EIS 671

AB019294

Environmental impact statement, BHP-AMAX-Mobil Joint Venture, Boggabri coal project

boggabri coal project environmental impact statement

Boggabri joint venture

FORM 4

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

ENVIRONMENTAL IMPACT STATEMENT

This Statement has been prepared by, and on behalf of, the Boggabri Joint Venture, being the applicant making the development application referred to below.

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

Boggabri Joint Venture, Boggabri Coal Project, Development of a Coal Mine and Associated Transport and Coal Loading Facilities in the Namoi Valley

The development application relates to the land described as follows :

- MLA 70 and Authorisation 355
- Portions 31, 83,24,25,27,28,44,37,22,19,21,23,17,5,12,8,16,18 Parish of Leard, County of Nandewar
  Portions 124,125,127 Parish of Boggabri County of Nandewar
  Lot 1 DP566122 Parish of Boggabri County of Nandewar
  Lot 3 DP566122 Parish of Leard County of Nandewar
  Lot 1 DP622375 Parishs of Leard and Therribri County of Nandewar
  Portion 59 Parish of Therribri County of Nandewar
  Portions 105&PT156,107,191,202,203,262,264 Parish of Baan Baa County of Pottinger
  Parts of Portions 11,12 Parish of Boggabri County of Pottinger
  Portions 93,159,248, 158,161 Parish of Boggabri County of Pottinger
- Parts of Trunk Road No. 72, T.S. & C.R. 28354, Therribri Road (R9542) and the Leard Forest Road (R19387).
- All within the Land District of Narrabri.

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

Name, Qualifications and Address of person who prepared Environmental Impact Statement	J.G.Miedecke, Dip. C.E., Dip.Nat.Res.,Dip.Env.Stud. M.I.E. Aust., Aust IMM 20 Rowntree St Balmain NSW 2041

Certificate

I, John G. Miedecke of 20 Rowntree St Balmain, Sydney NSW, hereby certify that I have prepared the contents of this statement in accordance with clause 34 and 35 of the Environmental Planning and Assessment Regulation, 1980.

Signature

Date 8 Feb 1988

ENVIRONMENTAL IMPACT STATEMENT

BHP-AGIP-IDEMITSU JOINT VENTURE

BOGGABRI COAL PROJECT

Prepared by:
BHP-AGIP-IDEMITSU Joint Venture

BHP House
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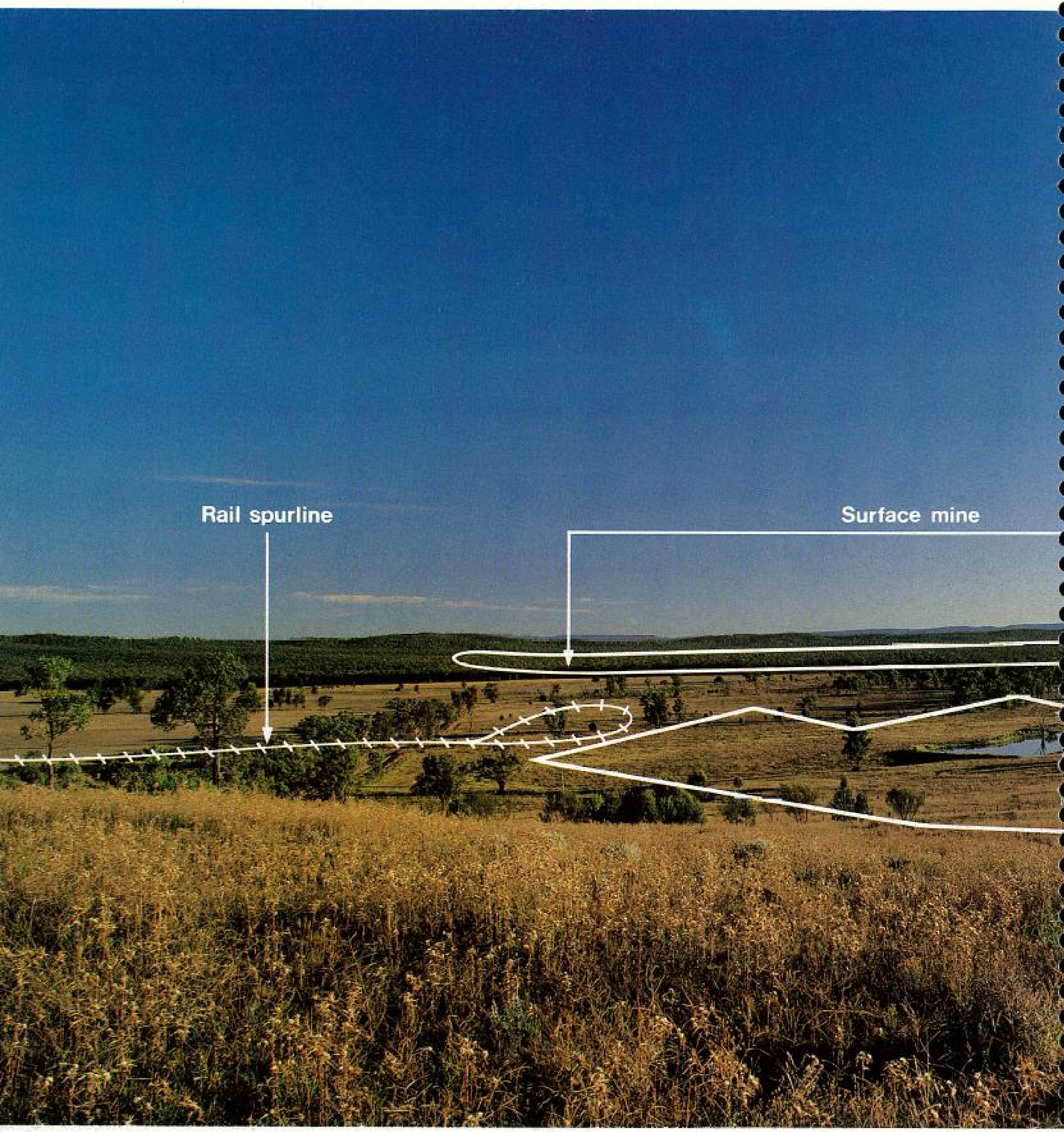
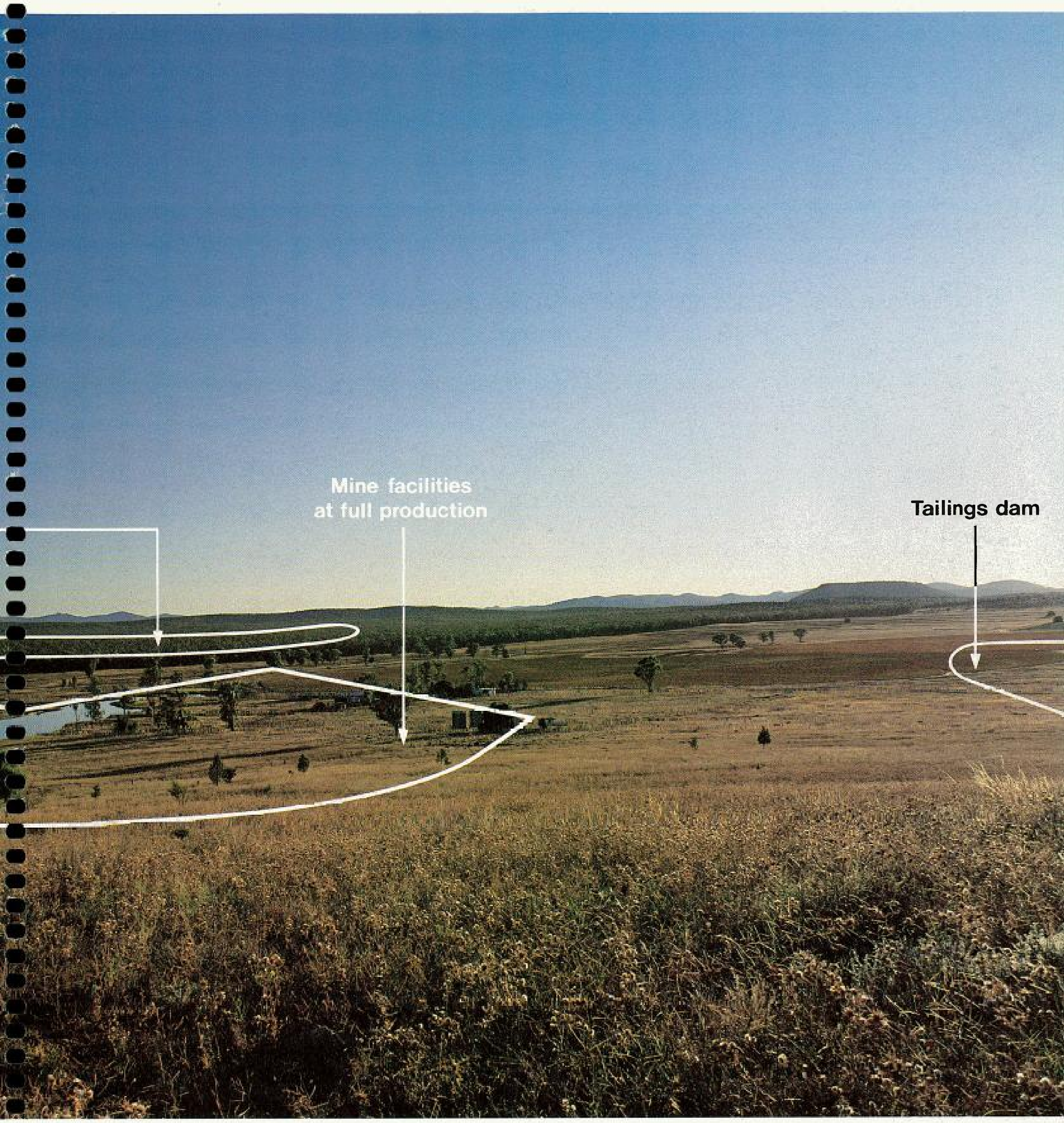
November, 1987


Rail spurline
Surface mine



VIEW OF MINE AREA FROM
SOUTH-EAST CORNER OF LEASE

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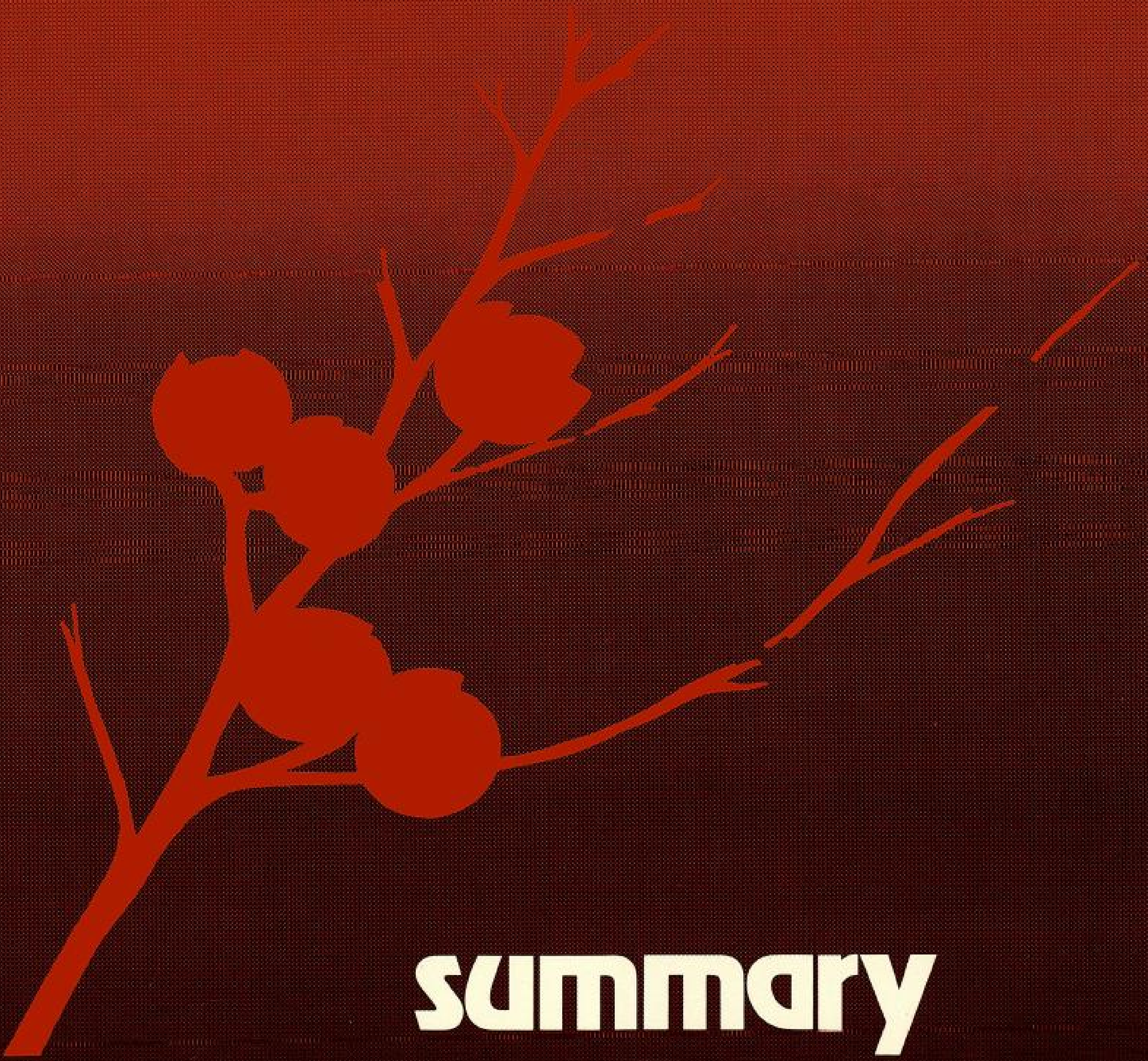

summary

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1.0 SUMMARY

1.1 Introduction and Objectives

BHP Minerals Limited (50%) and AMAX Pacific Inc. (50%) (formerly AMAX Iron Ore Corporation) were granted Exploration Permit Tender Area No. 1 in December 1975, and after completion of exploration in this previously unexplored area they applied for a Coal Lease in December 1979. In 1983 Mobil Energy Minerals Australia Inc. purchased from AMAX a 25% interest in the Boggabri Joint Venture and in 1987 both sold their interests to Agip Coal Australia Pty. Ltd. and Idemitsu International Australia Pty. Ltd respectively

The Joint Venture consisting of BHP (50%), Agip (25%) and Idemitsu (25%) has prepared this Environmental Impact Statement to support its application to:

- the Minister of Mineral Resources and Energy for a Coal Lease,
- the Narrabri Shire Council and the Department of Environment and Planning for development consent; and
- other State and Federal Authorities for approvals and licenses to establish a coal mining operation near Boggabri in north-western NSW.

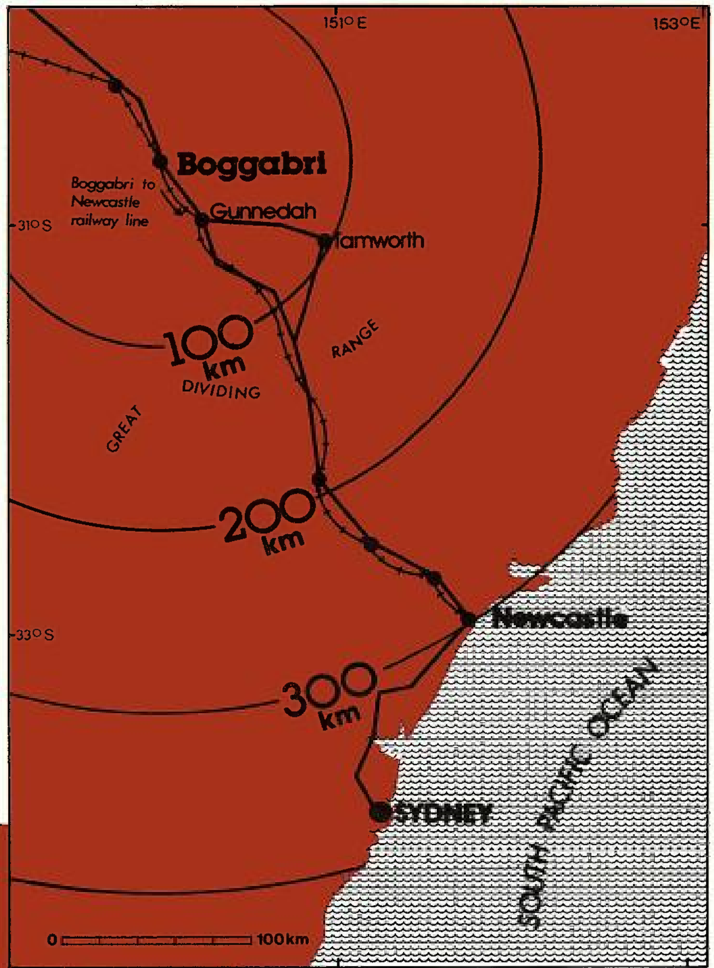
The Boggabri coal mine, when developed, will be one of the more remote export coal mines in NSW. The objective is to develop an economically viable, highly productive and environmentally acceptable coal mine which will be capable of maintaining its competitiveness in the international market.

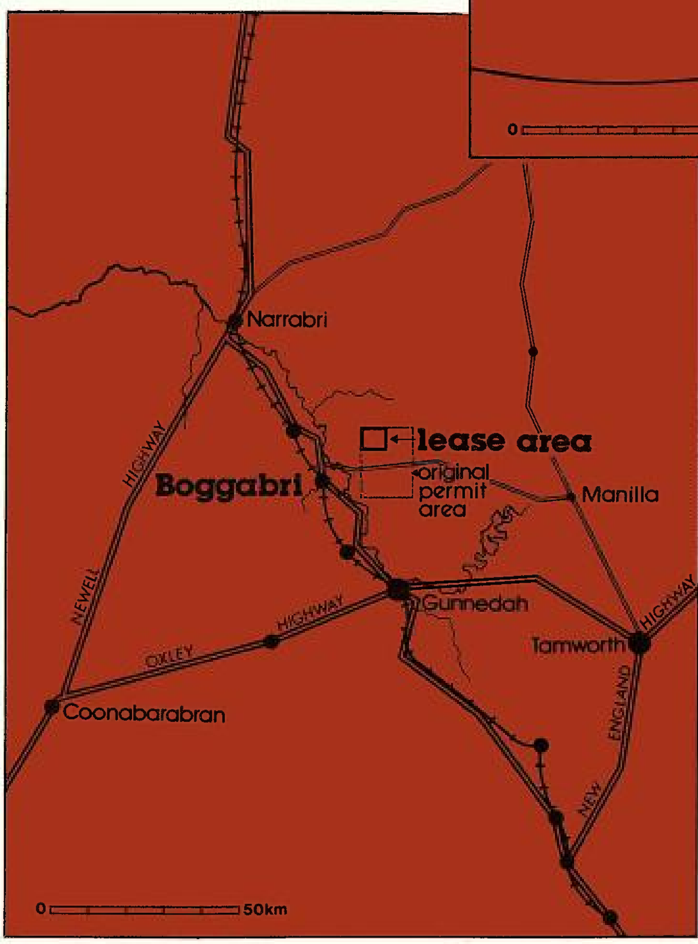
This Environmental Impact Statement contains information on the proposed surface and underground mine developments, coal handling, processing and stockpiling facilities, transportation, infrastructure and likely markets. The existing environment is described in detail, together with the potential environmental impact of the mine development and the environmental management and safeguard procedures that will be adopted to mitigate any adverse effects.

The Joint Venture believes that the operations outlined in this statement (the mining of coal, its preparation and transport) can be achieved in an environmentally sound manner and that the project has considerable advantages and benefits which will outweigh the environmental impacts.

The Joint Venture initiated baseline and impact analysis environmental studies in 1976. These studies were substantially completed by 1980 and other than an update to more recent information (such as census and noise), these studies are unchanged. There have been no significant changes in technology and these studies are considered relevant and complete in 1987.

The development timetable of the mine and rates of coal production are flexible and will be dependent upon market factors and project economics.





LOCATION MAP
Figure 1

However, any variations to the development plan, that may be dictated by market or other influences, will be within the scale and rationale presented in this document. The local community has indicated its support for the project which will have major economic and social benefits for the region, the State of NSW and Australia.

Boggabri coal is considered one of the highest quality energy coals available in the world. Specific export markets have been identified and studies have shown a ready acceptance of this high quality coal by potential customers in Europe, Japan and South East Asia.

1.2 The Development Proposal

The Joint Venture proposes to construct, develop and operate a coal mine at Boggabri to initially produce approximately 0.5 million tonnes of saleable coal per annum increasing to the ultimate production level of approximately 5.0 million tonnes per annum (Mtpa).

The current development plan is subject to market commitments being available and acceptable project economics being realised. At present an initial period is envisaged for market assessment where production levels are expected to be in the range of 0.2 to 0.5Mtpa, followed by an increase up to 5Mtpa as markets dictate. The construction of the mine facilities and other works is expected to precede the commencement of mining by 12 months. Initial installed capacity should achieve an 0.5Mtpa production rate of saleable coal in mining year 1. Upgrading of the facilities to achieve a production rate of approximately 5Mtpa of saleable coal may be initiated within 10 years. The life of the mining operations within the lease area is likely to exceed 50 years.

The lease application area has a total insitu resource of 650 million tonnes of coal contained in 12 seams to a maximum depth of 500m. Of this amount, it is estimated 210 million product tonnes may be recovered by surface mining methods. Of the remaining tonnage it is estimated that 140 million product tonnes may be recovered by underground mining methods. The coal is essentially an energy coal, however, two of the lower seams have some metallurgical coal properties. Due to the complexity of the resource, maximum recovery will be achieved by optimising the proportion of coal mined by surface methods. This will depend upon the economic viability and market requirements of the proposed developments.

The proposed mining development will begin as a high productivity, small scale surface mining operation which will extract the shallower recoverable reserves in the Merriown seam at a production rate of approximately 0.5Mtpa. The initial mining method will be by small dragline. The initial production rate and further increases will be consistent with market demands. Ultimate production will be a large scale surface mine operation producing up to 5.0Mtpa and recovering the deeper reserves. The mining method at this stage will be by combined large dragline and truck and shovel and the mine at full production will be a complete multi-seam operation. The main surface mine plan has been developed to recover approximately 90 million tonnes of saleable coal to a total overburden depth of 140 metres.

Opportunities also exist for surface mining outside the current mine plan area. Extensions of the coal lease term and/or additional production would facilitate a further 120 million tonnes to be recovered by surface mining and an estimated 140 million product tonnes from underground.

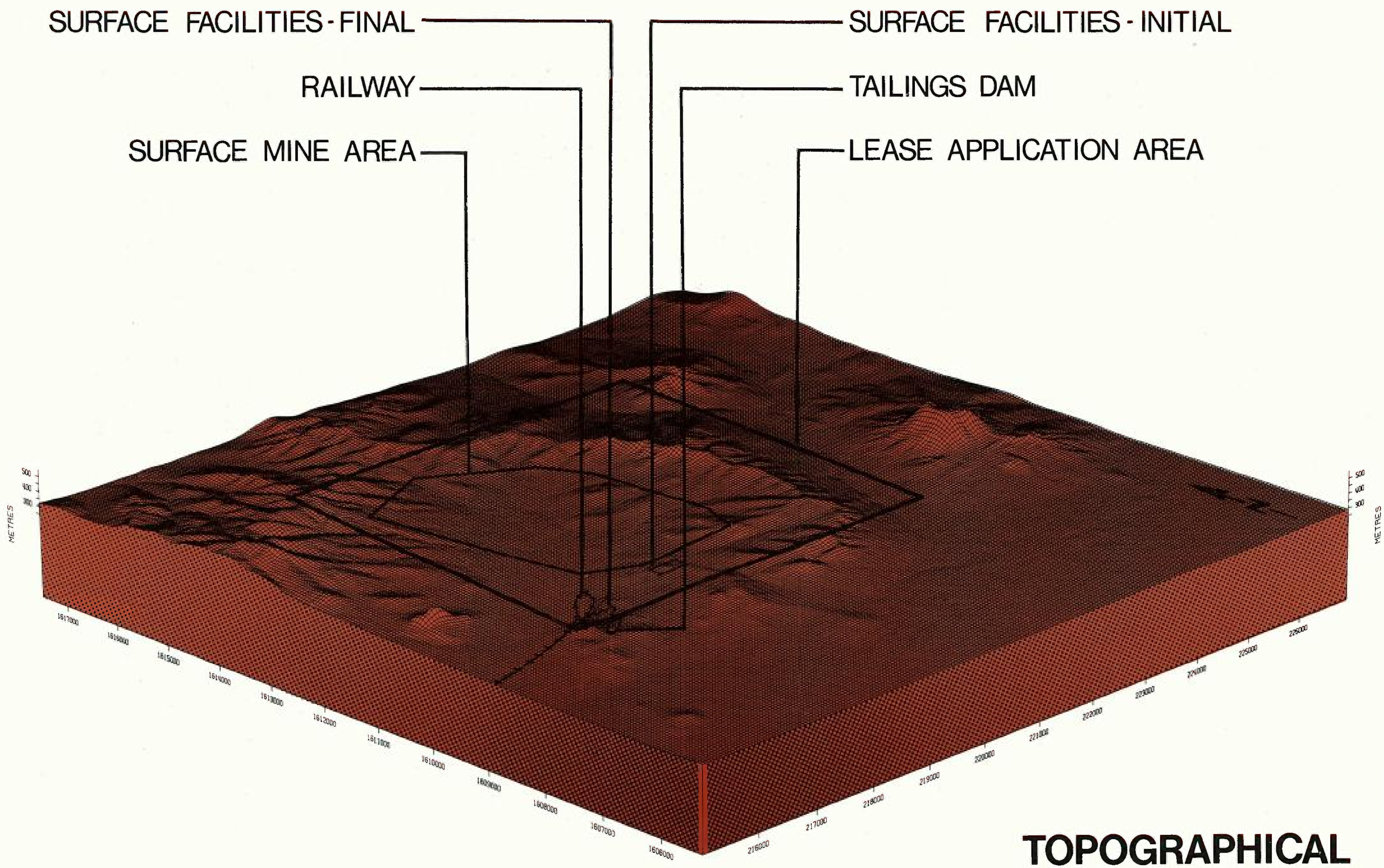
The initial mine production will only require the construction of a relatively simple coal sizing plant. At full production coal handling and preparation facilities will be provided for the washing of coal, where appropriate, to provide a low ash product. Refuse from the coal preparation plant will be disposed of in the mine spoil piles and a tailings dam. The plant and facilities have been designed to minimise noise levels and dust emissions. It is proposed that mining operations will proceed on a 24 hour per day basis when required. Road transport operations will initially be restricted to daylight hours, however, as production rates increase additional shifts may be required, until the rail apurline is constructed.

The initial production of coal will be road hauled from the mine site to a train loading facility. At full production a 17km rail spurline and an access road to the mine will be constructed north of Boggabri. This will include the construction of a high level rail bridge over the Namoi River and flood plain. Coal will be railed to the Port of Newcastle for export. Transportation studies have confirmed the existing railway system to have an unused capacity of 3.2Mtpa which may be increased by another 2.0Mtpa to 5.2Mtpa with minor upgrading work.

The initial production workforce will number approximately 50, with a similar construction workforce. Current planning is for the mine workforce to increase as production increases from the initial production levels (year 10) to a probable 495 (year 16).

It is believed that a substantial proportion of the mine workforce could be recruited locally, particularly in the initial production period. In this period existing accommodation is adequate for the proposed workforce. The secondary construction workforce will be housed at a temporary camp located near the mine site. The operating mine workforce will be housed within the region, with Boggabri expected to be the major residential area. Measures will be adopted to ensure that adequate supplies of land, housing and associated facilites are available for future needs.

Rehabilitation plans have been developed to return the disturbed areas, in time, to an aesthetically pleasing landform capable of supporting a native forest similar to that now existing. The objective of the rehabilitation plan is to return the disturbed areas to as near as practical their original native forest



TOPOGRAPHICAL MESH PERSPECTIVE

Figure 2

land use, as alternative land uses such as agriculture will not produce a stable ecosystem. This will also have benefits in terms of retaining wildlife habitats and provide the potential for timber production. A large amount of pre-mine planning has been undertaken, including soil and overburden studies and rehabilitation trials. This information has been incorporated into the mine plan and equipment and manning structures have been provided to ensure that rehabilitation objectives will be achieved. The mine plan allows for the handling and storage of topsoil for future use in the best possible manner, selective handling of overburden to ensure burial of materials with undesirable characteristics, return of a rooting medium beneath the topsoil, and a return to a topography suitable to maintain a viable native forest. The planned handling of topsoil to minimise degradation, selective handling of overburden to ensure burial of materials with undesirable characteristics and a return to a topography suitable to maintain a stable ecosystem will ensure that rehabilitation objectives are achieved.

A water management plan has been developed to optimise the use of water, control water pollution and soil erosion, and protect the mining operations against flooding. The efficiency of water use, control of water pollution and erosion, and the protection of ongoing mining operations as well as the water rights of downstream users have been a major consideration in the planning of the project. BHP Engineering conducted a comprehensive water management study for the mine at full production to fulfill these objectives. The study included such aspects of water management as rainfall runoff handling and control from so-called clean and dirty areas, groundwater quality and inflow to the mine, water sources, tailings disposal and the overall water balance of the development. The plan provides for runoff water from dirty areas to be separated from clean areas, enabling collection and treatment or storage. A closed circuit water system will be provided which will be supplemented from on-site water sources to satisfy project water requirements. The water balance studies have shown that the mining development will be a net water consumer except during periods of heavy rainfall or prolonged wet weather. Maximum use will be made of on-site water before external sources are used .Water make up to the system will be met from a bore field established on Joint Venture owned property near the Namoi River bridge crossing.

1.3 Existing Environment

The lease area lies almost wholly within the Leard State Forest, adjacent to the Namoi Valley flood plain. The township of Boggabri is the nearest urban centre approximately 15km to the south-west. Coal mines have operated in the region since the 1800's and three mines are operating near Gunnedah.

The lease area is bounded by a ridge which encloses the catchment of the ephemeral Nagero Creek and the surface mine area. Slopes are principally less than 10%. The climate is typical of the north-west slopes and plains of NSW with hot summers and short winters with frequent frosts. Droughts are common.

Coal exploration started in 1976 and has involved a detailed programme of cored and non-cored holes, plus a box cut to provide bulk samples for prospective customers. Total insitu reserves of the lease area are assessed at 650 million tonnes. Aproximately 210 million tonnes are at depths and overburden ratios that may be suitable for surface mining. Coal seams are suitable for energy and metallurgical applications.

Soil and overburden characteristics have been defined and materials both suitable and potentially deleterious to rehabilitation have been identified. The predominant soil type is Duplex soils with lesser amounts of Lithosols and Structured Loams. Most of the strata is devoid of potential acid producing pyrites, except for are some roof and floor rock immediately associated with coal seams. The major emphasis was placed on the evaluation of possible sodic conditions and problems during rehabilitation.

The lease area contains a number of minor creek systems which flow intermittently after heavy rain. The proposed mine is totally within the catchment of Nagero Creek which eventually flows into "The Slush Holes" which form part of the Namoi River flood plain. Extensive flood studies were undertaken to assist the design of the mine access road and rail bridge. Groundwater within the lease area is derived from precipitation and recharge in the elevated areas. The major aquifers, as is common with coal measure sequences, are the coal seams themselves. Water quality is poor and classified as high sodium/medium salinity.

Existing noise levels have been monitored at Nagero, the proposed location of the mine facilities, along the access road and rail spurline and in Boggabri itself. Sound propogation characteristics were also established in the mine vicinity. Noise levels are typical of a rural area. Boggabri, the nearest residential area 15km from the mine site is quiet, except in the proximity of the main road highway and railway line.

Dust monitoring in the vicinity of the mine has established that dust levels are typical of a rural area.

The Leard State Forest is regarded as typical of the western slope district of NSW. The forest type is uniformly dry sclerophyll and consists mainly of a mixed eucalypt/cypress pine community. Eight major plant associations were identified in the Forest. The most common associations in the mine area are White Box/Cypress Pine and Ironbark/White Box/Cypress Pine. The Pilliga Box/Bimble Box/Belah Association occurs in the lease and was noted in Specht (Specht, 1974) as inadequately conserved in Australia. However regional studies have indicated that this association is widespread.

A total of one hundred and eleven (111) bird species were recorded together with eleven (11) species of native mammals. Two bird species of interest occur and four species of mammals are considered uncommon. There is no evidence of threatened status. No rare or endangered plant species were recorded.

Rehabilitation trials have investigated regeneration potential of natural vegetation, introduced grass and native tree species. These have demonstrated the necessity of topsoil replacement, the efficiency of natural regeneration, the suitability of grasses for soil conservation purposes and the advantages of tree planting or seed broadcasting of desired species. Tree planting trials have been established in association with the Forestry Commission.

No Aboriginal artifacts, sites or features of historic interest exist in or near the lease area. The National Parks and Wildlife Service has indicated that it has no objections to a mining development on these grounds.

The lease area lies wholly within the boundaries of the Narrabri Shire. The population in the region has remained basically stable over the past decade. However, Boggabri and surrounding rural area have experienced a population decline. Unemployment levels are high and no improvement is seen without a broadening of the economic base. The local economy is principally based on agriculture and is subject to fluctuations due to prevailing market and climatic conditions.

The existing stock of residential land and housing, while sufficient for the needs of the initial workforce, will require augmentation when the mine increases production. The Narrabri Shire has acquired undeveloped land in Boggabri suitable for residential development. Existing facilities and services can be readily expanded to cater for the expected population growth. Local Government planning is well advanced in expectation of growth associated with coal developments in the region.

1.4 Impacts and Management

Environmental impacts representing a worst case situation have been used throughout this document. This is for the mine at full production. Where relevant, distinction has been made between the initial production impacts and those at full production.

Environmental considerations have had a high priority in the exploration, planning and design of the mining development. The possible impacts of mining, treatment and transportation of coal have been identified and methods have been developed to eliminate or mitigate adverse effects. The Joint Venture believes that the mine development with the associated management procedures will not result in significant long term adverse environmental impacts and, indeed, development of the project will have important social and economic benefits to the region. Its remote location avoids direct impacts on urban areas and the provision of a buffer zone around the mine will minimise effects on the surrounding mixed farming and grazing areas.

Mine operations will have an impact on air quality through the emission of dust. By comparing with similar coal mines in the Hunter Valley it is concluded that even using conservative criteria, adverse impacts due to dust generation are not expected to extend beyond 1.5km from the minesite. As the mine has buffer distances of at least 3km no adverse impacts are likely. Control measures will be adopted to minimise emissions.

The most significant impact will be the clearing and disruption to the land form of approximately 40 hectares of forest per year for the mine at full production. The existing vegetation will be removed and all fauna displaced. Associated with this will be the potential for increased soil erosion, dust and noise generation, and changes in water quality and quantities. However, because of the location of the mine and the environmental safeguards, these impacts will be limited in effect and of little significance in the long term.

Specific measures will be adopted to control soil erosion and all suitable topsoil will be salvaged for reuse in rehabilitation. The combined total thickness of undesirable overburden/interburden material makes up less than 30% of the total overburden thickness. Therefore, because the potentially sodic and acidic materials will be selectively buried, it is highly unlikely that undesirable conditions will develop.

A new landform will be developed which will have similar slopes and grades to those existing, except that at the start and finish of the mine where there will be a respective surplus and deficit of overburden materials. Rehabilitation plans will ensure the development of an aesthetically pleasing and stable post-mining landform, capable of supporting a native forest. The final void at the cessation of surface mining will necessitate developing a new drainage pattern and, if required, surface flows can be directed into the final void to improve water quality.

The proposed mining development will have effects on the quantity of both surface water and groundwater. The operation at full production will require significant quantities of water for use in dust control, in the coal washing plant, and for drinking and sanitary needs. Overall, except in wet conditions, the mining operation will be a net consumer of water and during active surface mining operations less surface water and groundwater will leave the lease area.

Less significant impacts on surface water quantity could be decreased flows of streams draining the mine area (Nagero Creek catchment).

However, the amount of surface water draining the mine area is not great and it flows onto properties owned by the Joint Venture. The mining operation will inevitably lower water levels in the intercepted aquifer. It has been estimated that drawdowns are unlikely to be more than 0.5 metres, 2km away from the mining pit. Thus, significant water table declines will only occur within the lease area. Following mining and rehabilitation, groundwater recharge and storage capacity will be altered and thus groundwater recharge should be greater. Because of the overburden swell factor, storage capacity will increase. In the longer term, there will be a shift toward lesser surface runoff and greater groundwater recharge. This must be regarded as beneficial as flood flow contributions will be decreased.

A change in water quality at the mine site will be an inevitable consequence of the mining development. The anion distribution for both surface and groundwater will shift from $Cl>HCO_3>SO_4$ to $SO_4>Cl>HCO_3$. The cation distribution in surface water is expected to remain similar to premining providing the sodic overburden is correctly handled, and groundwater may become slightly less dominated by sodium ions. Surface runoff from bare spoil is estimated to have a salinity similar to premining, with an increased sodium content. Groundwater will have an increased salinity , with a decrease in sodium. All of these estimates are based on worst case assumptions, which assumes that all overburden is present as reactive size particles and is involved in geochemical reactions. The proposed selective placement and handling of potential saline, sodic and/or acid producing materials will greatly lessen the overall impacts to the re-established groundwater and surface water resources of the area. Because of the proposed topsoiling and overburden handling techniques, the worst case water quality levels should not be realised following mining.

Runoff from mine areas, haul roads, coal preparation plant area and coal stockpiles will be contaminated by suspended solids and coal dust. Surface runoff following mining will decrease because of increased groundwater recharge and storage capacity. This will effectively reduce the likelihood of downstream pollution. The Water Management Plan proposes collection of all runoff from dirty areas and to maximise the on-site water resources, as the mine operation is a net consumer of water. Therefore, except under extreme rainfall conditions, zero discharge will be maintained and effects on water quality outside the lease shall be minimal.

The rail spurline for the mine at full production, and the access road will cross the Namoi River and flood plain. These structures have been designed to have a minimal effect on water flow. Flood levels will be raised by a maximum of 190mm at the bridge site and this level will decrease with increasing flood sizes and also decrease upstream.

The existing rail network can accept the initial production and can be readily upgraded to take the projected tonnages of 5Mtpa. Planning has allowed for this increase. Further upgrading would be required if the other mines in the area are expanded or developed.

The mining operation will replace the existing land use of State Forest in the short term. This in general, will initially be at a rate of 5 hectares per year increasing to 40 hectares at full production. Over the total mine life, an area of approximately 1200 hectares will be disturbed (37% of the lease area, or 15% of the Leard State Forest).

The replacement in the short term of existing land uses (State Forest and to a much lesser extent agricultural production) by the mine is inevitable. By ensuring that rehabilitation follows closely behind the mining operation, only a relatively small area will be disturbed at any time. The opportunity will exist through the selection of tree species and silvicultural treatment, to create a more economically productive forest.

A greater area of native forest under Forestry Commission control may result, as it is the Joint Venture's understanding that the Commission wishes to purchase other areas of forest with the financial compensation for lost timber values. The coal preparation plant area, rail spurline and access road have all been located to minimise effects on agricultural land and the number of properties affected.

Sources of noise resulting from the mining development will include the mining operation itself, the coal treatment process, coal transport initially by road, and ultimately via rail, and the road transport of employees.

A computer programme which generates noise contours was used to predict the impact of the full production mining and coal treatment operation. The worst case situation was adopted for the study. Noise levels resulting from the mine are considered unlikely to result in any significant loss of acoustical amenity for the residences. In the initial development, coal would be transported by road from the mine site to the rail loading facility north of Boggabri. It was concluded that the assessment of noise from the proposed trucking operations indicates that these are unlikely to result in a significant loss of acoustical amenity for the nearest residences (approximately 750m distant). Similarly, the predicted noise levels at rail loading operations at the closest residences (approximately 3km) are considered as fully acceptable.

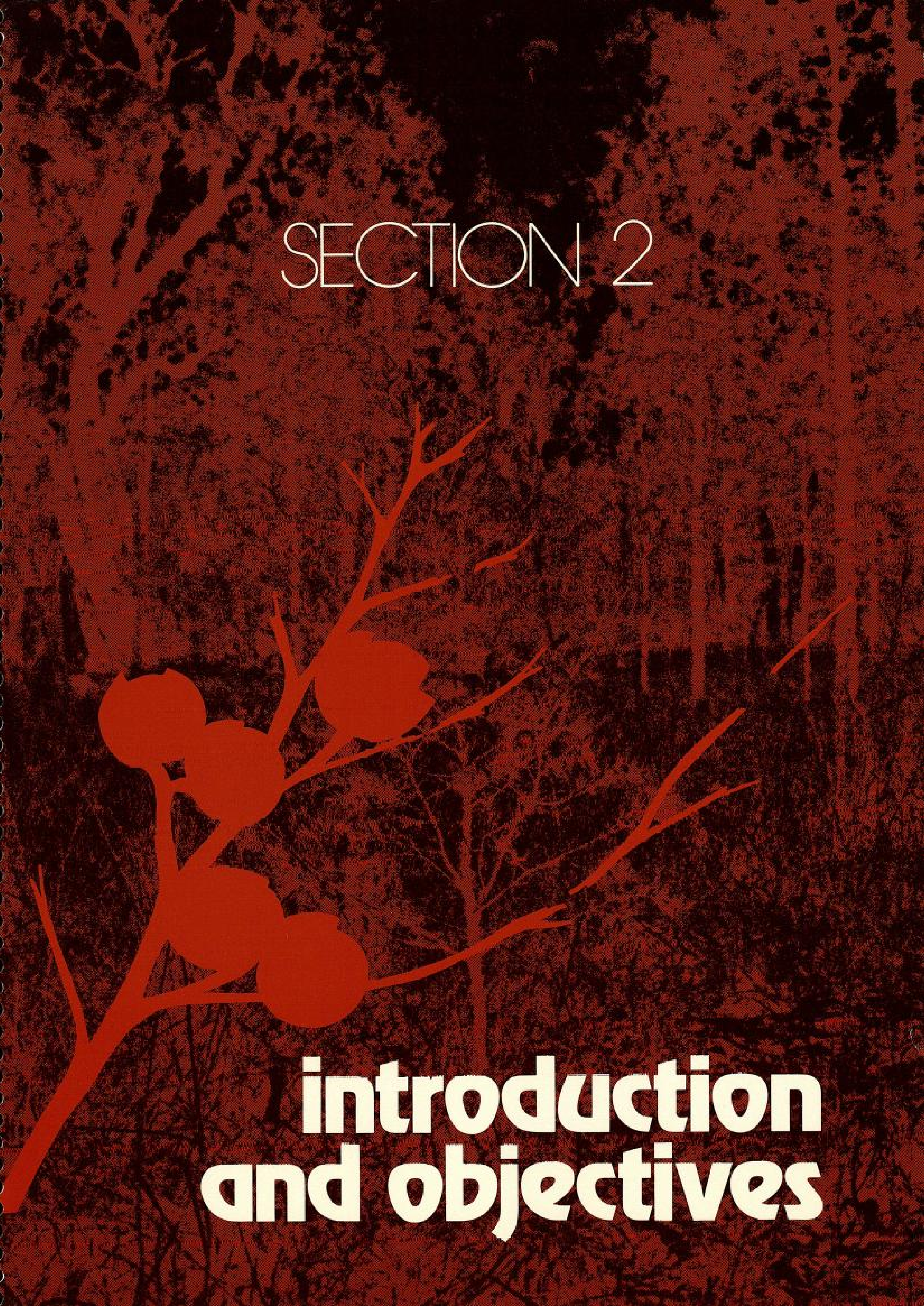
The noise of road traffic on the mine access road is within the acceptable criteria and would not cause any significant annoyance to nearby residences. The noise levels of rail movement on the spurline between the mine and the junction with the main Northern Line have been calculated for the years 10, 15 and 20, for the 2 nearest residences along the spurline. Noise levels are well within the adopted criteria and noise impacts are expected to be insignificant. The acoustical environment within the township of Boggabri will probably undergo gradual, though significant, changes over a period of some 10-15 years. These changes, if noted, are likely to be accepted by the residents as a sign of urban regeneration. The increase in road traffic at the northern end of town associated with shift changes at the mine is likely to result in a significant acoustical impact for a short evening period on one residence at the corner of Boston Street and Oakham Street, and in a marginal acoustical impact at the next two residences in Oakham Street. The effect of increases in rail traffic will to some extent depend on the timing of track upgrading work and the introduction of larger capacity unit trains. The analysis shows that a marginally significant increase is expected in the L_{Aeq24} hr noise levels. This increase would take effect gradually over the next 10-15 years. A small number of residences situated in close proximity to the railway line may experience future noise levels which Louis Challis and Associates classified as being normally unacceptable. However, the bulk of the residences along the railway line are located at distances 70 metres or greater from the track and the future noise levels in these areas are likely to lie in the normally acceptable or clearly acceptable criteria ranges. The Joint Venture has no control over rail movements and noise resulting from any rail traffic increase.

The siting of the mine and its location away from major transportation routes and centres of population ensures that there will be little adverse visual impact.

There are many beneficial social and economic impacts that will accrue from the project. Construction and operation of the mine will provide diversity to the cyclical agricultural economy in the region and provide a major source of employment well into the next century. The Joint Venturers have every reason to believe that the project has the support of the community and Narrabri Shire Council. Prevailing socio-economic conditions will change and growth management will be required to ensure that breakdowns or overloads of community services do not occur when the mine expands production to its full capacity. The Joint Venture and the Narrabri Shire Council have planned for this growth, which is likely to centre on Boggabri.

Environmental monitoring will be provided to ensure environmental considerations remain a high priority in the construction and operation of the mine.

Other mining developments in the area are the existing underground coal mining operations and a small surface mine operation near Gunnedah. Of more significance is the Vickery Sampling Operation (Red Hill) which has commenced production and will expand in the next few years,. Another possible mine is at Maules Creek. The most significant regional effects of the development of other mines are likely to be on the coal transportation system, and the development of urban areas to house the workforce.



SECTION 2

introduction and objectives

SECTION 2: INTRODUCTION AND OBJECTIVES

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2.0 INTRODUCTION AND OBJECTIVES

2.1 Introduction

BHP Minerals Limited and AMAX Pacific Inc. were granted Exploration Permit Tender Area No 1 by the New South Wales Minister for Mines (now the Minister for Mineral Resources) on 22 December, 1975. The Permit was granted for an initial period of two years, and was subsequently renewed for two further periods, each of one year. The Permit expired on 22 December, 1979 and the Joint Venture applied on 17 December, 1979 for a Coal Lease, as required by the provisions of the Coal Mining Act, 1973. In July 1981 Authorisation 260 was granted for a 2 year period over the lease application area. In October 1983 AMAX transferred a 25% interest in the Project to Mobil Energy Minerals Australia Inc. and Authorisation 260 was reissued as Authorisation 339 to accommodate the new Joint Venture Partner. In 1987 both Amax and Mobil sold their interests in the project to Intemitsu International Australia Pty. Ltd., and Agip Coal Australia Pty. Ltd. respectively. Authorisation 339 has been reissued to reflect the change in the Joint Venture.

Since 1976, the Joint Venture has undertaken detailed and extensive geological, engineering, environmental and marketing studies to determine the viability of developing the deposit.

This document has been prepared to support the Joint Venture's application for a coal lease and approvals to establish a coal mining operation near Boggabri in north-western NSW. It has been prepared in accordance with the requirements and regulations of the Environmental Planning and Assessment Act, 1980. Under the provisions of Section 101 of that Act, Development Consent will be determined by the Minister for Planning and Environment.

The following consents or approvals are being sought:-

(i) Development Consent from the Minister for Planning and Environment for a surface coal mining development and associated infrastructure to progressively achieve a production of approximately 5 million tonnes per annum (5Mtpa).

(ii) Approvals from the State Pollution Control Commission to construct the mine and associated facilities under the Clean Air Act (1961), the Clean Waters Act (1970) and the Noise Control Act (1975).

(iii) The grant of a Coal Lease from the Minister for Mineral Resources as defined in the Joint Venture's application of 17 December, 1979.

(iv) The grant of a Mining Purposes Lease from the Minister for Mineral Resources to include mine facilities off the lease area.

(v) Permission to open a mine in accordance with Joint Coal Board Order No. 27

(vi) Commonwealth Government approvals from the Minister for Trade and the Minister for Arts, Heritage and Environment, under the Environment

Protection Act, 1974.

The timetable for construction of the mine and rates of coal production are flexible, and will ultimately be dependent upon market factors. The Joint Venture believes that for the scale of operations outlined in this statement, the mining of coal and its preparation and transport can be achieved in an environmentally sound manner, and that the advantages and benefits of this project will considerably outweigh any short term environmental impacts. Any variations to the development plan which may occur because of market and other influences will take place within the parameters presented in this document.

This document contains information on the proposed surface and underground mine developments, coal processing, transportation methods, infrastructure and likely markets. The existing environment is described in detail, together with the potential environmental impact of the mine development and the environmental management and safeguard procedures that will be adopted to mitigate any adverse effects. Other matters, as required by the Environmental Planning and Assessment Regulations, 1980, are discussed.

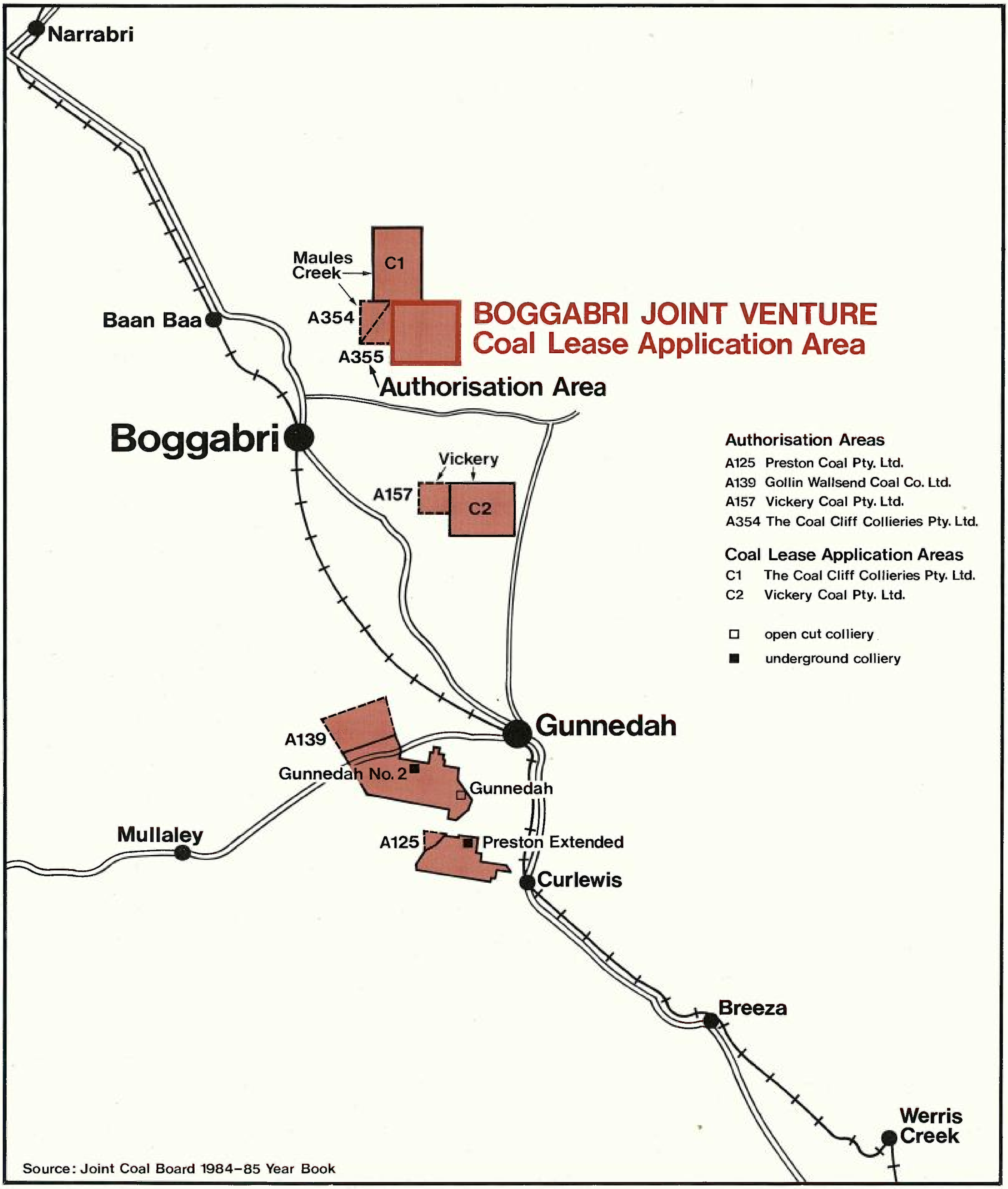
The Joint Venture has adopted a philosophy to mitigate or eliminate environmental problems by careful design. The practical understanding of ecological principles and the knowledge gained during extensive and detailed environmental studies will ensure that the mining operation will be developed according to modern environmental criteria and practices.

2.2 Location

The lease application area (lease area) is located within the Narrabri Shire approximately 15km north-east of the township of Boggabri in north-western NSW (Figure 2). Boggabri is on the main north-western railway, 360 rail kilometres from Newcastle. The lease area is defined by meridians of longitude 150°08'E and 150° 12'E, and parallels of latitude 30°35'S and 30°38'S. Present access to the lease area from Boggabri is by road, mostly unsealed.

2.3 Discovery, Background and Studies

Coal was discovered in the area early this century whilst drilling for water. In 1972 Sunshine Gold conducted a reconnaissance drilling programme approximately 11km to the south of lease area in the vicinity of the Vickery State Forest. This was followed by a series of holes drilled by the NSW Department of Mineral Resources, and on this information an area of approximately 14.5km by 18.5km was released in 1975 for tender as Exploration Permit Tender Area No 1.



COAL LEASE & PROSPECTING AREAS

Scale 1:500 000

0 25km

JOINT VENTURE

Boggabri coal

Figure 3

Following the granting of the Tender Area (Figure 2) in December 1975, exploration drilling and environmental studies were commenced early in 1976. After initial broad spaced drilling an area in the north-west of the original Tender Area was identified as having the potential for a mining operation. Intensive geological exploration continued until mid 1979 together with associated engineering and environmental studies. Subsequent work has been carried out under the provisions of Authorisation Numbers 260 and 339.

Approximately 34,000 metres of both cored and non-cored drilling has proven extensive coal resources, most of which lie within the boundaries of the Leard State Forest. A trial boxcut to obtain a 100 tonne sample of the Merriown seam and to allow revegetation and reafforestation trials was constructed in mid 1979.

Associated with the latter stages of the geological appraisal were environmental, surface and underground mining feasibility studies, and transportation, marketing and infrastructure studies.

Environmental considerations have had a continuous input into the project. Baseline studies of the flora, fauna and ecology of the Leard State Forest were initiated early in 1976 prior to exploratory drilling. A preliminary environmental assessment of a coal mine development in the forest was conducted in mid 1976 to highlight likely environmental constraints and to document existing information. After consultation with relevant Authorities, a programme of baseline environmental studies was designed to develop the data needed to identify any potential environmental impacts and their magnitude, for use in mine planning and rehabilitation, and to enable an environmental impact statement to be prepared.

A list of these studies is included in Section 6. These technical reports are of considerable length and will be made available to relevant authorities and placed on public display, if required. The individual reports are available at reproduction cost on request to the Joint Venture.

2.4 The Companies

BHP Minerals Limited is a subsidiary of The Broken Hill Proprietary Company Limited. The parent company (BHP) is incorporated in Victoria and is Australia's largest public company. Its principal activities are centred around the production of oil and gas, steel, and minerals, including iron ore, manganese, coal, gold and base metals. BHP manages coal production capacity in excess of 30Mtpa from underground and surface mines. It has coking coal deposits in Australia and both coking coal and energy coal interests in the US.

Agip Coal Australia is a subsidiary of Agip Carbone S.p.A., (Agip Carbone) which, in turn is wholly owned E.N.I., the Italian state-owned hydrocarbon corporation. ENI is one of the largest 20 corporations in the world and Agip Carbone is its sector head company responsible for all coal activities world wide.

The principal activities of Agip Carbone are exploration and development of coal resources, production of coke, coal marketing and research into coal utilization.

Agip Carbone has interests in producing mines in North America and Africa, in exploration and development projects in South America and Australia and is developing a mine to extract coal from Italy's only significant coal deposit on the island of Sardinia. Agip Carbone is (after ENEL and the Italsider group), the third largest importer of coal into Italy.

Idemitsu International Australia Pty. Ltd., a Company incorporated in NSW , is a wholly owned subsidiary of Idemitsu Kosan Co., Ltd., (IDEMITSU) the largest independent energy resources company in Japan. IDEMSITU was established in 1911 as an oil trading company in Japan and expanded its business line greatly through its 76 year company history.

The Company is now involved in a full range of resources-related activities, including oil exploration, production, transportation, refining, distribution and marketing, coal and uranium exploration, the development of geothermal energy and research into alternative energy sources.

In Australia, IDEMITSU, through its subsidiary Idemitsu Queensland Pty. Limited, has a participation share in Ensham Coal Exploration Joint Venture in Central Queensland and is also involved in coal trading, exploration for uranium and in the Victorian Brown Coal Liquefaction Project.

The three Companies have the experience and financial resources for the successful development of the Boggabri Project. BHP has expertise in the supply, marketing and utilisation of metallurgical and energy coal. It has experience in the rehabilitation of surface mines under Australian and NSW environments. Agip Coal, through Agip Carbone, has access to one of the fastest growing thermal coal markets in the world resulting from its special role in Italy and its relationship with ENEL (the Italian electrical generating authority). IDEMITSU has access to the Japanese market.

Initially, AMAX and BHP formed a Joint Venture with each company holding a 50% interest, to explore and develop the Boggabri coal resources. With the introduction into the Project of Mobil, the participants equity in the Project became BHP Minerals Limited 50%, AMAX Pacific Inc. 25%, Mobil Energy Minerals Australia Inc. 25%. With the sale of Amax's and Mobil's interests , the participants are BHP Minerals Limited 50%, Agip Coal Australia Pty. Ltd. 25% and Idemitsu International Australia Pty. Ltd., 25%. Boggabri Coal Company Pty Limited was incorporated to manage the development, construction, maintenance and operation of the project and Boggabri Coal

Sales Pty Limited was incorporated as the sales representative.

2.5 Project Objectives and Justification

The Joint Venture was awarded Exploration Permit Tender Area No 1 on a competitive tender basis by the NSW Government and has applied to the Minister for Mineral Resources for the granting of a Coal Lease over an area covering approximately 36 square kilometres.

The objective is to develop an economically viable, efficient and environmentally acceptable coal mine which will be capable of maintaining its competitiveness in the international market. The Joint Venture believes that this can be done in an environmentally sound manner. The development will be in accordance with the relevant policies, controls and conditions of the Narrabri Shire Council, State and Federal Governments and their Authorities.

The local and regional community has indicated its support. Major economic and social benefits will accrue from the development to the residents of the area, the people of NSW and Australia and it is believed that the advantages and benefits of this project will considerably outweigh any short term environmental impact. The significance of these environmental affects and how they will be compensated and mitigated are discussed in Section 5. The project will benefit the area by:-

- providing job opportunities, reducing the high levels of unemployment currently in the region;
- stabilising the current cyclical agricultural base to the local economy;
- stimulating an increase in demand for goods and services both in Boggabri and surrounding communities; and
- serving as a new focus for decentralisation whilst easing the burden on the Hunter Valley.

2.6 Markets

2.6.1 International Trade in Coal

Coal is now firmly reinstated as a major worldwide energy source and is expected to maintain its dominant position through to the end of this century. During the period 1960 to 1985 Australia's coal exports increased from virtually nothing to about 80Mtpa spurred on by the oil crises of 1973 and 1979 and the rise in the Japanese and Asian steel industries.

2.6.2 Coal Supply and Demand

Prediction of the future international trade in energy and metallurgical coal has been the subject of numerous studies in recent years. Among these were studies prepared by the International Energy Agency (IEA), Chase Econometrics, the Energy Information Administration (EIA) and the Australian Coal Consultative Committee (ACCC). In September 1985 the Energy Authority of NSW (EANSW) published their assessments for the period 1985-1995. This study provides a reasonably reliable assessment of likely coal requirements in 1985-1995 of those countries which could import significant quantities of Australian (and in particular NSW) energy and metallurgical coals. A summary of the projected Australian energy and metallurgical coal exports is shown in Table 1.

Table 1 - Projected Coal Exports 1990-1995 (Million Tonnes)

	Energy Coal		Metallurgical Coal		Total	
	1990	1995	1990	1995	1990	1995
Total Import Requirements						
Europe	93.6	118.6	48.5	53.7	142.1	172.3
Middle East	8.8	13.3	8.4	9.6	17.2	22.9
Latin America	-	-	13.4	17.4	13.4	17.4
Far East	56.8	82.9	82.6	85.2	139.4	168.1
Other Asia	6.2	15.9	-	-	6.2	15.9
Total Import	165.4	230.7	152.9	166.0	318.3	396.7
Australian Exports						
Europe	13.5	18.4	10.5	13.1	24.0	31.5
Middle East	1.1	1.7	4.0	4.3	5.1	6.0
Latin America	-	-	1.7	2.2	1.7	2.2
Far East	27.9	40.7	39.0	41.5	66.9	82.2
Other Asia	3.7	9.3	-	-	3.7	9.2
Total Australia	46.2	70.1	55.2	61.1	101.4	131.2
World Share (%)	28.0	30.4	36.1	36.8	31.8	33.1

The results of this study is summarised as follows:

Energy Coal

World energy coal imports are projected to increase by 104Mtpa over the period, from 127Mt in 1985 to 231Mt in 1995. This represents a growth rate of about 6% pa. Most new demand is located in the Far East (45Mt increase) and Europe (38Mt increase) with about 21Mt increased demand in the

Middle East and Other Asia regions.

Australian energy coal exports are forecast to increase by about 37 Mt over the period from 33Mt in 1985 to 70Mt in 1995. This is a growth rate of 8% pa and represents an increase in Australian market share of world trade from 26% to 30% over the period. Increased exports will flow mainly to the Far East (21 Mt increase), and Europe (9 Mt increase) and Other Asia (7 Mt increase).

Metallurgical Coal

World metallurgical coal import requirements are forecast to increase by 31 Mt pa over 1985-1995 from 135 Mt in 1985 to 166 Mt in 1995 - a growth rate of 2% pa. Increased import demand is located mainly in the Far East (10 Mt increase), Europe (9 Mt) and Latin America (8 Mt). Australian metallurgical coal exports are projected to increase by 13 Mt over the period 1985-1995 from 48 Mt (1985) to 61 Mt (1995). Australian market share is forecast to increase marginally from 35% to 39% resulting in a growth rate of 2.5% pa for metallurgical coal exports. This demand is mainly generated by Europe and the Far East (4 Mt and 7 Mt increase respectively).

2.6.3 Specific Markets for Boggabri Coal

Boggabri coal is considered one of the highest quality energy coals available in Australia. Indeed, Boggabri coal is considered by most potential importers to be one of the higher quality coals available for future development anywhere in the world. In this regard Boggabri coal can be differentiated from the majority of coals to be exported from Newcastle.

Although Boggabri coal can be used in any application requiring a energy coal its prime use will most likely be in the markets having special environmental or industrial process considerations. The high energy content together with low levels of sulphur and ash make this coal ideally suited for use in environmentally conscious locations.

2.6.4 Project Development Viability

The Boggabri coal mine, when developed, will be one of the more remote export coal mines in NSW. The quality of the Boggabri coal makes it eminently suitable for export, necessitating transport to the port of Newcastle for shiploading and export.

To achieve a long term and viable coal mine development in the Gunnedah Basin a reduction in total operating costs is required, or alternatively market prices must increase. The Joint Venturers will endeavour to minimise the direct mine operating costs through the application and operation of highly productive mining methods.

The Joint Venture has no control over the off mine costs, which consist of the following major components:

- rail freight;
- port charges;
- government royalties; and
- mine lease rentals.

2.7 Alternatives and No Development Option

Alternative mining operations and transportation methods have been investigated. These included surface mining operations producing at various levels from 0.2 to 5.0Mtpa and underground operations from 0.2 to 2.5Mtpa. Recovery of the resource, because of the complex nature of the deposit, is greatly enhanced by maximising the proportion of coal mined by surface methods. Underground mining is proposed to recover the remainder of the mineable resource.

Transportation modes from the mine site to a rail head near Boggabri were investigated and included the use of private and public roads, conveyor, slurry pipeline and rail spurline. As an alternative to rail transportation to the Port of Newcastle, a slurry pipeline from the mine site to an offshore loading facility was considered. The rail transport option was chosen as the most feasible and desirable alternative. The road and rail access route was chosen after extensive investigations and is located to avoid flood prone areas, minimise property sterilisation and provide a buffer to any nearby residences.

Specialised markets for Boggabri coal have been identified to include :-

- power and manufacturing industry users;
- coal gasification;
- steel industry users;
- coal-oil fuel mixtures;

It is believed that few other Australian producers can supply low ash coal for these special markets. If the Boggabri project does not proceed, these potential markets will not be realised and the Federal, State and Local Governments will lose substantial revenue and the social and economic benefits to the region.

2.8 Government Approvals, Regulations and Negotiations

2.8.1 Regulations and Approvals

The mining development will be subject to the approvals, regulations and controls of Federal, State and Local Governments. Before the mine can proceed it will require:-

(i) Development Approval from the Narrabri Shire Council and the Minister for Planning and Environment. The proposal falls within Part IV of the Environmental Planning and Assessment Act, 1979, and is a "designated development" under the Regulations to that Act. Under Section 77(d) an Environmental Impact Statement is therefore required to be prepared in accordance with Clause 34 of the Regulations, which sets out the requirements for the EIS. Under Clause 35 the company has consulted with the Director, Department of Environment and Planning as to the form and content of the EIS. The EIS is required to be made available for public display and sale after approval of the document by the Department. Public objections may be lodged and a public hearing may be held. Development approval will be subject to conditions resulting from comments, submissions or objections from the public and Government authorities.

(ii) A Coal Lease from the Department of Mineral Resources. The Lease will contain schedules of conditions for the protection of the environment and other items as defined under the mining regulations. Environmental conditions may include; progressive rehabilitation, control of erosion within catchment areas and State Forests, prevention of soil erosion and the lodgement of security deposits. Under Section 91 of the Coal Mining Act, 1973, development approval will be required before the granting of a Coal Lease.

(iii)Approval to commence surface mining operations from the Minister for Mineral Resources. The Minister may revoke or vary such consent. The holder of the approval is required to rehabilitate mined areas to the satisfaction of the Minister. Information required by the Minister includes:-

- detailed plans of areas to be mined, topsoil depth, mine plans and approximate surface rehabilitation contours;
- methods proposed to prevent effluent or contaminated water discharging from mining areas;
- topsoil handling details;
- details of grasses, plants, shrubs and/or trees to be planted on the rehabilitated area;
- such other details as the Minister may require.

The Minister may grant approvals for the whole or part of the Lease Area. This scheme allows the Department to closely monitor the progress of mining and rehabilitation. The granting of further approvals is dependent upon the progress of rehabilitation achieved. The specific conditions which are included in the surface mining consent are drawn up with the assistance of the Soil Conservation Service.

(iv) Licences and approvals from the State Pollution Control Commission under the Clean Air Act (1961), Clean Water Act (1970), Noise Control Act (1975) and State Pollution Control Commission Act (1970). Licence conditions may be specified regarding control equipment, operating techniques and emission levels.

(v) Other consultations and approvals with the Forestry Commission of NSW, the National Parks and Wildlife Service, the Heritage Council of NSW, the Department of Main Roads, the Department of Agriculture, the Land Commission of NSW and the State Rail Authority of NSW. The Water Resources Commission will require licences for dams, streams diversion and extraction of groundwater resources.

(vi) Commonwealth Government approvals from the Minister for Trade and Energy and the Minister for Arts, Heritage and Environment will be required for the export of coal.

(vii)Joint Coal Board approval under Order 27 to enable the mining, transportation and export of coal.

2.8.2 Status of Negotiations

Discussions and negotiations with the respective Government Authorities on aspects of the project have been held since project inception and are continuing with:-

Narrabri Shire Council. The council has been continually advised on the status and nature of the project and the likely affects on their services and facilities.

Department of Environment and Planning. The Department has been formally advised of the project and has issued guidelines for the preparation of the EIS and reviewed a draft. This document has been prepared in accordance with the requirements of the Act.

Department of Mineral Resources. The Department is fully aware of all aspects of the proposal and is awaiting the release of this document and the Development Consent prior to awarding a Coal Lease.

Soil Conservation Service. The Service has provided information and advice on rehabilitation aspects of the project.

Department of Agriculture. Discussions were held with the Department regarding classification of land within the lease area.

Forestry Commission of NSW. Discussions have been held with the Commission since 1978 regarding mining in the Leard State Forest, compensation, rehabilitation objectives and the establishment of silvicultural trials by the Commission.

Joint Coal Board. The Board has been advised of the proposal.

State Pollution Control Commission. Discussions have been held with the Commission regarding their requirements under the Acts. Licence applications will be submitted at a later stage.

State Rail Authority of NSW. Discussions have been held on design requirements for the rail spurline and bridge and on coal haulage to Newcastle.

Department of Main Roads. Discussions have been held regarding the access road to the mine site.

Water Resources Commission. Design requirements for the Namoi River rail bridge and access roads have been discussed, together with more general aspects of water supply and management.
Electricity Commission of NSW. Power requirement aspects have been discussed.
Namoi County Council. Conditions for the supply of electric power to the site.
National Parks and Wildlife Service. The service is aware of the development proposal and information has been provided on flora, fauna and surveys for Aboriginal artifacts or sites.
Premiers Department. The Industrial Investment Unit has been fully informed of the development.

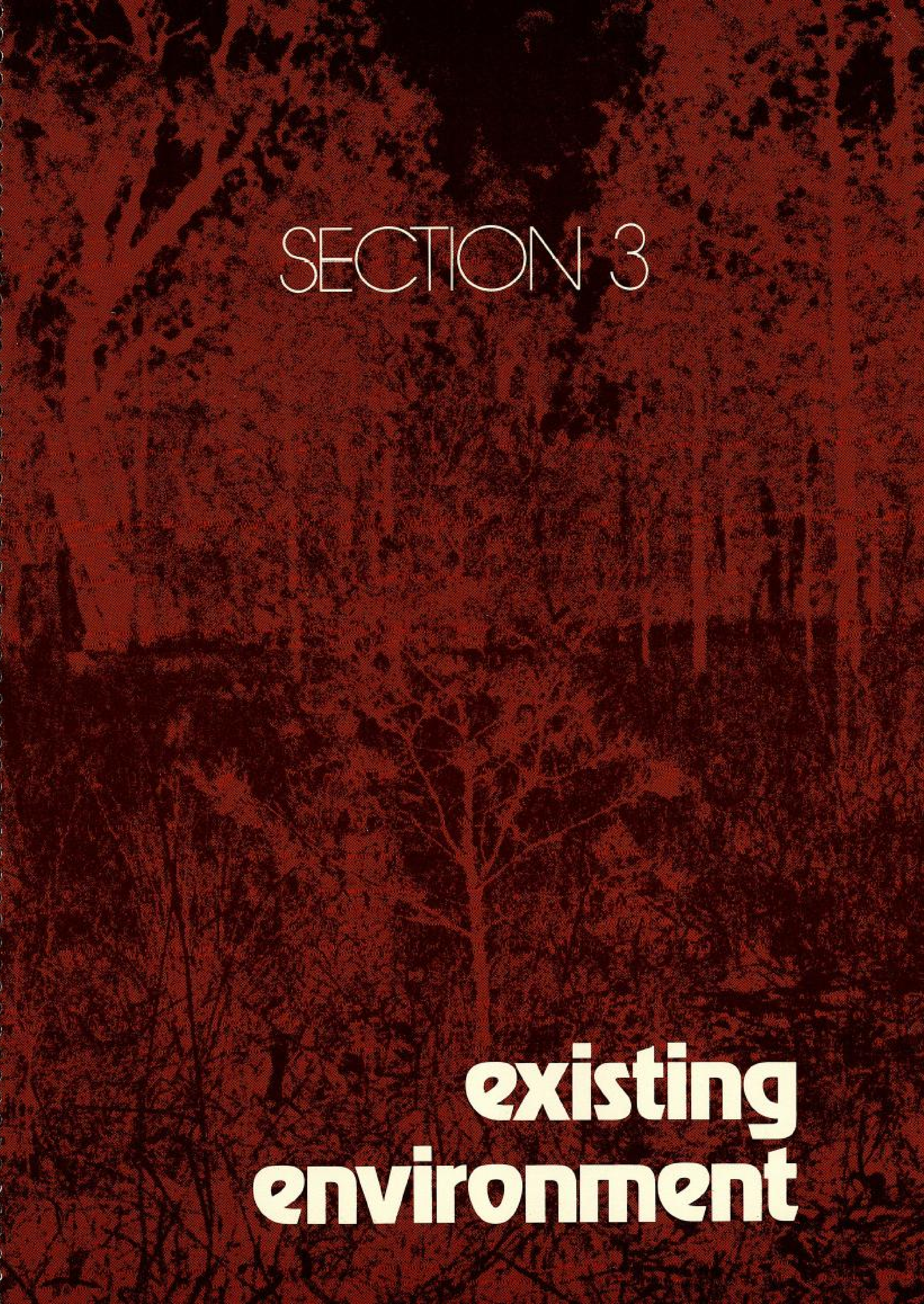
2.9 Statement Preparation

This document has been coordinated and prepared by BHP Minerals Limited on behalf of the Joint Venture. The principal personnel responsible were:

Project Director and Geology	D. Nelson	Senior Development Officer
Project Engineering	R.M.Weston	Senior Mining Engineer

To provide additional expertise in specialised environmental areas the following consultants were commissioned:

Principal Environmental Consultant and Report Director	John Miedecke & Partners, Sydney
Biological	James B Croft and Associates, Newcastle
Hydrology	Environmental Engineering Department, AMAX Coal Company Indianapolis BHP Engineering, Sydney Australian Groundwater Consultants, Sydney Dames and Moore, Sydney
Water Supply	Australian Groundwater Consultants,
Soils & Overburden	Environmental Engineering Department, AMAX Coal Company, Indianapolis Dames and Moore, Sydney
Acoustical	Louis Challis & Associates, Sydney
Air Quality & Meteorology	Dames and Moore, Sydney
Water Management	BHP Engineering, Sydney
Rehabilitation	Department of Ecosystem Management, University of New England
Socio-economic	Nexus Environmental Studies,Sydney



SECTION 3

existing environment

SECTION 3 : EXISTING ENVIRONMENT

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3.0 EXISTING ENVIRONMENT

3.1 Introduction

The Joint Venture initiated baseline environmental studies in 1976. During the execution of these and impact analysis studies, numerous consultants have been employed. Their input has ranged from periodic review of study results, to the actual implementation of the studies and monitoring programmes. The studies performed, and the consultants employed under supervision by the Joint Venture, are listed in Section 2.9. These studies have been updated as indicated to include more recent information or to refelct changes in the project.

The main features of the individual studies have been incorporated into this report whilst the consultant's reports are noted as reference documents.

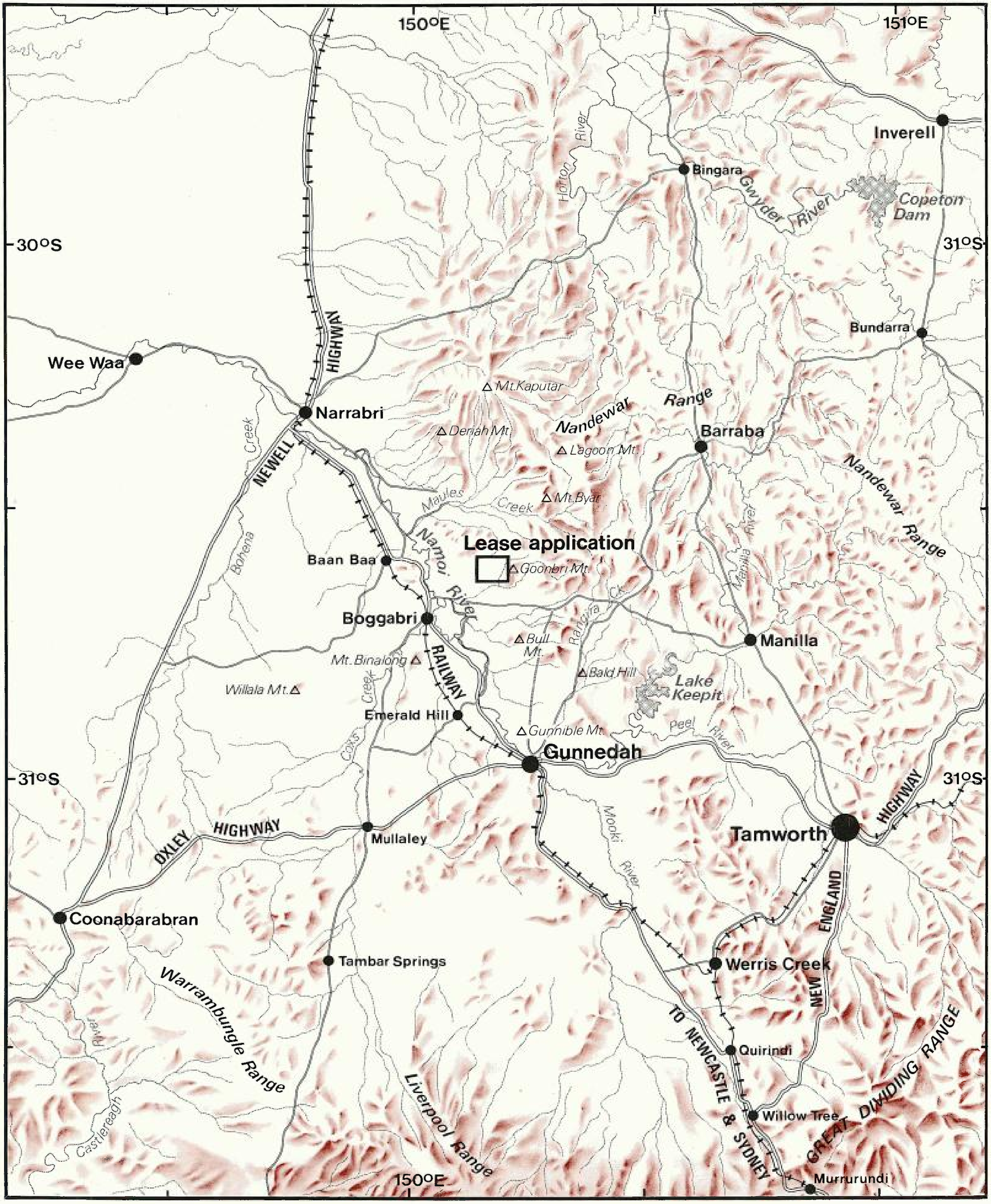
3.2 Regional Setting

The lease area lies near the edge of the Namoi River alluvial flood plain, the open plain country below Keepit Dam (Figure 4). Deep black soils have developed on the alluvial plains, and although heavy and difficult to work, they are fertile and of high agricultural importance. Most of these plains have been cleared for agriculture and it is only on the higher ground with steeper slopes and poorer soils that any large tracts of natural vegetation remain.

Some of these forested areas, virtually by default, have been dedicated as State Forest. The lease area lies on the gentle slopes of the Willow Tree Range, almost wholly within the boundaries of the Leard State Forest.

The Namoi River Valley has a long history of both flood and drought which have extremely disruptive effects on the local rural economy, which is essentially based on irrigated and dryland cropping and grazing. The township of Boggabri is the closest urban centre to the lease area, approximately 15km to the south-west. Boggabri is itself situated approximately 40km and 60km from the larger centres of Gunnedah and Narrabri. The city of Tamworth is the main regional centre.

Coal mines have operated in the region since the late 1800's, when the Preston Mine and the Gunnedah Colliery commenced operations. These two underground mines are still operating and have expanded operations since 1969, when ownership changed hands to larger national concerns. Present production is in the vicinity of 1.0Mtpa, principally for export. The Gunnedah Colliery has installed a washing plant capable of treating 1.0Mtpa and has developed a small surface mining operation to supplement the existing underground mine. A new underground coal mine has been established at Vickery for trial marketing purposes. Production from Vickery is envisaged to be 200,000 tonnes per year for two years.



BOGGABRI AREA

JOINT VENTURE

Boggabri coal

Figure 4

Scale 1:1,000,000

0 — 50 km

Coal exploration has expanded in recent years, with exploration programmes well advanced to the south and north of the lease area (Figure 3). The Vickery area is being investigated by a Joint Venture between Kembla Coal and Coke (through its wholly owned subsidiary, The Coal Cliff Collieries Pty. Limited) and Sunshine Gold and the Maules Creek area is being explored by The Coal Cliff Collieries Pty. Limited.

3.3 Topography

The lease area is bounded by a ridge which encloses the catchment of the ephemeral Nagero Creek and the surface mine area, forming a broad south-west facing basin (Figure 2). The topography, away from this ridge is gently undulating. Except for small areas on the ridge with slopes greater than 15%, the slopes have grades of 1 to 10% (Figure 5).

3.4 Climate and Air Quality

The overall climate of the region is determined by its latitude, inland location and proximity to the Nandewar Range. Rainfall is influenced by a number of phenomena:-

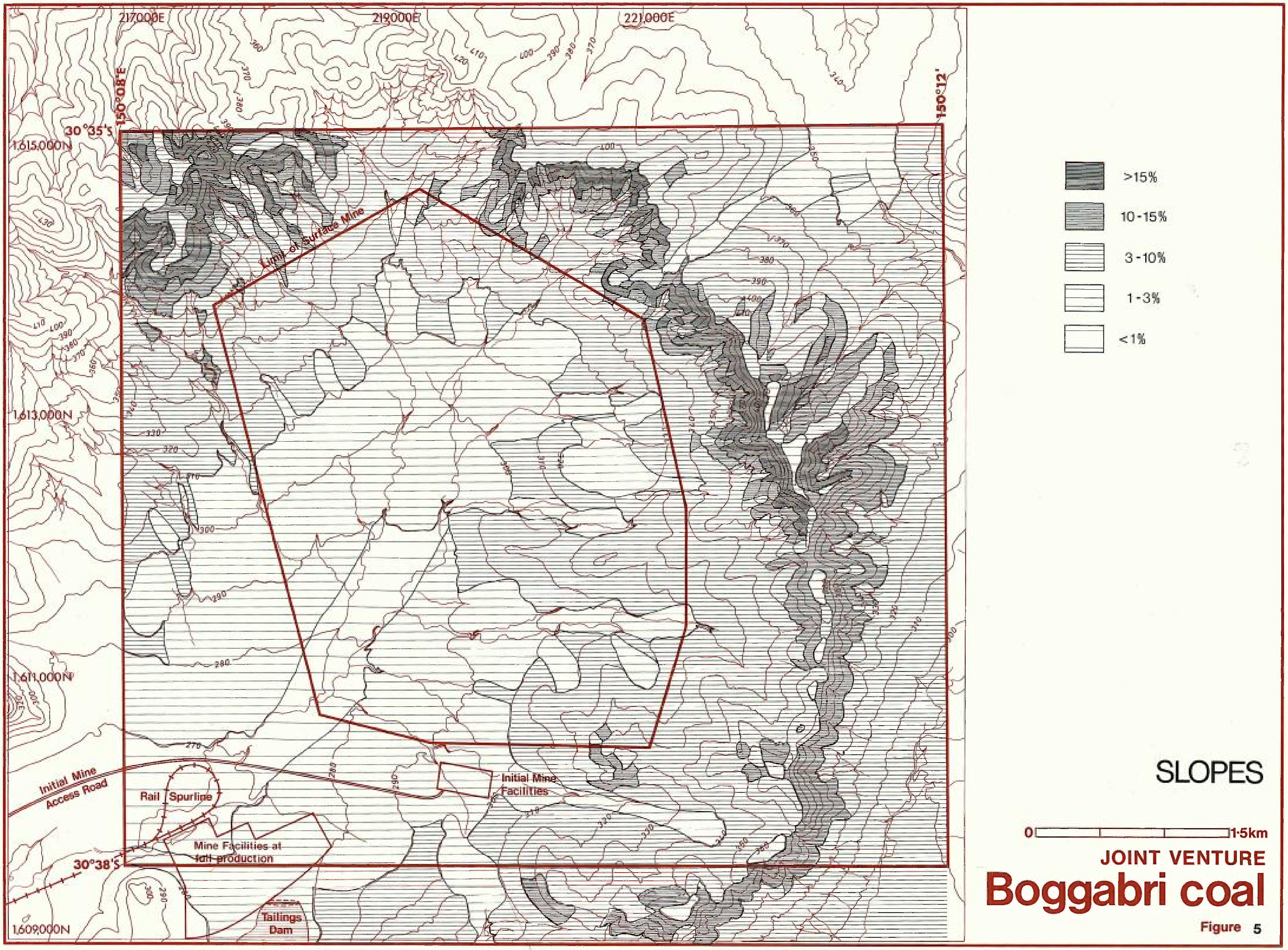
- passage of moist upper atmospheric low pressure cells from the north which often cause high intensity daily rains;
- passage of inland tropical cyclones and low pressure systems which often cause long duration high intensity rainfall periods during summer;
- passage of cold fronts across NSW; and
- localised convection storms which can cause a certain amount of the high intensity summer rainfalls.

Droughts affect the region, their length and severity increasing towards the west. Summers are generally hot, winters short with numerous frosts. It is recognised that temperature inversions are common in winter months, forming in the late afternoon and reaching maximum resistence at dawn. This is particularly the case in valleys on the edge of the Nandewar Ranges.

An on-site meteorology station and network of dust deposit gauges were established in August 1980 by Dames and Moore. Their report of twelve months collection of data:- "Report on Wind, Rain and Particulate Monitoring Programme at Nagero-Boggabri, NSW" has been used in preparing this Section together with data available from the Bureau of Meteorology and BHP Engineering's studies.

3.4.1 Rainfall

Monthly rainfall distribution and variation for Boggabri Post Office are illustrated in Figure 6. Records for Boggabri Post Office exist from 1884, and for the nearby property Penryn since 1899. The median values give a useful measure of the typical rainfall. Median deviation is a measure of the reliability of rainfall.

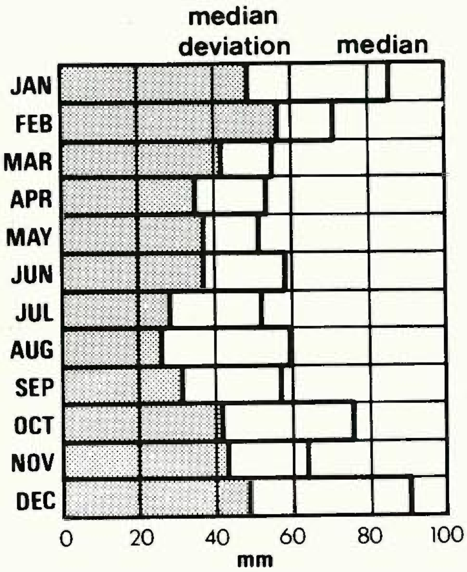


SLOPES

JOINT VENTURE
Boggabri coal

Figure 5

The lower the median deviation, the greater the consistency and reliability of the rainfall in the area. The driest months occur from March to September, and the wettest between December and February.

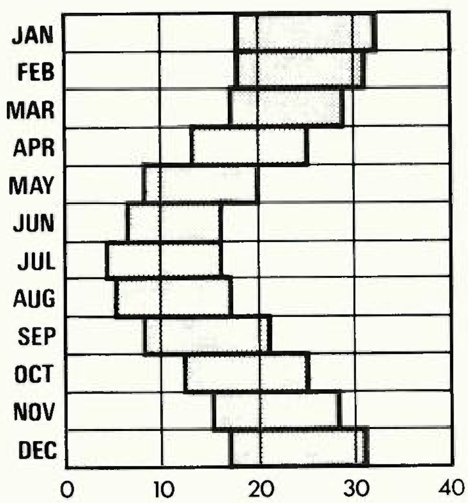


RAINFALL
Figure 6

Rainfall is normally least reliable between October and May. The average number of rain-days/month remains fairly constant throughout the year, although the median rainfall reaches a low in winter. This indicates that rainfall intensities are lower during winter where only 2% of falls are at an intensity greater than 50mm per hour, compared with over 20% in summer. The area has a normally highly variable rainfall and the recent past has been one of the driest periods on record. Comparison between the rainfall at the Nagero meteorology station and the Boggabri Post Office has shown similar patterns.

However, local intensification on the Nagero site due to the nearby Nandewar Ranges, might be expected to occur. Long term annual rainfall for the Nagero site is expected to be between 600 to 700mm. Based on point rainfall records the Bureau of Meteorology derived rainfall intensity-frequency-duration curves in order to enable the design of the water management system. A study of the Probable Maximum Precipitation occurring during thunder-storms was also undertaken by the Bureau.

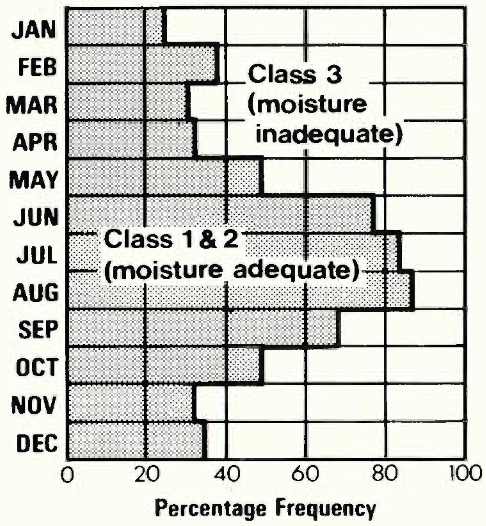
3.4.2 Temperature and Frosts



TEMPERATURE
Figure 7

Figure 7 illustrates long term average daily maximum and minimum temperatures recorded at Gunnedah. Frost is a major determinant of the length of the growing season. The only data available is from the Gunnedah Research Station, where readings have been Temperature taken since 1948. On average, frost occurs on 42 days each year with the highest occurrence in July of 14 days.

3.4.3 Evaporation and Soil Moisture



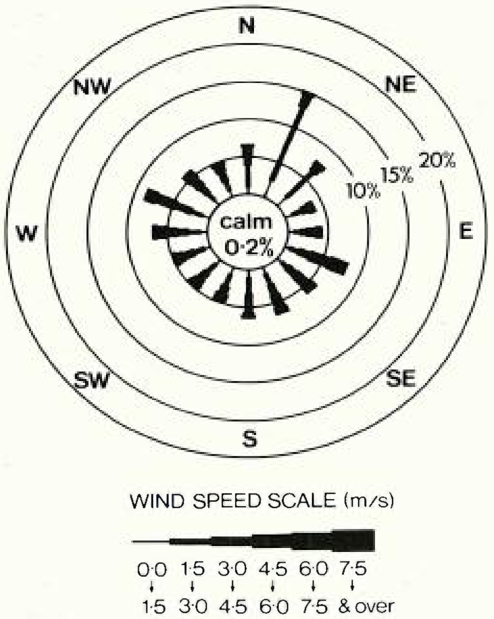
SOIL MOISTURE CONDITIONS
Figure 8

The mean evaporation at Boggabri is estimated by the Soil Conservation Service, (SCS, 1978) at 1,512mm per year or approximately three times precipitation. The SCS has derived a monthly moisture index based on rainfall and evaporation data. This is shown in Figure 8 and enables an interpretation of periods when:-

- maximum runoff can be expected (soil moisture high);
- reliability for plant growth is greater;
- earthmoving activities will be restricted due to wet or dry conditions; or
- unfavourable periods for dust generation (soil moisture low) can be determined.

Soil moisture is clearly highest during the winter months.

3.4.4 Wind



WINDROSE
Figure 9

Figure 9 shows a wind rose produced from hourly average surface measurements of wind speeds for the Nagero site, from September 1980 to August 1981. An analysis of this data shows a wind regime typical of stations in the central north of NSW. Winds with a basically westerly component are most common during winter and spring, while easterly winds begin to dominate during the warmer months. Highest wind speeds were recorded in summer. The high frequency of winds from the NNE direction (at low speeds) was attributed to local topography.

3.4.5 Dust

Particulate dust fallout in the vicinity of the mine site has been monitored since September 1980 by Dames and Moore. The mean fallout of dust has been highly variable over this period. Table 2 shows the mean values for the various sites. The highest deposition rates were at Site 2, the lowest at Site 1. Dames and Moore interpreted the results as being comparable with other rural areas and less than is typical for an urban area. For example dust deposition rates for Sydney ranged from 1.0 to 4.4 g/m^2/month during 1977. Various rural communities in NSW range from 1.8 to 2.8 g/m^2/month. (Source: State Pollution Control Commission).

TABLE 2 : MEAN MONTHLY DUST FALLOUT (g/m^2/month)

Site	1	2	3	4	5	6*
Mean	0.29	0.95	0.44	0.30	0.41	0.35

* One sample deleted because of contamination.

3.5 Geology and Coal Reserves

3.5.1 Exploration

Drilling commenced in January 1976. The first year's drilling of 20 cored holes, totalling some 6,000 metres indicated that the area of most likely economic potential was the north-western corner of the original 260 square kilometre Tender Area. After drilling a further 25 cored holes (approximately 7,000 metres) and 220 non-cored holes (approximately 27,000 metres) in this north-west portion, the Tender Area was reduced to some 60 square kilometres (December 1977) and subsequently reduced to about 35.4 square kilometres for the Coal Lease Application in December 1979.

All boreholes were geophysically logged if possible. Detailed analysis of coal from the slim (50mm) and large (200mm) diameter drill holes, float/sink tests on slim cores, and washability tests on large cores from large diameter drill holes have provided accurate information on coal quality. In the Merriown seam close to its subcrop a 25 metre deep boxcut has been excavated. From this, some 110 tonnes of coal has been taken for bulk testing, analysis, washing and sizing tests and the provision of representative samples to potential customers in Europe and Asia.

3.5.2 Geology and Coal Reserves

The Boggabri lease application area is located in the Gunnedah Basin between the Boggabri Ridge and the Mooki Thrust Fault. The lease application area contains early Permian coal measure sediments of the Nandewar Group. These coal measures are underlain by basement Boggabri Volcanics which outcrop in the south-western corner of the lease area. The coal bearing sediments dip gently to the north-east, at up to five degrees, reaching a thickness greater than 500 metres. The Nandewar Group is sub-divided into the Maules Creek Formation and the Leard Formation which rests conformably on the Boggabri Volcanics. The Maules Creek Formation, the principal coal bearing sequence, consists predominantly of conglomerate and coal with minor interbedded sandstone, siltstone and mudstone. It contains 12 identifiable coal members which generally split to the north-east. The area appears to have been free of igneous activity. Some moderate fault complexes have been inferred from the drilling programme.

Total insitu reserves of the lease area are assessed at 650 million tonnes. Table 3 summarises the coal reserves and characteristics. Approximately 210 million product tonnes are at depths and overburden ratios that may be suitable for surface mining. Most of the surface mineable coal is contained in the subcropping four uppermost seams, the Braymont, Bollol Creek, Jeralong and Merriown Coal Members (Figure 10). Other seams have limited potential for surface mining. Figure 11 illustrates typical cross -sections of the geological sequence. Reserves potentially extractable by underground mining include the deeper areas of the Braymont, Jeralong and Merriown seams, as well as intermediate and lower seams. The lower seams such as the Tarrawonga and Templemore Coal Members have some coal of coking quality. Recoverable underground coal is estimated at 140 million product tonnes. This figure is based on a lower workable thickness limit of 1.5 metres and takes into account the likely mining recoveries due to the complex nature of this multi-seam deposit.

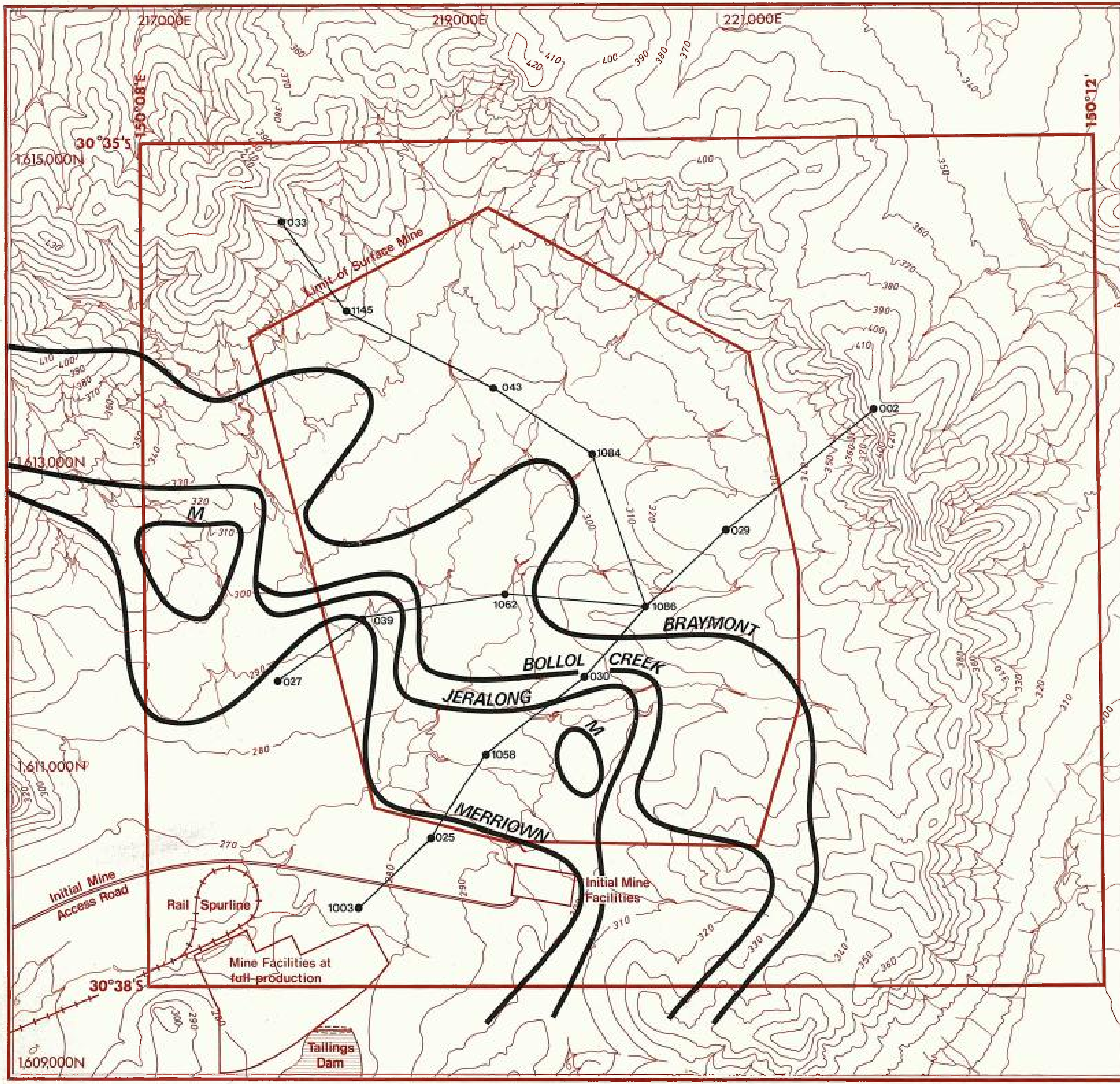
3.5.3 Coal Quality

Coal seams from the Boggabri project are suitable for energy and metallurgical applications.

The major energy coal seams are the:-
- Braymont;
- Bollol Creek;
- Jeralong; and
- Merriown.

The major metallurgical coal seams are the:-
- Tarrawonga; and
- Templemore.

The Braymont, Bollol Creek, Jeralong and Merriown seams are suitable for use in steam raising, gasification, blast furnace tuyere injection, formed coke manufacture and coal-oil mixtures. This energy coal has a high calorific value and low ash. The coal is also low in sulphur, chlorine, phosphorus and trace elements and has good ash fusion properties.



Seam subcrop

Bore hole ●027

Line of section (Fig 10)

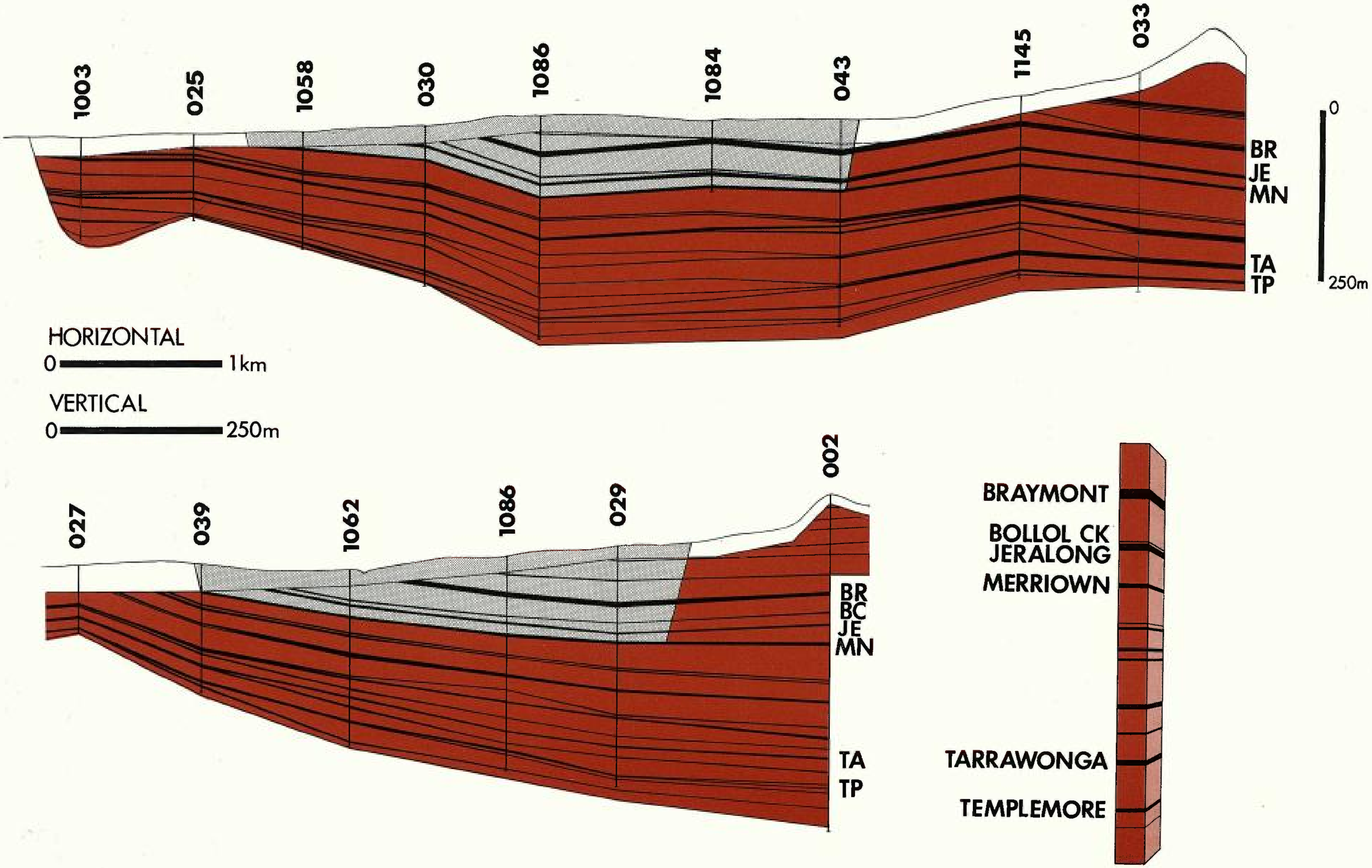
GEOLOGY

0 — 1·5km

JOINT VENTURE

Boggabri coal

Figure 10

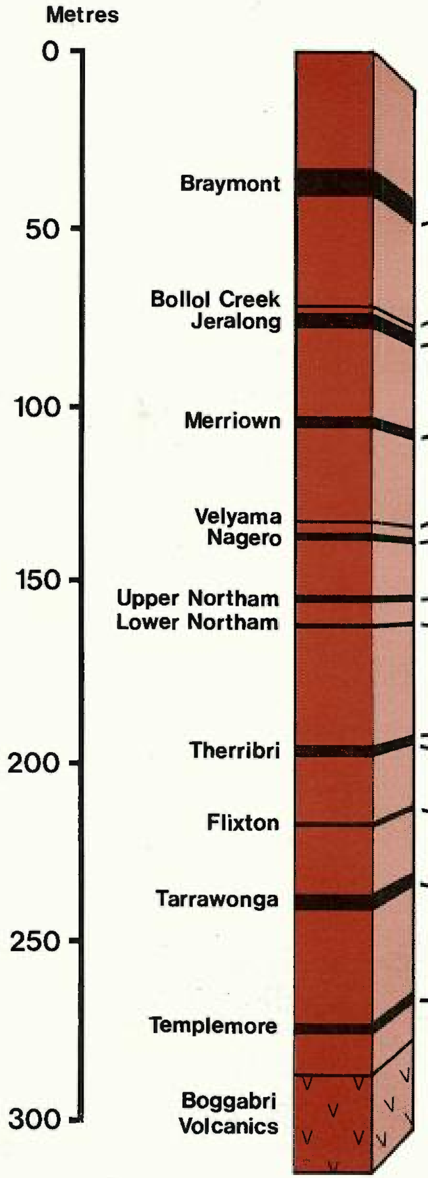


GEOLOGICAL CROSS SECTION

JOINT VENTURE

Boggabri coal

Figure 11



Average thickness (metres)	ROM coal *		Total Insitu Reserves $X10^6$ tonnes		Recoverable product Reserves $X10^6$ tonnes	
	Ash content % (db)	Specific energy MJ/kg	Opencut	Underground	Opencut	Underground
5.5	22	27.0	90	20	78	13
0.9	32	24.0	14	—	12	—
3.0	11	30.5	70	26	62	20
2.5	12	30.2	66	33	58	15
0.8	5	32.3	—	4	—	—
1.8	6	32.0	—	65	—	22
1.8	11	30.0	—	37	—	10
1.2	7	31.5	—	—	—	—
1.5	7	31.5	—	35	—	10
1.8	11	30.0	—	50	—	15
1.0	16	29.0	—	—	—	—
3.0	9	31.0	—	90	—	20
2.5	10	30.7	—	50	—	15
		TOTAL	240	410	210	140

*Considers contamination during mining for open cut seams

RESERVES AND COAL SEAM CHARACTERISTICS

JOINT VENTURE

Boggabri coal

Table 3

The coal falls in the range of the International Classification Code Numbers 611 to 633 and is described as High Volatile A Bituminous in the ASTM Classification. The coal is reasonably hard (Hardgrove Grindability Index of approximately 52) and produces low levels of dust during mining, handling and transportation. Boggabri coal washes easily to produce a low ash product of between 5 and 6% with high product yields.

The Tarrawonga and Templemore seams yield a metallurgical coal product. These two seams are deeper than the energy coal seams and exhibit a higher rank. After preparation, this highly fluid and reactive coal is suitable for use in coking blends where low ash and low sulphur additives are beneficial. Caking properties are generally good, with good Gieseler fluidities, positive dilatation and reasonable swelling properties.

3.5.4 Boggabri Coal Characteristics

Detailed resource analysis has provided a year-by-year prediction of energy coal quality for the surface mine. The study used data obtained from slim and large diameter cores, bulk boxcut samples and geophysical logs of non-cored holes, together with the production schedules and preparation plant configuration to generate data on product coal quality. Samples were extracted from a boxcut into the Merriown seam for processing at the Australian Coal Industry Research Laboratories pilot coal preparation plant at Maitland to generate washplant design data and provide washed coal marketing samples. Samples have also undergone extensive testing at BHP Central Research Laboratories to evaluate the merit of the coal as:-

- a blending coal in coke making; and
- a blast furnace tuyere injectant (replacing oil).

A sample has been evaluated in the USA to assess its combustion and NOx formation characteristics when burnt under conditions simulating conventional coal-fired power stations. The testing and evaluation programme undertaken on Boggabri bulk samples has provided a wealth of information for the market development programme. To date more than 30 samples have been supplied to potential customers in 8 different countries for testing and evaluation.

3.6 Soils and Overburden

Preliminary soil and overburden studies have been completed for the Braymont, Bollol Creek, Jeralong and Merriown coal seams. The studies were conducted by the Environmental Engineering Department, AMAX Coal Company, Indianapolis and by Dames and Moore, Sydney. AMAX's report:- "Soils-Overburden Characterisation of Boggabri Coal Prospect Area, Boggabri, N.S.W., Australia", (Wiram, 1982) which includes Dames and Moore's report, is a reference document.

The objectives of the studies were:-

- to define baseline conditions and properties;
- to determine the most suitable topdressing materials for designated future use in rehabilitation of mined areas;
- to identify all materials potentially deleterious to rehabilitation; and
- to design and incorporate into the Mining and Rehabilitation Plan, selective mine handling procedures based upon soil overburden data in order to assure proper placement of suitable overburden and deep burial of potential problematic materials.

With assistance from the Soil Conservation Service (SCS) Gunnedah Research Station a soil inventory and subsequent sampling programme was conducted over the area of surface mineable reserves (Figure 12). Cores taken during exploration drilling were used for characterisation of the consolidated overburden materials. Unconsolidated materials above the Merriown seam were sampled in the trial boxcut. Selected representative samples were submitted for detailed chemical analyses.

Routine agronomic and micro-nutrient determinations were completed on the various materials in order to define their suitability for use as topsoiling material and/or rooting media. Salinity and alkali parameters were sought for the purpose of identifying saline and sodic materials. Trace metal determinations were made in order to define baseline concentration levels as well as identification of potential environmental problems.

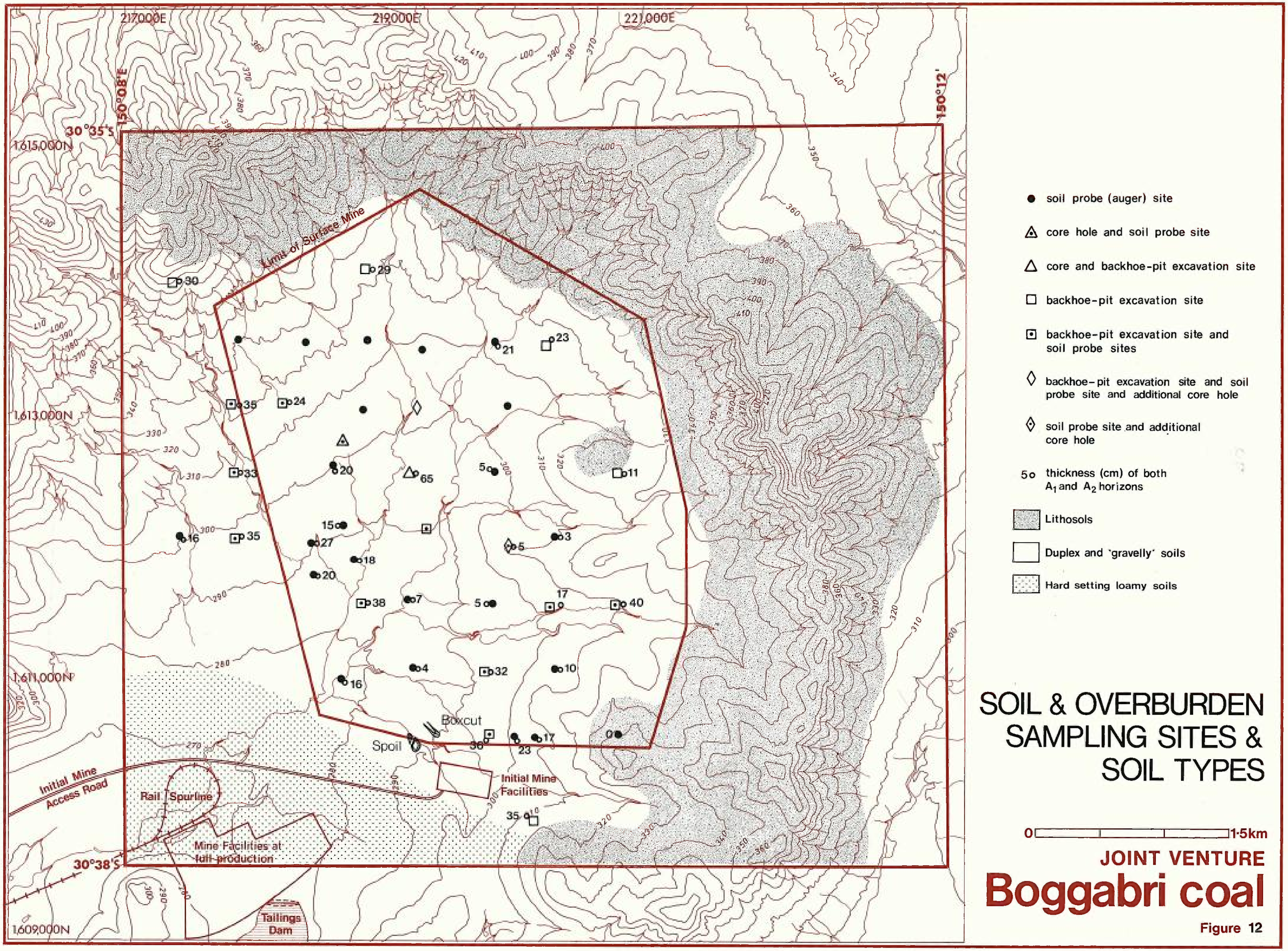
3.6.1 Soils

Most of the soils within the lease area have developed from two major sources of parent materials, namely :-

- residuum of weathered sandy conglomerates; and
- alluvium and/or colluvium derived from weathering of former soil profiles and bedrock of surrounding volcanic and sedimentary outcrops.

By far, the greatest influence on soil development within the area has been the bedrock sandy conglomerate(s) and throughout the majority of soil profiles examined, textures ranged from gravelly sandy clay loams to sandy clays.

Field observations substantiated the generalised soils map prepared by the SCS. Duplex soils (Yellow and Brown Solodics) predominate over lesser amounts of Lithosols and Structured Loams. Typical soil profiles are shown in Figure 13. With the possible exception of the Structured Loams, the soils have a shallow profile. The A-horizon of the soil profile rests upon an extremely compacted hardpan which, for the most part, marks the upper boundary of the B-horizon or C-horizon where the B-horizon is absent. Topsoil or A-horizon thickness ranges from 50mm to 650mm and averages 220mm. Figure 12 illustrates the general distribution patterns of the topsoiling materials.



SOIL & OVERBURDEN SAMPLING SITES & SOIL TYPES

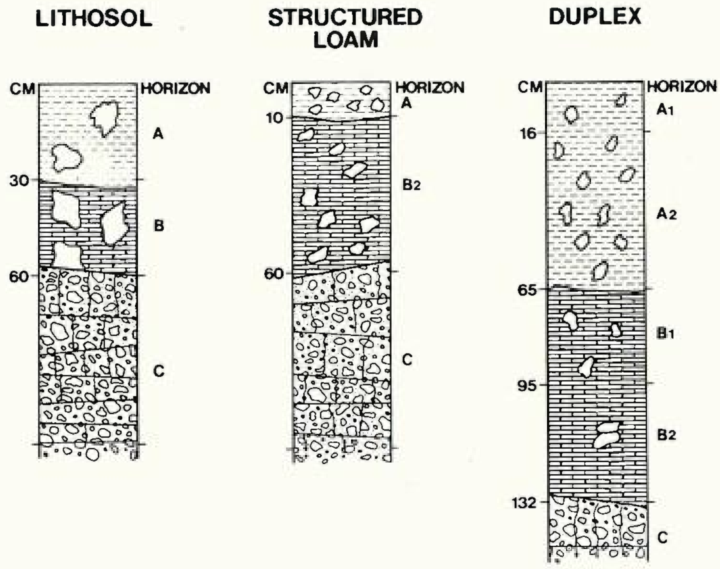
JOINT VENTURE

Boggabri coal

Figure 12

(i) Duplex Soils

The Duplex soils occupy the more gently sloping (3-8%) terrains within the study area. They show a strong texture differentiation with an abrupt boundary (hardpan) between the A and B-horizons and a conspicuously bleached A2-horizon. From a rehabilitation/revegetation viewpoint, the A-horizon is by far the best topsoiling material available on the site.



SOIL PROFILES
Figure 13

Although a slight increase in soil salinity with depth was observed, the entire profile can be characterised as non-saline and no soil saline revegetation problems are anticipated following mining. However, there does exist a potential problem with sodic Duplex subsoils. These sodic conditions when coupled with the expandable clay content of the C-horizon could pose potential problems to rehabilitation if such materials are left at the surface following grading.

(ii) Lithosols

The second most abundant soils to be encountered during mining are the Lithosols. These lack horizon development, apart from an occasional thin A1-horizon, their surface generally consisting of gravelly material. Within the lease area they occupy the steeper sloping (8-15%) terrain and ridge top areas. Agriculturally, they are of little use due to their low fertility and low moisture holding capabilities.

(iii) Structured Loams

The Structured Loam soils (Red and Brown Earths) occur in two locations:-
- adjacent to the small tributary drainage system within the lease area and
- in the area which has undergone severe faulting.

Structured Loam soils are very similar to Duplex soils from the standpoint of most physical and chemical properties and are suitable for topsoiling purposes. Their profiles are non-saline but with sodic subsoil conditions.

3.6.2 Overburden

The overburden/interburden materials associated with the coal seams, because of their rapid fluvial mode of deposition, exhibit considerable changes in rock type. Typical strata between the various coal seams are shown in Figure 14.

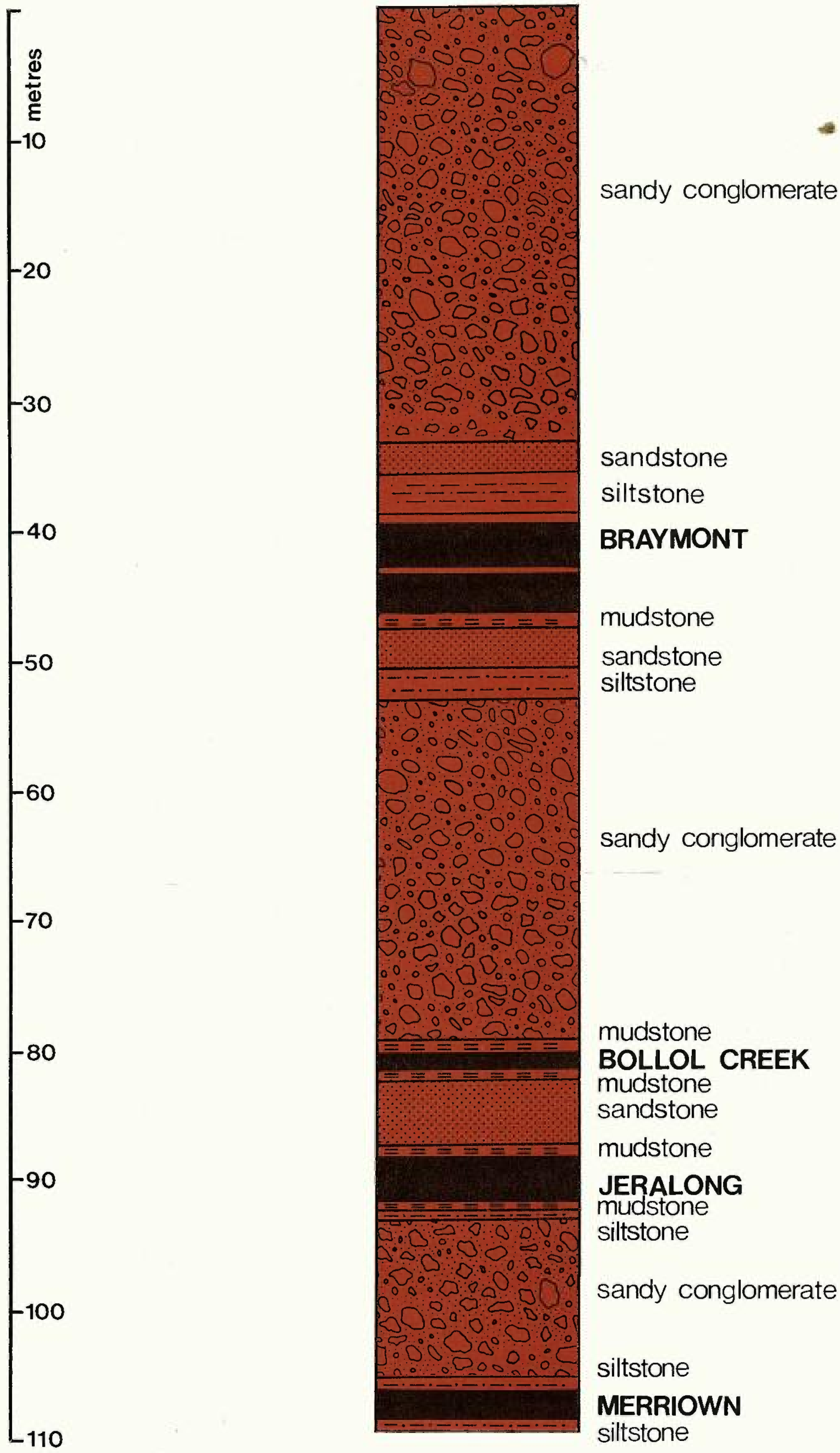
Most of the strata are devoid of potential acid producing pyrites. Exceptions are some roof and floor rock immediately associated with coal seams. The major factor governing the bedrock geochemistry relative to rehabilitation appears to be the origin of the majority of sediment which is comprised of derivatives of acid volcanic igneous rocks rich in sodium. As an overbalance of sodium when combined with expandable clays can create undesirable sodic problems during rehabilitation, major emphasis in overburden characterisation is placed on the evaluation of these conditions.

Macro-nutrient levels in the various rock types reflect similar conditions to those observed in the native soils, being deficient in phosphorus and nitrogen. Micro-nutrient and trace metal levels are slightly higher than soil conditions but are within the normal range of rock constituents influenced by volcanic activity.

(i) Braymont Seam Overburden

Overburden rock types of the Braymont seam consist of (in descending order):-
- sandy conglomerate;
- sandstone; and
- siltstone (roof of Braymont seam).

This interval is non-saline except for the roof siltstone showing a slight increase in salinity. More important than the salinity issue are the sodic concentrations of the sandy conglomerate, as indicated by the SAR values. Of lesser concern, because of limited clay content and sandy textures, are the SAR and Exchangeable Sodium Percentage values of the sandstone. If the major portion of conglomerate matrix is expandable clay, then it could



TYPICAL OVERBURDEN/INTERBURDEN STRATIGRAPHY OF THE BRAYMONT, BOLLOL CREEK, JERALONG AND MERRIOWN SEAMS

JOINT VENTURE

Boggabri coal

Figure 14

pose undesirable sodic spoil revegetation problems. The second most important observation to make from the overburden data deals with acid overburden potential. The sandy conglomerate is alkaline in nature, possessing adequate neutralisation potentials to assure alkaline conditions following prolonged weathering. The siltstone roof of the Braymont seam has the potential to develop acid conditions because total sulphur concentrations are far greater than the inherent neutralisation potentials of this unit.

(ii) Bollol Creek and Jeralong Seam Overburden/Interburden

Overburden/interburden of the Bollol Creek/Jeralong seam consists of (in descending order):-

- shale/mudstone (floor of Braymont seam);
- sandstone;
- siltstone, sandy conglomerate;
- Bollol Creek Seam;
- mudstone/sandstone;
- silty shale/mudstone (roof of Jeralong seam); and
- siltstone (parting in upper Jeralong seam interval).

The various strata are non-saline, with only slight salinity increases shown for shales. Both the sandstone and sandy conglomerates show sodic characteristics as indicated by SAR values. There appears to be a considerable increase in sodic conditions in the basal sections of the interval. There is also a noticeable increase in salinity and sodicity of the Braymont-Jeralong interval in the overburden versus interburden situation.

As with the Braymont overburden, the major concern over the acid bearing potential of the strata is with the roof shale of the Jeralong seam. Increased total sulphur concentrations and inherent neutralisation deficiencies indicate acid producing potential.

(iii) Merriown Seam Overburden/Interburden

Overburden/interburden of the Merriown seam consists of (in descending order):-

- shale (floor of the Jeralong seam);
- siltstone;
- sandy conglomerate; and
- siltstone (roof of Merriown seam).

The various strata units are non-saline, however outside the subcrop of the overlying Jeralong seam a significant increase in salinity and sodicity is observed in sandy conglomerates. The detailed study of the trial boxcut illustrates this change. The chemical profile of the weathered section of the cut shows potential sodic and salinity hazards

The underclay of the Jeralong seam is acid producing. However the roof material of the Merriown seam is not, as demonstrated by the revegetation trial studies and core analyses. This material would be suitable for placement underneath topsoil as a rooting media.

3.7 Hydrology

Hydrological studies commenced in mid 1977 with a detailed surface water flow and water quality programme. In mid 1978 a groundwater hydrology study, which included groundwater pump tests and routine water level monitoring, commenced. The broad objectives of these studies were to gather sufficient data on groundwater and surface water quality and quantity to enable:-

- definition of existing conditions and prediction of impacts of mining;
- determination of potential sources of water for mining purposes;
- design of a comprehensive Water Management Plan; and
- to suggest possible measures to mitigate undesirable impacts.

This initial study was designed and implemented with the assistance of AMAX Coal Company's Environmental Engineering Department in the United States.

In 1981 and 1982 further studies were undertaken by Australian Groundwater Consultants (AGC), BHP Engineering and Dames and Moore. AGC examined and tested possible water supply sources, which included a comprehensive drilling and pump testing programme on one of the Joint Venture's properties near the Namoi River This area was outlined by the Water Resources Commission (WRC) as a possible groundwater supply site. BHP Engineering investigated flood levels and designed a comprehensive Water Management Plan, which incorporated possible on-site surface water and groundwater resources. Dames and Moore investigated the post-mining surface and groundwater hydrology, with emphasis on water quality.

The following reports are reference documents:- "Hydrology of the Boggabri Coal Prospect" (Herring 1978). "Boggabri Mine Site Hydrogeological Review and Pit Inflow Estimates" (AGC 1982). "Report on Flood Levels at Boggabri" (BHP Engineering 1982). "Water Management Study for Boggabri Coal Mine" (BHP Engineering 1982). "Post-Mining Surface and Sub-Surface Hydrology: AMAX-BHP Boggabri Coal" (Dames and Moore, 1982).

3.7.1 Surface Water

(i) Regional

The lease area lies on the edge of the Namoi River valley alluvial plain, in the foothills of the Willow Tree Range. The area contains a number of minor creek systems, which flow intermittently after periods of heavy rain. Figure 15 shows the location of these creeks and their catchment boundaries. The proposed mine is totally within the catchment of Nagero Creek. This creek ultimately discharges via "The Slush Holes", which forms part of the Namoi River flood plain, into the Namoi River alluvials.

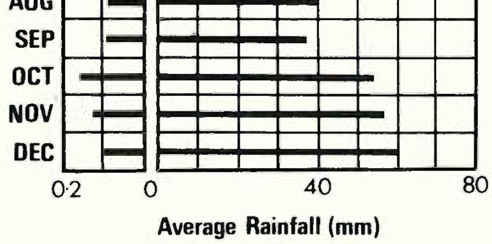
The stream flow of the Namoi River and tributaries is marked by a high degree of variability, both in annual and monthly flows. Flooding may occur at any time but is most common in January, February, March and July.

The combined catchment of the Namoi and its contributing rivers upstream of Boggabri has an area of 23,000 square kilometres, one of the biggest in NSW. However, the flood flows in the Namoi River are very small in comparison. This is because catchment size and characteristics result in a long retention time, hence dampening sudden changes in discharge and spreading out peak flows.

The 1955 flood was the most extensive ever recorded in the area. Its limits are shown on Figure 15. The peak flow, measured at 4,300 cubic metres per second at Boggabri, was assessed as a one in 90-100 year flood by the WRC. This is in close agreement with the analyses and intensive studies of floods undertaken by BHP Engineering to establish flood levels and return frequencies to enable the design of the mine access road and rail bridge, and their affects on flood levels. Along with regular flooding, the Namoi River also experiences extended periods of low or nil flow. The longest recorded period of zero flow extended over 252 days commencing on 19 Jan. 1902.

(ii) Local

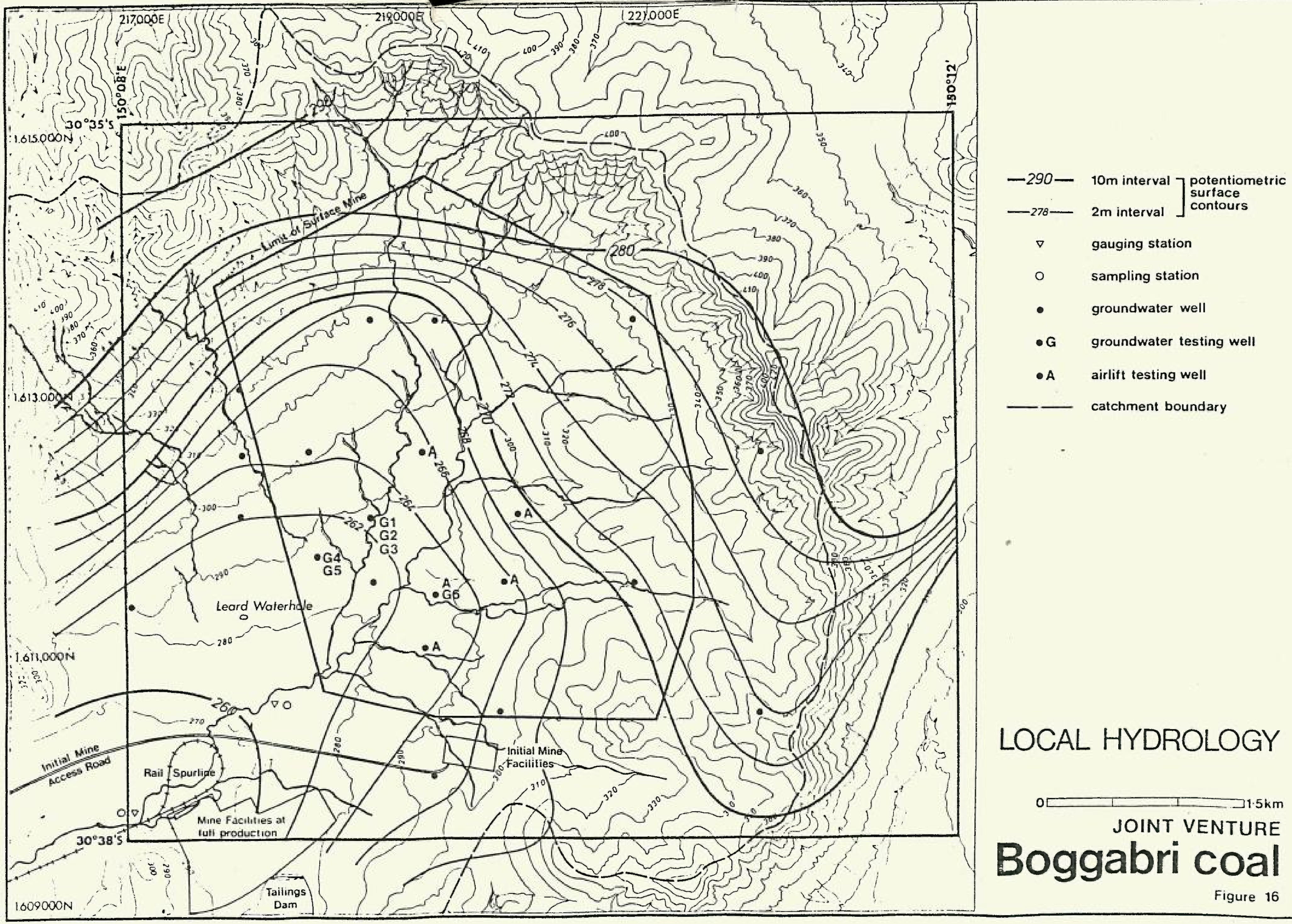
The lease area contains no permanent creeks. Surface monitoring stations were set up in mid 1977 (Figures 15 and 16). The B2 catchment area, which includes the mine area, is approximately 36 square kilometres.



MONTHLY RUNOFF COEFFICIENTS

Figure 17

Stream flows in the area show an extreme variability, only flowing after periods of heavy rain. Figure 17 shows the monthly runoff co-efficients calculated by BHP Engineering. The majority of flows were only observed on individual days while throughout most of the time, nil flows were recorded. These observations are in close agreement with BHP calculations which indicate that although high runoff potentials exist due to the nature of the soil and vegetation, average runoff is low. This infers that most rainfalls are of low intensity and that storms seldom extend over several days. Therefore ground conditions do not reach saturation point.

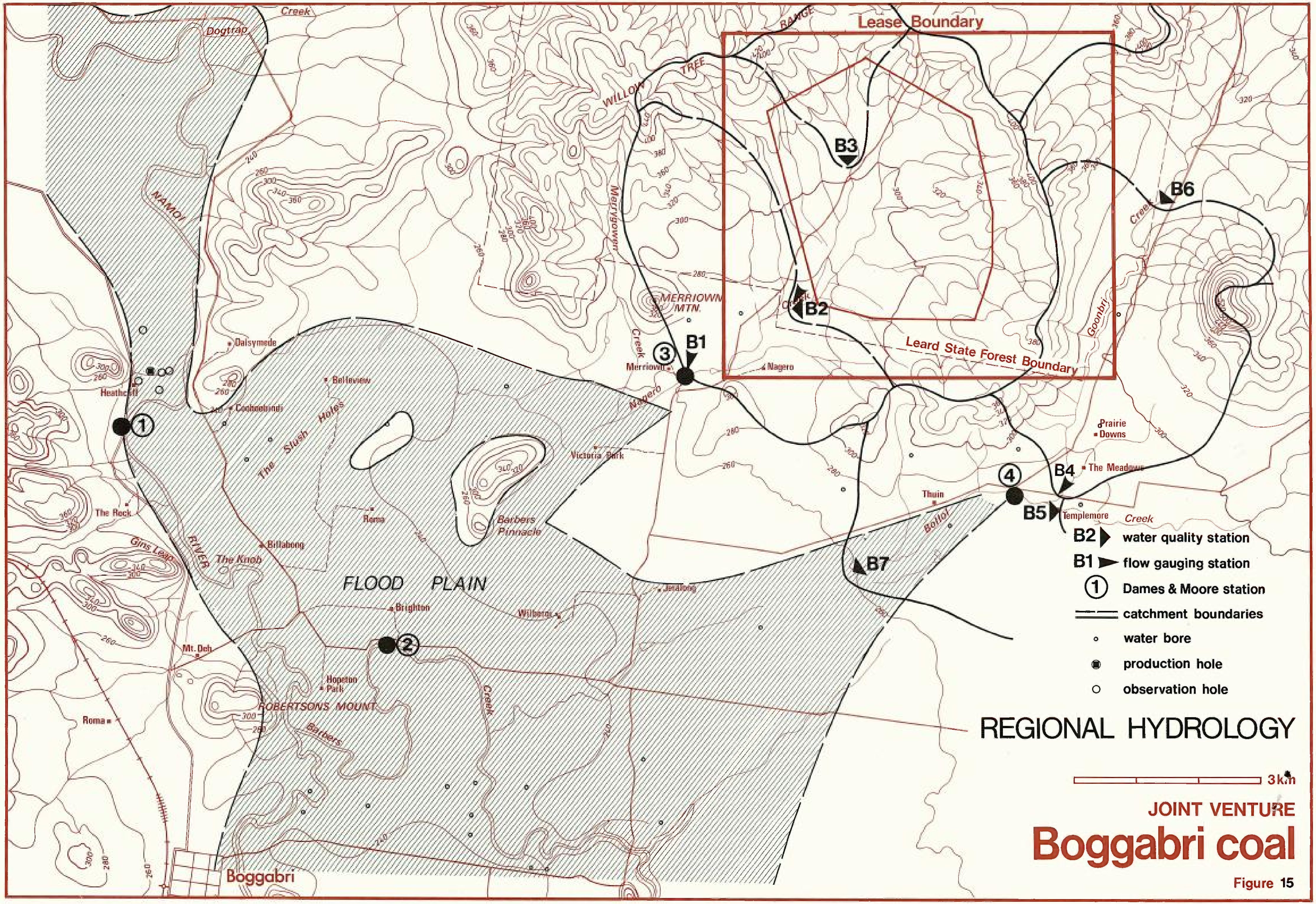


LOCAL HYDROLOGY

JOINT VENTURE

Boggabri coal

Figure 16

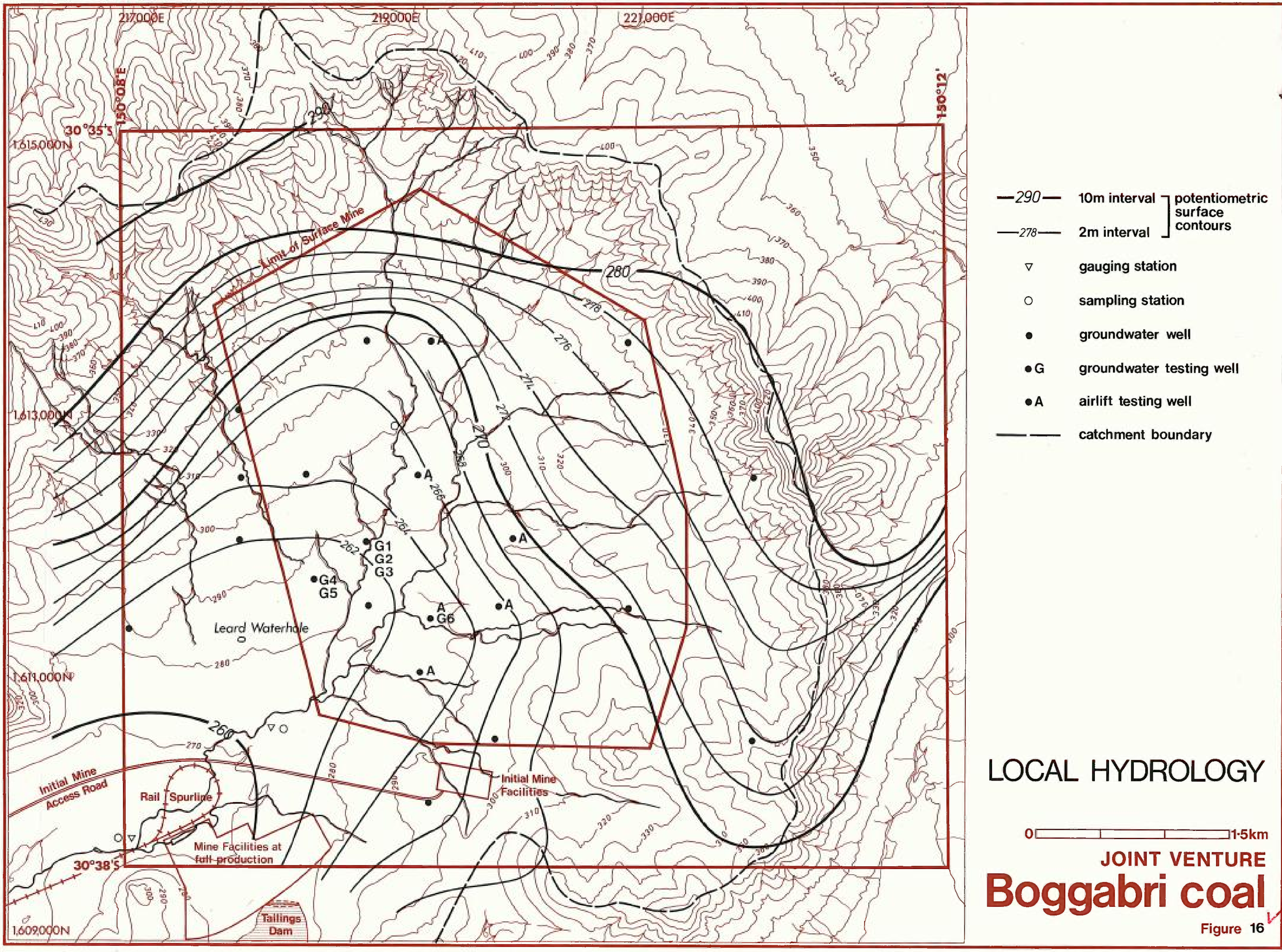


REGIONAL HYDROLOGY

JOINT VENTURE

Boggabri coal

Figure 15



LOCAL HYDROLOGY

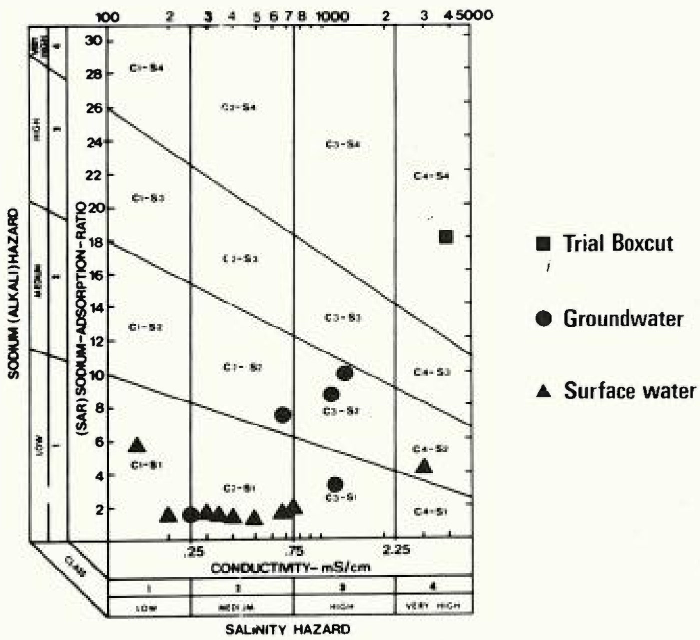
JOINT VENTURE

Boggabri coal

Figure 16

(iii) Water Quality

Location of sampling points are shown in Figures 15 and 16. Surface waters of the Namoi River and Barbers Lagoon were weakly alkaline, slightly hard and had reasonable buffering capacity. Tributaries of the Namoi River near the proposed mine site contained soft to slightly hard waters with a low to moderate buffering characteristic and were nearly neutral to alkaline in pH. Other ionic constituents of all these waters were generally low although the phosphate levels were above the 0.025mg/1 level generally deemed as the threshold level for creating algal blooms as part of the entrophication process (Hart, 1974). In terms of suitability for irrigation, all the waters fall in the categories of low sodium and medium salinity, except in instances of prolonged dry periods when salts become more concentrated (Figure 18).



WATER QUALITY

Figure 18

The waters are generally murky especially during rainy periods and in those small streams which are utilised by livestock. The organic load of the Namoi River and Barbers Lagoon was generally low, although in terms of criteria influencing the acceptability for domestic supply the levels may be considered doubtful. The higher load level in the Namoi River is probably a result of discharge from the sewage treatment works upstream of sampling Station 1.

3.7.2 Groundwater

(i) Regional

The alluvium of the Namoi River Valley is considered by the WRC to have the greatest overall potential of any prospective groundwater resource in NSW.

Intensive use of this resource for irrigation, stock and domestic supply has been made in the region. The aquifer material can be up to 240 metres thick. However, the vertical and horizontal distribution of water bearing formations is extremely complex. Water bores exist on the west and east bank. The majority on the east bank are less than 30 metres deep, with yields up to 2.7Ml/day (mega litres per day). Two bores have been sunk in this area to supply domestic water for Boggabri and yields of 4.9Ml/day have been recorded. Boggabri average daily water demands are in the vicinity of 1.8Ml/day. Other bores have been sunk around Barbers Lagoon to achieve yields sufficient for irrigation, however, most bores are only used to supply water for livestock.

AGC conducted a groundwater investigation programme on the Joint Venture owned Heathcliff property during 1981 (Figure 15). An underground reservoir capable of supplying the full water requirements of the mine development was located. The test production bore has a sustained yield of 1.8Ml/day.

(ii) Local

In the vicinity of the lease area, the Permian Nandewar Group and Quaternary Alluvium constitute the two most significant aquifer systems. The major portion of the Quaternary alluvial aquifer is located within the Namoi River Valley proper. Minor branches of the aquifer may extend some distance up tributary creek valleys. The Nandewar Group aquifer system, which generally dips to the north-east, occurs beneath the upland slopes and hills, except in the south-west corner of the lease area were the Boggabri Volcanics outcrop. These volcanics serve as a relatively low permeability base for this aquifer.

As is common in coal measure sequences, the coal seams have a higher permeability than the adjacent strata, and are the main aquifers in the area. Some faulting and folding has been identified by the exploration drilling programme and AGC has identified "lineaments" from aerial photograph interpretation. These lineaments are normally associated with weaknesses in the surface rocks and generally prove to be fracture zones, which if open and weathered, can act as groundwater flow paths and storage zones.

Groundwater within the exploration area is derived from precipitation that percolates downward through the soil and rock materials. Recharge to the Nandewar aquifer system generally occurs in topographically higher areas and discharge in lower areas, such as the valleys of Nagero Creek and Bollol Creek. Figure 16 shows a potentiometric (water level) map for part of the Nandewar aquifer system which was compiled from monitoring and pump testing wells.

The groundwater contours indicate that underflow is regionally to the south-west, similar to surface water flows. Seasonal variations in water levels do occur, but from measurements between June 1978 and December 1980 such variations appear to be limited to less than one metre.

Because of the relatively thick section of weathered Nandewar Group, gravelly stream bottoms and Quaternary Alluvium in the lower reaches of the streams, groundwater in the Nandewar aquifer system does not generally form surface springs. Rather, a portion of it continues underground through the alluvium/weathered bedrock to eventually discharge to the Namoi River.

The main occurences of groundwater are likely to be in areas where lineaments intersect and where adequate surface water catchment areas exist to recharge the groundwater system. The southern part of the lease in the vicinity of bore 1012 appears to be such an area.

A total of 6 groundwater wells were tested by pumping to obtain aquifer parameters and water samples. A further 6 large diameter bore holes were "airlift" tested. Pumping rates during the tests ranged from 3.9 to 50 litres/minute (5.6 to 72kl/day). Calculated transmissivities ranged from 0.225 to 5.1875m^2/day/m. The data indicates maximum permeabilities for the Merriown seam of between 0.1 to 1.0m/day, and for the remaining seams between 0.25 and 0.75m/day. These permeabilities are in the higher range of those measured for coal seams in the upper Hunter Valley, possibly because the transmissivity values incorporate aquifer layers from the intervening strata.

(iii) Water Quality

Groundwater quality data from bores in the general area was collected by the WRC and in the lease area by the Joint Venture and AGC. The data, which classifies water for irrigation use (Figure 18), indicates the variability of the groundwater quality. In general the water can be classified as low sodium/low to medium salinity. Some waters are hard, but still suitable for domestic use and irrigation. The water quality in the lease area is not high, being classified as high sodium/medium salinity. This may produce sodium problems in soils and because of the high salinity, cannot be used for irrigation on soils with restricted drainage.

3.8 Acoustic Characteristics

Louis A Challis and Associates, Consulting Acoustical and Vibration Engineers of Sydney, were employed in 1979 to undertake acoustical studies of the proposed coal development. Their report "Noise Emission Prediction for the AMAX/BHP Boggabri Coal Mine", (Louis Challis, 1982) is a reference document.

Investigations included extensive measurements near the proposed mine site, along the proposed rail spurline route, access road and in Boggabri itself, to determine:-

- existing background noise levels;
- sound propagation characteristics from typical sound sources located within the mine site to the nearest residence;
- sound generation characteristics of the machinery being used in the trial boxcut excavation;
- noise levels resulting from the mining development over the lease and adjoining areas; and
- noise effects of road and rail traffic on the mine access road and rail spurline on adjoining areas and the township of Boggabri.

A series of criteria were developed for assessing the impact of mining and transportation operations, and for blast vibration and overpressure.

The intensity of a sound is measured in decibels (dB). To simulate the frequency/loudness response of the human ear, sound level meters are fitted with an "A" scale weighted network. Sound measured on the "A" scale of the meter is termed dB(A). Human response to sound varies from just audible at 10dB(A), a soft whisper 30dB(A), 65dB(A) normal conversation, a shout at one metre 85dB(A), to the threshold of painful hearing at about 130dB(A). The decibel scale is a logarithmic function, with a doubling of loudness representing an increase of approximately 10dB(A).

The general acoustical characteristics of the area are described in the following Sections.

3.8.1 Existing Noise Levels

(i) Nagero Homestead

Measurements of the existing background noise levels were carried out at Nagero, the proposed location of the mine facilities. The background noise levels indicated that the background (L90) level during the night could drop as low as 23dB(A), rising to 30-35dB(A) during the day. These measurements were carried out during windless conditions and confirmed the characteristics of this rural area. Whilst particularly quiet in the very early hours of the morning, the foreground noises due to farm machinery and animals tend to raise the ambient noise levels from 4am or 5am to peak levels which regularly exceed 70dB(A). This pattern is considered to be representative of the type of environment prevailing at other nearby farmhouses.

(ii) Along The Proposed Access Route

Measurements were carried out near Heathcliff and Cooboobindi homesteads along the proposed access route. Background noise levels near Heathcliff are in the vicinity of 30dB(A), falling to 20-25dB(A) at night. At Cooboobindi noise levels were 31dB(A).

(iii) Boggabri and Vicinity

Measurements of the existing background noise levels were carried out at various locations in Boggabri and along the main railway line. These measurements indicate that the town is very quiet, particularly during the evening and night, with L90 levels lying in the range 20-25dB(A). However, houses in close proximity to the main highway (Wee Waa Street) are subject to higher noise levels than other areas of the town, due to the continual passage of vehicular traffic, including heavy trucks. Noise levels range between 61-71dB(A).

Further measurements carried out in the township indicated that the trains which currently move through at restricted speeds of 15kph, and 25kph on leaving, are producing peak levels of the order of 70dB(A) at the nearest residences and between 60-70dB(A) at residences further removed from the line. The majority of the through trains and shunting operations occur during the day. Existing rail movements do not appear to cause any significant annoyance to the residents.

3.8.2 Sound Propagation Characteristics

To establish the characteristics of sound propagation in the vicinity of the likely mine site, measurements were carried out between Nagero and four sites within the lease.

The measurements of sound propagation showed a wide variation according to the environmental conditions prevailing during their recording. The measurements during April 1979 indicate that sound attenuation characteristics greatly exceed the theoretically predicted attenuation due to distance and air absorption. This was attributed to ground absorption, tree screening effects, wind direction and upward inversion of sound.

However, later measurements carried during June 1979 indicate that under more ideal conditions for the propagation of sound, the measured propagation characteristics were more closely aligned with the theoretically predicted propagation characteristics (taking into account distance and air absorption).

The modelling carried out in the assessment of the impact of a mining operation assumed the worst case for measured sound propagation at the site, that is, under normal theoretical conditions. However, it is apparent from the measurements that for a significant portion of the year, the sound attenuation from the mine site to the nearest residences would be greater than the theoretically expected levels, that is, lower sound levels would result.

3.9 Flora and Fauna

Exploratory drilling within the Leard State Forest was delayed until comprehensive field studies of the forest ecology were carried out in the late spring and early summer of 1976. These studies, conducted by James B Croft and Associates of Newcastle, were continued until early 1978 in order to cover a full range of seasons. General regional observations were used for comparative purposes. Croft's report:- "Report on the Botany, Wildlife and Ecology of the Leard State Forest" (James B. Croft, 1979), is a supporting document.

The aims of the study were:-

- to identify and list all species of flora and fauna observed in the Forest, covering as much area of the Forest as possible, and including habitat preferences, broad behaviour patterns and distributions;
- to identify and examine seasonal variations and processes of succession; and
- to investigate the conservation status, viability and ecological value of the forest components and forest ecosystem.

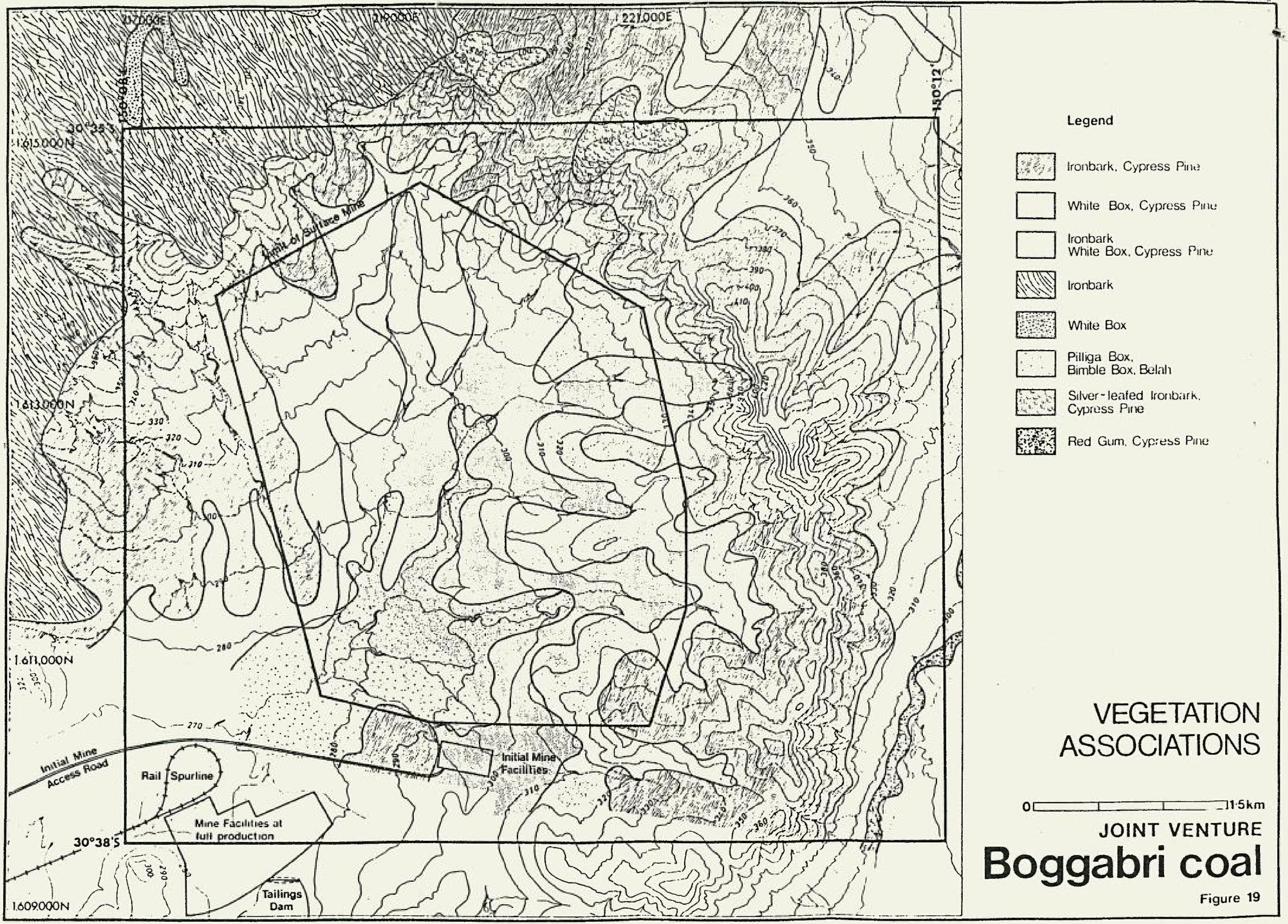
3.9.1 Flora

(i) General Descriptions of the Vegetation

The Leard State Forest can be taken as being typical of the type of forest that grows on the western slope districts of NSW. It is relatively homogenous in structure and composition, and is classified as an open forest. The forest type is uniformly dry sclerophyll and consists mainly of mixed eucalypt/ cypress pine community. The general structure is very open, however some areas have a lower tree understorey and a dense shrub layer usually reaching 2 to 3 metres in height. Ground cover is variable and may consist of dense grasses to 1.5 metres or sparse grass tussocks, with a dense layer of leaf litter up to 100mm deep. Dead timber is also common in the ground layer.

The most common dominant trees within the Forest are White Cypress Pine (Callitris glauca) and Black Cypress Pine (Callitris endlicheri) which are widespread and occur as co-dominant species over large areas. Other dominant tree species are, in order of lessening frequence:-

Narrow Leaved Ironbark (Eucalyptus crebra), Blue Leaved Ironbark (Eucalyptus fibrosa subsp. nubila), White Box (Eucalyptus albens), Belah (Casuarina cristata), Pilliga Box (Eucalyptus pilligaensis), Silver Leaved



VEGETATION ASSOCIATIONS

JOINT VENTURE

Boggabri coal

Figure 19

Ironbark (Eucalyptus melanophloia), and Bimble Box (Eucalyptus populnea).

Smaller tree species (generally from 5 to 10 metres) and shrubs commonly grow through the majority of the Forest. Juvenile eucalyptus and cypress pines also form a major part of the shrub understorey in some sections. Ground cover species are variable, consisting of grasses and forbs. Fern species are also common and mosses are present in wet seasons.

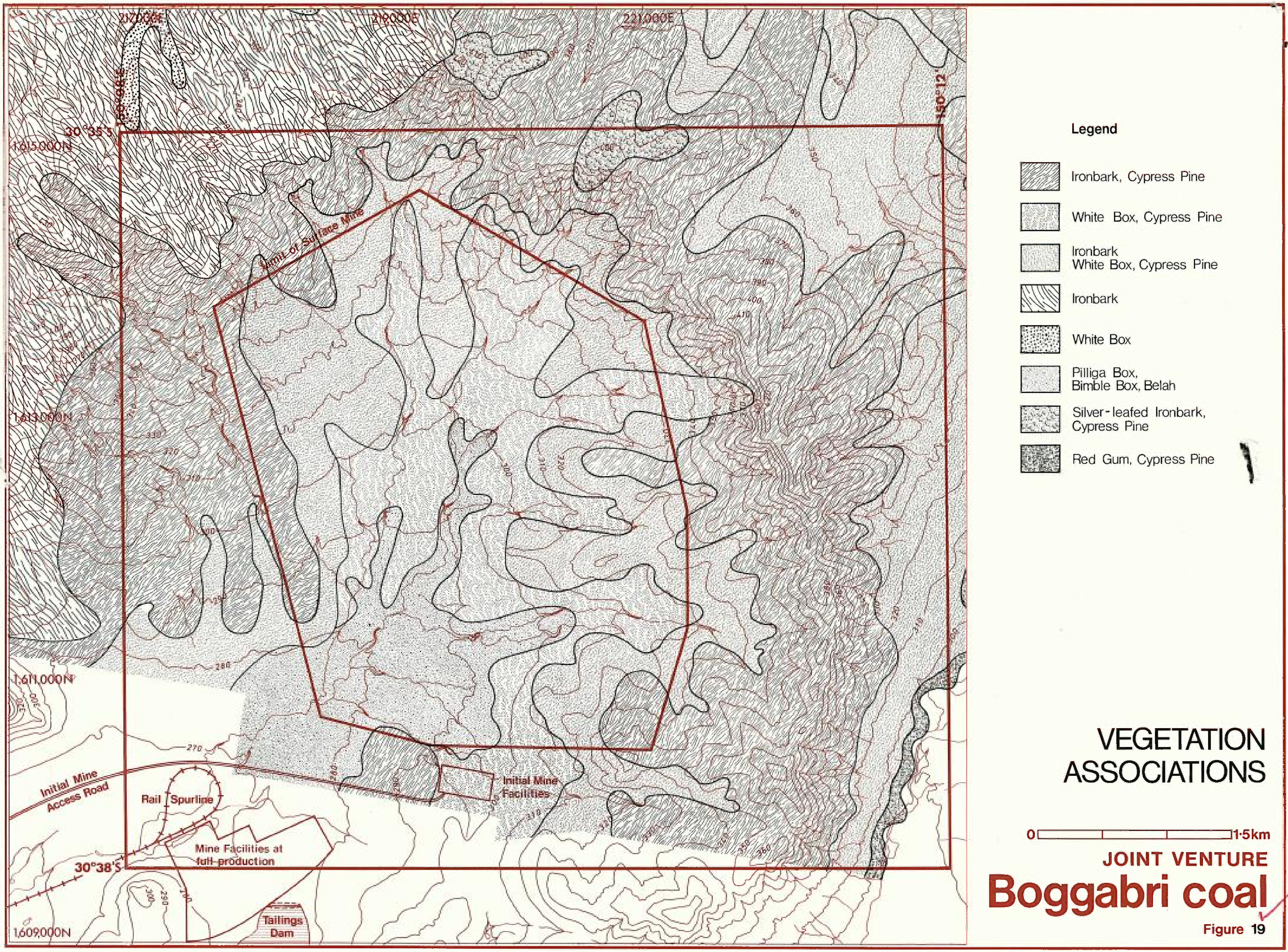
(ii) Distribution of the Associations and Plant Species

Eight major plant associations were recognised in the Forest, differing from each other mainly in speciation of dominants, but also showing some variations in subordinate species and overall structure. Variations also occur within each association. The largest association is Ironbark/ Cypress covering 2,652 hectares (32.6%) of the Forest and 1,285 hectares (39.5%) of the lease area. The distribution of the associations in the lease area are shown in Figure 19. Relative sizes of all associations in the Forest, lease area and the likely mine area, are shown in Table 4.

TABLE 4 - AREA OF VEGETATION ASSOCIATIONS

Association	Total Area of Forest		Area in Lease		Area in Surface Mine		
	ha	%	ha	%	ha	%	% of TFA*
1 Ironbark/ Cypress Pine	2,652	32.6	1,285	39.5	112	9.3	4.2
2 White Box/ Cypress Pine	1,057	13.0	503	15.5	437	36.3	41.3
3 Ironbark/ White Box/ Cypress Pine	1,684	20.7	1,069	32.9	465	38.6	27.6
4 Ironbark	1,863	22.9	94	2.9	0	0	0
5 White Box	203	2.5	0	0	0	0	0
6 Pilliga Box/ Bimble Box	293	3.6	263	8.1	189	15.7	64.5
7 Silver Leaved Ironbark/ Cypress Pine	114	1.4	23	0.7	0	0	0
8 Red Gum	268	3.3	17	0.5	0	0	0
TOTAL	8,134	100	3,253	100	1203	100	-

* Total Forest Association



VEGETATION ASSOCIATIONS

Figure 19

From the association composition, it can be seen that some species occur in most associations and are, therefore, widespread within the Forest. Such species include White Cypress Pine, Western Silver Wattle, Golden Wattle, Hop Bush and Feathery Cassia. Other less common species are found in varying frequency throughout the Forest. Some species such as Silver Leaved Ironbark and Bimble Box are much localised and specific in their habitat requirements. The analyses of growth patterns suggest that Cypress Pine species have been favoured over eucalypt and other species in recent times. Definite patterns of vegetation associations are evident from examination of Figure 19.

These can be related in general to topography and soils. White Cypress Pine favours dry sandy loam, avoiding stiff impermeable subsoils, as does Black Cypress Pine. Consequently, these species do not occur in the low lying areas where drainage is restricted. Heavy soils in these areas encourage the presence of Belah, Pilliga and Bimble Box. Narrow Leaved Ironbark tends to be found on reasonably fertile soil or sandy loams and therefore has a concurrent distribution over much of the Forest.

3.9.2 Fauna

(i) Birds

A total of 111 species were identified in the Leard State Forest. Information on species occurring, likely to occur, breeding characteristics and feeding habits is summarised in Table 5.

TABLE 5 : SUMMARY OF INFORMATION ON AVIFAUNA SPECIES IN THE LEARD STATE FOREST AND THE BOGGABRI REGION

	Leard State Forest	Boggabri Region
Species expected to occur	126	177
Species recorded	111 (88%)	153 (86%)
Species expected to breed	98 (78%)	127 (72%)
Species found breeding	39 (31%)	41 (23%)
Raptores[1]	10 (8%)	15 (8%)
Frugivores[2] and insectivores[3]	81 (64%)	94 (53%)
Graminivores[4]	20 (16%)	23 (13%)
Waterbirds	-	21 (12%)
Migratory and nomadic species	49 (39%)	66 (37%)

Note: Percentages refer to percentage of number of species expected to occur.
1. Birds of prey 2. Fruit feeding species 3. Insect feeding species
4. Grass feeding species

The high proportion of fruit and insect feeding species reflects the type of plant communities present. As expected, because of the lack of suitable habitat, no waterbirds were observed. A total of 39% of the bird species recorded were migratory or nomadic.

The most common species recorded was the Fuscous Honeyeater (Meliphage fusca). It was evident that the frequency of occurence of species varies with different habitats and seasons. Overall species diversity (a measure of the number of species and individuals present) was greatest in October and least in April. This was probably related to species immigration into the Forest for breeding in spring, plus greater food supply.

The Ironbark and Eucalypt/Belah communities exhibited the greatest species diversity within habitats, although the figures for the latter were not conclusive because of restricted sampling. When considering common species between habitats, the Ironbark habitat appeared to have a more constant species population.

The Box habitat has the greatest number of birds followed by the Eucalypt/Belah and Ironbark communities. This was related to the breeding behaviour of species the expression of habitat preferences being most pronounced in the breeding season.

(ii) Other Fauna

Table 6 shows the average number of sightings per day per study period for each species recorded. Figure 20 shows the sightings of all species made during the study period. Probable and known distributions have been drawn for the most commonly observed species from sightings, signs of species, habitat requirements and topography of the area.

The majority of observations were made along the central road in the Forest and in two areas which were the camp site and the permanent water borehole. It was logical that most sightings would be made in these locations as most time was spent in these areas during the study. Observation in areas outside the lease area was made difficult by weather constraints, and as a result, very little time was spent in the far western portion of the Forest which accounts for the absence of sightings in this area.

Eleven species of native mammals inhabit the Leard State Forest, including four macropods. The Eastern Grey Kangaroo was the most commonly observed. Other macropod species were seen infrequently. The number of reptiles, both in individuals and species, was lower than expected.

TABLE 6 : AVERAGE NUMBER OF SIGHTINGS PER DAY OF FAUNA SPECIES DURING FOUR SEASONAL STUDY PERIODS IN THE LEARD STATE FOREST

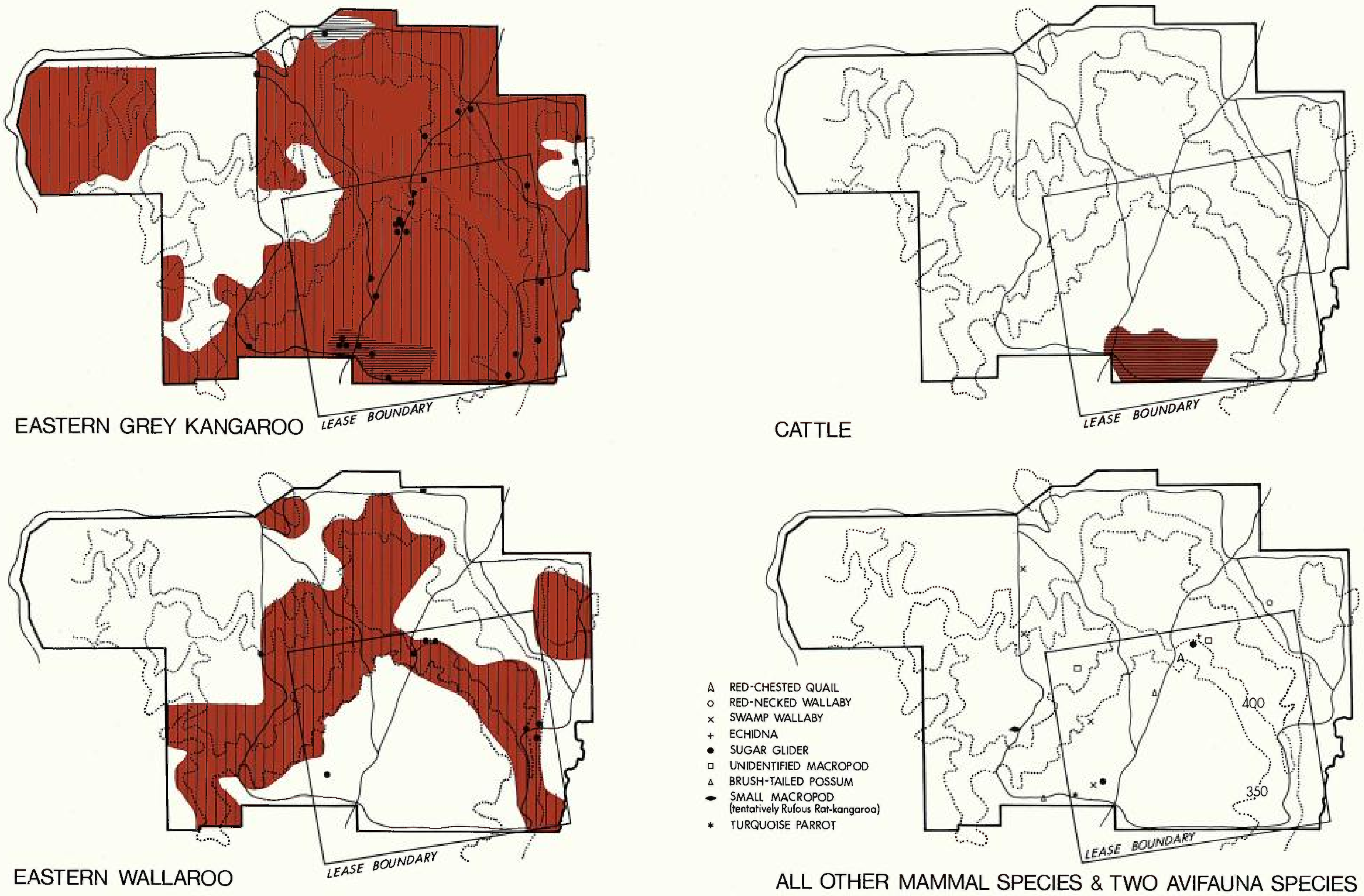
		Average Number of Sightings per Day				
		Aug	Oct	Dec	Jan	Apr
MAMMALS						
Native Species:						
Macropus giganteus	Eastern Grey Kangaroo	6.0	2.0	13.0	10.5	24.0
Macropus robustus	Eastern Wallaroo	-	-	-	1.0	6.7
Wallabia bicolor	Swamp Wallaby	-	-	0.3	-	2.0
Unidentified Small Macropod (i) (tentatively Rufous Rat- kangaroo)		0.6	-	-	-	-
Unidentified Small Macropod (ii)		-	-	-	0.5	-
Unidentified Small Macropod(iii)		-	-	-	0.5	-
Petaurus breviceps	Sugar Glider	-	-	1	-	-
Trichosurus vulpecula	Brush-tailed Possum	-	-	-	-	0.7
Tachyjlossus aculeatus	Echidna	2	0.3	-	-	-
Exotic Species:						
Vulpes vulpes	Red Fox	-	-	0.3	-	-
Oryctolagus cuniculus	Rabbit	-	0.3	0.5	2	2
Lepus europaens	Hare	-	-	0.8	-	-
REPTILES						
Underwoodisaurus milii	Thick-tailed Gecko	2	1.1	-	-	-
Gehyra sp	Northern Dtella	-	-	0.3	-	-
Amphibolurus barbatus	Bearded Dragon	-	1.4	-	-	-
hibolurus sp		-	-	-	-	-
Varanus varius	Lace Monitor	-	0.6	0.5	1	-
Egernia striolata	Tree Skink	-	0.3	-	-	-
Lamphropholis	Garden Skink	2	0.9	-	-	-
Guichenoti	Skink sp	-	0.3	-	-	-
Furina diadema	Red-napped Snake	-	-	-	0.5	-
Morelia spilotes	Carpet Snake	-	-	-	-	1.3

Note (i) Unidentified - tentative Rufous Rat Kangaroo (ii) (iii) unidentified

3.9.3 Conservation Status

(i) Species

No rare or endangered plant species has been recorded in the Forest. Two bird species of interest occur. The Turquoise Parrot (Neophema pulchella) is recorded as having doubtful conservation status and being highly vulnerable. However, recent observation suggests that the species is now more common than was previously believed (Bell, 1978).



0 4 kms

- Sightings
- Areas of Concentration
- Areas of Major Distribution

FAUNA DISTRIBUTION & SIGHTINGS

JOINT VENTURE

Boggabri coal

Figure **20**

The Red Chested Quail (Turnix pyrrhothora) is not endangered but its distribution is little known within the State. Observations in the Narrabri region suggest that the species is quite common in the district (Bell, 1978).
Most of the mammal species are considered to have an adequate conservation status. The Grey Kangaroo is considered by Bell to have been advantaged by European settlement. Four species were considered by Bell to be uncommon and their future survival uncertain, but show no definite evidence of threatened status at this stage. These were the Rufous Rat Kangaroo, Tiger Cat, Koala and Sugar Glider. Only the last species was positively identified in the Forest. The presence of other species was assumed on the basis of sightings by locals (Koala), unconfirmed sightings and scats.

None of the amphibian or reptile species recorded were considered to be of uncommon status.

(ii) Vegetation Associations

In order to determine the status of the various vegetation associations, reference was made to the Specht Report (Specht, 1974) on the conservation of major plant communities in Australia and Papua New Guinea. The status classification is based on the amount of the particular community in the various structural formations reserved in Nature Reserves and National Parks. Because of its broad scale it, of necessity, lacks detail in some areas and does not attempt to measure the amount of each vegetation unit remaining in State Forests and other forested areas. In this respect, Bell (Bell, 1978) is a more relevant study.

Vegetation in the Specht Report was generally defined in terms of alliances, which are an assemblage of a number of associations. Specht lists the Blue Leaved Ironbark and Bimble Box/White Cypress Pine Alliances as inadequately conserved in any structural formation within the State, and the Silver Leaved Ironbark Alliance as not reserved at all. These alliances are represented in the Forest by Associations 1 and 4 for the Blue Leaved Ironbark Alliance, and 6 and 7 for the remaining alliances.

Association 7 will not be affected by any mining development, and Associations 1 and 4 only to a relatively minor extent (Table 5). However, Association 6 would be quite significantly affected. Following Croft's recommendations, further studies were carried out on a regional scale to determine the extent of the poorly conserved associations.

The regional study by AMAX environmental staff involved an extensive literature search, examination of forest "type" maps and discussions with the NSW National Parks and Wildlife Service, and the Forestry Commission. Existing conservation areas are the Mount Kaputar National Park and the Pilliga Nature Reserve.

It is from these areas that Specht obtained information on the conservation status of the alliances mentioned. Information reliability for the Kaputar reserve was C (poor, based on a knowledge of the district) and for Pilliga B (fair, based on personal knowledge of the reserve or on reliable literature).

A major difficulty was encountered in obtaining suitable information for the regional study. Because of the detail of the Leard Forest studies, far more is known of the vegetation in this forest than the surrounding forest areas. Little is known of the associations or alliances in the Mount Kaputar National Park and the Pilliga Nature Reserve. The National Parks and Wildlife Service was not able to provide vegetation maps for these areas. Forest type maps from the Forestry Commission are of necessity of broad scale and commercially oriented. As such, although useful, they are not strictly comparable to the Leard Forest mapping. The Soil Conservation Service (SCS, 1978) mapped the tree communities of the region on an alliance basis. Again, although useful, it was a far less detailed study than the Leard study.

In conclusion, the vegetation of the Leard State Forest is regarded as well represented in other forested areas. The two alliances of concern were recognised by Bell as major communities of State Forests in the northern part of the "Pilliga Scrub". He recommended that forested areas in the Pilliga Scrub and southerly extensions of the Mount Kaputar National Park be set aside as reserves. The Leard State Forest is not included in either suggested reserve area.

3.10 Revegetation and Reafforestation Trials

A series of trials were established in mid 1979 on the overburden materials (spoil) removed from the trial boxcut. The revegetation trials, covering approximately 3 hectares, included native grass species, natural regeneration and tree planting. The spoil heaps were shaped, levelled and topsoiled. The average topsoil depth of 100mm is likely to be less than that replaced in the mining operation. The results of the trials have been used to develop the Rehabilitation Plan as discussed in Section 4.3.

Introduced grass species trials were established following recommendations of the SCS in September 1979. The remainder of the spoil heaps were allowed to regenerate naturally, including some areas of exposed spoil. Roof material from the Merriown seam was exposed to test its weathering characteristics.

The Department of Ecosystem Management, University of New England, was engaged: -

- to monitor and assess the grass species trials and native species recolonisation; and
- to establish preliminary experiments to examine soil salinity and leaching processes in overburden heaps.

Their report on studies to February 1982, "Rehabilitation Studies for the Proposed Boggabri Open-Cut Coal Mine" (Duggin et al 1982), is a reference document. The University has also carried out further surveys. These have included a resurvey of vegetation transects and soil sample collection.

In conjunction with the Forestry Commission a eucalypt species planting trial was established in September 1982 (Section 3.10.4).

3.10.1 Introduced Grass Species Trials

The results from this trial show that a pasture containing at least Rhodes grass and Couch grass would be able to provide an adequate vegetation cover for soil conservation purposes, provided that it is correctly managed.

3.10.2 Natural Regeneration

Observations on natural regeneration of native trees and shrubs have demonstrated a need for undertaking supplementary programmes in order to develop stands of the desired species. Natural regeneration to date has been dominated by the wattle Acacia deanei and 3 shrub species.

The density of native regeneration was strongly influenced by topsoil depths. No eucalypt or cypress pine regeneration was noted over the study period, however eucalypt and cypress pine regeneration has since occurred. Natural ground cover development was slow and patchy and was considered unsatisfactory from a soil conservation viewpoint on steeper slopes in the initial few years of vegetation establishment. However, drought occurred in this period and ground cover is now excellent, particularly considering the poor conditions experienced since the trials were established.

3.10.3 Topsoil and Plant Growth

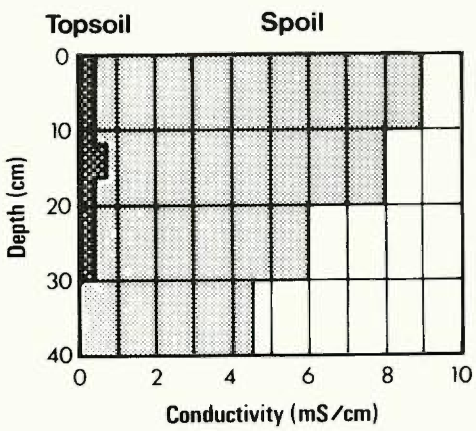
Glasshouse experiments showed that topsoil yielded healthier plants and promoted plant growth when it was spread to depth equal to or greater than that from which it was collected. In this regard little advantage was achieved in using topsoil collected down to a depth of 200mm and respread at 50 or 100mm compared to the bare overburden.

It was noted on the trials (see photograph) that where the topsoil cover was good, regeneration was more numerous and healthier compared to areas of inadequate cover. No regeneration occurred on areas of exposed overburden.

Topsoil is therefore needed, both as a seed source as well as a medium for healthy plant growth.

REAFFORESTATION TRIALS

3.10.4 Soil Salinity and Sodicity



SALT PROFILES

Figure 21

Leaching experiments showed that sodium is readily removed from the overburden and is by far the dominant cation.

The leachate results have been used to estimate both surface and groundwater effects of surface mining.

Measurements of salt profiles in November, 1982 by Dames and Moore (Dames and Moore, 1982) have illustrated the effect of topsoil on salt movements (Figure 21).

The rapid leaching of salts beneath the topsoil is evident, together with the accumulation of salts in surface areas of bare spoil.

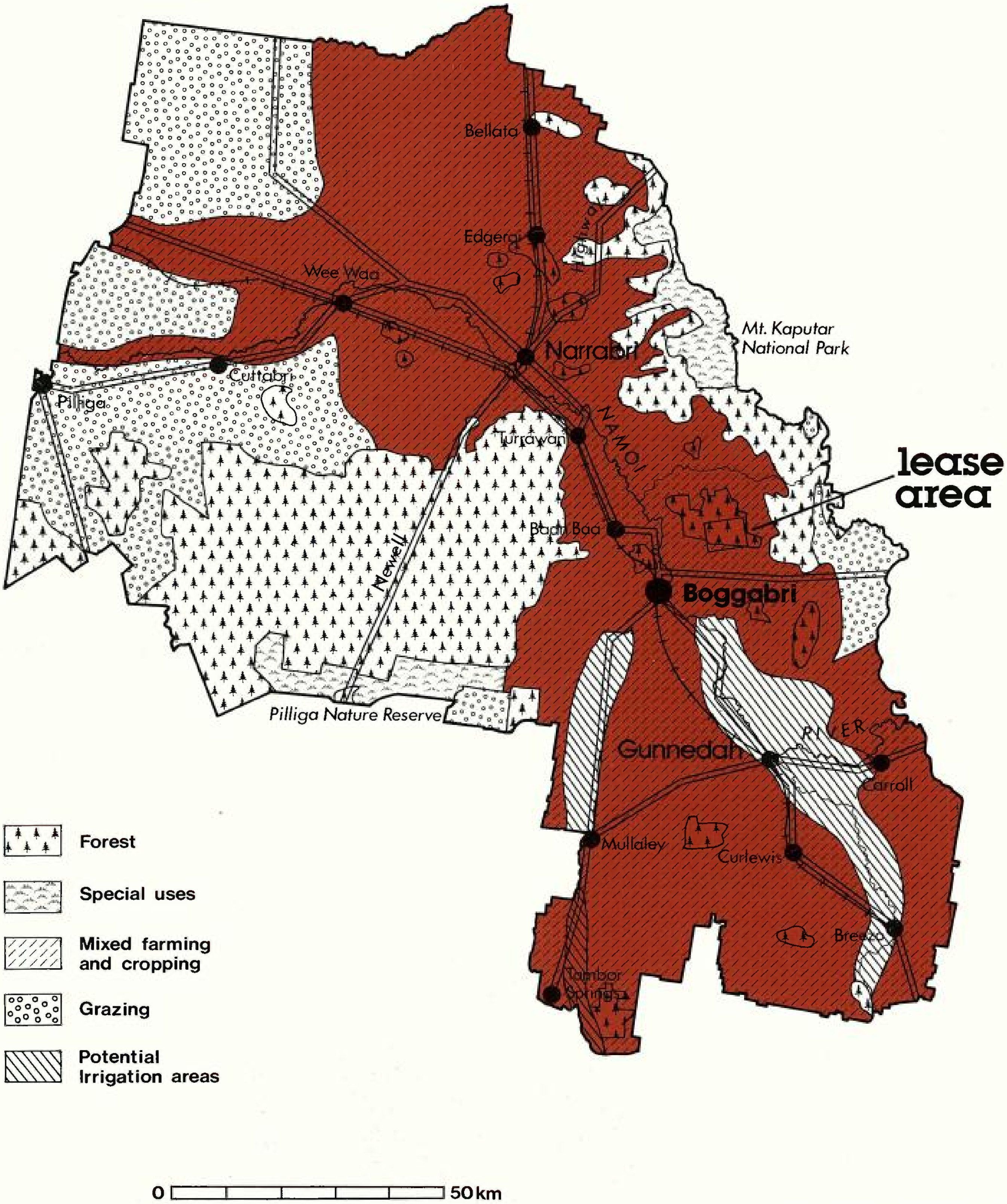
3.10.5 Tree Planting Trials

A series of tree planting trials were established in conjunction with the Forestry Commission. Seven tree species were planted on the spoil piles in September 1982 in order to establish their reafforestation potential. Unfortunately the planting coincides with a series of poor seasons and drought and the survival and growth rates suffered accordingly. Of the trees remaining some are making good progress but others are clearly restricted by soil (i.e. spoil) conditions. The trials are continuing and further studies will be carried out to assist with rehabilitation planning.

3.11 Land Use and Tenure

The lease area is wholly within the Narrabri Shire and the majority covers Crown Land, dedicated as State Forest. The remainder of the area is private agricultural land owned by the Joint Venture. Figure 22 shows the regional land use pattern. The Joint Venture has purchased a number of properties in the vicinity of the mining development and on the access route (Figure 23). The properties owned extend from the main north-west rail line through to the mine area. In addition they will provide a substantial buffer around the proposed development. The Joint Venture also owns a total of 3 houses and 5 blocks in Boggabri itself.

The Leard State Forest is incorporated in the Forestry Commission's Gunnedah District Forest Management Plan and is being logged on a 15 year cycle for Cypress Pine.

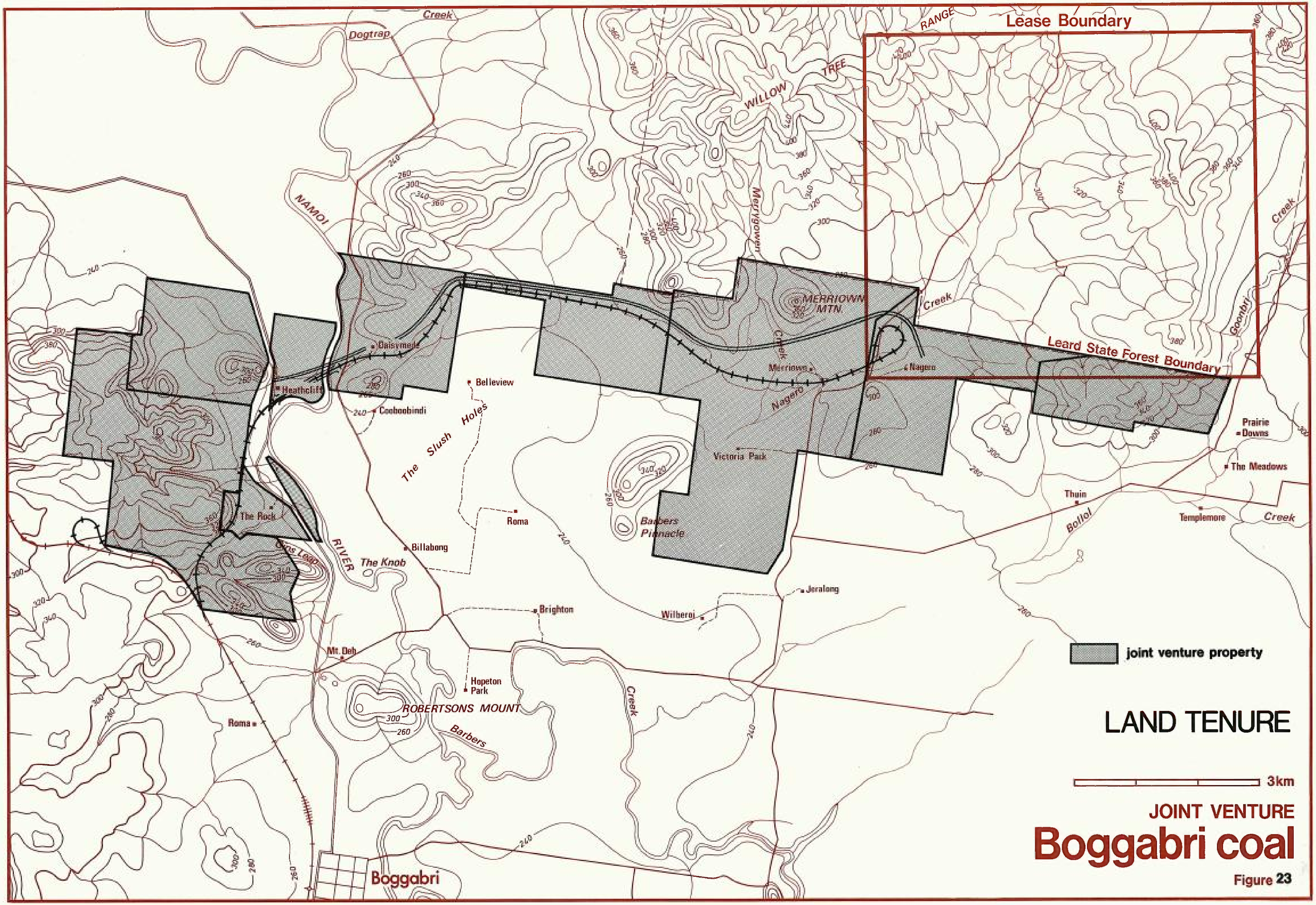


LAND USE

JOINT VENTURE

Boggabri coal

Figure 22



LAND TENURE

JOINT VENTURE

Boggabri coal

Figure 23

Forest management has been deferred by the Commission because of the likelihood of the mining development proceeding.

3.12 Aboriginal Heritage and the National Estate

No Aboriginal artifacts, sites or features with historic interest exist in or near the lease area. Dames and Moore, as part of their preliminary studies, conducted an archaeological survey. Their report was placed before the Aboriginal Relics Committee of the NSW National Parks and Wildlife Service. The studies have been deemed satisfactory and a letter has been received from the Service indicating that it has no objections to a mining development in the lease area on these grounds.

Historical societies in Boggabri and Gunnedah, the National Trust of NSW and the Australian Heritage Commission were contacted to check on the likelihood of historical sites or features being present in the vicinity and none were advised.

3.13 Social and Economic Environment

The socio-economic environment includes population characteristics and trends, business economy, employment, education, housing, health services, transportation and other general government services. This Section describes, and wherever possible quantifies, the socio-economic environment of the region so that the effects of the Boggabri project can be analysed and compared in the context of the region's history and its future.

For the purposes of this study, the labourshed or region where the major effects of the mining development will occur, was regarded as the Gunnedah, Boggabri and Narrabri area (Figure 3). Other nearby centres such as Manilla, Barraba and Tamworth were excluded because of their small size and/or greater distance from the mine site, although they constitute possible labour sources and minor residential areas. However, Barraba, due to the recent closure of the asbestos mine, is acknowledged as a potentially significant labour source.

From the commencement of the exploration stage, the Joint Venture has recognised that considerable planning was required to ensure that the needs of the workforce and of the area were provided for in the growth associated with a mine development. The Narrabri Shire Council has been kept fully informed of the status of the Project and it has also undertaken planning studies at Boggabri.

Studies have fully defined the existing characteristics of the area, with emphasis on the infrastructure requirements. The report by Nexus Environmental Studies; "Analysis of Social and Economic Aspects Gunnedah-Boggabri-Narrabri District" (Nexus, 1982) is a reference document. This report and the "Environmental Study of Boggabri" (Nexus, 1981). "Environmental Study Draft Local Environmental Plan Review Boggari and Adjoining Lands" (Fox, 1985) prepared for the Narrabri Shire Council, together with 1982 census information (latest available) and Joint Venture studies, form the basis for this Section.

3.13.1 History of Settlement

The Liverpool Plains were discovered by John Oxley in 1818. The Namoi Hut Station established at the junction of Cox's Creek and the Namoi River in 1835 was the first permanent settlement, becoming the town of Boggabri in 1860. Other settlements soon followed as the age of squatting was followed by closer settlement as cattle were replaced by sheep, and both later by wheat. The railway reached Gunnedah in 1879 and Boggabri and Narrabri in 1882.

Wheat growing expanded in the 1820's up to the First World War, and after both World Wars soldier settlement schemes helped to swell the rural population. However, after World War Two, sealed roads became common and rural populations became more mobile and the social, educational and employment requirements expanded beyond the capacity of smaller towns and villages such as Boggabri, generating a net emigration of population from these centres. The larger towns such as Narrabri and Gunnedah survived, having a slow increase in population and offering services and process facilities to the surrounding rural industries.

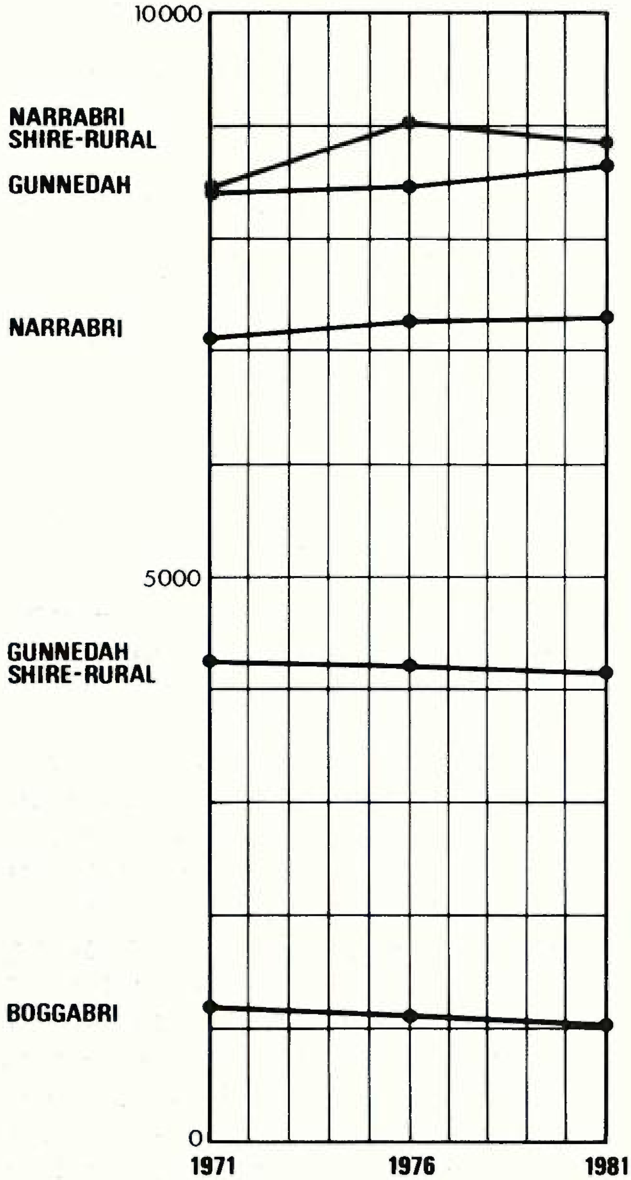
3.13.2 Local Government and Planning

The lease area and transport route lies wholly within the boundaries of the Narrabri Shire in an area covered by the operation of Interim Development Order No. 1-Namoi, which permits coal mining to be undertaken with the consent of the Council. The boundary between Narrabri and Gunnedah Shires lies almost mid-way between Boggabri and Gunnedah. These Shires resulted from the respective amalgamation of Namoi Shire-Narrabri Municipal Council and Liverpool Plains Shire-Gunnedah Municipal Council in 1980.

Local Government planning is well advanced in the region in expectation of growth associated with coal developments. This is particularly true with regard to the Narrabri Shire Council. The Joint Venture has maintained a policy of open communications with the Council and the residents of the Boggabri area since the commencement of exploration activities in 1977. As a result, the Namoi Shire purchased land in Boggabri in 1979 to ensure adequate residential land for expansion of the town. An environmental study has been prepared for Boggabri as a fore-runner to the Boggabri Local Environmental Plan, a legally binding planning instrument. The Plan was publically exhibited in early 1986. A Narrabri Local Environmental Plan has also been prepared, as has one for Gunnedah.

3.13.3 Population and Trends

The population of the region has remained stable over the past decade, with a growth rate of 0.6% per year.



POPULATION TRENDS 1971-81

Figure 24

However, the rural (Shire) areas and the small town of Boggabri have experienced a population decline, while the larger towns of Narrabri and Gunnedah have shown a slight increase over the same period.

Boggabri has declined in population from 1378 in 1954 to 1050 in 1981, a reduction of 24%.

Figure 24 shows the population trends for the region and Table 7 shows elements of the population change.

These indicate that there has been significant migration from all areas except Gunnedah.

However, this migration has been counterbalanced in some cases by natural increases. The pattern of the migration of people from rural areas and smaller towns to the larger centres and the coast, is part of an Australian wide trend that is causing considerable concern at all levels of Government.

TABLE 7 : ELEMENTS OF POPULATION CHANGE 1971-1981

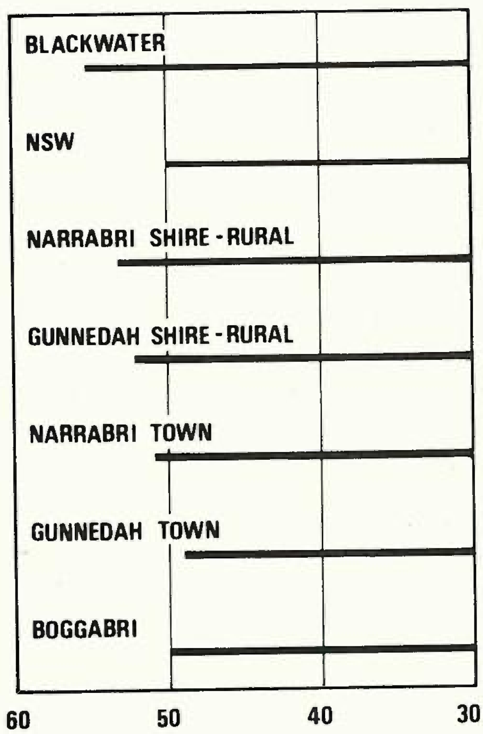
	Natural Increase		Net Migration		Change	
	1971 -1976	1976 -1981*	1971 -1976	1976 -1981*	1971 -1976	1976 -1981*
NARRABRI	557	N/A	-350	N/A	200	N/A
NARRABRI SHIRE	576	926	-600	-650	-50	+200
GUNNEDAH	436	N/A	100	N/A	550	N/A
GUNNEDAH SHIRE	208	587	-300	-500	-100	+100
TOTALS:	1777		-1150		600	

Source: Nexus (1982), & ABS.
* Shire figures include the respective urban areas for the 1976-81 figures.

3.13.4 Population Characteristics

(i) Structure

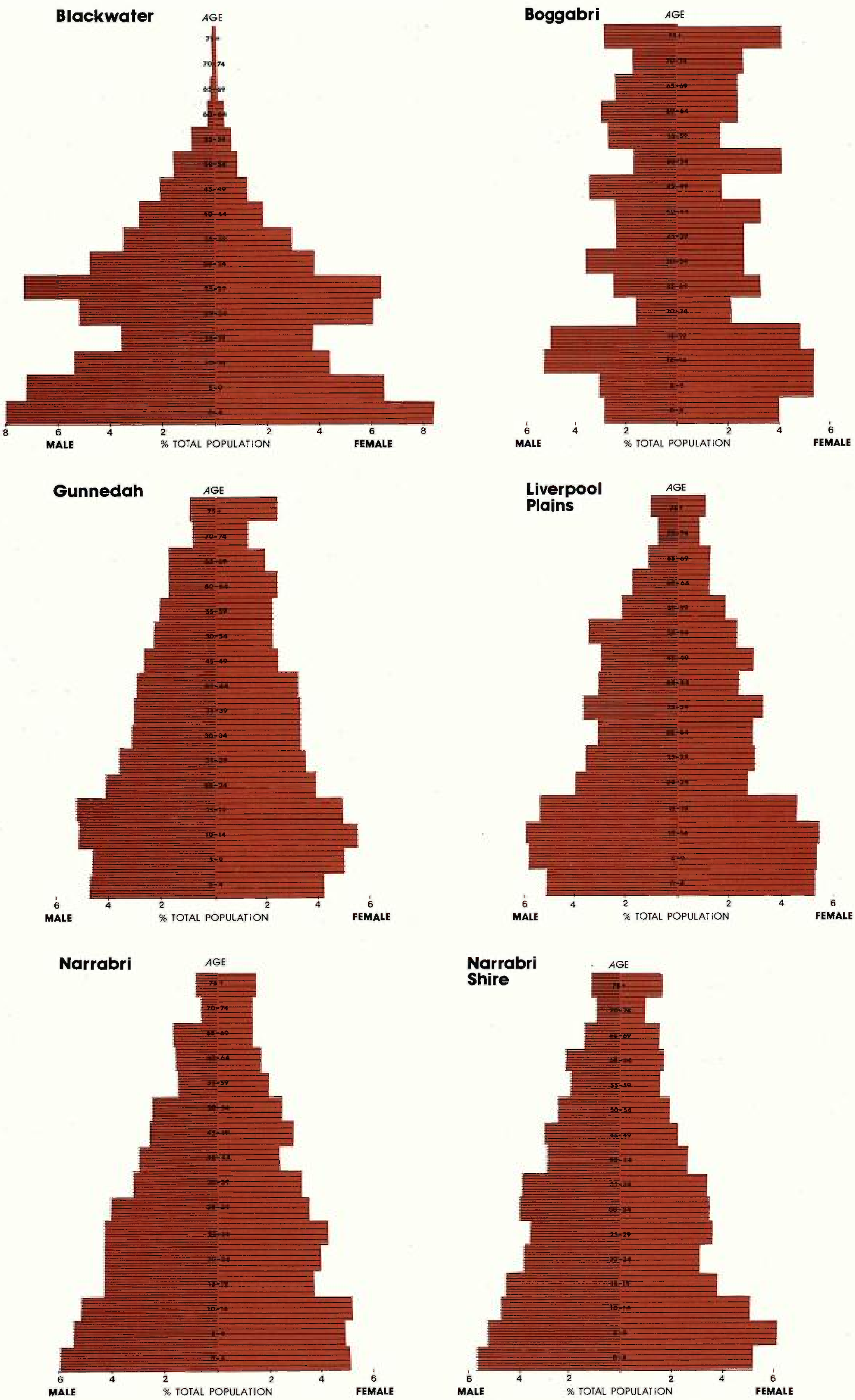
Figure 25 (following page) compares the age structure for the region with Blackwater (a mining town in Queensland). Sex structure is illustrated in Figure 26.



SEX STRUCTURE
(% POPULATION MALE)
Figure 26

The relative size of each age group within the total population of each area is a useful device to determine present and future demands for community services, such as kindergartens, schools, sporting facilities, homes for the aged, e.t.c. It is also useful as a measure of population trends and changing social phenomena. Narrabri, Gunnedah and the Shires have age distributions which are rather unusual for country areas. Rather than emphasis towards the older age groups, they have a higher proportion of children. The Blackwater age structure is especially notable for its youthfullness.

Boggabri's age structure is more typical, with an emphasis on the older age group and a very low proportion in the young adult age bracket (19-30 years).

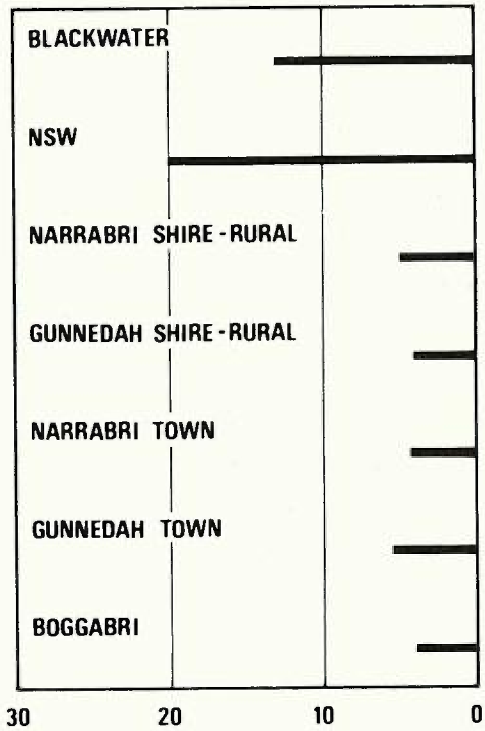


AGE STRUCTURE

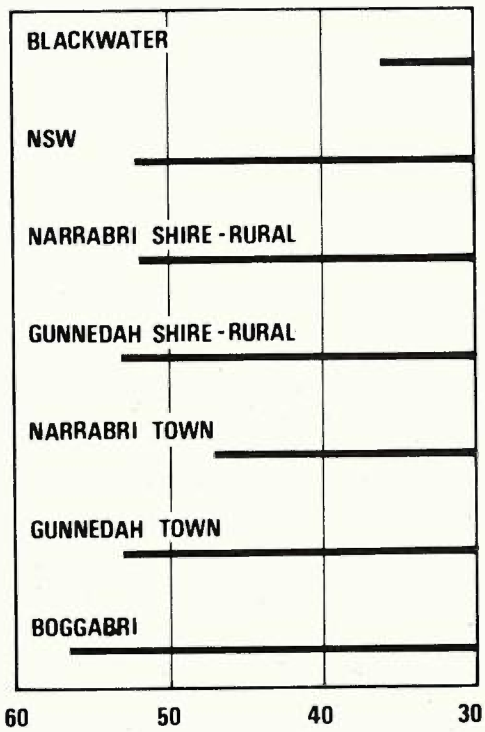
JOINT VENTURE

Boggabri coal

Figure 25



OVERSEAS BORN
(% POPULATION)
Figure 27



MOBILITY
(% POPULATION IN SAME PLACE OF RESIDENCE)
Figure 28

This is most likely an indication of the lack of suitable employment for this group.

Boggabri tends to have a lower proportion of males than NSW or the other areas considered. Boggabri also has a high proportion of females in the older age groups.

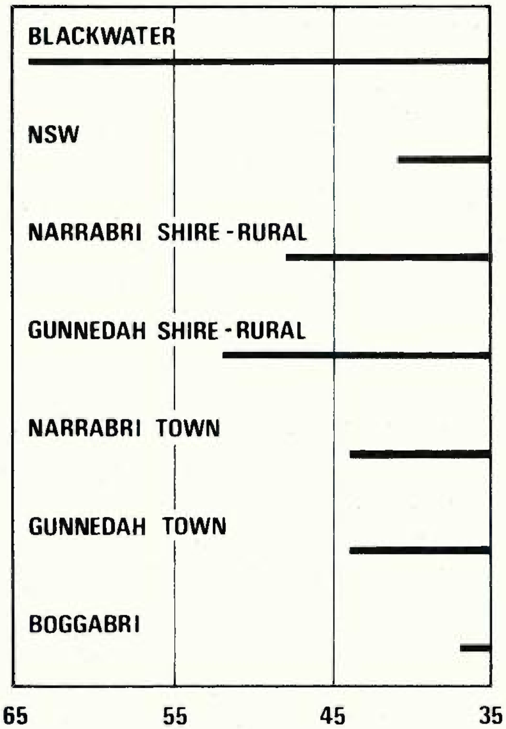
(ii) National Origin and Mobility

Figure 27 shows the proportion of the population that is overseas born. Clearly the population of the region is predominantly homogeneous, with very few migrants, Boggabri having the lowest proportion.

In contrast NSW and Blackwater have much higher proportions of migrants. The proportion of the population that were in the same place of residence in 1976 gives a measure of the mobility of the population (Figure 28).

The Boggabri and the Shire populations tend to be less mobile than the State as a whole, while the towns more.

Blackwater has the typically highly mobile population of a developing mining town.



FAMILY TYPE
(% POPULATION)
Figure 29

(iii) Family Type

The percentage of the population that has a family unit consisting of the household head, spouse and children is shown in Figure 29. The predominance of the nuclear family unit is used as a measure of the presence of strong family ties. As suggested by its age structure, Boggabri has a lower proportion with Blackwater much higher.

3.13.5 Education, Health and Social Service

(i) Education

Boggabri at present only has Primary School facilities and secondary students travel daily to Gunnedah to attend High Schools. Primary Schools have excess capacity in each of the three towns (Source: Education Department). Boggabri has the capacity to absorb 50 additional students. Secondary Schools at Narrabri and Gunnedah have excess capacity for 40 pupils each, with Education Department forecasts predicting a drop in enrolment. In addition to the spare capacity, the Department of Education has sites at Gunnedah and Boggabri for a High School and Primary-High School complex respectively. Three boarding schools exist at Tamworth. There are no universities or Colleges of Advanced Education in the region. The nearest university is located at Armidale. Technical Colleges are located in Tamworth, Gunnedah and Narrabri, with a small associated centre at Boggabri.

(ii) Health Services

Narrabri, Gunnedah and Boggabri all have hospitals with bed numbers of approximately 70, 60 and 15 respectively. All major cases are directed to the major regional hospital in Tamworth via ambulance.

Both Gunnedah and Narrabri offer similar levels of non-hospital health care, including:-
ambulance services, community health and baby health centres, community nursing services, school dental clinics and comparable numbers of private dental and medical practices.

Boggabri Hospital has approximately 15 beds including 5 acute care. The operating theatre has been closed due to lack of medical staff, although one consultant surgeon visits from Tamworth every three weeks. Other medical officers visit the town on a regular basis.

One doctor is a resident and the community nurse at Boggabri Hospital has the support of a social worker, one drug and alcohol counsellor and one social welfare officer. Patients requiring specialist services normally travel to Gunnedah or Tamworth.

(iii) Social Services

Gunnedah and Narrabri have similar levels of social services, with community centres and local newspapers functioning as the major information exchanges. Facilities for the aged and children are well developed. Boggabri, as expected with its smaller size, has a lower level of services. However, the Narrabri and Gunnedah community centres extend their services.

3.13.6 Recreation and Tourism

Recreation facilities are well developed in Narrabri and Gunnedah. Entertainment tends to concentrate in sporting clubs and facilities, which are varied and well patronised. Apart from the sporting facilities, restaurants, movie theatres, hotels and service clubs are well developed.

Sporting clubs in Boggabri again form the main recreational activities. There are also six licensed premises, a small theatre group, youth clubs, craft groups and religious groups. Community activity groups are well developed.

The region is well served with outdoor recreation facilities which are significant tourist attractions. The Kaputar National Park, Keepit Dam Recreation Reserve and Kelvin State Forest offer high quality recreation opportunities.

3.13.7 Housing and Accommodation

The description of housing stock, vacant and rental housing, and residential land was based on the Nexus Report, the 1981 Census, updated with local information and Council records.

(i) Housing Stock

A hierarchy, in terms of turnover for sale and number of new dwellings constructed exists from Gunnedah to Narrabri to Boggabri. The type and number of private dwellings in the three centres and the rural part of the Shires, together with the increase in housing stock since 1976 and vacancies are shown in Table 8.

TABLE 8 : HOUSING STOCK

	Houses	Flats	Mobile	Other*	Total	1976-1981 Increases	Vacant (1981)
GUNNEDAH	2471	203	24	85	2782	11.3%	188
NARRABRI	1710	335	10	65	2120	11.7%	138
BOGGABRI	321	2	2	9	334	10.6%	31
GUNNEDAH RURAL	1119	2	30	27	1180	11.5%	227
NARRABRI RURAL	2204	20	72	60	2405	12.9%	50

* not stated, improvised, dwelling attached to non-dwelling

Growth in urban housing has been fairly steady, with the major increase in Boggabri in the 1977-1978 period. Vacancy rates in Boggabri and the rural areas were higher than in Narrabri and Gunnedah. However few houses were for rent, most were vacant because of their poor condition. There does not appear to be a sizeable pool of vacant housing in any of the three towns. The high proportion of mobile dwellings in the Narrabri rural areas is an indication of the itinerant nature of the workforce.

(ii) Vacant and Rental Housing

Availability of vacant housing for sale in the three towns is reasonable. However, rental housing is limited. At the present time agents' comments simply indicate a shortage of rental housing based very largely in Gunnedah and Narrabri on a physical shortage, while in Boggabri the shortage is seen as largely the result of speculation coupled with the poor condition of much of the housing stock. Both Gunnedah and Narrabri have a good supply of quality housing to buy ($70,000 and above), although lower priced houses are in short supply. Rent and housing prices vary between the towns, as shown in Table 9.

Gunnedah tends to be the most expensive, with Boggabri the least. House prices have been observed to fluctuate with supply in all towns. Speculative buying in Boggabri has escalated prices in recent years, although prices have declined recently.

TABLE 9 : RENT AND HOUSE PRICES

	House Prices Low - High	Rent
GUNNEDAH	$60 - 150,000	$60 - 200
NARRABRI	$40 - 125,000	$60 - 120
BOGGABRI	$20 - 60,000	$60 - 100

(iii) Semi-permanent Housing

All towns have semi-permanent accommodation available in the form of motels, hotels and caravan parks. These are shown in Table 10.

TABLE 10 : SEMI-PERMANENT ACCOMMODATION

		Boggabri Narrabri	Gunnedah	
Type of Accommodation	No.	Sites No.	Units/ No. Units	Units
Motels & Hotels		1	17	7
		170	8	165
Caravan Parks Permanent		0	0	2
		28	-	-
Tourist		1	6	1
		71	2	145
TOTAL		2	33	10
		269	10	310

Source: NRMA Directories

(iv) Residential Land

Residential lots were in short supply in Gunnedah and Narrabri, with Boggabri having better supplies. However, council developments have recently released vacant lots to the market. Both Gunnedah and Narrabri Shire Council's propose to stage residential expansion in the three centres and there is adequate land for coal related expansion. Land prices have stabilised greatly after rising in the early 1980's due to the shortage of supply in Narrabri and Gunnedah, and speculation in Boggabri. Residential serviced blocks vary in price from $8-12,000 in Boggabri, $11,000 in Narrabri to $13-30,000 in Gunnedah. Boggabri has substantial capacity for infilling in the existing town, with approximately 150 lots serviced or readily serviced. In addition, as a result of the Joint Venture's activities and encouragement, the Narrabri Shire Council purchased approximately 200 hectares west of the railway line which will require servicing. The N.S.W. Government also has 300 vacant blocks immediately west of the railway line.

3.13.8 Transportation, Communications and Community Facilities.

Boggabri, as the closest urban centre to the mine development, is expected to capture most of the associated growth (Section 5.10.2). This Section of the report therefore concentrates principally on the existing situation in Boggabri.

(i) Transportation

A well established transportation network services the area. Boggabri is linked to Gunnedah and Narrabri via Trunk Road No. 72 which is a major sealed road carrying approximately 1,450 vehicles daily, approximately 30% of which are heavy vehicles. The road is liable to flooding, as are most of the roads in the area. Main Road No. 357, intersecting the Narrabri road 3km north of Boggabri, leads to Manilla and Maules Creek and currently provides access to the lease area. Existing traffic is approximately 210 vehicles daily. The local road system is shown in Figures 1 and 4.

Public transport is limited. A Moree-Tamworth bus service runs 5 days a week. Three school buses run daily from Boggabri to Gunnedah and 3 local school buses service Boggabri. Freight rail services are well established. Passenger rail services to the north-west terminate at Werris Creek with a bus service connection to Boggabri. The principal regional freight is wheat. Coal is railed from Gunnedah to Newcastle. Boggabri presently has an unsealed airstrip. Sealed airstrips are located at Narrabri and Gunnedah. Air New South Wales operates out of Narrabri and small commuter airlines out of Gunnedah. In addition, there is a bus commuter service connecting Gunnedah with East West Airlines flights from Tamworth, the major regional airport.

(ii) Communications

Two local radio stations broadcast respectively from Gunnedah and Tamworth, with two television channels from Tamworth. Mail is distributed through the local post office and a 2-day service to Sydney is normal. The manual telephone exchange service at Boggabri has been converted to an automatic exchange.

(iii) Other Community Facilities

Boggabri has an established fire brigade operated by volunteers, a recently upgraded police station and a small Court of Law. Public buildings include a library, museum and a number of halls.

Water is obtained from 2 wells near the Namoi River and is untreated. The storage capacity is less than the Public Works Department of NSW (PWD) recommended capacity and present consumption is 80% higher than the PWD allowance. The existing sewerage scheme was constructed in 1954 for a designed population of 2,000. This would accommodate the development of the existing town area to another 500 dwellings. The treatment works can be readily upgraded. A solid waste tip is located south of the town. Electricity supply is provided from a substation located on the western side of the township.

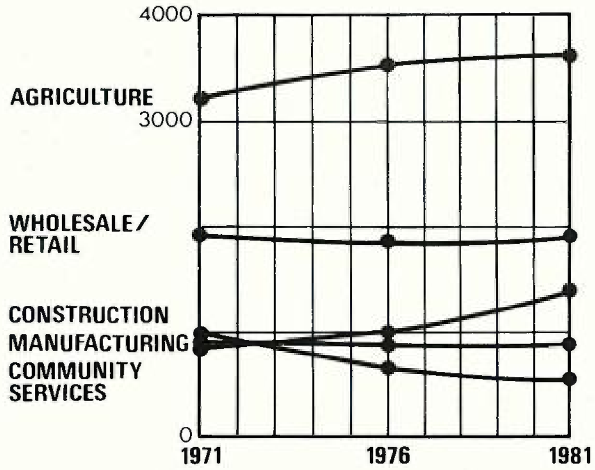
3.13.9 Economic Base

The economic base of the region is predominantly one of agriculture, employing approximately 33% of the workforce. Towns have developed as rural service centres and this has constrained the type of industries that have been attracted to them. Industrial growth and a broadening of the economy outside of this rural servicing framework suffers through isolation from the major centres of the State.

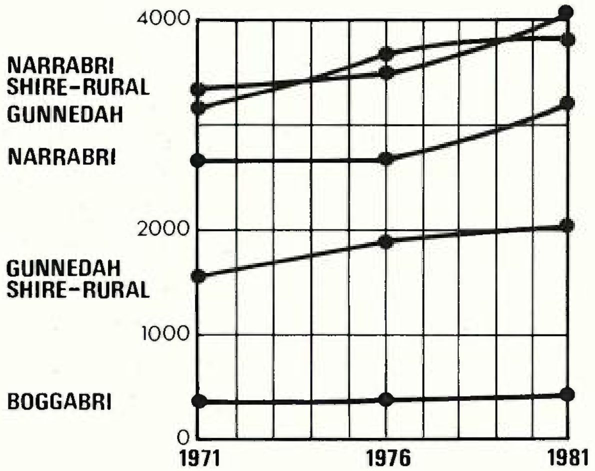
The prosperity of the region is therefore currently dependent on the prevailing economic conditions for rural products which in turn are dependent upon prevailing market and climatic conditions. This is traditionally cyclical, with boom and bust characteristics due to the inland location, frequent flooding and/or drought.

3.13.10 Employment and Labour Force

Trends in employment are shown in Figure 30 (following page). The cyclical nature of the economy is obvious, together with the stagnant employment opportunities in Boggabri. Figure 31 illustrates recent trends in unemployment in the Narrabri labour region. Monthly counts were made to October 1980. However, no data is available after this date until June 1982 when 'quarterly transactions' were resumed. They are not strictly reliable but do show trends.

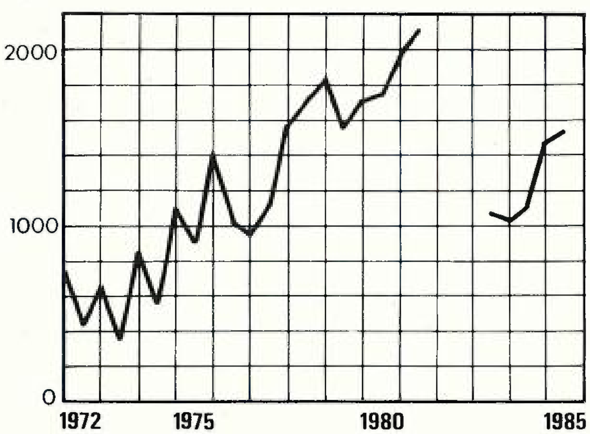


INDUSTRY



SHIRES & TOWNS

EMPLOYMENT TRENDS
Figure 30



UNEMPLOYMENT TRENDS 1972-85
Figure 31

Local unemployment has continued to increase since 1980. The Commonwealth Employment Service (CES) can see no improvement of employment opportunities without a diversification of the economic base, particularly for the young.

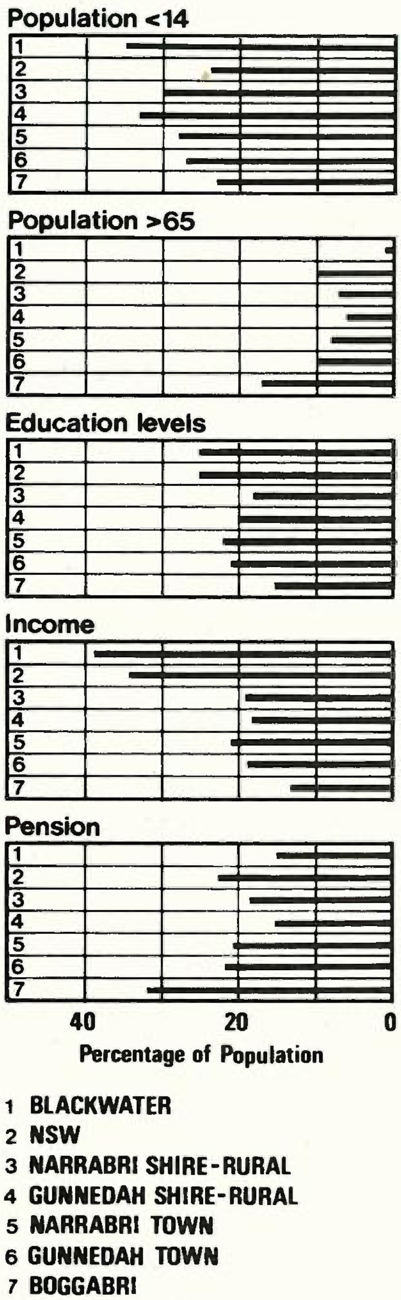
When the structure of the employed industry is examined, the rural areas are typically dominated by agriculture with Narrabri and Gunnedah having more diversity. These towns are more diverse in their employment opportunities than many other NSW country towns. Coal mining in the vicinity of Gunnedah currently employs approximately 300 people and becoming increasingly important.

The Boggabri employment structure is typical of a small town providing a limited range of services to the surrounding rural community.

A study of the workforce participation rates, when considered with the age structure of the population, indicates that there would not appear to be great scope for increasing these rates except perhaps for the female workforce. The CES has identified a large potential workforce, principally unskilled while there are relatively few skilled workers seeking work. Over a thousand male unemployed are on the CES lists for the Narrabri region.

3.13.11 Socio-Economic Indicators

Social and economic indicators are used as a measure of a communities' well-being and can be used to identify areas of relative need. For example, the proportion of the population under 14, and over 65, can give a guide to level of services required for these age groups.



SOCIO-ECONOMIC INDICATORS

Figure 32

Refer to text for explanation of this figure

Walmsley (Walmsley, 1977), examined social indicators of the New England region using 1971 Census data.

By a mathematical analysis technique, he reduced twenty indicators into four underlying variables, added components and calculated scores and ranks for the 27 Local Government areas in the region.

The principal component analysis showed that large rural centres such as Gunnedah and Narrabri exhibited a much higher rate of growth than the surrounding Shires. The Shires had a lower proportion of pensioners than the towns, possibly because they have inadequate facilities to cater for aged persons. Narrabri and its surrounding Narrabri Shire had quite different family characteristics than other areas, possibly reflecting an unsettled population.

The most recent information is the 1981 Census. Boggabri, Blackwater and NSW are also included to provide comparisons. Figure 32 illustrates the population percentages for dependant population, education levels, income and pensions. Dependant population is defined as the percentage of young (0-14years) and old (65 years or more) to the total population.

As discussed in Section 3.13.4, data on the age structure of the population, especially the proportion of young and old, are important in planning for adequate and appropriate community services. The rural areas Shires and towns have a dependant population higher than NSW, excepting Boggabri which has a high proportion of its population over 65. They also have a high percentage in the under 14 age group, Blackwater having an extremely high percentage of almost 35%. The education indicator measures the percentage of the population with university, technical and non-degree tertiary education. Individuals with tertiary education generally are more assured of job opportunities and have a higher income potential than those without. The region has a lower education indicator than the NSW average, which also correlates with the family incomes. An individual's income has a direct relationship to his material standard of living and well-being, as well as his access to the range of available goods and services. Blackwater is notable for its high family income, Boggabri for the lowest. The proportion of the population receiving pensions is a measure of the well-being of the community and the demand for public services. Boggabri has a high proportion, with Blackwater the lowest.

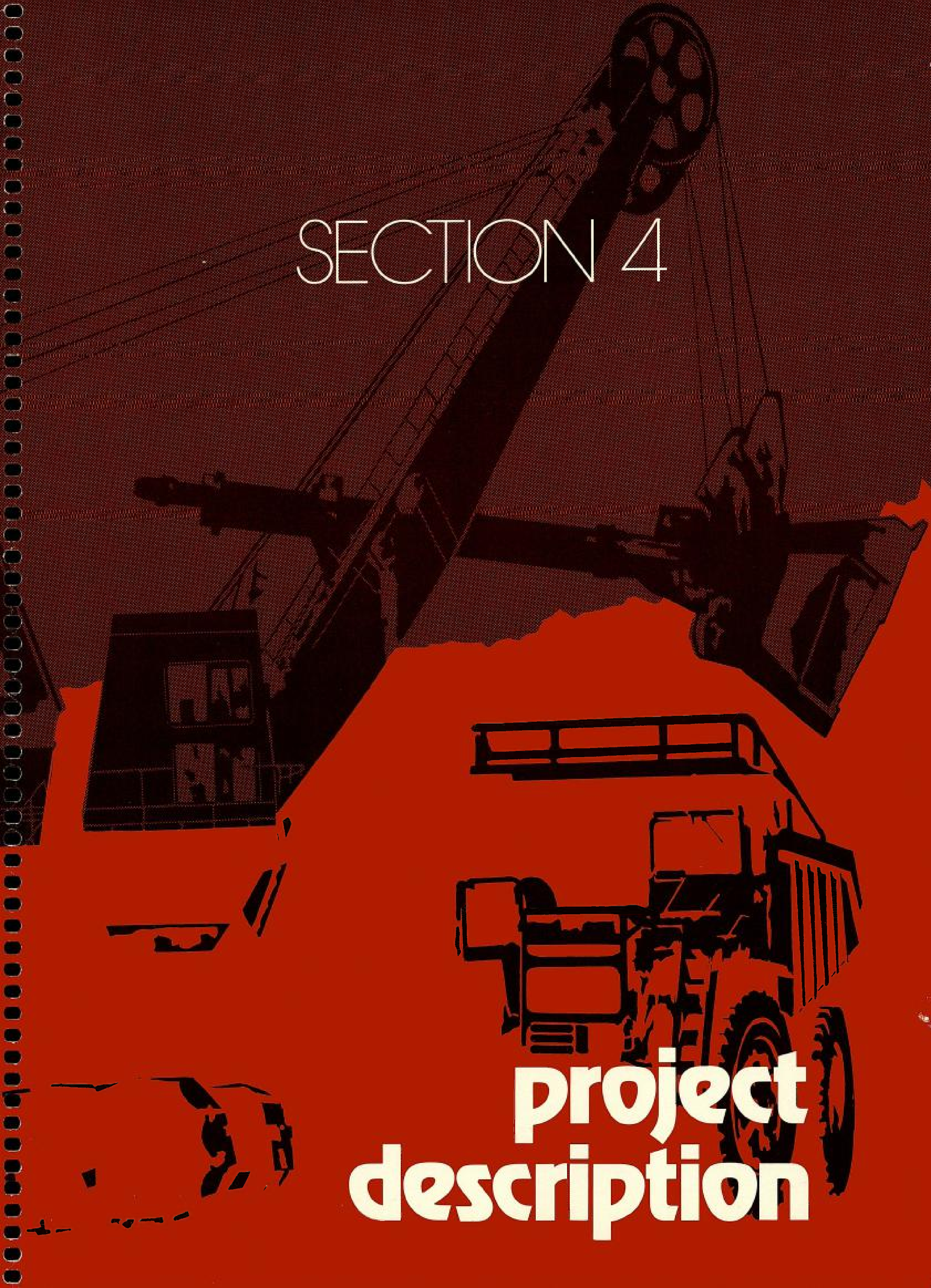
3.13.11 Employment Multipliers

Associated with any significant basic industry, are service industries which are necessary to provide supporting services. Any expansion in the basic sector will provide an associated 'flow on' effect to the regional economy.

An historic estimate of these multipliers can be made from census data by dividing the workforce into basic and service industries. The Vickery Project EIS (Vickery, 1986) used this approach and calculated economic base multipliers (total employed divided by basic employed) of 1.5 for Gunnedah Shire, 1.6 for Boggabri and 2.6 for the Northern Statistical Division. Using the same approach, Narrabri Shire has a multiplier of 1.5.

The Northern Statistical Division base multiplier value is greater than the Shires because of the increased service larger centres such as Tamworth provide to the area. Taking into account the specialised nature of the coal industry and the level of support from outside the region (supply of equipment, technological services, etc.) estimated at 60%, a coal project multiplier of 1.2 for the Shires and 1.3 for Boggabri is estimated. That is, for each direct project job, an additional 0.2 in the Gunnedah and Narrabri Shires, and 0.3 in Boggabri, will be created.

SECTION 4



project description

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4.0 PROJECT DESCRIPTION

4.1 General Development Plan

The lease area contains insitu coal reserves of 650 million tonnes in 12 seams to a depth of 500 metres. The reserves are recoverable by surface and underground mining methods, with resource recovery optimised by maximising surface mining. The mining of the resource by surface methods is required to provide a more predictable mining operation for long term economic viability. Underground mining with its inherent higher risks and costs can only be considered as a subsequent development of successful surface mining operations and only when economically viable consistent with market requirements. Reserves are estimated at 210 and 140 million product tonnes for surface and underground mines respectively.

The proposed mining development will begin as a high productivity, small scale surface mining operation which will extract shallower recoverable reserves, at a production rate of approximately 0.5Mtpa. The initial production rate and further increases will be consistent with market demands and acceptable project economics being realised. The planned ultimate production will be achieved by a large scale surface mining operation recovering the deeper reserves at up to 5.0Mtpa. The main surface mine plan has been developed to recover approximately 90 million product tonnes to a total overburden depth of 140 metres. Extensions of the coal lease term and further increases in mining rate would enable a further 120 million product tonnes to be recovered by surface mining. Additional surface recoverable reserves exist but are considered secondary due to high overburden to coal ratios, and the difficulty of mining.

The timing of commencement of underground mining of the deposit will be dependent upon markets and economic viability. Underground mining could result in the extraction of a further 140 million product tonnes of coal. The life of the total mining operation in the lease area is expected to exceed 50 years.

The present development timetable is for construction to precede mining by 12 months, with the actual commencement date dependent on market requirements and definite sales contracts. Construction of the mine site facilities will be phased to match the mine production. Initial capacity is planned to be 0.5Mtpa with expansion of facilities to meet the full 5.0Mtpa capacity. Output of product coal is expected to progressively increase from 0.5Mtpa in year 1, to full production of 5.0Mtpa by year 10. However, market requirements will dictate the initial production rate, which may be less than 0.5Mtpa, and the progression period to full production, which may vary from the 10 year period proposed.

4.2 The Surface Mine

4.2.1 Mine Plan

(i) Mine Planning

To satisfy the requirements for the Coal Lease Application, the surface mine plan covers a 21 year mine life. However, as the lease area contains an additional 120 million product tonnes of surface recoverable reserves the mine plan has been developed to continue mining with lease extensions until all reserves are recovered.

The surface mine development proposal that has evolved is considered the most practicable and economic for the surface recovery of the resource. The surface mining plan at full production considers coal at depths of less than 140m and an overburden to coal ratio of less than 10:1 (cu. m per tonne). The proposed mine plan is shown in Figure 33.

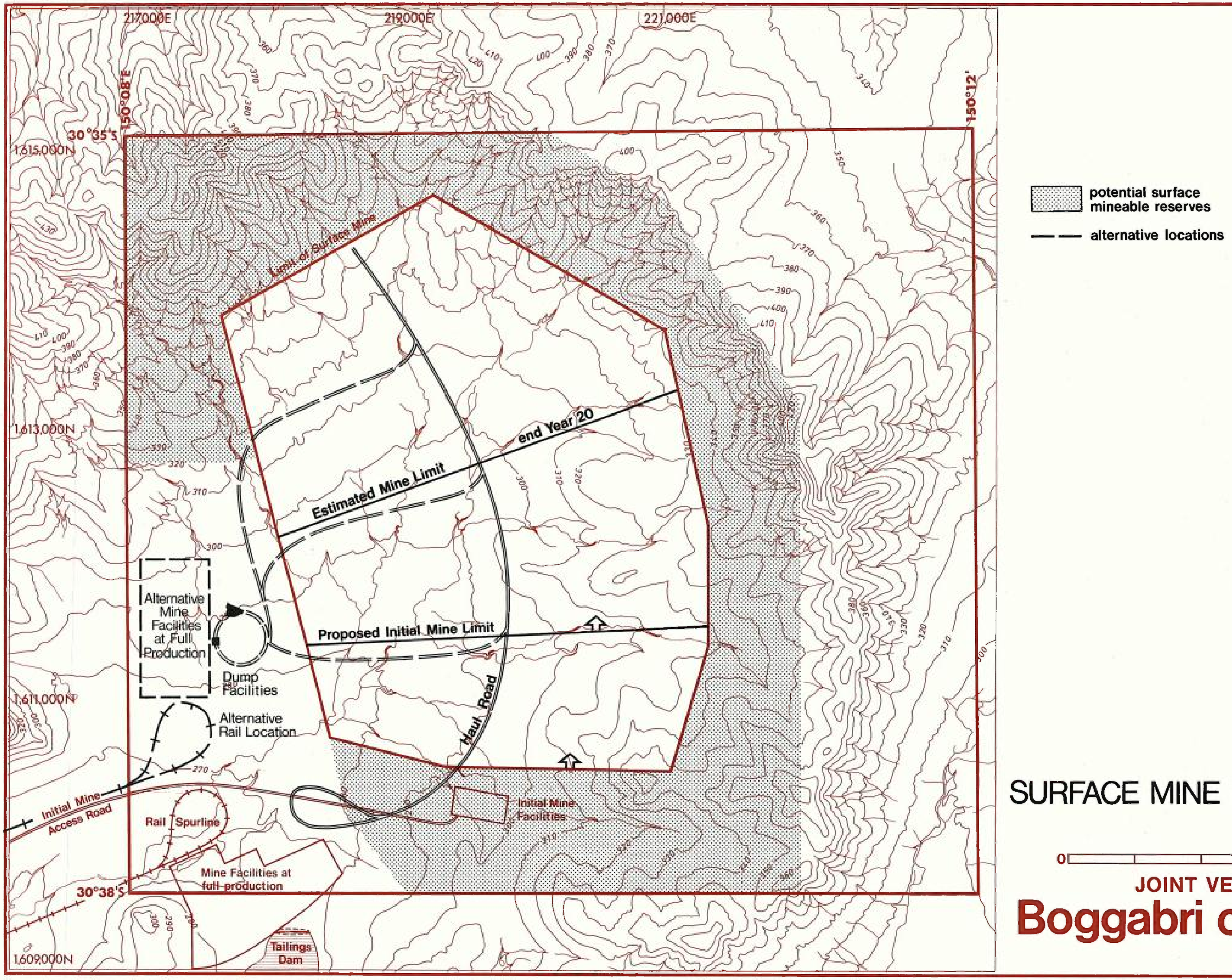
The mining plan has been developed within the bounds of existing operational practices, current technology and environmental constraints. The level of production is influenced by market demands and overall operational costs. The mining plan proposed, while being as precise as possible, should be considered as dynamic and liable to change to take advantage of improvements or changes in technology, operating practices, market requirements, or other factors affecting the total free on board (f.o.b.) cost of coal.

High washing yields and the good coal quality anticipated from the seams will offset the overburden ratios (the ratio of cubic metres of rock removed to tonnes of coal recovered) which are, in general, high by NSW and Hunter Valley surface coal mine standards. Surface mining is planned to recover coal at depths of 140 metres in areas where overburden ratios are acceptable.

Separate feasibility studies have examined surface mining of the deposit using truck-shovel only, dragline only and various combinations of dragline/truck-shovel at different levels of output. With the current technology available for overburden removal, the recovery of the resource has been assessed using a combination of dragline and truck-shovel methods.

The application of new, cost effective mining technology, in particular continuous mining systems for overburden removal, may optimise the recovery of the total resource and reduce environmental impacts.

Environmental impacts in this statement have been assessed for the combined dragline and truck-shovel development. This mining method, or similar methods with new technology will allow the development of a long term, large scale mining operation.



SURFACE MINE PLAN

JOINT VENTURE
Boggabri coal

Figure 33

Essentially two phases of mining will be undertaken; an initial period for market assessments where the production level is expected to be 0.5Mtpa, followed by an increase to full production of 5Mtpa as markets dictate.

The total surface mining concept involves the stripping and extraction of all coal seams down to the Merriown seam. The Bollol Creek seam, being thin and relatively dirty, may not be recovered in certain areas of the surface mine plan. Overburden above the Braymont seam horizon will be removed by truck-shovel, or more cost effective alternate technology, while interburden layers between the Braymont-Bollol Creek, Bollol Creek-Jeralong and Jeralong-Merriown seams will be handled by dragline. This results in a mining operation at full production whereby approximately equal proportions of overburden are removed by dragline and truck-shovel operation. The only "out of pit" overburden placement is in the initial box cut and in limited areas where overburden is required to merge the rehabilitated surface with the existing topography.

(i) Initial Production

Mining will start at the southern end of the lease where a small dragline will commence overburden stripping from the sub-crop of the Merriown seam (see Figure 33). This dragline will also uncover the Jeralong seam when it is encountered. Depending on market demands, coal production rates may range from 0.2 to 0.5Mtpa.

Overburden to coal ratios for the seams below the Merriown to the south of the mine area preclude mining these seams. To the south-east inferred geological disturbance and faulting limits the mine in this direction.

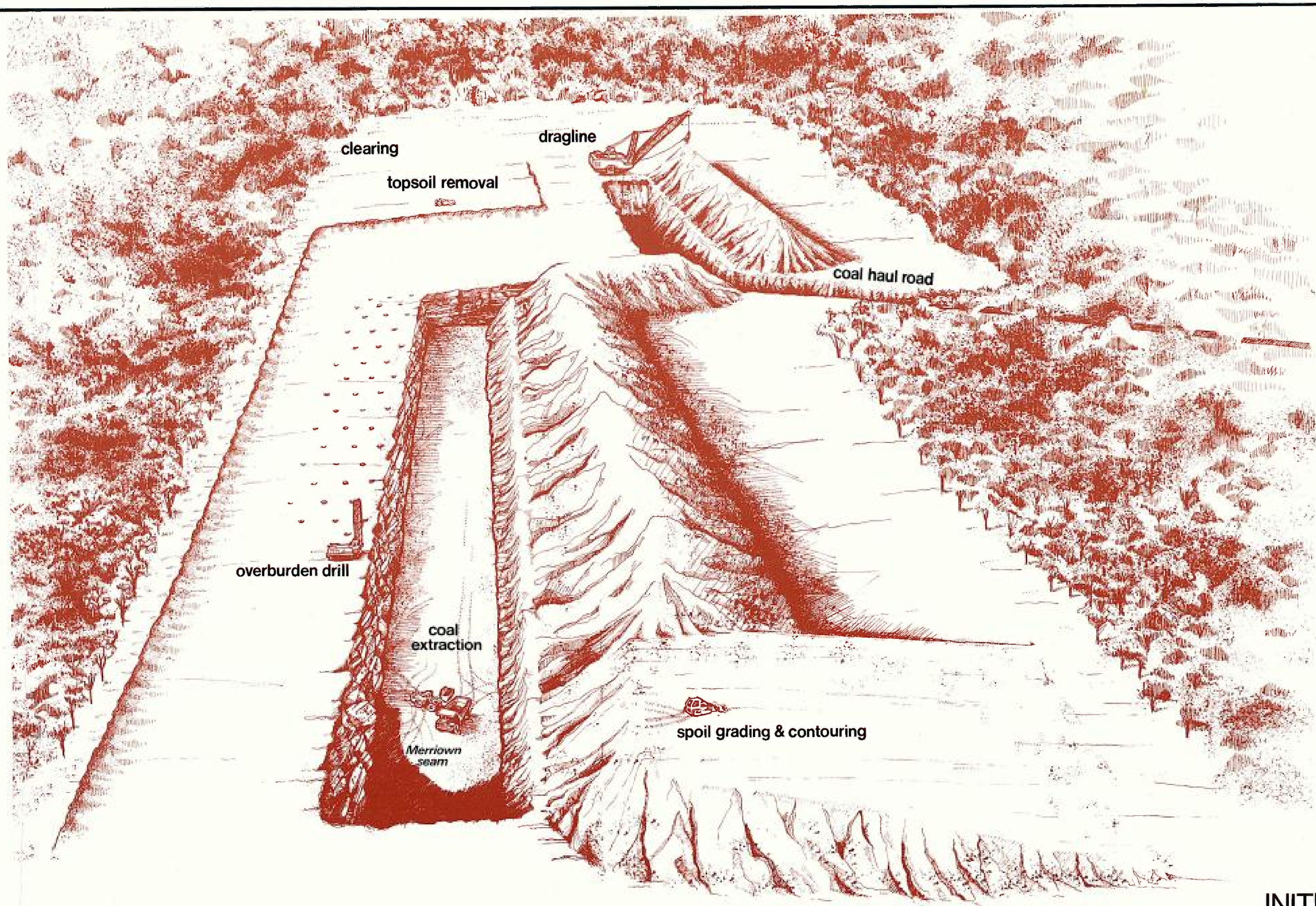
Figure 34 is a computer generated perspective view of the box cut and Figure 35 the location of the mine pit after the initial production period, which is expected to take 10 years.

Coal cleaning is not proposed for this initial stage of development and only minimal coal crushing and sizing facilities will be provided (see Section 4.4.1 for details).

(ii) Progression to Full Production

The small dragline will be replaced by a larger unit near the Bollol Creek seam sub-crop. Due to the increased production capacity of this machine, production rates will increase to approximately 2.5Mtpa (dependent on final machine selection) and a coal preparation plant may be constructed (see Section 4.4.2 for details), dependent on market requirements.

The dragline stripping method proposed uses multiple passes to remove overburden above, and interburden between the lower seams.

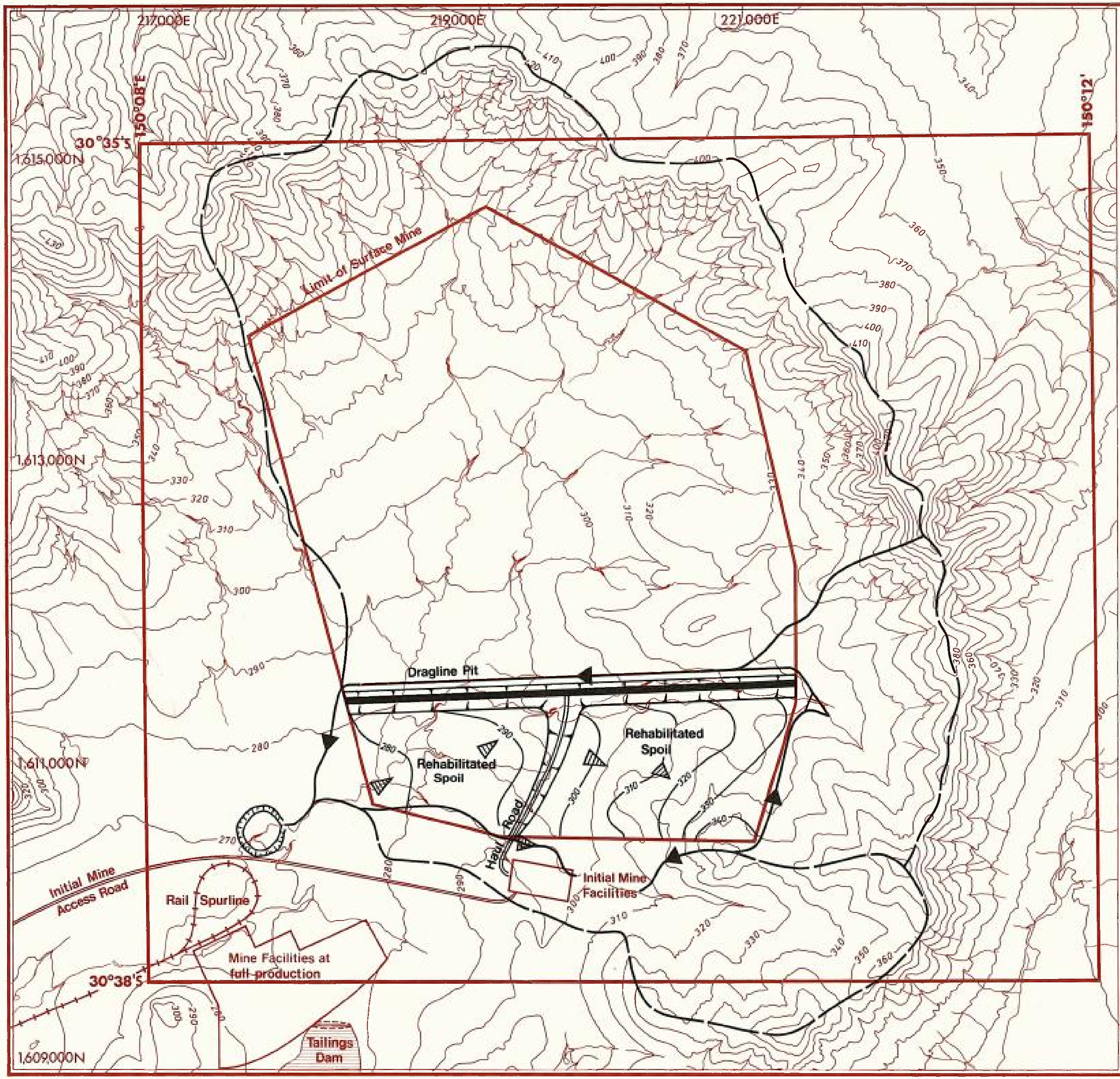


INITIAL MINE
BOXCUT PERSPECTIVE

JOINT VENTURE

Boggabri coal

Figure 34



MINE DRAINAGE

- catchment boundary
- diversion channel
- sedimentation dam
- clean runoff storage dam

PROPOSED LIMIT OF SMALL MINE

0 1·5km

JOINT VENTURE

Boggabri coal

Figure 35

As the dragline pit advances, it progressively uncovers the Jeralong seam and the Bollol Creek seam (where viable). This will require pre-stripping by truck and shovel or more cost effective alternate technology. When the Braymont seam is encountered, overburden will be removed progressively.

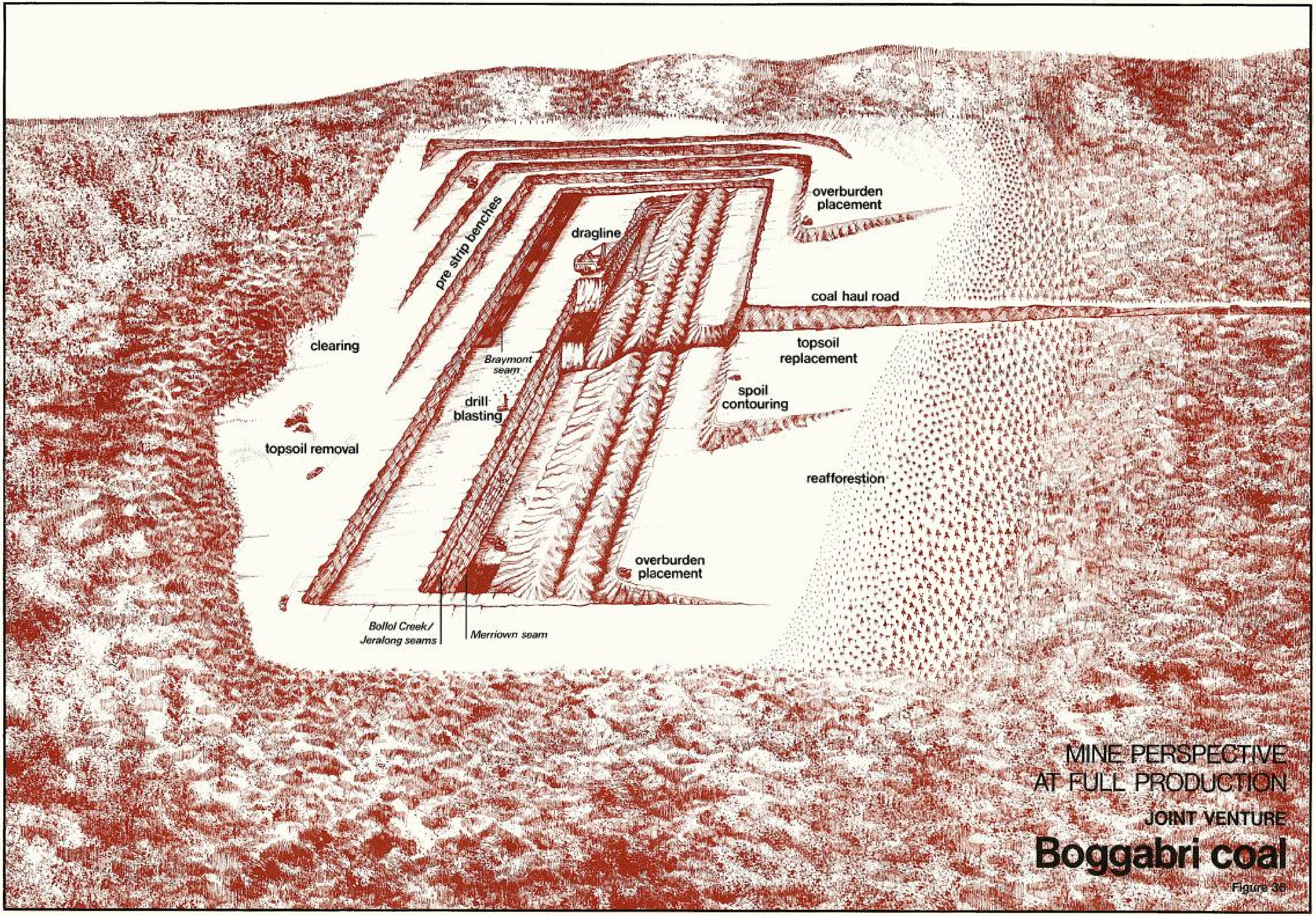
The introduction of the truck and shovel fleet or alternate technology will allow a further increase in production from 2.5Mtpa. At full production the Braymont seam will provide an additional 2.5Mtpa of saleable coal (i.e. 5Mtpa total) and the coal preparation plant is duplicated at this stage (Section 4.4.2). Major mining equipment items are shown in Table 11.

TABLE 11: MINING EQUIPMENT SCHEDULE - MAJOR EQUIPMENT ITEMS

Type	Use	Capacity	Number
Initial			
Dragline	Overburden	15-30m^3	1
Drill	Overburden	150-250mm	1
Grader	Road works	200kW	1
Excavator	Coal loading	8m^3	2
Scraper	Rehabilitation	15m^3	2
Dozer	Tracked	350kW	3
Trucks	Coal haulage	50-85 tonne	5
	Water		1
Full Production			
Dragline	Overburden	85-90m^3	1
Shovels	Overburden	23m^3	5
Trucks	Overburden	154 tonne	30
Trucks	Coal haulage	150 tonnes	12
Trucks	Water	45kL	4
Drills	Overburden	380mm	4
Drills	Coal/parting	250mm	3
Excavators	Coal/parting	15m^3	3
Loaders	Coal/parting	10m^3	2
Scrapers	General	30m^3	2
Graders	Road works	200kW	4
Dozers	Tracked	520kW	4
Dozers	Tracked	350kW	10
Dozers	Rubber tyred	300kW	3

Note: The equipment numbers and sizing are indicative for the worst case. Both equipment sizing and numbers may change by the adoption of improved technologies and operating practices to increase productivity.

The proposed mine at full production will be a multi-seam operation as depicted in Figure 36. Figure 37 shows the anticipated pit location at year 20 of the present mine plan.

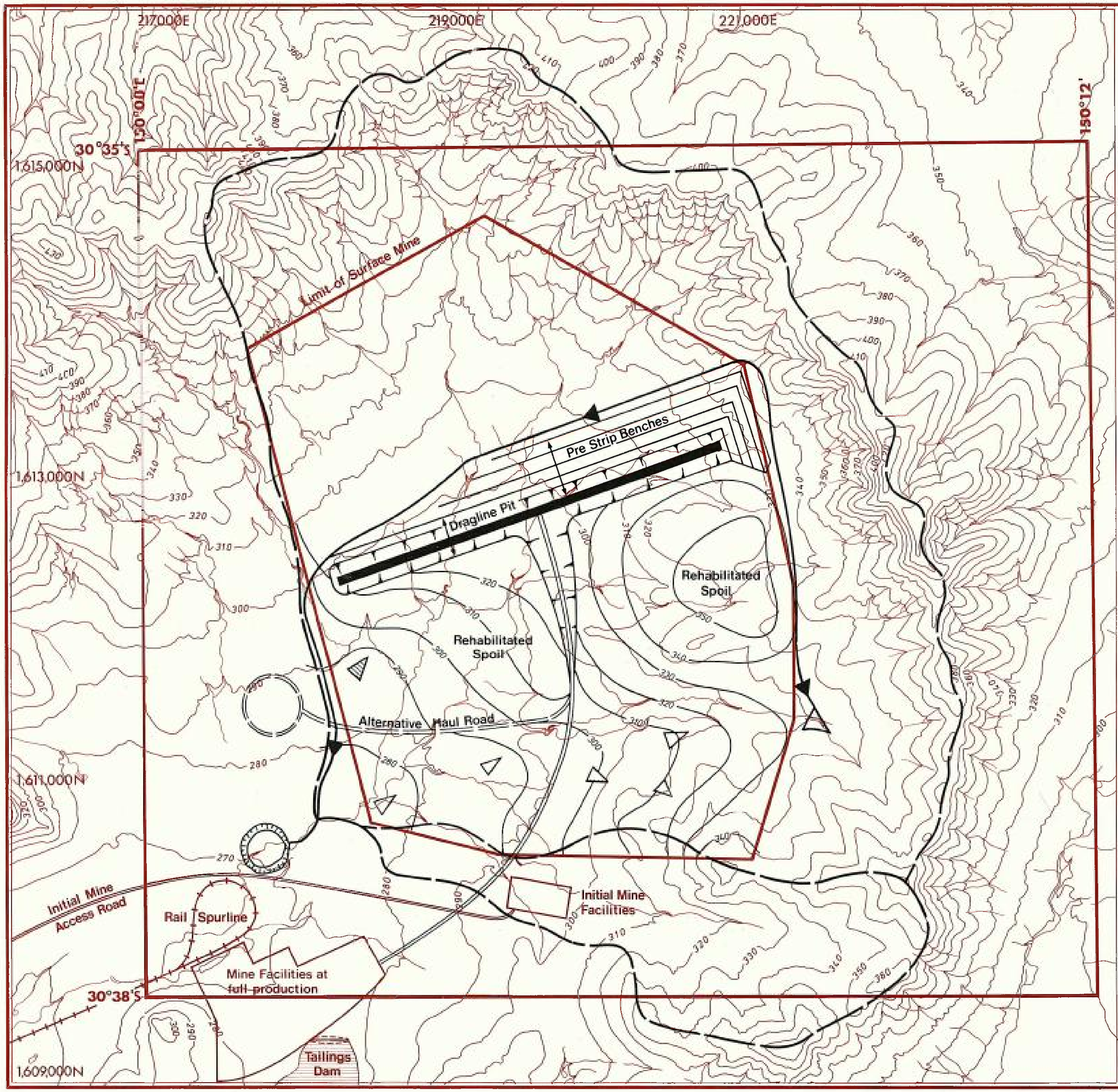


MINE PERSPECTIVE AT FULL PRODUCTION

JOINT VENTURE

Boggabri coal

Figure 36



MINE DRAINAGE

- catchment boundary
- diversion channel
- sedimentation dam
- clean runoff storage dam

LOCATION OF PIT AT END OF YEAR 20

0 — 1·5km

JOINT VENTURE

Boggabri coal

Figure 37

The mine plan that has been developed results in an efficient dragline operation based on low overburden rehandle. Sufficient volume is pre-stripped to improve project flexibility and increase total recovery of coal. This proposed mine plan is shown in Figure 33. A possible alternative site for the facilities is also shown.

(iii) Year 21 Pit

Provisional planning has been made for a void remaining at the cessation of mining at the end of the 21 year term of the Coal Lease. However, as there are over 120 million tonnes of additional surface recoverable reserves remaining, it is proposed that these will be recovered. The final void at the end of the surface mine life is expected to be significantly smaller than the void created in year 21. The final void will be rehabilitated as decribed in Section 4.3.

4.2.2 Mining Operations

General overburden removal principles for the proposed mine have been described in the preceding Section. Mining and associated operations, when required, will be conducted on a 24 hour per day 7 day per week basis.

Mining will proceed in the following manner:-

(i) Site Preparation and Topsoil Handling

This phase of the operation is discussed in detail in Section 4.3.2. Roads, water diversion channels and banks will be constructed as required at an early stage. Topsoil will be stripped and stockpiled for later use.

The proposed mine lies wholly within the Leard State Forest. All trees and undergrowth will be cleared in advance of the pit to allow for efficient scheduling of top soil removal, overburden drilling and blasting prior to removal of overburden. This clearing will be kept to a minimum consistent with safety and operational requirements.

(ii) Drilling and Blasting

Preliminary studies indicate that most overburden, major coal seams and interburden will require blasting to fragment the material for removal by truck, shovel and dragline. Thick overburden and interburden will be drilled by large overburden drills (up to 380mm diameter) to a predetermined pattern for blasting with bulk explosives such as ammonium nitrate/fuel oil mixture (ANFO).

In areas of interburden less than 10 metres thick and for coal seams greater than 2 metres thick smaller drills will be used. The use of hydraulic excavators as coal loaders or alternate continuous loading equipment may decrease the need to drill and blast the coal. The application of good blast design and practice will minimise any of the adverse effects of blasting.

(iii) Overburden/Interburden Removal

Initial Production

A small dragline will be used to strip the overburden above the Merriown seam. When the Jeralong seam is encountered some pre-stripping will be required to enable the dragline to uncover the two seams. When the Bollol Creek seam is encountered a large dragline will become the main stripping unit as production increases, and the small unit assigned secondary functions such as rehabilitation or pit stabilisation duties.

Full Production

A large electric dragline (85-90 cubic metre bucket capacity), a fleet of electric shovels (20-25 cubic metre), hydraulic excavators, front-end loaders and overburden trucks are currently planned for the removal of the overburden, interburden and in-seam partings at full production. However, the application of new, cost effective mining technology, in particular continuous mining systems for overburden removal, may be utilised.

The dragline will use multiple passes to remove overburden above and interburden between the lower seams. Material spoiled from the high-wall (advancing face of the pit) will be levelled with dozers to form a spoil bench from which the dragline in turn removes the lower interburden. One high-wall and up to two spoil passes are required to mine Bollol Creek, Jeralong and Merriown seam coals.

At full production, overburden stripping ahead of the dragline down to the top coal seam (Braymont) will be carried out by large electric shovels or hydraulic excavators loading the overburden haulage trucks. These trucks will haul along roads on 15 to 20 metre high benches, crossing the end of the pit on an inter-bench road system, then dump on the overburden area no closer than two spoil peaks from the dragline pit for stability reasons.

Interburden and parting material will be loaded by either large capacity front-end loaders or hydraulic excavators into the overburden haulage trucks. The material will be hauled out of the pit, onto the main central coal haulage ramp, then dumped onto the overburden area. Some material will be dumped within the ramp area to progressively back-fill and regrade the main haulage road. Wherever possible, any material that may be deleterious to revegetation and/or water quality will be buried within the spoil piles (Section 3.6). Provision has also been made to provide a layer of rooting material between the spoil and top soil.

(iv) Coal Excavation and Haulage

Coal seams greater than 2 metres thick may be drilled and blasted depending upon the type of coal loading equipment used. Coal seams thinner than 2 metres in thickness will be ripped with dozers or loaded directly by hydraulic excavator. It is proposed that one coal loader will operate on the Merriown, Jeralong and Bollol Creek seams when uncovered by the dragline. An additional excavator will be employed to load Braymont seam coal. The coal excavators will be supplemented by large capacity front-end loaders which will also be used for general purposes, interburden and partings removal.

The use of in-pit conveyors will be investigated to replace coal haulage by trucks. The coal haulage conveyors would handle all coal from the pit.

The coal will be hauled from coal seam benches to the raw coal dumping station or emergency coal stockpile by rear dump or unitised bottom dump coal haulers. Coal from the Bollol Creek, Jeralong and Merriown seams will be hauled along seam floor benches with ramps to connect with the main haulage road. The mine will have one central pit haul-ramp, with a maximum grade of 10%, which is relocated as required. Figure 33 shows the ramp locations if the alternative plant site is adopted. Braymont seam coal and splits will be hauled along the bench at Braymont floor level and then around the eastern and western pit ends. Two major haul roads will connect to the main central ramp. The location of these pit end haul roads will change periodically as the operation advances.

4.3 Rehabilitation

The objective of the rehabilitation plan is to return the disturbed areas to as near as practical their original native forest land use, as alternative land uses such as agriculture will not produce a stable ecosystem. This will also have benefits in terms of retaining wildlife habitat and provide the potential for timber production.

A large amount of pre-mine planning has been undertaken, including soil and overburden studies and rehabilitation trials. This information has been incorporated into the mine plan and equipment and manning structures have been provided to ensure that rehabilitation objectives will be achieved.

The mine plan allows for the handling and storage of topsoil for future use in the best possible manner, selective handling of overburden to ensure burial of materials with undesirable characteristics, return of a rooting medium beneath the topsoil, and a return to a topography suitable to maintain a viable native forest.

4.3.1 Rehabilitation Plan

(i) Clearing, Site Preparation and Topsoil Removal

In conjunction with the Forestry Commission, all commercial timber will be recovered where feasible and the remaining vegetation stockpiled for burning and incorporation of ash in the topsoil. All significant topsoil would be removed by scrapers and/or trucks and loader, taking care that the undesirable B-horizon is not incorporated. Topsoil will either be directly replaced on the regraded spoil or stockpiled. Weather and soil moisture conditions may require limiting soil handling operations during excessively dry or wet conditions to minimise adverse soil quality effects. Stockpiles will be clearly marked and constructed to ensure that soil degradation is minimised.

(ii) Overburden and Interburden Emplacement

Following clearing and topsoil removal, the overburden is blasted and removed, coal mined and the overburden replaced (Section 4.2.2). Except in the boxcut area and the initial years of the mine life, a significant part of overburden will be moved by large trucks and placed on top of dragline spoil. In the initial period, overburden will be handled only by the dragline. The use of trucks gives flexibility to selectively handle the overburden strata and select material to be left on the surface upon which topsoil is replaced. In the boxcut area, the Merriown seam roof materials will be left on top of the spoil.

The final spoil surface will be shaped to a pre-determined landform. Soil and overburden studies (Section 3.6) have identified materials with undesirable characteristics which may be harmful to rehabilitation and/or water quality. Provision has been made to bury these materials, which have been identified as:-

- sodic and saline B and C-horizon of the soil profile;
- sodic sandy conglomerates in the overburden of the Braymont seam;
- sodic basal section of the sandy conglomerates above the Jeralong seam;
- acid roof and underclay materials associated with the Braymont and Jeralong seams.

(iii) Topsoil Replacement and Reafforestation

After the final spoil surface has been graded to the required topography and the rooting media placed where required, topsoil will be replaced. The spoil may require ripping prior to topsoil placement to ensure the breakdown of any hardpan or crust that may prevent water penetration and downward movement of salts. An application of gypsum may also be made to alleviate high sodium problems should these exist.

Topsoil will be dumped on the spoil surface and spread using a small low ground pressure dozer to minimise compaction and ensure maximum efficiency in topsoil replacement. Wherever possible, topsoil will be directly recycled from in advance of the mine. The soil, as demonstrated in the rehabilitation trials, contains a reservoir of native seeds which germinate readily after topsoil replacement. Reafforestation and ground stabilisation will be achieved by native species where feasible. To ensure early erosion control, supplementing with strips of introduced grass species and mulching of the steeper slopes may be required. The desired tree species will be established by the broadcasting of seeds and/or the planting of tree seedlings.

(iv) Erosion Control

Water erosion occurs in two main ways, by raindrop splash, and as gully or sheet erosion by flowing water. Raindrop splash cannot be controlled except by vegetation. However gully and sheet erosion are a function of the velocity of surface water flow and the cohesiveness of the soil particles and as such can be controlled. The cohesiveness of the soil particles is affected by soil type and by the binding effect which organic matter and plant roots have upon the soil. Rapid vegetation establishment will therefore increase cohesiveness and resistance to erosion.

The flow velocity of surface runoff is determined by the depth of flow, the slope angle, and the roughness of the soil surface. The slope angle can be controlled in the mining operation and therefore considerable control can be expected over flow velocities. The existing slopes are gentle and the majority of slopes after mining will be similarly constructed and, wherever feasible, kept to a minimum to reduce erosion. The commonly employed structural earthworks in soil conservation (contour furrows, banks, waterways and spillways) will be integrated into a drainage and erosion control system. This will ensure the control of surface flow by reducing both depth and velocity. Areas with steeper slopes such as road and rail spurline embankments, the outer limit of boxcut spoil and the final pit, may require such structures and mulching. However, the best means of long term erosion control is a dense, permanent vegetation cover.

The revegetation and reafforestation techniques that have been discussed are aimed at producing a dense cover as quickly as possible. Nevertheless, there will exist a period between final shaping, topsoiling and the establishment of vegetation during which the surface is highly susceptible to erosion. Measures which will be adopted to reduce both this period and the magnitude could include:-

- delaying final shaping until as close as possible to topsoil replacement;
- scheduling the final operations of topsoiling, cultivation and sowing so that they are not carried out in the summer period of high intensity rains but when soil moisture conditions are most favourable to seed

germination and vegetation establishment; and

- ensuring rapid revegetation by grasses and ground cover by the planting of strips of introduced grass species; mulching of steep slopes; and contour ripping and cultivation along contours to retard runoff, crust formation and to promote water infiltration.

4.3.2 Final Landform

The final landform developed will be aesthetically pleasing, stable and able to support a productive native forest. A drainage network will be established to control and direct runoff, minimise erosion and protect mining operations. Provision has been made to collect runoff and direct it south of the mined area through sedimentation dams (Section 4.7). This will enable the facility, at the close of operations, to redirect surface runoff into the central haul road and thereby into the final void to improve final water quality.

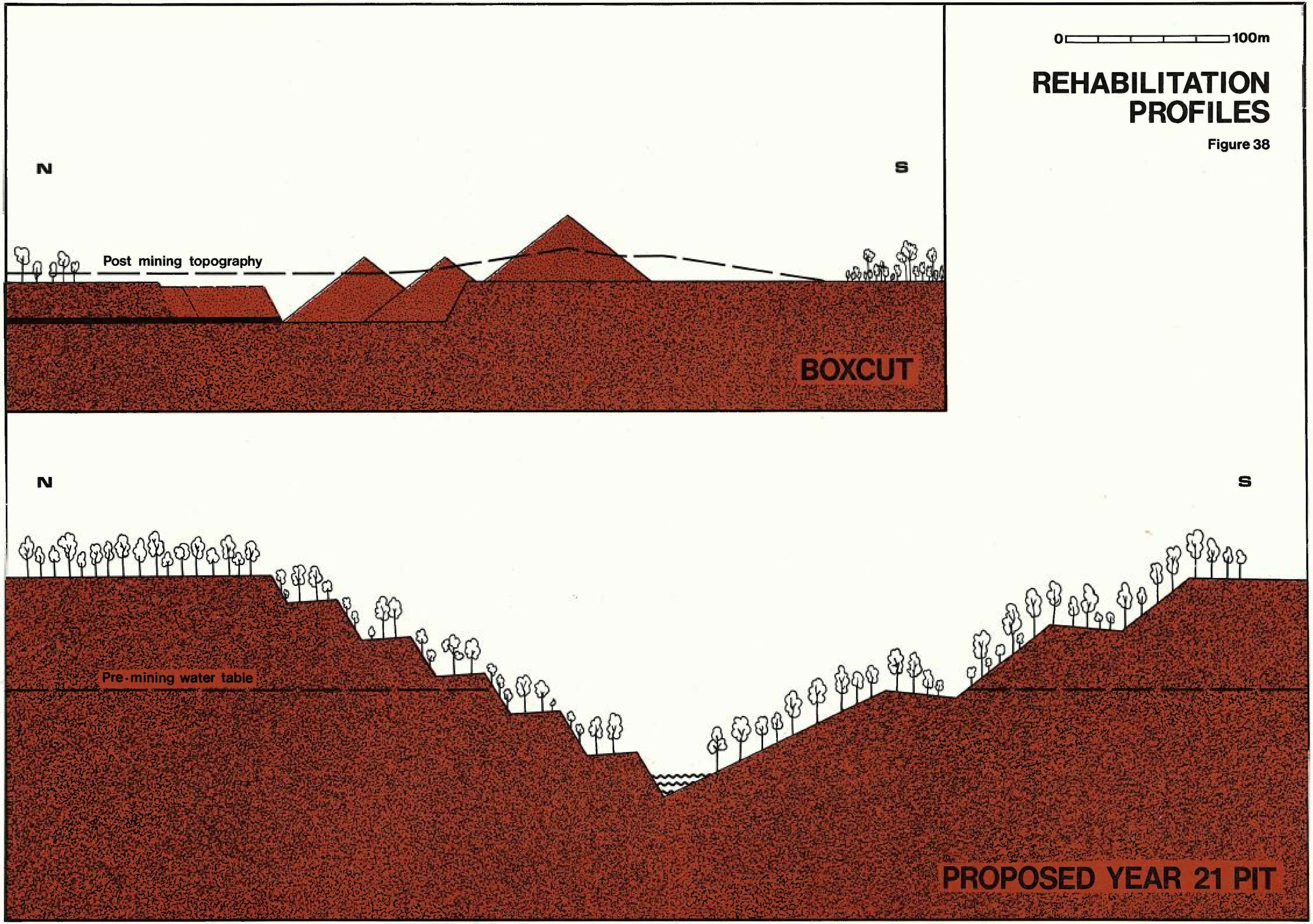
The final topography will be similar to the original, except in the vicinity of the boxcut (year 2) where a surplus of spoil will exist and in the final pit area where a deficit of spoil will occur. The only "out of pit" overburden placement is in the initial box cut and in limited areas where overburden is required to merge the rehabilitated surface with the existing topography.

The rehabilitated land surface in the box cut and final void areas are shown in Figure 38. The fracturing and replacement of the overburden will result in an increase in volume in the vicinity of 25%. The final landform will depend on the total depth of overburden removed and replaced, the resulting swell factor, the depth of coal removed, the amount of additional spoil placed, and the amount of grading required to ensure stable rehabilitation.

The final landform may vary from an average of 10 metres to 25 metres above the original surface (see Figures 35 and 37).

The main pit haul road will be relocated throughout the mine life to minimise coal haulage distances and will be progressively filled and regraded to maintain a slope of approximately 10%. If the alternative plant site is adopted, the haul roads will be filled and the area rehabilitated.

At the close of surface mining operations, current planning is to regrade the haul road to form a water-course to lead surface runoff from the mine catchment into the pit. Groundwater may gradually fill this void to a level just above the Braymont seam (Section 5.4). As water quality is expected to deteriorate as evaporation concentrates salts, it is currently planned to direct surface runoff into the pit to create a water resource and improve water quality. The edges of the pit will be battered and reafforested. Another possible option is to use the final void as a deposit for washery refuse from continuing underground mining operations.



REHABILITATION PROFILES

Figure 38

4.4 Coal Handling and Preparation Facilities

For the initial production tonnages, with selective clean mining practices, it is proposed to provide only coal crushing and sizing facilities.

As the tonnage increases it is expected that selective mining of the coal may become more difficult and as a result it is proposed to provide washing facilities to ensure a consistent low ash product. The coal preparation will maximise coal recovery, obtain better and more consistent coal product and cope with any unexpected changes in the nature of the coal seams.

4.4.1 Coal Handling for Initial Production

Figure 39 shows the mine facilities at the initial production. Run of mine (ROM) coal is received at the dump hopper, conveyed to a rotary breaker for crushing and sizing and then conveyed to the product coal stockpile (10,000 tonnes capacity) prior to being loaded in road haulage trucks for transfer to the train loader facility. An alternative location for the dump hopper and rotary breaker is at the train loadout station. Any coal rejects will be returned to the pit for disposal.

4.4.2 Coal Handling to meet Full Production

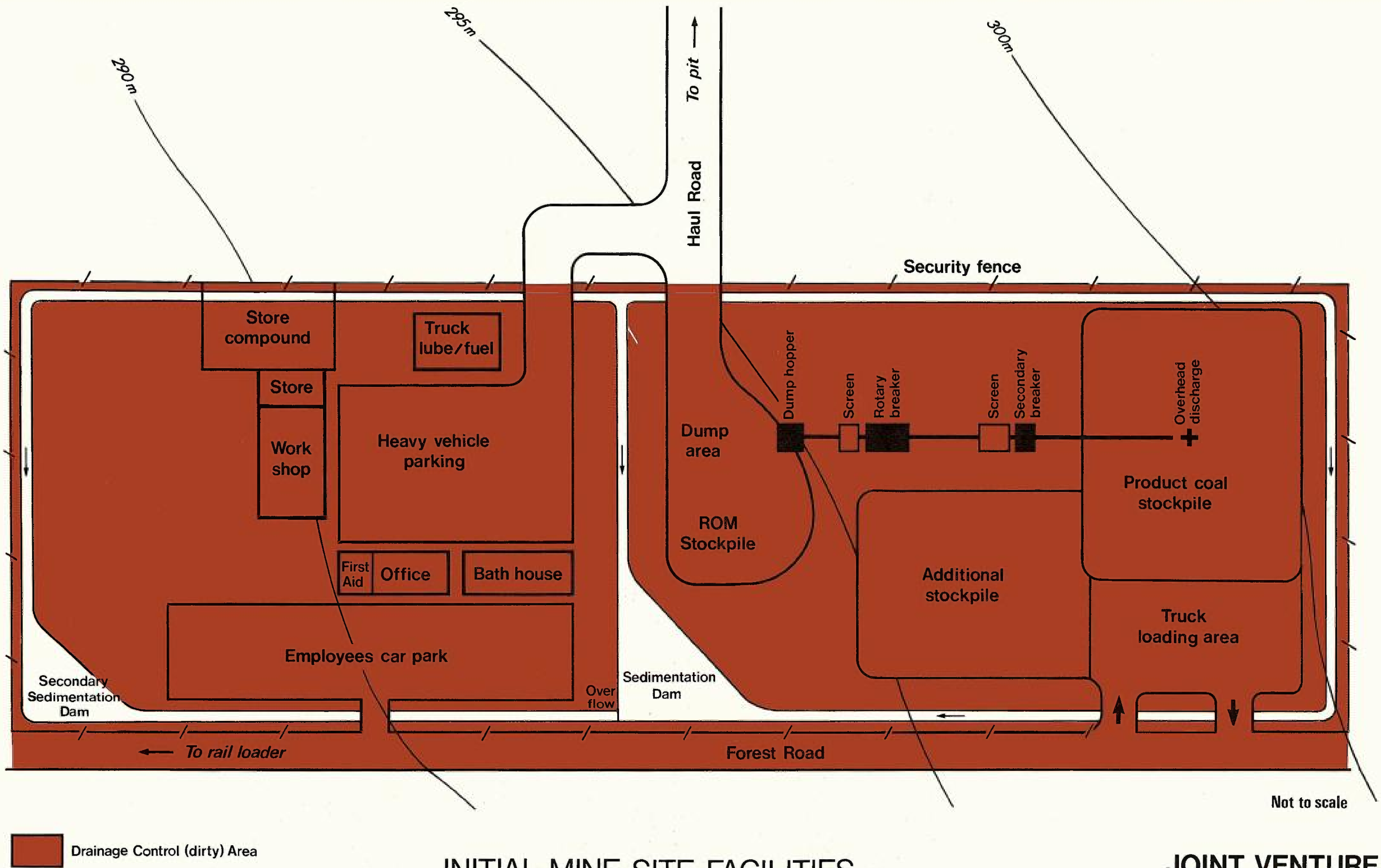
As markets dictate production increases provision has been made for the construction of two identical systems, comprising raw coal handling, coal bypass, coal preparation, and product coal handling facilities to ensure high reliability. Each system is planned to handle up to 2.5Mtpa and each system will be installed to suit market requirements, with the two systems operational at the full 5.0Mtpa capacity. Figure 40 shows the layout of the facilities, while Figure 41 illustrates the sequence and nature of the operations. Present planning is for the plant to be located south of the mine, however an alternative site to the west of the mine will be investigated (see Figure 33). The amount of coal bypassing the coal preparation plant will be dependent upon product coal quality parameters.

(i) Raw Coal Handling

ROM coal is received at the dump station, conveyed to a rotary breaker for crushing and sizing and then conveyed to the raw coal stockpile (45,000 tonne capacity) where it is stacked and blended prior to reclaiming. A facility for stockpiling ROM coal adjacent to the dump station will be provided to cater for plant shutdowns or disruptions in ROM flow.

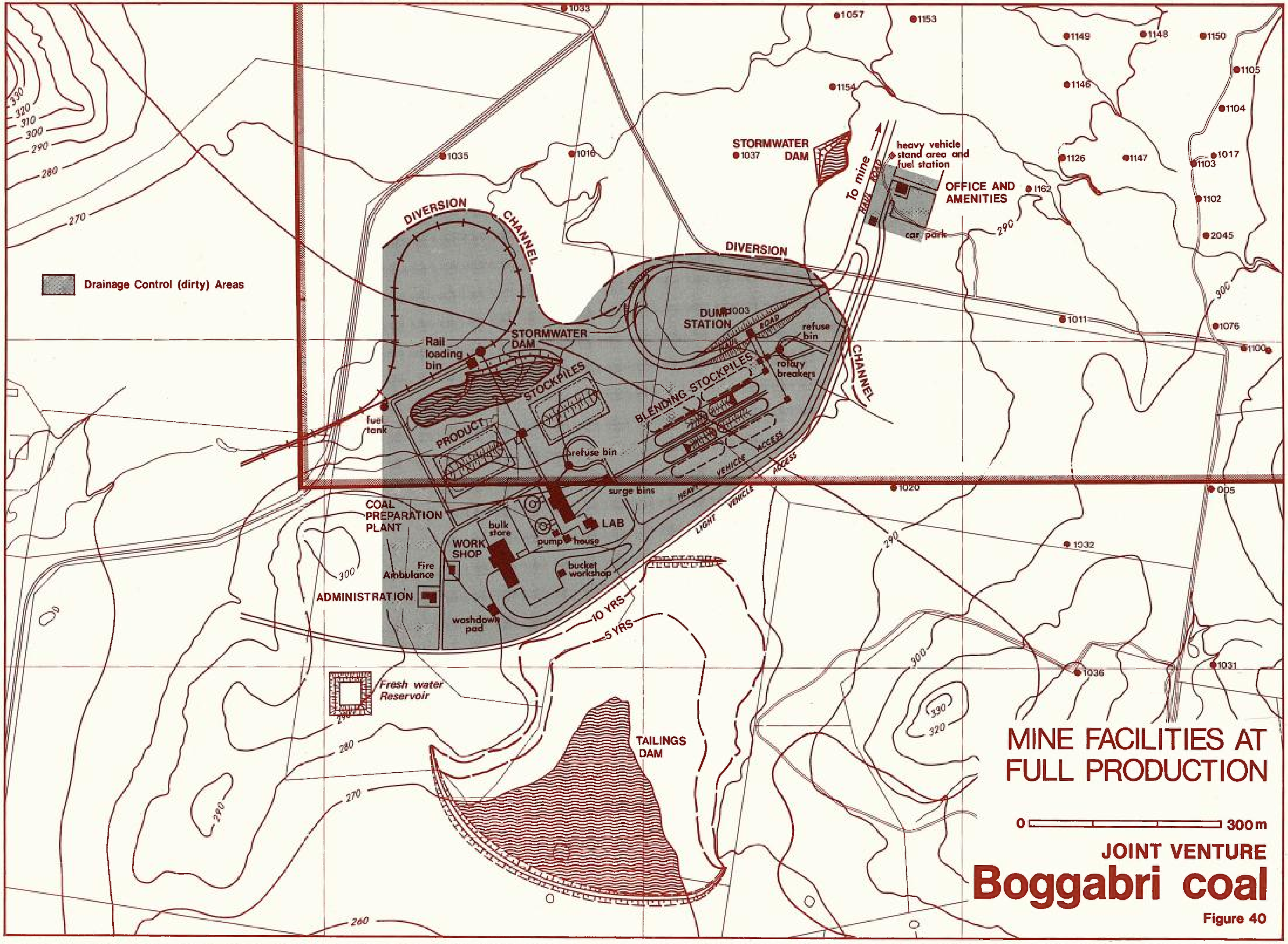
(ii) Coal Preparation

The coal preparation plant comprises facilities for the upgrading of the raw coal into a high grade clean product by separating refuse from crushed raw



INITIAL MINE SITE FACILITIES
Showing Drainage Control Areas

JOINT VENTURE
Boggabri coal
Figure 39



MINE FACILITIES AT FULL PRODUCTION

JOINT VENTURE

Boggabri coal

Figure 40

COAL HANDLING AND TREATMENT FACILITIES

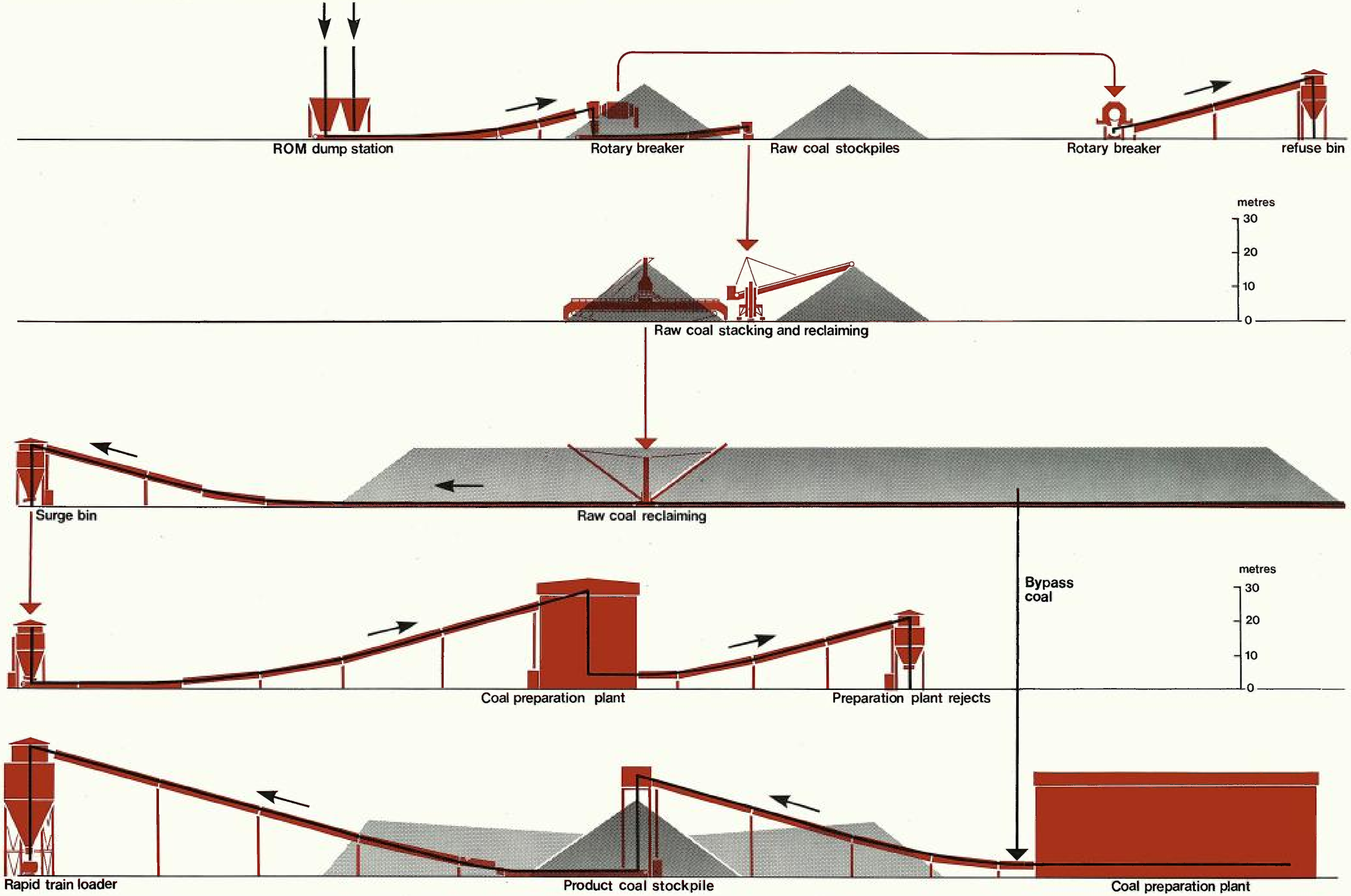


Figure 41

coal. There will ultimately be 4 modules of 400tph capacity each. The utilisation of the bypass system will reduce the coal preparation plant requirements.

Figure 42 shows the process flow chart. ROM coal from the surge bin (350 tonne capacity) will be conveyed to each module in the preparation plant. The coal will be divided by sizing on 12mm screens.

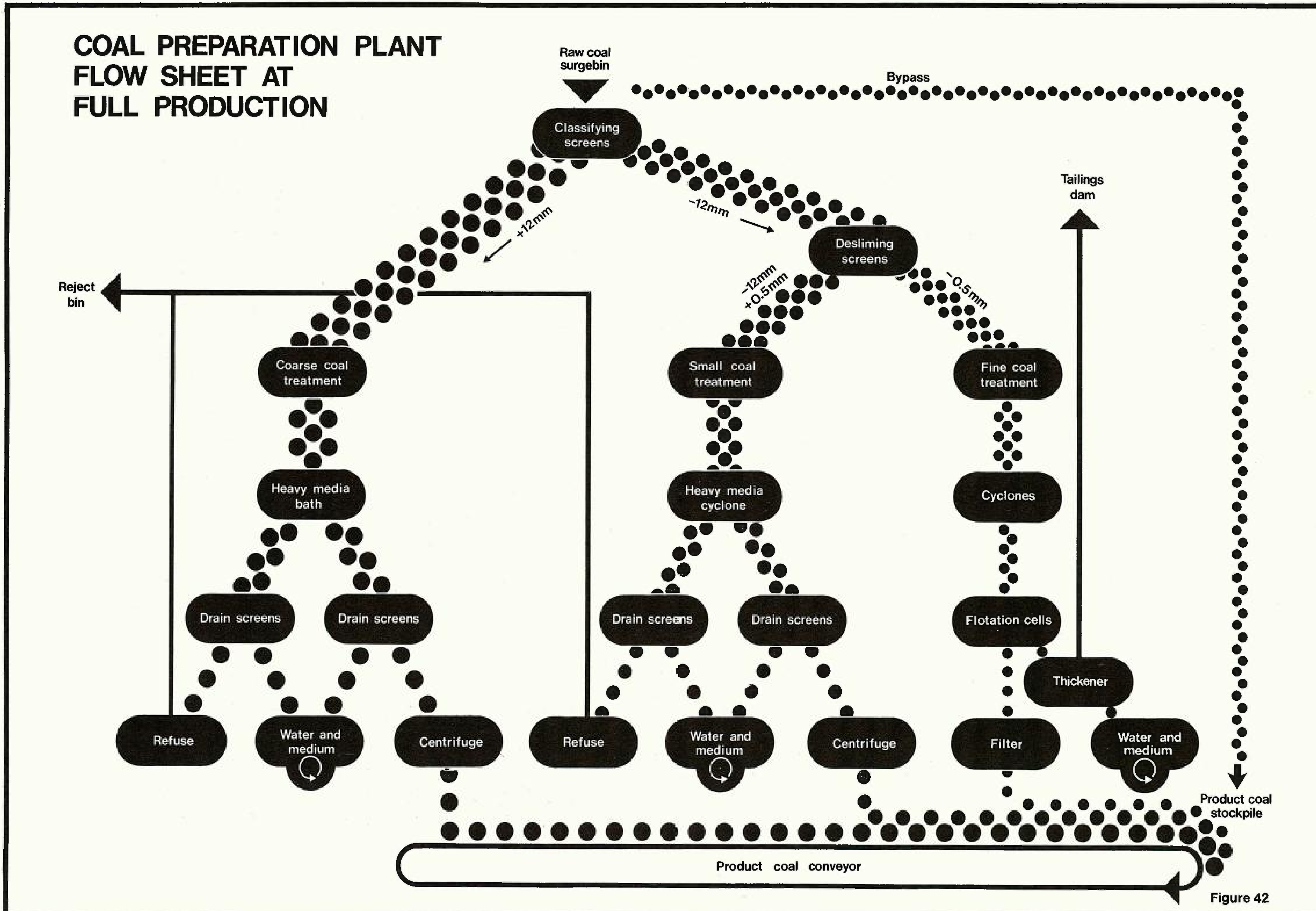
- Low ash ROM coal will bypass the preparation plant. The proportion of coal bypassed will be determined under actual operating conditions.
- The coarse coal fraction (plus 12mm) as oversize from the screens will be transferred to a dense media bath which will be controlled to produce clean product and refuse. Both product and refuse will pass via media recovery screens to product coal and refuse conveyors.
- The small coal fraction (minus 12mm, plus 0.5mm) will be deslimed at 0.5mm by vibrating screens and the fine coal fraction will pass to the fine coal circuit. The small coal feed will pass through heavy media cyclones to produce clean product and rejects. The small coal fraction will be screened and centrifuged to remove moisture, and then blended with the coarse coal on the product conveyor. The rejects will pass via media recovery screens to the rejects conveyor.
- The fine coal fraction (minus 0.5mm) will pass via desliming cyclones to flotation cells, to produce clean coal and tailings. The clean fine coal will gravitate to a drum filter station for dewatering, then pass to the product conveyor for blending.

(iii) Refuse Handling and Disposal

Initial production will only generate coarse breaker rejects and it is proposed this will be disposed of in the pit. Coal refuse, at higher production, will consist of both coarse reject from the breaker, the coarse and small coal circuits, and tailings. The coarse reject will be conveyed to a 300 tonne refuse bin for collection by trucks and disposal in the overburden.

The fine tailings will pass to a tailings thickener to allow sedimentation, thickening and water recovery, after which it will constitute 40% of inorganic material such as clay and some coal particles. Allowance has been made for the construction of a 3 million cubic metre capacity tailing dam located to the south of the plant. A mining purposes lease will be applied for over this area.

The tailing dam embankments will be of earthfill construction with a crest height of approximately ten metres. Material for the wall will be obtained from suitable material on site. Sufficient free board will be maintained to ensure overtopping does not occur and water will be for mine use as part of the water management system. The small quantity of leakage through the embankment is expected to be of good quality because of the coal characteristics, and require no treatment.



COAL PREPARATION PLANT FLOW SHEET AT FULL PRODUCTION
Raw coal surgebin
Bypass
Classifying screens
+12mm
−12mm
Desliming screens
−12mm +0.5mm
−0.5mm
Tailings dam
Reject bin
Coarse coal treatment
Small coal treatment
Fine coal treatment
Heavy media bath
Heavy media cyclone
Cyclones
Drain screens
Drain screens
Drain screens
Drain screens
Flotation cells
Thickener
Refuse
Water and medium
Centrifuge
Refuse
Water and medium
Centrifuge
Filter
Water and medium
Product coal stockpile
Product coal conveyor

Figure 42

The ultimate life of this tailings dam is dependent on the required market specifications which will dictate washing arrangements. In the worst case of full washing to achieve a unique quality product the dam would have a life approaching 10 years, and then be rehabilitated by final dewatering, covering with rock fill and topsoil, and revegetated. The use of alternate coal preparation technologies may negate the requirement for a tailings dam.

(iv) Product Coal Handling

The clean coal handling system comprises stockpiling, reclaiming, sampling, and loading into rail wagons. Except for the main product conveyor and rail loading bin, two parallel handling systems will be provided. Washed coal will be stacked to a stockpile of 60,000 tonne capacity. Tracked dozers will bench out product coal to a maximum stockpile capacity of 360,000 tonnes.

Coal from the stockpile will be reclaimed and conveyed to a single 1,500 tonne rail loading bin located at the mine site, or alternatively conveyed by overland conveyor to the site of the small mine loading facility. Maximum train loading capacity will be 5,000tph. Sampling facilities will be included for quality control.

4.5 Transportation and Shiploading

4.5.1 Road Access

Present access to the mine site is via a 16km unsealed gravel road and low-level bridge crossing over the Namoi River. A new access road will be built adjacent to the proposed rail spurline route. This road will extend from an intersection approximately 6km north of Boggabri, through to light vehicle stand areas at the mine. A low level bridge, with a 3.5 year flood frequency, will be built over the Namoi River for road access.

For the initial development the road will be used for the transport of coal (Figure 43). It is proposed that the road will be unsealed initially, but be sealed when production levels increase.

Once the rail spur to the mine site has been constructed, this will be used for emergency access to the mine by limited numbers of light road vehicles when the low-level road bridge is cut by floodwaters. Provision will be made for parking areas, access ramps and control signals. Due to State Rail Authority (SRA) restrictions, public access cannot be provided.

The existing Leard Forest road will eventually be replaced by upgrading the 21.5km of peripheral road along Goonbri Creek to bypass local traffic to Maules Creek (Figure 44).

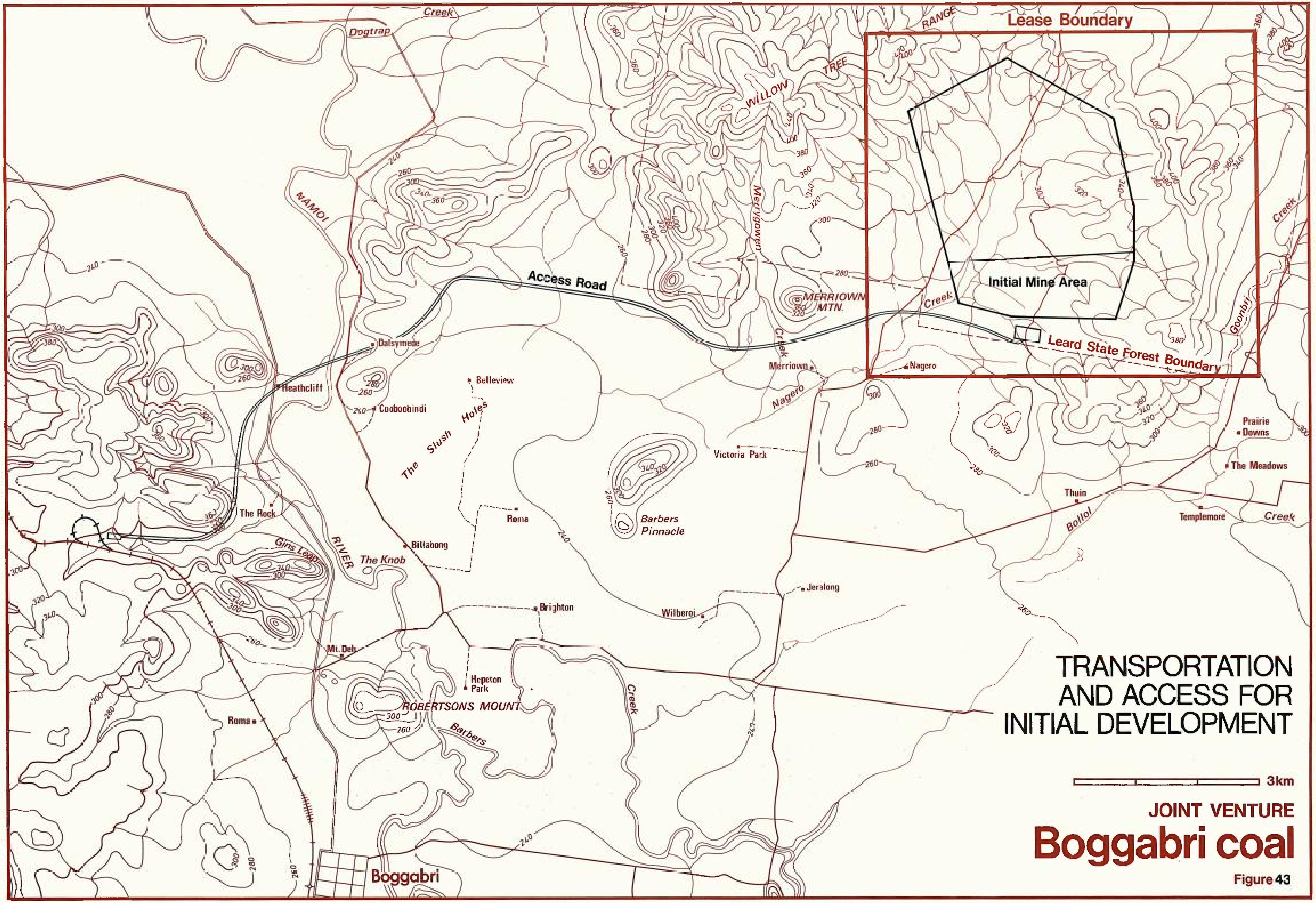
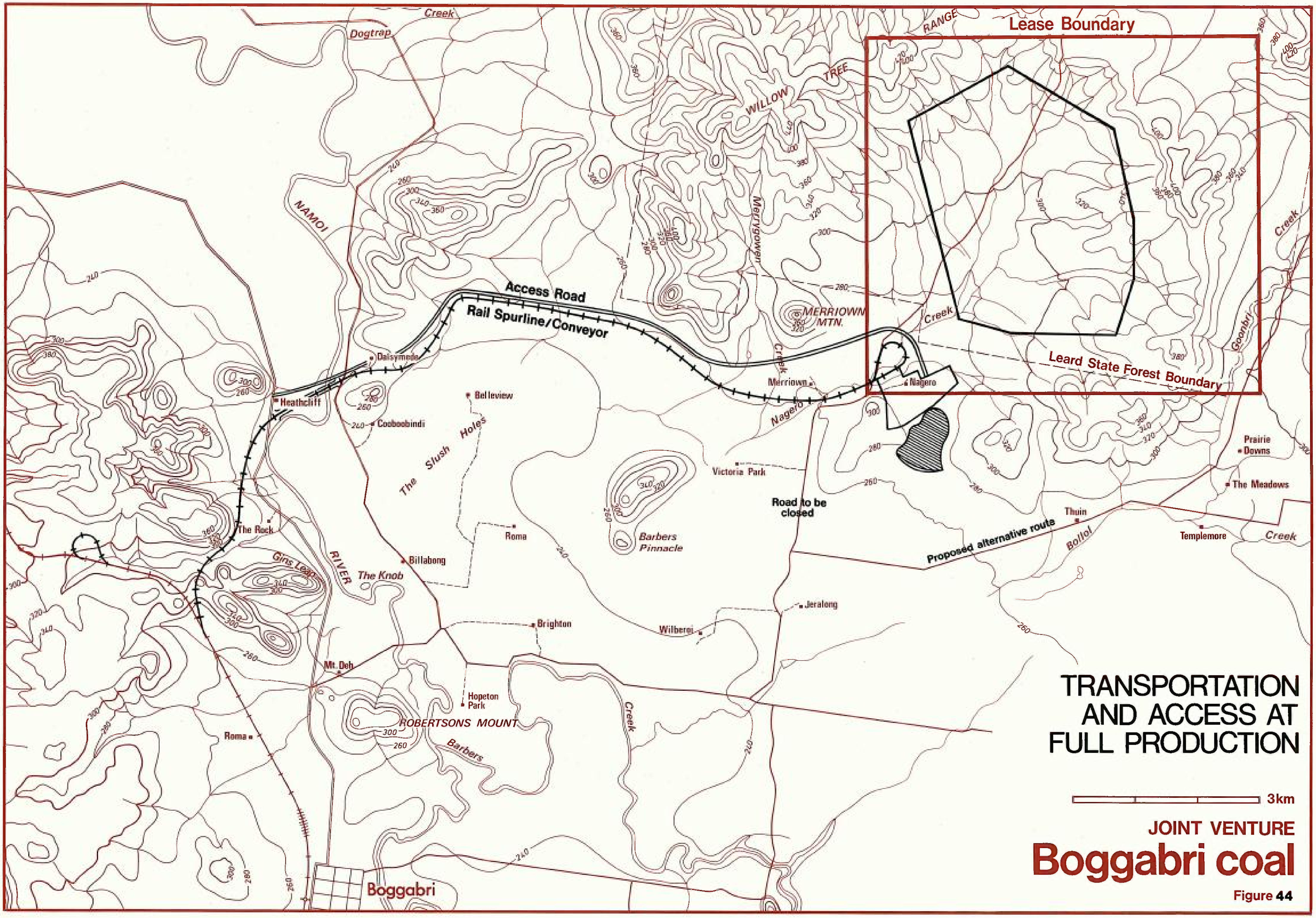

Lease Boundary
Initial Mine Area
Access Road
Leard State Forest Boundary
Creek
Dogtrap
RANGE
WILLOW
TREE
NAMOI
RIVER
Merrygowen
Creek
MERRIOWN MTN.
Creek
Goonbri
Creek
Nagero
Merriown
Nagero
Daisymede
Heathcliff
Belleview
Cooboobindi
The Slush Holes
Victoria Park
Prairie Downs
The Meadows
Thuin
Templemore
Bollol
Creek
The Rock
Gins Leap
The Knob
Billabong
Roma
Barbers Pinnacle
Jeralong
Brighton
Wilberoi
Mt. Deh
Hopeton Park
ROBERTSONS MOUNT
Barbers
Creek
Roma
Boggabri
TRANSPORTATION AND ACCESS FOR INITIAL DEVELOPMENT
3km
JOINT VENTURE
Boggabri coal

Figure 43



TRANSPORTATION AND ACCESS AT FULL PRODUCTION

JOINT VENTURE
Boggabri coal

Figure 44

4.5.2 Coal Transport

(i) Initial Development

For the initial mine production, coal will be road hauled from the mine site to a balloon loop on the main rail line (Figure 43). Trucks (commercial road trailers) will travel along the newly constructed mine access road across the new low level bridge on the Namoi River and cross the highway to the truck discharge area at the train loadout. Operations will initially be restricted to daylight hours, however, as production rates increase additional shifts may be required.

All road crossings will be designed to meet design requirements of the DMR and local authorities. Preliminary design has taken into account the possible development of other coal mines in the area and the sharing of the transport corridor and coal loading facility (see also Section 5.12).

The train loadout area will consist of a truck dumping area to allow for the coal to be stockpiled prior to reclaiming and train loading (Figure 45). Because other mines are likely to share the facilities, the train loading bin will be designed to meet the SRA requirements for a Category A loading facility and a balloon loop will be constructed to allow for three trains consisting of 42 CHS wagons to be accommodated on the loop. However, should this mine be a sole user, other coal loading facilities may be considered.

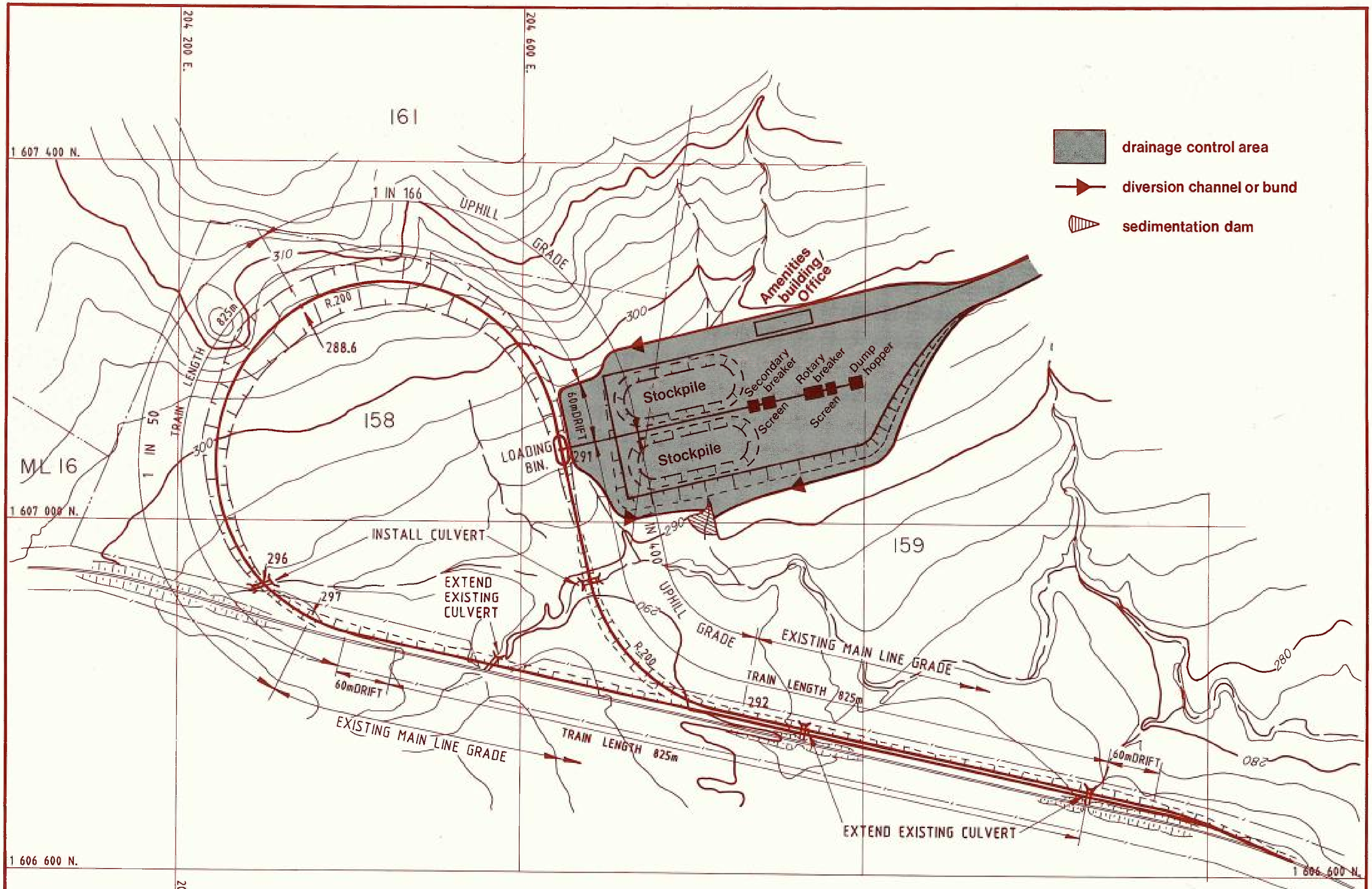
It is the Joint Venturer's intention that the loop will be extended, consistent with commercial viability, when the SRA operates trains consisting of 84 CHS wagons between Boggabri and Newcastle. Transportation of the coal from the train loadout bin will be by rail to the Port of Newcastle.

(ii) Full Production

For full production, it is planned to transport coal from the mine site to the Port of Newcastle by rail. This requires the construction of a 17km spurline north of Boggabri to the mine, including a balloon loop for rapid loading of unit trains (Figure 44). The spurline has been designed to SRA standards. The crossing over the Namoi River will be by high level bridge designed to be above the estimated one in one hundred year flood level. An impression of the bridge is shown in Figure 46.

Alternatively it may be feasible to construct an overland conveyor to transport the coal from the mine to the balloon loop already constructed to service the initial development.

Transportation studies and discussions with the SRA have confirmed that the existing railway system is rated to have a total capacity for coal of 4.2Mtpa.



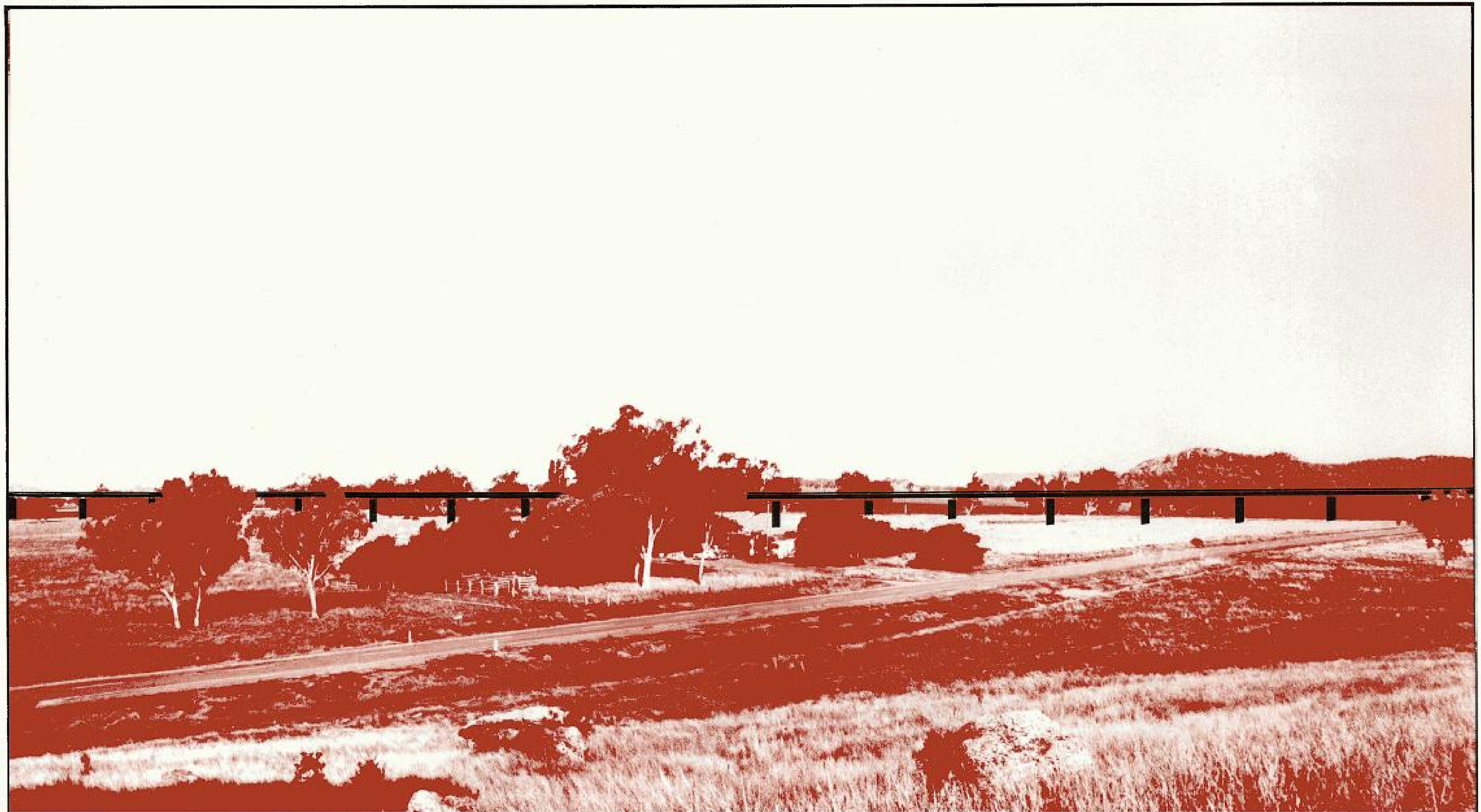
INITIAL TRAIN LOADING FACILITIES

Showing alternative coal crushing facilities

JOINT VENTURE

Boggabri coal

Figure 45



RAIL BRIDGE AT NARRABRI ROAD

JOINT VENTURE
Boggabri coal
Figure 46

Current coal production from existing mines at Gunnedah and Curlewis is in the vicinity of 1.2Mtpa, therefore available rail excess capacity is 3.0Mtpa. Total capacity may be increased to 6.2Mtpa (an excess of 5.0Mtpa) by track upgrading, extension of the Centralised Traffic Control System (which has commenced) and further lengthening of passing loops. This will permit an increase in train size to 30 CHS wagons (2,310 tonnes net) from the current 21 CHS wagons (1,617 tonnes net). The SRA intends to use unit trains, 42 CHS wagons (3,234 tonnes net) or even larger 84 CHS wagons to allow for the more efficient haulage of coal and greater haulage capacity potential.

The introduction of larger capacity trains would also reduce the number of coal train movements. A further study has been commissioned by the SRA to recommend methods to increase the capacity of the line above 6.2Mtpa.

Table 12 shows that the number of train movements per day will be highly dependent on the train sizes adopted by the SRA. This in turn will be dependent on the amount of coal hauled from the region to the port.

At a production level of 5.0Mtpa, and assuming 42 CHS wagons per train, the average train movements through Boggabri would be a total of 10 per day, i.e. 5 loaded and 5 empty. However, the number of train movements is proportional to train size, and this factor is entirely dependent on SRA operating philosophies.

TABLE 12 : TRAIN MOVEMENTS/DAY

Production (Mtpa)	Loaded Train Movements/day* 21CHS Wagons	30CHS Wagons	42CHS Wagons	84CHS Wagons
0.5	1.0	0.7	0.5	0.25
5.0	10.4	7.2	5.2	2.6

* 300 days per year
Total train movements are twice

4.5.3 Shiploading

Boggabri coal will be exported through the Port of Newcastle using the new Kooragang Island Coal Loader.

4.6 Dust and Noise Controls

4.6.1 Dust

The mine and plant sites are located in an isolated area and the Joint Venture has purchased all the land that is likely to be effected. The nearest private residence is 3.5km from the mine site and plant areas.

Predictions of dust and noise impacts (Section 5) indicate that with normal operating practices both noise and dust emissions will not exceed established criteria. The final mine design, equipment selection, coal treatment and coal transportation will incorporate the required controls in detail. However, at this stage of project planning only broad principles can be presented.

(i) Mining Operations

Clearing and Topsoil Stripping. Clearing will be limited to a distance ahead of mining consistent with operational requirements and safety. Where possible, topsoil stripping will be limited to periods when soil moisture is such that dust will not be generated. Haulage routes may be watered in dry periods if this is not feasible.

Blasthole Drilling. Overburden and coal drills may be fitted with dust collection equipment if dust emissions are likely to be significant.

Blasting. Dust minimisation will be one criterion in blasting design and execution. However, efficient blasting will also minimise premature venting and dust emissions.

Dragline Operations. Dump height of the spoil will be minimised to reduce dust from this source, while maintaining efficiency.

Overburden and Coal Haulage. All haul roads and regularly trafficked unsealed areas will be watered in dry periods.

Overburden Dumps. These areas will be susceptible to wind erosion. To minimise dust generation the surface areas will be kept to a minimum and topsoil replaced as soon as practical. Active dumping areas will also be watered along with the haul roads.

(ii) Coal Preparation and Handling

The initial development will have no coal treatment other than crushing, and passage through a rotary breaker. Because of the location and low production rates no particular dust controls are considered necessary unless operational requirements necessitates some controls.

At full production the preparation plant is planned to have dust controls similar to existing Hunter Valley operations. These include:

- Screening and wash down facilities at the dump hopper, with water sprays at the charge and discharge of the dump hopper.
- Enclosing of conveyors and transfer points, with scraper on conveyor belts.
- Sumps to collect spillages and aid clean ups.
- Water sprays at rotary breaker, coal stacker and in stockpiles.

(iii) Coal Transport

Initially coal will be transported from the mine site to the rail loading facility adjoining the new railway line by road transport. The road will be regularly watered and eventually sealed. Coal trucks will be covered.

At full production the coal will be either loaded into the trains at the minesite, or transported by covered conveyor to the rail loading facility.

4.6.2 Noise

(i) Mining Operations

All items of mobile equipment will be silenced to comply with specifications nominated by the Joint Venture to meet acceptable noise levels. Mobile equipment numbers will be limited as electrically powered draglines will be used to move a large proportion of the total material to be handled.

(ii) Coal Preparation and Handling

The coal preparation plant has been designed to restrict noise levels to 85db(A) within the plant itself. The plant is to be enclosed in a steel clad building which will further reduce noise levels outside. No other noise controls are proposed as the impact assessment (Section 5.5) demonstrates the noise levels to be satisfactory.

(iii) Coal Transport

For the road haulage in the initial development the trucks will be fully silenced to meet the noise criteria (Section 5.5). At full production with the rail spurline no controls are feasible or necessary. If the coal is to be transported by conveyor, additional studies will be carried out to determine if controls are required.

4.7 Water Management

The efficiency of water use, control of water pollution and erosion, and the protection of ongoing mining operations as well as the water rights of downstream users has been a major consideration. BHP Engineering conducted a comprehensive Water Management Study for the mine at full production to fulfill these objectives. The study included such aspects of water management as rainfall runoff handling and control from so-called clean and dirty areas, groundwater quality and inflow to the mine, water sources, tailings disposal and the overall water balance of the development. Their report, "Water Management Study for Boggabri Coal Mine" is a reference document.

The general design philosophy of the Water Management Plan is as follows:-

- Surface Water running onto the site will be retained on-site for use in operations or leave the site undiminished in quality;
- Runoff resulting from rainfall on dirty areas will be collected and used in the washery process or for dust suppression; and
- Groundwater and other inflows into the mine pit will be collected and stored for use in dust suppression.
- A contaminated water system will be provided which can be supplemented from on-site uncontaminated water storage and external water supply sources.
- Uncontaminated water storage on-site will be optimised to reduce water demands external to the system.

The Plan provides for runoff water from dirty areas to be separated from that from clean areas, enabling collection and treatment or storage. The plant area, containing raw coal handling and treatment, coal stockpiles and workshop, has been located to minimise haulage distances from the central ramp. This location also ensures the plant is not in danger of flooding, renders collection of runoff a simple matter and minimises the need for diversion channels upslope. Two creek channels located north of the plant will be diverted around the plant area and rail loop. A similar system will be provided if an alternative plant site is adopted.

4.7.1 Clean Areas

These are areas where no significant contamination of runoff water will be caused by mining operations. They include catchments along the rail spurline and areas outside the active mine and coal treatment plant. Wherever feasible, runoff from clean areas will be diverted around dirty areas to minimise the risk of water pollution. Twenty-four principal catchments were identified along the spurline and in the vicinity of the mining development. Catchments adjacent to the active mine area have been treated separately, although they form part of a major catchment. Catchment sizes vary from 0.06 square kilometres to 32.73 square kilometres, with more than 75% having an area less than one square kilometre.

Provision has been made to install a system of diversion channels upstream from the mine pit to intercept and divert runoff around the pit perimeter. To satisfy the objective of flood risk, such channels are designed to carry runoff from storms of Probable Maximum Precipitation intensity. The diversion channel concept is shown in Figure 35 for the initial development of the mine (approximately year 10) , and Figure 37 for Year 20. The channels are designed to carry runoff from contributing catchments and therefore size varies along the channel, decreasing upstream as catchment size decreases. A series of small dams will be constructed to provide local water supply for dust suppression and settling of suspended sediment. These will be located to suit operational conditions and designed to contain the runoff from single high intensity storms. Other channels have been designed for plant areas. A major storage dam will be constructed just north of the plant site. This will collect virtually all the runoff from the mine catchment, plus any overflows from dams constructed to contain contaminated water, as discussed in Section 4.7.2. A provisional dam of 400ML capacity has been provided.

Design criteria for culverts for access and haul roads are for a one in twenty year flood and for railroad structures, a one in fifty year flood. A high Runoff Potential Coefficient (ratio of runoff to rainfall) was adopted for design purposes. Storages have been designed with an annual runoff coefficient of 0.15.

4.7.2 Dirty Areas

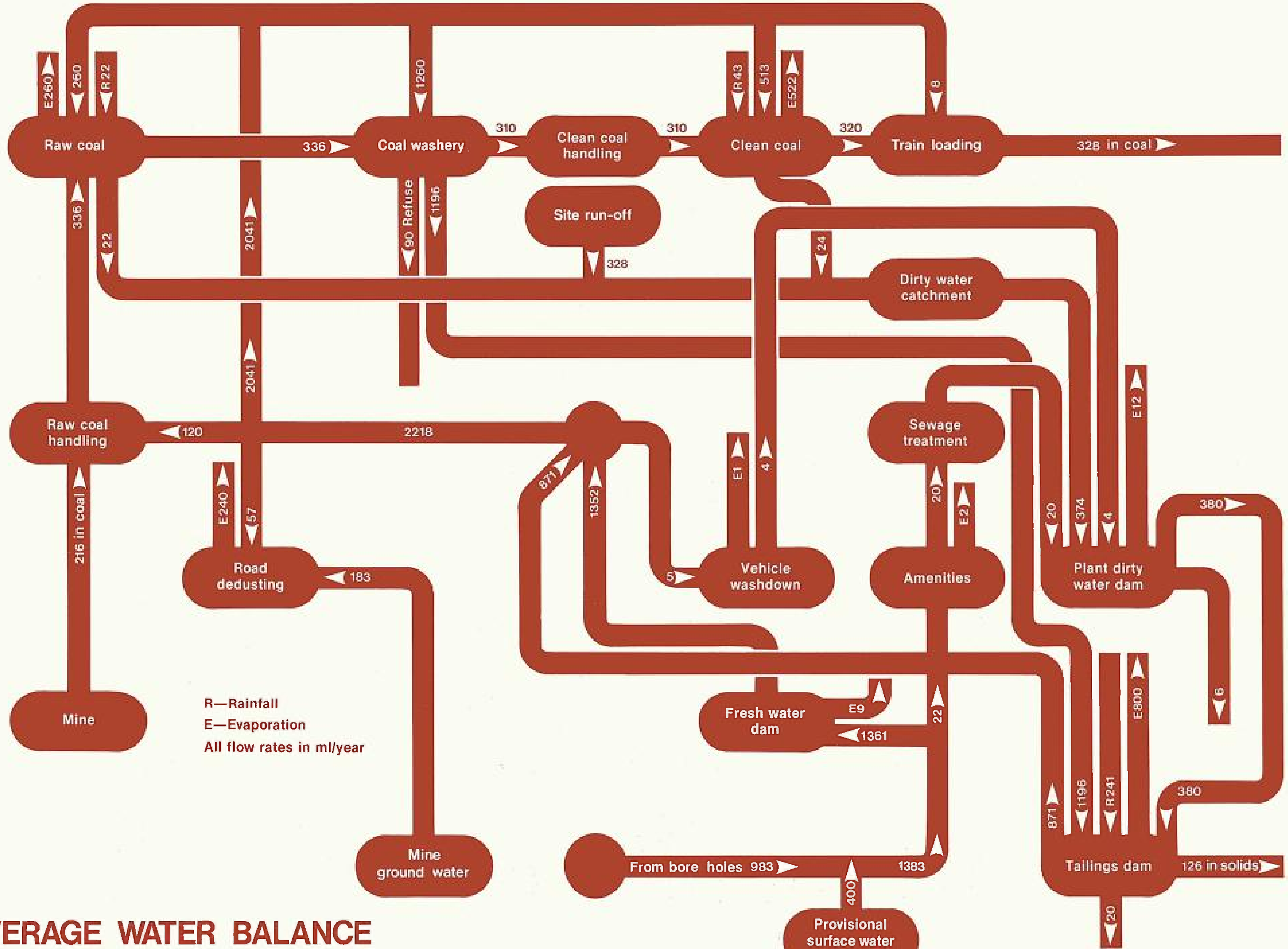
Dirty areas are defined as areas where development activities will contaminate surface runoff. These include the coal preparation plant, coal handling and storage areas, tailings disposal area, overburden emplacement areas, the actual mine pit and haulage roads.

Provision has been made to collect all the runoff from the mine facilities area, preparation plant, hard stand area and coal loading facilities (Figures 39, 40 and 45), which are regarded as the main dirty areas for design purposes. At full production two catchment dams, designed to contain all runoff from a storm of 85mm of rainfall, have been provided. Depending on quantity and quality, water can be used directly from these dams or pumped to the tailings dam for storage and eventual re-use. No discharges will be made from this system except from heavy rainfall events, when the runoff water is expected to be clean. Fuels, oils and greases will be retained in oil and grit arrestors for disposal.

Groundwater flow into the mine pit will be collected, together with any other inflows and pumped to settling dams for eventual use in haul road dust suppression. Similarly, runoff from previously mined areas will be impounded. Water quality studies have indicated that this water will be of good quality but that it is likely to be high in suspended solids until vegetation cover is re-established.

4.7.3 Water Balance and Use

Water balances have been estimated for average years at initial production and calculated for dry, average and wet years at full production. Figure 47 represents an average year at full production and Table 13 summarises other conditions.



AVERAGE WATER BALANCE AT FULL PRODUCTION

Figure 47

The water balance studies have shown that the mining development will be a net water consumer except during periods of heavy rainfall or prolonged wet weather. Maximum use will be made of on-site water before external sources are used. In the initial years monitoring will be maintained to validate these estimates.

TABLE 13 : MINE WATER BALANCE

DESCRIPTION	INITIAL	WATER VOLUME Ml /Year FULL PRODUCTION		
		DRY	AV.	WET
WATER CONSUMPTION				
Coal handling and stockpiles	10	1247	782	320
Roads	100	260	240	200
Other	5	3	3	3
TOTAL DUST CONTROL	115	1510	1025	523
Coal Preparation	-	90	90	90
Other	50	480	480	480
TOTAL CONSUMPTION	165	2080	1595	1093
WATER SOURCES				
On-mine				
groundwater	100	183	183	183
dirty water	5	251	393	614
Collected rainfall and runoff	100	548	641	783
In raw coal	20	216	216	216
TOTAL ON-MINE SOURCE	225	1198	1433	1796
Evaporation	200	976	821	719
TOTAL ON-MINE AVAILABLE	25	222	612	1077
OFF-MINE SUPPLY REQUIRED	140	1858	983	16

4.8 Infrastructure

4.8.1 Water Supply

An external water supply will be required for the mine development to supplement on-site water sources. Water balance studies have indicated that external requirements will be up to approximately 2,000 Ml/yr at full production. Licences will be sought from the Water Resources Commission for this amount. Australian Groundwater Consultants conducted a groundwater investigation programme on the Heathcliff property owned by the Joint Venture (Figure 15). One test production bore has been constructed and has a sustained yield of 1.8Ml/day. Two additional production wells designed to yield 2.2Ml/day are anticipated to supply the full water requirements. Their location is shown in Figure 15. An analysis of river flow and reservoir storage indicates that maximum pumping supply requirements of 7.6Ml/day could be sustained indefinitely. The water quality is of domestic standard but hard. The water will be pumped from the wellfield via a 0.5Ml collecting tank and pipeline to a 60Ml reservoir near the mine site. Potable water will also be from this source.

4.8.2 Power Supply

Power requirements for an initial mine development may be met from the existing grid. For full production bulk power will be provided to the mine site by the Namoi County Council via an overhead transmission line from the Council's 132/66KV substation at Gunnedah. The route is being investigated by the County Council to service the likely coal development at Vickery, Boggabri and Maules Creek. A 66KV substation located near the coal preparation plant will distribute power to the plant, other facilities and mine equipment.

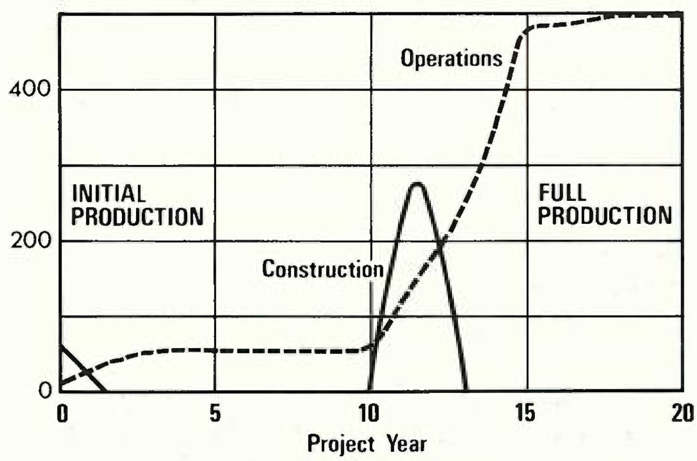
4.8.3 Sewerage Treatment

A package type sewage treatment plant will be provided at the facilities.

4.9 Workforce, Housing and Associated Infrastructure

4.9.1 Workforce Requirements

A workforce will be required to both construct and operate the mine. The likely build up in this workforce is shown in Figure 48.



PROJECT WORKFORCE

Figure 48

These numbers are based on the development schedule discussed in Section 4.1 and do not include any underground mine. There are two phases of construction proposed due to the nature of the mine development.

The Project will commence with the construction of the limited facilities to cater for the initial production. This will include the rail loop, loading facility, access road, and initial production mine facilities area. An initial construction workforce of 50 will be required. The production workforce will also number approximately 50. This workforce will consist of personnel to manage and operate all aspects of the mine. An approximate breakdown by classification is shown in Table 14.

TABLE 14 : MINE WORKFORCE BY CLASSIFICATIONS

	Initial Production	Full Production
Professional	8%	6%
Clerical	16%	8%
Tradesmen	20%	27%
Skilled Operators	20%	27%
Other Operators	21%	16%
Labourers	10%	13%
Apprentices	5%	3%

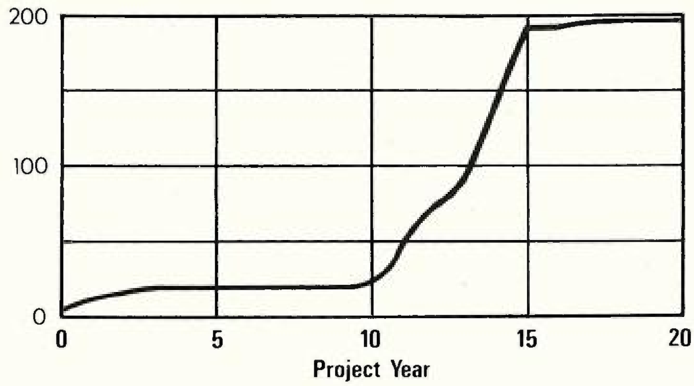
For full production, the mine construction phase will require a workforce of approximately 300. This workforce will construct the rail spurline, bridge, coal preparation plant, mine facilities and major mining equipment. The production workforce is expected to increase to approximately 495 in year 16.

Based on discussions with the Commonwealth Employment Service, it has been estimated that up to 60% of the full production mine workforce may be recruited locally. The proportion of the initial production workforce could be higher. Most of the unskilled positions may be filled by the local unemployed. With the implementation of training programmes a substantial proportion of the semi-skilled workers (plant operators etc) may also be recruited locally. The majority of the professional and skilled workforce may need to be recruited elsewhere.

4.9.2 Housing and Infrastructure

The initial construction and operation workforce will be accommodated in the region, using existing temporary and permanent accommodation. Should additional housing need to be constructed, there is more than adequate serviced land available in Boggabri. (See Section 5.10 for a detailed evaluation of the impact on housing and services.)

As the production increases, it is presently planned to accommodate the construction workforce in a construction camp near the mine site. The production workforce will be accommodated in the region, with Boggabri expected to be the major centre. The existing housing supplies at that time (around the year 2000) are likely to be inadequate and additional housing will be required. Taking into account the expected local employment factor (approximately 60%) the likely housing requirements are shown in Figure 49. A small component is also allowed for the construction workforce. Section 5.10.2 discusses the workforce housing.



PROJECT HOUSING

Figure 49

4.10 Land Ownership and Management

The pattern of land ownership and use has been discussed in Section 4.3. The Joint Venture owns properties totalling approximately 3,050 hectares. The actual mine area is dedicated as State Forest under the control of the Forestry Commission of NSW. This area will be rehabilitated to natural forest (Section 4.3) and ultimately return to the jurisdiction of the Commission.

The Joint Venture recognises the potential for bush/grass fires and will adopt strict measures to minimise such occurrences. Under the Coal Mines Regulation Act, the mine is required to have fire fighting facilities.

Farming land currently owned by the Joint Venture is being leased to former or nearby property owners. In the future, the Joint Venture may retain ownership of only the land it requires for mine access and operations and any necessary environmental buffer zones and sell the remainder.

4.11 Underground Mining Plan

It is the philosophy of the Joint Venture to maximise the recovery of the coal resource, and underground mining, in addition to surface mining, will be required to fulfil this goal. The mining of the resource by surface methods is required to provide the basis for long term economic viability. Underground mining with its inherent higher costs can only be considered as a subsequent development of successful surface mining operations and only when economically viable consistent with market requirements. The surface mine plan, devised to maximise coal recovery, will not be an impediment to underground mining or the recovery of the underground reserves, and may improve the accessibility of some underground seams.

Underground mining may be carried out in up to nine seams and therefore the development and subsequent mining strategies will require detailed planning to ensure minimum loss of coal due to sterilisation. Coal potentially recoverable by underground mining has been assumed to have a minimum seam thickness of 1.5m with no stone band greater than 0.3m and the section containing at least 50% coal. Table 15 shows the estimated saleable reserves.

TABLE 15 : UNDERGROUND RESERVES (SALEABLE)

	Seam	Reserves Tonnes x 10^6
1	Braymont	13
2	Jeralong	20
3	Merriown	15
4	Nagero	20
5	Upper Northam	11
6	Upper Therribri	10
7	Lower Therribri	15
8	Tarrawonga	21
9	Templemore	15
	TOTAL	140

Studies for underground mining have investigated various levels of production ranging from 0.5Mtpa to 2.5Mtpa. Mining investigations have been carried out on all seams fulfilling the above parameters, with particular emphasis on the Braymont, Jeralong and Merriown seams. These seams and the intermediate seams are essentially energy coals, whilst the two lowest seams also exhibit some coking coal characteristics. The underground mine plan ultimately implemented will be dependent on the economic viability and market acceptability of the various seams.

4.11.1 Proposed Mining Sequence

The proposed extraction sequence is to mine from upper to lower seams, however, market and economic parameters may dictate a different sequence (Figure 50). Access to, and ventilation of, the Braymont, Jeralong and Merriown seams would be by direct access from final highwall positions or by inclined drift or shafts. Achieving viable operations in these upper seams would precede any development of the lower seams. The subsequent underground mining phase will necessitate development of access shafts and inclines to the lower seams as well as ventilation shafts.

Underground mining has not been carried out in the immediate Boggabri area. This area is characterised by high energy depositional sediments such as conglomerates and sandstones as opposed to the finer sediments that exist in the Gunnedah region. Any successful underground mine will be dependent on the absence of geotechnical problems associated with incompetent roof and floor materials, faulting, intrusions, seam erosion and splitting, compaction around lensoid bodies and the presence of gas. Exploration has not detected intrusions or gas. However, some faulting, seam splitting and seam erosion have been indicated while some of the interseam sediments are considered to be lensoid.

Initial development may be by continuous miners and shuttle cars, using bord and pillar methods with belt transport of coal to the surface. Investigations to assess the possible introduction of more productive longwall mining systems to maximise the recovery of coal and improve the viability of underground mining, will continue.

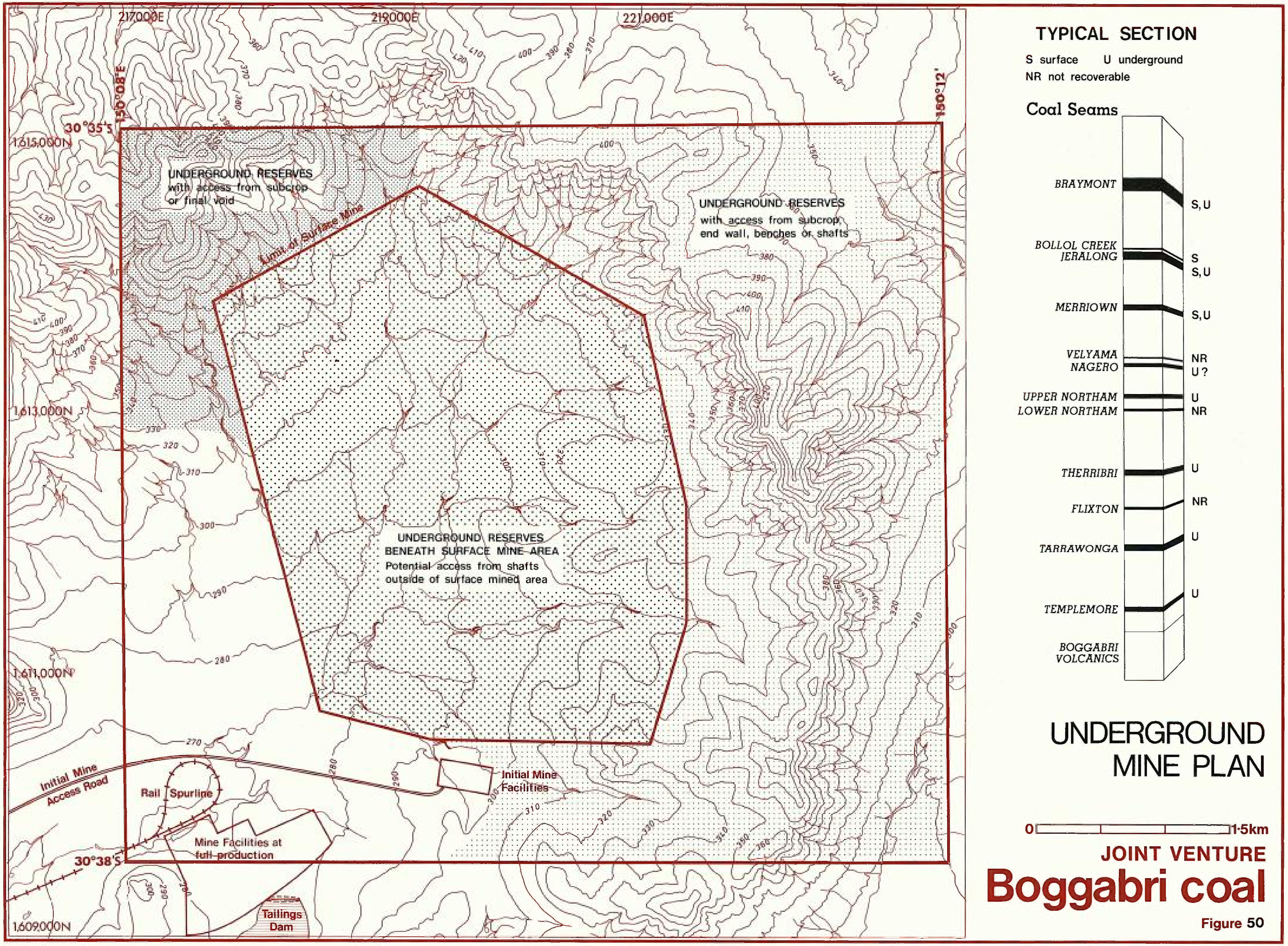
Raw coal from the underground mine will be transported to the surface mine coal handling facility. It is not contemplated that the underground production from the Jeralong and Merriown seams will be washed, however coal from other seams may require washing. The existing surface facilities, in particular, the coal preparation and handling facilities may require enlargement and/or modification. Such changes will be dictated by underground production levels and market requirements.

4.11.2 Entry Locations

The surface mine may provide greater accessibility to the Braymont, Jeralong and Merriown seams through final highwall access sites. Multiple underground access sites may be left at intervals on the end walls of the pit in the advancing surface mine for later underground developments. On completion of the surface mine the final void may also be utilised for underground access.

However, a strong case exists for the underground entries to be independent of the surface mine to ensure:

- the underground development programme is not dependent on the surface production schedule;



UNDERGROUND MINE PLAN

JOINT VENTURE

Boggabri coal

Figure 50

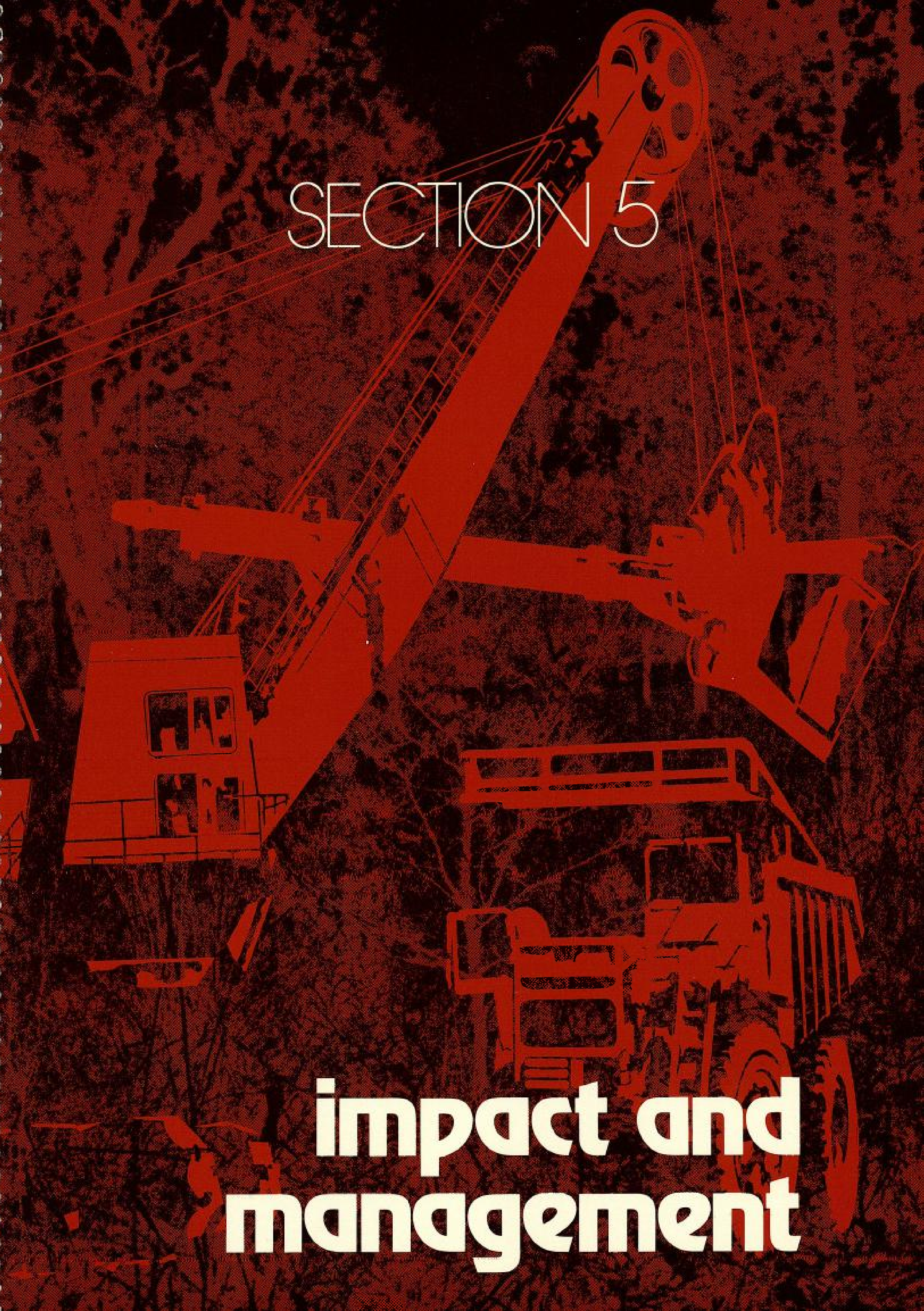
- the underground mine can be located away from any deleterious effects of overburden blasts;
- minimisation of potential drainage problems.

4.11.3 Underground Manning Requirements

Due to the indeterminate production schedule of the underground mining proposal, specific manpower figures cannot be determined.

SECTION 5

impact and management



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5.0 IMPACTS AND MANAGEMENT

5.1 Introduction

This section examines the various potential impacts, safeguards and mitigating procedures for the proposed coal development. The impacts and safeguards range from the immediate physical environment through to national economic and social benefits. Environment impacts representing the "worst case" situation have been used throughout. The "worst case" has been taken as the dragline-truck and shovel operation operating at 5.0Mtpa. However, advances in mining technology such as continuous mining equipment in overburden handling (refer Section 4.2.1) are likely to reduce environmental impacts. Where relevant, distinction has been made between the initial production impacts and those at full production (for example on socio-economic conditions).

The potential impacts of coal mining, treatment and transportation were identified early in planning for the Project and methods have been developed to eliminate or mitigate any adverse effects. The environmental management procedures that are proposed are described in this Section. Section 5.13 reviews and summarises the likely impacts of the project.

The mine site is distant from any significant population centres and to minimise the impacts of mining on the surrounding mixed farming and grazing areas, a buffer zone has been secured. Outside this zone only six homesteads are located within 3.5 to 6km of the mine site and plant areas (Figure 23).

5.2 Air Quality

5.2.1 Impacts

Mine operations will have an impact on air quality through the emission of smoke, dust and gases. Emissions could be carried by wind to be deposited on or near the lease area. The low rainfall coupled with a high evaporation rate enhances conditions for dust generation.

An evaluation of the likely air quality impacts was made by Dames & Moore by assessing the dust generating capacity of the mine at the two stages in its development. Dames & Moore concluded that the level of dust generation by the proposed mine will be similar to levels generated by coal mines in the Hunter Valley. The modelling studies undertaken for Hunter Valley mines (and actual measurements) show that even using conservative criteria, adverse impacts due to long-term dust nuisance do not extend beyond 1 km from dust generating areas. "Worst-case" dust episodes due to a particular mine generally are not expected to extend more than 1.5 km from the mine. As the mine has buffer distances of at least 3 km separating non-company owned residences and dust generating areas in the mine, no adverse air quality impacts on nearby properties are likely.

5.2.2 Management

In order to minimise dust emissions, various control techniques will be used. Control measures on specific dust sources may include the following:-

- sealing of roadways and parking areas within the lease area where possible;
- initially watering and eventually sealing the main access road;
- where sealing is not feasible, due to high pavement loads and temporary nature of the haul and service roads, road surfaces will besprayed as required with water and/or chemical surfactants;
- enclosing raw coal receiving stations, coal transfer points and conveyors;
- installation of a water spray system on coal stockpiles and rotary breaker;
- Limiting pre-mining clearing to a minimum; and prompt rehabilitation of mined areas.

Specific dust controls are discussed in Section 4.6.1. These dust control measures have been found to be successful and have led to acceptable air quality at other mining centres. The present meteorological station and dust monitoring programme will be continued and augmented.

5.3 Landforms, Soils and Overburden

5.3.1 Impacts

(i) Landform

The mining of coal by surface mining methods will involve the removal and handling of large quantities of overburden, and subsequent development of a new local topography. The final topography will be dependent upon the mining method, overburden swell factor and the requirements for final land use. Similar slopes and grades to those existing will be constructed, except at the start and finish of the mine where a respective surplus and deficit of overburden materials will occur (refer to Figures 35, 37 and 39). The major topographical difference after mining will be the existence of a final cut or void, as discussed in Section 4.3. A new drainage pattern will be developed, which will allow all runoff from the mine catchment to be directed into the final void thus creating a water resource.

Calculations by Dames and Moore are that the void and spoil aquifer will fill to the pre-mining water table level in 60-200 years. The wide range results from variation in the prediction of the annual runoff co-efficient.

(ii) Soils

The major impacts to the various soils occurring within the area would be for the most part temporary. They are, in order of decreasing significance:-

- increased susceptibility to erosion due to physical disturbance of the soil profile;
- alteration of infiltration and subsequent water holding capacities of the various soil materials;
- alteration or destruction of soil biota; and
- chemical alteration of the soil media.

In any earth handling operation the soil profile is disaggregated and the structural stability of the soil media is lessened, resulting in an increased potential for erosion. The Soil Conservation Service of NSW (SCS) has defined the respective erodibility of soils within the study area.

The hard setting Loamy and Duplex soils are classified highly erodible. This is related directly to the unstable and impervious nature of the B-horizon or C-horizon when the B-horizon is absent from their profiles. The instability of the basal horizons of the profiles is the result of the combination of expandable clays and sodic content. The hard setting surface created by the sodic clays within the B-C-horizons gives rise to high runoff. The stabilisation effect of the vegetative cover and consequent organic content of the surface soil has prevented the erosion of much of the A1-horizon, as a result of the solodic subsoil conditions. The lithosols are classified as low to moderately erodible.

Tree clearing, topsoil and overburden removal will lead to an increase in erosion potential of the various soils. This impact will be temporary and limited in scope due to the topography, the restricted areas affected, rapid revegetation and rehabilitation practices.Water percolation rates within the disturbed areas willultimately increase as a result of disaggregation of the heavier unstable B-C-horizons. Such an impact is favourable in that the increased percolation rates within the underlying replaced spoil will decrease the total volume of surface runoff. Thus, both soil erosion and consequent sediment load of recipient drainage will be lessened.

The impact of surface mining on the water holding capacity of the surface soils (A1-A2-horizons) is anticipated to be minimal. In fact, this soil parameter should remain essentially the same as that which exists today. The majority of moisture retained for vegetation consumption within the Leard Forest is derived from the surface A-horizon. The hard setting B-horizon restricts the water holding capacity of the subsoil. Replacement of A-horizon materials and rooting material following mining should restore the moisture holding capability of disturbed areas. Although no detailed study of the biota within the soil profile has been made, the proposed mining activities will undoubtedly have an impact on the micro-organism activities. However, since maximum populations of fungi,bacteria, insects, earthworms, etc. occur within the upper 100-150mm of the soil profile, the impact is expected to be minimal with rapid rehabilitation.

Since some of the topsoil removal/replacement process may be seasonal due to rainfall patterns, there may be periods when stockpiling of topsoil will be required. The overall impact of topsoil stockpiling will be greatest on the aerobic bacteria and fungi buried deeply in the pile. However, once such materials are replaced during rehabilitation and vegetation has been established, the soil biota populations should return to original levels. The mixing action of the A1 and A2-horizons resulting from the topsoil removal process will have a minimal impact on the chemical properties of the replaced soil media. Adverse changes that do occur can readily be corrected following mining.

(iii) Overburden

Impacts resulting from the mining of the overburden/interburden lithologies are:-

- fragmentation of the stratigraphic sequence;
- disturbance of potential sodic and pyritic bearing materials; and
- effects on groundwater and surface water hydrology (Section 5.4).

During the mining process, coherent rock units will be fragmented and mixed with other overburden/interburden and because of fragmentation and increased pore volume, greater water storage capacities can be anticipated. For the surrounding Leard Forest such an impact will be beneficial. Increased groundwater recharge potentials in the disturbed land will tend to lessen flooding during rainy periods.

Previously discussed chemical baseline conditions identified potentially sodic overburden/interburden materials. During topsoil removal and coal extraction, these materials will be exposed. If left at or near the surface of the graded spoil, they have the potential of creating both erosion and stability problems. The combination of expandable clays and sodium within the clay matrix of the conglomerate has the potential of developing a hard setting surface on exposure to weathering. Surface waters would be discharged off the land instead of infiltrating, ultimately leading to erosion. The second concern over exposure of sodic spoil near the final graded surface is with the development of "tunnelling" or "piping" phenomena resulting in unstable land surface conditions following rehabilitation.

Of lesser concern than exposure of potential sodic overburden/interburden, is the exposure of potentially acid producing materials. The preliminary baseline studies show pyritic bearing rocks to be associated with roof and floor materials of the Braymont and Jeralong seams. Although the overall neutralisation potential of the overburden/ interburden approaches neutral (being only slightly acidic), the roof and floor strata have the potential for creating undesirable acid conditions if left at or near the surface following mining.

The combined total thickness of undesirable overburden/interburden material makes up less than 30% of the total overburden thickness and because these potentially sodic and acidic materials will be selectively buried, it is highly unlikely that undesirable conditions will develop.

5.3.2 Management

(i) Landform

The chosen mining method allows considerable flexibility in the choice of the final landform, with the exception of the final void. The post-mining landform that has been described in Section 4.3 will provide a landform that is aesthetically pleasing, stable and capable of supporting a productive native forest.

Because of the size of the final void (approximately 40-50 million cubic metres), it is not feasible for this to be filled. Therefore, it is proposed to rehabilitate it as described in Section 4.3. The establishment of a dense forest cover will ensure the development of a stable landform. In order to improve water quality, all surface flows in the catchment can be directed into the void via the regraded haul road. Alternative future uses of the final void will be investigated in more detail during the life of the mine.

(ii) Soils

The A-horizon of the soil profile is by far the best available plant growth media. During mining and rehabilitation efforts will be taken to protect and salvage this valuable resource. All available A-horizon material will be selectively removed and replaced to provide for a minimum 100mm cover of all graded replaced spoil. Measures will be taken to minimise soil erosion as described in Section 4.3.

Impacts on the soil biota will be minimised by reducing topsoil stockpiling. Where possible, topsoil removed in advance of disturbed areas, will be immediately placed on regraded spoil. This should be possible except in the first 1-2 years of the mine life or in extremely wet conditions. Where topsoil stockpiles are required, they will be kept well spread out to minimise heat build up and to ensure rapid revegetation, by maintaining seed viability. Careful topsoil handling will minimise many adverse effects and ensure its continued viability, texture and moisture holding capacity.

(iii) Overburden

Surface mining will begin in the vicinity of the existing trial boxcut in overburden of the Merriown seam. The dragline will strip overburden up to its maximum capability then truck and shovel equipment will be phased in for prestripping. Therefore, for the majority of the mine life, the material left on the surface of the spoil will be dumped by truck. This method of mining will allow flexibility in selecting material to be placed on the spoil surface before topsoiling. With the dragline operation, the Merriown roof shale has been demonstrated to be a satisfactory rooting medium. The mining and rehabilitation plan has allowed for selective placement of overburden materials, with the burial of deleterious sodic, saline or acid materials.

5.4 Hydrology

5.4.1 Impacts

(i) Flooding

BHP Engineering investigated flood levels and effects of the elevated rail bridge and low level road crossing of the Namoi River. The rail bridge will be flood free except during floods exceeding the 1 in 100 year flood frequency. The low level road will have a flood frequency of 1 in 3.5 years. This is equivalent to 2.5 flood days per year.

Bridge abutments, piers and other changes to the natural topography will have minimal effect on present flood levels. Flood levels will be raised by a maximum of 190mm at the bridge site. This level will decrease with increasing flood sizes and also decrease upstream.

(ii) Water Quantity

The proposed mining development will have effects on the quantity of both surface water and groundwater. The operation at full production will require significant quantities of water for use in dust control, in the coal washing plant, and for drinking and sanitary needs. Overall, except in wet conditions, the mining operation will be a net consumer of water and during active surface mining operations less surface water and groundwater will leave the lease area. Water balances are shown in Table 13 (Section 4.7).

Less significant impacts on surface water quantity could be decreased flows of streams draining the mine area (Nagero Creek catchment). Reductions may come from increased infiltration following mining and increased evaporation of surface waters which drain into sediment trap ponds and into the main general storage reservoir. Water will also be lost to evaporation resulting from its use in the various coal processing activities and in dust control.

However, as noted in Section 3.7, the amount of surface water draining the mine area is not great and it flows onto properties owned by the Joint Venture. Significant flow occurs only after heavy rains. The four coal seams lie below the potentiometric surface of the aquifer system. Seam extraction will result in some physical disruption to the aquifer system. As mining progresses below the water table, the groundwater flowing into the pit will be pumped out. Australian Groundwater Consultants (AGC) have estimated pit inflows to be in the vicinity of 0.5Ml per day. The impact on the overall aquifer system, however, will be lessened by the fact that mining will generally take place in the normal discharge areas. The primary recharge areas will not be disturbed, so the quantity of groundwater moving through the unmined aquifer system into the mine will be unaffected. The mining operation will inevitably lower water levels in the intercepted aquifer. AGC have estimated that drawdowns are unlikely to be more than 0.5 metres 2km away from the mining pit. Thus, significant water table declines will only occur within the lease area. Following mining and rehabilitation, groundwater recharge and storage capacity will be altered. Because of the overburden swell factor, storage capacity will increase and in the longer term, there will be a shift toward lesser surface runoff and greater groundwater recharge. This must be regarded as beneficial as flood flow contributions will be decreased.

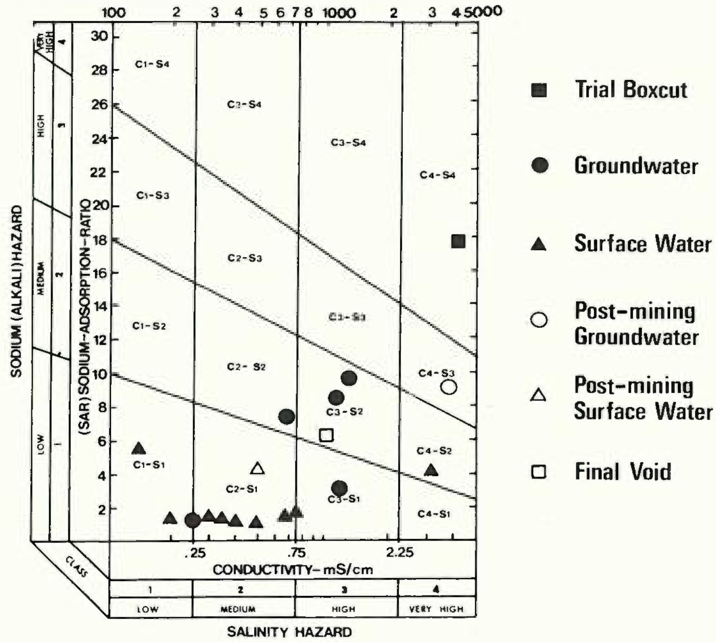
(iii) Water Quality

A change in water quality at the mine site will be an inevitable consequence of the mining development. Fragmentation of the overburden during mining will result in accelerated mineral solution reactions between overburden rocks and percolating water. Hence the soluble component of rocks will influence the quality of post-mining water.

The proposed selective placement and handling of potential saline, sodic and/or acid producing materials will greatly lessen the overall impacts to the re-established groundwater and surface water resources of the area,and the worst case water quality levels should not be realised following mining.

Dames and Moore have calculated that the anion distribution for both surface and groundwater will shift from $Cl>HCO_3>SO_4$ to $SO_4>Cl>HCO_3$. The cation distribution in surface water is expected to remain similar to premining providing the sodic overburden is correctly handled, and groundwater may become slightly less dominated by sodium ions. Surface runoff from bare spoil is estimated to have a conductivity (eC) of 0.5mS/cm (0.5 before mining) with a sodium absorption ratio (SAR) of 5-6 (1-5 before mining. Therefore, the SAR is likely to be moderately higher than average pre-mining levels resulting in water classified as C2S1 (Section 3.7). Figure 51 (following page) shows the likely composition of post mining surface and groundwaters.

Groundwater will have an .eC of 4mS/cm (cf 1-2) and an SAR of approximately 8-9 (cf 8-10), and be classified as C4S4. Final void water quality is also shown in Figure 54 and is classified as C3S2. All of these estimates are based on worst case assumptions, which assumes that all overburden is present as reactive size particles and is involved in geochemical reactions.



POST-MINING WATER QUALITY

Figure 51

In addition to effects on the chemical constituents of surface water, mining and construction activities will expose bare soil and overburden materials to the effects of wind and water erosion. Runoff from mine areas, haul roads, coal preparation plant area and coal stockpiles will be contaminated by suspended solids and coal dust. The Water Management Plan (Section 4.7) proposes collection of all runoff from dirty areas and to maximise the on-site water resources, as the mine operation is a net consumer of water. Surface runoff following mining has been assessed as likely to decrease because of increased groundwater recharge and storage capacity. This will effectively reduce the likelihood of downstream pollution. Therefore, except under extreme rainfall conditions, zero discharge will be maintained and effects on water quality outside the lease are expected to be minimal.

5.4.2 Management

Extensive studies have been undertaken over a period of 5 years to determine baseline hydrological characteristics, possible water supply sources and the likely effects of mining on surface water and groundwater hydrology. All structures crossing the Namoi River flood plain have been designed to minimise effects on flood flows and levels. A comprehensive water management plan has been developed to ensure:-

- maximum use of water resources existing in the lease area;
- collection and utilisation of contaminated water; and
- non discharge of water from the operations except possibly during periods of heavy rainfall or prolonged wet weather.

The methods by which these objectives will be achieved are detailed in Section 4.7. As the mine development, is a net consumer of water, there will no water discharges from the operations except under extremely wet weather conditions. By maximising use of on-site water resources external water demands will be minimised. Adequate underground water supply sources for makeup have been located on property owned by the Joint Venture near the Namoi River (Section 4.8.1).

The proposals for diversion of clean water and separate collection of contaminated water will ensure that no water pollution occurs. The plans to selectively handle and bury potential acid producing spoil will prevent prolonged exposure and oxidation. Only slightly acid (pH 6.5-7.0) conditions should result and therefore only a minimal increase in total dissolved solids can be anticipated. Similarly, all highly sodic and saline materials will be deeply buried in the mining process and not exposed to prolonged leaching.

5.5 Acoustical

5.5.1 Impacts

Sources of noise resulting from the mining development will include the mining operation itself, the coal treatment process, coal transport initially by road, via rail and the road transport of employees. These impacts are discussed in this section. Criteria for assessing the significance of the acoustical impacts were developed by Louis Challis and Associates. These are set out below.

(i) Criteria

• Mining Operations - Discontinuous or semi-continuous broad band noise levels up to 35dB(A) at night and 45dB(A) during the day would not result in significant annoyance.

• Blast Vibration and Overpressure - In terms of prevention of damage to property, a maximum particle velocity criterion for blast vibration would be 10mm/sec. However, in terms of human annoyance and discomfort, a criterion of 5mm/sec is proposed for daily blasting. The blast overpressure wave should be maintained within a limit of 115dB (unweighted) at the nearest residence (State Pollution Control Commission criterion).

• Train Noise - Scales of acceptability in terms of a function of both the level and duration of the noise were developed and are presented in Table 16. The L_{Aeq24}, is the energy equivalent noise level in dB(A) calculated over a 24 hour period. The impact of an increase in rail movements resulting in an increase of 5dB or more in the Leq would be regarded as significant.

TABLE 16 : TRAIN NOISE CRITERIA

Acceptability	Rural Area (L_{Aeq24})	Rural-Urban Areas (L_{Aeq24})
Clearly Acceptable	-35	-40
Normally Acceptable	35-45	40-50
Normally Unacceptable	45-55	50-60
Clearly Unacceptable	55	60

• Road Coal Transport and Loading - In the case of the fluctuating noise such as trucks passing, the increase in $L_{AO.1}$ levels or L_{Aeq} levels of 5dB or less over the corresponding existing levels are regarded as satisfactory. $L_{AO.1}$ is the level exceeded for 0.1% of a given sample time, and L_{Aeq1} is the equivalent noise level taken over a one hour period.

• Road Traffic Noise - For a mixed rural residential environment such as Boggabri or surrounding farms, the L_{10} traffic noise levels as presented in Table 17 are regarded as acceptable for planning purposes. The L_{10} (1 hr) noise level is the level exceeded for 10% of a one hour sample.

TABLE 17 : ROAD TRAFFIC ACCEPTABLE NOISE CRITERIA

		L_{10} (hr)dB(A)
daytime	6am-8pm	60
night-time	10pm-6am	50

(ii) Mining and Coal Treatment

A computer programme which generates noise contours was used to predict the impact of the full production mining and coal treatment operation. The worst case situation was adopted for the study. This was taken as a three shift operation at full production in the late night period with the machinery and plant operating at maximum levels and numbers. The series of contours developed in Figure 52 show the typical maximum (L_{10}) noise levels in dB(A) for this situation.

The results, for farm houses in the area, are:-

The Meadows	37 dB(A)
Templemore	36 dB(A)

Thuin	33 dB(A)
Green Hills	34 dB(A)
Prairie Downs	32 dB(A)
Jeralong	31 dB(A)

Except for The Meadows and Templemore, all of the residences fall below the 35dB(A) criteria. That these two residences which are not the closest to the mine exceed this criteria is attributed to the window effect, where sound propagates between hills encircling the mine. The most significant noise sources in terms of these two residences are trucks on the spoil piles. As the mine plan allows for an initial development with a dragline, these trucks will move to different positions and it is likely that these residences like Thuin, will fall into shadow zones. Therefore, this worst case situation is not likely to arise and noise levels resulting from the mine are considered unlikely to result in any significant loss of acoustical amenity for the residences. Daytime operations are unlikely to result in significant annoyance.

(iii) Road Transport and Rail Loading for Initial Production

In the initial development, coal would be transported by road from the mine site to the rail loading facility north of Boggabri. The nearest residences not owned by the Joint Venture is "Cooboobindi"(see Figure 23). At a production rate of 0.5Mtpa, operating on a five day week from 7.00am to 6.00pm, the average number of trucks would be approximately eight per hour. The noise of the road traffic has been calculated at the two residences. The results are shown in Table 18.

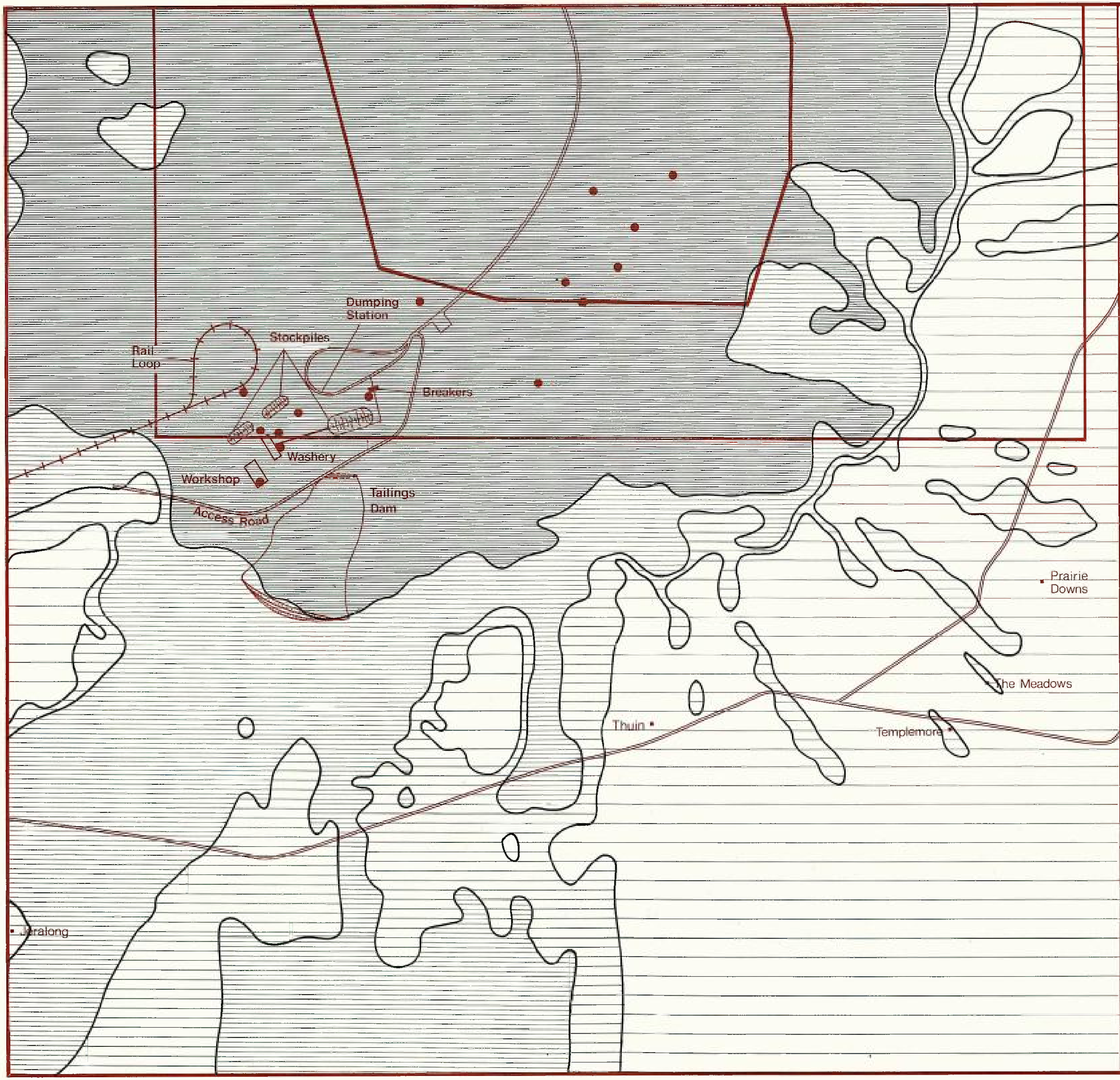
TABLE 18 : NOISE OF ROAD TRANSPORT OF COAL

Residence	$L_{A0.1}$dB(A)	L_{Aeq1}dB(A)
"The Rock"	55	39

The existing traffic noise levels at "Cooboobindi" from existing traffic were $L_{A0.1}$ = 47dB(A) and L_{Aeq1} = 30dB(A). The predicted noise levels from the haul road are therefore some 4-5 dB(A) above the existing levels. The absolute levels are considered to be fully acceptable for daytime operations. In summary, Louis Challis and Associates concluded that the assessment of noise from the proposed trucking operations indicates that these are unlikely to result in a significant loss of acoustical amenity for the nearest residences. Similarly the predicted noise levels at rail loading operations at "Roma" the closest residence, were $L_{A0.1}$ = 45dB(A) and L_{Aeq24} = 20dB(A), which are considered as fully acceptable.

(iv) Access Road Traffic

The noise of road traffic on the mine access road has been calculated as L_{10} (1 hr) levels for each shift change period, in year 2 for the nearest residence



● Source positions

Mean Peak Noise Level dB(A)

- >50
- 40–50
- 35–40
- <35

PREDICTED WORST CASE NOISE LEVELS

0 ——— 1·5km

JOINT VENTURE
Boggabri coal

Figure 52

Cooboobindi (Figure 23) and the results are shown in Table 19.

TABLE 19 : NOISE OF TRAFFIC ON ACCESS ROAD YEAR 2 FULL PRODUCTION OPERATIONS

Shift Change	No. of Vehicles	L_{10}(1 hr) Noise Level dB(A)
Day-afternoon	122	42
Afternoon-night	99	41
Night-day	125	42

These noise levels are within the acceptable criteria of L_{10} (1 hr) of 60dB(A) day and 50dB(A) night and road traffic along the access would not cause any significant annoyance to nearby residences.

(v) Train Noise from Spurline

The noise levels of rail movement on the spurline between the mine and the junction with the main Northern Line have been calculated for the years 10, 15 and 20, for the 2 nearest residences along the spurline. The results, based on the estimated number of train movements, are shown in Table 20. Discussions with the SRA indicate that train sizes are likely to be large i.e. 84 CHS wagons and therefore train movements will be lower.

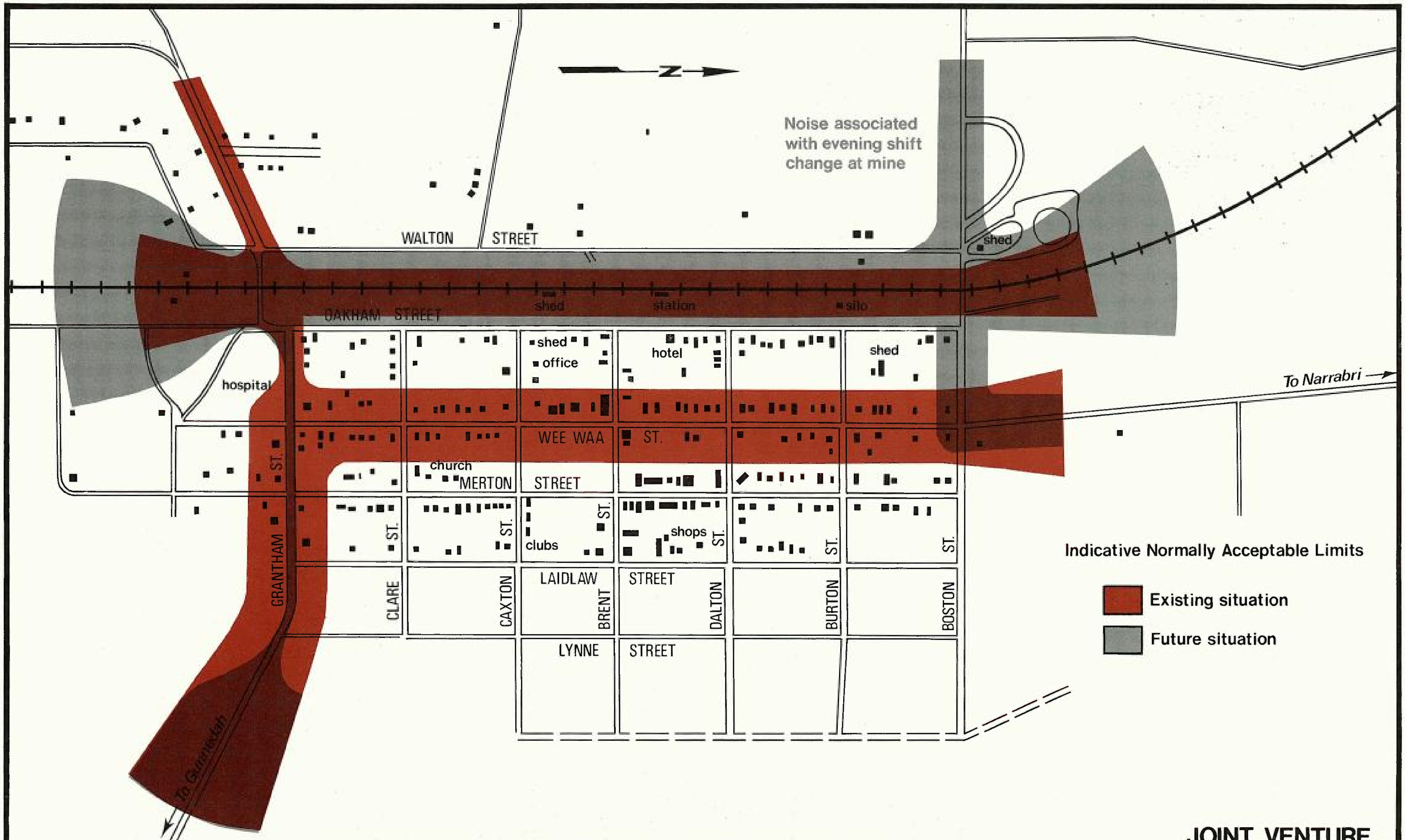
TABLE 20 : NOISE OF TRAINS ON SPURLINE

Year	10	15	20
No. of wagons/train	30	42	42
Train movements	4	8	10
L_{Aeq24}			
"Cooboobindi"	38	43	44

The noise levels at Cooboobindi are higher than those at The Rock despite the latter being closer to the spurline. This results from the increased noise levels likely to be generated whilst trains pass over the rail bridge. However, noise levels are well within the adopted criteria and noise impacts are expected to be insignificant.

(vii) Acoustical Environment in Boggabri

The acoustical environment within the township of Boggabri will probably undergo gradual, though significant, changes over a period of some 10-15 years (Figure 53). These changes, if noted, are likely to be accepted by the residents as a sign of urban regeneration.



BOGGABRI ACOUSTICAL ENVIRONMENT

JOINT VENTURE
Boggabri coal

Figure 53

The increase in road traffic at the northern end of town associated with shift changes at the mine is likely to result in a significant acoustical impact for a short evening period on one residence at the corner of Boston Street and Oakham Street, and in a marginal acoustical impact at the next two residences in Oakham Street.

The effect of increases in rail traffic will to some extent depend on the timing of track upgrading work and the introduction of larger capacity unit trains. The analysis shows that a marginally significant increase is expected in the L_{Aeq24} hr noise levels. This increase would take effect gradually over the next 10-15 years.

A small number of residences situated in close proximity to the railway line would thus likely experience future noise levels which Louis Challis and Associated classified as being normally unacceptable (see Figure 53). However the bulk of the residences along the railway line are located at distances 70 metres or greater from the track and the future noise levels in these areas are likely to lie in the normally acceptable or clearly acceptable criteria ranges.

5.5.2 Management

The basic philosophy adopted in mitigating noise levels around the mining operation, has been to purchase those properties most affected in order to provide an effective buffer zone. The siting of the coal treatment plant and coal haulage road has also taken into consideration noise level propagation. The present location is shielded by a hill and the tailings dam wall which provide an effective visual and acoustical screen to the south.The mining operation itself will be in the confines of the Forest which has similar benefits. Additional measures that could be adopted if necessary include additional engine silencing and acoustical shielding of noise sources. Section 4.6.2 describes the proposed noise controls in more detail.

A number of rail spurline locations were considered in order to minimise the noise effects on residences and disturb the least number of properties. The two homesteads most effected, Merriown and Daisymede, have been purchased. The Joint Venture has no control over rail movements and noise resulting from any rail traffic increase.

5.6 Flora and Fauna

5.6.1 Impacts

Flora and fauna will be affected by the clearing of areas for the surface mining operations. Other effects could arise from dust and noise but these are not likely to be significant.

Clearing of vegetation will result in its destruction in the short term. Likewise, fauna resident in these areas would be displaced into adjacent forested areas. Taking an average figure, 1.4 birds per hectare of disturbed forest would be affected. It is not possible to detail such information for the remaining fauna. However, from Figure 20, it is likely that the Grey Kangaroo will be the main species affected.

The major vegetation association affected will be the White Box/Cypress Pine Association. Figure 19 and Table 4 indicate the areas of each vegetation association within the likely surface mine area. A total area of approximately 1200 hectares will ultimately be disturbed over the total mine life.

In the long term, a stable forest ecosystem will be re-established. Birds and animals displaced during the mining operation will re-invade reclaimed areas and the majority of original species and populations should re-establish. However, it is not possible to forecast whether the original vegetation associations will be returned, and in some cases it is likely that different species may be favoured. For example, the Pilliga Box/Bimble Box/Belah community, which requires heavy soils with poor drainage conditions, which will probably not exist after mining, so this association is not likely to become re-established.

5.6.2 Management

Strict controls will be enforced to minimise clearing and disturbance. Clearing will be restricted to areas immediately ahead of the surface mining operation. Rehabilitation will closely follow the mining operation, and disturbed lands should be in the process of reafforestation 1-2 years after mining. Reafforestation methods that have been investigated on the boxcut spoil will ensure that a stable forest ecosystem is returned. A fire management plan will be developed to prevent any likelihood of wild fires occurring.

Research will be undertaken to monitor effects on fauna species and populations, and the rate at which they recolonise the reclaimed areas. Every attempt will be made to provide suitable habitats during the rehabilitation process. If warranted this may involve the removal and replacement of ground cover in the form of logs, brush and rocky outcrops.

5.7 Land Use and Tenure

5.7.1 Impacts

The mining operation will replace the existing land use of State Forest in the short term. This in general, will initially be at a rate of 5 hectares per year increasing to 50 hectares at full production. Over the total mine life, an area of approximately 1200 hectares will be disturbed (37% of the lease area, or 15% of the Leard State Forest). The coal preparation plant area, rail spurline, access road and loading facility will replace existing predominantly grazing land use. No significant areas of productive agricultural land will be affected.

In economic terms mining will be a far more productive land use than the existing uses. Progressively throughout the life of the mine the original land uses will be returned and no significant long term impacts should eventuate.

5.7.2 Management

The replacement in the short term of existing land uses (State Forest and to a much lesser extent agricultural production) by the mine is inevitable. By ensuring that rehabilitation follows closely behind the mining operation, only a relatively small area will be disturbed at any time. The opportunity will exist through the selection of tree species and silvicultural treatment, to create a more economically productive forest. For example, the planting of spotted gum could allow for their later use as pit props in an underground mining operation. Discussions have been held with the Forestry Commission regarding compensation for the loss of timber. It is the Joint Venture's understanding that as the Commission intends to purchase other areas of similarly forested land to compensate for the temporary loss of an area of the Leard State Forest, in the long term, a greater area of State Forest may eventuate.

The coal preparation plant area, rail spurline and access road have all been located to minimise effects on agricultural land and the number of properties affected.

5.8 Transportation

5.8.1 Impacts

(i) Rail Transport to Newcastle

Coal will be transported initially by road and then by rail from the mine site to the Port of Newcastle. There will be an increase in road and rail traffic from mine site to port and therefore an associated increase in traffic noise. Section 5.5 has considered the impact of increased road and rail traffic. The effects of increased traffic on the main Northern Line have been considered by environmental impact studies for the Kooragang Island Coal Loader. "Kooragang Island Coal Environmental Impact Statement" (McDonald, Wagner and Priddle, 1981), released in October 1981 assumes that the Boggabri mine would commence production in 1986 with output rising from 1.5Mtpa to 5.0Mtpa.

Table 21 from this Environmental Impact Statement (EIS) shows the likely number of train paths used in Stage II of the Loader. The critical sectors of the Northern Line were identified as Narrabri-Muswellbrook and

Whittingham-Maitland. As discussed in Section 4.5, the Narrabri-Muswellbrook capacity can be upgraded beyond 6.2Mtpa (Stage II). The SRA is currently studying the means to achieve this upgrading. Assuming a full production level of 5.0Mtpa, and current planning for other developments of 1.2Mtpa, no excess capacity will exist for Stage II as discussed above. No allowance was made for possible development of the Vickery mine. Therefore, its timing and size is important in determining the timing for upgrading of the line. The noise impacts of additional train movements for both stages of loader development were considered in the EIS.

TABLE 21 - AVAILABLE TRAIN PATHS AT STAGE II OF KOORAGANG LOADER

SECTION	No. of available paths allowing for existing	No. of paths used for Stage II other traffic
Narrabri-Werris Creek	9	8
Werris Creek to Muswellbrook	11	8
Muswellbrook to Antienne	22	14
Sandy Hollow Line	16	5
Antienne Whittingham	60	39
Whittingham to Maitland	60	59
Maitland to Port Waratah	80	66

Source: McDonald Wagner and Priddle, 1981.

Product from the proposed mine will form only a small component of the total coal transported to Newcastle (1.5Mtpa of 15Mtpa Stage I, 5.0Mtpa of 50Mtpa Stage II). However, from Muswellbrook North to Boggabri the mine output will be a major component of future train movements. Predicted increase in levels (Leq) is shown in Table 22.

TABLE 22 : PREDICTED INCREASES IN NOISE LEVELS (Leq) ALONG MAIN NORTHERN RAILWAY

SITE	STAGE I		STAGE II	
	DAY	NIGHT	DAY	NIGHT
East Maitland	2	-	3	1
Branxton	2	1	3	2
Singleton Heights	1	-	3	1
Muswellbrook East	3	1	5	1
Muswellbrook North	1	-	4	1

Source: McDonald Wagner and Priddle, 1981.

Muswellbrook North was taken in the EIS, as representive of all sites north to Boggabri. Daytime predicted Leq's for Stage II indicate a noticeable increase in noise level along the whole length of the main Northern Line by coal loader rail traffic. A total of 673 houses in residential areas from Kooragang Island to Boggabri were identified as being influenced by coal train movements, 420 being north of Muswellbrook. Night-time Leq's are not significant except near Branxton.

(ii) Road Transportation

Additional road traffic will be generated between the mine and the workforce's residential areas, principally Boggabri. The affects of noise on residences adjacent to the access road and in Boggabri has been considered in Section 5.5. The existing gravel road through the Forest will eventually (after Year 10) be closed and replaced by another of similar standard running to the east of the Forest. The Joint Venture has had preliminary discussions with the Narrabri Shire Council regarding a possible route.

5.8.2 Management

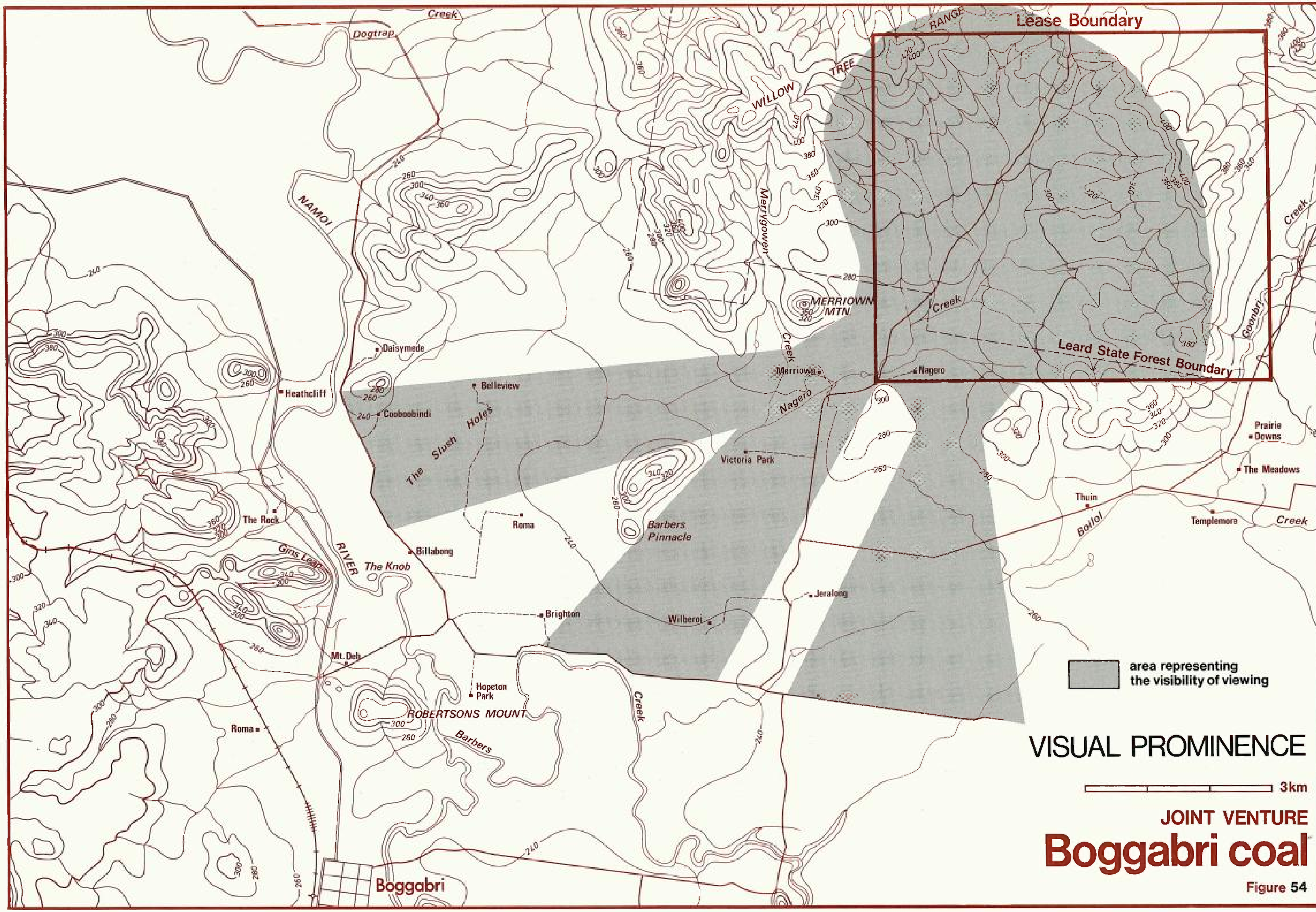
Increased road and rail traffic is an inevitable consequence of the development. As discussed in Section 5.5, the location of the mine access road together with the rail spurline took into consideration the location of residences and as a consequence noise effects are minimal. Rail traffic to the Port of Newcastle will increase, as will noise levels adjacent to the main line. The Joint Venture has no control over these effects as they fall under the jurisdiction of the SRA.

5.9 Visual and Aesthetic

5.9.1 Impacts

The siting of the mine and its location away from major transportation routes and centres of population ensures that there will be little adverse visual impact. The mine will be most visible from the road through the forest, the public road adjoining Barbers Lagoon and the road past Billabong (Figure 54).

The most obvious feature of the mine at full production from these points will be the 38 metre high rail loading bin (see Figure 41 for profiles) and the treatment plant. The coal stockpiles, (16 metres) which because of their colour are likely to be most noticeable, are shielded by the hill in front of the plant site and will only be visible at distances greater than 6 kilometres. If the alternative site is chosen, both the stockpiles and loading bin will be located in the forest and their visability lessened.



VISUAL PROMINENCE

JOINT VENTURE

Boggabri coal

Figure 54

The first years dragline boxcut spoil will also be evident until it is reduced in height and reafforested. At closer distances to within the 3 kilometres of the mine, (the road past Jeralong and Thuin properties), the visibility lessens because of the effective visual screening by the hill south of the plant site and the tailings dam wall. From these locations, (Figure 54) the mine facilities or mine operations will not be evident. Therefore, because of the distance of view, the existing screen of trees alongside some of the roads and the Leard State Forest in the background, the mine and facilities will not be conspicuous.

In the long term, after reafforestation, the actual mine area will blend into the surrounding hills and be imperceptible. However, the access road, rail spurline and bridge over the Namoi River will be much more noticeable and the most obvious feature of the mining development. These will clearly be seen from the main Narrabri road north of Boggabri (Figure 46) as the rail spurline crosses over the road. This view of the bridge is superimposed on a photograph taken looking south from the edge of the road near Heathcliff. The railway line from the bridge to the mine site will be evident from public roads and several properties. However, it will not be conspicuous. The initial coal transport road will be visible from the main road as it passes behind 'The Rock.' The train loading facility will not be visible.

5.9.2 Management

The plant site, access road and spurline are located to reduce visual impacts as much as possible and the purchase of properties in the immediate vicinity of the mine will provide an effective buffer zone. The mine site buildings will be of a neutral colour in order to blend with the forest background. Allowance has been made to topsoil, grass and establish trees near the tailings dam wall. The closing of the Leard road through the Forest and its resiting east of the lease area will eventually remove road traffic from the immediate vicinity of the mine. The road and rail spurline embankments and bridge abutments will be revegetated where they are likely to be in public view and for soil conservation purposes. The routing of the rail spurline along the base of hills to the south of the Forest will ensure that it merges with the existing landscape.

5.10 Social and Economic Conditions

5.10.1 Impacts

The construction and operation of the proposed mining development will have major social and economic impacts on the Narrabri-Boggabri-Gunnedah Region. There will also be significant beneficial impacts on other nearby centres, such as Tamworth and Manilla, as well as the state and nation. The construction and operation of the surface mine will provide a diversification to the existing cyclical agricultural economy and begin a new era for the local community by providing a major source of employment well into the next century.

The increased demand for goods and services created by the workforce will stimulate new employment growth in the regional economy. The large amounts of capital invested in the construction and operation of the mine will in itself, due to the multiplier effect, generate employment elsewhere in the State. Because of its location, the mine will provide a new focus for decentralisation, with development and associated population and economic growth removed from the congested Hunter Valley. The Joint Venture has every reason to believe that this project has the support of the local community and the Narrabri Shire, within which the proposed mine is located. The social and economic impacts that will accrue from the project are quantified where possible in the following paragraphs. The existing socio-economic environment is described in Section 3.13.

(i) Employment and Population

The mine development will initially employ approximately 50 people in the construction phase and 60 in the mining operation itself. These numbers will increase significantly in the late 1990's as production increases (See Section 4.9.1). Associated with any significant basic industry (such as coal mining), are service industries which are necessary to provide supporting services. Any expansion in the basic sector will provide an associated "flow on" effect to the regional economy.

An historic estimate of these multipliers can be made from census data by dividing the workforce into basic and service industries. The Vickery Project EIS (Vickery, 1986) used this approach and calculated economic base multipliers (total employed divided by basic employed) of 1.5 for Gunnedah Shire, 1.6 for Boggabri and 2.6 for the Northern Statistical Division. Using the same approach, Narrabri Shire has a multiplier of 1.7. The Northern Statistical Division base multiplier value is greater than the Shires' because of the increased service larger centres such as Tamworth provide to the area. Taking into account the specialised nature of the coal industry and the level of support from outside the region (supply of equipment, technological services, etc.) estimated at 60%, a coal project multiplier of 1.2 for the Shires and 1.3 for Boggabri is estimated. That is, for each direct project job, an additional 0.3 in Boggabri, will be created.

The construction phase will occupy only a short period in the life of the mine development. When compared with the operations phase, only short term influence on employment and population growth are assumed. The expected workforce is shown in Figure 48 Section 4.9.1. No local multiplier effect is assumed in this stage because of the small size of the initial construction workforce, and the provision of a construction camp when the major construction period commenced in the mid 1990's.

The expected build-up in the operations work force, together with the growth in service employment associated with the direct employment is shown in Table 23. An employment multiplier of 1.3 is assumed in these figures. Also shown is the likely population growth. This is based on the following assumptions:

- Operations workforce to be 40% imported. Service employment to be 20% imported.
- Direct and service imported employment to comprise 70% married, with a family size of 3.
- Population assumed to be located 85% Boggabri, 15% surrounding areas.

TABLE 23 : INDICATIVE EMPLOYMENT AND POPULATION GROWTH*

YEAR	0	1	2	3-9	10	12	14	16-20
EMPLOYMENT								
Direct	10	30	40	50	55	180	350	495
Non Local	4	12	16	20	22	72	140	198
Pop'n Increase	10	29	38	48	53	173	336	475
Service	3	9	12	15	16	54	105	148
Non Local	0	2	2	3	3	11	21	30
Pop'n Increase	0	4	6	7	8	27	57	74
TOTAL								
Non Local Employ.	4	14	18	23	25	83	161	228
Pop'n Increase	10	31	42	55	61	200	393	549
Boggabri Pop'n Increase	8	26	36	47	52	170	334	466

* Under current planning assumptions.

The population increases are dependent on the number of non-local employees moving into the area. For the period considered, a conservative 40% of the direct workforce has been adopted.

There is a demonstrated large pool of unemployed in the region, and a significant segment of underemployed with appropriate skills for a new mining development. The progressive build up in operational workforce will allow sufficient time for these skills to be recognised and, with training programs, an increasing proportion of the local population could be expected to gain employment. The non-local employment and associated population increases are therefore likely to be less than estimated.

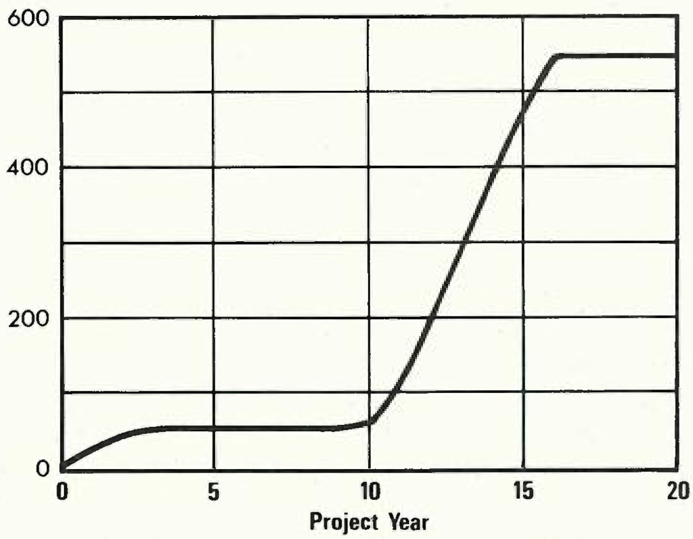
Because of the predominantly rural basis of the local economy (Section 3.13), there is little opportunity for increased employment without the development of a major alternative industry. The Commonwealth Employment Services (CES) therefore expects the current high unemployment to continue. The employment created by the proposed mining development, the diversification of employment opportunities and provision of training and apprenticeships for the young is seen by the CES as a very important social benefit to the area.

The CES has identified a potential workforce within the region in excess of one thousand. The gloomy outlook for the Woods Reef asbestos mine and its declining workforce requirement has been identified by the CES as one potential labour source. Most of the unskilled and semi-skilled workforce requirement should be capable of local recruitment with implementation of training programmes and apprenticeships. However, because of the lack of a local skilled workforce, many necessary skills may have to be recruited from outside the region.

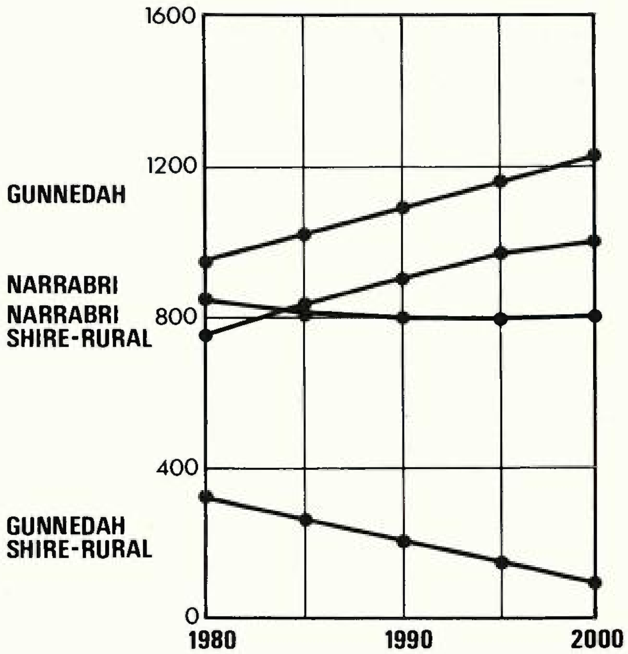
(ii) Decentralisation and Population Growth

The NSW Government's decentralisation programme will receive a substantial boost through a private initiative which will eventually spend some $500 million to establish the mine, treatment and transport facilities. Besides providing a major new industry in the region, the project will require support from other sectors of the economy and a side effect will be the growth of industries and services that supply the needs of the mine workforce.

A population growth in the vicinity of 550 will result from the development. Figure 55 illustrates the likely population build up to year 20 (approximately 2010). Population projections for the different centres without the project are shown in Figure 56 (Ref: Atlas of New England, University of New England).



POPULATION GROWTH
Figure 55



POPULATION PROJECTIONS WITHOUT PROJECT

Figure 56

As a result of the drift to the cities and to promote balanced growth, the State Government has an active policy of aiding decentralisation through financial incentives and declared growth centres. In the decade from 1970-1980, State Government assistance amounted to $121 million (Department of Industrial Development and Decentralisation).

The additional population includes people attracted to the area for direct project employment (employees and their families) and people associated with additional employment induced by the project in service, retail trade, construction and Government sectors. Boggabri is expected to capture the majority of this growth (Section 5.10) and arrest the steady decline in population that both it and the Narrabri Shire have experienced in recent years.

(iii) Economic Benefits

The development of the Boggabri coal mine would have the major effect of broadening the industrial base of the region, providing a diversification of the economy to give a measure of stability against fluctuating market conditions for agricultural products and climatic influences on their production. The operation at full production will generate gross revenues in the vicinity of

$220 million annually, almost three times the total agricultural production of the region. Consultants estimate that the local expenditure on goods and services in the region by each employee would be approximately $7,600 annually, or a total expenditure of $3.76 million by the projected direct workforce of approximately 495 at full production. The Narrabri Shire Council will have an expanded rate basis and an increase in property valuations will boost Local Government revenues.

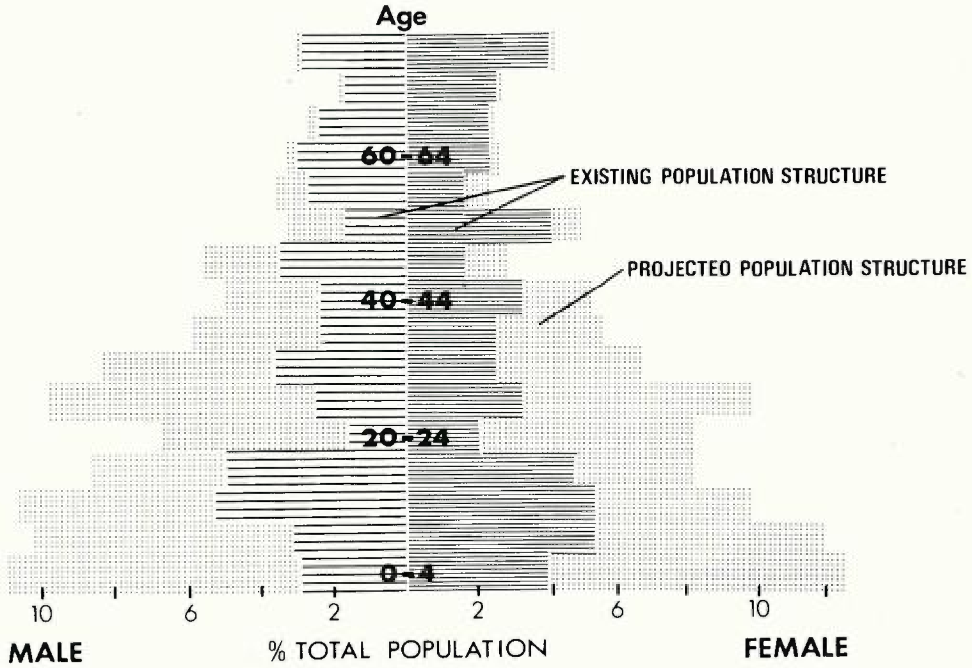
(iv) Socio-Economic Conditions

Recent major development projects, especially those in which rapid resource or energy related growth has been superimposed on a rural environment, have illustrated the need for adequate socio-economic impact assessment and growth management to ensure that overloads or breakdowns of basic institutions do not occur. Problems which have accounted for most of the undesirable boom town situations are:-

• Market failures where sudden increased demand for labour, housing, commercial capital, and public capital are not met by existing market mechanisms;
• Shortfalls in Government facilities and services where Local and possibly State Governments lack fiscal resources, expertise, and experience in providing the services and facilities needed to accommodate a growing population, or where Governments are unwilling or unable to make the investments necessary to provide them; and
• Social and political disruption where existing social relationships and systems break down because of stresses caused by market failures, inadequate delivery of Goverment services and conflict between the existing and new population.

Boggabri being the closest town to the mine, is expected to capture much of the population growth associated with the project. With planning, it is well situated to cater for the growth associated with the mine. The incoming workforce is likely to be considerably different in age sructure and composition to existing residents and resemble that described for Blackwater (Section 3.13.5). The likely population structure is shown in Figure 57. The markedly youthful bias and increase in the population will mean gearing planning towards this sector as well as the general increase in demand for services and facilities in the town.

The sex ratio is likely to become more balanced and there will be an increase in the density of the ethnic component of the population. There will also be a marked difference in the wealth and affluence between the existing residents and the new arrivals. In summary, the new arrivals will be younger, more varied in ethnic composition, probably better educated, more urban and accustomed to somewhat different lifestyles and perhaps more liberal in their social values. Considerations must be made of these factors in planning for the community needs, facilities and services.



BOGGABRI POPULATION STRUCTURE
Figure 57

(v) Housing, Community and Physical Infrastructure

The project is expected to result in a population increase of approximately 50 in the first ten years of operation. The major population growth with its associated implications for housing, infrastructure and services, will not occur until after this period. A population growth of approximately 400 would occur when the mine is at full production.

The Joint Venture expects that the majority of the population growth will be attracted to Boggabri because of its proximity to the mine, historical connections with the Joint Venture's activities and adequate existing capacity to cater for this growth. It is therefore assumed that 85% of the growth will be attracted to Boggabri, with 15% to the surrounding area. Boggabri is relatively well served with community facilities, and a wide range of services are available in Narrabri (Section 3.13).

A comparison of the above facilities with the desired standards (as adopted by the Department of Environment and Planning; Local Government and various Government bodies) is set out in Table 24.

TABLE 24 : EXISTING COMMUNITY FACILITY CAPACITY / PROVISION

Facility	Generalised Standard	Desired Level of Prov'n	Actual Prov.
Open Space (1)			
General ha/1000	2.83 ha/1000	2.90 ha	6.4
Active ha/1000	1.21 ha/1000	1.24 ha	5.0
Passive ha/1000	1.62 ha/1000	1.67 ha	1.5
Community Facilities (2)(3)			
Baby Health Centre	1:3-6,000 persons	1	1
Child Care Centre	1:500-700 dwellings	1	-
Community Health Centre	1:5-10,000 persons	-	-
Aged/Senior Citizens Centre	1:4-10,000 persons	-	-
Aged persons units	1 unit/225 persons	4.5	11
Hospital	1:15-20,000 persons	-	1
Schools (4)			
Pre-Schools	1:6,000 persons	-	1
Primary	1:1,400 homes	-	2
Secondary	1:4,000 homes	-	-

Sources:
(1) Department of Environment and Planning
(2) Lotona Masterman and Associates (1981) Community Facilities and Services in Land Commission Estates
(3) Youth and Community Services guidelines
(4) NSW Department of Education, Directorate of Planning Services, Procedures for Allocating and Siting Schools.

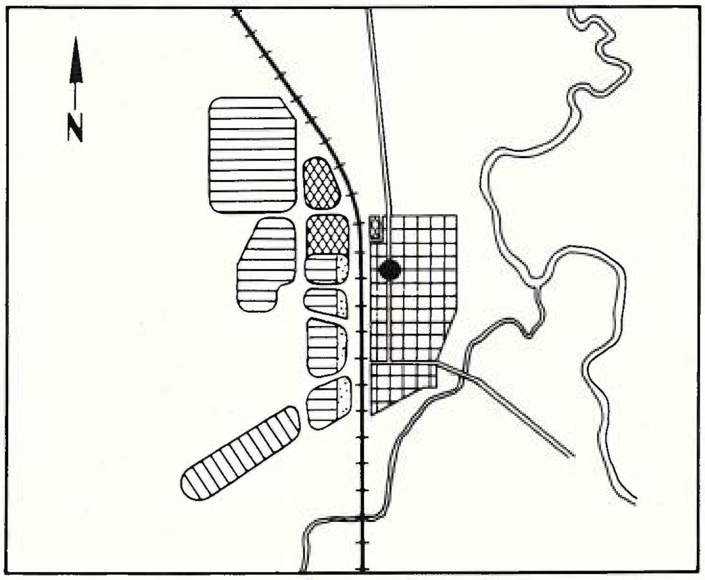
The existing level of community based resources is generally adequate and spare capacity exists with the resources to cater for a minor population increase such as that associated with the Maules Creek development. The population of Boggabri has varied between 1256 and 1023 in the 20 year period from 1961 to 1981. An additional 67 people in the first ten years operation will be well within the range of normal town size fluctuations.

5.10.2 Management

(i) Planning for Growth Management

To maximise the advantages and minimise the disadvantages of population growth will require efforts to influence its rate and location, and the type and level of Government and private sector services. The Joint Venture has had a special interest in these issues since the earliest stage of the project.

From the commencement of the exploration, the Joint Venture has recognised that the availability of housing in the region was limited, and has taken an active role in ensuring that planning was undertaken to cater for the needs of the likely population increase. It has maintained a policy of open communication with State Government Departments, Shire Council and local community, keeping them informed of likely effects on community and Local Government planning. The Narrabri Shire Council following discussions, purchased 200 hectares on the outskirts of Boggabri in 1979 to ensure that sufficient residential land was available for housing the likely population growth, and to restrict land speculation.The Council also recently completed an Environmental Study for Boggabri as a basis for the preparation of a Local Environmental Plan. This Plan was placed on public display in mid 1986. Existing services and facilities can also be readily expanded to cater for expected population growth. Figure 58 shows the proposed development areas at Boggabri.



Source: Fox 1985, Boggabri Environmental Study

BOGGABRI POTENTIAL DEVELOPMENT AREAS
Figure 58

(ii) Population Distribution

The population growth attributed to the project will be distributed in the region in a manner largely determined by the availability of housing, public facilities and services. Studies undertaken by the Joint Venture have revealed that housing for rental or purchase is in limited supply. However, serviced or residential land is in better supply. By ensuring the provision of adequate supplies of residential land and supporting public facilities and services, Boggabri could become the centre for population growth.

Boggabri, rather than experiencing economic stagnation and the steady ageing and decline of the population numbers, will experience strong growth and a revitalised economy and future.

(iii) Housing

The Council owns undeveloped land sufficient for 2,000 lots to the west of Boggabri and approximately 140 vacant sites are available in the town. When additional sites are required, the Joint Venture will enter into a arrangement with the Council to enable the development of sufficient housing allotments for the needs of its workforce. This will provide finances to the Council and enable an early start to the provision of serviced land. The Joint Venture will ensure that a pool of rental housing or suitable temporary accommodation is developed to provide temporary accommodation for the incoming employees while their permanent housing is being constructed. It is expected that project home builders will construct the houses for employee purchase. A co-operative arrangement with financial institutions and/or building societies will ensure that housing finance is available for house purchase. These schemes will be based on a response to a need rather than attempt to provide accommodation and housing on some predictive basis. The full production construction workforce will be accommodated in a temporary construction camp at the mine site.

5.11 Environmental Monitoring and Management

5.11.1 Management Procedures

Previous Sections have described the environmental management and safeguard procedures that will be adopted to minimise any adverse effects of the project. The administration of these safeguards, rehabilitation and the overall control of environmental matters will be the responsibility of an Environmental Officer/Engineer who will report directly to mine management. This structure will ensure that environmental considerations remain a high priority in the construction and operation of the mine.

The Joint Venture enjoys a good relationship with the Narrabri Shire Council and residents of the area. It will continue to maintain this relationship and keep the Council informed of its plans and likely implications for Council services and responsibilities.

5.11.2 Monitoring

The Joint Venture has continued environmental monitoring in the mine area since 1977. A comprehensive programme will be implemented during the construction phase and continued during the operations. The programme will include:

- socio-economic conditions
- rehabilitation.
- dust and vibration.
- noise.
- hydrology.

(i) Socio-Economic Conditions

The Project employees are expected to reside mostly in the Boggabri area. The Joint Venture will continue to monitor relevant aspects of the social and economic environment of the region. Emphasis will be placed on housing and the related needs of the workforce to ensure that adequate accommodation is available together with associated community services.

(ii) Rehabilitation

Ongoing studies of the existing trials, soils, overburden and interburden material ahead of mining will enable site specific plans to be formulated. These will provide the basis for rehabilitation and landform planning. Flora and fauna studies of the revegetated areas will provide a basis to monitor the success of the rehabilitation plans.

(iii) Dust

Dust levels around the mine, access route and train loading facility will be monitored to provide information upon which project management can ensure emissions are contained within the prescribed limits.

(iv) Noise and Vibration

Noise levels will be monitored to ensure the design noise and vibration criteria are met.

(v) Hydrology

Impacts on both water quality and quantities will be monitored. Regular water samples will be taken around the mine site. The use of water on site will be monitored to provide information on consumption and determine areas where water conservation measures could be implemented. Runoff quantities and quality from both pre and post mined lands will be part of a regular programme.

5.12 Other Development Projects

As discussed in Section 2.3, coal exploration in the area has expanded in recent years. In particular Kembla Coal and Coke (KCC), in a Joint Venture with Sunshine Gold, is proceeding to develop the Vickery area. The Maules Creek area, to the north of the lease area is in a mine feasibility phase. The most likely future scenario is for both the Vickery and Boggabri mines to proceed in the next few years. KCC may also develop a surface mine to the north of the lease area (Maules Creek).

All mines are likely to produce local effects of dust, noise, hydrology and landuse. These are not considered to be significant in a regional context. Regional affects that are more significant are transportation and workforce location.

Transportation impacts are considered in Section 5.8. The route chosen for the Vickery mine is towards Gunnedah. A common Boggabri Joint Venture - KCC transport route/loading facility has been discussed should both the Boggabri and Maules Creek mines proceed.

Workforce location and its associated population growth (Section 5.10.2) will be influenced by both company policy and Government planning. The Boggabri Environmental Study (Fox, 1985) has allowed for the full workforce needs of the Boggabri Joint Venture, the Vickery mine and Maules Creek using conservative figures (i.e. higher population). However, the Vickery mine is located close to Gunnedah which may also become a residential area, together with Manilla and Barraba. Both Gunnedah and Narrabri have also recognised the potential growth associated with coal developments in the region.

5.13 Review of Impacts

The proposed coal mining project will undoubtedly have short term physical impacts on both the mine site environment and the social and economic well being of the local community. However, it is considered that in the long term, the impacts will not have a significant adverse effect and indeed there will be substantial economic benefits that will accrue to the region, state and nation.

5.13.1 Physical Environment Impacts

In the short term, the most significant impacts will be the clearing and landform change of the mined areas. Associated with this will the potential for increased soil erosion, dust and noise generation, and changes in water qualities and quantities. However, because of the location of the mine and the environmental safeguards to be adopted, the impacts will be ameliorated during operations and in the long term impacts will not be of significance. Mined land will be progressively returned to native forest type vegetation and a larger area of possibly more productive native forest will be returned to the Forestry Commission Control after mining has been completed.

5.13.2 Social and Economic Impacts

There will be significant socio-economic changes locally and within the region.

A major source of employment will be created and will provide diversity to the existing cyclical agricultural economy. It will also relieve considerably the high levels of unemployment currently being experienced in the region. The large capital injection will also generate employment elsewhere in the state and the nation.

The operation of an efficient economically viable mine will provide a new and additional source of revenue to all levels of Government, and introduce a sound, long term input to the economy of this region.

Boggabri will be the major residential centre for new mine employees and consequently its population characteristics will change and diversify as the new arrivals will be different in composition to the existing inhabitants. As the mine increases to full production there will be a significant population growth for a short period and the existing social infrastructure will have increased demands placed upon it. Local Government planning is well advanced to cater for these changes and adequate areas are available for residential development. The Joint Venture will adopt policies to ensure the early development of housing and accommodation. In the long term, the incoming population will broaden and diversify the existing social structure and base.

SECTION 6

references

SECTION 6: REFERENCES

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SECTION 7: GLOSSARY OF TERMS

A	acoustics:	sound and its characteristics.
	afforestation:	to establish forest cover.
	A-horizon (soil):	is a layer within the soil profile with some organic accumulation and generally darker in colour than the underlying horizons.
	algal blooms:	a readily visible proliferation of aquatic plants.
	alkali (soil):	soil material that contains sufficient exchangeable sodium to impair its productivity.
	alliance (floristic):	particular combination of plant species.
	alluvium:	clay, silt, sand etc. deposited by running water.
	aquifer:	a water bearing bed of strata.
	ash:	the inorganic residue after incineration of coal under standard conditions.
	ash fusion:	behavioral properties of ash under high temperatures principally in a power station.
	attenuate (noise):	to lessen the amount of noise.
	Authorisation No. 339:	Document granted to the Joint Venture which allows technical investigations to be carried out over the specific area defined by latitudes 30°35'S and 30°38'S and longitudes 150°08'E and 150°12'E.
B	baseline (environmental studies):	studies to establish prevailing environmental conditions.
	bedrock:	unweathered rock below the soil.
	B-horizon (soil):	layer(s) within the soil profile characterised by a concentration of clay and/or with a structure unlike other horizons.
	blast vibration:	vibration caused by explosives, including air-blast effects.
	boxcut:	the initial cut in the mining process.
	bulk testing:	a large quantity of coal collected for analysis and marketing

C	calorific value:	a measure of the number of heat units liberated when a unit mass of coal is burned under standard conditions.
	catchment (area):	area which feeds river or stream.
	C-horizon (soil):	Layers beneath the A- and B-horizons consisting of partially weathered, consolidated or unconsolidated parent material.
	Clean Air Act, 1961:	NSW Government Act to make provision to prevent air pollution.
	Clean Waters Act, 1970:	NSW Government Act to make provision to prevent water pollution.
	Coal Lease:	Lease granted under Section 41 of the Coal Mining Act, 1973.
	Coal Mining Act, 1973:	NSW Government Act to make provision for prospecting and mining coal.
	coking coal:	a metallurgical coal.
	colluvium:	rock detritus and soil accumulated at the base of a slope.
	cored drilling:	the recovery of lengths of rock strata by boring into the ground.
D	dB(A):	decibel A scale. The scale is an electronic weighing network incorporated in sound monitoring equipment to represent the frequency response of the normal human ear.
	decibel:	a unit for expressing the relative intensity of sounds on a scale from zero for the average least perceptible sound to about 130 for the average pain level.
E	ecology:	the pattern of relationships between organisms and their environment.
	energy coal:	coal used principally for the generation of electricity.
	entrophication:	process of aging involving material enrichment. Characterised by blooms of aquatic plants leading to eventual drying up in lakes and water bodies.

	Environmental Planning & Assessment Act 1980:	NSW Government Act to institute a system of environmental planning and assessment.
	ephemeral (flow):	lasting a short time.
F	fault:	a break along which observable relative displacement of parts of a rock mass has occurred.
	fault complex:	an area containing a number of faults.
	fauna:	animals or animal life of a region.
	float sink tests:	the determination of proportions of coal that either float or sink in a series of liquids of differing specific gravities.
	flora:	plant life of a region.
	fluvial:	produced by stream action.
	fold:	a bend in stratified rocks resulting in a change in direction and/or angle of dip.
	forb:	a herb other than grass.
	frugivore:	fruit feeding fauna.
G	geophysically logged:	a hole that is logged with a suite of tools that measure the geological strata's response to induced electricity, natural and emission radiation.
	graminivore:	grass feeding fauna.
	groundwater:	water within the earth that supplies wells and springs.
H	habitat:	the place or type of site where a plant or animal normally lives and grows.
	Hardgrove Grindability	a laboratory test quantifying the hardness of coal as a means of estimating the capacity of commercial pulverisers to grind different coals.
	hardpan (soil):	a cemented or compacted layer, often clayey.
	hard water:	water high in calcium causing

		hardness to lather.
	hydrogeologic	vertical and horizonal section cross section:of hydrology and geology properties.
	hydrology:	properties, distribution and circulation of water.
I	intensity-frequency duration curves:	estimates of rainfall intensity for different recurrence intervals and rainfall durations.
	interburden:	rock material between coal seams.
	ionic:	characterised by ions (atoms with positive or negative charge).
	insectivore:	insect feeding fauna.
	insitu:	in the natural or original position.
J	Joint Coal Board Order No. 27:	Approval by the Board to open a mine, vary production or undertake major associated development work.
L	L_{90} level:	the noise level in dB(A) for 20 percent of a sample period. Also referred to as background sound level.
	lineaments:	a linear topographic feature.
M	median deviation:	statistical variable that gives the deviation of another variable from the median value.
	median value:	a value above and below which there is an equal number of values.
	mammal:	class of higher vertebrates that nourish their young with milk secreted by mammary glands and have the skin usually more or less covered by hair.
	metallurgical coal:	coal used principally for the manufacture of steelworks coke.
	meteorology:	the atmospheric phenomena and weather of a region.
N	Noise Control Act,1975:	NSW Government Act to make

		provision to control noise.
	non-core drilling:	the recovery of fragments of rock strata by boring into the ground.
	NO_x :	oxides of nitrogen which cause atmospheric pollution.
O	outcrop:	a coming out of bedrock or coal seam to the surface of the ground.
	overburden:	rock and soil materials overlying the coal seam.
	overburden ratio:	ratio of cubic metres of overburden to tonnes of coal.
	overpressure (noise):	explosive blast pressure wave causing atmospheric pressures above normal.
P	Permeability:	the ability of rock to allow water to pass through it by pores, bedding planes or joints.
	Permian:	Geological time from 280 to 225 million years.
	pH:	scale used to express acidity and alkalinity. Values run from 0-14 with 7 representing neutrality. Numbers less than 7 represent acidity.
	potentiometric	the surface which represents (surface): water levels.
	probable maximum	estimate of extreme precipitation: precipitation (rainfall) for various durations.
	product/Coal Tonnes	coal available after treatment.
	propagation (noise):	the spreading of noise.
	pyrites:	mineral consisting of iron disulphide (FeS2).
Q	Quaternary:	Geological time fom 2 million years to present.
R	raptor:	bird of prey.
	raw coal:	coal that has not been washed or processed.
	reclamation:	the act or process of reclaiming disturbed areas.

	rehabilitation:	the process of restoring to a condition of health and usefullness.
	reptile:	class of air breathing vertebrates, includes snakes, lizards etc.
	reserves:	the amount of coal within the boundaries of the deposit. See insitu, saleable, surface mineable and underground mineable.
	residuum (soil):	a residual product of weathering.
	resource:	a natural source of wealth or revenue.
	revegetation:	the process of re-establishing a vegetation cover.
	ROM:	Run Of Mine coal - as mined.
	rooting media:	soil or other medium provided to ensure revegetation.
S	saleable coal:	coal available for sale after treatment.
	saline (soil):	contains mineral salts sufficient to impair productivity.
	SAR:	Sodium Absorption Ratio, a measure of the level of exchangeable sodium. Soils with an SAR greater than 15 are defined as sodic.
	socio-economic:	combination of social and economic factors.
	sodic (soil):	contains exchangeable sodium sufficient to impair productivity.
	species:	an individual or kind belonging to a biological species.
	surface mineable:	coal available for mining by surface methods under defined parameters.
T	tailings:	residue separated in the coal preparation process.
	thermal coal:	an energy coal
	trace elements (soil):	chemical elements used by organisms and essential to their physiology, usually occurring in very small amounts in the natural environment.
	transmissivity:	the rate at which water can be transmitted through a unit strip of aquifer under a unit gradient.

U	underclay:	clay materials underlying the coal seam.
	underground mineable:	coal available for mining by underground methods.
W	washability tests:	laboratory analysis of the amenability of a coal to be improved in quality by suitable preparation.