Prepared For:
Bloomfield Collieries Pty Limited

ENVIRONMENTAL IMPACT STATEMENT FOR PROPOSED MODIFICATION OF MINING OPERATIONS - RIXS CREEK COAL MINE

VOLUME 2 : APPENDICES

Prepared by

ENVIROSCIENCES PTY LIMITED

122 Parry Street, Newcastle West NSW 2302

(Offices also at Sydney, Brisbane, Gladstone, Mackay and Melbourne)

November 1994

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APPENDIX 1:

CORRESPONDENCE

FROM COAL GEOLOGY 9018520

Minister for Agriculture and Fisheries and Minister for Mines

Ian Causley, MP

C94/2077

Mr P Murray
Consultant
Bloomfield Collieries Pty Limited
PO Box 4
EAST MAITLAND NSW 2323

30 NOV 1994

Dear Mr Murray,

I refer to your request made to the Department of Mineral Resources at the meeting in Newcastle on 21 November 1994, for a direction to apply for development consent for the proposed Rixs Creek mine extension.

I hereby direct you pursuant to Schedule I Clause 13 of the Mining Act 1992, to apply to the appropriate consent authority before the 31 January 1995, for development consent for the use of the land for the purpose of obtaining minerals. This direction applies only to the area subject to Mining Lease Application No 17 Singleton and it should be noted that this mining lease application does not cover the entire area for which development consent is being sought.

I also wish to confirm that this direction has only been issued in order to assist with the commencement of the appropriate approvals process under the Environmental Planning and Assessment Act. It does not indicate support for the proposal, as outlined in the Environmental Impact Statement for Proposed Modification of Mining Operations - Rixs Creek Coal Mine, prepared by Envirosciences Pty Limited and dated November 1994.

Should you have any further queries, please contact Mr David Agnew, Regional Manager, Coal and Petroleum Administration Branch on (065) 724200.

Yours sincerely,

Ian Causley

IAN CAUSLEY MP
MINISTER FOR AGRICULTURE AND FISHERIES
MINISTER FOR MINES

DEPARTMENT OF MINERAL RESOURCES

NEW SOUTH WALES GOVERNMENT

L 1 / 1 CIVIC AVENUE SINGLETON NSW 2330
PO BOX 51 DX7071 FACSIMILE: (065) 721 201

Mr P J Murray
Development Consultant
Bloomfield Collieries
P O Box 4
East Maitland NSW 2323

Our Ref: C94/2077

Dear Mr Murray

REVISED CONCEPTUAL MINE PLAN FOR PROPOSED RIXS CREEK MINE EXTENSION.

I refer to your letter of the 30 September 1994 and the alternative mine plan lodged with Mr A Morgan on the same day.

The Department has assessed the alterative mine plan and we consider this plan to be acceptable on a conceptual basis. The plan is however somewhat cursory in nature, considering the scale and sensitive location of the project. Further support studies and information would therefore be required in order to fully appraise the project.

Consequently, the continued support of the Department for the alternative mine plan is conditional on the provision of more detailed supporting information as the approval process progresses. Most of this information would no doubt have to be presented in the Environment Impact Statement (EIS) for the project.

From the Department's point of view, this EIS should present the recently lodged alternative mine plan as a preferred option. As previously advised, the Department does not support the original plan. It would be very much appreciated if the Department could have the opportunity of reviewing the draft EIS prior to this document going on public display.

Regarding your request for a directive to apply for development consent, the Department will be in a position to recommend to the Minister that he issue such a notice to the Company, when we have seen a satisfactory draft EIS.

Should you have any further queries, please contact me on (065) 724200.

Yours sincerely,

19/10/94

David Agnew
REGIONAL MANAGER (NORTHERN)
COAL AND PETROLEUM ADMINISTRATION BRANCH

RHA PASTORAL COMPANY PTY LIMITED
A.C.N. 000 098 202

Incorporated in New South Wales
Registered Office:
Level 2, 55 Lavender Street,
PO Box 165 MILSONS POINT NSW 2061
Phone (02) 955 2600 Fax (02) 955 6575
Bridgman Road,
PMB 7 SINGLETON NSW 2330
Phone (065) 77 4111 Fax (065) 77 4088

30 November, 1994

The Minister for Planning for
the State of New South Wales

Dear Sir,

RE: APPLICATION BY BLOOMFIELD COLLIERIES PTY. LIMITED FOR DEVELOPMENT CONSENT IN ACCORDANCE WITH STATE ENVIRONMENTAL PLANNING POLICY NO. 34 IN RESPECT OF COAL LEASE 352 FOR THE RIXS CREEK COAL MINE.

RHA Pastoral Company Pty. Limited being the owner of land which is land located within Coal Lease Application 185 near Singleton which land is now the subject of Coal Lease 352 does hereby consent to Bloomfield Collieries Pty. Limited lodging an application for development consent seeking approval of Rixs Creek Coal Mine which may effect the said land.

Yours truly,

Mr Y. Shinkai
Director

DATE: 30 NOVEMBER 1994

The Minister for Planning for
the State of New South Wales

Dear Sir

RE: APPLICATION BY BLOOMFIELD COLLIERIES PTY. LIMITED FOR DEVELOPMENT CONSENT IN ACCORDANCE WITH STATE ENVIRONMENTAL PLANNING POLICY NO. 34 IN RESPECT OF COAL LEASE 352 FOR THE RIXS CREEK COAL MINE

Miss E S Bowman being the owner of Lot 1 in Deposited Plan 170704 in the Parish of Auckland, County of Durham being the land in Certificate of Title Volume 7518 Folio 79 which is land located within Coal Lease Application 185 near Singleton which land is now the subject of Coal Lease 352 does hereby consent to Bloomfield Collieries Pty. Limited lodging an application for development consent seeking approval of Rixs Creek Coal Mine which may effect the said land.

Yours truly,

Elizabeth S Bowman

DATE: 30th November 1994

The Minister for Planning for
the State of New South Wales

Dear Sir

RE: APPLICATION BY BLOOMFIELD COLLIERIES PTY. LIMITED FOR DEVELOPMENT CONSENT IN ACCORDANCE WITH STATE ENVIRONMENTAL PLANNING POLICY NO. 34 IN RESPECT OF COAL LEASE 352 FOR THE RIXS CREEK COAL MINE

Four Mile Pty. Limited being the owner of land which is land located within Coal Lease Application 185 near Singleton which land is now the subject of Coal Lease 352 does hereby consent to Bloomfield Collieries Pty. Limited lodging an application for development consent seeking approval of Rixs Creek Coal Mine which may effect the said land.

Yours truly,

FOUR MILE PTY. LIMITED

[signature]

D. A. CUNNINGHAM
SECRETARY

DATE: 30 November 1994

The Minister for Planning for
the State of New South Wales

Dear Sir

RE: APPLICATION BY BLOOMFIELD COLLIERIES PTY. LIMITED FOR DEVELOPMENT CONSENT IN ACCORDANCE WITH STATE ENVIRONMENTAL PLANNING POLICY NO. 34 IN RESPECT OF COAL LEASE 352 FOR THE RIXS CREEK COAL MINE

Singleton Shire Council being the owner of land which is land located within Coal Lease Application 185 near Singleton which land is now the subject of Coal Lease 352 does hereby consent to Bloomfield Collieries Pty. Limited lodging an application for development consent seeking approval of Rixs Creek Coal Mine which may effect the said land.

Yours truly,

General Manager
Singleton Shire Council.

88/M.4014;3
Mr C R Johnstone
Phone (049) 240 332

P J Murray & Associates Pty Limited
23 Corona Street
HAMILTON NSW 2303

Attention : Mr Peter Murray

STATE HIGHWAY No 9 - NEW ENGLAND HIGHWAY. SHIRE OF SINGLETON. PROPOSED MODIFICATION OF MINING OPERATIONS, RIXS CREEK.

Dear Sir,

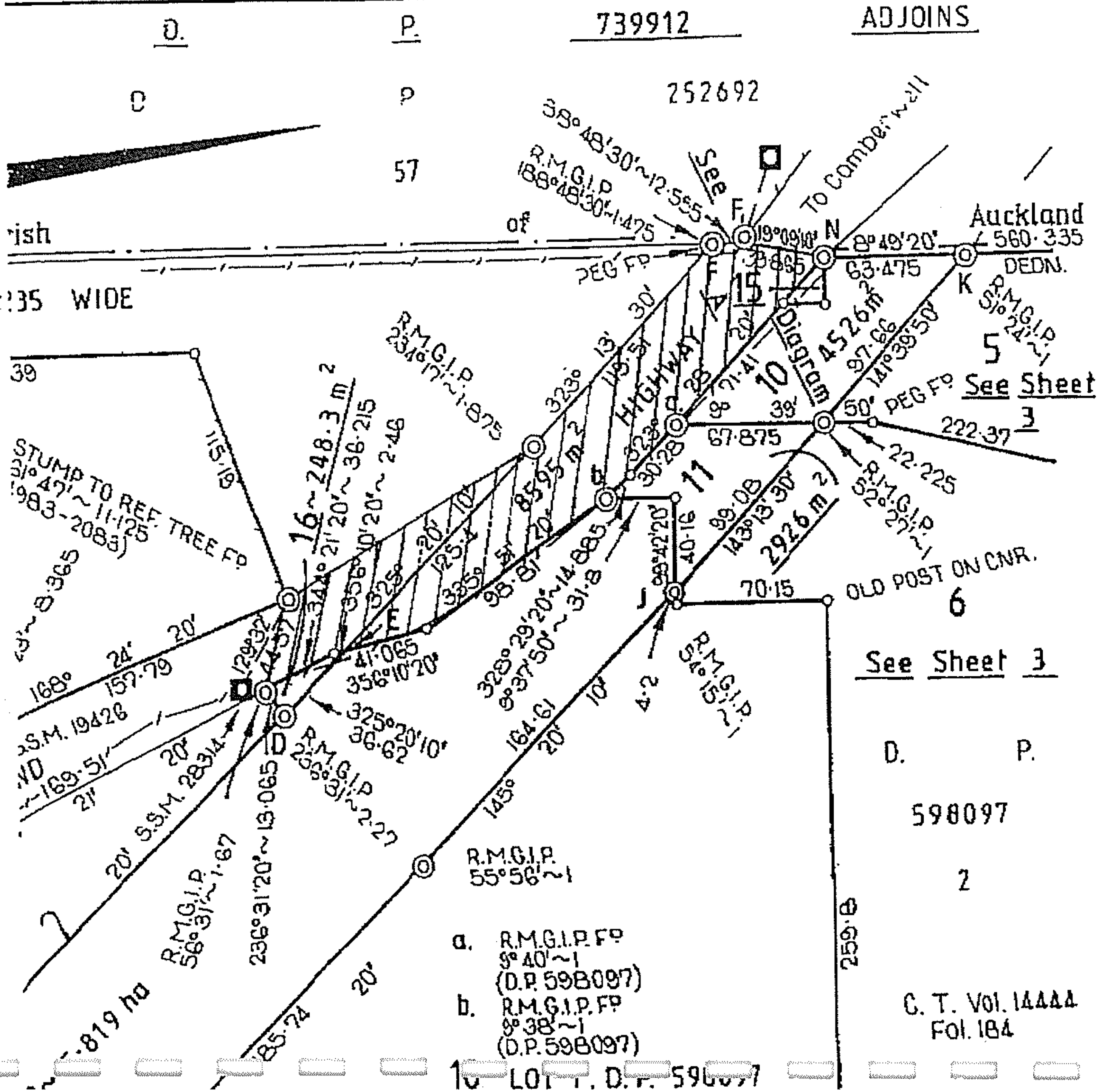
With reference to your facsimile of 4 December 1994 (your ref 4\16\850 94\638) it appears that the land in question on your sketch is part of an unused road reserve and as such would be vested in Council and therefore does not belong to the Authority, although the Authority may have been the acquiring body. The consent needed by you for lodgement of development consent should be sought form Singleton Council.

However mining operations which would effect the road reserve shown hatched on the attached sketch should be restricted as detailed in Section 5.8 Transportation Impacts of the draft Environmental Impact Statement of June 1994.

Yours faithfully

Mr C Nunn
Zone Planner
6 December, 1994

o appear in this space



D.M.R. PLAN Nº 0009 402 SS0833

D. P. 739913

Registered:

C.A.:

Title System:

Purpose:

Ref. Map:

Last Plan:

PLAN OF LAND TO BE ACQUIRED FOR THE PURPOSES OF THE STATE ROADS ACT, 1986.

Reduction Ratio 1: 2500
Lengths are in metres.

~~Mun.~~/Shire ~~City~~: SINGLETON

Locality: CAMBERWELL

Parish: DARLINGTON

County: DURHAM

This is sheet 1 of my plan in 3 sheets.
(Delete if inapplicable).

... DONALD GRABURN FERGUSSON

APPENDIX 2:

DIRECTOR'S REQUIREMENTS

New South Wales Government

Department of Planning

Leanne

Remington Centre
175 Liverpool Street, Sydney 2000
Box 3927 G.P.O. Sydney 2001
DX. 15 Sydney

Telephone :(02) 391 2000 Ext.2077

Fax No. :(02) 391 2111

Contact : V Thomson

Our Reference : N90/356/702

Your Reference :

Mr P J Murray
Development Consultant
Bloomfield Collieries Pty Ltd
PO Box 4
EAST MAITLAND NSW 2323

Dear Sir

PROPOSED EXTENSION OF RIXS CREEK COAL MINE

Following the Planning Focus meeting of 17 November 1993, this letter is the final advice. The proposal has been identified as falling within State Environmental Planning Policy No. 34 and will be for the determination of the Minister for Planning.

2. As development consent is required for the proposal and it is a designated development within the meaning of Schedule 3 of the Environmental Planning and Assessment Regulation, 1980, as amended, an EIS must accompany the development application to the Singleton Council. The EIS shall be prepared in accordance with Clause 34 of the Regulation and shall bear a certificate required by clause 26(1)(b) of the Regulation (see Attachment No.1).

3. In addition, pursuant to Clause 35 of the Regulation, the Director requires that the following matters be specifically addressed in the EIS:

- Synopsis of results of environmental monitoring to date, including that of both Rix's Creek Coal Mine and Camberwell Coal Mine;
- The established relationships between the environmental monitoring results and other factors and measurements including meteorological data, plant and equipment employed, quantities of material moved and their emplacement and mine plans;
- Description of the mine as developed in accordance with the development consent of 19 October, 1989 and Coal Lease 352;
- Identification of the proposed expansion of mining activity including mining areas and typical, timed mining schedules of quantities of overburden and coal;
- Rationale and justification of proposed expansion of mining;
- Description of proposed mining methods, equipment and manning levels;

- Assessment of worst case impacts of dust emissions in adverse meteorological conditions affecting nearest residences and sensitive land uses;
- Noise levels of fixed and mobile equipment to be used and projected noise and vibration levels from blasting;
- Reassessment of existing acoustic environment using measured results with simulation modelling as necessary to identify accumulative noise levels at affected residences;
- Estimation of envelope of zone of affectation based on exceedance of 4g/m2/month annual average and L90 15 min = 50d B(A) day time (see attachment).
- Amended noise monitoring program;
- Revised water management plan specifying necessary works and controls and site water balance;
- Proposals for an expanded water monitoring program;
- The New England Highway and its protection under the established mining procedures;
- Proposed rehabilitation plans for the extension area (show final landform) including final void;
- Proposals for relocation and/or closure of Middle Falbrook Road;
- Outline of medium to long-term land use proposals in the vicinity of the mine and the Singleton Heights area;
- Results of community consultations including discussions with Singleton Council;
- Applicable Section 94 contribution in accordance with Council's Plan;
- Results of consultation with EPA, RTA, Department of MIneral Resources, Department of Agriculture, Department of conservation and Land Management.

4. Attachment No. 2 is a guide to the type of information most likely to be relevant to the development you propose; not all of the matters raised therein may be appropriate for consideration in the EIS for your proposal; equally, the guide is not exhaustive.

5. Should you require any further information regarding this matter please do not hesitate to contact us again.

Yours faithfully

B Adams 17.1.94

B Adams
Manager
Assessments & Major Hazards Branch

ATTACHMENT

1. DUST FALLOUT PREDICTION

Presentation of Results:

At a scale of 1:25,000 set out a grid to cover the existing mine site and proposed mining extension.

Carry out predictive modelling study for the worst case for the year that the DG is first operating and adverse meteorological conditions apply.

Record the worst case fallout in each grid square. Draw the envelope values of 4g/m2/month annual average and higher.

2. NOISE IMPACT ASSESSMENT

Presentation of Results:

Carry out L90, 15min predictive survey and show worst case day and night results in each grid square. Highlight day values exceeding 50dBA and night values exceeding 35dBA.

3. REVISED ZONE OF AFFECTATION

The area inside the 4g/m2/months annual average supplemented by the above highlighted noise values day or night is the affected land relevant to the mine extension.

DEPARTMENT OF PLANNING

ATTACHMENT NO 2

ADVICE ON THE PREPARATION OF AN ENVIRONMENTAL IMPACT STATEMENT (EIS) FOR AN OPEN CUT COAL MINING OPERATION

Coal mining is designated development by virute of paragraph (m) to Schedule 3 of the Environmental Planning and Assessment Regulation, 1980, (as amended).

The purpose of this paper is to outline various issues relevant to the preparation and consideration of an EIS for an open cut coal mining operation. It is intended to assist preparation of the EIS. However, it is the applicant's responsibility to identify and address as fully as possible the matters relevant to the specific development proposal in complying with the requirements for EIS preparation (see Attachment No 1).

The matters nominated in this paper are not intended as a comprehensive identification of all issues which may arise in respect of a surface mining operation. Some of the issues nominated may not be relevant to a specific proposal. On the other hand, there may be other issues, not included, that are appropriate for consideration in the EIS.

Information provided should be clear, succinct and objective and where appropriate be supported by maps, plans, diagrams or other descriptive detail. The purpose of the EIS is to enable members of the public, the consent authority (usually the Council) and the Department of Planning to properly understand the environmental consequences of the proposed development.

1. Description of the proposal.

The description of the proposal should provide general background information on the location and extent of the works proposed, an indication of adjacent developments, and details of the site, land tenure, zonings and relevant forward planning proposals and any other land use constraints.

This section should provide specific information on the nature, intent and form of the development. It should, as far as possible, include such details as the processes involved highlighting any proposed blasting, water management and treatment, coal screening, crushing and washing, disposal of wastes, handling of overburden, landscaping and rehabilitation. A description should also be provided of associated operations such as the transport of materials.

Particular details that may be relevant include:

- Characteristics and economic significance of the resource.
- Quantity of materials to be mined.
- Coal mining techniques, plans of operations.
- Type of machinery and equipment to be used.
- Coal handling on site.
- Coal preparation, including any washing.
- Expected life of the operation.

- Number of persons to be employed.
- Hours of operation.
- Power requirements.
- Proposals for dealing with overburden.
- Water management, including water supply, site drainage, erosion controls, proposals for retention of runoff and interception of groundwaters, water reuse and discharge offsite, if any.
- Proposals for rehabilitation and landscaping including assurances of effective completion.
- Disposal of coarse and fine washery rejects including any proposals for mechanical dewatering.
- coal haulage on site and transport offsite.
- Monitoring proposals.

2. Description of the Environment.

This should provide details of the environment in the vicinity of the development site and also of aspects of the environment likely to be affected by any facet of the proposal. In this regard, physical, natural, social, archaeological and economic aspects of the environment should be described to the extend necessary for assessment of the environmental impact of the proposed development.

3. Analysis of Environmental Impacts.

Environmental impacts usually associated with open cut coal mining operations are listed below. Where relevant to the specific proposal, these should be addressed in the EIS and suitably quantified, taking into account the adequacy of safeguards proposed to minimise them.

- Any likely cumulative effects of the proposed operation when considered together with other operations in this vicinity.
- Any effects on the agricultural viability of the adjoining land holdings.
- Dust emissions and controls.
- Water pollution potential.
- Likely noise/vibration disturbance caused by the operations, including transport operations, on nearby residences.
- Other impacts of transport movements, both road and rail including access over railways and onto highways.
- Disposal of coal washery rejects.
- Overburden disposal and emplacement and the rehabilitation thereof including relevance to past mining land use.
- Effects on valuable flora and fauna.
- Effects on the visual environment.
- Any likely affectation of sites of Aboriginal archaeological or European heritage value (including industrial heritage) if located in the vicinity of operations.
- Socio-economic implications including effects on nearby community facilities and services, and proposals with regard to Government's Infrastructure Financing Policy.

In addition, any potential for hazard or risks to public safety and proposals to monitor and reduce the environmental impacts of the proposal should be included.

4. Contact with relevant Government Authorities.

In preparing the EIS, it is suggested that authorities, such as those listed below, should be consulted and their comments taken into account in the EIS.

- The State Pollution Control Commission in regard to air, water and noise impacts and relevant pollution control legislation requirements;
- The Department of Mineral Resources in regard to requirements under the Coal Mining Act.
- The Soil Conservation Service regarding appropriate erosion control and rehabilitation procedures;
- The Department of Water Resources with regard to water supply requirements.
- The Department of Agriculture and Fisheries if prime agricultural land may be affected by the proposal; and
- The Heritage Council of NSW if the proposal is likely to affect any place or building having heritage significance or the National Parks and Wildlife Service if aboriginal places or relics are likely to be affected.

It is the responsibility of the person preparing the EIS to determine those Departments relevant to the proposed development.

END

APPENDIX 3:

CONDITIONS OF DEVELOPMENT CONSENT

19 OCTOBER 1989

Schedule 2 of the development consent for Rixs Creek Mine, issued on 19 October 1989 lists conditions under which the mine can operate. These conditions are listed below together with the mine's compliance with them.

Several of the conditions have been satisfied entirely and are no longer applicable. Alternatively, it is anticipated that many of the conditions will continue to be appropriate for the proposed expansion. The relevance of these conditions to the current proposal is outlined and further detailed in **Appendix 10**.

GENERAL

1. *The development is to be carried out generally in accordance with the Environmental Impact Statement dated 14 June 1988 prepared by Croft & Associates Pty Limited (EIS) certified in accordance with Section 77(3) of the Act, supplemented by the documents listed in Appendix 5.1 of the Report of the Commissioners of Inquiry, dated July 1989, as may be modified by the conditions set out herein.*

Compliance with this condition continues.

DURATION

2. *This consent shall lapse 21 years from the date of granting this development consent.*

Compliance with this condition continues.

HERITAGE ITEMS

3. *The coke ovens site identified in the EIS shall be protected from intrusion by mining in accordance with the requirements of the Department of Minerals and Energy.*

Within three months of the date of granting consent, the Applicant shall prepare and submit to the Heritage Council of NSW and the Singleton Shire Council a conservation plan in respect of the coke ovens protection area as shown in Figures 3 and 18 of the EIS. The plan shall contain photographs and shall deal with the curtilage of the area, protection of historic artefacts and conservation of the area.

The Coke Ovens have been protected as described in Section 2.15.2 of the EIS. The proposed expansion will have no further impact on the site and the condition is therefore no longer relevant.

WATER SUPPLY

4. *The Applicant shall obtain all necessary approvals from the Department of Water Resources for importation of water to the site.*

The current operation complies with this condition. The present proposal includes the continuance of the requirement to obtain all necessary approvals from the Department of Water Resources for the importation of water to the site.

LANDSCAPING

5. (a) *Within six months of the date of granting this consent or within such further period as the Council may permit, the Applicant shall submit for the Council's approval:*

   (i) *A detailed landscaping and land use plan covering all portions of land within the proposed coal lease area. The Applicant shall engage a qualified landscape architect to assist in the landscape design. The plan shall provide for the establishment of trees and shrubs during the construction stage and shall also address the disposal of solid wastes from the colliery operations. The plan shall incorporate appropriate erosion control and sedimentation control practices for any earthworks associated with the development.*

(ii) *Proposal for the visual appearance of the structural components of the development including paint colours and specifications. Buildings and structures shall be designed so as to present a neat and orderly appearance and to blend as far as possible with the surrounding landscape.*

(iii) *A comprehensive plan of landscape management which shall include detailed plans, specifications and staged work programmes to be undertaken, maintenance of all landscape works and plantings, and maintenance of building materials and cladding.*

(b) *Within two years of the granting of this consent the Applicant shall construct and vegetate the bunds as shown in Figure 3, Volume 3 of the EIS. The bund plan shown in Figure 3, Volume 3 of the EIS shall be modified by:*

(i) *extending the bund on the northern side of the New England Highway for a distance of 400 m at the same height as that bund along the eastern side of Middle Falbrook Road; and*

(ii) *by constructing a bund immediately to the north of the southern mining area extending from the bund on the southern side of the New England Highway at the same height as that bund to within 20 metres of the bank of Rixs Creek.*

(c) *The Applicant shall apply to all out-of-pit overburden areas, a surface sealant such as bitumen/straw/seed within 30 days of completion and all other disturbed areas of the mine site including in-pit areas which exceed 0.5 hectares in area and which will not be further worked for a period in excess of 30 days.*

(d) *The applicant shall apply a surface sealant such as bitumen/straw/seed within 30 days of its construction to any bund which will not be revegetated within that time.*

Prescribed construction works required have been satisfied.

The current operations and impact assessment of the proposal have demonstrated that the application of surface sealants in accordance with conditions 5(c) and 5(d) is unnecessary. Compliance with conditions 5(a) i, ii and iii will continue

VISUAL AMENITY

6. *The Applicant shall comply with the requirements of the Council in respect to any supplementary tree planting and visual amenity enhancement works immediately outside the proposed coal lease area, which may be identified by the Council as necessary for the maintenance of a satisfactory visual amenity in the local area.*

The condition has been satisfied and will continue to apply for the extended operations.

AFFECTED LANDS AND RESIDENCES

7. *(a)* *The Applicant shall:*

   (i) *Within 6 months of a receipt of a request to purchase from an owner of land wholly within the area of affectation shown on the attached plan, purchase such land;*

   (ii) *Within 6 months of a receipt of a request from any of the following owners:*

   - *HA and LA Olek (Residence No. 58)*
   - *DS and VF Bright (Residence No. 65)*
   - *D Castledine*
   - *W Bowman (Residence No. 67)*

   to purchase the whole of the properties which fall partly within the area of affectation purchase such land;

   (iii) *Within 6 months of receipt of a request to purchase land from an owner of land which is partly within the area of affectation, not being land referred to in subclause (ii) herein, purchase that part of the land.*

(b) *In respect of a request to purchase land arising under subclause 7 (a) (i) or (ii) or (iii) herein the Applicant shall:*

(i) *pay all owners not less than market value for the land having regard to existing use of the land whosoever is the occupier and all improvements thereon immediately prior to the granting of this consent as if the land was unaffected by the proposed development. The provisions of this subclause do not apply to the holder of an Authorisation or concession under the Coal Mining Act, 1973.*

(ii) *pay the owners reasonable compensation for the disturbance and relocation within the Shire of Singleton, within the general area of Singleton;*

(iii) *pay the owners reasonable costs for obtaining legal advice and expert witnesses for the purposes of determining the purchase price of the land and the terms upon which it is to be acquired.*

(c) *In the event that the Applicant and any owner referred to in subclause 7 (a) herein cannot agree within the time limit upon the purchase price of the land and/or the terms upon which it is to be acquired, then:*

(i) *either party may refer the matter to the Director of the Department of Planning who shall request the President for the time being of the institute of Valuers to appoint an independent valuer who shall determine the current market value of the land as if it were not affected by the proposed development, together with the amount of costs and compensation referred to in subclause (b) herein;*

(ii) *in the event of a dispute between the Applicant and an owner as to that part of a property which is to be acquired under subclause (a)(iii) herein, either party may refer the matter to the Director who shall request the President for the time being of the Institution of Surveyors (NSW) to appoint an independent surveyor to determine the part of the land to be acquired in relation to the area of affectation which may reasonably be subdivided and acquired having regard to topography, provisions of planning instruments and other associated matters;*

(iii) *the Applicant shall bear the costs of any valuation or survey assessment requested by the Director in accordance with subclauses (i) and (ii) herein;*

(iv) *upon receipt of a valuation arising pursuant to subclauses (i) or (ii) herein, the Applicant shall offer to purchase the relevant land at a price not less than the said valuation. Should the Applicant's offer to purchase not be accepted by an owner within 6 months of the date of such an offer, the Applicant's obligations to such an owner pursuant to the Claus 7 shall cease;*

(v) *upon settlement of a purchase referred to in this Clause 7 the Applicant shall also pay to the owner the costs and compensation assessed pursuant to subclause 7(c) herein including the owner's reasonable costs in the event of a subdivision.*

(d) *In the event that the owner or occupier of a dwelling situated on land in the area of affectation which the Applicant is not required to acquire under this Clause 7 requests the Applicant to carry out measures to mitigate the impact of dust, noise and/or blasting upon the dwelling, the Applicant shall forthwith carry out such measures at its own expense. In the event that within three months of such a request by an owner or occupier, the Applicant and the owner or occupier cannot agree upon measures to be carried out, either party may refer the matter for determination by the Council's Health and Building Surveyor. The Applicant shall bear the costs of such determination and shall carry out the measures which may be required by the surveyor forthwith.*

Condition 7 has been satisfied by the purchase of all lands within the area of affectation in respect of which the owners have made a request for the land to be purchased.

Those lands that have not been purchased and are now proposed to be mined are protected by the provisions of the Mining Act 1990 which provides that mining may not commence until compensation to the owner has been determined by agreement or by the Mining Warden. In the case of land owned by Miss E Bowman which is presently being mined

and which has not been purchased by the lessee, an agreement has been registered with the Department of Mineral Resources to permit mining.

The present proposal is that any requirement for the lessee to purchase affected land be based on the affectation determined by monitoring of the mining operations being in excess of the limits used to set the present area of affectation. It is proposed that the predicted area of affectation as defined in the 1989 consent, no longer apply. However, the existing rights of landholders identified as being within the area of affection as defined within this development consent will be preserved.

It is also proposed that Condition 7E inserted in the Development Consent on 29 June 1993 be amended by deleting the second sentence namely, "This condition would only apply to land which is restricted in use to rural purposes for the duration of the Development Consent."

MAIN NORTHERN RAILWAY

8. (i) Within six months of the date of this consent being granted, the Applicant shall submit plans satisfactory to the State Rail Authority in respect of the modification of the Thornton rail loading/unloading facility.

(ii) The Applicant shall consult with the State Rail Authority before the commencing mining of the Year 7 block shown in the EIS in respect to the implementation of any additional protection measures for the main northern railway and carry out such measures in accordance with that Authority's requirements.

Condition 8 is not now relevant as there has been no need to modify the Thornton rail loading facility.

CROWN LANDS

9. *Prior to the commencement of mining, the Applicant shall negotiate with the Crown Lands Office for purchase by the Applicant of crown lands within the coal lease area.*

Condition 9 still applies. An application will be made with the crown lands office for purchase of crown land prior to any mining taking place in the proposed expansion area.

STATE POLLUTION CONTROL COMMISSION APPROVALS

10. *Prior to the commencement of construction of the proposed development, the Applicant shall obtain from the State Pollution Control Commission all statutory approvals and licences as may be required under the Clean Air Act 1961, the Clean Waters Act 1970 and the Noise Control Act 1975 together with such other approvals or licences that may be required under future legislation or regulations for the conduct of the development in accordance with the terms of such approvals and licences.*

Condition 10 is still applicable and is administered by the Environment Protection Authority. Rixs Creek will obtain all relevant approvals necessary to conduct the proposed expansion.

PUBLIC AUTHORITIES

11. *The Applicant shall meet the requirements of all public authorities having statutory responsibilities in respect of the proposed development.*

The development complies with Condition 11 and will continue to do so. Refer to Sections 1.6, 39, 3.11, 4.3, 4.7, 4.8 and 4.10 of the EIS.

NOISE CONTROL

12. (i) *The Applicant shall investigate, design and construct a bund wall approved by the Commission to acoustically shield residences in Maison Dieu Road from the southern mining area. The bund shall provide a minimum predicted reduction of noise level of 5 dB(A) at residences numbered 17 to 23 inclusive, 27 and 28 under neutral atmospheric conditions during Years 7 to 21 inclusive of the conduct of the mining in the southern mining area. The bund shall be constructed south of the southern mining area and run from the south of the New England Highway to a point 50 m west of the western extremity of mining in the southern area. The bund wall shall be constructed not less than 20 m from Rixs Creek and shall be suitably overlapped at that location and shall be constructed and vegetated a minimum of 2 years prior to commencement of mining in the area that it is to shield.*

(ii) *Upon any day in which mining operations are permitted the Applicant shall not haul coal within the coal lease application area before 6.30 am nor after 8.00 pm.*

(iii) *The Applicant shall comply with the L_{10} daytime noise level design goals set out below using "worst case" conditions for the following areas as follows:*

Bridgeman Road : 38 dB(A)
Singleton Heights : 40 dB(A)

(iv) *The Applicant shall comply with the L_{10} daytime noise level design goals set out below using neutral atmospheric conditions as defined by the Commission for the following area in the absence of any bund to mitigate the effects of noise:*

Maison Dieu Road : 38 dB(A)

The current operations comply with this condition.

As a result of a noise impact assessment (refer to **Appendix 6**) the company is proposing that for the extended operations the L_{10} daytime noise level design goals using "worst case" conditions would be:

42 dB(A) at the Retreat

42 dB(A) at Singleton Heights

38 dB(A) at Maison Dieu Road

The following night time design goals would also apply:

40 dB(A) at The Retreat

40 dB(A) at Singleton Heights

38 dB(A) at Maison Dieu Road.

As part of the current proposal the Company is also seeking to have the limitation of hauling coal within the hours of 6.30 a.m. to 8.00 p.m. be removed so that operations can take place up to 24 hours per day.

TAILING DAMS

13. The Applicant shall meet the requirements of the Soil Conservation Service in respect of the design, construction, maintenance and filling of any tailings dams at the site.

Compliance with Condition 13 has been met and will continue to be with the proposed expansion. Refer to Sections 3.4 and 4.5 of the EIS. The role of the Soil Conservation Service now falls under the jurisdiction of the Department of Conservation and Land Management (CALM).

RIXS CREEK DIVERSION

14. (i) The Applicant shall liaise with the Department of Water Resources and the Soil Conservation Service and meet their requirements for the design, construction and maintenance of any diversion of Rixs Creek.

(ii) The Applicant shall not divert Rixs Creek in the southern mining area.

(iii) The Applicant shall not mine within 20 m of the bank of Rixs Creek in the southern mining area.

Compliance continues with Condition 14 and the conceptual mining plan complies with this condition. Mining to the south of the New England Highway will not disrupt the creek. Refer to Section 2.7.1 of the EIS.

BLASTING

15. (i) The Applicant shall not blast within 500 m of the New England Highway or any approved diversion of the highway while either are open for traffic.

(ii) The Applicant shall design all blasts to minimise airblast overpressure and vibration using the NONEL system or equivalent.

(iii) The Applicant shall design all blasts based on the results of monitored blasts designed to minimise airblast and overpressure and vibration using the NONEL system such that any one blast has less than a 5 per cent probability of exceeding airblast overpressure and vibration design goals set by the Commission for affected property excluding historic buildings.

(iv) *The Applicant shall determine the appropriate weather data by taking measurements immediately prior to blasting and from that data shall predict whether noise levels outside the area of affectation are likely to be increased above the levels expected under neutral atmospheric conditions. The said data shall be recorded by the Applicant as part of its monitoring data.*

(v) *The Applicant shall not blast if the predictions in subclause (iv) herein indicate that the Commissions noise goals (excluding those for historic buildings) are likely to be exceeded.*

(vi) *The Applicant shall monitor all blasts, to the satisfaction of the Department.*

(vii) *The Applicant shall in respect of the coke ovens structure, shall:*

(a) *ensure that initial blasting controls are implemented such that a peak particle velocity of 5mm/sec is not received at the coke ovens structure with more than a 5 per cent probability of being exceeding*

(b) *monitor the effects of blasting on the coke ovens structure in such a manner that the peak particle velocity received by the coke ovens structure is able to be related to any observable structural damage occasioned to the ovens. Should damage become evident, the Applicant shall appropriately modify the blasting techniques*

(c) *submit a report detailing the effects of blasting on the coke ovens structure to the Council and the Heritage Council after each of the first five blasts and then at three monthly intervals or otherwise agreed to by the Council and the Heritage Council*

Compliance continues with Condition 15 and the present proposal does not include any variation. Continuing arrangements are in place with the Roads and Traffic Authority

regarding blasting within 500 metres of The New England Highway. Refer to Sections 2.12 and 5.8 of the EIS.

COAL TRANSPORTATION

16. (i) *The Applicant shall transport all coal from the site by rail but may transport coal by road from Rixs Creek to its Bloomfield Colliery at East Maitland for a period not exceeding 2 years from the date of the first delivery.*

(ii) *The Applicant shall give written prior notice to the Council of the date of the first delivery of coal from the site. After the expiration of 2 years from the first delivery of coal from the site road transport of coal from the site shall cease unless an extension is granted by the Council or recommencement applied on account of emergency requirements.*

(iii) *The Applicant shall not road-haul coal in excess of the 300,000 tpa from Rixs Creek.*

(iv) *The Applicant shall upgrade the intersections required for coal truck egress and ingress in respect of the New England Highway at Rixs Creek and at Thornton to the requirements of the Roads and Traffic Authority.*

(v) *The Applicant may road haul coal off site only between the hours of 7.00 am and 2.00 pm Mondays to Fridays inclusive, Saturdays, Sundays and Public Holidays excluded.*

(vi) *The Applicant shall not load coal to road haul vehicles before 7.00 am on any day.*

(vii) *The Applicant shall use only the New England Highway for the transport of coal between the proposed egress and ingress points at Rixs Creek and Thornton.*

All coal is now transported from the mine by rail and no conditions in the future consent will be necessary as the facility is fully described in this Environmental Impact Statement. All coal will continue to be transported by rail throughout the proposed expansion. Refer to Sections 3.5 and 4.6 of the EIS.

ROADS

17. (i) The Applicant shall design and construct a NAASRA Type C Intersection at the junction of Rixs Creek Lane and the New England Highway according to the requirements of the Authority.

(ii) The Applicant shall meet the reasonable requirements of the Authority in relation to any future diversion of the New England Highway, especially in regard to ground levels and compaction densities of fill.

The intersection of Rixs Creek Lane has been constructed and there is no proposal for any future diversion of the New England Highway. Refer to Sections 2.12 and 5.8 of the EIS.

FLOODLIGHTING

18. The Applicant shall construct flood lighting to mitigate direct sight lines of on-site flood lighting and vehicle headlights onto dwellings to the satisfaction of the Council. Direct flood lighting shall not be directed to dwellings.

Compliance with this condition will continue.

TRANSMISSION LINES

19. *The applicant shall undertake the relocation of any electrical transmission lines which may be required due to the operations of the proposed development to alignments satisfactory to the Shortland County Council.*

Compliance with this condition will continue.

ENVIRONMENTAL MONITORING - GENERAL

20. (i) *The Applicant shall undertake and implement environmental monitoring in respect of soil rehabilitation as may be required by the Service and the Department in respect of groundwater levels and quality as may be required by the Department of Water Resources.*

(ii) *The Applicant shall ensure that all environmental safeguards proposed for the development and required by this consent and other statutory approvals are enforced.*

(iii) *The Applicant shall provide to the Department, the Commission and the Council for public release, results and analyses of environmental monitoring undertaken in pursuance of the provisions of subclause (i) herein and subclause 22 (i), (iv) and (vi) herein. Such results and analyses shall be provided on a quarterly basis, for review by the responsible government bodies.*

Compliance with this condition will continue.

ANNUAL REPORT

21. (i) *Within 6 months of the commencement of construction of the proposed development, the Applicant shall ascertain the requirements of the Director in relation to an annual report to be submitted to the Director, the Commission and the Council in respect of the performance of the development. Each report shall be in respect of the calender year ending 31 December and the first such report shall be submitted by 31 March*

(ii) *The annual report shall provide the following information:*

(a) *the performance of the development;*

(b) *the implementations and effectiveness of the environmental controls and conditions relating to the development;*

(c) *results of environmental monitoring in respect of air, water and noise pollution;*

(d) *mining operations undertaken during the preceding 12 months;*

(e) *workforce characteristics of the development;*

(f) *modifications to mining operation, if any, to mitigate and adverse environmental impacts.*

Compliance with this condition as modified by the Minister for Planning on 29 June 1993 will continue.

ENVIRONMENTAL MONITORING SPECIFIC REQUIREMENTS

22. (i) *The Applicant shall install and utilise a wind direction and velocity monitoring and recording station at the highest non-protected location immediately adjacent to the area to be mined over each ensuing 12 month period in the north mining area, as directed by the Commission.*

(ii) *The Applicant shall relocate the wind monitoring and recording station referred to in subclause (i) at 12 monthly intervals, as directed by the Commission.*

(iii) *The Applicant shall use the data collected by the wind monitoring and recording station referred to in subclause (i) herein to determine when and how the mine operation is to be modified in accordance with subclauses 23 (i) and (ii) herein.*

(iv) *The Applicant shall install dust deposition gauges and in each calender month shall determine the dust deposition rate in g/m^2/month such that the +2g/m^2/month incremental isopleth for dust arising from mining operations is able to be plotted on an annual basis, with baseline data defined by the Commission.*

(v) *The Applicant shall measure and record the L90 noise level over a 72 hour period at least twice per year such that the 40 dB(A) daytime and 35 dB(A) night time noise level isopleths related to the mining operations are able to be plotted in respect of the area from the Retreat through Singleton Heights to the location where Maison Dieu Road crosses Rixs Creek.*

(vi) *The Applicant shall analyse to the satisfaction of the Commission all waters other than uncontaminated storm water to be discharged from the mining, coal preparation or water storage areas of the mine site.*

(vii) *The Applicant shall obtain the prior approval of the Commission before discharging of any waters other than uncontaminated stormwater from the mining, coal preparation or water storage areas of the mine site.*

Compliance with this condition has been met for the current mining operation. For the future extension being proposed this condition will continue to be met, however, as a result of the noise impact assessment it is proposed that the noise levels to be reported will be the L_{10} 42 and 38 dB(A) daytime and 40 and 38 dB(A) night time (refer to **Appendix 6** and **Condition 12**).

AIR QUALITY

23. (i) *The Applicant shall cease all mining operations at any time when the average hourly wind velocity from any direction exceeds 10 m/s.*

(ii) *The Applicant shall cease all out-of-pit overburden dumping and shaping, topsoil stripping and emplacement and bund wall and earthworks construction at any time when the average hourly wind velocity exceeds 5.6 m/s from the segment due west clockwise through to the northeast.*

(iii) *The Applicant shall cease all mining operations at any time when visibility is impaired on the New England Highway as a result of mining operations in accordance with the requirements of the Council.*

(iv) *The Applicant shall design the raw coal dump station and coal breaker to minimise the emission of coal dust in accordance with the requirements of the Commission.*

Monitoring results from high volume air samplers and dust deposition gauges indicate that to date levels monitored have all been well below acceptable limits. Experience at the mine therefore indicates that this condition is therefore redundant. Real time monitoring employed at the site would indicate if, under certain meteorological conditions, mining was causing a deterioration in air quality. If this was shown to be the case then mining should have to cease under those conditions. It is therefore proposed that real time monitoring should be employed at the site. Part (iii) of this condition will continue to be met at all times in the future.

DUST SUPPRESSION

24. (i) The Applicant shall provide a standby water cart for each operating water cart proposed in the EIS at each stage of mining.

(ii) the Applicant shall install automatic water sprays on the coal stockpiles such that the stockpiles are sprayed when the wind speed from any direction exceeds 5.6 m/s.

Automatic water sprays have been installed on coal stockpiles in compliance with this condition. Refer to Section 3.8. As part of the future operations it is proposed that adequate road watering equipment will be available for the scale of the operation.

ENVIRONMENTAL OFFICER

25. Prior to the commencement of any construction or operations in the coal lease application area the Applicant shall appoint an on-site environmental officer responsible directly to the mine manager whose qualifications are to the satisfaction of the Department.

Compliance with this condition continues.

HOURS OF OPERATION

26. (i) *The Applicant shall ensure that major items of plant equipment such as bulldozers, scrapers, haul trucks, dump trucks and loaders shall not be started or operated prior to 6.30 a.m. on the first shift of each day.*

(ii) *The Applicant shall not carry out mining operations on weekends or Public holidays.*

The current mining operation complies with this condition. The present proposal for development consent is that there are no time restrictions on the operation of any plant. Refer to Section 4.9.

JOINT RAIL LOADING FACILITY

27. *In the event that development consent is granted for the construction of a joint rail loading facility, the following conditions shall apply:*

(i) *Within 3 months of the date of granting development consent for the mine, the applicant shall give a written undertaking to the Joint Coal Board that it will use a joint rail loading facility outside the proposed coal lease area for Rixs Creek.*

(ii) *Upon the granting of such development consent the Applicant shall forthwith enter into such agreements with the Board as may be required by the Board for the construction of a joint rail loading facility.*

(iii) *The Applicant shall use such facility for the transport of all coal immediately upon the completion of the facility.*

(iv) *If for reasons beyond the control of the Applicant the joint facility cannot be constructed then the provisions of clause (v) herein shall apply.*

(v) *No coal loading facility for the mine shall be constructed within the proposed Rixs Creek coal lease area unless the Minister approves such construction. Rail spur access to the Main railway line would be permitted within the lease area.*

(vi) *The washed coal stockpile for the Rixs Creek mine shall be adjacent to the coal loading facility and not within the Rixs Creek coal lease area unless the Minister otherwise grants approval.*

A joint rail loading facility has been constructed (refer to Section 1.3) in compliance with this condition.

ROAD ACCESS

28. (i) The Applicant shall seal Rixs Creek Lane from its intersection with the New England Highway to its junction with any site access road prior to the use of Rixs Creek Lane for any access to the site.

(ii) The site access road from the site entry point to the employee and visitor car park (s) shall be sealed prior to commencement of any operations other than roadworks on site.

(iii) For the initial 2 years of mining when road haulage of coal is permitted, the Applicant shall seal roads as follows:

(a) those sections of the on-site roads in areas outside the mine plan;

(b) those section of the haul road in areas in the mine plan which have been rehabilitated to the final landform, or otherwise, so as to leave no more than 300m of unsealed road which is traversed by coal haulage vehicles at any one time, all to the satisfaction of the Commission.

The works required have been completed and there is now no road haulage of coal. All product coal from the proposed expansion will continue to be transported by rail (refer Section 4.7).

WATER MANAGEMENT

29. (i) *The Applicant shall liaise with those land owners who presently use water from Rixs Creek to ascertain the full range of uses of the water and to then formulate in conjunction with relevant government bodies, a water management plan for Rixs Creek, which takes account of those users.*

(ii) *The Applicant shall obtain the approval of the Commissions for the water management plan referred to in subclause (i) herein before commencement of operations.*

Compliance with this condition continues.

FINANCIAL CONTRIBUTIONS

30. *The Applicant shall pay a financial contribution to the Council, pursuant to Section 94 of the Act.*

In the event that the Applicant and the Council cannot agree on the total amount of such contribution, the Minister shall determine the said amount, after referring the dispute to a Commissioners of Inquiry and after receiving the Commissioner's recommendations.

Compliance with this condition continues.

OFF SITE EFFECTS

31. *In the event that impact of dust from the mining operations at residences outside the area of affectation is in excess of the amenity criteria of the Commission, the Applicant shall modify the mining operations or undertake such works as may be required by the Commission to mitigate those impacts.*

It is proposed in the present application that should the impact of dust from the mining operations at any residence be in excess of the annual deposition criteria of the EPA, a process to provide mitigation of the impact or purchase of the property will apply.

WORKING AREAS

32. (i) *The Applicant shall not clear vegetation in advance of the mining in stage 1, in excess of 1 hectare.*

(ii) *The Applicant shall not clear vegetation in advance of mining in stage 2 in excess of 100 m, nor having a total area in excess of 5.0 ha cleared in advance of mining at any one time in respect of both the north and south mining areas.*

Stage 1 mining is now completed and part (i) of this condition is no longer relevant.

In relation to Part (ii) it is, however, proposed in this application that mining rehabilitation be subject only to approval by the Department of Mineral Resources in accordance with Conditions of the Coal Lease, the Mining Act and the Coal Mines Regulation Act. This condition was not applied in the proposed mining plan for which the impacts have been calculated in this EIS.

PRODUCTION LEVELS

33. (i) The production levels of ROM coal shall not exceed those levels set out in the EIS in any one year.

(ii) The Applicant shall annually notify Council by 28 January of the total quantity of ROM coal mined and the total quantity of saleable coal produced from the mine for each month in the preceding calender year.

It is proposed in the application that the production level be determined by a limit of 15 million bank cubic metres per year of total material mined. (refer to Sections 1.1 and 4.3).

PARTICIPATING COAL INDUSTRY PROJECTS

34. The Applicant shall participate in any financial arrangements (including financial arrangements with other coal industry members) in accordance with the requirements of the Government of NSW for sharing the capital costs of infrastructure such as rail rolling stock, rail track, coal loader and other related infrastructure to be use jointly by participating coal industry members.

Compliance with this condition continues.

DISPUTE RESOLUTION

35. In the event that the Applicant and the Council or a government body, other than the Department cannot agree on the specification of requirements applicable under this consent, other than provided for in clause 30 herein, the matter shall be referred to the Director whose determination of the disagreement shall be final and binding on the parties.

The current operations comply with this condition. For the future extension it is proposed that a dispute resolution plan should be formulated.

APPENDIX 4:

FLORA AND FAUNA

FLORA AND FAUNA ASSESSMENT FOR PROPOSED EXTENSIONS TO MINING AT RIXS CREEK COAL MINE

TABLE OF CONTENTS

STUDY BRIEF

This study was commissioned by Bloomfield Collieries Pty. Limited to investigate flora and fauna within the existing coal mining lease number 352, known as Rixs Creek Coal Mine. The brief was to survey the area for fauna and flora species including bats, small mammals, herpetofauna and rare animals and plants that may occur. The value of remnant vegetation and the significance of fauna and requirements of rare or endangered fauna were assessed.

The Rixs Creek lease has been the subject of several environmental studies in the past. Flora and fauna investigations were initially carried out in 1979 with additional surveys in 1981 and 1982.

BACKGROUND

Rixs Creek Coal Mine is situated approximately 1.5 km northwest of Singleton in the Hunter Valley, N.S.W.. The mine comes under Coal Lease 352 which covers an area of approximately 700 ha. The mining company wishes to extend its current open-cut mining operations within the existing Coal Lease. Mining is currently confined to a small area to the north of the New England Highway, in the northeastern corner of the lease. It is proposed that operations be extended over a larger area to the west of the current operations, and to the southern side of the New England Highway, on both sides of Rixs Creek.

STUDY PERIOD

The study was carried out over four days and three nights, from 6th April to 9th April, 1994 with a total of 32 hours spent in the field.

WEATHER

The weather over the study period was generally mild to warm and fine, with light breezes. There were light to moderate overnight showers on the 6th and 7th April, which cleared by morning. A moderate, cool dry and gusty wind blowing from the WSW picked up from mid-morning on the 7th and continued into the afternoon. A cool southerly change occurred on the morning of the 9th bringing cool southeasterly breezes but no rainfall.

Temperatures for the study period -

6/4 max 31^{0}C overnight min 17^{0}C
7/4 max 30^{0}C overnight min 11^{0}C
8/4 max 25^{0}C overnight min 8^{0}C
9/4 at 9:30 am temperature recorded was 18.5^{0}C

METHODOLOGY

The proposed area of mining was traversed on foot. A broadscale survey of vegetation types was also carried out from a vehicle along boundary roads and throughout the property where possible. This groundtruthing was carried out to check the accuracy of the former EIS and to compare observations gained from a recent (late 1993) colour aerial photograph.

Methods of faunal surveys used in this study included spotlighting, call recognition, mist netting, ground and litter searches and trapping with Elliott traps. These methods were employed in a number of areas but were concentrated in areas considered most likely to harbor native fauna. Areas concentrated on were remnant forest and more advanced regeneration, creek-side vegetation and near dams. Pastureland was also surveyed.

SPOTLIGHTING

Spotlighting was carried out on foot and from a vehicle on three nights in remnant forest, regenerating forest, along creeklines, near dams and in open pastureland. This was done for several hours each night and areas on both sides of the New England Highway.

CALL RECOGNITION

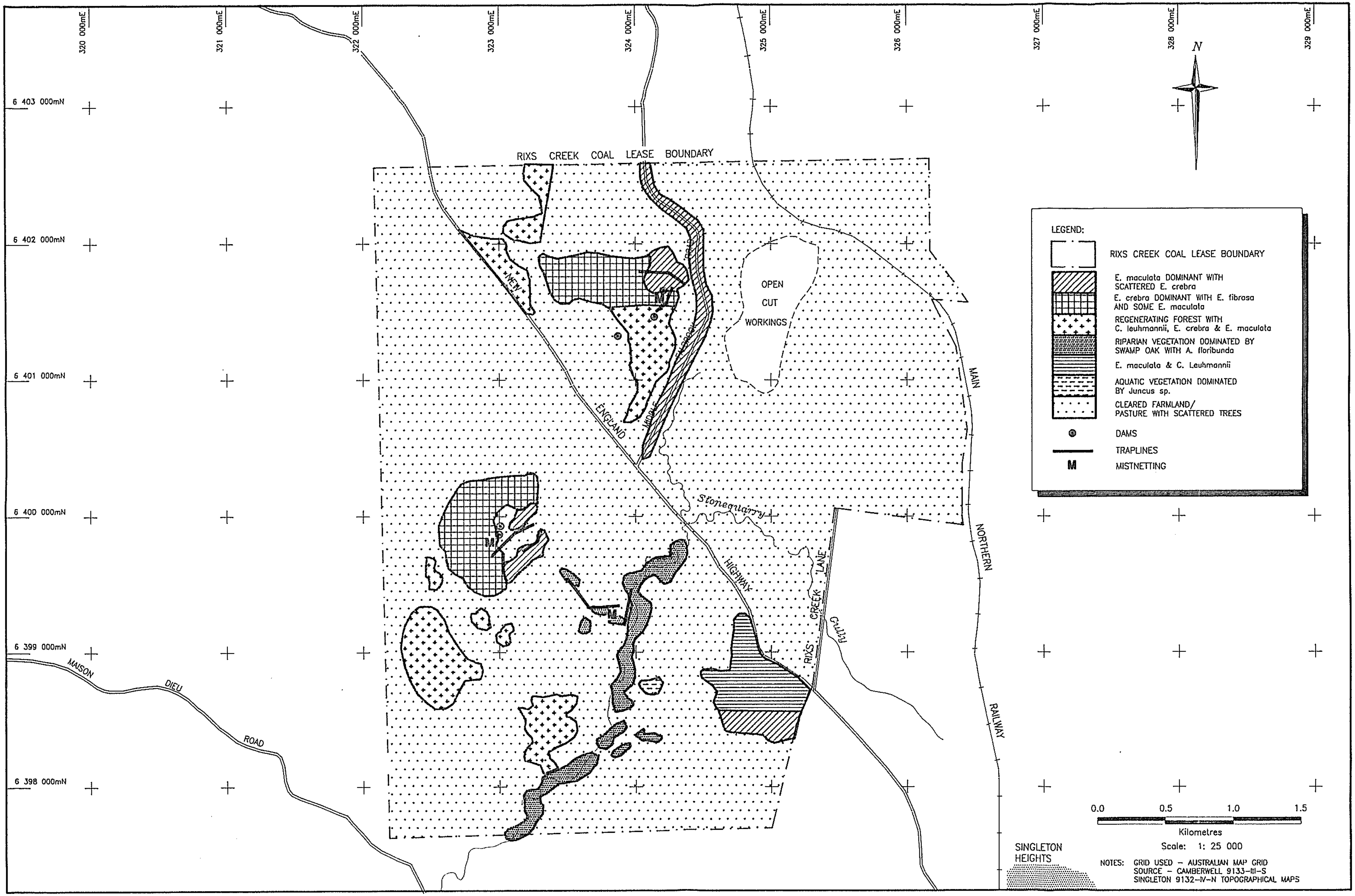
Call recognition was used to identify both bird and frog species over the three days of the survey. This method was used mainly in the mornings and afternoons for birds and after sunset for frogs the most active times for these fauna respectively. A stereo tape recorder and directional microphone was used to assist in the identification of fauna calls.

SYSTEMATIC GROUND SEARCHES

Systematic ground searches were employed in an effort to identify small terrestrial taxa, particularly reptiles. This method consisted of searching the ground, litter and under logs for the presence of fauna. The hollows and crevices of trees and under their bark were also checked where possible. Low vegetation and debris around creek lines and dams was searched for frog species.

TRAPPING

Trapping using size "A" and "B" Elliot traps was carried out over three nights in various "habitat" types over the study area. On each of the three nights of the study 30 traps were set at three different locations giving a total of 90 trap-nights. At each location (see **Figure 1**) two trap lines (one of 10 and one of 20) were set at intervals of 10 m, in denser forest / undergrowth, and 20m in more open or grassy areas. Trap lines were set to cover all habitat / microhabitat types in the study area. Traps were baited with a mixture of rolled oats, peanut butter, honey and cat biscuits.



ENVIROSCIENCES PTY LIMITED

PROJECT No.: F1127

VEGETATION DISTRIBUTION

FIG. 1

MIST NETTING

Mist nets were used to try and catch microchiropteran bat species that may have been present. There are few sites suitable for the use of mist nets in the study area since it is mostly open pasture with scattered trees. However, three sites were found that were reasonable for the use of the nets. Nets were set near dams surrounded by some tree cover on two nights and one was set between trees on a tributary that runs into Rixs creek (see **Figure 1** for net locations).

ANIMAL TRACKS AND SIGNS

During the survey the spoor of animal species was also checked for. Signs such as nests, tracks, scratches on trees and droppings were noted.

RESULTS

FLORA

No rare or endangered plant species were found during this survey. It is possible, but unlikely that any rare flora still exists within the proposed mining extension area due to the highly modified nature of the site.

The vegetation of the study area consists of habitats that have been greatly modified by farming practices. The resulting floral assemblages consist mainly of open pastureland, dominated by native and introduced grass species with scattered trees. There are several stands of modified remnant open forest (see **Figure 1**) dominated by *Eucalyptus maculata* (Spotted Gum) with some *E. crebra* (Narrow-leaved Ironbark) and *Casuarina leuhmannii* (Bull Oak). Scattered specimens of Grey Box (*E. molucanna*) and Forest Red Gum (*E. tereticornis*) can also be found throughout these stands and in areas of regeneration. There are also two large areas of relatively advanced regeneration dominated by Narrow-leaved Ironbark with occasional mature trees (see **Figure 1**). There are also several large, but less advanced, regenerating areas within the study area with various mixtures of tree species including Ironbark, Grey Box, Bull Oak, Red Gum and Spotted Gum.

The remnant and regenerating forest areas have a relatively sparse understorey consisting mainly of grasses such as *Cymbopogon refractus*, *Aristida* and *Stipa* species and with scattered shrubs and herbs such as *Acacia amblygona*, *Myoporum montanum*, *Calotis dentex* and *Dianella revoluta*. The most common weeds found throughout the area were Cotton Weed (*Gomphocarpus fruticosus*)in pasture and forest, Fireweed (*Senecio madagascariensis*) in pasture and Purpletop (*Verbina rigida*) along roadsides.

The vegetation along much of Rixs creek ,and the lower parts of a few small tributaries, consists of remnant but mostly regenerating stands of Swamp Oak (*Casuarina glauca*). The stands are now almost contiguous and quite dense in many parts. A number of large specimens of Rough Barked Apple (*Angophora floribunda*) can be found in the creekside

vegetation. The understorey is dominated by grasses, with the creeper "Old Man's Beard" (*Clematis aristata*) also common here.

The findings of this report are consistent with an earlier report for the site (Croft & Associates 1989). This earlier report provides detailed and accurate descriptions on vegetation types, extent and species in the area to be mined, and surrounding areas outside the proposed mining boundary, within the lease. The only significant difference between the findings of this and previous reports is the extent and age of the regenerating "forest" on site.

The remnant and regenerating vegetation to be affected by mining was found not to contain rare species and is not considered to be of a unique floral composition. Similar vegetation can be found in surrounding areas and the remnant / regenerating forest vegetation is not in a natural state, being modified in the past by clearing and grazing. The flora of the study area is therefore not considered to be of a regional significance. However, due to the fact that much of the similar vegetation around the Singleton area has been cleared it may be considered to be of local value as potential fauna refuge. The riparian vegetation can also be considered of importance as habitat, but mainly as a buffer zone between Rixs Creek and the mining operation.

FAUNA

No rare or endangered fauna species were found in the study area during this survey.

Avifauna was the most abundant and diverse vertebrate fauna recorded on site, with a total of 46 bird species recorded during the survey. The most common species were those typical of woodland and wooded pasture, such as Eastern Rosellas (*Platycercus eximius*), Magpies (*Gymnhorina tibicen*) and Pied Butcherbirds (*Cracticus nigrogularis*). In more disturbed and open areas introduced birds such as the European Starling (*Sturnus vulgaris*) and Indian Myna (*Acridotheres tristis*) were common.

The numbers and variety of mammals detected was low with only eight species recorded. These results are similar to those of previous studies and consistent with the open and disturbed nature of the vegetation.

Grey Kangaroos (*Macropus giganteus*) and Echidnas (*Tachyglossus aculeatus*) were the only two native mammals that were apparently common on site. Rabbits were common in some areas. Small ground fauna and arboreal mammal species were uncommon or absent from study area as no small native mammals were trapped and only the signs of a few Brushtail Possums (*Trichosurus vulpecula*) were found. Trapping yielded only one house mouse. Scratchmarks on a number of smooth-barked eucalypts, particularly in the main stand just to the west of current mining, were consistent with small arboreal mammals such as small Gliders such as *Petaurus sp.*.

Herpetofauna was noticeably absent during the survey as not one snake or lizard was recorded during the survey. One Long-necked Tortoise (*Chelodina longicollis*) was sighted

in Rixs Creek south of the highway. The climatic conditions do not seem to account for the lack of reptiles since the weather during the survey was generally warm and fine and it was not particularly late in the season to impair reptile mobility. The disturbed conditions of the site due to grazing and the former long absence of forest may account for the lack of reptiles.

Frogs of several species were relatively common in several places in the study area. A dam, southwest of current mining operations and south of the highway, near the largest stand of Ironbark regrowth had the most numbers and species of frogs (4) found in this study. A dam west of the current mine, and on the edge of the large stand of remnant Spotted Gum, and Rixs Creek south of the highway also had reasonable numbers of frogs (mostly juveniles).

Mist netting failed to capture any bats in the study area. This was not unexpected due to the generally unsuitable nature of the site for this survey technique. Only one individual bat of an unidentified species was sighted during the three nights of the survey. The bat was flying too high for mist nets to capture it. It is unlikely that many species or individuals of a bat species live in the study area due to its disturbed nature.

Scientific Name	Common Name
Melanodryas cuculatta	Hooded Robin
Ochyphaps lophotes	Crested Pigeon
Pachycephala rufiventris	Rufous Whistler
Pardalotus punctatus	Spotted Pardalote
Pardalotus striatus	Striated Pardalote
Passer domesticus *	House Sparrow
Phalacrcorax melanoleucos	Little Pied Cormorant
Phaps sp.	Bronzewing sp.
Philemon corniculatus	Little Friarbird
Platycersus eximius	Eastern Rosella
Pomatostomus temporalis	Grey-crowned Babbler
Poephila bichenovii	Double-barred Finch
Ptilinorhynchus violoaceus @	Satin Bowerbird
Rhipidura fuliginosa	Grey Fantail
Rhipidura leucophrys	Willy Wagtail
Smicroornis brevirostris	Weebill
Strepera graculina	Pied Currawong
Sturnus vulgaris *	European Starling
Zosterops lateralis	Silvereye
FROGS	
Limnodynastes fletcheri	Fletcher's Frog
Litoria latopalmata	Broad-palmed Frog
Litoria lesueuri	Lesueur's Frog
Litoria tyleri	Tyler's Tree Frog
Uperoleia laevigata	Smooth Toadlet
REPTILES	
Chelodina longicollis	Long-necked Tortoise
Varanus sp. @	Goanna sp.

FLORA SPECIES RECORDED OR REPORTED DURING THIS SURVEY

Scientific Name	Common Name
TREES & SHRUBS	
Acacia falcata	Sallow Wattle
Acacia armata	Kangaroo Thorn
Acacia amblygona	Fan Wattle
Acacia parvipinnula	
Angophora floribunda	Rough-barked Apple
Callitris endlicheri	Black Cypress-pine
Casuarina gluaca	Swamp Oak
Casuarina leuhmanii	Bull Oak
Daviesia ulicifolia	Bitter Pea
Eucalyptus crebra	Narrow-leaved Ironbark
E. moluccana	Grey Box
E. tereticornis	Forest Red Gum
Exocarpus cupressiformis	Native Cherry
Grevillea arenaria	Grevillea sp.
Indigofera australis	Austral Indigo
Jacksonia scoparia	Dogwood
Maireana sp.	
Melichrus urceolatus	
Myoporum debile	
M. motanum	
Pittosporum undulatum	Mock Orange
HERBS AND GRASSES	
Aristida vagans	Speargrass
Calotis dentex	
Cheilanthes sieberi	Rock Fern
Commelina cyanea	Running Sailor
Cynodon dactylon	Couch
Danthonia sp.	Wallaby Grass
Dianella revoluta	Flax Lily
Dianella tasmanica	Flax Lily
Dichondra repens	
Hibbertia heterophylla	Guinea Flower
Lomandra longifolia	Mat Rush
Lomandra filiformis coreacea	
Lomandra sp.	

Scientific Name	Common Name
Pannicum sp.	Panic Grass
Pratia purpurascens	
Poranthera microphylla	
Solanum sp.	Nightshade
Stipa ramosissima	Bamboo Grass
Stipa sp.	Grass Species
Themeda australis	Kangaroo Grass
Veronica plebiea	
Wahlenbergia stricta	Native Blue Bell

VINES/CREEPERS

Clematis aristata	Old Man's Beard
Glycine clandestina	
Glycine tabacina	
Hardenbergia violaces	False Sarsparilla

AQUATIC AND RIPARIAN PLANTS

Eleocharis sp	Spike Rush
Juncus acutus	Spiny Rush
Juncus usitatus	Common Rush
Ottelia ovalifolia	Swamp Lilly
Phragmites australis	Native Reed
Triglochin procera	Water Ribbons

INTRODUCED PLANTS

Cirsium vulgare	Spear Thistle
Chloris gayana	Rhodes Grass
Conyza albida	Fleabane
Gomphocarpus fruticosus	Cottonweed
Hypocoeris radicata	Cat's Ear
Lycium ferocissimum	African Box-thorn
Opuntia sp.	Prickly Pear
Paspalum dilatatum	Pasalum
Sida rhombifolia	Paddy's Lucerne
Sonchus oleraceus	Common Sow Thistle
Verbena rigida	Wild Verbena

FAUNA SPECIES RECORDED OR REPORTED DURING THIS SURVEY

Scientific Name	Common Name

* Introduced species, # Schedule 12 species, @ reported by residents

MAMMALS

Macropus rufogriseus	Red-Necked Wallaby
Macropus giganteus	Grey Kangaroo
Mus musculus *	House Mouse
Oryctolagus cuniculus *	Rabbit
Tacyglossus aculeatus	Echidna
Trichosurus vulpecula	Brushtail Possum
Vulpes vulpes *	Fox
Microchiropteran	Unidentified insectivorous bat species

BIRDS

Acanthiza nana	Yellow Thornbill
Accipiter fasciatus	Brown Goshawk
Acridotheres tristis *	Indian Myna
Aegotheles cristatus	Owlet Nightjar
Anthus novaeseelandiae	Richard's Pipit
Aquila audax	Wedge-tailed Eagle
Cacatua roseicapilla	Galah
Chenonetta jubata	Wood Duck
Corvus coronoides	Australian Raven
Cracticus nigrogularis	Pied Butcherbird
Chthonicola sagittata	Speckled Warbler
Coracinia novaehollandiae	Black-faced Cuckoo-shrike
Corcorax melanorhamphos	White-winged Chough
Dacelo novaeguineae	Laughing Kookaburra
Eopsaltria australis	Eastern Yellow Robin
Falco cencroides	Australian Kestrel
Falco longipenis	Little Falcon
Gerygone olivacea	White-throated Warbler
Grallina cyanoleuca	Pied Mud-lark
Gymnorhina tibicen	Magpie
Haliastur sphenurus	Whistling Kite
Hirundo neoxena	Welcome Swallow
Lichenostomus chrysops	Yellow-faced Honeyeater
Lichenostomus leucotis	White-eared Honeyeater
Manorina melanocephala	Noisy Miner

ENDANGERED FAUNA (INTERIM PROTECTION) ACT, 1991

The effect of the proposed development has been assessed in accordance with the Endangered Fauna (Interim Protection) Act, 1991, which lists factors A to G which must be taken into account. These issues are discussed below.

A *"The extent of modification or removal of habitat in relation to the same habitat type in the locality."*

Areas to be mined within the proposed extension area will be entirely cleared of vegetation (and soil layers) during the open cut operations. The proportion of regrowth "forest" vegetation to be affected will be less than half of that which can be found within the entire lease, outside of the mining operation.

B *"The sensitivity of the species of fauna to removal or modification of its habitat."*

No endangered or rare fauna species were recorded during the survey and it is unlikely that any populations live on-site. However, since the site does contain potential habitat (Ironbark Forest) for the Brushtailed Phascogale (*Phascogale tapoatafa*) and Squirrel Glider (*Petaurus norfolcensis*) there is a small chance that these two species may utilise the site. Similarly the site would provide suitable seasonal feeding areas (when the Ironbarks flower) for the nomadic Regent Honeyeater. This schedule 12 bird species would be more likely to occur, at least occassionally, on-site than the Phascogale or Squirrel Glider since it is not sedentary and is highly mobile.

The Phascogale and Squirrel Glider would be highly sensitive to habitat clearance due to mining as they are sedentary species and both dependent upon mature forest for nest sites, food and shelter. These two species would disappear from cleared stands of forest and possibly from sections of forest adjacent to mining operations due to disturbance. The Regent Honeyeater would be less sensitive to habitat removal on-site as it is nomadic and very mobile being able to move easily to other stands locally. It would obviously not be found in areas cleared due to mining. All three species could, if they occur, survive in other areas of forest that will be left unaffected over the lease area.

C *"The time required to regenerate critical habitat, namely the whole or any part of the habitat which is essential for the survival of that species of fauna."*

No critical habitat will be affected during mining operations on this site. The time required for the affected areas to regain a similar type of regrowth vegetation with similar structure and age classes to that which currently exists is estimated to be approximately 15 - 30 years, following site restoration.

D *"The effect on the availability of the fauna population to recover, including interactions between the subject land and adjacent habitat that may influence the population beyond the area proposed for development or activities."*

No endangered fauna species were recorded and there is no evidence to suggest that the proposed development will significantly impact on rare or threatened fauna species on the site or in adjacent areas.

E *"Any proposal to ameliorate the impact."*

It is proposed that the riparian vegetation along Rixs Creek be protected by a buffer zone of at least 50 m. Additionally an extensive rehabilitation programme will be undertaken throughout the life of the mining operation.

The proposed operation will be constructed in such a manner so as to comply with Environment protection Authority and Department of Conservation and Land Management requirements.

F *"Whether the land is currently being assessed for wilderness by the Director of National Parks and Wildlife under the Wilderness Act, 1987."*

The subject land is not currently, or likely ever to be, under consideration for Wilderness by the NPWS.

G *"Any adverse effect on the survival of that species of protected fauna or populations of that fauna."*

The proposed development is unlikely to have an adverse effect upon the survival of protected fauna that may occur on-site since the site contains no significant habitat types and no schedule 12 species were recorded. If the Squirrel Glider, Phascogale and Regent Honeyeater do occur, the proposed development would not affect the survival of these species in the wild since the area only provides a small area of potential (but non-critical) habitat for these species. The greatest impact that could be expected would be the extinction of localised populations from areas of the site of the Glider and Phascogale, if they occur, or the loss of some **potential** habitat.

CONCLUSIONS

No rare or endangered plants or animals were recorded and no significant habitats occur in the study area. The proposed extension to mining will not have a significant impact on the flora and fauna assemblage of the area as the site is not in a natural state and similar species and habitats exist in surrounding areas.

RECOMMENDATIONS

Even though the flora of the study site is not significant in its composition several areas have potential habitat value. A large proportion of the natural flora, particularly of the lowlands, in the Singleton area has been cleared or highly modified and therefore pockets of remnant vegetation may have potential refuge value. Remnants and regenerated areas will become increasingly important in the area. It is therefore recommended that where possible native vegetation be left standing. Remnant pockets of vegetation would be of greater value if linked by corridors to allow movement fauna. Mine rehabilitation should incorporate substantial shrub and tree planting in order to reinstate habitat.

The more mature remnant and regrowth forest growing on ridges and hill tops, particularly the stands of Spotted Gum and Ironbark would offer suitable habitat for the Brush-tailed Phascogale (*Phascogale tapoatafa*) or the Squirrel Glider (*Petaurus norfolcensis*) both schedule 12 species. These two mammal species are unlikely to be living on the site in its present state but may still exist in the area. No rare bird species were recorded, but the remnant and advanced regrowth forest, particularly the stands of Ironbark, would be suitable for the nomadic and rare Regent Honeyeater (*Xanthomyza phrygia*) which is known to follow the flowering patterns of such eucalypts. If possible these areas should receive higher priority for preservation.

The remnant and regenerating creekside vegetation is, as previously mentioned, an important buffer to help maintain the water quality of Rixs Creek and ultimately the Hunter River. It is understood that this vegetation will not to be removed by mining operations. However mining too close to the creek may be detrimental due to changes in the watertable and flow and by sedimentation and other runoff. It is therefore important that waterflow in the creek be maintained and that a large buffer zone be left either side of the creek to protect the vegetation. A buffer zone of at least 50 metres wide, is recommended. Proposed controls will maintain vegetation and water quality in these areas.

EXPECTED SPECIES LIST

Scientific Name	Common Name

Schedule 12 species

MAMMALS

Antichinus flavipes	Yellow-footed Antichinus
Antichinus stuartii	Brown Antichinus
Phascogale tapoatafa #	Brush-tailed Phascogale
Isoodon macrourus	Northern Brown Bandicoot
Perameles nasuta	Long-nosed Bandicoot
Acrobates pygmaeus	Feathertail Glider
Pseudocheirus peregrinus	Ring-tail possum
Petaurus norfolcensis #	Squirrel Glider
Petaurus breviceps	Sugar Glider
Wallabia bicolor	Swamp Wallaby
Pteropus poliocephalus	Grey-headed Flying-fox
Pteropus scapulatus	Little Red Flying-fox
Chalinobus Dwyeri #	Large Pied Bat
Chalinobus gouldii	Gould's Wattled Bat
Chalinobus morio	Chocolate Wattled Bat
Eptesicus vulturnus	Small Forest Eptesicus
Mormopterus loriae	Little Northern Mastiff Bat
Mormopterus norfolkensis #	Little Eastern Mastiff Bat
Nyctonomus australis #	White-striped Mastiff Bat
Nyctophylus geoffroyi	Lesser Long-eared Bat
Nyctophylus gouldi	Gould's Long-eared Bat
Nycticeius rueppellii #	Greater Broad-nosed Bat
Miniopteris schreibersii #	Common Bent-wing Bat
Saccolaimus flaviventris #	Yellow-bellied Sheathtail Bat
Hydromys chrysogaster	Water Rat
Pseudomys gracilicaudatus #	Eastern Chestnut Mouse
Rattus fuscipes	Bush Rat
Rattus lutreolus	Swamp Rat
Vombatus ursinus	Common Wombat

FROGS

Adelotus brevis	Tusked Frog
Crinia signifera	Common Eastern Froglet
Limnodynastes dumerillii	Eastern Banjo Frog

Scientific Name	Common Name
Limnodynastes ornatus	Ornate Burrowing Frog
Limnodynastes peronii	Brown-striped Frog
Limnodynastes salmini	
Limnodynastes tasmaniensis	Spotted Grass Frog
Litoria aurea #	Green & Gold Bell Frog
Litoria caerulea	Green Tree Frog
Litoria fallax	Dwarf Tree Frog
Litoria freycineti	Freycinet's Frog
Litoria peronii	Peron's Tree Frog
Litoria Verreauxii	Frog sp
Pseudophryne bibronii	Brown Toadlet

LIZARDS & TORTOISES

Scientific Name	Common Name
Egernia striolata	Tree skink
Emydura signata	Short-necked Tortoise
Delma plebeia	Gecko sp.
Diplodactylus vittatus	Wood Gecko
Gehyra variegata	Tree Dtella
Oedura lesueurii	Lesueur's Velvet Gecko
Underwoodisaurus milii	Thick-tailed Gecko
Amphibolurus barbartus	Bearded Dragon
Amphibolurus diamensis	Mountain Dragon
Amphibolurus muricatus	Jacky Lizard
Carlia burnettii	Skink sp.
Carlia tetradactyla	Skink sp.
Cryptoblepharus boutonii	Bouton's Snake-eyed skink
Ctenotus robustus	Striped Skink
Ctenotus taeniolatus	Copper-tailed Skink
Egernia Whitii	White's Skink
Leiopisma guichenotti	Garden Skink
Leiopisma mustelina	Weasel Skink
Morethia boulengeri	Skink sp.
Pygopus lepidopus	Common Scaly-foot
Saiphos equalis	Three-toed Skink
Sphenomorphus tenuis	Skink sp
Tiliqua casuarinae	She-oak Skink
Tiliqua scincoides	Common Blue-tongued Lizard
Trachydosaurus rugosus	Shingle-back
Varanus gouldii	Gould's Sand Monitor

Scientific Name	Common Name
Varanus various	Lace Monitor

SNAKES

Scientific Name	Common Name
Acanthophis antarcticus	Common Death Adder
Boiga Irregularis	Brown Tree Snake
Cryptophis nigrescens	Small-eyed Snake
Demansia psammophis	Yellow-faced Whip Snake
Furia diadema	Red-naped Snake
Hemiaspis signata	Swamp Snake
Hoplocephalus bitorquatus	Pale-headed Snake
Morelia spilotes variegata	Carpet Python
Notechis scutatus	Tiger Snake
Pseudechis guttatus	Blue-spotted Black Snake
Pseudechis porphryacus	Red-bellied Black Snake
Pseudonaja textilis	Eastern Brown Snake
Vermicella anulata	Bandy Bandy

BIRDS

Scientific Name	Common Name
Acanthiza chrysorrhoa	Yellow-rumped Thornbill
Acanthiza lineata	Striated Thornbill
Acanthiza reguloides	Buff-rumped Thornbill
Accipiter cirrhocephalus	Collared Sparrowhawk
Accipiter novaehollandiae	Grey Goshawk
Aegintha Temporalis	Red-browed Finch
Aidemosyne modesta	Plum-capped Finch
Anas castanea	Chestnut Teal
Anas gracilis	Grey Teal
Anas superciliosa	Pacific Black Duck
Apus pacificus	Fork-tailed Swift
Ardea novaehollandiae	White Faced Heron
Ardea pacifica	Pacific Heron
Artamus cyanopterus	Dusky Woodswallow
Athyla australis	Hardhead Duck
Cacatua galerita	Sulphur-crested Cockatoo
Cecropus ariel	Fairy Martin
Cecropus nigricans	Tree Martin
Cinclorhamphus mathewsi	Rufous Songlark
Cinclosoma punctatum	Spotted Quail-thrush

Scientific Name	Common Name
Circus assimilis	Spotted Harrier
Cisticola exilis	Golden-headed Cisticola
Climacteris leucophaea	White-throated Treecreeper
Climacteris picumnus	Brown Treecreeper
Colluricincla harmonica	Grey Thrike-thrush
Coracina papuensis	White-bellied Cuckoo-shrike
Coracina tenuirostris	Cicadabird
Corvus mellori	Little Raven
Coturnix australis	Brown Quail
Coturnix Pectoralis	Stubble Quail
Coturnix chinensis	King Quail
Cracticus torquatus	Grey Butcherbird
Crysococcyx basilis	Horsefield's Bronze Cuckoo
Crysococcyx lucidus	Shining Bronze Cuckoo
Cuculus pallidus	Pallid Cuckoo
Cuculus pyrrophanus	Fan-tailed Cuckoo
Cuculus variolosus	Brush Cuckoo
Daphnoenositta chrysoptera	Varied Sittella
Dicaeum hirundinacaeum	Mistletoe Bird
Egreta alba	Great Egret
Egretta garzetta	Little Egret
Egretta intermedia	Intermediate Egret
Elanus notatus	Black-shouldered Kite
Entomyzon cyanotis	Blue-faced Honeyeater
Eudynamys scolopacea	Koel
Eurystomus orientalis	Dollar Bird
Falco berigora	Brown Falcon
Falco peregrinus	Peregrine Falcon
Falco subniger	Black Falcon
Falcunculus frontatus	Crested Shrike-tit
Gallinula tenebrosa	Dusky Moorehen
Geopelia placida	Peaceful Dove
Gerygone fusca	Western Warbler
Glossopsitta concinna	Little Lorikeet
Grantiella picta #	Painted Honeyeater
Halcyon macleayii	Forest Kingfisher
Halcyon pyrropygia	Red-backed Kingfisher
Halcyon sancta	Sacred Kingfisher
Haliastur sphenurus	Whistling Kite

Scientific Name	Common Name
Lirundapus caudacutus	Spine-tailed Swift
Lalage leucomela	Varied Triller
Lalage sueri	White-winged Triller
Lathamus discolor #	Swift Parrot
Lichenostomus Penecillatus	White-plumed Honeyeater
Lichmera indistuncta	Brown Honeyeater
Malurus assimilis	Variegated Fairywren
Malurus cyaneus	Superb Fairywren
Melithreptus brevirostris	Brown-headed Honeyeater
Megalurus timoriensis	Tawny Grassbird
Merops ornatus	Rainbow Bee-eater
Microeca leucophaea	Jacky Winter
Milvus migrans	Black Kite
Myiagra inqueita	Restless Flycatcher
Myiagra rubecula	Leaden Flycatcher
Neophema pulchella #	Turquoise Parrot
Ninox novaeseeelandiae	Southern Boobook Owl
Ninox connivens	Barking Owl
Nycticorax caledonicus	Nankeen Night Heron
Nymphicus hollandicus	Cockatiel
Oriolus sagittatus	Olive-backed Oriole
Peopelia guttata	Zebra Finch
Petroica goodenovii	Red-capped Robin
Petroica phoenicea	Flame Robin
Petroica multicolor	Scarlet Robin
Phalacrcorax sulcirostris	Little Black Cormorant
Phesphotus haematonotus	Red-rumped parrot
Platalea flavipes	Yellow-billed Spoonbill
Platalea regia	Royal Spoonbill
Plectorhyncha lanceolata	Striped Honeyeater
Podargus strigoides	Tawny Frogmouth
Pomatostomus superciliosus	White-browed Babbler
Porphyrio porphyrio	Purple Swamphen
Psephotus haematogaster	Blue Bonnet Parrot
Scythrops novaehollandiae	Channel-billed Cuckoo
Sericornis frontalis	White-browed Scrub-wren
Sericornis magnirostris	Large-billed Scrub-wren
Streptopelia chinensis	Spotted Turtle Dove
Threskiornis spinicollis	Straw-necked Ibis
Threskiornis aethiopica	Sacred Ibis

Scientific Name	Common Name
Trichoglossus chlorolepidotus	Scaly-breasted Lorikeet
Trichoglossus haematodus	Rainbow Lorikeet
Turnix varia	Painted Button Quail
Turnix pyrrhothorax	Red-chested Button Quail
Tyto alba	Barn Owl
Vanellus miles	Masked Lapwing
Xanthomyza phrygia #	Regent Honeyeater

APPENDIX 5:

AIR QUALITY ASSESSMENT

AIR QUALITY ASSESSMENT:

PROPOSED RIX'S CREEK OPEN CUT MINE, NEAR SINGLETON, NSW

Prepared

for

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by

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8 November 1994

CONTENTS

FIGURES

(Figures at end of report)

19. PREDICTED ANNUAL DUST DEPOSITION RATE DUE TO EMISSIONS FROM RIXS CREEK IN YEAR-22 OPERATING CONCURRENTLY IN YEAR-13 - g/m^2/month

TABLES

1.0 INTRODUCTION

This report has been prepared by Nigel Holmes & Associates on behalf of Envirosciences Pty Limited. It assesses the air quality impacts associated with the implementation of plans to increase the volume and extent of mining at the Rixs Creek open cut coal mine near Singleton (see **Figures 1** and **2**, which show the project area in regional and local contexts respectively).

In recent years the conventional approach to air quality assessments for open cut mines has been to analyse the mine plan and to develop estimates of the dust that will be generated from each operation on the mine for critical periods in the life of the mine. These estimated dust emissions are then used with a long-term dust dispersion model and local meteorological data to calculate annual average dust deposition rates and concentrations levels at a grid of points surrounding the mine. The predicted deposition rates and concentrations can then be presented as contour plots, which can be used to determine the air quality at dust sensitive locations. Dust impacts can then be assessed by comparing estimated dust concentrations and fallout levels with relevant air quality criteria.

The Rix's Creek mine is an existing operation and has approximately six years of operational and environmental monitoring data. In addition the nearby by Camberwell mine has operated since April 1991 and has developed a significant body of operational and corresponding environmental monitoring data. These data have been used to review the performance of the dispersion modelling procedure that was used in the environmental impact statements for the two mines and to modify the procedure to obtain a more realistic impact assessment. In both cases the environmental impact assessments appear to have been overly conservative resulting in estimated "areas of affectation" larger than has been the case in practice.

Finally, a particularly useful element of the above approach is the ability to use actual data to assess dust concentrations under episodic conditions. No theoretical approach available at present can reliably assess the impact of dust emissions under episodic conditions (dry windy conditions).

The planned life of the mine is 40 years during which it will produce approximately 83 MT of Run of Mine (ROM) coal, approximately 54 Mt of product coal and 517.4 Mbcm of overburden and partings. Only the first 22 years of the mine plan has been assessed in this study. These years cover the "worst-case" period in terms of dust emissions.

2.0 LOCAL SETTING AND DESCRIPTION OF THE PROJECT

2.1 Local setting

The land within and surrounding the project area is mostly gently undulating and has been largely cleared for use as grazing land.

The northern built-up residential areas of Singleton and Singleton Heights are located approximately 1.5 km to the SE of the most easterly area that will be disturbed by the mine. Isolated residences associated with small holdings are located on all boundaries of the mine.

2.2 Existing and proposed operations

Open cut coal mining takes place on the Rix's Creek and Camberwell leases and underground mining is planned at Glennies Creek. All other mines in the area are too far away to contribute significantly to the air quality effects in the study area.

The mine plan proposes to recover coal from three pits (see **Figure 2**). Pit 1 with a proposed life of 38 years is estimated to yield between 0.617 (Year 2) and 0.862 Mt/y (Year 11). Pit 1 with a proposed life of 4 years is estimated to yield between 0.771 (Year 1) and 0.920 Mt/y (Year 2). Pit 3 with a proposed life of 36 years is estimated to yield between 0.487 (Year 25) and 0.827 Mt/y (Year 15).

Overburden will be removed by a combination of dragline and shovel and excavator. Two options have been assessed, the first referred to as the Dragline Option and the second as the Shovel Option. The emissions inventories indicate that the shovel option would produce marginally more dust than the Dragline Option and the dispersion model runs have only been presented for the Shovel Option.

Coal will be recovered by loaders/excavators loading 85 t trucks.

ROM coal will be stockpiled, washed, and then stockpiled again before being loaded to trains for transport to Newcastle. Reject material from the washery, which will comprise approximately 35 per cent of the ROM coal, will be returned by truck to the open cut areas for disposal with overburden waste.

An inventory of equipment (with the potential to generate dust) that will be used on the mine is presented in **Table 1**.

TABLE 1- EQUIPMENT INVENTORY		
Item	Dragline Option Number	Shovel Option Number
Marion 7900 dragline for overburden removal	1	-
Marion 305M dragline for overburden	-	1
P&H 2355 dragline for overburden	-	1
P&H 2800 XPA Shovel for overburden	1	1
P&H 5700 Shovel	-	1
Excavator 400 t	1	1
CAT 992 front-end loader	2	2
CAT 994 front-end loader	1	1
CAT 793 trucks for pre-strip/overburden	6	6
CAT 120 t trucks	3	3
CAT 657 Scrapers for top-soil stripping and rehabilitation	3	3
CAT Tiger RB bulldozer	1	1
CAT bulldozers D11	3	3
CAT 16G graders	1	1
CAT road profiler RR250	1	1
DJB 20,000L water trucks	2	2
CAT 777 80,000L water truck	1	1
BE 45R drills	2	2
Drilltech D40K Drill	1	1

3.0 DISPERSION METEOROLOGY AND REVIEW OF SELECTED CLIMATIC ELEMENTS

3.1 Introduction

This section presents meteorological data to assist in assessing the dispersion meteorology of the area.

3.2 Wind Data

The wind data used for the study have been collected (using an anemometer and wind vane mounted at 10 m above local ground-level) by the Rix's Creek environmental monitoring program. The location of the meteorological station is shown on **Figure 3**. Other parameters monitored by the meteorological station include temperature, humidity and rainfall. On-site data for the period 1991, 1992 and 1993 were available for the study.

Seasonal and annual wind roses have been prepared from the data for these years and are presented in **Figures 4** to **6**. As noted on the figures for the 1993 data the data for autumn are for March only. Data for April and May were missing. Winter data relate mainly to July. Data for June and August are missing. Thus caution should be adopted when interpreting the data for autumn and winter of 1993. Examination of the wind roses shows that over the year the most common winds were from the southeast, south-southeast and north-northwest. The southeasterlies were most common in summer and autumn. North-northwesterlies were most common in winter. Winds in spring were most frequently either from the west-northwest, southeast or south-southeast.

3.3 Temperature and humidity

The on-site data span a relatively brief period of approximately four years. Bureau of meteorology records of temperature and humidity collected over 29 years are available from Singleton at a site (6 km south-southeast of the project area) and rainfall data collected over more than 100 years are also available. For this reason the data reviewed here have been taken from Singleton.

Temperature and humidity data for Singleton are presented in **Table 2**. December is the warmest month experiencing a mean monthly maximum temperature of 30.7 C and July is the coolest experiencing a mean monthly minimum temperature of 5.1 C.

3.4 Rainfall and evaporation

Table 2 presents Bureau of Meteorology rainfall data for Singleton. Mean annual rainfall is 706 mm and median rainfall is 668 mm. January and February are the two wettest months (in terms of average, but not median rainfall amounts) and July and August are the driest.

Evaporation data are available from the "Climatic Atlas of Australia" (**Bureau of Meteorology, 1988B**). Evaporation rates for Singleton for January, April, July and October are approximately 225, 125, 75, and 175 mm respectively. Thus evaporation is well above the expected rainfall amount for all the months of the year.

TABLE 2- TEMPERATURE HUMIDITY AND RAINFALL DATA FOR SINGLETON
(Station Number 061275 Latitude 32 Deg 37 Min S Longitude 151 Deg 10 Min E Elevation 9.0 m)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
9 am Mean Temperatures (C) and Relative Humidity (%) (14 years of record)													
Dry-bulb	22.6	22.3	21.2	17.6	13.4	10.6	9.3	11.5	15.6	18.8	20.1	22.9	17.2
Wet-bulb	19.3	19.6	18.3	15.1	11.7	9.1	7.6	8.9	12.0	14.6	16.2	18.5	14.2
Humidity	72	77	74	75	81	81	77	69	63	61	65	63	72
3 pm Mean Temperatures (C) and Mean Relative Humidity (%) (14 Years of record)													
Dry-bulb	28.4	28.1	26.6	23.5	19.8	16.8	16.2	18.5	21.3	23.7	25.9	29.3	23.2
Wet-bulb	20.7	21.2	19.9	17.0	14.5	12.2	11.3	12.0	14.2	16.2	18.1	20.1	16.5
Humidity	47	51	51	49	53	55	51	41	41	42	43	39	47
Daily Maximum Temperature (C) (15 Years of record)													
Mean	30.6	29.8	28.1	25.0	20.9	17.7	17.2	19.5	22.3	25.3	27.6	30.7	24.6
86 Percentile	36.5	35.0	32.0	28.5	24.0	20.0	19.5	22.9	26.6	30.4	33.0	36.5	
14 Percentile	25.3	24.6	24.0	21.5	17.9	15.5	14.8	16.5	17.9	20.5	22.0	24.7	
Daily Minimum Temperature (C) (15 Years of record)													
Mean	17.9	18.2	16.1	12.5	9.1	6.8	5.1	6.1	8.9	12.1	14.3	17.0	12.0
86 Percentile	20.7	20.9	19.0	16.0	12.9	10.0	8.5	9.5	12.3	15.5	17.4	19.9	
14 Percentile	15.0	15.5	13.3	8.9	5.8	3.5	2.0	3.0	5.4	8.5	11.8	13.9	
Rainfall (mm) (16 Years of record)													
Mean	97	92	77	47	61	38	26	28	44	71	65	60	706
Median	71	52	69	40	53	26	22	19	34	55	63	58	668
Raindays (Number) (16 Years of record)													
Mean	11	11	11	9	9	10	8	7	9	10	11	8	114

Source: Bureau of Meteorology (1988A)

3.5 Mixing-height and stability class

Information on hourly mixing height and stability class are required as input to the dispersion model. Intensive sonde studies of the upper atmosphere around the Liddell power plant have been undertaken on behalf of the Electricity Commission of NSW (now Pacific Power) by **Malfroy (1989)** and **Malfroy (1992)**. However, no long-term direct measurements on mixing height are available for the area and theoretically derived values have been used. The theoretical values in the day have been estimated by assuming that the maximum mixing height reached during the day was 1500, 1200, 1000 and 1200 m for summer, autumn, winter and spring respectively and at night theoretical values based on wind speed and stability have been derived. These give mixing height values which are consistent with the values reported by Malfroy.

Stability class is used by dispersion models to determine the rate at which the plume grows by the process of turbulent mixing. Each stability class is associated with a dispersion curve, which is used by the model to calculate the plume dimension and dust concentration at points downwind of the source. In the model used here the Pasquill-Gifford dispersion curves have been used.

The frequency of occurrence of particular stability classes in the Rixs Creek data for 1991, 1992 and 1993, is shown in **Table 3**. Data used in the modelling studies were 1991 and 1992 combined. The data retrieval rates for 1991, 1992 and 1993 were 85.2, 66.4 and 72.6 per cent respectively. The reason for using 1992 data in combination with 1991 was to increase the period of over which the data were collected. This will tend to reduce the influence of any particularly unrepresentative periods. At first sight it might be considered that 1993 data should also be included, particularly since it has more valid data than 1992. However, the missing data for 1993, include a block of data for April, May and June, whereas in 1992 the missing data are more randomly distributed over the year. Using 1992 data would be less likely to introduce a bias than using a year with a block of contiguous missing data.

TABLE 3- FREQUENCY OF OCCURRENCE OF STABILITY CLASSES

Stability	Frequency of occurrence in percent		
	1991	1992	1993
A	0.4	1.6	2.3
B	7.3	9.5	12.5
C	11.7	14.4	14.6
D	30.5	23.3	24.1
E	26.6	24.0	20.3
F	23.5	27.4	26.1

Average wind speeds for 1991, 1992 and 1993 respectively were 3.4, 2.7 and 2.5 m/s.

4.0 AIR QUALITY CRITERIA

The effects of dust on health and amenity can be assessed by comparing dust deposition rates and dust concentrations with recognised air quality criteria. These criteria have been established as a result of research both in New South Wales and overseas. To cover the full range of possible adverse impacts it is necessary to make reference to criteria for both long-term (annual averages) and short-term (24-hours) periods.

4.1 Short-term criteria

Concentration

In assessing the acceptability of air quality the New South Wales Environment Protection Authority (EPA) notes the United States Environmental Protection Agency (US EPA) 24-hour air quality standard of 150 $\mu g/m^3$ for particles less than 10 μm (referred to as sub-10 μm particles, or PM_{10}).

Deposition

There are no air quality criteria for short-term dust deposition rates.

4.2 Long-term criteria

Concentration

The EPA refer to the Australian National Health and Medical Research Council (NH&MRC) 90 $\mu g/m^3$ annual average goal for total suspended particulate matter (TSP) when assessing long-term dust impacts. This level is recommended as the maximum concentration that should be permitted in urban environments. Also the Environment Protection Authority note the US EPA 50 $\mu g/m^3$ annual mean concentration for PM_{10}. In practice particle size distributions in dust due to open cut mines are such that approximately 50 per cent of the TSP particles are in the sub-10 μm size range and so the two goals are essentially the same.

Deposition

In the past the EPA/SPCC has considered that residential areas would begin to experience dust related nuisance impacts when annual average dust (insoluble solids) deposition levels exceeded 4 g/m^2/month, and that dust impacts would be at unacceptable levels when they reached 10 g/m^2/month (SPCC 1983). The EPA/SPCC (Dean et al., 1990) has refined these criteria. **Table 4** shows the maximum acceptable increase in dust deposition over the existing dust levels for a range of existing levels.

For example, in residential areas with annual average deposition levels of between 0 and 2 g/m^2/month, an increase of up to 2 g/m^2/month would be permitted before it is considered that a significant degradation of air quality had occurred.

The above criteria for dust deposition are set to protect against nuisance impacts and they are not relevant for interpreting the significance of dust in mine working areas, where the concept of dust fallout level becomes meaningless, for example in areas where overburden is being dumped.

TABLE 4- ENVIRONMENT PROTECTION AUTHORITY CRITERIA FOR DUST DEPOSITION		
Existing dust fallout level (g/m^2/month)	Maximum acceptable increase over existing fallout levels - (g/m^2/month)	
	Residential	Other
2	2	2
3	1	2
4	0	1

5.0 REVIEW OF HISTORICAL AIR QUALITY OF THE AREA

5.1 Dust deposition

Dust deposition and concentration levels can vary markedly with location and depend strongly on the distance from the source of dust and the prevailing meteorological conditions. To use the information discussed in **Section 4.0** to select appropriate criteria it is necessary to know the dust deposition and concentration levels for the area being assessed. High dust concentration or deposition levels within the mine itself, or on land used for mining infrastructure, does not cause an environmental impact. High levels in residential areas, or in farming areas, may be considered a problem. Thus the key requirement is to determine dust deposition data at private residences and on privately owned land. The mine itself is not particularly sensitive to dust deposition levels (apart from considerations of worker comfort and safety).

The monitoring program measures dust deposition at 27 sites (see **Figure 3**). The results for the program for 1991 to 1993 are presented in Table 5. It is clear that all fallout levels have been within the limit of 4 g/m^2/month over this period with the highest levels being recorded well away from the mine in areas which clearly are not affected by mine dust.

Monitoring for dust deposition is also conducted at eight sites in the area surrounding the Camberwell mine. The location of the Camberwell dust deposition monitors are shown in **Figure B-1 (Appendix B)**.

TABLE 5-RIXS CREEK DUST DEPOSITION DATA (INSOLUBLE SOLIDS) - $g/m^2/month$

SITE	1990			1991			1992			1993		
	Min	Max	Avge	Min	Max	Avge	Min	Max	Avge	Min	Max	Avge
1	0.20	5.34	1.17	0.65	2.81	1.3	0.85	3.37	1.6	0.31	4.48	1.99
2	0.35	2.57	0.95	0.70	3.41	1.5	0.51	3.06	1.6	0.95	3.64	2.16
3	0.32	1.05	0.56	0.63	2.5	1.05	0	1.48	0.9	0.18	2.63	1.16
4	0.42	3.85	2.01	0.46	3.86	1.50	0.84	1.65	1.2	0.69	3.27	1.74
5	0.58	3.91	1.93	1.01	8.22	2.60	0.15	3.42	1.4	1.36	5.36	3.27
6	0.52	2.16	1.30	0.53	3.3	1.50	0.6	2.28	1.3	0.89	1.38	1.13
7	0.39	1.13	0.76	0.50	8.1	3.0	0.7	1.51	1.06	0.63	1.49	1.07
8	0.46	3.79	1.42	0.34	2.57	1.0	0	1.95	0.85	0.30	1.24	0.81
9	0.32	1.77	0.78	0.35	2.94	1.0	0.42	1.47	0.83	0.45	1.25	0.82
10	0.33	1.54	0.78	0.30	4.55	1.5	0.46	1.87	1.16	0.39	1.45	0.94
11	0.63	2.68	1.30	0.30	3.19	1.3	0.46	7.14	2.33	1.09	4.03	1.85
12	0.44	4.06	1.89	0.44	2.78	1.3	0.92	7.48	2.36	1.05	6.38	3.31
13	0.19	10.80	1.56	0.35	2.85	1.2	0.47	1.99	1.1	0.59	2.14	1.21
14	0.92	6.41	2.44	0.44	3.83	2.1	1.06	3.44	1.6	0.63	2.52	1.39
15	0.18	2.86	1.05	0.57	3.59	1.8	0.49	3.76	1.5	0.61	2.11	1.32
16	0.46	2.85	1.15	0.75	3.95	1.8	0.61	2.61	1.48	0.58	2.46	1.52
17	0.25	7.04	3.15	0.86	2.86	1.5	0.57	5.06	2.45	0.73	4.18	2.25
18	0.38	1.51	0.88	0.42	2.3	1.0	0.62	1.92	1.2	0.77	1.30	1.06
19	0.14	4.00	1.62	0.09	4.84	1.4	0.59	9.44	1.07	0.49	2.51	1.15
20	0.37	3.13	1.38	0.65	4.36	1.6	0.89	2.15	1.4	0.71	2.84	1.54
21	0.64	3.05	1.50	0.83	3.72	1.5	0.66	5.73	1.86	0.56	2.00	1.30
22	0.33	1.92	0.87	0.55	2.93	1.2	0.59	1.40	0.9	0.59	1.13	0.83
23	0.69	3.13	1.40	0.25	2.22	0.9	0	2.92	1.05	1.24	2.04	1.61
24	0.28	2.96	1.27	0.51	2.46	1.1	0.6	1.55	1.15	0.84	3.75	1.50
25	0.27	6.54	1.55	0.00	4.8	2.0	1.33	3.98	2.15	1.12	4.57	1.86
26	0.24	4.60	1.38	0.55	3.53	1.5	0.55	6.24	1.5	0.34	2.72	1.18
27	0.35	5.50	2.85	1.02	3.93	2.2	1.2	3.92	2.25	1.47	2.85	2.05

5.2 Dust concentration

The air quality monitoring program also includes measurements of 24-hour TSP concentrations on a six-day cycle at three sites; the Mines Rescue Station in Singleton Heights, east of Rix's Creek Lane and east of Bridgeman Road (The Retreat) (see **Figure** 3). It will be noted (see **Figure 3**) that the monitoring sites are located in areas where there has been a special concern to ensure that air quality is not adversely impacted by dust from the mine. Because the dust sensitive sites for Rix Creek are either to the E or SE of the mine this has meant that all the monitoring sites are to the E or SE of the mine. As will be seen in later discussions, this is creates a minor difficulty when attempting to determine if elevated dust concentrations are due to emissions from Rix's Creek, or whether they are due to widespread dust from more distant locations. Nevertheless, by reviewing dust concentration data and concurrent wind speed and wind direction data it is possible to draw some conclusions as to the contribution that Rix's Creek makes to dust concentration levels in the area. This remainder of this section discusses the data.

The data are summarised in **Table 6** and in **Figure 7**. In assessing the significance of the data reported in Table 6 it should be remembered that the EPA's annual average TSP goal is 90 $\mu g/m^3$ and the annual average and 24-hour goals for PM_{10} are 50 $\mu g/m^3$ and 150 $\mu g/m^3$ respectively. For assessment purposes it is useful to assume that the TSP to PM_{10} ratio is 2:1. (It is satisfactory to assume this because the TSP and PM_{10} levels are so far below the goals that small errors in this assumption will not affect the validity of conclusions as to the acceptability of dust concentrations.)

In 1993 the annual TSP concentrations were 53, 49 and 49 $\mu g/m^3$ for the Rix's Creek, The Retreat and Mines Rescue Station monitors respectively. In 1994 the average concentrations to the end of March have been 64, 40 and 42 for Rix's Creek, The Retreat and Mines Rescue Station respective. On a twenty four hour basis the concentrations at all sites appear to be similar, but there are some exceptions, for example on 17 June 1993 the Rix's Creek monitor recorded a 24-hour average of 65 $\mu g/m^3$, the Retreat monitor recorded 63 $\mu g/m^3$, but the Mines Rescue Station recorded only 18 $\mu g/m^3$. There is another similar exception on 26 December 1993 when the Rix's Creek monitor recorded 90 $\mu g/m^3$ and the Retreat and Mines Rescue Station monitors recorded 48 and 68 $\mu g/m^3$ respectively. Thus while most of the variations in dust concentrations appear to affect all three monitors suggesting that the changes in dust concentration are on a large scale (at least the scale of the monitoring network) there are occasions when local sources clearly contribute, affecting one monitor and not the others. This strong correlation in the concentration of dust at all three monitoring sites is most clearly shown in **Figure 7** rather than in the table. This suggests that dust from the mine is generally only a minor contributor to the dust in the area. Data for the 7 January 1994 is an example of this. All three sites recorded 24-hour average concentrations above 100 $\mu g/m^3$. This suggests a wide spread dust episode.

If the mine was a major contributor it would be expected that there would be less correlation in the dust from the three monitors and further it would be expected that dust concentrations in the Rix's Creek monitor, which lies approximately 1000 m SSE (downwind of the most commonly occurring winds) of the 1993 open cut area, should be elevated relative to dust concentrations measured at The Retreat or at the Mines Rescue Station. As it is the Rix's Creek monitor recorded an annual average dust

TABLE 6- RIX'S CREEK MINE HIGH-VOLUME AMBIENT AIR SAMPLING DATA
(micrograms/cubic metre)

Date	Rixs Creek	Retreat	Mines Rescue Station
6-Jan-93	44		49
12-Jan-93	73		66
18-Jan-93	71		64
24-Jan-93	36		50
30-Jan-93	35		46
5-Feb-93		86	88
11-Feb-93		46	48
17-Feb-93		41	50
23-Feb-93		66	63
1-Mar-93	120	133	109
7-Mar-93	43	41	42
13-Mar-93	36	33	32
19-Mar-93	67	45	61
25-Mar-93	52	34	41
31-Mar-93	57	43	50
6-Apr-93	73	80	62
12-Apr-93	53	30	41
18-Apr-92		24	26
24-Apr-93	52	66	38
30-Apr-93	53	40	53
6-May-93	45	32	44
12-May-93	37	30	44
18-May-93	36	20	48
24-May-93	35	44	49
30-May-93	47	47	51
5-Jun-93	27	16	30
11-Jun-93	54	48	44
17-Jun-93	53	63	18
23-Jun-93	65	75	81
29-Jun-93	41	30	52
4-Aug-93	21	23	19
10-Aug-93	63	73	53
16-Aug-93	61	71	56
22-Aug-93	48	54	48
28-Aug-93	26	21	30
3-Sep-93	28	31	23
9-Sep-93		30	35
15-Sep-93	28	29	35
21-Sep-93	39	42	50
27-Sep-93	49	43	60
3-Oct-93	55		30
9-Oct-93	66	78	56
15-Oct-93	35	27	27
21-Oct-93	48	29	43
27-Oct-93		38	47
2-Nov-93	83	40	142
8-Nov-93	96	92	82
14-Nov-93	36	31	25
20-Nov-93	39	27	27
26-Nov-93	42	74	32
2-Dec-93	120	95	
8-Dec-93	33	17	25
14-Dec-93	84	108	
20-Dec-93	90	48	68
26-Dec-93	68	43	38
Average	53	49	49

11/8/94 3:35 PM

TABLE 6 (Cont) RIX'S MINE CREEK HIGH-VOLUME AMBIENT AIR SAMPLING DATA
(micrograms/cubic metre)

Date	Rixs Creek	Retreat	Mines Rescue Station
1-Jan-94	88	57	59
7-Jan-94	121	134	105
13-Jan-94	94	85	
19-Jan-94	89	25	33
25-Jan-94	56		28
31-Jan-94	38	19	24
6-Feb-94	43	47	31
12-Feb-94	44	19	39
18-Feb-94	65	15	59
24-Feb-94	52	30	27
2-Mar-94	59	12	34
8-Mar-94	56	22	33
14-Mar-94	69	26	33
20-Mar-94	55	32	45
26-Mar-94	36	30	38
Average	64	40	42

concentration in 1993 of 53 μg/m^3 compared with 49 μg/m^3 at both The Retreat and the Mines Rescue Station. The data for 1994 suggest a greater contribution from the mine at the Rix's Creek monitor. The average 24-hour concentration from January 1994 to March 94 has been 64 μg/m^3. These concentrations are still well within the EPA's old goal of 260 μg/m^3 for TSP and well below the PM_{10} goal of 150 μg/m^3 even on the assumption that all the TSP is PM_{10}.While none of the monitored concentrations are close to the EPA's goals of 90 μg/m^3 (annual average) or PM_{10} goal of 150 μg/m^3 (24-hour) and 50 μg/m^3 (annual average) it is still interesting to examine the meteorological data that applied on the days with relatively high TSP concentration. The five days with the highest monitored TSP concentrations are reviewed in detail below. Although the mine must inevitably contribute some dust to the area, in only one of these days is it possible to attribute dust at the monitoring station to dust from the mining operation and the levels monitored make this event of academic interest rather than of any environmental significance.

On 1 March 1993 (Monday), when all three monitors recorded 24-hour TSP concentrations above 100 μg/m^3 the wind was generally from the NNW and the hourly average wind speeds never exceeded 4.1 m/s. The complete set of meteorological data for 1 March 1993 is provided in Appendix A. Given the wind directions that applied during that period it is possible that the open cut contributed to TSP levels at the monitors, but it would seem more likely that the elevated concentrations were a result of generally elevated TSP levels from distant sources. Certainly wind conditions were not those that would normally be associated with episodic conditions on open cut mines and the highest TSP levels were recorded at The Retreat, which would only be affected by dust from the mine under westerly winds, which occurred for only a brief period (less than one hour) during that day

On 2 December 1993 (Thursday) 24-hour TSP concentrations at Rix's Creek and the Retreat were 120 and 95 μg/m^3 respectively. While these concentrations are well below levels of concern, they are high relative to the majority of the data. The data in Appendix A shows that light to moderate winds blew from the NW from midnight to 11 am. After 11 am strong winds (10.1 m/s hourly average speed) blew from the east. The fresh to strong winds from the E persisted until 5 pm after which the wind speed fell to between 2.8 and 4.5 m/s from the east. Although the mine may have contributed some dust during the light morning winds is likely that most of the dust was provided during the period of strong E winds in the late morning and afternoon.

On 8 November 1993 (Monday) 24-hour TSP concentrations were generally elevated, 96 μg/m^3, 92 μg/m^3 and 82 μg/m^3 at Rix's Creek, the Retreat and the Mines Rescue Station respectively. Winds were generally light during the day and were from the NW and E (see Appendix A). These are not the conditions under which the open cut would be expected to contribute significantly to TSP levels at the monitoring sites.

On 14 December 1993 (Wednesday), elevated TSP levels were recorded at Rix's Creek and the Retreat (84 and 108 μg/m^3 respectively). Again the meteorological data (see Appendix A) do not show that the mine is likely to have been a significant contributor to the TSP concentrations at the monitors.

Finally, on 2 November 1993 (Tuesday), elevated TSP levels were recorded at Rix's Creek and the Mines Rescue Station (83 and 142 μg/m^3 respectively). The Retreat recorded an average 24-hour concentration of 40 μg/m^3. The meteorological data (see

Appendix A) show that in the afternoon winds were moderately strong from the NW and NNW. The mine is likely to have contributed dust to the Rix's Creek monitor and the Mines Rescue Station but not to the Retreat on this day. This could explain the 40 $\mu g/m^3$ recorded at the Retreat compared with 83 and 142 $\mu g/m^3$ recorded at the other two monitors during the same monitoring period. It should be noted that these levels are well below the levels of concern.

6.0 EMISSIONS INVENTORY

Dust emissions have been estimated by analysing the mine plan and using dust emission factors to estimate dust emissions for each operation on the mine. The emission factors used have been developed both locally (Dames & Moore 1988) and by the US EPA (1985). Table 6 summarises the estimated emissions for each activity and Appendix B presents the details of the calculations. As a result of the model calibration work presented in Appendix B several important modifications have been made to the emission factors used. These changes adopted are listed below.

- The wind erosion factor used has been reduced from the SPCC/EPA 0.4 kg/ha/h to the factor suggested by the US EPA (1985) of 0.097 kg/ha/h, which applies for graded and seeded land.

- The dust emission factor for transport sources has been reduced from the figure of 2 kg/VKT (after watering), which has normally been applied in the Hunter Valley to a 1 kg/vkt. Field tests (TRC 1980) show that emissions from watered haul roads could well be as low as 1 kg/vkt and in view of the overprediction for in the Rix's Creek and Camberwell EISs it would seem appropriate to reduce the emission from this source.

- Finally a further modification has been made to the way in which wind erosion dust has been handled in the model. This is not related to the emission factor, but is related to the way in which the model works. Normally wind erosion dust is assumed to be released at an equal rate in all wind speed classes. This can lead to over estimation in the deposition and concentration rates at low wind speeds when dispersion is poor and in practice wind erosion dust is negligible. Thus the model can create an artificially high concentration and deposition level under these condition. The modification involves assuming that wind erosion dust emission rate vary as the cube of the wind speed, so that wind erosion emissions are only significant when dispersion conditions are favourable. This is clearly a more realistic approach and assists in allowing the model to predict concentration and deposition rates which more closely match the monitoring results.

TABLE 7- SUMMARY OF Rix's CREEK DUST EMISSION - kg/y								
Activity	Year-I		Year-VIII		Year-XV		Year-XXII	
	Dragline Option	Shovel Option	Dragline Option	Shovel Option	Dragline Option	Shovel Option	Dragline Option	Shovel Option
Hauling O/B	476,952	419,351	911,922	803,922	876,182	768,182	904,954	796,954
Loading O/B	596,190	524,190	605,790	533,790	584,506	512,526	602,622	530,622
Dumping O/B	286,171	251,611	290,778	256,218	280,572	246,012	289,259	254,698
Drilling	4,777	4,777	4,833	4,833	4,708	4,708	4,816	4,814
Blasting	5,959	5,959	9,015	9,015	5,889	5,889	5,998	5,998
Hauling coal	157,205	157,205	170,715	170,715	246,599	246,599	203,039	203,039
Loading coal	62,486	62,486	56,984	56,984	71,369	71,369	59,125	59,125
Dumping coal	21,547	21,547	19,650	19,650	24,610	24,610	20,388	20,388
Dozer on coal	145,256	145,256	153,256	153,256	145,256	145,256	145,256	145,256
Dozer on O/B	106,912	106,912	106,912	106,912	49,792	49,792	49,792	49,792
Scraper on O/B	43,648	43,648	43,648	43,648	43,646	43,646	43,646	43,646
Graders	1,969	1,969	2,954	2,954	2,954	2,954	3,200	3,200
Stockpile wind erosion	63,072	63,072	63,072	63,072	63,072	63,072	63,072	63,072
Mine area wind erosion	84,972	84,972	169,944	169,944	254,916	254,916	254,916	254,916
Waste dump wind erosion	101,966	101,966	169,944	169,944	169,944	169,944	169,944	169,944
Train loadout	319	319	646	646	810	810	671	671
Load coal stockpile	318	318	646	646	810	810	671	671
Hauling rejects	15,958	15,958	32,367	32,367	45,598	45,598	37,773	37,773
Dragline	483,912	751,664	483,912	751,664	483,912	483,912	483,912	751,664
Total	2,659,596	2,763,187	3,296,995	3,350,187	3,355,152	3,140,612	3,343,061	3,396,250
Ratio of Dust to ROM coal (kg/t)	1.23	1.28	1.68	1.70	1.36	1.28	1.36	1.38

TABLE 8- PARTICLE SIZE DISTRIBUTIONS BY MASS FROM MINING OPERATIONS (Percent)

Operation	Fine particle (0 to 2.5 μm)	Inhalable particles (2.5 to 15 μm)	Coarse particles (15 to 30 μm)	Reference
Coal haulage	6	53	41	D&M 1986
Dragline	7	50	43	D&M 1986
Drilling	9	62	29	D&M 1986
Blasting	5	39	56	USEPA 1981
Scrapers	6	53	41	assumed to be as for trucks
Coal loading	6	57	37	D&M 1986
Dumping coal	4	49	47	D&M 1986
Graders	6	48	46	US EPA 1981
Wind erosion	0	67	33	US EPA 1981
Dozers	6	48	46	D&M 1986

7.0 APPROACH TO PREDICTING AIR QUALITY IMPACTS

As indicated earlier, impact assessment has been undertaken using the dust dispersion model DUSTGLC, with modified dust emission factors to those normally used, and by reference to the performance of the Camberwell mine.

The reason for adopting this dual assessment approach is that the traditional modelling approach has proved to be possibly overly conservative in the past, resulting in zones of affectation which are possibly larger than necessary. The proposed Rix's Creek mine is in the position of having data from an existing environmental monitoring program that has operated since 1989 and has data for the pre-mining period. It also has available the operational experience from the Camberwell mine on its northern boundary, which is currently operating at the level planned for the expended Rix's Creek mine.

In 1993 Rix's Creek mine produced 0.8 Mt/y of ROM coal. In addition, the Camberwell mine, located immediately to the north of the Rix's Creek coal lease boundary has been operating since April 1991. In 1993 Camberwell produced 1,610,475 t of clean coal from 2,597,328 t of ROM. In uncovering this coal 10,853,092 bcm of waste have had to be removed.

Camberwell operates in a similar environment in terms of rainfall, vegetation cover, and wind speed and direction conditions as does the current Rix's Creek mine. Further its current production level is similar to the proposed maximum production from Rix's Creek, which is planned to be 1,599,700 t/y of clean coal from 2,461,000 t of ROM coal. In producing this coal approximately 13,242,100 bcm of waste will have to be

handled. The proposed mining methods and production rates for the Camberwell mine in 1993 are similar to the proposed mining methods and production levels that will apply when Rix's Creek has reached its maximum production level in Year 15. In practice the Rix's Creek mine will need to move approximately 22 per cent more waste than Camberwell and therefore dust levels could be higher by approximately the same factor.

Given the above, the current dust generation rates and dust concentration and deposition levels in the vicinity of the Camberwell mine should provide a reasonable indication of the concentration and deposition levels around Rix's Creek at it period of maximum production.

From an assessment, or planning point of view, it is necessary to determine the area that is expected to be affected by dust deposition levels (or concentration levels) above the EPA's goals. If two assessment approaches are used there is a possibility that there will be an incompatibility between the two, with for example the modelling work indicating a different area of affectation than the monitoring based assessment. If the monitoring based assessment was known to be more reliable than the modelling approach then there would be no difficulty and the monitoring based assessment would be accepted. On the basis of commonsense it would naturally be accepted that the monitoring based assessment would be more reliable than an assessment based on modelling results.

The monitoring data for the Camberwell mine is reviewed in detail in Appendix B. Unfortunately the location of the monitors in relation to the dust sources on the mine is such that all monitoring data fall well below the level at which dust fallout levels would be considered a problem. It is not possible from the data to determine the zone of affectation. It is only possible to determine the maximum limits of the zone of affectation. It is clear that this is also much more conservative than is necessary.

The Camberwell monitoring data do however suggest that the original modelling assessment was conservative and do allow some modifications to the assessment to be made to reduce the level of conservatism. The adjustments relate to the emission factors used for wind erosion dust and dust from haulage of coal and overburden. In addition, a modification has been made to the way in which wind erosion dust is assumed to be generated. The details of the modifications are discussed in Section 6 and in Appendix B.

The model used as basis of the assessment is the computer-based dispersion model known as DUSTGLC. DUSTGLC has been widely used in the Hunter Valley and a full technical description is presented in the Environmental Impact Statement for the Lemington Northern Open Cut Extension (CSR, 1984). Validation of the model, in which predicted dust deposition levels are compared with measured deposition levels at two operating mines in the Hunter Valley, is also presented in the same report.

The model uses work by Slinn (1982) to estimate dust deposition rates and is based on the sector average model outlined by Turner (1970).

8.0 PREDICTED AIR QUALITY IMPACTS

Predicted annual average dust deposition rates and dust concentrations arising as a results of mining at Rix's Creek for Year-1, Year-8, Year-15 and Year-22 are shown in **Figures 9 to 16.**

Figure 9 shows that in Year-1 the 2 g/m^2/month is also almost wholly contained within the Rix's Creek lease boundary. The area where the 2 g/m^2/month (annual average) contour extends beyond the boundary is to the SE and S where the contour extends approximately 1 km beyond the lease boundary. **Figure 10** shows the predicted concentrations for the same time.

Figure 11 shows that in Year-8 the centre of mining for both the N and S pits moves westward relative to the locations in Year-1. The 2 g/m^2/month is again generally contained within the lease, with an excursion of approximately 600 m beyond the southern boundary of the lease. **Figure 12** shows the corresponding concentrations.

Figures 13 and 14 show the deposition and concentration levels in Year-15. Again the mining has moved westward and again the 2 g/m^2/month is generally contained within the lease. A small excursion occurs in the north into the Camberwell lease and to the south.

Figures 15 and 16 shows the deposition and concentration levels in Year-22. Again the mining has moved further westward and the 2 g/m^2/month is contained within the lease except for two small excursions in the north into the Camberwell lease and to the south.

9.0 EPISODIC IMPACTS

It is extremely difficult to assess episodic impacts reliably using dispersion modelling techniques because of the very large uncertainties in dust emissions under adverse weather conditions. In practice the most reliable method of assessing such impacts is probably to examine historical 24-hour TSP monitoring data from the existing Rix's Creek and Camberwell mines. These data show no evidence of any periods when adverse weather resulted in TSP concentrations above the EPAs goals.

However, TSP measurements are only made every sixth day and they are only made at a limited number of sites (three sites for Rix's Creek and four sites for Camberwell). It could be argued that episodic events could have been missed or that wind directions were such that the monitors would not have received dust. For this reason a modelling study has been undertaken to attempt to define the areas that might be affected by an episodic event.

Before, providing the modelling results it is useful to discuss the problems that are encountered in accurately modelling dust from episodes. An episodic event is envisaged as a dry windy day. Such days can occur in winter as well as during summer. It is know that wind speeds above approximately 5.6 m/s will be sufficient to raise dust from exposed surfaces. Stronger winds will generate more dust. However most surfaces only have a limited amount of dust that can be raised by a wind at a given speed. This is known as the wind erosion potential of the surface for the

particular wind speed. US EPA (1982) data indicates that a wind speed of 17 m/s will generate 112 kg of dust per hectare from a scoria surface.

Typically what will happen in an episode is that strong gusty winds will initially generate large quantities of dust from exposed areas where loose dust is lying on the surface. Once the loose dust has been removed the surface will generate relatively little dust unless more dust is generated by mechanical disturbance of the exposed areas. Thus the first few hours of an episode will usually be significantly dustier than subsequent hours, unless of course the wind speed increases. Another phenomenon which is observed in episodic conditions is that exposed areas that have been left undisturbed since the last rain are generally not significant sources of dust. This is because rain will wash fine particles from steep slopes and deposit them in sheltered areas and fine clay particles when wetted will form a crust, which is usually stable against wind erosion.

Dispersion is always very efficient under episodic conditions and the dust clouds from limited dust source such as an open cut mine will disperse to low concentrations within a kilometre or so. This is in contrast to wind erosion from drought affected agricultural land or desert areas where the quantities of dust may be extremely large and are trapped within the mixed-layer and may be transported at high concentrations without significant dilution for many hundreds and in some cases thousands of kilometres.

Thus, there are considerably difficulties in not only defining the "worst-case" meteorological conditions that will constitute an episode, but also in estimating the dust emissions. The approach adopted in the modelling has been to assume that the dust generated in the episode is the full erosion potential of a scoria surface at 17 m/s wind speed and that all exposed areas on the mine generate this quantity of dust over a 24 hour period. Thus 17 m/s wind speed, or gusts up to this speed, have been assumed in attempting to simulate the dust generation rate. The average wind speed used in the dispersion model during the episode has been taken to be 6 m/s. It should be noted that the lower the average wind speed assumed in the dispersion model the higher will be the estimated dust concentrations. It has further been assumed that the wind is confined to a 22.5 degree sector centred on the NNW. Mining is assumed to continue through out the episode.

To assess the reasonableness of these assumptions it is useful to examine Figure 17 which is a cumulative frequency plot showing the number of ten-minute periods the wind speed exceeded the indicated thresholds for the data that has been collected by the Rix's Creek during the period 20 March 1991 to 11 April 1994. A total of 116,320 ten-minute average wind speed were collected during that period. Scanning the data set it would appear that the worst period for episodic conditions occurred during 21 August 1991. Hourly average wind speeds for each hour of the day are shown in Appendix A. An examination of the raw data (data with 10-minute averages) showed 10-minute average wind speeds between 17 and 18 m/s for two ten minute periods. The hourly average data summarised in Appendix A shows that the hourly average wind speed increased progressively from 4 am when it was 5.4 m/s to a peak of 14.6 m/s at 10 am. There were five hours on the 21 August 1991 (8 am to 12 am) when the hourly average wind speed was above 10 m/s. The hourly average wind direction for the entire period was confined to between 322 and 345 degrees. These would generally be described as NNW winds. The average wind speed over the full 24-hour period was 7.3 m/s.

Figure 17 can also be used to see what percentage of the time the 10-minute average wind speed will exceed certain thresholds. For example it can be seen that there were 800, out of the 116,320 readings available, when the 10-minute average wind speed was above 10 m/s. This corresponds to 0.67 per cent of the time.

Figure 18 shows the estimated 24-hour TSP concentrations under the assumed "worst-case" scenario for episodic impacts. This scenario assumes that periods where the wind speed is 17 m/s occur with sufficient frequency that all the potentially erodable dust at 17 m/s is in fact suspended. It is then assumed that a 24-hour average wind speed of only 6 m/s is the speed that determines the concentration of dust. Figure 17 assumes a NNW wind. This direction was selected because it was the direction that applied in the actual data for the 21 August 1991, which was the day with the strongest winds over the three year monitoring period.

The wind of course could blow from other directions and the expected concentrations for different wind direction can be determined approximately by rotating the contours appropriately. NW winds would be marginally worse for Singleton Heights than would the NNW that were used.

It is not certain what the PM_{10} to TSP ratios would be in episodic conditions, but strong winds would be likely to result in a higher proportion of coarser particles so a predicted 24-hour TSP concentration of 300 $\mu g/m^3$ would most likely correspond to PM_{10} concentrations of less than 150 $\mu g/m^3$. Using this as the bench mark it would seem from the contours in Figure 18 that with exposed areas of the size envisaged for the Rix's Creek mine that adverse air quality impacts due to episodic conditions would not be expected at distance of more than 1000 m or so from the edges of the exposed areas.

10.0 CUMULATIVE IMPACTS

Two mining operations are presently operating in the area, Rix's Creek (the expansion of which is the subject of this assessment) and Camberwell. Glennies Creek is a third potential mine. These mines are approximately located on a N-S line. The most common winds in the area are aligned on a NNW-SE or SSE axis. This results in parallel plumes from each mine and reduces the area where cumulative impacts occur.

Glennies Creek will be an underground mine and its closest dust sources are at least five kilometres north of the northern boundary of the Rix's Creek lease. It will not contribute significantly to any dust in the area where Rix's Creek dust emissions are significant (that is close to 2 g/m^2/month (annual average)). The southern boundary of the Camberwell lease is common with the northern boundary of the Rix's Creek lease and land between Camberwell and Rix's Creek will clearly be affected by dust emissions from both Rix's Creek and Camberwell.

For the purposes of assessing cumulative impacts it can be argued that dust from Camberwell's operations is reflected in the current monitoring data and consequently using current monitoring data takes account of the potential for cumulative impacts. In the future Camberwell mine will develop to the south towards the Rix's Creek mine and slightly (under 1 km) to the west. The net effect of this is to increase dust levels on land already affected by mining.

In an attempt to provide a picture showing the worst extent of the cumulative interaction between Rix's Creek and Camberwell dust emissions a model run has been undertaken using dust emissions for Rix's Creek as they will be in Year 22 of the Rix's Creek development schedule and Camberwell emissions as they will be in Year 13 of Camberwell's development. It is unlikely that these two phases in the development of the two mines would in fact occur simultaneously, but by using these two periods it is possible to cover the worst-case both with respect to the emissions from the two mines and with respect to the locations of the disturbed areas.

Figure 19 shows the results of the model run including emissions from Camberwell. Comparison of **Figure 15**, which shows the predicted increase in dust deposition with only emissions from Rix's Creek included, with **Figure 19** shows that the interaction in dust from the two mines is minor in that the effect on the 2 g/m^2/month (annual average) contour is small except of course in areas where Camberwell has a high contribution. In areas where the contribution from both mines is small the interaction is of course larger. For example when Rix's Creek alone is taken into account the NW corner of Singleton Heights is predicted to experience just under 0.5 g/m^2/month increase in the annual average dust deposition. When Camberwell is included in the assessment this area is predicted to experience an increase of 0.9 g/m^2/month in annual average dust deposition. This is a doubling, approximately, in the annual dust fallout rate, but it still well within the acceptable level.

11.0 AIR POLLUTION CONTROLS

The mine will be controlled by the EPA with respect with respect to measures to control air pollution. The mine will adopt the following operational procedures that will control dust, or assess the effectiveness of controls:

- operate a meteorological station to monitor wind speed, wind direction, temperature and rainfall
- operate a dust deposition gauge monitoring network to monitor monthly dust deposition
- operate high-volume samplers to measure 24-hour TSP concentrations
- maintain all trafficked surfaces in a damp condition
- maintain dust collectors on drills
- minimise the area of exposed land.

13.0 CONCLUSIONS

The modelling study has examined the pattern of dust deposition and concentrations in the vicinity of the proposed expanded Rix's Creek open cut mine for Years 1, 8, 15 and 22. The study identifies those area where increases in dust deposition or concentration will increase above levels acceptable for residential land use. The study has not yet specified what action should be taken in respect of areas identified as being expected to be adversely affected.

An analysis of meteorological data to determine adverse weather that might give rise to episodic dust events has used to identify worst case conditions in the three years of available data has been used to simulate 24-hour TSP concentrations that would be

expected to result from episodic conditions. The areas that are likely to be adversely affected are identified on a contour plot.

Finally, an assessment has been made of the potential for cumulative effects due to emissions from Rix's Creek and Camberwell to give rise to adverse effects. It is concluded that there is only a minor expansion (compared with each mine being assessed separately) in the area contained by the critical 2 g/m^2/month annual average dust incremental deposition contour.

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APPENDIX A
METEOROLOGICAL DATA

Rixs Creek 1992/91 (combined)
FROM 91. 1.22 TO 92.12.31

ALL PASQUILL STABILITY CLASSES
WIND SPEED CLASS (MPS)

WIND SECTOR	.00 TO 1.50	1.51 TO 3.00	3.01 TO 4.50	4.51 TO 6.00	6.01 TO 7.50	7.51 TO 9.00	9.01 TO 10.50	GREATER THAN 10.50	TOTAL	MEAN SPEED
NNE	.009309	.005556	.001877	.001051	.000526	.000075	.000000	.000000	.018393	1.99
NE	.005030	.002628	.001201	.001126	.000225	.000000	.000000	.000000	.010210	2.18
ENE	.009309	.002327	.000676	.000225	.000225	.000075	.000000	.000000	.012838	1.30
E	.008559	.004054	.001126	.000300	.000150	.000075	.000000	.000000	.014264	1.60
ESE	.015916	.017568	.013438	.006006	.002102	.000450	.000075	.000000	.055556	2.78
SE	.023198	.045871	.034234	.024850	.008108	.003453	.000751	.000075	.140541	3.40
SSE	.019820	.029279	.018243	.009459	.003378	.000901	.000300	.000000	.081381	2.88
S	.022447	.020045	.005856	.002553	.000826	.000300	.000075	.000000	.052102	2.05
SSW	.014640	.016141	.008258	.003228	.001351	.000225	.000075	.000000	.043919	2.46
SW	.031682	.010511	.004655	.002402	.001802	.000450	.000225	.000225	.051952	1.83
WSW	.016592	.004805	.001577	.000826	.000075	.000000	.000075	.000000	.023949	1.38
W	.007057	.003604	.001201	.000601	.000375	.000075	.000000	.000000	.012913	1.86
WNW	.006231	.005330	.001802	.001276	.000300	.000300	.000000	.000075	.015315	2.32
NW	.011036	.022222	.022898	.016441	.012087	.007282	.004354	.003153	.099474	4.58
NNW	.028679	.071622	.085285	.052102	.025225	.011637	.003829	.001276	.279655	3.96
N	.031006	.043994	.009384	.001952	.000901	.000000	.000075	.000000	.087312	2.01
CALM									.000225	
TOTAL	.260511	.305556	.211712	.124399	.057658	.025300	.009835	.004805	1.000000	3.10

NUMBERS BELOW BASED ON ALL OBSERVATIONS
NUMBER OF INVALID OBSERVATIONS = 0
NUMBER OF VALID OBSERVATIONS =13320

Rixs Creek 1992/91 (combined)
FROM 91. 1.22 TO 92.12.31

PASQUILL STABILITY CLASS "A"
WIND SPEED CLASS (MPS)

WIND SECTOR	.00 TO 1.50	1.51 TO 3.00	3.01 TO 4.50	4.51 TO 6.00	6.01 TO 7.50	7.51 TO 9.00	9.01 TO 10.50	GREATER THAN 10.50	TOTAL	MEAN SPEED
NNE	.000225	.000075	.000150	.000000	.000000	.000000	.000000	.000000	.000450	1.83
NE	.000150	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000150	.90
ENE	.002553	.000075	.000075	.000000	.000000	.000075	.000000	.000000	.002778	.87
E	.001426	.000075	.000075	.000000	.000000	.000000	.000000	.000000	.001577	.79
ESE	.001201	.000075	.000000	.000000	.000000	.000000	.000000	.000000	.001276	.77
SE	.000225	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000225	.50
SSE	.000300	.000150	.000000	.000000	.000000	.000000	.000000	.000000	.000450	1.10
S	.000150	.000075	.000000	.000000	.000000	.000000	.000000	.000000	.000225	1.03
SSW	.000000	.000075	.000075	.000000	.000000	.000000	.000000	.000000	.000150	3.10
SW	.000150	.000075	.000000	.000000	.000000	.000000	.000000	.000000	.000225	.93
WSW	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.00
W	.000075	.000150	.000000	.000000	.000000	.000000	.000000	.000000	.000225	1.43
WNW	.000075	.000000	.000000	.000150	.000000	.000000	.000000	.000000	.000225	4.00
NW	.000075	.000150	.000000	.000000	.000000	.000000	.000000	.000000	.000225	2.10
NNW	.000375	.000075	.000000	.000000	.000000	.000075	.000000	.000000	.000526	1.94
N	.000075	.000075	.000000	.000000	.000000	.000000	.000000	.000000	.000150	1.45
CALM									.000000	
TOTAL	.007057	.001126	.000375	.000150	.000000	.000150	.000000	.000000	.008859	1.13

NUMBERS BELOW BASED ON ALL OBSERVATIONS
NUMBER OF INVALID OBSERVATIONS = 0
NUMBER OF VALID STABILITY DEPENDENT OBSERVATIONS =13320

PASQUILL STABILITY CLASS "B"
WIND SPEED CLASS (MPS)

WIND SECTOR	.00 TO 1.50	1.51 TO 3.00	3.01 TO 4.50	4.51 TO 6.00	6.01 TO 7.50	7.51 TO 9.00	9.01 TO 10.50	GREATER THAN 10.50	TOTAL	MEAN SPEED
NNE	.000976	.001802	.000300	.000000	.000000	.000000	.000000	.000000	.003078	1.94
NE	.000526	.000526	.000225	.000000	.000075	.000000	.000000	.000000	.001351	2.31
ENE	.002628	.000901	.000150	.000000	.000000	.000000	.000000	.000000	.003679	1.05
E	.001502	.001802	.000075	.000000	.000000	.000000	.000000	.000000	.003378	1.58
ESE	.001276	.004505	.001502	.000000	.000000	.000000	.000000	.000000	.007282	2.26
SE	.001577	.005856	.002027	.000000	.000000	.000000	.000000	.000000	.009459	2.33
SSE	.001802	.004354	.001426	.000000	.000000	.000000	.000000	.000000	.007583	2.18
S	.001502	.003003	.000300	.000000	.000000	.000000	.000000	.000000	.004805	1.90
SSW	.002102	.002477	.000150	.000000	.000000	.000000	.000000	.000000	.004730	1.72
SW	.002778	.002402	.000150	.000000	.000000	.000000	.000000	.000000	.005330	1.52
WSW	.002102	.001351	.000075	.000000	.000000	.000000	.000000	.000000	.003529	1.34
W	.001051	.001201	.000075	.000000	.000000	.000000	.000000	.000000	.002327	1.64
WNW	.001276	.002027	.000225	.000000	.000000	.000000	.000000	.000000	.003529	1.78
NW	.001426	.003979	.001201	.000000	.000000	.000000	.000000	.000000	.006607	2.21
NNW	.003078	.004429	.002628	.000000	.000000	.000000	.000000	.000000	.010135	2.15
N	.001652	.003529	.000450	.000000	.000000	.000000	.000000	.000000	.005631	1.89
CALM									.000000	
TOTAL	.027252	.044144	.010961	.000000	.000075	.000000	.000000	.000000	.082432	1.95

NUMBERS BELOW BASED ON ALL OBSERVATIONS
NUMBER OF INVALID OBSERVATIONS = 0
NUMBER OF VALID STABILITY DEPENDENT OBSERVATIONS =13320

PASQUILL STABILITY CLASS "C"
WIND SPEED CLASS (MPS)

WIND SECTOR	.00 TO 1.50	1.51 TO 3.00	3.01 TO 4.50	4.51 TO 6.00	6.01 TO 7.50	7.51 TO 9.00	9.01 TO 10.50	GREATER THAN 10.50	TOTAL	MEAN SPEED
NNE	.001201	.000526	.000300	.000375	.000000	.000075	.000000	.000000	.002477	2.35
NE	.000601	.000375	.000375	.000300	.000000	.000000	.000000	.000000	.001652	2.72
ENE	.001502	.000375	.000225	.000075	.000000	.000000	.000000	.000000	.002177	1.35
E	.000826	.000751	.000375	.000075	.000000	.000075	.000000	.000000	.002102	2.25
ESE	.001351	.002928	.004805	.001351	.000000	.000000	.000000	.000000	.010435	3.25
SE	.002327	.006081	.007207	.004279	.000000	.000000	.000000	.000000	.019895	3.31
SSE	.000976	.003153	.002327	.000751	.000000	.000000	.000000	.000000	.007207	2.93
S	.001952	.002027	.000375	.000075	.000000	.000000	.000000	.000000	.004429	1.84
SSW	.001952	.001802	.001051	.000450	.000000	.000000	.000000	.000000	.005255	2.37
SW	.002252	.002402	.000976	.000225	.000000	.000000	.000000	.000000	.005856	2.12
WSW	.003153	.000450	.000375	.000150	.000000	.000000	.000000	.000000	.004129	1.33
W	.001051	.000901	.000300	.000000	.000000	.000000	.000000	.000000	.002252	1.79
WNW	.000526	.001502	.000676	.000300	.000000	.000000	.000000	.000000	.003003	2.60
NW	.001201	.005330	.007733	.003003	.000000	.000000	.000000	.000000	.017267	3.42
NNW	.003228	.008709	.013664	.007658	.000000	.000000	.000000	.000000	.033258	3.50
N	.003003	.003078	.000751	.000450	.000000	.000000	.000000	.000000	.007282	1.98
CALM									.000000	
TOTAL	.027102	.040390	.041517	.019520	.000000	.000150	.000000	.000000	.128679	2.94

NUMBERS BELOW BASED ON ALL OBSERVATIONS
NUMBER OF INVALID OBSERVATIONS = 0
NUMBER OF VALID STABILITY DEPENDENT OBSERVATIONS =13320

PASQUILL STABILITY CLASS "D"
WIND SPEED CLASS (MPS)

WIND SECTOR	.00 TO 1.50	1.51 TO 3.00	3.01 TO 4.50	4.51 TO 6.00	6.01 TO 7.50	7.51 TO 9.00	9.01 TO 10.50	GREATER THAN 10.50	TOTAL	MEAN SPEED
NNE	.001276	.000526	.000300	.000601	.000526	.000000	.000000	.000000	.003228	3.18
NE	.000450	.000676	.000450	.000676	.000150	.000000	.000000	.000000	.002402	3.53
ENE	.000751	.000450	.000075	.000150	.000225	.000000	.000000	.000000	.001652	2.64
E	.001126	.000826	.000450	.000225	.000150	.000000	.000000	.000000	.002778	2.37
ESE	.002402	.002553	.002778	.003829	.001802	.000450	.000075	.000000	.013889	3.96
SE	.003303	.010285	.009610	.012988	.006231	.003153	.000751	.000075	.046396	4.51
SSE	.002853	.008183	.005180	.004505	.002477	.000676	.000225	.000000	.024099	3.67
S	.002778	.004129	.001877	.001351	.000601	.000225	.000075	.000000	.011036	2.99
SSW	.001877	.003679	.003303	.002177	.001201	.000225	.000075	.000000	.012538	3.48
SW	.002477	.001652	.000976	.001577	.001351	.000150	.000225	.000225	.008634	3.81
WSW	.001577	.001126	.000676	.000601	.000075	.000000	.000075	.000000	.004129	2.54
W	.000450	.000450	.000526	.000601	.000300	.000075	.000000	.000000	.002402	3.94
WNW	.000676	.000826	.000751	.000751	.000300	.000150	.000000	.000000	.003453	3.64
NW	.002177	.005255	.005105	.009384	.010135	.006532	.004279	.003153	.046021	6.18
NNW	.003829	.012838	.014489	.019069	.015991	.008033	.003153	.001276	.078679	5.20
N	.003679	.005556	.001952	.000826	.000601	.000000	.000000	.000000	.012613	2.46
CALM									.000000	
TOTAL	.031682	.059009	.048499	.059309	.042117	.019670	.008934	.004730	.273949	4.56

NUMBERS BELOW BASED ON ALL OBSERVATIONS
NUMBER OF INVALID OBSERVATIONS = 0
NUMBER OF VALID STABILITY DEPENDENT OBSERVATIONS =13320

PASQUILL STABILITY CLASS "E"
WIND SPEED CLASS (MPS)

WIND SECTOR	.00 TO 1.50	1.51 TO 3.00	3.01 TO 4.50	4.51 TO 6.00	6.01 TO 7.50	7.51 TO 9.00	9.01 TO 10.50	GREATER THAN 10.50	TOTAL	MEAN SPEED
NNE	.002252	.000826	.000826	.000075	.000000	.000000	.000000	.000000	.003979	1.84
NE	.001201	.000526	.000150	.000150	.000000	.000000	.000000	.000000	.002027	1.66
ENE	.000526	.000225	.000150	.000000	.000000	.000000	.000000	.000000	.000901	1.64
E	.001126	.000300	.000150	.000000	.000000	.000000	.000000	.000000	.001577	1.44
ESE	.003303	.002027	.004354	.000826	.000300	.000000	.000000	.000000	.010811	2.78
SE	.004805	.006306	.015390	.007583	.001877	.000300	.000000	.000000	.036261	3.60
SSE	.005631	.004129	.009309	.004204	.000901	.000225	.000075	.000000	.024474	3.24
S	.003754	.002628	.003303	.001126	.000225	.000075	.000000	.000000	.011111	2.58
SSW	.002402	.002553	.003679	.000601	.000150	.000000	.000000	.000000	.009384	2.71
SW	.001727	.001051	.002553	.000601	.000450	.000300	.000000	.000000	.006682	3.23
WSW	.002402	.000976	.000450	.000075	.000000	.000000	.000000	.000000	.003904	1.55
W	.001652	.000375	.000300	.000000	.000075	.000000	.000000	.000000	.002402	1.42
WNW	.001727	.000225	.000150	.000075	.000000	.000150	.000000	.000075	.002402	1.97
NW	.002252	.002252	.008859	.004054	.001952	.000751	.000075	.000000	.020195	4.03
NNW	.003153	.006532	.054505	.025375	.009234	.003529	.000676	.000000	.103003	4.39
N	.003979	.003754	.006231	.000676	.000300	.000000	.000075	.000000	.015015	2.69
CALM									.000150	
TOTAL	.041892	.034685	.110360	.045420	.015465	.005330	.000901	.000075	.254279	3.61

NUMBERS BELOW BASED ON ALL OBSERVATIONS
NUMBER OF INVALID OBSERVATIONS = 0
NUMBER OF VALID STABILITY DEPENDENT OBSERVATIONS =13320

PASQUILL STABILITY CLASS "F"
WIND SPEED CLASS (MPS)

WIND SECTOR	.00 TO 1.50	1.51 TO 3.00	3.01 TO 4.50	4.51 TO 6.00	6.01 TO 7.50	7.51 TO 9.00	9.01 TO 10.50	GREATER THAN 10.50	TOTAL	MEAN SPEED
NNE	.003378	.001802	.000000	.000000	.000000	.000000	.000000	.000000	.005180	1.24
NE	.002102	.000526	.000000	.000000	.000000	.000000	.000000	.000000	.002628	1.03
ENE	.001351	.000300	.000000	.000000	.000000	.000000	.000000	.000000	.001652	.96
E	.002553	.000300	.000000	.000000	.000000	.000000	.000000	.000000	.002853	.94
ESE	.006381	.005480	.000000	.000000	.000000	.000000	.000000	.000000	.011862	1.51
SE	.010961	.017342	.000000	.000000	.000000	.000000	.000000	.000000	.028303	1.77
SSE	.008258	.009309	.000000	.000000	.000000	.000000	.000000	.000000	.017568	1.62
S	.012312	.008183	.000000	.000000	.000000	.000000	.000000	.000000	.020495	1.35
SSW	.006306	.005556	.000000	.000000	.000000	.000000	.000000	.000000	.011862	1.49
SW	.022297	.002928	.000000	.000000	.000000	.000000	.000000	.000000	.025225	.78
WSW	.007357	.000901	.000000	.000000	.000000	.000000	.000000	.000000	.008258	.75
W	.002778	.000526	.000000	.000000	.000000	.000000	.000000	.000000	.003303	.88
WNW	.001952	.000751	.000000	.000000	.000000	.000000	.000000	.000000	.002703	1.17
NW	.003904	.005255	.000000	.000000	.000000	.000000	.000000	.000000	.009159	1.71
NNW	.015015	.039039	.000000	.000000	.000000	.000000	.000000	.000000	.054054	1.97
N	.018619	.028003	.000000	.000000	.000000	.000000	.000000	.000000	.046622	1.70
CALM									.000075	
TOTAL	.125526	.126201	.000000	.000000	.000000	.000000	.000000	.000000	.251802	1.54

NUMBERS BELOW BASED ON ALL OBSERVATIONS
NUMBER OF INVALID OBSERVATIONS = 0
NUMBER OF VALID STABILITY DEPENDENT OBSERVATIONS =13320

Meteorological data from Rix's Creek Weather Station
for days with relatively high 24-hour TSP concentrations

Key - from left to right.
Year, month, day, hour, temperature (C), wind speed (m/s), wind direction (degrees from north), atmospheric stability class and mixing height (m).

93030101	20	0.5	343	F	53
93030102	18	0.5	343	F	53
93030103	15	0.5	242	F	53
93030104	16	0.5	343	F	53
93030105	16	0.5	317	F	53
93030106	15	0.5	334	F	53
93030107	14	0.5	333	F	220
93030109	17	4.7	338	C	579
93030110	18	4.7	334	C	741
93030111	19	3.9	337	C	886
93030112	20	4.0	332	C	1010
93030113	21	3.8	327	B	1111
93030114	22	4.1	303	C	1185
93030115	23	2.0	316	B	1232
93030116	23	3.1	245	C	1250
93030117	22	3.2	236	C	1238
93030118	22	1.2	230	C	323
93030119	19	0.5	221	F	53
93030120	16	0.5	220	F	53
93030121	15	0.5	235	D	53
93030122	14	0.5	313	D	53
93030123	14	0.5	353	E	118
93030124	13	0.5	359	F	53

93110201	9	1.0	73	D	194
93110202	9	1.2	133	F	83
93110203	8	0.9	59	F	72
93110204	8	0.7	10	F	62
93110205	7	0.8	255	F	69
93110206	8	1.3	345	C	257
93110207	8	0.6	357	A	439
93110208	12	0.6	351	C	612
93110209	17	0.8	331	C	771
93110210	16	0.7	200	C	912
93110211	18	1.4	344	C	1032
93110212	21	4.3	335	C	1128
93110213	23	6.0	323	D	1197
93110214	24	6.0	324	D	1238
93110215	24	7.6	340	D	1250
93110216	23	7.2	335	D	1232
93110217	22	6.5	338	D	1185
93110218	19	6.2	301	D	1111
93110219	14	4.4	225	E	351
93110220	12	3.6	223	E	316
93110221	12	2.2	282	E	247
93110222	11	4.3	303	E	343
93110223	11	3.7	288	D	343
93110224	10	4.7	312	E	362

93110801	11	2.0	101	F	106
93110802	11	2.1	105	F	107
93110803	11	1.8	103	F	101
93110804	10	1.7	100	F	96
93110805	10	1.7	97	F	74
93110806	9	0.9	96	D	262
93110807	12	2.1	109	D	444
93110808	15	2.1	84	C	616
93110809	18	2.6	63	B	775
93110810	19	1.9	62	B	915
93110811	19	1.7	114	B	1035
93110812	21	1.8	119	B	1130
93110813	21	2.4	306	B	1198
93110814	23	2.3	341	B	1239
93110815	24	2.3	304	B	1250
93110816	25	2.5	309	C	1231
93110817	25	3.4	319	C	1184
93110818	23	3.2	323	D	1109
93110819	21	2.2	328	F	111
93110820	18	1.6	46	F	93
93110821	16	1.9	66	E	230
93110822	15	1.4	77	F	86
93110823	14	1.0	210	F	73
93110824	14	0.7	300	F	63
93120201	21	1.9	306	D	298
93120202	21	2.1	293	E	242
93120203	21	2.2	314	D	242
93120204	20	2.5	322	E	265
93120205	19	2.6	327	F	73
93120206	19	3.0	335	D	307
93120207	23	3.9	314	D	535
93120208	27	3.7	296	C	751
93120209	31	3.8	271	C	950
93120210	33	3.5	260	B	1126
93120211	33	4.1	138	C	1276
93120212	26	10.1	86	D	1396
93120213	24	10.0	93	D	1483
93120214	22	8.2	82	D	1535
93120215	21	7.7	90	D	1550
93120216	19	6.5	87	D	1528
93120217	17	6.2	96	D	1470
93120218	17	4.5	81	E	1377
93120219	16	4.9	80	E	367
93120220	13	4.6	97	E	356
93120221	13	3.8	97	E	322
93120222	14	2.8	84	F	124
93120223	14	4.5	101	E	354
93120224	12	4.2	104	E	341

93121401	15	0.9	0	F	71
93121402	14	1.0	108	D	71
93121403	13	0.8	85	F	67
93121404	13	0.5	138	F	53
93121405	14	0.5	180	E	51
93121406	14	0.5	212	D	286
93121407	17	0.8	71	C	515
93121408	22	1.9	326	C	732
93121409	24	1.9	278	C	932
93121410	25	2.1	280	C	1111
93121411	27	4.0	289	C	1264
93121412	29	4.5	300	C	1387
93121413	30	5.0	293	C	1477
93121414	30	5.0	308	D	1532
93121415	31	5.4	309	C	1550
93121416	31	5.4	300	D	1532
93121417	30	4.9	303	D	1477
93121418	28	4.0	323	E	1387
93121419	28	3.0	329	E	289
93121420	27	2.7	326	F	123
93121421	26	2.4	336	F	115
93121422	25	2.4	348	F	115
93121423	24	2.2	349	F	110
93121524	23	1.0	316	F	73

Data for very windy day

91082101	10	5.8	322	E	402
91082102	9	5.3	330	E	382
91082103	8	5.2	336	E	378
91082104	7	5.4	343	E	385
91082105	9	7.1	345	D	385
91082106	10	8.4	343	D	73
91082107	12	9.1	336	D	229
91082108	13	11.7	329	D	381
91082109	14	14.3	324	D	525
91082110	14	14.6	322	D	656
91082111	14	11.7	324	D	773
91082112	13	11.5	324	D	872
91082113	13	8.9	320	D	951
91082114	11	8.2	324	D	1008
91082115	10	6.7	324	D	1041
91082116	10	6.3	326	D	1050
91082117	9	5.5	328	E	1034
91082118	8	4.3	323	E	346
91082119	8	4.3	326	E	344
91082120	7	5.4	331	E	387
91082121	6	3.9	342	E	329
91082122	6	3.6	345	E	318
91082123	6	4.3	344	E	346
91082224	6	4.5	344	E	352

APPENDIX B
ASSESSMENT OF MODEL PERFORMANCE

FIGURES

TABLES

APPENDIX B - COMPARISON OF PREDICTED AND ACTUAL IMPACTS AT CAMBERWELL

Figure B-1 shows the locations of eight dust deposition gauges and four high volume samplers operated by Camberwell mine. **Table B-1** and **Figure B-2a** summarise the dust deposition monitoring data collected around the Camberwell mine from January 1987 to December 1988 and February 1989 to September 1993. Data for 1988 are not available. Data for eight gauges are available, but the data for Gauge 8, which is located in Camberwell village (see **Figure B-1**) has been omitted from Figure B-1, but is included in Table B-1. Gauge 8 is clearly too far from the mine to be affected by dust from the mine. It is interesting however that it is Gauge 8 that records the highest dust fallout levels (see Table B-1). The reasons for the high fallout levels at Camberwell village are not known but are almost certainly related to local activities in Camberwell. **Figure B-2b** shows the ROM coal and waste handled annually since commencement of mining in April 1991. Annual total rainfall recorded at Singleton and Jerrys Plains for 1987 to 1993 is plotted on **Figure B-2c** and the number of raindays at Jerrys Plains are shown in **Figure B-2d** (rain-day data are not available for Singleton).

It is useful to review these data to see how they might assist in predicting the future impacts that will arise for the Rix's Creek mine, which at peak production will operate in a very similar way to the current Camberwell mine, both in terms of the quantities of materials handled, the mining methods and the geological and meteorological characteristics of the area.

The most notable feature of the dust deposition data is that there are large year-to-year variations in the dust deposition levels. The significance of these variations have been tested using paired sample Student's t-Tests[1]. The first test done was on the dust deposition data for 1987 and 1989. The test shows that these two samples are significantly different at the 0.042 per cent level. That is, there is a very good reason to believe that some underlying change occurred in the factors that control dust deposition in the monitoring network between these two monitoring periods. This change was clearly not mining, because mining at Camberwell did not commence until 1991. Other mines are too far away from the monitoring network to affect the gauges directly. The fact that the fallout levels are different is perhaps obvious from Figure B-1 without the need for statistical testing. However, the statistical test is a more objective assessment method and uses paired data (that is compares the differences in each gauge separately, which is not readily done by eye.

Possible causes of the differences are year-to-year weather changes, changes in the quality of the laboratory analysis of the samples, or changes in dust emission sources, which in this case would most probably be other mines and agriculture.

A second Student's t-Test has been done in which deposition data in 1990 (again before Camberwell had begun) has been tested against data from 1993, when Camberwell handled approximately 14 Mbcm of coal and waste. The means for these

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[1] The Student's t-Test is a statistical test that can determine the probability that the differences in means of two samples, occurs as a results of chance, or if the difference is a results some underlying cause. The statistical test does not allow the underlying cause of the differences to be determined, only that the differences are significant given the overall variation that appears in the samples.

two years (on a paired test basis) were also significantly different at the 2.5 per cent level. In statistical terms this is a highly significant result. That is, it is very unlikely

TABLE B-1 - ANNUAL AVERAGE INSOLUBLE SOLIDS DUST DEPOSITION FOR CAMBERWELL (g/sq. m/month)

Gauge	D1	D2	D3	D4	D5	D6	D7	D8	Average excl. D8
1987									
Jan	1.8	1.9	2.3	1.7	1.5	1.7	ND	ND	1.82
Feb	1.2	2.2	3	2	1.3	1.9	ND	ND	1.93
Mar	0.8	1.1	ND	1.6	3	4.6	ND	ND	2.22
Apr	0.4	1.1	1	1.6	1	1.1	ND	ND	1.03
May	1.3	1.5	ND	ND	1.7	ND	ND	ND	1.50
Jun	2.5	1.5	ND	1.3	ND	1.5	ND	ND	1.70
Jul	1.8	2.6	1.3	2	1.6	2.3	ND	ND	1.93
Aug	1.4	1.1	0.6	1.8	1.8	4	ND	ND	1.78
Sep	2	1.3	ND	0.4	1.6	1.7	ND	ND	1.40
Oct	2.4	1.8	2.2	1	1	1.9	ND	ND	1.72
Nov	1.3	1.8	1.6	2.7	2.1	1.3	ND	ND	1.80
Dec	4	1.4	1.3	2.9	2.9	1.2	ND	ND	2.28
Annual Average	1.7	1.6	1.7	1.7	1.8	2.1	ND	ND	1.77
Standard deviation	0.9	0.5	0.8	0.7	0.7	1.1	ND	ND	0.79
No data for 1988									
1989									
Feb	0.7	0.6	0.9	1.2	0.6	0.2	ND	ND	0.69
Mar	0.7	0.6	0.9	1.2	0.6	0.2	ND	ND	0.70
Apr	0.9	0.7	0.7	1.1	2.5	ND	ND	ND	1.18
May	0.8	0.7	0.6	0.7	0.5	0.4	ND	ND	0.62
Jun	0.5	0.6	0.5	0.3	0.3	0.5	ND	ND	0.45
Jul	0.5	0.4	0.8	0.6	0.4	0.3	ND	ND	0.50
Aug	0.6	0.7	0.9	2.4	0.2	0.3	ND	ND	0.85
Sep	0.8	0.8	1.5	0.8	0.6	0.6	ND	ND	0.85
Oct	0.9	0.9	1.4	1.0	0.7	0.5	ND	ND	0.91
Nov	0.5	0.7	0.7	0.9	0.2	1.8	ND	ND	0.81
Dec	0.6	1.1	0.5	0.9	0.9	ND	ND	ND	0.80
Annual Average	0.68	0.71	0.86	1.01	0.68	0.54	ND	ND	0.75
Standard deviation	0.15	0.18	0.34	0.53	0.64	0.51	ND	ND	0.39
1990									
Jan	0.3	0.8	0.8	1.2	1.3	2.3	ND	ND	1.12
Feb	0.4	0.5	0.4	1	0.3	0.7	ND	ND	0.55
Mar	0.3	0.9	0.7	0.1	0.6	ND	ND	ND	0.52
Apr	ND	0.8	0.6	0.6	ND	1.5	ND	ND	0.88
May	2.8	1.2	1.2	1.9	0.9	2.7	ND	ND	1.78
Jun	2.1	2.6	3.4	3.0	3.8	1.9	ND	ND	2.80
Jul	1.5	1.3	1.7	1.1	1.0	3.5	1.4	ND	1.64
Aug	0.9	0.5	0.8	3.6	0.7	0.8	0.9	0.7	1.17
Sep	1.7	0.3	1.8	2.5	1.8	1.3	1.5	1.7	1.56
Oct	2.1	0.5	0.8	0.8	0.4	1.1	2.1	3.5	1.11
Nov	1.9	0.8	1.8	0.8	0.8	2.1	1.5	4.2	1.39
Dec	1.8	1.1	1.3	1.3	1.1	2.3	1.5	4.2	1.49
Annual Average	1.44	0.94	1.28	1.49	1.15	1.84	1.48	2.86	1.37
Standard deviation	0.8	0.6	0.8	1.0	1.0	0.9	0.4	1.6	0.79

TABLE B-1 - ANNUAL AVERAGE INSOLUBLE SOLIDS DUST DEPOSITION FOR CAMBERWELL (g/sq. m/month)

1991									
Jan	2.2	1.1	0.9	1.0	0.6	1.5	2.8	ND	1.44
Feb	2.7	0.3	0.4	0.6	0.4	0.5	0.4	20.8	0.76
Mar	1.4	0.7	1.8	0.7	1.0	0.8	1.0	ND	1.06
Apr	1.5	0.8	1.4	1.1	1.3	1.3	1.6	4.1	1.29
May	0.5	0.3	0.5	0.3	0.4	0.4	0.1	2.5	0.36
Jun	0.6	0.1	0.2	0.7	0.2	0.4	0.6	18.2	0.40
Jul	1.3	0.3	0.5	0.5	0.4	0.5	0.4	21.0	0.56
Aug	1.2	0.5	1.9	0.6	0.6	0.4	1.2	0.6	0.91
Sep	2.7	1.7	3.6	2.3	2.2	1.7	2.9	10.4	2.44
Oct	1.3	1.1	1.3	1.7	0.7	0.6	0.9	0.8	1.09
Nov	2.6	0.9	1.3	1.4	1.3	0.6	1.3	2.1	1.34
Dec	1.6	2.1	1.4	1.1	1.0	2.4	1.3	1.3	1.56
Annual average	1.63	0.83	1.27	1.00	0.84	0.93	1.21	8.18	1.10
Standard deviation	0.8	0.6	0.9	0.6	0.6	0.7	0.9	8.7	0.71
1992									
Jan	2.2	0.4	1.1	0.9	0.4	0.6	0.6	1.2	0.89
Feb	0.6	0.8	1.0	0.5	0.7	0.5	0.7	1.3	0.69
Mar	1.3	0.5	1.0	0.5	0.5	0.4	0.7	0.4	0.70
Apr	0.3	0.2	0.5	0.2	0.1	0.2	0.7	1.2	0.31
May	1.1	0.4	0.4	0.7	1.0	0.3	1.6	1.2	0.79
Jun	1.2	0.8	0.8	0.9	0.5	0.4	0.9	0.7	0.79
Jul	1.0	2.2	0.5	1.0	0.9	0.5	1.0	1.4	1.01
Aug	1.2	0.5	1.4	0.9	0.4	0.5	0.8	1.1	0.81
Sep	1.5	0.6	1.1	0.7	1.1	0.6	1.4	1.2	1.00
Oct	1.1	0.4	1.8	1.0	1.7	1.2	0.9	2.5	1.16
Nov	1.6	0.3	1.3	1.0	1.1	1.0	2.5	1.3	1.26
Dec	1.1	0.7	0.8	0.8	0.8	1.0	0.8	1.4	0.86
Annual Average	1.18	0.65	0.98	0.76	0.77	0.60	1.05	1.24	0.85
Standard deviation	0.5	0.5	0.4	0.3	0.4	0.3	0.5	0.5	0.42
1993									
Jan	2.9	0.8	1.1	0.5	1.0	0.8	1.7	1.1	1.26
Feb	1.7	0.8	1.2	0.9	0.8	0.5	1.3	1.5	1.03
Mar	0.7	0.7	0.9	0.7	0.6	0.4	1.1	1.0	0.73
Apr	1.8	0.6	0.9	0.5	0.5	0.4	1.6	0.8	0.90
May	1.3	0.8	0.9	0.8	0.5	0.6	0.8	0.8	0.81
Jun	1.0	0.9	0.9	0.8	0.4	0.8	1.2	0.8	0.86
Jul	1.0	0.6	0.5	0.5	0.3	0.5	0.7	0.5	0.59
Aug	0.6	1.8	1.4	1.1	1.1	1.8	2.7	2.8	1.50
Sep	1.2	1.1	0.6	0.9	0.6	1.0	1.1	ND	0.93
Oct	0.6	1.8	1.4	1.1	1.1	1.8	2.7	2.8	1.50
Nov	1.3	1.3	1.4	1.1	0.7	1.0	1.5	ND	1.19
Dec	1.7	1.3	1.6	ND	0.9	1.0	2.0	2.9	1.42
Annual Average	1.32	1.04	1.07	0.81	0.71	0.88	1.53	1.50	1.05
Standard deviation	0.7	0.4	0.3	0.2	0.3	0.5	0.7	1.0	0.44

that the difference is due simply to the inherent variability of the measurements and it is highly likely that one of the underlying factors controlling dust deposition in the monitoring network has changed between these two years.

A third test was done in which deposition data in 1989, a year of low dust fallout, before Camberwell had begun, has been tested against data from 1993, when (as noted above) Camberwell handled approximately 14 Mbcm of coal and waste. These two means (on a paired test basis) were significantly different at the 31.4 per cent level. In conventional statistical analysis terms this would not be considered significantly different because there is a 31.4 per cent chance that the differences could have occurred due to the normal variability indicated in the samples.

In summary it can be stated that:

- that 1993 dust fallout levels, which include dust contributions from the operating mine are not significantly different from the dust levels measured in the least dusty of the pre-mining years

- that differences in dust deposition in 1987, a dusty pre-mining year, are significantly different from deposition levels in 1989 another pre-mining year, but with low dust fallout.

The conclusion to be drawn from the two points above is that dust in the area is more influenced by factors not-related to mining at Camberwell than by operations at Camberwell.

This is a surprising result and it is useful to explore why this might be the case. The first and obvious factor to examine is the location of dust gauges with respect to the mining activity. Mining, overburden dumps and potential dusty areas, are shown in Figure B-1, which also shows the locations of the dust gauges. Wind roses are shown in Figures 4 to 6 of the main text. Table B-2 shows the predicted increase in annual dust deposition at each gauge in the monitoring network for Year 5 (as taken from Figure 7.4.5 of the EIS) and the annual dust deposition data measured in 1993. It should be remembered that 1993 is actually Year 3 of the mine plan.

At first sight the data in Table B-2 would appear to indicate that the model is grossly over-predicting dust deposition levels. However, a careful analysis of the data indicates that, although the model may be conservative, the degree of overprediction is minor. The following analyses the data and develops the arguments to support this conclusion.

Comparing the wind roses for 1993 (Figure 6) and the locations of the mining area and waste dump areas relative to the dust gauges it can be seen that Gauges D2 and D3 would not expect to receive much dust from mining in its current configuration because winds only rarely blow from the mining dust sources to these monitors. Further gauges D4, D5 and D6 are at least 3 km from the open cut and waste dump areas and consequently, even if the wind were to blow in these directions, fallout levels would be expected to be low. Thus only gauges D1 and D7 would be expected to receive significant dust from mining at Camberwell at this stage in the development of the mine.

Table B-2	PREDICTED YEAR 5 DUST DEPOSITION AND MEASURED CURRENT (YEAR 3) DEPOSITION - g/m^2/month		
Gauge	Predicted increase in dust deposition - Year 5	Measured total deposition - 1993 (Year 3)	Predicted increase in deposition for 1993 (Year 3) using revised emission factors
1	3.8	1.4	0.3
2	0.0	0.9	0.1
3	2.2	0.9	1.0
4	0.8	0.7	0.06
5	0.9	0.6	0.3
6	0.4	0.8	< 0.3
7	4.0	1.4	0.4
8	0.0	1.2	<0.05

Deposition data from gauges D1 and D7 is shown in Figure B-3 plotted on a month-by-month basis since monitoring began in January 1987 for D1 and July 1990 for D7. The deposition rates recorded by Gauge D1 show an interesting sharp decrease in dust deposition in early 1989 and deposition rates remained low until mid-1990, when they increased from low values of less than 1.0 g/m^2/month to higher and more variable values, generally above 1.0 g/m^2/month, but reaching as high as 2.9 g/m^2/month. However, interestingly mining at Camberwell did not commence until April 1991, approximately eleven months later. The data suggest that site has been affected by dust from an operation that ceased sometime between November 1987 and February 1989. The exact date cannot be specified because it occurred during a period when the monitoring program was not operating. The mean dust deposition levels between February 1989 and March 1990 and May 1990 to the present at Gauge D1 were 0.56 g/m^2/month and 1.48 g/m^2/month. Thus the gauge D1 has experienced an increase in dust deposition of 0.92 g/m^2/month in this period.

A possible source of this dust is the quarry located approximately 600 m to the SE of D1. The disturbed area of the quarry is approximately 28 ha and the equipment used on site includes a D4 Dozer, 966 (3 m^3) Loader, Komatsu 200 Excavator. The quarry generates a maximum of approximately 20 road truck movements per week. Unfortunately the detailed history of dust generating activities in the area around D1 is not sufficiently well known to enable a reliable explanation of the variation in dust fallout levels in D1 to be developed.

Deposition levels for Gauge D7 are also plotted on Figure B-3. This gauge is approximately 1.1 km west of the middle of the North Pit. Monitoring at this site did not commence until August 1990, before mining, but after the period when Gauge D1 had shown its 0.9 g/m^2/month increase. Monthly dust deposition rates at this site are generally correlated with the deposition values at Gauge D1, although the correlation is by no means perfect. Any degree of correlation in the deposition levels at the two gauges suggests either a common source of dust or a response to general changes in dustiness in the area presumably related to rainfall and associated changes in vegetative cover.

The average value of deposition recorded at D7 since its installation to the present is 1.24 g/m^2/month. If the background level at this site was the same as that at D1 then the increase has been 0.7 g/m^2/month.

Considering all the data from Gauges D1 and D7 it would appear that dust deposition levels in the area have increased by between 0.7 and 0.9 g/m^2/month since May 1990. The timing of the increase makes it difficult to attribute all of the increase as being due to mining at Camberwell, unless there was significant activity prior to the main mining operation in April 1991.

It is now interesting to compare currently measured dust deposition levels with those predicted in the Camberwell EIS. Unfortunately the earliest year for which predictions are available is Year 5. Currently the mine is in Year 3 and measured deposition levels would not be expected to match predicted levels at this time. Waste handling volumes have now reached the maximum levels planned in the Camberwell EIS and so the dust deposition should be trending in the direction of the predicted values if the predictions are accurate. However, by Year 5 the mine will be only 350 m from Gauge D1. It is presently 600 m away. If this distance is taken into account then extrapolating from the EIS's Year 5 prediction, Year 3 should produce an increase of approximately 1.0 g/m^2/month compared with the 3.8 g/m^2/month that is predicted when the mine is 350 m away in Year 5. The best estimate that is available for the current increase in dust deposition is 0.9 g/m^2/month (see **Figure B-2**).

Gauge D4 is presently 1.2 km west of the current disturbed mining area. Since there is no pre-mining dust fallout data it is not possible to estimate the increase in dust fallout that has occurred as a result of mining. In the EIS the Year 5 predicted annual increase was approximately 6 g/m^2/month, but again there is a steep gradient in deposition rate with distance from the mine. The predicted annual deposition rate increase falls from a value of 10 g/m^2/month to 1 g/m^2/month in a distance of only 600 m. If the mine is progressing to the west at the rate of 250 m over the next two years (Year 3 to Year 5) the predicted increase for Year 3, interpolated from the Year 5 figure in the EIS) is approximately 1 g/m^2/month. However D7 recorded a total annual deposition rate of 1.53 g/m^2/month in 1993. This implies that the pre-mining annual background deposition level was 0.53 g/m^2/month. This would seem to be too low and it is possible that the model is over-predicting. A pre-mining background level of closer to 1 g/m^2/month would seem more reasonable. This would suggest that the model should predict an increase of approximately 0.5 g/m^2/month rather than 1 g/m^2/month. A possible reason for problem is that the mine plan has developed slightly differently from the way envisaged in the EIS particularly with respect to the haul roads, which are significantly further to the east than was assumed in the EIS (see **Figure 7.4.5** in the EIS).

This review of the model performance, based effectively on the results from only two gauges, suggests that the model has a slight tendency to over predict. A much more effective test of the model performance might be undertaken at the conclusion of Year 5 mining. On the basis of evidence available to data there is a case for attempting to revise downwards the predicted dust deposition levels.

To do this we have analysed the Camberwell mining operation for Year 3 and developed an emissions inventory for Year 3 assuming the same emission factors as were assumed in the EIS and making use of revised emission factors for transport and

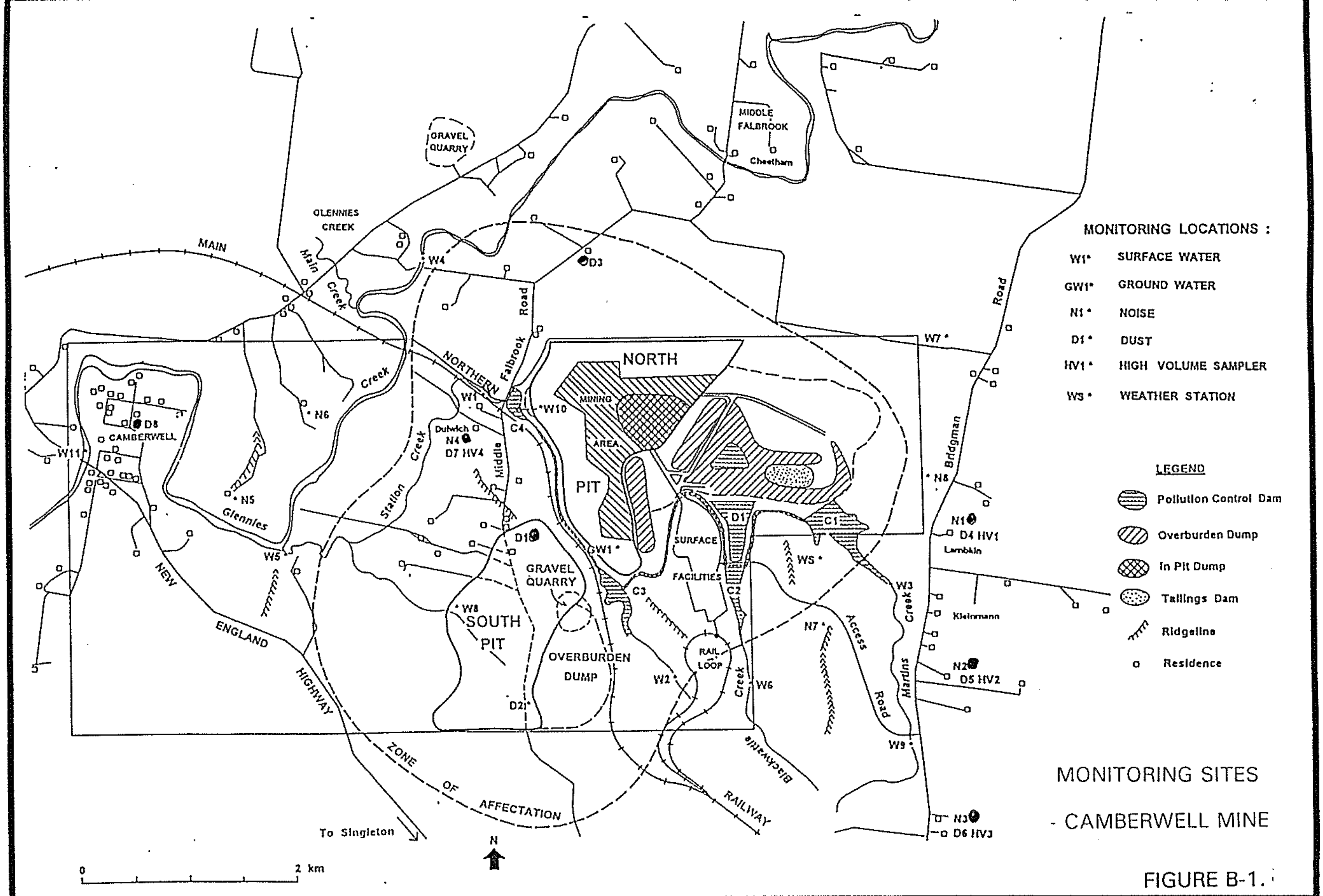
wind erosion dust. The emissions inventory is summarised in **Table B-3**, which also includes data for Year 5. (Note: a typographical error in the EIS listed dust emissions in for dumping of coal as 200.0 t/y when it should have read 20.0 t/y. This has been corrected in **Table B-3**).

A DUSTGLC model run have been undertaken using with the inventory with revised dust emissions factors for transport dust (from the EIS factor of 2 kg/VKT to 1 kg/VKT) and for wind erosion (from 0.4 kg/ha/h to 0.097 kg/ha/h, which is the US EPA factor for graded and seeded land). In addition, the model runs take account of the actual locations of the haul roads rather than those assumed in the EIS and the wind erosion dust has been assumed to be proportional to the cube of the wind speed, rather than the approach adopted in the EIS which assumed that wind erosion dust was emitted at the same rate under all wind speed categories.

TABLE B-3 ESTIMATED DUST EMISSIONS FOR CAMBERWELL (kg/y)

Activity	Year-V (EIS)	Year-III	Year-III (revised transport and wind erosion emission factors)
Hauling overburden	668.5	759.7	379.9
Loading overburden	626.8	651.2	651.2
Dumping overburden	300.8	312.6	312.6
Drilling	0.5	7.7	7.7
Blasting	33.7	7.6	7.6
Hauling coal	180.1	215.8	107.9
Loading coal	58.0	75.9	75.9
Dumping coal	20.0	26.2	26.2
Dozers on coal	312.1	284.2	284.2
Dozers on overburden	0.7	137.6	137.6
Scrapers on overburden	86.7	-	-
Graders	2.3	20.5	20.5
Stockpile wind erosion	63.1	63.1	63.1
Mine wind erosion	175.0	350.4	79.9
Waste dump wind erosion	87.6	350.4	79.9
Loading coal to stockpile	-	0.8	0.8
Dozer on stockpile	29.4	-	-
Loading trains		0.8	0.8
TOTAL	2,637.3	3,256.5	2,238.8

The results of the model run is shown in **Figure B-4** and the results are summarised in **Table B-2**. There remains a real difficulty of not knowing how much of the monitored dust is due to the mine and how much is due to other sources. This difficulty is unavoidable except in areas close to the mine and where dust deposition is dominated by dust from mining. At this stage of mining there are no gauges where this is the case. Nevertheless the revised emission factors appear to give better agreement between monitored and predicted dust deposition level. The revised emission factors have therefore been adopted for the Rix's Creek assessment.



MONITORING SITES

- CAMBERWELL MINE

FIGURE B-1.

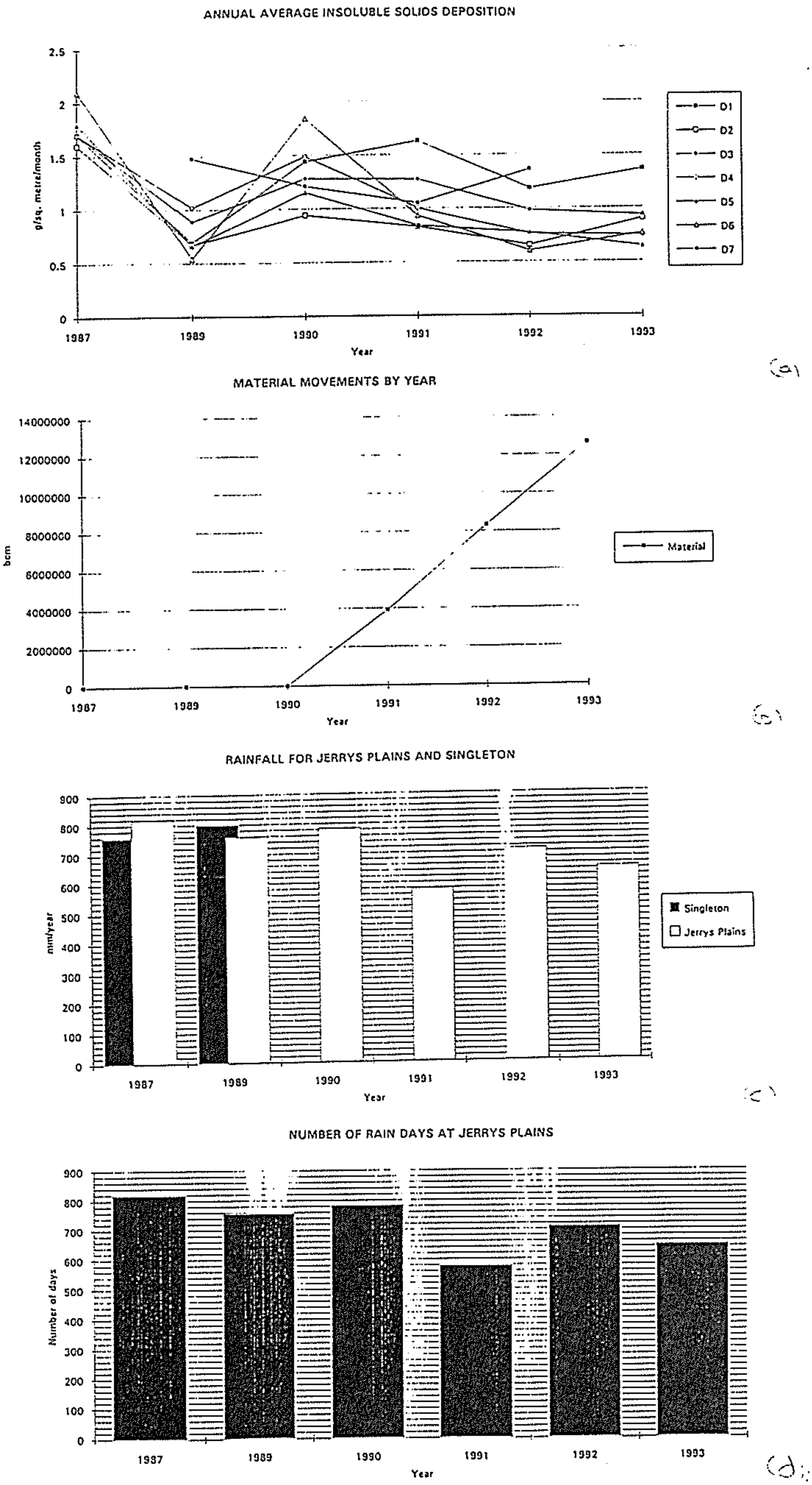

ANNUAL AVERAGE INSOLUBLE SOLIDS DEPOSITION
g/sq. metre/month
Year
D1
D2
D3
D4
D5
D6
D7
(a)
MATERIAL MOVEMENTS BY YEAR
bcm
Year
Material
(b)
RAINFALL FOR JERRYS PLAINS AND SINGLETON
mm/year
Year
Singleton
Jerrys Plains
(c)
NUMBER OF RAIN DAYS AT JERRYS PLAINS
Number of days
Year
(d)

FIGURE B-2.

INSOLUBLE SOLID DEPOSITION FOR D1 AND D7

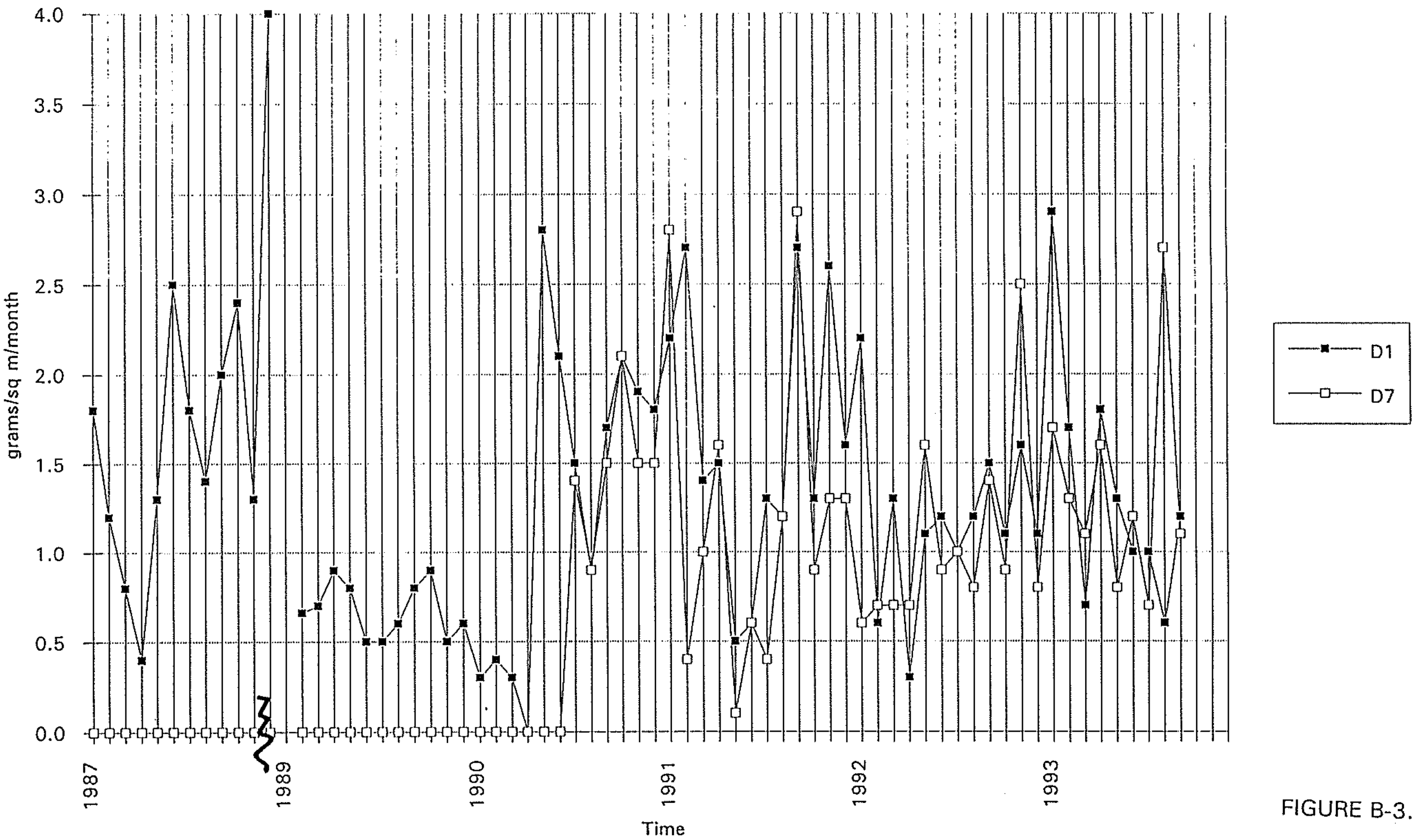


FIGURE B-3.

28/06/94

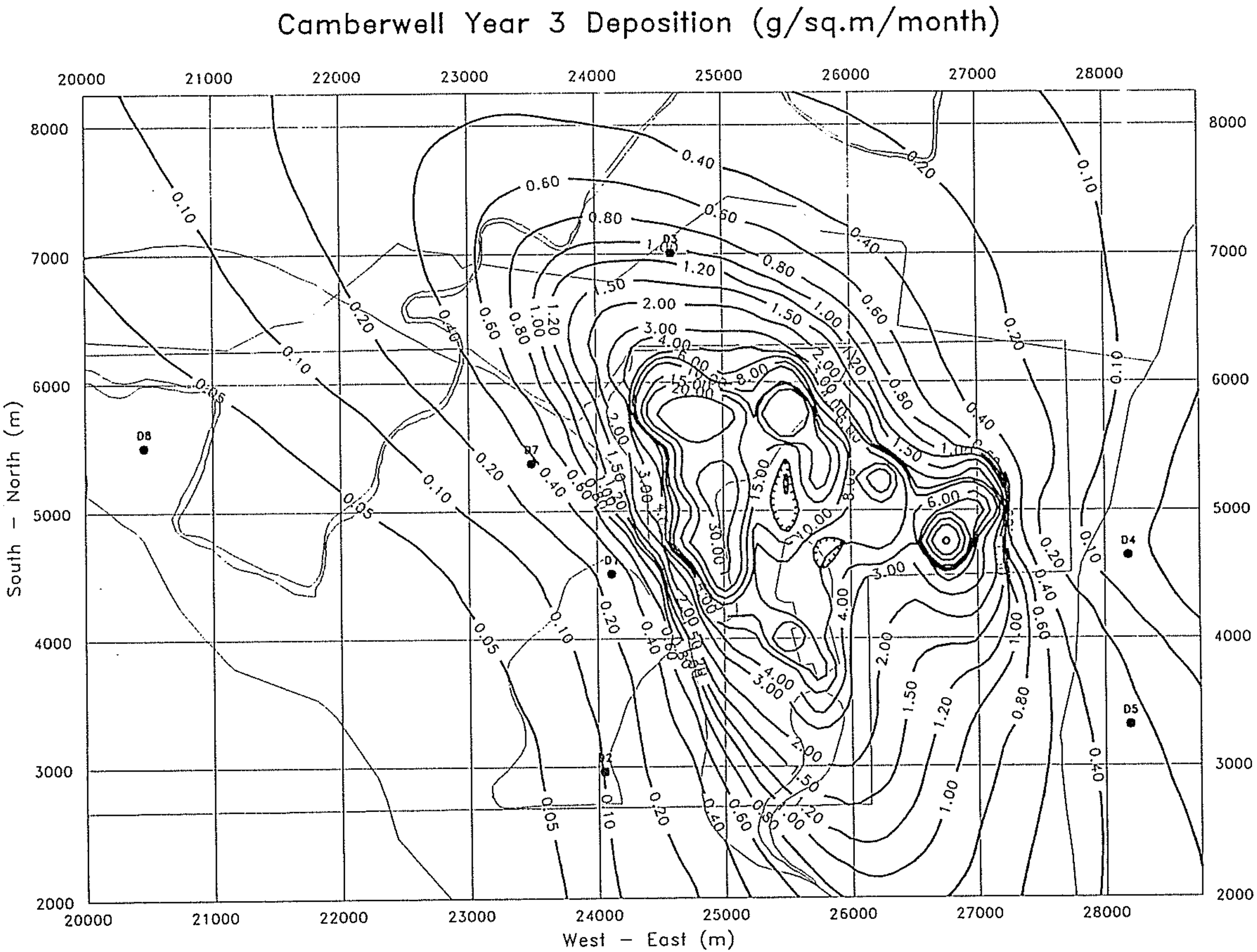

Camberwell Year 3 Deposition (g/sq.m/month)
West - East (m)
South - North (m)
D1
D2
D3
D4
D5
D7
D8

FIGURE B-4.

APPENDIX C
DUST EMISSION ESTIMATES

Rix's Creek Emission Estimates for Year-1

RIXS CREEK YEAR 1 (Dragline option)				RIXS CREEK YEAR 1 (Truck and shovel option)			
HAULING OVERBURDEN - N PIT		HAULING OVERBURDEN - SE PIT		HAULING OVERBURDEN - N PIT		HAULING OVERBURDEN - SE PIT	
- average distance (km)	2.400	- average distance (km)	2.400	- average distance (km)	2.400	- average distance (km)	2.400
- quantity of material bcm	5,033,600.000	- quantity of material bcm	4,902,900.000	- quantity of material bcm	4,433,600.000	- quantity of material bcm	4,302,900.000
- truck size (t)	120.000	- truck size (t)	120.000	- truck size (t)	120.000	- truck size (t)	120.000
- density (t/bcm)	2.400	- density (t/bcm)	2.400	- density (t/bcm)	2.400	- density (t/bcm)	2.400
- emission factor (kg/VKT)	1.000	- emission factor (kg/VKT)	1.000	- emission factor (kg/VKT)	1.000	- emission factor (kg/VKT)	1.000
Particle size distribution		Particle size distribution		Particle size distribution		Particle size distribution	
- FP	0.060	- FP	0.060	- FP	0.060	- FP	0.060
- IP	0.530	- IP	0.530	- IP	0.530	- IP	0.530
- CP	0.410	- CP	0.410	- CP	0.410	- CP	0.410
Total annual emission (kg/y)	241,612.800	Total annual emission (kg/y)	235,339.200	Total annual emission (kg/y)	212,812.800	Total annual emission (kg/y)	206,539.200
Total emission in g/s	7.661	Total emission in g/s	7.463	Total emission in g/s	6.748	Total emission in g/s	6.549
Number of points	10.000	Number of points	8.000	Number of points	10.000	Number of points	8.000
- FP emission/point (g/s)	0.046	- FP emission/point (g/s)	0.056	- FP emission/point (g/s)	0.040	- FP emission/point (g/s)	0.049
- IP emission/point (g/s)	0.406	- IP emission/point (g/s)	0.494	- IP emission/point (g/s)	0.358	- IP emission/point (g/s)	0.434
- CP emission/point (g/s)	0.314	- CP emission/point (g/s)	0.382	- CP emission/point (g/s)	0.277	- CP emission/point (g/s)	0.336
LOADING OVERBURDEN - N PIT		LOADING OVERBURDEN - SE PIT		LOADING OVERBURDEN - N PIT		LOADING OVERBURDEN - SE PIT	
- quantity of material bcm	5,033,600.000	- quantity of material bcm	4,902,900.000	- quantity of material bcm	4,433,600.000	- quantity of material bcm	4,302,900.000
- density (t/bcm)	2.400	- density (t/bcm)	2.400	- density (t/bcm)	2.400	- density (t/bcm)	2.400
- emission factor (kg/t)	0.025	- emission factor (kg/t)	0.025	- emission factor (kg/t)	0.025	- emission factor (kg/t)	0.025
Particle size distribution		Particle size distribution		Particle size distribution		Particle size distribution	
- FP	0.040	- FP	0.040	- FP	0.040	- FP	0.040
- IP	0.440	- IP	0.440	- IP	0.440	- IP	0.440
- CP	0.530	- CP	0.530	- CP	0.530	- CP	0.530
Total annual emission (kg/y)	302,016.000	Total annual emission (kg/y)	294,174.000	Total annual emission (kg/y)	266,016.000	Total annual emission (kg/y)	258,174.000
Total emission in g/s	9.577	Total emission in g/s	9.328	Total emission in g/s	8.435	Total emission in g/s	8.187
Number of points	3.000	Number of points	2.000	Number of points	3.000	Number of points	2.000
- FP emission/point (g/s)	0.128	- FP emission/point (g/s)	0.187	- FP emission/point (g/s)	0.112	- FP emission/point (g/s)	0.164
- IP emission/point (g/s)	1.405	- IP emission/point (g/s)	2.052	- IP emission/point (g/s)	1.237	- IP emission/point (g/s)	1.801
- CP emission/point (g/s)	1.692	- CP emission/point (g/s)	2.472	- CP emission/point (g/s)	1.490	- CP emission/point (g/s)	2.169
DUMPING OVERBURDEN - N PIT EMPLACEMENT		DUMPING OVERBURDEN - SE PIT EMPLACEMENT		DUMPING OVERBURDEN - N PIT EMPLACEMENT		DUMPING OVERBURDEN - SE PIT EMPLACEMENT	
- quantity of material bcm	5,033,600.000	- quantity of material bcm	4,902,900.000	- quantity of material bcm	4,433,600.000	- quantity of material bcm	4,302,900.000
- density (t/bcm)	2.400	- density (t/bcm)	2.400	- density (t/bcm)	2.400	- density (t/bcm)	2.400
- emission factor (kg/t)	0.012	- emission factor (kg/t)	0.012	- emission factor (kg/t)	0.012	- emission factor (kg/t)	0.012
Particle size distribution		Particle size distribution		Particle size distribution		Particle size distribution	
- FP	0.040	- FP	0.040	- FP	0.040	- FP	0.040
- IP	0.440	- IP	0.440	- IP	0.440	- IP	0.440
- CP	0.530	- CP	0.530	- CP	0.530	- CP	0.530
Total annual emission (kg/y)	144,967.680	Total annual emission (kg/y)	141,203.520	Total annual emission (kg/y)	127,687.680	Total annual emission (kg/y)	123,923.520
Total emission in g/s	4.597	Total emission in g/s	4.478	Total emission in g/s	4.049	Total emission in g/s	3.930
Number of points	9.000	Number of points	6.000	Number of points	9.000	Number of points	6.000
- FP emission/point (g/s)	0.020	- FP emission/point (g/s)	0.030	- FP emission/point (g/s)	0.018	- FP emission/point (g/s)	0.026
- IP emission/point (g/s)	0.225	- IP emission/point (g/s)	0.328	- IP emission/point (g/s)	0.198	- IP emission/point (g/s)	0.288
- CP emission/point (g/s)	0.271	- CP emission/point (g/s)	0.396	- CP emission/point (g/s)	0.238	- CP emission/point (g/s)	0.347
DRILLING N PIT		DRILLING SE PIT		DRILLING N PIT		DRILLING SE PIT	
Volume of material (bcm)	6,783,600.000	Volume of material (bcm)	6,652,900.000	Volume of material (bcm)	6,783,600.000	Volume of material (bcm)	6,652,900.000
fraction of material (0 to 1)	0.500	fraction of material (0 to 1)	0.500	fraction of material (0 to 1)	0.500	fraction of material (0 to 1)	0.500
hole spacing (m)	7.500	hole spacing (m)	7.500	hole spacing (m)	7.500	hole spacing (m)	7.500
bench depth	15.000	bench depth	15.000	bench depth	15.000	bench depth	15.000
emission factor (kg/hole)	0.600	emission factor (kg/hole)	0.600	emission factor (kg/hole)	0.600	emission factor (kg/hole)	0.600
Particle size distribution		Particle size distribution		Particle size distribution		Particle size distribution	
- FP	0.050	- FP	0.050	- FP	0.050	- FP	0.050
- IP	0.390	- IP	0.390	- IP	0.390	- IP	0.390
- CP	0.560	- CP	0.560	- CP	0.560	- CP	0.560
Total annual emission (kg/y)	2,411.947	Total annual emission (kg/y)	2,365.476	Total annual emission (kg/y)	2,411.947	Total annual emission (kg/y)	2,365.476
Total emission in g/s	0.076	Total emission in g/s	0.075	Total emission in g/s	0.076	Total emission in g/s	0.075
Number of points	3.000	Number of points	2.000	Number of points	3.000	Number of points	2.000
- FP emission/point (g/s)	0.010	- FP emission/point (g/s)	0.015	- FP emission/point (g/s)	0.010	- FP emission/point (g/s)	0.015
- IP emission/point (g/s)	0.014	- IP emission/point (g/s)	0.021	- IP emission/point (g/s)	0.014	- IP emission/point (g/s)	0.021
- CP emission/point (g/s)	0.014	- CP emission/point (g/s)	0.021	- CP emission/point (g/s)	0.014	- CP emission/point (g/s)	0.021
BLASTING - N PIT		BLASTING - SE PIT		BLASTING - N PIT		BLASTING - SE PIT	
Volume of material (bcm)	6,783,600.000	Volume of material (bcm)	6,652,900.000	Volume of material (bcm)	6,783,600.000	Volume of material (bcm)	6,652,900.000
fraction of material (0 to 1)	0.500	fraction of material (0 to 1)	0.500	fraction of material (0 to 1)	0.500	fraction of material (0 to 1)	0.500
moisture content (%)	7.200	moisture content (%)	7.200	moisture content (%)	7.200	moisture content (%)	7.200
bench depth (m)	15.000	bench depth (m)	15.000	bench depth (m)	15.000	bench depth (m)	15.000
number of blast/year	104.000	number of blast/year	104.000	number of blast/year	104.000	number of blast/year	104.000
emission factor (kg/blast)	28.874	emission factor (kg/blast)	28.428	emission factor (kg/blast)	28.874	emission factor (kg/blast)	28.428
Particle size distribution		Particle size distribution		Particle size distribution		Particle size distribution	
- FP	0.050	- FP	0.050	- FP	0.050	- FP	0.050
- IP	0.390	- IP	0.390	- IP	0.390	- IP	0.390
- CP	0.560	- CP	0.560	- CP	0.560	- CP	0.560
Total annual emission (kg/y)	3,002.896	Total annual emission (kg/y)	2,956.520	Total annual emission (kg/y)	3,002.896	Total annual emission (kg/y)	2,956.520
Total emission in g/s	0.095	Total emission in g/s	0.094	Total emission in g/s	0.095	Total emission in g/s	0.094
Number of points	3.000	Number of points	2.000	Number of points	3.000	Number of points	2.000
- FP emission/point (g/s)	0.012	- FP emission/point (g/s)	0.018	- FP emission/point (g/s)	0.012	- FP emission/point (g/s)	0.018
- IP emission/point (g/s)	0.018	- IP emission/point (g/s)	0.026	- IP emission/point (g/s)	0.018	- IP emission/point (g/s)	0.026
- CP emission/point (g/s)	0.018	- CP emission/point (g/s)	0.026	- CP emission/point (g/s)	0.018	- CP emission/point (g/s)	0.026
HAULING COAL - N PIT		HAULING COAL - SE PIT		HAULING COAL - N PIT		HAULING COAL - SE PIT	
- average distance (km)	4.000	- average distance (km)	8.000	- average distance (km)	4.000	- average distance (km)	8.000
- quantity of material (t)	968,800.000	- quantity of material (t)	1,185,900.000	- quantity of material (t)	968,800.000	- quantity of material (t)	1,185,900.000
- truck size (t)	85.000	- truck size (t)	85.000	- truck size (t)	85.000	- truck size (t)	85.000
- density (t/bcm)	1.500	- density (t/bcm)	1.500	- density (t/bcm)	1.500	- density (t/bcm)	1.500
- emission factor (kg/VKT)	1.000	- emission factor (kg/VKT)	1.000	- emission factor (kg/VKT)	1.000	- emission factor (kg/VKT)	1.000
Particle size distribution		Particle size distribution		Particle size distribution		Particle size distribution	
- FP	0.060	- FP	0.060	- FP	0.060	- FP	0.060
- IP	0.530	- IP	0.530	- IP	0.530	- IP	0.530
- CP	0.410	- CP	0.410	- CP	0.410	- CP	0.410
Total annual emission (kg/y)	45,590.588	Total annual emission (kg/y)	111,614.118	Total annual emission (kg/y)	45,590.588	Total annual emission (kg/y)	111,614.118
Total emission in g/s	1.446	Total emission in g/s	3.539	Total emission in g/s	1.446	Total emission in g/s	3.539
Number of points	9.000	Number of points	14.000	Number of points	9.000	Number of points	14.000
- FP emission/point (g/s)	0.010	- FP emission/point (g/s)	0.015	- FP emission/point (g/s)	0.010	- FP emission/point (g/s)	0.015
- IP emission/point (g/s)	0.085	- IP emission/point (g/s)	0.134	- IP emission/point (g/s)	0.085	- IP emission/point (g/s)	0.134
- CP emission/point (g/s)	0.066	- CP emission/point (g/s)	0.104	- CP emission/point (g/s)	0.066	- CP emission/point (g/s)	0.104
LOADING COAL - N PIT		LOADING COAL - SE PIT		LOADING COAL - N PIT		LOADING COAL - SE PIT	
- quantity of material (t)	968,800.000	- quantity of material (t)	1,185,900.000	- quantity of material (t)	968,800.000	- quantity of material (t)	1,185,900.000
- density (t/bcm)	1.500	- density (t/bcm)	1.500	- density (t/bcm)	1.500	- density (t/bcm)	1.500
- emission factor (kg/t)	0.029	- emission factor (kg/t)	0.029	- emission factor (kg/t)	0.029	- emission factor (kg/t)	0.029
Particle size distribution		Particle size distribution		Particle size distribution		Particle size distribution	
- FP	0.040	- FP	0.040	- FP	0.040	- FP	0.040
- IP	0.440	- IP	0.440	- IP	0.440	- IP	0.440
- CP	0.530	- CP	0.530	- CP	0.530	- CP	0.530
Total annual emission (kg/y)	28,095.200	Total annual emission (kg/y)	34,391.100	Total annual emission (kg/y)	28,095.200	Total annual emission (kg/y)	34,391.100
Total emission in g/s	0.891	Total emission in g/s	1.091	Total emission in g/s	0.891	Total emission in g/s	1.091
Number of points	3.000	Number of points	2.000	Number of points	3.000	Number of points	2.000
- FP emission/point (g/s)	0.012	- FP emission/point (g/s)	0.022	- FP emission/point (g/s)	0.012	- FP emission/point (g/s)	0.022
- IP emission/point (g/s)	0.131	- IP emission/point (g/s)	0.240	- IP emission/point (g/s)	0.131	- IP emission/point (g/s)	0.240
- CP emission/point (g/s)	0.157	- CP emission/point (g/s)	0.289	- CP emission/point (g/s)	0.157	- CP emission/point (g/s)	0.289
DUMPING COAL - N + SE PITS				DUMPING COAL - N + SE PITS			
- quantity of material (t)	2,154,700.000			- quantity of material (t)	2,154,700.000		
- emission factor (kg/t)	0.010			- emission factor (kg/t)	0.010		
Particle sizes				Particle sizes			
- FP	0.040			- FP	0.040		
- IP	0.440			- IP	0.440		

- CP	0.530			- CP	0.530		
Total annual emission (kg/y)	21,547.000			Total annual emission (kg/y)	21,547.000		
Total emission in g/s	0.683			Total emission in g/s	0.683		
Number of points	1.000			Number of points	1.000		
- FP emission/point (g/s)	0.027			- FP emission/point (g/s)	0.027		
- IP emission/point (g/s)	0.301			- IP emission/point (g/s)	0.301		
- CP emission/point (g/s)	0.362			- CP emission/point (g/s)	0.362		
DOZER ON COAL - N PIT		DOZER ON COAL - SE PIT		DOZER ON COAL - N PIT		DOZER ON COAL - SE PIT	
- silt content (%)	8.000	- silt content (%)	8.000	- silt content (%)	8.000	- silt content (%)	8.000
- moisture content (%)	6.000	- moisture content (%)	6.000	- moisture content (%)	6.000	- moisture content (%)	6.000
- hours	1,728.000	- hours	1,728.000	- hours	1,728.000	- hours	1,728.000
Particle sizes		Particle sizes		Particle sizes		Particle sizes	
- FP	0.030	- FP	0.030	- FP	0.030	- FP	0.030
- IP	0.490	- IP	0.490	- IP	0.490	- IP	0.490
-CP	0.480	-CP	0.480	-CP	0.480	-CP	0.480
Emission factor (kg/h)	42.030	Emission factor (kg/h)	42.030	Emission factor (kg/h)	42.030	Emission factor (kg/h)	42.030
Total annual emission (kg/y)	72,628.169	Total annual emission (kg/y)	72,628.169	Total annual emission (kg/y)	72,628.169	Total annual emission (kg/y)	72,628.169
Total emission in g/s	2.303	Total emission in g/s	2.303	Total emission in g/s	2.303	Total emission in g/s	2.303
Number of points	3.000	Number of points	2.000	Number of points	3.000	Number of points	2.000
- FP emission/point (g/s)	0.023	- FP emission/point (g/s)	0.035	- FP emission/point (g/s)	0.023	- FP emission/point (g/s)	0.035
- IP emission/point (g/s)	0.376	- IP emission/point (g/s)	0.564	- IP emission/point (g/s)	0.376	- IP emission/point (g/s)	0.564
- CP emission/point (g/s)	0.368	- CP emission/point (g/s)	0.553	- CP emission/point (g/s)	0.368	- CP emission/point (g/s)	0.553
DOZER ON OVERBURDEN - N PIT		DOZER ON OVERBURDEN - SE PIT		DOZER ON OVERBURDEN - N PIT		DOZER ON OVERBURDEN - SE PIT	
- silt content (%)	10.000	- silt content (%)	10.000	- silt content (%)	10.000	- silt content (%)	10.000
- moisture content (%)	5.000	- moisture content (%)	5.000	- moisture content (%)	5.000	- moisture content (%)	5.000
- hours	10,512.000	- hours	10,512.000	- hours	10,512.000	- hours	10,512.000
Particle sizes		Particle sizes		Particle sizes		Particle sizes	
- FP	0.200	- FP	0.200	- FP	0.200	- FP	0.200
- IP	0.540	- IP	0.540	- IP	0.540	- IP	0.540
-CP	0.260	-CP	0.260	-CP	0.260	-CP	0.260
Emission factor (kg/h)	5.085	Emission factor (kg/h)	5.085	Emission factor (kg/h)	5.085	Emission factor (kg/h)	5.085
Total annual emission (kg/y)	53,456.152	Total annual emission (kg/y)	53,456.152	Total annual emission (kg/y)	53,456.152	Total annual emission (kg/y)	53,456.152
Total emission in g/s	1.695	Total emission in g/s	1.695	Total emission in g/s	1.695	Total emission in g/s	1.695
Number of points	5.000	Number of points	5.000	Number of points	5.000	Number of points	5.000
- FP emission/point (g/s)	0.068	- FP emission/point (g/s)	0.068	- FP emission/point (g/s)	0.068	- FP emission/point (g/s)	0.068
- IP emission/point (g/s)	0.183	- IP emission/point (g/s)	0.183	- IP emission/point (g/s)	0.183	- IP emission/point (g/s)	0.183
- CP emission/point (g/s)	0.088	- CP emission/point (g/s)	0.088	- CP emission/point (g/s)	0.088	- CP emission/point (g/s)	0.088
SCRAPER ON OVERBURDEN - N PIT		SCRAPER ON OVERBURDEN - SE PIT		SCRAPER ON OVERBURDEN - N PIT		SCRAPER ON OVERBURDEN - SE PIT	
- silt content (%)	10.000	- silt content (%)	10.000	- silt content (%)	10.000	- silt content (%)	10.000
- moisture content (%)	5.000	- moisture content (%)	5.000	- moisture content (%)	5.000	- moisture content (%)	5.000
- weight (t)	48.000	- weight (t)	48.000	- weight (t)	48.000	- weight (t)	48.000
- hours	10,512.000	- hours	10,512.000	- hours	10,512.000	- hours	10,512.000
Particle sizes		Particle sizes		Particle sizes		Particle sizes	
- FP	0.200	- FP	0.200	- FP	0.200	- FP	0.200
- IP	0.540	- IP	0.540	- IP	0.540	- IP	0.540
-CP	0.260	-CP	0.260	-CP	0.260	-CP	0.260
Emission factor (kg/h)	2.076	Emission factor (kg/h)	2.076	Emission factor (kg/h)	2.076	Emission factor (kg/h)	2.076
Total annual emission (kg/y)	21,824.060	Total annual emission (kg/y)	21,824.060	Total annual emission (kg/y)	21,824.060	Total annual emission (kg/y)	21,824.060
Total emission in g/s	0.692	Total emission in g/s	0.692	Total emission in g/s	0.692	Total emission in g/s	0.692
Number of points	5.000	Number of points	5.000	Number of points	5.000	Number of points	5.000
- FP emission/point (g/s)	0.028	- FP emission/point (g/s)	0.028	- FP emission/point (g/s)	0.028	- FP emission/point (g/s)	0.028
- IP emission/point (g/s)	0.075	- IP emission/point (g/s)	0.075	- IP emission/point (g/s)	0.075	- IP emission/point (g/s)	0.075
- CP emission/point (g/s)	0.036	- CP emission/point (g/s)	0.036	- CP emission/point (g/s)	0.036	- CP emission/point (g/s)	0.036
GRADERS				GRADERS			
- speed (km/h)	8.000			- speed (km/h)	8.000		
- hours	400.000			- hours	400.000		
Particle sizes				Particle sizes			
- FP	0.060			- FP	0.060		
- IP	0.480			- IP	0.480		
- CP	0.460			- CP	0.460		
Emission factor (kg/VKT)	0.615			Emission factor (kg/VKT)	0.615		
Total annual emission (kg/y)	1,969.490			Total annual emission (kg/y)	1,969.490		
Number of points	28.000			Number of points	28.000		
- FP emission/point (g/s)	0.000			- FP emission/point (g/s)	0.000		
- IP emission/point (g/s)	0.001			- IP emission/point (g/s)	0.001		
- CP emission/point (g/s)	0.001			- CP emission/point (g/s)	0.001		
STOCKPILE WIND EROSION				STOCKPILE WIND EROSION			
wind speed (m/s)	3.070			wind speed (m/s)	3.070		
area (ha)	18.000			area (ha)	18.000		
Particle sizes				Particle sizes			
- FP	0.000			- FP	0.000		
- IP	0.670			- IP	0.670		
- CP	0.330			- CP	0.330		
Emission factor (kg/ha.h)	0.400			Emission factor (kg/ha.h)	0.400		
Total annual emission (kg/y)	63,072.000			Total annual emission (kg/y)	63,072.000		
Number of points	3.000			Number of points	3.000		
- FP emission/point (g/s)	0.000			- FP emission/point (g/s)	0.000		
- IP emission/point (g/s)	0.447			- IP emission/point (g/s)	0.447		
- CP emission/point (g/s)	0.220			- CP emission/point (g/s)	0.220		
MINE WIND EROSION - N PIT		MINE WIND EROSION - SE PIT		MINE WIND EROSION - N PIT		MINE WIND EROSION - SE PIT	
wind speed (m/s)	3.070	wind speed (m/s)	3.070	wind speed (m/s)	3.070	wind speed (m/s)	3.070
percent of time u>5.4 m/s	11.100	percent of time u>5.4 m/s	11.100	percent of time u>5.4 m/s	11.100	percent of time u>5.4 m/s	11.100
number of rain days	114.000	number of rain days	114.000	number of rain days	114.000	number of rain days	114.000
area (ha)	50.000	area (ha)	50.000	area (ha)	50.000	area (ha)	50.000
Particle sizes		Particle sizes		Particle sizes		Particle sizes	
- FP	0.000	- FP	0.000	- FP	0.000	- FP	0.000
- IP	0.670	- IP	0.670	- IP	0.670	- IP	0.670
- CP	0.330	- CP	0.330	- CP	0.330	- CP	0.330
Emission factor (kg/ha.h)	0.097	Emission factor (kg/ha.h)	0.097	Emission factor (kg/ha.h)	0.097	Emission factor (kg/ha.h)	0.097
Total annual emission (kg/y)	42,486.000	Total annual emission (kg/y)	42,486.000	Total annual emission (kg/y)	42,486.000	Total annual emission (kg/y)	42,486.000
Number of points	3.000	Number of points	2.000	Number of points	3.000	Number of points	2.000
- FP emission/point (g/s)	0.000	- FP emission/point (g/s)	0.000	- FP emission/point (g/s)	0.000	- FP emission/point (g/s)	0.000
- IP emission/point (g/s)	0.301	- IP emission/point (g/s)	0.451	- IP emission/point (g/s)	0.301	- IP emission/point (g/s)	0.451
- CP emission/point (g/s)	0.148	- CP emission/point (g/s)	0.222	- CP emission/point (g/s)	0.148	- CP emission/point (g/s)	0.222
WASTE DUMP WIND EROSION - N PIT		WASTE DUMP WIND EROSION - SE PIT		WASTE DUMP WIND EROSION - N PIT		WASTE DUMP WIND EROSION - SE PIT	
wind speed (m/s)	3.070	wind speed (m/s)	3.070	wind speed (m/s)	3.070	wind speed (m/s)	3.070
area (ha)	60.000	area (ha)	60.000	area (ha)	60.000	area (ha)	60.000
Particle sizes		Particle sizes		Particle sizes		Particle sizes	
- FP	0.000	- FP	0.000	- FP	0.000	- FP	0.000
- IP	0.670	- IP	0.670	- IP	0.670	- IP	0.670
- CP	0.330	- CP	0.330	- CP	0.330	- CP	0.330
Emission factor (kg/ha.h)	0.097	Emission factor (kg/ha.h)	0.097	Emission factor (kg/ha.h)	0.097	Emission factor (kg/ha.h)	0.097
Total annual emission (kg/y)	50,983.200	Total annual emission (kg/y)	50,983.200	Total annual emission (kg/y)	50,983.200	Total annual emission (kg/y)	50,983.200
Number of points	3.000	Number of points	2.000	Number of points	3.000	Number of points	2.000
- FP emission/point (g/s)	0.000	- FP emission/point (g/s)	0.000	- FP emission/point (g/s)	0.000	- FP emission/point (g/s)	0.000
- IP emission/point (g/s)	0.361	- IP emission/point (g/s)	0.542	- IP emission/point (g/s)	0.361	- IP emission/point (g/s)	0.542
- CP emission/point (g/s)	0.178	- CP emission/point (g/s)	0.267	- CP emission/point (g/s)	0.178	- CP emission/point (g/s)	0.267
TRAIN LOADOUT				TRAIN LOADOUT			
wind speed (m/s)	3.07			wind speed (m/s)	3.07		
moisture (%)	5			moisture (%)	5		
k (US EPA p 11.2.3-3, 9/1988)	0.74			k (US EPA p 11.2.3-3, 9/1988)	0.74		
Emission factor (kg/t)	0.000506251			Emission factor (kg/t)	0.000506251		
tonnes of coal loaded	629700			tonnes of coal loaded	629700		

Annual emission (kg)	318.7864009		
Particle sizes			
- FP	0.05		
- IP	0.58		
- CP	0.37		
Number of points	1.000		
- FP emission/point (g/s)	0.001		
- IP emission/point (g/s)	0.006		
- CP emission/point (g/s)	0.004		
LOAD TO STOCKPILES			
wind speed (m/s)	3.07		
moisture (%)	5		
k (US EPA p 11.2.3-3, 9/1988)	0.74		
Emission factor (kg/t)	0.000506251		
tonnes of coal loaded	629700		
Annual emission (kg)	318.7864009		
Particle sizes			
- FP	0.05		
- IP	0.58		
- CP	0.37		
Number of points	1.000		
- FP emission/point (g/s)	0.001		
- IP emission/point (g/s)	0.006		
- CP emission/point (g/s)	0.004		
HAULING COAL - REJECTS TO N PIT			
- average distance (km)	4.000		
- quantity of material (t)	339,100,000		
- truck size (t)	85.000		
- density (t/bcm)	1.500		
- emission factor (kg/VKT)	1.000		
Particle size distribution			
- FP	0.060		
- IP	0.530		
- CP	0.410		
Total annual emission (kg/y)	15,957.647		
Total emission in g/s	0.506		
Number of points	9.000		
- FP emission/point (g/s)	0.003		
- IP emission/point (g/s)	0.030		
- CP emission/point (g/s)	0.023		
DRAGLINE HANDLING OF O/B - N PIT		DRAGLINE HANDLING OF O/B - SE PIT	
- quantity of prime (bcm)	1,750,000.000	- quantity of prime (bcm)	1,750,000.000
- per cent rehandle (bcm)	34.000	- per cent rehandle (bcm)	34.000
- drop height (m)	12.000	- drop height (m)	12.000
- moisture (%)	2.000	- moisture (%)	2.000
- swell factor	1.400	- swell factor	1.400
- Emission factor (kg/cu. m)	0.074	- Emission factor (kg/cu. m)	0.074
- Total annual emission (kg/y)	241,956.454	- Total annual emission (kg/y)	241,956.454
Particle size distribution		Particle size distribution	
- FP	0.070	- FP	0.070
- IP	0.500	- IP	0.500
- CP	0.430	- CP	0.430
Number of points	3.000	Number of points	2.000
- FP emission/point (g/s)	0.107	- FP emission/point (g/s)	0.107
- IP emission/point (g/s)	0.767	- IP emission/point (g/s)	0.767
- CP emission/point (g/s)	0.660	- CP emission/point (g/s)	0.660

Annual emission (kg)	318.7864009		
Particle sizes			
- FP	0.05		
- IP	0.58		
- CP	0.37		
Number of points	1.000		
- FP emission/point (g/s)	0.001		
- IP emission/point (g/s)	0.006		
- CP emission/point (g/s)	0.004		
LOAD TO STOCKPILES			
wind speed (m/s)	3.07		
moisture (%)	5		
k (US EPA p 11.2.3-3, 9/1988)	0.74		
Emission factor (kg/t)	0.000506251		
tonnes of coal loaded	629700		
Annual emission (kg)	318.7864009		
Particle sizes			
- FP	0.05		
- IP	0.58		
- CP	0.37		
Number of points	1.000		
- FP emission/point (g/s)	0.001		
- IP emission/point (g/s)	0.006		
- CP emission/point (g/s)	0.004		
HAULING COAL - REJECTS TO N PIT			
- average distance (km)	4.000		
- quantity of material (t)	339,100.000		
- truck size (t)	85.000		
- density (t/bcm)	1.500		
- emission factor (kg/VKT)	1.000		
Particle size distribution			
- FP	0.060		
- IP	0.530		
- CP	0.410		
Total annual emission (kg/y)	15,957.647		
Total emission in g/s	0.506		
Number of points	9.000		
- FP emission/point (g/s)	0.003		
- IP emission/point (g/s)	0.030		
- CP emission/point (g/s)	0.023		
DRAGLINE HANDLING OF O/B - N PIT		DRAGLINE HANDLING OF O/B - SE PIT	
- quantity of prime (bcm)	2,350,000.000	- quantity of prime (bcm)	2,350,000.000
- per cent rehandle (bcm)	55.000	- per cent rehandle (bcm)	55.000
- drop height (m)	12.000	- drop height (m)	12.000
- moisture (%)	2.000	- moisture (%)	2.000
- swell factor	1.400	- swell factor	1.400
- Emission factor (kg/cu. m)	0.074	- Emission factor (kg/cu. m)	0.074
- Total annual emission (kg/y)	375,832.146	- Total annual emission (kg/y)	375,832.146
Particle size distribution		Particle size distribution	
- FP	0.070	- FP	0.070
- IP	0.500	- IP	0.500
- CP	0.430	- CP	0.430
Number of points	3.000	Number of points	2.000
- FP emission/point (g/s)	0.167	- FP emission/point (g/s)	0.167
- IP emission/point (g/s)	1.192	- IP emission/point (g/s)	1.192
- CP emission/point (g/s)	1.025	- CP emission/point (g/s)	1.025

RIXS CREEK YEAR 8 - (Dragline option)				RIXS CREEK YEAR 8 - (Shovel option)			
HAULING OVERBURDEN - N PIT		HAULING OVERBURDEN - SW PIT		HAULING OVERBURDEN - N PIT		HAULING OVERBURDEN - SW PIT	
- average distance (km)	4.000	- average distance (km)	5.000	- average distance (km)	4.000	- average distance (km)	5.000
- quantity of material bcm	4,886,400.000	- quantity of material bcm	5,210,100.000	- quantity of material bcm	4,286,400.000	- quantity of material bcm	4,610,100.000
- truck size (t)	120.000	- truck size (t)	120.000	- truck size (t)	120.000	- truck size (t)	120.000
- density (t/bcm)	2.400	- density (t/bcm)	2.400	- density (t/bcm)	2.400	- density (t/bcm)	2.400
- emission factor (kg/VKT)	1.000	- emission factor (kg/VKT)	1.000	- emission factor (kg/VKT)	1.000	- emission factor (kg/VKT)	1.000
Particle size distribution		Particle size distribution		Particle size distribution		Particle size distribution	
- FP	0.060	- FP	0.060	- FP	0.060	- FP	0.060
- IP	0.530	- IP	0.530	- IP	0.530	- IP	0.530
- CP	0.410	- CP	0.410	- CP	0.410	- CP	0.410
Total annual emission (kg/y)	390,912.000	Total annual emission (kg/y)	521,010.000	Total annual emission (kg/y)	342,912.000	Total annual emission (kg/y)	461,010.000
Total emission in g/s	12.396	Total emission in g/s	16.521	Total emission in g/s	10.874	Total emission in g/s	14.619
Number of points	15.000	Number of points	15.000	Number of points	15.000	Number of points	15.000
- FP emission/point (g/s)	0.050	- FP emission/point (g/s)	0.066	- FP emission/point (g/s)	0.043	- FP emission/point (g/s)	0.058
- IP emission/point (g/s)	0.438	- IP emission/point (g/s)	0.584	- IP emission/point (g/s)	0.384	- IP emission/point (g/s)	0.517
- CP emission/point (g/s)	0.339	- CP emission/point (g/s)	0.452	- CP emission/point (g/s)	0.297	- CP emission/point (g/s)	0.400
LOADING OVERBURDEN - N PIT		LOADING OVERBURDEN - SW PIT		LOADING OVERBURDEN - N PIT		LOADING OVERBURDEN - SW PIT	
- quantity of material bcm	4,886,400.000	- quantity of material bcm	5,210,100.000	- quantity of material bcm	4,286,400.000	- quantity of material bcm	4,610,100.000
- density (t/bcm)	2.400	- density (t/bcm)	2.400	- density (t/bcm)	2.400	- density (t/bcm)	2.400
- emission factor (kg/t)	0.025	- emission factor (kg/t)	0.025	- emission factor (kg/t)	0.025	- emission factor (kg/t)	0.025
Particle size distribution		Particle size distribution		Particle size distribution		Particle size distribution	
- FP	0.040	- FP	0.040	- FP	0.040	- FP	0.040
- IP	0.440	- IP	0.440	- IP	0.440	- IP	0.440
- CP	0.530	- CP	0.530	- CP	0.530	- CP	0.530
Total annual emission (kg/y)	293,184.000	Total annual emission (kg/y)	312,606.000	Total annual emission (kg/y)	257,184.000	Total annual emission (kg/y)	276,606.000
Total emission in g/s	9.297	Total emission in g/s	9.913	Total emission in g/s	8.155	Total emission in g/s	8.771
Number of points	5.000	Number of points	5.000	Number of points	5.000	Number of points	5.000
- FP emission/point (g/s)	0.074	- FP emission/point (g/s)	0.079	- FP emission/point (g/s)	0.065	- FP emission/point (g/s)	0.070
- IP emission/point (g/s)	0.818	- IP emission/point (g/s)	0.872	- IP emission/point (g/s)	0.718	- IP emission/point (g/s)	0.772
- CP emission/point (g/s)	0.985	- CP emission/point (g/s)	1.051	- CP emission/point (g/s)	0.864	- CP emission/point (g/s)	0.930
DUMPING OVERBURDEN - N PIT		DUMPING OVERBURDEN - SW PIT		DUMPING OVERBURDEN - N PIT		DUMPING OVERBURDEN - SW PIT	
- quantity of material bcm	4,886,400.000	- quantity of material bcm	5,210,100.000	- quantity of material bcm	4,286,400.000	- quantity of material bcm	4,610,100.000
- density (t/bcm)	2.400	- density (t/bcm)	2.400	- density (t/bcm)	2.400	- density (t/bcm)	2.400
- emission factor (kg/t)	0.012	- emission factor (kg/t)	0.012	- emission factor (kg/t)	0.012	- emission factor (kg/t)	0.012
Particle size distribution		Particle size distribution		Particle size distribution		Particle size distribution	
- FP	0.040	- FP	0.040	- FP	0.040	- FP	0.040
- IP	0.440	- IP	0.440	- IP	0.440	- IP	0.440
- CP	0.530	- CP	0.530	- CP	0.530	- CP	0.530
Total annual emission (kg/y)	140,728.320	Total annual emission (kg/y)	150,050.880	Total annual emission (kg/y)	123,448.320	Total annual emission (kg/y)	132,770.880
Total emission in g/s	4.462	Total emission in g/s	4.758	Total emission in g/s	3.915	Total emission in g/s	4.210
Number of points	8.000	Number of points	5.000	Number of points	8.000	Number of points	5.000
- FP emission/point (g/s)	0.022	- FP emission/point (g/s)	0.038	- FP emission/point (g/s)	0.020	- FP emission/point (g/s)	0.034
- IP emission/point (g/s)	0.245	- IP emission/point (g/s)	0.419	- IP emission/point (g/s)	0.215	- IP emission/point (g/s)	0.370
- CP emission/point (g/s)	0.296	- CP emission/point (g/s)	0.504	- CP emission/point (g/s)	0.259	- CP emission/point (g/s)	0.446
DRILLING N PIT		DRILLING SW PIT		DRILLING N PIT		DRILLING SW PIT	
Volume of material (bcm)	6,636,400.000	Volume of material (bcm)	6,960,100.000	Volume of material (bcm)	6,636,400.000	Volume of material (bcm)	6,960,100.000
fraction of material (0 to 1)	0.500	fraction of material (0 to 1)	0.500	fraction of material (0 to 1)	0.500	fraction of material (0 to 1)	0.500
hole spacing (m)	7.500	hole spacing (m)	7.500	hole spacing (m)	7.500	hole spacing (m)	7.500
bench depth	15.000	bench depth	15.000	bench depth	15.000	bench depth	15.000
emission factor (kg/hole)	0.600	emission factor (kg/hole)	0.600	emission factor (kg/hole)	0.600	emission factor (kg/hole)	0.600
Particle size distribution		Particle size distribution		Particle size distribution		Particle size distribution	
- FP	0.050	- FP	0.050	- FP	0.050	- FP	0.050
- IP	0.390	- IP	0.390	- IP	0.390	- IP	0.390
- CP	0.560	- CP	0.560	- CP	0.560	- CP	0.560
Total annual emission (kg/y)	2,359.609	Total annual emission (kg/y)	2,474.702	Total annual emission (kg/y)	2,359.609	Total annual emission (kg/y)	2,474.702
Total emission in g/s	0.075	Total emission in g/s	0.078	Total emission in g/s	0.075	Total emission in g/s	0.078
Number of points	5.000	Number of points	5.000	Number of points	5.000	Number of points	5.000
- FP emission/point (g/s)	0.006	- FP emission/point (g/s)	0.006	- FP emission/point (g/s)	0.006	- FP emission/point (g/s)	0.006
- IP emission/point (g/s)	0.008	- IP emission/point (g/s)	0.009	- IP emission/point (g/s)	0.008	- IP emission/point (g/s)	0.009
- CP emission/point (g/s)	0.008	- CP emission/point (g/s)	0.009	- CP emission/point (g/s)	0.008	- CP emission/point (g/s)	0.009
BLASTING - N PIT		BLASTING - SW PIT		BLASTING - N PIT		BLASTING - SW PIT	
Volume of material (bcm)	6,636,400.000	Volume of material (bcm)	6,960,100.000	Volume of material (bcm)	6,636,400.000	Volume of material (bcm)	6,960,100.000
fraction of material (0 to 1)	0.500	fraction of material (0 to 1)	0.500	fraction of material (0 to 1)	0.500	fraction of material (0 to 1)	0.500
moisture content (%)	7.200	moisture content (%)	7.200	moisture content (%)	7.200	moisture content (%)	7.200
bench depth (m)	15.000	bench depth (m)	15.000	bench depth (m)	15.000	bench depth (m)	15.000
number of blast/year	104.000	number of blast/year	104.000	number of blast/year	104.000	number of blast/year	104.000
emission factor (kg/blast)	28.372	emission factor (kg/blast)	29.473	emission factor (kg/blast)	28.372	emission factor (kg/blast)	29.473
Particle size distribution		Particle size distribution		Particle size distribution		Particle size distribution	
- FP	0.050	- FP	0.050	- FP	0.050	- FP	0.050
- IP	0.390	- IP	0.390	- IP	0.390	- IP	0.390
- CP	0.560	- CP	0.560	- CP	0.560	- CP	0.560
Total annual emission (kg/y)	2,950.653	Total annual emission (kg/y)	3,085.240	Total annual emission (kg/y)	2,950.653	Total annual emission (kg/y)	3,065.240
Total emission in g/s	0.094	Total emission in g/s	0.097	Total emission in g/s	0.094	Total emission in g/s	0.097
Number of points	5.000	Number of points	5.000	Number of points	5.000	Number of points	5.000
- FP emission/point (g/s)	0.007	- FP emission/point (g/s)	0.008	- FP emission/point (g/s)	0.007	- FP emission/point (g/s)	0.008
- IP emission/point (g/s)	0.010	- IP emission/point (g/s)	0.011	- IP emission/point (g/s)	0.010	- IP emission/point (g/s) *	0.011
- CP emission/point (g/s)	0.010	- CP emission/point (g/s)	0.011	- CP emission/point (g/s)	0.010	- CP emission/point (g/s)	0.011
HAULING COAL - N PIT		HAULING COAL - SW PIT		HAULING COAL - N PIT		HAULING COAL - SW PIT	
- average distance (km)	7.000	- average distance (km)	8.000	- average distance (km)	7.000	- average distance (km)	8.000
- quantity of material (t)	1,209,100.000	- quantity of material (t)	755,900.000	- quantity of material (t)	1,209,100.000	- quantity of material (t)	755,900.000
- truck size (t)	85.000	- truck size (t)	85.000	- truck size (t)	85.000	- truck size (t)	85.000
- density (t/bcm)	1.500	- density (t/bcm)	1.500	- density (t/bcm)	1.500	- density (t/bcm)	1.500
- emission factor (kg/VKT)	1.000	- emission factor (kg/VKT)	1.000	- emission factor (kg/VKT)	1.000	- emission factor (kg/VKT)	1.000
Particle size distribution		Particle size distribution		Particle size distribution		Particle size distribution	
- FP	0.060	- FP	0.060	- FP	0.060	- FP	0.060
- IP	0.530	- IP	0.530	- IP	0.530	- IP	0.530
- CP	0.410	- CP	0.410	- CP	0.410	- CP	0.410
Total annual emission (kg/y)	99,572.941	Total annual emission (kg/y)	71,143.529	Total annual emission (kg/y)	99,572.941	Total annual emission (kg/y)	71,143.529
Total emission in g/s	3.157	Total emission in g/s	2.256	Total emission in g/s	3.157	Total emission in g/s	2.256
Number of points	11.000	Number of points	15.000	Number of points	11.000	Number of points	15.000
- FP emission/point (g/s)	0.017	- FP emission/point (g/s)	0.009	- FP emission/point (g/s)	0.017	- FP emission/point (g/s)	0.009
- IP emission/point (g/s)	0.152	- IP emission/point (g/s)	0.080	- IP emission/point (g/s)	0.152	- IP emission/point (g/s)	0.080
- CP emission/point (g/s)	0.118	- CP emission/point (g/s)	0.062	- CP emission/point (g/s)	0.118	- CP emission/point (g/s)	0.062
LOADING COAL - N PIT		LOADING COAL - SW PIT		LOADING COAL - N PIT		LOADING COAL - SW PIT	
- quantity of material (t)	1,209,100.000	- quantity of material (t)	755,900.000	- quantity of material (t)	1,209,100.000	- quantity of material (t)	755,900.000
- density (t/bcm)	1.500	- density (t/bcm)	1.500	- density (t/bcm)	1.500	- density (t/bcm)	1.500
- emission factor (kg/t)	0.029	- emission factor (kg/t)	0.029	- emission factor (kg/t)	0.029	- emission factor (kg/t)	0.029
Particle size distribution		Particle size distribution		Particle size distribution		Particle size distribution	
- FP	0.040	- FP	0.040	- FP	0.040	- FP	0.040
- IP	0.440	- IP	0.440	- IP	0.440	- IP	0.440
- CP	0.530	- CP	0.530	- CP	0.530	- CP	0.530
Total annual emission (kg/y)	35,063.900	Total annual emission (kg/y)	21,921.100	Total annual emission (kg/y)	35,063.900	Total annual emission (kg/y)	21,921.100
Total emission in g/s	1.112	Total emission in g/s	0.695	Total emission in g/s	1.112	Total emission in g/s	0.695
Number of points	5.000	Number of points	5.000	Number of points	5.000	Number of points	5.000
- FP emission/point (g/s)	0.009	- FP emission/point (g/s)	0.006	- FP emission/point (g/s)	0.009	- FP emission/point (g/s)	0.006
- IP emission/point (g/s)	0.098	- IP emission/point (g/s)	0.061	- IP emission/point (g/s)	0.098	- IP emission/point (g/s)	0.061
- CP emission/point (g/s)	0.118	- CP emission/point (g/s)	0.074	- CP emission/point (g/s)	0.118	- CP emission/point (g/s)	0.074
DUMPING COAL - FROM N + SW PITS				DUMPING COAL - FROM N + SW PITS			
- quantity of material (t)	1,965,000.000			- quantity of material (t)	1,965,000.000		
- emission factor (kg/t)	0.010			- emission factor (kg/t)	0.010		
Particle sizes				Particle sizes			
- FP	0.040			- FP	0.040		
- IP	0.440			- IP	0.440		

- CP	0.330			- CP	0.330		
Total annual emission (kg/y)	19,650.000			Total annual emission (kg/y)	19,650.000		
Total emission in g/s	0.623			Total emission in g/s	0.623		
Number of points	1.000			Number of points	1.000		
- FP emission/point (g/s)	0.025			- FP emission/point (g/s)	0.025		
- IP emission/point (g/s)	0.274			- IP emission/point (g/s)	0.274		
- CP emission/point (g/s)	0.330			- CP emission/point (g/s)	0.330		
DOZER ON COAL - N PIT		DOZER ON COAL - SW PIT		DOZER ON COAL - N PIT		DOZER ON COAL - SW PIT	
- silt content (%)	8.000	- silt content (%)	8.000	- silt content (%)	8.000	- silt content (%)	8.000
- moisture content (%)	6.000	- moisture content (%)	6.000	- moisture content (%)	6.000	- moisture content (%)	6.000
- hours	1,728.000	- hours	1,728.000	- hours	1,728.000	- hours	1,728.000
Particle sizes		Particle sizes		Particle sizes		Particle sizes	
- FP	0.030	- FP	0.030	- FP	0.030	- FP	0.030
- IP	0.490	- IP	0.490	- IP	0.490	- IP	0.490
-CP	0.480	-CP	0.480	-CP	0.480	-CP	0.480
Emission factor (kg/h)	42.030	Emission factor (kg/h)	42.030	Emission factor (kg/h)	42.030	Emission factor (kg/h)	42.030
Total annual emission (kg/y)	72,628.169	Total annual emission (kg/y)	72,628.169	Total annual emission (kg/y)	72,628.169	Total annual emission (kg/y)	72,628.169
Total emission in g/s	2.303	Total emission in g/s	2.303	Total emission in g/s	2.303	Total emission in g/s	2.303
Number of points	5.000	Number of points	5.000	Number of points	5.000	Number of points	5.000
- FP emission/point (g/s)	0.014	- FP emission/point (g/s)	0.014	- FP emission/point (g/s)	0.014	- FP emission/point (g/s)	0.014
- IP emission/point (g/s)	0.226	- IP emission/point (g/s)	0.226	- IP emission/point (g/s)	0.226	- IP emission/point (g/s)	0.226
- CP emission/point (g/s)	0.221	- CP emission/point (g/s)	0.221	- CP emission/point (g/s)	0.221	- CP emission/point (g/s)	0.221
DOZER ON OVERBURDEN - N PIT		DOZER ON OVERBURDEN - SW PIT		DOZER ON OVERBURDEN - N PIT		DOZER ON OVERBURDEN - SW PIT	
- silt content (%)	10.000	- silt content (%)	10.000	- silt content (%)	10.000	- silt content (%)	10.000
- moisture content (%)	5.000	- moisture content (%)	5.000	- moisture content (%)	5.000	- moisture content (%)	5.000
- hours	10,512.000	- hours	10,512.000	- hours	10,512.000	- hours	10,512.000
Particle sizes		Particle sizes		Particle sizes		Particle sizes	
- FP	0.200	- FP	0.200	- FP	0.200	- FP	0.200
- IP	0.540	- IP	0.540	- IP	0.540	- IP	0.540
-CP	0.260	-CP	0.260	-CP	0.260	-CP	0.260
Emission factor (kg/h)	5.085	Emission factor (kg/h)	5.085	Emission factor (kg/h)	5.085	Emission factor (kg/h)	5.085
Total annual emission (kg/y)	53,456.152	Total annual emission (kg/y)	53,456.152	Total annual emission (kg/y)	53,456.152	Total annual emission (kg/y)	53,456.152
Total emission in g/s	1.695	Total emission in g/s	1.695	Total emission in g/s	1.695	Total emission in g/s	1.695
Number of points	8.000	Number of points	5.000	Number of points	8.000	Number of points	5.000
- FP emission/point (g/s)	0.042	- FP emission/point (g/s)	0.068	- FP emission/point (g/s)	0.042	- FP emission/point (g/s)	0.068
- IP emission/point (g/s)	0.114	- IP emission/point (g/s)	0.183	- IP emission/point (g/s)	0.114	- IP emission/point (g/s)	0.183
- CP emission/point (g/s)	0.055	- CP emission/point (g/s)	0.088	- CP emission/point (g/s)	0.055	- CP emission/point (g/s)	0.088
SCRAPER ON OVERBURDEN - N PIT		SCRAPER ON OVERBURDEN - SW PIT		SCRAPER ON OVERBURDEN - N PIT		SCRAPER ON OVERBURDEN - SW PIT	
- silt content (%)	10.000	- silt content (%)	10.000	- silt content (%)	10.000	- silt content (%)	10.000
- moisture content (%)	5.000	- moisture content (%)	5.000	- moisture content (%)	5.000	- moisture content (%)	5.000
- weight (t)	48.000	- weight (t)	48.000	- weight (t)	48.000	- weight (t)	48.000
- hours	10,512.000	- hours	10,512.000	- hours	10,512.000	- hours	10,512.000
Particle sizes		Particle sizes		Particle sizes		Particle sizes	
- FP	0.200	- FP	0.200	- FP	0.200	- FP	0.200
- IP	0.540	- IP	0.540	- IP	0.540	- IP	0.540
-CP	0.260	-CP	0.260	-CP	0.260	-CP	0.260
Emission factor (kg/h)	2.076	Emission factor (kg/h)	2.076	Emission factor (kg/h)	2.076	Emission factor (kg/h)	2.076
Total annual emission (kg/y)	21,824.060	Total annual emission (kg/y)	21,824.060	Total annual emission (kg/y)	21,824.060	Total annual emission (kg/y)	21,824.060
Total emission in g/s	0.692	Total emission in g/s	0.692	Total emission in g/s	0.692	Total emission in g/s	0.692
Number of points	8.000	Number of points	5.000	Number of points	8.000	Number of points	5.000
- FP emission/point (g/s)	0.017	- FP emission/point (g/s)	0.028	- FP emission/point (g/s)	0.017	- FP emission/point (g/s)	0.028
- IP emission/point (g/s)	0.047	- IP emission/point (g/s)	0.075	- IP emission/point (g/s)	0.047	- IP emission/point (g/s)	0.075
- CP emission/point (g/s)	0.022	- CP emission/point (g/s)	0.036	- CP emission/point (g/s)	0.022	- CP emission/point (g/s)	0.036
GRADERS				GRADERS			
- speed (km/h)	8.000			- speed (km/h)	8.000		
- hours	600.000			- hours	600.000		
Particle sizes				Particle sizes			
- FP	0.060			- FP	0.060		
- IP	0.480			- IP	0.480		
- CP	0.460			- CP	0.460		
Emission factor (kg/VKT)	0.615			Emission factor (kg/VKT)	0.615		
Total annual emission (kg/y)	2,954.236			Total annual emission (kg/y)	2,954.236		
Number of points	28.000			Number of points	28.000		
- FP emission/point (g/s)	0.000			- FP emission/point (g/s)	0.000		
- IP emission/point (g/s)	0.002			- IP emission/point (g/s)	0.002		
- CP emission/point (g/s)	0.002			- CP emission/point (g/s)	0.002		
STOCKPILE WIND EROSION				STOCKPILE WIND EROSION			
wind speed (m/s)	3.070			wind speed (m/s)	3.070		
area (ha)	18.000			area (ha)	18.000		
Particle sizes				Particle sizes			
- FP	0.000			- FP	0.000		
- IP	0.670			- IP	0.670		
- CP	0.330			- CP	0.330		
Emission factor (kg/ha.h)	0.400			Emission factor (kg/ha.h)	0.400		
Total annual emission (kg/y)	63,072.000			Total annual emission (kg/y)	63,072.000		
Number of points	3.000			Number of points	3.000		
- FP emission/point (g/s)	0.000			- FP emission/point (g/s)	0.000		
- IP emission/point (g/s)	0.447			- IP emission/point (g/s)	0.447		
- CP emission/point (g/s)	0.220			- CP emission/point (g/s)	0.220		
MINE WIND EROSION - N PIT		MINE WIND EROSION - SW PIT		MINE WIND EROSION - N PIT		MINE WIND EROSION - SW PIT	
wind speed (m/s)	3.070	wind speed (m/s)	3.070	wind speed (m/s)	3.070	wind speed (m/s)	3.070
percent of time u>5.4 m/s	11.100	percent of time u>5.4 m/s	11.100	percent of time u>5.4 m/s	11.100	percent of time u>5.4 m/s	11.100
number of rain days	114.000	number of rain days	114.000	number of rain days	114.000	number of rain days	114.000
area (ha)	100.000	area (ha)	100.000	area (ha)	100.000	area (ha)	100.000
Particle sizes		Particle sizes		Particle sizes		Particle sizes	
- FP	0.000	- FP	0.000	- FP	0.000	- FP	0.000
- IP	0.670	- IP	0.670	- IP	0.670	- IP	0.670
- CP	0.330	- CP	0.330	- CP	0.330	- CP	0.330
Emission factor (kg/ha.h)	0.097	Emission factor (kg/ha.h)	0.097	Emission factor (kg/ha.h)	0.097	Emission factor (kg/ha.h)	0.097
Total annual emission (kg/y)	84,972.000	Total annual emission (kg/y)	84,972.000	Total annual emission (kg/y)	84,972.000	Total annual emission (kg/y)	84,972.000
Number of points	5.000	Number of points	5.000	Number of points	5.000	Number of points	5.000
- FP emission/point (g/s)	0.000	- FP emission/point (g/s)	0.000	- FP emission/point (g/s)	0.000	- FP emission/point (g/s)	0.000
- IP emission/point (g/s)	0.361	- IP emission/point (g/s)	0.361	- IP emission/point (g/s)	0.361	- IP emission/point (g/s)	0.361
- CP emission/point (g/s)	0.178	- CP emission/point (g/s)	0.178	- CP emission/point (g/s)	0.178	- CP emission/point (g/s)	0.178
WASTE DUMP WIND EROSION - N PIT		WASTE DUMP WIND EROSION - SW PIT		WASTE DUMP WIND EROSION - N PIT		WASTE DUMP WIND EROSION - SW PIT	
wind speed (m/s)	3.070	wind speed (m/s)	3.070	wind speed (m/s)	3.070	wind speed (m/s)	3.070
area (ha)	100.000	area (ha)	100.000	area (ha)	100.000	area (ha)	100.000
Particle sizes		Particle sizes		Particle sizes		Particle sizes	
- FP	0.000	- FP	0.000	- FP	0.000	- FP	0.000
- IP	0.670	- IP	0.670	- IP	0.670	- IP	0.670
- CP	0.330	- CP	0.330	- CP	0.330	- CP	0.330
Emission factor (kg/ha.h)	0.097	Emission factor (kg/ha.h)	0.097	Emission factor (kg/ha.h)	0.097	Emission factor (kg/ha.h)	0.097
Total annual emission (kg/y)	84,972.000	Total annual emission (kg/y)	84,972.000	Total annual emission (kg/y)	84,972.000	Total annual emission (kg/y)	84,972.000
Number of points	8.000	Number of points	5.000	Number of points	8.000	Number of points	5.000
- FP emission/point (g/s)	0.000	- FP emission/point (g/s)	0.000	- FP emission/point (g/s)	0.000	- FP emission/point (g/s)	0.000
- IP emission/point (g/s)	0.226	- IP emission/point (g/s)	0.361	- IP emission/point (g/s)	0.226	- IP emission/point (g/s)	0.361
- CP emission/point (g/s)	0.111	- CP emission/point (g/s)	0.178	- CP emission/point (g/s)	0.111	- CP emission/point (g/s)	0.178
TRAIN LOADOUT				TRAIN LOADOUT			
wind speed (m/s)	3.07			wind speed (m/s)	3.07		
moisture (%)	5			moisture (%)	5		
k (US EPA p 11.2.3-3, 9/1988)	0.74			k (US EPA p 11.2.3-3, 9/1988)	0.74		
Emission factor (kg/t)	0.000506251			Emission factor (kg/t)	0.000506251		
tonnes of coal loaded	1277200			tonnes of coal loaded	1277200		

Annual emission (kg)	646.5840738			Annual emission (kg)	646.5840738		
Particle sizes				Particle sizes			
- FP	0.05			- FP	0.05		
- IP	0.58			- IP	0.58		
- CP	0.37			- CP	0.37		
Number of points	1.000			Number of points	1.000		
- FP emission/point (g/s)	0.001			- FP emission/point (g/s)	0.001		
- IP emission/point (g/s)	0.012			- IP emission/point (g/s)	0.012		
- CP emission/point (g/s)	0.008			- CP emission/point (g/s)	0.008		
LOAD TO STOCKPILES				LOAD TO STOCKPILES			
wind speed (m/s)	3.07			wind speed (m/s)	3.07		
moisture (%)	5			moisture (%)	5		
k (US EPA p 11.2.3-3, 9/1988)	0.74			k (US EPA p 11.2.3-3, 9/1988)	0.74		
Emission factor (kg/t)	0.000506251			Emission factor (kg/t)	0.000506251		
tonnes of coal loaded	1277200			tonnes of coal loaded	1277200		
Annual emission (kg)	646.5840738			Annual emission (kg)	646.5840738		
Particle sizes				Particle sizes			
- FP	0.05			- FP	0.05		
- IP	0.58			- IP	0.58		
- CP	0.37			- CP	0.37		
Number of points	1.000			Number of points	1.000		
- FP emission/point (g/s)	0.001			- FP emission/point (g/s)	0.001		
- IP emission/point (g/s)	0.012			- IP emission/point (g/s)	0.012		
- CP emission/point (g/s)	0.008			- CP emission/point (g/s)	0.008		
HAULING COAL - REJECTS TO N PIT				HAULING COAL - REJECTS TO N PIT			
- average distance (km)	4.000			- average distance (km)	4.000		
- quantity of material (t)	687,800.000			- quantity of material (t)	687,800.000		
- truck size (t)	85.000			- truck size (t)	85.000		
- density (t/bcm)	1.500			- density (t/bcm)	1.500		
- emission factor (kg/VKT)	1.000			- emission factor (kg/VKT)	1.000		
Particle size distribution				Particle size distribution			
- FP	0.060			- FP	0.060		
- IP	0.530			- IP	0.530		
- CP	0.410			- CP	0.410		
Total annual emission (kg/y)	32,367.059			Total annual emission (kg/y)	32,367.059		
Total emission in g/s	1.026			Total emission in g/s	1.026		
Number of points	8.000			Number of points	8.000		
- FP emission/point (g/s)	0.008			- FP emission/point (g/s)	0.008		
- IP emission/point (g/s)	0.068			- IP emission/point (g/s)	0.068		
- CP emission/point (g/s)	0.053			- CP emission/point (g/s)	0.053		
DRAGLINE HANDLING OF O/B - N PIT		DRAGLINE HANDLING OF O/B - SE PIT		DRAGLINE HANDLING OF O/B - N PIT		DRAGLINE HANDLING OF O/B - SE PIT	
- quantity of prime (bcm)	1,750,000.000	- quantity of prime (bcm)	1,750,000.000	- quantity of prime (bcm)	2,350,000.000	- quantity of prime (bcm)	2,350,000.000
- per cent rehandle (bcm)	34.000	- per cent rehandle (bcm)	34.000	- per cent rehandle (bcm)	55.000	- per cent rehandle (bcm)	55.000
- drop height (m)	12.000	- drop height (m)	12.000	- drop height (m)	12.000	- drop height (m)	12.000
- moisture (%)	2.000	- moisture (%)	2.000	- moisture (%)	2.000	- moisture (%)	2.000
- swell factor	1.400	- swell factor	1.400	- swell factor	1.400	- swell factor	1.400
- Emission factor (kg/cu. m)	0.074	- Emission factor (kg/cu. m)	0.074	- Emission factor (kg/cu. m)	0.074	- Emission factor (kg/cu. m)	0.074
- Total annual emission (kg/y)	241,956.454	- Total annual emission (kg/y)	241,956.454	- Total annual emission (kg/y)	375,832.146	- Total annual emission (kg/y)	375,832.146
Particle size distribution		Particle size distribution		Particle size distribution		Particle size distribution	
- FP	0.070	- FP	0.070	- FP	0.070	- FP	0.070
- IP	0.500	- IP	0.500	- IP	0.500	- IP	0.500
- CP	0.430	- CP	0.430	- CP	0.430	- CP	0.430
Number of points	5.000	Number of points	5.000	Number of points	5.000	Number of points	5.000
- FP emission/point (g/s)	0.107	- FP emission/point (g/s)	0.107	- FP emission/point (g/s)	0.167	- FP emission/point (g/s)	0.167
- IP emission/point (g/s)	0.767	- IP emission/point (g/s)	0.767	- IP emission/point (g/s)	1.192	- IP emission/point (g/s)	1.192
- CP emission/point (g/s)	0.860	- CP emission/point (g/s)	0.860	- CP emission/point (g/s)	0.860	- CP emission/point (g/s)	0.860

RIXS CREEK YEAR 15 DUST EMISSION ESTIMATES - (Dragline option)			
HAULING OVERBURDEN - N PIT		HAULING OVERBURDEN - SW PIT	
- average distance (km)	4.000	- average distance (km)	5.000
- quantity of material bcm	4,901,400.000	- quantity of material bcm	4,840,700.000
- truck size (t)	120.000	- truck size (t)	120.000
- density (t/bcm)	2.400	- density (t/bcm)	2.400
- emission factor (kg/VKT)	1.000	- emission factor (kg/VKT)	1.000
Particle size distribution		Particle size distribution	
- FP	0.060	- FP	0.060
- IP	0.530	- IP	0.530
- CP	0.410	- CP	0.410
Total annual emission (kg/y)	392,112.000	Total annual emission (kg/y)	484,070.000
Total emission in g/s	12.434	Total emission in g/s	15.350
Number of points	17.000	Number of points	17.000
- FP emission/point (g/s)	0.044	- FP emission/point (g/s)	0.054
- IP emission/point (g/s)	0.388	- IP emission/point (g/s)	0.479
- CP emission/point (g/s)	0.300	- CP emission/point (g/s)	0.370
LOADING OVERBURDEN - N PIT		LOADING OVERBURDEN - SW PIT	
- quantity of material bcm	4,901,400.000	- quantity of material bcm	4,840,700.000
- density (t/bcm)	2.400	- density (t/bcm)	2.400
- emission factor (kg/t)	0.025	- emission factor (kg/t)	0.025
Particle size distribution		Particle size distribution	
- FP	0.040	- FP	0.040
- IP	0.440	- IP	0.440
- CP	0.530	- CP	0.530
Total annual emission (kg/y)	294,084.000	Total annual emission (kg/y)	290,442.000
Total emission in g/s	9.325	Total emission in g/s	9.210
Number of points	7.000	Number of points	7.000
- FP emission/point (g/s)	0.053	- FP emission/point (g/s)	0.053
- IP emission/point (g/s)	0.586	- IP emission/point (g/s)	0.579
- CP emission/point (g/s)	0.706	- CP emission/point (g/s)	0.697
DUMPING OVERBURDEN - N PIT		DUMPING OVERBURDEN - SW PIT	
- quantity of material bcm	4,901,400.000	- quantity of material bcm	4,840,700.000
- density (t/bcm)	2.400	- density (t/bcm)	2.400
- emission factor (kg/t)	0.012	- emission factor (kg/t)	0.012
Particle size distribution		Particle size distribution	
- FP	0.040	- FP	0.040
- IP	0.440	- IP	0.440
- CP	0.530	- CP	0.530
Total annual emission (kg/y)	141,160.320	Total annual emission (kg/y)	139,412.160
Total emission in g/s	4.476	Total emission in g/s	4.421
Number of points	9.000	Number of points	5.000
- FP emission/point (g/s)	0.020	- FP emission/point (g/s)	0.035
- IP emission/point (g/s)	0.219	- IP emission/point (g/s)	0.389
- CP emission/point (g/s)	0.264	- CP emission/point (g/s)	0.469
DRILLING N PIT		DRILLING SW PIT	
Volume of material (bcm)	6,651,400.000	Volume of material (bcm)	6,590,700.000
fraction of material (0 to 1)	0.500	fraction of material (0 to 1)	0.500
hole spacing (m)	7.500	hole spacing (m)	7.500
bench depth	15.000	bench depth	15.000
emission factor (kg/hole)	0.600	emission factor (kg/hole)	0.600
Particle size distribution		Particle size distribution	
- FP	0.050	- FP	0.050
- IP	0.390	- IP	0.390
- CP	0.560	- CP	0.560
Total annual emission (kg/y)	2,364.942	Total annual emission (kg/y)	2,343.360
Total emission in g/s	0.075	Total emission in g/s	0.074
Number of points	7.000	Number of points	7.000
- FP emission/point (g/s)	0.004	- FP emission/point (g/s)	0.004
- IP emission/point (g/s)	0.006	- IP emission/point (g/s)	0.006
- CP emission/point (g/s)	0.006	- CP emission/point (g/s)	0.006
BLASTING - N PIT		BLASTING - SW PIT	
Volume of material (bcm)	6,651,400.000	Volume of material (bcm)	6,590,700.000
fraction of material (0 to 1)	0.500	fraction of material (0 to 1)	0.500
moisture content (%)	7.200	moisture content (%)	7.200
bench depth (m)	15.000	bench depth (m)	15.000
number of blast/year	104.000	number of blast/year	104.000
emission factor (kg/blast)	28.423	emission factor (kg/blast)	28.215
Particle size distribution		Particle size distribution	
- FP	0.050	- FP	0.050
- IP	0.390	- IP	0.390
- CP	0.560	- CP	0.560
Total annual emission (kg/y)	2,955.987	Total annual emission (kg/y)	2,934.387
Total emission in g/s	0.094	Total emission in g/s	0.093
Number of points	7.000	Number of points	7.000
- FP emission/point (g/s)	0.005	- FP emission/point (g/s)	0.005
- IP emission/point (g/s)	0.007	- IP emission/point (g/s)	0.007
- CP emission/point (g/s)	0.007	- CP emission/point (g/s)	0.007
HAULING COAL - N PIT		HAULING COAL - SW PIT	
- average distance (km)	8.000	- average distance (km)	9.000
- quantity of material (t)	1,188,000.000	- quantity of material (t)	1,273,000.000
- truck size (t)	85.000	- truck size (t)	85.000
- density (t/bcm)	1.500	- density (t/bcm)	1.500
- emission factor (kg/VKT)	1.000	- emission factor (kg/VKT)	1.000
Particle size distribution		Particle size distribution	
- FP	0.060	- FP	0.060
- IP	0.530	- IP	0.530
- CP	0.410	- CP	0.410
Total annual emission (kg/y)	111,811.765	Total annual emission (kg/y)	134,788.235
Total emission in g/s	3.546	Total emission in g/s	4.274
Number of points	15.000	Number of points	20.000
- FP emission/point (g/s)	0.014	- FP emission/point (g/s)	0.013
- IP emission/point (g/s)	0.125	- IP emission/point (g/s)	0.113
- CP emission/point (g/s)	0.097	- CP emission/point (g/s)	0.088
LOADING COAL - N PIT		LOADING COAL - SW PIT	
- quantity of material (t)	1,188,000.000	- quantity of material (t)	1,273,000.000
- density (t/bcm)	1.500	- density (t/bcm)	1.500
- emission factor (kg/t)	0.029	- emission factor (kg/t)	0.029
Particle size distribution		Particle size distribution	
- FP	0.040	- FP	0.040
- IP	0.440	- IP	0.440
- CP	0.530	- CP	0.530
Total annual emission (kg/y)	34,452.000	Total annual emission (kg/y)	36,917.000
Total emission in g/s	1.092	Total emission in g/s	1.171
Number of points	7.000	Number of points	7.000
- FP emission/point (g/s)	0.006	- FP emission/point (g/s)	0.007
- IP emission/point (g/s)	0.069	- IP emission/point (g/s)	0.074
- CP emission/point (g/s)	0.083	- CP emission/point (g/s)	0.089
DUMPING COAL - FROM N + SW PITS			
- quantity of material (t)	2,461,000.000		
- emission factor (kg/t)	0.010		
Particle sizes			
- FP	0.040		
- IP	0.440		

RIXS CREEK YEAR 15 DUST EMISSION ESTIMATES - (Shovel option)			
HAULING OVERBURDEN - N PIT		HAULING OVERBURDEN - SW PIT	
- average distance (km)	4.000	- average distance (km)	5.000
- quantity of material bcm	4,301,400.000	- quantity of material bcm	4,240,700.000
- truck size (t)	120.000	- truck size (t)	120.000
- density (t/bcm)	2.400	- density (t/bcm)	2.400
- emission factor (kg/VKT)	1.000	- emission factor (kg/VKT)	1.000
Particle size distribution		Particle size distribution	
- FP	0.060	- FP	0.060
- IP	0.530	- IP	0.530
- CP	0.410	- CP	0.410
Total annual emission (kg/y)	344,112.000	Total annual emission (kg/y)	424,070.000
Total emission in g/s	10.912	Total emission in g/s	13.447
Number of points	17.000	Number of points	17.000
- FP emission/point (g/s)	0.039	- FP emission/point (g/s)	0.047
- IP emission/point (g/s)	0.340	- IP emission/point (g/s)	0.419
- CP emission/point (g/s)	0.263	- CP emission/point (g/s)	0.324
LOADING OVERBURDEN - N PIT		LOADING OVERBURDEN - SW PIT	
- quantity of material bcm	4,301,400.000	- quantity of material bcm	4,240,700.000
- density (t/bcm)	2.400	- density (t/bcm)	2.400
- emission factor (kg/t)	0.025	- emission factor (kg/t)	0.025
Particle size distribution		Particle size distribution	
- FP	0.040	- FP	0.040
- IP	0.440	- IP	0.440
- CP	0.530	- CP	0.530
Total annual emission (kg/y)	258,084.000	Total annual emission (kg/y)	254,442.000
Total emission in g/s	8.184	Total emission in g/s	8.068
Number of points	7.000	Number of points	7.000
- FP emission/point (g/s)	0.047	- FP emission/point (g/s)	0.046
- IP emission/point (g/s)	0.514	- IP emission/point (g/s)	0.507
- CP emission/point (g/s)	0.620	- CP emission/point (g/s)	0.611
DUMPING OVERBURDEN - N PIT		DUMPING OVERBURDEN - SW PIT	
- quantity of material bcm	4,301,400.000	- quantity of material bcm	4,240,700.000
- density (t/bcm)	2.400	- density (t/bcm)	2.400
- emission factor (kg/t)	0.012	- emission factor (kg/t)	0.012
Particle size distribution		Particle size distribution	
- FP	0.040	- FP	0.040
- IP	0.440	- IP	0.440
- CP	0.530	- CP	0.530
Total annual emission (kg/y)	123,880.320	Total annual emission (kg/y)	122,132.160
Total emission in g/s	3.928	Total emission in g/s	3.873
Number of points	9.000	Number of points	5.000
- FP emission/point (g/s)	0.017	- FP emission/point (g/s)	0.031
- IP emission/point (g/s)	0.192	- IP emission/point (g/s)	0.341
- CP emission/point (g/s)	0.231	- CP emission/point (g/s)	0.411
DRILLING N PIT		DRILLING SW PIT	
Volume of material (bcm)	6,651,400.000	Volume of material (bcm)	6,590,700.000
fraction of material (0 to 1)	0.500	fraction of material (0 to 1)	0.500
hole spacing (m)	7.500	hole spacing (m)	7.500
bench depth	15.000	bench depth	15.000
emission factor (kg/hole)	0.600	emission factor (kg/hole)	0.600
Particle size distribution		Particle size distribution	
- FP	0.050	- FP	0.050
- IP	0.390	- IP	0.390
- CP	0.560	- CP	0.560
Total annual emission (kg/y)	2,364.942	Total annual emission (kg/y)	2,343.360
Total emission in g/s	0.075	Total emission in g/s	0.074
Number of points	7.000	Number of points	7.000
- FP emission/point (g/s)	0.004	- FP emission/point (g/s)	0.004
- IP emission/point (g/s)	0.006	- IP emission/point (g/s)	0.006
- CP emission/point (g/s)	0.006	- CP emission/point (g/s)	0.006
BLASTING - N PIT		BLASTING - SW PIT	
Volume of material (bcm)	6,651,400.000	Volume of material (bcm)	6,590,700.000
fraction of material (0 to 1)	0.500	fraction of material (0 to 1)	0.500
moisture content (%)	7.200	moisture content (%)	7.200
bench depth (m)	15.000	bench depth (m)	15.000
number of blast/year	104.000	number of blast/year	104.000
emission factor (kg/blast)	28.423	emission factor (kg/blast)	28.215
Particle size distribution		Particle size distribution	
- FP	0.050	- FP	0.050
- IP	0.390	- IP	0.390
- CP	0.560	- CP	0.560
Total annual emission (kg/y)	2,955.987	Total annual emission (kg/y)	2,934.387
Total emission in g/s	0.094	Total emission in g/s	0.093
Number of points	7.000	Number of points	7.000
- FP emission/point (g/s)	0.005	- FP emission/point (g/s)	0.005
- IP emission/point (g/s)	0.007	- IP emission/point (g/s)	0.007
- CP emission/point (g/s)	0.007	- CP emission/point (g/s)	0.007
HAULING COAL - N PIT		HAULING COAL - SW PIT	
- average distance (km)	8.000	- average distance (km)	9.000
- quantity of material (t)	1,188,000.000	- quantity of material (t)	1,273,000.000
- truck size (t)	85.000	- truck size (t)	85.000
- density (t/bcm)	1.500	- density (t/bcm)	1.500
- emission factor (kg/VKT)	1.000	- emission factor (kg/VKT)	1.000
Particle size distribution		Particle size distribution	
- FP	0.060	- FP	0.060
- IP	0.530	- IP	0.530
- CP	0.410	- CP	0.410
Total annual emission (kg/y)	111,811.765	Total annual emission (kg/y)	134,788.235
Total emission in g/s	3.546	Total emission in g/s	4.274
Number of points	15.000	Number of points	20.000
- FP emission/point (g/s)	0.014	- FP emission/point (g/s)	0.013
- IP emission/point (g/s)	0.125	- IP emission/point (g/s)	0.113
- CP emission/point (g/s)	0.097	- CP emission/point (g/s)	0.088
LOADING COAL - N PIT		LOADING COAL - SW PIT	
- quantity of material (t)	1,188,000.000	- quantity of material (t)	1,273,000.000
- density (t/bcm)	1.500	- density (t/bcm)	1.500
- emission factor (kg/t)	0.029	- emission factor (kg/t)	0.029
Particle size distribution		Particle size distribution	
- FP	0.040	- FP	0.040
- IP	0.440	- IP	0.440
- CP	0.530	- CP	0.530
Total annual emission (kg/y)	34,452.000	Total annual emission (kg/y)	36,917.000
Total emission in g/s	1.092	Total emission in g/s	1.171
Number of points	7.000	Number of points	7.000
- FP emission/point (g/s)	0.006	- FP emission/point (g/s)	0.007
- IP emission/point (g/s)	0.069	- IP emission/point (g/s)	0.074
- CP emission/point (g/s)	0.083	- CP emission/point (g/s)	0.089
DUMPING COAL - FROM N + SW PITS			
- quantity of material (t)	2,461,000.000		
- emission factor (kg/t)	0.010		
Particle sizes			
- FP	0.040		
- IP	0.440		

- CP	0.530			- CP	0.530		
Total annual emission (kg/y)	24,610.000			Total annual emission (kg/y)	24,610.000		
Total emission in g/s	0.780			Total emission in g/s	0.780		
Number of points	1.000			Number of points	1.000		
- FP emission/point (g/s)	0.031			- FP emission/point (g/s)	0.031		
- IP emission/point (g/s)	0.343			- IP emission/point (g/s)	0.343		
- CP emission/point (g/s)	0.414			- CP emission/point (g/s)	0.414		
DOZER ON COAL - N PIT		DOZER ON COAL - SW PIT		DOZER ON COAL - N PIT		DOZER ON COAL - SW PIT	
- silt content (%)	8.000	- silt content (%)	8.000	- silt content (%)	8.000	- silt content (%)	8.000
- moisture content (%)	6.000	- moisture content (%)	6.000	- moisture content (%)	6.000	- moisture content (%)	6.000
- hours	1,728.000	- hours	1,728.000	- hours	1,728.000	- hours	1,728.000
Particle sizes		Particle sizes		Particle sizes		Particle sizes	
- FP	0.030	- FP	0.030	- FP	0.030	- FP	0.030
- IP	0.490	- IP	0.490	- IP	0.490	- IP	0.490
-CP	0.480	-CP	0.480	-CP	0.480	-CP	0.480
Emission factor (kg/h)	42.030	Emission factor (kg/h)	42.030	Emission factor (kg/h)	42.030	Emission factor (kg/h)	42.030
Total annual emission (kg/y)	72,628.169	Total annual emission (kg/y)	72,628.169	Total annual emission (kg/y)	72,628.169	Total annual emission (kg/y)	72,628.169
Total emission in g/s	2.303	Total emission in g/s	2.303	Total emission in g/s	2.303	Total emission in g/s	2.303
Number of points	7.000	Number of points	7.000	Number of points	7.000	Number of points	7.000
- FP emission/point (g/s)	0.010	- FP emission/point (g/s)	0.010	- FP emission/point (g/s)	0.010	- FP emission/point (g/s)	0.010
- IP emission/point (g/s)	0.161	- IP emission/point (g/s)	0.161	- IP emission/point (g/s)	0.161	- IP emission/point (g/s)	0.161
- CP emission/point (g/s)	0.158	- CP emission/point (g/s)	0.158	- CP emission/point (g/s)	0.158	- CP emission/point (g/s)	0.158
DOZER ON OVERBURDEN - N PIT		DOZER ON OVERBURDEN - SW PIT		DOZER ON OVERBURDEN - N PIT		DOZER ON OVERBURDEN - SW PIT	
- silt content (%)	10.000	- silt content (%)	10.000	- silt content (%)	10.000	- silt content (%)	10.000
- moisture content (%)	9.000	- moisture content (%)	9.000	- moisture content (%)	9.000	- moisture content (%)	9.000
- hours	10,512.000	- hours	10,512.000	- hours	10,512.000	- hours	10,512.000
Particle sizes		Particle sizes		Particle sizes		Particle sizes	
- FP	0.200	- FP	0.200	- FP	0.200	- FP	0.200
- IP	0.540	- IP	0.540	- IP	0.540	- IP	0.540
-CP	0.260	-CP	0.260	-CP	0.260	-CP	0.260
Emission factor (kg/h)	2.368	Emission factor (kg/h)	2.368	Emission factor (kg/h)	2.368	Emission factor (kg/h)	2.368
Total annual emission (kg/y)	24,896.795	Total annual emission (kg/y)	24,896.795	Total annual emission (kg/y)	24,896.795	Total annual emission (kg/y)	24,896.795
Total emission in g/s	0.789	Total emission in g/s	0.789	Total emission in g/s	0.789	Total emission in g/s	0.789
Number of points	9.000	Number of points	5.000	Number of points	9.000	Number of points	5.000
- FP emission/point (g/s)	0.018	- FP emission/point (g/s)	0.032	- FP emission/point (g/s)	0.018	- FP emission/point (g/s)	0.032
- IP emission/point (g/s)	0.047	- IP emission/point (g/s)	0.085	- IP emission/point (g/s)	0.047	- IP emission/point (g/s)	0.085
- CP emission/point (g/s)	0.023	- CP emission/point (g/s)	0.041	- CP emission/point (g/s)	0.023	- CP emission/point (g/s)	0.041
SCRAPER ON OVERBURDEN - N PIT		SCRAPER ON OVERBURDEN - SW PIT		SCRAPER ON OVERBURDEN - N PIT		SCRAPER ON OVERBURDEN - SW PIT	
- silt content (%)	10.000	- silt content (%)	10.000	- silt content (%)	10.000	- silt content (%)	10.000
- moisture content (%)	5.000	- moisture content (%)	5.000	- moisture content (%)	5.000	- moisture content (%)	5.000
- weight (t)	48.000	- weight (t)	48.000	- weight (t)	48.000	- weight (t)	48.000
- hours	10,512.000	- hours	10,512.000	- hours	10,512.000	- hours	10,512.000
Particle sizes		Particle sizes		Particle sizes		Particle sizes	
- FP	0.200	- FP	0.200	- FP	0.200	- FP	0.200
- IP	0.540	- IP	0.540	- IP	0.540	- IP	0.540
-CP	0.260	-CP	0.250	-CP	0.260	-CP	0.260
Emission factor (kg/h)	2.076	Emission factor (kg/h)	2.076	Emission factor (kg/h)	2.076	Emission factor (kg/h)	2.076
Total annual emission (kg/y)	21,824.060	Total annual emission (kg/y)	21,824.060	Total annual emission (kg/y)	21,824.060	Total annual emission (kg/y)	21,824.060
Total emission in g/s	0.692	Total emission in g/s	0.692	Total emission in g/s	0.692	Total emission in g/s	0.692
Number of points	9.000	Number of points	5.000	Number of points	9.000	Number of points	5.000
- FP emission/point (g/s)	0.015	- FP emission/point (g/s)	0.028	- FP emission/point (g/s)	0.015	- FP emission/point (g/s)	0.028
- IP emission/point (g/s)	0.042	- IP emission/point (g/s)	0.075	- IP emission/point (g/s)	0.042	- IP emission/point (g/s)	0.075
- CP emission/point (g/s)	0.020	- CP emission/point (g/s)	0.036	- CP emission/point (g/s)	0.020	- CP emission/point (g/s)	0.036
GRADERS				GRADERS			
- speed (km/h)	8.000			- speed (km/h)	8.000		
- hours	600.000			- hours	600.000		
Particle sizes				Particle sizes			
- FP	0.060			- FP	0.060		
- IP	0.480			- IP	0.480		
- CP	0.460			- CP	0.460		
Emission factor (kg/VKT)	0.615			Emission factor (kg/VKT)	0.615		
Total annual emission (kg/y)	2,954.236			Total annual emission (kg/y)	2,954.236		
Number of points	33.000			Number of points	33.000		
- FP emission/point (g/s)	0.000			- FP emission/point (g/s)	0.000		
- IP emission/point (g/s)	0.001			- IP emission/point (g/s)	0.001		
- CP emission/point (g/s)	0.001			- CP emission/point (g/s)	0.001		
STOCKPILE WIND EROSION				STOCKPILE WIND EROSION			
wind speed (m/s)	3.070			wind speed (m/s)	3.070		
area (ha)	18.000			area (ha)	18.000		
Particle sizes				Particle sizes			
- FP	0.000			- FP	0.000		
- IP	0.670			- IP	0.670		
- CP	0.330			- CP	0.330		
Emission factor (kg/ha.h)	0.400			Emission factor (kg/ha.h)	0.400		
Total annual emission (kg/y)	63,072.000			Total annual emission (kg/y)	63,072.000		
Number of points	3.000			Number of points	3.000		
- FP emission/point (g/s)	0.000			- FP emission/point (g/s)	0.000		
- IP emission/point (g/s)	0.447			- IP emission/point (g/s)	0.447		
- CP emission/point (g/s)	0.220			- CP emission/point (g/s)	0.220		
MINE WIND EROSION - N PIT		MINE WIND EROSION - SW PIT		MINE WIND EROSION - N PIT		MINE WIND EROSION - SW PIT	
wind speed (m/s)	3.070	wind speed (m/s)	3.070	wind speed (m/s)	3.070	wind speed (m/s)	3.070
percent of time u>5.4 m/s	11.100	percent of time u>5.4 m/s	11.100	percent of time u>5.4 m/s	11.100	percent of time u>5.4 m/s	11.100
number of rain days	114.000	number of rain days	114.000	number of rain days	114.000	number of rain days	114.000
area (ha)	150.000	area (ha)	150.000	area (ha)	150.000	area (ha)	150.000
Particle sizes		Particle sizes		Particle sizes		Particle sizes	
- FP	0.000	- FP	0.000	- FP	0.000	- FP	0.000
- IP	0.670	- IP	0.670	- IP	0.670	- IP	0.670
- CP	0.330	- CP	0.330	- CP	0.330	- CP	0.330
Emission factor (kg/ha.h)	0.097	Emission factor (kg/ha.h)	0.097	Emission factor (kg/ha.h)	0.097	Emission factor (kg/ha.h)	0.097
Total annual emission (kg/y)	127,458.000	Total annual emission (kg/y)	127,458.000	Total annual emission (kg/y)	127,458.000	Total annual emission (kg/y)	127,458.000
Number of points	7.000	Number of points	7.000	Number of points	7.000	Number of points	7.000
- FP emission/point (g/s)	0.000	- FP emission/point (g/s)	0.000	- FP emission/point (g/s)	0.000	- FP emission/point (g/s)	0.000
- IP emission/point (g/s)	0.387	- IP emission/point (g/s)	0.387	- IP emission/point (g/s)	0.387	- IP emission/point (g/s)	0.387
- CP emission/point (g/s)	0.191	- CP emission/point (g/s)	0.191	- CP emission/point (g/s)	0.191	- CP emission/point (g/s)	0.191
WASTE DUMP WIND EROSION - N PIT		WASTE DUMP WIND EROSION - SE PIT		WASTE DUMP WIND EROSION - N PIT		WASTE DUMP WIND EROSION - SE PIT	
wind speed (m/s)	3.070	wind speed (m/s)	3.070	wind speed (m/s)	3.070	wind speed (m/s)	3.070
area (ha)	100.000	area (ha)	100.000	area (ha)	100.000	area (ha)	100.000
Particle sizes		Particle sizes		Particle sizes		Particle sizes	
- FP	0.000	- FP	0.000	- FP	0.000	- FP	0.000
- IP	0.670	- IP	0.670	- IP	0.670	- IP	0.670
- CP	0.330	- CP	0.330	- CP	0.330	- CP	0.330
Emission factor (kg/ha.h)	0.097	Emission factor (kg/ha.h)	0.097	Emission factor (kg/ha.h)	0.097	Emission factor (kg/ha.h)	0.097
Total annual emission (kg/y)	84,972.000	Total annual emission (kg/y)	84,972.000	Total annual emission (kg/y)	84,972.000	Total annual emission (kg/y)	84,972.000
Number of points	9.000	Number of points	5.000	Number of points	9.000	Number of points	5.000
- FP emission/point (g/s)	0.000	- FP emission/point (g/s)	0.000	- FP emission/point (g/s)	0.000	- FP emission/point (g/s)	0.000
- IP emission/point (g/s)	0.201	- IP emission/point (g/s)	0.361	- IP emission/point (g/s)	0.201	- IP emission/point (g/s)	0.361
- CP emission/point (g/s)	0.099	- CP emission/point (g/s)	0.178	- CP emission/point (g/s)	0.099	- CP emission/point (g/s)	0.178
TRAIN LOADOUT				TRAIN LOADOUT			
wind speed (m/s)	3.07			wind speed (m/s)	3.07		
moisture (%)	5			moisture (%)	5		
k (US EPA p 11.2.3-3, 9/1988)	0.74			k (US EPA p 11.2.3-3, 9/1988)	0.74		
Emission factor (kg/t)	0.000506251			Emission factor (kg/t)	0.000506251		
tonnes of coal loaded	1599700			tonnes of coal loaded	1599700		

Annual emission (kg)	809.8500962			Annual emission (kg)	809.8500962		
Particle sizes				Particle sizes			
- FP	0.05			- FP	0.05		
- IP	0.58			- IP	0.58		
- CP	0.37			- CP	0.37		
Number of points	1.000			Number of points	1.000		
- FP emission/point (g/s)	0.001			- FP emission/point (g/s)	0.001		
- IP emission/point (g/s)	0.015			- IP emission/point (g/s)	0.015		
- CP emission/point (g/s)	0.010			- CP emission/point (g/s)	0.010		
LOAD TO STOCKPILES				LOAD TO STOCKPILES			
wind speed (m/s)	3.07			wind speed (m/s)	3.07		
moisture (%)	5			moisture (%)	5		
k (US EPA p 11.2.3-3, 9/1988)	0.74			k (US EPA p 11.2.3-3, 9/1988)	0.74		
Emission factor (kg/t)	0.000506251			Emission factor (kg/t)	0.000506251		
tonnes of coal loaded	1599700			tonnes of coal loaded	1599700		
Annual emission (kg)	809.8500962			Annual emission (kg)	809.8500962		
Particle sizes				Particle sizes			
- FP	0.05			- FP	0.05		
- IP	0.58			- IP	0.58		
- CP	0.37			- CP	0.37		
Number of points	1.000			Number of points	1.000		
- FP emission/point (g/s)	0.001			- FP emission/point (g/s)	0.001		
- IP emission/point (g/s)	0.015			- IP emission/point (g/s)	0.015		
- CP emission/point (g/s)	0.010			- CP emission/point (g/s)	0.010		
HAULING COAL - REJECTS TO N PIT				HAULING COAL - REJECTS TO N PIT			
- average distance (km)	4.500			- average distance (km)	4.500		
- quantity of material (t)	861,300.000			- quantity of material (t)	861,300.000		
- truck size (t)	85.000			- truck size (t)	85.000		
- density (t/bcm)	1.500			- density (t/bcm)	1.500		
- emission factor (kg/VKT)	1.000			- emission factor (kg/VKT)	1.000		
Particle size distribution				Particle size distribution			
- FP	0.060			- FP	0.060		
- IP	0.530			- IP	0.530		
- CP	0.410			- CP	0.410		
Total annual emission (kg/y)	45,598.235			Total annual emission (kg/y)	45,598.235		
Total emission in g/s	1.446			Total emission in g/s	1.446		
Number of points	9.000			Number of points	9.000		
- FP emission/point (g/s)	0.010			- FP emission/point (g/s)	0.010		
- IP emission/point (g/s)	0.085			- IP emission/point (g/s)	0.085		
- CP emission/point (g/s)	0.066			- CP emission/point (g/s)	0.066		
DRAGLINE HANDLING OF O/B - N PIT		DRAGLINE HANDLING OF O/B - SE PIT		DRAGLINE HANDLING OF O/B - N PIT		DRAGLINE HANDLING OF O/B - SE PIT	
- quantity of prime (bcm)	1,750,000.000	- quantity of prime (bcm)	1,750,000.000	- quantity of prime (bcm)	2,350,000.000	- quantity of prime (bcm)	2,350,000.000
- per cent rehandle (bcm)	34.000	- per cent rehandle (bcm)	34.000	- per cent rehandle (bcm)	55.000	- per cent rehandle (bcm)	55.000
- drop height (m)	12.000	- drop height (m)	12.000	- drop height (m)	12.000	- drop height (m)	12.000
- moisture (%)	2.000	- moisture (%)	2.000	- moisture (%)	2.000	- moisture (%)	2.000
- swell factor	1.400	- swell factor	1.400	- swell factor	1.400	- swell factor	1.400
- Emission factor (kg/cu. m)	0.074	- Emission factor (kg/cu. m)	0.074	- Emission factor (kg/cu. m)	0.074	- Emission factor (kg/cu. m)	0.074
- Total annual emission (kg/y)	241,956.454	- Total annual emission (kg/y)	241,956.454	- Total annual emission (kg/y)	375,832.146	- Total annual emission (kg/y)	375,832.146
Particle size distribution		Particle size distribution		Particle size distribution		Particle size distribution	
- FP	0.070	- FP	0.070	- FP	0.070	- FP	0.070
- IP	0.500	- IP	0.500	- IP	0.500	- IP	0.500
- CP	0.430	- CP	0.430	- CP	0.430	- CP	0.430
Number of points	7.000	Number of points	7.000	Number of points	7.000	Number of points	7.000
- FP emission/point (g/s)	0.077	- FP emission/point (g/s)	0.077	- FP emission/point (g/s)	0.119	- FP emission/point (g/s)	0.119
- IP emission/point (g/s)	0.548	- IP emission/point (g/s)	0.548	- IP emission/point (g/s)	0.851	- IP emission/point (g/s)	0.851
- CP emission/point (g/s)	0.860	- CP emission/point (g/s)	0.860	- CP emission/point (g/s)	0.860	- CP emission/point (g/s)	0.860

RIXS CREEK YEAR 22 DUST EMISSION ESTIMATES - (dragline option)

HAULING OVERBURDEN - N PIT		HAULING OVERBURDEN - SW PIT	
- average distance (km)	4.000	- average distance (km)	5.000
- quantity of material bcm	4,970,800.000	- quantity of material bcm	5,072,900.000
- truck size (t)	120.000	- truck size (t)	120.000
- density (t/bcm)	2.400	- density (t/bcm)	2.400
- emission factor (kg/VKT)	1.000	- emission factor (kg/VKT)	1.000
Particle size distribution		Particle size distribution	
- FP	0.060	- FP	0.060
- IP	0.530	- IP	0.530
- CP	0.410	- CP	0.410
Total annual emission (kg/y)	397,664.000	Total annual emission (kg/y)	507,290.000
Total emission in g/s	12.610	Total emission in g/s	16.086
Number of points	18.000	Number of points	18.000
- FP emission/point (g/s)	0.042	- FP emission/point (g/s)	0.054
- IP emission/point (g/s)	0.371	- IP emission/point (g/s)	0.474
- CP emission/point (g/s)	0.287	- CP emission/point (g/s)	0.366
LOADING OVERBURDEN - N PIT		LOADING OVERBURDEN - SW PIT	
- quantity of material bcm	4,970,800.000	- quantity of material bcm	5,072,900.000
- density (t/bcm)	2.400	- density (t/bcm)	2.400
- emission factor (kg/t)	0.025	- emission factor (kg/t)	0.025
Particle size distribution		Particle size distribution	
- FP	0.040	- FP	0.040
- IP	0.440	- IP	0.440
- CP	0.530	- CP	0.530
Total annual emission (kg/y)	298,248.000	Total annual emission (kg/y)	304,374.000
Total emission in g/s	9.457	Total emission in g/s	9.652
Number of points	8.000	Number of points	8.000
- FP emission/point (g/s)	0.047	- FP emission/point (g/s)	0.048
- IP emission/point (g/s)	0.520	- IP emission/point (g/s)	0.531
- CP emission/point (g/s)	0.627	- CP emission/point (g/s)	0.639
DUMPING OVERBURDEN - N PIT		DUMPING OVERBURDEN - SW PIT	
- quantity of material bcm	4,970,800.000	- quantity of material bcm	5,072,900.000
- density (t/bcm)	2.400	- density (t/bcm)	2.400
- emission factor (kg/t)	0.012	- emission factor (kg/t)	0.012
Particle size distribution		Particle size distribution	
- FP	0.040	- FP	0.040
- IP	0.440	- IP	0.440
- CP	0.530	- CP	0.530
Total annual emission (kg/y)	143,159.040	Total annual emission (kg/y)	146,099.520
Total emission in g/s	4.540	Total emission in g/s	4.633
Number of points	10.000	Number of points	5.000
- FP emission/point (g/s)	0.018	- FP emission/point (g/s)	0.037
- IP emission/point (g/s)	0.200	- IP emission/point (g/s)	0.408
- CP emission/point (g/s)	0.241	- CP emission/point (g/s)	0.491
DRILLING N PIT		DRILLING SW PIT	
Volume of material (bcm)	6,720,800.000	Volume of material (bcm)	6,822,900.000
fraction of material (0 to 1)	0.500	fraction of material (0 to 1)	0.500
hole spacing (m)	7.500	hole spacing (m)	7.500
bench depth	15.000	bench depth	15.000
emission factor (kg/hole)	0.600	emission factor (kg/hole)	0.600
Particle size distribution		Particle size distribution	
- FP	0.050	- FP	0.050
- IP	0.390	- IP	0.390
- CP	0.560	- CP	0.560
Total annual emission (kg/y)	2,389.618	Total annual emission (kg/y)	2,425.920
Total emission in g/s	0.076	Total emission in g/s	0.077
Number of points	8.000	Number of points	8.000
- FP emission/point (g/s)	0.004	- FP emission/point (g/s)	0.004
- IP emission/point (g/s)	0.005	- IP emission/point (g/s)	0.005
- CP emission/point (g/s)	0.005	- CP emission/point (g/s)	0.005
BLASTING - N PIT		BLASTING - SW PIT	
Volume of material (bcm)	6,720,800.000	Volume of material (bcm)	6,822,900.000
fraction of material (0 to 1)	0.500	fraction of material (0 to 1)	0.500
moisture content (%)	7.200	moisture content (%)	7.200
bench depth (m)	15.000	bench depth (m)	15.000
number of blast/year	104.000	number of blast/year	104.000
emission factor (kg/blast)	28.660	emission factor (kg/blast)	29.008
Particle size distribution		Particle size distribution	
- FP	0.050	- FP	0.050
- IP	0.390	- IP	0.390
- CP	0.560	- CP	0.560
Total annual emission (kg/y)	2,980.636	Total annual emission (kg/y)	3,016.805
Total emission in g/s	0.095	Total emission in g/s	0.096
Number of points	8.000	Number of points	8.000
- FP emission/point (g/s)	0.005	- FP emission/point (g/s)	0.005
- IP emission/point (g/s)	0.007	- IP emission/point (g/s)	0.007
- CP emission/point (g/s)	0.007	- CP emission/point (g/s)	0.007
HAULING COAL - N PIT		HAULING COAL - SW PIT	
- average distance (km)	8.000	- average distance (km)	9.000
- quantity of material (t)	1,090,900.000	- quantity of material (t)	947,900.000
- truck size (t)	85.000	- truck size (t)	85.000
- density (t/bcm)	1.500	- density (t/bcm)	1.500
- emission factor (kg/VKT)	1.000	- emission factor (kg/VKT)	1.000
Particle size distribution		Particle size distribution	
- FP	0.060	- FP	0.060
- IP	0.530	- IP	0.530
- CP	0.410	- CP	0.410
Total annual emission (kg/y)	102,672.941	Total annual emission (kg/y)	100,365.882
Total emission in g/s	3.256	Total emission in g/s	3.183
Number of points	16.000	Number of points	20.000
- FP emission/point (g/s)	0.012	- FP emission/point (g/s)	0.010
- IP emission/point (g/s)	0.108	- IP emission/point (g/s)	0.084
- CP emission/point (g/s)	0.083	- CP emission/point (g/s)	0.065
LOADING COAL - N PIT		LOADING COAL - SW PIT	
- quantity of material (t)	1,090,900.000	- quantity of material (t)	947,900.000
- density (t/bcm)	1.500	- density (t/bcm)	1.500
- emission factor (kg/t)	0.029	- emission factor (kg/t)	0.029
Particle size distribution		Particle size distribution	
- FP	0.040	- FP	0.040
- IP	0.440	- IP	0.440
- CP	0.530	- CP	0.530
Total annual emission (kg/y)	31,636.100	Total annual emission (kg/y)	27,489.100
Total emission in g/s	1.003	Total emission in g/s	0.872
Number of points	8.000	Number of points	8.000
- FP emission/point (g/s)	0.005	- FP emission/point (g/s)	0.004
- IP emission/point (g/s)	0.055	- IP emission/point (g/s)	0.048
- CP emission/point (g/s)	0.066	- CP emission/point (g/s)	0.058
DUMPING COAL - FROM N + SW PITS			
- quantity of material (t)	2,038,800.000		
- emission factor (kg/t)	0.010		
Particle sizes			
- FP	0.040		
- IP	0.440		

RIXS CREEK YEAR 22 DUST EMISSION ESTIMATES - (Shovel option)

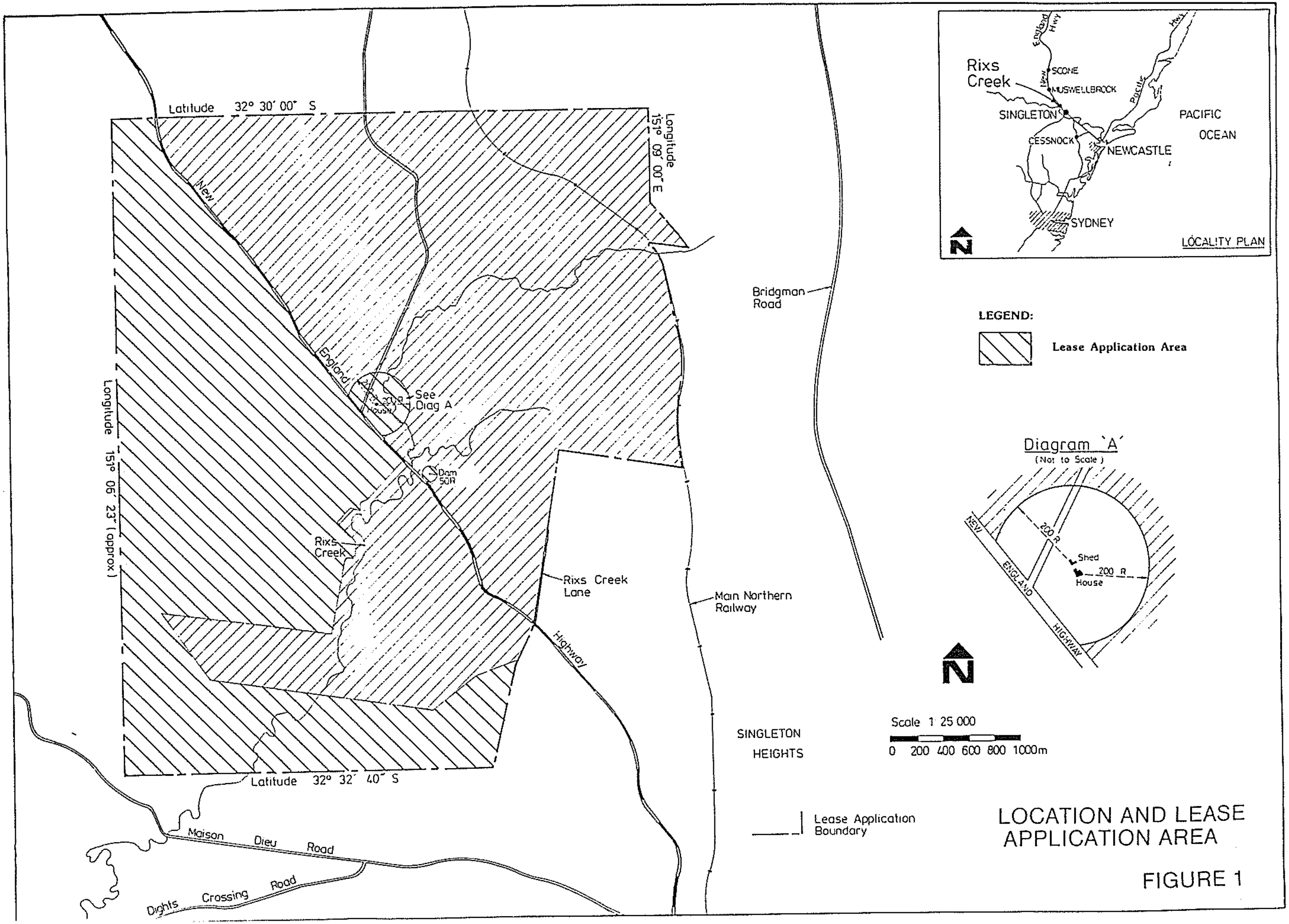
HAULING OVERBURDEN - N PIT		HAULING OVERBURDEN - SW PIT	
- average distance (km)	4.000	- average distance (km)	5.000
- quantity of material bcm	4,370,800.000	- quantity of material bcm	4,472,900.000
- truck size (t)	120.000	- truck size (t)	120.000
- density (t/bcm)	2.400	- density (t/bcm)	2.400
- emission factor (kg/VKT)	1.000	- emission factor (kg/VKT)	1.000
Particle size distribution		Particle size distribution	
- FP	0.060	- FP	0.060
- IP	0.530	- IP	0.530
- CP	0.410	- CP	0.410
Total annual emission (kg/y)	349,664.000	Total annual emission (kg/y)	447,290.000
Total emission in g/s	11.088	Total emission in g/s	14.183
Number of points	18.000	Number of points	18.000
- FP emission/point (g/s)	0.037	- FP emission/point (g/s)	0.047
- IP emission/point (g/s)	0.326	- IP emission/point (g/s)	0.418
- CP emission/point (g/s)	0.253	- CP emission/point (g/s)	0.323
LOADING OVERBURDEN - N PIT		LOADING OVERBURDEN - SW PIT	
- quantity of material bcm	4,370,800.000	- quantity of material bcm	4,472,900.000
- density (t/bcm)	2.400	- density (t/bcm)	2.400
- emission factor (kg/t)	0.025	- emission factor (kg/t)	0.025
Particle size distribution		Particle size distribution	
- FP	0.040	- FP	0.040
- IP	0.440	- IP	0.440
- CP	0.530	- CP	0.530
Total annual emission (kg/y)	262,248.000	Total annual emission (kg/y)	268,374.000
Total emission in g/s	8.316	Total emission in g/s	8.510
Number of points	8.000	Number of points	8.000
- FP emission/point (g/s)	0.042	- FP emission/point (g/s)	0.043
- IP emission/point (g/s)	0.457	- IP emission/point (g/s)	0.468
- CP emission/point (g/s)	0.551	- CP emission/point (g/s)	0.564
DUMPING OVERBURDEN - N PIT		DUMPING OVERBURDEN - SW PIT	
- quantity of material bcm	4,370,800.000	- quantity of material bcm	4,472,900.000
- density (t/bcm)	2.400	- density (t/bcm)	2.400
- emission factor (kg/t)	0.012	- emission factor (kg/t)	0.012
Particle size distribution		Particle size distribution	
- FP	0.040	- FP	0.040
- IP	0.440	- IP	0.440
- CP	0.530	- CP	0.530
Total annual emission (kg/y)	125,879.040	Total annual emission (kg/y)	128,819.520
Total emission in g/s	3.992	Total emission in g/s	4.085
Number of points	10.000	Number of points	5.000
- FP emission/point (g/s)	0.016	- FP emission/point (g/s)	0.033
- IP emission/point (g/s)	0.176	- IP emission/point (g/s)	0.359
- CP emission/point (g/s)	0.212	- CP emission/point (g/s)	0.433
DRILLING N PIT		DRILLING SW PIT	
Volume of material (bcm)	6,720,800.000	Volume of material (bcm)	6,822,900.000
fraction of material (0 to 1)	0.500	fraction of material (0 to 1)	0.500
hole spacing (m)	7.500	hole spacing (m)	7.500
bench depth	15.000	bench depth	15.000
emission factor (kg/hole)	0.600	emission factor (kg/hole)	0.600
Particle size distribution		Particle size distribution	
- FP	0.050	- FP	0.050
- IP	0.390	- IP	0.390
- CP	0.560	- CP	0.560
Total annual emission (kg/y)	2,389.618	Total annual emission (kg/y)	2,425.920
Total emission in g/s	0.076	Total emission in g/s	0.077
Number of points	8.000	Number of points	8.000
- FP emission/point (g/s)	0.004	- FP emission/point (g/s)	0.004
- IP emission/point (g/s)	0.005	- IP emission/point (g/s)	0.005
- CP emission/point (g/s)	0.005	- CP emission/point (g/s)	0.005
BLASTING - N PIT		BLASTING - SW PIT	
Volume of material (bcm)	6,720,800.000	Volume of material (bcm)	6,822,900.000
fraction of material (0 to 1)	0.500	fraction of material (0 to 1)	0.500
moisture content (%)	7.200	moisture content (%)	7.200
bench depth (m)	15.000	bench depth (m)	15.000
number of blast/year	104.000	number of blast/year	104.000
emission factor (kg/blast)	28.660	emission factor (kg/blast)	29.008
Particle size distribution		Particle size distribution	
- FP	0.050	- FP	0.050
- IP	0.390	- IP	0.390
- CP	0.560	- CP	0.560
Total annual emission (kg/y)	2,980.636	Total annual emission (kg/y)	3,016.805
Total emission in g/s	0.095	Total emission in g/s	0.096
Number of points	8.000	Number of points	8.000
- FP emission/point (g/s)	0.005	- FP emission/point (g/s)	0.005
- IP emission/point (g/s)	0.007	- IP emission/point (g/s)	0.007
- CP emission/point (g/s)	0.007	- CP emission/point (g/s)	0.007
HAULING COAL - N PIT		HAULING COAL - SW PIT	
- average distance (km)	8.000	- average distance (km)	9.000
- quantity of material (t)	1,090,900.000	- quantity of material (t)	947,900.000
- truck size (t)	85.000	- truck size (t)	85.000
- density (t/bcm)	1.500	- density (t/bcm)	1.500
- emission factor (kg/VKT)	1.000	- emission factor (kg/VKT)	1.000
Particle size distribution		Particle size distribution	
- FP	0.060	- FP	0.060
- IP	0.530	- IP	0.530
- CP	0.410	- CP	0.410
Total annual emission (kg/y)	102,672.941	Total annual emission (kg/y)	100,365.882
Total emission in g/s	3.256	Total emission in g/s	3.183
Number of points	16.000	Number of points	20.000
- FP emission/point (g/s)	0.012	- FP emission/point (g/s)	0.010
- IP emission/point (g/s)	0.108	- IP emission/point (g/s)	0.084
- CP emission/point (g/s)	0.083	- CP emission/point (g/s)	0.065
LOADING COAL - N PIT		LOADING COAL - SW PIT	
- quantity of material (t)	1,090,900.000	- quantity of material (t)	947,900.000
- density (t/bcm)	1.500	- density (t/bcm)	1.500
- emission factor (kg/t)	0.029	- emission factor (kg/t)	0.029
Particle size distribution		Particle size distribution	
- FP	0.040	- FP	0.040
- IP	0.440	- IP	0.440
- CP	0.530	- CP	0.530
Total annual emission (kg/y)	31,636.100	Total annual emission (kg/y)	27,489.100
Total emission in g/s	1.003	Total emission in g/s	0.872
Number of points	8.000	Number of points	8.000
- FP emission/point (g/s)	0.005	- FP emission/point (g/s)	0.004
- IP emission/point (g/s)	0.055	- IP emission/point (g/s)	0.048
- CP emission/point (g/s)	0.066	- CP emission/point (g/s)	0.058
DUMPING COAL - FROM N + SW PITS			
- quantity of material (t)	2,038,800.000		
- emission factor (kg/t)	0.010		
Particle sizes			
- FP	0.040		
- IP	0.440		

- CP	0.530		
Total annual emission (kg/y)	20,388.000		
Total emission in g/s	0.646		
Number of points	1.000		
- FP emission/point (g/s)	0.026		
- IP emission/point (g/s)	0.284		
- CP emission/point (g/s)	0.343		
DOZER ON COAL - N PIT		DOZER ON COAL - SW PIT	
- silt content (%)	8.000	- silt content (%)	8.000
- moisture content (%)	6.000	- moisture content (%)	6.000
- hours	1,728.000	- hours	1,728.000
Particle sizes		Particle sizes	
- FP	0.030	- FP	0.030
- IP	0.490	- IP	0.490
-CP	0.480	-CP	0.480
Emission factor (kg/h)	42.030	Emission factor (kg/h)	42.030
Total annual emission (kg/y)	72,628.169	Total annual emission (kg/y)	72,628.169
Total emission in g/s	2.303	Total emission in g/s	2.303
Number of points	8.000	Number of points	8.000
- FP emission/point (g/s)	0.009	- FP emission/point (g/s)	0.009
- IP emission/point (g/s)	0.141	- IP emission/point (g/s)	0.141
- CP emission/point (g/s)	0.138	- CP emission/point (g/s)	0.138
DOZER ON OVERBURDEN - N PIT		DOZER ON OVERBURDEN - SW PIT	
- silt content (%)	10.000	- silt content (%)	10.000
- moisture content (%)	9.000	- moisture content (%)	9.000
- hours	10,512.000	- hours	10,512.000
Particle sizes		Particle sizes	
- FP	0.200	- FP	0.200
- IP	0.540	- IP	0.540
-CP	0.260	-CP	0.260
Emission factor (kg/h)	2.368	Emission factor (kg/h)	2.368
Total annual emission (kg/y)	24,896.795	Total annual emission (kg/y)	24,896.795
Total emission in g/s	0.789	Total emission in g/s	0.789
Number of points	10.000	Number of points	5.000
- FP emission/point (g/s)	0.016	- FP emission/point (g/s)	0.032
- IP emission/point (g/s)	0.043	- IP emission/point (g/s)	0.085
- CP emission/point (g/s)	0.021	- CP emission/point (g/s)	0.041
SCRAPER ON OVERBURDEN - N PIT		SCRAPER ON OVERBURDEN - SW PIT	
- silt content (%)	10.000	- silt content (%)	10.000
- moisture content (%)	5.000	- moisture content (%)	5.000
- weight (t)	48.000	- weight (t)	48.000
- hours	10,512.000	- hours	10,512.000
Particle sizes		Particle sizes	
- FP	0.200	- FP	0.200
- IP	0.540	- IP	0.540
-CP	0.260	-CP	0.260
Emission factor (kg/h)	2.076	Emission factor (kg/h)	2.076
Total annual emission (kg/y)	21,824.060	Total annual emission (kg/y)	21,824.060
Total emission in g/s	0.692	Total emission in g/s	0.692
Number of points	10.000	Number of points	5.000
- FP emission/point (g/s)	0.014	- FP emission/point (g/s)	0.028
- IP emission/point (g/s)	0.037	- IP emission/point (g/s)	0.075
- CP emission/point (g/s)	0.018	- CP emission/point (g/s)	0.036
GRADERS			
- speed (km/h)	8.000		
- hours	650.000		
Particle sizes			
- FP	0.060		
- IP	0.480		
- CP	0.460		
Emission factor (kg/VKT)	0.615		
Total annual emission (kg/y)	3,200.422		
Number of points	37.000		
- FP emission/point (g/s)	0.000		
- IP emission/point (g/s)	0.001		
- CP emission/point (g/s)	0.001		
STOCKPILE WIND EROSION			
wind speed (m/s)	3.070		
area (ha)	18.000		
Particle sizes			
- FP	0.000		
- IP	0.670		
- CP	0.330		
Emission factor (kg/ha.h)	0.400		
Total annual emission (kg/y)	63,072.000		
Number of points	3.000		
- FP emission/point (g/s)	0.000		
- IP emission/point (g/s)	0.447		
- CP emission/point (g/s)	0.220		
MINE WIND EROSION - N PIT		MINE WIND EROSION - SW PIT	
wind speed (m/s)	3.070	wind speed (m/s)	3.070
percent of time u>5.4 m/s	11.100	percent of time u>5.4 m/s	11.100
number of rain days	114.000	number of rain days	114.000
area (ha)	150.000	area (ha)	150.000
Particle sizes		Particle sizes	
- FP	0.000	- FP	0.000
- IP	0.670	- IP	0.670
- CP	0.330	- CP	0.330
Emission factor (kg/ha.h)	0.097	Emission factor (kg/ha.h)	0.097
Total annual emission (kg/y)	127,458.000	Total annual emission (kg/y)	127,458.000
Number of points	8.000	Number of points	8.000
- FP emission/point (g/s)	0.000	- FP emission/point (g/s)	0.000
- IP emission/point (g/s)	0.338	- IP emission/point (g/s)	0.338
- CP emission/point (g/s)	0.167	- CP emission/point (g/s)	0.167
WASTE DUMP WIND EROSION - N PIT		WASTE DUMP WIND EROSION - SE PIT	
wind speed (m/s)	3.070	wind speed (m/s)	3.070
area (ha)	100.000	area (ha)	100.000
Particle sizes		Particle sizes	
- FP	0.000	- FP	0.000
- IP	0.670	- IP	0.670
- CP	0.330	- CP	0.330
Emission factor (kg/ha.h)	0.097	Emission factor (kg/ha.h)	0.097
Total annual emission (kg/y)	84,972.000	Total annual emission (kg/y)	84,972.000
Number of points	10.000	Number of points	5.000
- FP emission/point (g/s)	0.000	- FP emission/point (g/s)	0.000
- IP emission/point (g/s)	0.181	- IP emission/point (g/s)	0.361
- CP emission/point (g/s)	0.089	- CP emission/point (g/s)	0.178
TRAIN LOADOUT			
wind speed (m/s)	3.07		
moisture (%)	5		
k (US EPA p 11.2.3-3, 9/1988)	0.74		
Emission factor (kg/t)	0.000506251		
tonnes of coal loaded	1325300		

- CP	0.530		
Total annual emission (kg/y)	20,388.000		
Total emission in g/s	0.646		
Number of points	1.000		
- FP emission/point (g/s)	0.026		
- IP emission/point (g/s)	0.284		
- CP emission/point (g/s)	0.343		
DOZER ON COAL - N PIT		DOZER ON COAL - SW PIT	
- silt content (%)	8.000	- silt content (%)	8.000
- moisture content (%)	6.000	- moisture content (%)	6.000
- hours	1,728.000	- hours	1,728.000
Particle sizes		Particle sizes	
- FP	0.030	- FP	0.030
- IP	0.490	- IP	0.490
-CP	0.480	-CP	0.480
Emission factor (kg/h)	42.030	Emission factor (kg/h)	42.030
Total annual emission (kg/y)	72,628.169	Total annual emission (kg/y)	72,628.169
Total emission in g/s	2.303	Total emission in g/s	2.303
Number of points	8.000	Number of points	8.000
- FP emission/point (g/s)	0.009	- FP emission/point (g/s)	0.009
- IP emission/point (g/s)	0.141	- IP emission/point (g/s)	0.141
- CP emission/point (g/s)	0.138	- CP emission/point (g/s)	0.138
DOZER ON OVERBURDEN - N PIT		DOZER ON OVERBURDEN - SW PIT	
- silt content (%)	10.000	- silt content (%)	10.000
- moisture content (%)	9.000	- moisture content (%)	9.000
- hours	10,512.000	- hours	10,512.000
Particle sizes		Particle sizes	
- FP	0.200	- FP	0.200
- IP	0.540	- IP	0.540
-CP	0.260	-CP	0.260
Emission factor (kg/h)	2.368	Emission factor (kg/h)	2.368
Total annual emission (kg/y)	24,896.795	Total annual emission (kg/y)	24,896.795
Total emission in g/s	0.789	Total emission in g/s	0.789
Number of points	10.000	Number of points	5.000
- FP emission/point (g/s)	0.016	- FP emission/point (g/s)	0.032
- IP emission/point (g/s)	0.043	- IP emission/point (g/s)	0.085
- CP emission/point (g/s)	0.021	- CP emission/point (g/s)	0.041
SCRAPER ON OVERBURDEN - N PIT		SCRAPER ON OVERBURDEN - SW PIT	
- silt content (%)	10.000	- silt content (%)	10.000
- moisture content (%)	5.000	- moisture content (%)	5.000
- weight (t)	48.000	- weight (t)	48.000
- hours	10,512.000	- hours	10,512.000
Particle sizes		Particle sizes	
- FP	0.200	- FP	0.200
- IP	0.540	- IP	0.540
-CP	0.260	-CP	0.260
Emission factor (kg/h)	2.076	Emission factor (kg/h)	2.076
Total annual emission (kg/y)	21,824.060	Total annual emission (kg/y)	21,824.060
Total emission in g/s	0.692	Total emission in g/s	0.692
Number of points	10.000	Number of points	5.000
- FP emission/point (g/s)	0.014	- FP emission/point (g/s)	0.028
- IP emission/point (g/s)	0.037	- IP emission/point (g/s)	0.075
- CP emission/point (g/s)	0.018	- CP emission/point (g/s)	0.036
GRADERS			
- speed (km/h)	8.000		
- hours	650.000		
Particle sizes			
- FP	0.060		
- IP	0.480		
- CP	0.460		
Emission factor (kg/VKT)	0.615		
Total annual emission (kg/y)	3,200.422		
Number of points	37.000		
- FP emission/point (g/s)	0.000		
- IP emission/point (g/s)	0.001		
- CP emission/point (g/s)	0.001		
STOCKPILE WIND EROSION			
wind speed (m/s)	3.070		
area (ha)	18.000		
Particle sizes			
- FP	0.000		
- IP	0.670		
- CP	0.330		
Emission factor (kg/ha.h)	0.400		
Total annual emission (kg/y)	63,072.000		
Number of points	3.000		
- FP emission/point (g/s)	0.000		
- IP emission/point (g/s)	0.447		
- CP emission/point (g/s)	0.220		
MINE WIND EROSION - N PIT		MINE WIND EROSION - SW PIT	
wind speed (m/s)	3.070	wind speed (m/s)	3.070
percent of time u>5.4 m/s	11.100	percent of time u>5.4 m/s	11.100
number of rain days	114.000	number of rain days	114.000
area (ha)	150.000	area (ha)	150.000
Particle sizes		Particle sizes	
- FP	0.000	- FP	0.000
- IP	0.670	- IP	0.670
- CP	0.330	- CP	0.330
Emission factor (kg/ha.h)	0.097	Emission factor (kg/ha.h)	0.097
Total annual emission (kg/y)	127,458.000	Total annual emission (kg/y)	127,458.000
Number of points	8.000	Number of points	8.000
- FP emission/point (g/s)	0.000	- FP emission/point (g/s)	0.000
- IP emission/point (g/s)	0.338	- IP emission/point (g/s)	0.338
- CP emission/point (g/s)	0.167	- CP emission/point (g/s)	0.167
WASTE DUMP WIND EROSION - N PIT		WASTE DUMP WIND EROSION - SE PIT	
wind speed (m/s)	3.070	wind speed (m/s)	3.070
area (ha)	100.000	area (ha)	100.000
Particle sizes		Particle sizes	
- FP	0.000	- FP	0.000
- IP	0.670	- IP	0.670
- CP	0.330	- CP	0.330
Emission factor (kg/ha.h)	0.097	Emission factor (kg/ha.h)	0.097
Total annual emission (kg/y)	84,972.000	Total annual emission (kg/y)	84,972.000
Number of points	10.000	Number of points	5.000
- FP emission/point (g/s)	0.000	- FP emission/point (g/s)	0.000
- IP emission/point (g/s)	0.181	- IP emission/point (g/s)	0.361
- CP emission/point (g/s)	0.089	- CP emission/point (g/s)	0.178
TRAIN LOADOUT			
wind speed (m/s)	3.07		
moisture (%)	5		
k (US EPA p 11.2.3-3, 9/1988)	0.74		
Emission factor (kg/t)	0.000506251		
tonnes of coal loaded	1325300		

Annual emission (kg)	670.9347581			Annual emission (kg)	670.9347581		
Particle sizes				Particle sizes			
- FP	0.05			- FP	0.05		
- IP	0.58			- IP	0.58		
- CP	0.37			- CP	0.37		
Number of points	1.000			Number of points	1.000		
- FP emission/point (g/s)	0.001			- FP emission/point (g/s)	0.001		
- IP emission/point (g/s)	0.012			- IP emission/point (g/s)	0.012		
- CP emission/point (g/s)	0.008			- CP emission/point (g/s)	0.008		
LOAD TO STOCKPILES				LOAD TO STOCKPILES			
wind speed (m/s)	3.07			wind speed (m/s)	3.07		
moisture (%)	5			moisture (%)	5		
k (US EPA p 11.2.3-3, 9/1988)	0.74			k (US EPA p 11.2.3-3, 9/1988)	0.74		
Emission factor (kg/t)	0.000506251			Emission factor (kg/t)	0.000506251		
tonnes of coal loaded	1325300			tonnes of coal loaded	1325300		
Annual emission (kg)	670.9347581			Annual emission (kg)	670.9347581		
Particle sizes				Particle sizes			
- FP	0.05			- FP	0.05		
- IP	0.58			- IP	0.58		
- CP	0.37			- CP	0.37		
Number of points	1.000			Number of points	1.000		
- FP emission/point (g/s)	0.001			- FP emission/point (g/s)	0.001		
- IP emission/point (g/s)	0.012			- IP emission/point (g/s)	0.012		
- CP emission/point (g/s)	0.008			- CP emission/point (g/s)	0.008		
HAULING COAL - REJECTS TO N PIT				HAULING COAL - REJECTS TO N PIT			
- average distance (km)	4.500			- average distance (km)	4.500		
- quantity of material (t)	713,500.000			- quantity of material (t)	713,500.000		
- truck size (t)	85.000			- truck size (t)	85.000		
- density (t/bcm)	1.500			- density (t/bcm)	1.500		
- emission factor (kg/VKT)	1.000			- emission factor (kg/VKT)	1.000		
Particle size distribution				Particle size distribution			
- FP	0.060			- FP	0.060		
- IP	0.530			- IP	0.530		
- CP	0.410			- CP	0.410		
Total annual emission (kg/y)	37,773.529			Total annual emission (kg/y)	37,773.529		
Total emission in g/s	1.198			Total emission in g/s	1.198		
Number of points	9.000			Number of points	9.000		
- FP emission/point (g/s)	0.008			- FP emission/point (g/s)	0.008		
- IP emission/point (g/s)	0.071			- IP emission/point (g/s)	0.071		
- CP emission/point (g/s)	0.055			- CP emission/point (g/s)	0.055		
DRAGLINE HANDLING OF O/B - N PIT		DRAGLINE HANDLING OF O/B - SE PIT		DRAGLINE HANDLING OF O/B - N PIT		DRAGLINE HANDLING OF O/B - SE PIT	
	1,750,000.000	- quantity of prime (bcm)	1,750,000.000	- quantity of prime (bcm)	2,350,000.000	- quantity of prime (bcm)	2,350,000.000
- per cent rehandle (bcm)	34.000	- per cent rehandle (bcm)	34.000	- per cent rehandle (bcm)	55.000	- per cent rehandle (bcm)	55.000
- drop height (m)	12.000	- drop height (m)	12.000	- drop height (m)	12.000	- drop height (m)	12.000
- moisture (%)	2.000	- moisture (%)	2.000	- moisture (%)	2.000	- moisture (%)	2.000
- swell factor	1.400	- swell factor	1.400	- swell factor	1.400	- swell factor	1.400
- Emission factor (kg/cu. m)	0.074	- Emission factor (kg/cu. m)	0.074	- Emission factor (kg/cu. m)	0.074	- Emission factor (kg/cu. m)	0.074
- Total annual emission (kg/y)	241,956.454	- Total annual emission (kg/y)	241,956.454	- Total annual emission (kg/y)	375,832.146	- Total annual emission (kg/y)	375,832.146
Particle size distribution		Particle size distribution		Particle size distribution		Particle size distribution	
- FP	0.070	- FP	0.070	- FP	0.070	- FP	0.070
- IP	0.500	- IP	0.500	- IP	0.500	- IP	0.500
- CP	0.430	- CP	0.430	- CP	0.430	- CP	0.430
Number of points	8.000	Number of points	8.000	Number of points	8.000	Number of points	8.000
- FP emission/point (g/s)	0.067	- FP emission/point (g/s)	0.067	- FP emission/point (g/s)	0.104	- FP emission/point (g/s)	0.104
- IP emission/point (g/s)	0.480	- IP emission/point (g/s)	0.480	- IP emission/point (g/s)	0.745	- IP emission/point (g/s)	0.745
- CP emission/point (g/s)	0.860	- CP emission/point (g/s)	0.860	- CP emission/point (g/s)	0.860	- CP emission/point (g/s)	0.860

FIGURES

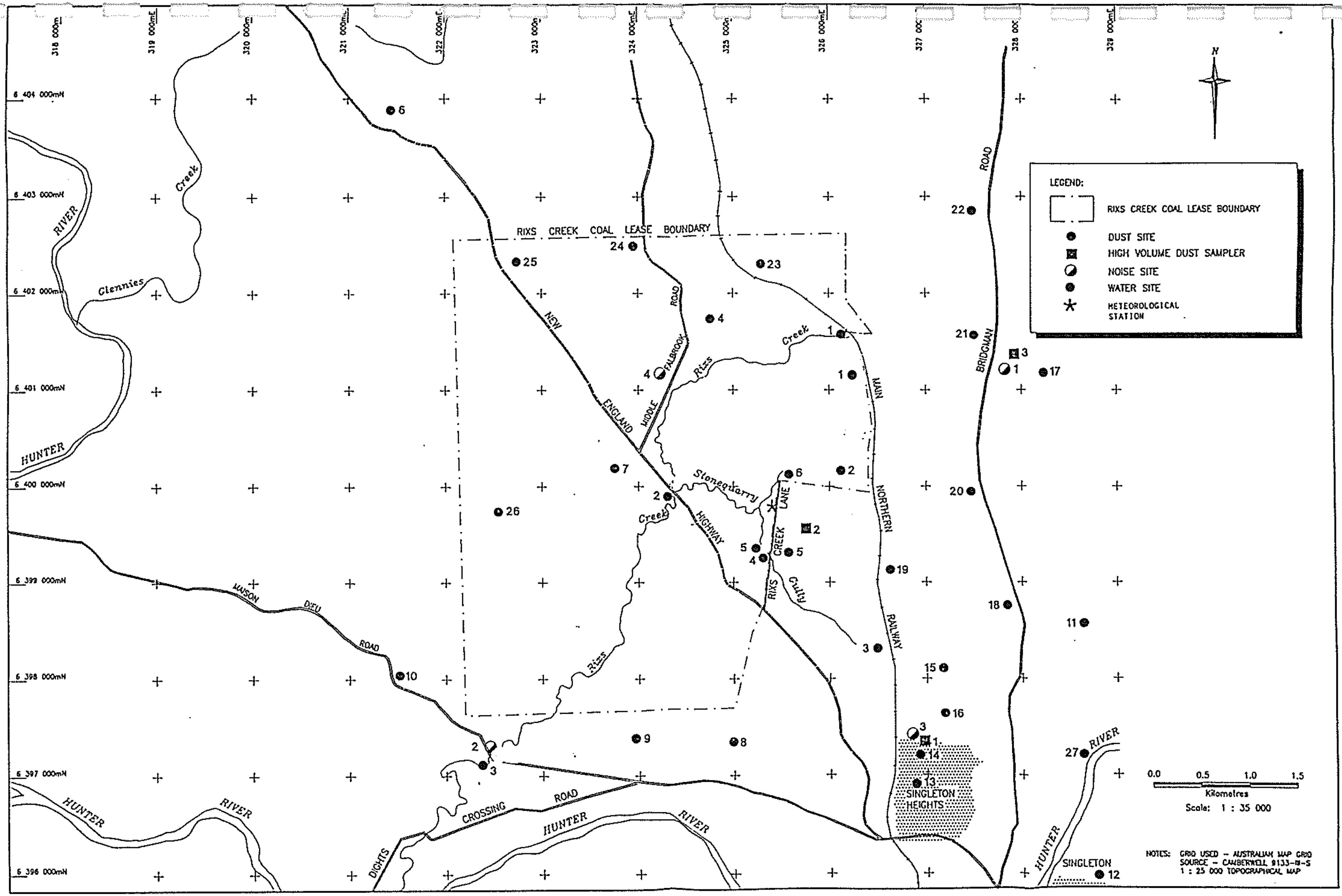


LOCATION AND LEASE APPLICATION AREA

FIGURE 1

FIGURE 2.

LOCAL LAND HOLDINGS,
MINE LAYOUT AND INFRASTRUCTURE

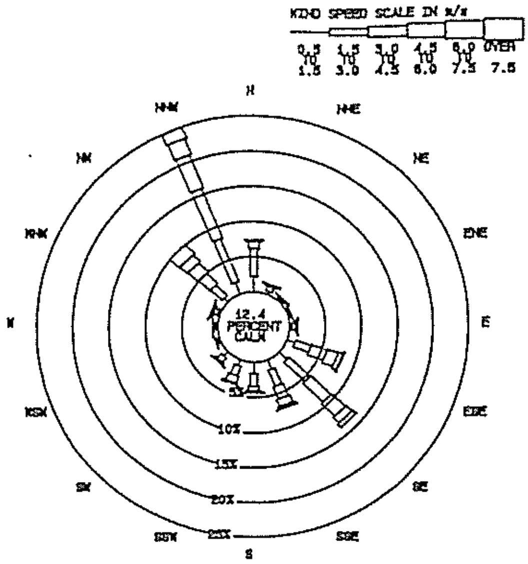


ENVIROSCIENCES PTY LIMITED
PROJECT No.: F1127

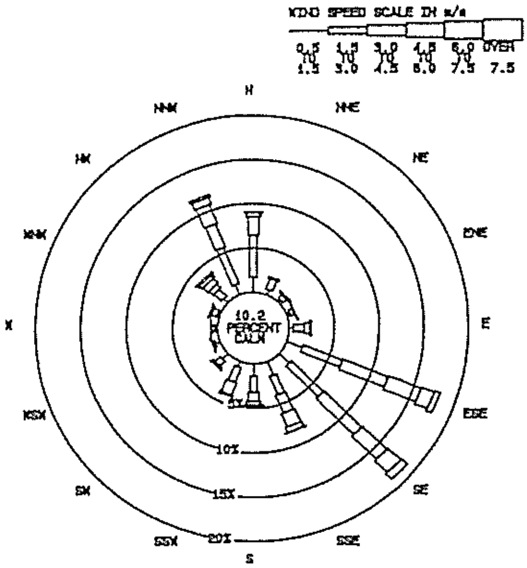
MONITORING SITES - RIXS CREEK MINE

FIGURE 3.

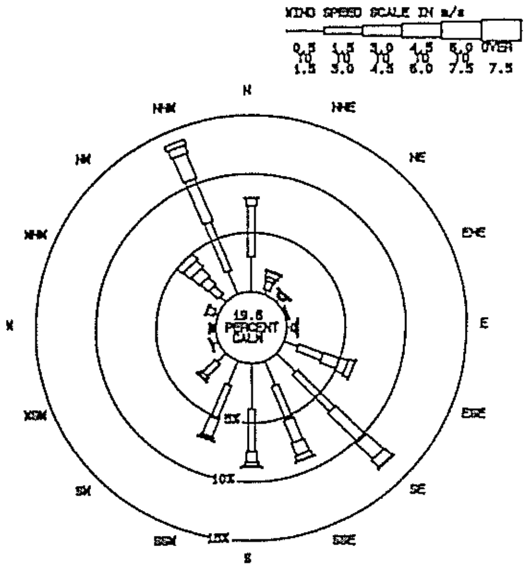
ANNUAL AND SEASONAL WINDROSES 1991



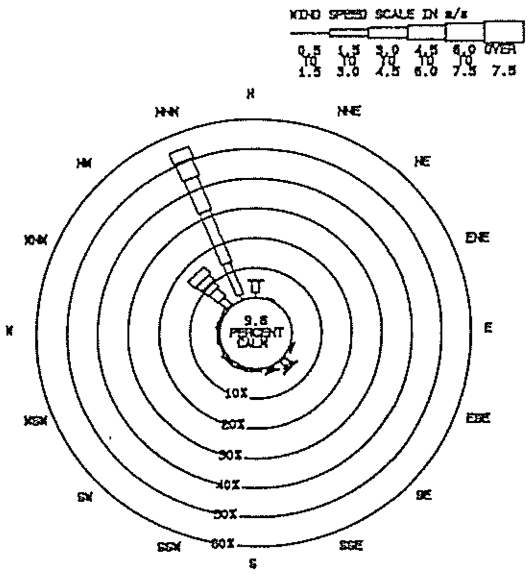
DISTRIBUTION OF WINDS
FREQUENCY OF OCCURRENCE IN PERCENT
Rixs Creek 1991 Annual



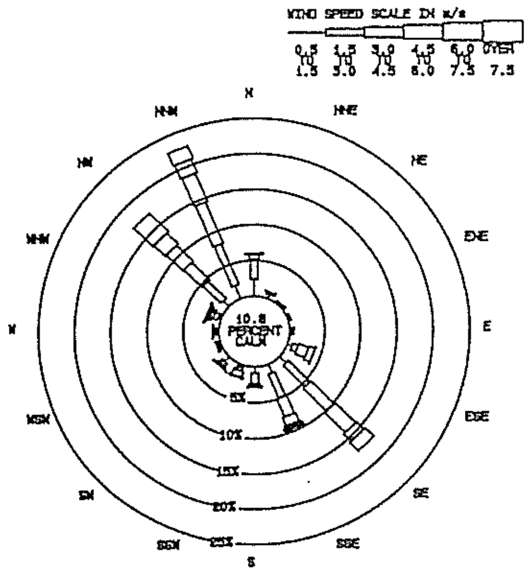
DISTRIBUTION OF WINDS
FREQUENCY OF OCCURRENCE IN PERCENT
Rixs Creek 1991 Summer



DISTRIBUTION OF WINDS
FREQUENCY OF OCCURRENCE IN PERCENT
Rixs Creek 1991 Autumn



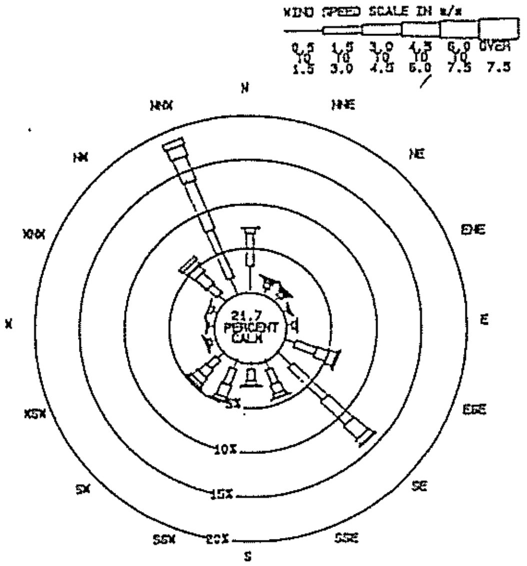
DISTRIBUTION OF WINDS
FREQUENCY OF OCCURRENCE IN PERCENT
Rixs Creek 1991 Winter



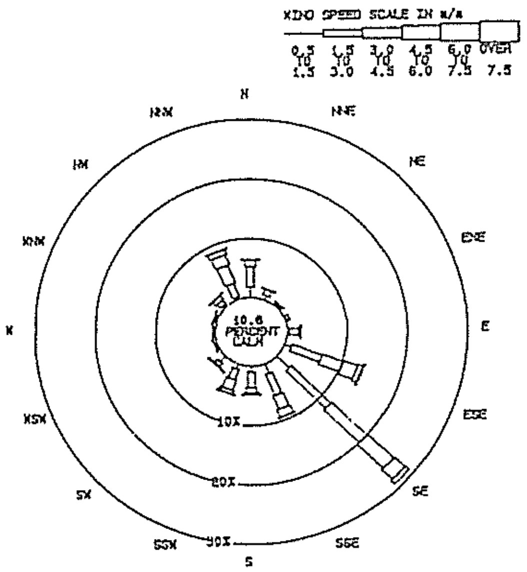
DISTRIBUTION OF WINDS
FREQUENCY OF OCCURRENCE IN PERCENT
Rixs Creek 1991 Spring

FIGURE 4.

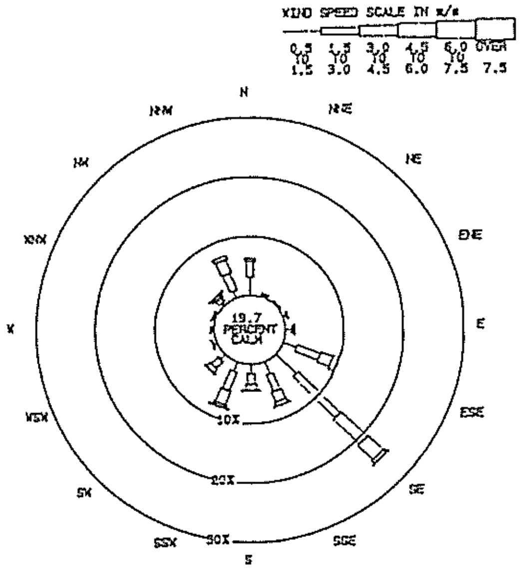
ANNUAL AND SEASONAL WINDROSES 1992



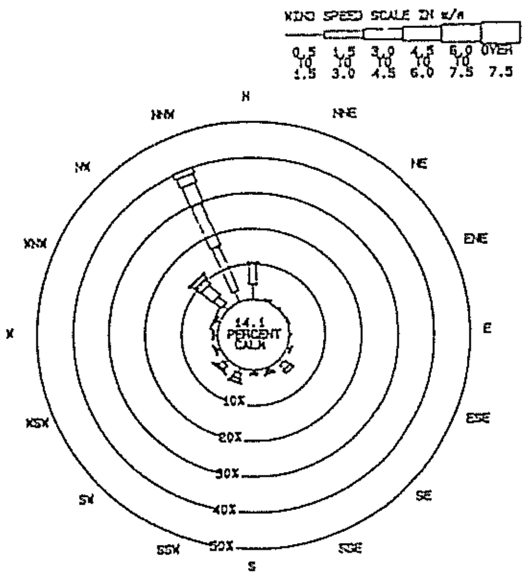
DISTRIBUTION OF WINDS
FREQUENCY OF OCCURRENCE IN PERCENT
Rixs Creek Annual 1992



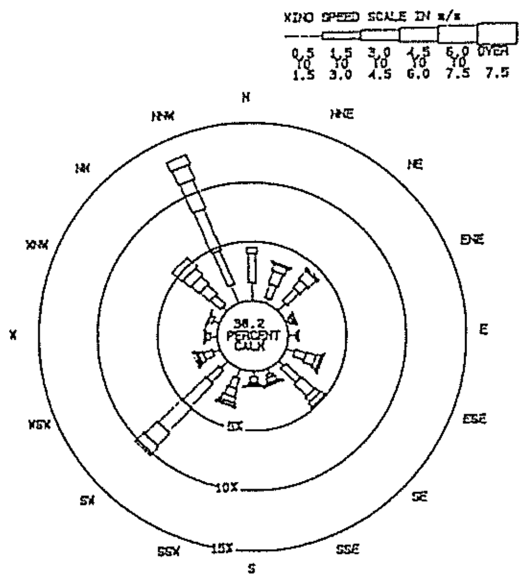
DISTRIBUTION OF WINDS
FREQUENCY OF OCCURRENCE IN PERCENT
Rixs Creek Summer 1992



DISTRIBUTION OF WINDS
FREQUENCY OF OCCURRENCE IN PERCENT
Rixs Creek Autumn 1992



DISTRIBUTION OF WINDS
FREQUENCY OF OCCURRENCE IN PERCENT
Rixs Creek Winter 1992

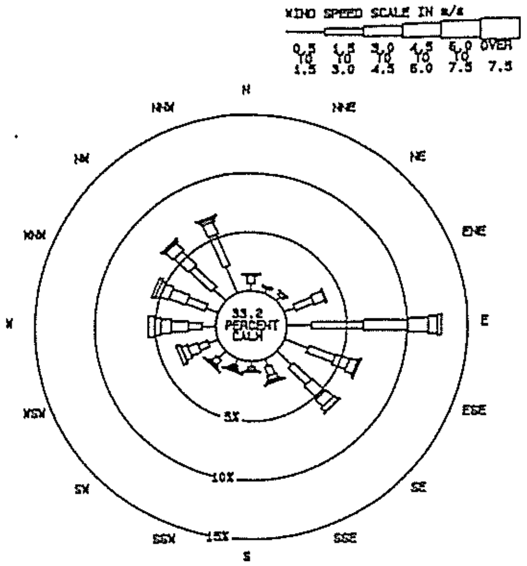


DISTRIBUTION OF WINDS
FREQUENCY OF OCCURRENCE IN PERCENT
Rixs Creek Spring 1992

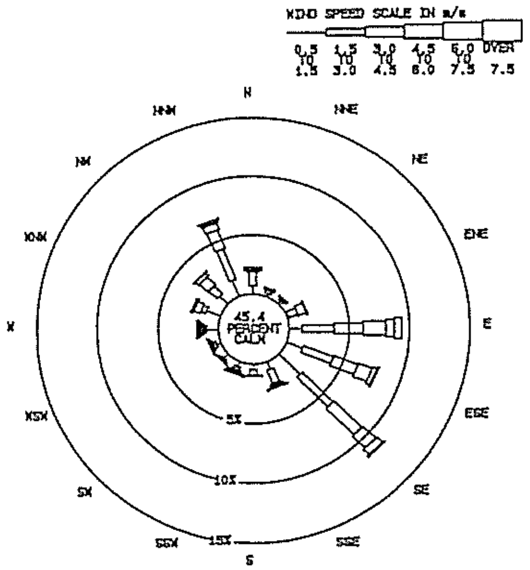
FIGURE 5

ANNUAL AND SEASONAL WINDROSES 1993

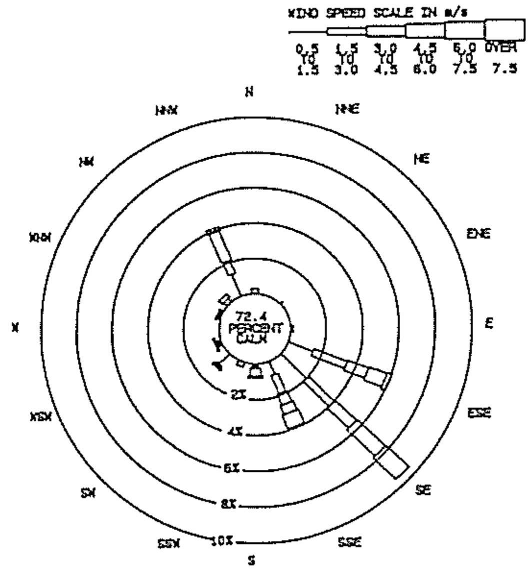
(refer to text concerning missing data for autumn and winter)



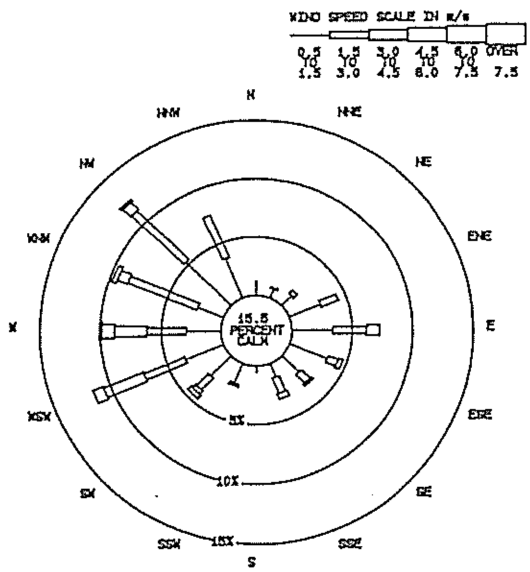
DISTRIBUTION OF WINDS
FREQUENCY OF OCCURRENCE IN PERCENT
Rixs Creek 1993 - Annual



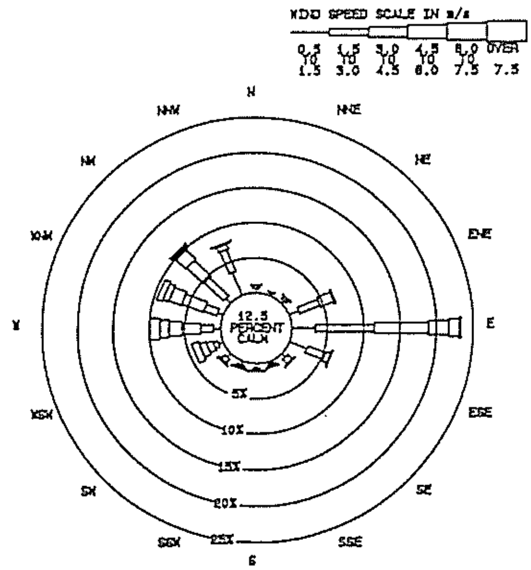
DISTRIBUTION OF WINDS
FREQUENCY OF OCCURRENCE IN PERCENT
Rixs Creek 1993 - Summer



DISTRIBUTION OF WINDS
FREQUENCY OF OCCURRENCE IN PERCENT
Rixs Creek 1993 - Autumn



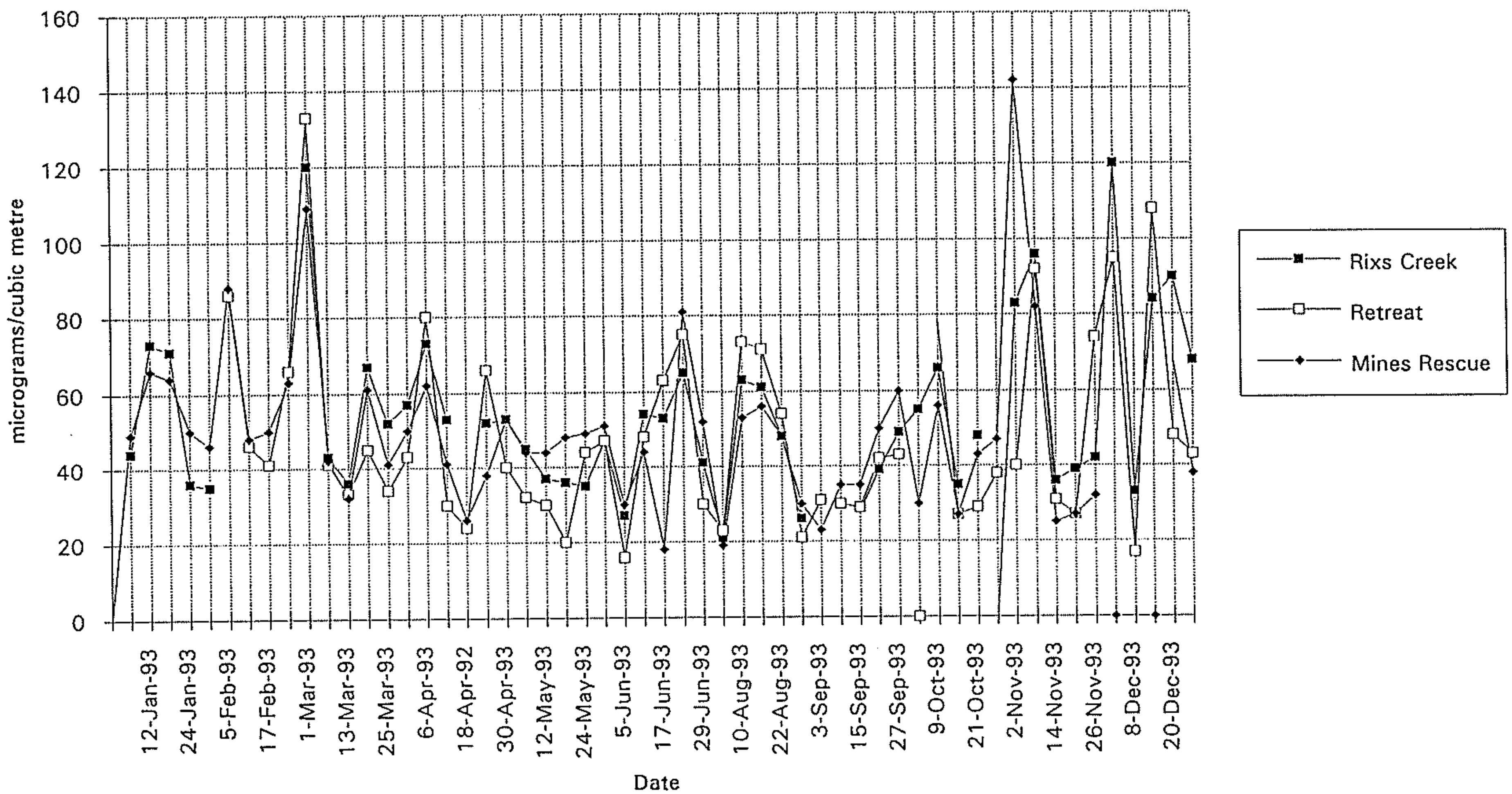
DISTRIBUTION OF WINDS
FREQUENCY OF OCCURRENCE IN PERCENT
Rixs Creek 1993 - Winter



DISTRIBUTION OF WINDS
FREQUENCY OF OCCURRENCE IN PERCENT
Rixs Creek 1993 - Spring

FIGURE 6.

Rix's Creek 24-hour TSP concentration data



Note: zero concentration is missing data

FIGURE 7.

PREDICTED DUST DEPOSITION RATE DUE TO EMISSIONS
FROM RIXS CREEK IN YEAR-1 - g/m²/month

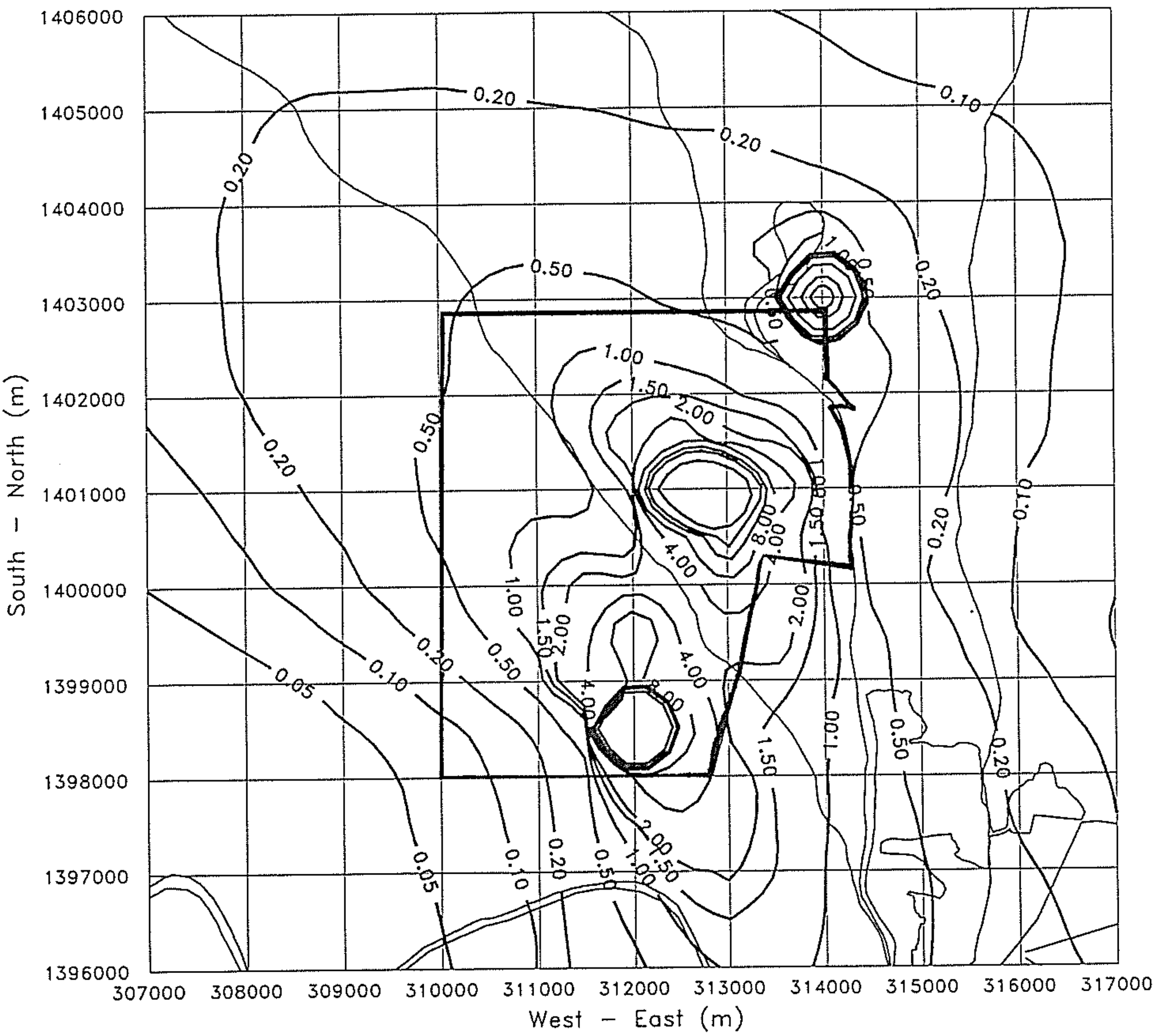


FIGURE 8

PREDICTED DUST CONCENTRATIONS DUE TO EMISSIONS FROM RIXS CREEK IN YEAR-1 - $\mu g/m^3$

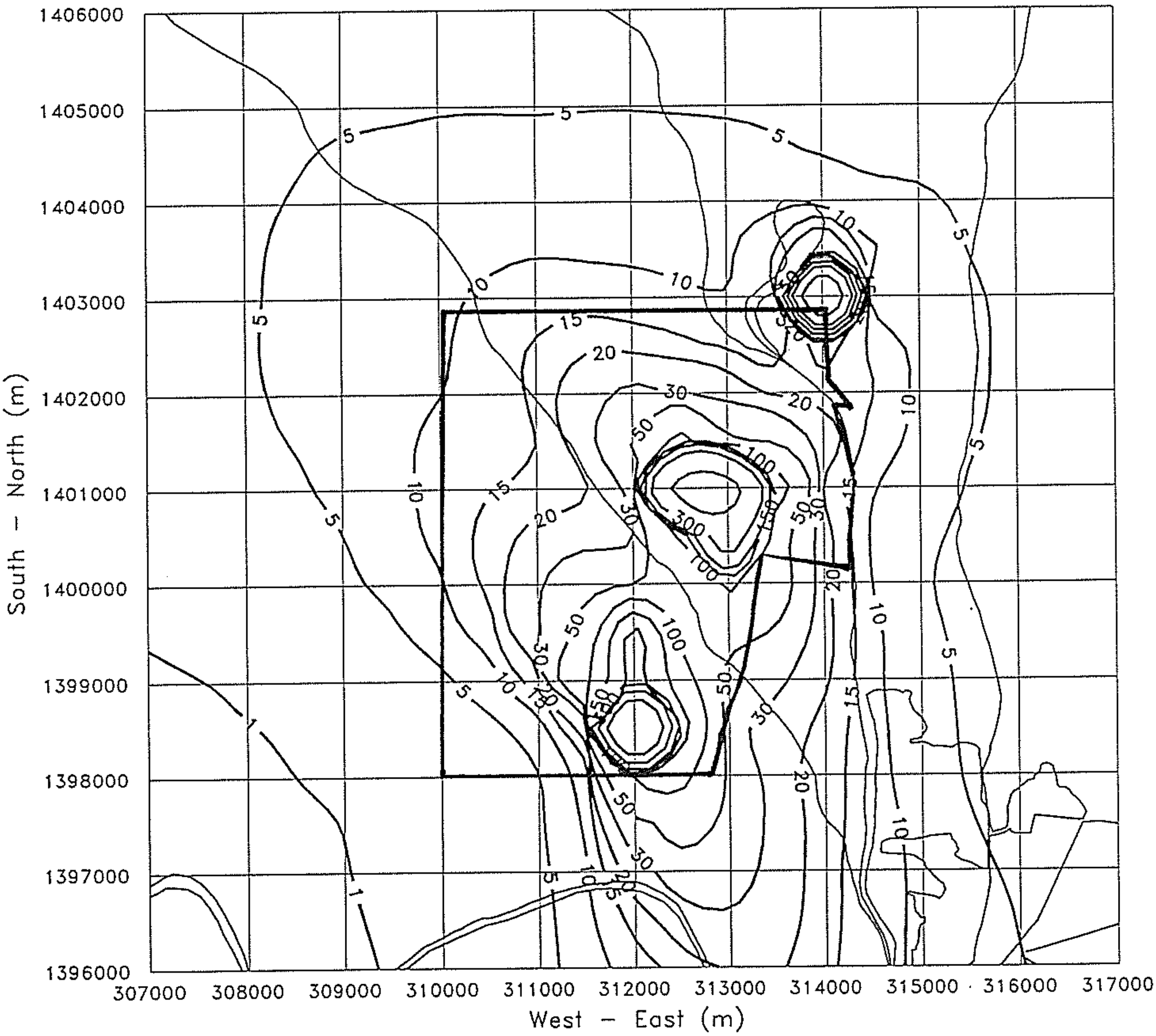


FIGURE 9

PREDICTED DUST DEPOSITION RATE DUE TO EMISSIONS FROM RIXS CREEK IN YEAR-8 – $g/m^2/month$

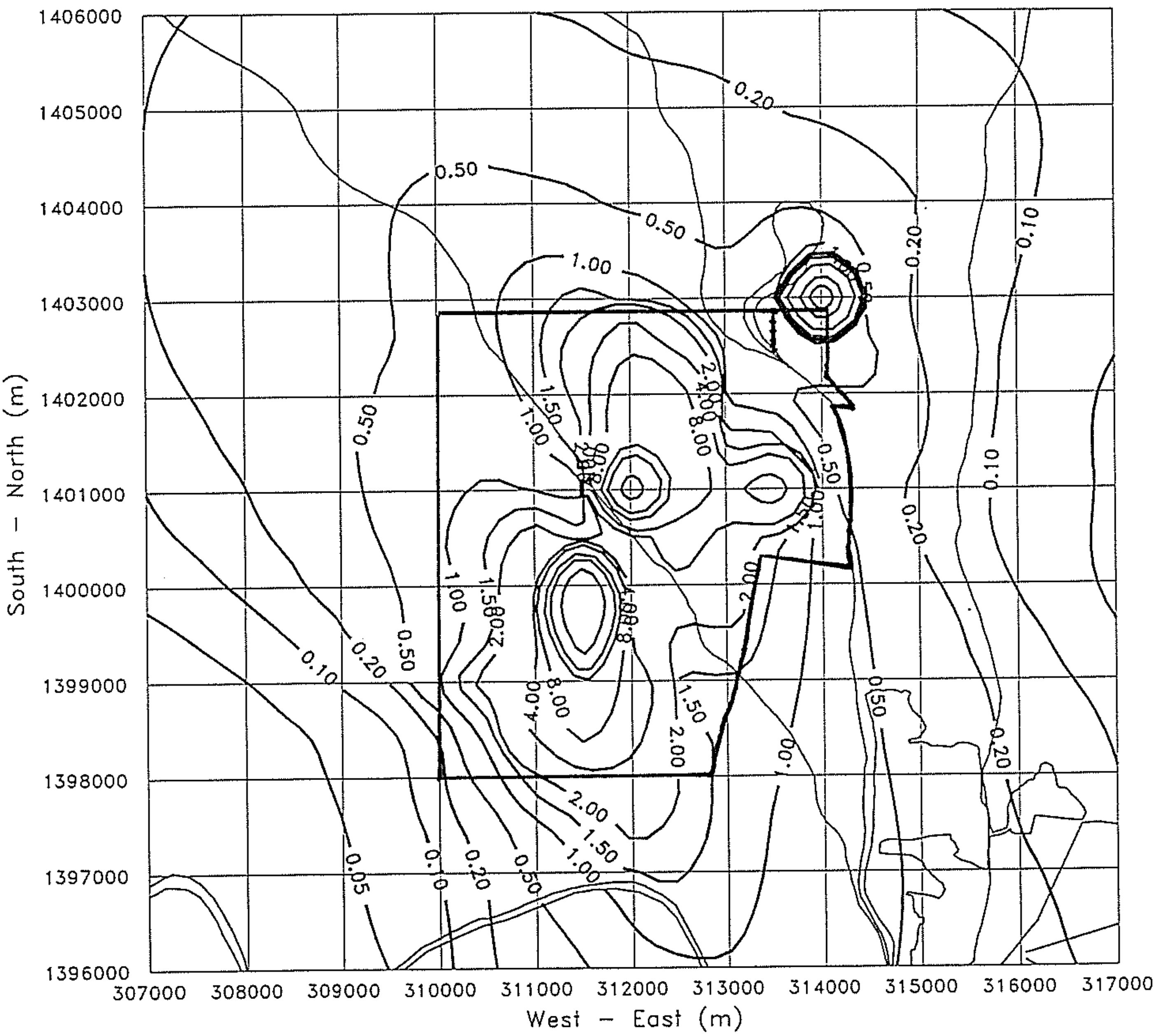


FIGURE 10

PREDICTED DUST CONCENTRATIONS DUE TO EMISSIONS FROM RIXS CREEK IN YEAR-8 - $\mu g/m^3$

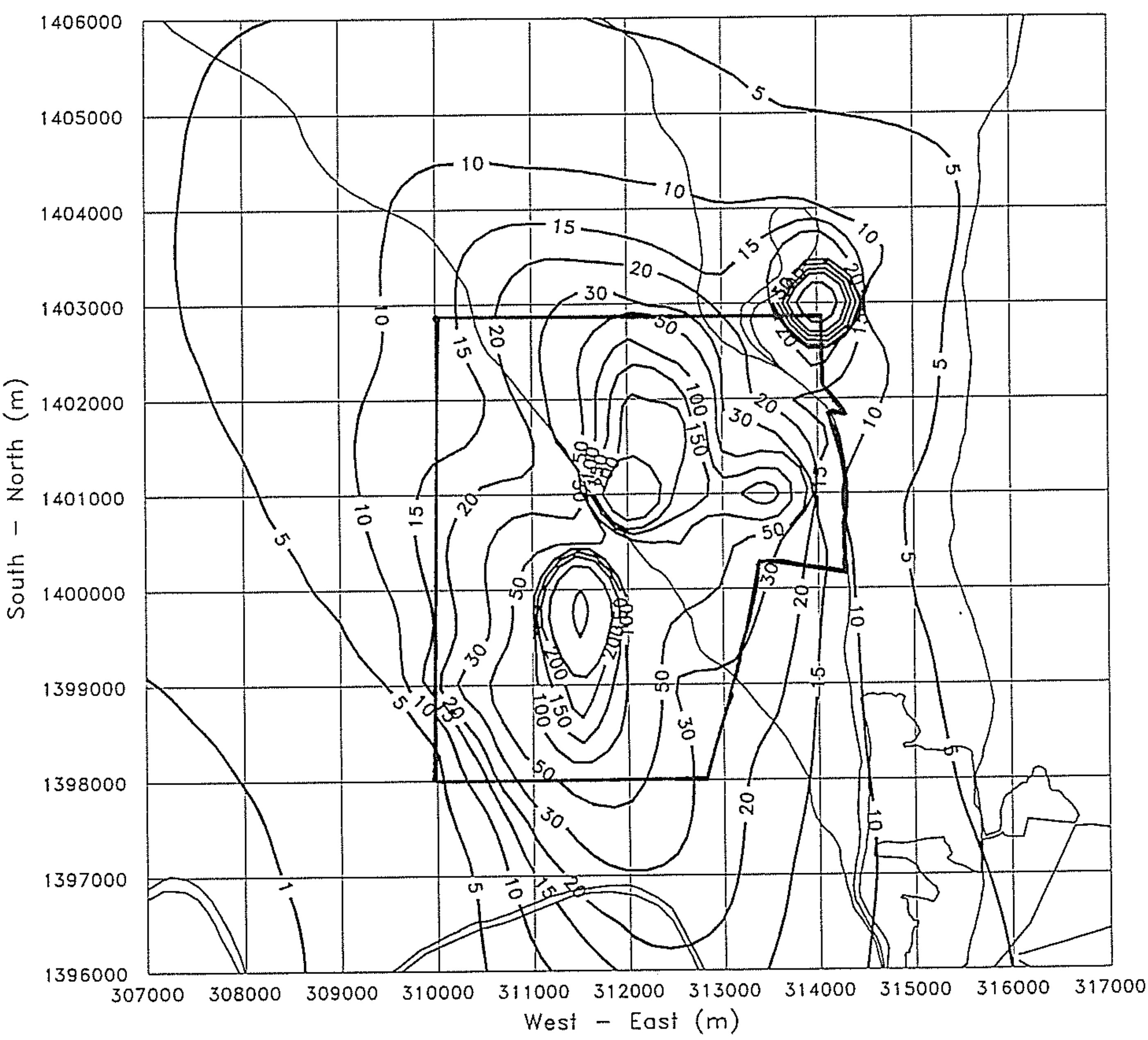


FIGURE 11

PREDICTED DUST DEPOSITION RATE DUE TO EMISSIONS FROM RIXS CREEK IN YEAR-15 - $g/m^2/month$

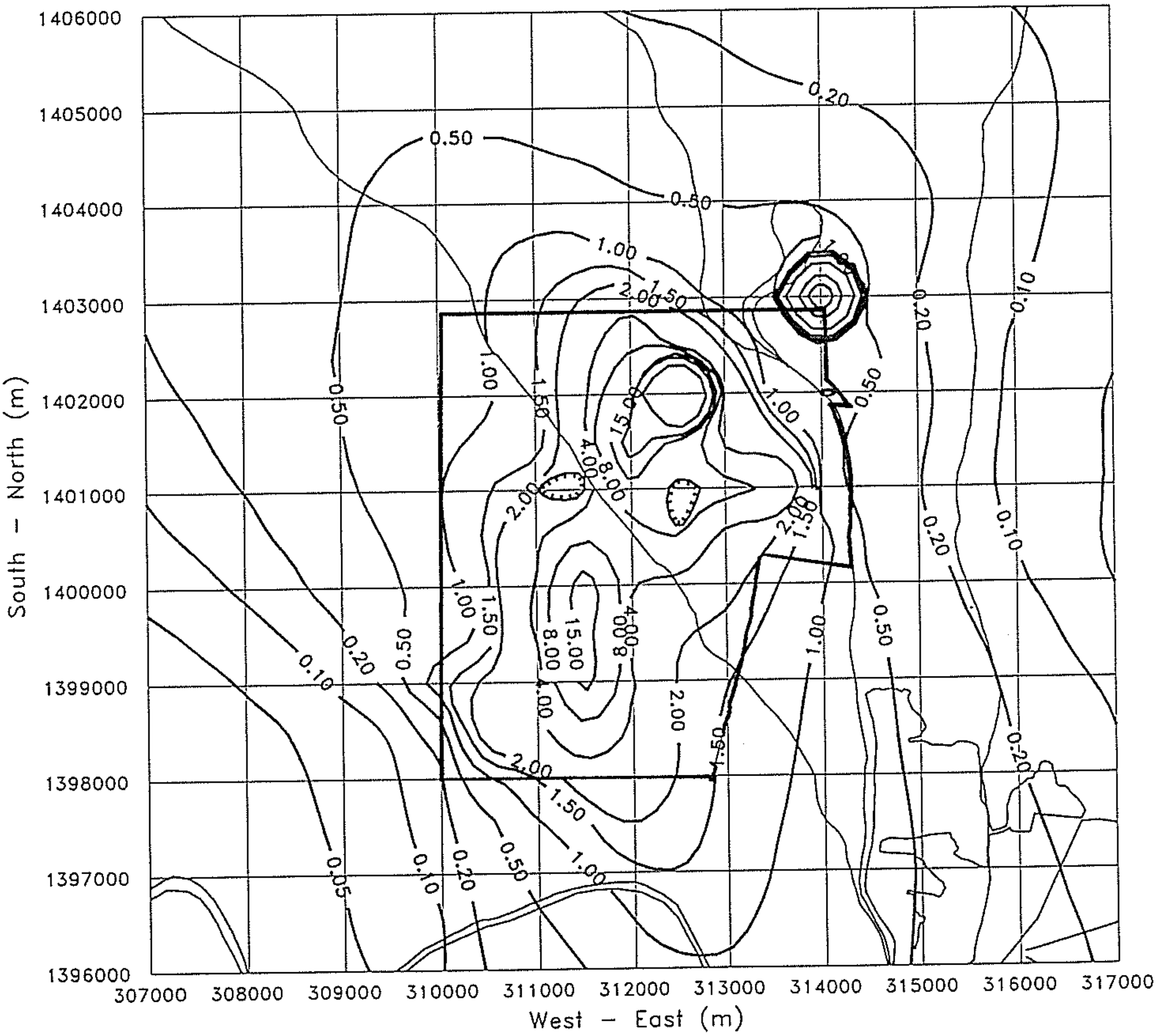


FIGURE 12

PREDICTED DUST CONCENTRATIONS DUE TO EMISSIONS FROM RIXS CREEK IN YEAR-15 - $\mu g/m^3$

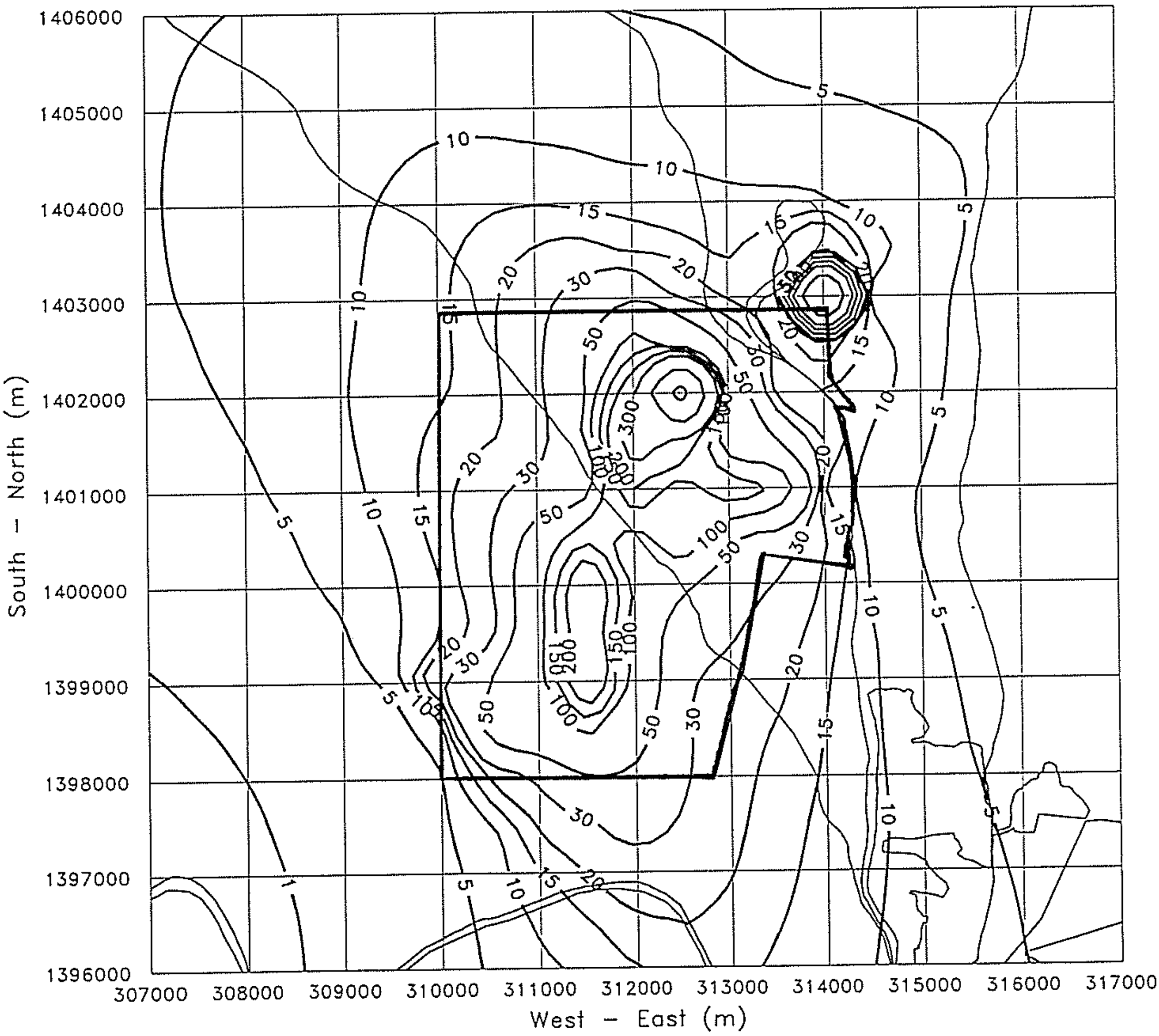


FIGURE 13

PREDICTED DUST DEPOSITION DUE TO EMISSIONS FROM RIXS CREEK IN YEAR-22 - $g/m^2/month$

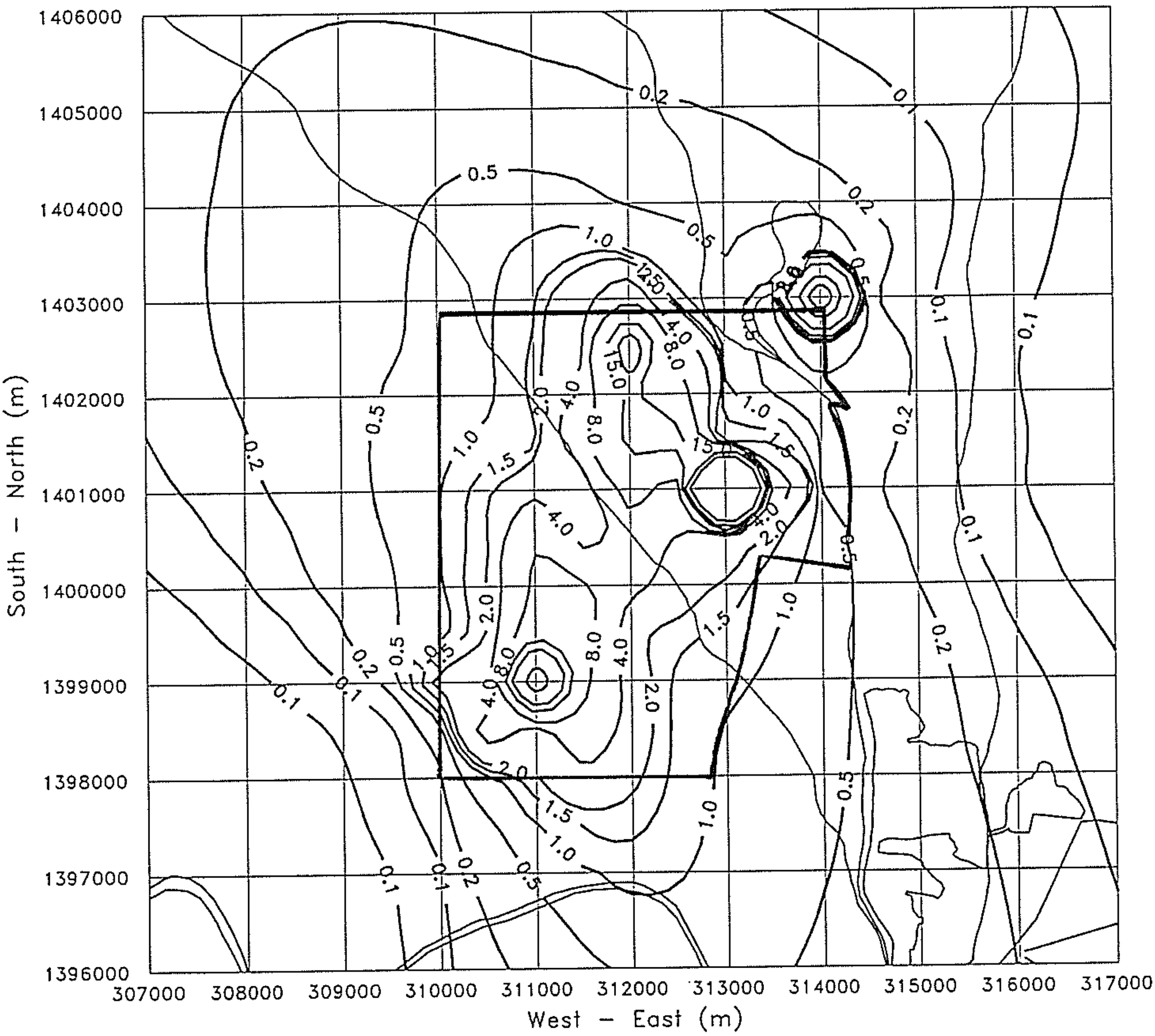


FIGURE 14

PREDICTED DUST CONCENTRATIONS DUE TO EMISSIONS FROM RIXS CREEK IN YEAR-22 - $\mu g/m^3$

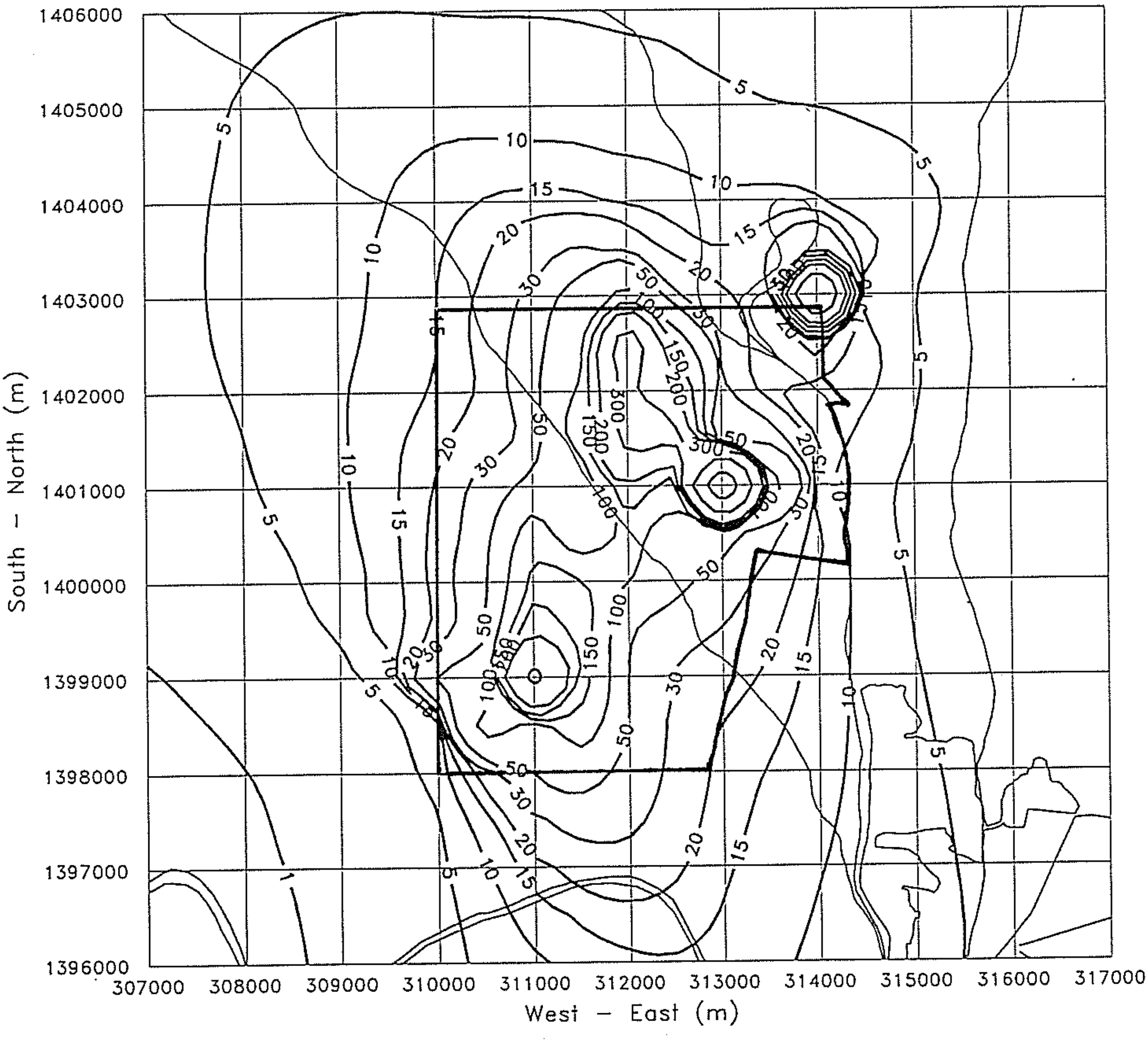


FIGURE 15

CUMULATIVE FREQUENCY PLOT OF 10-MINUTE AVERAGE WIND SPEEDS
FROM RIX'S CREEK DATA 1991 TO 1993

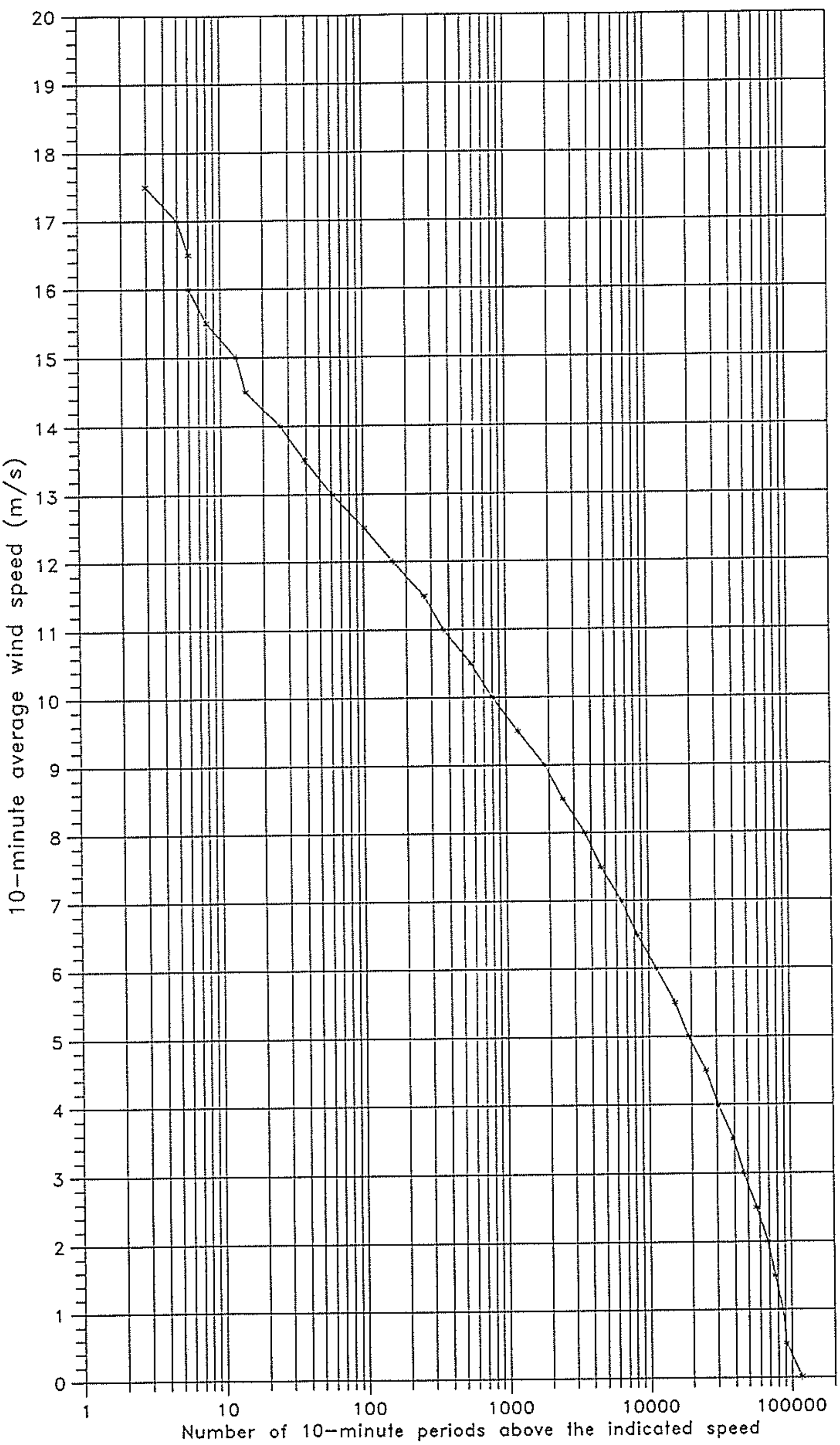


FIGURE 16.

PREDICTED 24-HOUR TSP CONCENTRATIONS DUE TO EPISODE EMISSIONS FROM RIXS CREEK IN YEAR-15 WITH EMISSIONS APPROPRIATE FOR 17 m/s NNW (see text)
$\mu g/m^3$

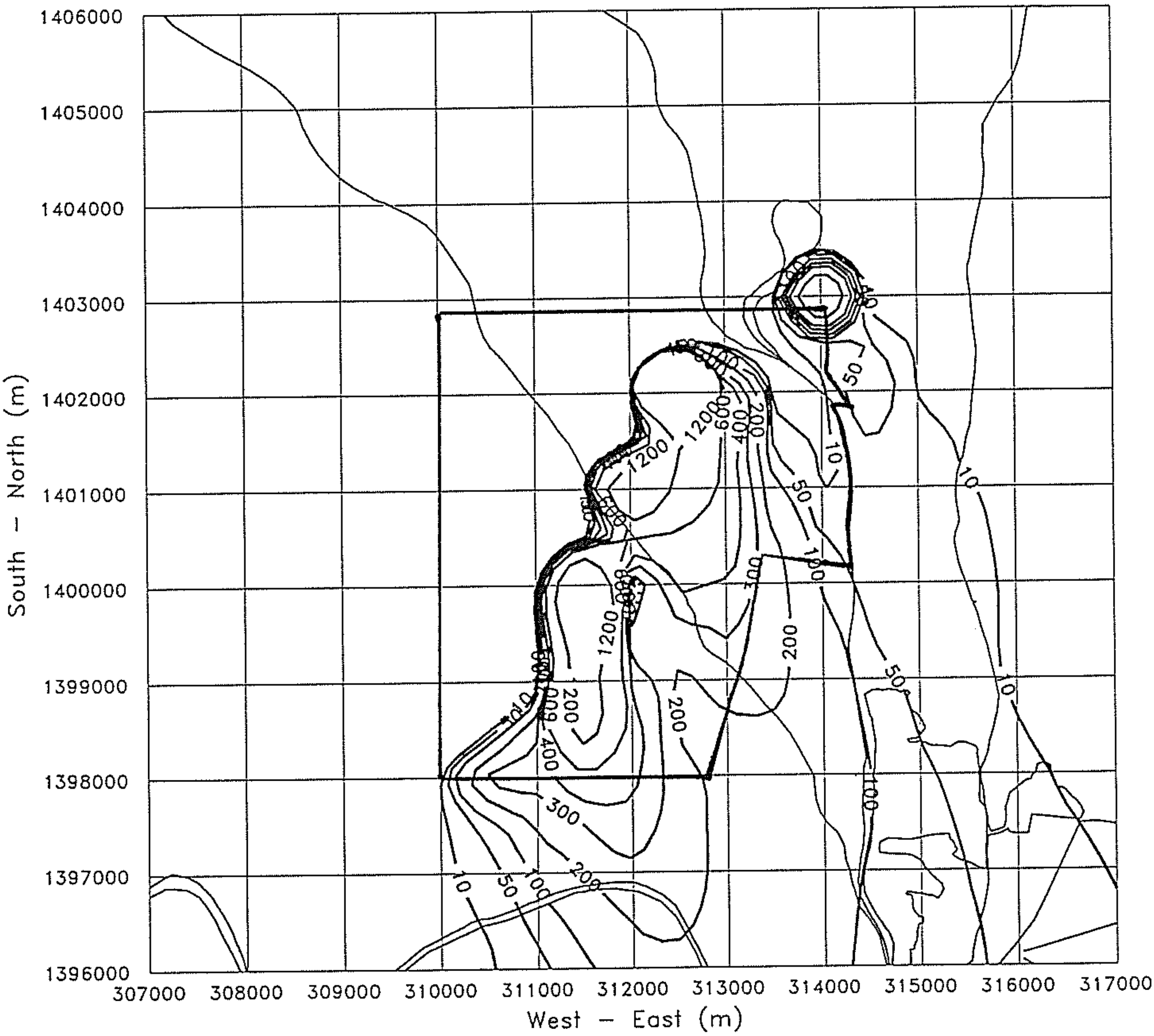


FIGURE 17.

PREDICTED ANNUAL DEPOSITION RATE DUE TO EMISSIONS FROM RIXS CREEK IN YEAR-22 OPERATING CONCURRENTLY WITH CAMBERWELL IN YEAR-13 - $g/m^2/month$

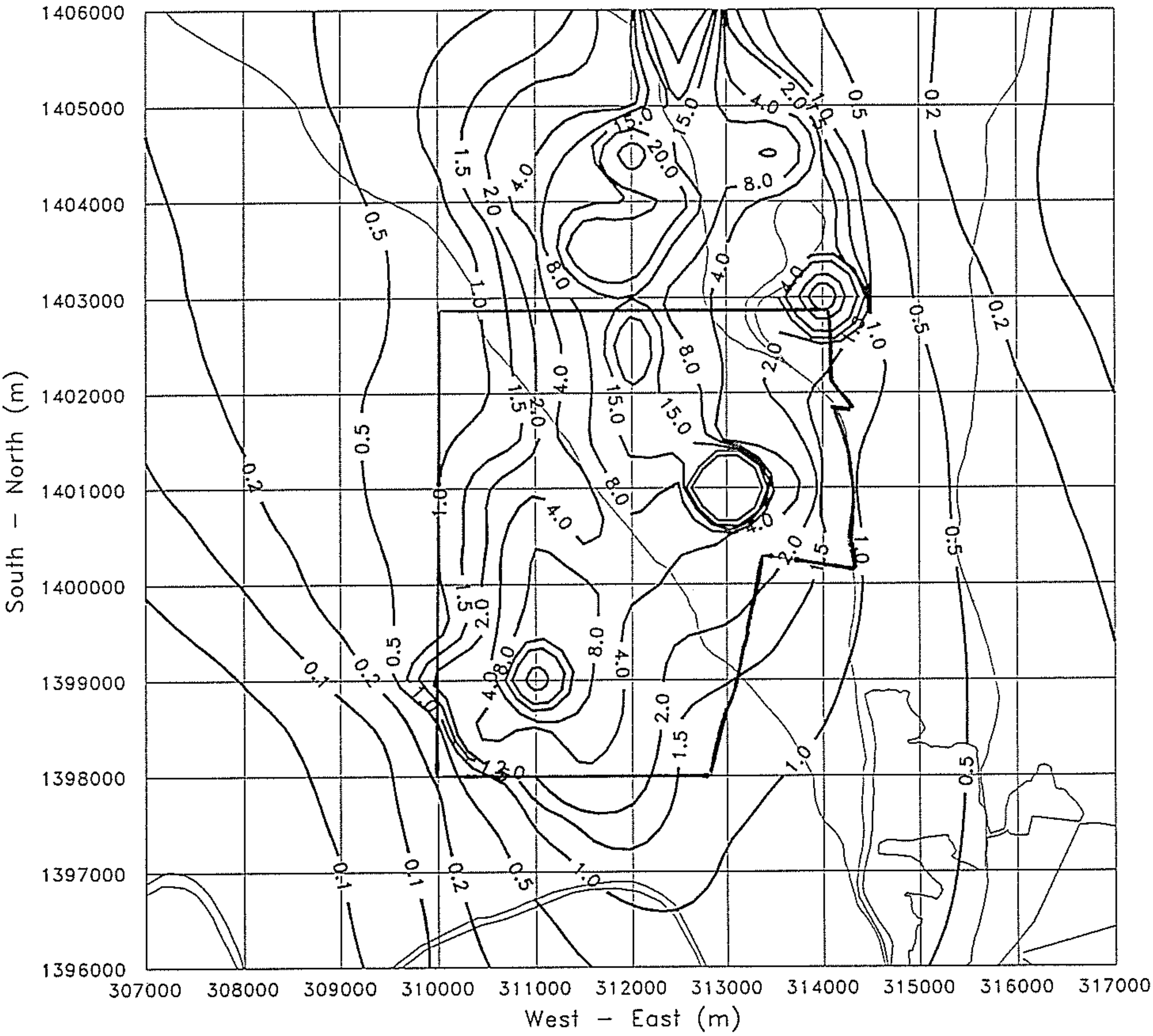


FIGURE 18

APPENDIX 6:

NOISE ASSESSMENT

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ACOUSTICAL ENGINEERS A.C.N. 002 009 529

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Telephone: (049) 50 5833 Facsimile: (049) 50 4276

REPORT NO 94.834.R1

NOISE IMPACT STATEMENT

RIX'S CREEK OPEN CUT COAL MINE EXTENSION

VOLUME I - PRIMARY INFORMATION

SINGLETON NSW

AUGUST 1994

Prepared for: Envirosciences Pty Ltd
122 Parry Street
NEWCASTLE NSW 2300

On behalf of: Bloomfield Collieries Pty Ltd

Table of Contents

Table of Contents (Cont...)

Executive Summary

This report outlines the results and findings of an acoustical assessment of the noise impact of proposed extensions to the Rix's Creek open cut coal mine, Singleton N.S.W.

The Rix's Creek mining area is divided into a total of three open cut pits. Pit 1 is north of the New England highway, Pit 2 is south of the New England highway and east of Rix's Creek while Pit 3 is also south of the New England highway but is west of Rix's Creek. A recently completed bridge over the New England highway will provide access to pits 2 and 3 when mining commences in these areas.

The proprietors of the Rix's Creek mine, Bloomfield Collieries Pty Ltd, are considering two options for the removal of overburden from each of the open cut pits: removal by a large shovel and two small draglines, or, removal by one large dragline and a small to medium shovel, and each permutation of both of the above options has been assessed in this report.

Noise contours were produced for the surrounding areas as a result of typical mining activities in either of Pits 1 or 2/3 for both the shovel and dragline option during day and night time operations. In addition, received noise levels were calculated at a number of selected residential receivers in close proximity to, or within, the Rix's Creek lease area.

No recommendations are included in this report with regard to property acquisition as it is the proprietors intention to compensate or purchase landowners based on monitored results and *not* the predicted results contained herein.

REPORT NO 94.834.R1
NOISE IMPACT STATEMENT
RIX'S CREEK OPEN CUT COAL MINE EXTENSION
SINGLETON NSW
AUGUST 1994

1.0 INTRODUCTION

This Report outlines the results and findings arising from an acoustical investigation of the proposed extension to Rix's Creek open cut coal mine, located to the west of Singleton NSW, as shown in the map of the study area given in Volume II.

The purpose of the investigation was to predict the potential effect of the extended operations of the mine on the existing acoustical climate of residential properties in close proximity to, or within, the Rix's Creek lease area. No recommendations are made in this report based on predicted results with regard to noise control or property acquisition as it is the proponents intention to purchase or compensate adjoining landowners if and when monitoring reveals exceedances of the relevant criteria.

2.0 BACKGROUND INFORMATION

2.1 Location

Rix's Creek open cut coal mine is located approximately 2km west of Singleton Heights in the Hunter Valley area of New South Wales, immediately south of the Camberwell Coal open cut coal mine. To the west and south of the mine are rural areas with scattered residences, and, approximately 6km north west of the current mining area is the village of Camberwell. At completion of mining, after a period of approximately forty (40) years, the Rix's Creek mining operations will be within 4 km of the Camberwell village.

This assessment has considered the mine lease area to be bounded by rural receptors to the west and south (with the exception of Camberwell village), and residential receptors to the east. At present, the mine currently operates north of the New England Highway although a previous Environmental Impact Statement (prepared by Croft and Associates, Newcastle) detailed operations on both sides of the highway, and the proposed mining plan and associated development applications were given approval by the relevant authorities.

2.2 Land Formation

The Rix's Creek mine lease area consists mainly of undulating land generally sloping towards Rix's Creek itself although the western section of the lease area is quite hilly. The hills on the western section of the lease area provide acoustic shielding for the Maison Dieu and Camberwell areas, while the escarpment east of the mine provides acoustic protection for the residents of Singleton, Singleton Heights and The Retreat.

3.0 PROPOSAL

Bloomfield Collieries Pty Ltd are the operators of Rix's Creek open cut mine. It is expected that the mine will produce an average of 1.4 Mtpa of clean coal over the forty year working life of the mine.

The present infrastructure and coal handling facilities are sufficient to cater for the increased production and workforce and, as coal handling is the limiting factor for overall production, all scheduling has been based on the assumption of maximum washery throughput. A 1.5km conveyor is proposed for the transport of clean coal to the rail loading area which is shared with Camberwell Coal.

The mining area is divided into a total of three (3) open cut pits. Pit 1 is located north of the highway, Pit 2 is located south of the highway and east of Rix's Creek while Pit 3 is located south of the highway and west of Rix's Creek. A recently constructed bridge over the New England Highway will provide access to Pits 2 and 3 when mining commences in these areas. The proposed mine plan is based on a series of one hundred (100) metre wide mining strips. Each mining strip will be worked to a pre–determined level prior to the adjacent strip being worked to that same level. Topsoil will be removed from each of these mining strips by scraper or dozer and dumped in heaps to be loaded out and transported by front end loader (FEL) and rear dump trucks (RDTs) respectively.

At present, two options are being considered for the removal of overburden: removal by a large shovel and two small draglines, or, removal by a small to medium sized shovel and one large dragline. In addition to either of the two (2) above alternatives, overburden will be removed by a large front end loader (FEL) and a four hundred (400) tonne hydraulic excavator, both of which will load into RDTs. Pre–stripping of overburden above the Lower Middle Liddell seam will be carried out by electric shovel, hydraulic excavator and FEL, each of which load into RDTs for transport to the spoils dumps. Overburden below the Lower Middle Liddell seam will be removed by dragline. All overburden spoil heaps formed by the RDTs and dragline will be progressively re–contoured, top dressed and re–planted, so as to blend in with the existing topography.

Dozers will break and heap ROM coal prior to it being loaded by FELs into RDTs for transport to the ROM stockpile, located in proximity to the existing coal preparation area. Coal will be crushed, screened and washed on site before being conveyed to the clean coal stockpile area for later transportation by rail to the Port of Newcastle. Storage, reclaiming and loading facilities are located on the south eastern side of the rail loading area.

4.0 CRITERIA

The Environment Protection Authority (EPA) and Singleton Shire Council share responsibility for the approval and control of noise emission from the Rix's Creek Lease area and, in most situations, Council will adopt the requirements of the EPA.

Both Authorities prefer the existing background noise level to be maintained, however, in certain circumstances the EPA will allow an exceedance of 5dB providing the received noise is bland in character and free from tonal or impulsive components.

4.1 Acceptable Background Noise Levels

The EPA Environmental Noise Control Manual, Chapters 19, 20 & 21, provides the Recommended Acceptable Background Noise Levels for various areas as outlined in Table 4.1.

Table 4.1: Recommended Acceptable Background Noise Levels

	Background Noise Levels, dB(A)	
Zoning	Night time	Daytime
Rural Residential	35	45
Urban Residential	35	45
Highway Residential	40	50

4.2 Mining Operations

For residential locations closest to the mining areas of the proposed Rix's Creek open cut mine extension, the lowest background noise levels for day-time and night time hours provide the basis for the criterion to be applied.

The measured background noise levels and derived planning levels (taking into account the previous development consent conditions) for the rural and residential areas around the Rix's Creek lease area are outlined in Table 4.2.

Table 4.2: Measured Background and Derived Planning Noise levels

	Measured Background, dB(A)		Planning Level, dB(A)	
Area	Day	Night	Day	Night
Rural	32	33	38	38
Residential	37	35	42	40

4.3 Construction Activities

The Environment Protection Authorities criterion for construction projects varies, dependant upon the length of time the project will take. Projects expected to take longer than 4 weeks but less than 26 weeks are allowed a 10dB exceedance above the existing background noise level, relative to the average maximum noise level, L10dB(A) of the intruding source.

Projects, such as the construction of the large dragline being considered for use by the proprietors of Rix's Creek, are subject to the criteria outlined in Table 4.3 and we would anticipate that these would be the limits imposed by the EPA.

Table 4.3: Construction Noise criteria

Project	Duration	Criterion, L10dB(A)
Short term	1 month or less	65
Medium term	1–6 months	55
Long term	> 6 months	50

4.4 Blasting Operations

The blast overpressure and ground vibration levels outlined in Table 4.4 are taken from the Australian and New Zealand Environment Conservation Council (ANZECC) guideline, "Technical Basis for Guidelines to Minimise Annoyance due to Blasting Overpressure and Ground Vibration". These levels are normally applied to blasting operations of this type to ensure the comfort and repose of residents and not to the protection of property.

Table 4.4: Vibration and Overpressure criteria for Blasting

Blasting Time	Overpressure, dB(Lin)	Peak Particle Velocity, $mmsec^{-1}$
Mon – Sat (0900 – 1700)	115	5

In addition, the Environmental Protection Authority accept that on a small number of occasions these criteria may be exceeded on infrequent occasions, but should be limited to not more then 5% of the total number of blasts with the maximum allowable peak particle velocity and overpressure limited to 10 $mmsec^{-1}$ and 120dB(Lin) respectively.

The Department of Mineral Resources and the Australian Standard AS2187–Part 2 (1983) "Use of Explosives", recommend that vibration in close proximity to commercial buildings, industrial buildings and structures constructed of steel and reinforced concrete should be limited to $10mmsec^{-1}$ and $25mmsec^{-1}$ Peak Particle Velocity (PPV) respectively.

In addition, they also require a limit of $2mmsec^{-1}$ vibration velocity for historic buildings, monuments, and buildings of special significance.

4.4 Intermittent Traffic Noise

Activities associated with the operation of the Rix's Creek open cut mine will result in a concentration of traffic at certain times of the day and low traffic flow at other times. Traffic movement on Rix's Creek Lane is likely to be of an intermittent nature and will related to the change of shifts. The Environment Protection Authority Environmental Noise Control Manual, Section 157–3, sets out environmental goals for the control of road traffic noise. Intermittent traffic noise measurement is to be averaged over the duration of the heavier traffic flow and is to be described as an Equivalent Continuous Noise Level for the period, Leq,T dB(A). The recommended Leq,T dB(A) for new developments in residential and rural areas adjacent to highway traffic are given in Table 4.5.

Table 4.5: Criterion for Intermittent Traffic Noise

Period	Criterion, dB(A),Leq(T)
Daytime	55
Evening	50
Night time	45

Previous assessments of intermittent traffic flow in close proximity to residential dwellings have resulted in a successful interaction when a maximum L10 18hr noise level of 55dB(A) has been adopted as the criterion for road traffic noise. This criterion, in addition to the above, has been adopted in our assessment of the potential effect of Rix's Creek Lane traffic on the acoustical amenity of residential properties.

The effect on New England Highway traffic noise levels, generated by an AADT (Average Annual Daily Traffic) of greater than 9780 (measured in 1988), from an additional 48 vehicle movements generated by change of shift personnel will be insignificant and has not been considered in this assessment.

4.5 Rail Traffic Noise

The Environment Protection Authority has set out criteria for rail traffic noise in section 163–1 of the Environmental Noise Control Manual. For residential receivers, noise criteria are specified as 24-Hr Leq,T dB(A) levels and maximum levels, neither of which should be exceeded. The relevant criteria limits are given in Table 4.6.

Table 4.6: Criteria limits for Rail Traffic Noise

Noise Level	Planning Level, dB(A)	Maximum Level, dB(A)
Leq, 24-Hr	55	60
L_{MAX}	80	85

In our assessment of the potential effect of additional rail traffic due to the proposed mine extension, the relevant planning levels have been adopted as the criteria.

5.0 METHOD OF ASSESSMENT

5.1 Terms and Definitions

Acoustical Terms and Definitions used in this Report are outlined in Table 5.1.

Table 5.1: Acoustical Terms and Definitions

Term	Definition
dB(A)	A quantitative measure of sound heard by the human ear, measured by the A–Scale Weighting Network of a sound level meter and expressed in decibels.
Blast Overpressure	The shock wave transmitted through the air, caused by explosive blasting and measured with a sound level meter fitted with a pressure microphone, and set to the peak hold function. Unit Symbol – dB(Lin Peak)
Ground Vibration	The resultant velocity of movement transmitted through the ground and measured with a vibration monitor and triaxial geophone. Unit Symbol – $mmsec^{-1}$
LAeq,T	An average energy, expressed in decibels, of the fluctuating sound levels over time.
Leq	The Equivalent Steady Sound Level, taking into account the fluctuations of a sound over time. The time varying level is computed to give an equivalent level that is equal to the energy content and time period.
Lw	The total radiating sound power level per unit time expressed in decibels.
L10	The Average Maximum Noise Level and the noise level exceeded for 10% of the measuring period.
L90	The Average Minimum or Background Noise Level. The noise level exceeded for 90% of the measuring period.

5.2 Instruments

Noise level measurements of plant and equipment were taken with a Larson Davis Laboratories LD700 Type 2 integrating sound level meter, fitted with a 12.7mm diameter precision prepolarised microphone, Type M4, and a wind–shield. This instrument has the capability to measure steady, fluctuating, intermittent and/or impulsive sound and computes and displays percentile noise levels for the measuring period.

Sound recordings were made with a Sony Walkman Professional Cassette Recorder, Type WMD–6C, and a Realistic Electret microphone, to record the noise for laboratory analysis. The recorded data was analysed by replaying the recorded signal through an Acoustic Research Laboratories Tones 1 sound analyser, to obtain the octave band spectrum of the recorded signal.

A calibration signal was used to align the instrument train prior to measuring and checked at the conclusion. Difference in the two measurements was less than 0.5dB.

Background noise levels in the area were measured over a fifteen (15) minute period using a Larson Davis Laboratories LD700.

5.2 Instruments (Cont...)

Noise levels on the Tisdell property were monitored on a continual basis by use of an Acoustic Research Laboratories Environmental Noise Logging Monitor, Type EL–015. This instrument was programmed to accumulate environmental noise data over sampling periods of twenty (20) minutes duration. The internal software is then capable of calculating and storing the Ln Percentile Noise Levels for the chosen sampling period, which is later be retrieved for detailed analysis.

5.3 Determination of Background Noise Level

To determine the ambient background noise level at any location, it is necessary to gather data over a period of time to allow confident statistical interpretations. Nigel Holmes and Associates have been conducting noise level surveys in the area surrounding Rix's Creek mine since it commenced operations in 1990. The results of these surveys have been made available to Caleb Smith Consulting Pty Ltd by the Rix's creek mine to provide a long term noise level history for the area.

The previous surveys by Nigel Holmes and Associates did not include monitoring in the rural area north–west of the proposed mine extensions and for this reason, an environmental noise logger was placed at the Tisdell residence from 27.04.94 to 09.05.94 to monitor ambient noise levels.

To confirm the Nigel Holmes and Associates survey results, a noise level survey was carried out in the area from 11:30am, 27.04.94, to 05:00pm, 28.04.94. A total of seven (7) monitoring locations were chosen and noise level measurements were recorded at each of these sites once during the daytime hours and twice during the night time hours. As a result of the monitoring, the ambient L90 noise levels that are representative of the acoustical climate surrounding the Rix's Creek lease area were determined.

5.4 Generation of Noise Contours

Noise Contours for the area surrounding the proposed extended mine were generated using the ENM noise modelling software. The Noise Modelling program considers the loss for distance between source and receiver, barrier attenuation due to the topography between source and receiver, molecular absorption and ground effects. Maps of the mining area for each mining stage and the surrounding topography were digitised into the computer along with ground types and noise source data to produce the numerical results and noise contours shown in Volumes II and III respectively.

In order to simplify the analysis, six (6) stages of the Rix's Creek open cut mine development have been considered. These stages are outlined in Table 5.2.

5.4 Generation of Noise Contours (Cont...)

Table 5.2: Assessed Mining Stages

Stage	Period
1	End of Year 1 mining
2	End of Year 8 mining
3	End of Year 15 mining
4	End of Year 22 mining
5	End of year 29 mining
6	End of year 36 mining

Although these stages are referred to by year number, actual mine development is dependant upon a variety of factors and mining may not progress at the rate assumed for the purposes of this assessment. Note that the maximum throughput of the existing coal handling facilities has been assumed to be the limiting rate of mining. The results presented for each stage are applicable for mining in the relevant area with the mining scenarios and equipment as specified by Bloomfield Collieries Pty Limited.

Received noise levels have been calculated for both day and night time mining operations and have been performed twice for each stage of mining, once for the shovel mining option and again for the dragline mining option. As most mining plant is mobile, the mine has been modelled with a concentration of equipment in Pit 1 (north) and then Pits 2 or 3 (south) for each stage. The pit with a concentration of equipment is referred to as the active pit while the remaining pits are referred to as the inactive pits even though some mining activity may still be occurring there.

The number of plant items at the mine is a restraint on the number of nominated operational activities that can occur simultaneously. For this reason, we have calculated the average maximum noise levels, L10dB(A), for each stage of mining, for daytime operations and night time operations, as a result of the simultaneous operation of a number of mining activities. These scenarios represent a realistic worst case event and most operating groups are included.

For daytime mining the worst case scenario includes each of the following equipment groups.

Shovel mining option	*Dragline mining option*
Topsoil removal	Topsoil removal
Overburden removal by large shovel	Overburden removal by small shovel
Overburden removal by small dragline	Overburden removal by large dragline
Overburden removal by medium dragline	Overburden removal by loader
Overburden removal by loader	Overburden removal by excavator
Overburden removal by excavator	Spoils dumping
Spoils dumping	Coal extraction
Coal extraction	Haul truck and water carts
Haul truck and water carts	Grader and water cart
Grader and water cart	

5.4 Generation of Noise Contours (Cont...)

Operation of the coal handling facilities and proposed conveyor will occur almost continually and has therefore been included in all operating scenarios.

For each stage, the worst case situation in regard to the location of plant items has been assessed. This assumes plant items nominated for each activity are situated in the most exposed positions (highest RL) likely to occur for each stage of mining. All mobile plant, with the exception of draglines, have been modelled as a point source 2.5 metres above their operating RL's. Draglines have been modelled as point sources 5 metres above their operating RL's.

The mine intends to dump overburden within the pit at night to reduce noise emissions and in addition, no topsoil removal is planned for night time hours. Consequently, the night time assessment of each mining stage has been assessed with spoils dumping relocated within the pit area.

Each operational group comprises items of equipment nominated by Bloomfield Collieries Pty Limited for use in the proposed extended mining area. Sections 5.5 and 5.6 list the equipment groups considered and provide the A-weighted acoustic power level (L_W) spectra of individual items as well as the group total.

The L_W and spectra of plant items used in this report were sourced by measuring the actual equipment proposed for use in the mine. This equipment is either already in use at Rix's Creek open cut mine or in use at Bloomfield Colliery, East Maitland, each of which are owned by Bloomfield Collieries Pty Limited.

The methodology employed in determining the L_W and spectra of mobile plant items owned by Bloomfield Collieries Pty Limited was to measure the item at high idle (or maximum noise output) at a known distance from the noisiest side of the machine. The measured sound pressure level (SPL) then allows an L_W to be determined. A tape recording of the plant item was made whilst measurements were being taken, this recording was later replayed through a Tones–1 analyser to provide the octave band spectrum.

The above methodology is conservative in that only a measurement of the machines noisiest side was used for L_W calculations, rather than an average of measurements on all 4 sides. Also, most of this equipment was in production conditions at the time and therefore, in some instances, the pit walls provided a semi–reflective environment. The majority of L_W results presented in this report can be considered as higher than an L_W determined according to Australian Standard 2012–1990 procedures.

Noise source L_W and spectra were sourced from our library of technical data when the equipment was not available to measure.

5.5 Coal Handling Facilities

The crushing, screening and washing of ROM coal followed by the stockpiling of product coal utilises the items and facilities outlined in Table 5.3.

Table 5.3: Plant Equipment and 1/1 Octave Spectra – Coal Handling Facilities

		A weighted octave band spectrum							
Item/Facility	L_w	63	125	250	500	1k	2k	4k	8k
ROM Feeders	*113*	81.4	86.6	97	103	109	109.4	104.2	93
ROM Breaker	*114*	82.6	90.2	96.2	103.8	108.2	109.4	106.2	100.2
Washery and 1000t bin	*121*	93.6	100	103.2	113.6	114	116	114	102.4
50m Conveyor, 1000t bin to transfer	*83*	63.2	76.4	72.4	81.2	72.4	69.6	68.8	73.2
Transfer station	*109*	74	83	104	104	104	96	90	80
50m Conveyor, transfer to stockpile	*83*	63.2	76.4	72.4	81.2	72.4	69.6	68.8	73.2
Stackout conv/generator	*109*	89.8	97.8	94.6	100.6	103.8	103.4	98.2	90.2
Rail load/generator	*116*	91.2	100	106.8	109.2	109.2	110.8	106.4	97.6

For the purposes of this assessment, the conveyor has been considered as a series of point sources 50 metres apart, i.e. a line of conveyor segments each being 50 metres in length. These equipment items (with the exception of rail loading plant) are expected to operate continuously and for the purposes of this assessment, and to represent a "worst case" scenario, all coal handling facilities have been included in each modelling scenario. As the above items have fixed locations, the modelled height of each source has been determined in relation to the actual dimensions of each, except for the proposed conveyors and transfer station. The conveyor was considered as a source 1.5 metres above the natural ground RL while the transfer station has been modelled as a source 3.0 metres above the natural RL.

5.6 Mining Operations

5.6.1 Topsoil removal

Initial topsoil removal will occur at the existing natural RL and will involve the items of equipment outlined in Table 5.4.

Table 5.4: Plant Equipment and 1/1 Octave Spectra – Prestrip

		A weighted octave band spectra							
Topsoil removal	L_w	63	125	250	500	1k	2k	4k	8k
Cat D11 dozer	*111*	76	92	97	104	105	106	102	91
Cat 785 RDT	*120*	95	104	108	116	114	112	104	95
Cat 992 FEL	*115*	77	97	99.8	106.2	110.6	109.4	105.4	89.4
Cat 785 RDT	*120*	95	104	108	116	114	112	104	95
Total of Items	*123*	98	108	111	119	118	116	110	99

5.6.2 Overburden Removal

In general, a bench within the active pit will be drilled, blasted and the resulting overburden will be removed. As we have stated in previous sections, removal of overburden above the Lower Middle Liddell seam will be by a shovel and truck operation or similar while overburden removal below the Lower Middle Liddell seam will be by dragline.

The items of equipment to be used for overburden removal if the Shovel option is used are listed in Table 5.5 while the equipment that will be used if the Dragline is employed is outlined in Table 5.6 Note that for each of the two (2) options, Shovel or Dragline, there will be a number of additional overburden removal methods in use. The group of plant items associated with each of the methods are referred to as 'units' and are outlined in column one (1) of Tables 5.5 and 5.6.

NB: For overburden removal above the Lower Middle Liddell Seam, the 'worst case' locations of plant (excluding draglines) for all stages of mine development, have been assumed to be 20 metres below the natural RL at that point. For overburden removal by dragline, the "worst case" location will occur following extraction of the Lower Middle Liddell Seam as the draglines will then be operating at their highest reduced level (RL). The Lower Middle Liddell seam height (for any location in the proposed mine extensions) has been determined from information supplied by P. J. Murray & Associates Pty Ltd.

Table 5.5: Plant Equipment and 1/1 Octave Spectra – Shovel Option

			A weighted octave band spectra							
Unit	Plant Items	L_W	63	125	250	500	1k	2k	4k	8k
Shovel + truck	P&H 5700 shovel	*107*	85	95.8	98.2	102.2	101.4	99	93.8	91
	Cat 793 RDT	*120*	87	104	106	116	115	113	106	97
	Cat RD dozer	*111*	80	100.4	102	105.2	106.4	104	98.4	88
	Drilltech D40K drill	*115*	89.4	107.4	107.4	109.4	108.2	107.8	101.8	97.4
	Total of Items	*122*	93	110	111	117	116	115	108	101
Dragline	Cat D11 dozer	*111*	76	92	97	104	105	106	102	91
	P&H 2553 dragline	*115*	92	104.4	103.2	111.2	109.6	107.2	102.8	94.8
	Bucyrus Erie BE45R drill	*112*	82	99	100	107	107	104	97	88
	Total of Items	*118*	93	106	106	113	112	111	106	97
Dragline	Cat D11 dozer	*111*	76	92	97	104	105	106	102	91
	Marion 305M dragline	*118*	90	100.8	106.4	113.6	112.8	110	105.2	94.4
	Bucyrus Erie BE45R drill	*112*	82	99	100	107	107	104	97	88
	Total of Items	*119*	91	103	108	115	114	112	107	97
Loader + truck	Cat D11 dozer	*111*	76	92	97	104	105	106	102	91
	Cat 994 FEL	*119*	81.4	104.2	100.2	116.6	113.4	111	103.4	94.6
	Cat 793 RDT	*120*	87	104	106	116	115	113	106	97
	Total of Items	*123*	88	107	107	119	118	116	109	100
Excavator + truck	Cat 400t excavator	*118*	87.5	101.5	109	112	115	110	104	95
	Cat 793 RDT	*120*	87	104	106	116	115	113	106	97
	Total of Items	*122*	90	106	111	117	118	115	108	99

5.6.2 Overburden Removal (Cont...)

Table 5.6: Plant Equipment and 1/1 Octave Spectra – Dragline Option

			A weighted octave band spectra							
Unit	Plant Items	L_w	63	125	250	500	1k	2k	4k	8k
Shovel + truck	P&H 2800 XPA shovel	109	82	93.6	96.8	101.6	104.4	101.6	99.2	94.8
	Cat 793 RDT	120	87	104	106	116	115	113	106	97
	Cat RD dozer	111	80	100.4	102	105.2	106.4	104	98.4	88
	Drilltech D40K drill	115	89.4	107.4	107.4	109.4	108.2	107.8	101.8	97.4
	Total of Items	122	92	110	111	117	117	115	108	102
Dragline	Cat D11 dozer	111	76	92	97	104	105	106	102	91
	Marion 7900 dragline	117	100	105	108	110	112	111	104	90
	Bucyrus Erie BE45R drill	112	82	99	100	107	107	104	97	88
	Total of Items	119	100	106	109	112	114	113	107	95
Loader + truck	Cat D11 dozer	111	76	92	97	104	105	106	102	91
	Cat 994 FEL	119	81.4	104.2	100.2	116.6	113.4	111	103.4	94.6
	Cat 793 RDT	120	87	104	106	116	115	113	106	97
	Total of Items	123	88	107	107	119	118	116	109	100
Excavator + truck	Cat 400t excavator	118	87.5	101.5	109	112	115	110	104	95
	Cat 793 RDT	120	87	104	106	116	115	113	106	97
	Total of Items	122	90	106	111	117	118	115	108	99

5.6.3 Coal Extraction

In general, coal extraction will carried out by dozer, FEL and RDTs although thin coal seams will be mined using a road profiler, FEL and RDTs. Plant items associated with the coal extraction, for both thin and thick coal seams, are outlined in Tables 5.7 and 5.8 respectively.

Table 5.7: Plant items and 1/1 Octave Spectra – Thin seam mining

		A weighted octave band spectra							
Plant Item	L_w	63	125	250	500	1k	2k	4k	8k
Cat RD dozer	111	80	100.4	102	105.2	106.4	104	98.4	88
Cat 785 RDT	120	95	104	108	116	114	112	104	95
Cat 992 FEL	115	77	97	99.8	106.2	110.6	109.4	105.4	89.4
Cat RR250 profiler	109	90	100.4	98.4	99.6	104.8	102.8	96.8	86.4
Total of Items	122	96	107	110	117	116	115	109	97

5.6.3 Coal Extraction (Cont...)

Table 5.8: Plant items and 1/1 Octave Spectra – Thick seam mining

		A weighted octave band spectra							
Plant Item	L_W	63	125	250	500	1k	2k	4k	8k
Cat D11 dozer	*111*	76	92	97	104	105	106	102	91
Cat 785 RDT	*120*	95	104	108	116	114	112	104	95
Cat 992 FEL	*115*	77	97	99.8	106.2	110.6	109.4	105.4	89.4
Total of Items	*122*	95	105	109	117	116	115	109	97

NB: The highest available coal seam and its RL (for any location in the proposed mine extension) has been determined from information supplied by P. J. Murray & Associates Pty Limited.

5.6.4 Spoils Dumping

Pit spoils will be placed on the eastern side of Pit 1 and the southern side of Pits 2 and 3 where they will be regraded, topsoiled and seeded to enable rehabilitation of the natural surface. By the completion of mining, Pit 2 will be filled to the current RL by spoils. Plant items associated with the soils dumping activities are outlined in Table 5.9.

Table 5.9: Plant items and 1/1 Octave Spectra – Spoils dumping

		A weighted octave band spectra							
Plant Item	L_W	63	125	250	500	1k	2k	4k	8k
Cat 793 RDT	*120*	87	104	106	116	115	113	106	97
Cat 793 RDT	*120*	87	104	106	116	115	113	106	97
Cat D11 dozer	*111*	76	92	97	104	105	106	102	91
Total of Items	*123*	90	107	109	119	118	116	110	101

NB: Throughout the duration of the mine's development the 'worst case' situation, in regard to spoils dumping, will occur when the nominated plant items are situated on top of a spoil deposit which has reached it's design reduced level (RL). This scenario has been used for the modelling of daytime received noise levels.

For modelling of night time received noise levels, spoils dumping has been considered to be located on the pit side of the dump. An RL similar to the natural ground on the opposite side of the pit has been used for this operation (dumps are stepped at 10 metre intervals during construction). The spoils dump design for the various mine stages has been supplied by P. J. Murray & Associates Pty Ltd.

5.6.5 In Pit Haulage and Haul Road Maintenance

During operation of the mine, a number of plant items could be expected to be on the haul roads at any given time. For the purpose of this assessment, we have considered the operation of all the haul road maintenance equipment and one (1) haul truck at any given instant. The road maintenance equipment has been divided into two (2) operating groups and a rear dump truck hauling overburden has been included in one (1) of these groups. The operating group that includes the haul truck has been located in the active pit, generally midway between the shovel and the spoils dump while the remaining group has been located in the inactive pit at a point that would be midway between a shovel and the spoils dump if this pit was active. Plant items associated with the Active and Inactive Pit road maintenance activities are outlined in Tables 5.10 and 5.11 respectively.

Table 5.10: Plant items and 1/1 Octave Spectra – Active Pit road maintenance

		A weighted octave band spectra							
Plant Item	L_W	63	125	250	500	1k	2k	4k	8k
Cat 793 RDT	***120***	87	104	106	116	115	113	106	97
Cat DJB water cart	***116***	78.2	97	101.8	105.4	112.2	111.8	107	95.4
Cat 777 water cart	***121***	82	103	105	113	113	118	108	97
Total of Items	***124***	89	107	109	118	118	120	112	101

Table 5.11: Plant items and 1/1 Octave Spectra – Inactive Pit road maintenance

		A weighted octave band spectra							
Plant Item	L_W	63	125	250	500	1k	2k	4k	8k
Cat DJB water cart	***116***	78.2	97	101.8	105.4	112.2	111.8	107	95.4
Cat 16G Grader	***111***	77.8	95	99.8	101.8	107	105	102.6	97.8
Total of Items	***117***	81	99	104	107	113	113	108	100

NB: For each mining stage assessment, the two (2) operating groups described above have been located within the pit at an RL no less than that determined for the shovel "worst case" during the same stage.

5.6.6 Dragline Construction

The Rix's Creek construction pad is located along the Rix's Creek access road, directly south of the washing plant. Large scale construction activities, such as the construction of the large dragline being considered as an option for overburden removal, can generate substantial noise emissions through the operation of construction cranes, air compressors and forklifts.

The L_W of all plant items associated with the dragline construction was determined to be 108dB(A) and this figure was used to generate a series of noise contours for the surrounding rural/residential areas as shown in Volume II. Note that the contours were generated assuming end of year one topographical features.

5.7 Blasting Operations

Blasting information contained in this report is based on the monitored results of production blasting carried out at Rix's Creek open cut mine. Ground constants, K and B, for the site were determined using results from the mine's blast monitoring and the equation for scaled distance, as outlined in Equation 5.1.

$$V = K \times \left(\frac{R}{\sqrt{W}} \right)^{-B} \quad \text{...... Equation 5.1}$$

Where V is the vibration velocity (mmsec^{-1})
R is the distance between charge and monitor (m)
W is the charge weight per delay (kgs) also known as the MIC
K and B are values defining ground conditions between the blast and monitor

Expected blast overpressure results were estimated using Equation 5.2, Airblast Pressure for Confined Blastholes.

$$P = 3.3 \times \left(\frac{R}{W^{1/3}} \right)^{-1/2} \quad \text{...... Equation 5.2}$$

Where P is the blast overpressure (kPa)
R is the distance between charge and monitor (m)
W is the charge weight per delay (kgs) also known as the MIC

Using Equation 5.3 the estimated blast overpressure (kPa) from Equation 5.2 is converted into decibels (dB).

$$SPL = 20LOG\left(\frac{p}{p_{REF}} \right) \quad \text{...... Equation 5.3}$$

Where SPL is the blast overpressure (dB(Lin))
p_{REF} is the reference RMS sound pressure (Pa)
p is the RMS sound pressure (Pa)

From monitored results of previous production blasts, and our calculation of typical K and B Scaled Distance Coefficients, the range of ground vibration and blast overpressure result expected at a given distance can be predicted. From these results, limiting Maximum Instantaneous Charges, MICs, can be derived to meet the relevant criteria at those distances. These results are outlined in Table 6.11.

5.8 Intermittent Traffic Noise

Information supplied by Rix's Creek Mine, indicates an insignificant amount of local traffic use Rix's Creek Lane. As a result, the traffic volumes presented below represent the amount of mine employee traffic likely to use the route, taking into account car pooling.

Traffic noise levels were calculated in accordance with the Environment Protection Authorities intermittent traffic noise guidelines. This criteria was adopted because of the infrequent traffic movements associated with the shift changes at the mine.

Equation 5.4 outlines the mathematical formula used in calculating the Leq,T noise level for intermittent traffic noise.

$$L_{eq},T = L_b + 10LOG\left[1 + \frac{ND}{T} \times \left(\frac{10((L_{MAX} - L_b)/10) - 1}{2.3} - \frac{(L_{MAX} - L_b)}{10}\right)\right] \text{......Equation 5.4}$$

Where L_b is background noise level
T is time in minutes
D is duration of noise in minutes
L_{MAX} is vehicle noise
N is number of vehicle trips

The equivalent continuous noise level was determined for the 'worst case' change of shift over a one hour period. On average, 12 cars enter and leave the present mine during a shift changeover hour, a total of 24 vehicle movements. The workforce is expected to rise from 46 to 92 employees should approval be given to move into the extended mining area. The average number of car movements during a shift changeover hour is expected to rise to 48.

5.9 Rail Traffic Noise

Should approval be given to increase production, the mines clean coal output is expected to increase from it's current level of 500,000tpa to approximately 1.5Mtpa. This increase in output necessitates an additional 200 trains per year to transport product to Newcastle assuming the use of 5000 tonne train loads, or an additional 333 trains per year using 3000 tonne train loads. This assessment considers the use of 3000 tonne trains which equates to approximately one additional train load per day, ie. a total of two additional train movements per day (one empty and one full).

An equivalent continuous noise level for rail traffic noise can be calculated as for intermittent road traffic noise. Trains used to transport additional product coal from Rix's Creek Mine will be the same as used at present, therefore maximum passby noise levels at any receptor will not change.

We will consider only noise levels generated by coal freight movements through Singleton, other freight traffic is sporadic and passenger services are minimal. There are many residences in Singleton and Singleton Heights located in audible proximity to the railway, this assessment calculates the noise level (Leq,T) at a hypothetical receptor point 50 metres from the track to indicate the degree of change.

5.10 Adverse Atmospheric Conditions

Average Maximum Noise levels, L10dB(A) for the proposed extensions to the Rix's Creek open cut coal mine have been predicted assuming neutral atmospheric conditions prevail. That is, no allowance has been made for wind or temperature effects in accordance with the Environment Protection Authorities requirements.

However, in situations like this, where individual receivers are affected dependant upon the location of the mining equipment and operations, it is worthwhile to consider the effects of both the prevailing winds for the area as well as temperature inversions.

5.10.1 Wind Effects

Prevailing winds can increase or reduce received noise levels at individual receivers by up to 9dB, depending on the wind direction and the locations of the source and receiver.

Analysis of wind roses of prevailing wind speed and direction, as monitored by the operators of the Rix's Creek mine within the lease area, indicates the prevailing winds for the summer and autumn months are from the south east while the prevailing winds for the winter and spring months are from the west to north–west and the east. Annual prevailing winds for the site are from the east or west to north–west at varying speeds from 0.5 – 7.5 $msec^{-1}$.

Individual case scenarios which, based on predicted results, have the greatest impact upon the surrounding rural/residential areas have been assessed for the prevailing wind conditions outlined above. Predicted noise contours appear in Volume II.

5.10.2 Temperature Inversions

Temperature inversions can occur during cold and still atmospheric conditions, usually during the evening or early morning hours in winter, and result in increased noise level at considerable distances from the noise source. This effect is caused by the refraction of sound waves off layers of warmer air at different altitudes towards the ground. Residences in proximity to the source are usually unaffected by this phenomenon.

The incidence and effects of temperature inversion are not predictable to any degree of accuracy, neither for the focus area nor for the duration of the incident. In general, the affected area may only have a radius of 200 metres, the duration of onset could last from twenty minutes to one hour or more and residences may or may not be affected.

No site specific measured or recorded data was available for this investigation so the assessment of the individual scenarios which appear to have the greatest impact were conducted using a vertical temperature gradient of $3^{0}C.100m^{-1}$. This figure corresponds to a *very strong* temperature inversion and in reality, one would expect that the temperature gradient would be significantly less than this. Predicted noise contours appear in Volume II.

6.0 RESULTS

6.1 Background Noise Level Surveys

A background noise level survey was conducted on the 27th and 28th of April 1994 at the seven (7) rural and residential properties listed in Table 6.1 These properties are considered to be representative of the differing acoustic environments surrounding the lease area.

Table 6.1: Background noise level monitoring locations

Location	Residence	Area	Represents
1	Stair	The Retreat	Residential
2	Treweek	Singleton Heights	Residential
3	Ridhalgh	Maison Dieu Road	Rural
4	Wright	Maison Dieu Road	Rural
5	Humble	New England Highway	*
6	Eveleigh	Rix's Creek Mine	*
7	Tisdell	Camberwell	Rural

* These rural residences are in close proximity to the mine. Both are affected by nearby noise sources, highway noise at the Humble residence, Rix's Creek mine noise at the Eveleigh residence.

Results of both the day and night time monitoring at the seven (7) survey locations are presented Tables 6.2 and 6.3 respectively.

Table 6.2: Background noise level survey results – Daytime

	Measured Noise Levels, dB(A)					
Location	L1	L10	L90	Lmin	Leq	L90 source
1	59.5	53	38.5	36	49.4	B
2	55	44.5	35.5	31	42.8	C
3	61	41.5	31	28.5	45.3	D
4	56	33.5	27.5	26.5	40.9	D
5	62	56.5	44.5	34	52.9	A
6	60.5	48	38	34.5	49.1	F
7	49	40	31.5	28.5	38.4	A

Noise sources

- A New England Highway traffic.
- B Bridgeman Road traffic.
- C Singleton Heights traffic.
- D Insects, birds, or frogs.
- E Mining at Warkworth/Mt Thorley.
- F Rix's Creek mine.

6.1 Background Noise Level Surveys (Cont...)

Table 6.3: Background noise level survey results – Night time

	Measured Noise Levels, dB(A)					
Location	L1	L10	L90	Lmin	Leq	L90 source
1	57	49	35	32	46.3	D
2	43	39	33	30.5	36.9	A
3	39	37.5	34	32	35.9	D
4	39.5	35.5	31.5	30	34.2	E
5	61	56	35.5	33	51.9	A
6	54.5	49.5	35	32	45.2	D, A
7	47	43	34	31.5	40.3	A
1	53.5	50	37	34.5	45.5	D
2	51	46	36	32.5	42.6	A
3	42.5	39.5	34	31.5	37.4	E
4	36.5	33.5	30	29	31.9	E
5	60.5	56	38	34	51.6	A
6	56	51.5	35.5	33	47.2	D
7	47.5	43	32.5	29	40.2	D

Noise sources

A New England Highway traffic.
B Bridgeman Road traffic.
C Singleton Heights traffic.
D Insects, birds, or frogs.
E Mining at Warkworth/Mt Thorley.
F Rix's Creek mine.

A summary of the Caleb Smith Consulting data logger survey on the Tisdell property, Location 7, is given in Table 6.4. These figures are based on statistical results calculated for each 20 minute period of the survey.

Table 6.4: Summary of Data logger survey results (CSC) – Location 7 (Tisdell)

	Measured Noise Levels, dB(A)				
Level	L1	L10	L90	Lmin	Leq
Survey Average	48	42	35	32	40
Survey Maximum	77	68	49	42	64
Survey Minimum	36	32	28	26	30
Daytime Average	49	43	35	32	41
Daytime Maximum	77	68	49	42	64
Daytime Minimum	38	34	28	26	32
Night time Average	47	42	34	32	39
Night time Maximum	67	58	35	41	62
Night time Minimum	36	32	28	26	30

6.1 Background Noise Level Surveys (Cont...)

A summary of a Nigel Holmes and Associates data logger survey at Singleton Heights, Location 2, during November 1993 is given in Table 6.5. These figures are based on statistical results calculated for each 1 hour period of the survey (L90 results less than 26dB(A) have been ignored).

Table 6.5: Summary of Data logger survey results (NHA) – Location 7 (Tisdell)

	Measured Noise Levels dB(A)			
Level	L1	L10	L90	Lmin
Survey Average	50	45	35	31
Survey Maximum	63	55	50	38
Survey Minimum	38	37	28	23
Daytime Average	52	45	36	32
Daytime Maximum	63	55	50	38
Daytime Minimum	43	38	30	27
Night time Average	48	43	32	29
Night time Maximum	53	52	43	36
Night time Minimum	38	37	28	23

A summary of a Nigel Holmes and Associates data logger survey at Maison Dieu road, Location 4, during December 1993 is given in Table 6.6. The figures given are based on statistical results calculated for each 1 hour period of the survey, again L90 results less than 26dB(A) have been ignored).

Table 6.6: Summary of Data logger survey results (NHA) – Location 4 (Wright)

	Measured Noise Levels dB(A)			
Level	L1	L10	L90	Lmin
Survey Average	53	44	34	31
Survey Maximum	71	58	45	41
Survey Minimum	33	30	26	22
Daytime Average	56	47	35	32
Daytime Maximum	71	58	45	41
Daytime Minimum	36	33	28	22
Night time Average	47	41	33	30
Night time Maximum	65	53	42	37
Night time Minimum	33	30	26	24

A summary of a Nigel Holmes and Associates data logger survey at The Retreat, Location 1, during December 1993 is given in Table 6.7 The figures given are based on statistical results calculated for each 1 hour period of the survey (L90 results less than 26dB(A) have been ignored).

6.1 Background Noise Level Surveys (Cont...)

Table 6.7: Summary of Data logger survey results (NHA) – Location 1 (The Retreat)

	Measured Noise Levels dB(A)			
Level	L1	L10	L90	Lmin
Survey Average	54	49	39	35
Survey Maximum	61	58	52	46
Survey Minimum	46	42	32	26
Daytime Average	55	49	37	33
Daytime Maximum	61	58	52	46
Daytime Minimum	50	45	32	26
Night time Average	53	49	41	38
Night time Maximum	58	56	50	46
Night time Minimum	46	42	34	30

A summary of a Nigel Holmes and Associates data logger survey at Maison Dieu road (location 4) during July 1993 is given in Table 6.8 The figures given are based on statistical results calculated for each 1 hour period of the survey (L90 results less than 26dB(A) have been ignored).

Table 6.8: Summary of Data logger survey results (NHA) – Location 4 (Wright)

	Measured Noise Levels dB(A)			
Level	L1	L10	L90	Lmin
Survey Average	51	40	31	28
Survey Maximum	62	44	38	36
Survey Minimum	38	32	27	23
Daytime Average	55	40	30	27
Daytime Maximum	62	44	36	33
Daytime Minimum	43	35	27	23
Night time Average	46	40	33	30
Night time Maximum	59	44	38	36
Night time Minimum	38	32	27	24

A summary of a Nigel Holmes and Associates data logger survey at The Retreat, Location 1, during July 1993 is given in Table 6.9 The figures given are based on statistical results calculated for each 1 hour period of the survey (L90 results less than 26dB(A) have been ignored).

6.1 Background Noise Level Surveys (Cont...)

Table 6.9: Summary of Data logger survey results (NHA) – Location 1 (Stair)

Level	Measured Noise Levels dB(A)			
	L1	L10	L90	Lmin
Survey Average	53	46	34	30
Survey Maximum	57	51	44	38
Survey Minimum	42	34	28	26
Daytime Average	54	49	36	31
Daytime Maximum	57	51	44	38
Daytime Minimum	51	45	31	28
Night time Average	50	41	30	28
Night time Maximum	56	50	34	29
Night time Minimum	42	34	28	26

The measured background noise levels for the rural and residential areas around the Rix's Creek lease area are summarised in Table 6.10.

Table 6.10: Summarised background noise levels

Area	Average Measured Background, dB(A)	
	Day	Night
Rural	32	33
Residential	37	35

6.2 Received Mining Noise Levels

Noise level calculations were undertaken for each permutation of the alternative mining options at each stage and, noise level contours were generated for the areas surrounding the mine lease area.

Predicted noise contours as a result of the mining operations for all stages of the mines development, for the shovel overburden removal option, are given in Volume II of this report. Because of the similarity of the plant and machinery that will be utilised, and hence the predicted results, for each the overburden removal options, contours are presented for the shovel option only.

6.3 Blast Vibration and Overpressure

Calculations made using blast monitoring data provided by Rix's Creek mine have provided the ground constants, K = 6640 and B = 2.06, for the area. Using these constants, and the equations presented in Section 5.8 of this Report, it is possible to calculate limiting Maximum Instantaneous Charges (MICs) to ensure criteria exceedances do not occur at any specified distance. The predicted results for both Blast Overpressure and Ground Vibration are given in Table 6.11 and in Figure 2 (Volume II).

Table 6.11: Limiting MIC (Blast Overpressure and Ground Vibration)

Distance (metres)	MIC ($5mmsec^{-1}$)	MIC ($2mmsec^{-1}$)	MIC ($1mmsec^{-1}$)	MIC ($0.5mmsec^{-1}$)	MIC (120dBLin)	MIC (115dBLin)
100	9	4	2	1	3	1
200	37	15	8	4	23	5
300	84	34	18	9	77	18
400	149	61	31	16	183	43
500	232	95	49	25	357	85
600	334	137	70	36	618	146
700	455	187	95	49	981	233
800	594	244	125	64	1464	347
900	752	309	158	80	2085	494
1000	928	381	195	99	2860	678
1100	1123	462	235	120	3807	903
1200	1337	549	280	143	4942	1172
1300	1569	645	329	168	6283	1490
1400	1820	748	381	195	7848	1861
1500	2089	858	438	223	9652	2289
1600	2377	976	498	254	11714	2778
1700	2683	1102	562	287	14051	3332
1800	3008	1236	631	322	16679	3955
1900	3352	1377	703	358	19616	4652
2000	3714	1526	778	397	22880	5425

Current blasting practises at Rix's Creek mine already allow for the proximity of historic coke ovens within the lease area and this issue has not been addressed in this report.

6.4 Intermittent Traffic Noise

Leq,T for day and night time shift changeover traffic have been calculated for the only privately owned residence along Rix's Creek lane. The residence is located approximately 20 metres from the lane where vehicles pass at around 80 km/hr. The following parameters were used for the calculations as detailed in Section 5.9 of this report.

Parameter	*Daytime*	*Night time*
L_b	38dB(A)	35dB(A)
L_{MAX}	69dB(A)	69dB(A)
D	0.03 minutes	0.03 minutes
T	60 minutes	60 minutes
N	24 and 48	24 and 48

Background noise levels used (L_b) are as measured along Rix's Creek lane during the noise level survey conducted on the 27th and 28th of April 1994.

The L_{MAX} figure has been sourced from our library of technical data and represents the received noise level at a distance of 20 metres from a car travelling at 80 km/hr. L_{MAX} is considered to be the received noise level as the car approaches and passes by the residence moving a total distance of 50 metres. The time taken (D) to travel this distance at 80 km/hr is 0.03 minutes.

It is assumed that the time taken (T) for shift changeover traffic to pass along the lane will be approximately 60 minutes. The number of vehicle movements (N) per shift changeover used for calculation are based on current and projected workforce numbers, see Section 5.9.

Using the above figures the results shown in Table 6.12 have been calculated.

Table 6.12: Predicted Intermittent Traffic Noise Levels

	Calculated Leq,T, dB(A)	
Traffic Volume	Daytime	Night time
Present shift changeover	47	46
Predicted shift changeover	49	49

Criteria limits for intermittent traffic noise levels are met for daytime and evening conditions. Present night time traffic noise exceeds the relevant criterion by 1dB while predicted traffic noise levels exceed the criterion by 4dB.

6.5 Rail Traffic Noise

Leq,T for existing and projected rail traffic noise have been calculated for a hypothetical receptor, some 50m from the rail line where trains pass at 80 km/hr (empty) and 50km/hr (loaded). A total Leq,T is calculated as the logarithmic addition of an Leq,T resulting from empty trains passing the receptor, and an Leq,T from loaded trains.

Wagon noise is insignificant, in comparison to locomotive and local traffic noise, and has not been considered in this assessment. The following parameters have been used to determine existing rail traffic noise. Equations used are detailed in Section 5.9.

Parameter	*Loaded trains*	*Empty trains*
L_b	36dB(A)	36dB(A)
L_{MAX}	82dB(A)	82dB(A)
D	0.12 minutes	0.08 minutes
T	1440 minutes	1440 minutes
N	20	20

The background noise level used (L_b) is a time weighted average of the day and night time values derived, Section 6.1, to apply to Singleton residential areas.

L_{MAX} is as specified by the Environment Protection Authority and represents the received noise level at a distance of 50 metres from a 3 x 81 class locomotive train. Although some trains only use two locomotives, a "worst case" condition has been applied by assuming all trains will have three locomotives.

The State Rail Authority has indicated a general speed of 50 km/hr can be applied to loaded trains while 80 km/hr is the speed limit for empty trains. For the purpose of this assessment it has been assumed that locomotive noise is a maximum as the first of three engines passes the receptor and is sustained for a period of time equal to an additional two locomotives passing (i.e. as the train travels approximately 100 metres). Travelling at either 80 km/hr or 50 km/hr, the time taken (D) for the train to pass is approximately 0.08 or 0.12 minutes respectively. Rail traffic results presented in this Section are calculated for a twenty four hour period so that T equals 1440 minutes.

The average number of train movements (N) per day used for calculation have been provided by the State Rail Authority although the actual number of coal train movements on any given day varies according to the transport needs of mines in the area. The following parameters have been used to determine projected rail traffic noise. All parameters are as per existing rail traffic bar the number of train movements (N) each way which has increased by one, see Section 5.10.

Parameter	*Loaded trains*	*Empty trains*
L_b	36dB(A)	36dB(A)
L_{MAX}	82dB(A)	82dB(A)
D	0.12 minutes	0.08 minutes
T	1440 minutes	1440 minutes
N	21	21

6.5 Rail Traffic Noise (Cont...)

Using the parameters overleaf, the results given in Table 6.13 have been calculated.

Table 6.13: Current and Predicted Rail Traffic Noise

	Calculated Leq, T, dB(A)		
Rail Traffic	Loaded	Empty	Total
Current	50.8	49.1	53.0
Predicted	51.0	49.3	53.2

As can be seen from the results presented in Table 6.13, the predicted Leq, T noise levels for both the existing and future rail traffic volumes are below the 55 dB(A) criterion. It is important to note however, that this assessment considers coal freight movements only and the resulting impact upon a hypothetical receptor.

The predicted 0.2dB increase in the Leq, T for future rail traffic volumes is negligible and consequently, no noticeable change in acoustical amenity will be experienced by the residents of Singleton and Singleton Heights due to increase in coal train numbers

6.6 Cumulative Effects of Mining

The Rix's Creek open cut coal mine, which has a relatively large area of affectation, has also to be assessed on the cumulative effects of the predicted noise emissions with regard to other mines in the vicinity. Immediately north of the Rix's Creek open cut mine lease area is the Camberwell Coal open cut coal mine. Because of the proximity of these mines to one another, the predicted noise contours for each development overlap to some degree and will cause a phenomena known as "creeping background" whereby the existing background noise level is raised by some amount due to the logarithmic addition of the received noise levels from each of the developments.

Although predicted noise contours for the Camberwell Coal project were available to year 13 only, these were compared to the predicted contours for year 36, Pit 1 of the Rix's Creek assessment which has the greatest impact to the north of the lease area of all the individual scenarios. Because of the difficulties in adding the contours from each of the developments, noise levels at selected receivers, see Figure 1 Volume II, were considered.

Predicted noise levels at Camberwell Village are well below 30dB(A) for both developments and consequently there will be no cumulative impacts at this location. Predicted noise levels at the Tisdell residence are approximately 38dB(A) for the Camberwell Coal project and 40dB(A) for the Rix's Creek extended operations. These noise levels will add to give a total received level of 42dB(A) at the residence. Predicted received noise levels at "Dulwich" vary from 45dB(A) for the Camberwell Coal project to approximately 28dB(A) for the extended Rix's Creek operations. Due to the large difference in received noise levels, there will be no cumulative impacts at this location.

In general, based on the worst predicted results, there will *not* be significant cumulative impacts from the Camberwell Coal and the proposed extended Rix's Creek open cut mining operations.

7.0 CONCLUSION

An acoustical investigation has been carried out to determine the potential effect of the operation of the proposed extension to Rix's Creek open cut coal mine on residences of the local area.

The results presented in this report are based on hypothetical "worst case" situations. Although these situations may not arise. it is the generally accepted method of assessment for these types of large scale operations.

No recommendations are made in this report with regard to property acquisition or compensation as it is the proprietors intent to negotiate with land owners based on monitored results of the mining activities and *not* the predicted results included within.

In conclusion, we recommend that Environmental Noise Level Surveys be conducted at practical intervals during the operation of the proposed extended open cut mine at Rix's Creek to ensure the requirements of the Environment Protection Authority are satisfied at residential locations.

CALEB SMITH CONSULTING PTY LTD August 1994

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REPORT NO 94.834.R1

NOISE IMPACT STATEMENT

RIX'S CREEK OPEN CUT COAL MINE EXTENSION

VOLUME II - FIGURES

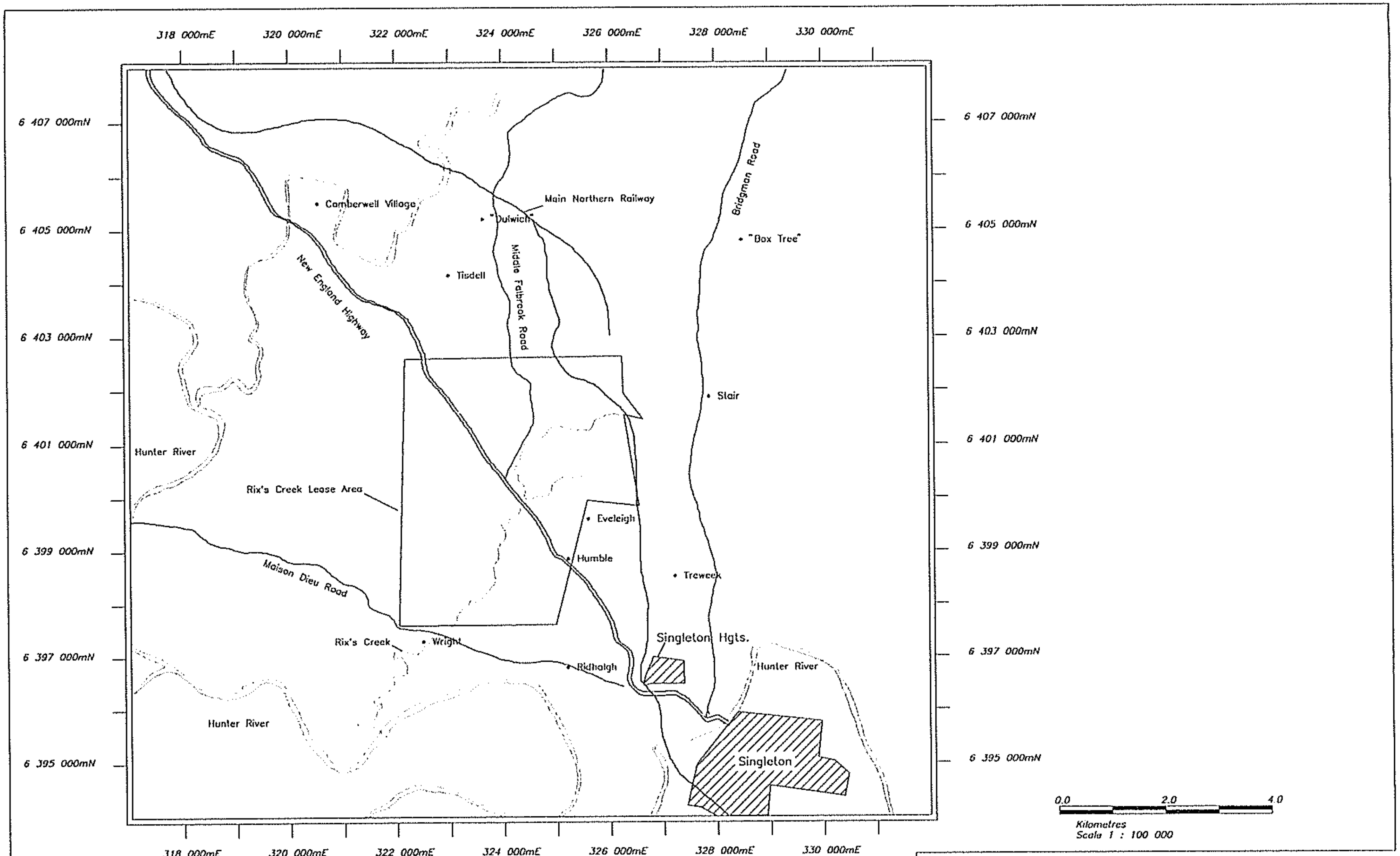
SINGLETON NSW

AUGUST 1994

Prepared for: **Envirosciences Pty Ltd**
122 Parry Street
NEWCASTLE NSW 2300

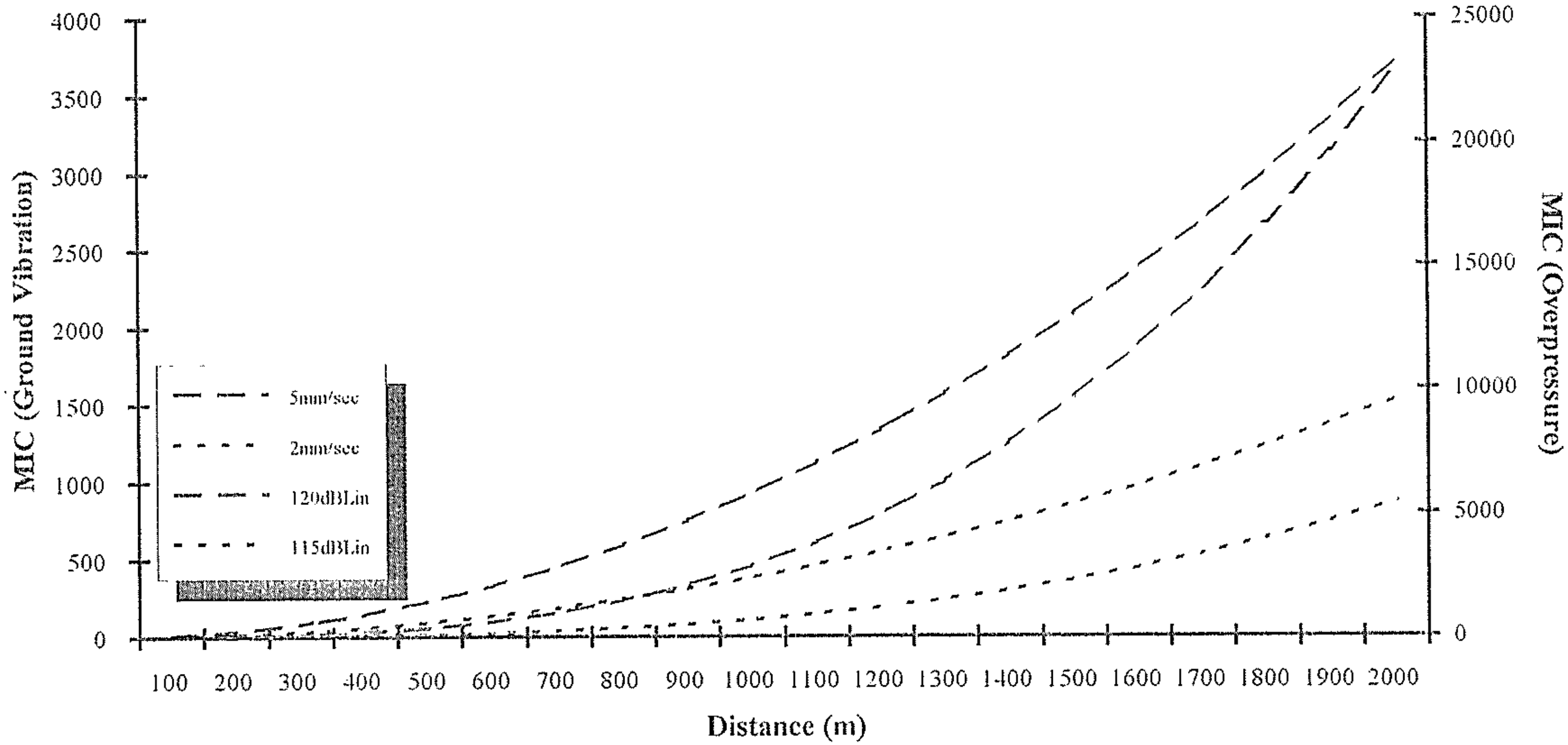
On behalf of: **Bloomfield Collieries Pty Limited**

List of Figures

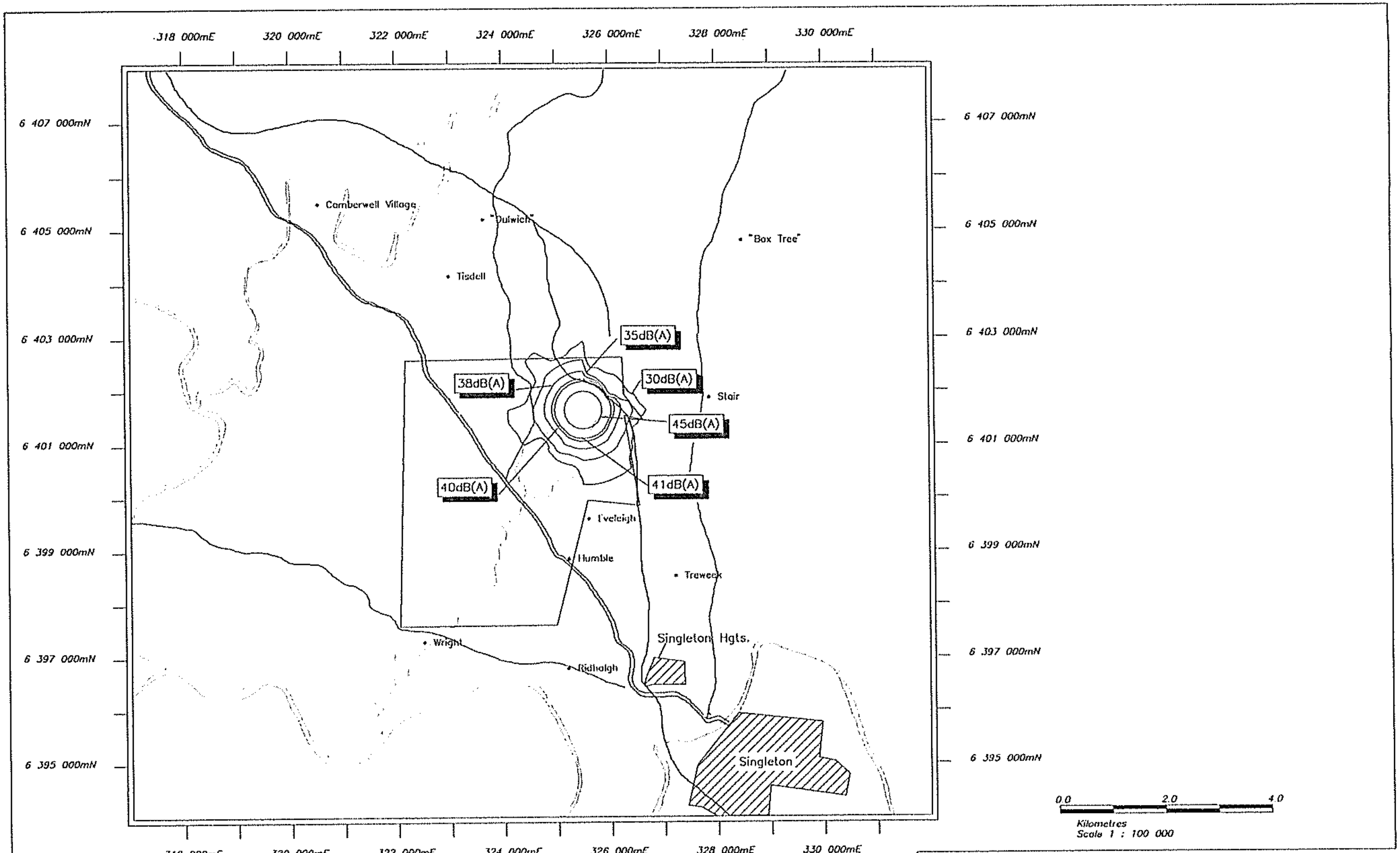


Rix's Creek Study Area

Figure 1 | August 1994



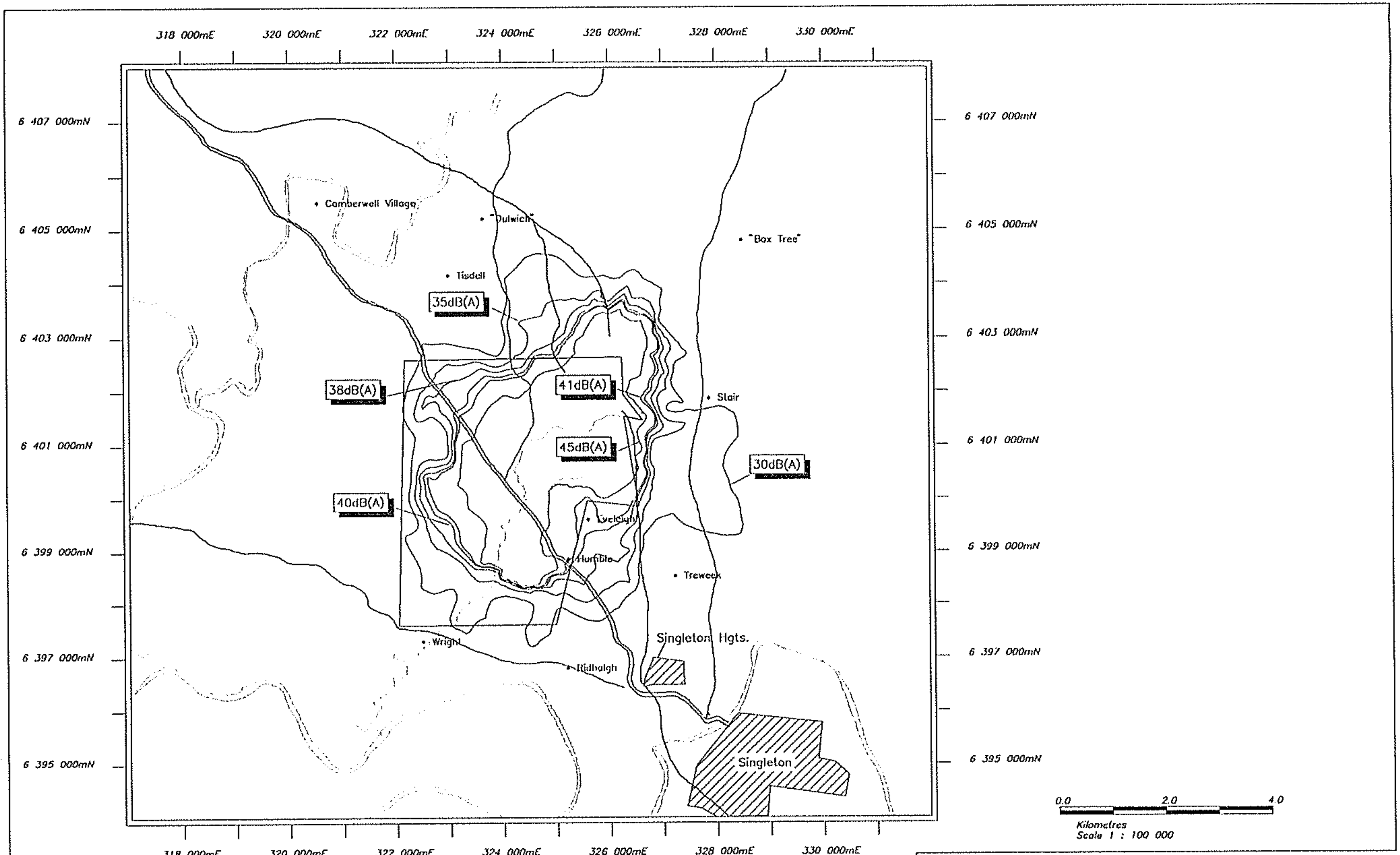
Limiling MIC (Ground Vibration and Overpressure)	
Figure 2	August 1994



Predicted Noise Contours – Dragline Construction

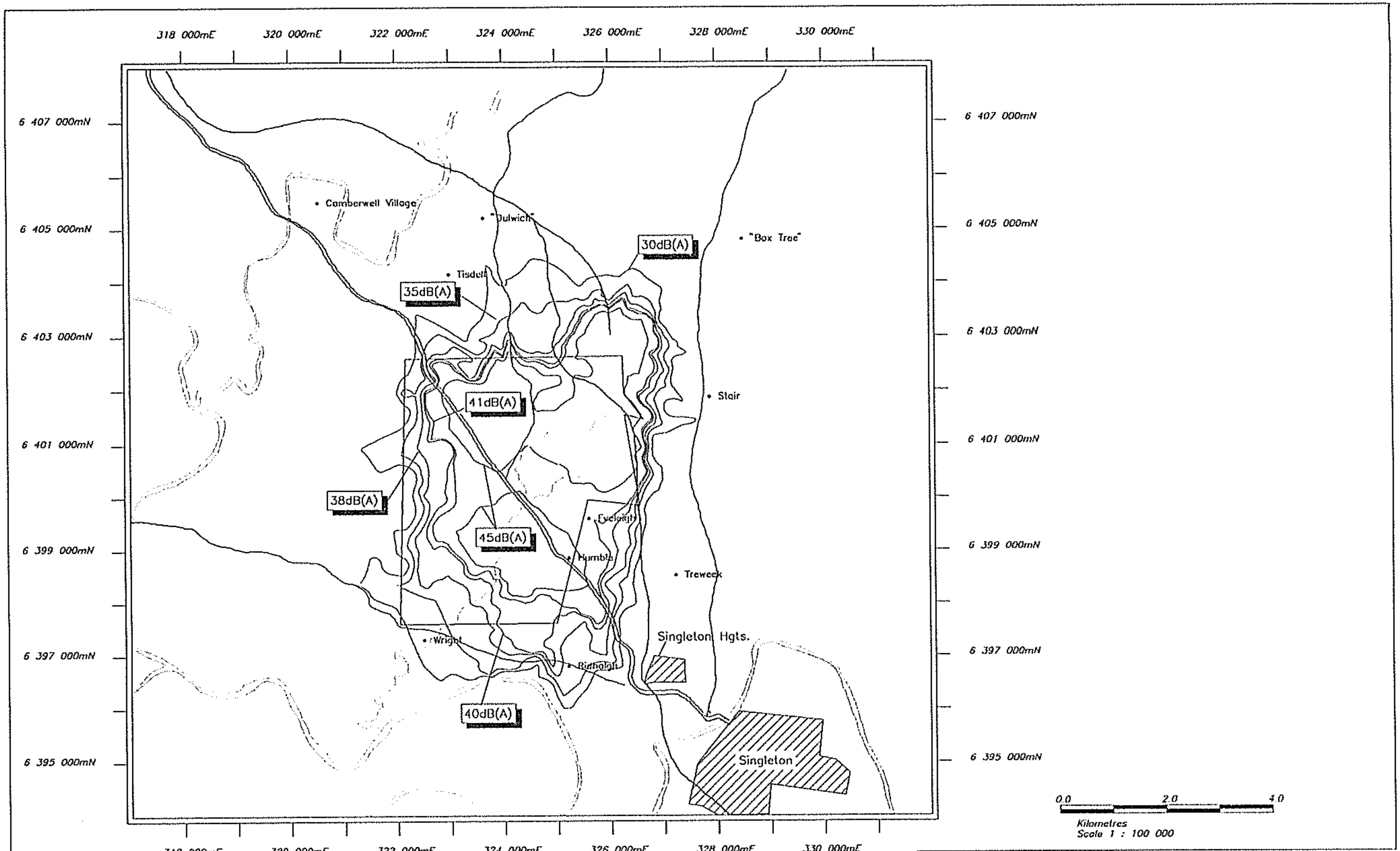
Figure 3

August 1994



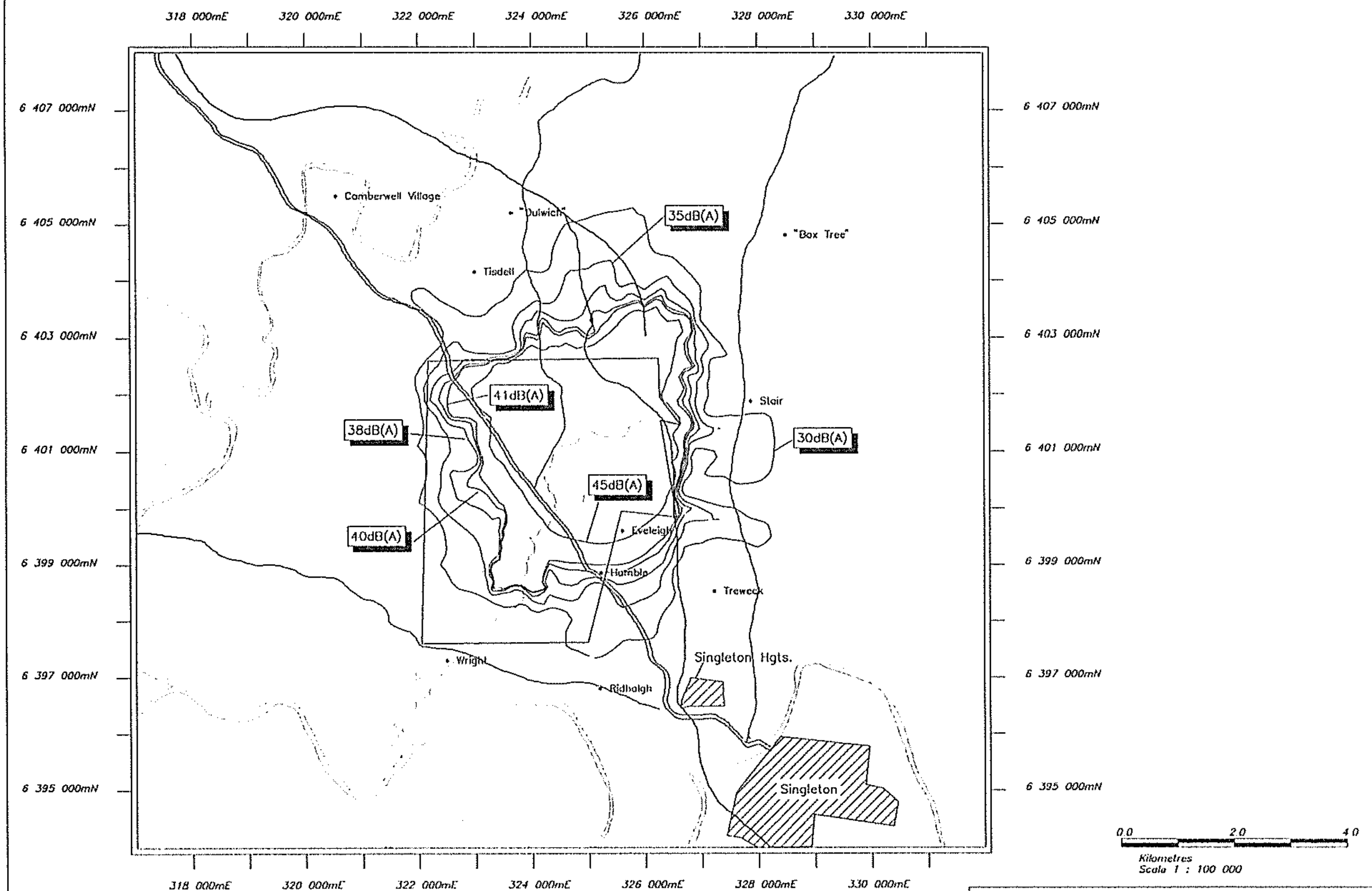
Predicted Noise Contours – Shovel, Yr 1 (Pit 1, Daytime)

Figure 4 | August 1994



Predicted Noise Contours –
Shovel, Yr 1 (Pit 2/3, Daytime)

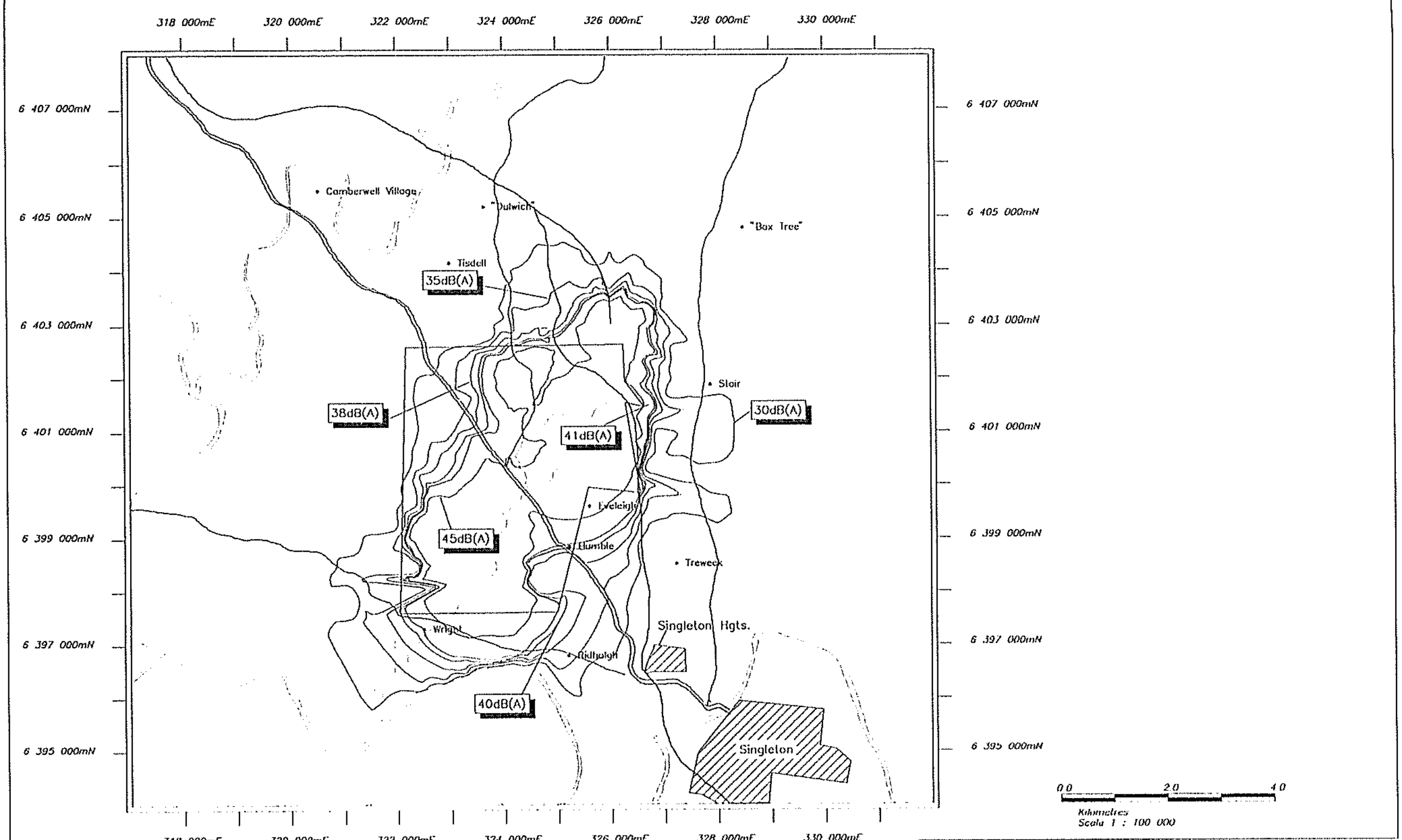
Figure 5 | August 1994



Predicted Noise Contours – Shovel, Yr 8 (Pit 1, Daytime)

Figure 6

August 1994



Predicted Noise Contours –
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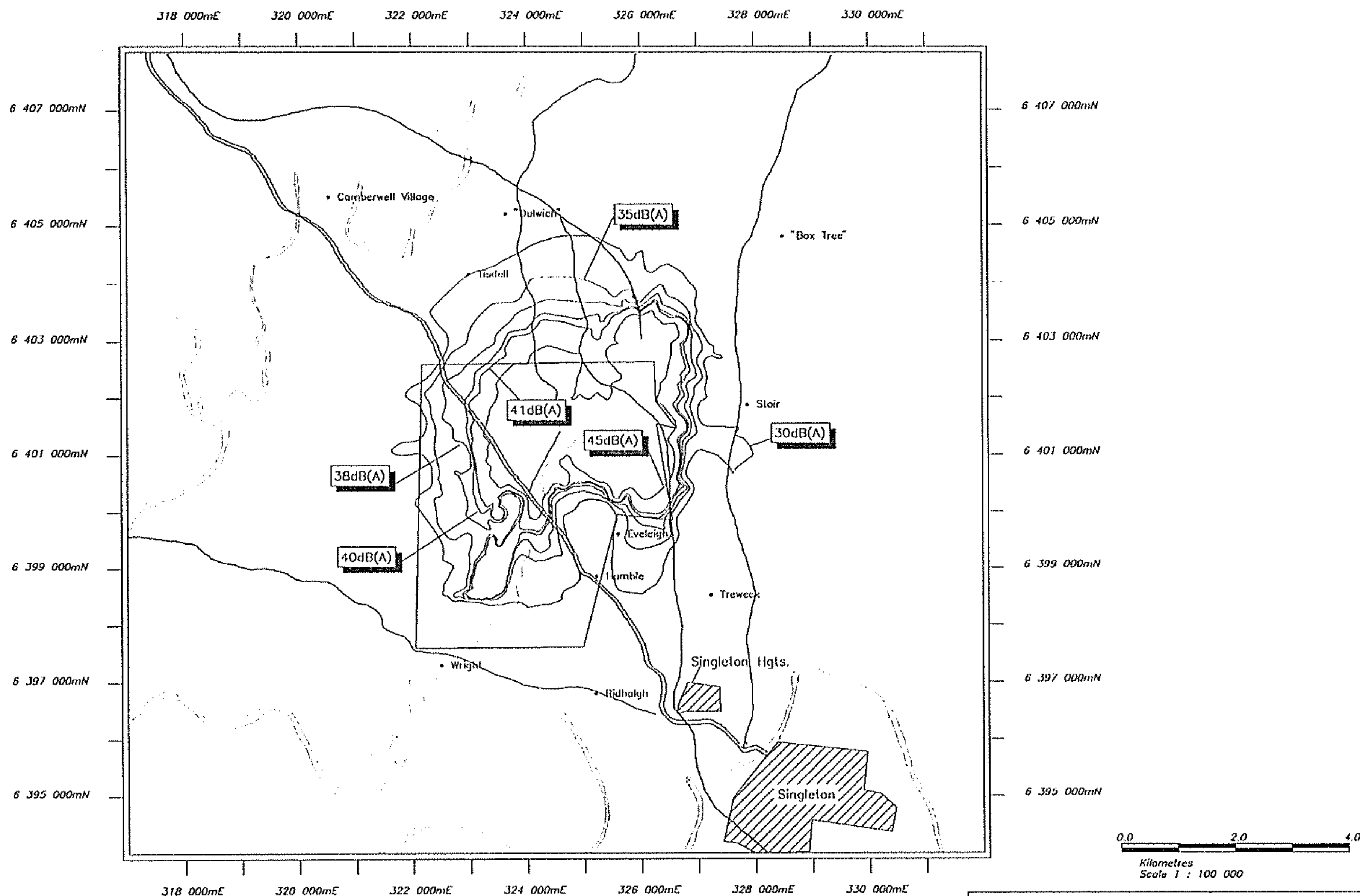
Figure 7 | August 1994



Predicted Noise Contours –
Shovel, Yr 15 (Pit 1, Daytime)

Figure 8

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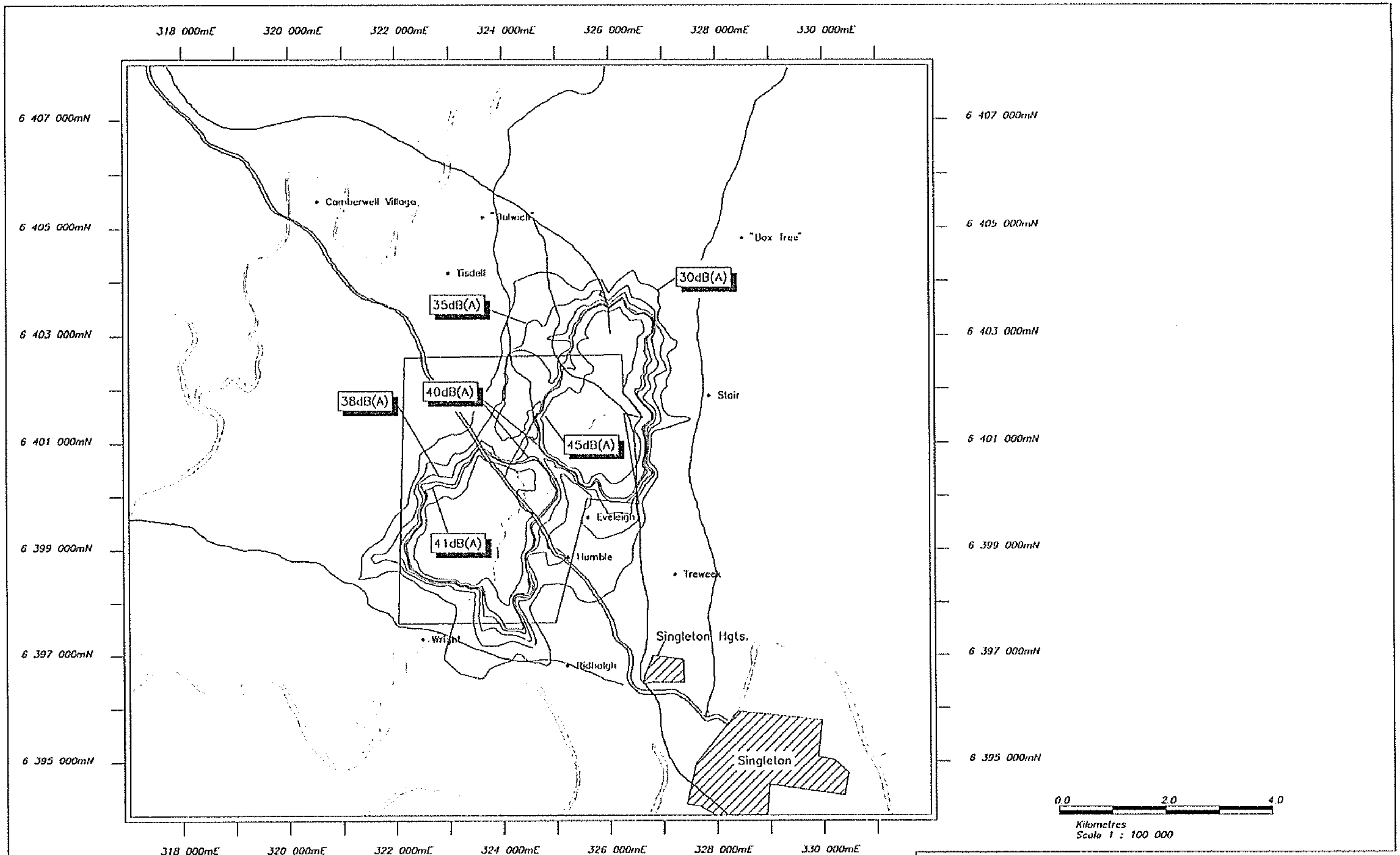

Predicted Noise Contours — Shovel, Yr 15 (Pit 2/3, Daytime)

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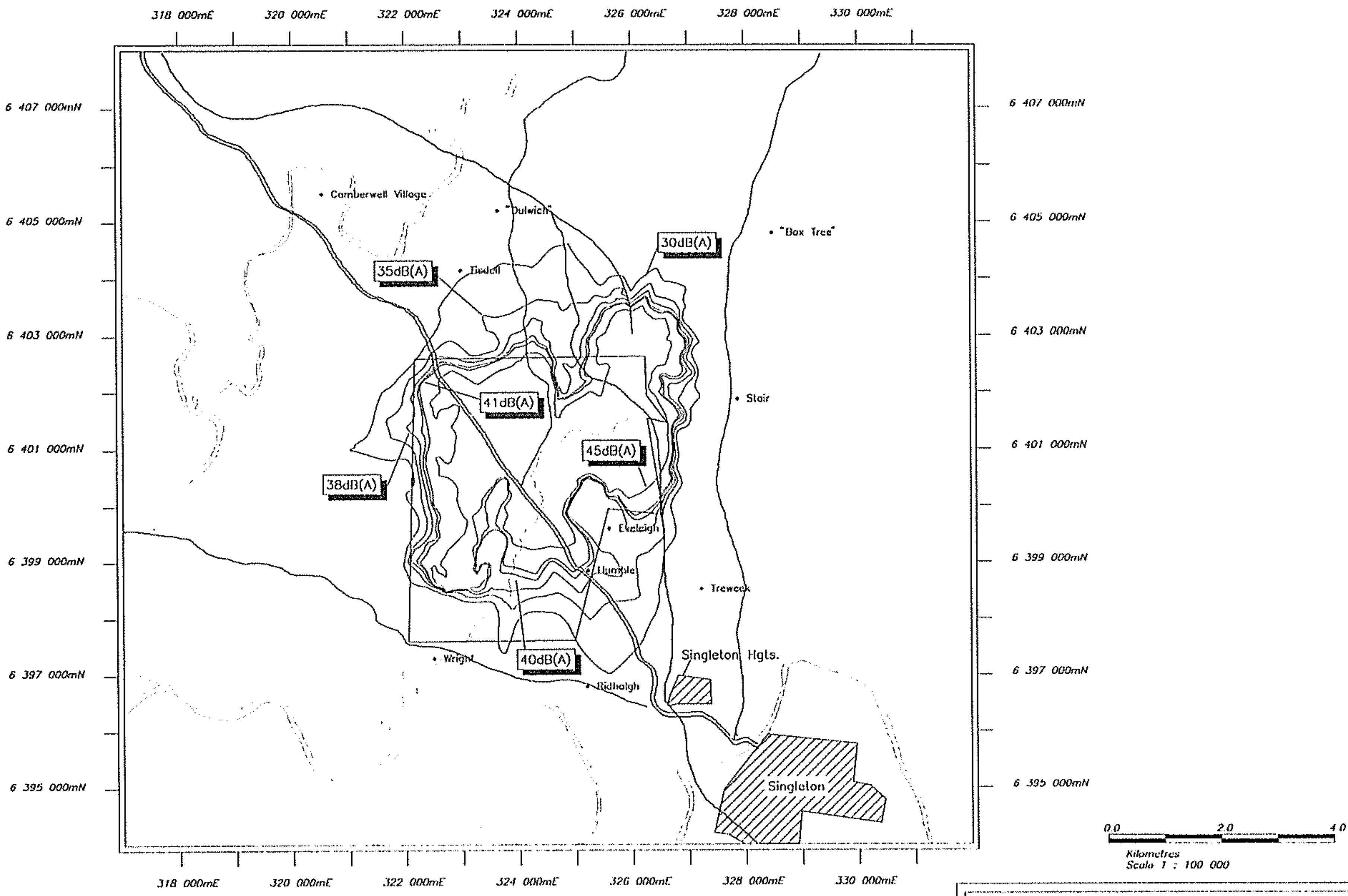
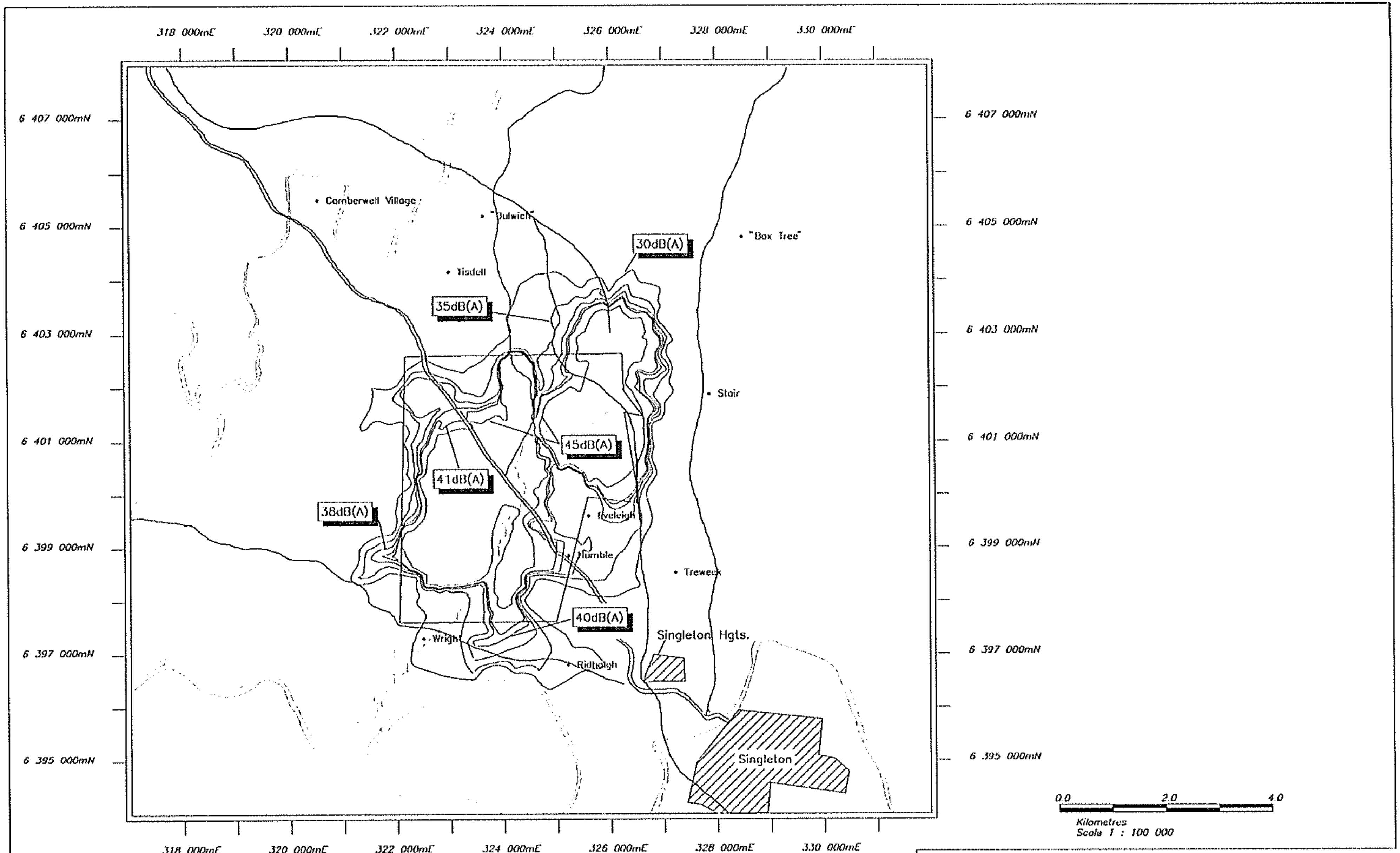


Predicted Noise Contours – Shovel, Yr 22 (Pit 1, Daytime)

Figure 10 | August 1994



Predicted Noise Contours –
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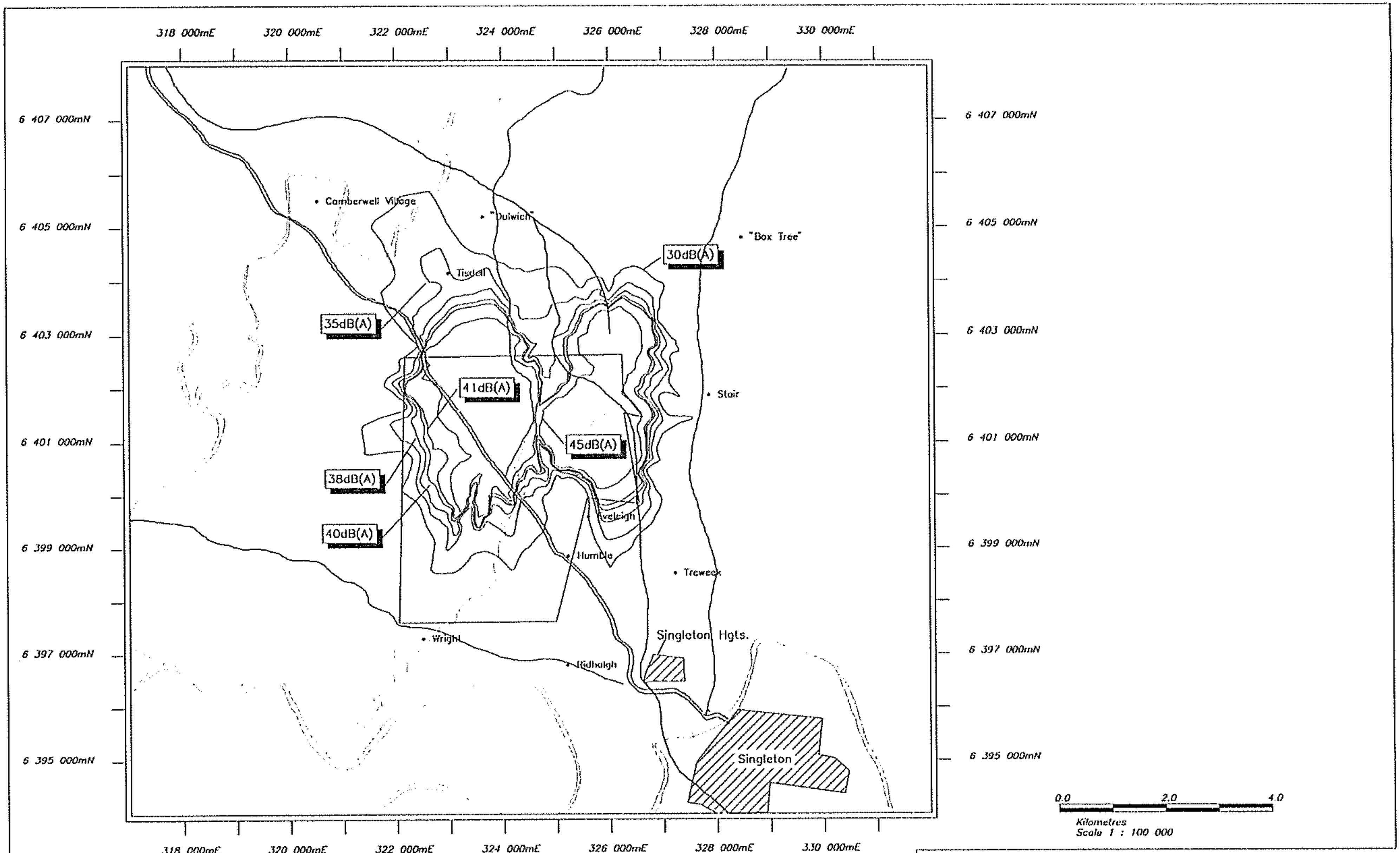

Predicted Noise Contours –
Shovel, Yr 29 (Pit 1, Daytime)

Figure 12

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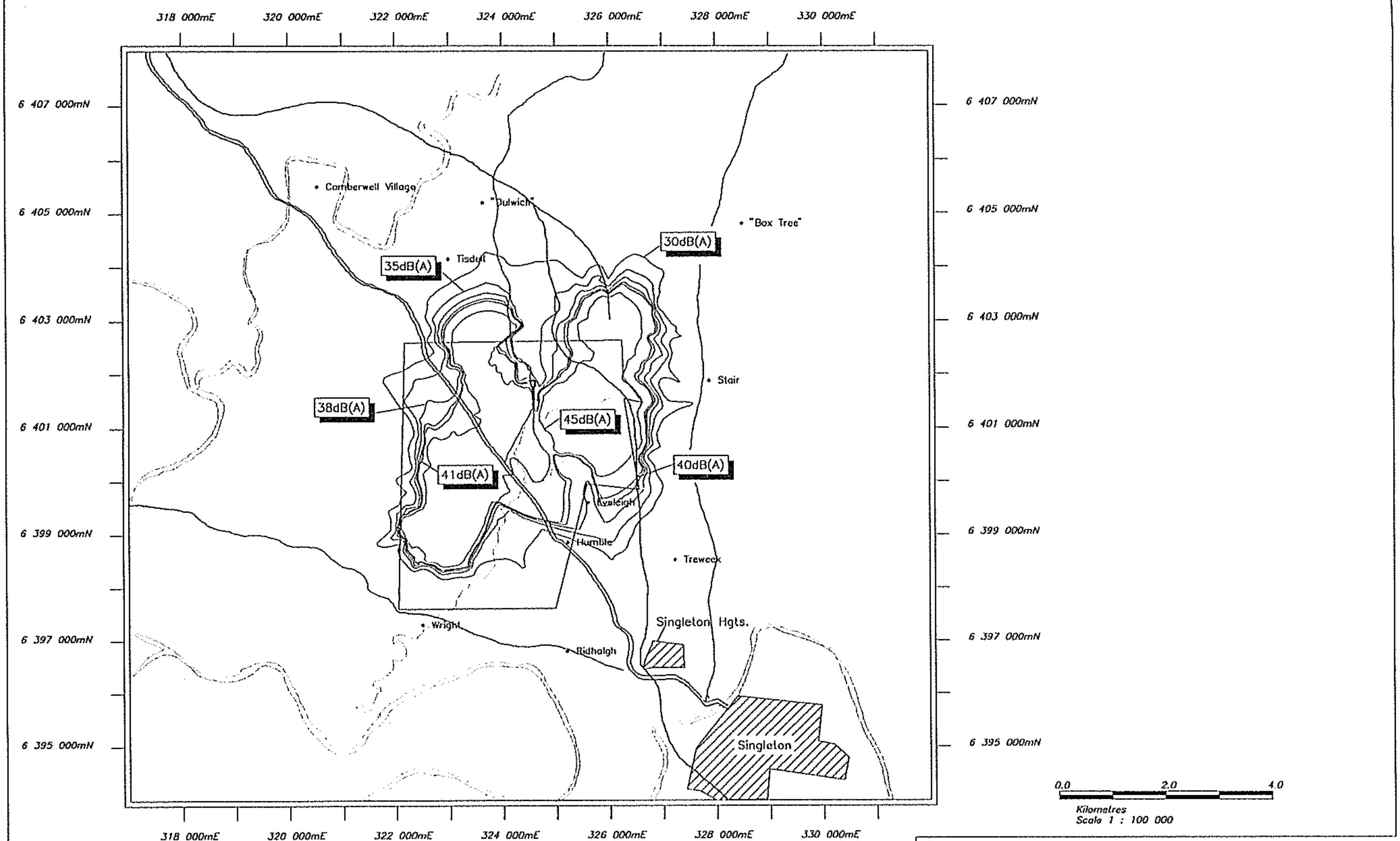

Predicted Noise Contours – Shovel, Yr 29 (Pit 2/3, Daytime)

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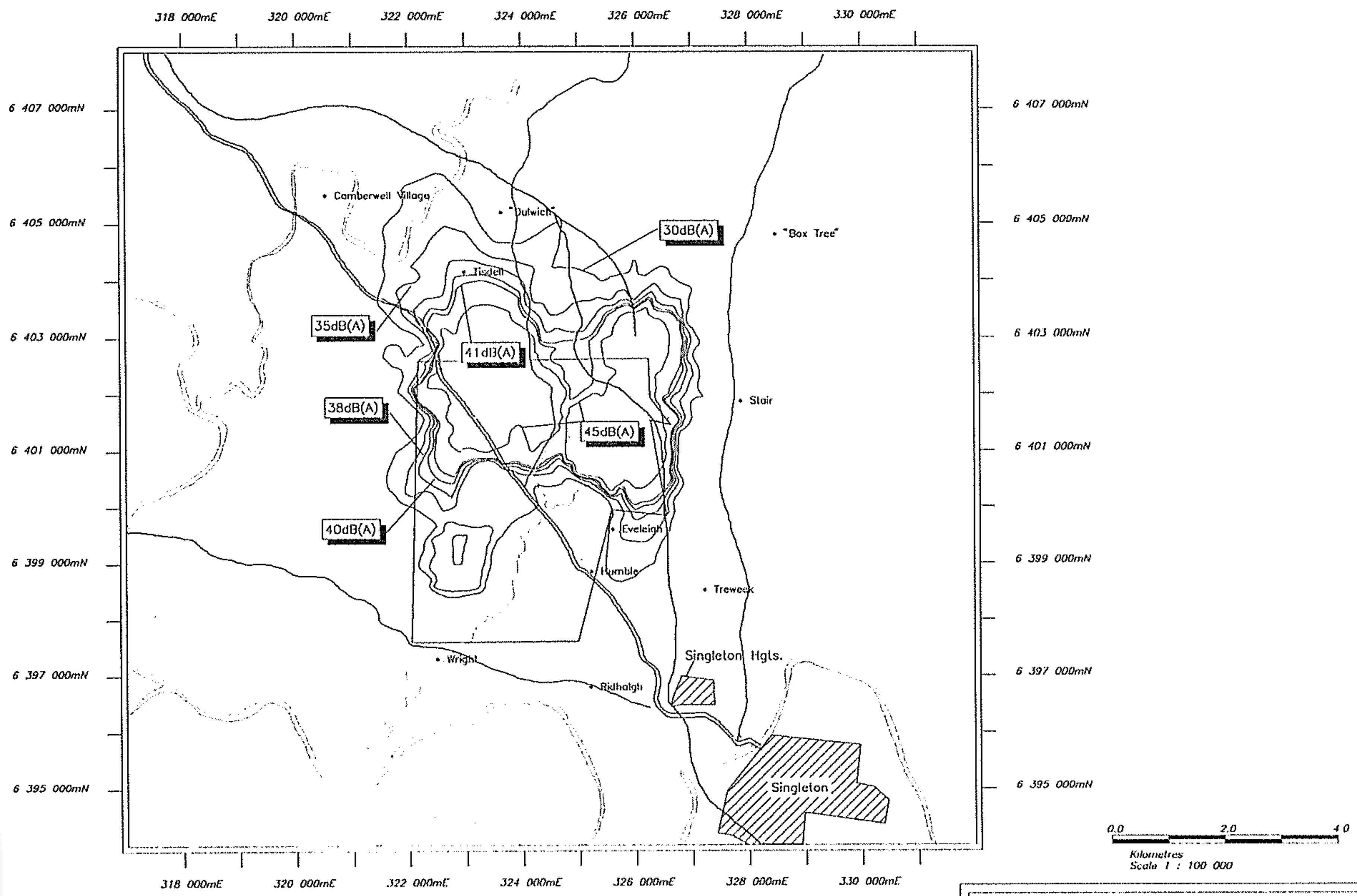

Predicted Noise Contours —
Shovel, Yr 36 (Pit 1, Daytime)

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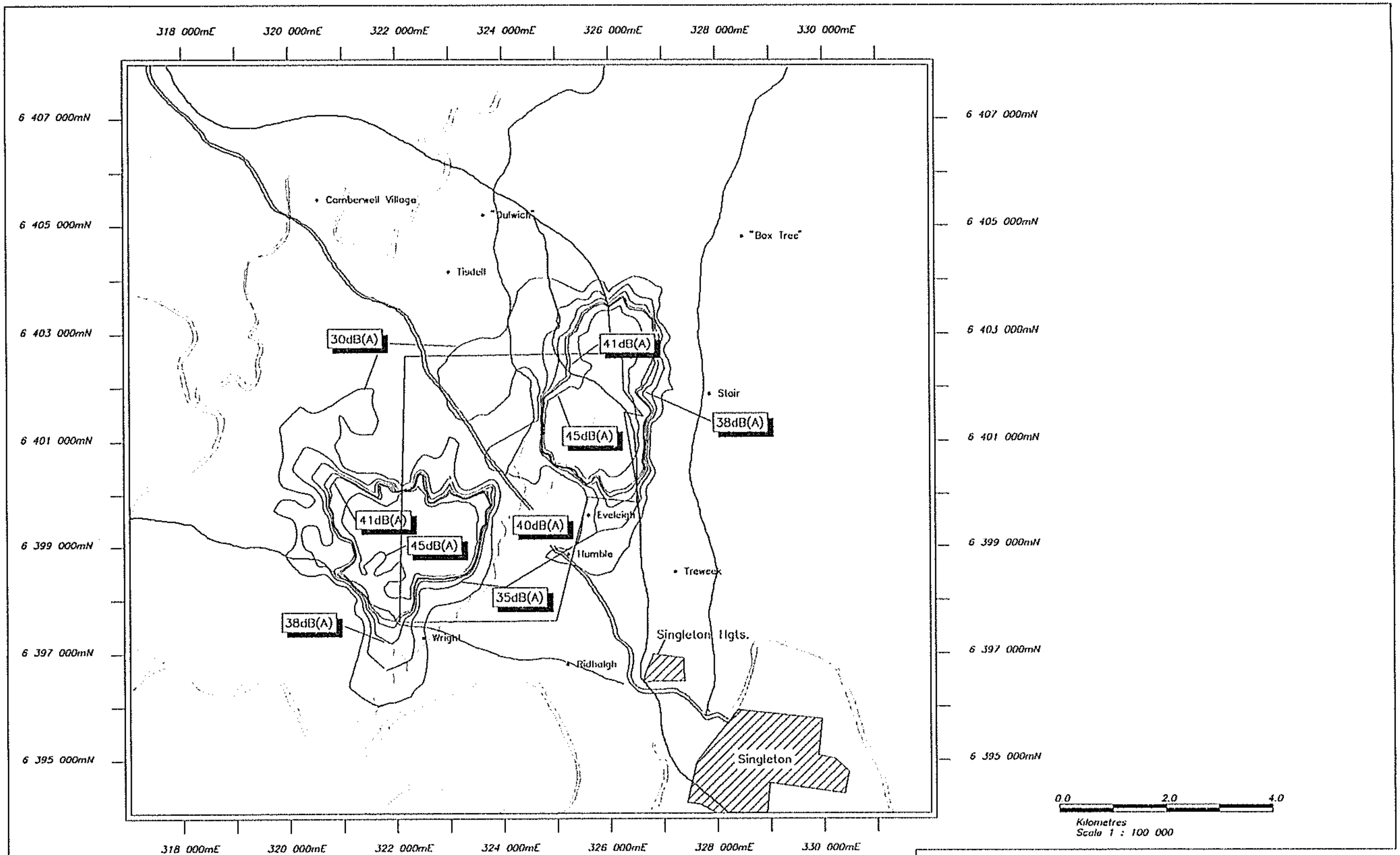

Predicted Noise Contours –
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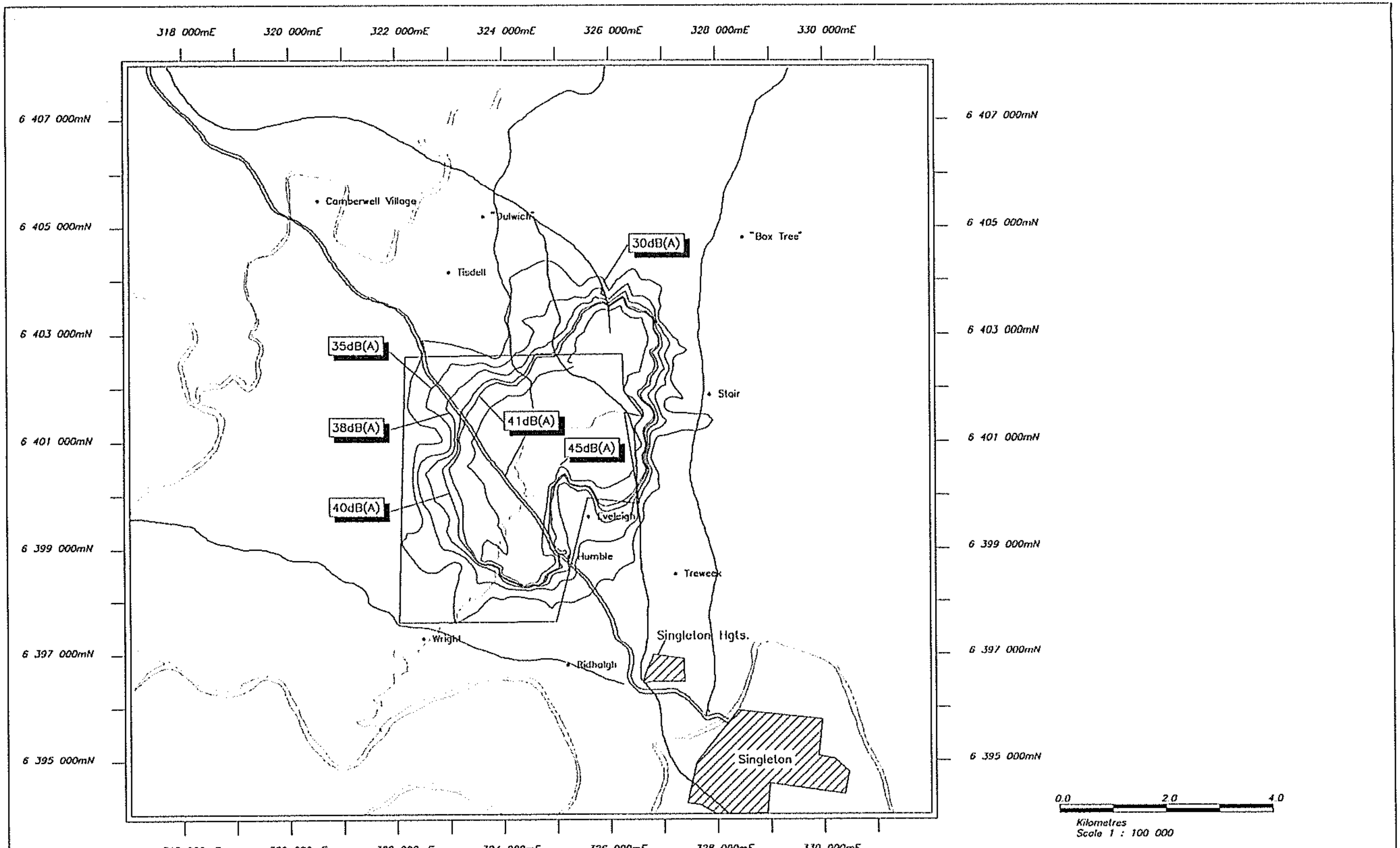

Predicted Noise Contours –
Shovel, Yr 1 (Pit 1, Night time)

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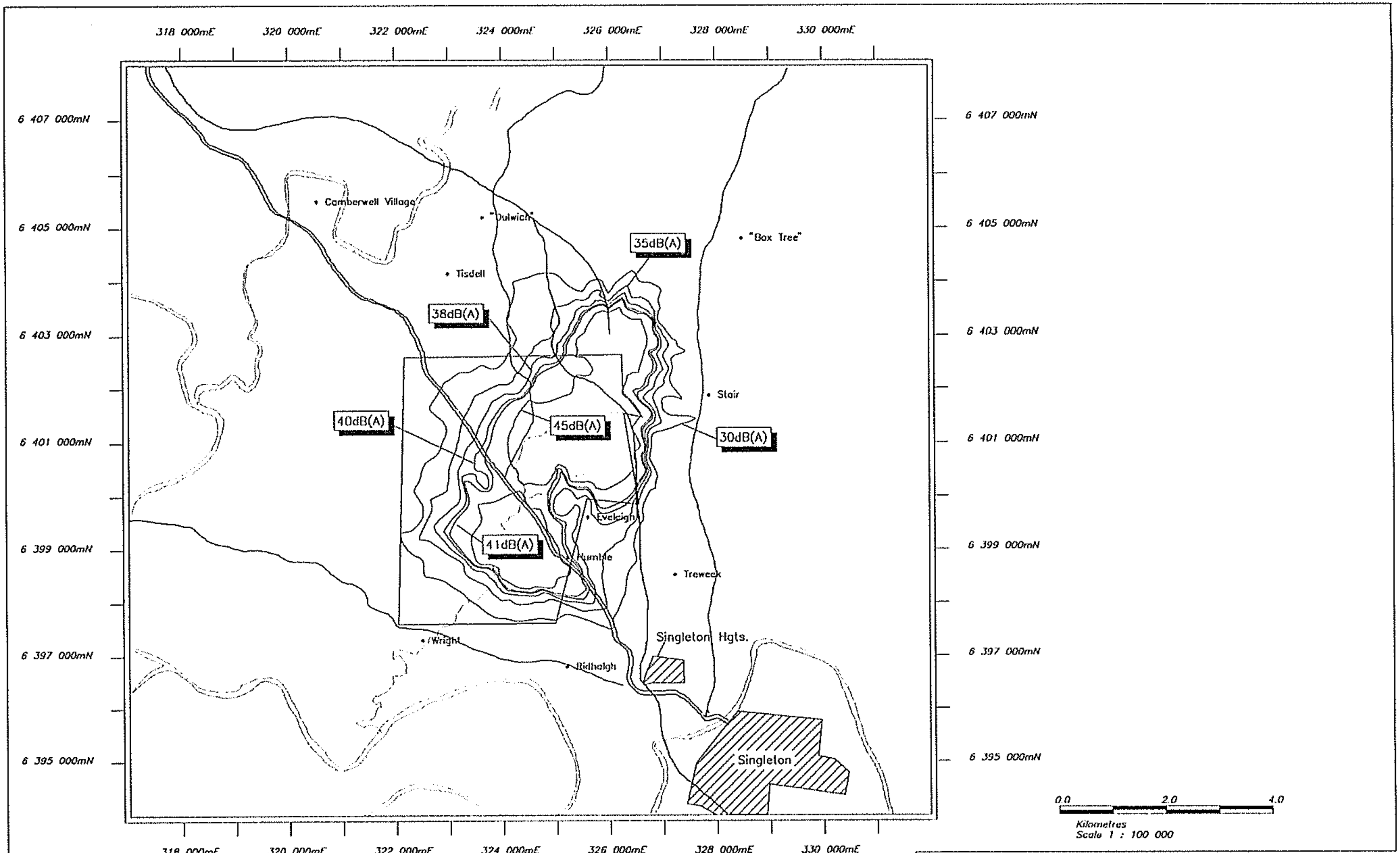
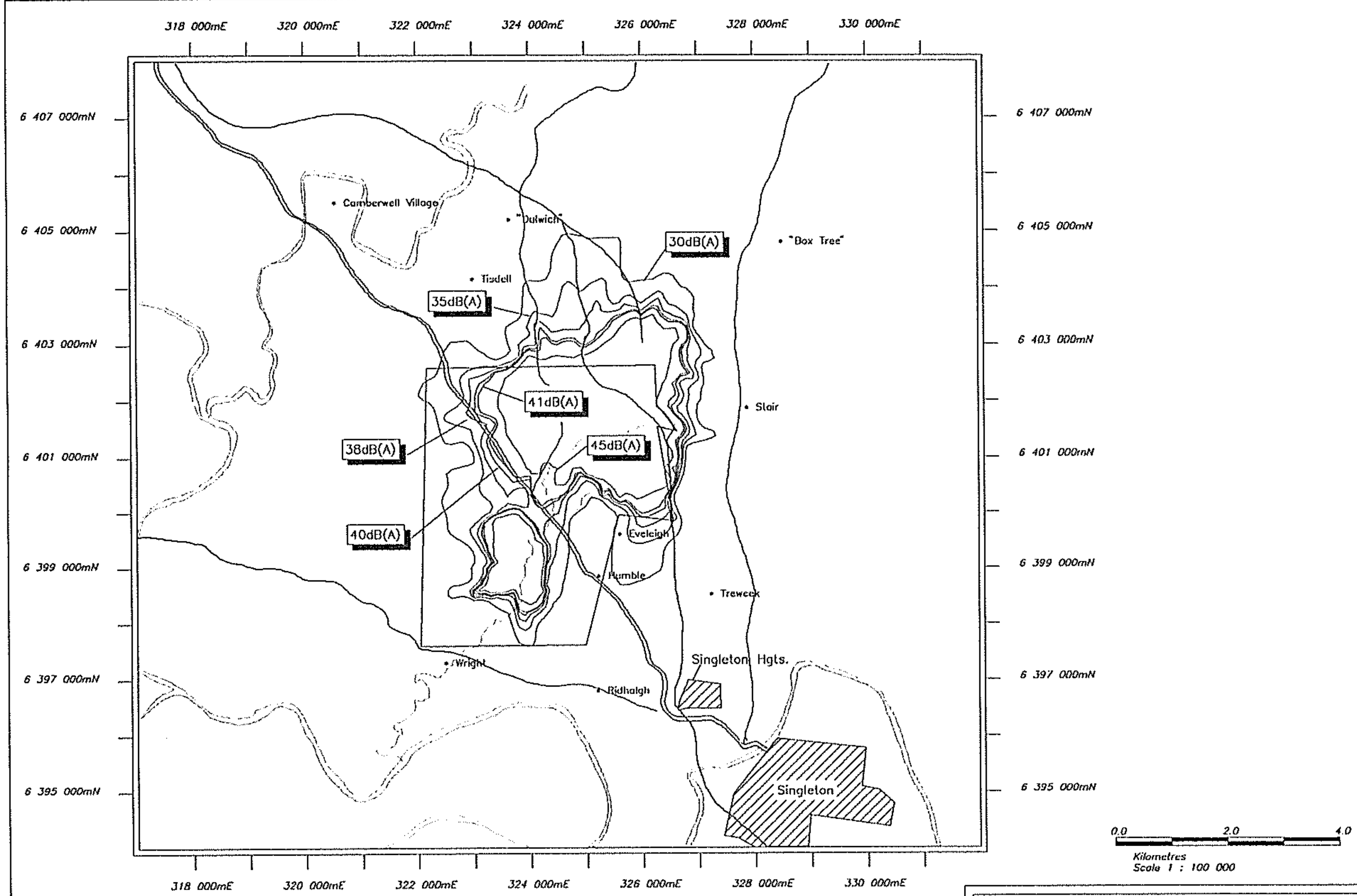


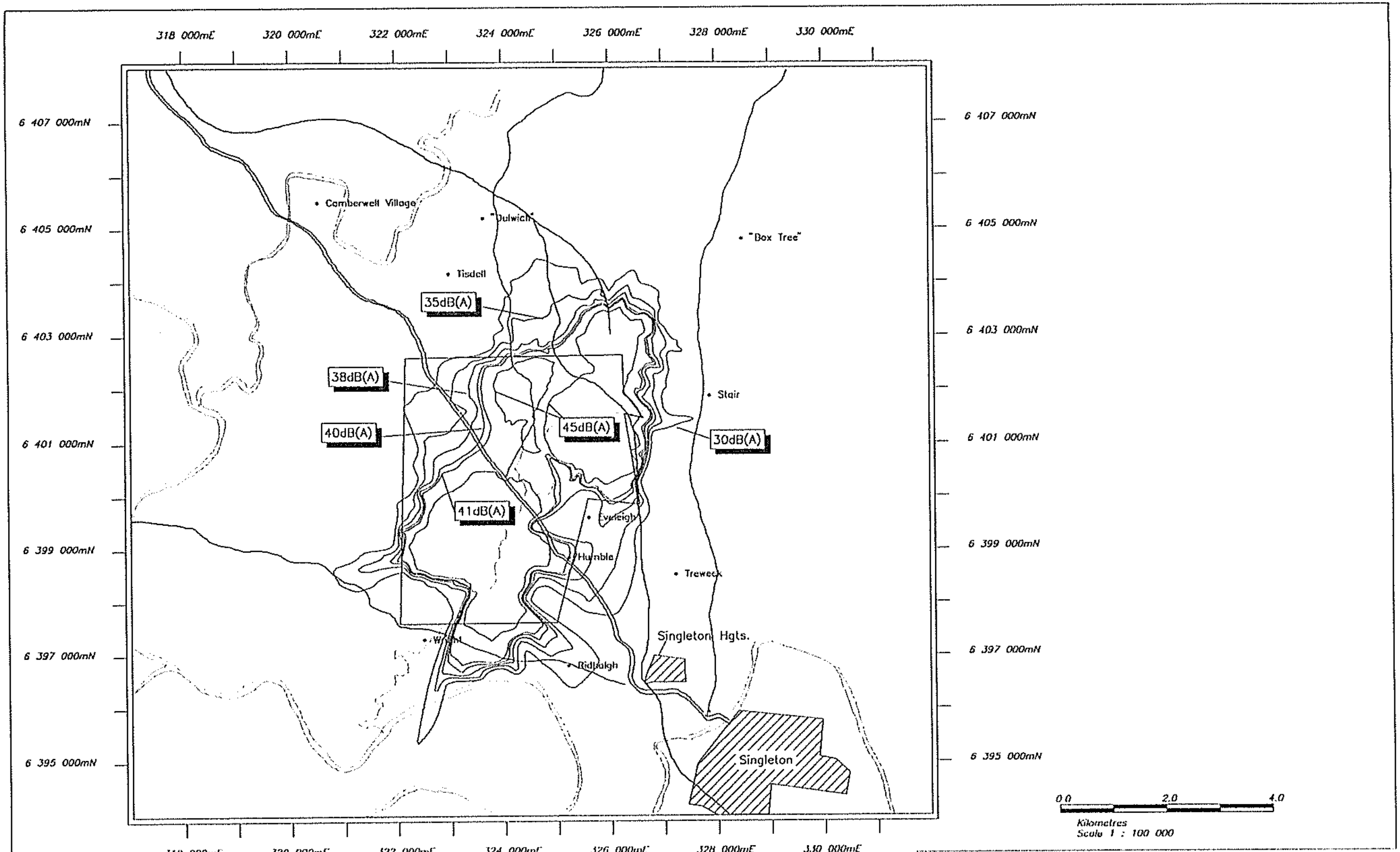
Predicted Noise Contours –
Shovel, Yr 1 (Pit 2/3, Night time)

Figure 17 | August 1994



Predicted Noise Contours –
Shovel, Yr 8 (Pit 1, Night time)

Figure 18 | August 1994



Predicted Noise Contours – Shovel, Yr 8 (Pit 2/3, Night time)

Figure 19

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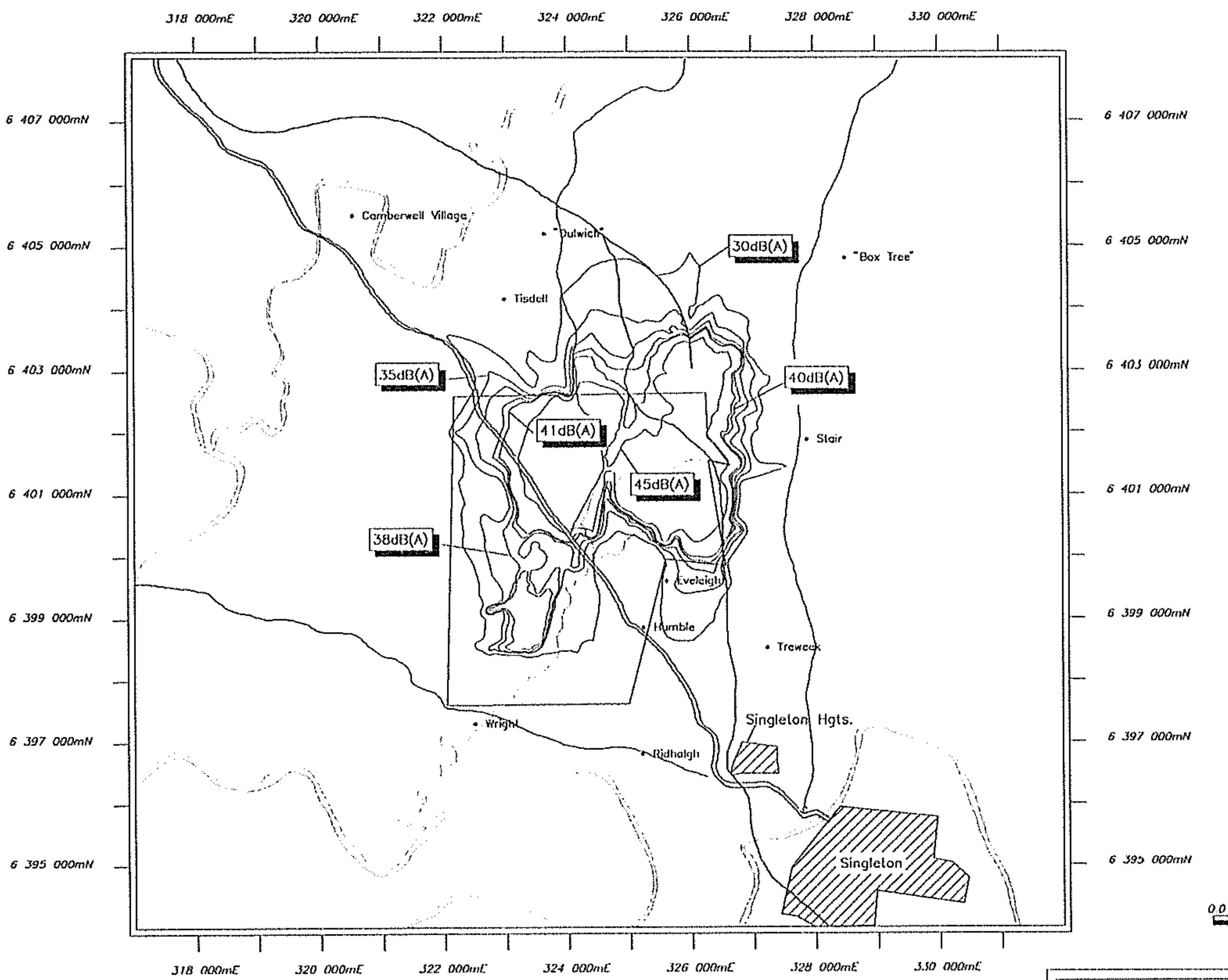
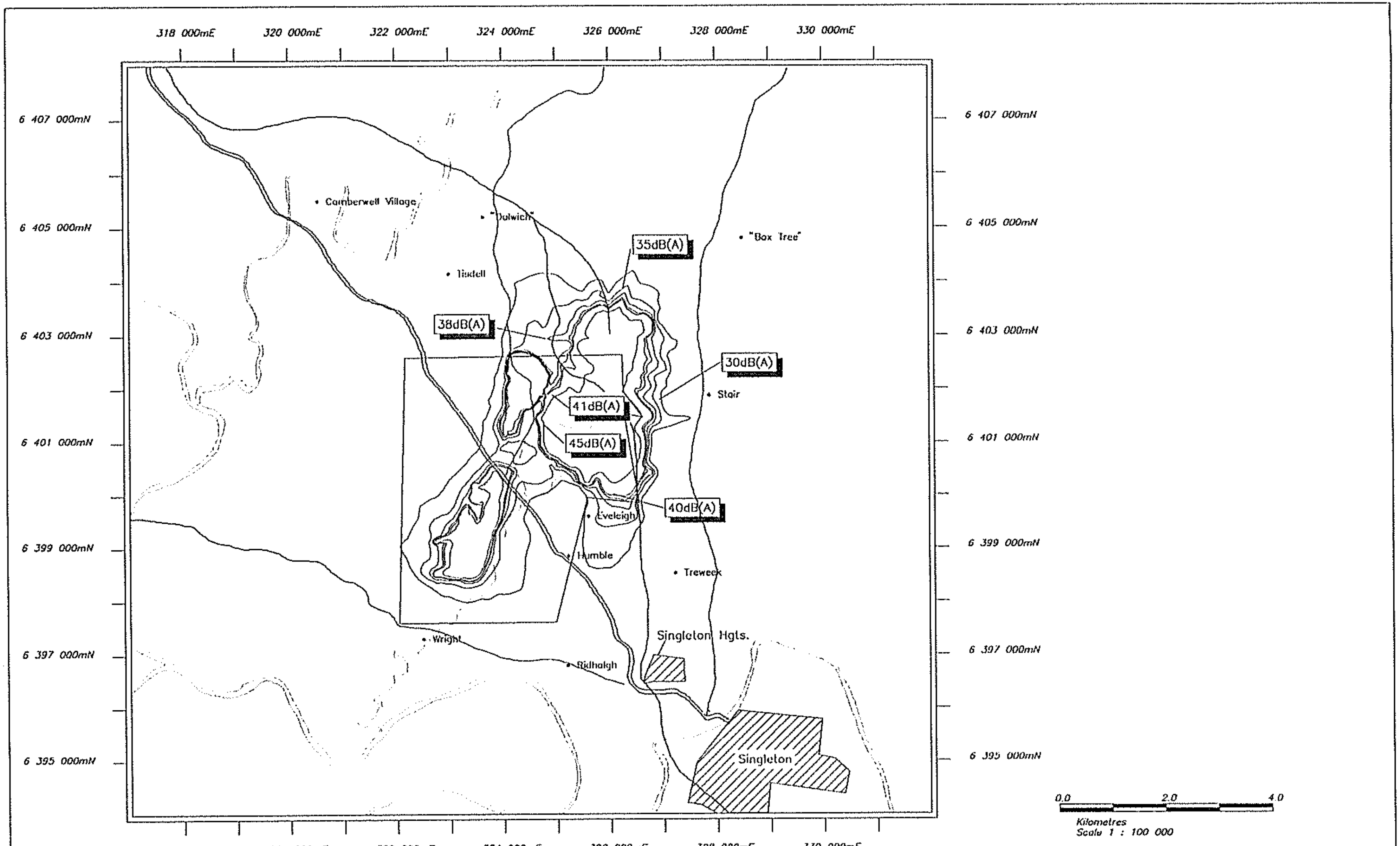


Predicted Noise Contours –
Shovel, Yr 15 (Pit 1, Night time)

Figure 20 August 1994



Predicted Noise Contours –
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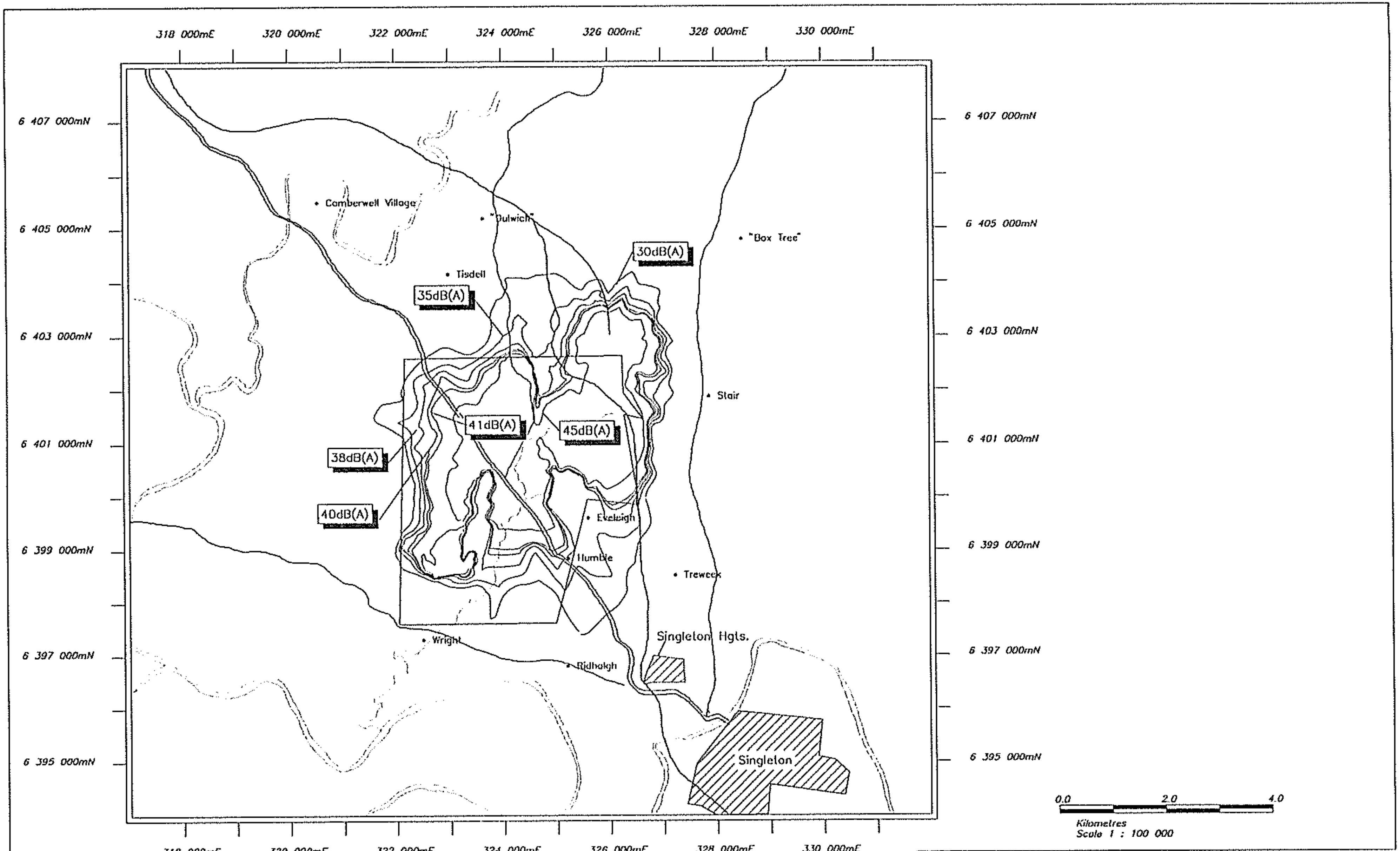
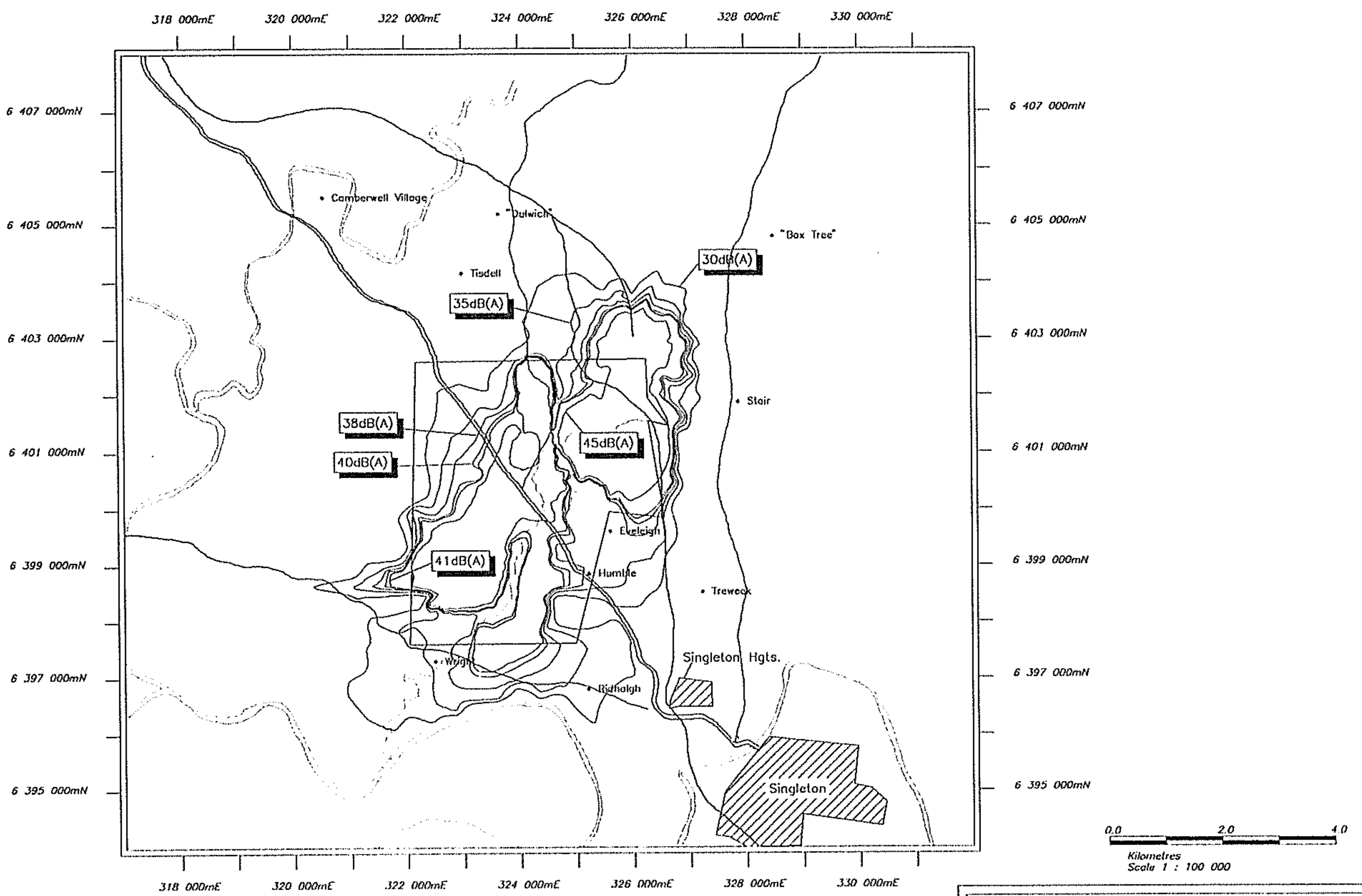


Predicted Noise Contours –
Shovel, Yr 22 (Pit 1, Night time)

Figure 22

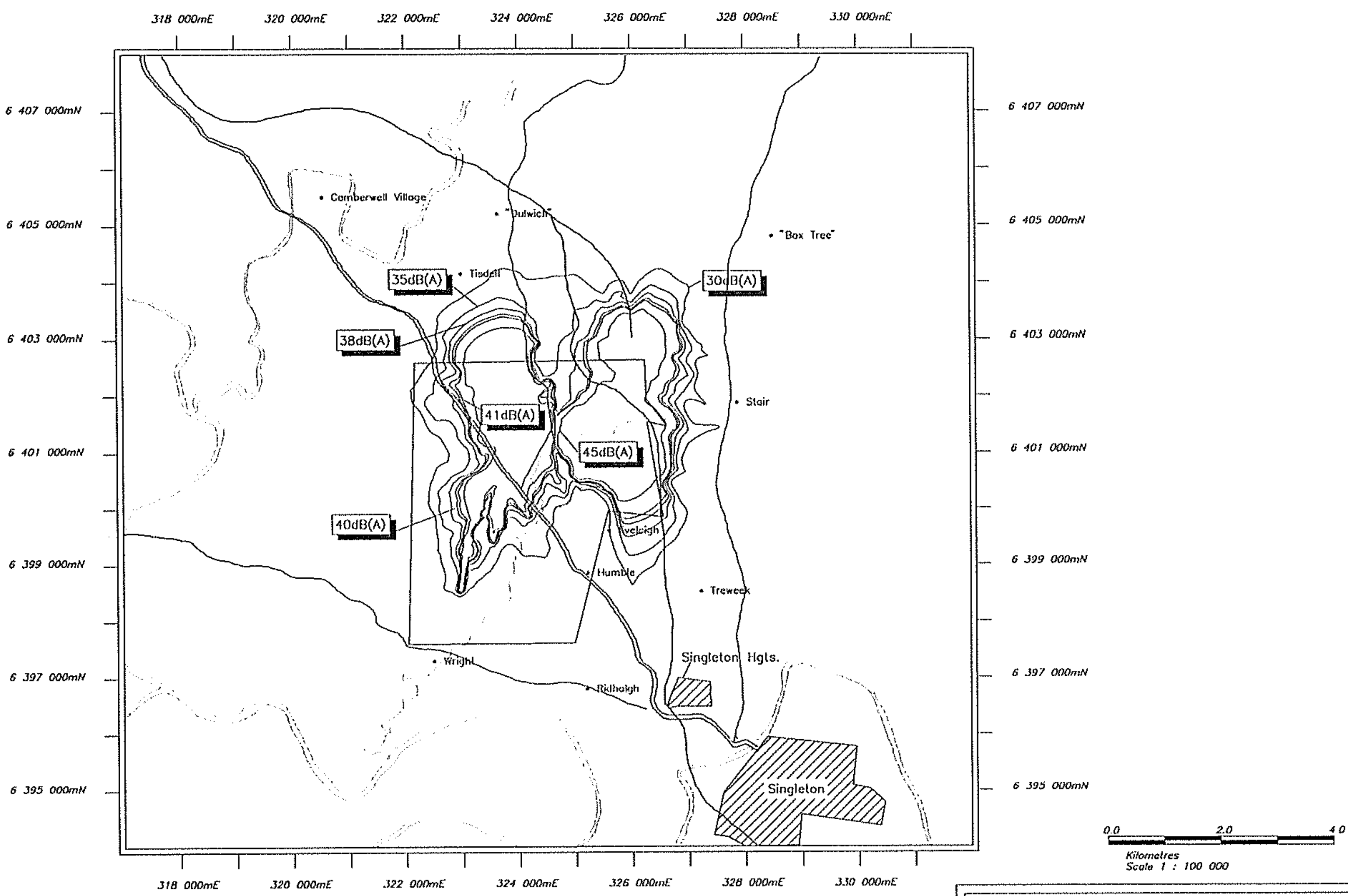
August 1994



Predicted Noise Contours –
Shovel, Yr 22 (Pit 2/3, Night time)

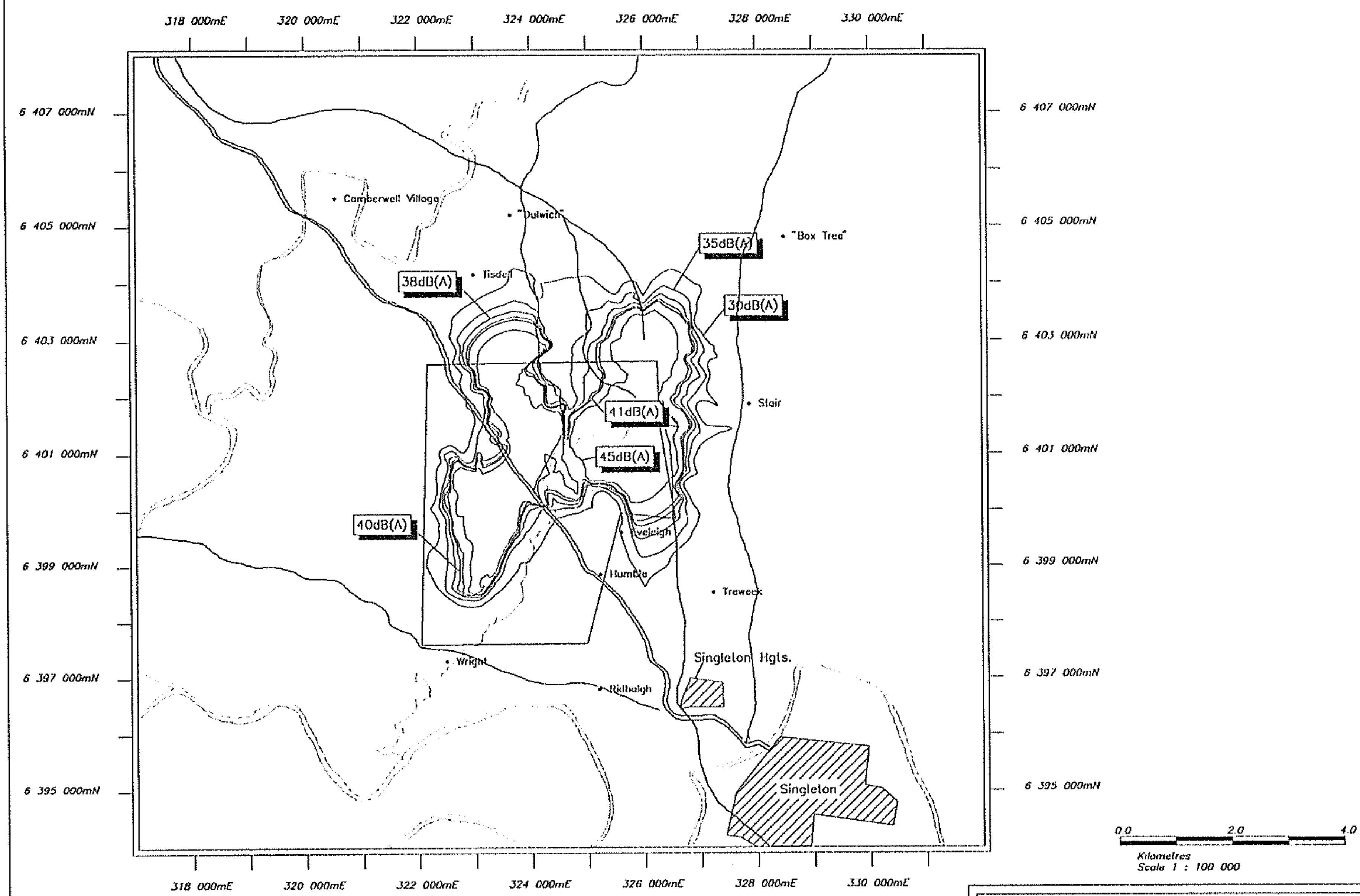
Figure 23

August 1994



Predicted Noise Contours –
Shovel, Yr 29 (Pit 1, Night time)

Figure 24 | August 1994



Predicted Noise Contours –
Shovel, Yr 29 (Pit 2/3, Night time)

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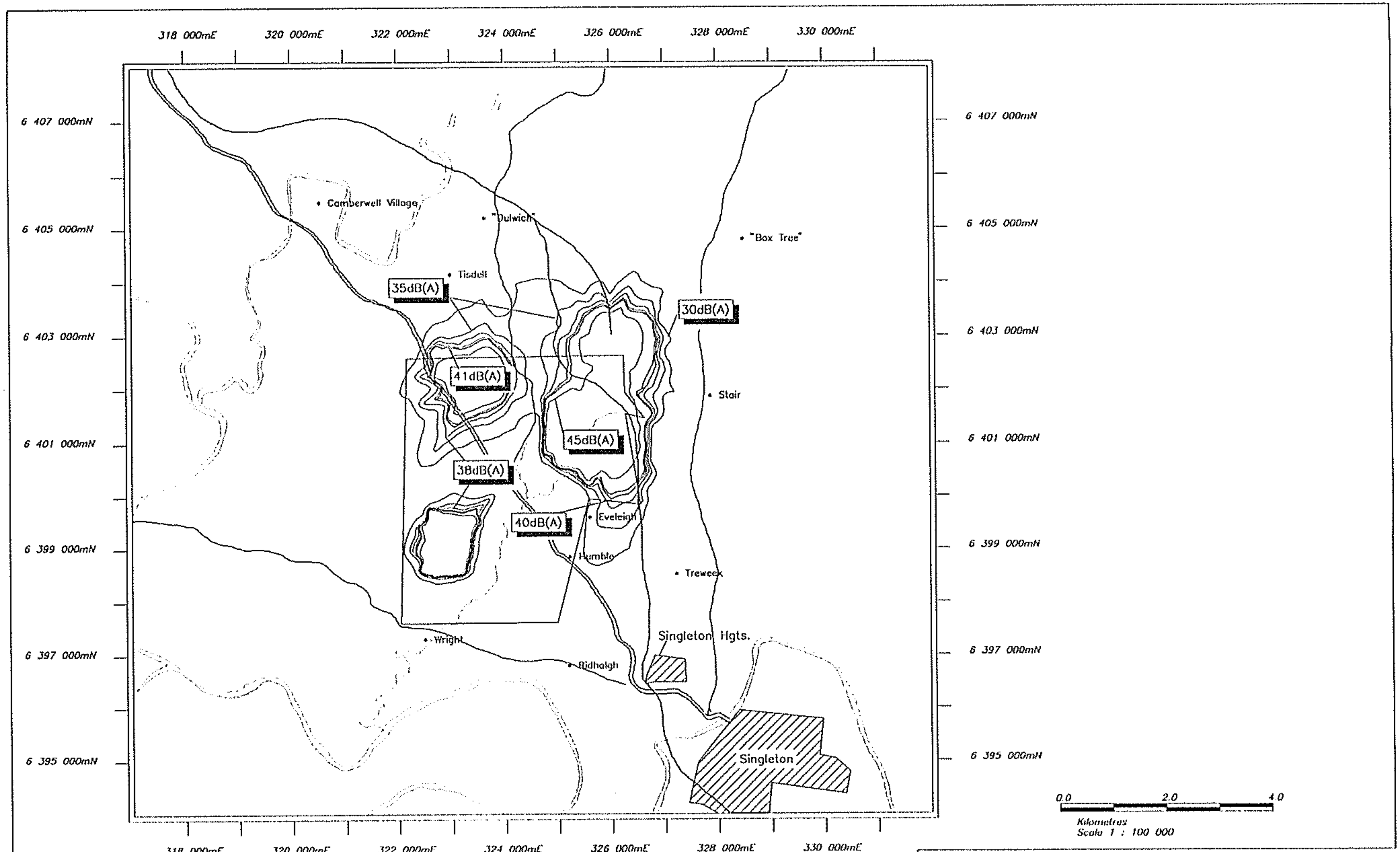
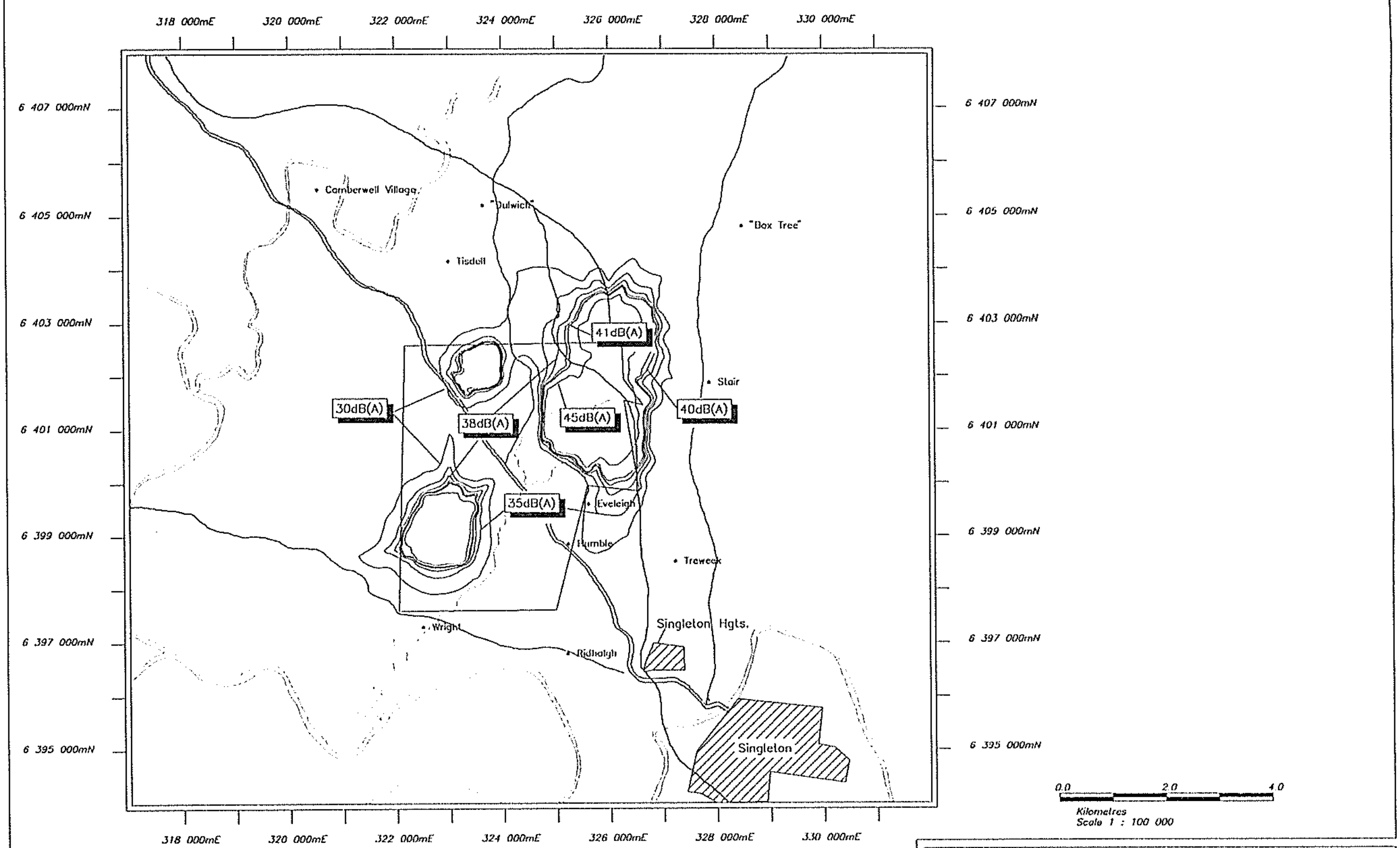


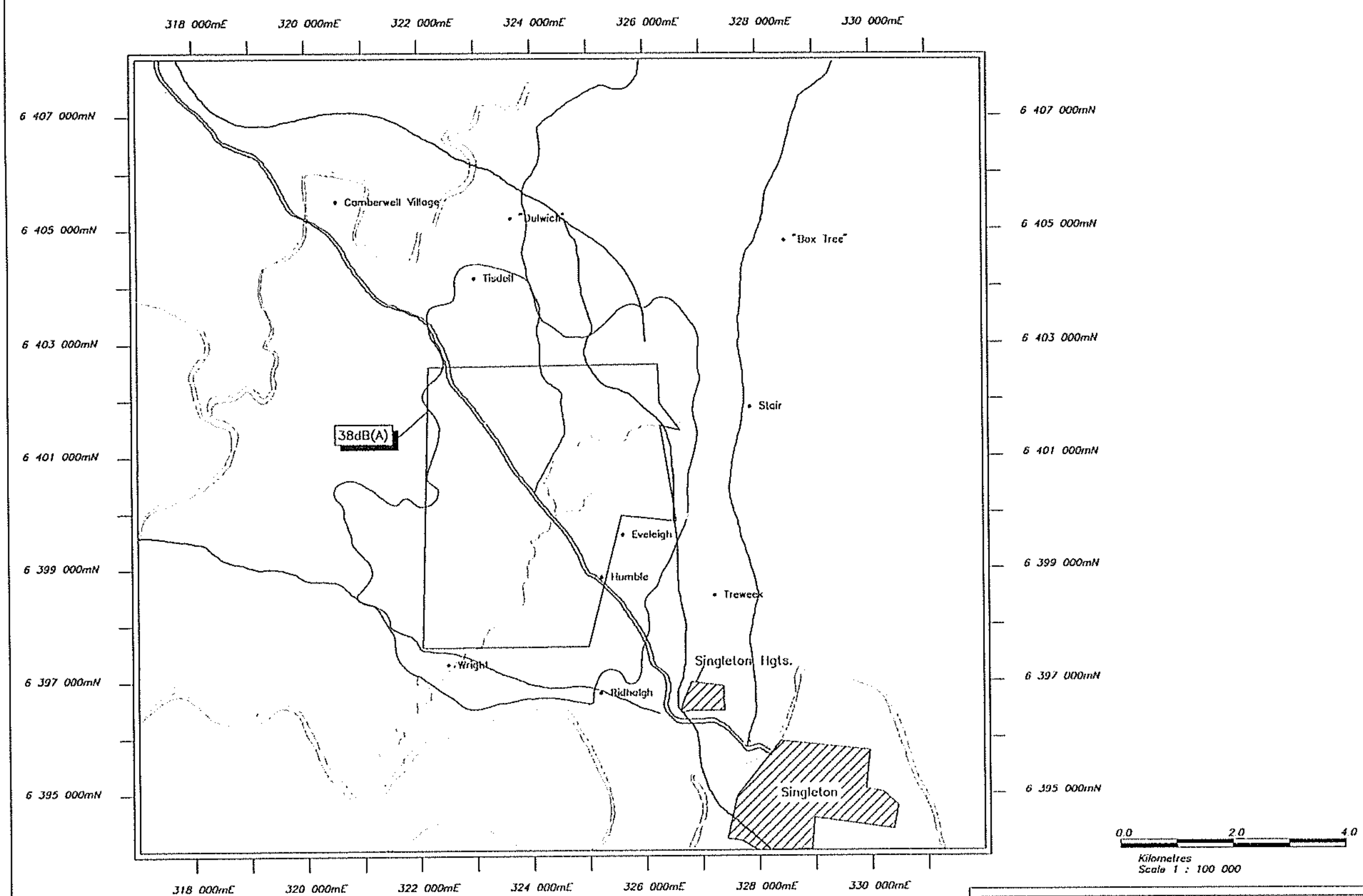
Predicted Noise Contours – Shovel, Yr 36 (Pit 1, Night time)

Figure 26 August 1994



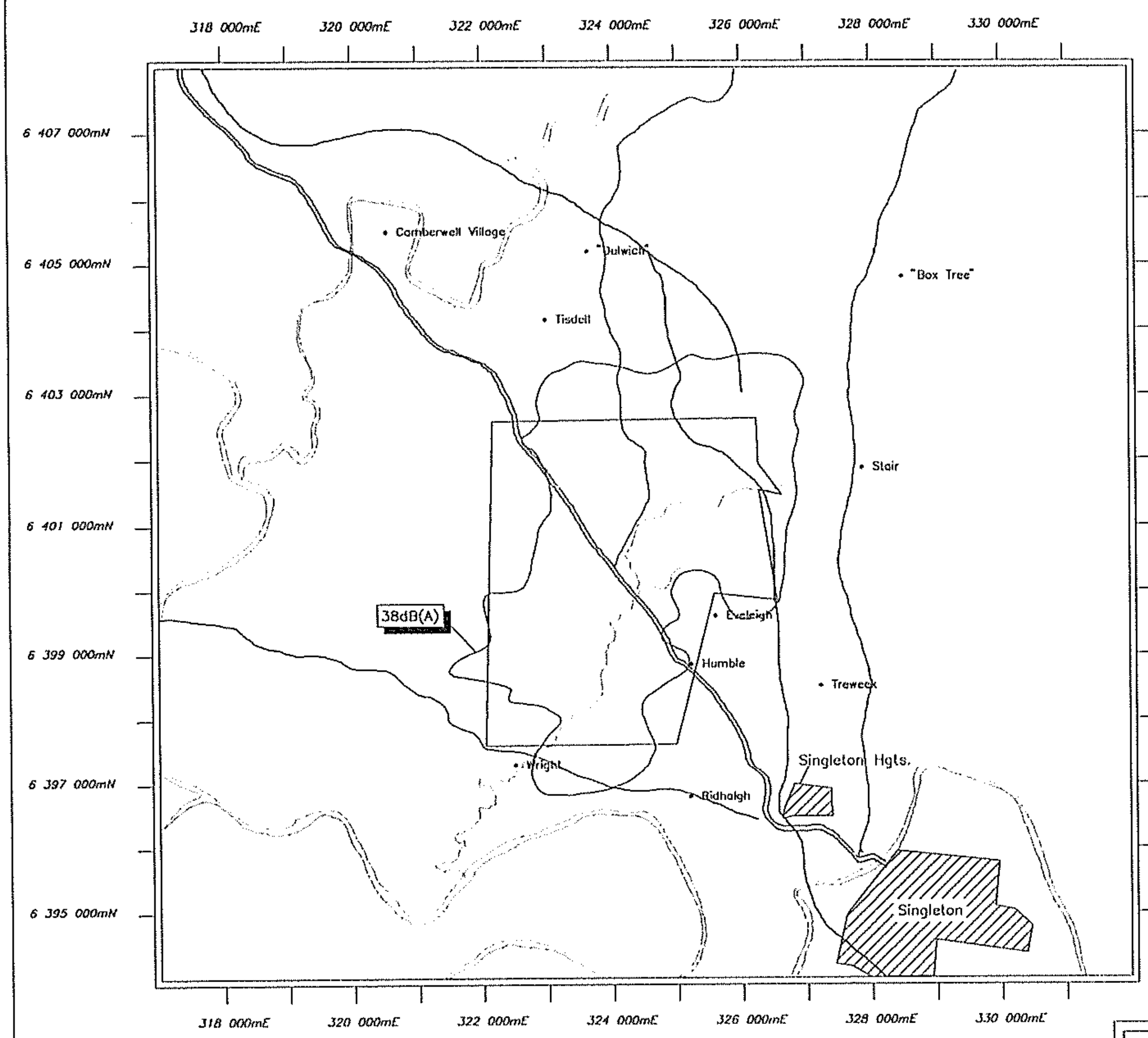
Predicted Noise Contours – Shovel, Yr 36 (Pit 2/3, Night time)

Figure 27	August 1994



Total Area of Affectation – Daytime

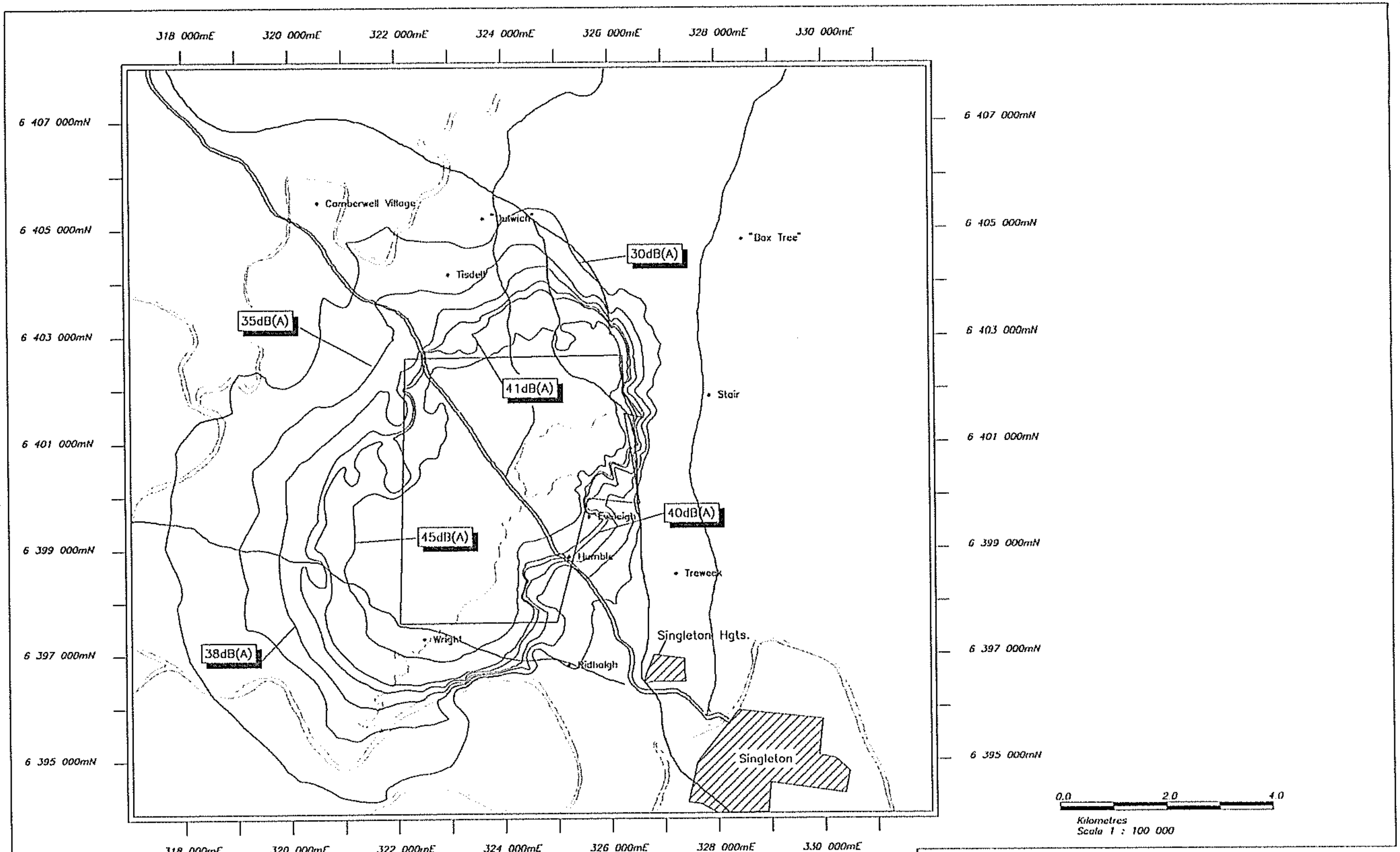
Figure 28 | August 1994



Total Area of Affectation –
Night time

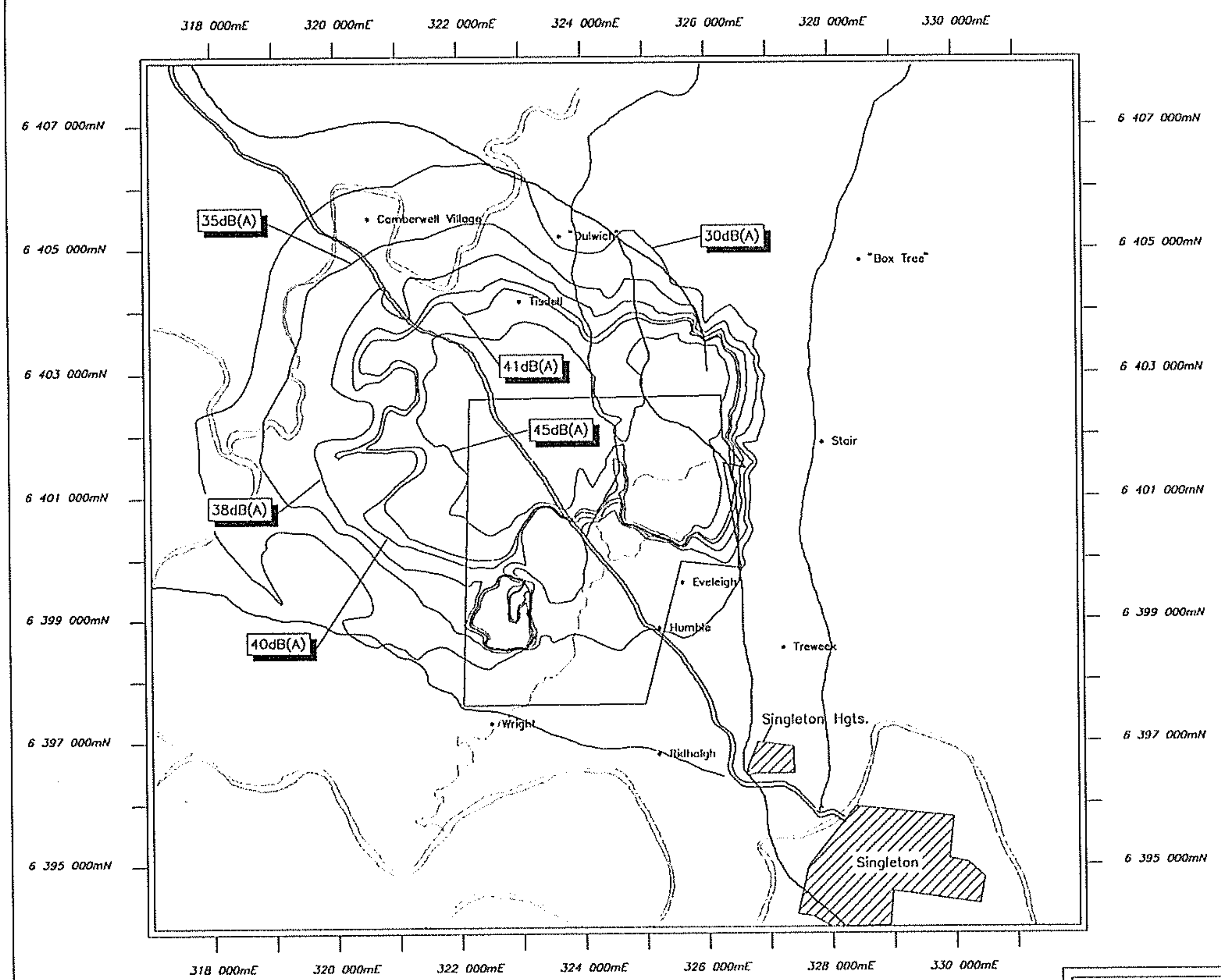
Figure 29

August 1994



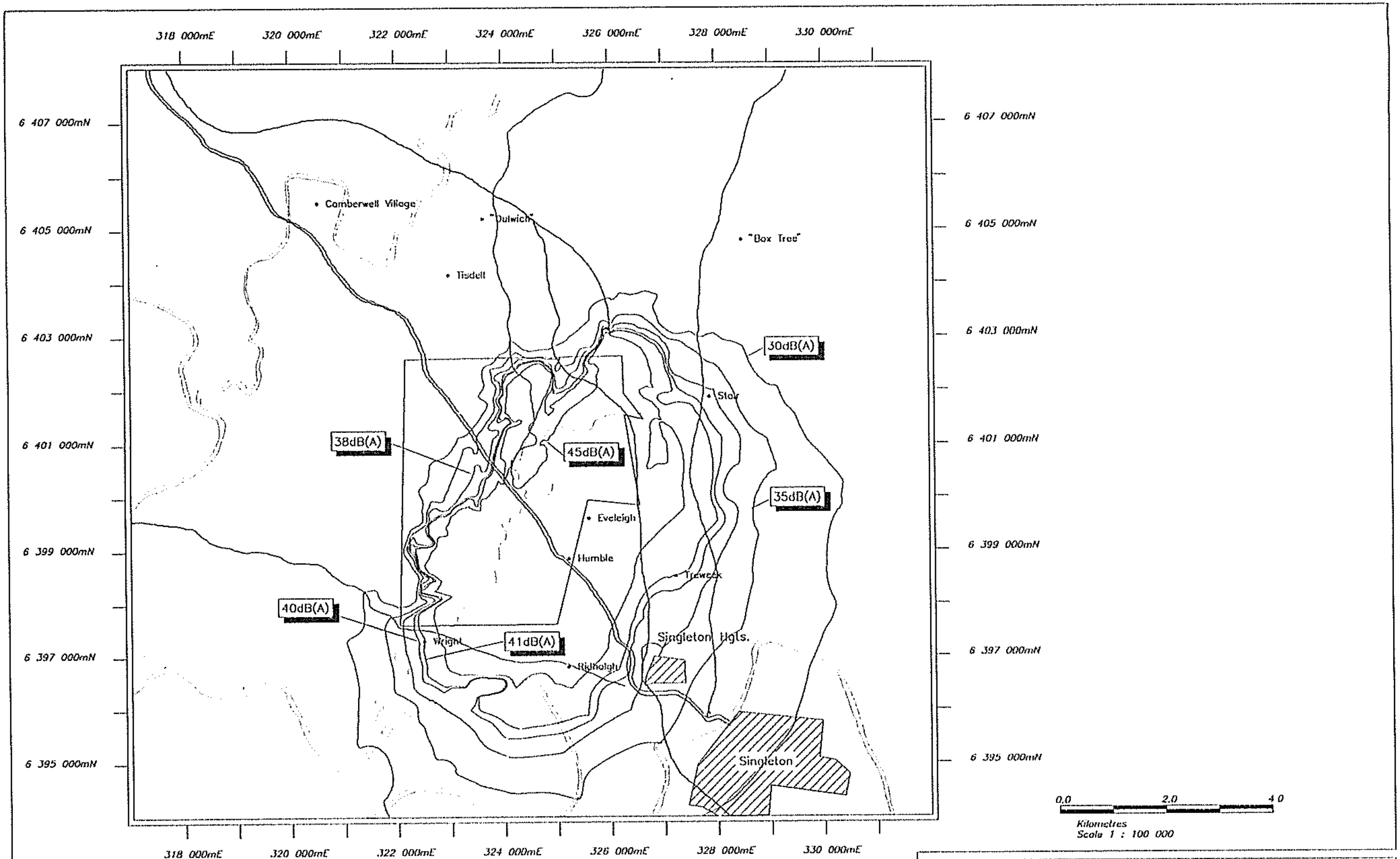
Predicted Noise Contours – Shovel, Yr 8 (Pit 2/3, Daytime)
Prevailing Wind – E (4.5m/s)

Figure 30 | August 1994



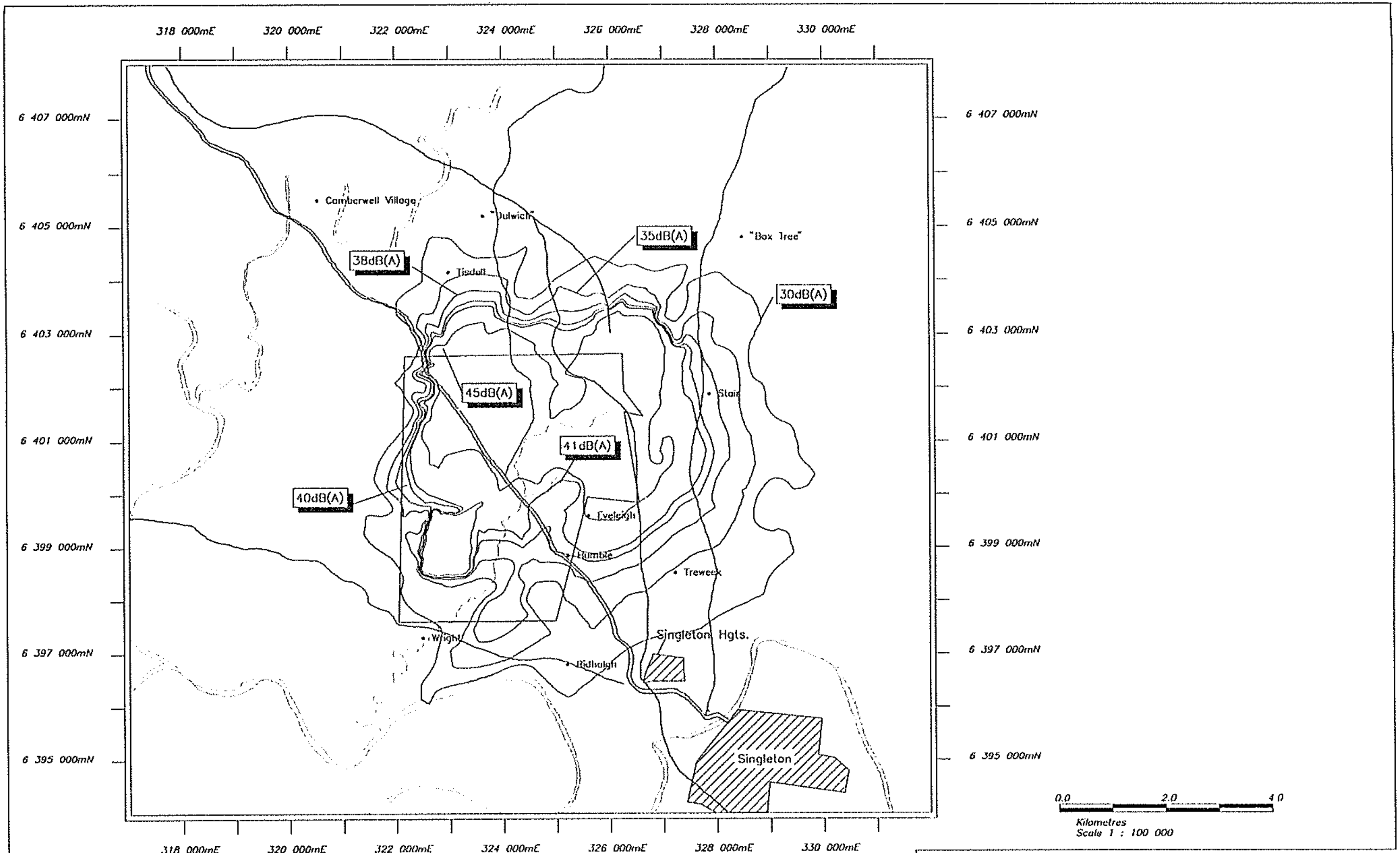
Predicted Noise Contours –
Shovel, Yr 36 (Pit 1, Daytime)
Prevailing Wind – E (4.5m/s)

Figure 31	August 1994



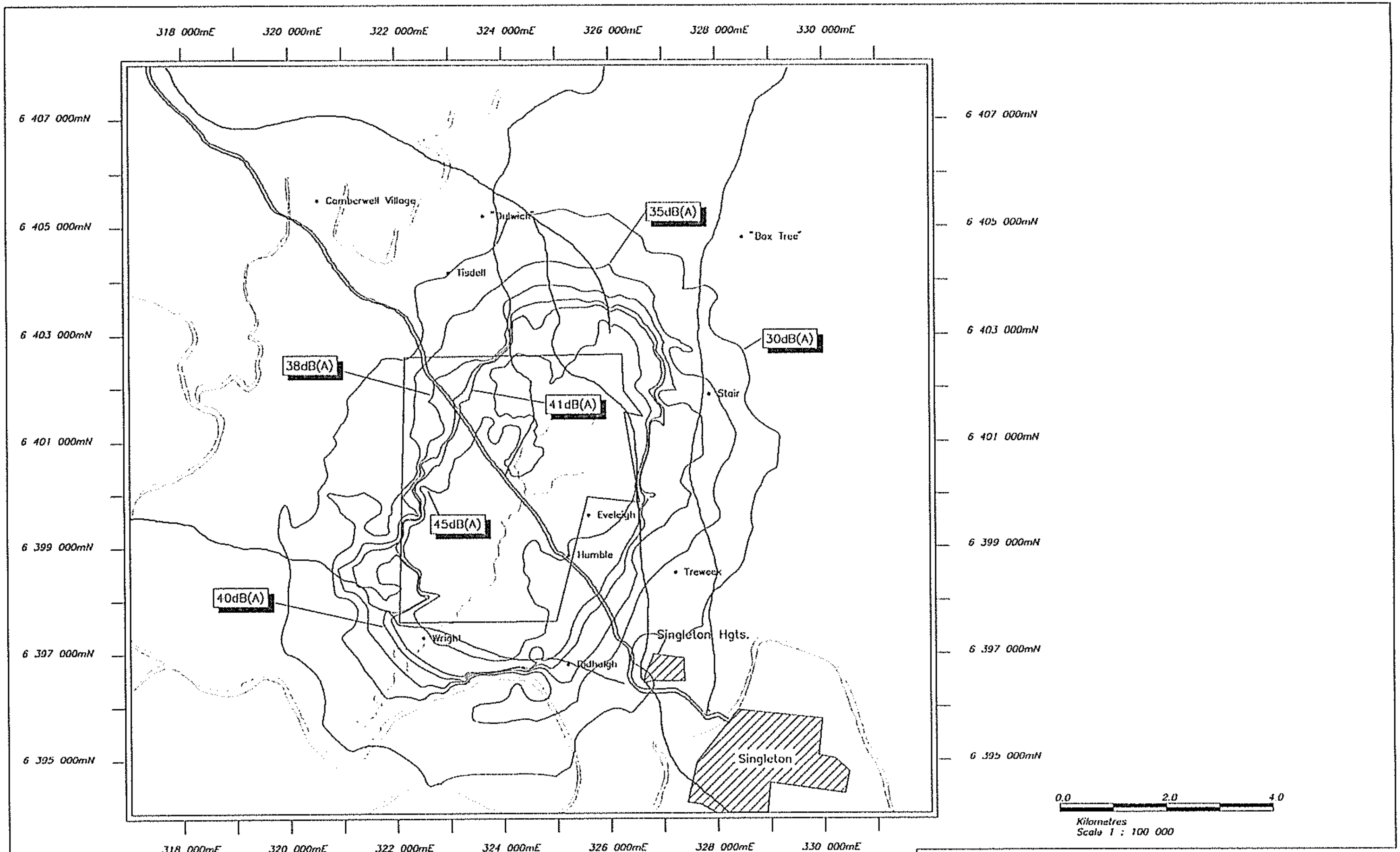
Predicted Noise Contours –
Shovel, Yr 8 (Pit 2/3 Daytime)
Prevailing Wind – NW (4.5m/s)

Figure 32 | August 1994



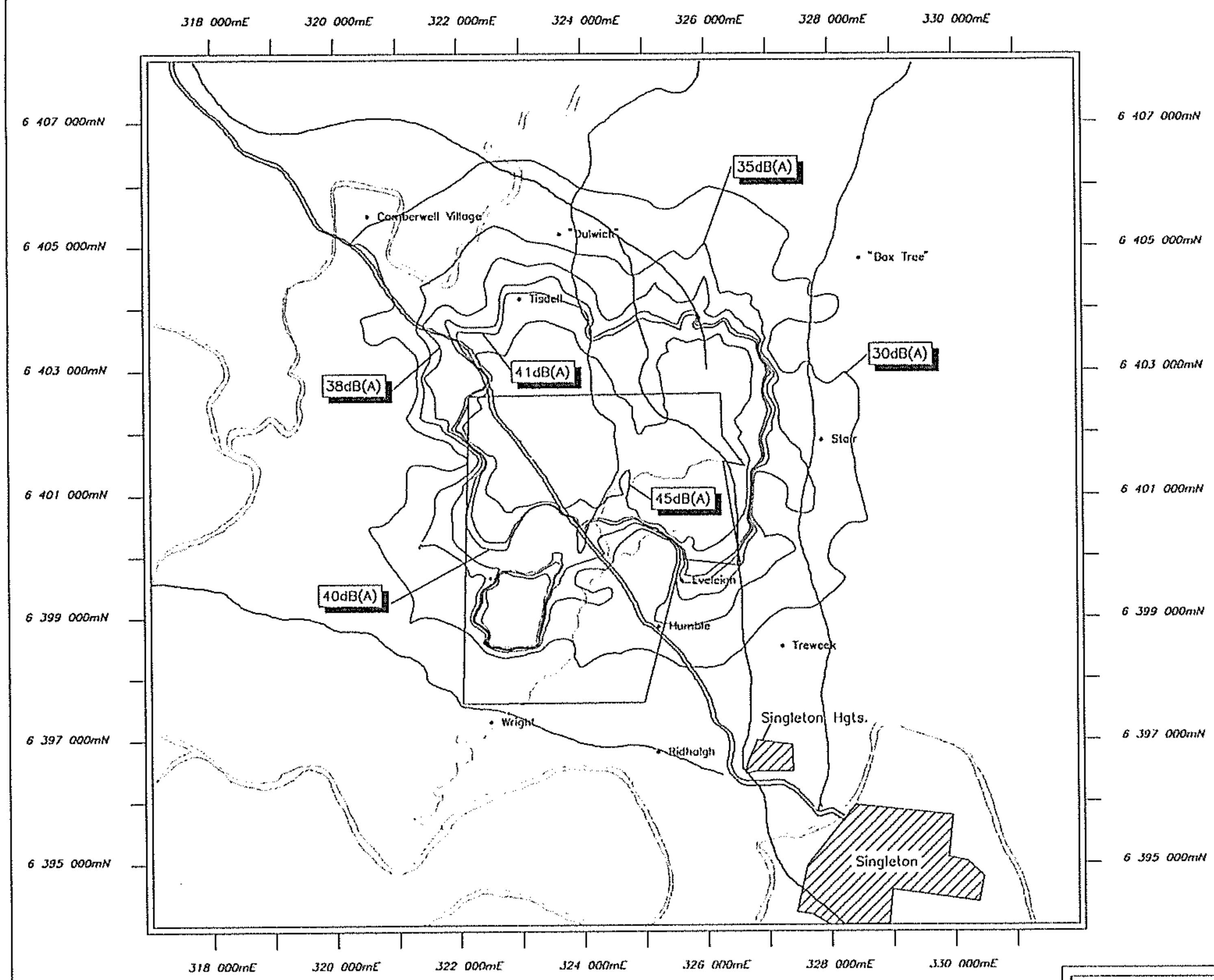
Predicted Noise Contours –
Shovel, Yr 36 (Pit 1, Daytime)
Prevailing Wind – NW (4.5 m/s)

Figure 33	August 1994



Predicted Noise Contours –
Shovel, Yr 8 (Pit 2/3, Daytime)
Temp. Inversion – 3 C/100m

Figure 34 | August 1994



Predicted Noise Contours –
Shovel, Yr 36 (Pit 1, Daytime)
Temp. Inversion – 3 C/100m

Figure 35	August 1994

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SUPPLEMENTARY REPORT NO 94.834.R2

NOISE IMPACT STATEMENT

RIX'S CREEK OPEN CUT COAL MINE EXTENSION

VOLUME I – PRIMARY INFORMATION AND FIGURES

SINGLETON NSW

SEPTEMBER 1994

Prepared for: **Envirosciences Pty Ltd**
122 Parry Street
NEWCASTLE NSW 2300

On behalf of: **Bloomfield Collieries Pty Limited**

REPORT NO 94.834.R2
NOISE IMPACT STATEMENT
RIX'S CREEK OPEN CUT COAL MINE EXTENSION
SINGLETON NSW
AUGUST 1994

1.0 INTRODUCTION

This Supplementary Report outlines the results and findings arising from an acoustical investigation of the alternative proposal to extend Rix's Creek open cut coal mine, located to the west of Singleton NSW, as shown in the map of the study area given in Volume II of Report No. 94.834.R1.

The proprietors of Rix's Creek mine, Bloomfield Collieries Pty Limited, have formulated a new reduced mine plan as an alternative to the proposal that was used to produce the results given in Volume II of Report No. 94.834.R1. This new mine plan was formulated in part, as a result of the relatively large area of affectation for the total mine life that was presented in Figures 28 & 29, Volume II. The results included in this Volume are the predicted noise contours for each stage of mining in each of Pits 1 or 2/3 based on this alternative mining plan. Additionally, the areas of affectation, for both day and night, for this alternative mining plan have been determined and are presented in Figures 17 & 18 at the rear of this report.

2.0 PROPOSAL

As with the original mining plan, the Proprietors of Rix's Creek mine, Bloomfield Collieries Pty Ltd, plan to produce an average of 1.4Mtpa of clean coal over the twenty two year working life of the mine, reduced from the forty year working life set out in the original plan. Because both the ROM coal extraction and clean coal output rates are identical to that proposed in the original plan, all plant and machinery that has been used in the original assessment has, likewise, been included in this supplementary assessment although, due to the different Pit designs, their locations and RLs have been changed accordingly.

3.0 CRITERIA AND METHOD OF ASSESSMENT

Background noise levels, and the corresponding planning levels, are the same for this supplementary assessment as outlined in Table 3.1, as those determined for the Rix's Creek mining operations in Section 4.2 of Volume I of Report No. 94.834.R1.

Table 3.1: Measured Background and Derived Planning Levels

	Measured Background, dB(A)		Planning Level, dB(A)	
Area	Day	Night	Day	Night
Rural	32	33	38	38
Residential	37	35	42	40

3.0 CRITERIA AND METHOD OF ASSESSMENT (Cont...)

Additionally, the method of assessment used in producing the predicted noise contours given at the rear of this report was the same as that used in the original assessment although, because of the reduced working life of the mine, a total of four mining stages were assessed, as outlined in Table 3.2, as opposed the six stages used in the original assessment.

Table 3.2: Assessed Mining Stages – Reduced Pit

Stage	Period
1	End of Year 1 mining
2	End of Year 8 mining
3	End of Year 15 mining
4	End of Year 22 mining

4.0 RESULTS

As with the original assessment, noise level calculations were undertaken for each permutation of the alternative mining options at each stage and noise level contours were generated for the areas surrounding the mine lease area.

Predicted noise contours as a result of the mining operations for all stages of the mines development, for the shovel overburden removal option, are given at the rear of this report. Because of the similarity of the plant and machinery that will be utilised, and hence the predicted results, for each the overburden removal options, noise contours are presented for the shovel option only.

5.0 CONCLUSION

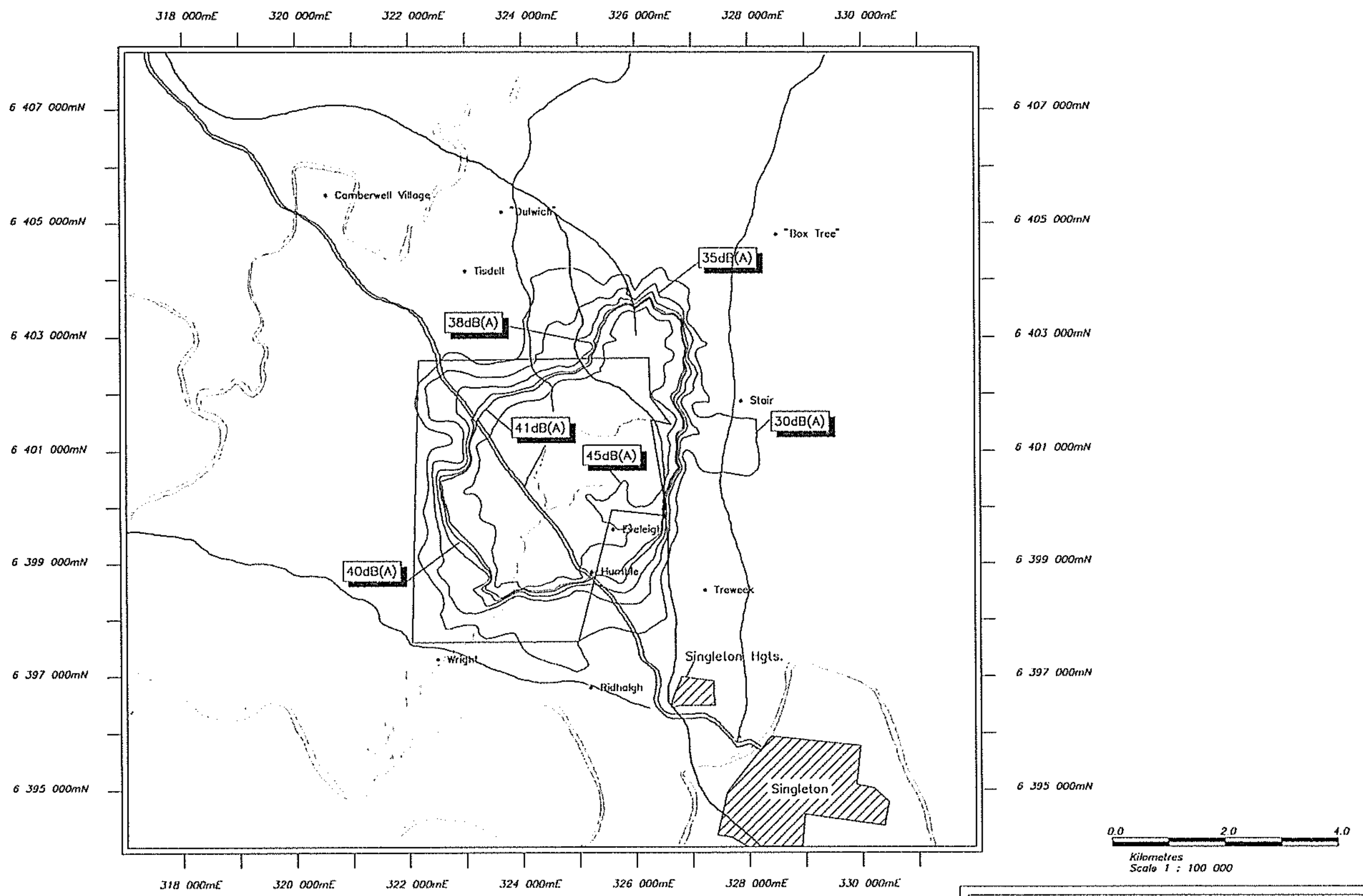
An Acoustical Assessment has been undertaken to assess the potential impacts of an alternative mining plan for the proposed extensions to the Rix's Creek open cut coal mine.

As with the assessment of the original mine plan, the results presented are based on hypothetical "worst case" situations and although these situations may not arise, this is the generally accepted method of assessment for these types of large scale operations. This supplementary report and the corresponding predicted noise contours were prepared to assess the impacts of the alternative mining plan and determine the total area of affectation of the mine over it's working life and to provide a comparison to the results presented in Volume II of the original report

As was our conclusion in the original assessment, it would be our recommendation that Environmental Noise Level surveys be conducted at practical intervals throughout the life span of the Rix's Creek open cut coal mine, to ensure that individual receptors are not affected and the requirements of the Environment Protection Authority are met.

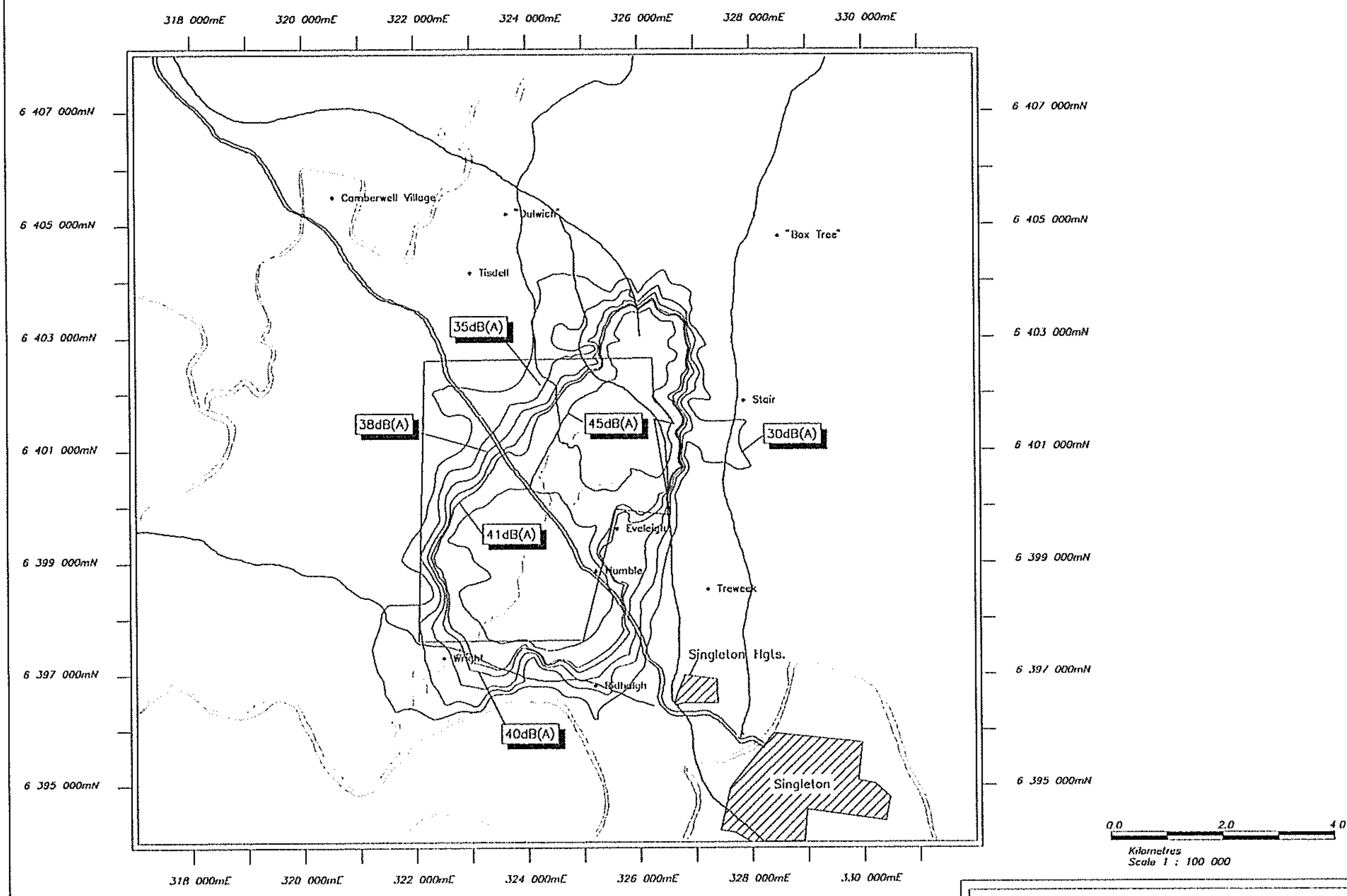
CALEB SMITH CONSULTING PTY LTD **September 1994**

List of Figures



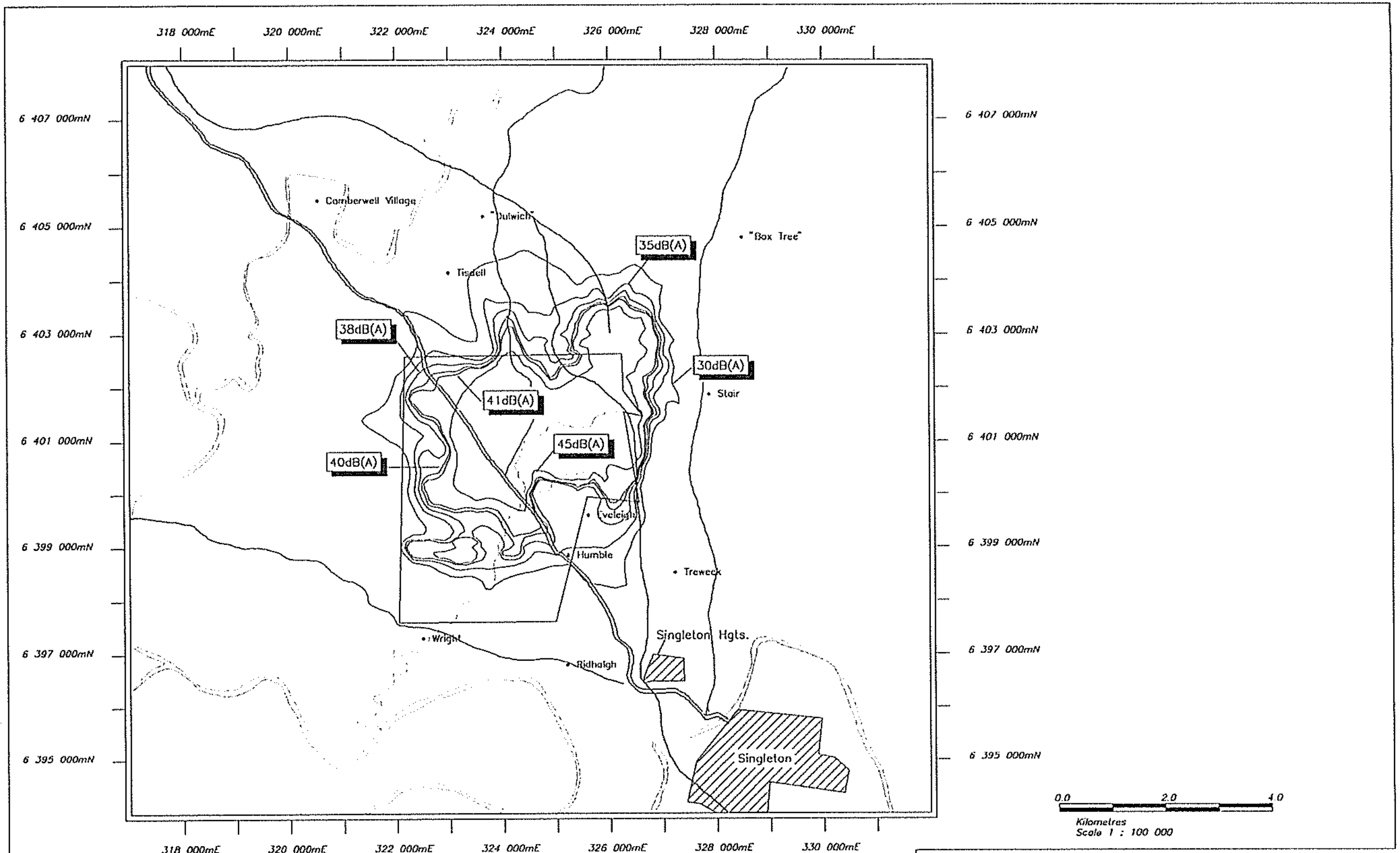
Predicted Noise Contours – Shovel, Yr 1 (Pit 1, Daytime)
Reduced Pit Plan

Figure 1	September 1994



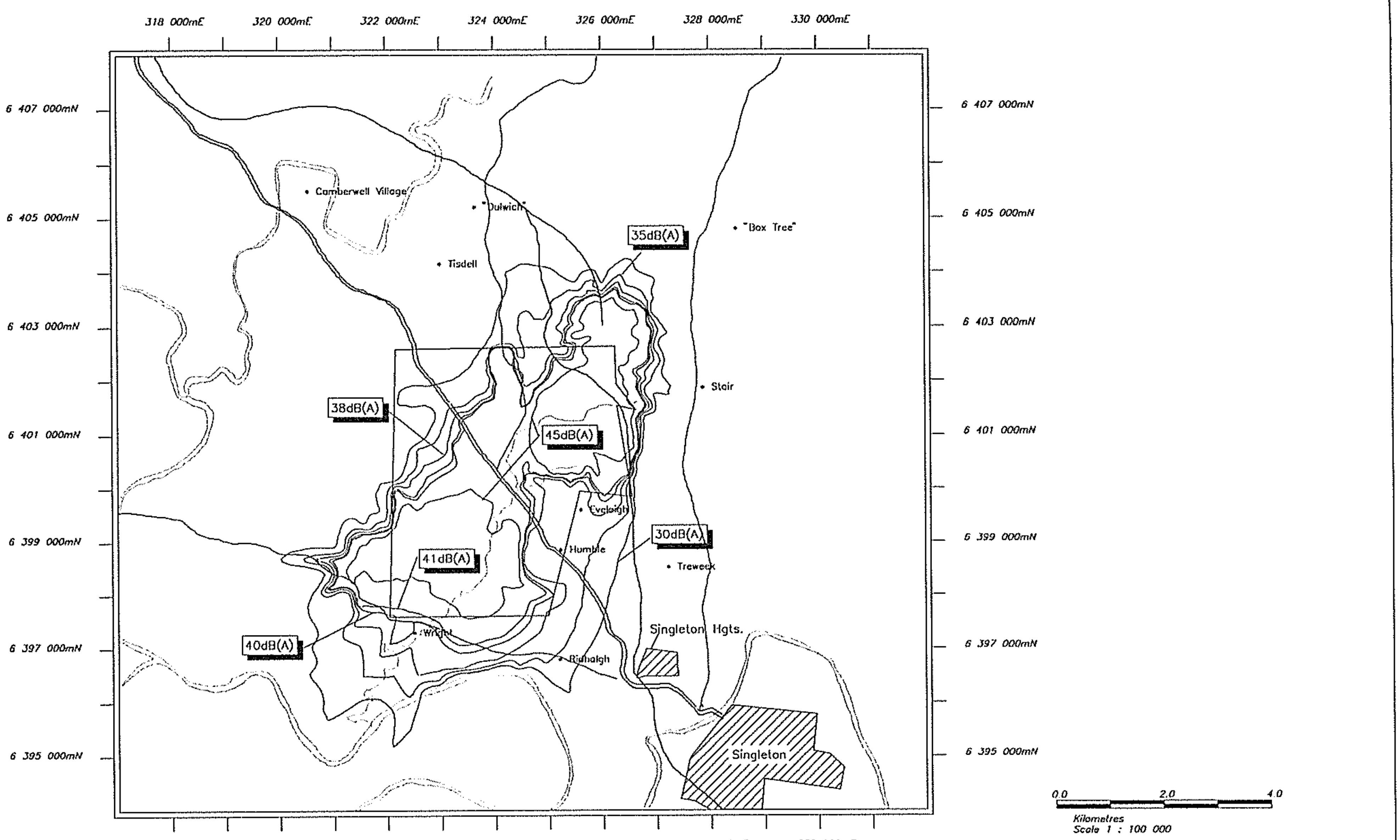
Predicted Noise Contours –
Shovel, Yr 1 (Pit 2/3, Daytime)
Reduced Pit Plan

Figure 2	September 1994



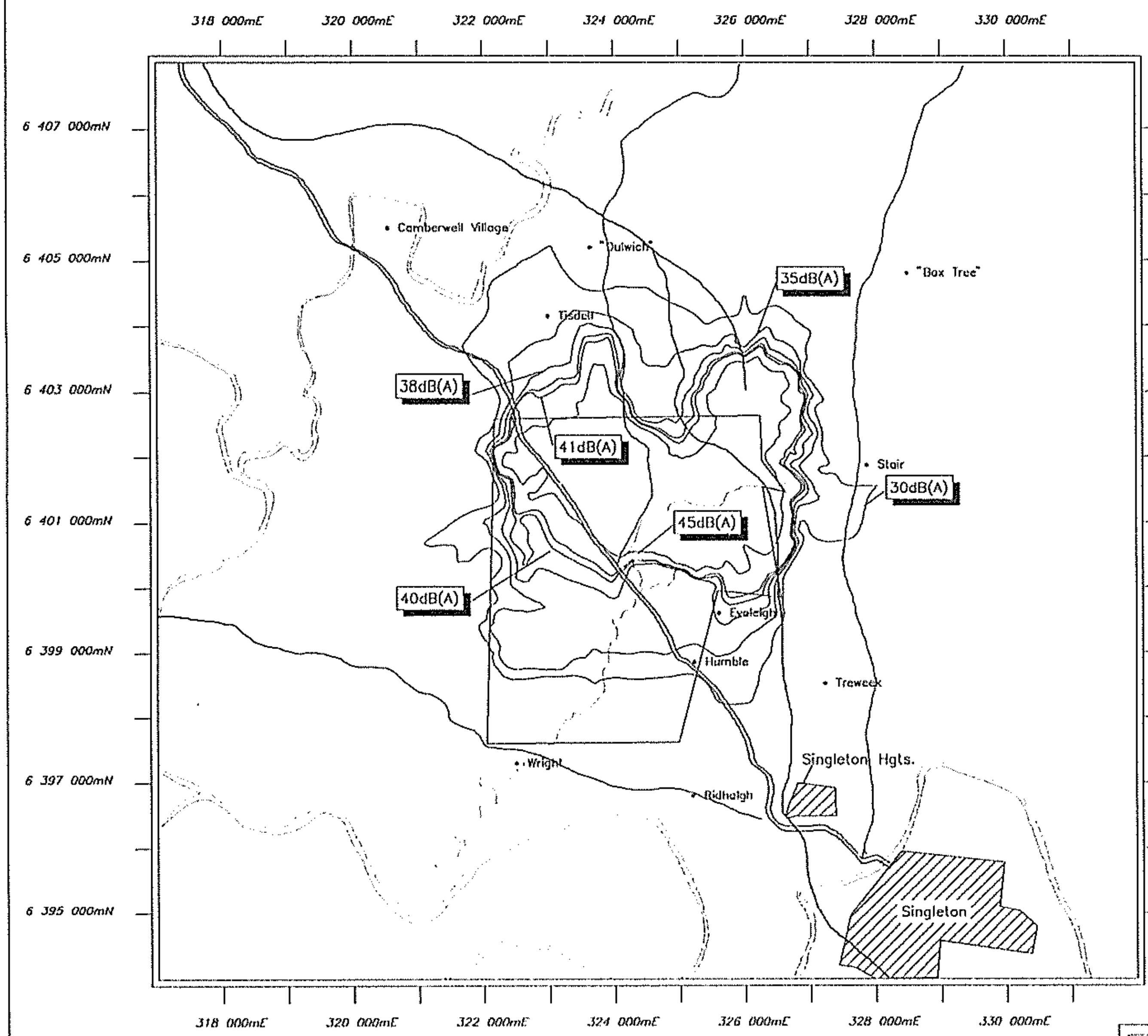
Predicted Noise Contours –
Shovel, Yr 8 (Pit 1, Daytime)
Reduced Pit Plan

Figure 3 | September 1994



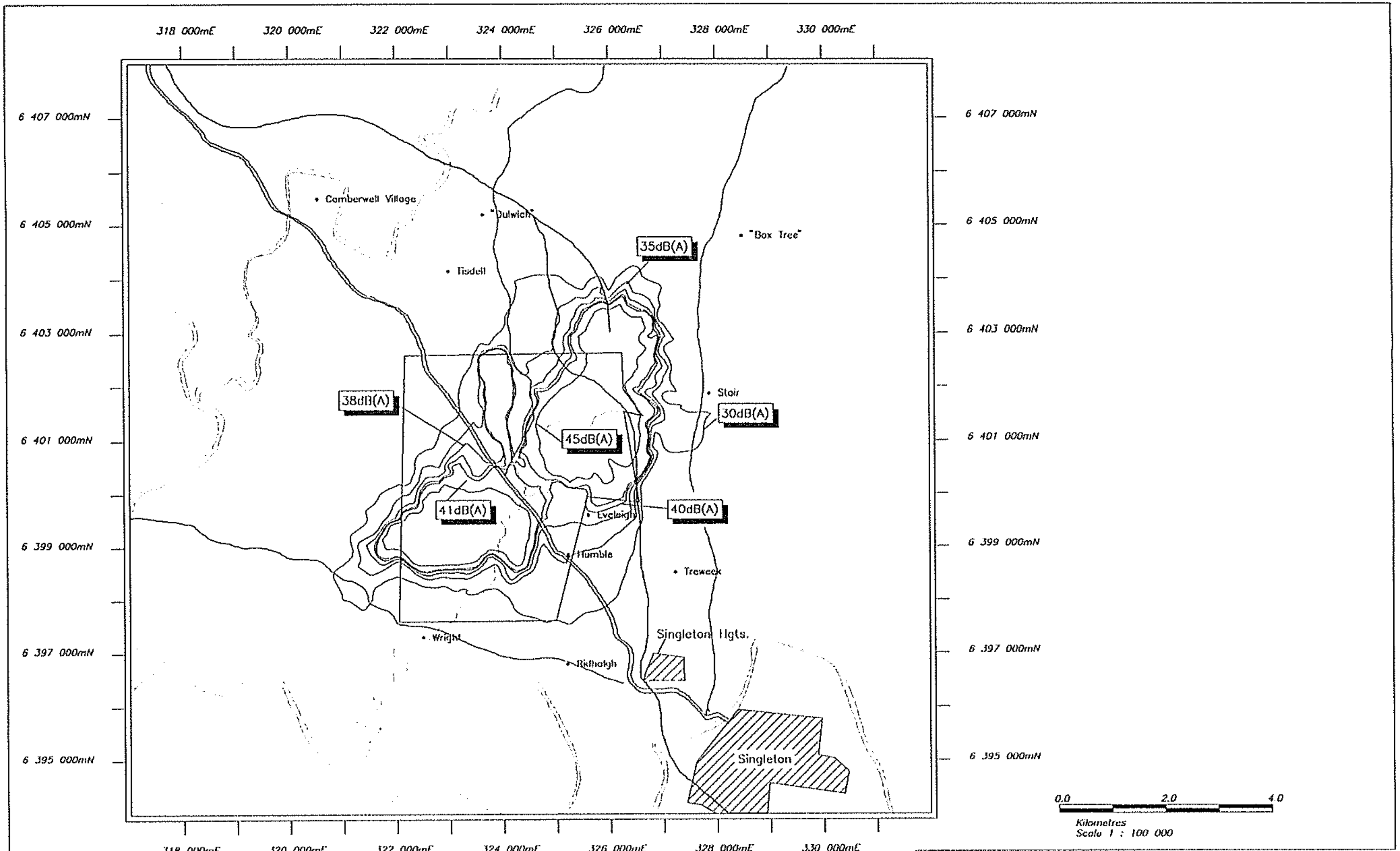
Predicted Noise Contours –
Shovel, Yr 8 (Pit 2/3, Daytime)
Reducted Pit Plan

Figure 4	September 1994



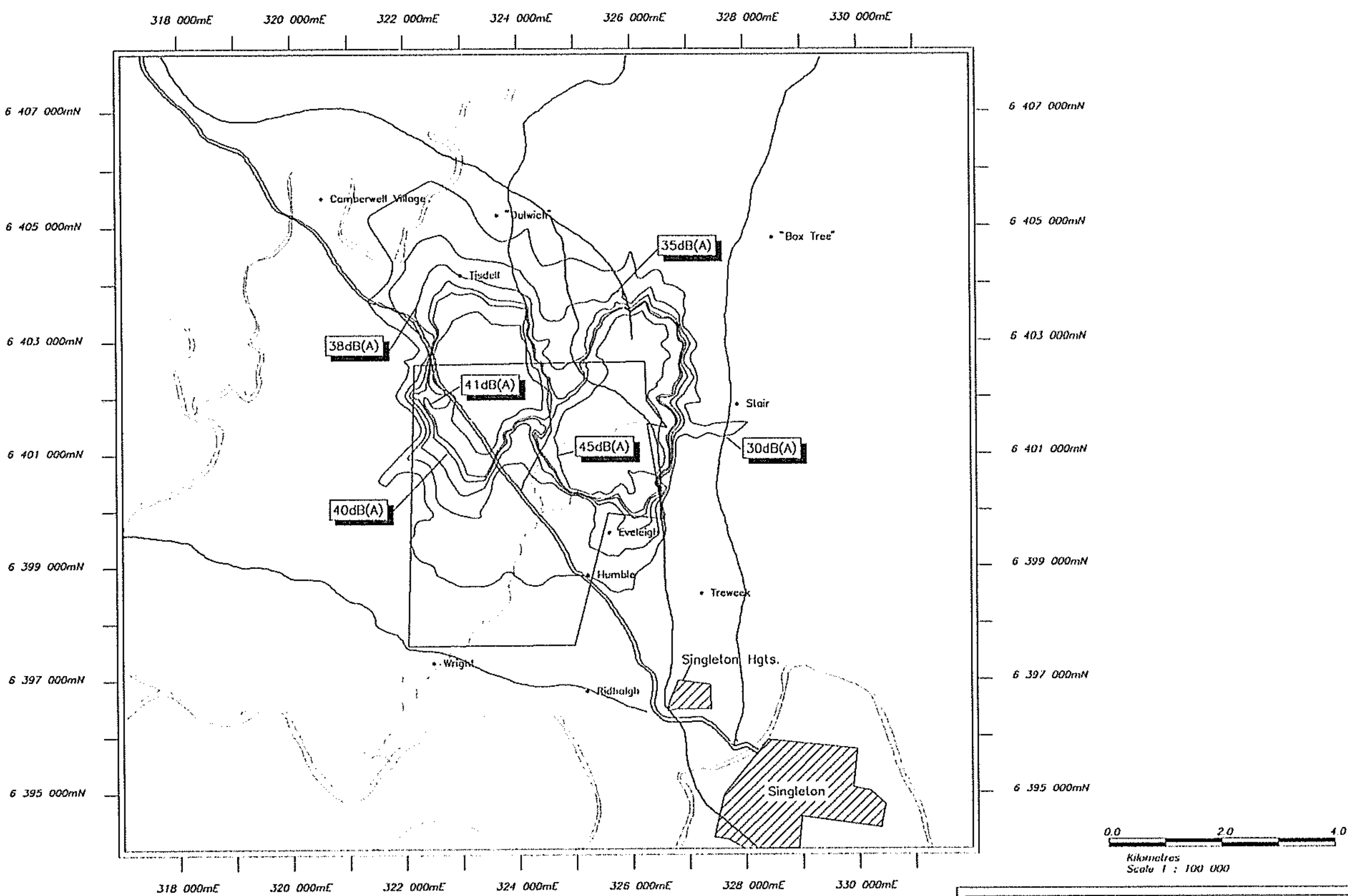
Predicted Noise Contours -
Shovel, Yr 15 (Pit 1, Daytime)
Reduced Pit Plan

Figure 5	September 1994



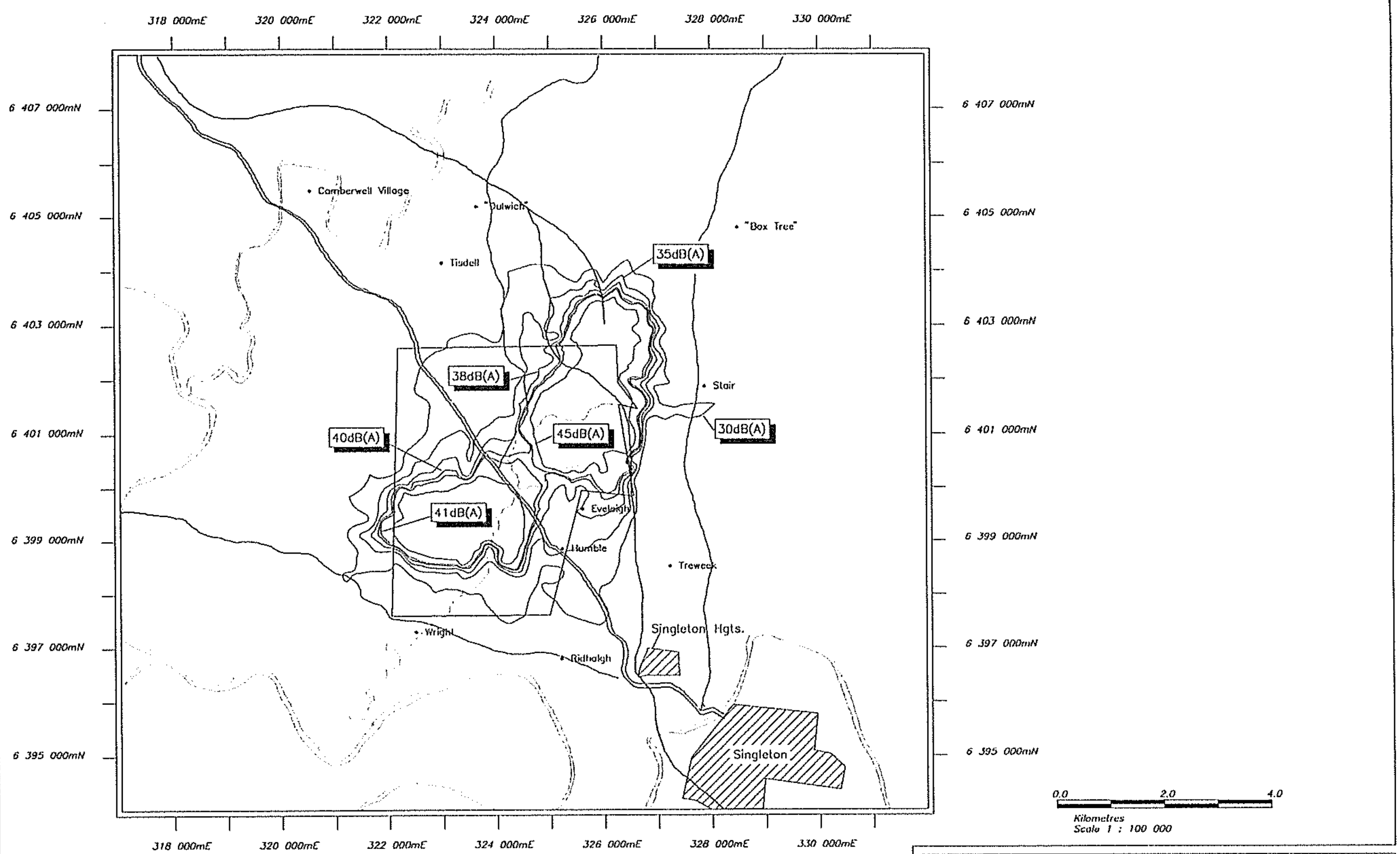
Predicted Noise Contours --
Shovel, Yr 15 (Pit 2/3, Daytime)
Reduced Pit Plan

Figure 6	September 1994



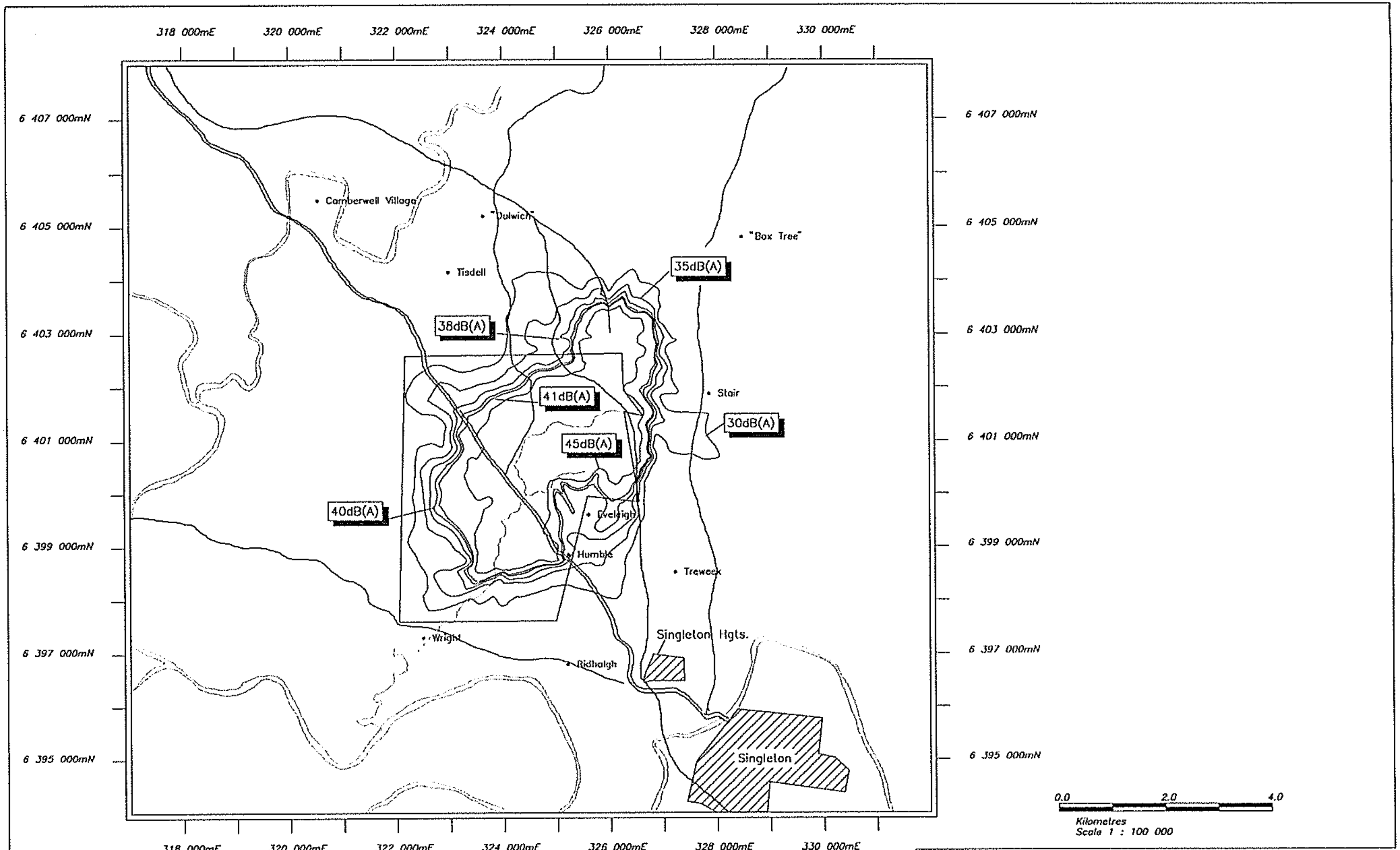
Predicted Noise Contours — Shovel, Yr 22 (Pit 1, Daytime)
Reduced Pit Plan

Figure 7	September 1994



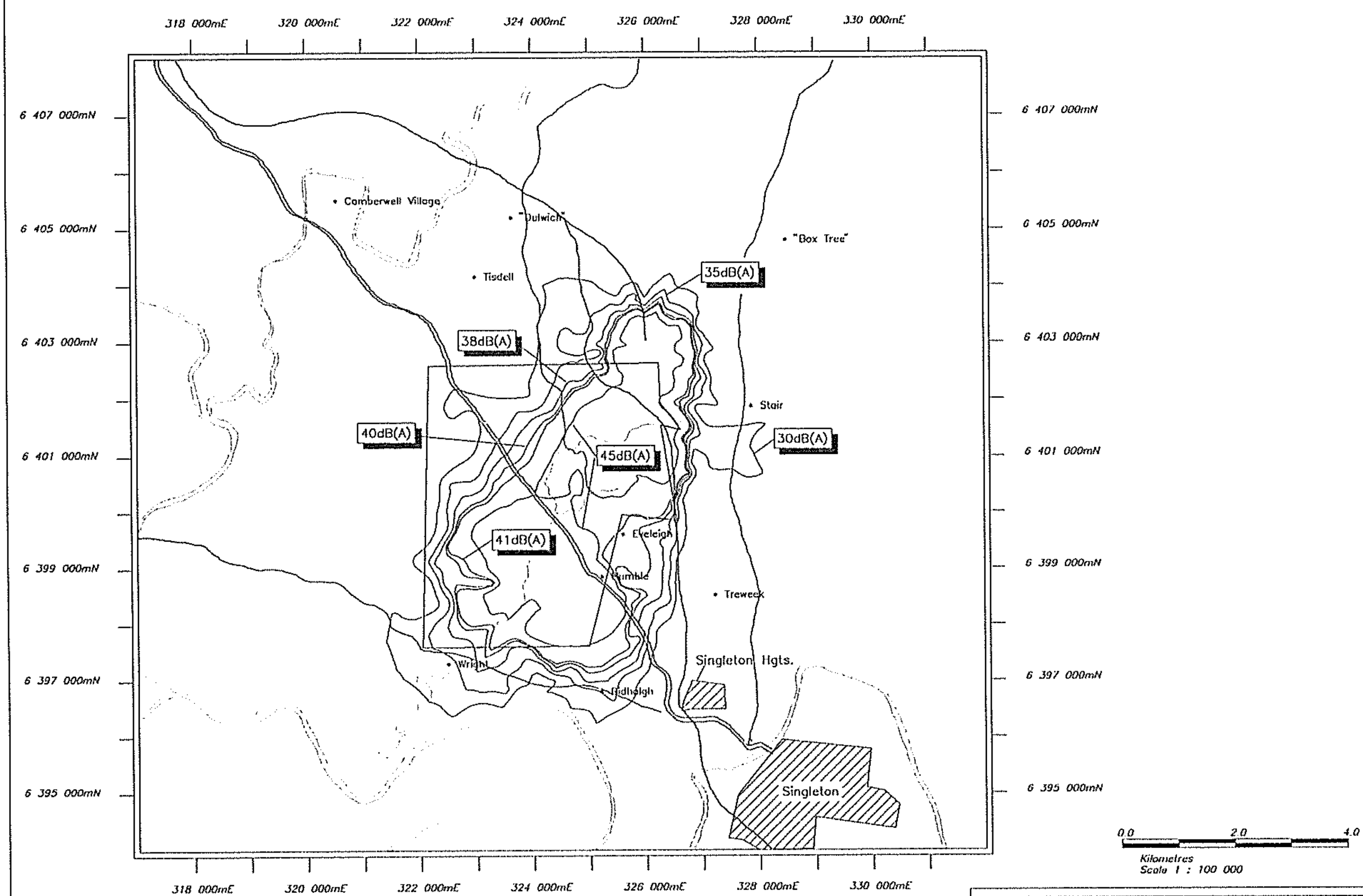
Predicted Noise Contours –
Shovel, Yr 22 (Pit 2/3, Daytime)
Reduced Pit Plan

Figure 8 | September 1994



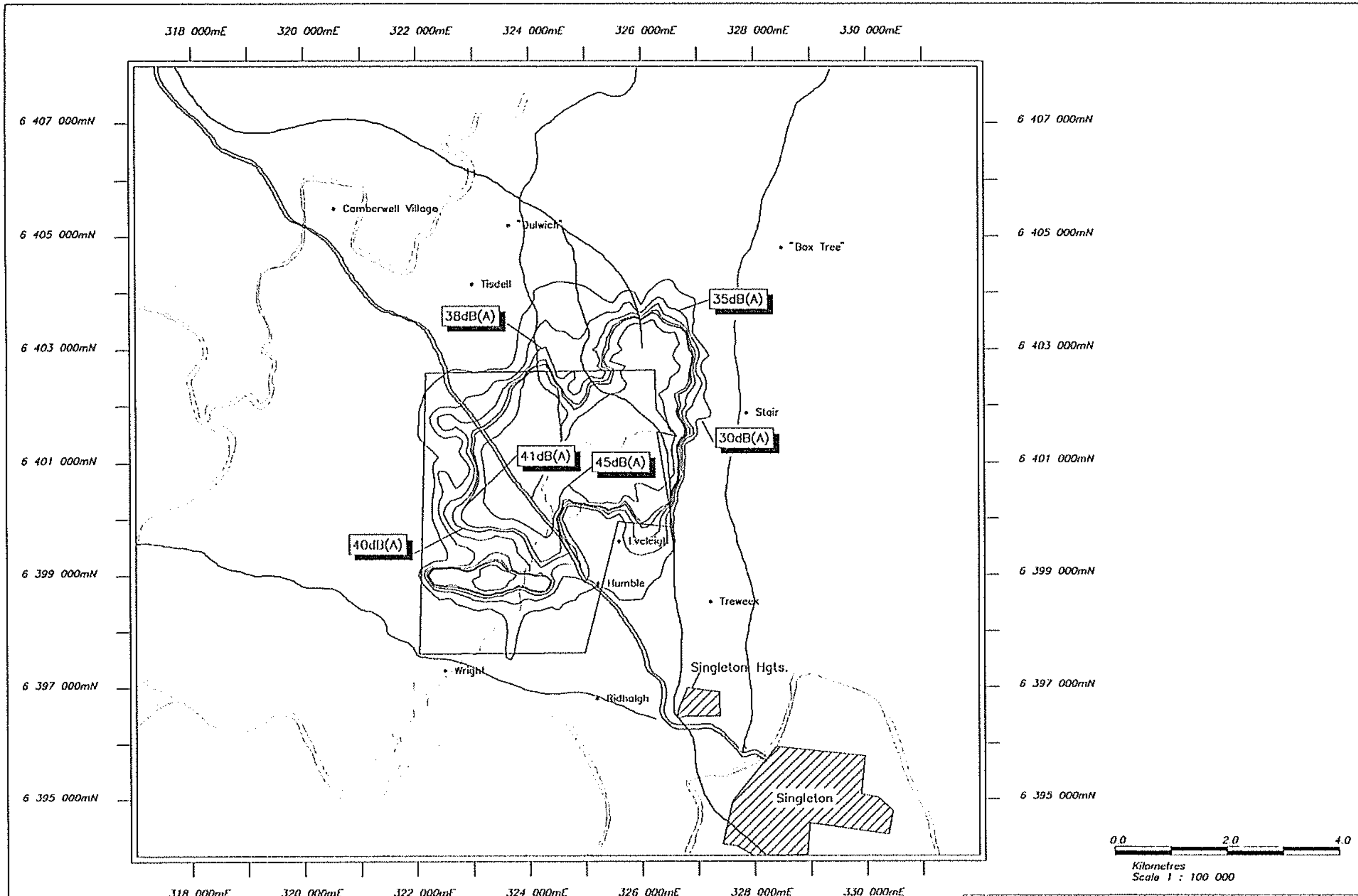
Predicted Noise Contours –
Shovel, Yr 1 (Pit 1, Night time)
Reduced Pit Plan

Figure 9	September 1994



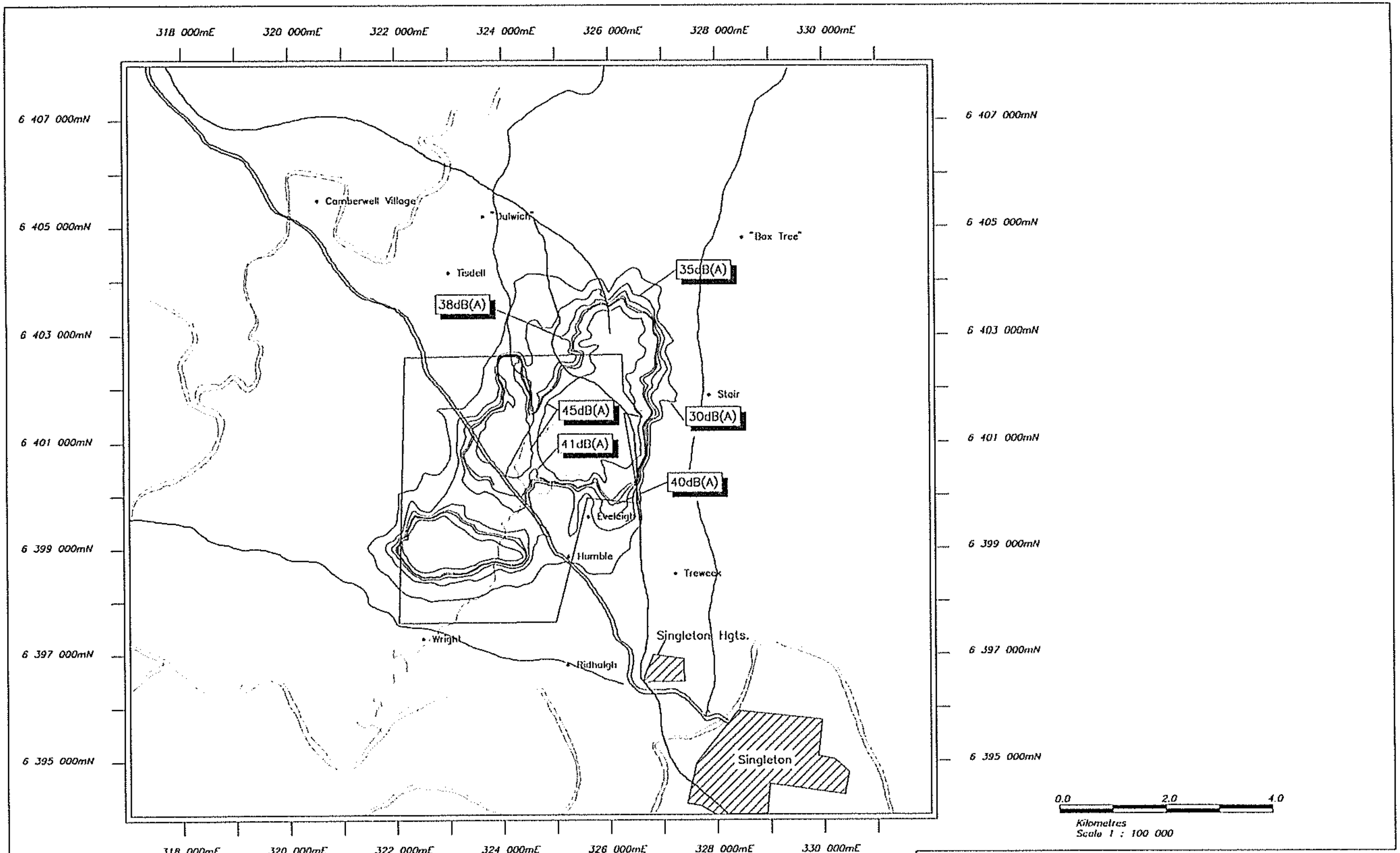
Predicted Noise Contours –
Shovel, Yr 1 (Pit 2/3, Night time)
Reduced Pit Plan

Figure 10	September 1994



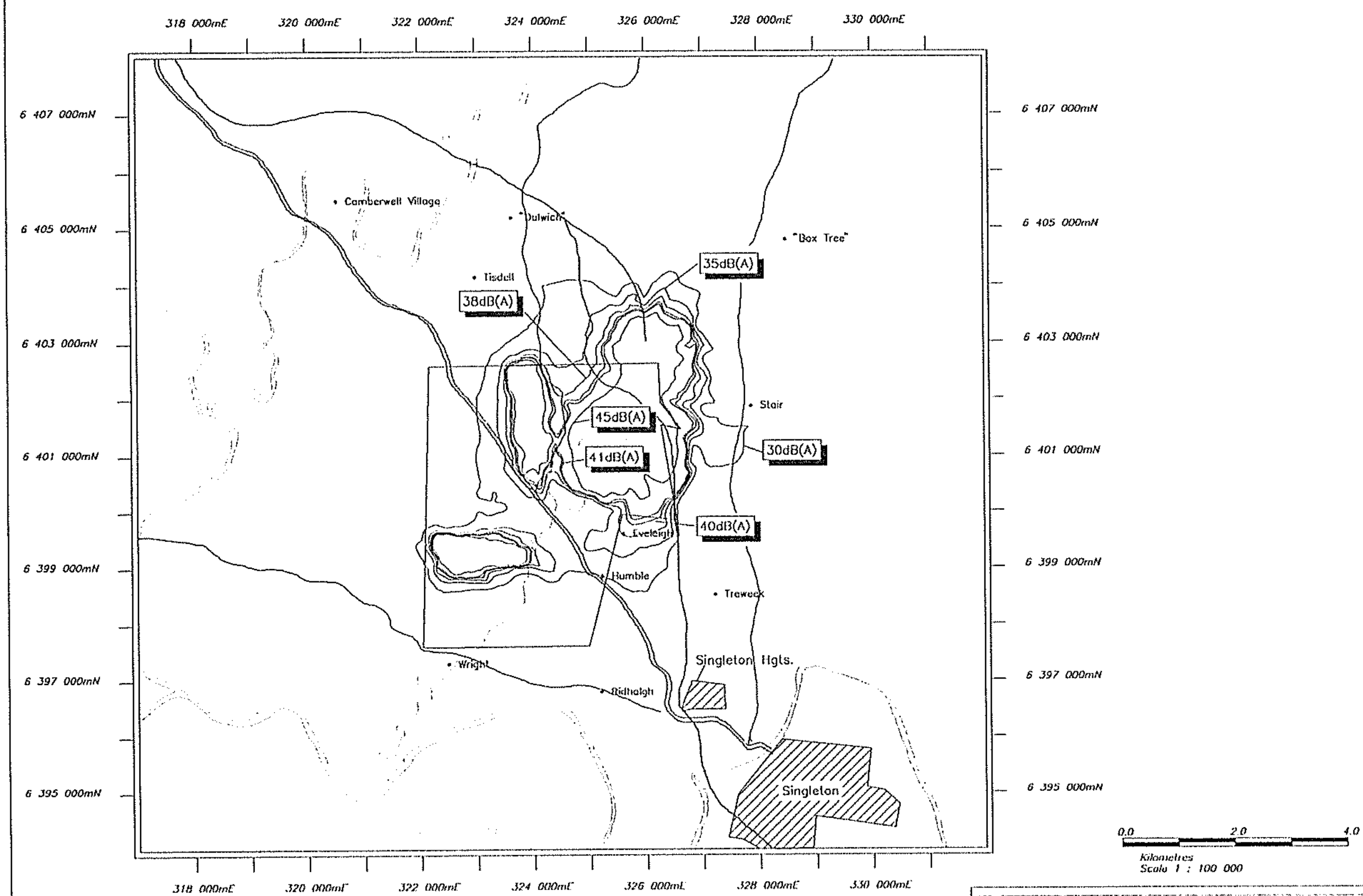
Predicted Noise Contours —
Shovel, Yr 8 (Pit 1, Night time)
Reduced Pit Plan

Figure 11	September 1994



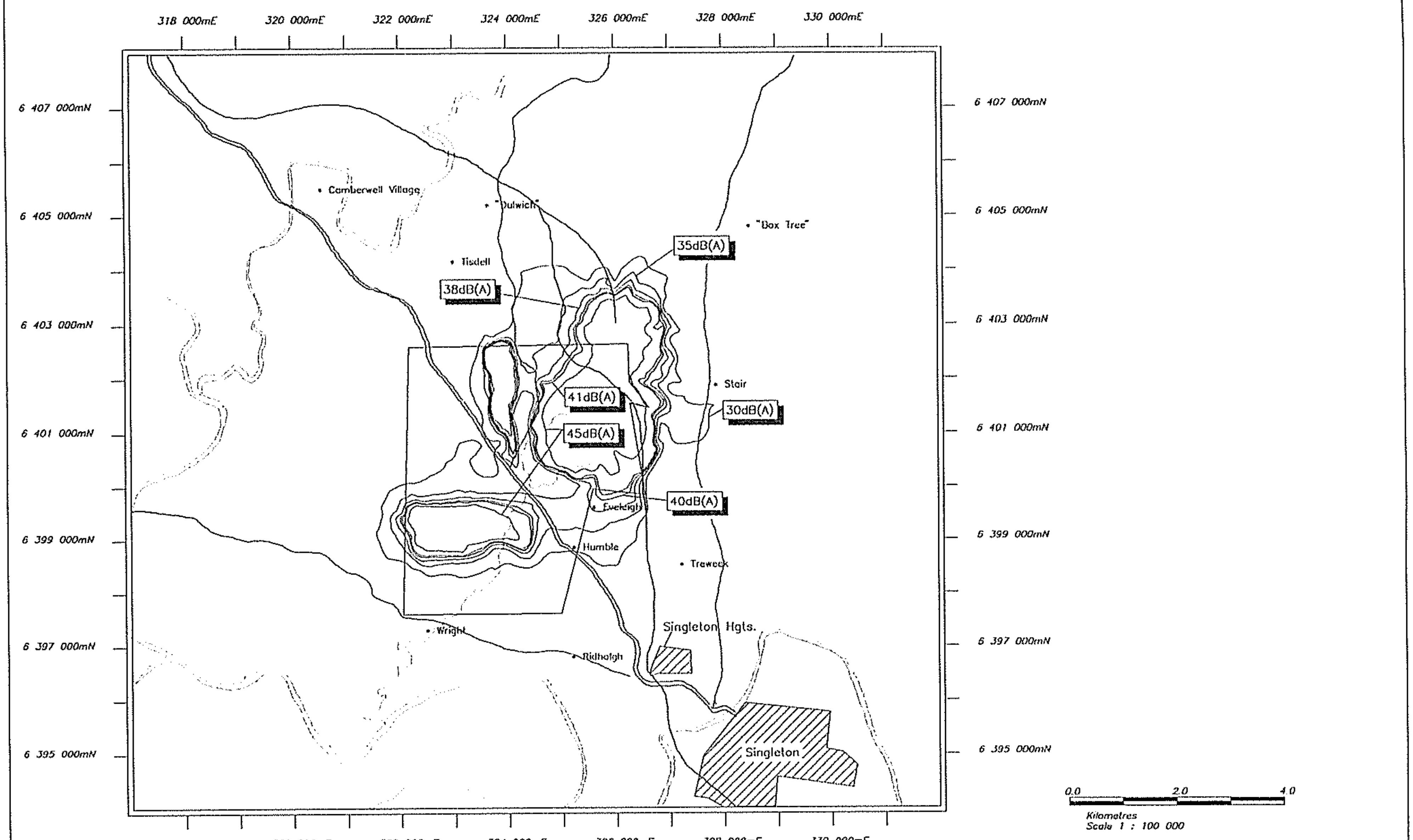
Predicted Noise Contours –
Shovel, Yr 8 (Pit 2/3, Night time)
Reduced Pit Plan

Figure 12	September 1994



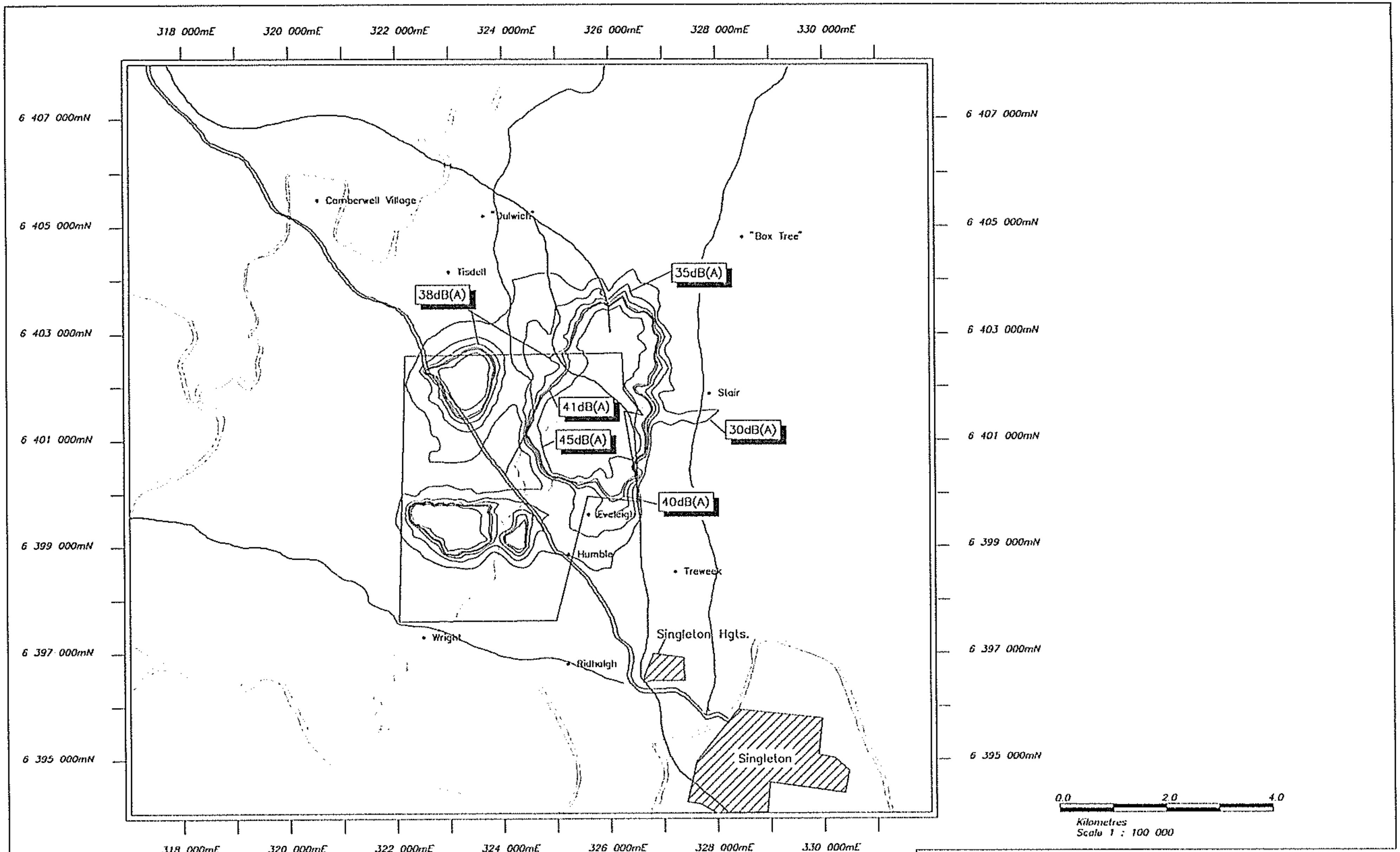
Predicted Noise Contours –
Shovel, Yr 15 (Pit 1, Night time)
Reduced Pit Plan

Figure 13	September 1994



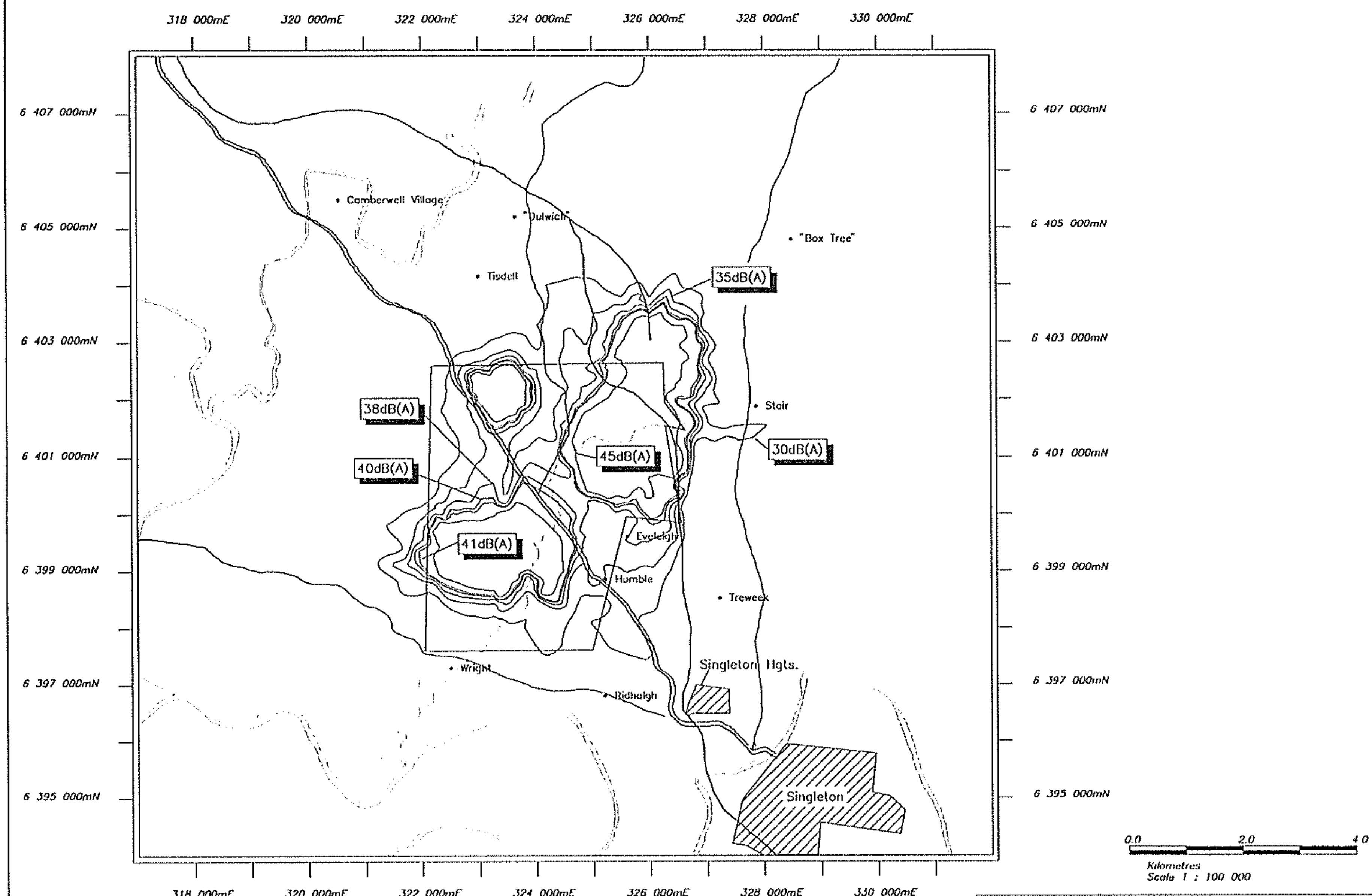
Predicted Noise Contours –
Shovel, Yr 15 (Pit 2/3, Night time)
Reduced Pit Plan

Figure 14	September 1994



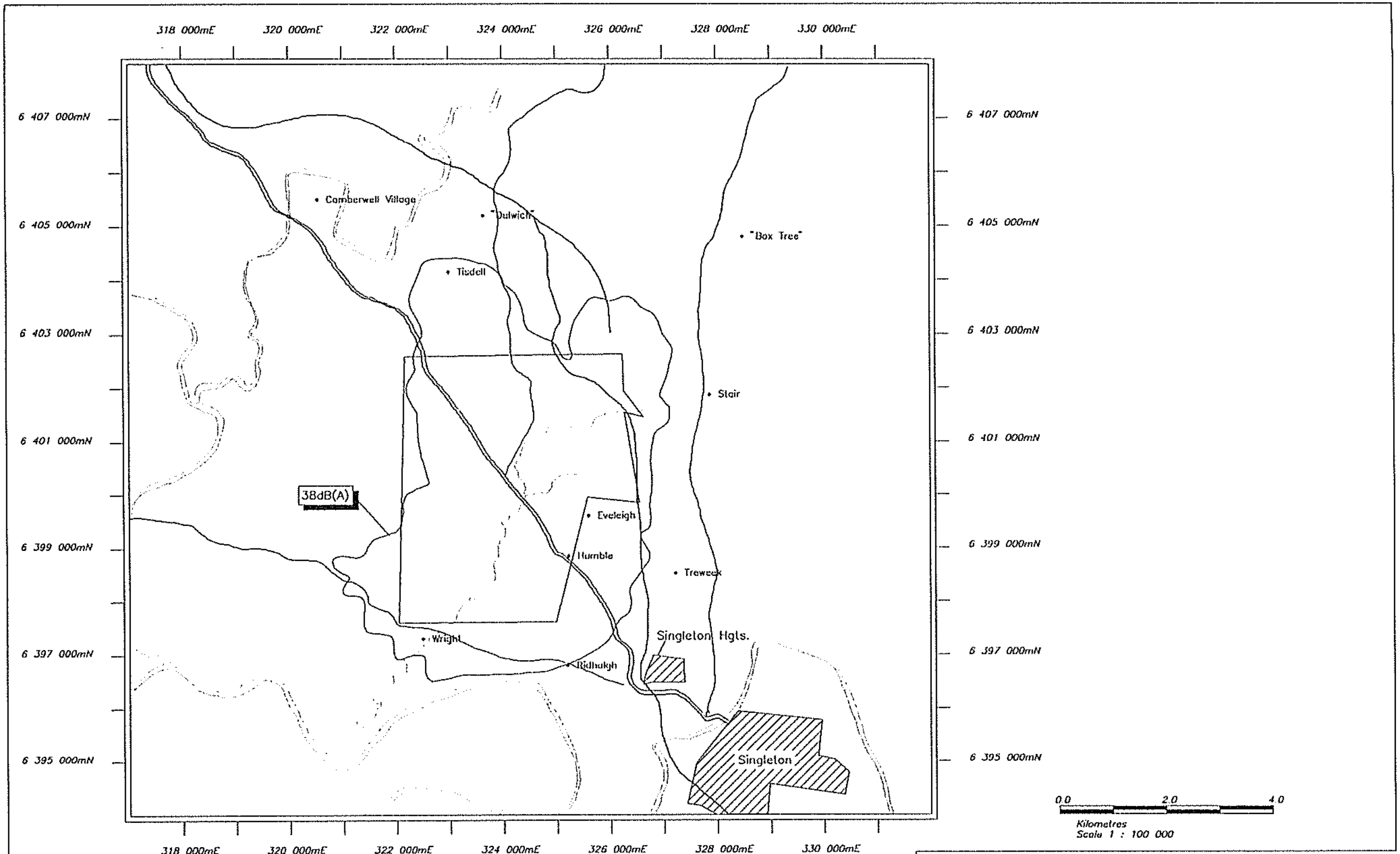
Predicted Noise Contours –
Shovel, Yr 22 (Pit 1, Daytime)
Reduced Pit Plan

Figure 15 | September 1994



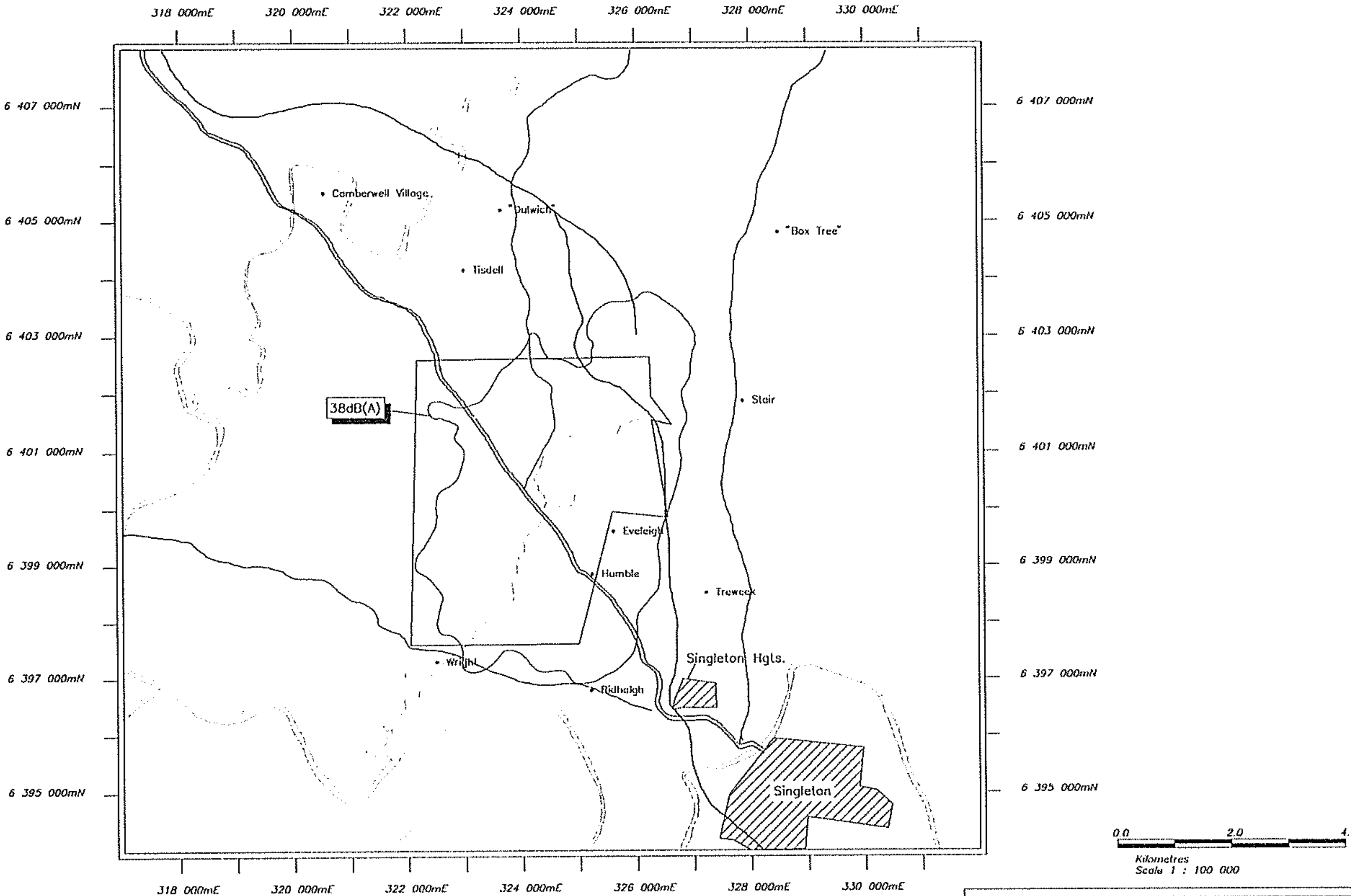
Predicted Noise Contours –
Shovel, Yr 22 (Pit 2/3, Night time)
Reduced Pit Plan

Figure 16	September 1994



Total Area of Affectation – Daytime (Reduced Pit Plan)

Figure 17 | September 1994



Total Area of Affectation –
Night time (Reduced Pit Plan)

Figure 18

September 1994

APPENDIX 7:

ARCHAEOLOGICAL INVESTIGATIONS

Prepared For:
Bloomfield Collieries Pty Limited
PO Box 4
EAST MAITLAND NSW 2323

ARCHAEOLOGICAL ASSESSMENT RE-SURVEY COAL LEASE EXTENSION BLOOMFIELD COLLIERY RIXS CREEK SINGLETON, NSW

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Checked By:

Alan Wells, BA, T&CP(Ord4),
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Manager, Planning & Development

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1.0 INTRODUCTION

Bloomfield Collieries Pty Limited, East Maitland have established the Rixs Creek open cut coal mine near Singleton. Coal Lease No 352 at Rixs Creek was issued to Bloomfield in 1989 as part of the development consent for the mine.

Rixs Creek colliery is applying to expand its mining operations to the west and southwest of the current mining area (see **Figure 1** for general location) as part of its mine planing.

The archaeological survey that is the subject of this report had been completed by Ms Sue Effenberger of Envirosciences on behalf of Bloomfield Collieries as part of an Environmental Impact Statement for the mining extension which will be submitted to the NSW Department of Planning for the granting of a development consent.

2.0 PREVIOUS SURVEY

The land in question (see **Figure 2**) had previously been surveyed in 1981 by consultant archaeologist Dr Helen Brayshaw in conjunction with representatives of the Awabakal and Biraban Aboriginal Co-operatives and Mr Glen Morris of the NSW NPWS. A total of 18 sites were identified in this survey. Sites 3, 4, 5, 6, 7 ,8 and 11 as identified by Brayshaw (3:37-6-237, 4:37-6-238, 5:37-6-239, 6:37-6-242, 7:37-6-241, 8:37-6-240 and 11:37-6-245) were to be affected by the proposed mining operations and ancillary services. Mr Philip Mane of Muswellbrook participated in the 1983 salvage of several of the original sites recorded as part of a "Consent to Destroy" application to the Director of the NSW NPWS.

The proposed expansion of mining at Rixs Creek will affect sites 10, 17 and 18 (10:37-6-244, 17:37-6-251, and 18:37-6-252). Substantial time has elapsed (some 13 years) to warrant a re-survey of these sites so that they may be re-assessed in the light of current archaeological models of the Hunter Valley and conservation status of the sites.

3.0 SCOPE OF THE PROJECT

In a letter from the Upper Hunter District Manager of NPWS to Envirosciences dated 14 March 1994, the following objectives of the current archaeological study had been identified:

- That an archaeologist and a member of the Wanaruah Local Aboriginal Land Council conduct an archaeological assessment of the area within the proposed mine extension.

- That the sites previously identified by Dr Brayshaw in the new mining area be assessed, as they may now require a "Consent to Destroy" application.

- *"Reassessment of the research archaeology undertaken by Dr Brayshaw... addressing any deficiencies in the light of modern best practices"*

4.0 LOCATION

Rixs Creek coal mine is located in the Hunter Valley of New South Wales, approximately 4 km north west of Singleton along the New England Highway, which dissects the coal lease.

5.0 RECOMMENDATIONS

On the basis of the results and site descriptions below, the regional archaeological context, and the likely impacts that the extension of the Rixs Creek coal mine might have, the following recommendations are made to the client, Bloomfield Collieries:

i. That the client submit 4 copies of this report to NPWS with an application for a "Consent to Destroy" to the Director, for GRANBALONG 1-6 sites, on the basis of their low scientific potential. Once NPWS has reviewed the contents of the report and recommendations, the mine extensions may proceed with their approval.

ii. That an area, indicated on Figure 2 be set aside for future study/assessment. The NPWS recommends that further sub-surface testing be undertaken within this area to determine the areal extent of archaeological material at the sites Rixs Creek 1 and 2 and other nearby areas judged to be of archaeological potential.

    This testing programme would allow a more comprehensive assessment of the significance of the sites and the development of appropriate management options for each site. The sub-surface testing and permit applications should be undertaken prior to potential mining of the area and within an appropriate time frame so as to avoid unnecessary delay to mining operations.

iii. That all members of the construction team be made aware, by brochure or induction, of the nature of archaeological sites in the immediate area, and the roles of the Wanaruah Local Aboriginal Land Council and National Parks and Wildlife Service in the region. Appendix 1 contains the National Parks and Wildlife Service Brochure, *For Planners and Developers*.

iv. That if any hitherto undiscovered site is threatened with disturbance, or has been disturbed then construction must cease and the disturbance reported to Upper Hunter

regional office of National Parks and Wildlife Service (Muswellbrook) through the Regional Archaeologist. The Regional Archaeologist may be contacted on (065)433533.

All sites and isolated finds are protected under the *National Parks and Wildlife Act* 1974 and as such there are provisions in the Act for their destruction, disturbance or removal. If there is any likelihood that the artefacts might be disturbed, then the client should apply for another "Consent to Destroy" permit from the Director of National Parks and Wildlife Service.

6.0 ABORIGINAL CONSULTATION

On 20 and 21 April 1994 field studies were conducted by Mr Barry French, Site Curator of the Wanaruah Local Aboriginal Land Council in conjunction with the archaeologist. The Wanaruah Local Aboriginal Land Council have been consulted for all aspects of the survey. A copy of Mr Barry French's report on behalf of the Wanaruah Local Aboriginal Land Council assessing the results of the survey has been placed in Appendix 2.

7.0 ENVIRONMENTAL CONTEXT

7.1 REGIONAL GEOLOGY

The coal bearing strata around Singleton is of the Singleton Super Group which are coal seams embedded with sequences of mudstones, siltstones, sandstones and conglomerates. There are also occasional beds of tuffaceous claystones.

The Singleton Coal Measures are bounded to the north and east of the Hunter Valley by a major regional fault, known as the Hunter Thrust System.

At the base of the coal measures is the distinctive Saltwater Creek Formation which is a shoreline deposit separating the underlying marine sediments called the Maitland Group from the terrestrial sediments of the basal coal bearing sequence of the Wittingham Coal Measures.

The Saltwater Creek Formation contains a massive erosion resistant sandstone bed called Caswell Sandstone. This sandstone forms a prominent ridge separating the mine lease from the Singleton Heights residential area. The Caswell Sandstone may also be seen exposed at or near the eroded creek beds, in the lower lying terrain of the lease. This is especially the case for Rixs Creek and its tributaries.

7.2 TOPOGRAPHY

The landform within the lease area is undulating with steeper grades on the upper and middle slopes, with flatter areas adjacent to the creeks. The relief ranges from a maximum height of approximately 170 m AHD in the northwest to roughly 60 m AHD where Rixs Creek intersects the southern boundary.

The majority of the area has slopes which are less than 2 degrees, with much of the remaining area having gradients between 2 and 5 degrees. Areas with grades of between 5 and 10 degrees are confined to the upper slopes, while areas greater than 10 degrees occur along the banks of deeply eroded stream lines.

7.3 DRAINAGE

Severe stream bank erosion and gullying are evident along all the drain lines and sheet erosion is evident on the lower slopes. The combination of extensive clearing, poor management practices and shallow soil has led to the generation of large runoff volumes during infrequent but intense rainfall events.

7.4 SOILS

The podsolic or solonetzic soils which are quite common within the Hunter Valley away from the alluvial areas are well represented on the lease area. The textural character of the profile of these soils is duplex. The red and yellow duplex soils, which are the predominant types, have a high mineral content.

Uniform soils, which are characterised by small to negligible textural differences throughout the profile, are also found on small areas of the site.

As a general rule, the yellow duplex soils occur in areas of poor drainage on lower slopes and drain lines and the red duplex soils on the higher slopes and ridge tops. The red soils are generally more stable with respect to soil conservation. Yellow duplex soils predominate along Rixs Creek in the central part of the area. These soils contain some organic material in their horizons in the form of weathered coal products. The erodable nature of the soils is due to the duplex structure.

Gully erosion, rilling and tunnelling are evident along Rixs Creek and other watercourses. Areas of sheet erosion, resulting in the loss of topsoil also occur, particularly on the steeper mid slope positions which collect runoff from higher ground.

7.5 FLORA AND FAUNA

A very dense and pure stand of Swamp Oak (*Casuarina glauca*) fringes Rixs Creek. The stand has grown to a height of 15 m in places, put there is no understorey, apart from some pasture grasses.

Small remnants of forest generally consist of dense young trees with an average height of 15 m. Spotted Gum (*Eucalyptus maculata*) Narrow leaved Ironbark (*E. crebra*), Grey Box (*E. moluccana*), and Forest Red Gum (*E. tereticornis*) are other species present in the woodland. The ground cover is usually clumped with grass with the occasional Prickly Pear (*Opuntia stricta*).

Among the trees, there is a large number of juvenile eucalypts and wattles, most of which are representative of regrowth after recent timber-felling and previous site clearing.

In some of the waterlogged areas, a dense growth of Spiny Rush (*Juncus acutus*) has developed. This salt tolerant, introduced weed is well established in the Hunter Valley and appears to be spreading.

Pastureland consists of numerous grass species combined with number of dicotyledons. At the time of study, the grass cover was relatively dense due to the low stocking rates; some parts of the site not having been grazed at all for some time.

Native terrestrial fauna were represented by several Eastern Grey Kangaroo (*Macropus giganteus*). Brush-tailed Possum (*Trichosurus vulpecula*) and the Echidna (*Tachyglossus aculeatus*) may also be found on the site. There has been one recording of the Long-necked Tortoise (*Chelodina longicollis*).

7.6 LANDUSE

The clearing of land for mining in the late 1870s and its subsequent use for mining and grazing since that time had greatly altered the original physical environment. Little of the surface soil has been left undisturbed and the few vegetation remnants represent regrowth and are only generally indicative of the original ground cover.

Previous clearing of the vegetation cover has caused saline ground water to rise, and salt to accumulate in low-lying areas. Considerable erosion resulting from clearing, over-grazing and general

land mismanagement is widely evident. Rixs Creek and its tributaries are particularly degraded. These eroded, often waterlogged drainage lines have created ideal conditions for the establishment of the introduced plant, Spiny Rush.

The construction of farm dams over the site have altered the drainage regimes.

8.0 ARCHAEOLOGY

8.1 APPROACH OF PREVIOUS CONSULTANT

In 1981 the consultant Dr Helen Brayshaw recorded 18 sites on the Rixs Creek Coal lease. At the time of the survey, there were few consultants working in the Hunter Valley, and a firm model of site formation and stone tool technology had not yet emerged. Since the time of that survey, the guidelines for consulting archaeologists and report preparation have evolved, and there is now a greater expectation from NPWS that the reports will comprehensively cover not only detailed information about the sites themselves, but also a consideration of the current models of site formation and stone tool technology.

Sites from the original survey that are likely to be affected by the current proposal were recorded by Dr Brayshaw as follows:

"SITE 10 (NPWS 37-6-244). 2272 9885 About 20 flakes of chert and silcrete in an eroded area above a gully junction.

SITE 17 (NPWS 37-6-251). 2326 0028. Two flakes on an elevated bank between a gully junction

SITE 18 (NPWS 37-6-252). 2360 9951. On an eroded bank near a gully junction up to 30 artefacts, including chert flakes, several cores and one scraper, occur in an area of 60 X 40 metres."

Brayshaw's conclusions for all 18 sites were that sites had been found mostly on the tributaries of Rixs Creek, often high up near the source of the creek. She postulated that this was a function of site visibility rather than Aboriginal occupation, as most of the erosion occurred on higher ground. Brayshaw noted that only two sites (3:37-6-237, 15:37-6-249) had artefacts eroding out of the upper soil horizon, beneath the organic layer and above the underlying red clay. Site 15:37-6-249 contained some microliths, which Brayshaw believed indicated that the site occupation might have ceased between 1000 and 400 years ago (from McBryde 1980).

Brayshaw had consulted with Mrs Jean Miller of Singleton about Aboriginal interest in the area.

In summary, Brayshaw concluded,

> *"given that all of these sites are so typical of open sites occurring in the Upper Hunter Valley the artefacts present, raw materials used, and deposition of artefacts in the upper soil horizon, no salvage is recommended"*

In 1983, a more detailed report had been instigated by NPWS so that the sites to be affected by the mining plan, subject to a "Consent to Destroy" application by the proponent to the Director of NPWS, would require salvage. The recording method used had been employed by Koettig and Hughes to record sites on Redbank Creek on the United Collieries lease near Warkworth. The sites that were affected were 3:37-6-237, 4:37-6-238, 5:37-6-239, 6:37-6-242, 7:37-6-241, 8:37-6-240, and 11:37-6-245. All but Site 7:37-6-241 were within the area to be mined.

Of the sites to be affected in future mine plans, only Site 11:37-6-245 had been included in salvage work by Brayshaw. A total of 38 artefacts were collected from the site and none appeared to be *in situ*, however, a small number had eroded out of the Unit A soil horizon.

A description of the regional prehistory by Brayshaw had been based on a paper by Stern (1981), which was an excavation report of an open camp site at Nine Mile Creek on the Saxonvale Coal Mine.

However in 1983, Brayshaw linked the stone tool technology found at Rixs Creek with the work of Lambert 1971 and Mulvaney 1975, according to the chronology:

Pleistocene and Early Holocene: Large stone cores and core tools.

4500 to 5000 Years ago: A variety of small finely chipped stone implements called backed blades (geometric microliths, eloueras, Bondi points)

1500 years ago to the time of European settlement: Disappearance of backed blades and finely retouched pieces and an increase in the use of undifferentiated small tools and quartz as well as organic raw materials (bone, wood and shell).

At the time of Brayshaw writing the report a the model for Hunter Valley technology had not yet emerged. Neither had geomorphological aspects of site formation been addressed.

Brayshaw categorised the artefacts according to the following:

- Modified pieces edge or surface damage probably resulting from use, backed pieces noted. Asymmetrical Bondi Points and geometric microliths (symmetrical).

- Cores single platform, multi platform.

- Non modified pieces, flakes, and flaked pieces.

9.0 RESULTS

The Brayshaw 1983 results revealed:

- That for raw materials, most sites contained indurated mudstone with some silcrete. At Site 11:37-6-245 there was no silcrete, which she attributed to the distance from raw material sources, site function or an inadequate sample.

- At Site 11:37-6-245, the 38 artefacts could be classified into 29 non-modified indurated mudstone, 4 non-modified quartz, 1 modified indurated mudstone, 2 indurated mudstone cores.

- For sizes, indurated mudstone at 79% fell below the 5 cm size class, 21% over. Silcrete was 70% below and 30% above. The 1-3 cm size class was most common.

- Of the shape most common flake (broader than long), followed by elongate (longer than broad).

- There were 9 cores, 6 of indurated mudstone, 2 of silcrete and 1 of quartz.

- Backed blades occurred in small numbers, with all but 2 pieces modified. Five backed blades were made from indurated mudstone but 2 were made from silcrete.

- Quartzite was bifacially flaked and indurated mudstone had been flaked with bilateral use fracture.

- Site patterning over the study area was rare. Only in Sites 5:37-6-239 and 11:37-6-245 were artefacts derived from the same lump of material, indicating a knapping process. The only distinct feature was an absence of silcrete at Site 11:37-6-245.

In general, Brayshaw found that the only diagnostic stone tool was the backed blade, which presumably dates the sites to a period after 4,500 years ago. Bondi Points may occur as late as 810 ± 110 years ago, a date derived from charcoal (C_{14} SUA 1670) at a rock shelter at the junction of Merriwa and Goulburn Rivers (Haglund 1981).

The trends that Brayshaw did establish were that sites were most likely to occur at the upper reaches of creeks or tributaries, with little inter-site patterning. Indurated mudstone was dominant, with silcrete being the next most common raw material. The raw material was local and not brought from distances away. Most artefacts were less than 3 cm, and the flake shapes varied widely. Modified artefacts were rare, being 2.7% of total. All artefacts had eroded from the Unit A soil horizon.

10.0 ARCHAEOLOGICAL MODELS SINCE 1983

Hughes in a 1984 study stated that sites generally diminish in frequency along minor creek lines away from the major drainage lines which supported Brayshaws 1983 findings. He hypothesised that Unit A soils may be younger than 5,000 years because the mid- to late-Holocene artefact assemblages are found towards the base of the unit. He therefore suggested that the Hunter Valley had not been occupied by Aborigines until the second half of the Holocene.

The sequence of technological change found that backed blades, part of the Bondaian industry, were less than 5,000 years old and most sites fell into this category.

Until the availability of the NPWS report by Baker in 1992, the main source of a methodology to analyse the stone artefact content of archaeological sites was offered by Hiscock (1984), who based his approach on the analysis of assemblages excavated from Redbank Creek and Sandy Hollow, located in the Singleton region of the Hunter Valley. As part of his strategy, Hiscock "re-analysed" past reports and their archaeological material, to "infer aspects of the prehistoric stone working technology".

Since the appearance of his work, many consultant archaeologists have used his methodology as a framework within which to place their own approaches. As a basis for his analysis, he provided a comprehensive definition of diagnostic features associated with point of force application (PFA). The terms most often used by archaeologists, and hence in this report, are in bold.

On the **dorsal** side, or the side opposite the ventral (inner face), an artefact may have varying degrees of **cortex**, the weathered, unworked skin of the stone. If this side has had flakes detached, this is clear evidence for the flake being an artefact, because it indicates that the platform has been struck with the purpose to detach flakes. The likelihood that this event would happen as a result of natural agents is very small. The more flake **scars** (remnants of detached flakes) present, the more the artefact has been subject to advanced technology.

Technological studies have shown that the **raw material** for artefacts was carefully selected for its fracture qualities and content of silica, which causes a glassy texture. The stone was worked to form an artefact which would have fallen into one of the following categories:

Flake - A piece of rock which had been struck off a core and may have had subsequent flakes struck from it. A **blade** is a type of flake that is longer than it is wide.

Core - A lump of stone which has had flakes struck from it. The core may have been carried, and worked as flakes were needed, or may have been exhausted at one location, creating a concentration of small flakes known as **debitage** to form a **knapping floor**, the evidence of which archaeologists seek when they survey a site.

Retouched flake - Is any flake that has had subsequent flakes struck from it, identified by flake scars on the ventral surface. The shorthand R/U is a notation used by archaeologists to denote that an artefact has had **usewear** (caused by repeated abrasion from use) or **retouch** to it. The retouch usewear may be the "modified" category found in Brayshaw's 1981 report. The term **tranchet blow** refers to the technique of striking to sharpen or resharpen cleavers and handaxes. A flake is therefore removed crosswise, leaving a sharp transverse edge. The term **tranchet-retouched** flake was coined by Hiscock to refer to a flake (the flake-body core) that has had tranchet blows applied to it in order to create parallel ridges to facilitate further removal.

Flaked piece - Is a chipped artefact which cannot be classified as one of the above categories, and often exhibits natural cleavage plains and geometric fractures. Flaked pieces may also include the numerous spalls which result from heat shattering of stone, a technique which artisans used to break up a rock for flaking.

Stone tools - Are those artefacts which have a definite shape and form, and are the end result after a step-by-step manufacturing process termed **reduction**. They included **backed blades** (small symmetrical flakes worked along the thick spine of the flake with a sharp edge often known as **geometric microliths**), **bondi points** (asymmetrically shaped and trimmed on the butt of the flake) and **elouera** (worked on thick margin and cutting edge). Typologies of the past have been problematic, as there was a tendency for archaeologists to use terms such as **scraper, fabricator, anvil, hammer** or **axe**, which reflected an intended use rather than type. Now the tendency is to use a reductionist/technological categorisation of tools.

Hiscock (1984) made a generalisation about the basic technological behaviours of the stoneworkers. He describes the similarities between manufacture of the assemblages, "Generalised Reduction Sequences", the main feature being "tranchet" reduction. He described the following sequence:

1. A large, thick flake is struck from a core.

2. This flake is retouched by blows applied to the ventral surface and removing small flakes from the dorsal surface. Location for the blow can be decided on the basis of whether retouch of lateral margins is required to set up platforms, or whether retouch on the proximal or distal ends is required to form ridges and to remove unwanted mass.

3. Blows are applied to the platforms to remove flakes from the ventral surface of the tranchet flake or the core.

4. Steps 2. and 3. are alternated to enable reduction to continue.

Not all steps continue on a single site, and tranchet flakes are transported to another place for further reduction. Some flakes struck from the tranchet flake were re-examined for backing, to make, for example, backed blades and bondi points.

The raw materials for the artefacts may include indurated mudstone, silcrete, quartz, fossil wood, chert and quartzite. Silcrete was almost always heat treated to enhance the flaking qualities (Hiscock 1984). Sandstone in the form of river pebbles was worked for simple chopping or hammer tools, but it was not flaked as the fine grained rocks were, due to its poor flaking qualities.

The radiocarbon dates from stratified sites, obtained from excavated samples, have placed most of the stone tool technology of the Hunter Valley to as early as 5,000 years ago, that is during the mid to late Holocene. Information obtained from the stone artefacts, in conjunction with the (imprecise) laboratory dates, have aided archaeologists to devise a chronological sequence for stone tools.

Hiscock has proposed, and archaeologists have generally adopted since, a three phase chronology for the Hunter Valley based on his Sandy Hollow Creek analysis (Hiscock 1984).

Hiscock identified the following phases:
Pre Bondaian ending 1300 years ago (using age-depth curve). An opportunistic assemblage, made by flaking stone on the spot, often discarding a core that has not been exhausted. There are no back blades present. During the manufacture there was a large amount of force applied, and the platform was not specially prepared.
Bondaian Phase I 1300 years ago. Presence of faceted platforms and the introduction of backed blades. The Bondaian phase exhibited greater platform control than Pre-Bondaian. With numerous backed blades. The core platforms were selected to be steep angled, and the platforms were very highly prepared. The cores were constantly rotated to optimise the flake during reduction and flakes were frequently retouched.
Bondaian II 800 years ago. Has only a few backed blades. Smaller amounts of force were used to strike the flakes. The steep angled cores were prepared by overhang (the shape formed after flakes are detached where the platform edge overhangs the negative flake scar) removal but the platform was not overly prepared.

Since there is evidence from sites for the co-existence of non-Bondaian technology with Bondaian, the above scheme has not had widespread support in Hunter Valley reports, since it has not been possible to replicate Hiscock's method (see the work by Haglund at Kerabee Dam, Goulburn River).

Baker in his 1992 work has had a fresh look at Hiscock's seminal paper and the ramifications it has had for consultant archaeologists. He described archaeologists attempts to replicate Hiscock's work, particularly his reduction sequence (esp. Haglund 1988), and some of the difficulties experienced. Baker modified Hiscock's original thesis and presented three main stone-working strategies based on the Narama technological analysis, reflecting opportunistic and specialised trends. The details of the analysis are beyond the scope of this project, however, they may be described briefly as:

1. **Unidirectional flaking of stone around available margins and utilising opportunities provided by core morphology.** The three extents of reduction were identified by the amount of cortex. In decreasing amount of cortex they are primary reduction cores, extended reduction cores and intermediate cores. The cores were often "wastefully" used, the flake scars being squat, and no large flakes were taken from them.

2. **Controlled flaking conditions and specialised alternating platform strategy.** The scarring on cores was elongate and was suitable for the removal of blades, and the tranchet core/blade strategy fits comfortably in this sequence.

3. **Alteration of form and structure of silcrete by various uses of heat.** The silcrete was broken into manageable elements by controlled heating in specially prepared ovens. Experiments where silcrete was thrown into fires in an ad hoc, as opposed to controlled, manner revealed that the desired result was not achieved. The diagnostic features to look for at a site containing heat-treated silcrete was potlid (spall) debitage, a lustrous sheen on the ventral surface of the flake, and a change of colour caused by oxidation of the elements in the structure of the rock. Silcretes change to red shades after oxidation.

Dr Dan Witter of NPWS has been working on a model for stone tool technology and the quality of consultant reports within the Hunter Valley. So far, he has identified two technological industries, those of the Microblade Industry and the Core and Flake Tool (Utilitarian) Industry.

Within the Microblade industry, the microblade core reduction results in a large quantity of very small and thin flake by-products.

The utilitarian industry produces larger artefacts with thicker flakes struck from the producer cores. The nuclear tools from this assemblage are "heavy duty" bifacial artefacts which are neither flakes nor the cores that produced them. They were resharpened on the site, producing bifacial debitage.

Since the earlier studies which have tried to establish a post-5,000 years ago chronological sequence for the Hunter Valley, Koettig has found a site at Glennies Creek with carbon dates of more than 10,000 years (sites SGCD15 and SGCD16), at the Glennies Creek Dam, thereby throwing some doubt on the assertion that sites in the Hunter Valley only post date 5,000 years ago. The dates of the site SGCD16 at 10,000 years, with the hearth date at 20,000 years ago suggests that Aboriginal occupation commenced as early as Late Pleistocene.

That site had been found 1 m below the ground surface within the solodized solonetz soil. The Aboriginal hearth had been found at the same depth, at foot of slope at SGCD16. Koettig had found that volcanic rock was more frequent in the Unit B layer at this site, and there were no backed blades, which places the site at earlier than Bondaian I, according to the Hiscock model.

Most generalisations found in reports about the Hunter Valley have been restrictive because most the surveys are sample-oriented rather than total surveys. Prior to 1984, 70% were sample surveys, after 1984 40% were sample and 60% total surveys. There has been a definite bias in sampling towards the valley floors and drainage lines, presumably because of the increased exposure and the perceived increased chance of finding sites by archaeological survey teams.

11.0 GEOMORPHOLOGICAL MODELS SINCE 1983

In response to the need for modelling in Hunter Valley archaeological interpretations, Dean-Jones and Mitchell prepared a study for National Parks and Wildlife Service which investigated the geophysical basis for the prediction of site location over the landscape. They examined the existing sources for geographical information and some of the assumptions about soil formation used by archaeologists. Although Dean-Jones and Mitchell looked at the Central Lowlands, some of their findings may be incorporated into any archaeological study for inland areas within the Hunter Valley.

For sources of stone artefact raw material other than outcrops, Dean-Jones and Mitchell viewed the river gravels as a possible source, but warned that the exposure of the gravels is greater now than 200 years ago, giving a misleading indication of raw material availability. She also warned that the duplex soils, which have been interpreted as two distinct time zones by archaeologists (referred to as Unit A - recent and Unit B -earlier), might have developed chemically, or in response to certain prevailing

climatic factors. The boundary between soil horizons does not therefore indicate a distinct transition between occupation levels.

Dean-Jones and Mitchell also discussed the value of exposures for sites location. It has been found that exposures caused by erosion and trails do increase the likelihood of finding sites and numbers of artefacts by a factor of 200 (Kohen 1985 cited in Dean-Jones and Mitchell 1992). This causes the bias towards sites found at drainage lines, or where there has been animal or human activity causing erosion.

Dean Jones and Mitchell concurred with previous studies (see also Hughes 1984) that occupation deposit has most often been found on drainage lines, however, consultants should not ignore the possibility that sites may be present on other landform units, for example, ridge lines and terraces.

12.0 LOCAL STUDIES

Figure 1 shows the archaeological sites that have been encountered in the general area.

In 1981, Dyall undertook a survey of the Saxonvale Mine to the southwest, which included sections of Loders Creek and the tributaries of Nine Mile Creek which are within the Bulga Authorisation area. He identified 49 axe grinding grooves (36-6-148), and an open site with over 100 artefacts. Another open site with a similar number of artefacts was recorded 800 m upstream on Loders Creek, and a third site with 50 artefacts (37-6-141) on a tributary of Loders Creek. At 37-6-141 Dyall found an edge ground axe.

To the north, Hughes and Silcox 1983 investigation of the Mount Thorley lease resulted in the identification of an open site (37-6-287) near the boundary on a tributary of Loders Creek at which 273 artefacts, mostly mudstone flakes with silcrete, igneous, and quartz flakes were examined in three sample areas. Altogether they found a total of 36 sites, all open camp sites, and 19 isolated finds. Half the sites contained less than 50 artefacts.

Excavation and surface collection were undertaken by Stern (1981) at an open site identified by Dyall (1981) on a tributary of Nine Mile Creek only 600 metres east of the present study area. This was the first of many detailed investigations which have been undertaken in the lower Hunter Valley.

In 1988, Brayshaw surveyed the north eastern corner of the Bulga Coal Lease and the full length of Nine Mile Creek and "a good sample of Loders Creek". Coverage included the western ridge tops and

hill slopes and a small section of the tributary of Wollombi Brook. The artefacts found at Nine Mile Creek did not reach the density found on Loders Creek. On Loders Creek artefacts were found at all exposures but there was a tendency for exposures, hence the number fo found artefacts, to decrease upstream. The artefacts were predominantly mudstone (71 per cent) and silcrete (26 per cent), and included modified flakes and cores, and a dressed hand axe. A scarred tree (Bulga 6) and axe griding grooves (NPWS 37-6-148a) were also located.

Rich 1991 has described a number of surveys which have been completed in the Warkworth/Wambo area as part of the archaeological context for her own survey along North Wambo Creek and Stoney Creek in the study area. She recorded 17 sites and two isolated finds along North Wambo Creek. Thick grass had obscured the sites previously recorded by Dyall in 1980 (described below). There was a possible scarred tree adjacent to Wollombi Brook. Three sites and 4 isolated finds were found along Stoney Creek. Most of the sites were open sites, the artefacts either eroding out of the A layer of the soil profile, or lying at the base of the profile as lag deposits. Eroding hearths had been recorded. The artefacts found included scrapers, geometric blades, bulga knives, pebble tools, a stone axe, backed blades. Her final recommendation for the future of the sites was for test excavations to be carried out at NPWS sites 37-5-30,-31,-32,-33 and the isolated find at North Wambo Creek.

Dyall was the first person to survey the northern part of the Wambo Coal Lease area in 1980, finding 7 sites along the tributaries of 20 - 50 flakes, bulga knives, backed blades and axe grinding grooves (NPWS sites 37-5-32,-31,-34,-136). The bulga knives are being questioned today as being naturally formed lenticular limestone cobbles and having no sign of working on them (Baker 1992). Dyall had also surveyed the United Collieries Coal Lease (coal tender area) along Redbank Creek at Warkworth in 1979, where he recorded 15 sites and 3 single isolated finds including 73 axe grinding grooves. Four sites consisted of large scatters of artefacts, one site (37-6-151) had 500 artefacts. Backed blades were seen at the large site (37-6-162). He reported a bulga knife as one of the isolated find sites.

In 1981 and during the following four years, Brayshaw conducted a number of surveys in the area on behalf of the Wambo mining company (1984), and for a proposed railway between Mt Thorley and Warkworth (1981). Brayshaw re-recorded the same sites (NPWS sites 37-6-135,-136) recorded by Dyall in 1980 and overlooking the Wollombi Brook. She found that the site was more extensive and possibly contained in situ deposit. During the 1984 survey, Brayshaw re-recorded a number of Dyall's sites and in addition recorded another three small sites. Brayshaw also conducted surveys on behalf of the Buchanan and Lemington mines, to the east of the Wambo mine, in 1982, 1983 and 1984.

Koettig and Hughes re-surveyed the United Collieries coal lease previously investigated by Dyall in 1979, leading to more detailed investigations of the Redbank Creek sites. Sixty four sites were recorded in total (NPWS sites including 37-5-77,-71,-324,-93,-94,-105,-108,-323,-86,-89,-94,-103,-107,-109,-110 and -327). They found artefacts located on nearly all ground exposures, with deposit continuing underneath the fringing ground cover. Most of the sites were small, having less than 30 artefacts however, eight sites had between 50 and 90 artefacts and 4 had more than 120 artefacts. Indurated mudstone was the predominating raw material for the stone tools, followed by "silcrete" with a small amount of chert, petrified wood, quartz and quartzite. There were few cores and only five per cent of the flakes had been modified into tools. At site 12 a knapping floor was systematically excavated. Hiscock analysed the technological characteristics of the assemblages from three sites (identification numbers 5, 12 and 13) which had been salvaged by Koettig and Hughes in 1984 and 1986.

In 1990 Corkill conducted a preliminary survey of the Wambo mining lease, at south Wambo. Creek lines were surveyed as were hill slopes and flood plain areas of South Wambo Creek and Stoney Creeks. Six archaeological sites and 9 isolated artefacts were found during the survey, most consisting of less than 30 artefacts. The artefacts were manufactured from indurated mudstone, silcrete and quartz, in order of frequency. Test excavations at Stoney Creek and the Harris House sites revealed that the sites were more extensive than previously thought, and the several hundred artefacts included backed blades, scrapers and a variety of flakes. Corkill also addressed the issue of mine subsidence effects on sites, not previously discussed in the other reports.

Rich summarised the nature of artefacts and sites in the Wambo mine area as being predominantly small scatters of indurated mudstone with smaller quantities of silcrete. She described the scatters at North and South Wambo Creeks as being "rather amorphous assemblages" of flaked artefacts. She stated an idea that the artefact variety increases towards the Hunter River, as demonstrated by the Redbank Creek assemblages

13.0 SITE PREDICTION AND SURVIVAL

Based on what is known about the sites in the Hunter Valley and in the lease vicinity, it could be predicted that sites, should they exist, would be open artefact scatters located near drainage lines, scarred mature trees, or axe grinding grooves on sandstone platforms on or near running creeks. There is also a possibility that sites will be located at the crest of a ridge, near a reliable source of water.

On the basis of the soil formation, geology, amount of erosion, and human and/or animal landscape modification the consultant does not anticipate that site integrity would be particularly good for most areas over the Rixs Creek lease. However, recent studies in analogous areas of the Hunter Valley have shown that despite initial assessments of low significance further archaeological work based on sub-surface testing, has determined that rich archaeological sites nay still occur in these areas. Therefore the southern portion of the lease to be mined should be left, until such time as it can be re-surveyed for archaeological sites. The sites there may still be intact, as the density of pasture grass suggested that the paddocks had not been used by stock for quite some time.

At the crest of ridges, sites had been exposed through sheet erosion which drained to the waterways in the Rixs Creek valley below. However inspection of the surrounding area supported the first impression that the area has a low archaeological potential.

Elsewhere on the property, the soils have not been well developed and there was no indication of a good source of raw material for stone manufacture other than the cobbles from creek beds.

The site register printout from NPWS for the general area has been placed in Appendix 3, and the sites marked on Figure 1.

14.0 RESULTS

14.1 SURVEY STRATEGY

Figure 2 depicts the survey coverage for the project. The 700 ha proposed mining extension had been sampled for archaeological potential by the survey teams on 20 April 1994 (Sue Effenberger, Warwick Pearson, Barry French) and 21 April (Sue Effenberger, Barry French) according to the following scheme:

i. The sites originally identified by Brayshaw in the 1981 report were relocated for re-assessment.

ii. Any large eroded area, which had been encountered during the survey was inspected for sites. 80% to 100% visibility.

iii. Two transects had been walked over the grassy hill slope between Rixs Creek and site GRANBALONG 6 (18:37-6-252). 20% to 40% visibility.

iv. Transects had been made through the pasture grass by four wheel drive vehicle to inspect creek lines, dams and exposures for archaeological sites. 20% to 40% visibility.

v. Creek lines at the vicinity of previously identified sites (Brayshaw 1981) had been inspected. 0% to 10% visibility, 100% visibility at tracks and exposures.

vi. The main track through the property had been inspected. 100% visibility.

The land units of the study area: ridge, slope and creek line had been effectively covered in the survey for both cleared and woodland areas. The ridge had been covered in i, ii and iv, the slope had been covered in i., ii. and iv., and the creek line in i. and v.. Inspection of exposures in ii. and v. would have provided additional coverage.

Therefore the coverage had been adequate in the consideration of the original brief to assess the sites previously identified by *"Dr Brayshaw in the new lease area, as they may now require a "Consent to Destroy" application"* (letter from NPWS to Envirosciences.

14.2 SITES DESCRIPTION

The following sites had been recorded during the survey on 20 and 21 April 1994. "AMG", "AHD" and "SSM" are abbreviations for Australian Map Grid, Australian Height Datum and State Survey Mark respectively. Appendix 4 contains the site cards for the archaeological sites.

GRANBALONG 1 AMG 32306E 639976 N Singleton 1:25,000 map

Open camp site, 5 chert flakes, 1 silcrete flaked piece, 3 quartzite flakes, 1 igneous/pebble hammer dressed axe/blank, 1 indurated mudstone flake, *11 total.* Microblade workshop, small flake products, multi-faceted platforms, mostly 0% cortex.

The site may be approached via a vehicle track, opposite Middle Falbrook Road, in *"Granbalong"*, owned by Mrs Wendy Bowman. The track leads to the first hill of a ridge, of 120 m AHD. Approximately 100 m from the crest on the saddle, is a scatter of artefacts which have either washed down the vehicle track, or the slope of the hill towards the tributary (of Rixs Creek).

This site was not likely to have been recorded previously, having been exposed through sheet erosion from the ridge. The visibility at the site was 60-80%. The site was located approximately 150 m, south east of the creek and appeared to be the most dense of the sites in the area. The scatter covered 40 m by 50 m, which is 1 artefact per 182 m^2. SIGNIFICANCE: LOW ARCHAEOLOGICAL, ABORIGINAL.

GRANBALONG 2 AMG 32303E 639988N Singleton 1:25,000 map

Open camp site, 6 chert flakes, 1 silcrete flake, 1 quartz flake, 1 igneous/pebble tool, *9 total.* Utilitarian technology, thicker flakes, scalar retouch of flakes.

The site may be approached via a vehicle track, opposite Middle Falbrook Road, in *"Granbalong"*, owned by Mrs Wendy Bowman. The track leads to the first hill of a ridge, of 120 m AHD. Half way up the hill, the site is located around a small dam that has been created by blocking the creek. This site had originally been recorded as "17" by Brayshaw in 1981.

The artefacts have eroded from the bank around the dam. There are also 4 artefacts which are located to the north west of the dam batter. The main disturbance to the area would be

from grazing cattle and gully/rill erosion, which would be frequent in heavy rains. Hence the visibility at the dam is good (80% to 100%). The whole site (including dam) covered an area of 100 m by 80 m, which is a density of 1 artefact per 888 m^2. SIGNIFICANCE: LOW ARCHAEOLOGICAL, ABORIGINAL

GRANBALONG 3 AMG 32322E 640024N Singleton 1:25,000 map

Isolated find, 1 chert flake

Previously 37-6-251 (NPWS) and Site 17 (Brayshaw 1981). The artefact had been located 120 m away from GRANBALONG 2, and was located 20 m higher than the creek line, in an exposure created by sheet erosion, from the last heavy rainfall. The visibility was good at 50% to 60%.

GRANBALONG 4 AMG 32338E 640024N Singleton 1:25,000 map

Open camp site, 3 chert artefacts

The site may be approached via a vehicle track, opposite Middle Falbrook Road, in *"Granbalong"*, owned by Mrs Wendy Bowman. The track leads to the first hill of a ridge, of 120 m AHD. The artefacts were located on the southern bank of the dam, with a visibility of 100%. There has been considerable disturbance around the dam from construction and from stock watering. SIGNIFICANCE: LOW ARCHAEOLOGICAL, ABORIGINAL

GRANBALONG 5 AMG 32344E 639990N Singleton 1:25,000 map

Open camp site, 9 indurated mudstone flakes, 1 indurated mudstone core, 4 chert flakes, 4 silcrete flakes, *18 total*. Microblade workshop (possibly related to GRANBALONG 1), optimal platform preparation of cores, small flake products.

This site may be approached via a vehicle track, opposite Middle Falbrook Road, in *"Granbalong"*, owned by Mrs Wendy Bowman. The track leads to the first hill of a ridge, of 120 m AHD. At the saddle of the ridge, near GRANBALONG 1, the site can be located by walking south east from the vehicle track. Alternativey, the site is at the head of the gully that feeds the dam at GRANBALONG 6, at the south western end of the main vehicle track.

As a result, the visibility is good at 80% to 100%. The artefacts are scattered around a large bulldozed and eroded area. Therefore, it not expected that the site stability would be very high. The scatter covers an area of approximately 10 m by 50 m, which is a density of 1 artefact per 28 m^2. SIGNIFICANCE : LOW ARCHAEOLOGICAL, ABORIGINAL

GRANBALONG 6 AMG 32358E 639958N Singleton 1:25,000 map

Open camp site, approximately 15 artefacts of indurated mudstone, silcrete and quartz. Microblade workshop with optimal use of core platforms, small flake products, wide range of raw material, creek-sourced.

Previously 37-6-252 (NPWS), Site 18 (Brayshaw 1981). A detailed recording of the artefacts on the site had not been attempted due to time constraints. The site may be approached along a vehicle track from the main gate of the property owned by Mrs Wendy Bowman, named *"Granbalong"*. To locate the site, continue south east along the vehicle track past the two homesteads, to a dried creek bed. This site had originally recorded as "18" by Brayshaw in 1981.

The site is very degraded, as the banks have been bulldozed, presumably to construct/maintain the dam at its northern end. The site visibility is 80% to 100%. The area covered by the artefacts is approximately 80 m by 20 m, which is approximately 1 artefact per 106 m^2. SIGNIFICANCE: LOW ARCHAEOLOGICAL, ABORIGINAL.

RIXS CREEK 1 AMG 32322E 639814N Singleton 1:25,000 map

Open camp site, 22 indurated mudstone flakes, 4 silcrete flakes, 2 chert flakes, 2 quartz flakes, *30 total*. 2 *in situ* artefacts, 1 blade core, 1 elouera (incomplete), 2 nuclear tools, 1 flake tool.

Appears to be a combination of microblade and utilitarian strategies, as there are elouera blanks and a number of nuclear-type tools with scalar retouch. Tool workshop.
This site may be approached south west along the northern bank of Rixs Creek. On the map the tributary is the second one after New England Highway. The property, named *"Granbalong"*, is owned by Mrs Wendy Bowman. The site is on the eastern bank of the tributary, approximately 250 m from its junction with Rixs Creek, at a wide sandstone platform.

The artefacts have been exposed on the sandstone platform amongst the conglomerate gravel. Most of the artefacts have eroded out of the creek bank, but two remain *in situ*. There is a grassed and shaded glade area immediately to the south of the exposure, where no artefacts were visible. The sandstone platforms were inspected for axe grinding grooves, but none were located, presumably because the surface of the sandstone was too hard and rough to be suitable for honing, or axes were not made, there being an absence of suitably large pebbles. The manufacture of stone tools appears to have extended some 80 m around the western creek bank, and no artefacts had been seen on the eastern creek bank.

The erosion is extensive through gully and rill erosion, however the banks are relatively well protected from stock.
The visibility, as a result is good at 80% to 100%. The area covered by the artefacts is 80 m by 20 m, which is approximately 1 artefact per 53 m^2. SIGNIFICANCE: HIGH ARCHAEOLOGICAL, ABORIGINAL.

RIXS CREEK 2 AMG 32314E 639828N Singleton 1:25,000 map

Open camp site, approximately 15 flakes, including indurated mudstone and silcrete, with a small amount of quartz. Related to RIXS CREEK 1, and most likely represents a microblade workshop.
This site may be approached south west along the northern bank of Rixs Creek. On the map the tributary is the second one after New England Highway. The property, named *"Granbalong"*, is owned by Mrs Wendy Bowman. The site is 200 m north west of RIXS CREEK 1, on the opposite side of the creek at a bend in the creek.

The site consists of two flake scatters, one of which is around a large ants nest. The site appears to be relatively stable, and has not been subjected to extensive erosion. The site is approximately 5 m from the creek line, and covers an area of 20 m by 10 m. This is a density of 1 artefact per 13 m^2. The visibility was reasonably good at 60% to 80%. SIGNIFICANCE: HIGH ARCHAEOLOGICAL, ABORIGINAL.

The artefacts described above suggest that the sites themselves were the location of stone tool manufacture and maintenance. There is some evidence of microblade technology, as blade cores and microdebitage had been found in GRANBALONG 1 and 5 and RIXS CREEK 1 and 2. The technology appears to be raw material-driven and the proportions of indurated mudstone to silcrete does lend some support to Brayshaw's findings about the use of raw material.

In addition to the microblade tools, there appears to be a proportion of tools within the "utilitarian" category of flake and core tools, concurrent with the microblade tools at the RIXS CREEK sites, illustrated by the nature of the retouch (scalar) and the size of the bifacial artefacts which appear to be neither flakes nor cores.

15.0 CONCLUSION

The chronological sequences proposed by Mulvaney and Lambert, first used in the Brayshaw 1981 study and the later modified sequence which appeared later in the 1984 Hiscock study have posed some difficulties for archaeological consultants in the Hunter Valley. Added to the confusion of the Bondaian chronologies, is the notion that quartz technology had been introduced into some sequences of the southern tablelands of the state as late as 1,000 years ago. The earlier Brayshaw study should be seen in the light of the changing models and analysis strategies for consultants.

The technologically based, rather than the qualitative chronology studies represented by earlier attempts, have greater favour in the current consultant reports. Therefore, use of reductionist approaches to describe the stone tool technology represented on sites can be used more effectively. These approaches may be found in the Baker and Witter studies.

In view of the most recent studies, the sites found in the proposed Rixs Creek coal mine extension would fall into a number of different categories, as found in the descriptions above. The predominating site type is the microblade workshop, which had been found at a ridge (GRANBALONG 1 and 5) and near Rixs Creek (RIXS CREEK 1 and 2). Somewhere in between a utilitarian strategy developed, evidenced by the larger, more opportunistic reduction strategies.

The microblade workshops demonstrated a more permanent encampment, with the available raw materials (mostly indurated mudstone, followed by silcrete then quartz) coming from the creek beds. The utilitarian strategies would have been associated with a more transient use of the creeks and plains, perhaps for hunting or food processing. The *in situ* material at RIXS CREEK 1 does not necessarily prove a Bondaian age for the site as suggested by previous consultant reports, although the artefacts occur less than 1 m below the surface in the Unit A horizon. The division of Unit A and B is arbitrary in terms of the chronology. Rather, the transition between soil horizons has resulted from pedological processess. Therefore, no date may be confidently assigned to the sites.

Of importance to the categorisation and significance of the sites is the amount of erosion that has occurred in the area, since the first Brayshaw report. The erosion has exposed more artefacts and has concealed others. For this reason, the original Brayshaw site 10:37-6-244 could not be relocated, however new ones were found closer to Rixs Creek and over the GRANBALONG ridge.

The erosion and land modification in and around the sites described as GRANBALONG 1, 4, 5 and 6 has been considerable. There has been an amount of bulldozer activity in the area for the

construction of dams (at GRANBALONG 4, 5 and 6) and vehicular disturbance of GRANBALONG 1. Erosion through natural processes and watering stock at the dams has also undermined the integrity of the sites.

Notwithstanding the considerable disturbance of the GRANBALONG sites, the integrity of sites at the southern end of lease at RIXS CREEK 1 and 2, appears to be good. This is likely to be because stock have not been using the paddocks for quite some time, judging by the density of the pasture grass. As Brayshaw site 10:37-6-244 could not be located, it may have been grassed-over in time or have washed away in heavy rainfall.

16.0 SIGNIFICANCE ASSESSMENT

Significance is not a quantity that is easy to define. It differs from person to person according to their cultural and educational perspective. This perspective will add bias to a decision about significance which has been based on current research and debate. However, the wide acceptance of the principles of significance outlined by the Australia International Council on Monuments and Sites (ICOMOS) Burra Charter 1979 has attempted to avoid bias by providing a firm guideline (not law) for cultural significance assessment. The ICOMOS definition of cultural significance is,

> *"the concept which helps in estimating the value of places. The places that are likely to be of significance are those which help an understanding of the past or enrich the present, and which will be of value to future generations."* (ICOMOS 1988)

The Burra Charter refers most closely to historic and architectural features and the term "cultural significance" embraces aesthetic, historic, scientific and social value for past, present or future generations. Practitioners in the field of Aboriginal archaeology have redefined appropriate criteria for assessment of Aboriginal site significance.

In principle, significance should be established in two parts, first by the assessment of significance through research and accurate documentation and second by a statement of significance.

The Aboriginal significance is assessed by Aborigines as a community or through the Local Aboriginal Land Council. This assessment can only be determined by adequate consultation with Aborigines. In some cases, it may be applicable to consult an individual vested with authority in the community to make a judgement on behalf of the community, for example an Aboriginal elder.

The sites which have been badly degraded have little Aboriginal significance. They include GRANBALONG 1-6 sites. They have been bulldozed for dam construction and the artefacts original context has been undermined. While the artefacts themselves have some interest as comprising a microblade workshop, better examples exist elsewhere in the Hunter Valley. The Wanaruah Local Aboriginal Land Council should apply to NPWS to collect the artefacts for an educational collection if the Land Council wishes.

The RIXS CREEKS 1 and 2 sites, however, have a high Aboriginal significance, because the area in which they exist is relatively undisturbed, and has some potential for further study.

The scientific significance is often referred to as the archaeological significance. Most significance classifications in archaeological reports fall into this category. The scientific significance is the concern of archaeologists working in the field and theoreticians in terms of the aims, interests, problems and debates of the profession as a whole. The strength of the scientific significance will depend on the rarity, representativeness and quality of the data. It is most certainly strengthened by the presence of *in situ* material. Scientific significance may lead to the long term preservation of a site, or it may result in the destruction of the site through collecting and excavation of artefacts for scientific purposes.

The GRANBALONG 1-6 sites have a low archaeological or scientific significance because of the disturbed nature of the context, thereby ruling out the possibility of spatial studies. The artefacts themselves exhibit the characteristics of a microblade workshop (especially 1, 5 and 6), with platform preparation of cores and the retouch of flakes with specialised techniques. There is some evidence of a utilitarian industry for the more transient encampments (2-4). Because the artefacts may have moderate significance, the Wanaruah Local Aboriginal Land Council could benefit by collecting them.

The RIXS CREEK 1,2 sites have in situ *material and as such exhibit a high scientific significance. They also have a combination of microblade and utilitarian industries. Therefore they should be left undisturbed until such time as the whole area (southern extension) be re-surveyed. This will protect the as yet unlocated 10:37-6-244. An analysis of the artefacts in context would reveal information about the manufacture of utilitarian flakes, and quartz technologies.*

The dating of the profile based on the artefacts alone would be spurious, as the debate continues about the nature of stone tool chronologies in the Hunter Valley, whether Bondaian technologies existed concurrently with the Pre-Bondaian or utilitarian industries.

The assessment of historical significance results from the culmination of historical, and documentary research which ties a relic or place into historical themes, and regional or individual histories. A place may have an historic value if it has been associated with an historic figure, event, phase or activity or the local community assigns some level of historic importance.

There is no relic nor site of historic significance.

The archaeological features of the study area do not have aesthetic, nor public/social significance.

Some educational benefit may be gained from the artefacts themselves if Wanaruah Local Aboriginal Land Council wishes to collect them systematically for an educational collection.

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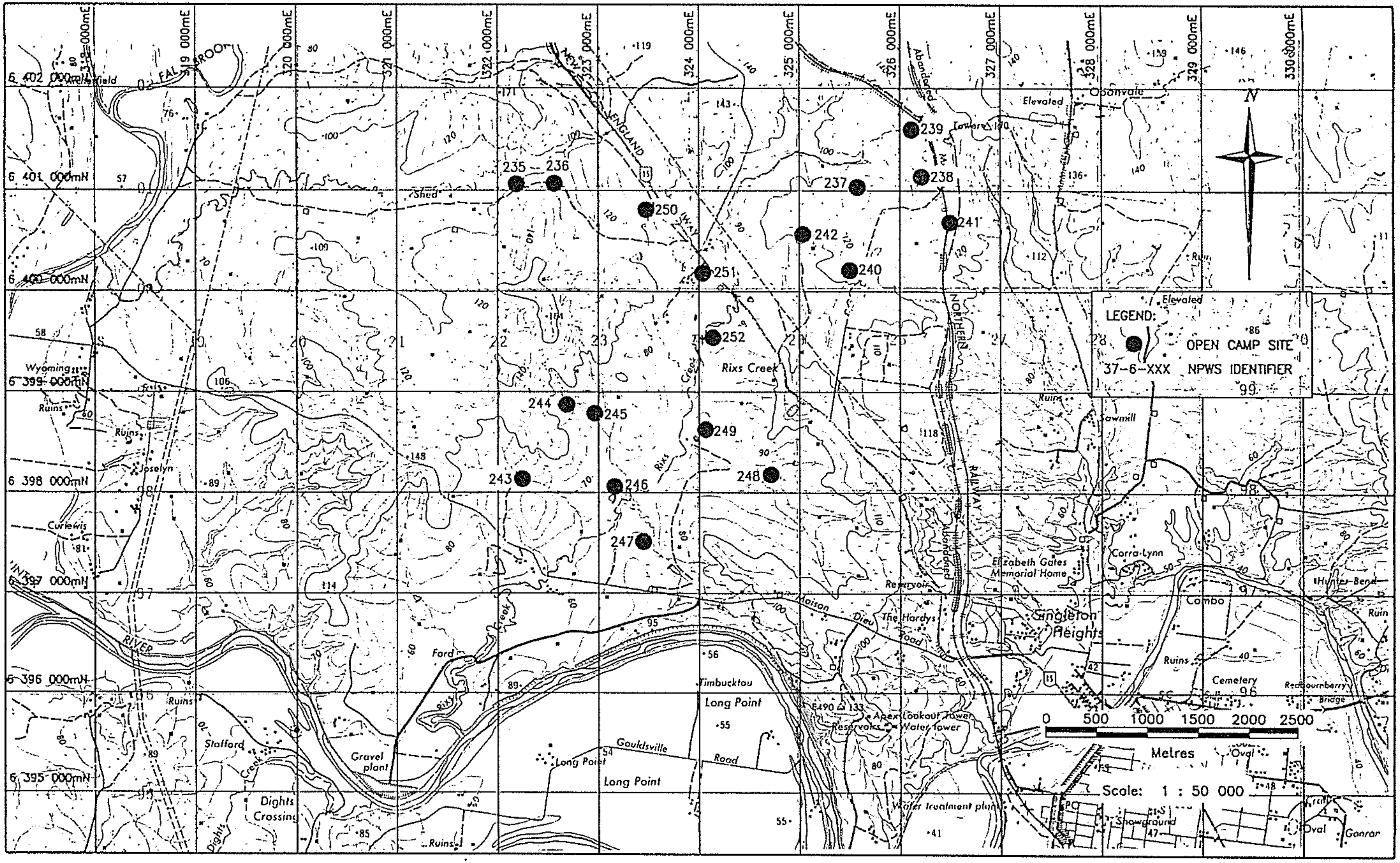

ENVIROSCIENCES PTY LIMITED
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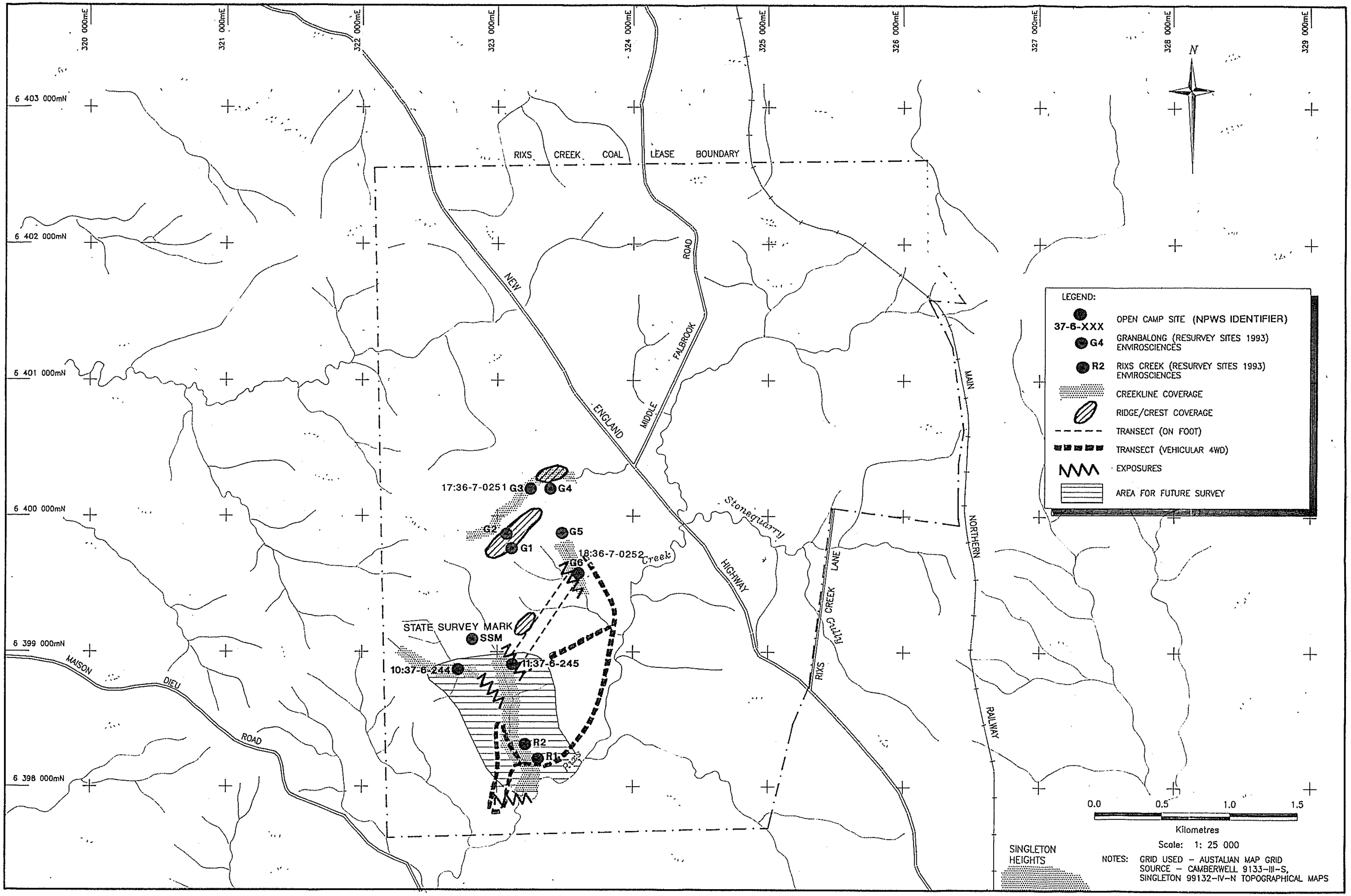
LOCATION OF STUDY AREA
NPWS SITES

FIG. 1



ENVIROSCIENCES PTY LIMITED

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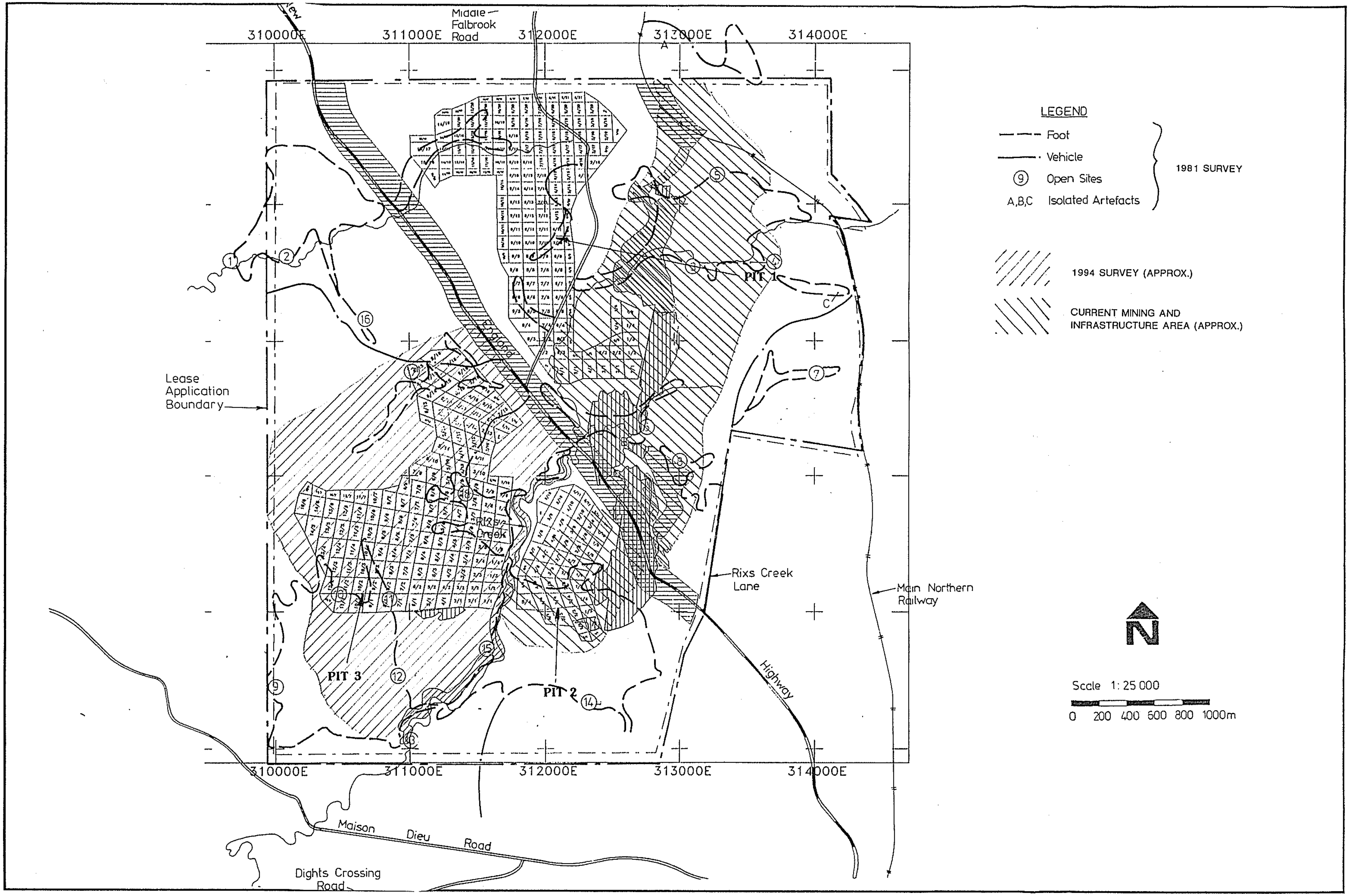
RIXS CREEK EXTENSION SURVEY COVERAGE
ARCHAEOLOGICAL SITES

FIG. 2



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RIXS CREEK LEASE
ARCHAEOLOGICAL SURVEY BOUNDARIES

FIG. 3

APPENDIX 8:

SOIL REPORTS

STUDY 3

PROPERTIES OF SOILS

S3.1 INTRODUCTION

A soil survey was conducted on the Lease Application Area and the soil types were identified and mapped.

Soils were exposed in excavated pits, the profiles were classified using the Northcote Factual Key (Northcote, 1979) and important horizons were sampled for laboratory physical and chemical testing and analysis. The results of the soil surveys and other geomorphological information were used to prepare a land capability plan of the site.

Field and laboratory soils data were used to assess the thickness and suitability of the soils on the site for conservation and for use as a topdressing material in rehabilitation after mining.

S3.2 DESCRIPTION OF SOIL TYPES

S3.2.1 Distribution

The podzolic or solonetzic soils which are quite common within the Hunter Valley away from the alluvial areas are well represented on the Lease Application Area. The properties of these soil groups have been investigated by Van de Graaf (1963) who described the profiles as being characterised by abrupt texture changes between horizons and the soil types as being highly dispersable, erodible and having low fertility.

According to the Northcote Key, the textural character of the Primary Profile Form of these soils is duplex. The red and yellow duplex soils, which are the predominant types in the area, are dominated by a mineral fraction and have a texture contrast of 1 to 1.5 texture groups or greater between the A and B horizons. This change in texture between horizons commonly occurs over a vertical interval of about 10 cm.

Uniform soils characterised by small to negligible textural differences throughout the soil profile are also found on small areas of the site.

The distribution of the three main soil types is shown in Figure 9. The soil type boundaries indicate areas of gradual change from one type to another over lateral distances of up to 100 m.

The duplex soils display minor variations due to topography, slope and drainage. The texture contrasts between the A and B horizon were observed to vary from clayey sand to fine sandy clay loam, clayey sand to clay loam, fine sandy clay loam to medium/heavy clay and sandy loam to medium clay.

As a general rule, the red and yellow duplex soils are found in toposequence. The yellow soils occur in areas of poor drainage on lower slopes and drain lines and the red soils on the higher slopes and ridge tops. The red soils are generally more stable with respect to soil conservation structures and cultivation, although at certain locations where shallow profiles occur, the thin A horizons may be underlain by dispersable medium to heavy clays.

Yellow duplex soils predominate along Rixs Creek in the central part of the area. These soils may contain some organic material in their horizons in the form of weathered coal products. While fluvial processes are evident along the floodplain, sufficient horizon development exists to characterise these soils as duplex. In fact, much of the significant erosion within the area is due to the duplex nature of these soils. The sharp texture change down the profile results in poor water infiltration and drainage making the soils highly susceptible to erosion when disturbed or poorly managed.

Gully erosion, rilling and tunnelling are evident along Rixs Creek and other watercourses. Areas of sheet erosion resulting in the loss of topsoil also occur, particularly on steeper midslope positions which collect runoff from higher ground.

The uniform coarse soils occupy small areas of the Lease Application Area. The medium to coarse gravels which occur at two locations form the bulk of the soil material throughout the profile. These locations on prominent ridgetops have little agricultural value and no worth for rehabilitation works. A quarry operating in one of these areas adjacent to the New England Highway is supplying road base for construction works nearby.

Underground coal mining and coking operations carried out intermittently at Rixs Creek from 1875 until 1948 have disturbed parts of the area. These areas remain in a derelict and unrehabilitated state.

Details of the soil profiles mapped in the Rixs Creek soil survey are described below.

S3.2.2 Yellow Duplex Soils

Distribution : This soil is the most common in the Lease Application Area occupying approximately 85 per cent of the area. It is associated with the flatter areas and middle and lower slope positions and occurs along most of the drain lines. Where badly eroded sections occur, the A horizons have been completely removed exposing the highly dispersable clays of the B horizon.

Morphology : The A_1 horizon at the majority of locations is composed of dark brown clay loam or sandy clay loam to a depth of 15 cm. This soil sets hard when dry and grades either sharply or gradually into a grey or light brown A_2 horizon, which rarely exceeds 10 cm. The A_2 horizon is commonly present as a bleached horizon in the yellow duplex soils, although its thickness may vary.

The B horizon shows a marked increase in clay content, usually from a depth of 25 cm. The medium clays vary in colour from bright yellow to a mottled yellowish brown depending on local drainage conditions. They have a hard consistence when dry and are highly dispersable. The distinct texture contrast between the A and B horizons and the low permeability of the clay contributes to the high erosion potential of these soils.

S3.2.3 Red Duplex Soils

Distribution : This soil occupies approximately 12 per cent of the Lease Application Area. It is commonly associated with the better drained upper slopes and ridge crests. The thickness varies greatly between sites according to variations in topography and parent material.

Morphology : The brown or chocolate brown A_1 horizon may vary in thickness between sites. Near site 3, the A_1 horizon is less than 10 cm while near site 5

(refer to Figure 9), a deeper A_1 horizon of up to 20 cm may be observed. The texture is dominantly of clay loam. At some sites the A_2 horizon is absent while at more downslope situations, a lighter A_2 horizon of 10 cm thickness may be present. The red duplex soil is normally more friable and better drained than the extensive yellow duplex soils, however, the soil thicknesses are quite variable across the site.

The B horizons are typically a red to red-brown medium to heavy clay of massive structure. The colour appears to intensify with increasing depth. Little evidence of mottling is seen in the B horizon. The red duplex soils are also susceptible to erosion on these areas in comparison with the yellow duplex soils.

Photographs of typical red and yellow duplex soil profiles encountered within the area are contained in Appendix S3.1.

S3.3 LAND CAPABILITY

Figure 13 shows the land capability plan prepared for the Lease Application Area. The plan is at a scale of 1:25,000 and is based upon broader scale maps prepared by the Soil Conservation Service (Cessnock 1:100,000) and studies of soil type, topography, climate and geomorphology on the site. Criteria used in the land capability classification shown in Table S3.1 closely followed those specified by the Soil Conservation Service (1984) and Hunt, et al (1982).

Most of the Lease Application area is Class IV and Class V land with smaller areas of Class II and Class VI land.

Lands in Classes IV and V are suitable for grazing. They are not suited for cultivation on a regular basis because of limitations of slope, shallowness, rockiness and erosion potential of the soils, and climate. Major structural soil conservation works are required for land in these classes.

The small area of Class II land occurs along the Rixs Creek floodplain at the southern boundary of the Lease Application Area. Table S3.1 indicates that this land is suitable for regular cultivation.

TABLE S3.1

LAND CAPABILITY

LAND CLASSIFICATION AND SOIL CONSERVATION PRACTICES				INTERPRETATIONS AND IMPLICATIONS
SUITABLE FOR REGULAR CULTIVATION		I	No special soil conservation works or practices	Land suitable for a wide variety of uses. Where soils are fertile, this is land with the highest potential for agriculture and may be cultivated for vegetable and fruit production, cereal and other grain crops, energy crops, fodder and forage crops and sugar cane in specific areas. Includes "prime agricultural land".
		II	Soil conservation practices such as strip cropping, conservation tillage and adequate crop rotation.	Usually gently sloping land suitable for a wide variety of agricultural uses. Has a high potential for production of crops on fertile soils similar to Class I, but increasing limitations to production due to site conditions. Includes "prime agricultural land".
		III	Structural soil conservation works such as graded banks, waterways and diversion banks, together with soil conservation practices such as conservation tillage and adequate crop rotation.	Sloping land suitable for cropping on a rotational basis. Generally used for the production of the same type of crops as listed for Class I, although productivity will vary depending upon soil fertility. Individual yields may be the same as for Classes I and II, but increasing restrictions due to the erosion hazard will reduce the total yield over time. Soil erosion problems are often severe. Generally fair to good agricultural land.
SUITABLE FOR GRAZING	Occasional Cultivation	IV	Soil conservation practices such as pasture improvement, stock control application of fertilizer and minimal cultivation for the establishment or re-establishment of permanent pasture.	Land not suitable for cultivation on a regular basis owing to limitations of slope, gradient, soil erosion, shallowness or rockiness, climate, or a combination of these factors. Comprises the better classes of grazing land of the State and can be cultivated for an occasional crop, particularly of a fodder crop, or for pasture renewal. Not suited to the range of agricultural uses listed for Classes I to III. If used for "hobby farms", adequate provision should be made for water supply, effluent disposal and selection of safe building sites and access roads.
		V	Structural soil conservation works such as absorption banks, diversion banks and contour ripping, together with the practices as in Class IV.	Land not suitable for cultivation on a regular basis owing to considerable limitations of slope gradient, soil erosion, shallowness or rockiness, climate, or a combination of these factors. Soil erosion problems are often severe. Production is generally lower than for grazing lands in Class IV. Can be cultivated for an occasional crop, particularly a fodder crop or for pasture renewal. Not suited to the range of agricultural uses listed for Classes I to III. If used for "hobby farms" adequate provision should be made for water supply, effluent disposal, and selection of safe building sites and access roads.
	No Cultivation	VI	Soil conservation practices including limitation of stock, broadcasting of seed and fertilizer, prevention of fire and destruction of vermin. May include some isolated structural works.	Steep grazing land. Productivity will vary due to soil depth and soil fertility. Comprises the less productive grazing lands. If used for "hobby farms", adequate provision should be made for water supply, effluent disposal, and selection of safe building sites and access roads.
OTHER		VII	Land best protected by green timber.	Generally comprises areas of steep slopes, shallow soils and/or rock outcrop. Adequate ground protection must be maintained by limiting grazing and minimising damage by fire. Destruction of trees is not generally recommended, but partial clearing for grazing purposes under strict management controls can be practised on small areas of low erosion hazard. Where clearing of these lands has occurred in the past, unstable soil and terrain sites should be returned to timber cover.
		VIII	Cliffs, lakes or swamps and other lands unsuitable for agricultural and pastoral production.	Land unusable for agricultural or pastoral uses. Recommended uses are those compatible with the preservation of the natural vegetation, namely; water supply catchments, wildlife refuges, national and state parks, and scenic areas.
		U	Urban areas	
		M	Mining and quarrying areas	

CLASS SUBSCRIPTS	SPECIAL USES
c	Terrain developed for a specific crop (capability class range IV to VII) as a result of the combination of particular soil, terrain, climatic and economic conditions. The class includes such crops as grapes, bananas, avocados and pineapples.
d	Terrain developed for intensive agricultural production and associated with flood irrigation. The class includes land developed for cotton and rice production.

Lands within the Class VI classification occur on the steeper slopes towards the western boundary of the area. These areas are classified as less productive grazing lands and are not suitable for cultivation on any basis.

Figure 3 shows the proposed mining limits and associated surface facilities within the Lease Application Area. Mining would be undertaken on Class IV and Class V lands and the surface facilities would be constructed on Class V land. The areas of quality Class II land will not be disturbed by the project.

S3.4 SOIL COMPOSITION

Samples of A and B horizon soils were collected from the seven sites on the Authorisation shown in Figure 9. The locations and samples were chosen as being representative of the principal soil types.

The samples were subjected to a range of physical and chemical tests to verify predictions of behaviour based on field observations and to assess the suitability of the soil types for recovery and use as topdressing materials.

The methods of sampling and analyses employed were generally in accordance with the requirements for the assessment of soil and overburden at proposed mine sites preferred by several Government Departments (Anonymous, 1984) and suggested by Hannan (1984).

Much of the B horizon material was identified in the field to be physically unsuitable for use in topdressing rehabilitated areas and detailed chemical analyses were mainly undertaken on selected A horizon samples (Samples 1, 2, 3 and 5). Tests included pH, electrical conductivity, organic matter content, available phosphorus, total nitrogen, exchangeable cations, iron, manganese, aluminium (for pH <5.0) and the determination of a range of minor elements considered to be essential plant elements. Physical tests included particle size analysis, Emerson crumb test and dispersability.

The limited testing undertaken on soils from the B horizon at the four sampling sites involved determinations for pH, electrical conductivity, total nitrogen, soluble phosphorus, particle size analysis, Emerson crumb test and

dispersability. pH and electrical conductivity were determined on samples from the A and B horizons from the remaining sites.

S3.4.1 Methods

Appendix S3.2 provides descriptions of the methods used in soil testing.

S3.4.2 Results

Physical Testing

The results of the physical testing of the samples from sites 1, 2, 3 and 5 are presented in Table S3.2. The criteria used in the interpretation of the results are:-

Particle Size Analysis (%) - this test determines the proportion of clay, silt, fine sand and coarse sand sized particles in a sample. The values, expressed as a percentage of the total sample, give an indication of stability.

Texture Grade - this descriptive term relates to the grades of soil texture outlined in the Northcote Factual Key (1979).

Dispersability (%) - this quantitative test indicates how much of a sample will disperse. The values can be interpreted as follows:

- >67% - severely erodible, unstable
- 37%-67% - moderately erodible
- 17%-37% - slightly erodible
- <17% - stable.

Surface sealing in a soil is considered to occur with a dispersability value greater than 67%.

Emerson Crumb Test (ECT) - this test is basically a classification of soil aggregates based upon their coherence in water. The interaction in water of clay-sized particles in aggregates may largely determine the structural stability of a soil (Charman, 1978). The ECT is a simple physical test for dividing aggregates into eight main classes:-

Class 1 - very dispersable soils with a high tunnelling susceptibility.

Class 2 - moderately dispersable soils with some degree of tunnelling susceptibility.

Class 3 - slightly or non-dispersable soils which are

TABLE S3.2

PHYSICAL TEST RESULTS FOR BLOOMFIELD AUTHORISATION SOIL SAMPLES

Sample Site	Horizon	Depth (cm)	Particle Size Analysis % Coarse Sand	% Fine Sand	% Silt	% Clay	Texture Grade	Dispersability (%)	ECT
1	A	0-25*	8.9	54.0	27.8	9.3	Fine sandy loam (FSL)	40.9	2
	B	25+	4.4	30.8	20.1	44.7	Medium clay (MC)	87.8	1
2	A	0-20	4.5	54.5	25.4	15.6	Fine sandy loam (FSL)	19.4	8
	B	20+	14.8	49.8	19.0	16.4	Fine sandy clay loam (FSCL)	16.1	3
3	A	0-10	19.8	51.4	17.4	11.4	Fine sandy loam (FSL)	10.4	8
	B	10+	1.4	27.9	19.1	51.6	Heavy clay (HC)	31.8	2
5	A	0-30*	55.0	23.9	12.0	9.1	Sandy loam (SL)	24.3	2
	B	30+	43.1	17.5	23.2	16.2	Sandy clay loam (SCL)	73.2	2

*A_2 horizon present.

generally stable and suitable for soil conservation earthworks.

Classes 4-6- more highly aggregated materials which are less likely to hold water. Special compactive efforts are required in the construction of earthworks.

Classes 7-8- highly aggregated materials exhibiting low dispersion characteristics.

Chemical Testing

The results of the chemical testing of the soil samples are provided in Table S3.3 and were interpreted on the basis of the following criteria:-

pH - pH is a measure of acidity and alkalinity. For 1:5 soil:water suspensions, soil samples having pH values below 4.5 are regarded as strongly acidic, 4.5 to 5.0 moderately acidic, 5.0 to 7.0 slightly acidic and greater than 7.0 alkaline. The pH range of most soils is between 4.0 and 8.5.

Electrical Conductivity - EC is a measure of salinity. For a 1:5 suspension, the effects of various levels can be seen in the following table:

0 to 0.15 (mS/cm)	- negligible effect on plants
0.15 to 0.30	- yield of very salt sensitive plants restricted
0.30 to 1.0	- only salt tolerant plants yield satisfactorily
1.0	- only a few salt tolerant plants yield satisfactorily

Most published data refers to the electrical conductivity of the saturation extract (EC_e). As the laboratory procedure for obtaining the saturated extract is time consuming and subjective, the following equation has been determined after extensive testing:

$EC_e = 6.4\ EC_{1:5}$ (Talsma, 1968)

Although soil type has since been found to be important, EC_e can be satisfactorily predicted with a considerable degree of confidence from $EC_{1:5}$. Conventionally, saline soils are defined as those having an EC_e value greater than 4 mS/cm (Bradley, et al, 1983).

Organic Material - The organic matter level of a soil is determined by measurement of its organic carbon content and by use of the fact that the average carbon content of soil organic matter is approximately 57 per cent. Soil organic matter levels of less than 1

TABLE S3.3

CHEMICAL TEST RESULTS FOR BLOOMFIELD AUTHORISATION SOIL SAMPLES
SAMPLE SITE/HORIZON

Test	1 A	1 B	2 A	2 B	3 A	3 B	4 A	4 B	5 A	5 B	6 A	6 B	7 A	7 B
$pH_{1:5}$	5.3	7.6	5.9	6.5	5.3	5.4	6.1	6.0	5.5	5.3	6.0	6.8	5.7	5.9
$EC_{1:5}$ (mS/cm)	0.060	0.399	0.066	0.063	0.070	0.055	0.090	0.140	0.023	0.085	0.070	0.110	0.033	0.128
Organic Material (%)	2.67	3.92			11.30				1.52					
Available P (ug/g)	5.0	N.A.	7.0	4.0	4.0	3.0	6.0	4.0	3.0	3.0	3.0	3.0		
Total N (ug/g)	1270	500	2020	1090	5450	440			880	300				
Exchangeable Na (meq/100g)	0.24		0.31		0.20				0.11					
Exchangeable K (meq/100g)	0.28		0.54		0.98				0.53					
Exchangeable Ca (meq/100g)	2.02		5.52		6.15				1.69					
Exchangeable Mg (meq/100g)	1.72		5.91		4.23				1.25					
ESP (%)	5.6		2.5		1.7				3.1					
Fe (ug/g)	246		172		440				79.2					
Mn (ug/g)	31.1		37.7		12.8				7.08					
Cu (ug/g)	2.20		2.58		1.00				0.76					
Zn (ug/g)	2.38		3.62		8.36				1.60					
Co (ug/g)	0.48		1.12		1.10				0.30					
Mo (ug/g)	0.01		<0.01		<0.01				<0.01					
B (ug/g)	5.5		3.5		7.0				2.7					

N.A. - not available

per cent are regarded as very low, 1-2 per cent low and greater than 2 per cent generally satisfactory. In addition to its chemical effects in supplying nutrients to plants, organic matter plays an important role in the physical soil structure.

Nutrients - Both total nitrogen and available phosphorus are important aspects of soil composition indicating the status of the main limiting growth factors. By most standards, Australian soils are particularly low in phosphorus; many contain less than 0.02 per cent of total P, much of which is unavailable to plants. As the available phosphorus is only a small fraction of the total concentration in the soil, very low concentrations are to be expected. Available phosphorus concentrations of 4 ug/g have been found in topsoils in the area by Elliott et al (1980). The rate at which total nitrogen becomes available varies greatly. Agricultural soils in the area (Elliott et al, 1980) have been found to have between 500 and 3000 ug/g of total nitrogen. As a guide, the following figures for total N may be used: less than 0.1 per cent low, 0.1 to 0.2 per cent medium and greater than 0.2 per cent high.

Exchangeable Cations - The amounts and relative proportions of the exchangeable cations in soils have important effects on both soil physical and chemical properties. High levels of exchangeable sodium cause dispersion and increased swelling, whereas exchangeable calcium flocculates colloids and reduces swelling tendencies. Excessively high or low levels of one or the other of the cations may result in nutritional disturbances in a growing crop. The concentrations of the five most abundant cations may be summed to give an approximate value of cation exchange capacity (CEC) which is a measure of the total quantity of cations that a soil can hold. The following concentrations have been suggested by Bell (1981) as critical levels of exchangeable cations above which plant response to the addition of the element could be expected:

potassium	0.2 to 0.3 meq/100 g
calcium	1.2 meq/100 g
magnesium	0.4 to 0.8 meq/100 g.

Exchangeable Sodium Percentage (ESP) - ESP is the extent to which the absorption complex of a soil is occupied by sodium. It is expressed as follows:-

$$ESP = \frac{\text{Exchangeable Sodium (meq/100g)}}{\text{Total Exchangeable Cations (meq/100g)}} \times 100$$

High ESP values are associated with soil structural instability and detrimental effects on plants. Soils having values of ESP exceeding 6 are described as sodic. The clay particles are liable to disperse on wetting, causing structure to deteriorate with resultant problems for agricultural production.

Trace Elements - A large number of minor elements such as boron, molybdenum, zinc, copper, cobalt and manganese are considered to be essential plant elements in low concentrations. At higher

concentrations, several trace elements may have toxic effects on plant growth. A range of 'normal' values of each trace element determined by several workers using a variety of extractants is listed in Elliott et al (1980). Reference should be made to Elliott et al (1980) or Bell (1981) for a more detailed discussion of toxic concentrations and concentrations necessary for optimal plant growth.

S3.4.3 Discussion

The results of the testing programme were used to assess the suitability of the soils for rehabilitation. Account has also been taken of the result of duplex soil testing programmes at other locations in the Hunter Valley (Walker & Elliott, 1982; Croft & Associates, 1986).

The physical test results in Table S3.2 indicate a marked difference between the soils of the A and B horizon at each site and reflect the duplex character of the profiles. The shallow A horizons tend to be sandier than the clay dominated B horizons, particularly for samples at sites 1 and 3.

The dispersability results indicate that with the exception of site 2, the B horizons soils have the greater tendency to disperse and can be expected to be erodible and unstable when the A horizon is removed and the soils disturbed.

The results of the Emerson Crumb Test confirm that soil aggregates are unstable in water and that the soils in-situ will be prone to tunnelling type problems.

The results of the chemical testing of the samples also emphasise the significant differences between the A and B horizons. The soils in general are classified as slightly acidic with only one sample (site 1, B horizon) being alkaline. There is generally an increase in pH with depth. With the exception of site 1B, the conductivity values are low suggesting that there will be negligible effects on plants if these soils are used in rehabilitation. Using the $EC_{1:5}$ conversion to EC_e developed by Talsma (1968), the results in salinities of between 0.2 and 2.5 mS/cm are less than the critical value of 4 mS/cm prescribed for a sodic soil.

The total nitrogen and available phosphorus in the soils of the Lease Application Area are typical of the concentrations of nutrients recorded by Elliott et al (1980). Total nitrogen concentrations of between 500 and 3000 ug/g and an

available phosphorus content of 4 ug/g indicate that the soils are deficient in nutrients and require the application of a complete fertiliser to aid plant growth.

The exchangeable cation concentrations are variable among the A horizon samples. Exchangeable sodium concentrations are low.

Black (1965) has reported that exchangeable calcium to exchangeable magnesium ratios of 5:1 to 1:1 are the most desirable. Although soils in which the exchangeable magnesium exceeds the exchangeable calcium are not uncommon, plant growth tends to be affected. The results for the area indicate that the soils do not suffer from a calcium deficiency as determined by Walker & Elliott (1982) although they are below the level at which clay dispersion is expected. On the other hand, the ESP values are low and not indicative of sodic soils.

Trace element concentrations were examined in relation to established criteria (Bell, 1981) and to work on similar topsoils (Elliott et al, 1980; Walker & Elliott, 1982). Aluminium concentrations were not assessed as pH values were greater than 5.0 to 5.5 pH units.

Total iron concentrations were found to be very high at each site examined and much higher in this survey than at other nearby locations. The high concentrations may be related to previous occupation of the site and associated mining and metallurgical procedures. While high manganese concentrations were also recorded in soils, they do not approach the toxic concentrations reported by Walker & Elliott (1982), although Bell (1981) has suggested that concentrations greater than 50 ug/g may be toxic especially with an acid pH.

Concentrations of copper and zinc in topsoil are higher than the critical respective values of 0.2 and 0.5 to 1.0 ug/g listed by Bell (1981) as values below which a plant response to the application of the element might reasonably be expected. Results for cobalt and molybdenum are quite low and comparable with other trace element work on Hunter Valley soils.

As with all trace elements, the extractant used is quite critical in metal determinations. For boron, where a hot water extract was prepared, critical levels indicate that a concentration of between 1 and 5 ug/g is usually quite

acceptable. With the exception of site 3, all other soils tested indicate satisfactory levels of boron for use in rehabilitation.

In summary, the results of the physical and chemical testing of the soils show that the nutrient levels are low and that fertiliser applications will be required in rehabilitation. With the exception of iron, the concentrations of salts and trace metals are also low and toxic concentrations affecting plant growth were not detected. The soils are prone to physical breakdown and erosion on disturbance and will require a high level of management when used for rehabilitation.

S3.5 ASSESSMENT OF TOPSOIL SUITABILITY

S3.5.1 Topsoil Recovery

Opencut mining operations are planned for an area of approximately 367 ha. Of this total, 271 ha will be to the north of the New England Highway and 96 ha to the south. Approximately 70 ha will be cleared for the construction of the surface facilities in the northeast of the Lease Application Area.

Topsoil from the initial excavations will be used for landscaping haul road batters and for topdressing bunds formed around the site to shield the mining operations from view. Although the mining method will vary between stages 1 and 2 of the operations, there will be no stockpiling of topsoil during mining. Rehabilitation will be completed as the mine advances.

During stage 1 of mining, scrapers and bulldozers will remove topsoil in 40-50 m wide strips and transport it around the active workings. This material will be placed behind the advancing mine on the nearest reformed area which will be generally about 80-100 m or two cuts away from the working area. Backfilling and rehabilitation will be undertaken concurrently with mining and will commence during the first year of operation.

During stage 2 of mining, truck and shovel operations will excavate larger areas. Again, prior to overburden stripping, topsoil will be removed and transported around the active workings and placed on the nearby backfilled and reformed areas

ready for sowing. At the completion of mining at the site, only a small area of the most recently excavated material will require topdressing and rehabilitation.

S3.5.2 Topsoil Thicknesses

Figure 10 is a plan showing the topsoil stripping thicknesses in the areas of the Lease Application Area proposed for opencut mining. The term "topsoil" refers to a combination of both A_1 and A_2 horizons as the selective removal of the shallow A_1 horizon by large machinery is not practicable.

Investigations of topsoil properties on proposed mine sites in the Upper Hunter Valley have shown that not all soil material is suitable for recovery and reuse in rehabilitation. Soils which are too weakly structured, poorly drained or too sandy and gravelly may not be able to support vegetation. The procedure described by Elliott & Veness (1981) involving the use of study results of soil structure, coherence, mottling, ped strength, texture and gravel and sand content, pH and salt content has been used to assist in designating soils worthy of recovery for topdressing purposes.

The A horizons of both the red and yellow duplex soils were found to be suitable for rehabilitation, though the texture of some yellow duplex A horizons tended to be rather coarse. The A horizons of both soil types have a tendency to set when dry, so techniques to counter the likely formation of surface crusts will be employed when these soils are used.

The B horizon material of the yellow duplex soils was found unsuitable due to its massive, apedal structure. The red duplex B horizon material was also considered unsuitable because of the dispersive nature of the clays when wet.

Areas of gravel soils, previously disturbed sites and eroded areas were excluded from the topsoil assessment procedure as these areas have no significant topsoil reserves.

Areas of topsoil which can be stripped and used as topdressing material have been calculated from the topsoil survey plan, soil type plan and the results of physical and chemical testing. Table S3.4 summarises the areas of topsoil

suitable for stripping and use on the reformed areas of backfill.

Based upon the estimates of soil thickness it has been concluded that topsoil to a depth of 10 cm is available for topdressing throughout most of the proposed mined areas. Topsoil to a depth of 20 cm is available from a smaller, yet still significant area, while areas of nil topsoil occur on disturbed sites and slopes experiencing sheet erosion.

TABLE S3.4

TOPSOIL AREAS SUITABLE FOR USE AS TOPDRESSING

Topsoil Depth	Surface Facilities Area (ha)	Northern Mined Area (ha)	Southern Mined Area (ha)	Total
Nil	14	29	3	46
10 cm	56	122	51	229
20 cm	0	120	42	162

Calculations based upon Table S3.4 indicate that a total volume of $5.53 \times 10^5 m^3$ of A horizon material to a depth of 10 cm will be available as topdressing material. Assuming a soil recovery of 70 per cent and a soil swell of 30 per cent, the soil will cover approximately 553 ha to a depth of 10 cm. As the total area within the Lease Application Area to be distubed is 437 ha, there will be an approximate surplus of suitable topdressing material of 116,000 m^3.

Field studies at some locations in the Upper Hunter Valley where soil deficiencies occur have suggested that a topsoil thickness of 5 cm may be adequate. Even with the surplus on the Lease Application Area, maximum conservation will be practiced and a general target thickness of 10 cm will be aimed at and a minimum thickness of 5 cm.

The Company is aware of the research and investigations being conducted in the Upper Hunter Valley by the New South Wales Soil Conservation Service and the New South Wales Forestry Commission and proposes to conduct its own rehabilitation trials in consultation with these Authorities. Bloomfield Collieries Pty. Limited have had over 10 years experience in rehabilitating mined areas at its colliery at East Maitland and proposes to incorporate similar general procedures

at Rixs Creek. The Company is interested in further experimentation in tree planting and will incorporate a mixture of pastures and wooded areas in the post-mining land use for its Rixs Creek project. These aspects are considered further in Study 11.

S3.6 CONCLUSIONS

The studies of the soils of the Lease Application Area have shown that sufficient topsoil material can be recovered for the rehabilitation of the proposed mining areas.

In general, the soils investigated were found to be of poor quality, deficient in nutrients and prone to rapid breakdown and erosion when mismanaged.

The Company is aware of the magnitude of the task of soil conservation with the poor soils at its disposal and proposes to implement a programme to maximise protection of the soil resource.

S3.7 REFERENCES

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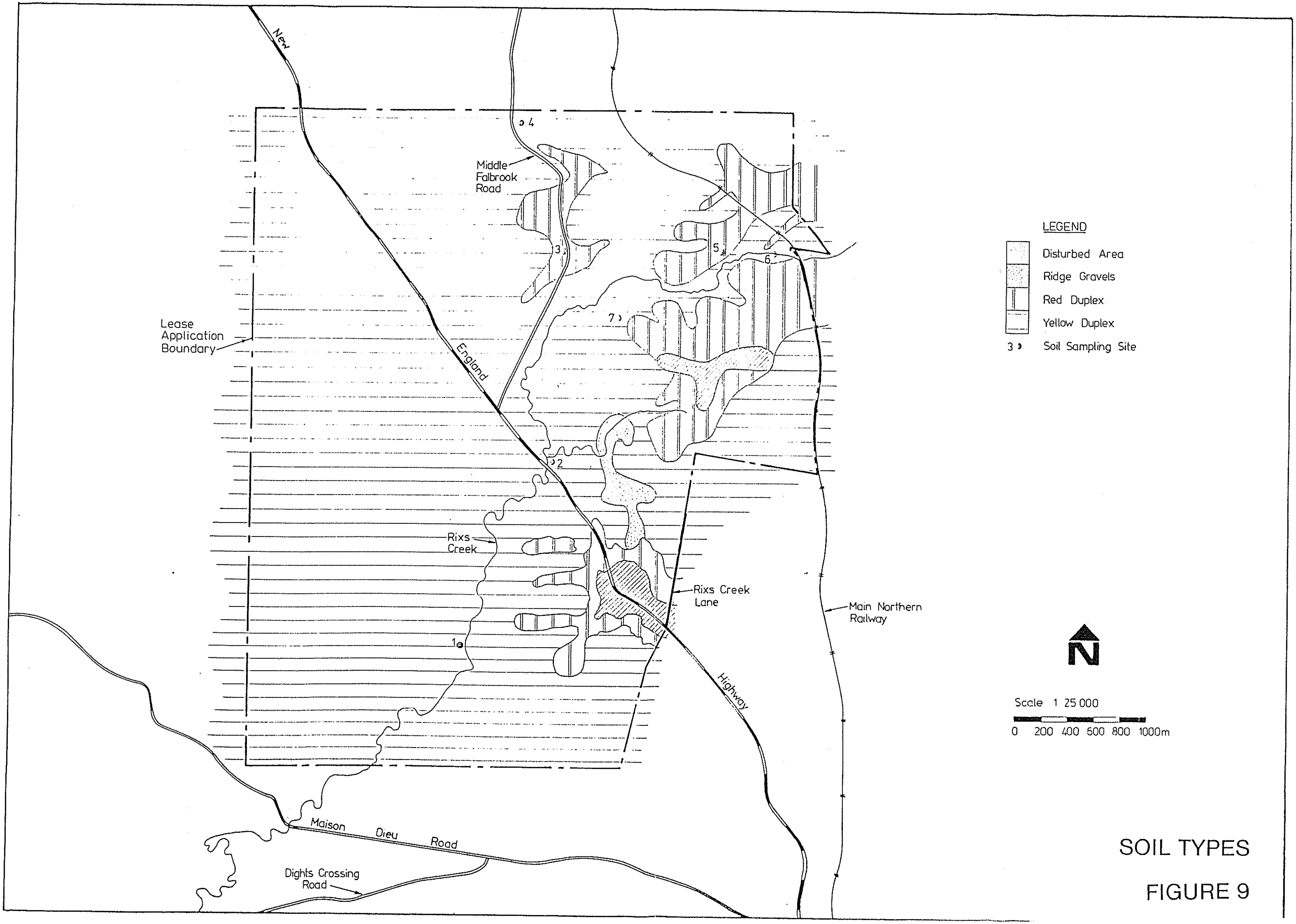
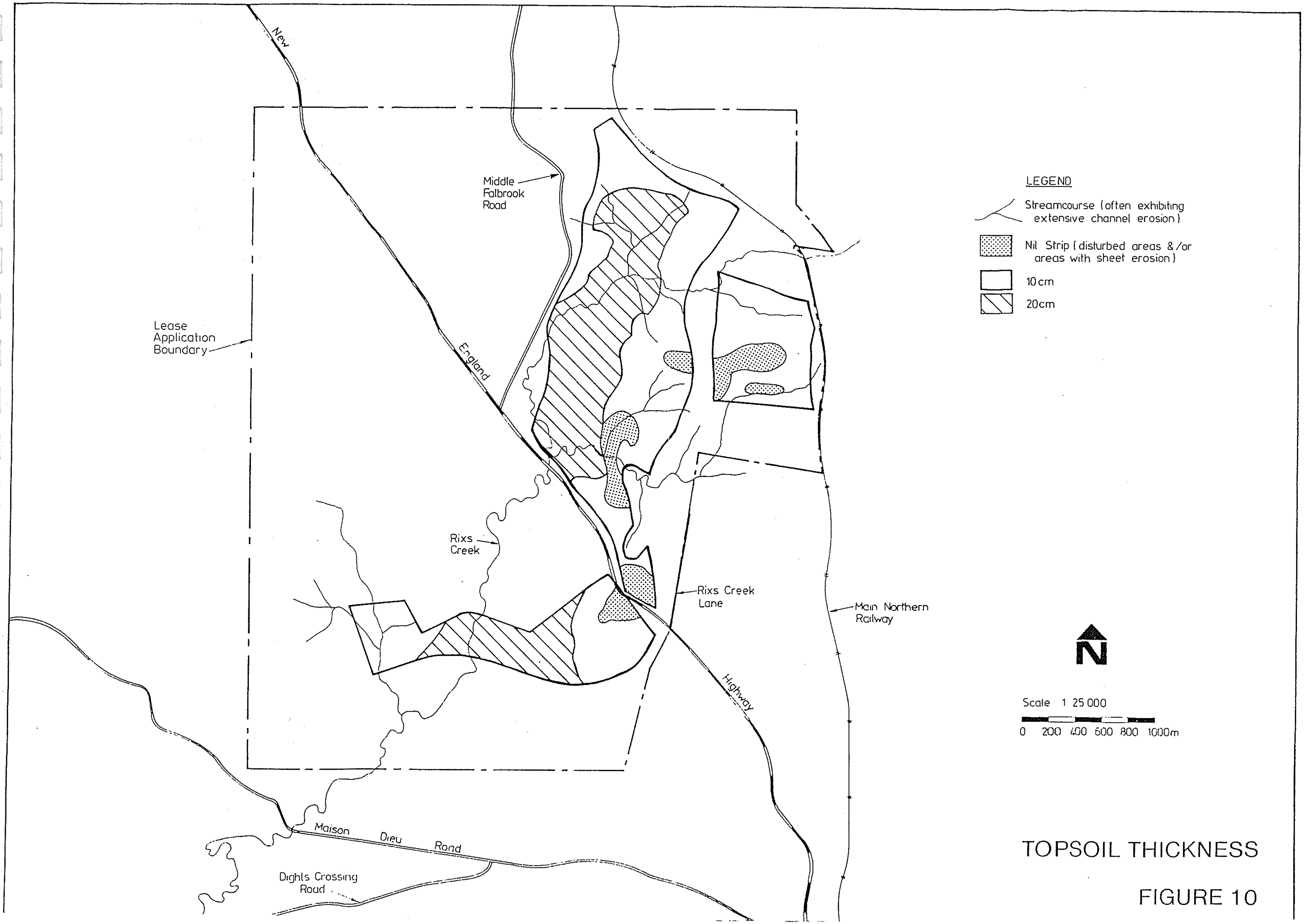


SOIL TYPES

FIGURE 9



TOPSOIL THICKNESS

FIGURE 10

Rix's Creek Pty Limited

RIX'S CREEK COLLIERY
SOIL SURVEY FOR
OPENCUT APPLICATION

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Table of Contents

1. SOIL SURVEY

A soil survey of 112ha was undertaken as part of the opencut investigations on behalf of Rixs Creek Mine and follows the guidelines set out by Charman and Murphy (1991), and specific recommendations for surveys of opencut mine sites (Soil Conservation Service, 1985).

The locations for soil sampling were based on landform elements within each 25ha area in accordance with Soil Conservation Service recommendations. Sampling locations are shown in Plan 4.

Seven soil profiles were exposed in excavated pits and classified using the Factual Key for the Recognition of Australian Soils (Northcote, 1979).

Access to the exposed profiles enabled observations of all horizon properties which were fully described in the field following the method of Morse, Atkinson and Craze (1982).

Boundaries of the soil elements were delineated by soil profile description, landform elements and spot checks of 'A' horizon material between principal sampling points.

2. TOPSOIL STRIPPING AND MANAGEMENT

2.1 TOPSOIL SUITABILITY

The assessment of suitability of soil for use in rehabilitation has been undertaken in accordance with the criteria presented in Elliott and Veness (1981).

According to this criteria, the duplex soils on the hillslopes comprising the main body of the study area are suitable for use in rehabilitation works, provided that soil conditioning with gypsum is undertaken, either at the time of stripping, or immediately following respreading to enhance cation exchange capacity and the infiltration capacity of the soil. A small area at the northeastern end of area 4a is unsuitable for stripping due to extensive sheet erosion.

The red duplex soils described on the southern side of the New England Highway are unsuitable for stripping due to the presence of ironstone gravel float within the 'A' horizon.

2.2 TOPSOIL QUANTITIES

The depth of topsoil available for stripping is detailed in the soil profile descriptions and confirmed by more than 30 observations of depth of the 'A' horizons. Table 1 details the stripping zones, mean depth of topsoil, and quantities of topsoil available. In most areas the depth of the 'A' horizon measures between 10 and 15cm. Two smaller areas have marginally deeper topsoils, up to 20cm depth. Plan 4 incorporates a topsoil stripping map with the depth of the material to be stripped marked in isohyets.

Table 1

Topsoil Stripping Depth by Area

AREA Nº	MEAN DEPTH OF TOPSOIL (cm)	AREA OF STRIPPING ZONE (ha)	QUANTITY OF TOPSOIL TO BE STRIPPED (m^3)
1	10	13.7	13,700
2	15	11.3	17,000
3	10	12.9	12,900
4	10	12.6	12,600
4a	10	5.0	5,000
4b	0	6.5	nil
5	10	15.0	15,000
6	15	15.0	22,500
7	0	20.5	nil
Total		112.6	95,700

2.3 GENERAL SOIL CHARACTERISTICS

According to the Northcote Classification System (1979) the soils sampled throughout the study area are Duplex with yellow or red clayey 'B' horizons. The Great Soil Group Classification describes the soils as Yellow or Brown Podzolic or Solonetzic soils. These soils are characterised by a marked colour and texture contrast between the 'A' and 'B' horizons.

The soils within the study area all comprised shallow, (10-15cm) hard setting 'A' horizons of light textured fine sandy clay loam. The single exception was Sample 7 which contained considerable ironstone gravel float within the 'A' horizon. The structure of all 'A' horizons tended to exhibit weak to crumbly pedality. One soil sample (sample 1) displayed a bleached 'A_2' horizon and was suspected to be solodic. Similarly all 'A' horizons were mildly acidic with pH levels of 5.5.

The 'B' horizons throughout the site tend to be comprised of massive apedal clays of low permeability and high shear strength when dry. When wet these clays are highly dispersable and readily erode to form major gullies and tunnels. Some evidence of gully and rill erosion was sighted along the unnamed watercourse through the site.

The 'C' horizons throughout the site are comprised of a mixture of weathered sandstone, mudstone or conglomerate, and are generally weak with low shear strength.

Some areas of sheet erosion resulting in the loss of topsoil were observed, particularly in steeper mid slope zones which are adversely affected by accumulated runoff from upslope.

3. LABORATORY ANALYSIS

Laboratory analysis of representative samples of the two soil types was undertaken by the Wellington Research Service Centre of the Department of Conservation and Land Management. Results of this analysis, provided in Appendix 1 and summarised in Table 2, confirmed the textural qualities of the soil samples determined in the field. These results also broadly agreed with the previous results of Particle Size Analysis undertaken for the Environmental Impact Statement.

Table 2

Results of Soil Analysis

SAMPLE	YELLOW DUPLEX	RED DUPLEX
Sample depth (cm)	15	15
Clay %	17	42
Silt %	16	26
Fine sand %	35	24
Coarse sand %	28	8
Gravel %	4	0
Dispersion %	58	59
Emerson Agg.	3(2)	2(1)
Conductivity mS/cm	0.06	0.18
pH	5.2	5.4

Results of dispersion percentage (58 and 59%) revealed that the 'A' horizons of both soil types are moderately erodible. Similarly, results of the Emerson Aggregate Test showed that the yellow duplex soils are generally stable and suitable for soil conservation works, although slightly dispersable. Alternatively, the red duplex soils have some degree of tunnelling susceptibility and are moderately dispersable.

The results of pH analysis for both soil samples (5.2 and 5.4) confirmed those measured in the field. Conductivity of both soil samples indicated that the yellow duplex was suitable for growing a wide range of salt sensitive plants, while salt sensitive plants grown in the red duplex soils would have reduced yields caused by greater levels of salinity within the soils.

4. SOIL PROFILE DESCRIPTIONS

Details of soil profile descriptions are included in Appendix 2.

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Appendix 1

Wellington Research Service Centre

Soil Analysis Results.

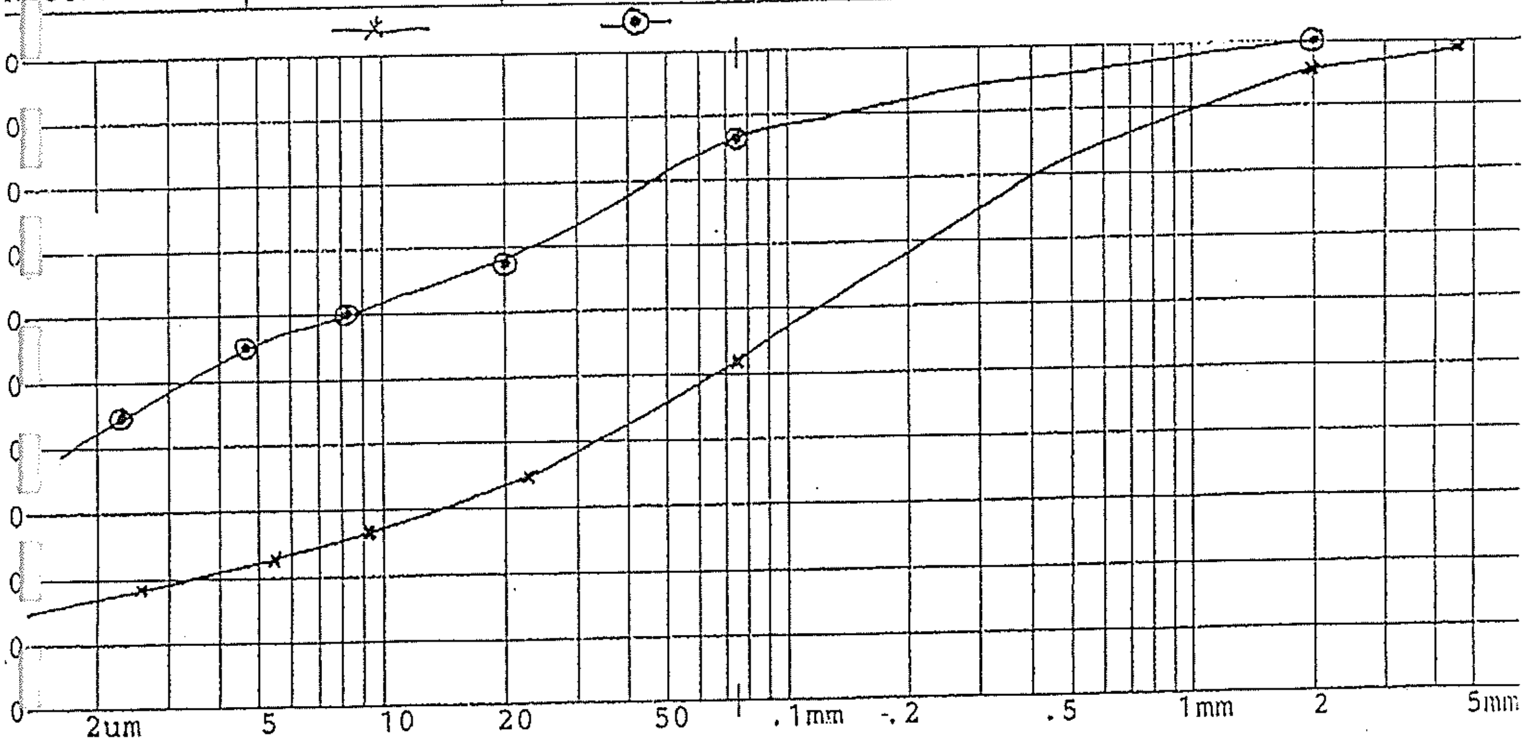
02/12/91 09:13 002

WELLINGTON RESEARCH SERVICE CENTRE

REGIONAL SOIL TEST RESULTS

ndholder: WAYNE PERRY AND ASSOCIATES. Property: File:
M G. Ref: District: Location:

A PLE IDENT:	WEL 91/90/1 SAMPLES 2,3+4	WEL 91/90/2 SAMPLES 5+7			UNITS	TEST REF. NO.
AMPLE DEPTH					cm.	
CLAY	17	42			%	P7B/1
SILT	16	26			%	P7B/1
FINE SAND	35	24			%	P7B/1
COA E SAND	28	8			%	P7B/1
GRAVEL	4	0			%	P7B/1
ISPERSION	58	59			%	P8A/2
EMERSON AGG.	3(2)	2 (1)			CLASS	P9B/2
O UME EXPAN.					%	P5A/1
ds/m ~~U.S.C.S.~~	0.06	0.18			CODE	~~P4.3~~3
pH	5.2	5.4			FIELD	TEST
SOIL COLOUR					MOIST	
RECOMMENDED					CODE	



C MMENTS:

Appendix 2

Soil Profile Descriptions.

Soil Profile Description.

SAMPLE 1

LOCATION: Southern section of Bowman property.	DATE: 22/11/91	SLOPE AND ASPECT < 10^{o} WSW
UNDERLYING BEDROCK: Mudstone, Sandstone, Conglomerate.		
VEGETATION & LAND USE: Scattered remnant Ironbark, Eucalyptus mollucana and Eucalyptus maculata forest, with some regeneration evident. Dry cattle grazing and beef grazing.	DRAINAGE: Lower slopes	
SOIL CLASSIFICATION: Duplex Dy 2.71	AV. ANNUAL RAINFALL: Approx. 700mm	

HORIZON	DEPTH (cm)	LOWER BOUNDARY (cm)	MOISTURE	TEXTURE	STRUCTURE	COLOUR	ORGANIC MATTER	pH	SPECIAL FEATURES
A	10cm	Sharp transition between A and B.	Nil	Fine sandy clay loam.	Angular blockey with a tendency towards crumbliness. Very weak.	10YR 4/3 Brown		5.5	Some sheet erosion evident adjacent to sampling site. Suitable for stripping.
A_2	Bleached								Unsuitable for stripping.
B	10cm to 100cm	Boundary between the B & C horizon gradual.	Nil	Massive clay.	Apedal Massive clay with some columna structure.	10YR 5/6 Yellowish Brown.			Unsuitable for stripping.
C	1.5m			C Horizon is weak comprised of a sandy clay mixture, and weathered sandstone.		10YR 5/8 Bright Brown.			Unsuitable for stripping.

Soil Profile Description.

Sample 2

LOCATION: 200m west of fenceline, just below the ridgeline.	DATE: 22/11/91	SLOPE AND ASPECT 5° NNW
UNDERLYING BEDROCK: Sandstone, Mudstone and Conglomerate.		
VEGETATION & LAND USE: Scattered remnant Ironbark, Eucalyptus mollucana and Eucalyptus maculata forest, with some regeneration evident. Dry cattle and beef grazing.	DRAINAGE: Upper slopes	
SOIL CLASSIFICATION: Duplex Dy 2.11	AV. ANNUAL RAINFALL: Approx. 700mm	

HORIZON	DEPTH (cm)	LOWER BOUNDARY (cm)	MOISTURE	TEXTURE	STRUCTURE	COLOUR	ORGANIC MATTER (%)	pH	SPECIAL FEATURES
A	15cm	Sharp between A & B horizons.	Dry	Sandy loam.	Weak pedality tending to crumble.	10YR 3/6 Dark Yellowish		5.5	Immediately upslope of band of Eucalyptus maculata. Suitable for stripping.
B	15cm to 80cm	Gradual	Damp	Massive clay.	Prismatic structure.	10YR 5/3 Brown			Roots observed to 35cm level. Unsuitable for stripping.
C	80cm+		Dry	Weathered sandstone. Sandy.	Weak	10YR 5/3 Yellowish Brown			Unsuitable for stripping.

Soil Profile Description.

Sample 3

LOCATION: 300m from the western boundary fence adjacent to a dry creek bed.	DATE: 22/11/91	SLOPE AND ASPECT 5° ENE
UNDERLYING BEDROCK: Sandstone, Mudstone and Conglomerate.		
VEGETATION & LAND USE: Band of Eucalyptus maculata runs around the hill about 100m upslope. Scattered remnant Ironbark, Eucalyptus mocculana and Eucalyptus maculata. Dry cattle and beef grazing.	DRAINAGE: Lower slopes poor drainage.	
SOIL CLASSIFICATION: Duplex Dy 2.11	AV. ANNUAL RAINFALL: Approx. 700mm	

HORIZON	DEPTH (cm)	LOWER BOUNDARY (cm)	MOISTURE	TEXTURE	STRUCTURE	COLOUR	ORGANIC MATTER (%)	pH	SPECIAL FEATURES
A	10-15cm	Sharp between A & B Horizon.	Nil	Sandy loam.	Prismatic, weakly pedal tending to crumble.	10YR 3/6 Dark Yellowish Brown		5.5	Immediately adjacent to colluvial fan. Suitable for stripping.
B	15 - 120cm	Gradual between B and C horizon.	Damp	Massive Clay. Some mottling is evident.	Apedal	10YR 5/4 Yellowish Brown.			Some evidence of tree roots. Unsuitable for stripping.
C	1.2m+		Dry	Sandy clay	Weak				Tree roots to 1m mark. Unsuitable for stripping.

Soil Profile Description.

Sample 4

LOCATION: Northern section of the Bowman property. Midway down the slope, 250m from the western fenceline. Distance from the northern boundary about 400m.	DATE: 22/11/91	SLOPE AND ASPECT 8 - 10° East.
UNDERLYING BEDROCK: Sandstone, Mudstone and Conglomerate.		
VEGETATION & LAND USE: Vegetation change. Remnant Ironbark forest with some Eucalyptus maculata and Angophra costata. Grasses not as dense in this area. Dry cattle and beef grazing.	DRAINAGE: Mid slope	
SOIL CLASSIFICATION: Duplex Dy 2.51	AV. ANNUAL RAINFALL: Approx. 700mm	

HORIZON	DEPTH (cm)	LOWER BOUNDARY (cm)	MOISTURE	TEXTURE	STRUCTURE	COLOUR	ORGANIC MATTER (%)	pH	SPECIAL FEATURES
A	10cm	Sharp between A and B horizon.	Nil	Sandy loam.	Weakly pedal, prismatic tending to crumble.	10YR 3/2 Very dark grayish brown		5.5	Sheet erosion evident on slope. Suitable for stripping.
B	10cm to 60cm	Sharp line	Damp	Massive clay.	Apedal	10YR 5/2 Grayish Brosn			Tree roots to 50cm. Unsuitable for stripping.
C	60cm+	Gradual	Nil	Sandy clay with ironstone gravel.	Weathered sandstone. Weak.				Unsuitable for stripping.

Soil Profile Description.

Sample 5

LOCATION: Ridgetop, southern portion of Camberwell lease, 100m NE of Middle Falbrook Rd.	DATE: 22/11/91	SLOPE AND ASPECT Ridgetop South to East
UNDERLYING BEDROCK: Mudstone, Sandstone, Conglomerate.		
VEGETATION & LAND USE: Scattered remnant Ironbark and Eucalyptus maculata forest. Some regeneration. Dry cattle and beef grazing.	DRAINAGE: Good	
SOIL CLASSIFICATION: Duplex Dr 2.11	AV. ANNUAL RAINFALL: Approx. 700mm	

HORIZON	DEPTH (cm)	LOWER BOUNDARY (cm)	MOISTURE	TEXTURE	STRUCTURE	COLOUR	ORGANIC MATTER (%)	pH	SPECIAL FEATURES
A	10-15cm	Sharp	Nil	Sandy clay loam	Weak pedality.	10YR 3/1 Very dark gray.		5.5	Siotable for stripping.
B	15 to 60cm	Gradual to C horizon	Damp	Massive clay.	Columna/weak.	5YR 4/6 Yellowish Red			Mottles present. Unsuitable for stripping.
C	60cm+		Nil		Crumbly, due to sandstone and conglomerate nature of the material.				Unsuitable for stripping.

Soil Profile Description.

Sample 6

LOCATION: Middle portion of Camberwell's land holding, 300m from Middle Falbrook Road.	DATE: 22/11/91	SLOPE AND ASPECT 5° NW
UNDERLYING BEDROCK: Sandstone, Mudstone, Conglomerate.		
VEGETATION & LAND USE: Open woodland Eucalyptus crebra and Eucalyptus maculata. Considerable regeneration. Dry cattle grazing.	DRAINAGE: Mid slope zone.	
SOIL CLASSIFICATION: Duplex Dy 2.11	AV. ANNUAL RAINFALL: Approx. 700mm	

HORIZON	DEPTH (cm)	LOWER BOUNDARY (cm)	MOISTURE	TEXTURE	STRUCTURE	COLOUR	ORGANIC MATTER (%)	pH	SPECIAL FEATURES
A	15cm	Sharp between A and B	Damp	Sandy clay loam.	Apedal, crumbly structure	10YR 4/2 Dark grayish brown		5.5	Suitable for stripping.
B	15 to 80cm	Gradual between B and C	Damp.	Clay	Massive, tending towards prismatic.				Some floating sandstone clasts were evident. Unsuitable for stripping.
C	80cm+			Sandy clay					Unsuitable for stripping.

Soil Profile Description.

Sample 7

LOCATION: Southern side of New England Highway, within the Colliery landholding.	DATE: 22/11/91	SLOPE AND ASPECT 5° South to East
UNDERLYING BEDROCK: Mudstone, Sandstone.		
VEGETATION & LAND USE: Predominantly scattered Eucalyptus crebra. Dry cattle grazing.	DRAINAGE: Poor, lower slopes.	
SOIL CLASSIFICATION: Duplex Dr 2.51	AV. ANNUAL RAINFALL: Approx. 700mm	

HORIZON	DEPTH (cm)	LOWER BOUNDARY (cm)	MOISTURE	TEXTURE	STRUCTURE	COLOUR	ORGANIC MATTER (%)	pH	SPECIAL FEATURES
A	10cm	Sharp between A and B	Moderate	Fine clay loam with stoniness.	Apedal, crumbly	7.5YR 4/4 Brown		5.5	Evidence of sheet erosion exists throughout the area. Unsuitable for stripping.
B	10 to 60cm	Gradual between B and C.	Damp	Clay	Massive. Weak	5 Yr 4/5 Red, brown			Mottling evident. Unsuitable for stripping.
C	60cm+				Weak clay bleached with mottling present.				Unsuitable for stripping.

APPENDIX 9

ENVIRONMENTAL IMPACT OF

EXISTING MINING OPERATION

TABLE OF CONTENTS

1.0 REHABILITATION

Progressive rehabilitation of disturbed areas has been undertaken since the commencement of operations. All rehabilitation works are reported annually to the Department of Mineral Resources as part of the company's Environmental Management Plan.

Up until the end of 1993, 138 hectares of land had been disturbed. This is inclusive of 28 hectares of infrastructural elements.

Rehabilitation has been implemented on approximately 80 hectares of disturbed land utilising a combination of pasture and direct tree seeding. Consequently 73% of disturbed land, exclusive of land upon which permanent infrastructure is located, has been rehabilitated.

Seasonal conditions have impacted on the success of the germination and promulgation of vegetation at the time of sowing. Subsequent maintenance seeding and fertilising in conjunction with ongoing rehabilitation in times of more favourable weather conditions has resulted in the establishment of an adequate vegetative cover that is progressing in accordance with the requirements of the Department of Mineral Resources and CALM. Within the overall rehabilitation works a trial plot of 1.44 hectares was treated with sewage sludge to assess the potential of daughterhood sewage sludge as a topsoil substitute and a fertilising agent. The trial was conducted by a student of the Newcastle University, in conjunction with the Hunter Water Corporation, as part of the requirements for a Masters Degree in Environmental Studies.

The trial found that all areas treated with sewage sludge gave superior dry biomass yields to that of non-sludge treatments. Investigation also found that no significant problem arose from the use of sewage sludge in respect of heavy metals and organic pollutants.

Direct tree seeding has been implemented, generally, in the small isolated areas where pasture has not grown effectively. This method has resulted in the successful establishment

of tree-lots throughout the rehabilitated area, achieving a long-term natural landscape of dispersed stands of trees that will provide shade and refuge locations.

2.0 AIR QUALITY

Air quality is a major issue when assessing the environmental effects of all developments and is an issue that received a great deal of scrutiny in the initial environmental impact statement and the subsequent commission of enquiry.

To monitor atmospheric dust a system of dust deposition gauges and high volume dust samplers are located through and around the mine lease area. Seventeen dust deposition gauges were in place prior to the approval of the development. This regime of dust deposition gauges was increased in February 1990 to 27 and three high volume dust samplers were also located around the mine site, in accordance with the requirements of the EPA.

Due to the variation in mine production, for the initial 4 years of the operation, from that which was outlined in the original EIS, a direct correlation between predicted dust isopleths and recorded dust levels cannot be obtained.

An annual coal production rate for years 1 to 6 of 300,000 ROM tonnes was proposed in the original EIS. The actual ROM tonnes produced for the first 4 years of production are given in **Table 1**.

TABLE 1
ROM COAL PRODUCTION RATES

YEAR	ROM/Annum
1990	60,000
1991	260,000
1992	400,000
1993	600,000

Consequently the closest comparison that can be made is between predicted increase in annual dust deposition for Year 1 and the average annual dust deposition (suspended solids) for 1991 - Year 2 of the mining operation. During 1991 the location of mining operations and mining methods were closest to that modelled in the EIS for Year 1.

Dust deposition recorded during the period 1990-1993 are given in **Table 2**.

Figure S8.1 of the original EIS prepared by Croft & Associates predicted an increase in annual dust deposition along Rixs Creek Lane of 2.0 gm/m^2/mth

Table S5.10 in Volume 2 of the EIS, prepared by Croft & Associates, tabulated average background dust levels recorded at gauge 5 adjacent to residence No. 60 on Rixs Creek Lane of 2.24 for the period November 1981 to October 1985 and 1.48 for the period November 1985 to February 1988. Based on these background levels plus the predicted increase in annual dust deposition for Year 1 of 2 gm/m^2/mth, a level of between 3.48 gm/m^2/mth and 4.24 gm/m^2/mth was anticipated. The annual average recorded at gauge 5 adjacent to residence No. 60 on Rixs Creek Lane for 1991 was 2.6 gm/m^2/mth. Consequently this shows that the level of dust experienced, against that predicted was less by a range of 0.88 gm to 1.64 gm.

Also a comparison of the arithmetic means for dust deposition gauges tabulated in table S5.10 of the original EIS (reproduced as **Table 4**) and the annual averages of recorded results (**Table 2**) indicates a close correlation between background levels prior to the commencement of mining operations and levels recorded after the commencement of mining. In fact all results, other than gauges 5 and 12 are less than those results recorded during the period November 1981 to October 1985. Gauge 5 exceeds the recorded background by 0.06 gm/m^2/mth. Gauge 12, which is located adjacent to the Singleton Civic Centre, approximately 5 km from mining operations, and in the same wind path as gauges 3, 13, 14, 15 and 16 exceeds recorded background by 0.48 gm/m^2/mth.

TABLE 2
DUST DEPOSITION RATES
(g/m²/month)

Gauge No.	1990		1991		1992		1993		Annual Average
	IS	AR	IS	AR	IS	AR	IS	AR	Insoluble Solids
1	1.17	0.45	1.3	0.8	1.6	1.1	2.17	1.2	1.6
2	0.95	0.41	1.5	0.83	1.6	0.7	2.02	1.1	1.5
3	0.56	0.36	1.05	0.65	0.9	0.5	1.50	0.7	1.0
4	2.01	1.37	1.50	0.94	1.2	0.7	1.84	1.5	1.6
5	1.93	1.13	2.6	1.7	1.4	0.8	3.07	1.62	2.3
6	1.30	0.76	1.5	1.0	1.3	0.8	1.22	0.64	1.3
7	0.76	0.41	3.0	1.35	1.06	0.67	1.07	0.55	1.5
8	1.42	0.92	1.0	0.57	0.85	0.42	0.95	0.52	1.1
9	0.78	0.34	1.0	0.6	0.83	0.42	0.96	0.49	0.9
10	0.78	0.40	1.5	0.87	1.16	0.53	0.93	0.47	1.1
11	1.30	0.86	1.3	0.9	2.33	0.9	1.82	0.84	1.7
12	1.89	0.82	1.3	0.7	2.36	1.14	3.22	1.24	2.2
13	1.56	1.27	1.2	0.74	1.1	0.6	1.28	0.6	1.3
14	2.44	1.33	2.1	1.3	1.6	0.8	1.54	0.84	1.9
15	1.05	0.76	1.8	1.4	1.5	1.05	1.54	1.06	1.5
16	1.15	0.80	1.8	1.2	1.48	0.83	1.64	0.96	1.5
17	3.15	1.66	1.5	0.7	2.45	1.15	2.35	1.15	2.4
18	0.88	0.58	1.0	0.8	1.2	0.76	1.34	0.88	1.1
19	1.62	1.00	1.4	1.2	1.07	1.26	1.16	0.8	1.3
20	1.38	1.10	1.6	1.2	1.4	0.86	1.76	1.18	1.5
21	1.50	1.05	1.5	0.9	1.86	0.84	1.27	0.87	1.5
22	0.87	0.57	1.2	0.7	0.9	0.44	1.06	0.56	1.0
23	1.40	0.93	0.9	0.7	1.05	0.59	1.75	1.19	1.3
24	1.27	0.78	1.1	0.8	1.15	0.63	1.8	1.09	1.3
25	1.55	0.59	2.0	1.2	2.15	1.13	1.77	0.98	1.9
26	1.38	0.44	1.5	0.9	1.5	0.73	1.16	0.67	1.4
27	2.85	1.6	2.2	1.1	2.25	0.9	1.91	0.88	2.3
Annual average of total dust gauge network									1.5

KEY: IS Insoluble Solids
AR Ash Residue

Consequently the closest comparison that can be made is between predicted increase in annual dust deposition for Year 1 and the average annual dust deposition (suspended solids) for 1991 - Year 2 of the mining operation. During 1991 the location of mining operations and mining methods were closest to that modelled in the EIS for Year 1.

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Also a comparison of the arithmetic means for dust deposition gauges tabulated in table S5.10 of the original EIS (reproduced as **Table 4**) and the annual averages of recorded results (**Table 2**) indicates a close correlation between background levels prior to the commencement of mining operations and levels recorded after the commencement of mining. In fact all results, other than gauges 5 and 12 are less than those results recorded during the period November 1981 to October 1985. Gauge 5 exceeds the recorded background by 0.06 gm/m^2/mth. Gauge 12, which is located adjacent to the Singleton Civic Centre, approximately 5 km from mining operations, and in the same wind path as gauges 3, 13, 14, 15 and 16 exceeds recorded background by 0.48 gm/m^2/mth.

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Gauge No.	1990		1991		1992		1993		Annual Average
	IS	AR	IS	AR	IS	AR	IS	AR	Insoluble Solids
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2	0.95	0.41	1.5	0.83	1.6	0.7	2.02	1.1	1.5
3	0.56	0.36	1.05	0.65	0.9	0.5	1.50	0.7	1.0
4	2.01	1.37	1.50	0.94	1.2	0.7	1.84	1.5	1.6
5	1.93	1.13	2.6	1.7	1.4	0.8	3.07	1.62	2.3
6	1.30	0.76	1.5	1.0	1.3	0.8	1.22	0.64	1.3
7	0.76	0.41	3.0	1.35	1.06	0.67	1.07	0.55	1.5
8	1.42	0.92	1.0	0.57	0.85	0.42	0.95	0.52	1.1
9	0.78	0.34	1.0	0.6	0.83	0.42	0.96	0.49	0.9
10	0.78	0.40	1.5	0.87	1.16	0.53	0.93	0.47	1.1
11	1.30	0.86	1.3	0.9	2.33	0.9	1.82	0.84	1.7
12	1.89	0.82	1.3	0.7	2.36	1.14	3.22	1.24	2.2
13	1.56	1.27	1.2	0.74	1.1	0.6	1.28	0.6	1.3
14	2.44	1.33	2.1	1.3	1.6	0.8	1.54	0.84	1.9
15	1.05	0.76	1.8	1.4	1.5	1.05	1.54	1.06	1.5
16	1.15	0.80	1.8	1.2	1.48	0.83	1.64	0.96	1.5
17	3.15	1.66	1.5	0.7	2.45	1.15	2.35	1.15	2.4
18	0.88	0.58	1.0	0.8	1.2	0.76	1.34	0.88	1.1
19	1.62	1.00	1.4	1.2	1.07	1.26	1.16	0.8	1.3
20	1.38	1.10	1.6	1.2	1.4	0.86	1.76	1.18	1.5
21	1.50	1.05	1.5	0.9	1.86	0.84	1.27	0.87	1.5
22	0.87	0.57	1.2	0.7	0.9	0.44	1.06	0.56	1.0
23	1.40	0.93	0.9	0.7	1.05	0.59	1.75	1.19	1.3
24	1.27	0.78	1.1	0.8	1.15	0.63	1.8	1.09	1.3
25	1.55	0.59	2.0	1.2	2.15	1.13	1.77	0.98	1.9
26	1.38	0.44	1.5	0.9	1.5	0.73	1.16	0.67	1.4
27	2.85	1.6	2.2	1.1	2.25	0.9	1.91	0.88	2.3
Annual average of total dust gauge network									1.5

KEY: IS Insoluble Solids
AR Ash Residue

Consequently recorded levels of deposited dust indicate that the mining operation at Rixs Creek has had no effect on ambient air quality and no exceedence of the nominal 4 gm/m2/mth, as an annual average, has been recorded.

As indicated previously a system of high volume air samplers are also located around the mine site and record total suspended particulates over a 24 hour period on a six day cycle. Background levels for total suspended particulates were not recorded prior to the commencement of mining operations.

Two limits are established for total suspended particulates. The USEPA 24 hour maximum TSP level of (260 $\mu g/m^3$) and the nominal annual average of 90 $\mu g/m^3$. Table 3 outlines the annual averages for total suspended particulates, that have been recorded at each monitor location.

TABLE 3
TOTAL SUSPENDED PARTICULATES
($\mu g/m^3$)

Gauge	Mean				
	1990	1991	1992	1993	Annual Average
Mines Rescue Station	38	61	51	48	50
Rixs Creek Lane	52	62	50	54	55
The Retreat	55	53	41	47	49

The recorded levels are all well below the nominal annual average and no individual 24 hour recording has exceeded the USEPA limit of 260 $\mu g/m^3$.

TABLE 4 PRE-MINING DUST DEPOSITION DATA g/m^2/month		
Gauge	Dust Deposition (Insoluble Solids)	
	Nov'81 to Oct'85	Nov'85 to Feb'85
1	2.14	2.51
2	4.34	1.04
3	1.77	0.85
4	2.71	1.30
5	2.24	1.48
6	2.55	1.26
7	4.22	1.15
8	2.0	0.73
9	1.89	0.78
10	1.94	0.89
11	2.11	1.46
12	1.72	0.96
13	1.90	1.31
14	2.20	1.76
15	-	1.43
16	-	1.30

Source: Table S5.10, Croft & Associates, 1989.

3.0 SURFACE WATER

The Environmental Impact Statement prepared by Croft & Associates, Volume 2, Study 5, stated the following when describing the pre-mine development, water quality of Rixs Creek:-

> *"Water in Rixs Creek is classified as highly saline and median concentrations of soluble salts indicate that there would be restrictions in its use. Analysis of the statistical data indicates a general increase in salinity in a downstream direction between Sites 3 and 4. This trend has been attributed to the presence of underlying marine Permian sediments which contribute large amounts of soluble material. Saline concentrations in Rixs Creek are quite similar to those previously presented for Bowmans Creek (Croft & Associates, 1986) and Glennies Creek".*

Results of water quality monitoring in Rixs Creek prior to mining showed considerable temporal variability. Much of the variability is due to fluctuations in hydro-meteorological conditions caused by drought during

1980-81 followed by wetter periods from 1985-88. Results demonstrate a flow dependent and roughly inverse relationship between suspended and soluble material concentrations. High concentrations of soluble salts (conductivities) and low concentrations of suspended material occur during low flow periods. After heavy rainfall, higher flows dilute soluble salts concentrations and also result in higher sediment concentrations from sheet and gully erosion.

The trend of the inversely proportional relationship between soluble salt concentrations and suspended solids has continued through the initial 5 years of mine operation. Due to the ephemeral nature of Rixs Creek and the predominantly dry weather conditions that have existed since 1989, the amount of time there has been flow in Rixs Creek is minimal.

Tables 5 and 6 below show the pre-mining and post mining water quality respectively. Sites 3 and 4 of the premining environment relate to current monitoring points on Rixs Creek at the New England Highway Bridge and Maison Dieu Bridge respectively. Post mining sample points are:

Sample Point 1A	Railway Underpass (as the creek enters the site)
Sample Point 2A	New England Highway Bridge (at the mid-point of the lease)
Sample Point 3A	Maison Dieu Bridge (as the creek leaves the site)

Sample points 4A, 5A and 6A are water storage dams on the lease.

Sample Point 1A is northeast of the mine operations and is thus not affected by mining operations. This point therefore creates an effective control.

The mine company currently holds a licence, under the Clean Waters Act, to discharge mine water. The discharge is limited to a maximum of 3 ML/day and is dependent upon specific water quality conditions and flow rates within the Hunter River. The mine however has only discharged 11.48 ML over six days during January and June of 1991.

TABLE 5 PRE-MINING WATER QUALITY, OCTOBER 1981 - FEBRUARY 1988				
	Site 1	Site 2	Site 3	Site 4
pH	7.25	7	7.3	7.3
Conductivity μS/cm	256	242	1313	2137
Suspended Solids (mg/L)	238	342	30	33
Turbidity (NTU)	190	216	21	20
Soluble Salts (mg/L)	158	178	754	1505
Chloride (mg/L)	35	26	301	473
Sulphate (mg/L)	20	24	62	216
Sodium (mg/L)	34	29	195	298
Calcium (mg/L)	3.1	5.8	23.6	34.5
Magnesium (mg/L)	5.4	6.0	30.9	66.6

TABLE 6 SURFACE WATER QUALITY						
	Site Number					
	1A	2A	3A	4A	5A	6A
1990						
pH	7.4	7.4	7.5	7.5	7.6	7.0
EC (μS/cm)	4289	1083	3607	237	232	162
TDS (mg/L)	2603	705	2277	193	215	270
NFR (mg/L)	36	64	58	79	81	125
1991						
pH	7.7	7.8	7.8	8.0	8.4	7.6
EC (μS/cm)	6505	3977	6964	509	470	310
TDS (mg/L)	3862	2440	4598	324	281	209
NFR (mg/L)	85	29	19	105	14	24
1992						
pH	7.8	7.6	7.8	8.1	8.0	7.7
EC (μS/cm)	5568	1743	4796	320	284	212
TDS (mg/L)	3296	1050	3052	210	227	196
NFR (mg/L)	26	48	34	26	68	231
1993						
pH	7.5	7.8	7.6	7.5	7.5	7.8
EC (μS/cm)	5582	2124	2924	320	297	221
TDS (mg/L)	3138	1226	1644	224	215	185
NFR (mg/L)	20	104	26	227	66	138

Key: EC = electrical conductivity
TDS = total dissolved solids
NFR = non filterable residue

The monitoring results for Sample Point 1A indicate the high concentrations of soluble salts that are present within Rixs Creek.

The corresponding results for Sample Point 2A, which is located mid-point of the mining lease and down-stream of the mining operation, for the period 1990-1993, indicate consistently lower levels of soluble salts. The level of soluble salts then increases, as results for Sample Point 3A indicate, as the stream proceeds further southwest.

Suspended solid results at the same sample points indicate the historically proven inverse relationship to soluble salt levels. The results for 1991 at Sample Point 1A are slightly anomalous for the level of suspended solids. The rainfall for 1991 has been the lowest recorded since the commencement of mining operations and the higher levels of suspended solids were due to the shallow nature of the sampling point and the occurrence of raised sediments while obtaining the sample.

The levels of pH at all sampling points has remained neutral.

Sites 2A and 3A from the current surface water monitoring programme are located in similar positions to Sites 3 and 4 of the pre-mining programme. This enables a comparison to be made of the quality of Rixs Creek prior to and after commencement of mining operations. Analysis of **Tables 5 and 6** indicate similar trends in water quality in both programmes with Rixs Creek exhibiting high to extremely high salinity levels. On average, suspended solids or non filterable residue levels have generally remained low with no significant increase with the mining operations.

Consequently the operations of Rixs Creek mine has not adversely affected the water quality of Rixs Creek. Water quality is flow dependent with the historically proven inverse relationship between soluble salt concentrations and non-filterable residue remaining.

4.0 GROUNDWATER QUALITY

Analysis of groundwater quality, collected at various locations within the Rixs Creek Lease are given in **Table 7**. The samples analysed indicate that the groundwater in the coal lease is of high salinity with electrical conductivities ranging from 4850 to 5900 μS/cm. The waters are therefore unsuitable for the majority of beneficial uses and are typical of those found in the marine sediments of the Hunter Valley other than for recycling through the coal preparation plant.

TABLE 7
GROUNDWATER QUALITY, RIXS CREEK LEASE

Parameter	Site and Date Sampled						
	A* 30/1/91	B 30/1/91	C 14/11/90	D 16/1/91	E 14/6/91	F 12/6/91	G 16/7/92
pH	8.7	6.5	6.3	8.3	7.3	8.6	8.6
TDS (mg/L)	3420	3430	3300	3450	4040	NA	3750
TSS (mg/L)	14	NA	25	1	50	35	15
Specific Conductance (μS/cm)	5050	5050	4850	5100	5900	5500	5430

Source: ACIRL/Bloomfield Collieries
Key: TDS = Total Dissolved Solids
TSS = Total Suspended Solids
*A = Mine Water Discharge
B = Old Shaft
C = Water From Old Workings
D = DWD2
E = Mine Water Discharge
F = DWD2
G = DWD2

5.0 NOISE

In accordance with the conditions of the development consent and license conditions established by the EPA, ambient noise level surveys have been undertaken at the four nominated locations around the mine site since December 1990. The four nominated

locations are:

1. "The Retreat" off Bridgeman Road
2. Maison Dieu Road
3. Singleton Heights
4. Middle Falbrook Road

The measurements are taken twice per year, during July and December.

Table 8 outlines the average noise levels recorded during the monitoring period.

TABLE 8
NOISE RESULTS dB(A)

Location	Reporting Periods	'90	'91		'92		'93	
		Dec	July	Dec	July	Dec	July	Dec
Bridgeman Road	Daytime L_{90}	33	37	36	32	39	33	36
	Night time L_{90}	33	32	33	28	42	29	42
Maison Dieu	Daytime L_{90}	33	31	33	34	34	23	35
	Night time L_{90}	40	33	32	30	34	26	32
Middle Falbrook Road	Daytime L_{90}	39	41	39	38	45	41	41
	Night time L_{90}	33	34	38	30	38	34	38
Singleton Heights	Daytime L_{90}	38	42	38	37	35	27	36
	Night time L_{90}	40	38	32	33	32	33	31

All noise readings are inclusive of extraneous noise such as bird and insect and any noise due to wind.

The EPA's "acceptable" goals for noise levels at a residence in a rural residential area (as applies to this area) are set at:

L_{A90} = 45 dB(A) day
L_{A90} = 35 dB(A) night

The Commissioners of Inquiry report went further to refine background noise level goals for the area. Of those readings taken during the period of the Inquiry the readings made by

the council were considered to be "typical" for the area. Daytime design goals were based on the typical minimum background reading plus 5 dB(A). These goals were set at:

Bridgeman Road	38 dB(A)
Singleton Heights - Sth	40 dB(A)
Singleton Heights - Nth	40 dB(A)
Maison Dieu Road	38 dB(A)

These goals are more stringent than the EPA's 'standard goals' as specified in the "Noise Control Manual" (1986). They do not reflect the goals under 'worst-case' meteorological conditions (see discussion on Pages 170 and 171 of the Commissioners' report (1989).

All daytime (07:00 to 22:00) noise level readings were within the 'acceptable goals' established by the EPA.

The recordings for the night-time (22:00 to 07:00) however exceeded the EPA goal at one or more of the locations during each of the monitoring periods. The mine however has not been operating during the night-time hours other than for the December monitoring period of 1993. The night-shift that commenced in October 1993 finishes at 01:30.

All exceedences of the night-time noise level have occurred during the summer monitoring period and the recordings have been consistent prior to and after the commencement of the night shift. It appears that the elevated noise levels are due to insect, bird and wind noise as the majority of higher recordings are in the rural and rural residential areas of Middle Falbrook Road and The Retreat.

The initial two recordings in Singleton Heights also exceeded the EPA's acceptable goals for night-time noise levels. The monitor location for these recordings were at the Mines Rescue Station which is in close proximity to the main Northern Rail line. The monitor for subsequent recordings has been positioned approximately 500 m northeast of the mines rescue station and a more consistent result has been recorded.

Study 9 of the Environmental Impact Statement prepared by Croft & Associates outlined maximum sound power level for individual items of plant. Quarterly assessment of the sound power levels of equipment on site has shown that the levels are consistently lower than the levels outlined in the EIS.

Consequently the operation of the mine has not adversely affected the pre-mining ambient noise level and has operated within the acceptable noise goals established by the EPA.

6.0 BLAST NOISE AND VIBRATION

Production blasting at Rixs Creek Mine commenced during May 1991. Up until the end of 1993, 135 blasts had been initiated in the mining area on the northern side of the NEH.

The initial twelve (12) blasts were in the area adjacent to the NEH and within 500 m of the highway. The remainder of the blasts, until the end of 1993 were not within 500 metres of the NEH and were within the area that approximates mining blocks 6, 7, 8, 9, 10 & 11 (Reference EIS Figure 21).

During the initial twelve (12) blasts, the highway was closed with the approval of the RTA, for the duration of the blast and the period there-after during which an inspection of the area was carried out to check for misfires and determine that the area was safe. All blasts have been monitored at one or more of the following locations, to determine the level of vibration and overpressure as a result of the blasting procedure.

1. Rixs Creek Lane
2. Singleton Heights
3. Middle Falbrook Road
4. Bridgeman Road
5. New England Highway

As a condition of development consent, the coke oven structures were monitored to

determine the effects of blasting and a subsequent report submitted to the Council and the Heritage Council.

The blast design was determined, after a number of test blasts, with the assistance of Australian Blasting Consultants and ICI Explosives.

Blast monitoring outside the area of affectation has indicated that no adverse affects due to vibration and overpressure are being experienced. One complaint has been received regarding overpressure. This occurred on the 15.09.93 and was the result of inadequate stemming to one blast hole. The actual level of sound blast could not be determined due to monitor failure.

The situation has been rectified and no further complaints nor exceedences of the permissible limits have occurred.

APPENDIX 10:

PROPOSALS FOR THE MANAGEMENT OF IMPACTS

Bloomfield Collieries Pty Limited (Bloomfield), the applicant for proposed extension/modification of open cut mine operations at Rixs Creek Coal Mine includes in its proposals the following conditions for the control and amelioration of impacts introduced by the mine development and operation. They include some of the conditions set out in the development consent for Rixs Creek Coal Mine of 19 October 1989, issued by the then Minister for Planning. Some of the conditions from the same consent are not included because they have been fulfilled; each condition has its present status described in **Appendix 3**.

In order to manage impacts of the proposed mining operations, Bloomfield Collieries proposes that it will undertake the following:

General

1. The development is to be carried out generally in accordance with this Environmental Impact Statement (EIS).

Duration

2. This consent shall lapse 21 years from the date of issue of a Mining Lease pursuant to Mining Lease Application No. 17 Singleton (ACT 1992).

Water Supply

3. Bloomfield shall obtain all necessary approvals from the Department of Water Resources for importation of water to the site.

Landscaping

4(a) Within 6 months of the date of granting this consent or within such further period as the Council may permit, the Bloomfield shall submit for the Council's approval:

i. A detailed landscaping and land use plan covering all portions of land within the proposed coal lease area. Bloomfield shall engage a qualified landscape architect to assist in the landscape design. The plan shall provide for the establishment of trees and shrubs during the construction stage and shall also address the disposal of solid wastes from colliery operations. The plan shall incorporate appropriate erosion control and sedimentation control practices for any earthworks associated with the development.

ii. proposals for the visual appearance of the structural components of the development including paint colours and specifications. Buildings and structures shall be designed so as to present a neat and orderly appearance and to blend as far as possible with the surrounding landscape.

iii. a comprehensive plan of landscape management which shall include detailed plans, specifications and staged work programs to be undertaken, maintenance of all landscape works and plantings, and maintenance of building materials and cladding.

Visual Amenity

5. Bloomfield shall comply with the requirements of Singleton Council in respect to any supplementary tree planting and visual amenity enhancement works immediately outside the proposed coal lease area, which may be identified by the Council as necessary for the maintenance of a satisfactory visual amenity in the local area.

Off-Site Affects

6(a) In the event that the impact of dust or noise from the mining operations at residences is in excess of the amenity or health criteria of the Environment Protection Authority (EPA), Bloomfield shall undertake such works or change mining practices so as to achieve the EPA's amenity criteria. If the EPA then ascertains that such works or

changes to mining practices have not resulted in compliance with its criteria subject to Condition 26, then Bloomfield shall be required to purchase the affected land on a mutually agreed basis or by reference to Sub-Clause (b) immediately following.

6(b) In respect of a request to purchase land arising under subclause (a) Bloomfield shall:

i. Pay all owners not less than market value for the land having regard to existing use of the land whosoever is the occupier and all improvements thereon as if the land was unaffected by the proposed development. The provisions of this subclause do not apply to the holder of a lease under the Mining Act, 1992 or authorisation or concession under the Coal Mining Act 1973.

ii. Pay the owners reasonable compensation for disturbance and relocation within the Singleton local government area.

iii. Pay the owners reasonable costs for obtaining legal advice and expert witnesses for the purpose of determining the purchase price of the land and the terms upon which it is to be acquired.

6(c) In the event that Bloomfield and any owner referred to in subclause (b) herein cannot agree within six months upon the purchase price of the land and/or the terms upon which it is to be acquired, then:

i. either party may refer the matter to the Director of the Department of Planning ("the Director") who shall request the President for the time being of the NSW Division of Australian Institute of Valuers and Land Managers Inc. or his nominee to appoint an independent valuer who shall determine the current market value of the land as if it was not affected by the proposed development, together with the amount of costs and compensation referred to in subclause (b) herein;

ii. Bloomfield shall bear the costs of any valuation assessment requested by the

Director in accordance with subclause (i) herein;

iii. upon receipt of a valuation arising pursuant to subclause (i) herein, Bloomfield shall offer to purchase the relevant land at a price not less than the said valuation. Should Bloomfield's offer to purchase not be accepted by an owner within six months of the date of such offer, Bloomfield's obligations to such owner pursuant to this subclause shall cease;

iv. upon settlement of a purchase referred to in this subclause Bloomfield shall also pay to the owner the costs and compensation assessed pursuant to subclause (c) herein including the owner's reasonable costs in the event of a subdivision.

6(d) Once the conditions of 6(a), 6(b) and 6(c) have been complied with they shall not be reapplied for the duration of the development consent.

Specific Affected Lands

7(a) In addition to any land required to be purchased by Condition 6:

i. Bloomfield shall within six months of the receipt of a request to purchase land identified as being within the area of affectation defined in the development consent for Rixs Creek Coal Mine of 19 October 1989 and owned by any of:

R. Eveleigh
Wendy Bowman
Bowman Family Trust
I.H. Bowman Estate
Alistair Stuart Bowman
Canravo Pty Limited
Elizabeth S. Bowman
Keith Heuston Pty Limited

purchase such land.

7(b) In respect of a request to purchase land arising under subclause (a)(i) Bloomfield shall:

i. Pay all owners not less than market value for the land having regard to existing

use of the land whosoever is the occupier and all improvements thereon immediately prior to the granting of the consent as if the land was unaffected by the proposed development. The provisions of this subclause do not apply to the holder of an authorisation or concession under the Coal Mining Act 1973 or a Mining Lease under the Mining Act 1992;

ii. Pay the owners reasonable compensation for disturbance and relocation;

iii. Pay the owners reasonable costs for obtaining legal advice and expert witnesses for the purpose of determining the purchase price of the land and the terms upon which it is to be acquired;

7(c) In the event that Bloomfield and the owner cannot agree within the time limit upon the purchase price of the land and/or the terms upon which it is to be acquired, then the following shall apply:

i. either party may refer the matter to the Director of the Department of Planning ("the Director") who shall request the President for the time being of the NSW Division of Australian Institute of Valuers and Land Managers Inc. or his nominee to appoint an independent valuer who shall determine the current market value of the land as if it was not affected by the proposed development, together with the amount of costs and compensation referred to in subclause (ii) herein;

ii. Bloomfield shall bear the costs of any valuation assessment requested by the Director in accordance with subclause (i) herein;

iii. upon receipt of a valuation arising pursuant to subclause (i) herein, Bloomfield shall offer to purchase the relevant land at a price not less than the said valuation. Should Bloomfield's offer to purchase not be accepted by an owner within six months of the date of such offer, Bloomfield's obligations to such owner pursuant to this Clause shall cease;

iv. upon settlement of a purchase referred to in this clause Bloomfield shall also pay to the owner the costs and compensation assessed pursuant to subclause (iii) herein including the owner's reasonable costs in the event of a subdivision.

7(d) Once the conditions of 7(a), 7(b) and 7(c) have been complied with they shall not be reapplied for the duration of the development consent.

Crown Lands

8. Prior to commencement of mining, Bloomfield shall negotiate with the Department of Conservation and Land Management for purchase by Bloomfield of any Crown Lands within the coal lease area.

Environment Protection Authority Approvals

9. Prior to the commencement of construction of the proposed development, Bloomfield shall obtain from the EPA all statutory approvals and licences as may be required under the Clean Air Act 1961, the Clean Waters Act 1970 and the Noise Control Act 1975 together with such other approvals or licences as may be required under future legislation or regulations for the conduct of the proposed development. Bloomfield shall conduct the development in accordance with the terms of such approvals and licences.

Public Authorities

10. Bloomfield shall meet the requirements of all public authorities having statutory responsibilities in respect of the proposed development.

Noise Control

11. i. Bloomfield shall comply with the L_{10} daytime noise level design goals set out below using "worst case" conditions for the following areas, as follows:

The Retreat	42 dB(A)
Singleton Heights	42 dB(A)
Maison Dieu Road	38 dB(A)

ii. Bloomfield shall comply with the L_{10} night-time noise level design goals set out below using "worst case" conditions for the following areas, as follows:

The Retreat	40 dB(A)
Singleton Heights	40 dB(A)
Maison Dieu Road	38 dB(A)

Tailing Dams

12. Bloomfield shall meet the requirements of the Conservation and Land Management (CALM) in respect of the design, construction, maintenance and filling of any tailings dams at the site.

Rixs Creek Diversion

13. i. Bloomfield shall liaise with the Department of Water Resources and CALM and meet their requirements for the design, construction and maintenance of any diversion of Rixs Creek.

ii. Bloomfield shall not divert Rixs Creek in the southern mining area.

iii. Bloomfield shall not mine within 20 m of the bank of Rixs Creek in the southern mining area.

Blasting

14. i. Bloomfield shall not blast within 500 m of the New England Highway or any approved deviation of the highway while either are open for traffic.

ii. Bloomfield shall design all blasts to minimise airblast overpressure and vibration using the NONEL system or equivalent.

iii. Bloomfield shall design all blasts based on the results of monitored blasts designed to minimise airblast overpressure and vibration using the NONEL system such that any one blast has less than a 5 per cent probability of exceeding airblast overpressure and vibration design goals as set by the EPA for affected property excluding historic buildings.

iv. Bloomfield shall determine the appropriate weather data by taking measurements immediately prior to blasting and from that data shall predict whether noise levels outside the limit predicted in this EIS of the area in which the EPA's noise goals may be exceeded, are likely to be increased above the levels expected under neutral meteorological conditions. The said data shall be recorded by Bloomfield as part of its monitoring data.

v. Bloomfield shall not blast if the predictions in subclause (iv) herein indicate that the EPA's noise goals (excluding those for historic buildings) are likely to be exceeded.

vi. Bloomfield shall monitor all blasts, to the satisfaction of the Department.

vii. Bloomfield, in respect of the coke ovens structure, shall:

(a) monitor the effects of blasting on the coke ovens structure in such a manner that the peak particle velocity received by the coke ovens structure is able

to be related to any observable structural damage occasioned to the ovens. Should damage become evident, Bloomfield shall appropriately modify the blasting techniques.

(b) Submit a report detailing the effects of blasting on the coke ovens structure to the Council and the Heritage Council at three monthly intervals or as otherwise agreed to by the Council and the Heritage Council

Flood Lighting

15. Bloomfield shall construct flood lighting to mitigate direct sight lines of on-site flood lighting and vehicle headlights onto dwellings to the satisfaction of the Council. Direct flood lighting shall not be directed to dwellings.

Transmission Lines

16. Bloomfield shall undertake the relocation of any electrical transmission lines which may be required due to the operations of the proposed development to alignments satisfactory to the Shortland County Council.

Environmental Monitoring - General

17. i. Bloomfield shall undertake and implement environmental monitoring in respect of soil rehabilitation as may be required by CALM and the Department of Mineral Resources ("the Department") and in respect of ground water levels and quality, as may be required by the Department of Water Resources.

ii. Bloomfield shall ensure that all environmental safeguards proposed for the development and required by this consent and other statutory approvals are enforced.

iii. Bloomfield shall provide to the Department, the EPA and Singleton Council for public release, results and analyses of environmental monitoring undertaken in pursuance of the provisions of subclause (i) herein and clause 18 herein. Such

results and analyses shall be provided on a quarterly basis, for review by the EPA.

Annual Report

18. i. The annual report shall provide the following information and shall be in respect of the calendar year ending 31 December:

(a) the performance of the development, including , but not limited to:
* records of the monthly production of raw and clean coal, coal dispatches, coal stocks held;
* noise and dust isopleths based on records of monitoring in the year of report and previous years;
* lands owned, acquired and sold;
* current approved mining plans (including the time sequence of mining) and those currently proposed for the term of the consent, mining and coal preparation equipment and plant in use, acquired or planned for introduction.

(b) the implementations and effectiveness of the environmental controls and conditions relating to the development;

(c) results of environmental monitoring in respect of air, water and noise pollution;

(d) mining operations undertaken during the preceding 12 months;

(e) workforce characteristics of the development;

(f) modifications to mining operations, if any, to mitigate any adverse environmental impacts.

Environmental Monitoring - Specific Requirements

19. i. Bloomfield shall install and utilise a wind direction and velocity monitoring and recording station, the location of which shall be arranged by agreement between

the EPA and Bloomfield.

ii. Bloomfield shall relocate the wind monitoring and recording station referred to in clause (i) as directed by the EPA.

iii. Bloomfield shall install dust deposition gauges and in each calendar month shall determine the dust deposition rate in gm/m^2/mth such that the +2 gm/m^2/mth incremental isopleth for deposited dust is able to be plotted on an annual basis, with baseline defined by the EPA.

iv. Bloomfield shall measure and identify the L_{90} and L_{10} noise levels over a 72 hour period at least twice per year such that the 42 dB(A) and 38 dB(A) daytime and 40 dB(A) and 38 dB(A) night-time noise levels are able to be reported in respect of the area from The Retreat through Singleton Heights to the location where Maison Dieu Road crosses Rixs Creek.

v. Bloomfield shall analyse to the satisfaction of the EPA all waters other than uncontaminated stormwater to be discharged from the mining, coal preparation or water storage areas of the mine site.

vi. Bloomfield shall obtain the prior approval of the EPA before discharging of any waters other than uncontaminated stormwater from the mining, coal preparation or water storage areas of the mine site.

Air Quality

20. Bloomfield shall cease all mining operations at any time when visibility is impaired on the New England Highway as a result of mining operations in accordance with the requirements of Singleton Council.

Dust Suppression

21. Bloomfield shall:

i. Maintain sufficient equipment with the capacity to apply water to all trafficked areas at the rate of at least one litre per square metre per hour;

ii. ensure the rehabilitation of all disturbed areas as soon as practicable to minimise the generation of wind erosion dust and in accordance with the requirements of the Department of Mineral Resources.

Environmental Officer

22. Prior to the commencement of any construction or operations in the coal lease application area Bloomfield shall appoint an on-site environmental officer responsible directly to the Mine Manager, whose qualifications are to the satisfaction of the Department.

Water Management

23. i. Bloomfield shall liaise with those landowners who presently use water from Rixs Creek to ascertain the full range of uses of the water and to then formulate in conjunction with relevant government bodies, a water management plan for Rixs Creek, which takes account of those uses.

ii. Bloomfield shall obtain the approval of the EPA for the water management plan referred to in subclause (i) herein before commencement of mining.

Financial Contributions

24. Bloomfield shall pay a financial contribution to Singleton Council, pursuant to

Section 94 of the Act.

In the event that Bloomfield and Singleton Council cannot agree on the total amount of such contribution, Bloomfield will request the Minister to determine the said amount, after referring the dispute to a Commissioner of Inquiry and after receiving the Commissioner's recommendations.

Production Levels

25. Mining plans approved by the Department shall be based on a total movement of materials in mining not exceeding 15 million bank cubic metres per year.

Participating in Coal Industry Projects

26. Bloomfield shall participate in any financial arrangements (including financial arrangements with other coal industry members) in accordance with the requirements of the Government of New South Wales for sharing the capital costs of infrastructure such as rail rolling stock, rail track, coal loader and other related infrastructure to be used jointly by participating coal industry members.

Dispute Resolution

27 (a) In the event that Bloomfield and Singleton Council or a government body, other than the Department, cannot agree on the specification of requirements applicable under this Consent, other than provided for in Clause 23, the matter shall be referred to the Director whose determination of the disagreement shall be final and binding on the parties.

(b) In the event that Bloomfield refuses to modify mining methods or to buy a property pursuant to Condition 6 on the grounds that EPA criteria are not exceeded, Bloomfield will request that the Director establish an Affectation

Assessment Panel, which shall comprise one representative each nominated by the Director, Bloomfield, Singleton Council and the Environment Protection Authority.

i. The Chairperson on the Panel will be a representative of the Director.

ii. The Panel shall meet as directed by the Chairperson.

iii. The Panel shall have the power to co-opt representatives from other relevant bodies, authorities or persons where necessary.

iv. Bloomfield shall refer to the Chairperson of the Panel all complaints it has received with respect to affectation by dust or noise.

v. The Panel shall by reference to the monitoring data provided in accordance with Condition 16 consider whether a complaint is of an affect exceeding the EPA's criteria.

vi. The Panel shall in respect of such a complaint request Bloomfield to implement within a stipulated period of time such remedial action as it considers appropriate.

vii. The Panel shall at the expiration of 12 months from the date of making the above request to Bloomfield consider the effect of any remedial action of the affectation.

viii. Where the Panel considers that Bloomfield has been unsuccessful in carrying out such a remedial action so as to rectify the cause of the affectation, then the affected resident experiencing the affectation, may lodge with the Panel a request for Bloomfield to either acquire the affected resident's land or to pay out adequate compensation to the affected resident

to enable reasonable ameliorated measures to be carried out to the affected residence so as to reduce the affectation.

ix. The Panel shall consider the request from any affected resident by taking into account the following:

(a) All environmental reports prepared pursuant to Condition 17.

(b) Any recommendations from the Environmental Committee.

(c) Any other matters which the Panel considers relevant.

x. Where the Panel decides that the request from the affected resident is properly based upon an exceedence of the EPA criteria, it shall inform the affected resident and Bloomfield of its decision in writing and those parties shall act in accordance with Condition 6.

Environmental Committee

28. (a) Bloomfield shall participate and co-operate in the establishment by Singleton Council of an Environmental Committee to monitor compliance with conditions of this consent during the term of the development;

(b) Bloomfield shall at its own expense:

i. nominate a representative to attend all meetings of the Environmental Committee;

ii. provide an Annual Report to all members of the Environmental Committee detailing the following:

1. measures Bloomfield has adopted and the resources Bloomfield has utilised over the preceding 12 months to ensure compliance with monitoring conditions;

2. monitoring data as part of the report which includes interpretation and discussion by a suitably qualified person;

3. wind data and results of dust and noise/vibration monitoring programmes and the surface/groundwater monitoring programme.

iii. promptly provide to the Environmental Committee such other information as the Chairman of the Environmental Committee may reasonably request concerning compliance with a condition of this consent or the environmental impact of the development;

iv. the committee shall meet on an annual basis in April of each calendar year. Members of the committee shall be provided with a copy of the Annual environmental Report one (1) week prior to the meeting.

Other Approvals

29. Bloomfield will obtain any other approval under the Local Government Act 1993 as amended, the Ordinance made thereunder including approval of building plans, or any other act.

APPENDIX 11:

VISUAL IMPACT ASSESSMENT

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LIST OF FIGURES:

INTRODUCTION

In order to assess the potential visual impacts associated with the proposed development, Select Mining Services Pty Limited have generated perspective views of the mine at various stages of the development.

The computer generated images are "worst case" examples of views of the project from selected vantage points. These images are "worst case" as they do not take into consideration existing vegetation that ameliorates both the current and potential future views of the site. Additionally cross sections from similar points to the perspective view have been generated to provide a schematic representation of the visual impacts. Finally photographs of the existing views have been included to indicate the extent of existing vegetation that currently shields views into the site.

METHODOLOGY

Five viewing locations were selected to provide a representative coverage of areas of potential visual impacts. These locations are shown on **Figure 1** and include:

- View Point 1 - Singleton Heights
- View Point 2 - Bridgeman Road
- View Point 3 - On New England Highway, northwest of lease
- View Point 4 - Maison Dieu Road
- View Point 5 - On New England Highway at centre of proposed mining operations (intersection of Highway and Middle Falbrook Road)

A visual impact assessment has been undertaken for both the proposed conceptual mine plan as well as the alternative (reduced) mine plan as described in **Section 6.4**. **Figures 2A** to **7B** illustrate the results of this assessment.

The majority of the images are shown at ground level + 2 m. However, in some instances aerial shots have been included to further demonstrate theotential impacts and these have been marked accordingly. For example for View Point 1 no pits or dumps were visible

from Singleton Heights. An aerial view was therefore taken to determine at what height the workings would be visible.

For View Point 3 additional shots to the left and right have been taken to cover the field of view. The central azimuth was 130 degrees, left and right views were directed at azimuths of 125 degrees and 145 degrees respectively.

Figure 8 illustrates cross sections from the view points at a natural scale.

Key to Images:

Yellow line	=	lease boundary
White dashed line	=	railway line
Light Green	=	original topography
Dark Green	=	rehabilitated areas
White	=	pit excavation
Cream	=	active dump

VISUAL IMPACTS

Figures 2A and 2B illustrate views from Bridgman Road across to the centre of the lease. **Photograph A** provides a similar perspective of the existing view. These figures indicate that residents in this vicinity will experience views of the large out-of-pit overburden dump associated with Pit 1 as it is being developed between Years 8 and 15. Existing scattered mature vegetation (**Photograph A**) will obscure this view slightly.

Figure 3 illustrates views from Singleton Heights towards the mine. The mine is currently shielded from the residential areas of Singleton and will continue to be so in the future. This is as a result of an intervening ridgeline. Elevated views of the mine have been generated to illustrate this point (refer to **Figure 3**).

Figures 4A and 4B represent views from Maison Dieu Road towards the centre of the lease. **Photograph B** provides a corresponding existing view. Residences and travellers along Maison Dieu Road will be able to see the mine's initial development with open cut

workings progressing in a westerly direction. The mining plan incorporates the formation of two out-of-pit overburden dumps on the southern limit of the disturbed area. These will be revegetated as soon as final contours are achieved. These spoil dumps will then provide a permanent screen between the mine operations and view points to the south. Forward tree planting will also be undertaken on selective areas south of the proposed spoil dumps to screen views to the disturbed areas and to reduce the severity of visual impacts.

The remainder of the figures (**5A, 5B, 6A, 6B, 7A and 7B**) illustrate varying views along the New England Highway. For travellers proceeding north along the Highway views of the workings will be obtained on both the left and right (refer to **Figures 5A and 5B**). **Photographs C and D** indicate that existing tree coverage is relatively sparse in this area and will not effectively shield the operations.

Figures 6A, 6B, 7A and 7B illustrate views for travellers proceeding south. **Photographs E and F** show corresponding current views. The figures indicate that extensive views of the pits will be obtained, especially to the left of the Highway (**Figures 7A and 7B**), however, a comparison with **Photograph F** indicates that extensive stands of existing mature vegetation which is located within the 100 m barrier will help ameliorate these potential "worst case" impacts.

A comparison between the original mine plan to that of the alternative (reduced) plan indicates that as a result of the reduced pit depths and subsequent reduction in out-of-pit overburden dumping the visual impacts are substantially reduced.

AMELIORATIVE MEASURES

As a result of the visual impact assessment three areas have been identified that will benefit from forward tree planting and the construction of bunds to reduce visual impacts. Rixs Creek propose that they will undertake the following:

(i) Tree planting along the ridgeline between Singleton Heights and the development from the water storage reservoir running north along the Main

Northern Rail line to the lease boundary. This would help to screen views of the developing mine from Bridgeman Road.

(ii) Bunding and screen planting within 100 m barrier of New England Highway to reinforce the existing tree coverage.

(iii) Tree planting along the ridge of the initial out-of-pit dump at the extremity of Pit 2. This will aid in shielding views from the Maison Diéu area.

Photograph A: View Point 2 looking to View Point 5 (Bridgman Road to centre of lease). Corresponds to **Figures 2A and 2B**.

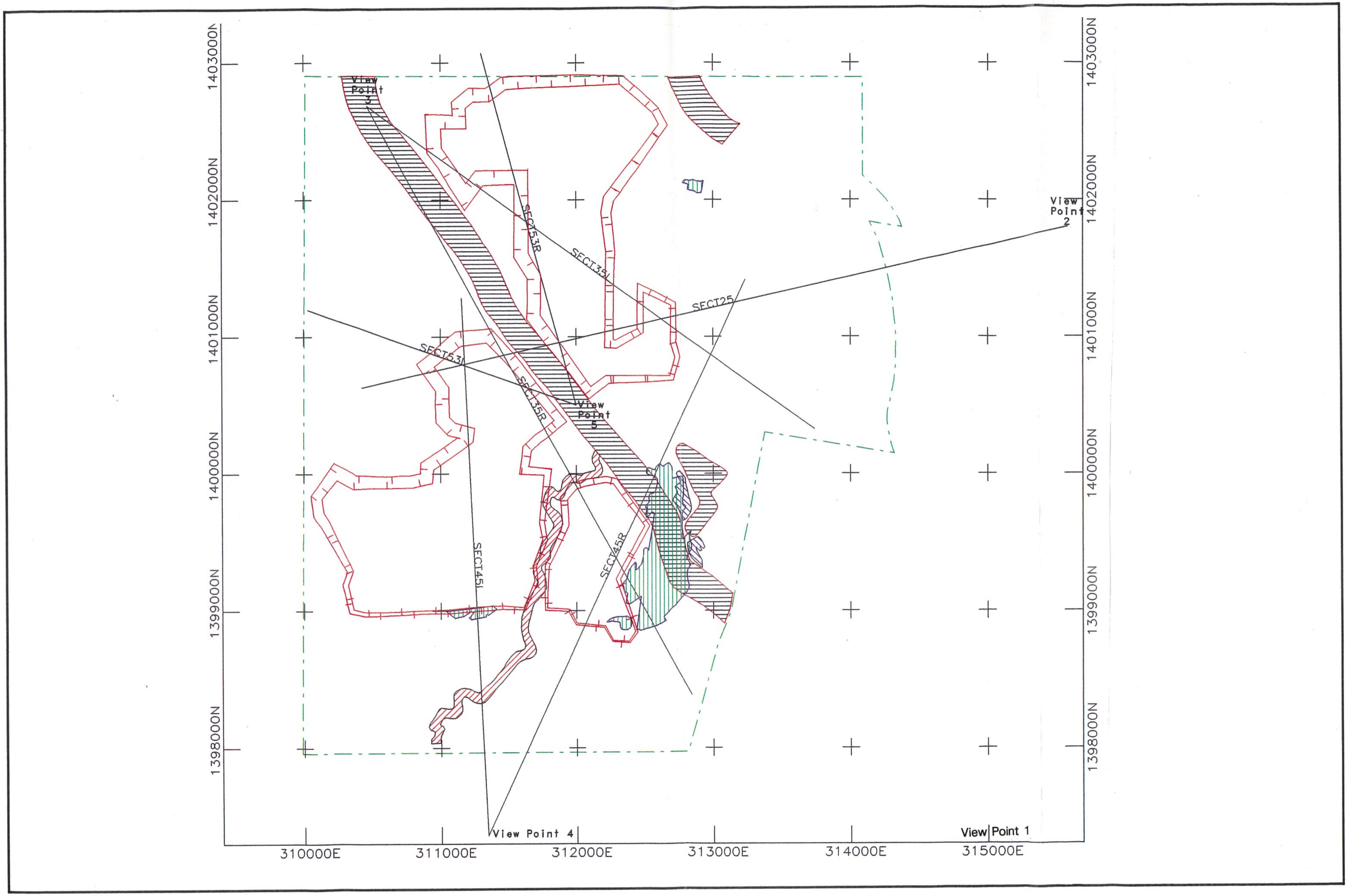
Photograph B: View Point 4 looking to View Point 5 (Maison Dieu Road looking to centre of lease). Corresponds to **Figures 4A and 4B**.

Photograph C: View Point 5 looking right towards View Point 3 (centre of lease looking right/north). Corresponds to **Figures 5A and 5B**.

Photograph D: View Point 5 looking left towards View Point 3 (centre of lease looking north/left). Corresponds to **Figures 5A and 5B**.

Photograph E: View Point 3 looking right to View Point 5 (northwestern corner of the lease looking right to centre of the lease). Corresponds to **Figures 6A and 6B**.

Photograph F: View Point 3 looking left to View Point 5 (northwestern corner of lease looking left to centre of lease). Corresponds to **Figures 7A and 7B**.



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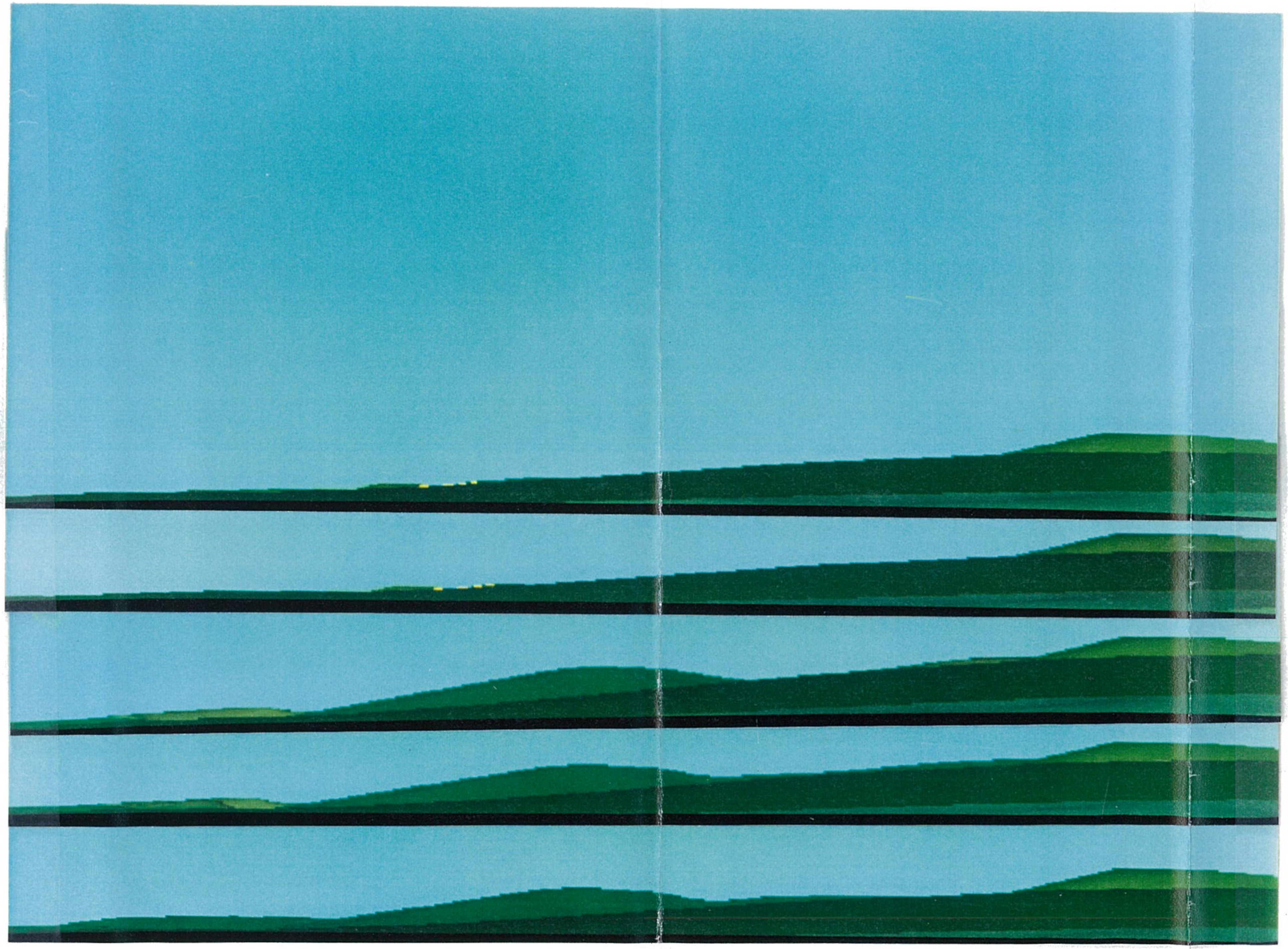
PLAN SHOWING LOCATIONS OF SECTION LINES CORRESPONDING TO VIEW DIRECTIONS FROM EACH VIEW LOCATION

FIG. 1

BRIDGMAN ROAD LOOKING ACROSS
LEASE TO NEW ENGLAND HIGHWAY



YEAR 1

YEAR 8

YEAR 15

YEAR 22

END

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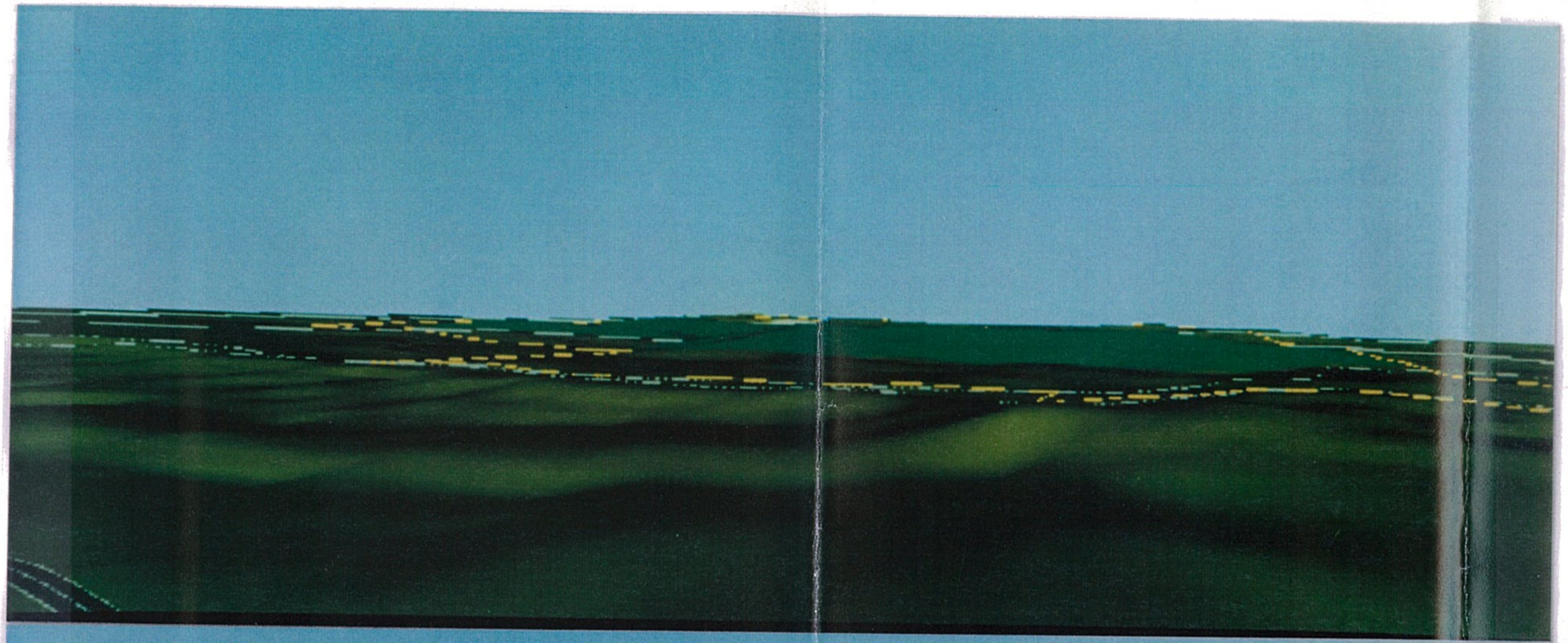
VIEW POINT 2 LOOKING TO VIEW POINT 5
ORIGINAL MINE PLAN

FIG. 2a

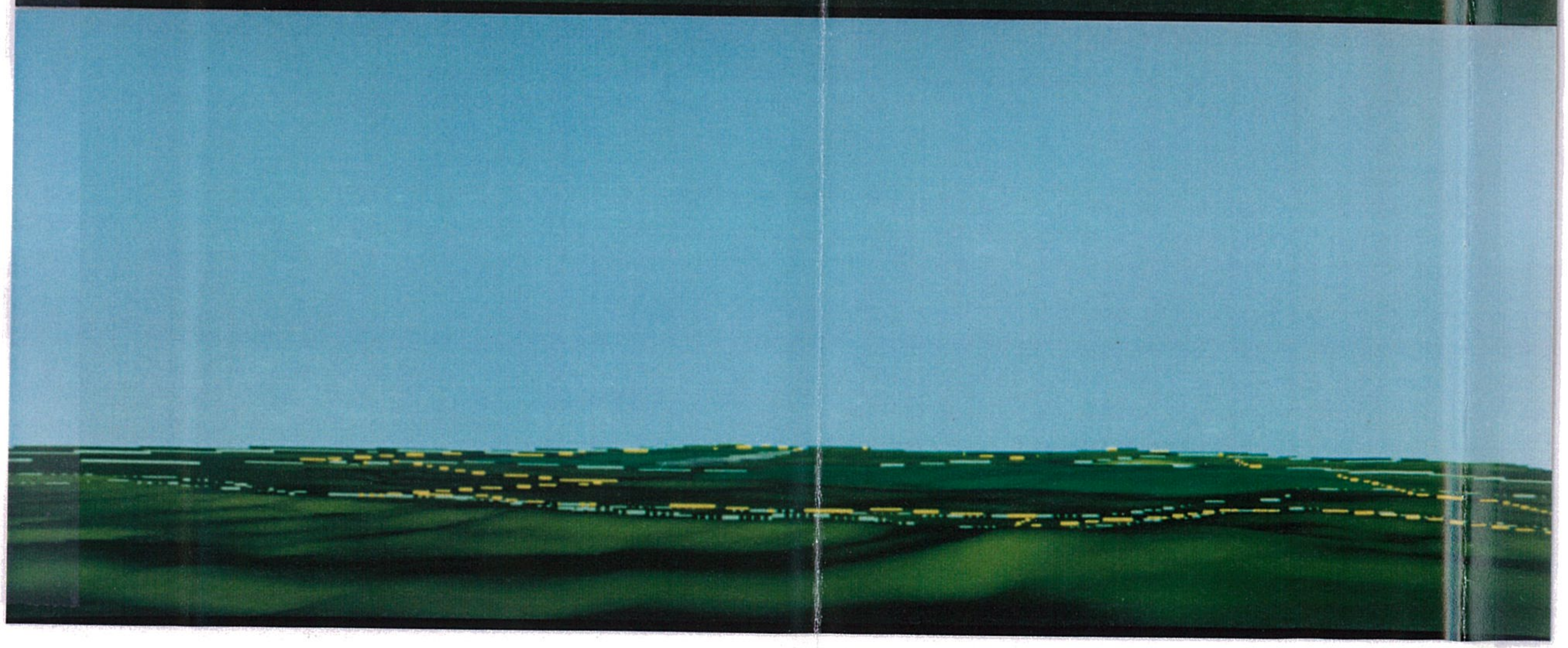
BRIDGMAN ROAD LOOKING ACROSS LEASE TO NEW ENGLAND HIGHWAY



ORIGINAL MINE PLAN

END OF MINE LIFE

+100m ELEVATION



ALTERNATIVE MINE PLAN

END OF MINE LIFE

+ 100m ELEVATION

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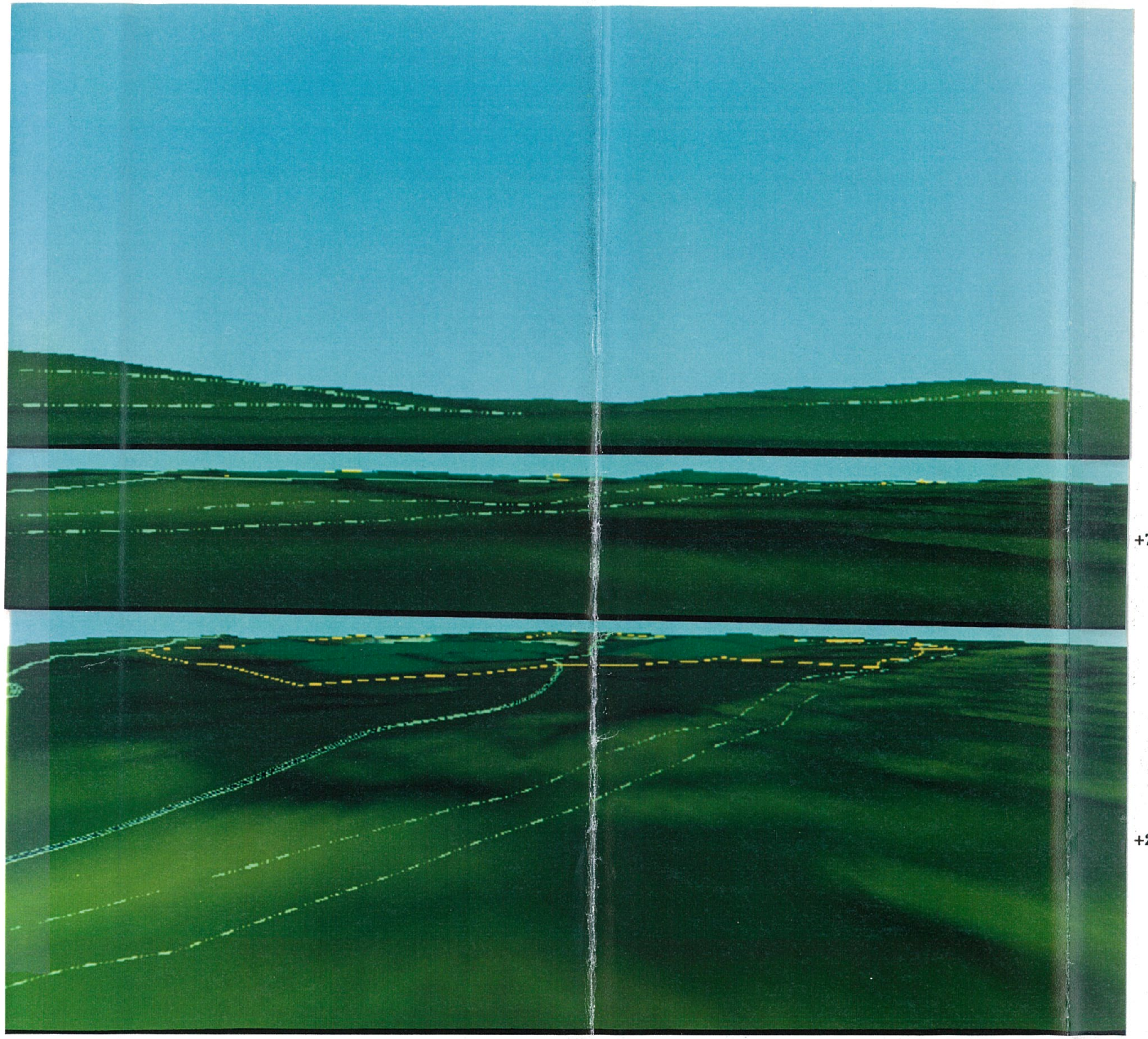
VIEW POINT 2 LOOKING TO VIEW POINT 5
ELEVATED

FIG. 2b

SINGLETON HEIGHTS TO
MID POINT OF LEASE



END

+70m ABOVE GROUND SURFACE

+200m ABOVE GROUND SURFACE

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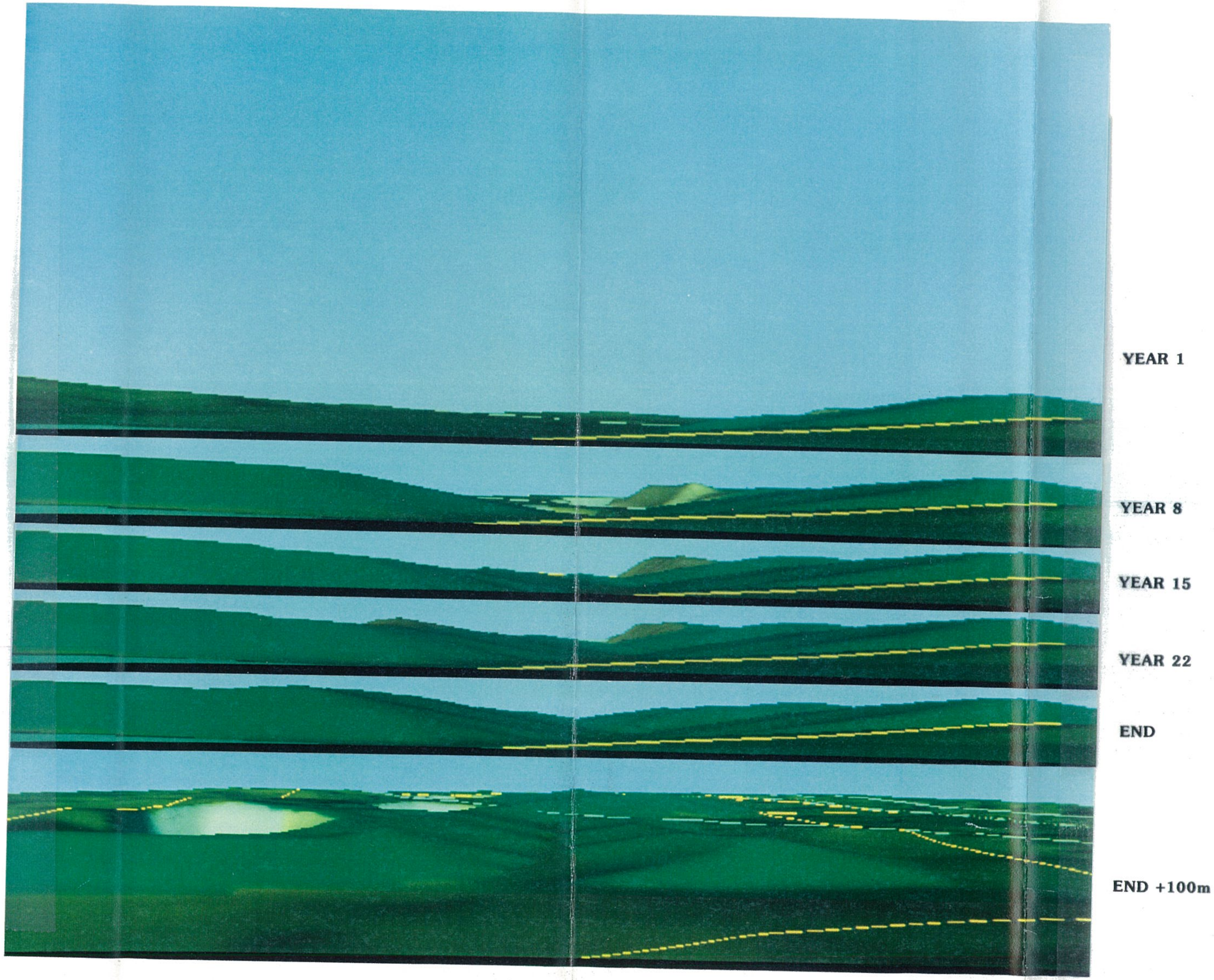
VIEW POINT 1 LOOKING TO VIEW POINT 5
ORIGINAL MINE PLAN

FIG. 3

MAISON DIEU ROAD TO
CENTRE OF LEASE



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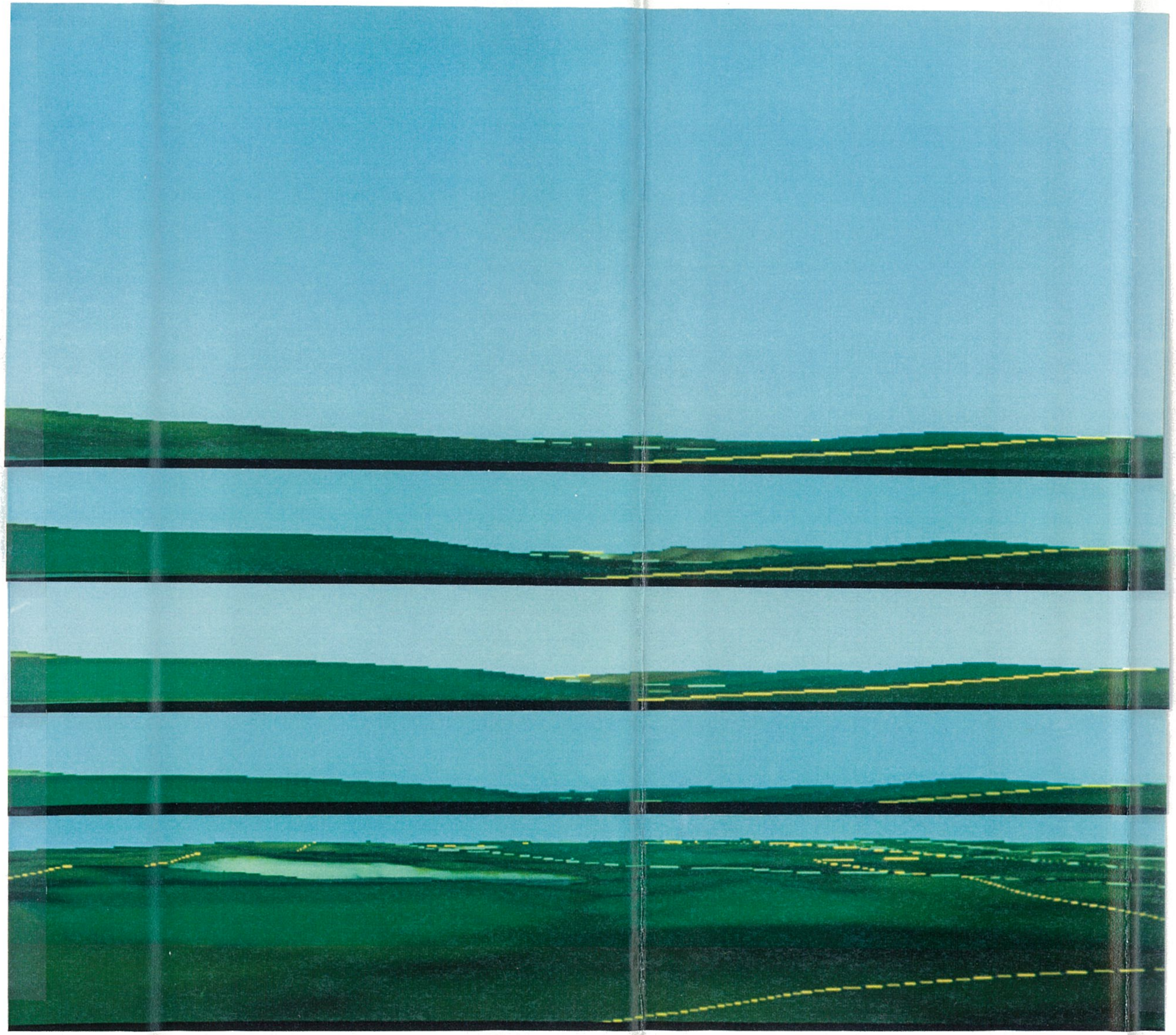
VIEW POINT 4 LOOKING TO VIEW POINT 5
ORIGINAL MINE PLAN

FIGURE 4a

MAISON DIEU ROAD TO CENTRE OF LEASE



YEAR 1

YEAR 8

YEAR 15

YEAR 22(END)

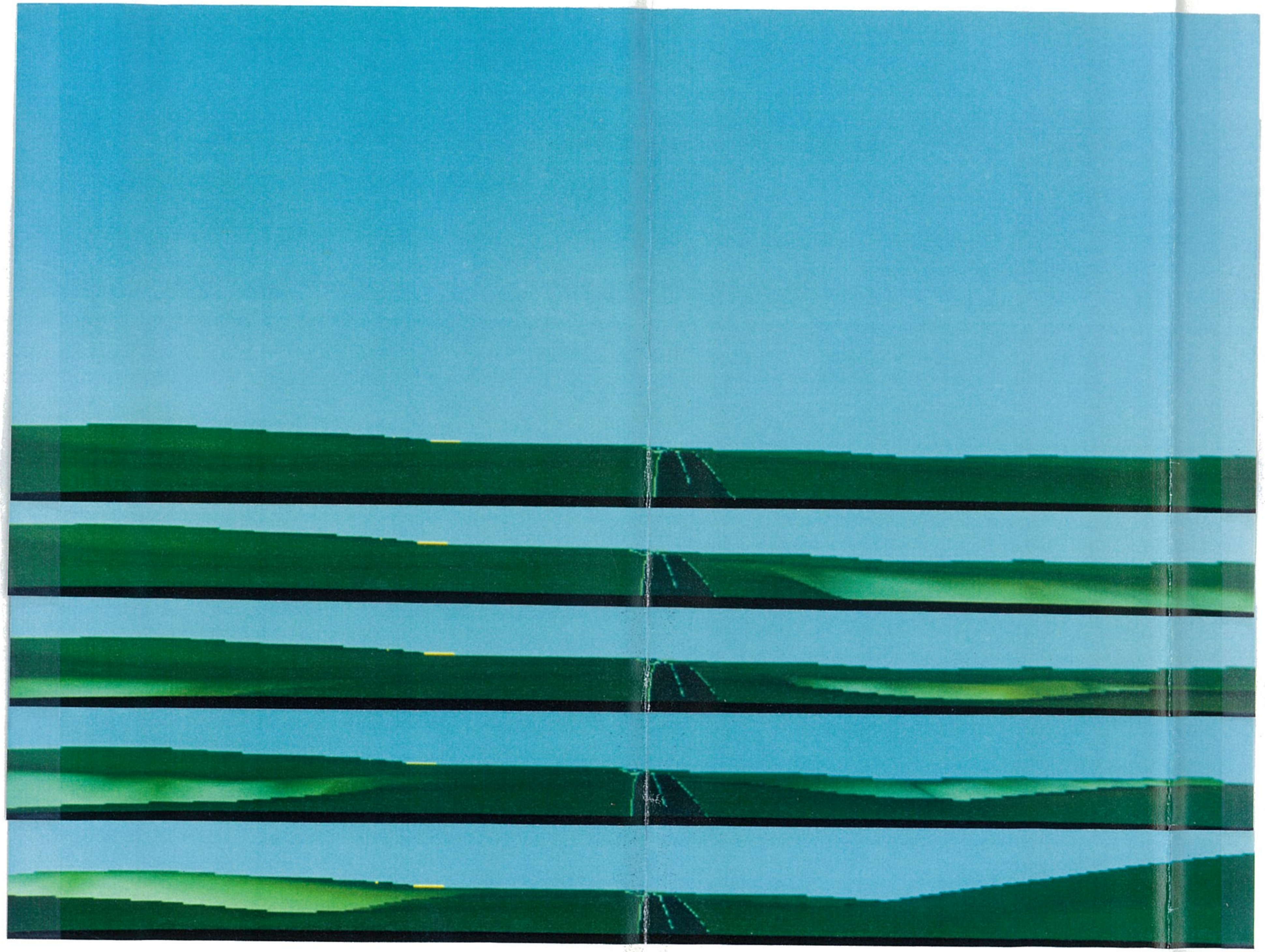
VP4 → VP5 MIN. PIT
+100m
END OF LIFE

ENVIROSCIENCES PTY LIMITED
PROJECT No.: F1127

VIEW POINT 4 LOOKING TO VIEW POINT 5
ALTERNATIVE MINE PLAN

FIGURE 4b

CENTRE OF LEASE
LOOKING NORTH



YEAR 1

YEAR 8

YEAR 15

YEAR 22

END

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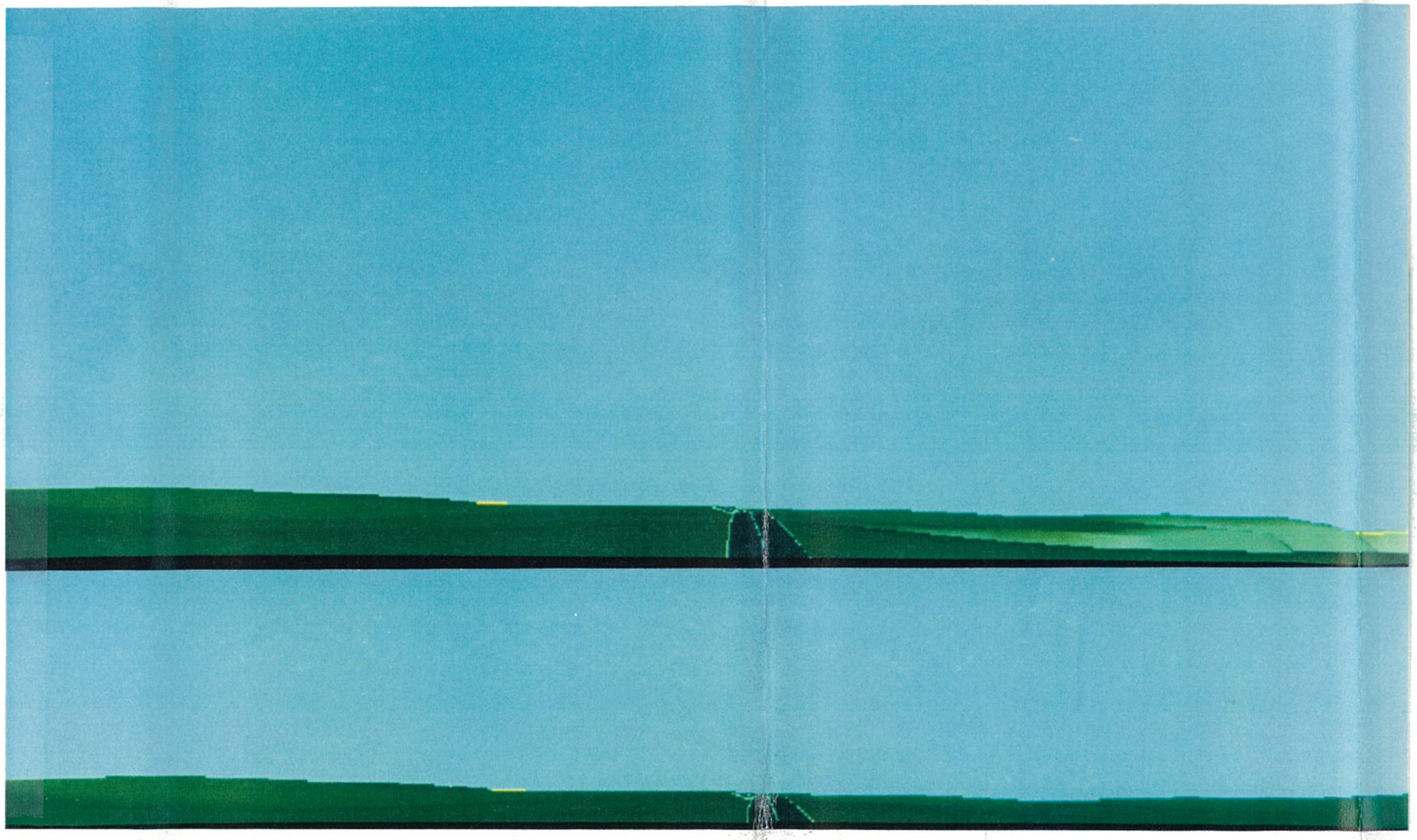
VIEW POINT 5 LOOKING TOWARDS VIEW POINT 3
ORIGINAL MINE PLAN

FIGURE 5a

CENTRE OF LEASE
LOOKING NORTH



YEAR 15

END

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VIEW POINT 5 LOOKING TOWARDS VIEW POINT 3
ALTERNATIVE MINE PLAN

FIGURE 5b

NORTH WESTERN LEASE CORNER
LOOKING TO CENTRE OF LEASE

YEAR 1

YEAR 8

YEAR 15

YEAR 22

END

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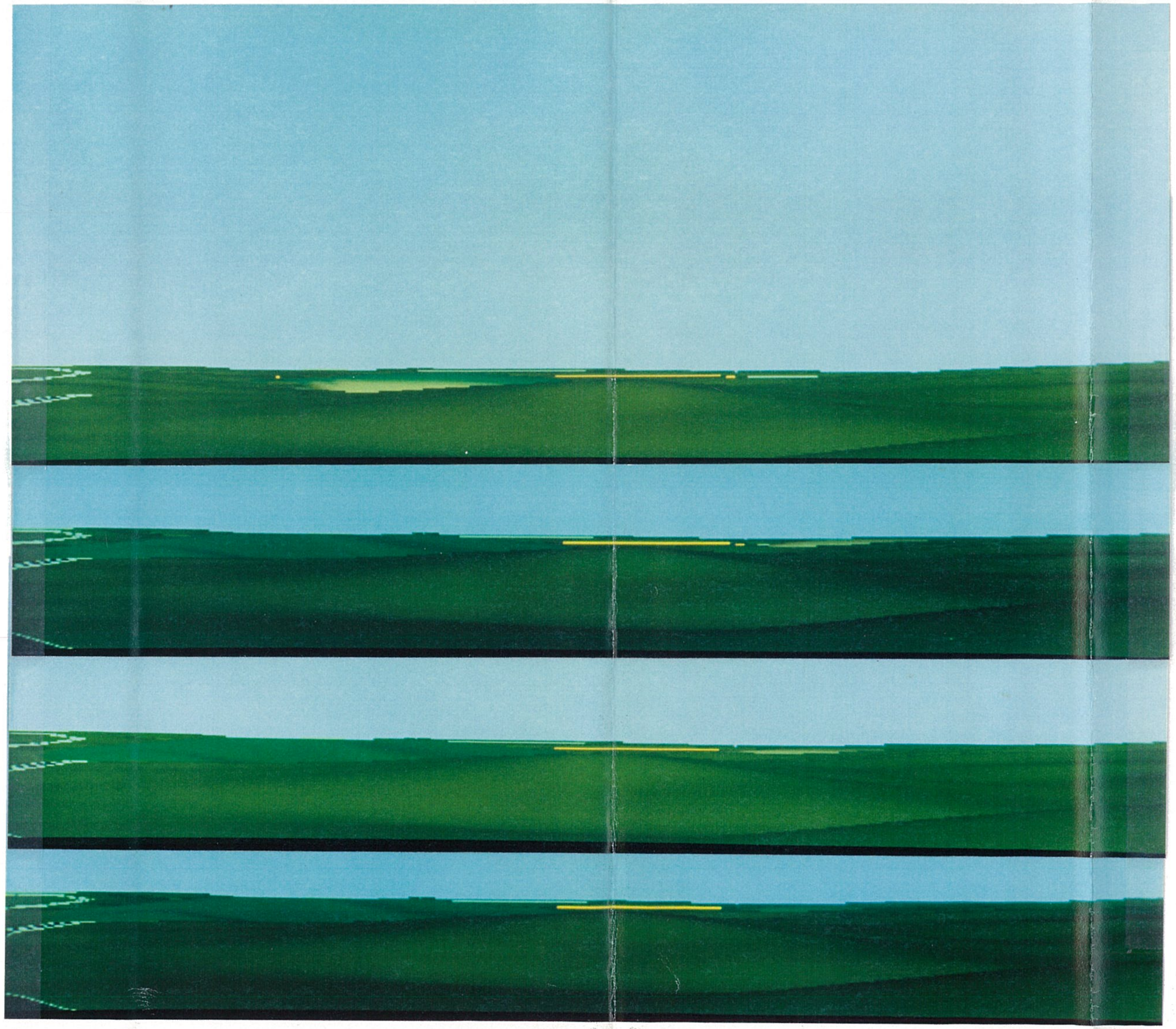
VIEW POINT 5 LOOKING TOWARDS VIEW POINT 3
ORIGINAL MINE PLAN - RIGHT VIEW

FIGURE 6a

NORTH WESTERN LEASE CORNER
LOOKING TO CENTRE OF LEASE



YEAR 1

YEAR 8

YEAR 15

YEAR 22

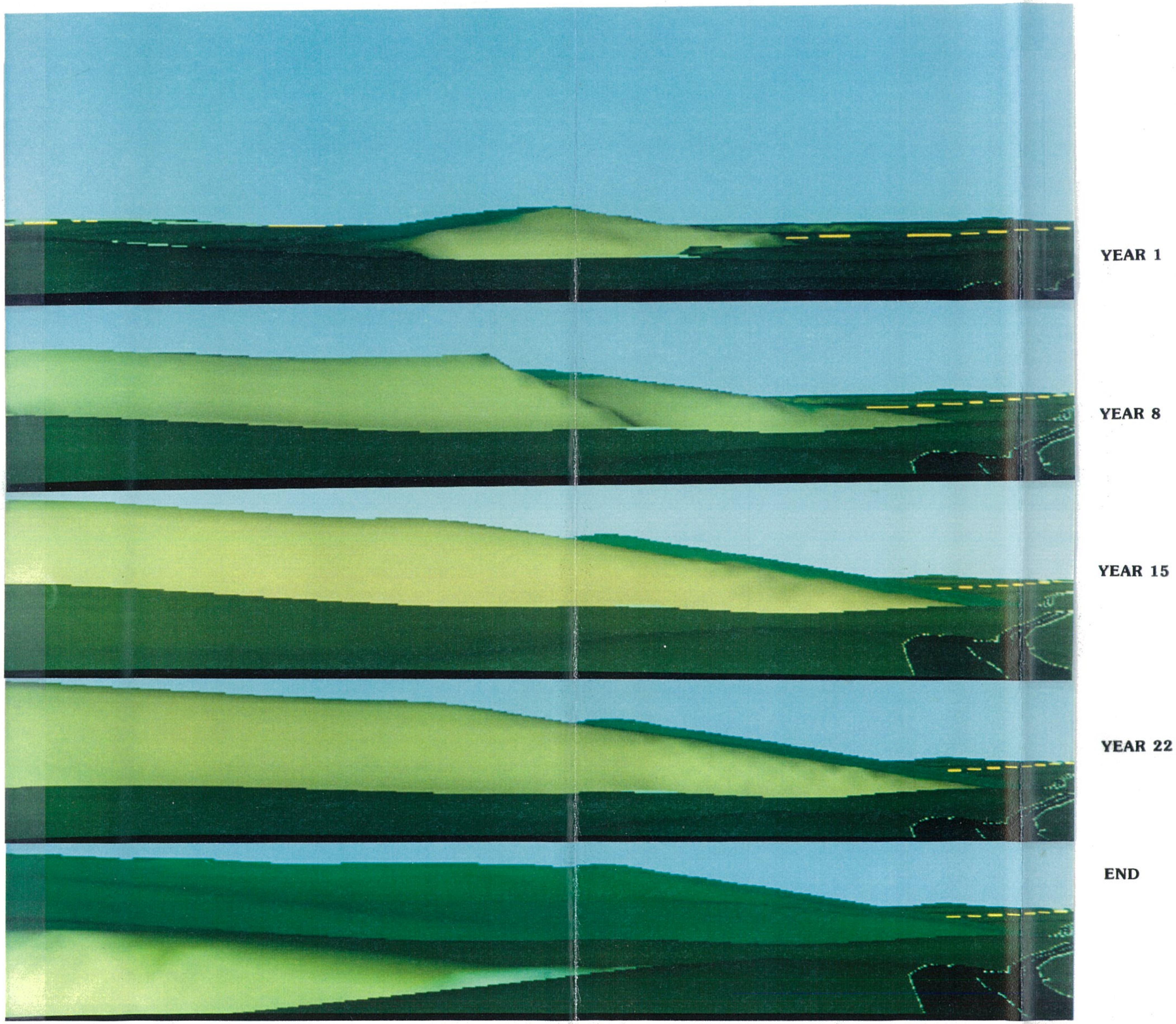
ENVIROSCIENCES PTY LIMITED

PROJECT No.: F1127

VIEW POINT 5 LOOKING TOWARDS VIEW POINT 3
ALTERNATIVE MINE PLAN - RIGHT VIEW

FIGURE 6b

NORTH WESTERN LEASE CORNER
LOOKING TO CENTRE OF LEASE



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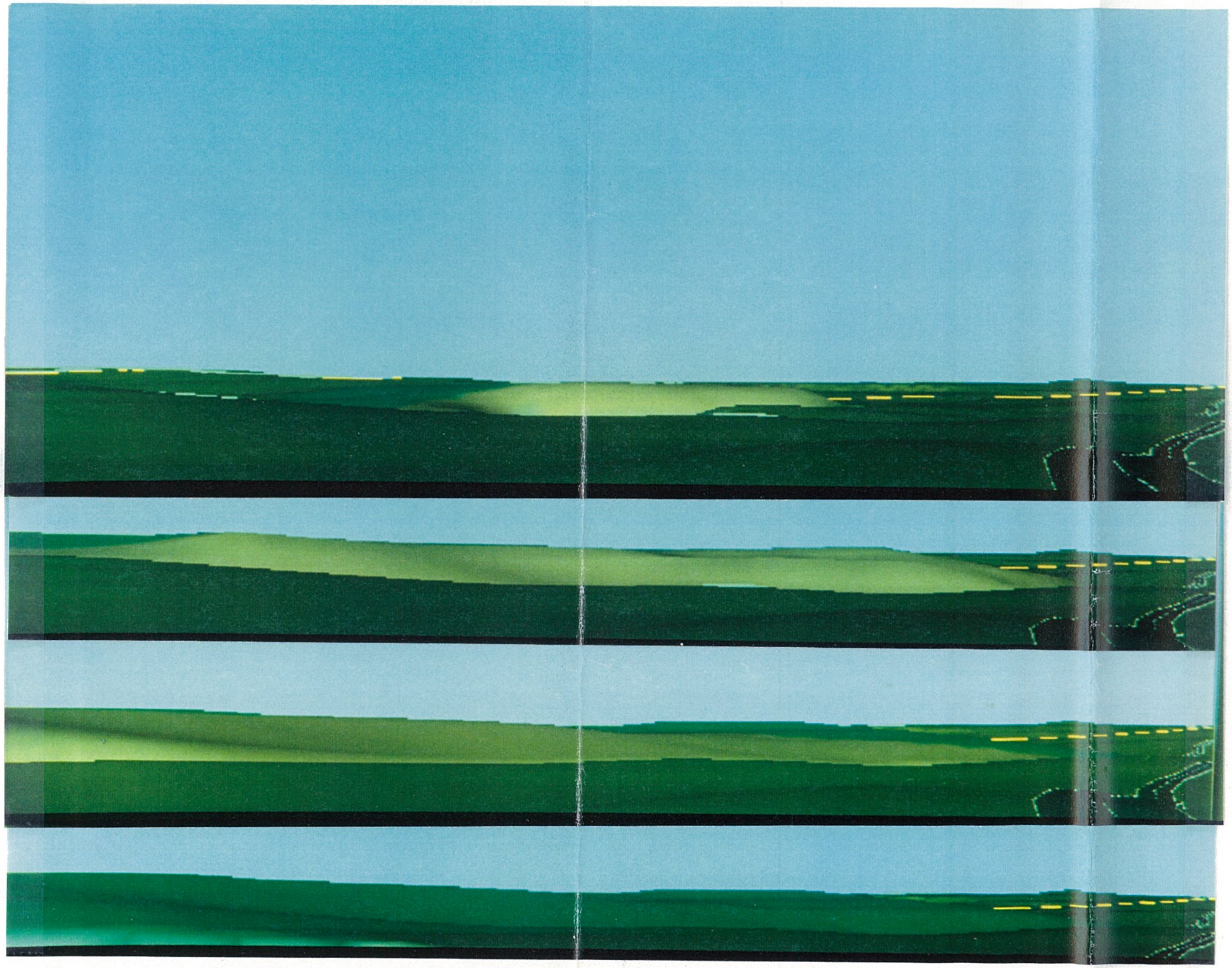
VIEW POINT 5 LOOKING TOWARDS VIEW POINT 3
ORIGINAL MINE PLAN - LEFT VIEW

FIGURE 7a

NORTH WESTERN LEASE CORNER
LOOKING TO CENTRE OF LEASE



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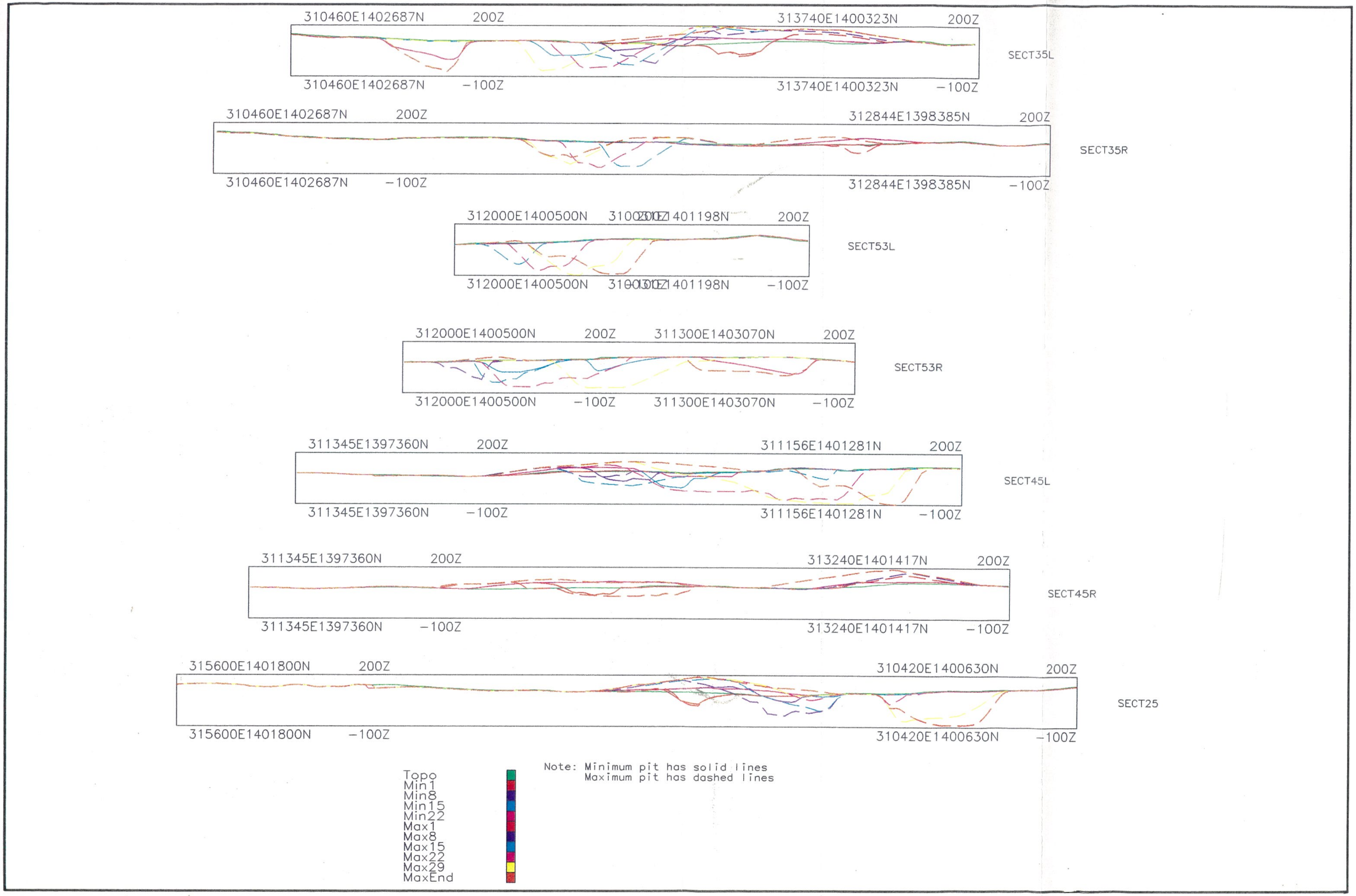
VIEW POINT 5 LOOKING TOWARDS VIEW POINT 3
ALTERNATIVE MINE PLAN - LEFT VIEW

FIGURE 7b



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CROSS-SECTIONS FROM VIEWPOINTS ALIGNED ALONG DIRECTION OF MAJOR INTEREST FOR EACH SET OF MINING SEQUENCES

FIG.8