Velvet Gecko (Oedura reticulata) and Rufous Tree-creeper (Climacteris rufa) being typical examples.

Lithic Complex, especially where exfoliations are present is also important for species such as the Ornate Rock Dragon (Ctenophorus ornatus) and several geckos which use these slabs of rocks for refuge.

9.0 REGIONAL AND LOCAL IMPLICATIONS

9.1 REGIONAL STATUS OF THE FAUNA

In any assessment of the significance of an area to fauna it is important that zoogeographic considerations are reviewed. A pioneer in this field was Baldwin Spencer (1896) who recognised three major, distinct, zoogeographic sub-regions in Australia. His concept took into account broad faunal distribution patterns which aligned fairly well with the wetter south-eastern zone of Australia (Bassian Sub-region), the northern, hot, wet, coastal area (Torresian Sub-region), and inland, arid Australia (Eyrean Sub-region).

Spencer's concept was carefully considered by Serventy and Whittell (1976) who examined bird distributions in Western Australia and concluded that there was a need to define a fourth, and much smaller sub-region: the south-western corner of Western Australia where an intermingling of two faunas, the Eyrean and Bassian, occurred. The Pioneer Quarry and its proposed extensions are situated within this small south-west sub-region. The south-west of Western Australia has a number of species of vertebrates identical to those found in southern Victoria but which no longer have a continuous distribution across the continent. More importantly, however, it supports several endemic species with no equivalent populations in eastern Australia. Examples recognised by Serventy and Whittell as being of special significance are: Western Rosella (Platycercus icterotis), Red-capped Parrot (Purpureicephalus spurius), Baudin's Cockatoo (Calyptorhynchus baudinii), White-breasted Robin (Eopsaltria georgiana), Red-winged Fairy-wren (Malurus elegans), Western Thornbill (Acanthiza inornata) and the Western Spinebill (Acanthorhynchus superciliosus). Five of these endemic birds have been recorded or are likely to be present in the Project Area (Appendix D). Consideration has also been given to evaluating the importance of different regions for other faunal groups. Storr (1964) confirmed that the distinctness of the south-west for reptiles paralleled the situation previously indicated for birds and believed that geographical influences, especially the presence of a large belt of forest-covered laterite, explained some of the speciation which had occurred in reptiles and frogs. The discontinuous distributions of some reptiles and birds from the Western Australian Wheatbelt to the east and the Swan Coastal Plain to the west can also be attributed to this feature. In examining the distribution patterns of south- western reptiles Chapman and Dell (1985) concluded that an earlier defined south-western sub-region

encompassing the area south of a line from Shark Bay to Israelite Bay was not valid since many species with wide distributions in arid Australia extended well to the west and south of this line; they instead drew attention to a much smaller region within the south-west. This area has a number of mesio-temperate elements from south-eastern Australia as well as a significant number of endemic species. Some typical examples of the latter are Leiolopisma trilineatum, Ctenotus labillardieri, C. delli, Diplodactylus polyophthalmus, several snakes from the genera Notechis and Rhinoplocephalus and the frog genera Crinia and Ranidella. Most of these endemic reptiles have been recorded or are expected to occur within the proposed quarry extensions and adjacent areas.

Several mammals are also endemic to the south-west. In many cases they do not fit into the south-western sub-region outlined for reptiles but have a larger distribution defined by the previously mentioned line from Shark Bay to Israelite Bay. Examples of these are the Western Brush Wallaby (Macropus irma) and the Honey Possum (Tarsipes rostratus). Others are restricted to the south-west sub-region either because of their specialised habitat requirements or because their geographic range has substantially contracted since European settlement.

Heavier rainfall coupled with a higher clay content in the soil has resulted in denser understoreys in the southern portion of the Darling sub-region in the South-West Botanical Province (Beard, 1977). This, and other influencing factors, has produced a fauna peculiarly adapted to an unique environment (Mulchahy, 1980). The south-west of Western Australia, particularly the heavier forested portion, is therefore an area of great zoogeographical significance and a number of species have evolved in its mesio-temperate environment which provided refuge as the continent became more arid. Its proximity to large centres of population, the presence of valuable mineral deposits, water catchments and timber resources, however, has placed its very limited area under ever increasing development pressure.

9.2 LOCAL STATUS OF THE FAUNA

The following discussion deals with the environmental implications of the proposed quarry on vertebrates, their habitats and current conservation status. It also provides background on why various government instrumentalities are concerned with the long term implications of future development proposals on the Darling Scarp.

Apart from a few species of bird which have benefited from European settlement of the Darling Range e.g. Australian Magpie (Gymnorhina tibicen), Australian Magpie-lark (Grallina cyanoleuca), Yellow-rumped Thornbill (Acanthiza chrysorrhoa), most have been adversely affected. Habitat-specific passerine birds have in some instances declined dramatically. Typical examples are the White-breasted Robin (Eopsaltria georgiana), White-browed Scrubwren (Sericornis frontalis), Red-winged Fairy-wren (Malurus elegans), Southern Emu-wren (Stipiturus malachurus), Tawny-crowned Honeyeater (Phylidonyris melanops), Rufous Tree-creeper (Climacteris rufa) and Red-eared Firetail (Emblema oculata).

Mammals have also suffered a decline, among these being the rare and endangered Chuditch (Dasyurus geoffroii), Brush-tailed Phascogale (Phascogale tapoatafa), Southern Brown Bandicoot (Isoodon obesulus) and Brushtail Possum (Trichosurus vulpecula). Species such as the Quokka (Setonix brachyurus) have disappeared entirely from the northern portions of the Darling Range and the Numbat (Myrmecobius fasciatus) is close to local extinction. The gecko (Gehyra variegata) and the dragon (Ctenophorus ornatus) are restricted to surface granite and are dependent on exfoliate slabs. Both species have declined and some populations have been exterminated on granite outcrops by removal of rock for garden decoration (Dell, 1983).

Of the 15 affected species listed above (which represent extreme examples only), five were recorded during the field survey, five are almost certainly present and the remaining five are unlikely to occur within the area covered by the proposed quarry extensions.

The combination of too frequent burning (accidental or planned), pastoral activity, damming of streams, housing development, mining and the presence of many introduced predators has resulted in a greatly modified Darling Range environment and a marked decline in fauna populations. The most important local significance of areas such as the proposed Pioneer Quarry extensions is that these less developed areas have the capacity to act as refuges for species which have long since disappeared from the adjacent Swan Coastal Plain or are under localised or widespread pressure in the Darling Range.

Considering the proposed extensions in isolation, the long term, adverse effects of further development are liable to be fairly minor with the lack of a major stream zone within the proposed quarry sites and the relatively small area involved being the contributing factors. In addition, this section of the Scarp is relatively wide from west to east compared to other areas, thus being less susceptible to partitioning of its capacity as a potential movement corridor. However, in the broader perspective the extensions represent a further and cumulative attrition of the already highly developed metropolitan sections of the Darling Scarp and, as such, require careful consideration of the potential impact of works and the conservation strategies required to reduce this effect.

Appendices D-F show that 160 native vertebrates are likely to occur within the boundaries of the proposal. Leaving aside migratory, nomadic or dispersive birds which are unlikely to be affected to any measurable extent, some 90 species of vertebrates (65%) are judged to be permanent or semi-permanent residents. This represents the group of species which will absorb the main impact of habitat loss. Within this group there are two subgroups:

- o highly mobile vertebrates such as territorial birds, bats, kangaroos, wallabies and monitor lizards; and
- o small, terrestrial vertebrates with a limited capacity to travel relatively large distances i.e. all small marsupials, frogs and reptiles.

The first sub-group has the ability to gradually disperse as disturbance levels reach a threshold, and while there will be an indeterminate, but probably minor mortality rate through territorial conflict over adjacent feeding, breeding and refuge areas, the overall impact of this "ripple effect" will probably be no greater than the periodic wildfires which are a feature of this type of country (given that it takes several years for an area of land to recover after fire and that most territorial disturbance and mortality has already taken place before habitat regeneration occurs).

The nature of aggregate quarrying will inevitably result in areas of granite outcrops, woodland and heath being totally cleared to allow for efficient and economically sound mining. The end result of this will be that the second sub-group, representing 30% of the total species list, will eventually lose that portion of their local populations occurring in the 40 hectares set aside for extensions. Little, if anything, can be done

to ameliorate this impact in the short term and it has to be considered as one of the unavoidable costs of mining. However, no species of rare fauna are members of this sub-group and all representatives have distribution patterns covering the south-west of Western Australia. It is therefore most unlikely that the numbers which will be affected will have any regional impact. The main effect will be a small but cumulative reduction in the available area of fauna habitat remaining in the Darling Scarp and a localised impact on populations of some of the less mobile vertebrates.

9.3 IMPACT REDUCTION STRATEGIES

Unlike gravel, mineral sand and bauxite mining operations, the condition of the minesite after aggregate quarrying is such that it is not amenable to normal methods of rehabilitation such as ripping, forming batters and replacing large quantities of stockpiled topsoil prior to replanting. Vertical working faces are left behind and the soils overlying granite are generally too shallow to provide a large enough stockpile for successful tree planting. It is therefore most unlikely that the whole of the original workings and proposed extensions to the Pioneer Quarry can be rehabilitated back to a condition resembling its original conservation status without clearing a much larger area to reduce the slope of the vertical working faces and trucking in topsoil. This would ultimately make the quarry operation uneconomical and result in greater disruption to vertebrate habitats. In order to minimise adverse effects during the quarrying phase and encourage as many species of vertebrates as possible into the quarry after mining, it is recommended that:

- as little Wandoo woodland as possible is cleared for construction of the sediment trap at the base of the proposed East Pit and that all trees are left within its confines so that old and new hollows can be used by birds for breeding;
- wherever possible existing tracks are upgraded and used to service the quarry rather than further partitioning habitats with new roads;
- overburden, low grade granite and available topsoil is dumped on all benches associated with abandoned working faces and seeded with a heathland seed-mix in order to encourage vertebrate fauna, particularly birds; and
- rehabilitation effort is commenced as soon as is practicable in worked-out quarry faces.

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Appendix E

APPENDIX E

LIST OF BIRD SPECIES RECORDED AND EXPECTED TO OCCUR IN THE HABITATS OF THE PROJECT AREA

APPENDICES E TO G

KEY

FAUNA HABITAT	PLANT COMMUNITIES
1	Low Woodlands of Marri-Wandoo, Marri-Jarrah and Marri. (Code - Ec+w, Em+c and Ec).
2	1st Order Stream - Wandoo. (Code - W).
3	1st Order Stream - Marri. (Code - M).
4	Heath. (Code - H).
5	Lithic Complex. (Code - L).
6	Revegetation Area. (Code - R).

Plant community descriptions may be expanded by reference to Section 6.1 VEGETATION - The Project Area.

SYMBOL

X	Species recorded during field survey.
+	Species expected to occur.
A	Mainly aerial species expected to occur.
*	Species scheduled as rare, or otherwise in need of special protection (Schedules 1 or 2 of the Wildlife Conservation Act).
1	Species recorded in February 1986.
2	Introduced species

APPENDIX E

LIST OF BIRD SPECIES RECORDED AND EXPECTED TO OCCUR IN THE HABITATS OF THE PROJECT AREA

FAUNA HABITAT		1	2	3	4	5	6
	BIRD SPECIES						
DROMAIIDAE							
Dromaius novaehollandiae,	Emu	+	+	+	+	+	+
ACCIPITRIDAE							
Elanus notatus,	Black-shouldered Kite	A	A	A	A	A	A
Lophoictinia isura,	Square-tailed Kite	A	A	A	A	A	A
Haliastur sphenurus,	Whistling Kite	A	A	A	A	A	A
Accipiter fasciatus,	Brown Goshawk	A	A	A	A	A	A
A. cirrhocephalus,	Collared Sparrowhawk	A	A	A	A	A	A
Aquila audax,	Wedge-tailed Eagle 1	X	A	A	A	X	A
Hieraaetus morphnoides,	Little Eagle	A	A	A	A	A	A
FALCONIDAE							
Falco peregrinus,	Peregrine Falcon *	A	A	A	A	A	A
F. longipennis,	Australian Hobby	A	A	A	A	A	A
F. berigora,	Brown Falcon	X	X	A	A	A	A
F. cenchroides,	Australian Kestrel				A	A	A
TURNICIDAE							
Turnix varia,	Painted Button-quail	+	+	+	+	+	+
RALLIDAE							
Porzana tabuensis,	Spotless Crake		+	+			
COLUMBIDAE							
Phaps chalcoptera,	Common Bronzewing 1	+	+	+	X	X	+
CACATUIDAE							
Calyptorhynchus magnificus,	Red-tailed Black-Cockatoo	+	+	+			
C. latirostris,	White-tailed Black-Cockatoo	+	+	+			
Cacatua roseicapilla,	Galah	+	+	+			+
LORIIDAE							
Glossopsitta porphyrocephala,	Purple-crowned Lorikeet	+	+	+			+
PLATYCERCIDAE							
Purpureicephalus spurius,	Red-capped Parrot	+	+	X	X	X	
Platycercus icterotis,	Western Rosella	+	+	+			+
Barnardius zonarius,	Port Lincoln Ringneck	+	X	X	+	X	+
Neophema elegans,	Elegant Parrot		X	+	+	+	+
CUCULIDAE							
Cuculus pallidus,	Pallid Cuckoo	+	X	+			+
C. pyrrhophanus,	Fan-tailed Cuckoo	+	X	+			+
Chrysococcyx osculans,	Black-eared Cuckoo	+	X	+			+
C. basalis,	Horsfield's Bronze-Cuckoo	+	X	+			+
C. lucidus,	Shining Bronze-Cuckoo	+	X	+			+
STRIGIDAE							
Ninox novaeseelandiae,	Southern Boobook	+	+	+			+
TYTONIDAE							
Tyto alba,	Barn Owl	A	A	A	A	A	A

FAUNA HABITAT		1	2	3	4	5	6
	BIRD SPECIES						
PODARGIDAE							
Podargus strigoides,	Tawny Frogmouth	+	+	X		+	+
AEGOTHELIDAE							
Aegotheles cristatus,	Australian Owlet-nightjar	+	+	+	+	+	+
CAPRIMULGIDAE							
Caprimulgus guttatus,	Spotted Nightjar	+	+	+	+	+	+
APODIDAE							
Apus pacificus,	Fork-tailed Swift	A	A	A	A	A	A
ALCEDINIDAE							
Dacelo novaeguineae,	Laughing Kookaburra 2	+	+	+			X
Halcyon sancta,	Sacred Kingfisher	+	+	+			+
MEROPIDAE							
Merops ornatus,	Rainbow Bee-eater 1	X	A	A	A	X	A
HIRUNDINIDAE							
Hirundo neoxena,	Welcome Swallow	A	A	A	A	A	A
Cecropis nigricans,	Tree Martin	A	X	A	X	X	A
MOTACILLIDAE							
Anthus novaeseelandiae,	Richard's Pipit					+	+
CAMPEPHAGIDAE							
Coracina novaehollandiae,	Black-faced Cuckoo-shrike	+	X	X			+
Lalage sueurii,	White-winged Triller	+	+	+		+	+
MUSCICAPIDAE							
Petroica multicolor,	Scarlet Robin	+	X	+	X	+	X
P. goodenovii,	Red-capped Robin					+	X
Eopsaltria griseogularis,	Western Yellow Robin	+	+	+			
Microeca leucophaea,	Jacky Winter	+	+			+	+
Pachycephala pectoralis,	Golden Whistler	+	X	+			X
P. rufiventris,	Rufous Whistler		X	+		+	X
Colluricincla harmonica,	Grey Shrike-thrush	+	X	+			+
Myiagra inquieta,	Restless Flycatcher		+				
Rhipidura fuliginosa,	Grey Fantail	+	X	+	X	X	X
R. leucophrys,	Willie Wagtail					+	+
MALURIDAE							
Malurus splendens,	Splendid Fairy-wren		X	+	X	+	
Stipiturus malachurus,	Southern Emu-wren 1		+	+	X		
ACANTHIZIDAE							
Sericornis frontalis,	White-browed Scrubwren	+	X	+	+	+	
Smicrornis brevirostris,	Weebill	+	X	X	+	X	X
Gerygone fusca,	Western Gerygone	+	X	+			X
Acanthiza apicalis,	Inland Thornbill	+	X	+	+	+	X
A. inornata,	Western Thornbill	+	+	X	+	X	X
A. chrysorrhoa,	Yellow-rumped Thornbill					+	X
NEOSITTIDAE							
Daphoenositta chrysoptera,	Varied Sittella 1	+	+	+	X		
CLIMACTERIDAE							
Climacteris rufa,	Rufous Treecreeper		+				

FAUNA HABITAT		1	2	3	4	5	6
	BIRD SPECIES						
MELIPHAGIDAE							
Anthochaera carunculata,	Red Wattlebird	+	+	+			+
A. chrysoptera,	Little Wattlebird	+	+	+	+		X
Lichenostomus virescens,	Singing Honeyeater				+	+	+
L. ornatus,	Yellow-plumed Honeyeater	X	X				+
Melithreptus brevirostris,	Brown-headed Honeyeater	+	+	+			+
M. lunatus,	White-naped Honeyeater	+	+	+		X	+
Lichmera indistincta,	Brown Honeyeater	+	X	X	X	+	X
Phylidonyris novaehollandiae,	New Holland Honeyeater	+	X	X		X	
P. nigra,	White-cheeked Honeyeater		+	+		+	
P. melanops,	Tawny-crowned Honeyeater		X	+	X	+	
Acanthorhynchus superciliosus,	Western Spinebill	+	X	X	+	X	X
DICAEIDAE							
Dicaeum hirundinaceum,	Mistletoebird 1	+	X	X	X	+	+
PARDALOTIDAE							
Pardalotus punctatus,	Spotted Pardalote	+	+	X		+	+
P. striatus,	Striated Pardalote 1	+	X	X		X	+
ZOSTEROPIDAE							
Zosterops lateralis,	Silvereye	+	+	X	+	X	X
GRALLINIDAE							
Grallina cyanoleuca,	Australian Magpie-lark 1		X	X	X		+
ARTAMIDAE							
Artamus personatus,	Masked Woodswallow	A	A	A	A	A	A
A. cyanopterus,	Dusky Woodswallow	A	X	A	A	A	A
CRACTICIDAE							
Cracticus torquatus,	Grey Butcherbird	+	X	+		+	+
Gymnorhina tibicen,	Australian Magpie 1		X	X	X		+
Strepera versicolor,	Grey Currawong	+	+	+			
CORVIDAE							
Corvus coronoides,	Australian Raven	+	X	X			X
C. bennetti,	Little Crow	+	+	+			+

Appendix F

APPENDIX F

SPECIES OF MAMMALS RECORDED AND EXPECTED TO OCCUR IN THE HABITATS OF THE PROJECT AREA

APPENDICES E TO G

KEY

FAUNA HABITAT	PLANT COMMUNITIES
1	Low Woodlands of Marri-Wandoo, Marri-Jarrah and Marri. (Code - Ec+w, Em+c and Ec).
2	1st Order Stream - Wandoo. (Code - W).
3	1st Order Stream - Marri. (Code - M).
4	Heath. (Code - H).
5	Lithic Complex. (Code - L).
6	Revegetation Area. (Code - R).

Plant community descriptions may be expanded by reference to Section 6.1 VEGETATION - The Project Area.

SYMBOL

X	Species recorded during field survey.
+	Species expected to occur.
A	Mainly aerial species expected to occur.
*	Species scheduled as rare, or otherwise in need of special protection (Schedules 1 or 2 of the Wildlife Conservation Act).
1	Species recorded in February 1986.
2	Introduced species

APPENDIX F

SPECIES OF MAMMALS RECORDED AND EXPECTED TO OCCUR IN THE HABITATS OF THE PROJECT AREA

FAUNA HABITAT		1	2	3	4	5	6
	MAMMAL SPECIES						
TACHYGLOSSIDAE							
Tachyglossus aculeatus,	Short-beaked Echidna	+	X	+	+	X	X
DASYURIDAE							
Dasyurus geoffroii,	Chuditch*	+	+	+			
Phascogale tapoatafa,	Brush-tailed Phascogale	+	+	+			
Antechinus flavipes,	Yellow-footed Antechinus		+	+			
Sminthopsis gilberti,	Common Dunnart	+	+	+	+	+	
S. griseoventer,	Common Dunnart	+	+	+	+	+	
PERAMELIDAE							
Isoodon obesulus,	Southern Brown Bandicoot	+	+	+	+	+	+
PHALANGERIDAE							
Trichosurus vulpecula,	Common Brushtail Possum	+	+	+			
BURRAMYIDAE							
Cercartetus concinnus,	Western Pygmy-possum	+	+	+	+	+	+
TARSIPEDIDAE							
Tarsipes rostratus,	Honey-possum				+	+	
MACROPODIDAE							
Macropus irma,	Western Brush Wallaby1	+	X	X	+	+	
M. fuliginosus,	Western Grey Kangaroo	X	+	+	X	X	X
MOLOSSIDAE							
Tadarida australis,	White-striped Mastiff-bat	A	A	A	A	A	A
Mormopterus planiceps,	Little Mastiff-bat	A	A	A	A	A	A
VESPERTILIONIDAE							
Nyctophilus major,	Greater Long-eared Bat	A	A	A	A	A	A
N. gouldi,	Gould's Long-eared Bat	A	A	A	A	A	A
N. geoffroyi,	Lesser Long-eared Bat	A	A	A	A	A	A
Chalinolobus gouldii,	Gould's Wattled Bat	A	A	A	A	A	A
C. morio,	Chocolate Wattled Bat	A	A	A	A	A	A
Falsistrellus mckenziei,	Great Pipistrelle	A	A	A	A	A	A
Eptesicus regulus,	King River Eptesicus	A	A	A	A	A	A
MURIDAE							
Hydromys chrysogaster,	Water-rat		+	+			+
Rattus rattus,	Black Rat2		+	+			+
Mus musculus,	House Mouse2	+	+	+	+	+	+
LEPORIDAE							
Oryctolagus cuniculus,	Rabbit2	+	+	X	+	X	X
CANIDAE							
Canis familiaris,	Domestic Dog2	+	+	+	+	+	+
Vulpes vulpes,	Fox2	+	X	+	X	X	+
FELIDAE							
Felis catus,	Feral Cat2	+	+	+	+	+	+
EQUIDAE							
Equus caballus,	Horse2	+	X	+	+	+	+

Appendix G

APPENDIX G

LIST OF AMPHIBIANS AND REPTILES RECORDED AND EXPECTED TO OCCUR IN THE HABITATS OF THE PROJECT AREA

APPENDICES E TO G

KEY

FAUNA HABITAT	PLANT COMMUNITIES
1	Low Woodlands of Marri-Wandoo, Marri-Jarrah and Marri. (Code - Ec+w, Em+c and Ec).
2	1st Order Stream - Wandoo. (Code - W).
3	1st Order Stream - Marri. (Code - M).
4	Heath. (Code - H).
5	Lithic Complex. (Code - L).
6	Revegetation Area. (Code - R).

Plant community descriptions may be expanded by reference to Section 6.1 VEGETATION - The Project Area.

SYMBOL

X	Species recorded during field survey.
+	Species expected to occur.
A	Mainly aerial species expected to occur.
*	Species scheduled as rare, or otherwise in need of special protection (Schedules 1 or 2 of the Wildlife Conservation Act).
1	Species recorded in February 1986.
2	Introduced species

APPENDIX G

LIST OF AMPHIBIANS AND REPTILES RECORDED AND EXPECTED TO OCCUR IN THE HABITATS OF THE PROJECT AREA

FAUNA HABITAT		1	2	3	4	5	6
AMPHIBIAN AND REPTILE SPECIES							
LEPTODACTYLIDAE	Frogs						
Crinia georgiana		+	X	+	+	X	X
Geocrinia leai			+	+			
Heleioporus barycragus		+	+	+			+
H. inornatus		+	+	+			+
Limnodynastes dorsalis		+	+	+	+	+	+
Neobatrachus pelobatoides			+	+			
Pseudophryne guentheri		+	+	+	+	+	X
Ranidella glauerti			+	+			+
R. pseudinsignifera			+	+			X
HYLIDAE	Frogs						
Litoria adelaidensis			+	+			
GEKKONIDAE	Geckos						
Crenadactylus o. ocellatus		+	+	X	+	+	
Diplodactylus granariensis					+	+	
D. polyophthalmus		+	+	+	+	X	+
D. pulcher					+	+	
D. spinigerus 1		X	+	+	+	+	+
Gehyra variegata					+	X	
Oedura reticulata			+				
Phyllodactylus m. marmoratus		+	+	+			+
Phyllurus milii		+	+	+	+	+	+
PYGOPODIDAE	Legless Lizards						
Aprasia repens		+	+	+	+	+	+
Delma fraseri 1		X	+	+	X	+	
D. grayii		+	+	+	+	+	
Lialis burtonis		+	+	+	+	+	
AGAMIDAE	Dragon Lizards						
Ctenophorus ornatus						X	
Pogona m. minor		+	+	+	+	+	+
SCINCIDAE	Skinks						
Cryptoblepharus plagiocephalus		+	+	X			+
Ctenotus delli *		+	+	+			
C. fallens		+	+	X	+	+	
C. labillardieri		+	+	+	+	+	
Egernia kingii			+	+			
E. napoleonis		+	+	+	+	+	+
Hemiergis i. initialis		+	+	+	+	+	+
Leiolopisma trilineatum			+	+			
Lerista distinguenda		+	+	+	+	+	
Menetia greyii 1		X	+	+	X	+	+
Morethia obscura		+	+	+	+	+	+
Tiliqua r. rugosa 1		X	+	+	+	X	+

FAUNA HABITAT		1	2	3	4	5	6
AMPHIBIAN AND REPTILES SPECIES							
VARANIDAE	Monitors						
Varanus gouldii		+	+	+	+	+	+
V. rosenbergi		+	+	+	+	+	+
V. t. tristis		+	+	+		+	
TYPHLOPIDAE	Blind Snakes						
Ramphotyphlops australis		+	+	+			+
R. pinguis		+	+	+			+
R. waitii		+	+	+			+
BOIDAE	Pythons						
Morelia spilota imbricata *		+	+	+	+	+	
M. s. stimsoni					+	+	
ELAPIDAE	Elapid Snakes						
Demansia psammophis reticulata		+	+	+	+	+	
Notechis scutatus occidentalis			+	+			+
Pseudechis australis		+	+	+	+	+	+
Pseudonaja a. affinis		+	+	+	+	+	+
Rhinoplocephalus gouldii		+	+	+	+	+	+
R. nigriceps		+	+	+	+	+	+
Vermicella bertholdi		+	+	+	+	+	
V. bimaculata		+	+	+	+	+	
V. semifasciata		+	+	+	+	+	

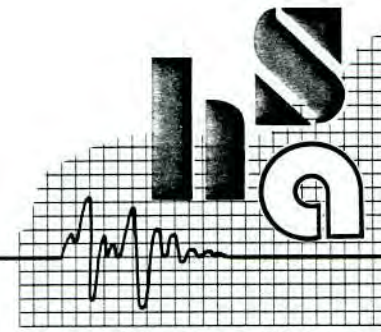
Appendix H

APPENDIX H

NOISE MODELLING FOR PIONEER No. 2

HERRING STORER ACOUSTICS
Suite 34, 11 Preston Street, Como,
Western Australia, 6152.

Telephone: (09) 367 6200
Facsimile: (09) 474 2579



ALLAN HERRING M.I.E. AUST. M.A.A.S.
LYNTON STORER M.A.I.E.A., M.A.A.S.

NOISE LEVEL IMPACT ASSESSMENT

PIONEER QUARRY

HERNE HILL

Our ref: 0183-90053

PIONEER QUARRY

HERNE HILL OPERATIONS

1. Introduction

The purpose of this study is to determine the likely noise emission of the proposed Herne hill quarry operations of Pioneer Concrete, calculate the propagation to the nearest residential areas and assess the impact generally in accordance with the Environment Protection Authority 1986 Regulations.

2. Method

Sound level measurements were carried out at and around the existing quarry site in Herne Hill during normal operations but ensuring all equipment was running so as the maximum sound levels were obtained. The sound level data thus collected was used to build a computer model of the existing operations which could then be verified against the measured levels. The overall plant sound power levels obtained from this exercise were then adjusted to account for differences in equipment and their locations at the proposed site and a computer model built for the proposed site. The results from this model, in the form of noise level contours, were used to assess the impact to the surrounding area.

3. Results: Existing Plant

Near field measurements were recorded for both the crushing and screening plant as well as quarry operations. This information was primarily used to determine the octave band make up of the various sources. Results of these measurements are as follows:

3.1 CRUSHING PLANT

Nominal distance 10m. Overall level 93 dB(A)

Frequency Hz	31	63	125	250	500	1K	2K	4K	8K
Pressure Level dB	94	98	97	91	89	86	84	80	70

3.2 SCREENING PLANT

Nominal distance 7m. Overall level 89 dB(A)

Frequency Hz	31	63	125	250	500	1K	2K	4K	8K
Pressure Level dB	91	85	83	83	83	83	83	80	75

3.3 QUARRY OPERATIONS

Nominal distance 60m. Overall level 67 dB(A)
Includes 2 Loaders
2 Drill Rigs
Mobile Crusher
2 Haul Trucks
Mobile Crane
Water Truck

Frequency Hz	31	63	125	250	500	1K	2K	4K	8K
Pressure Level dB	75	67	63	64	61	60	61	56	42

Various measurements were also recorded at varying distances. The most reliable of these is considered to be at locations A & B. **Refer Fig.1**

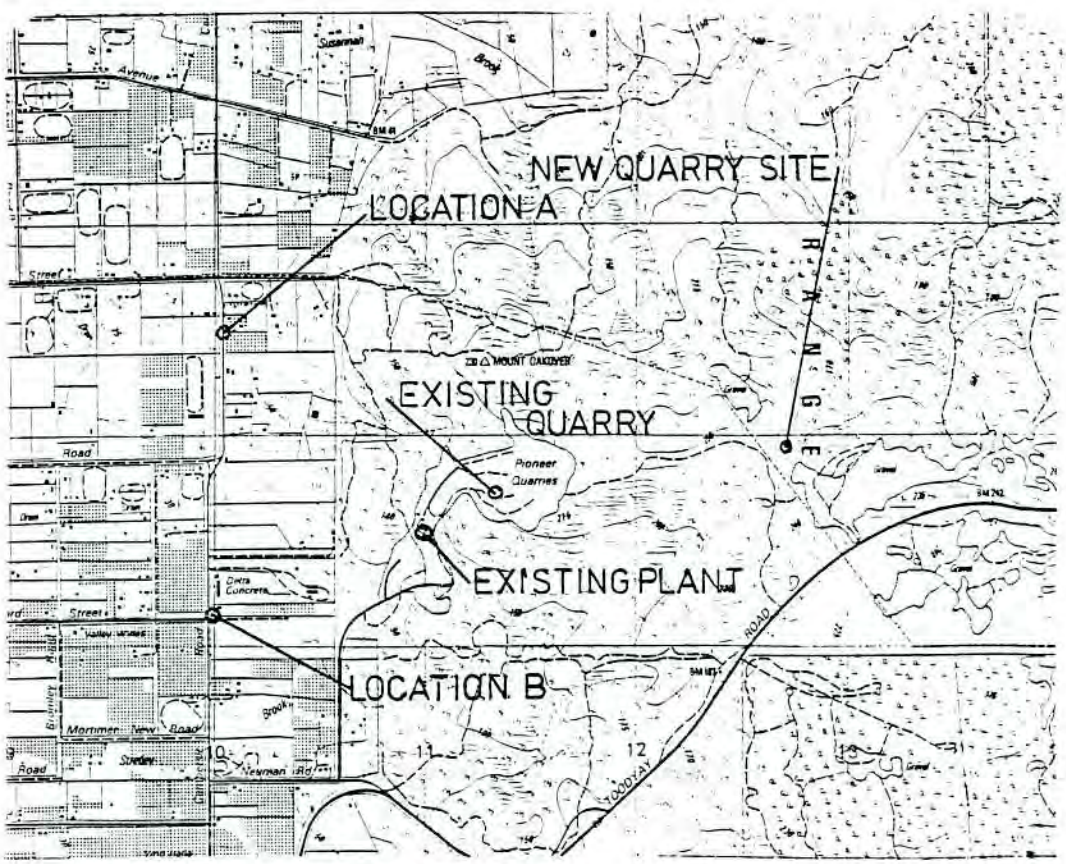


FIGURE 1

Location A is generally in line with the quarry pit through a valley. Location B is in line of sight of the crushing/screening plant.

Measured Level Location A: 40 dB(A)
Measured Level Location B: 49 dB(A)

Conditions of measurement were fine with a temperature of 25°C, relative humidity of 29% and a strong N.E. breeze of 7m/s. Location A & B are both directly down wind under these conditions.

The results of modelling this data can be seen in Figure 2 in the form of noise level contours under the same conditions as the measured data.

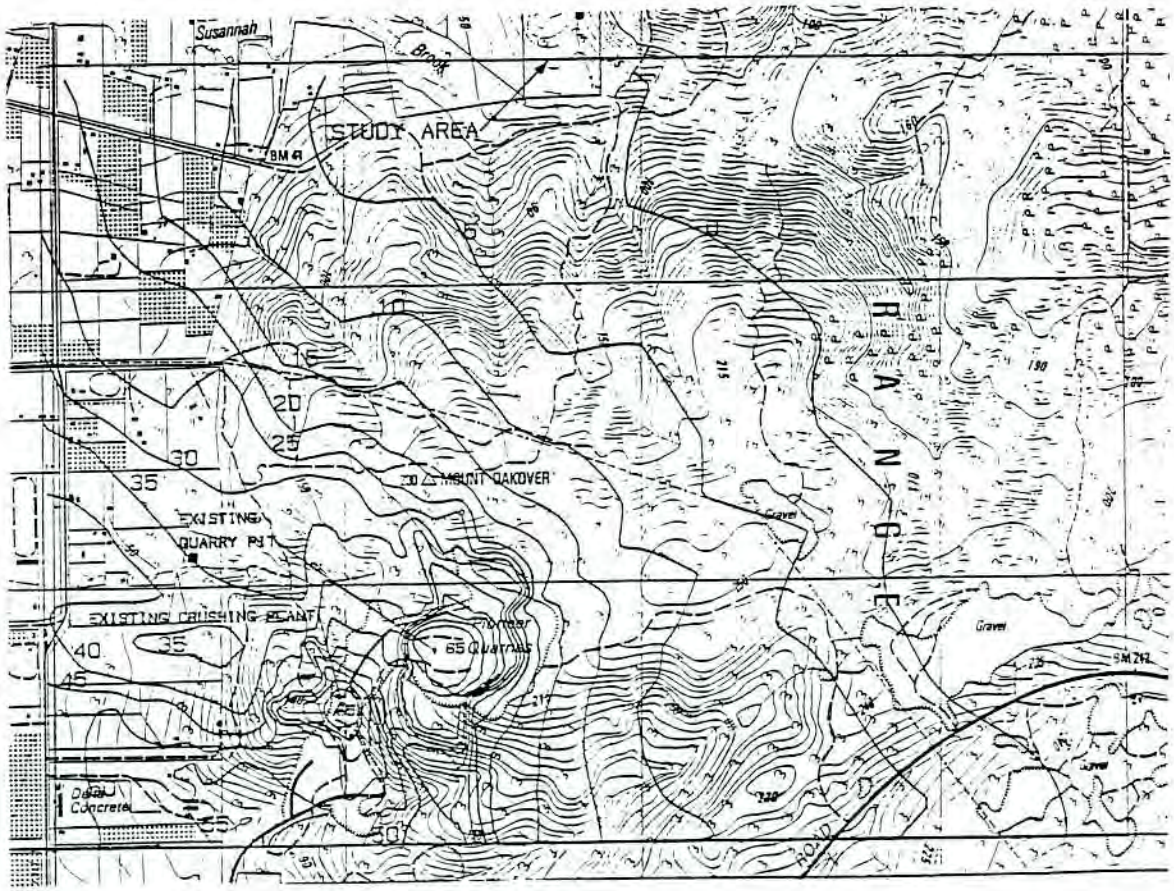


FIGURE 2

(Refer to Appendix for full size plot)

4. Results: Proposed Plant

Using measured data from the existing plant with modifications due to separate primary/secondary crushing area and tertiary crushing area the same modelling was undertaken for the proposed site. the resultant noise level contours are shown in Fig.3 for the same propagation conditions as above i.e. N.E. wind 7m/s.

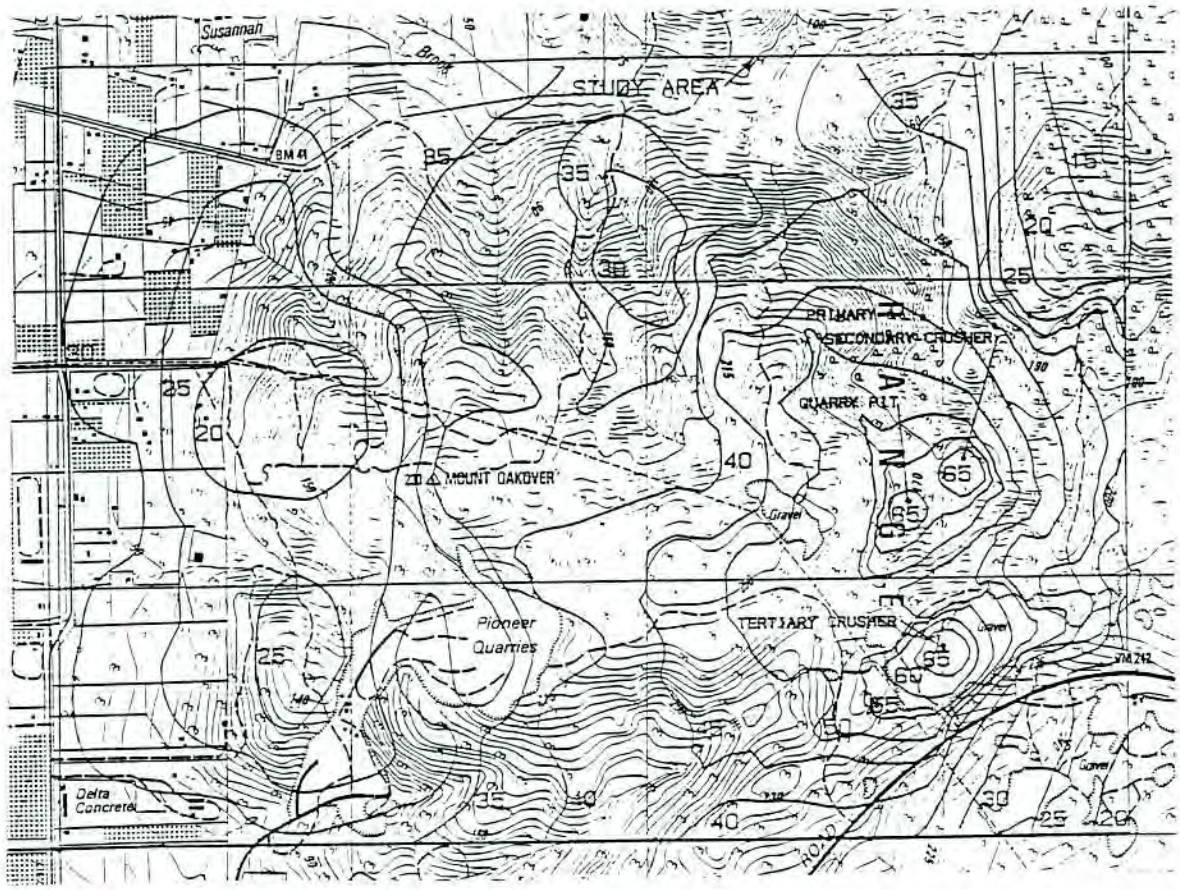


FIGURE 3

(Refer to Appendix for full size plot)

5. Discussion

Guidance as to acceptable noise levels can be taken from the E.P.A. 1986 Regulations. The most critical area for receipt of noise is judged to be the residential area surrounding Campersic Road. this area being best classified under Table 1 of the Regulations as category A2. This category gives an assigned outdoor level of -

0700 - 1900 hrs	45 dB(A)
1900 - 2200 hrs	40 dB(A)
2200 - 0700 hrs	35 dB(A)

Proposed changes to the Regulations site the following as the maximum acceptable noise levels that are not unreasonable for the purposes of the Environmental Protection Authority 1986.

0700 - 1900	Mon to Sat	50 dB(A)
2200 - 0700		40 dB(A)
any other time		45 dB(A)

These emissions shall not include tonal components, impulsive or other annoying characteristics.

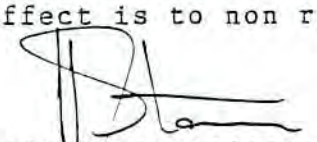
For the purposes of this study 40 dB(A) has been taken as the level not to be exceeded at any time. Noise emissions from the operations is likely to have tonal components with sometimes impulsive noise due to rock fall within the crusher system, particularly hopper loading. To take account of the characteristics, the acceptable level should be 35 dB(A).

Under the considered worst case conditions of down wind propagation it can be seen, for the existing operations, that levels up to 50 dB(A) are experienced near the intersection of Campersic and Lennards Street. This area, however, contains other industry where "acceptable" levels would be higher. Other nearby areas, that may be considered only residential, receive levels of around 45 dB(A) which could be considered in excess by up to 10 dB(A) depending upon the characteristics.

For the proposed quarry and plant site it can be seen that these same areas would receive noise levels less than 30 dB(A) under similar conditions. Under varying wind conditions noise levels along the eastern and southern boundaries of the study area could equal or exceed 45 dB(A) however, these are non residential areas.

6. Summary

Moving of quarry and plant operations to the proposed eastern site will reduce noise levels in the main Herne Hill residential area, particularly along Campersic Rd, from considered excessive levels to well within considered acceptable levels (from 45 dB(A)+ to 30 dB(A)-). Similar noise emission will exist at the new operations, however, the effect is to non residential areas.



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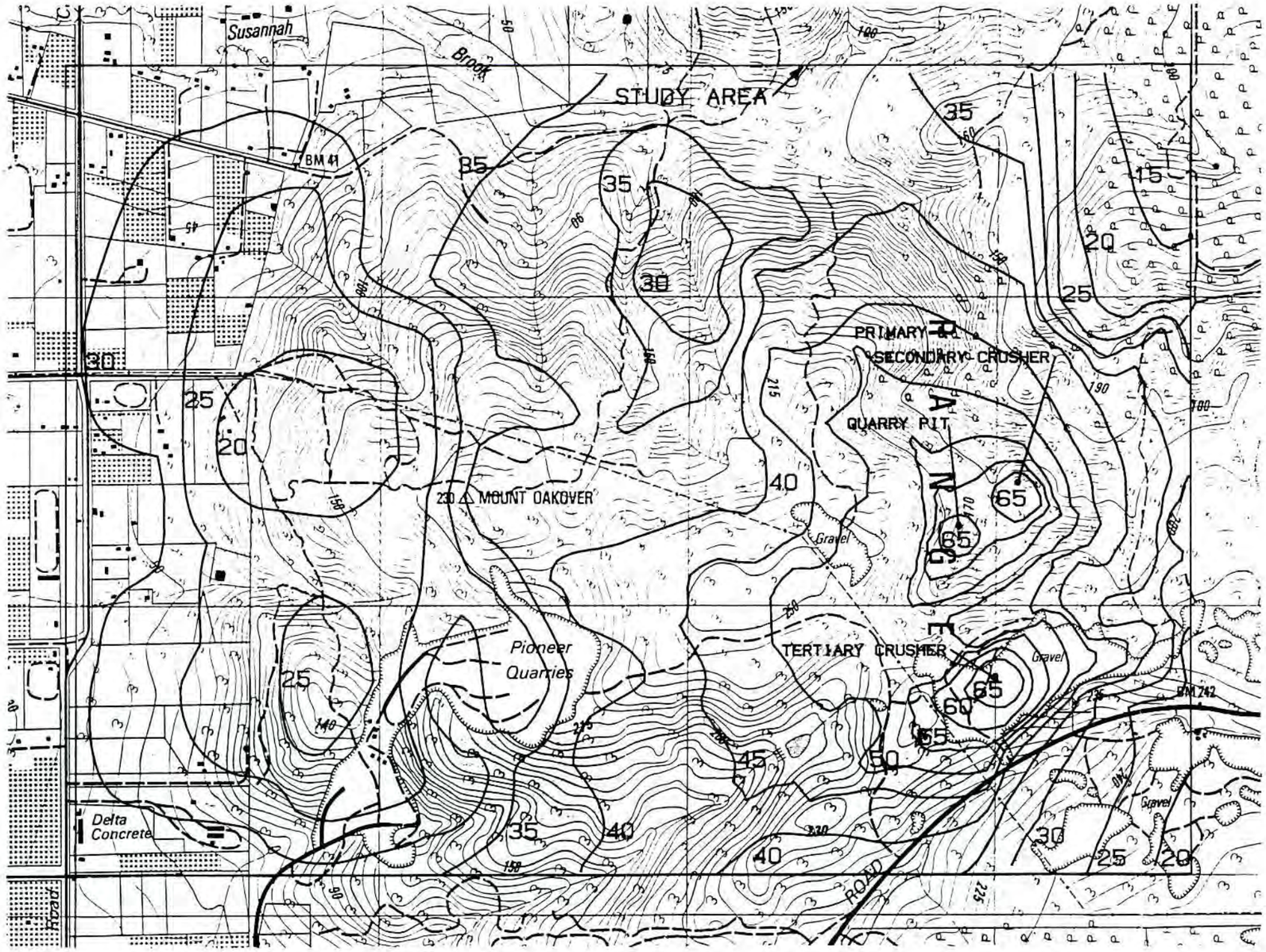
Lynton Storer

N



Noise contours shown are dB(A)

Propagation shown is for a 7m/s N.E. wind.

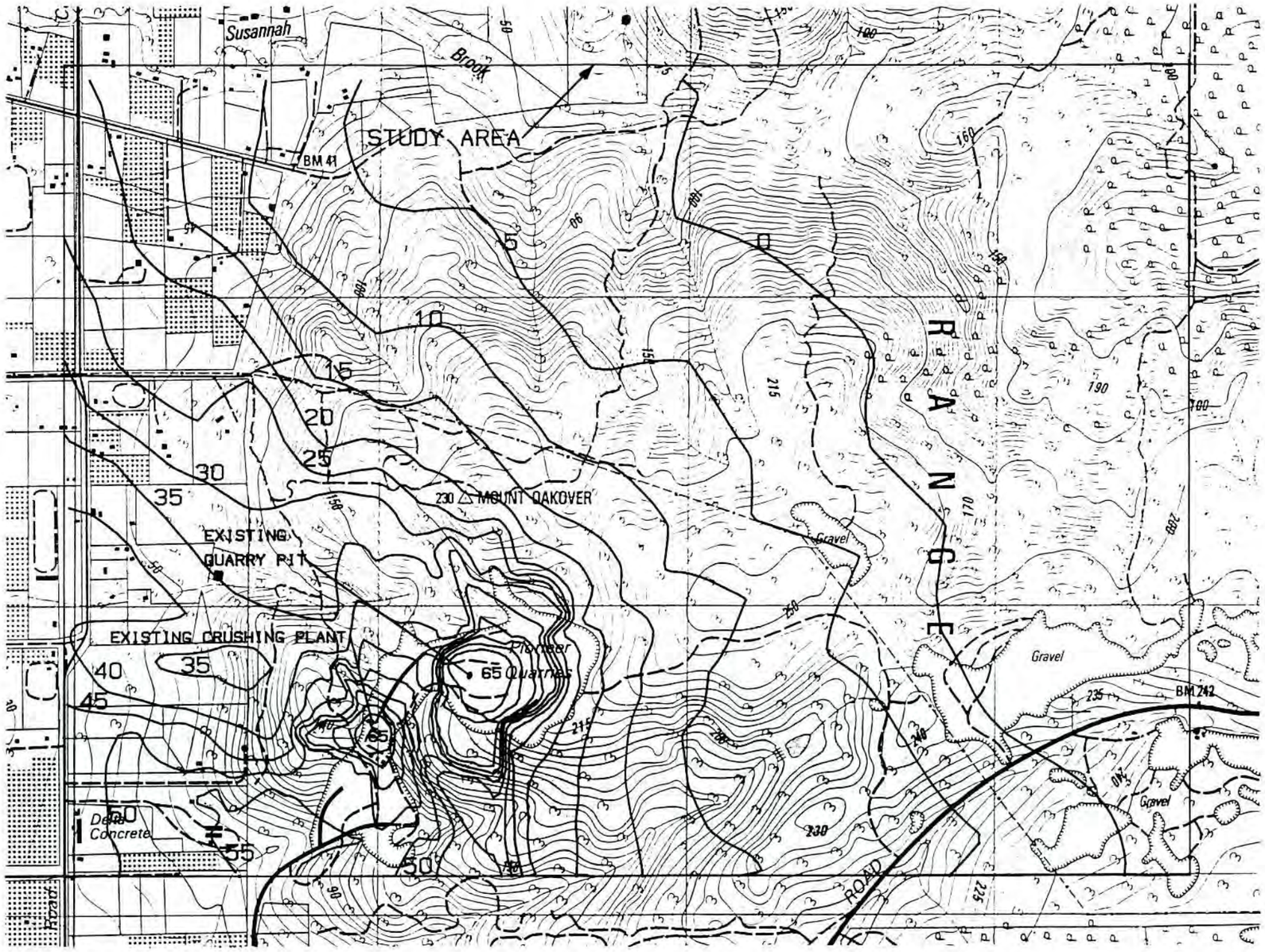
PROPOSED OPERATIONS

HERRING STORER ACOUSTICS
Suite 34, 11 Preston Street, Como,
Western Australia, 6152.
Telephone: (09) 367 6200 (09) 367 0621
Facsimile: (09) 474 2579

SCHEMATIC DRAWING - NOT TO SCALE

PIONEER CONCRETE (WA) PTY. LTD.
HERNE HILL QUARRY NOISE LEVELS

N



Noise contours shown are dB(A)

Propagation shown is for a 7m/s N.E. wind.

EXISTING OPERATIONS

HERRING STORER ACOUSTICS
Suite 34, 11 Preston Street, Como,
Western Australia, 6152.
Telephone: (09) 367 6200 (09) 367 0621
Facsimile: (09) 474 2579

SCHEMATIC DRAWING - NOT TO SCALE

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