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ENVIRONMENTAL GEOLOGY SUBSECTION
GEOLOGICAL SURVEY OF N.S.W.

ELURA E.I.S.

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SECTION ONE

INTRODUCTION

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1. INTRODUCTION

Electrolytic Zinc Company of Australasia Limited (EZ) proposes to establish an underground lead/zinc mine and concentrating plant in Central New South Wales about 41 kilometres north-north west of the town of Cobar.

The mine, to be known as the Elura Mine, will be on mining leases held by EZ on a section of Bundella Station, Western Lands Commission Lease No. 2114.

The concentrating plant is being designed to treat 1,100,000 tonnes of ore annually. Average annual output will be 132,000 tonnes (dry weight) of zinc concentrate and 99,000 tonnes (dry weight) of lead concentrate.

EZ was granted an exploration licence over the area in December 1971, and a subsequent airborne magnetic survey revealed an anomaly which suggested the presence of sulphide minerals at depth. Follow-up geophysical exploration on the ground confirmed the anomaly. Diamond drilling commenced in February 1974, and by February 1976, some 11,223 metres of drilling (29 holes) had defined an orebody and established a mineral resource of 27,000,000 tonnes assaying 8.3% zinc, 5.6% lead and 140 grams of silver per tonne.

Development Consent for operations at Elura was granted by the Cobar Shire Council in February 1976, after consideration of EZ proposals which included a "Review of Environmental Factors". Four mining leases surrounding the orebody were granted in March 1976, and in August 1976, permission was obtained for prospecting operations, including underground exploration, to be carried out on the mining leases.

An exploratory shaft, commenced in December 1976, was completed to 165 metres below surface in August 1977, and at 160 metres depth a crosscut (tunnel) was driven through the orebody. Samples recovered from the crosscut were treated in a pilot concentrating plant at the Australian Mineral Development Laboratories (Amdel) in Adelaide. This testwork formed the basis of proposals for ore treatment and tailings disposal.

The proposed mine will be entirely underground. Access will be by a vertical shaft, sunk initially to 590 metres. Access by decline (inclined tunnel) will also be provided to permit early development of the upper zones of the orebody.

Metallurgical treatment to produce separate lead and zinc concentrates will be based on semi-autogenous primary grinding and an essentially conventional flotation flowsheet, but with regrinding in both lead and zinc circuits and a reverse flotation step to upgrade the zinc concentrate.

1. INTRODUCTION (CONTINUED)

Classified coarse tailings from the concentrator will be returned to the mine to fill worked-out areas. Fine tailings will be pumped to a disposal area and formed into a stable pile.

On-site non-process facilities will include a workshop, laboratories, warehouse, offices, changehouse and two residential houses.

Concentrates will be railed from Elura to Newcastle where shiploading facilities will be established.

Water for the operations will be piped from Cobar, requiring an augmented supply from the Macquarie River. Electricity will be supplied via a new transmission line.

The total estimated work force is 382 people. New homes and single accommodation for employees will be established in the town of Cobar.

The requirement for an Environmental Impact Statement covering these proposals was determined in December 1977, by the then Commonwealth Minister for Environment, Housing and Community Development.

CONTRIBUTORS

The following consultant and specialist organisations employed by EZ have played important roles in developing the proposals and in surveying aspects of the existing environment.

Associated Aerial Surveys Pty. Ltd.	- aerial colour photographs, contoured maps of the mining leases and surrounding areas.
Australian Groundwater Consultants Pty. Ltd.	- groundwater availability and quality.
Australian Mineral Development Laboratories	- metallurgical testing, base-line soil analyses.
Australian Rock Engineering Consultants	- rock mechanics
Central Mineralogical Services	- mineralogy and petrology
Dames & Moore	- "Review of Environmental Factors".
Fluor Australia Pty. Ltd.	- overall engineering studies.
Golder Associates	- terrain evaluation, soil mapping, tailings disposal testwork.
Natural Systems Research Pty. Ltd.	- detailed studies of flora, fauna, archaeology and surface hydrology.

1. INTRODUCTION (CONTINUED)CONTRIBUTORS (CONTINUED)

Other information and advice made use of in compiling this statement has been drawn from a wide range of sources, including governmental agencies, whose co-operation is gratefully acknowledged.

SECTION TWO

SUMMARY

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- 2.1 Project Title
- 2.2 Proponent
- 2.3 Objectives of the Proposed Development
- 2.4 Benefits of the Proposed Development
- 2.5 Description of the Proposed Development
- 2.6 Construction Period
- 2.7 Principal Features of Existing Environment
- 2.8 Potential Environmental Effects and Safeguards
Proposed
- 2.9 Summary of Environmental Impacts and Management

2. SUMMARY

2.1 Project Title

Elura Mine

2.2 Proponent

Electrolytic Zinc Company of Australasia Limited is a wholly owned subsidiary of EZ Industries Limited, an Australian owned and controlled public company employing 3,300 people, with interests in exploration, mining, transport and zinc refining.

The Company's existing operations are based mainly in Tasmania, where it owns and operates underground lead/zinc/copper/silver mines at Rosebery, and one of the world's largest zinc refineries at Risdon, near Hobart. Current annual output of refined zinc is 200,000 tonnes, of which over 75% is exported. By-products include cadmium, sulphuric acid and fertilisers.

Through the wholly-owned Emu Bay Railway Company Limited the EZ Group also owns and operates a railway in Tasmania, together with concentrate shiploading facilities at the port of Burnie.

2.3 Objectives of the Proposed Development

The principal objective of the proposed development is the commercial exploitation of the Elura orebody for production of zinc and lead concentrates.

A related objective is to ensure the supply of zinc concentrate to the Risdon zinc refinery. The Company's existing mines currently provide about a third of the raw material required by the refinery. The balance must be purchased from other sources, supplies from which cannot be assured in the long term.

Although some of the lead concentrate produced may be sold to existing Australian lead smelters it is likely that most of it, if not all, will be exported.

2.4 Benefits of the Proposed Development

Anticipated benefits from the proposed development are:

- (i) The establishment of another major industry in the Cobar district will present new employment opportunities, not only at the mine but also in service areas such as schools, hospitals, banks and shops, and will improve the prosperity of the established town;

2. SUMMARY (CONTINUED)

2.4 Benefits of the Proposed Development (Continued)

- (ii) Local government will receive rate payments on the new properties, while enjoying greater patronage of town facilities;
- (iii) State authorities in New South Wales will gain additional revenue from mining royalties, rail freight charges, water and power tariffs and harbour fees;
- (iv) Federal and State Treasuries will benefit from the additional taxes levied;
- (v) Export of part of the output from the proposed mine will boost the national balance of payments;
- (vi) There will be an assured supply of raw material to the Risdon zinc refinery and financial benefits to an Australian owned company, Electrolytic Zinc Company of Australasia Limited, as a return on its investment in the project.

2.5 Description of the Proposed Development

It is proposed to establish an underground mine and concentrating plant in the Shire of Cobar. The proposed mine complex will be situated 41 kilometres north-north west of the town on Cobar, in relatively flat, semi-arid scrubland used for grazing. Present access from Cobar is via the Cobar - Louth public road for 43 kilometres and then by pastoral access road for 13 kilometres to the east (see Figure 1).

During the first year of production the mine will work up to an annual output of 1.1 million tonnes. Mineral reserves to a depth of 510 metres below surface will support a minimum life of fifteen years at that production rate. The mineralisation has not been explored below that depth.

Mechanised mining will follow established practices. Ore and waste rock will be crushed separately underground and hoisted to the surface via a vertical circular shaft. Access by decline (inclined tunnel) will also be provided, to facilitate early development of the upper zones of the orebody. Crushed ore will be transported on surface by conveyor belt to a coarse ore stockpile, and waste rock will be trucked to a temporary stockpile for later use as mine fill.

Ore from the stockpile on the surface will be processed at an average rate of 3,000 tonnes per day. Processing will begin with wet semi-autogenous grinding to produce a finely divided suspension of solids. From this suspension the valuable mineral components will be separated into concentrates for shipping to smelters and refineries. Separation and concentration will be by the flotation process and will result in the production of separate lead and zinc concentrates. Silver will be recovered preferentially in the lead concentrate.

2. SUMMARY (CONTINUED)

2.5 Description of the Proposed Development (Continued)

The concentrates will be dewatered by thickening and filtration followed by drying in rotary dryers. Concentrates shipped from the mine site will contain approximately 8% moisture.

The residue (tailings) from the processing plant will be cycloned to recover a coarse product for returning underground to fill worked-out areas of the mine. The fine fraction of the tailings will be thickened and pumped by pipeline to a disposal area. The pipeline will be elevated by a ramp, and tailings discharged from it will form into a stable cone. Water run-off from the tailings pile will be collected in a dam and returned to the concentrating plant.

Water from plant floors, and water run-off from ore stockpiles, will be collected and returned to the concentrating plant. Water pumped from the mine will also be re-used to the maximum possible extent, any excess being directed to an evaporation pond. Stormwater drainage from the site generally will be accommodated by the provision of open, unlined drains which will be directed to natural drainage systems. With this exception there will be no liquid effluents from the site.

Concentrates will be transported to Newcastle by rail. This will involve the construction of a branch line 32 kilometres long from the mine site to a point about 12 kilometres from Cobar on the branch line to Cobar Mines Pty. Ltd.'s Mine. The port facility constructed at Kooragang Island, Newcastle, will comprise a rail wagon tippler, a concentrate storage shed and a shiploader.

The electric power supply to the project will be via an aerial transmission line from Cobar. This will be built as an extension of the present regional power supply system by the Electricity Commission of New South Wales. Two oil-fired generators will be installed for emergency use.

Water will be supplied through a buried pipeline from Cobar. The additional demand will require that the present supply to Cobar from the Macquarie River be augmented by duplicating the existing pipeline from Nyngan to Cobar.

Two houses for key employees are tentatively proposed at Elura, but otherwise the work force will be housed in Cobar, with new housing integrated as far as possible with the existing township. 268 new houses are proposed, plus single quarters. The total estimated work force is 382.

Access to the mine by road for employee bus transport, etc., requires upgrading and sealing of a 34 kilometre section of the Cobar - Louth public road, plus 13 kilometres of access road.

2. SUMMARY (CONTINUED)

2.6 Construction Period

During the construction period a temporary construction camp will be erected on site, comprising transportable modules serviced with water, electricity and sewerage. The camp will be supervised by the construction manager, who will ensure that the operation, cleanliness and hygiene comply with relevant laws and regulations.

Power for construction purposes will be provided by the early installation of one of the emergency generators. Bore water will be used wherever possible and potable water will be carted by road tanker from Cobar. The permanent sewage treatment plant will be installed at the start of the construction period.

During construction, topsoil will be removed where appropriate and stockpiled for subsequent use in revegetation. Sub-soil and rock removed from surface and underground excavations will be selected for use in embankments or mine fill. Rock destined for later use as mine fill will be formed into a temporary stockpile.

Off-site construction works will comprise access road upgrading, railway branch line, water supply pipeline, power transmission line, housing in Cobar, and port facilities. Some of these works will be constructed by, or under the supervision of, the State or local authorities.

2.7 Principal Features of Existing Environment

The proposed mine is situated in flat or gently undulating scrubland with no outstanding surface features. The geologically old landscape comprises low erosional mounds between broad, sediment filled watercourses.

The climate is semi-arid, and there is no natural source of permanent surface water within a considerable radius. Nearly all land in the area is Crown Land administered by the Western Lands Commission. Sheep have been grazed in the area since about 1870, the stocking rate varying with food and water availability. Groundwater in the Elura area is very saline and potable water for stock is provided almost entirely from earthen dams or "tanks". Land use management is restricted mainly to the extent of fencing, provision of stock water, and rotational stocking.

Sheep grazing has progressively destroyed the palatable species of plants (grasses, saltbushes and herbs) and in later years has caused the reduction of shrubs and small trees. The remaining vegetation consists mainly of stunted trees and shrubs which can withstand grazing and can regenerate on poor soils. Sheet erosion of soil has been widespread.

2. SUMMARY (CONTINUED)

2.7 Principal Features of Existing Environment (Continued)

The effect of grazing, probably aided by fire control, has thus been to modify the vegetation significantly since European settlement began. There has been a general change from a more open to a more wooded landscape, and stocking rates have gradually fallen as a consequence.

No rare or endangered species of flora or fauna has been found in the area of the proposed mine site. An archaeological search for signs of aboriginal activity has discovered several sites of interest, including former campsites adjoining gilgais (depressions that contain water after rain).

Cobar is an old-established mining town founded following the discovery of copper in 1869. It has also become the centre of a widespread agricultural district. The population has varied widely over the years as mines have opened and closed in the area, and was approximately 10,000 at the turn of the century. It is currently about 3,300, having fallen from 4,400 in 1975 following retrenchments by Cobar Mines Pty. Ltd. Business in the town has been generally depressed since that time.

Visual evidence of former mining and smelting operations is widespread, particularly on the south-eastern side of the town.

Many of the buildings in Cobar are relatively modern. The town is well-endowed with facilities, including water supply, sewerage, airport, generous sporting and leisure facilities, convent and state primary schools, high school, hospital and ambulance centre.

2.8 Potential Environmental Effects and Safeguards Proposed

The project development and operation at Elura appears to have no serious detrimental environmental implications. This is due to the remote location of the site, and the need to conserve water. Many aspects of the environment will be affected, but only in minor ways. This will be ensured by a properly engineered and operated project to control dust, noise, waste water and stormwater run-off.

The water management programme will aim to maximise water recycling in order to minimise consumption of fresh water, and also to ensure that contaminated liquid effluent does not escape into the surrounding drainage systems. Water management, together with appropriate revegetation procedures, will form the basis of the overall environmental management programme.

The biggest single impact on the environment at Elura will be from the tailings dump. It is proposed to build the dump sequentially in three segments, so that work on revegetating the first segment can begin after the first five years of operation.

2. SUMMARY (CONTINUED)

2.8 Potential Environmental Effects
and Safeguards Proposed (Continued)

The significance of the archaeological sites recently discovered has not yet been established. Before any construction work begins, steps to avoid, protect or excavate the sites as appropriate will be taken in consultation with the National Parks and Wildlife Service.

The proposed mine will have a major impact on the town of Cobar, but the effects will be overwhelmingly beneficial to the town's prosperity. Social impacts will be minimised by integrating new housing into the existing town to the maximum extent, and ensuring that the new houses are of a design and standard in keeping with existing structures.

2.9 Summary of Environmental Impacts and Management

Project Managers will be appointed to undertake detailed design and construction of the Elura Mine. EZ personnel will be in constant consultation with the Project Managers and will be closely involved in the engineering, mining and technical aspects, as well as the environmental effects and impacts of the project. It is believed that this close involvement will lead to the elimination or control and minimisation of many potential problems at the design stage.

The following tabulations summarises the impact and management of various aspects of the project.

ENVIRONMENTAL IMPACT & MANAGEMENT

ACTIVITY	EFFECT	MANAGEMENT	RESIDUAL	RESPONSIBILITY
<u>Construction Activities and Provision of Off-Site Facilities</u>				
Construction Activities on Mine Site	Influx of 550 workers (peak)	Build construction camp on site.	Completed plant and facilities	Project Managers
	Temporary clearing, destruction of fauna habitats	Remove after use and revegetate area		
Rail Link from C.S.A. siding to Mine Site	Traversing grazing properties	Provide stock & vehicle crossings. Follow boundary fences where possible.	Permanent features over insignificant area.	Project Managers Public Transport Commission
	Destruction of flora & fauna habitat			
Upgrade road to Mine Site	Improved access to adjacent properties.	Provide cattle grids	Improved access	Project Managers
Electricity Supply	Tree clearance along easement. Visual appearance of pylons and overhead lines.		Changed landscape	Electricity Commission

ENVIRONMENTAL IMPACT & MANAGEMENT (CONTINUED)

ACTIVITY	EFFECT	MANAGEMENT	RESIDUAL	RESPONSIBILITY
<u>Construction Activities and Provision of Off-Site Facilities (Continued)</u>				
Water Supply to Cobar	Visual effect of duplicate pipeline. Increased water supply to town.		Insignificantly changed landscape. Increased water supply to Cobar.	Public Works Department
Water Supply to Elura	Temporary disturbance above trench.		Insignificantly changed landscape.	Public Works Department
Port	Increased rail and ship traffic. Visual effect of shiploader.	Minimise dust and noise.	Berth and shiploader for other uses.	Public Works Department Maritime Services Board Project Managers
Clearing Site	Destruction of vegetation and of fauna habitats	Clear minimum area and plant gardens and trees.	Changed flora and fauna.	Project Managers
Erection of Plant and buildings	Visual	Paint in harmonious colours		Project Managers
Upgrade Cobar/Louth Road	Improved public road	Provide culverts	Improved public highway	Public Works Department
Build houses in Cobar	Increased population, business activity.	Integrate housing. Expand facilities.	(Depends on future exploration, etc.)	Project Managers

ENVIRONMENTAL IMPACT & MANAGEMENT (CONTINUED)

ACTIVITY	EFFECT	MANAGEMENT	RESIDUAL	RESPONSIBILITY
<u>General Site Operations</u>				
Administration & Maintenance Areas	Potential contamination with sewage and sullage.	Treatment and use of effluent and residue for revegetation.	Fertilised area.	EZ
Worn out or obsolete equipment	Visual appearance.	Sell as scrap	Nil	EZ
Used lubricating oils & combustible materials.	Visual appearance.	Burn to requirements of Air Quality Regulations	Nil	EZ
Garbage	Visual appearance and fire hazard.	Remove to Council tip.	Nil	EZ
Magazine	Visual appearance	Remove at end of operations.		
	Explosion hazard	Design & maintain according to State regulations.		
	Security risk	Fence completely and keep locked when not attended.	Nil	EZ

ENVIRONMENTAL IMPACT & MANAGEMENT (CONTINUED)

ACTIVITY	EFFECT	MANAGEMENT	RESIDUAL	RESPONSIBILITY
<u>Mining Operations</u>				
Decline Portal	Visual	Secure against entry at end of operations.	Visual	EZ
Shaft Headframe	Visual	Secure against entry at end of operations.	Visual	EZ
Shaft		Cover and secure at end of operations.		EZ
Vent Rises and Fans	Visual	Dismantle fans and cover rises at end of operations.	Visual at ground level.	EZ
Underground Mining	Utilisation of Mineral Resource	Maximise extraction of available ore.	Consumption of resource.	EZ
Waste Dumps	Visual	Exhaust by end of Mine life. Revegetate cleared area.	Nil	EZ
Mine Water	Potential pollution of surface water.	Re-use or loss by evaporation. Bury solid deposits.	Nil	EZ

ENVIRONMENTAL IMPACT & MANAGEMENT (CONTINUED)

ACTIVITY	EFFECT	MANAGEMENT	RESIDUAL	RESPONSIBILITY
<u>Concentrator Operations</u>				
Coarse Ore Stockpile	Visual	Remove at end of operations.		
	Dust	Suppress dust.	Nil	EZ
Plant - General	Visual	Remove at end of operations.	Visible foundations	EZ
Tailings Dump	Visual	Collect all run-off.	Changed landscape.	EZ
	Potential pollution of surface water.	Revegetate segments sequentially.		

SECTION THREE

DESCRIPTION OF EXISTING ENVIRONMENT

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- 3. 1 Location
- 3. 2 Landform
- 3. 3 Regional Geology
- 3. 4 Soils
- 3. 5 Meteorology
- 3. 6 Hydrology and Drainage
- 3. 7 Seismology
- 3. 8 Flora
- 3. 9 Fauna
- 3.10 Archaeology
- 3.11 Land Tenure
- 3.12 Land Use
- 3.13 Community
- 3.14 Transport and Service Facilities
- 3.15 Port Facilities
- 3.16 References

3. DESCRIPTION OF EXISTING ENVIRONMENT

3. 1 Location

The proposed Elura Mine is located approximately 41km north-northwest of Cobar, on the Bundella pastoral lease, in west central New South Wales, which is zoned as non-urban land.

3. 2 Landform

The landform at Elura comprises part of an ancient land surface with a very gently undulating topography. The elevation of the proposed mine site is about 210m above sea level. Total relief within the area is 21m and slopes range from a maximum of $1\frac{1}{2}^{\circ}$ to less than $\frac{1}{2}^{\circ}$, generally lying between $\frac{1}{2}^{\circ}$ and 1° . The nearest prominent topographical feature is a low range of hills some 35km to the west.

3. 3 Regional Geology

The Elura zinc-lead-silver deposit is situated within a lithological sequence called the Cobar Group which has accumulated in the Cobar trough. This group consists of a number of recognisable sedimentary units which tend to merge vertically and laterally through facies changes (see Figure 2).

The units are listed below:

Amphitheatre Formation	Sandstones and siltstones.
C.S.A. Siltstone Member	Bedded siltstone and fine grained sandstone.
Great Cobar Slate	Slate.
Chesney Formation	Sericitic sandstone and siltstone.
Drysdale and Bee Conglomerate Members	Coarse conglomerate.

The Cobar Group units lie above and to the west of a basement sequence called the Ballast Beds, a late Ordovician to early Silurian sedimentary sequence of sandstones and siltstones that contain cherts and some coarser grained grits and conglomerates. An unconformity or disconformity separates this basement sequence from the overlying Lower Devonian Cobar Group.

Mineralisation of importance in the Cobar Field has to date been outlined in the Great Cobar Slate and C.S.A. Siltstone Members. A regional trend north from Cobar can be recognised. Important features are:

3. DESCRIPTION OF EXISTING ENVIRONMENT (CONTINUED)3. 3 Regional Geology (Continued)

1. a trend from gold (Occidental Mine), to a copper with gold (Great Cobar Mine), to copper with zinc and lead (C.S.A. Mine), to zinc and lead with silver (Elura deposit);
2. an increase in the sulphide content and massive nature of the deposits;
3. an apparent upward change in the stratigraphic position of the mineralisation.

The Elura mineralisation is in the C.S.A. Siltstones at the northern end of the Cobar trough.

Structurally, the Cobar Group rocks dip steeply west, however tight folding causes local easterly dips in the southern regions of the trough where a tight syncline called the "Myrt Syncline" trends to the north for 15 kilometres before opening out to form a broad regional structural basin. The C.S.A. Siltstone that contains the Elura mineralisation is north of this structural basin in an area where bedding appears to form a flat to broadly undulating domal zone. Outcrop throughout the Cobar trough area underlain by the finer grained sediments is poor. This lack of outcrop, particularly in the vicinity of Elura, makes detailed structural interpretation extremely difficult.

A description of the Elura orebody is included as Appendix A. An isometric diagram is included as Figure 3.

3. 4 Soils

Soils at Elura are red earths, mostly non-calcareous loams. They have weak profile differentiation, except for a darker surface horizon, and a neutral pH trend.

On the low rises, the upper five centimetres are red sandy clay loams, with a reasonable content of organic matter. Below this, soil is massive red sandy clay devoid of organic matter.

Soils in the watercourses are variable, and depend upon the degree of deposition accumulation. The surface horizon is often quite deep (0.5 to 1.5m), with sand to sandy loam over silty loam. This horizon overlies sandy clay to clay, red to red-brown in colour.

Amdel have sampled and assayed the soils surrounding the proposed mine area to establish baseline levels of heavy metals. Their findings are detailed in Appendix B.

3. DESCRIPTION OF EXISTING ENVIRONMENT (CONTINUED)

3. 4 Soils (Continued)

Golder Associates have examined the soil types in the area in connection with a terrain evaluation for preliminary tailings disposal studies. Their findings are mapped and described in Figure 4.

3. 5 Meteorology

The nearest meteorological recording station to the mine site is at Cobar. It is considered that there should be no significant difference between the weather patterns at Elura and at Cobar and little possibility of a micro-climate at Elura. The meteorological observations at the Cobar weather station (operated by the Bureau of Meteorology) and the Cobar Post Office are therefore expected to apply to the mine area. There may be some variation in wind gusts, but the variation is expected to be minimal.

The Cobar region has a sub-tropical continental climate. Maritime air masses rarely penetrate so far inland and the relatively dry air leads to large daily variations in temperature. In summer the region is 75% of the time (Gentilli, 1971) under the influence of the Australian sub-tropical continental air mass, which has low humidity and often very high day-time temperatures. Occasional incursions of Pacific sub-tropical maritime air occur (25% of the time), creating conditions for summer thunderstorms which contribute the larger part of the regional rainfall, with maximum monthly falls occurring in December, January and February. During the cooler part of the year the region is still subject to sub-tropical continental air 75% of the time, with incursions of southern polar maritime air reaching north in the rear of the low pressure troughs between travelling anticyclones. This leads to a secondary rainfall maximum in June.

Annual rainfall is low with a median value of 343mm and a mean of 356mm. Despite this low annual fall, very heavy rainsqualls may occur, particularly in association with summer thunderstorms, resulting in extensive flash flooding.

The aridity is exemplified by the annual evaporation total of 2,730mm on average over the period 1969 to 1974 inclusive, or 8 times that of the median rainfall. The evaporation rate ranges from 500mm in a summer month to 60mm in a winter month. The dry continental air leads to clear skies and strong radiation inversions at night, particularly in winter.

Temperatures range from frost in the winter to over 40°C in summer on the hottest days.

3. DESCRIPTION OF EXISTING ENVIRONMENT (CONTINUED)3. 5 Meteorology (Continued)

Prevailing winds in the winter are from the west-southwest, while during the rest of the year they tend to be more variable. In general, winds are light, but strong gusts may occur during thunderstorm squalls. The extreme wind gusts for various return periods are listed below:

Extreme Wind Gusts at Cobar

<u>Return Period (Years)</u>	<u>Gust Speeds (km/hr)</u>
1	97
10	122
20	130
50	137
100	151

Source: Whittingham, 1964

It is considered that climatic conditions do not offer any obstacles to the implementation of the proposed project.

3. 6 Hydrology and Drainage

The site is within the catchment of the Darling River. Land is of very low relief and no well developed drainage channels exist. Rainfall run-off covers broad, almost flat watercourse areas, the main direction of drainage being towards the south-west.

3. 6.1 Hydrology

The contorted old sediments beneath the surface yield no artesian water - live stock depend largely on surface water stored in excavated dams ("tanks"), which lie along watercourses and slopes. The water table lies some 80m below the surface at Elura and groundwater quality is exceptionally poor. An analysis of groundwater pumped from a bore at the site for diamond drilling during the exploration phase is attached as Appendix C. Exploratory drilling on the site has not revealed the presence of any perched aquifers close to the surface.

3. 6.2 Drainage

All streams in the Cobar region are ephemeral and flow infrequently. At Elura the low ridges supporting shrubland act as run-off areas, and the broad, more densely vegetated woodlands of the watercourses are normally run-on areas. The more gentle slopes, deeper soils, and dense vegetation cover in these watercourse areas require substantially higher rainfall before run-off over the whole catchment will occur.

3. DESCRIPTION OF EXISTING ENVIRONMENT (CONTINUED)
3. 6 Hydrology and Draining (Continued)
3. 6.2 Drainage (Continued)

Work at the Cobar Experimental Station of the Soil Conservation Service (Walker and Cunningham, 1976) has shown that, on average, run-off occurs from small trial plots on 19 occasions each year. Threshold run-off values were approximately 5mm and both antecedent rainfall and season were found to be virtually irrelevant. Elura is drained by the Mosquito Creek catchment which joins Buckwaroon Creek and later Crowl or Sandy Creek, eventually terminating in very flat country some 200km south-west of the mine site. Estimated frequencies of flow range from once per year at Elura to once every three years at the Cobar - Louth Road, and once every five to ten years for Crowl Creek.

Plate 8 shows the section of the Cobar - Louth Road traversed by Mosquito Creek when in flood.

Figures 5 and 6 are maps indicating the drainage channels in the area. These maps were prepared by Natural Systems Research Pty. Ltd. from study of aerial photographs, investigations on the ground, and discussions with local residents.

3. 7 Seismology

The Earthquake Risk Map of Australia, 1978, prepared by the Bureau of Mineral Resource, shows the Elura site to be 125km from the nearest recorded epicentre and that only four recorded epicentres occur within a radius of 200km - all of these to the north and east of the proposed mine site. To the south and west, the area bounded by the Lachlan and Darling Rivers is free of recorded seismic activity and the mine site is in a zone of least expected earthquake risk.

3. 8 Flora

The vegetation of the mining lease and proposed railway easement is essentially all one community, the "Eucalyptus populnea - Acacia - (bimble box - wattle) Association" of Beadle (1948). Within this association, eight vegetation types have been identified, reflecting the minor topographic variations with changes in the dominant species and in structure. There is a substantial intergradation of the seven woodland types and only the watercourse shrublands show a clearly defined zonation. There are also two outliers characteristic of adjacent associations.

The ten vegetation types have been classified in standard structural sequence as follows:

3. DESCRIPTION OF EXISTING ENVIRONMENT (CONTINUED)3. 8 Flora (Continued)Woodland

1. Eucalyptus populnea (bimble box) woodland
2. E. intertexta (red box) woodland
3. E. populnea - Acacia aneura (bimble box - mulga) woodland

Open Woodland

4. E. populnea - A. excelsa (bimble box - ironwood) woodland
5. E. intertexta - A. aneura (red box - mulga) woodland

Tall Shrubland

6. A. aneura (mulga) tall shrubland
7. A. amalophylla (yarran) tall shrubland
8. A. burkittii tall shrubland

Tall Open Shrubland

9. A. excelsa (ironwood) tall open shrubland
10. Eremophila-Dodonaea - Acacia shrubland

Variations in vegetation according to topography reflect different soil moisture conditions. The saline water table at some 80m depth is not expected to bear on the maintenance of the individual plants.

The predominant vegetation and outlier types on the mining lease and proposed railway alignment are characteristic of the region as a whole. The bimble box - wattle association covers some 12,000 km² of New South Wales, and the other types are characteristic of other major associations with a similarly extensive distribution.

Typically, vegetation has been substantially modified since European settlement by fire control; grazing by introduced sheep, cattle, goats and rabbits; and land clearance (Greig et al, 1969). The net effect has been to reduce the number of large gums in the watercourses (by felling) and the groundcover vegetation (by grazing) and to increase the small tree and shrub component (by fire control); a general change from a more open to a more wooded landscape.

Vegetation is described in more detail in Appendix D, and vegetation maps are included as Figures 7, 8, 9 and 10.

3. DESCRIPTION OF EXISTING ENVIRONMENT (CONTINUED)3. 9 Fauna3. 9.1 Terrestrial Fauna

As far as mammals are concerned, the area's habitat characteristics have been drastically modified by the effects of European settlement, and species depending on large trees (such as possums), and on fallen limbs and a formerly grassy groundcover over soft soils (small marsupials and rodents) have been entirely eliminated, including the usually ubiquitous introduced house mouse Mus musculus: larger trees have been felled; fire control has altered the vegetation of the area from open Savannah woodland to a more wooded shrub-dominated landscape, grazing animals have severely compacted the soil, making it difficult and hazardous for burrowing animals, and the introduction of foxes and cats has applied predatory pressure. The grossly depauperated remnants of the mammal fauna comprise three species of kangaroo, which have probably increased in numbers as a result of permanent water storages, seven species of bat, and the unpalatable, insectivorous spiny anteater.

The frog fauna will also have increased substantially in abundance and diversity as a result of the numerous farm dams in the area. Reptiles are probably of a similar diversity to pre-European times.

Natural Systems Research Pty. Ltd. have carried out an extensive assessment of fauna population in the Elura area and details, including an inventory of known fauna are given in their report - Appendix E.

3. 9.2 Avifauna

A detailed record of 216 bird species sighted in the Cobar region has been compiled by B. L. Schmidt. The sightings covered a period of several years during which Mr. Schmidt was employed as a Senior Geologist by EZ, in a supervisory role in geological exploration, both at Elura and the Cobar area generally.

Mr. Schmidt's work was incorporated as an interim report in the "Review of Environmental Factors" prepared by Dames and Moore in 1975, and a more detailed review has since been published (Schmidt, 1978).

A number of factors have modified the composition of the bird fauna, and the abundance of individual species, since European settlement. Species wholly or partly dependent on the saltbush areas of the Darling Floodplain, on the previously widespread grassy Savannah woodland and on large individual trees, have declined as European agricultural development, tree felling, and in particular the reduction in fire frequency, brought about a change from more open to more wooded country, with extensive belts of shrubland. Other species,

3. DESCRIPTION OF EXISTING ENVIRONMENT (CONTINUED)

3. 9 Fauna

3. 9.2 Avifauna

on the other hand, have benefitted, particularly those favouring a shrubland habitat, while municipal storages and a large number of farm dams have provided a suitable habitat for some 45 water birds, none of whom would have appeared as more than occasional visitors to an area generally devoid of permanent standing water.

The mallee fowl, bustard and bush stone curlew have been under severe pressure from shooting and foxes over their extensive ranges, and are locally extinct in areas around Cobar where formerly they were numerous.

3.10 Archaeology

Several important archaeological sites are known to the north and west of Cobar, as shown in Figure 11. The closest to Elura are at Wuttagoona, some 30km to the west. None of these sites is threatened by the proposed development.

A brief archaeological survey of the Elura mine site and surrounding area has been made in search of signs of former aboriginal activity. This survey has identified fourteen sites of archaeological interest. The sites are of four main types:

- (a) isolated stone tools;
- (b) possible sources of siliceous raw material for flaked stone artifacts;
- (c) scarred trees;
- (d) surface camp sites.

The significance of these sites, and of the area generally, is unknown. Figure 12 records the location of the sites, described in more detail in Appendix F.

Further archaeological surveys are required before the precise routes of access and service corridors to the mine site are established.

3.11 Land Tenure

Bundella pastoral property is on Crown Land and comprises Western Lands Lease 2114, Parish of Booroondarra, County of Cobar.

Mining Leases 158, 159, 160, 161 within Bundella (issued pursuant to the Mining Act 1973) are held by Electrolytic Zinc Company of Australasia Limited.

3. DESCRIPTION OF EXISTING ENVIRONMENT (CONTINUED)

3.12 Land Use

The proposed mining development is located on the Bundella pastoral property. Sheep grazing here is the main land use, with the stocking rate varying depending upon food and the availability of water. There are no permanently flowing creeks, and water is obtained almost entirely from farm dams described as "tanks".

Land use management is mainly in the form of fencing, provision of stock water and rotational stocking. Few improvements have been possible in recent years because economic returns have been generally low.

3.13 Community

The town of Cobar is situated some 56 road kilometres from the mine site. It is a well-established town and is the administrative centre of the Cobar Shire which covers an area of 44,000km².

3.13.1 History

Cobar was the centre of major mining operations a century ago, the first copper mine at Cobar beginning operations in 1871. Mining developed quickly and the population of Cobar reached 10,000 in the early 1900's.

Mining continued until 1919 when low copper prices, low grades of ore, rising costs and other difficulties caused the closure of most mines. The last big producer closed in 1920.

Between 1932 and 1952 New Occidental Gold Mines N.L. operated in Cobar and, in 1957, Cobar Mines Pty. Ltd. was formed to purchase Mining Leases and other assets from this Company. Cobar Mines started shaft sinking at the C.S.A. Mine in 1962 and production commenced in 1965.

Prior to the re-opening of the mines at Cobar, the town existed purely as a service centre for the surrounding rural area. It supported a maximum population of 2,000 people at a time when the rural sector was buoyant and affluent. The wool industry, which assumed considerable importance in the district from about 1920, was largely responsible for the continued existence of the town during the periods of low mining activity.

In 1974 a base camp for the Natural Gas Pipeline was established in Cobar and the population exceeded 4,500 people. The camp's departure and declining metal prices resulting in retrenchments at Cobar Mines Pty. Ltd. have contributed to a decline in the population at Cobar since 1974 and official census figures put the population of Cobar at 30th June 1976 at 3,335 people.

3. DESCRIPTION OF EXISTING ENVIRONMENT (CONTINUED)3.13 Community (Continued)3.13.2 Economic Climate

In recent years the rural industry in the areas has been at a low ebb - much lower than was the case prior to the re-opening of Cobar Mines and, as a result, requiring and supporting a smaller service centre. Cobar is in a semi-arid part of New South Wales and diversification from the major rural industry - wool, and the minor industry - cattle, shows limited promise.

The business section in Cobar is heavily dependent upon supplying Cobar Mines Pty. Ltd., their employees and families, and other services and supply personnel generated by them. Following retrenchments at Cobar Mines a large number of business undertakings are now operating marginally in the hope of future improvements to the economic state of the town.

3.13.3 Facilities

Cobar has well established service facilities including piped water supply, sewerage, sealed aerodrome, Olympic sized swimming pool, golf course, race course and playing fields. Most facilities would be adequate for a larger population.

Shortage of water has always been one of the town's biggest problems. However, pumping capacity on the Nyngan-Cobar pipeline is planned to be increased and ultimately duplication of this pipeline will assist in overcoming any future problems.

Schools in Cobar service the town and the surrounding rural community. Enrolment as at August 1977 was as follows:

High School	443
Primary School	225
Infant School	222
Convent School (5-12 years)	<u>172</u>
	1,062

The Cobar hospital can accommodate 40 patients. There are 2 doctors in private practice in town and one dentist. Other facilities are a pre-school centre, child health centre, an ambulance centre and a fire station.

Rock mechanics?

Government Departments with regional offices in Cobar include Bureau of Meteorology, C.S.I.R.O., Commonwealth Employment Agency, Department of Agriculture, Department of Main Roads, Soil Conservation Service of New South Wales and the Western Lands Commission. Local bodies include the Shire Council, Cobar District Ambulance Service, Pastures Protection Board, Water Board and the Macquarie County Council.

3. DESCRIPTION OF EXISTING ENVIRONMENT (CONTINUED)3.13 Community (Continued)3.13.3 Facilities (Continued)

Cobar is well off for many construction and building materials, and for local engineering and housing works. There are adequate banking, business and professional services provided in the town.

Houses in the town are predominantly timber-framed, with asbestos cement cladding and galvanised iron roofing and lined with plaster board or fibrous plaster. There are relatively few brick houses or tiled roofs.

Plate 9 shows a section of Marshall Street in the business centre of Cobar. Plate 10 indicates the standard of present miners' housing in the town.

3.13.4 Demographic Characteristics (Figures provided by the Australian Bureau of Census - 1976 Census)

The population of the Cobar Shire at 30th June 1976 was 4,618 people, comprising 2,400 males and 2,218 females. Young people are predominant in the population. Eleven percent are less than 5 years of age, and 43% less than 20. Only 9½% are 60 or over. The ethnicity ratio is low with only 5 overseas-born people per hundred and the majority of these were born in the United Kingdom.

3.14 Transport and Service Facilities3.14.1 Rail

The New South Wales Railways track terminates at Cobar, and Cobar Mines Pty. Ltd. has the right of ownership of a 12 kilometre link between Cobar Station and the C.S.A. Mine. The railway line to Cobar was opened in 1892. Since 1962 the line from Cobar to Dubbo has been upgraded to cope with increased traffic of heavy ore trains from the Cobar Mines.

A standard gauge rail line extends from Cobar via Orange to the Sydney rail network, via Werris Creek to Newcastle, and via Parkes, with a break of gauge to the South Australian network. The respective rail distances to Sydney, Newcastle and Adelaide are 785 kilometres, 874 kilometres and 1,420 kilometres.

Passenger rail services to Cobar have recently been discontinued. Air-conditioned road coaches connect with rail services from Dubbo on three days each week.

3. DESCRIPTION OF EXISTING ENVIRONMENT (CONTINUED)3.14 Transport and Service Facilities (Continued)3.14.2 Road

The Louth-Cobar Road passes within 13km of the Elura deposit. From Cobar it is sealed for 8km to the C.S.A. Mine turn-off and the remaining section is an all weather gravel road. A gravel road 3.7m wide connects the Elura site with the Louth-Cobar Road.

From Cobar the Barrier Highway extends in the south-easterly direction to Sydney and in a south-westerly direction to Adelaide, the respective road distances being 718 kilometres and 997 kilometres.

3.14.3 Air

The Cobar airfield, situated 5km south-west of the town, is a modern sealed, all-weather strip capable of accommodating Fokker Friendship aircraft. Airport facilities include navigational aids, fuel depot and terminal building.

Cobar airport is serviced commercially by Davy Air Services to Dubbo with connections to Sydney by Airlines of New South Wales.

3.14.4 Water Supply

Water to Cobar comes via open channel, ^{and} pipeline and from its source at the Burrendong Dam on the Macquarie River. Water is directed from the Macquarie River at Warren into the Albert Priest Channel to Nyngan and then through a 300mm pipeline to Cobar.

3.14.5 Electricity

Electricity to Cobar is supplied by the Electricity Commission of New South Wales through Macquarie County Council and a 132kV transmission line extends to the C.S.A. Mine.

3.15 Port Facilities

Shipping is likely to be from a new berth to be established by the Maritime Services Board of New South Wales at Kooragang Island, which is being formed through the reclamation of six low-lying islands near the mouth of the Hunter River. The Island is adjacent to the Port of Newcastle, and 4km from the Pacific Ocean. Several industries, including Greenleaf Fertilizers Ltd. and Eastern Nitrogen Ltd., have established operations at the south-east end of the Island, where further industrial development is being actively encouraged by local and State authorities.

3. DESCRIPTION OF EXISTING ENVIRONMENT (CONTINUED)3.15 Port Facilities (Continued)

The proposed berth will be on Walsh Point on the northern side of existing berths, in a dredged inlet known as "Rotten Row". The site is served by an existing railway branch from the Main Northern Lane, and land is available for storage facilities.

3.16 References

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SECTION FOUR

DESCRIPTION OF THE PROPOSED DEVELOPMENT

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- 4.1 Mine - General

- 4.2 Mining
 - 4.2.1 Mine Development
 - 4.2.2 Stoping
 - 4.2.3 Mine Ventilation
 - 4.2.4 Drainage and Pumping
 - 4.2.5 Primary Crushing
 - 4.2.6 Temporary Waste Rock Stockpile

- 4.3 Ore Treatment
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- 4.4 On-Site Facilities
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- 4.5 Off-Site Facilities
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CONTINUED.....

- 4.6 Construction
- 4.6.1 Construction Management
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- 4.6.6 Construction Power Supply
- 4.6.7 Construction Water Supply
- 4.6.8 Construction Sewerage
- 4.6.9 Construction Transport and Storage Facilities

4. DESCRIPTION OF THE PROPOSED DEVELOPMENT4.1 Mine - General

The proposed mine will be underground, with a mining rate of 1.1 million tonnes per annum. Annual production will be 130,000 tonnes of zinc concentrate and 99,000 tonnes of lead concentrate.

The proposed layout of installations at the mine site is shown in Figure 13.

Predicted numbers of employees at the mine are:

	<u>Staff</u>	<u>Wages</u>
Management	10	-
Mine	30	85
Concentrator and laboratory	17	44
Engineering	18	115
Industrial	16	15
Accounts, purchasing, stores	23	9
	<hr/>	<hr/>
	114	268
	<hr/>	<hr/>
TOTAL		382
		<hr/>

4.2 Mining4.2.1 Mine Development

Initial access to the upper section of the orebody will be through a decline driven from the surface, and development of the upper levels will be carried out from the decline. Extraction levels will be driven at vertical intervals of 90m and a crown pillar of 10m depth will be left below each extraction level.

The decline will be used for all access purposes and for trucking development ore and waste from the initial mining areas. It will be extended below these areas as mining progresses, to provide an alternative means of access and for inter-level transfer of mining equipment.

Concurrent with the driving of the decline a vertical circular shaft will be sunk from surface to the lowest level of the mine and then equipped with two ore skips and a large cage with counterweight. Winding engines will be installed in the concrete headframe.

When the shaft has been commissioned, broken ore will be transported on the extraction levels to ore-passes by diesel load-haul-dump machines.

4. DESCRIPTION OF THE PROPOSED DEVELOPMENT (CONTINUED)

4.2 Mining (Continued)

4.2.2 Stoping

A long-hole open stoping method with delayed fill is proposed. Stopes will be across the width of the orebody and will be 15m wide, separated initially by 25m pillars. Drawpoints and undercut troughs will be developed from the extraction level drives and, from cross-cuts below the crown pillars, large diameter vertical holes will be drilled and blasted to break the ore.

Completed stopes will be filled with the coarser fraction of the concentrator tailings to which cement has been added. This material will be pumped into the mine as a slurry. Waste rock will also be disposed of as fill material, being returned through a raise-drilled pass.

As mining progresses, stopes will be developed in the pillars between the filled areas, leaving a nominal 5m of ore between the cemented fill and the new stopes. These stopes will also be filled when mined out.

Figure 14 shows a simplified cross-section of several stopes at various stages of development.

4.2.3 Ventilation

West of the orebody at the northern and southern ends two 3.0m diameter ventilation shafts connecting to each level will be raise-bored. An exhaust fan of 94m³/s capacity will be installed above each shaft. Air will enter the mine through the main shaft and the decline to be distributed to each of the main levels. It will be drawn through the stopes and leave the mine by the ventilation shafts.

4.2.4 Drainage and Pumping

Investigations indicate that very little water will enter the mine from the surrounding country, but subsurface water has proved to be very saline and corrosive. The greatest water intake to the mine will be from the stope-filling operation and a further smaller quantity will derive from sundry mining activities. Until the shaft is commissioned the water will be drained to the 230m level and pumped to the surface via the decline, and when the shaft is operating drainage will be led to the 500m level.

The two pumping stations, at the 230m and 500m levels, will be identically equipped with four centrifugal pumps of stainless steel construction. Three pumps in each set will handle the estimated maximum requirement of 75.8 l/s.

Water will be pumped from the 500m station to the 230m station and thence to a surface headtank and from there to one of three means of disposal - an evaporation pond, the sand fill plant, or the concentrator.

4. DESCRIPTION OF THE PROPOSED DEVELOPMENT (CONTINUED)

4.2 Mining (Continued)

4.2.5 Primary Crushing

Before being hoisted in the shaft the ore and waste material will be crushed underground to facilitate handling and safety in subsequent operations.

4.2.6 Temporary Waste Rock Stockpile

All waste rock from mine development outside the orebody not required for construction purposes, will be eventually used for mine fill. However, until exhausted stopes are available for filling, the waste (with the exception of that required for construction purposes) will be stockpiled. It is estimated that at peak storage the stockpile will cover approximately 3 hectares.

The site for the stockpile was chosen after an environmental constraints map had been prepared by Natural Systems Research. This map is included as Figure 15, and the criteria used are recorded in Appendix G.

4.3 Ore Treatment

A graphic flowsheet of the ore treatment process is included as Figure 16.

4.3.1 Coarse Ore Stockpile

A coarse ore stockpile of approximately 1,300 tonnes live capacity will be provided to receive primary crushed ore from the mine and to maintain a surge capacity ahead of the grinding section. Feeders situated in a reclaim tunnel beneath the stockpile will provide a controlled feed to the grinding section.

4.3.2 Mill and Concentrator

The coarse ore will be ground in a semi-autogenous mill and the slurry from the mill will be processed by flotation to produce the zinc and lead concentrates, and tailings.

The ground ore will first be conditioned with reagents and then pass to the lead flotation section where the lead concentrate will be recovered. The remaining ore will be treated in the zinc section to obtain a zinc concentrate.

4.3.3 Filtration Drying and Storage

Both lead and zinc concentrates will be filtered, dried in oil-fired rotary driers and then conveyed to a storage building at the rail-head.

$$\frac{1.1}{15} = \frac{1.5}{16.5 \text{ million tons}}$$

$$\begin{aligned} \text{area} &= \frac{22}{7} \times \left(\frac{1150}{2}\right)^2 \\ &= 1,039,107 \text{ sq m} \\ &= 104 \text{ hectares} \end{aligned}$$

4. DESCRIPTION OF THE PROPOSED DEVELOPMENT (CONTINUED)4.3. Ore Treatment (Continued)4.3.4 Tailings Disposal

The tailings from the flotation plant will be separated by cyclones into two fractions, of coarse and fine particles respectively. The coarse fraction will be returned to the mine for filling exhausted stopes. The fine fraction will be thickened, and the thickened pulp pumped by pipeline to a disposal area centred some 800m from the plant (Figure 17). At the disposal area the pipeline will be elevated by a ramp, constructed of waste rock generated during mine construction, to a central discharge point 12 metres above ground level. Settled tailings will form a stable cone below this point, with an expected "beach" slope of 2 in 100 to the horizontal.

Two additional ramps, also constructed from waste rock, will permit the deposit to be developed sequentially in three segments. The final diameter of the deposit, after a projected mine life of 15 years, will be approximately 1,150 metres, with a maximum depth of 11.5 metres at the centre.

The selected disposal area is on a slight slope. Water drainage and run-off from the deposit will be collected by an embankment further down the slope, constructed from compacted materials excavated at the site. Collected water will be pumped back to the concentrator for re-use.

4.4 On-Site Facilities4.4.1 Mine

Surface works for the mine will comprise shaft headframe, decline portal, temporary waste stockpiles, and exhaust fans.

4.4.2 Concentrator

The major concentrator building will house the flotation and reagent mixing facilities and separate ancillary buildings will house the analytical laboratory, sample preparation, filter and drying plant, and concentrate storage. Other concentrator ancillaries will comprise the coarse ore stockpile, grinding section, thickeners and sand fill storage tanks.

4.4.3 Water Storage and Reticulation

Raw water will be stored in tanks and will provide a reserve supply for fire fighting, for concentrator make-up and for general use.

Raw water will also feed to a treatment plant which will provide potable water for reticulation to the change house, other service buildings and the mine.

Water reclaimed from the tailings dam will be stored in tanks for concentrator use.

4. DESCRIPTION OF THE PROPOSED DEVELOPMENT (CONTINUED)4.4 On-Site Facilities (Continued)4.4.4 Drainage, Water Management and Sewerage

Surface water will drain to open unlined drains with pipe culverts under roads and hardstands, thence to the natural drainage system of the area. All contaminated water from the coarse ore stockpile area will be collected and directed to the concentrator circuit.

Water pumped from the mine will be directed to an evaporation pond with provision for diverting to the concentrator circuit the maximum amount capable of re-circulation through the plant (as determined by impurity build-up). Mine water will also be used for make-up purposes at the sand fill plant.

Washdown water from the reagent mixing area will also be pumped to the evaporation pond.

Sewage and sullage will be collected in sub-surface mains leading to an underground tank, thence pumped to a treatment plant. Fully treated effluent water will be discharged to the evaporation pond, or if suitable, used for garden irrigation.

4.4.5 Plant Maintenance and Stores

A combined workshop and warehouse facility will be provided. Surface installations will also include a standby power plant, electrical substations, fuel oil storage tanks, and water tanks. A small rock drill service shop will be located near the shaft.

The engineering section will provide repair and maintenance services to mine, surface plant, and support facilities.

4.4.6 Mine Office and Change House

This building will accommodate change rooms for award employees, staff, and management personnel, together with a mine rescue base, offices, lamp room and crib rooms.

4.4.7 Administration Buildings

Situated outside the compound, the main office block will accommodate senior management, administration and accounting staff.

Other buildings under administrative control are the first-aid station near the shaft and the gate house.

4. DESCRIPTION OF THE PROPOSED DEVELOPMENT (CONTINUED)4.4 On-Site Facilities (Continued)4.4.8 Explosives Storage

The facilities provided in the magazine area include the following:

Ammonium Nitrate Storage Building

Fuel Oil Tank

ANFO Mixing Building

Explosives Magazine

Detonator Store

The explosives magazine and detonator store will be bunded and the area will be supplied with water for washdown, and electricity. A drainage pit will collect any spillage as well as washdown water.

4.4.9 Elura Houses

Two houses may be built outside the works area for personnel required for standby or emergency call out.

4.5 Off-Site Facilities4.5.1 Concentrate Transport

After filtration the concentrates will be fed to rotary driers where the moisture contents will be further reduced to below the transportable moisture limits, but still adequate to prevent dust generation. The concentrates will then be stored in a completely enclosed building.

A rubber tyred front-end loader operating within the storage building will reclaim the concentrates and load into a hopper which will feed a conveyor system leading to the train loading building.

Concentrates will be railed from Elura to the port facility at Newcastle by the Public Transport Commission of New South Wales. Rail access to Elura will be via a new 32km spur line which will connect with the existing C.S.A. Mine's branch line about 12km from Cobar. The proposed line will traverse the "Red Tank", "Mopone", and "Allednub" properties to the mine site in the north-east corner of "Bundella". Frequency of traffic will be 5 trains per week.

Trains will comprise 24 covered wagons of about 50 tonnes capacity. For loading, each wagon will be positioned over a weighbridge and the cover automatically removed. When loaded the wagons will be weighed and the covers will be replaced.

4. DESCRIPTION OF THE PROPOSED DEVELOPMENT (CONTINUED)4.5 Off-Site Facilities (Continued)4.5.2 Port Facilities

At Kooragang Island, Newcastle, the rail wagons will be unloaded by a rotary tippler, the concentrates being conveyed by belt to a storage building. From there, front-end loaders will reclaim the concentrates and place them on conveyors leading to a travelling, luffing, shiploader. A plan of the proposed facilities is shown in Figure 18.

The loading facilities will be similar to those installed by the Company on the wharf at Burnie, Tasmania. A photograph of the latter is included as Plate 11.

This proposal involves dredging and wharf construction by the Maritime Services Board and Public Works Department. It is dependent on the availability of a second user to share the berth.

4.5.3 Power Supply

Elura will be supplied from the regional power supply system by an aerial transmission line from Cobar terminating at a high-tension substation.

4.5.4 Water Supply

The proposed water supply involves augmenting the existing supply from the Bogan River storage at Nyngan to storage and treatment facilities at Fort Bourke Hill near Cobar by running a second pipeline parallel with the present conduit. This will provide for both the Elura mine and the increased population in Cobar. From Fort Bourke Hill a buried pipeline will supply water by gravity feed to the mining operation.

This proposal has been recommended by the New South Wales Department of Public Works.

4.5.5 Access Roads

Road access to the site will be provided by a sealed road connecting with the Cobar - Louth Road about 43km from Cobar. The section of the Cobar - Louth Road between the C.S.A. and Elura turn-offs will be widened and sealed.

4.5.6 Housing

The Company will build approximately 268 houses in Cobar and also provide single quarters for 40 people (10 staff and 30 wages employees). The houses will be integrated as much as is practicable within the existing Cobar township, but owing to the large number of homes required about half will be located in newly developed areas. Houses will be of similar standard

4. DESCRIPTION OF THE PROPOSED DEVELOPMENT (CONTINUED)4.5 Off-Site Facilities (Continued)4.5.6 Housing (Continued)

and quality to those existing at present in the town and will be fully serviced with power, water, electricity and sealed access roads.

Single quarters will be semi-self-contained flats with sealed car park areas.

4.5.7 Employee Transport

✓ A contracted bus service will transport employees between Cobar and Elura.

4.6 Construction4.6.1 Construction Management

EZ will appoint a firm of consulting engineers to engineer, procure, and manage the construction work. During this period the EZ operating staff will be assembled to work in close liaison with the consulting engineers.

4.6.2 Construction Schedule

Shaft sinking (including contract award and mobilisation) and ancillary work are expected to take 42 months. The decline development will commence six months after the start of shaft sinking. The major part of the surface plant construction will be carried out during the final 15 months of the 42 month programme.

After the completion the facilities will be immediately used for production purposes, although commissioning of the concentrator to design capacity is expected to require a further three months.

4.6.3 Construction Accommodation and Work Force

For the use of the construction sub-contractors, a temporary single-quarter construction camp, with messing and recreational facilities, will be erected at the site. These buildings will be transportable modules, fully serviced with water, electricity and sewerage. Supervision will be provided by the Construction Manager.

At the peak of the construction period, the temporary camp will accommodate 550 construction workers.

*Why not include a canvas
park for manureeds? or will
they have to stay in Cobar.*

4. DESCRIPTION OF THE PROPOSED DEVELOPMENT (CONTINUED)4.6 Construction (Continued)4.6.4 Earthworks

On-site, the major earthworks for the project will be the site development for the mine access, ore storage, surface plant, support buildings and plant roads.

Topsoil will be removed and stockpiled for use in revegetation in the area after construction has been completed.

Excavated materials will be selected for use as earthwalls or as mine fill. Drains surrounding the on-site structures will be excavated as contour drains where possible, to prevent erosion.

4.6.5 Security Fence

A security fence will be erected to enclose the entire mine and plant area. Access to the area for personnel and road traffic will be through the main gate and a gate restricted to rail traffic will be constructed on the railway line.

A security fence will be provided at the evaporation pond.

Temporary security fencing will be provided by sub-contractors to secure their materials and equipment during construction. The temporary fences will be removed at the completion of construction.

4.6.6 Construction Power

Construction power will be provided by installing one of the emergency generators early. Power at 415 volts for plant construction will be obtained using an 11 kV ring main unit and 11 kV/415 V transformer which, at a later stage can be utilised in the permanent electrical installation. 11 kV supply for excavating the decline will also be available from the same ring main unit.

4.6.7 Construction Water

Such groundwater as may be suitable for construction purposes will be pumped from the exploration shaft and potable water will be transported by road tanker from Cobar. The final water supply line will be completed at the earliest possible date.

4.6.8 Construction Sewerage

The permanent treatment plant will be supplied and installed at the start of construction, to service the construction camp.

4. DESCRIPTION OF THE PROPOSED DEVELOPMENT (CONTINUED)4.6 Construction (Continued)4.6.9 Transport and Storage Facilities

During the construction phase, building materials and equipment will be transported to site via the Cobar - Louth Road. Hardstanding areas will be provided close to the works. These areas will be regenerated after completion of the works.

The permanent workshop and warehouse will have priority in construction, so that they may be used for covered storage during construction. Fuels for use during construction will be stored in a bunded area.

Concrete will be mixed on site and transported to forms by transit mixers. Cement and aggregates for construction will be transported from other places by a concrete supply sub-contractor. On completion of construction the concrete batch plant will be removed from the job-site.

SECTION FIVE

DISCUSSION OF ALTERNATIVES CONSIDERED

JUNE 1979

- 5. 1 Mining Methods
- 5. 2 Siting of Mine Facilities
- 5. 3 Ore Treatment
- 5. 4 Tailings Disposal
- 5. 5 Water Management
- 5. 6 Concentrate Transport
- 5. 7 Port Facilities
- 5. 8 Power Supply
- 5. 9 Water Supply
- 5.10 Housing
- 5.11 Employee Transport

5. DISCUSSION OF ALTERNATIVES CONSIDERED

5. 1 Mining Methods

Mining studies have been carried out since 1975 by Company staff and by specialist consultants. The studies covered the following alternatives:

- (i) Initial extraction by open-cut methods.
- (ii) Underground mining by sub-level caving.
- (iii) Underground mining by long-hole open stoping.
- (iv) Combinations of (i) with (ii) and (i) with (iii).
- (v) Underground development from a shaft alone.
- (vi) Underground development from a shaft and a decline.

More recent exploratory drilling has indicated that the upper limit of mineable ore is at a greater depth below the surface than was originally assumed and this made the open-cut proposal unacceptable. Further, the high proportion of pyrrhotite present in the mineralisation raised doubts as to the wisdom of leaving broken ore underground for long periods and so the sub-level caving concept was discarded. An entirely underground operation with long-hole open stoping was thus chosen.

Underground access by both shaft and decline is preferred. One advantage of this approach is that development of the upper zones of the orebody can be carried out from the decline while shaft sinking is still in progress, thus reducing the overall lead time to production. The decline will provide for great mobility of equipment, and there are also advantages from a safety viewpoint in having two separate means of access to the mine.

5. 2 Siting of Mine Facilities

It is proposed that the shaft and surface facilities will be on the eastern side of the orebody. The main reason for this lies in the nature of the country rock surrounding the orebody. Examination of diamond drill core has shown that the country rock tends to be badly broken in the zone immediately adjacent to the contact with ore. This will require careful support of all openings traversing this zone. Rock fractures appear to be less widespread on the eastern side of the orebody, and hence it is desirable that main access should be from that side.

A secondary advantage of the arrangement chosen is that most of the buildings will lie on a slight rise of ground, where the effects of floodwaters resulting from the occasional downpour will be minimal. However, this also means that stormwater falling on the site will flow to the west, east and south, making collection of all run-off extremely difficult and expensive (see 5.5.5).

5. DISCUSSION OF ALTERNATIVES CONSIDERED (CONTINUED)5. 3 Ore Treatment

Some consideration was given to siting the ore treatment facilities closer to the town of Cobar. The only real advantage of this approach would be to reduce the daily travelling distance of those employees affected. However, this advantage is overwhelmingly outweighed by the higher costs of materials transport and the greater difficulties of supervision, maintenance, water reclamation, tailings disposal and mine fill.

Few alternatives for the treatment process are available except in the crushing and grinding circuit. A conventional crushing and grinding plant would have an advantage in that it could be designed with a greater measure of confidence in its performance. However, testwork has shown that the ore is amenable to semi-autogenous grinding, and this approach has been preferred. It has the advantage of eliminating a secondary/tertiary crushing plant and the need for intermediate storage of finely crushed ore. Storage of ore in that form might create problems due to the known reactivity of the ore.

5. 4 Tailings Disposal

Tailings disposal is probably the most difficult environmental problem at the mine site, and alternative approaches have received considerable attention, *as outlined below:*

5. 4.1 Mine Fill

The most desirable method of disposing of the tailings is to return them underground, to fill exhausted stopes. The method of open stoping selected does indeed require that exhausted stopes be backfilled to maintain stability of the mine.

It is, however, impossible to return all the tailings in this way. The total weight of tailings is less than the weight of the original ore mined, but following crushing and fine grinding the tailings occupy a much larger volume, even after settling and compaction. The density of settled tailings from the metallurgical pilot plant was measured at 1.9 tonnes per cubic metre on a dry solids basis. By comparison, the average in situ density of the ore is approximately 4.3 tonnes per cubic metre.

To achieve the required stability within the mine it is important that the backfill material achieves a certain minimum mechanical strength after settling, draining and compaction. Tests on these aspects by Golder Associates have shown that the tailings are unsuitable for the purpose of filling unless the smallest solid particles are removed. Classification by hydrocyclones, to give a coarse fraction representing 50% of the total weight, produces a material with satisfactory settling and drainage properties. To achieve the required mechanical strength it is necessary to add cement. This latter conclusion is based on tests by the C.S.I.R.O. Division of Mineral Chemistry.

5. DISCUSSION OF ALTERNATIVES CONSIDERED (CONTINUED)5. 4 Tailings Disposal (Continued)5. 4.1 Mine Fill (Continued)

A further factor limiting tailings usage underground is the desire to return to the exhausted stopes, the waste rock extracted during mine construction and development. This also gives added mechanical strength to the fill material.

5. 4.2 Quantity to be Dumped

The considerations above means that a substantial quantity of tailings, representing the fine or "slimes" fraction, must be stored or confined on the land surface. The approximate quantity involved is derived as follows:

Ore extracted	1,100,000	tonnes/year
Concentrate produced	230,000	tonnes/year
Total tailings produced	870,000	tonnes/year

Average in situ density of ore	=	4.3 tonnes per m ³
Volume to be filled	=	1,100,000 ÷ 4.3 = 256,000 m ³ /year
Density of settled tailings	=	1.9 tonnes solids per m ³
Total volume of tailings	=	870,000 ÷ 1.9 = 457,900 m ³ /year
Waste rock available from temporary stockpile (as fill)	=	183,000 m ³
Annual production of waste rock	=	21,200 m ³ /year

No fill is required for the first ten months of production.

Then if the waste stockpile is reclaimed over the remaining mine life (14 years) the annual usage of waste rock as fill is

$$(183,000 \div 14 + 21,200) \text{ m}^3/\text{year} = 34,200 \text{ m}^3/\text{year}$$

$$\begin{aligned} \text{Coarse tailings required for fill} &= (256,000 - 34,200) \text{ m}^3/\text{year} \\ &= 221,800 \text{ m}^3/\text{year} \end{aligned}$$

$$\begin{aligned} \text{Fine tailings to be dumped} &= (457,900 - 221,800) \text{ m}^3/\text{year} \\ &= 236,100 \text{ m}^3/\text{year} \end{aligned}$$

See fig 17
any tailing deposit
after 15 years life in wells
or area 3 extension to fill to
embankment or start new
area to east, what is the
betting on continued area 3?

5. DISCUSSION OF ALTERNATIVES CONSIDERED (CONTINUED)5. 4 Tailings Disposal (Continued)5. 4.2 Quantity to be Dumped (Continued)

The total volume of fine tailings to be dumped during the 15 year mine life is thus approximately:

0.83 years at $457,900\text{m}^3/\text{year} = 380,000\text{m}^3$
 14.17 years at $236,100\text{m}^3/\text{year} = 3,350,000\text{m}^3$

 3,730,000 m^3

*What happens
after 15 years?
is a higher hill (p31)
or a larger area (p31)
the same area?
(see p. 62)*

5. 4.3 Water Recovery

The tailings will be produced in the concentrator as a slurry in water. Because of the high value of water at Elura it is important to recover as much of it as is reasonably possible.

It is common practice at mines to pump the slurry to a dam, in which the solids settle to the bottom. Supernatant liquor can then be returned to the concentrator if desired. If this practice were adopted at Elura the loss of water by evaporation, especially during the summer months, would be very high. Because of the relatively flat terrain around Elura, a dam of this type would be difficult and expensive to construct, and its surface area would be large.

The logical first step in reducing water loss is to thicken the slurry. Pilot scale tests on the fine fraction have shown that a thickened slurry containing 65% solids or more can be readily obtained.

Filtration of the thickened slurry would achieve further substantial water recovery. However disposal of tailings as filter cake poses extremely difficult handling problems. To overcome these, briquetting of the filter cake has been considered. It seems certain, however, that to produce stable briquettes would require substantial quantities of binding agents, making the procedure prohibitively expensive.

5. 4.4 Discharge of Thickened Slurry

Consideration of disposal systems and alternative sites has thus been concentrated on pumping a thickened slurry of cycloned fine tailings by pipeline to a disposal area.

Tests on this system were carried out by Golder Associates in association with the pilot plant metallurgical programme at Amdel. On discharge from a pipe, solids were found to flocculate and settle well, forming a natural "beach" with an angle to the horizontal which varied with the solids content of the slurry. Run-off of water from the foot of the beach was essentially clear of solids. Results of these tests are

5. DISCUSSION OF ALTERNATIVES CONSIDERED (CONTINUED)5. 4 Tailings Disposal (Continued)5. 4.4 Discharge of Thickened Slurry (Continued)

summarised in Figure 19, and typical particle size analysis in Figure 20.

The beach slope selected for design purposes is 2 in 100, corresponding with a slurry solids content of 60%.

Published information on the thickened discharge method (Robinsky, 1975) indicates that a constant slope can be expected from the top to the bottom of the pile, that the pile will build uniformly without need for repeated redirection of the discharge, and that gullying and erosion of the tailings either during deposition or as a result of rainfall should not be serious problems. The test beaches formed during the pilot plant test programme confirmed these indications.

It should be noted that the embankment required to impound the tailings and/or water run-off cannot be constructed using coarse tailings, as is common practice. The tailings will be relatively fine, and a coarse fraction is required in any case as mine fill.

5. 4.5 Sites Considered

To assist in site selection a preliminary terrain evaluation was conducted by Golder Associates, including the mapping of soil types over a wide area (Figure 4). Contour maps were prepared, covering the Mining Leases and an area to the North.

(i) Brookong Gully

In the area surrounding Elura only one feature is known which could reasonably be described as a valley and dammed in the conventional sense. It is described here as Brookong Gully, and is approximately 6 kilometres north of Elura. It is within the catchment feeding Brookong Tank (shown in Figures 4 and 6).

Discharge to a dam in this shallow valley was considered in two alternative schemes. In one the pipeline would discharge at the head of the valley, forming a beach extending down the valley, with water run-off being collected in a relatively small dam downstream. In the other scheme, tailings would be discharged upstream from the top of a much larger dam.

Both these schemes were eventually rejected, because of the very high power consumption for pumping the necessary distances and because either scheme would seriously interfere with the collection of rainwater in Brookong Tank, the most important source of stock water on the Darling Downs pastoral lease.

5. DISCUSSION OF ALTERNATIVES CONSIDERED (CONTINUED)5. 4 Tailings Disposal (Continued)5. 4.5 Sites Considered (Continued)(ii) Mining Leases

There are no features on the Elura Mining Leases that could be described as valleys. All potential disposal sites are either flat or gently sloping. Emphasis was placed on discharging from the pipeline at an elevated point reached by ramp, from which point the tailings would spread out to form a cone. A major advantage of this system is the inherent stability of the pile formed.

Although the idea of impounding the tailings within an area completely surrounded by embankments was also studied, it was considered to offer no advantages and to have several disadvantages. In particular, tailings dumps contained by embankments are basically unstable, and subject to ultimate failure.

Using the central discharge system on a flat site it is feasible to collect water run-off in a surrounding ditch. In the interests of water conservation and of avoiding a contaminated effluent it is desirable to collect all run-off, including rainwater, and this requires that the ditch be large, and be prevented from silting up. The latter is not easily achieved.

Considerations such as these led to the final choice of a central discharge system on a gently sloping site, with all run-off being collected by an embankment constructed further down the slope.

5. 5 Water Management5. 5.1 Plant Waste Water

Reclamation and re-use of waste water is very important from both economic and conservation viewpoints.

The extent to which water can be re-used will depend upon the build-up of various contaminants. Water pumped from the mine, for example, will contain dissolved salts from the highly saline groundwater inflow, together with substances derived from the explosives, cement and other materials used underground. Whilst the concentrating plant should be able to tolerate limited amounts of these contaminants, performance will suffer if they are allowed to build up to critical levels as a result of recycling. An outlet for contaminants from the circuit is thus required.

At many mines the tailings disposal pipeline provides such an outlet. However, the choice of a thickened discharge system precludes this approach, since dilution of the slurry would cause it to flow unchecked instead of building into a cone. It is, in any case, proposed to recycle water run-off from the tailings dump.

5. DISCUSSION OF ALTERNATIVES CONSIDERED (CONTINUED)5. 5 Water Management (Continued)5. 5.1 Plant Waste Water (Continued)

In preference to discharging a contaminated effluent to the surrounding countryside to provide the necessary outlet for impurities, advantage has been taken of the climate to propose an evaporation pond. Minewater will be used to prepare sand-fill, and added to the concentrating plant to the maximum extent possible without affecting efficiency, and the excess will be directed to the evaporation pond.

As an alternative it may be better to re-use all minewater and bleed liquor (e.g. filtrate or thickener overflow) from the concentrating plant to the evaporation pond. The best course will be dictated by the critical levels of contaminants in the circuit, impossible to predict at this stage.

Effluent from the laboratory and from reagent wash-down will be unsuitable for re-use and will be directed straight to the evaporation pond. It is also most undesirable that treated sullage and sewerage effluent be sent down the mine or into the concentrator. It is proposed to use it for irrigating gardens and regeneration areas provided that it proves suitable; if not, it too will be piped to the evaporation pond. Suitability for irrigation may be limited by build-up to toxic levels of boron, derived from soap.

5. 5.2 Surface Run-Off

If it were readily achievable, collection of all stormwater run-off from the site and its environs would be desirable. It would further reduce the requirement for piped water, and entirely eliminate any possibility of the spread of heavy metal contamination by the run-off.

It is considered essential to contain run-off from the tailings dump, which will almost certainly contain heavy metal salts and reagents. Design of the necessary embankment is based on the calculated maximum monthly rainfall of 400mm once in every 100 years.

However, to contain run-off of this magnitude from the entire site would be extremely difficult and expensive because of the relatively flat terrain. As noted in Section 5.2 the surface buildings are centred on a slight rise, from which run-off will occur in all directions except north. Collection of run-off would require large peripheral drains and embankments and an enormous storage facility.

The preferred alternative is to collect run-off only from definite sources of contamination such as the ore stockpiles, with other run-off being allowed to enter the natural drainage systems. As run-off only occurs with very heavy rain, dilution will ensure that contamination is at very low concentrations.

5. DISCUSSION OF ALTERNATIVES CONSIDERED (CONTINUED)5. 6 Concentrate Transport

It is logical to use the existing railway to transport concentrates from Cobar to a port. As alternatives to extending the railway to Elura, the following were considered:

- (i) Trucking by existing roads to Cobar;
- (ii) Trucking by new private road to a siding on the C.S.A. branch line;
- (iii) Conveying by aerial ropeway to a siding as above;
- (iv) Pumping as slurry through a pipeline to a siding as above.

Each of these alternatives would require a loading facility at either Cobar or the rail siding, while the pipeline scheme also involves provision of filtering and drying installations at the discharge point.

None of these schemes is economically attractive in comparison with extension of the railway. A rail extension has an added advantage in that it is the most suitable means of transporting stores and equipment to Elura.

From an environmental viewpoint a pipeline has some attractions in that it could be buried, and disturbance to pastoral activities on the intervening properties would be largely temporary, though an access track would be necessary for maintenance. Similar considerations would apply to an aerial ropeway, the main impact of which would be visual. A private road, whether fenced or unfenced, would have a major impact on pastoral activities because of the high frequency of truck movements. A railway will have less impact because train movements will be infrequent. Use of existing roads would avoid disturbance to the pastoralists, but employing a fleet of heavy trucks on public roads would be undesirable in several respects.

5. 7 Port Facilities

Consideration has been given to shipping from Port Pirie, Newcastle, Sydney, Botany Bay and Port Kembla.

Of these, Port Pirie already has suitable concentrate loading facilities, partly owned by EZ. However, the rail journey from Cobar to Port Pirie is very long and circuitous, and rail freight costs would be very substantially higher than to the New South Wales ports. The shipping distance to Risdon would also be slightly longer, though this is relatively unimportant.

5. DISCUSSION OF ALTERNATIVES CONSIDERED (CONTINUED)5. 7 Port Facilities (Continued)

The Maritime Services Board of New South Wales has indicated that Sydney and Port Kembla are too congested for a suitable berth to be made available. Botany Bay is out of the question because of environmental problems.

Newcastle is thus the favoured port. The main alternative to a new berth at Kooragang Island is to employ a local contractor who already handles shipment of certain mineral products from No. 4 Western Basin. As the latter has no rail unloading facilities, it is necessary to unload from trains at Sandgate and truck by road to the berth, where shiploading is carried out using portable conveyors. Loading rates are low and overall operating costs relatively high. Whilst use of this system might be acceptable on a temporary basis, a major increase in road truck traffic is likely to be objectionable to local residents.

5. 8 Power Supply

Electricity will be supplied to the mine from the State system by the Macquarie County Council.

Alternative sources of energy considered were:

- (a) Natural gas from the Moomba-Sydney pipeline.

Although this was an attractive alternative in terms of operating costs, the high capital cost of a branch line was prohibitive.

- (b) On-site generation.

This was found to be economically less favourable than purchasing from the State system. However, a generating plant of limited capacity will be provided on site for emergency purposes.

5. 9 Water Supply

In a search financed by EZ, Australian Groundwater Consultants Pty. Ltd. found a potential source of groundwater suitable for process needs some 30km west of Elura.

Subsequently the Public Works Department of New South Wales was commissioned by the Cobar Water Board to make a detailed study of alternative means of supplying Elura. The Department reached the conclusion that although groundwater might provide a relatively cheap source of water for the mine, the future needs of the township plus Cobar Mines Pty. Ltd. would require duplication of the Nyngan-Cobar pipeline in any case. The latter was thus favoured.

5. DISCUSSION OF ALTERNATIVES CONSIDERED (CONTINUED)5. 9 Water Supply (Continued)

Another alternative studied by the Public Works Department was a piped supply from the River Darling near Louth. This scheme would involve the provision of a weir in the river, pumping station at the river, pipeline with booster pumps, service roads, and power supply. The overall cost would be comparable with that of a second Nyngan-Cobar pipeline, but the source was considered less reliable. The river flow at Louth is subject to drought conditions, a period of zero flow being recorded in the summer of 1944/45.

The preferred scheme at present is thus to duplicate the existing Nyngan-Cobar pipeline and install a new buried pipeline from Cobar to Elura. However, because of the high capital cost of this scheme, possible alternatives are being further investigated by Australian Groundwater Consultants Pty. Ltd.

5.10 Housing

Elura being some 56km from Cobar by road, a separate mine township near the site would have minor operating advantages. However, these are outweighed by the facilities available in the established town of Cobar and the consequent social benefits. Integration of the mine employees and their families into the larger community of Cobar will boost the population of the currently depleted town and will result in increased social and business facilities which will benefit the district as a whole.

5.11 Employee Transport

As an alternative to transporting workers to the site by bus, a rail motor service was considered. Although this would reduce travel time there would be disadvantages in the increased frequency of rail traffic through pastoral leases, and operational difficulties in coping with shift changes.

5.12 Reference

ROBINSKY, E.I. Thickened Discharge - A New Approach to Tailings Disposal. Bulletin, Canadian Institute of Mining and Metallurgy, December 1975, pp 47-59

SECTION SIX

ENVIRONMENTAL IMPACT AND PROTECTION

JUNE 1979

1. Elura Site

2. Off-Site Facilities

6. ENVIRONMENTAL IMPACT AND PROTECTION

6.1 Elura Site

6.1.1 General

The proposed mine will be large, and affect a substantial area of land surface. The overall impact will, however, be minimised by the remoteness of the site and the lack of any unique biological or geographical features.

The mine will have little or no visual impact except on employees and visitors. The highest structure will be the shaft headframe, rising to about 40 metres above ground level, but because of intervening undulations and trees it is unlikely to be visible from any public road. The nearest section of the Cobar - Louth Road is 12 kilometres away.

The visual impact on employees and visitors will be softened by painting the surface structures in harmonious colours. Trees will be retained or replanted to screen features such as the tailings dump and the temporary waste dump, and to provide shade. Other trees and shrubs will be planted for ornamental purposes.

Noise levels will be controlled to comply with the N.S.W. Noise Control Act. Background noise will emanate chiefly from the grinding section, and intermittent noise from skip discharge and workshops. However, these will not be sufficiently intense to cause any nuisance. It is unlikely that noise will be audible at the nearest homestead of Poon Boon, 4 kilometres north-west of the mine site, as it will be attenuated by intervening trees.

Dust emissions will be controlled to comply with the N.S.W. Clean Air Act. Roadways on site will be sealed, and the areas cleared during early development and not required for use will be revegetated. Dust generation in handling ore from the mine to the concentrator will be suppressed by water sprays. Experience during sinking of the exploratory shaft at Elura indicates that little dust should arise from the handling and storage of waste rock, but water sprays will be provided if necessary. No dust generation is expected from the tailings dump. (See Section 6.1.4)..

The area used for mining and associated purposes will be securely fenced off and unavailable for grazing stock. In addition to the loss of this area, the development will unavoidably interfere with pastoral activities conducted by the "Bundella" pastoral leaseholder. Every effort will be made to minimise this inconvenience, and appropriate compensation will be paid as required under the N.S.W. Mining Act.

6. ENVIRONMENTAL IMPACT AND PROTECTION (CONTINUED)6.1 Elura Site (Continued)6.1.1 General (Continued)

Because of the increased risk and serious consequence of fire, it is proposed to construct a fire break immediately inside the security fence surrounding the main mine complex. Fire-fighting equipment and vehicles will be based at the mine, and separate water storage provided for fire-fighting purposes.

Construction of the mine will lead to widespread destruction of vegetation over a total estimated area of 184 hectares (excluding access and service routes). The most extensive clearing will occur in the tailings disposal area. The ^{104 hectares} vegetation to be removed at the site contains no unique features. The destruction of habitats may lead to the deaths of some native fauna, but the population density is low and no endangered species will be affected. Effects on flora and fauna are discussed in more detail in Appendices D and E.

In the regional, or State-wide context, the proposed development must be considered to be of relatively minor environmental concern. In the immediate area there are tens of thousands of hectares of similar country, subject to similar patterns of land use. The removal of a relatively small section for development as a mine will have a negligible effect on the fauna or flora of the region as a whole.

Although aboriginal sites have been discovered in the general vicinity, there appears to be no site of real significance within the mine site itself. Concern about aboriginal sites is confined to access and service corridors.

After the conclusion of mining operations it is presumed that the area will revert to pastoral activity. With this in mind, topsoil will be removed from areas to be affected by surface works and stockpiled for subsequent use in revegetating those areas. In the interim, the piles of topsoil will be sown with grass seed and watered to prevent loss through wind.

The emphasis in revegetation will be on grasses and larger trees, with a return to pastoral activities in mind. To allow the new vegetation to establish, exclusion of grazing animals will probably be necessary for some years after the cessation of mining.

6.1.2 Mining Operations

As mining operations will be carried out underground there will be few significant surface environmental effects. Underground procedures will conform with the requirements of the N.S.W. Mines Inspection Act, which encompasses all aspects of the underground environment.

6. ENVIRONMENTAL IMPACT AND PROTECTION (CONTINUED)6.1 Elura Site (Continued)6.1.2 Mining Operations (Continued)

Surface aspects of the mining operation will comprise the dumping from the shaft and stockpiling of ore and waste rock, removal of air from the mine by the ventilating fans, discharge of waste water, and reclaiming of waste rock from the temporary dump for use as fill material.

Ore and waste hoisted in the shaft will already have been crushed and wetted, and sprays installed at the dumping point will control any dust generated in skip discharge.

^{used.} Vitiated mine air will be discharged from the ventilating fans, and will have a negligible pollutant content except once per week when stope ore is blasted. As the exhaust fans will be situated some 300 metres from the plant area, fan noise and vitiating air will not affect the surface operations.

Water pumped from the mine will be used in the concentrator to the maximum extent possible, as dictated by build-up of impurities, and the balance will be diverted to the evaporation pond.

Design and siting of the explosives magazine will comply with all relevant N.S.W. Legislation.

6.1.3 Ore Treatment

The "dead" volume of the coarse ore stockpile will be prepared from mine waste rock which will consolidate and not prove a dust hazard. Rainfall run-off from the stockpile area will be collected by drainage to a sump and thence directed to the tailings thickener, thereby avoiding any pollution of natural drainage. Transfer points for stockpile feed and withdrawal will be equipped with dust suppression sprays and dust extraction equipment to reduce atmospheric pollution.

The grinding and flotation circuits will use a wet process and no dust will be generated in the system. To handle spills and facilitate clean-up operations, the concrete ground floors in each section of the plant, other than the reagent mixing section, will be graded to sumps from which the spillage will be pumped back to the respective circuits.

The residue collected in the sumps in the reagent mixing area will be pumped to the evaporation pond, which will be fenced off. The grinding section will be an open air structure, and rainfall will be collected with spillage in a sump for transfer to the tailings thickener. The flotation and reagent sections will be fully housed in roofed buildings. Rainfall from these areas will be collected by the yard drainage scheme and directed to natural ground drainage.

6. ENVIRONMENTAL IMPACT AND PROTECTION (CONTINUED)6.1 Elura Site (Continued)6.1.3 Ore Treatment (Continued)

The filtration section will be a closed building with sloped concrete floors feeding sumps, from which spillages and floor washings will be pumped back to the respective circuits. The dryers will be outside the building and provided with concrete floor drainage to the filtration area floor wash sumps. The dryers will be oil-fired, with gases exhausted by stacks. Emission from these stacks will be gaseous only, since the exhaust from each dryer will be passed through a filter unit which will be designed to remove dust particles from the air flow. The material collected by the filters will be delivered to the concentrate storage building where it will be added to the concentrates.

Choice of fuel for the dryers will be such that the gaseous emission from the stacks will comply with the N.S.W. Clean Air Act with regard to its content of sulphur dioxide and other impurities.

The concentrate products from the dryers will contain an average 8 percent moisture (with a minimum of 6 percent), and dust generation will be small. However, dust collectors will be provided at the conveyor transfer points.

6.1.4 Tailings Disposal

Tailings disposal presents a major environmental problem, if only because of the large volume of material and the extensive area of land surface required.

Reasons for choosing a thickened discharge method of disposal on a slight slope, with collection of run-off by an embankment, have been described in Section 5.4. Compared with alternatives, the proposed method has the advantage that the dump of tailings formed will be inherently stable, that attempts can be made to revegetate it in stages during the life of the mine, and that all liquid run-off, including stormwater, can be collected.

The dump will be formed sequentially in three segments. Initially, only the two ramps required to contain the first segment will be constructed, using waste rock extracted during initial mine development. Trees and topsoil will be removed from the first segment. The trees will be burned as required under the conditions of the Mining Lease, and the topsoil will be stockpiled.

Once the first segment is nearly filled, the third ramp will be constructed and vegetation and topsoil removed from the second segment. Revegetation trials will then begin on the first segment by returning accumulated topsoil.

6. ENVIRONMENTAL IMPACT AND PROTECTION (CONTINUED)6.1 Elura Site (Continued)6.1.2 Tailings Disposal (Continued)

When the test dump of tailings was formed at Amdel, gullyng did not occur, nor is it expected. On completion of testwork the surface of the test dump was observed to dry within a few days, and to form a very hard skin in so doing. For this reason, problems of dusting after drying are not anticipated.

The skin should also restrict ingress of oxygen to the dump, and thus inhibit the rate of oxidation of pyrite contained in the tailings. However, it must be expected that oxidation will occur to some extent, with consequent formation of sulphuric acid and dissolved metal sulphates. Enhancement of oxidation rates by bacterial activity seems less likely than in many other tailings dumps but is nevertheless possible. The liquor contained in the pump discharged to the dump will initially be alkaline, with a pH of approximately 11. It must be assumed that this will be reduced by acid formation, but the final pH of liquor draining or seeping from the dump is impossible to predict. *No its not, it will be pH 2.5!*

Liquor draining from the dump will be collected by an embankment constructed further down the slope as in Figure 17. In designing this embankment it has been assumed that rainfall run-off from the dump should also be contained and ultimately pumped to the concentrator. It has been considered that the holding time for run-off should be one month and sufficient water recovery pumping capacity will be installed to meet this intention. To reduce the size of embankment required, diversion ditches are planned on the up-slope side of the dump.

To determine the volumes of water involved, the monthly rainfall figures for Cobar and for Lerida (some 50km south-west of Cobar) have been analysed over the periods 1963-74 and 1957-76 respectively. Extrapolating these figures gives a predicted maximum monthly rainfall of 400mm occurring once every 100 years.

The area encompassed by the diversion ditches and the embankment is approximately 1.6km². Assuming a conservative value of 0.9 for a run-off coefficient, the total volume of water to be stored after 400mm of rainfall would be 576,000 kl. The proposed embankment crest level will provide this storage capacity with 0.7 metres freeboard.

It is proposed to construct the embankment from soils and subsoils available at the site. Tests by Golder Associates have shown these to consist of clayey sands and low plasticity clay which appear suitable for the purpose provided that a substantial addition of water is made to aid compaction. More detailed investigation will be carried out before final design proceeds.

Because of the very high evaporation rate in the area, water only expected to collect behind the embankment during the winter months, or after rain. Return to the concentrator will thus be intermittent.

see p 68.5 who
interpreted government
& government's view!

6. ENVIRONMENTAL IMPACT AND PROTECTION (CONTINUED)6.1 Elura Site (Continued)6.1.4 Tailings Disposal (Continued)

Seepage of liquor will inevitably occur, both from the dump and the collecting pond. However, the clays contained in the underlying soils and subsoils should remove dissolved heavy metals by ion exchange within a relatively short distance of travel. Carbonates in the soils and rocks will help to neutralise any excess acidity.

The rate of seepage is impossible to predict but seems likely to be low. No special measures are required to prevent seepage losses from stock-watering "tanks" excavated in the area. Pores in the ground will tend to become blocked by fine tailings particles. The underlying country rock is known from tests on diamond drill core to have a very low average permeability (approximately 0.5 Lugeons), and seepage through it will be very slow. The groundwater in the area is deep (approximately 80 metres below surface) and highly saline, and seepage into it is unlikely to present any problems.

Lateral movement of seepage down the slope is probably of greater concern. Monitoring stations will therefore be established down-slope from the embankment. Golder Associates have warned that removing the topsoil for future revegetation purposes may increase the rate of seepage in the case of two soil types present at the site (designated types R2 and A3, Figure 4). This is one of the reasons for proposing that the first segment of the dump to be filled should be that furthest up-slope. This gives initially a maximum distance between dump and embankment for additional checks on seepage.

Some 400 metres down the slope below the embankment is a stock-watering "tank" known as Emu Tank. This tank must be considered at some risk of contamination by seepage and/or surface run-off. An alternative tank will be constructed in the same paddock at a site to be decided in consultation with the pastoralist. Emu Tank will be monitored frequently, but it is not proposed to fence it off unless contamination occurs. It is a small and relatively unimportant tank, and was dry as recently as April 1979, but is nevertheless a valuable source of water for stock.

Water collected by the embankment will almost certainly be polluted, and there is a possible danger that water birds may be poisoned by drinking it. No problem of this nature has been observed at the nearby CSA Mine, but measures to exclude birds will be investigated if a problem does arise.

6. ENVIRONMENTAL IMPACT AND PROTECTION (CONTINUED)6.1 Elura Site (Continued)6.1.4 Tailings Disposal (Continued)

Large-scale revegetation trials on tailings will not be possible until the first segment of the dump has been filled after five years, but small-scale tests will be conducted in the interim. Expert advice on the matter will be sought, for example from the Soil Conservation Service, which has operated an experimental station at Cobar for several years. Revegetation is expected to be difficult and slow, and it will probably be necessary to exclude grazing animals for several years after mine production ceases.

It remains to be seen whether topsoil initially removed from the area and returned to the surface of the tailings will be adequate for revegetation.

In preparing the dumping site, existing stands of trees close to the projected edge of the final dump will be protected by forming ridges around them, to assist in screening the dump. Mounds of soil will also be formed within the boundary, and planted with saplings, to form islands from which subsequent revegetation trials can develop.

6.1.5 Drainage

Sewage and sillage wastes will be collected in sub-surface mains feeding an underground tank and thence a treatment plant. Effluent water will be used for irrigation of gardens and revegetation areas if suitable, or otherwise passed to the evaporation pond.

Water draining from the tailings dump and ore stockpile will be returned to the concentrator circuit. Mine water will also be used to the maximum extent possible, and the balance drained to the evaporation pond. Effluents from the laboratory and the reagent mixing section will also be directed to the evaporation pond. The pond will be constructed in two sections such that accumulated solid deposits can be periodically removed and buried.

Stormwater run-off from all other areas around the mine, including the temporary waste dump, will be gathered via spoon drains for discharge to the natural drainage system.

The temporary waste dump will contain virtually no ore, since the contact between the orebody and the host rock is generally very abrupt. Numerous thin sections of host rock have been examined by experienced petrologists. No sulphides remain above a depth of 100 metres, having been oxidised completely by weathering. Below that depth fresh rock contains about 1% pyrite disseminated throughout it. Traces of zinc - and lead-bearing sulphides are rarely mentioned in descriptions.

6. ENVIRONMENTAL IMPACT AND PROTECTION (CONTINUED)6.1 Elura Site (Continued)6.1.5 Drainage (Continued)

Thus the waste rock dump cannot be considered to be a potential major source of heavy metal pollution. In the presence of water, pyrite contained in the rock will oxidise with formation of sulphuric acid. However, the region's semi-arid climate will ensure that the exposed rock surfaces within the dump will be dry for most of the time, and carbonates present in the host rock as dolomite and ankerite will assist by partly neutralising the acid formed. Run-off will only occur in the event of heavy rain, with a massive dilution effect. With the combination of these factors there is not expected to be any significant deterioration in the pH of the ephemeral creeks draining the area.

Despite all safeguards there will be small amounts of dust which cannot be collected and will be carried by the wind and dispersed over a wide area. This dust will inevitably contain small amounts of ore. However, this is not expected to contribute to a perceptible change in the heavy metal concentrations or acidity of streams and stock watering "tanks" in the area.

When the mine is in operation, regular monitoring of soil and water samples from the surrounding area will be carried out and corrective action taken if undesirable levels of contamination become evident. With this in view a pre-production baseline survey of existing heavy metal concentrations in some 210 soil samples has been carried out and is detailed in Appendix B.

Several spot samples from stock-watering "tanks" in the area were also analysed. However, these data are considered inadequate as a baseline for monitoring purposes and a further survey has begun. Samples of water and sediment have been taken from five "tanks", and have been analysed for a wide range of substances. Results of analyses are shown in the following table. Further samples will be taken from the same "tanks" at four-monthly intervals to establish representative baseline parameters.

*may need to seek
this data as
update.*

TANK WATER ANALYSIS - APRIL 1979
(Locality Reference Map - Figure 6)

SAMPLE REFERENCE

<u>Physical Water Samples</u>	<u>Total Solids</u> mg/l		<u>Conductivity</u> µS/cm		<u>pH</u>	<u>Sulphates</u> mg/l
Pongs	10.0		164		7.5	<0.02
Darling Downs	5.6		422		7.8	145
Brookong	15.6		100		7.2	<0.02
O'Donnells	36.0		123		6.6	<0.02
Emu	D R Y					
<u>Heavy Metal Water Samples</u>	<u>Zn</u> µg/l	<u>Pb</u> µg/l	<u>Cu</u> µg/l	<u>Fe</u> µg/l	<u>Cd</u> µg/l	<u>As</u> µg/l
Pongs	11.0	0.6	7.5	510	<0.05	1.0
Darling Downs	15.0	1.0	1.0	100	<0.05	1.5
Brookong	10.0	0.1	7.5	1120	<0.05	<1
O'Donnells	12.0	0.1	2.2	2850	<0.05	<1
Emu	D R Y					
<u>Sediments</u>	<u>Zn</u> p.p.m.	<u>Pb</u> p.p.m.	<u>Cu</u> p.p.m.	<u>Fe</u> %	<u>Cd</u> p.p.m.	<u>As</u> p.p.m.
Pongs	61	14	22	2.57	<0.1	1.1
Darling Downs	31	8	14	3.03	<0.1	3.5
Brookong	45	15	23	2.94	<0.1	3.9
O'Donnells	51	13	22	2.98	<0.1	1.1
Emu	50	15	22	2.47	<0.1	0.4

6. ENVIRONMENTAL IMPACT AND PROTECTION (CONTINUED)6.1 Elura Site (Continued)6.1.6 Miscellaneous Wastes

Disposal of garbage will be by burning, burying or removal to the municipal tip as appropriate. Worn-out or obsolete machinery will be sold as scrap or sent to the tip. Combustible liquids, e.g. used lubricants and oils, will be removed for refining or burnt.

Smoke from the incineration of waste materials will be controlled by burning in small quantities under favourable weather conditions.

6.1.7 Construction Period

The construction workforce will be housed in an extensive temporary camp of mobile buildings adjacent to the site. Establishment of this camp will require the clearing of access roads and a fire break. Much shrubbery within the camp areas will also be cleared, but larger trees will be retained where possible as they provide valuable shade.

On removal of the camp buildings the camp site will be tidied up and cleared areas revegetated.

During the construction period a Construction Manager will be responsible for ensuring that cleanliness and hygiene on the site comply with government laws and regulations. Removal of scrap and surplus construction materials will be required of each contractor engaged in the work.

The first major construction activity on the site will be sinking of the shaft. The evaporation pond will be built at an early stage, to receive via a temporary pipeline saline water pumped from the shaft during sinking.

Pre-production mine development will involve the stacking of excavated ore and waste rock. Some of the minerals oxidise rapidly, and ore stockpiled for an extended period prior to completion of the concentrator may prove intractable in subsequent treatment. If so it will be used for ramp construction in the tailings disposal area. As it is brought from the mine during the development phase the ore will be stacked close to the site of the future coarse ore stockpile so that drainage from the heap can be directed to the polluted water system. Until the concentrator is in operation such water will be directed via a temporary line to the evaporation pond.

6. ENVIRONMENTAL IMPACT AND PROTECTION (CONTINUED)6.1 Elura Site (Continued)6.1.8 Residual Aspects

At the completion of mining operations all openings to the surface (decline, shaft, ventilation and fill raise) will be secured against unauthorised access. The exhaust fans will be removed but the concrete headframe, with internal fittings removed, will remain. It will be secured against access.

All other surface buildings and installations will be dismantled and removed from the site, leaving only concrete floors and footings. The stockpiles of ore and waste rock will have been exhausted at the conclusion of operations. The area will be re-graded and surface excavations filled in. Topsoil previously removed from the area will be returned and planted with grasses and trees.

*in 15+ years?
the trees growing
in it will be
washed away
by themselves!*

6.2 Off-Site Facilities6.2.1 Township

Cobar is an established town with subdivided residential land and of sufficient size for its present culture to absorb the influx of additional mine personnel and their families.

The population is likely to increase from the present level of above 3,300 to approximately 4,850 when the mine is in operation, by the addition of the Elura workforce, their families and associated service personnel.

The establishment of the mine will provide new employment opportunities both at the mine and in the service areas, it will strengthen the economy and will give Cobar "a further mining base, quite distinct from the copper base it now has and ensure the long term stability of Cobar".* The increased population will increase consumer spending capacity and result in business expansion and additional prosperity in Cobar.

Local government will benefit by increased rate payments on new properties and existing under-utilised town facilities will be better patronised. Pressure will be placed on some service areas, such as water reticulation, sewerage plant and schools, and existing facilities will need to be expanded. Discussions have taken place with the relevant Authorities and they are aware of the impact a new mine will have on the demand for their services and what steps will need to be taken to meet that demand.

* Quoted from: Cobar Shire Council Submission to the Industries Assistance Commission.
(Enquiry into the Copper Industry, 1977)
Page 23.

6. ENVIRONMENTAL IMPACT AND PROTECTION (CONTINUED)6.2 Off-Site Facilities (Continued)6.2.1 Township (Continued)

Every effort will be made to make the integration into the existing community as smooth as possible. Many new homes for mine personnel will be dispersed within established areas. Newly developed housing areas will not become localised EZ communities with distinctive housing. Vacant blocks will be left in the new estates for service personnel and the homes will be of similar quality to those already existing in the town. The intention is to create a situation which will enable social relationships to develop independent of mine site heirarchy.

Social problems could occur during the construction stage. At the peak of the construction period 550 workers will be employed. These workers will be residing in a temporary camp at the mine site; however, a large portion of their leisure time will be spent in Cobar. This will only be a temporary phase and Cobar has experienced similar disturbances in the past, most recently with construction workers during the mid 1960's at the CSA Mine and pipeline workers from the Moomba-Sydney natural gas pipeline during the mid 1970's.

An increase in population at Cobar will place additional pressures on the surrounding countryside. Noise levels will increase, littering and vandalism may become more prevalent and road traffic will be heavier. These features of increased population are largely unavoidable and can be handled by existing control agencies.

Additional problems could arise if the construction period coincides with construction work by Cobar Mines Pty. Ltd. at its CSA and Chesney Mines. The probability of this occurring cannot yet be assessed. A resumption of development work at the CSA Mine has recently been announced, but this will not involve a major increase in employee numbers, or additional housing. Construction of the Chesney Mine was halted in 1975 following the severe slump in World copper prices, and no plans for a resumption of work have been announced as yet.

6.2.2 Concentrate Transport

The proposed route of the railway branch line has not been precisely defined. It is subject to detailed survey and to further consultation with landholders and the Public Transport Commission. However, it must inevitably traverse four pastoral properties.

It is provisionally proposed that the route should run alongside property boundaries where possible, for example as in Figure 8, to minimise the interference with pastoral activities. This route has the added advantage of following relatively high ground, not subject to flooding, for most of its length.

6. ENVIRONMENTAL IMPACT AND PROTECTION (CONTINUED)6.2 Off-Site Facilities (Continued)6.2.2 Concentrate Transport (Continued)

The railway easement will require clearing of vegetation to a total width of approximately 30 metres. There will also be minor cut and filled sections to maintain acceptable grades.

Study of the vegetation along the proposed route has revealed only one feature of note - an exceptional mallee tree shown in Plate 4. As the tree is immediately adjacent to the boundary fence it will be possible to retain and protect it.

A further problem is posed by two sites of archaeological interest found along the proposed route (Appendix F). The locations of these sites are such that it may be possible to avoid and protect them without a major diversion of the railway line. If not, permission to destroy the sites will be sought subject to more detailed archaeological investigation.

Disturbance to pastoral activities will be at peak during construction of the line. Thereafter, the most important requirement is that those sections of the line that cannot follow property boundaries should not form barriers preventing stock movements. This problem will be discussed with the pastoralists during the detailed design stage, and such fences, gates, crossings and stock-watering "tanks" as may be necessary to alleviate it will be provided.

The line will be remote from station homesteads and will not be visible from public roads. Disturbance by rail traffic will be minor, as only five return trips per week are planned.

6.2.3 Access Roads

The effects of strengthening and sealing the Cobar - Louth Road to the Elura turn-off can only be favourable. There will be a significant increase in road traffic, but traffic density will not be high and is likely to be of concern only to residents living alongside the road on the outskirts of Cobar. Apart from employee buses, few heavy vehicles will use the road except during mine construction.

Widening and sealing of the existing access road from the turn-off to the mine site presents a problem in that it cannot be done without serious risk of damage to an aboriginal site discovered alongside it. This site appears to be possibly the most important of those found in the area. It is proposed to divert this section of roadway, following an archaeological survey to find a route which avoids aboriginal sites. Existing gates at fence lines will be replaced by cattle grids, and culverts will be placed as appropriate to maintain natural drainage courses.

6. ENVIRONMENTAL IMPACT AND PROTECTION (CONTINUED)6.2 Off-Site Facilities (Continued)6.2.4 Power Supply

Although the precise route has not yet been determined, the pylons and transmission line will be remote from public roads and homesteads and have little visual impact. Their effect on pastoral activities will be negligible except during the construction phase. It will be necessary to keep clear an access track along the line of pylons for maintenance purposes.

The proposed route will be checked for possible aboriginal sites before a final decision is made.

6.2.5 Water Supply

It is understood (Public Works Department) that withdrawal of additional water from the Macquarie River is not expected to conflict with other demands on water from the River during the lifetime of the mine.

Duplication of the existing pipeline from Nyngan to Cobar will involve visible above-ground structures only where such structures already exist. The pipeline will be buried and will run roughly parallel to the existing line, thus minimising the amount of scrub to be cleared. No extra aerial power lines will be involved. The additional visual impact will be negligible.

The pipeline from Cobar to Elura will be buried and no above-ground structures will be involved. The route will first be surveyed for possible aboriginal sites. The re-filled trench should revegetate quickly, but a cleared track alongside the line will be necessary. The impact on pastoral activities will be negligible except during construction.

6.2.6 Port Facilities

The proposed berth and shiploader on the southern part of Kooragang Island, where industrial development is being actively encouraged, will be remote from residential areas. The visual impact of the storage shed and shiploader will not be objectionable. The additional rail traffic, of five return trips weekly, will not add greatly to the annoyance of residents living close to the access track.

The concentrates to be stored and shipped will be moist, and little dust will be generated during handling. However, with the dual objectives of containing dust and protecting the concentrates from the weather, all the storage and handling facilities will be fully enclosed. Concentrates will enter ships' holds via a sleeve as shown in Plate 11.

Experience at the similar concentrate shiploader operated at Burnie, Tasmania, by the Emu Bay Railway Company (an EZ subsidiary) indicates that no perceptible amount of dust will enter the environment.

alternatively

$$1.1 \times 15 \text{ years} = 16.5 \text{ mt}$$

∴ 10.5 mt are left as follows

eg 3!

+ 10 years → 510m

APPENDIX A

ELURA MINERALISATION

The Elura deposit was discovered in 1973 during regional exploration for mineralisation of the type found near Cobar. It involved the inspection of anomalies discovered by detailed low level aeromagnetic surveying. Diamond drilling has outlined an essentially blind (i.e. non outcropping) pipe-like massive sulphide body totalling more than 27 million tonnes.

←
1-1 mill
+ 25 years →

An isometric diagram of the mineralisation is included as Figure 3.

Three basic types of mineralisation have been recognised:

1. semimassive sulphide mineralisation with siliceous gangue; this mineralisation appears to envelop the whole deposit.
2. massive pyritic mineralisation.
3. massive pyrrhotitic mineralisation.

They occur as discrete entities within the sulphide mass and have readily recognisable contacts between the three types. There is very sharp contact between the sulphide body and the host rock.

The average density of the massive mineralisation is 4.46 t/m³, whilst that of the siliceous material is 3.72 t/m³. The sulphide minerals consist, in decreasing order, of:

- Pyrite
- Pyrrhotite
- Sphalerite
- Galena
- Chalcopyrite
- ✓ Arsenopyrite
- Tennantite-tetrahedrite

The main gangue minerals in the massive zone are carbonates (dolomite and siderite). Gangue within the siliceous zones is made up of silicified siltstones and cherts, and carbonates, with minor quartz veining. Below the weathered surface layer, alteration, due to oxidation, of both massive and siliceous sulphides has produced a number of secondary minerals, the main one being marcasite after secondary pyrite in the pyrrhotite ore.

Surface oxidation and weathering has progressed to a depth of 100 metres. Above this depth no sulphide minerals remain and the mineralisation exists as gossan (oxidised sulphides). Gossan occurs as two "horns" above the northern and southern zones of the deposit. The larger southern "horn" was originally mainly massive sulphide while the northern

APPENDIX A (CONTINUED)

"horn" was of siliceous nature. The main gossan mineral is goethite (a hydrous iron oxide) with such minerals as beudantite, scorodite, and coronadite containing the bulk of the lead and arsenic in this material. The copper and zinc content of the gossan is negligible.

At the base of the gossan, numerous large solution cavities have been discovered. Below these cavities, a 2 - 3 metre sulphide rich zone of supergene mineralisation occurs. This supergene zone is very well developed below the larger southern gossan "horn" and has been caused by leaching of metals downwards during gossan formation into the top of the unweathered sulphide thus producing high grades of lead, copper and arsenic.

The sulphide mineralisation below the southern "horn" originally contained a core of pyrrhotitic massive sulphide. This material is more readily altered and, to a depth of 140 metres, has been converted to pyrite and marcasite (marcasite has the same chemical formula as pyrite but a different crystal structure). This is still progressing and pyrrhotite is actively decomposing in a reactive section between 130 and 140 metres (vertical depth).

The pyritic massive sulphide surrounding this pyrrhotitic core, lacking the "catalytic" effect of the pyrrhotite, is less prone to alteration. Above the pyritic mineralisation, oxidation and alteration appears to have occurred only to a depth of 115 metres. These alteration features of the mineralisation have a significant effect on its milling characteristics.

Pyrrhotitic mineralisation below 140 metres is apparently fresh and contains up to 35% pyrrhotite, along with pyrite, sphalerite, galena, chalcopyrite and arsenopyrite. The mineralisation is coarsely banded into pyrrhotite/pyrite and sphalerite/galena bands with some mineral interlocking producing intricate textural intergrowths. Arsenopyrite appears mineralogically associated with sphalerite, but arsenic also occurs in primary pyrite.

Pyritic mineralisation tends to surround the pyrrhotitic core and is texturally and mineralogically different. The dominant mineral, pyrite, is hard but finely granular. There is less tendency for the sphalerite and galena to form continuous small bands and lenses. These minerals are often fine grained and intergranular, thus presenting some metallurgical problems. The tetrahedrite group mineral (possibly freibergite, a silver rich variety) is more conspicuous and is almost invariably associated with galena. It is probably the source of silver, mercury and antimony.

Siliceous mineralisation appears to be essentially diluted massive pyritic sulphide, although there is a patch of pyrrhotitic siliceous sulphide on the eastern side of the body. This material is hard and massive, sulphide content varies from 40% to 80%, while the siliceous matrix contains chert and silicified sediments with minor carbonates and quartz veins.

APPENDIX A (CONTINUED)

The host rock to the mineralisation consists of dark siltstones and shales with medium to fine grained sandstones interbedded throughout. There are numerous pre-consolidated textures, such as slumping, dewatering features, ripple marks, etc., indicative of an active sedimentary regime. Small (50 μ to 1mm) nodules of chert and carbonate minerals are disseminated in the sediments in the vicinity of mineralisation. Minor thin (<5mm) syngenetic sulphide bands have been observed parallel to bedding and very fine grained pyrite is a common feature of the finer grained sediments. Other sulphides are rare in the host rock.

Sub greenschist grade metamorphism is indicated by the clay assemblage present. This metamorphic grade is no more than would have been caused by load, or burial metamorphic conditions.

STRUCTURE

The sulphide body is almost oval in shape with long axis 200 metres long, trending true north-south, and the east-west axis up to 120 metres wide. Mineralisation, including the gossan, extends to within 20 to 50 metres of surface, with some evidence that a small portion of the gossan extends to the surface. The deepest drilling to date has established that mineralisation is still extensive at a depth of 500 metres. The body is vertical, and detailed logging of structure and stratigraphy in drill holes indicates that it penetrates the strata and has possibly caused some deformation, including jointing and faulting around the deposit. A north-south, essentially vertically dipping, slaty cleavage has been imposed upon the whole assemblage at a later date. This cleavage is evident in the sulphides as well as the host sediments.

TONNAGE AND GRADE

The tonnage contained within the deposit has been calculated to a depth of 510 metres (Mine RL9700) below surface. Drilling has outlined mineralisation to this level and a fairly confident interpretation is possible although the northern and southern boundaries still lack definition at depth. The total of approximately 27,000,000 tonnes of unoxidised mineralisation is composed of 29.0% siliceous, 44.4% massive pyritic, and 26.6% massive pyrrhotitic mineralisation. The mineralisation is still open at depth.

Mineral distribution is general fairly homogeneous, although zoning of some elements is apparent, notably silver and arsenic. Comprehensive assays are available for zinc, lead, silver, copper and arsenic. Analytical scans are available for a large range of elements and detailed assays of a large number of elements have been made on concentrates produced from bench scale tests using drill core.

The reserve data for the deposit are detailed below. The grade for each of the mineralisation types and the total weighted grade is presented, along with relevant reserve tonnages.

APPENDIX A (CONTINUED)

	Tonnage	Zn.	Pb.	Ag.
Siliceous semimassive mineralisation	7,779,000	6.44	4.56	200
Massive pyritic mineralisation	11,933,000	8.99	5.74	142
Massive pyrrhotitic mineralisation	7,149,000	9.26	6.46	61
Total tonnage and weighted average grades	26,861,000	8.32	5.59	137

APPENDIX B

3/30/15

August 1977

ELECTROLYTIC ZINC COMPANY OF AUSTRALASIA LIMITED

Amdel Report

No. 1186

ENVIRONMENTAL BASE-LINE
PARAMETERS - ELURA

by

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THE AUSTRALIAN MINERAL DEVELOPMENT LABORATORIES
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1. INTRODUCTION

The purpose of this project was to determine the concentration of a range of elements in surface soils, and in tank waters, about the Elura lead-zinc deposit, near Cobar, N.S.W. The samples were deliberately collected prior to the commencement of mining so that any later contamination effects caused by mining operations could be assessed with respect to this "base-line" survey.

2. WORK DONE AND RESULTS

Samples were collected from the 250 m x 50 m mine grid area illustrated on the accompanying map. As a preliminary orientation test five sites were selected as follows (see accompanying map* for localities):

<u>Site</u>	<u>Co-ordinates</u>	<u>Features of Site</u>
01	770N/988E	flat, sheetwash area, surface crusty
02	767½N/969E	as for 01
03	782½N/986E	as for 01, but broad drainage channel
04	782½N/968E	as for 03
05	782½N/974E	over Elura deposit similar to 01

At each of the five sites samples were collected over the vertical intervals 0-2 cm (excludes surface float such as ironstone pebbles, etc.), 2-5 cm and 10-30 cm, and all samples were later assayed, by Amdel, for the elements Cu, Pb, Zn, Co, Ni, Cd, Bi, Mn, Be, Mo, Sc, V, W, Y, Ag, Ga, Ge, Se, As, Te, Sb, Sn and Hg. Results are listed in Table 1A. The 2-5 cm interval samples from each site were also sieved into three size fractions and each fraction was analysed for Pb, As, Sb, Zn, Cd and Cu (see Table 1B).

The main base-line orientation survey initially involved the selection of 90 sites on the mine grid as indicated on the accompanying map.* Site selection was based partly on a knowledge of the drainage and prevailing wind directions, however sampling was also biased towards the immediate mine area, as indicated on accompanying map. At each of the 90 sites

* Map is included here as Figure 21.

(numbered 1 to 90 inclusive on map) surface material (grass, leaves, twigs, ironstone pebbles, etc.), was brushed or scraped off and two samples were collected; from 0-2 cm and 2-5 cm depth. All the 180 samples were subsequently analysed by Amdel for Pb, As, Sb, Zn, Cd, Cu and Hg (see Table 2 for results). Five water samples were also selected and analysed for As, Sb, Pb, Zn, Cd and Cu (see Table 3 and map).

The client requested that no interpretation of the data be made by Amdel.

Sb ?
B ?TABLE 1A: INITIAL GEOCHEMICAL DATA
(detection limits in brackets)

Site	Depth (cm)	Se (1)	As (2)	Cu (10)	Pb (10)	Zn (10)	Co (5)	Ni (10)	Cd (1)	Bi (10)	Mn (10)	Be (17)	Mo (3)	Sc (3)	V (100)	W (50)	Y (10)	Ag (0.1)	Ga (1)	Ge (1)	Sn (1)	Hg (0.02)
01	0-2	2	3	18	15	45	5	20	<1	<10	290	X	X	5	150	X	10	X	15	X	1	<0.02
	2-5	1	5	20	15	42	8	18	<1	<10	230	X	X	5	200	X	10	X	15	X	1	0.05
	10-30	<1	6	18	22	40	10	18	<1	<10	95	X	X	5	100	X	10	X	15	X	1	0.03
02	0-2	1	4	18	18	45	8	12	<1	<10	230	5	70	10	200	150	70	X	10	X	1	0.05
	2-5	2	4	18	20	48	8	20	<1	<10	220	X	X	3	100	X	10	X	10	X	1	0.08
	10-30	2	4	20	25	42	5	18	<1	<10	200	X	X	5	150	X	10	X	15	X	1	0.03
03	0-2	<1	2	20	25	50	10	18	<1	<10	450	X	X	10	100	X	10	X	10	X	1	0.06
	2-5	2	5	20	22	45	8	15	<1	<10	420	X	X	X	100	X	X	X	8	X	X	0.04
	10-30	1	10	18	25	35	5	15	<1	<10	150	X	X	5	150	X	30	X	15	X	1	0.05
04	0-2	1	10	18	30	40	8	18	<1	<10	290	X	X	5	150	X	10	X	15	X	1	0.10
	2-5	3	9	18	28	38	10	15	<1	<10	280	X	X	5	300	X	20	X	10	X	1	0.02
	10-30	1	13	18	35	35	8	18	<1	<10	180	X	X	10	200	X	30	0.1	15	X	1	0.04
05	0-2	1	90	20	150	42	8	18	<1	<10	200	X	X	3	150	X	X	0.1	15	X	1	0.07
	2-5	1	80	20	120	42	10	18	<1	<10	240	X	X	10	200	X	30	0.1	10	X	1	0.09
	10-30	1	105	18	140	38	10	20	<1	<10	240	X	X	3	150	X	10	0.1	10	X	1	0.06

Footnote: Both Sb and Te <0.1

TABLE 1B: GEOCHEMICAL DATA ON SIZED 2-5 CM SAMPLES OF TABLE 1A
(detection limits in brackets)

Site	Size Fraction	Geochemistry					
		Pb (2)	As (2)	Sb (4)	Zn (10)	Cd (0.1)	Cu (10)
01	+18#	75	46	16	35	<0.1	18
	-18+72#	28	5	6	40	<0.1	18
	-72#	22	7	4	42	<0.1	20
02	+18#	80	40	12	22	<0.1	15
	-18+72#	26	4	<4	45	<0.1	25
	-72#	22	3	<4	42	<0.1	18
03	+18#	65	55	14	25	<0.1	18
	-18+72#	26	8	<4	40	<0.1	18
	-72#	20	3	4	40	<0.1	20
04	+18#	110	65	10	18	<0.1	15
	-18+72#	32	11	<4	32	<0.1	15
	-72#	28	5	<4	35	<0.1	18
05	+18#	820	600	38	15	<0.1	15
	-18+72#	190	110	8	35	<0.1	18
	-72#	95	34	<4	40	<0.1	18

TABLE 2: GEOCHEMICAL BASE-LINE DATA
(detection limits in brackets)

Site No. (Position shown on Map)	Description of Site	Depth	Geochemistry						
			Pb (2)	As (2)	Sb (4)	Zn (5)	Cd (0.1)	Cu (5)	Hg (0.02)
1	Flat; near fence, few trees	0-2	22	2	<4	38	<0.1	18	<0.02
		2-5	19	2	<4	32	<0.1	15	<0.02
2	Flat; few trees	0-2	26	8	4	42	<0.1	18	<0.02
		2-5	28	7	4	40	<0.1	18	0.13
3	Flat; few large Gum trees	0-2	24	5	<4	35	<0.1	15	<0.02
		2-5	22	7	<4	30	<0.1	15	<0.02
4	Very flat; no trees	0-2	24	8	<4	38	<0.1	15	<0.02
		2-5	22	6	4	35	<0.1	12	<0.02
5	Near dam; few Ironwood trees, grass/nettles quite wet	0-2	18	2	4	45	<0.1	15	<0.02
		2-5	20	4	4	35	<0.1	15	<0.02
6	Scattered Broombush, flat with two Wilga trees	0-2	15	3	<4	25	<0.1	10	<0.02
		2-5	11	4	<4	20	<0.1	10	<0.02
7	One large Ghost Gum, surface somewhat disturbed by scraping	0-2	28	11	<4	30	<0.1	12	0.04
		2-5	26	5	<4	30	<0.1	15	0.02
8	Margin of ironstone ridge. Few Broombush trees	0-2	26	8	<4	28	<0.1	12	0.02
		2-5	26	6	4	25	<0.1	12	<0.02
9	One large Box Tree; few Broombush trees	0-2	26	3	<4	38	<0.1	15	0.02
			24	5	<4	35	<0.1	15	0.04
10	Near intersection of two fences; clear	0-2	20	7	4	25	<0.1	10	0.02
		2-5	18	6	<4	25	<0.1	12	0.02
11	Clear, few Gum and Ironwood trees	0-2	26	11	<4	28	<0.1	15	0.04
		2-5	22	11	<4	25	<0.1	12	0.02

TABLE 2: CONTINUED

Site No. (Position shown on Map)	Description of Site	Depth	Geochemistry						
			Pb (2)	As (2)	Sb (4)	Zn (5)	Cd (0.1)	Cu (5)	Hg (0.02)
12	Few Emu Bush and Ironwood trees; clear, but near thick scrub	0-2	16	3	<4	30	<0.1	15	0.04
		2-5	22	3	<4	40	<0.1	18	0.02
13	Few small, including one dead, Ironwood trees, several White Gums	0-2	22	4	4	42	<0.1	15	<0.02
		2-5	22	8	4	35	<0.1	15	0.02
14	Relatively clear, large Gum nearby	0-2	24	6	4	38	<0.1	15	0.02
		2-5	24	5	<4	35	<0.1	15	<0.02
15	Clear, with large White Gum nearby	0-2	24	4	<4	35	<0.1	15	0.06
		2-5	22	5	<4	32	<0.1	15	<0.02
16	Cleared thicket of Broombush on edge of Box Tree, flat	0-2	26	3	<4	40	<0.1	15	0.06
		2-5	22	4	6	35	<0.1	15	0.02
17	Clear, and near dead Box Tree	0-2	28	6	<4	30	<0.1	15	0.02
		2-5	28	12	6	28	<0.1	15	<0.02
18	Near Quondong tree, low Broombush and also Curran Bush nearby	0-2	22	5	<4	40	<0.1	15	0.02
		2-5	24	5	<4	35	<0.1	18	<0.02
19	Clear, beside track	0-2	24	2	<4	38	<0.1	18	0.02
		2-5	22	5	4	32	<0.1	15	<0.02
20	Next to large Gum stump; thick scrub, cleared.	0-2	22	4	<4	40	<0.1	15	<0.02
		2-5	24	5	<4	35	<0.1	15	<0.02
21	Clear	0-2	24	6	<4	45	<0.1	18	0.02
		2-5	24	5	4	42	<0.1	18	0.02
22	Clear and on ironstone ridge	0-2	20	4	<4	30	<0.1	15	<0.02
		2-5	26	4	<4	28	<0.1	12	<0.02
23	Wilga and Ironwood saplings	0-2	24	<2	<4	35	<0.1	15	<0.02
		2-5	20	4	<4	35	<0.1	15	<0.02

TABLE 2: CONTINUED

Site No. (Position shown on Map)	Description of Site	Depth	Geochemistry						
			Pb (2)	As (2)	Sb (4)	Zn (5)	Cd (0.1)	Cu (5)	Hg (0.02)
24	Small clearing, surrounded by Wilga trees	0-2	22	4	<4	35	<0.1	15	<0.02
		2-5	26	3	<4	35	<0.1	18	<0.02
25	Two small Wilga trees; one big Box Tree	0-2	28	11	4	28	<0.1	15	<0.02
		2-5	26	10	6	28	<0.1	15	0.04
26	One big Wilga tree	0-2	55	10	<4	35	<0.1	15	<0.02
		2-5	22	13	<4	25	<0.1	12	<0.02
27	Scrubby, with one split, dead Gum tree	0-2	19	4	<4	40	<0.1	15	<0.02
		2-5	24	6	<4	48	<0.1	18	<0.02
28	Cleared, with ironstone floaters	0-2	24	6	<4	40	<0.1	15	<0.02
		2-5	28	7	4	35	<0.1	15	<0.02
29	Large dead Gum tree near to peg	0-2	19	4	<4	30	<0.1	12	0.02
		2-5	22	7	<4	32	<0.1	15	0.02
30	Much low Broombush	0-2	22	3	<4	38	<0.1	15	0.02
		2-5	20	3	<4	32	<0.1	15	<0.02
31	Dead Yarran tree next to Broombush	0-2	24	2	<4	38	<0.1	15	<0.02
		2-5	26	8	<4	30	<0.1	15	<0.02
32	Near road; extensive Broombush scrub	0-2	22	5	<4	38	<0.1	15	<0.02
		2-5	20	5	<4	35	<0.1	15	<0.02
33	Young Box Tree with live/ dead Broombush	0-2	24	3	<4	35	<0.1	15	<0.02
		2-5	28	8	<4	30	<0.1	15	<0.02
34	Two small Ironwood trees	0-2 (a)	24	7	<4	42	<0.1	18	<0.02
		2-5	Lost						
		0-2 (b)	22	4	<4	40	<0.1	15	0.02
		2-5	Lost						
35	Dead and split Gum tree near stacked core trays	0-2	36	18	6	25	<0.1	15	<0.02
		2-5	34	10	4	22	<0.1	12	0.02

TABLE 2: CONTINUED

Site No. (Position shown on Map)	Description of Site	Depth	Geochemistry						
			Pb (2)	As (2)	Sb (4)	Zn (5)	Cd (0.1)	Cu (5)	Hg (0.02)
36	Small Wilga tree near road	0-2	30	7	<4	40	<0.1	18	0.02
		2-5	30	8	<4	40	<0.1	18	0.02
37	Clear, with minor Broombush	0-2	24	8	<4	35	<0.1	18	0.02
		2-5	22	8	4	30	<0.1	15	<0.02
38	Extensive dead Broombush	0-2	24	4	4	42	<0.1	18	<0.02
		2-5	24	6	<4	38	<0.1	18	<0.02
39	Near fence; clear and recently scraped; on edge of ironstone ridge	0-2	22	8	4	25	<0.1	12	<0.02
		2-5	22	8	<4	22	<0.1	12	0.02
40	Flat, Wilga trees/cleared	0-2	22	7	<4	32	<0.1	15	<0.02
		2-5	20	9	<4	28	<0.1	15	0.02
41	Clear beside small Ironwood tree	0-2	18	5	<4	20	<0.1	10	0.02
		2-5	16	6	<4	20	<0.1	10	0.02
42	Few large dead Gums, small Boxwood tree and minor Broombush	0-2	22	5	<4	40	<0.1	15	0.04
		2-5	30	8	<4	30	<0.1	15	<0.02
43	Flat, with a few Broombush	0-2	30	6	<4	40	<0.1	15	<0.02
		2-5	32	9	<4	30	<0.1	15	0.02
44	Very dense Needlewood saplings; flat area	0-2	22	3	<4	38	<0.1	15	0.02
		2-5	22	5	<4	35	<0.1	15	0.02
45	Flat, with a few Broombush	0-2	22	3	<4	48	<0.1	18	0.02
		2-5	22	5	<4	38	<0.1	15	0.02
46	Generally clear, but few Broombush and two Ironwood trees nearby	0-2	24	5	4	35	<0.1	15	0.08
		2-5	26	7	<4	28	<0.1	15	0.02
47	Two Broombush trees, one Emu Bush and one Sandelwood tree nearby	0-2	60	10	8	38	<0.1	15	<0.02
		2-5	70	13	<4	28	<0.1	15	0.02

TABLE 2: CONTINUED

Site No. (Position shown on Map)	Description of Site	Depth	Geochemistry						
			Pb (2)	As (2)	Sb (4)	Zn (5)	Cd (0.1)	Cu (5)	Hg (0.02)
48	Clear; on top of hill covered by few Broombush	0-2	26	7	4	32	<0.1	15	0.02
		2-5	26	6	<4	28	<0.1	15	0.02
49	Clear	0-2	46	26	<4	22	<0.1	15	0.04
		2-5	34	20	4	20	<0.1	10	0.04
50	Clear; occasional Wilga trees	0-2	24	4	<4	45	<0.1	18	0.04
		2-5	26	3	<4	45	<0.1	18	0.08
51	Clear; beside fence and track	0-2	17	6	<4	30	<0.1	12	0.06
		2-5	18	5	<4	25	<0.1	12	0.02
52	Clear, but large Gum surrounded by low Wilga trees	0-2	24	5	<4	42	<0.1	15	0.04
		2-5	28	6	<4	42	<0.1	18	0.04
53	Box Tree scrub area with bit of Broombush	0-2	24	8	<4	28	<0.1	12	0.02
		2-5	24	7	<4	25	<0.1	12	0.04
54	Clear, with a few Broombush	0-2	46	24	4	28	<0.1	15	<0.02
		2-5	24	6	<4	32	<0.1	15	0.04
55	Clear; near road, numerous Broombush nearby	0-2	30	11	4	30	<0.1	15	<0.02
		2-5	24	7	<4	28	<0.1	15	0.04
56	Two Ironwood saplings nearby; minor Broombush	0-2	34	8	<4	35	<0.1	15	0.04
		2-5	44	9	4	30	<0.1	15	0.04
57	Ironwood saplings abundant; dead Box Tree nearby	0-2	24	3	<4	38	<0.1	15	<0.02
		2-5	22	4	<4	35	<0.1	18	<0.02
58	Few Broombush; dead Gum tree saplings and Ironwood tree	0-2	26	2	<4	40	<0.1	15	<0.02
		2-5	24	4	<4	30	<0.1	15	<0.02

TABLE 2: CONTINUED

Site (Position shown on Map)	Description of Site	Depth	Geochemistry						
			Pb (2)	As (2)	Sb (4)	Zn (5)	Cd (0.1)	Cu (5)	Hg (0.02)
59	One small Ironwood tree; minor sparse Broombush	0-2	26	6	<4	38	<0.1	15	0.04
		2-5	32	9	4	35	<0.1	15	0.02
60	Clear and distinctly sloping	0-2	26	9	4	35	<0.1	15	<0.02
		2-5	130	6	4	38	<0.1	15	<0.02
61	Clear with nearby Box Tree	0-2	24	3	<4	38	<0.1	18	0.04
		2-5	26	5	6	32	<0.1	15	0.02
62	One Box Tree nearby, minor Broombush	0-2	20	8	<4	32	<0.1	15	0.04
		2-5	22	8	4	28	<0.1	15	<0.02
63	Curran Bush	0-2	24	8	4	35	<0.1	15	0.08
		2-5	30	13	4	30	<0.1	15	0.04
64	Very clear on pebbly ironstone ridge	0-2	18	9	<4	25	<0.1	12	0.12
		2-5	20	8	4	22	<0.1	10	<0.02
65	Clear near road and fence	0-2	15	3	<4	25	<0.1	12	<0.02
		2-5	15	4	<4	25	<0.1	10	0.04
66	Clear near Sandalwood, Ironwood and dead Gum tree	0-2	22	10	6	38	<0.1	18	0.14
		2-5	24	9	<4	32	<0.1	15	<0.02
67	Relatively clear; large Boxwood tree nearby	0-2	22	3	<4	38	<0.1	15	<0.02
		2-5	26	4	<4	35	<0.1	15	0.04
68	Clear area on flank of ironstone ridge	0-2	26	10	<4	32	<0.1	15	<0.02
		2-5	26	6	<4	28	<0.1	12	0.04
69	Much dead small Boxwood trees	0-2	24	6	4	38	<0.1	15	<0.02
		2-5	30	8	4	30	<0.1	18	<0.02
70	Bushy looking, little Wilga tree nearby	0-2	26	8	<4	38	<0.1	15	0.02
		2-5	24	9	4	35	<0.1	15	<0.02

TABLE 2: CONTINUED

Site (Position shown on Map)	Description of Site	Depth	Geochemistry						
			Pb (2)	As (2)	Sb (4)	Zn (5)	Cd (0.1)	Cu (5)	Hg (0.02)
71	Medium-sized Boxwood tree and several small Broombushes	0-2	19	5	<4	38	0.1	15	0.10
		2-5	22	3	<4	38	0.1	18	0.06
72	Clear area with big bushy willow looking Wilga tree nearby	0-2	26	10	<4	35	<0.1	18	<0.02
		2-5	26	7	<4	35	<0.1	15	<0.02
73	Thick Box Tree; flat; leaves thick on ground	0-2	24	2	4	35	<0.1	15	<0.02
		2-5	22	3	<4	35	<0.1	15	0.04
74	Cleared; near road	0-2	19	<2	<4	25	<0.1	12	<0.02
		2-5	22	5	<4	20	<0.1	10	<0.02
75	Cleared patch surrounded by Broombush and Box Trees	0-2	22	4	<4	32	<0.1	15	0.12
		2-5	22	3	<4	35	<0.1	15	0.06
76	Surrounded by small Ironwood trees, Gums and Wilga trees	0-2	24	9	<4	35	<0.1	15	0.13
		2-5	24	8	<4	32	<0.1	15	0.04
77	Few low Broombushes	0-2	26	3	<4	32	<0.1	15	0.20
		2-5	28	4	<4	30	<0.1	15	0.02
78	Large dead Gum tree	0-2	22	6	<4	40	<0.1	15	0.37
		2-5	26	7	4	35	<0.1	15	0.02
79	A Broombush thicket	0-2	20	4	<4	38	<0.1	15	<0.02
		2-5	30	4	<4	32	<0.1	15	0.02
80	Near Box Tree; much low Broombush	0-2	22	6	4	30	<0.1	15	0.04
		2-5	20	5	<4	30	<0.1	15	<0.02
81	Near tree on graded road	0-2	26	5	<4	40	<0.1	18	0.11
		2-5	22	9	<4	35	<0.1	18	0.04
82	Much low Broombush	0-2	24	7	<4	32	<0.1	15	0.04
		2-5	24	5	<4	30	<0.1	15	0.04

TABLE 2: CONTINUED

Site (Position shown on Map)	Description of Site	Depth	Geochemistry						
			Pb (2)	As (2)	Sb (4)	Zn (5)	Cd (0.1)	Cu (5)	Hg (0.02)
83	Curran bushes	0-2	24	6	<4	35	<0.1	15	0.02
		2-5	24	7	4	32	<0.1	15	<0.02
84	Site surrounded by large Box Trees	0-2	22	4	<4	38	<0.1	15	<0.02
		2-5	22	5	<4	35	<0.1	15	<0.02
85	Large Box Tree near three stemmed Boxwood tree; sparse Broombush	0-2	19	3	6	35	<0.1	15	<0.02
		2-5	24	7	<4	35	<0.1	18	<0.02
86	Surrounded by Broombush and Box Trees	0-2	26	7	<4	35	0.1	15	0.02
		2-5	24	6	<4	30	0.1	15	0.04
87	Thicket of Ironwood and Bluebush	0-2	24	5	4	42	<0.1	18	<0.02
		2-5	24	6	<4	38	<0.1	18	0.04
88	Road and fence near large old Wilga tree	0-2	26	6	<4	38	<0.1	15	<0.02
		2-5	24	6	<4	35	<0.1	15	0.02
89	Cleared area	0-2	26	8	<4	35	<0.1	15	<0.02
		2-5	28	9	4	30	<0.1	15	0.02
90	Small patch of Ironwood trees	0-2	18	5	<4	38	<0.1	15	<0.02
		2-5	22	4	<4	38	<0.1	15	0.03

Footnote: Broombush is more or less ubiquitous throughout the area.

TABLE 3: WATER GEOCHEMICAL DATA
 (detection limits in brackets)

Site	Details	mgs/l					
		As (0.002)	Sb (0.001)	Pb (0.03)	Zn (0.03)	Cd (0.003)	Cu (0.01)
01	Mine shaft (247 m)	0.004	<0.001	<0.03	0.11	<0.003	<0.01
02	Boulder Tank	<0.002	<0.001	<0.03	0.03	<0.003	<0.01
03	Unknown Tank (SE of Joe's Tank)	0.004	<0.001	<0.03	0.10	<0.003	0.01
04	Joe's Tank	<0.002	<0.001	<0.03	0.015	<0.003	<0.01

$$\begin{array}{r} 10654 \\ - 5841 \\ \hline 4813 \\ - 2383 \\ \hline 2430 \end{array}$$

APPENDIX C

LICENSE V102306

NEW SOUTH WALES
WATER CONSERVATION AND IRRIGATION COMMISSION
REPORT OF WATER ANALYSIS

BORE LICENSE V102306

19/8/75

EXPRESSED IN PARTS PER MILLION

Calcium	(Ca ⁺⁺)	901.8	Bicarbonate	(HCO ₃ ⁻)	122.0
Magnesium	(Mg ⁺⁺)	1191.7	Carbonate	(CO ₃ ⁻⁻)	x
Sodium	(Na ⁺)	5841.2	Sulphate	(SO ₄ ⁻⁻)	4010.5
Potassium	(K ⁺)	5.9	Chloride	(Cl ⁻)	10654.8
Silica	(SiO ₂)	13.0	Fluoride	(F ⁻)	α
Iron, Total	(Fe)	↑ ? not done?	Nitrate	(NO ₃ ⁻)	4.4

Reaction (pH) 7.5
Conductivity (EC at 25°C) 26000.0

Total Saline Matter 22683.3
Total Alkalinity (as Na₂CO₃) 106.0
Residual Alkalinity (as Na₂CO₃) 0.0
Total Hardness (as CaCO₃) 7157.2

COMMENT: JUDGED ON THE ABOVE DATA, THIS WATER IS SUITABLE FOR:

STOCK: NONE
DOMESTIC: NONE
FARMING USE: NONE

MANUFACTURING: SPECIFIC ADVICE SHOULD BE SOUGHT
FOR EACH PARTICULAR INDUSTRIAL USE

IRRIGATION CLASSIFICATION: C5 S4

APPENDIX DVEGETATION

From a report prepared by Natural Systems Research Pty. Ltd.

D.1 Introduction

This chapter presents the results of aerial photo-interpretation, a brief field survey carried out in September, 1978, subsequent specimen identification by the Herbarium, National Botanic Gardens Canberra and a review of relevant literature.

D.1.1 Objectives

The objectives of the vegetation study are to determine the direct and indirect effects of the proposed mining development on the existing vegetation of the area in the light of its regional significance and with particular emphasis on any rare or unique species.

D.1.2 Study Components

The study components have been:

- (i) To interpret aerial photographs and map vegetation types on the basis of structural form;
- (ii) To undertake a brief field survey and identify major vegetation communities, ground check photo-interpretation in the study area and observe the distribution of vegetation communities in the Cobar district;
- (iii) To make and record a representative species collection;
- (iv) To assess the extent to which past Aboriginal and European land uses have modified the vegetation, to evaluate the effects of the present land use on the persistence of existing vegetation and to assess the ecological status of the plant communities;
- (v) To describe the relationship of vegetation to soils and the hydrologic regime and assess the vulnerability of vegetation to land disturbance in the immediate vicinity;
- (vi) To document the regional significance of the main vegetation types occurring within the study area and describe the relative abundance of the major vegetation types outside the study area.

D.2 Methods

Aerial photo-interpretation was undertaken prior to visiting the site by stereoscopic examination of the 1:22,000 (high level) colour photographs (February, 1977) and perusal of the 1:5,000 (low level) colour photographs (March, 1977). Preliminary vegetation types were identified and mapped and these were later checked in the field by a series of vehicle traverses along tracks and fence lines, and on foot in the more inaccessible areas. This allowed a thorough coverage of the mining lease with particular emphasis on those areas most likely to be disturbed by the proposed mining operation. Certain areas along the proposed railway easement lacked adequate photo coverage, while others were not accessible for field checking and mapping resolution is correspondingly coarser for this section.

Vegetation of the surrounding district was examined using high level aerial photographs and mosaics and by observations along some of the major roads around Cobar.

A total of 310 plant specimens was collected in the field, recorded, pressed and then transported to Canberra where they were identified. The specimens now form part of the National Botanic Gardens' Herbarium collection in Canberra.

D.3 Results

D.3.1 Classification of Vegetation Types

Floristically, the vegetation within the study area is essentially all one community, the "Eucalyptus populnea (populifolia) - Acacia Association" (bimble box - wattle association) of Beadle (1948). Outliers of other vegetation associations also occur but these are restricted to relatively small areas. Vegetation types within the association were differentiated using a structural classification after Specht (1970), based on the life form and canopy cover of the tallest vegetation layer.

Variation in vegetation types reflects the topographic features of the study area and there is considerable intergradation between them. In general, boundaries are diffuse and difficult to recognise in the field except for the shrublands which occur along watercourses and can be sharply defined.

Within the "Eucalyptus populnea - Acacia Association" there are 8 vegetation types and two outliers of other associations. These ten are listed below under five broad structural headings. Their

distribution on the mining lease and proposed railway easement is shown in Figures 7 and 8 respectively, and the species composition for the different structural components is shown in (Table 1).

Woodlands

1. Eucalyptus populnea (bimble box) woodland
2. Eucalyptus intertexta (red box) woodland
3. Eucalyptus populnea - Acacia aneura (bimble box - mulga) woodland

Open Woodlands

4. Eucalyptus populnea - Acacia excelsa (bimble box - ironwood) open woodland
5. Eucalyptus intertexta - Acacia aneura (red box - mulga) open woodland

Tall Shrublands

6. Acacia aneura (mulga) tall shrubland
7. Acacia omalophylla (yarran) tall shrubland
8. Acacia burkittii tall shrubland

Tall Open Shrubland

9. Acacia excelsa (ironwood) tall open shrubland

Shrubland

10. Eremophila - Dodonaea - Acacia shrubland

D.3.2 Description of the "Eucalyptus populnea - Acacia (bimble box - wattle) Association"

The "Eucalyptus populnea - Acacia Association" occurs as a woodland to open woodland of widely spaced Eucalyptus trees 10-15 m tall, dominated mainly by E. populnea (bimble box), but with E. intertexta (red box) as a frequent associate which sometimes replaces it altogether.

Beneath the Eucalyptus is a tall understorey of shrubby Acacias, notably A. aneura (mulga) and A. excelsa (ironwood). They are 5-8 m tall and are usually widely spaced, but rarely does the

STRUCTURE AND DOMINANCE OF VEGETATION TYPES

Vegetation Type	Layer by layer composition and density (dominants underlined)		
	Layer	Density	Species
1. Bimble box woodland	tree (10-30m)	open (10 to 30% projected foliage cover)	<u>Eucalyptus populnea</u> , <u>E. intertexta</u>
	tall shrub	open	Acacia aneura, A. excelsa, A. omalophylla, Geijera parviflora, Hakea tephrosperma.
	medium shrub	mid-dense - v.open	Eremophila mitchellii, E. sturtii, Cassia eremophila Myoporum deserti, Apophyllum anomalum, Dodonaea attenuata.
	per. herb	mid-dense - v.open	Eragrostis setifolia, Aristida jerichoensis, Panicum xerophilum, Thyridolepis mitchelliana.
	ann. herb	open - absent	Cuphanotus humistratus, C. andraeanus, Calotis cuneifolia, C. lappulacea, Erodium crinitum, Crassula sieberana, C. colorata, Harmsiodoxa blennodioides, Helipterum variabile, Velleia paradoxa, Actinobole uliginosum, Stuartina muelleri.
2. Red box woodland	tree (10 - 30m)	open (10 to 30% projected foliage cover)	<u>Eucalyptus intertexta</u> , <u>E. populnea</u> .
	Tall shrub	open	Acacia aneura, A. excelsa, Geijera parviflora, Capparis mitchellii.
	medium shrub	mid-dense - v.open	As for Type 1 (Bimble box woodland)
	Per. herb	mid-dense - v.open	As for Type 1
	ann. herb	open - absent	As for Type 1

Vegetation Type	Layer by layer composition and density (dominants underlined)		
	Layer	Density	Species
3. Bimble box - mulga woodland	tree (10-30m)	very open (<10% projected foliage cover)	<u>Eucalyptus populnea</u> , <u>E. intertexta</u>
	tall shrub	open	<u>Acacia aneura</u> , <u>A. excelsa</u> , <u>Eucalyptus socialis</u>
	medium shrub	mid-dense-very open	As for Type 1 (Bimble box woodland)
	per. herb	open - absent	As for Type 1
	ann. herb	open - absent	As for Type 1
4. Bimble box - ironwood open woodland	tree (10-30m)	very open (<10% projected foliage cover)	<u>Eucalyptus populnea</u> , <u>E. intertexta</u>
	tall shrub	open	<u>Acacia excelsa</u> , <u>A. aneura</u> , <u>Eucalyptus socialis</u>
	medium shrub	mid-dense - very open	As for Type 1 (Bimble box woodland)
	per. herb	open - absent	As for Type 1
	ann. herb	open - absent	As for Type 1
5. Red box - mulga open woodland	tree (10-30m)	very open (<10% projected foliage cover)	<u>Eucalyptus intertexta</u> , <u>E. populnea</u> .
	tall shrub	open	<u>Acacia aneura</u> , <u>A. excelsa</u> , <u>Geijera</u> , <u>Capparis</u> , <u>Heterodendrum oleifolium</u> .
	medium shrub	mid dense - very open	As for Type 1 (Bimble box woodland)
	per. herb	open - absent	As for Type 1
	ann. herb	open - absent	As for Type 1

Vegetation Type	Layer by layer composition and density (dominants underlined)		
	Layer	Density	Species
6. Mulga tall shrubland	tall shrub (2 to 8m) medium shrub per. herb ann. herb	mid dense - open (10-30% projected foliage cover) v.open - absent ± absent mid-dense - open	<u>Acacia aneura</u> As for Type 1 (Bimble box woodland) As for Type 1 Wahlenbergia gracilentia, Stuartina muelleri, Millotia myosotidifolia, Helipterum laeve, Stipa nitida, Erodium crinitum.
7. Yarran tall shrubland	tall shrub (2 to 8m) medium shrub per. herb ann. herb	mid-dense - open (10-30% projected foliage cover) open - v.open	<u>Acacia omalophylla</u> , A. excelsa Apophyllum anomalum, Eremophila sturtii, Acacia burkittii. As for Type 1 (Bimble box woodland) As for Type 1
8. <u>Acacia burkittii</u> tall shrubland	tall shrub (2 to 8m) medium shrub) per. herb) ann. herb)	mid-dense (10 to 30% projected foliage cover)	<u>Acacia burkittii</u> , A. omalophylla As for Type 7 (Yarran tall shrubland)
9. Ironwood tall open shrubland	tall shrub (2 to 8m) medium shrub per. herb ann. herb	very open (10% projected foliage cover) open - v.open) ± absent) open - v.open)	<u>Acacia excelsa</u> , A. aneura As for Type 1 (Bimble box woodland)

Vegetation Type	Layer by layer composition and density (dominants underlined)		
	Layer	Density	Species
10. <u>Eremophila</u> - <u>Dodonaea</u> - <u>Acacia</u> Shrubland	Medium Shrub		<u>Eremophila mitchellii</u> , <u>Dodonaea lobulata</u> , <u>Acacia aneura</u> <u>E. sturtii</u> , <u>Myoporum deserti</u> , <u>E. oppositifolia</u> <u>Scaevola spinescens</u> .
	per. herb		As for Type 1 (Bimble box woodland)
	ann. herb		As for Type 1

A. aneura form stands so dense that the crowns touch. Common shrubs of similar height are Geijera parviflora (wilga), Hakea tephrosperma, Acacia omalophylla (yarran), A. burkittii, Heterodendrum oleifolium (rosewood), Santalum acuminatum (quondong), Grevillea striata (beefwood) and Capparis mitchellii (native orange).

There is a very well developed layer of medium shrubs 1-3 m tall. This was the densest layer of the vegetation at the time of the study, cover ranging from very open to mid-dense with crowns touching (Plate 1). Characteristic species are Eremophila mitchellii (budda), E. sturtii (turpentine), and Cassia eremophila. Common species are Myoporum deserti, Apophyllum anomalum (warrior bush), Dodonaea attenuata (hop bush), Olearia pimeleoides, Cassia artemisioides and several others.

A well developed layer of summer-growing perennial tussock grasses is normally a feature of this community (Beadle, 1948, Moore et al., 1970). At the time of the study (September) all growth from the previous summer had been grazed so heavily by sheep, cattle, goats and rabbits that the tussock grasses were all unidentifiable chewed-down butts. After a good season free of grazing, these grasses can be as dense as a wheatfield (Beadle, 1948). The relative frequency of species could not be determined, but Aristida jerichoensis, Eragrostis setifolia, Panicum subxerophilum and Thyridolepis mitchelliana were present.

After good winter rains, as was the case in 1978, a diverse layer of low annual herbs appears and at the time of the study they were at their flowering peak. The total ground cover is low but the diversity is very high - up to 50 species can be found in a few square metres. This layer includes a few perennial herbs which grow in winter and die back in summer. Common species are Cuphanotus humistratus, C. andraeanus, Calotis cuneifolia, C. lappulacea, Erodium crinitum, Crassula sieberana, C. colorata, Harmsiodoxa blennodioides, Helipterum variabile, Velleia paradoxa, Actinobole uliginosum, Stuartina muelleri and Cheilanthes seiberi.

The lowest layer of the vegetation is the cryptogams (lichens, liverworts and mosses) which encrust the soil surface. In the Cobar district this layer is well developed and diverse. When undamaged it completely covers the soil and plays an important role in reducing soil erosion (Rogers and Lange, 1971, 1972). Common lichen species are Parmelia amphixantha sens. lat., Heterodea beaugleholei, Collema coccophorum, Dermatocarpon lachneum, Buellia cf. subcoronata, Lecidea decipiens, Lecidea sp., and Diploschistes scruposus. Liverworts were Riccia sp., Asterella sp. and Fossombronia sp. Mosses included Gigaspermum repens.

D3.3 Outliers of Other Associations

Mallee:

Scattered through the study area are small pure stands of mallee (Eucalyptus socialis). They are depauperate outliers of the "Eucalyptus oleosa - E. dumosa Association" (Beadle, 1948) whose distribution limit is some 40 km south of Cobar. The stands on the Elura lease are too small to be mapped individually and have not been shown.

Mulga:

This occurs as tall shrubland in small stands and, in its most pure form, is typical of the "Acacia aneura Association" (Beadle, 1948) which extends from the north-west of New South Wales to within 20 km of Elura. Three pure stands occur between the eastern boundaries of the mining lease and Bundella (Fig. 7): the mulga is very dense (Plate 2) and the understorey is exclusively annual herbs, some of which are rare or absent in typical "Eucalyptus populnea - Acacia Association". Common species are Millotia myosotidifolia, Helipterum laeve, Wahlenbergia sp. aff. gracilis, Stuartina muelleri, Stipa nitida and Erodium crinitum.

Cypress Pine:

The "Eucalyptus populnea - Callitris columellaris (glauca) Association" of Beadle (1948) reaches its western limit about 20 km east of Cobar. Beyond this limit the cypress pine (Callitris), which characterises this association, occurs in scattered stands and two individuals were seen on the Elura lease.

D.3.4 Description of the Vegetation Types

The vegetation types which comprise the "Eucalyptus populnea - Acacia Association" and outliers from other associations are described in terms of their structure and dominance in Table 1. It is emphasised that definition of the ten vegetation types within the association is necessarily arbitrary because of the intergradation between them. A full list of plant species observed within the study area is given in Section D6.

D.3.5 Soil/Water/Vegetation Relationship

The mining lease is situated on gently undulating ground with a series of low, widely spaced rises separated by broad, poorly defined water courses. Towards Cobar, the relief gradually increases to a rolling topography at the C.S.A. Mine.

Soils are hard, red, acid clay loams throughout and vary only in being deeper in the watercourses (Green, personal communication). Heavy rainfall runs off the rises and slopes and onto the watercourse areas, creating an increasingly favourable soil moisture regime. The gradient in topography and soil moisture is reflected in the vegetation structure, with watercourses occupied by the densest phase of the Eucalyptus woodland. On the slopes the woodland becomes more open and on the rises the Eucalypts may disappear, leaving a tall shrubland of Acacias.

Two sequences with differing dominance can be recognised (Figure 9). In the "Bimble box Sequence", Eucalyptus populnea is the dominant tree, and Acacia excelsa the dominant tall shrub. The corresponding dominants in the "Red box Sequence" are E. intertexta and A. aneura. There is no obvious environmental cause for the differences between the two sequences, except that Bimble box woodland occupies the more favourable watercourse sites. The sequences intergrade laterally as well as along the obvious environmental gradients.

The regional water table lies deep (80m) below the surface and ground water quality is extremely poor: total dissolved solids content is high - approximately half that of sea water (Evans, personal communication) - and the trees and shrubs of the water course areas undoubtedly reflect a more suitable soil moisture regime and do not depend for survival on the water table.

D.3.6 Vegetation of the Surrounding District

Two groups are identified: variation in vegetation type within the characteristic local "E. populnea - Acacia Association", and outliers of other major associations.

Figure shows the distribution of major vegetation associations (after Beadle, 1948) and the location of the principal observation localities.

(a) Vegetation Types within the "E. populnea - Acacia Association"

At the broadest regional scale, the entire Cobar - Elura area falls within Beadle's "Eucalyptus populnea - Acacia Association", very close to its southern limit and bounded by his "Acacia - Eremophila

Association" to the south-west and "E. populnea - Callitris columellaris Association" to the east (Figure 10). From there the association extends north in a continuous belt nearly to the Darling River at Louth and Bourke, and north-east to Gongolgon. Beyond the Darling, it continues north in a broken belt well into Queensland. However, at a finer scale, several vegetation types can be distinguished in the Cobar-Louth area.

Variations within the string "Eucalyptus populnea - Acacia Associations" are discussed in Section D.3.2 and an indication of their distribution along the Cobar - Bundella road is given in Table 2.

(b) Other Associations

Seven other vegetation types identified in the district around Elura are outliers of adjacent associations:

i) Belah - rosewood woodland

This type dominated by Casuarina cristata and Heterodendrum oleifolium, is an outlier of the "Casuarina - Heterodendrum Association" which is distributed extensively throughout south-west New South Wales. There are small stands in the first 2km from the Bundella gate along the access road to Elura (Site 1, Figure 10). There is an extensive belt of this type on a sandplain 6km from the Bundella gate along the road to Louth (Site 2).

ii) Mallee

Mallee "Eucalyptus oleosa - E. dumosa Association" is widespread in the southern half of western New South Wales. Outliers dominated exclusively by E. socialis are common in the Cobar - Elura district. A large patch occurs along the Elura access road 6-7km in from the Bundella gate (Site 3). There is also a large belt 2km from the Bundella gate along the road to Louth (Site 4).

iii) Mulga tall shrubland

The "Acacia aneura Association" dominates the quarter of New South Wales north-west of the Darling River, with an extensive belt south of Louth. In the Cobar - Elura area are large outlying belts covering 6km (Site 5) and 4km (Site 6) on the Cobar - Louth road, and also occurring south-east of Cobar at Site 7.

iv) Bimble box - cypress pine woodland

The extensive "Eucalyptus populnea - Callitris columellaris Association" comes within 20km east of Cobar. It differs from the "E. populnea - Acacia Association", mainly in that Callitris replaces Acacia aneura & A. excelsa as the rainfall increases towards the east (Beadle 1948). Outlying patches are uncommon in the Cobar - Elura area, but one can be seen at about 15km from Cobar along the road to Louth (Site 8).

TABLE 2
VEGETATION TYPES ON THE COBAR - LOUTH ROAD

Distance from Cobar (km)	Vegetation type/location
0	Centre of Cobar
0-6	Vegetation highly disturbed and modified.
6-10	Mulga tall shrubland with belts of bimble box woodland.
10-12	Red box-mulga open-woodland
12-25	Bimble box woodland with some mulga
25-27	Bimble box woodland with yarran.
27-32	Mulga tall shrubland
32-38	Yarran tall shrubland
38-43.5	Red box open-woodland with abundant <u>Cassia</u> .
43.5	Turn-off to Elura

Of the 40km of relatively undisturbed vegetation, 30km were types belonging to the dominant "Eucalyptus populnea - Acacia Association". Almost all of the remainder were outlying mulga.

Similarly, along the first 20km of the road from Cobar to Bourke, the vegetation was virtually all "Eucalyptus populnea - Acacia Association", with small patches of mallee in the first 5km.

v) Eremophila - Dodonaea - Acacia shrubland

The only outlier of this association in the Cobar - Elura area occurs on the proposed railway easement (See Figure 8 and Table 1).

vi) Silver-leafed ironbark

Eucalyptus melanophloia has its main occurrence well to the north and east of Cobar. It is dominant in the "E. melanophloia Association" in a few small areas in northern New South Wales, and in Queensland. A solitary silver-leafed ironbark was found about 12km north-west of Cobar (Site 9).

vii) Eucalyptus viridis - Acacia doratoxylon shrubland

This is a distinct but very restricted community, found only on sharply defined ridges and hills in the Cobar district, and is too small in extent to have been mapped by Beadle. One such ridge was examined 8km south-east of Cobar (Site 10), supporting an open mallee-shrubland dominated by E. viridis and A. doratoxylon, with Eucalyptus morrisii, Eremophila latrobei and Dodonaea lobulata common. Many species in this community do not occur on the gently undulating surrounding country. An undescribed orchid, of the genus Pterostylis, was an exciting discovery on top of the ridge.

A list of species additional to those found in the study area is given in Section D7.

D.3.7 Past Modification

The vegetation of the Cobar district is indigenous but substantially modified. Following settlement of the area in the 1870's by squatters, there have been several extensive disturbing influences, all relating directly to the grazing industry, clearing, direct grazing effects, changes in the fire regime, and management practices aimed at assisting commercially useful fodder species.

Clearing:

Since settlement, extensive clearing and ringbarking has occurred in the Cobar district (Greig et al. 1969). The extent is unknown because of the capacity of the vegetation to regenerate, but some evidence of past clearing can be seen, for example, along the eastern boundary of Allednub, where air photos show the timber to be much denser in the adjacent property to the east. The proper boundary coincides with no obvious natural ecological boundary and reflects a history of partial clearing of Allednub. Some properties in the district have been cleared completely and are now open grasslands, but this is rare.

Grazing Influence:

Grazing animals introduced by European man to the district include domestic sheep and cattle, and feral goats, pigs and rabbits. In fact, feral goats apparently outnumber sheep and cattle on Bundella. Under this heavy grazing, the tree and shrub populations are remarkably resilient, and reproduction of most species is prolific. Some, however, are not reproducing: Acacia excelsa; Eucalyptus socialis (which reproduces poorly everywhere); and Apophyllum anomalum. There is evidence (Greig et al. 1969) that the low shrubs Rhagodia spinescens and Atriplex stipitata were once common but have been all but grazed out.

Graziers often perceive the resilience of the trees and shrubs as a problem. Under heavy grazing the important stock feed tussock grasses are suppressed, the herb cover stripped away and the lichen crust broken up, resulting in extensive severe sheet soil erosion (Beadle 1948, Greig et al 1969, Rogers and Lange 1971, Cunningham et al 1976). However it is the trees and shrubs, which are basically unaffected by grazing, that are often blamed for the lack of grass and erosion.

Management Practices:

Current management practices aim to suppress the natural regeneration of trees and shrubs and to encourage native or introduced grasses. They include: wholesale clearing followed by pasture sowing (Moore and Walker 1972); "crash" grazing by sheep or goats (Moore and Walker 1972); furrowing and ripping combined with pasture sowing (Cunningham et al 1976); firing; and waterspreading onto flats which are cleared and sown to fodder crops (Greig et al 1969). These practices obviously cause fundamental changes to the natural vegetation, but their use is not yet widespread.

Fire:

Fire was an important ecological factor in the Cobar district before the advent of European man, and fire frequency was probably increased by the aborigines. Greig et al (1969) suggest that it was sufficiently frequent to keep the country much more open than at present and a very large bushfire in 1921 cleared much of the district of trees and shrubs, which have since regenerated.

With European settlement, fires have been controlled to protect life, buildings and fences, and grazing has reduced the abundance of grasses, necessary to carry fire through semi-arid country. The effect overall has been to substantially increase the tree and shrub vegetation at the expense of the groundcover species. The long term effects of this change in fire frequency are unknown, but they are probably minor by comparison with grazing and management practices.

D.3.8 Present Status

The condition of the mining lease at Elura is fairly typical of the district. Whether it was once cleared is unknown, but the large size of many of the trees and occurrence of long-lived Acacias indicate that this is unlikely. In recent years the lessee of Bundella has felled a few mulgas for sheep fodder. The direct effects of grazing are much more apparent: soil erosion, especially around Emu (Charlies) Tank; the poor state of the soil lichen crust elsewhere; the poor condition of the perennial grasses; and grazed-down shrubs of Rhagodia spinescens and Apophyllum anomalum. Near to the eastern boundary of Bundella, the grazing effects are less apparent, and some of the vegetation and soil is in reasonably good condition.

The vegetation on the the proposed railway easement is generally in a similar condition to that on the mining lease. Exceptions are the partially cleared land on Allednub and the area extending from Cobar to just beyond the C.S.A. mine, where clearing has been more extensive, and it is difficult to determine the nature of the original vegetation over much of this area.

D.4 Effects of the ProposalD.4.1 Clearing and Disturbance

Construction of the mine will result in the total destruction of approximately 335 ha of vegetation. The most extensive clearing will occur in the tailings disposal area, temporary waste rock stockpile, mine head area and along the rail link with Cobar. Table 3 shows the extent of vegetation types which will be removed from both the mining lease and railway corridor.

TABLE 3.

EXTENT OF VEGETATION CLEARANCE ON THE MINING LEASE AND RAILWAY ROUTE

Vegetation Type	Area Cleared	
	Mining Lease ha	Railway Route* ha
1. Bimble box woodland	70	6
2. Red box woodland	-	21
3. Bimble box - mulga woodland	-	18
4. Bimble box - ironwood open woodland	100	15
5. Red box - mulga open woodland	-	83
6. Mulga tall shrubland	3	-
7. Yarran tall shrubland	-	-
8. <u>Acacia burkittii</u> tall shrubland	-	-
9. <u>Ironwood</u> tall open shrubland	11	-
10. <u>Eremophila</u> - <u>Dodonaea</u> - <u>Acacia</u> shrubland	-	8

TOTAL

* Calculated assuming a 50m cleared easement

Additional vegetation removal for the widening and bitumen sealing of the Cobar - Louth road to Bundella and access road to the mine will be minimal. Modifications to the vegetation will result from run-off retention and diversion works, with the soil water regime locally enriched in some places and impoverished in others. This will cause a gradual change in the distribution of plant species in the area affected. Where the available soil moisture is decreased, such as immediately down slope of a run-off collector drain, the taller eucalypts (bimble box and red box) may be gradually replaced by a wattle shrubland of ironwood and mulga (Figure 9). Examination of vegetation adjacent to disturbed areas around the C.S.A. mine and existing roads showed no obvious deleterious effects as a result of modifications to the surface drainage. A similar situation is expected at Elura with effects restricted to the immediate vicinity of the drainage works.

Improved access due to upgrading of the road to the Elura, and the presence of construction and operations workforce will contribute to increased pressure on the native vegetation through physical disturbance and an increased risk of fire, but the effect is expected to be minimal in the context of highly disruptive past and present land uses.

D.4.2 Regional Significance

The vegetation of the mining lease and proposed railway easement includes about 5km² of "Eucalyptus populnea - Acacia Association", incorporating most of its variations or types. Beadle maps about 12,000 km² of this association in New South Wales, mainly north-west of the Darling river.

The outliers of other associations are poorly represented on the mining lease and proposed railway easement. There are three large stands of Mulga tall shrubland (Acacia aneura Association) between Elura and the east fence of Bundella and the railway easement may cut through the southernmost of these. Mallee outliers on the mining lease and railway alignment are very small compared to others nearby, and the association is widespread throughout south-western New South Wales.

One outlier of the "Acacia - Eremophila Association" observed lies in the path of the railway, a patch of about 5km² on a low ridge on Mopone. This association covers extensive areas to the south and west of Cobar.

The visually distinctive Eucalyptus viridis - Acacia doratoxylon shrubland does not occur on the mining lease or along the proposed railway alignment.

D.4.3 Special Features

No rare or endangered species are known to occur in the study area and none of the 132 indigenous species collected are so classified by Specht et al (1974).

During the reconnaissance of the broader region, however, one example of a previously undescribed orchid of the genus Pterostylis was discovered 10km south-east of Cobar, approximately 40km from the mining lease. The locality was a rocky ridge top, some 60m above the surrounding plain, however pronounced topographic features of this sort, with skeletal soils supporting a distinctive vegetation community, are not found on the undulating terrain of the study area and surrounds. The occurrence there of this orchid is therefore extremely unlikely.

The one feature of note in the study area proper was an unusual example of Eucalyptus socialis, growing adjacent to the eastern Bundella boundary fence (Figure 7). Normally E. socialis has a whipstick mallee growth habit less than 5m tall (Plate 3) but this individual is a single stemmed tree some 12m high (Plate 4). This is the largest specimen known to the National Botanic Gardens Herbarium, Canberra and to Mr. I. Brooker (C.S.I.R.O. Division of Forest Research), a specialist in the study of mallee eucalypts. The location of the proposed railway route places this tree at risk.

Finally, the mulga outliers of the Acacia aneura association between the eastern limit of the mining lease and the eastern Bundella property boundary deserve a brief comment. These stands are relatively undisturbed, and although representative of an association extremely widespread in arid Australia, they have a moderate conservation value insofar as they provide some localised structural and floristic diversity within an area dominated by minor variation of the bumble box - wattle association (Plate 2). In addition, grazing pressure from rabbits has prevented the regeneration of mulga throughout most of its distribution except for the eastern part of its range and locally around Cobar.

D.5 References

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SECTION D6STUDY AREA BOTANICAL SPECIES CHECKLIST

(an asterisk donotes alien species).

LICHENSBuelliaceae

Buellia cf. subcoronata Muell.-Arg.

Soil crust.

Collemetaceae

Collema coccophorum Tuck.

Soil crust.

Dermatocarpaceae

Dermatocarpon lachneum (Ach.) AL. Sm.

Soil crust.

Diploschistaceae

Diploschistes scruposus (Schreb.) Norm.

Soil crust.

Heterodeaceae

Heterodea beaugleholei R. Filson

Soil crust.

Lecideaceae

Lecidea decipiens (Hedw.) Ach.

Soil crust.

Lecidea sp.

Soil crust.

Parmeliaceae

Parmelia amphixantha Muell.-Arg. sens. lat.

Soil crust.

HEPATICSFossombroniaceae

Fossombronia sp.

Soil crust.

Marchantiaceae

Asterella sp.

Soil crust. Under
shrubs.Ricciaceae

Riccia sp.

Soil crust.

MOSESSESGigaspermaceae

Gigaspermum repens (Hook.) Lindl.

Soil crust.

PTERIDOPHYTESSinopteridaceae

Cheilanthes sieberi Kunze

Common under shrubs.

GYMNOSPERMSCupressaceae

Callitris columellaris F. Muell.

"Cypress pine".

Rare.

MONOCOTYLEDONSLiliaceae

Bulbine alata H. Baijnath

Dianella laevis R.Br.

Common.

Rare.

Poaceae

Agrostis avenacea J.F. Gmel.

Aristida jerichoensis Domin

var. subspinulifera Henrard

Rare.

Common but very heavily grazed.

Bothriochloa macra (Steud.) S.T. Blake

Danthonia caespitosa Gaudich.

Enteropogon acicularis (Lindl.)

M. Lazarides

Eragrostis setifolia Nees

"Redleg grass".

Rare.

Rare.

Occasional, heavily grazed.

Common but heavily grazed.

* Hordeum glaucum Steud.

"Barley grass".

Common weed around tanks.

Panicum subxerophilum Domin

Common but heavily grazed.

Occasional.

Paspalidium constrictum (Domin)

C.E. Hubbard

* Schismus barbatus (L.) Thell.

Occasional in disturbed areas.

Frequent but heavily grazed.

Occasional.

Stipa nitida V.S. Summerhayes et C.E. Hubbard

Stipa tuckeri F. Muell.

Thyridolepis mitchelliana

(Nees) S.T. Blake

* Vulpia myuros (L.) C.C. Gmel.

"Rats-tail fescue."

Frequent, heavily grazed.

Common around tanks.

DICOTYLEDONSAmaranthaceae

Ptilotus atriplicifolius

(A. Cunn. ex Moq.) G. Benl

Ptilotus gaudichaudii (Steud.) J.M. Black

Frequent in watercourse areas.

Occasional.

Apiaceae

Daucus glochidiatus (Labill.) Fisch. et al.

Common under shrubs.

Apocynaceae

Parsonia eucalyptophylla F. Muell.

Common vine.

Asteraceae

Actinobole uliginosum (A. Gray) Hj. Eichler

Frequent.

Asteraceae

Brachycome ciliaris (Labill.) Less.	Occasional.
Calotis cuneifolia R.Br.	Common.
Calotis hispidula (F. Muell.) F. Muell.	Common, especially under shrubs.
Calotis lappulacea Benth.	Common.
Calotis multicaulis (Turcz.) Druce	Rare.
Centipeda thespidioides F. Muell.	"Sneeze weed". Common around tanks.
Cotula australis (Sieber ex Spreng.) Hook.f.	Occasional, around tanks.
Gnaphalium sphaericum Willd.	Frequent.
Helichrysum apiculatum (Labill.) D. Don	Occasional.
Helichrysum bracteatum (Vent.) Willd.	Rare.
Helipterum australe (A. Gray) Druce	Common.
Helipterum floribundum DC.	Frequent.
Helipterum jessenii F. Muell.	Occasional.
Helipterum laeve (A. Gray) Benth.	Rare, apparently confined to dense mulga.
* Hypochoeris glabra L.	"Cat's ear". Occasional, especially around tanks.
Isoetopsis graminifolia Turcz.	Common.
Millotia myosotidifolia (Benth.) Steetz	Rare, apparently restricted to dense mulga.
Minuria leptophylla DC.	Rare.
Myriocephalus rhizocephalus (DC.) Benth.	Frequent around tanks.
Olearia pimeleoides (DC.) Benth.	Occasional.
Senecio quadridentatus Labill.	Very common.
* Sonchus oleraceus L.	"Sow thistle" Rare, mainly near tanks.
Stuartina muelleri Sond.	Common under shrubs.
Vittadinia cuneata DC.	Rare.
Vittadinia sp.	Rare.

Boraginaceae

Omphalolappula concava (F. Muell.) Brand	Rare.
Plagiobothrys sp. aff. plurisepaleus (F. Muell.) I.M. Johnston	Frequent around tanks.

Brassicaceae

* Alyssum linifolium Steph. ex Willd.	Rare.
Cuphonotus andraeanus (F. Muell.) E.A. Shaw	Common.
Cuphonotus humistratus (F. Muell.) O.E. Schulz	Very common.
Harmsiodoxa blennodioides (F. Muell.) O.E. Schulz	Frequent.
Lepidium papillosum F. Muell.	Occasional under trees.
Menkea australis Lehm.	Common.
*Sisymbrium irio L.	"London rocket" Occasional weed around tanks.
Stenopetalum lineare R.Br. ex DC.	Rare.
Stenopetalum nutans F. Muell.	Rare.

Caesalpinaceae

Cassia artemisioides Gaudich.	Occasional.
Cassia eremophila A. Cunn. ex Vogel	"Punty bush". Very common.

Campanulaceae

- Wahlenbergia fluminalis* (J.M. Black)
Wimmer ex Hj. Eichler
Wahlenbergia sp. aff. *gracilis*
(Forst.f.) Schrad.
Wahlenbergia gracilentata N. Lothian

Occasional around tank
Common.
Common.

Capparaceae

- Apophyllum anomalum* F. Muell.
Capparis mitchellii Lindl.

"Warrior bush"
"Native orange"

Frequent; heavily
grazed.
Frequent.

Carvophyllaceae

- Spergularia* sp. aff. *media* (L.) C.Presl
Stellaria multiflora Hook. vel aff.

Rare, near tanks.
Rare, near a tank.

Chenopodiaceae

- Chenopodium anidiophyllum* Aellen
Chenopodium cristatum F. Muell.
Einadia nutans (R.Br.) A.J. Scott
Maireana enchylaenoides (F. Muell.)
P.G. Wilson
Rhagodia spinescens R.Br.
var. *deltophylla* F. Muell.
Salsola kali L. sens. lat.
Sclerolaena birchii (F. Muell.) Domin
Sclerolaena diacantha (Nees) Benth.

"Stinking
goosefoot"

Rare.
Occasional.
Occasional, heavily
grazed, under trees.
Rare, under trees.
Rare, heavily grazed,
under trees.
Occasional.
Rare.
Rare.

Convolvulaceae

- Convolvulus erubescens* Sims

Occasional

Crassulaceae

- Crassula colorata* (Nees) Ostenf.
Crassula sieberana (Schult. et Schult.f.)
Druce

Occasional.
Common.

Euphorbiaceae

- Chamaesyce drummondii* (Boiss.) D.C. Hassall

Occasional.

Fabaceae

- * *Medicago laciniata* (L.) Mill.
* *Medicago minima* (L.) L.
Swainsona microphylla A. Gray
subsp. *affinis* A.T. Lee

Occasional weed near
tanks.
Occasional weed near
tanks.
Occasional.

Geraniaceae

- Erodium crinitum* R.C. Carolin

Common.

Goodeniaceae

- Goodenia subintegra* F. Muell. ex J.M. Black
Velleia paradoxa R.Br.

Occasional.
Common.

Loranthaceae

Ameyma quandang (Lindl.) Van Tiegh.

Mistletoe, common
in Acacias.

Lysiana subfalcata (Hook.) B.A. Barlow

Mistletoe, frequent in
Santalum etc.

Malvaceae

Abutilon fraseri (Hook.) Walp.

Occasional under trees

Sida cunninghamii C.T. White

Rare under trees.

Mimosaceae

Acacia aneura F. Muell. ex Benth.

"Mulga"

Very common.

Acacia burkittii F. Muell. ex Benth.

Frequent in watercourse

Acacia colletioides Benth.

Frequent.

Acacia excelsa Benth.

"Ironwood"

Very common.

Acacia omalophylla A. Cunn. ex Benth.

"Yarran"

Common in watercourse

Myoporaceae

Eremophila bowmanii F. Muell.

Occasional.

Eremophila glabra (R.Br.) Ostenf.

Frequent.

Eremophila longifolia (R.Br.) F. Muell.

"Emu bush"

Occasional

Eremophila mitchellii Benth.

"Budda"

Very common.

Eremophila serrulata (A. Cunn. ex A.DC.)

Occasional.

Druce

Eremophila sturtii R.Br.

"Turpentine"

Very common.

Myoporum deserti A. Cunn. ex Benth.

Common.

Myrtaceae

Eucalyptus intertexta R.T. Baker

"Red box"

Common.

Eucalyptus populnea F. Muell.

"Bimble box"

Very common.

Eucalyptus socialis F. Muell. ex Miq.

"Mallee"

Occasional.

Oxalidaceae

Oxalis corniculata L.

"Wood-sorrel"

Common.

Papaveraceae

* *Papaver aculeatum* Thunb.

Rare.

* *Papaver hybridum* L.

Rare.

Pittosporaceae

Pittosporum phillyreoides DC.

Rare.

Plantaginaceae

Plantago turrifera B.G. Briggs et al.

Common.

Polygonaceae

Rumex sp.

"Dock"

Rare, near a tank.

Portulacaceae

Calandrinia eremaea A.J. Ewart

Frequent

Proteaceae

Grevillea striata R.Br.

"Beef wood"

Occasional.

Hakea tephrosperma R.Br.

"Needle bush"

Frequent.

Ranunculaceae

Ranunculua pentandrus J.M. Black
 var. *platycarpa* (F. Muell.) Hj. Eichler

Occasional near tanks

Rubiaceae

Canthium oleifolium Hook.

Rare.

Rutaceae

Flindersia maculosa (Lindl.) Benth.
Geijera parviflora Lindl.

"Leopardwood"
 "Wilga"

Rare.

Common.

Santalaceae

Santalum acuminatum (R.Br.) A.DC.
Santalum lanceolatum R.Br.

"Quondong"

Occasional.

Occasional.

Sapindaceae

Dodonaea attenuata A. Cunn.
Dodonaea lobulata F. Muell.
Dodonaea viscosa Jacq. sens. lat.
Heterodendrum oleifolium Desf.

"Hop bush"

Common.

"Hop bush"

Common.

"Hop bush"

Occasional.

"Rosewood"

Frequent.

Scrophulariaceae

Mimulus prostratus Benth.

Common around tanks.

Solanaceae

Nicotiana velutina H. Wheeler
Solanum ferocissimum Lindl.
Solanum sp.

Rare.

Occasional under trees

Rare under shrubs.

Zygothylaceae

Zygothylum apiculatum F. Muell.

Rare under trees.

SECTION D7

ADJACENT AREA BOTANICAL SPECIES CHECKLISTMONOCOTYLEDONSOrchidaceae

Pterostylis sp. aff. boormanii Rupp

Rocky ridges

Poaceae

Agropyron scabrum (Labill.) Pal. Beauv.

Rocky ridges.

Amphipogon caricinus F. Muell.

Rocky ridges.

Aristida caput-medusae Domin

Rocky ridges.

Eragrostis lacunaria F. Muell. ex Benth.

Rocky ridges.

Monachather paradoxa Steud.

Rocky ridges.

Stipa scabra Lindl.

Rocky ridges.

Stipa setacea R.Br.

Rocky ridges.

Thyridolepis xerophila (Domin) S.T. Blake

Rocky ridges.

DICOTYLEDONSAmaranthaceae

Ptilotus obovatus (Gaudich.) F. Muell.

Rocky ridges.

Asteraceae

Helichrysum rutidolepis DC.

Rocky ridges.

Helipterum molle (A. Cunn. ex DC.)

Rocky ridges.

P.G. Wilson

Olearia decurrens (DC.) Benth.

Rocky ridges.

Brassicaceae

Arabidella trisecta (F. Muell.) O.E. Schulz

Mulga woodland.

Lepidium oxytrichum Sprague

Rocky ridges.

* Sisymbrium orientale L.

"Wild mustard"

Roadsides.

Caryophyllaceae

Gypsophila australis

Rocky ridges.

(Schlechtendal) A. Gray

Casuarinaceae

Casuarina cristata Miq.

"Belah"

Belah-Rosewood
woodland.Chenopodiaceae

Dissocarpus paradoxus

Belah-Rosewood
woodland.

(R.Br.) F. Muell. ex Ulbrich

Sclerolaena convexula (R.H. Anderson)

Rocky ridges.

A.J. Scott

Goodeniaceae

Goodenia havilandii Maiden et Betche

Rocky ridges.

Haloragaceae

Gonocarpus elatus (A. Cunn. ex Fenzl)

Rocky ridges.

A.E. Orchard

Lamiaceae

Prostanthera ringens Benth.
 Prostanthera striatiflora F. Muell.
 * Salvia verbenacea L.

Rocky ridges.
 Rocky ridges.
 Roadside weed.

Malvaceae

Sida petrophila F. Muell.
 Sida sp. 2

Rocky ridges.
 Rocky ridges.

Mimosaceae

Acacia ? aneura F. Muell. ex Benth.
 Acacia doratoxylon A. Cunn.
 Acacia havilandii Maiden

Rocky ridges.
 Rocky ridges
 Bimble box woodland.

Myoporaceae

Eremophila latrobei F. Muell.
 Eremophila oppositifolia R.Br.
 var. rubra C.T. White et Francis

Rocky ridges.
 Rocky rises.

Myrtaceae

Eucalyptus melanophloia F. Muell.
 Eucalyptus morrisii R.T. Baker
 Eucalyptus viridis R.T. Baker

"Silver-leaf
 ironbark"

A rare outlier.
 Rocky ridges.
 Rocky ridges.

Plantaginaceae

Plantago drummondii Decaisne

Belah-Rosewood
 woodland.

Zygophyllaceae

Zygophyllum ammophilum F. Muell.

Belah-Rosewood
 woodland.

APPENDIX E

TERRESTRIAL FAUNA

From report by Natural Systems Research Pty. Ltd.

E.1 Introduction

This section presents the results of the fauna study. It is based on a five-day site survey made during September 1978, and a review of relevant literature.

E.1.1 Objectives

The objectives of the study are to determine the effects of proposed mining operations on the terrestrial fauna of the study area, with emphasis on its regional context and any rare or endangered species.

E.1.2 Study Components

- (a) To assess habitat loss and species affected, with particular reference to any rare or endangered species.
- (b) To assess disturbance by industrial and recreational activities.
- (c) To assess the regional significance of the loss of habitat and any special features.
- (d) To specify requirements for restricting access of fauna to the tailings dam.
- (e) To compile a list of vertebrate species known to occur in the study area.

E.2 Methods

E.2.1 Habitat Assessment

A preliminary assessment of habitat diversity was made in terms of vegetation structure, rather than species composition, as it is, in general, structure that determines what species of animals will occur in a particular stand of vegetation (Nudds, 1977). Thus the area was considered as open woodland, tall shrubland etc., rather than, say, Eucalyptus populnea woodland. The area was classified initially by reference to aerial photographs and later by ground verification, and sampling effort distributed so as to be representative of each major habitat type.

E.2.2

Fauna Assessment

The diverse natures and habits of animals require a fauna inventory to be based on a multiphase approach. A few species are large and relatively conspicuous, and can be surveyed by direct observation, but most are small and cryptic in their behaviour, and special techniques must be used to locate and identify them. The majority of mammals and frogs are active only at night, whereas most birds and reptiles are diurnal. Thus, a variety of survey methods is needed to ensure as full a coverage of the species present as possible, and these are summarised below.

(a) Direct Observation: all accessible areas of the mining lease were traversed during the day and at night by vehicle; much was also covered on foot. A daytime traverse of the proposed railway line was also made by vehicle, but this was not done at night. During these operations and routine trap-checking, detailed records were kept of animals seen, tracks and scats, and any other signs indirectly indicating the presence of animals. Attention was concentrated on the several dams in the area, as these tend to be focal points in an arid climate for feeding and watering animals.

(b) Spotlighting: because of the large number of nocturnal mammals in Australia it is necessary to survey an area at night, as well as by day. Spotlighting was conducted from a slow-moving vehicle equipped with a 100 watt spotlight. Spotlighting was carried out on each of the 5 nights of the study period, totalling 10.5 hours of observation. All of the major habitat types in the study area were covered in this way.

(c) Trapping: a lot of animals, particularly small mammals, are almost impossible to observe directly, as they are shy and secretive, emerge only at night and keep to cover. The only way to see them is to trap them.

Four types of traps were used in order to provide a full coverage of all possible species. Particular attention was paid to bats, as it was suspected that these would form an important component of the mammal fauna.

(i) Small Mammal Live Traps: 200 small mammal live-traps (Elliott 33 x 10 x 9cm) were distributed between the different habitat types. These were baited with a mixture of peanut butter, rolled oats and margarine, a combination of tastes attractive to a wide range of animals. Traps were set about ten metres apart in lines of twenty for two or three consecutive nights and were checked daily for captures.

The total number of trap-nights in the whole study was 640, but the number in each habitat type varied slightly.

(ii) Pitfall Traps: pitfall traps consist of holes sunk in the ground; they are an effective way of catching small mammals, small reptiles and frogs. By erecting a small "fence" between successive pitfalls in a line, the efficiency of the method is greatly increased.

Four lines of pitfall traps were set, one in each of the major habitats in the study area. Each line consisted of a training fence fifty metres long, along which pitfalls were positioned at ten metre intervals; the pitfalls were lined with a metal cylinder 25cm in diameter. Traplines were left set for four nights in each habitat type and were checked daily for captures. The total number of trap nights for the study area was eighty.

(iii) Bat Traps: trapping effort for bats was mainly concentrated at dams, as these serve as a focal point for bat activity, providing water and the aquatic insects, on which bats feed.

Bat traps (Tidemann & Woodside, 1978) were set at the following localities in the study area: Emu Tank, O'Donnell's Tank, Joe's Tank and at two points along the eastern boundary fence. Two traps were set at each location for two consecutive nights, giving an overall total of twenty trap-nights. Traps were checked at about midnight each night and then on the following morning.

(iv) Mist-nets: mist-nets are made of very fine nylon mesh to capture either birds or bats. Nets used in this study were twenty metres by three metres and were set in the late afternoon of two consecutive days at Emu Tank, O'Donnell's Tank, Boulder Tank and Murphy's Tank.

Nets were generally checked every thirty minutes or so, but in some cases this was not practicable and had to be left for longer periods unchecked. Total mist net nights was eight.

- (d) Predator Scat Analysis: hair, feathers and many bones pass through the gut of carnivores virtually unchanged. It is possible to identify prey species from an analysis of predator scats and sometimes species may be detected by this method when conventional survey methods have failed to reveal their presence (Friend, 1978). Fox scats were collected wherever found and an analysis made of their contents.

E.3

Results

E.3.1

Habitat

- (a) Habitat Type: four main structural vegetation types were recognised in the study area:

(i) Woodland is concentrated along the drainage channels; the trees Eucalyptus populnea and E. intertexta form the dominant in this association.

(ii) Open Woodland contains similar tree species to woodland but has also a prominent shrub stratus of Acacia excelsa and A. aneura. It spreads out from the watercourses onto the gently sloping areas.

(iii) Tall shrubland contains no or few trees and is dominated by Acacia aneura, A. omalophylla and A. burkittii. Tall shrubland grades into:

(iv) Open tall shrubland which is characterized in sparse Acacia excelsa and large areas of annual grasses and herbs.

- (b) Habitat quality: all habitat types in the study area have been subject to gross alteration since European settlement in the late nineteenth century by grazing, clearing and the introduction of feral animals such as goats, pigs and rabbits. Most of the changes have been detrimental to the indigenous fauna, although some species have undoubtedly benefited from the construction of permanent water sources.

Most large trees in the study area have been killed by ringbarking and felling and a number of big tree stumps can be seen along the drainage channels in the woodland associations. These trees would once have provided shelter and food for brushtail possums, Trichosurus vulpecula, and possibly other arboreal species, which now seem to have vanished from the area. Another effect of the removal of large trees is the resultant sparsity of hollow logs on the ground. Living trees periodically drop limbs, which play an important role as home-sites for small terrestrial mammals and reptiles and their insect prey. The lack of small ground-dwelling mammals can be attributed partly to the lack of fallen timber. Meanwhile, the regeneration of vegetation is hampered by the browsing of domestic stock, feral goats and rabbits. In general, the effects of European settlement and land use now favour dense shrub stands of Eremophila, Dodonea and Cassia, and these have become dominant in a landscape previously characterised by open woodland, with large trees along the drainage lines and grassed areas in between (Moore et al, 1975).

All habitat types have been degraded by the compaction of soil by grazing animals. This has led to restricted regeneration of some plant species, soil erosion and the elimination of small burrowing mammals. The complete absence of even the usually ubiquitous house mouse, Mus musculus, testifies to the grossly altered nature of the environment in this area. (Table 4, Section E.3.2). Introduced predators will also have reduced or eliminated many small species. Foxes are common in the area and feral cats, although not seen, are probably present also.

On the other hand, the provision of permanent water sources, in an otherwise dry area, has benefited some species greatly. All seed-eating birds, kangaroos and bats are able to sustain much higher numbers now than would have been possible before European settlement.

No systematic correlation between animals and habitat types (See Section E.2.1) was made in view of the extremely low abundance and diversity of species observed, inferred and trapped.

(c) Regional Significance: the study area is situated in a large belt of similar country stretching up into Queensland, (Moore, 1975); huge areas, supporting similar faunal assemblages, occur outside the study area, and the small area occupied by the mining lease and railway route is insignificant when viewed in a regional context.

E.3.2

Fauna Sampling Results

A terrestrial fauna species checklist for the mining lease and proposed railway easement is given in Table 4, based on the survey results.

Two species of lizard, two species of frog and three species of bat were trapped or netted while all other species were seen by day or by spotlight except the spiny anteater or echidna, which was recorded on the basis of extensive diggings and scats near Boulder Tank. No small terrestrial mammals were captured and an examination of fox scats failed to indicate the presence of any species other than those observed or trapped already. The absence of the normally ubiquitous introduced house mouse confirms the low habitat value of the grossly disturbed soil and groundcover, as this animal is generally extremely abundant in most partly disturbed areas of bush.

Two residents of Cobar area, Mr. L. Schmidt, E.Z. geologist, and Mr. Day of Bundella Station report sighting small hopping animals, possibly with a brushed tail. It has been suggested (Dames & Moore, 1975) that this could be the jerboa marsupial mouse or kultarr (Antechinomys laniger) but the present survey has failed to shed further light on the matter. The Dames and Moore report also suggests the possible occurrence of a number of other small marsupials but none have been sighted by Day or Schmidt and the degraded soil and ground cover, the presence of predatory foxes and the results of this survey indicate that this is unlikely.

Species Inventory

Species known to be in the study area are recorded, together with an assessment of their status.

TABLE 4
TERRESTRIAL FAUNA SPECIES LIST.

<u>MAMMALS</u>		<u>STATUS IN STUDY AREA</u>
<u>Monotretasa</u>		
<u>Tachyglossus aculeatus</u>	Echidna	Uncommon
<u>Marsupials</u>		
<u>Megaleia rufa</u>	Red Kangaroo	Uncommon
<u>Macropus fuliginosus</u>	Western Grey Roo	Very common
<u>M. giganteus</u>	Eastern " "	Uncommon
<u>Bats</u>		
<u>Pteropus poliocephalus</u>	Grey-headed Flying Fox	Rare vagrant
<u>Chalinolobus gouldii</u>	Gould's Wattled Bat	Abundant
<u>C. picatus</u>	Pied Wattled Bat	Rare
<u>Nycticeius greyi</u>	Little Broadnosed Bat	Very common
<u>Eptesicus pumilus</u>	Little Brown Bat	Uncommon
<u>Taphozous flaviventris</u>	Yellow-bellied Bat	Uncommon
<u>Tadarida australis</u>	White-striped Bat	Uncommon
<u>REPTILES</u>		
<u>Snakes</u>		
<u>Pseudonaja nuchalis</u>	Western Brown Snake	Common
<u>Lizards</u>		
<u>Varanus varius</u>	Lace Monitor	Uncommon
<u>Amphibolorus barbatus</u>	Bearded Dragon	Common
<u>A. nobbi</u>	Nobbi	Uncommon
<u>Lophognathus gilberti</u>	Gilbert's Dragon	"
<u>Trachydosaurus rugosus</u>	Stump-tail Lizard	Common
<u>Heteronotia binoei</u>	Bynoe's Gecko	"
<u>Ctenotus strauchii</u>	Skink	"
<u>Lerista muelleri</u>	"	"
<u>FROGS</u>		
<u>Cyclorana platycephalus</u>	Water-holding Frog	Uncommon
<u>Uperoleia rugosa</u>	Red-groined Toadlet	Common
<u>Neobatrachus pictus</u>	Meeowing Frog	"

INTRODUCED SPECIES

<u>Capria hircus</u>	Feral Goat	Very common
<u>Sus scrofa</u>	Feral Pig	Uncommon
<u>Vulpes vulpes</u>	Fox	Common
<u>Felis catus</u>	Feral Cat	Not seen, but probably uncommon
<u>Oryctolagus cuniculus</u>	Rabbit	Common

E.4 Effects of the ProposalE.4.1 Habitat Loss

The commencement of mining operations will completely destroy existing habitats at the mine site and in the area proposed for the tailings dam. Small resident species - reptiles and frogs will perish in this area, and the three species of kangaroos, birds and bats will be displaced into adjacent areas. Their survival there will be determined by the availability of food, shelter and water, in competition with numbers of their own and other species established in similar habitats. At any one point in time, a given fauna population will have reached a size compatible with the availability of food and shelter. This size will vary seasonally and over the longer term cycles of drought and fire, but will always be such that an influx of displaced animals will be resisted by competition from the existing population, in the short term, and a number from each group will be unable to survive. After this initial disruption, overall numbers will stabilise roughly to a pre-disturbance level and the loss, in the context of major cyclical fluctuations in species abundance, will not be significant.

The construction of the rail link to the siding of the CSA mine will result in the total destruction of a long thin strip of vegetation. It is not anticipated that the easement will be fenced which will allow the continued movement of large animals such as kangaroos to and from shelter, feeding areas and watering points. The animals will however, need to adjust to the noise and human presence during construction and operation of the track. Experience from other areas suggests that such adjustment is achieved rapidly and with minimal disturbance to faunal populations.

E.4.2 Access to Tailings Disposal System

The tailings disposal system will have an elevated centre discharge, forming a gently sloping conical mound. A system of peripheral retaining walls will trap any stormwater and tailings water, which will gravitate to a sump for return to the mill circuit and re-use. During the summer however, evaporation rates will preclude any collection of tailings water and during the season of greatest water stress in animals, the sump will be dry. During winter or following heavy rains, water will pond and be available for birds and animals to drink.

Evidence from the nearby C.S.A. copper-lead-zinc mine suggests that occasional free water in the tailings system has no obvious effect on the birds and animals drinking there, although the long term consequences are unknown. The only observed casualties to date have been two pelicans, which perished when trapped in the soft tailings sediment.

At Elura safeguards which might be considered would include, in the first place water quality tests, followed if necessary by protective and deterrent measures for animals and birds.

E.4.3 Special Features

Chalinolobus picatus, the Pied Wattled Bat, can be thought of as a rare species, although viable colonies occur elsewhere in NSW. Its rarity may well be apparent, rather than real, due to a lack of systematic searching. Only one animal was captured in the study area; it is a cave or mine-dwelling bat (Ryan, 1966) and colonies may well occur near the study site in abandoned mines. No such home-sites occur on the study area, so that the survival of the species should not be affected by mining operations there. No other rare or endangered species were recorded, nor are any expected to occur there.

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ARCHAEOLOGY

From report by Natural Systems Research Pty. Ltd.

F.1 Introduction

This chapter presents the results of a 5 day field survey undertaken in September 1978 and a literature review.

F.1.1 Objectives

The objectives of the study may be summarised as follows:

- (a) to determine the effects of proposed mining operations on archaeological sites of the study area.
- (b) to make recommendations for protecting or excavating any sites threatened by the proposed development.

F.1.2 Study Components

- (a) to briefly describe the regional archaeology and aboriginal culture of the region.
- (b) to identify, map and describe any archaeological or mythological sites within or in close proximity to the study area.
- (c) to evaluate the sites with particular reference to their regional significance.
- (d) to assess the need for special safeguards to protect archaeological sites for pre-construction salvage.

F.2 Methods

Perusal of aerial photographs and a regional geological map was undertaken prior to inspecting the site. Field survey work spanned 5 days and involved numerous vehicle transects within and adjacent to the study area with frequent inspections on foot. Areas most likely to be disturbed by the mining operation were examined in greatest detail such as the proposed mine area, tailings disposal area, access road and accessible segments of the proposed railway route.

Areas where slight soil stripping has occurred due to overgrazing or other disturbances causing water and wind erosion, provided the best opportunity to observe stone material and other evidence on the ground. Eroded areas were examined when seen during vehicle transects and these were commonly associated with the numerous stock watering tanks where physical trampling and overgrazing has facilitated erosion of the surface soil

Natural water holding depressions were examined closely,

particularly in areas of "gilgai country". Gilgais are shallow surface depressions formed by the differential swelling of clay minerals within the subsoil. They occur widely in semi-arid areas both singly or in groups and create a distinctive micro-topography capable of holding water for short periods after rain (Plates 5 and 6).

Sites were numbered sequentially in the field as they were identified. Some are large surface sites, others are where only one stone artifact was seen and some are places of other interest. No artifacts were collected.

The sections dealing with Aboriginal settlement and culture and regional archaeology were prepared from a review of relevant literature, findings of the survey and a knowledge of Aboriginal culture and relics in western New South Wales.

F.3 Results

F.3.1 Aboriginal Settlement and Culture

Cobar is the centre of a large area without permanent streams and with extremely few permanent surface waters. This area is roughly bounded by the Darling river to the north and west, the Bogan river to the east and the Lachlan river to the south.

This is the country of the Ngiyambaa people. The southern Ngiyambaa (or Wangaybuwan) now mainly live at Murrin Bridge, but also at Lake Cargellico, Ivanhoe, Menindee and Wilcannia. Northern Ngiyambaa people now mainly live at Brewarrina and Bourke. A few families are scattered around the towns of the area, including Cobar. Together with groups to the north-east and south-east, the ancestors of all these people shared a Central New South Wales culture of related languages, lifestyle, economy, social activities and religion. Connections with past traditions, and connections between the different local groups, still run strong. To the west along the Darling River is the Paakantji culture area. The people who have descended from groups with closest connection with the area to the north-west of Cobar have not been located during this survey; they probably live at Bourke or Brewarrina. The Aboriginal people at Cobar may also have an interest in the area.

Prior to European settlement Aboriginal life away from the rivers would have been based on several more or less permanent water holes - the ones at Wuttagoona and in the Gundabooks Range for example. The pattern of economic life would have been strongly influenced by the availability of water. After good falls of rain in the area, small groups could have spread out and exploited the scattered food resources, using small or even tiny sources of water such as gilgais and rock holes. As these sources of water dried up, people would be forced to gather around the few permanent waters, or go to parts of the Darling, Bogan and Lachlan Rivers that they had access to. In times of very short supply, or when retreating to reliable water during a drought, small amounts of water from Mallee or Needlewood roots could have sustained people.

We can presume that the diet consisted of bread made from a variety of grass seeds and mulga seed; small mammals, birds and reptiles; fruits and other edible plant parts; and larger game. The tools and other material belongings of the traditional groups of this area would have included those made from stone, wood, fibre, bone, skin and fur. Women's basic tools were the digging stick, dishes made from bark or wood, net bags, and large and small grinding stones, of which they could have had a number, left at various places. Men used spears, occasionally with stone points, spear throwers, often with an adze-stone hafted into the end, boomerangs, clubs, shields and stone axes. Other tools would have included stone knives, scrapers, choppers, hammer and anvil stones, bone awls, and a variety of nets.

The social organisation includes 'meat' (or totem) which is inherited from the mother, and marriage sections. These features occur in a number of tribes of the region and so help a person define their social position over a wide area. The Ngiyambaa tribe consisted of a number of local groups, with some dialect differences over the large area where this name is used. A major ritual was the bora, or borba, in which young men were introduced to tribal law. Some Ngiyambaa may have carved trees around graves, but this practice, as well as carving trees around bora grounds, was centred further east.

The basic cultural picture is a number of fairly small local groups occupying this dry country, dispersing and gathering with the availability and absence of small temporary water supplies. There was a number of more or less permanent water bases, and the dry country groups had some access to the rivers of some other Ngiyambaa groups or the country of other tribes: Paakantji, Wiradhuri and Wayilwan.

F.3.2 Regional Archaeology

It is a problem of archaeology as to how much of the material culture can be recovered or interpreted from the objects and patterns found at archaeological sites. Attempts are made to interpret possible changes in the material culture, as well as how this material evidence can give information about non-material aspects of life.

Previous archaeological work in the Cobar area includes that of Allen, 1972 and McCarthy, 1976, the latter of whom described a group of rock-painted sites north-west of Cobar that are unique in style and range of subjects. As well as the hand stencils and patterns at other art sites of the region, there is a range of small human and animal figures in red, white and yellow paint. It seems likely that these sites all belonged to the Ngiyambaa, although one (Iona) is close to the Darling river and may have been shared by one of the Paajantji groups. These five art sites are between 30 and 70km to the north-north-west and west of Elura. Both authors excavated several sites but these were of no great antiquity. Stone artifacts frequently recovered include 'tula' adze flakes; convex edged (side) scrapers; concave scrapers; fragments of grinding stones and hand grinders; with a few fragments of ground-edge axes and a few of other flaked stone artifact types. Waste-flake just exceeded flaked implements in number. Less frequently found were backed blades and McCarthy apparently saw a few 'pirri' points on surface sites. Animal bones excavated at

Mt. Grenfell 2, indicate an apparent dependence on brush-tailed possum for animal food, with other small mammals present. McCarthy noted the presence of several surface sites close to the rock water holes near the art sites.

Figure 11 shows the location of various Aboriginal art works and archaeological sites described by Allen and McCarthy in the Cobar district.

F.3.3 Elura Field Survey

A total of 14 sites was identified and their locations are shown in Figure 12. Map reference co-ordinates are as follows:

ARCHAEOLOGICAL SITES - MAP REFERENCES

Site No.	Map Title	Scale	Co-ordinates
1	Cobar Geol.	1:100,000	640482
2	Elura Base	1: 5,000	519500N 628000E
3	Elura Base	1: 5,000	529500N 6375000E
4	Cobar Geol.	1:100,000	609426
5	Cobar Geol.	1:100,000	606433
6	Cobar Geol.	1:100,000	707446
7	Cobar Geol.	1:100,000	715450
8	Cobar Geol.	1:100,000	717455
9	Cobar Geol.	1:100,000	717459
10	Cobar Geol.	1:100,000	715462
11	Cobar Geol.	1:100,000	694482
12	Elura Base	1: 5,000	5075000N 627000E
13	Cobar Geol.	1:100,000	774467
14	Cobar Geol.	1:100,000	784450

N.B. Cobar Geol. is Cobar Geological Map Sheet
Published by Department of Mines, New South Wales.

Elura Base is Elura Base Map Prepared by the
Electrolytic Zinc Co. Australia Ltd.

The sites are of four main types:

- (a) Isolated stone tools, probably occurring scattered all over the countryside as a consequence of the length of time involved with Aboriginal use.
- (b) Possible sources of siliceous raw material for flaked stone artifacts.
- (c) Scarred trees.
- (d) Surface camp sites, large and small, focused around probable or obvious sources of water.

Access Road:

There is a section of gilgai country along the Elura access road, mainly between 2 and 4 km from the Cobar - Louth road. Sites around gulgais in the Cobar area have been described by Cunningham, 1973.

Site 1 is a large gilgai on the south side of the track 3.9 km from the Cobar - Louth road (Plate 6). This gilgai is the focus of a large surface site, with stone artifacts all around it. Several areas examined in some detail gave the following sample: 11 rejuvenation flakes; 4 small cores; 2 core/hammer stones; 11 small flakes; 11 small flakes with some cortex; 5 small chips; an area of very fragmentary large mammal bones. Chert is the main material with similar amounts of quartzite, quartz-porphry and quartz.

North of Mine Site:

Site 2 is adjacent to the track 1.35km north-east from the exploratory shaft. Four stone artifacts were seen on this eroded area: small rejuvenation flakes; and a chert chip. About 50m to the north-west is a small water hole in a damp, scrub covered area.

Site 3 is on an eroded area 100m north-east of Joe's Tank. The artifacts seen in one small area are: one bondi point; one thick flake with steep working along two edges; 3 rejuvenation flakes; 1 large quartzite flake; 4 chert chips and 1 chert flake showing some nodule cortex; 2 small chert chips; and 2 pieces quartz. Very likely stone artifacts could be seen in other places around Joe's Tank.

Cobar - Louth Road and Nearby:

Site 4 is the silcrete hill 0.6 km south-east of Ram Tank on 'Cable Downs'. This hill was examined as a possible source of raw material for stone artifacts, but no suitable siliceous rock was seen. A small steep-sided scraper was the only stone artifact seen.

Site 5 is the eroded area at a slight depression, 200m up-gully north-east of Red Tank. This is a large surface campsite. One area taken as a sample showed: 5 rejuvenation flakes; 2 'tula' adze slugs; 1 small convex edged scraper; 2 large flakes; and 2 small flakes. Chert is the main material.

South of the Mine Site:

Site 6 is at a large deflated area around two small gilgais 1.55km south-west of Murphys Tank. This is a large surface site with many stone artifacts. One small area beside the track was examined and showed: 8 rejuvenation flakes; 1 small straight edged scraper; 1 small straight edged scraper made on a rejuvenation flake; 1 small steep-sided scraper; 2 small cores; 10 flakes; 4 small chips; and a burnt earth hearth. Elsewhere on the site were 4 hand grinding stones (close to a gilgai) and two large cores, one of which has steel working. Chert is the main flaked material. This is a very extensive surface site (Plate 5).

Site 7 is a large area around the junction of two tracks 0.7km south-south-west of Murphys Tank. The apparently uneroded surface is littered with siliceous nodules, large and small. This rock is good enough for "chert artifacts" and a few large flakes and cores were seen.

Site 8 is at a slight depression, which is without trees and may hold water. It is 50m east of the track 0.6km south of Murphys Tank. There is an outcrop of partly silicified rock, probably not good enough for flaking. One rejuvenation flake and two cores were seen.

Site 9 is 50m north of Murphys Tank on an eroded gentle slope. A low density of stone artifacts includes: 2 rejuvenation flakes; 1 fragment small grinding stone; 1 core; 3 small chips.

Site 10 is between two low hills on the west side of the watercourse leading 0.6km south-east down to Murphys Tank. This is a large surface camp site. One area sampled showed: 7 rejuvenation flakes, 1 "tula" adze slug; 2 small steep sided convex edged scrapers; 1 concave edged steep sided scraper, 6 fragments of grinding stone; 6 small cores; 8 flakes and 3 chips. Elsewhere a probable hearth was seen and several more grinding stone fragments. Chert is the material of most flaked stone. There is a small apparently recent dam in the watercourse which may be an enlargement of a small water holding depression which was the focus for this site.

Site 11 is an eroded area near the track and formed drainage ditches 500m north of O'Donnells Tank. A lot of siliceous nodules are exposed by erosion on the slope and in a small erosion gully. This material would be good enough "chert" for stone artifacts. No artifacts were found and it seems that the nodules have only been exposed by recent erosion.

The Mine Site:

Site 12 is where one artifact, a rejuvenation flake, was found 200m east of the exploratory shaft.

The Tailings Disposal Area Site:

No artifacts were found here and it is unlikely that any concentrations exist in this area.

The Proposed Railway Route:

Site 13 is a 'hilltop' gilgai on Allednub boundary, just south-south-east of Bundella boundary. The slight gilgai depression is marked by a dense stand of bimple box (*Eucalyptus populnea*). One rejuvenation flake and one flake were seen on a deflated area just south of the box stand.

Site 14 consists of two scarred trees 40m west of Allednub boundary fence, 2.05 km south-south-east of Bundella boundary. These two trees, one a red box (*Eucalyptus intertexta*) and the other a bimple box (*Eucalyptus populnea*), each bare a scar where a sheet of bark has been removed. Considerable healing appears to have taken place, but it is impossible to tell when the bark sheets were removed (Plate 7).

No other sites were seen along the considerable portion of the railway route examined. It does not seem to include any further gilgai country.

F.3.4 Evaluation of the Sites

The large surface sites around temporary water holes emerge as the dominant archaeological feature of the landscape. Their occurrence is controlled by the presence of gilgais or similar water holding depressions.

The most important sites are 1,3,5,6 and 10. Although essentially similar, each one can potentially provide unique information which could be used to piece together a regional picture from which conclusions could be drawn about the pattern of dispersal, gathering, food resources and social organisation of ancestral Aboriginals and their apparent fundamental relationship with sources of water.

Two scarred trees are hard to assess because of doubt about when and for what purpose the bark sheets were removed. They may not be Aboriginal. They are interesting because they occur together and they are living memorials of people using the trees. The bark sheets might have been removed for dishes, shields, or even as a variation of the custom from further east, of removing similar sheets of bark from trees near a grave and carving into the exposed wood.

Site 7 is the most interesting of the possible sources of stone for flaked artifacts, where a few siliceous nodules were found that looked as though they had flakes removed and also a few large flakes. More searching might show evidence of quarrying and of the variation in quality of the raw material.

F.3.5 Regional Significance

The study area is remote from permanent water and past Aboriginal settlement could only have been sustained for short periods, focussed around the gilai country and other shallow natural depressions which temporarily held small volumes of rainwater. Compared with areas of permanent water and along the Darling, Bogan and Lachlan rivers where a rich and diverse archaeological record exists, the Elura/Cobar region is relatively poor.

There are very extensive areas in western New South Wales of "dry country" similar to that on the mining lease and railway route, with common vegetation and fauna communities with a similar proximity to temporary and permanent sources of water. In general, the archaeological record in the study area is representative of a prolonged period of sporadic and temporary Aboriginal settlement in common with extensive tracts of surrounding land.

Within the Cobar region gilgaid soils generally occur as small isolated patches and occasionally as more extensive areas. One such area occurs as a narrow discontinuous band of some 1,000 ha (J. Walker, pers. comm.) to the west of the mining lease and is traversed by the access road. While only one site (Site 1) was described from this area it is likely that a disproportionately higher concentration of sites would be discovered if this area were systematically explored. Similar belts of gilgai country also occur further west and south-west of the Cobar-Louth Road.

F.4 Effects of the Proposal

F.4.1 Endangered Sites

While there are no specific locations of known archaeological or mythological significance within or close to the study area, the findings of this study have revealed the presence of a number of sites of archaeological interest. Their significance to the descendents of Aboriginal people traditionally and historically associated with the area is unknown.

Several sites are threatened by the proposed mining operation and its associated infrastructure.

Site 1 is situated alongside the existing access road to Poon Boon homestead. This track is also shared by traffic to Elura and is the proposed access road alignment for the mine. Earthworks required to widen and upgrade the track into a sealed bitumen road will partly or completely destroy this site.

Site 12 (200m east of the exploratory shaft) represents the location of a single artifact, a rejuvenation flake and will be destroyed by the mine industrial area.

Sites 13 and 14 lie in the path of the proposed railway and are therefore at risk.

F.4.2 Safeguards

Site 1 has been described (Section F.3.4) as one of the five most important archaeological sites identified and is the only one threatened by the proposed development. It can be protected by relocating the proposed access road to a new alignment. Similarly Sites 13 and 14 can be preserved by re-routing the proposed railway. Site 12, where a single rejuvenation flake was found, is merely representative of a prolonged period of sporadic and temporary Aboriginal settlement and does not constitute an archaeological site.

Safeguards to protect archaeological sites, adjacent to, but not directly threatened by the development, should include the following:

- i) restriction of access by provision of locked gates
- ii) active education of the construction and operational workforce on the importance and protection of the sites
- iii) periodic inspections of the sites to ensure their integrity

F.5 Recommendations for Additional Archaeological Work

Additional survey work by an approved archaeologist is necessary to establish alternative alignments for the access road and possibly the rail route, which by-pass the endangered sites and do not disturb any new sites. Alternatively, or if this is not feasible, application can be made to the Aboriginal and Historic Resources Section (AHRS) of the N.S.W. National Parks and Wildlife Service for consent to destroy the site(s). If granted, a properly conducted rescue collection and/or salvage excavation exercise will need to be carried out prior to construction.

The scope and intensity of additional archaeological work, to establish alternative alignments and also to assess the cultural significance of the sites and general area to the living Aboriginal population of the region, are currently the subject of discussions between EZ and AHRS.

F.6

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APPENDIX GEXPLANATORY NOTES
ENVIRONMENTAL CONSTRAINTS MAP
ELURA MINING LEASE

From report by Natural Systems Research Pty. Ltd.

Context

The attached map (Figure 13) and following explanatory notes are in response to a request to provide EZ with an environmentally sound basis on which to site the proposed waste rock stockpile.

Information Base

Information used to develop the constraints map was obtained from three draft reports:

- (i) Terrain Evaluation and Preliminary Tailings Disposal Studies by Golder Assoc., 1978
- (ii) Final Proposed Location and Method for Tailings Disposal by Golder Assoc., 1978
- (iii) Vegetation, Fauna, Archaeology and Site Drainage/Water Quality Studies for the Environmental Impact Assessment, Elura Base Metal Project Cobar, NSW by Natural Systems Research Pty. Ltd.

Constraints Criteria

Low lying land and the land which is seasonally boggy are expected to produce drainage problems and restrict or prohibit vehicular access and mobility during wet weather. Areas of dense vegetation provide the greatest diversity of micro-habitats and are relatively more important than the open woodlands and shrublands. In addition, the clearing of more densely wooded areas is physically more difficult and expensive to undertake. Special features, such as vegetation with conservation significance and archaeological sites, pose the most severe constraints.

APPENDIX G (CONTINUED)

Six categories have been developed which rank areas of land from most to least suitable and these are as follows:

<u>RANK</u>	<u>DESCRIPTION</u>
1A	Gently sloping land, mainly upper slopes and crests of low rises and ridges, shallow skeletal soils. Mostly tall open shrubland some open woodland. Well drained, absence of seasonally boggy areas.
1B	Gently sloping land, mainly upper slopes and crests of low rises and ridges, shallow skeletal soils. Denser vegetation than 1A mostly woodland with some open woodland. Well drained, absence of seasonally boggy areas.
2A	Very gently sloping middle to lower slopes and run-on areas, drainage lines very diffuse to absent. Soils are shallow to moderate hard red clay loams. Vegetation is tall, open shrubland to open woodland. Depressions with deeper soils and drainage lines are seasonally boggy in places.
2B	Very gently sloping middle to lower slopes and run-on areas, drainage lines very diffuse to absent. Soils are shallow to moderate hard red loams. Vegetation is denser than 2A and is mostly woodland with some tall shrubland. Depressions with deeper soils and drainage lines are boggy, seasonally in places.
3	Very gently sloping to depressional run-on areas, diffuse drainage lines. Soils are moderate to hard red clay loams. Vegetation is the most dense and comprises woodland and several thickets of <u>Acacia burkittii</u> and Yarran tall shrubland. Forms principal drainage lines and is very boggy seasonally.
4	Special features: <ul style="list-style-type: none"> Archaeological sites Significant vegetation

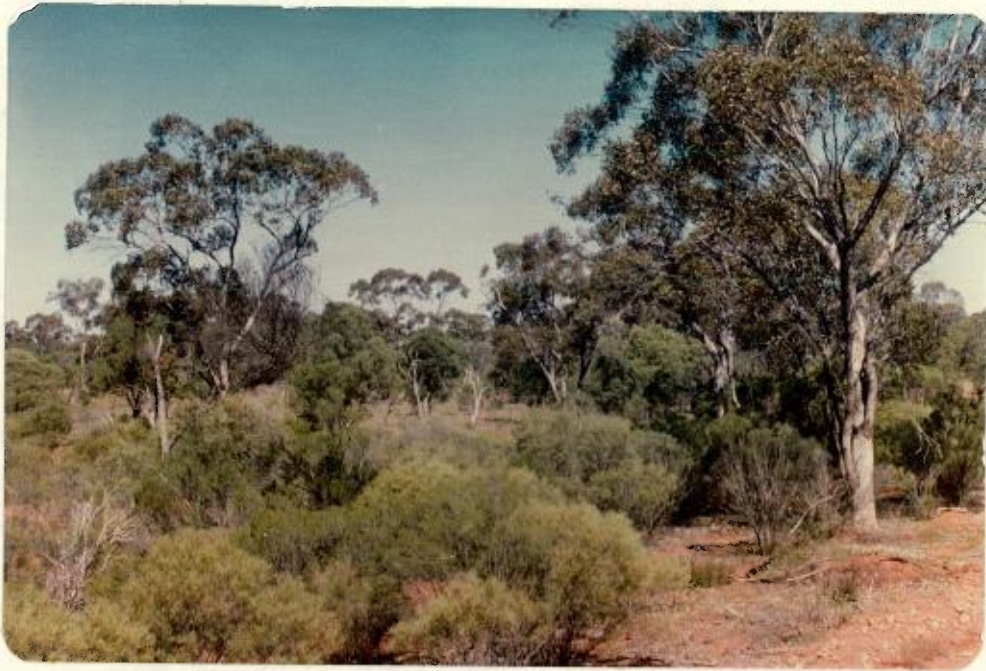


PLATE 1

Bimble Box - Wattle Association



PLATE 2

Mulga Association

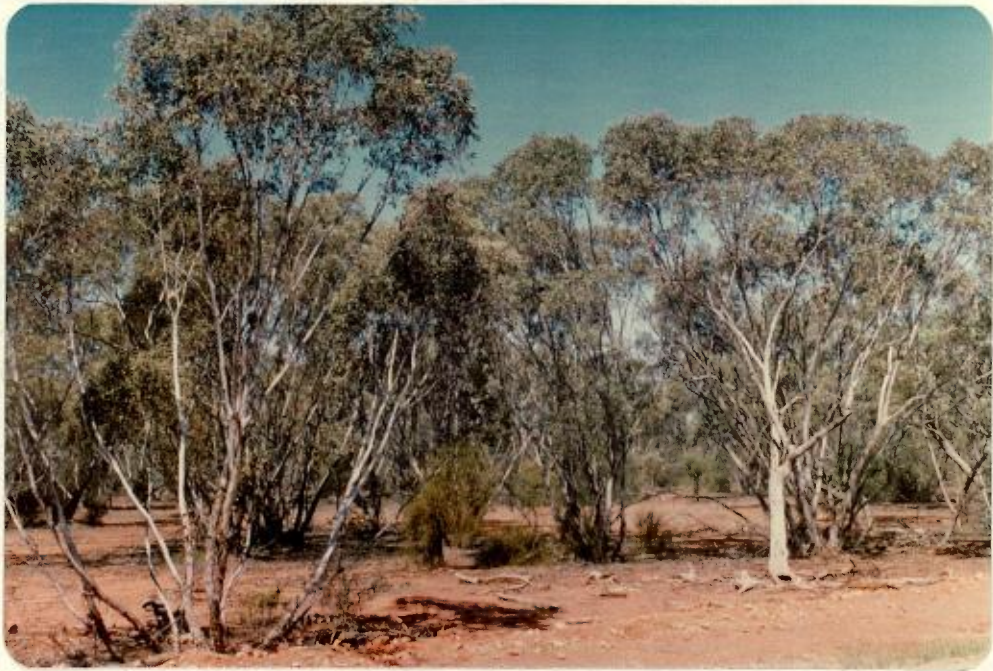


PLATE 3

Mallee Stand



PLATE 4

Unusual Individual
Mallee



PLATE 5

Small Gilgai (Archaeological Site 6)



PLATE 6

Large Gilgai (Archaeological Site 1)



PLATE 7

Scarred Trees



PLATE 8

Mosquito Creek Crossing Cobar-Louth Road



PLATE 9

Marshall Street,
Cobar



PLATE 10

Typical Mine
Employee's
Housing, Cobar

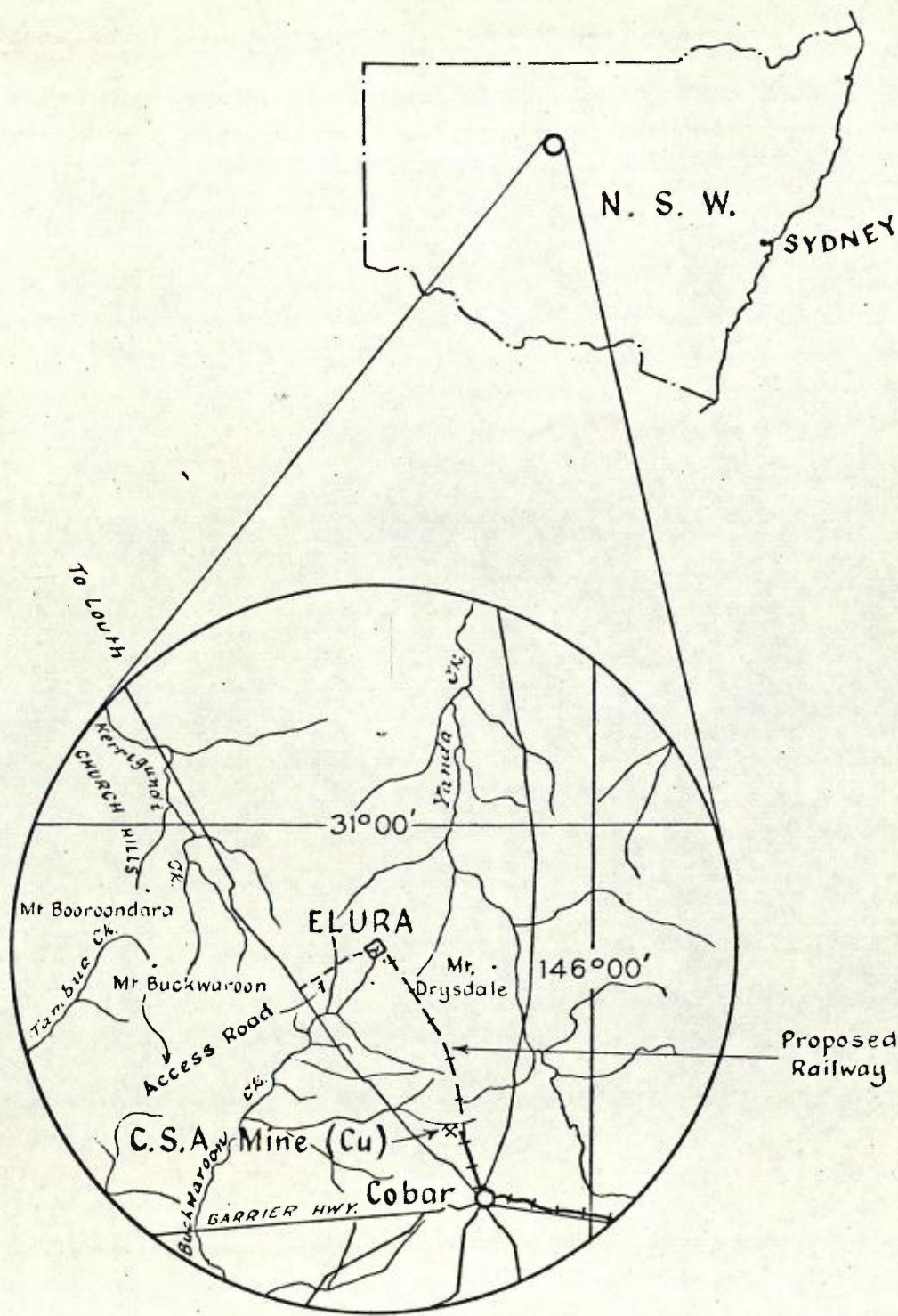


PLATE 11

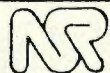
Concentrate
Shiploader at
Burnie, Tasmania

T.N.

1:20,000,000



SCALE 1:1,000,000



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FOR THE ELECTROLYTIC ZINC COMPANY
OF AUSTRALASIA LTD.

ELURA BASE METAL PROJECT

LOCALITY MAP

Compiled by: D.M.F.B.
Date: December '78

Figure 1

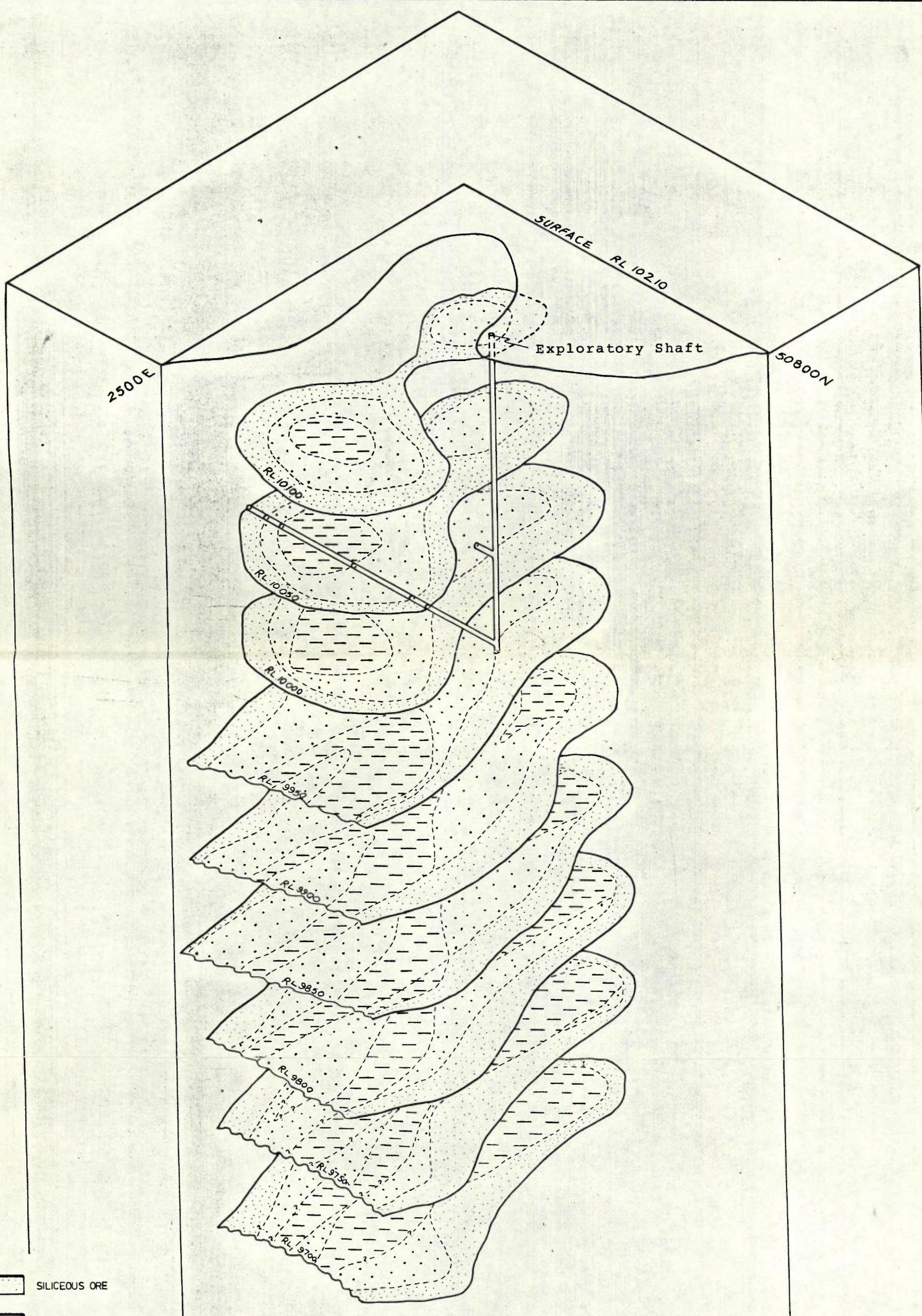





Figure 3

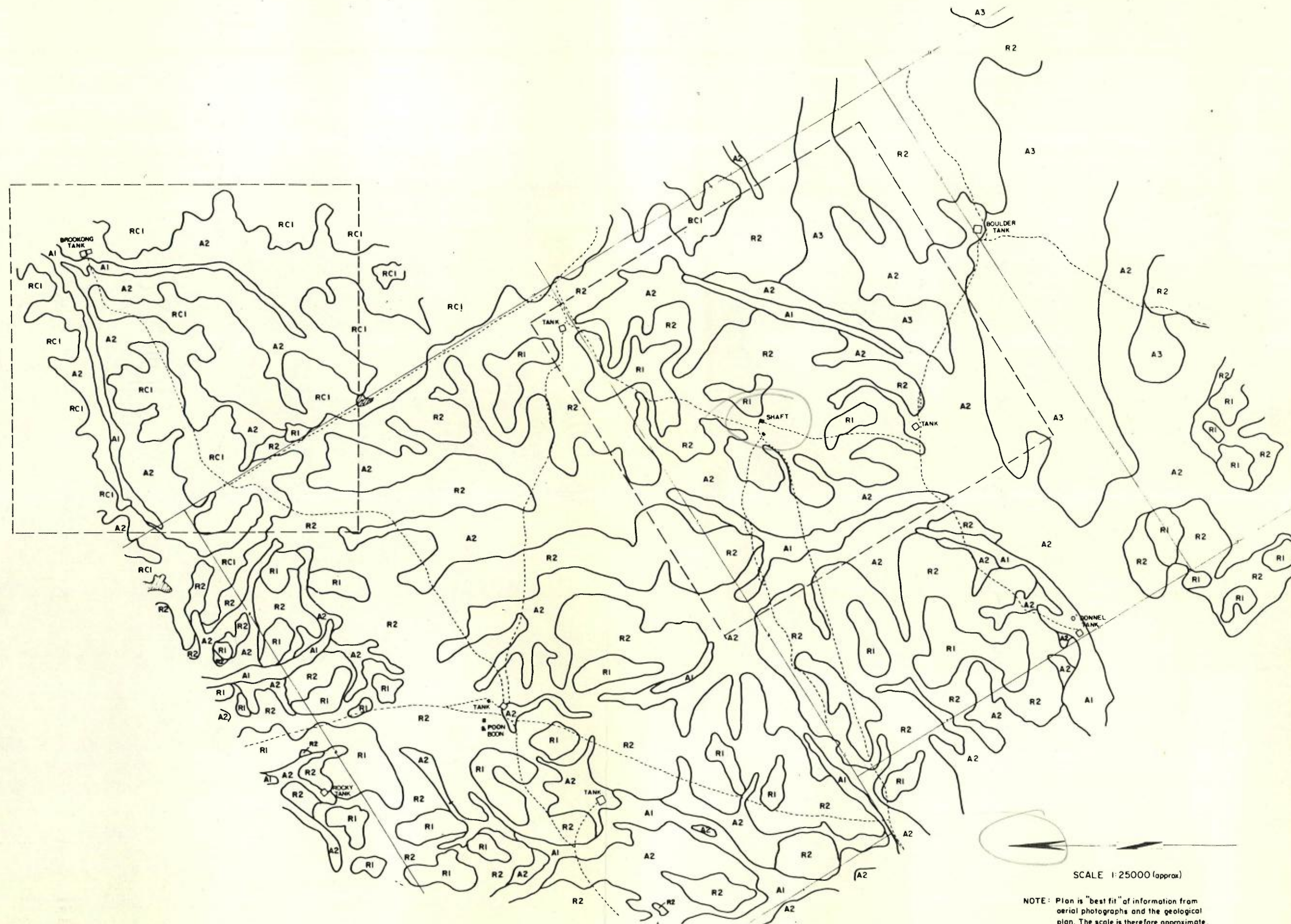
-  SILICEOUS ORE
-  MASSIVE PYRITIC ORE
-  MASSIVE PYRRHOTITIC ORE

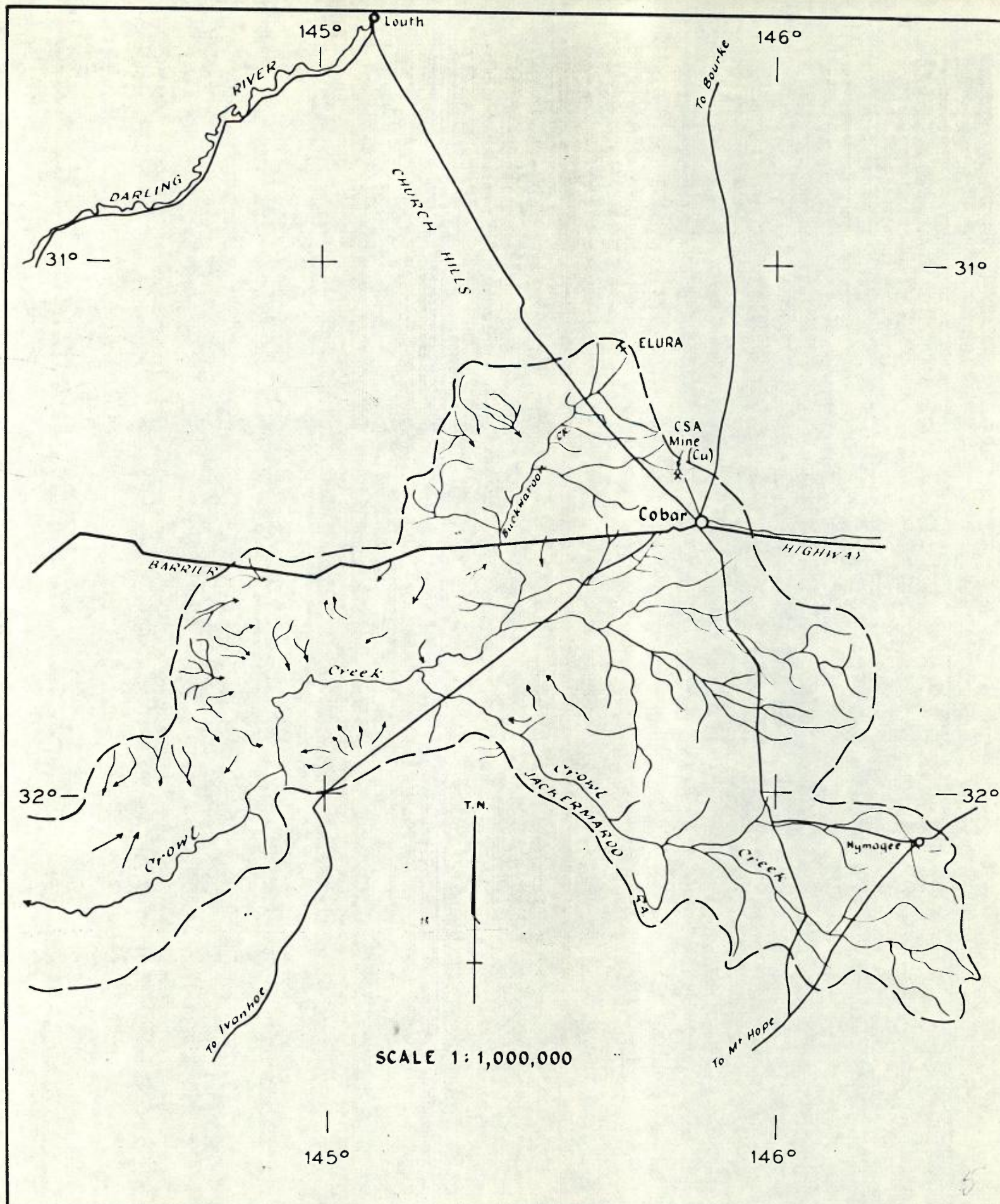
ELECTROLYTIC ZINC CO. OF ASIA LTD.		PROJECT: ELURA	N.S.W.
SCALE: 1:2,000 approx	Survey: R.L. Adams	ISOMETRIC DIAGRAM OF ELURA MINERALIZATION	
Revised:	Reference:		
Date: January 1979	Drawn: NEC		
			REF. NO. Fig. 3

LEGEND

TERRAIN EVALUATION

UNIT	TOPOGRAPHY	LITHOLOGY	SOIL / ROCK PROPERTIES	INDICATIVE VEGETATION	ENGINEERING EVALUATION
A1	Very gently sloping to depressional areas of concentrated run-on (diffuse drainage lines).	Alluvium, usually overlying ferricrete, silcrete, or calcrete at about 2m depth.	Red silty and sandy clay of low plasticity (CL).	Eucalypt (grey box), fairly dense, with understorey of scrub very common.	Forms parts of principal drainage lines of area. Very boggy seasonally.
A2	Very gently sloping areas of run-on (very diffuse drainage lines)	Alluvium, usually overlying ferricrete, silcrete, calcrete or siltstone at 0.5 to 1.5m depth.	Red silty and sandy clay of low plasticity (CL), or red clayey sand (SC).	Mixed open eucalypt and acacia woodland, with variable scrub and grass (seasonally).	Forms greatest part of drainage system of study area. Most of unit is boggy seasonally, although patchy.
A3	Very gently sloping alluvial plain (rarely flooded)	Alluvium, usually overlying ferricrete, silcrete, calcrete or siltstone at 0.5 to 1.5m depth.	Red silty and sandy clay of low plasticity (CL), or red clayey sand (SC).	Mixed open eucalypt and acacia woodland, with variable scrub and grass (seasonally).	Broad areas in southern part of study area, may become inundated after very heavy rain, but watercourses not evident within unit.
R1	Gently sloping upper slopes and crests of low rises and ridges.	Siltstone, almost everywhere ferruginised (near-surface) and partly silicified overlying pale-coloured highly to extremely weathered siltstone. (Lithic sandstone, fine sandstone, etc., may occur instead of siltstone in parts of unit, although weathering profile will be similar).	Shallow to skeletal red silty or clayey sand (gravelly in parts). Soil usually less than 300mm deep, and may be absent locally (rock outcrop).	Open to sparse mulga, scattered or patchy eucalypts, variable scrub and grass (seasonally).	Well-drained unit. Variability of duricrust (ferruginised/silicified near-surface zones) and degree of weathering below duricrust indicate necessity for detailed investigation and design for heavy structures. For light structures, route location, hard-standing areas, etc., this unit is very suitable.
R2	Gently sloping middle and lower slopes (between R1 and A1/A2/A3), and gently undulating terrain	Siltstone, almost everywhere ferruginised (near-surface) and partly silicified, overlying pale-coloured highly to extremely weathered siltstone. (Lithic sandstone, fine sandstone, etc., may occur instead of siltstone in parts of unit, although weathering profile will be similar).	Shallow to skeletal red silty or clayey sand (gravelly in parts). Soil usually less than 300mm deep. Patches of deeper soil are present in very small depressional components of this unit.	Open to sparse mulga, scattered or patchy eucalypts, variable scrub and grass (seasonally). Patches of deeper soil are often indicated by denser vegetation.	Very similar engineering characteristics to R1, except that depressional components with deeper soil may contain weaker duricrust, and will become boggy seasonally. These components appear to be recognisable on very low level photography, and could be delineated in areas of particular interest.
RC1	Gently and moderately sloping and undulating terrain in north-eastern part of study area.	Lithic sandstone, sandstone or conglomerate (Chesney Formation), commonly silicified and/or ferruginised near the surface.	Skeletal to shallow red silty or clayey sand or gravel. Soil 0 to 500mm deep. (deepest downslope and in saddles etc).	Open mulga, some large eucalypts, scrub consisting largely of acacia species.	Unit has greater relief than any other in study area. Other parts of Chesney Formation may have similar relief (photos unavailable). Small areas of this unit (white appearance on photo and shown hatched on Figure 3) contain hard silicified sandstone, may be useful for aggregate. Quantity not investigated in detail.





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FOR THE ELECTROLYTIC ZINC COMPANY
OF AUSTRALASIA LTD.

ELURA BASE METAL PROJECT

CROWL CREEK CATCHMENT

Source: Bourke & Canberra 1:1,000,000
World Aeronautical Charts

Compiled by: D.M.R.B.

Date: December '78

FIGURE 5

Source: Commonwealth of Australia
 Aerial Photography 1972-73
 Scale 1:84,000

- Catchment boundary
- ⊠ Tanks
- 'Maryvale' Station
- Road
- - - Fence
- Telephone line

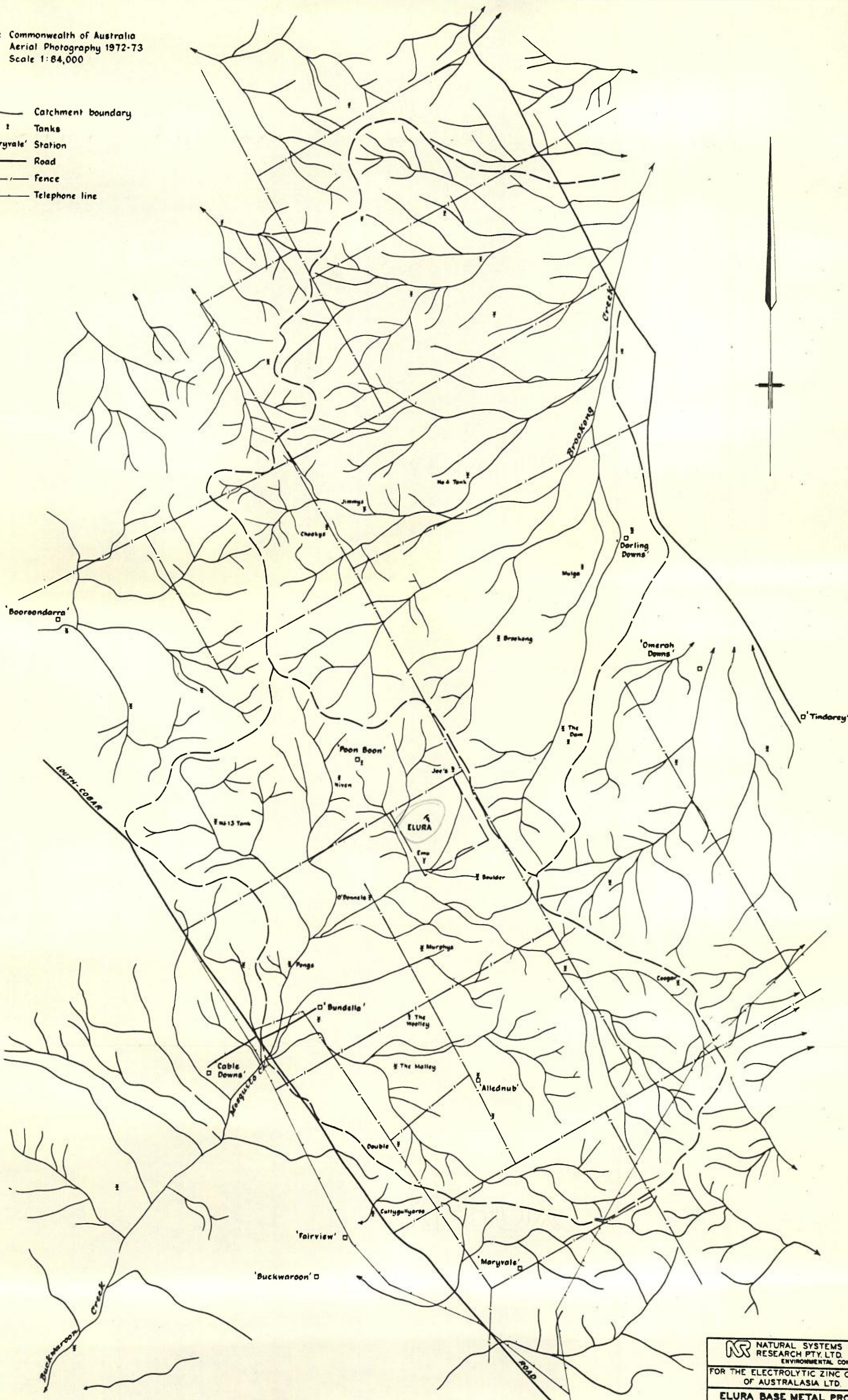

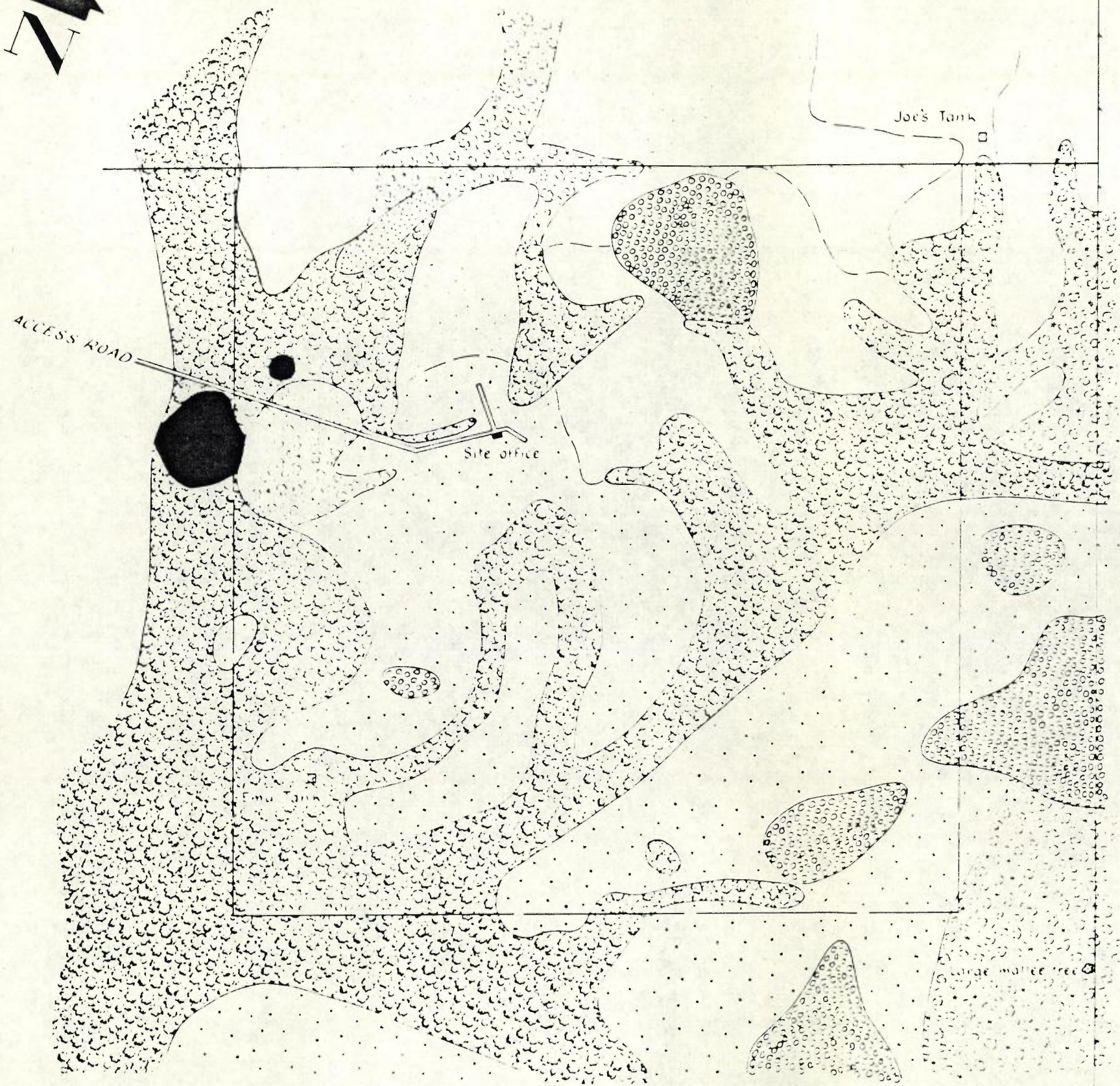
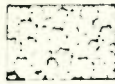
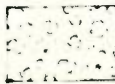







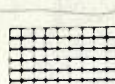


FIGURE 6


	NATURAL SYSTEMS RESEARCH PTY. LTD. ENVIRONMENTAL CONSULTANTS
	FOR THE ELECTROLYTIC ZINC COMPANY OF AUSTRALASIA LTD.
ELURA BASE METAL PROJECT	
MOSQUITO AND BROOKONG CREEK CATCHMENTS	
Compiled by: S. G. J. Date: December 1978	

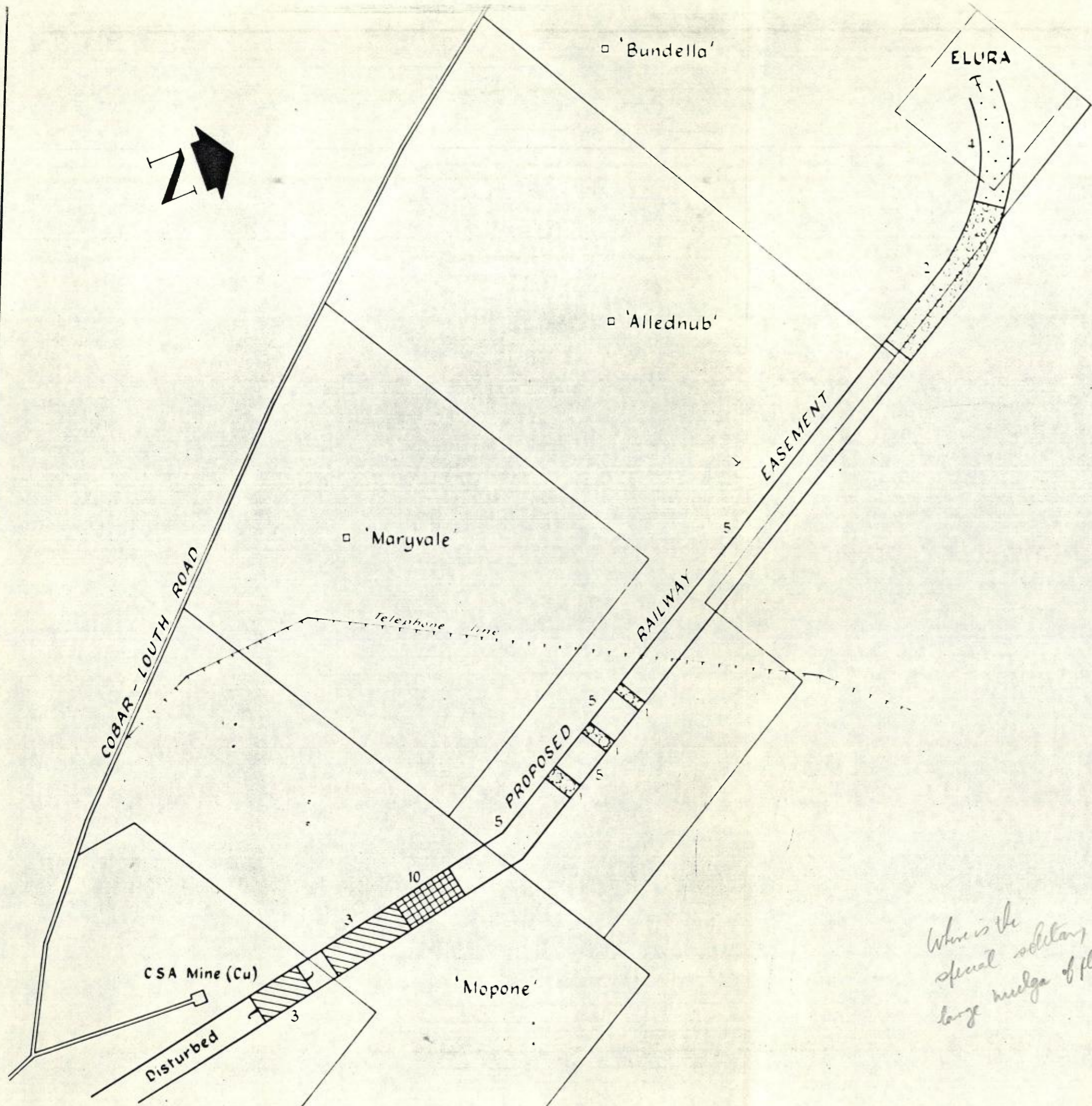


- 1  Bimble box woodland
- 2  Red box woodland
- 3  Bimble box - mulga woodland
- 4  Bimble box - ironwood open woodland
- 5  Red box - mulga open woodland
- 6  Mulga tall shrubland
- 7  Narran tall shrubland
- 8  Acacia Burkittii tall shrubland
- 9  Ironwood tall open shrubland
- 10  Eremophila - Dodonaea - Acacia shrubland

SCALE 1:22,000

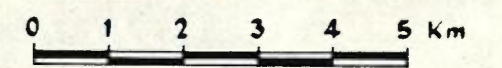


 NATURAL SYSTEMS RESEARCH PTY LTD. ENVIRONMENTAL CONSULTANTS	
FOR THE ELECTROLYTIC ZINC COMPANY OF AUSTRALASIA LTD	
ELURA BASE METAL PROJECT	
MINING LEASE VEGETATION MAP	
1:22,000	FIGURE 7



- 1 Bimble box woodland
- 2 Red box woodland
- 3 Bimble box-mulga woodland
- 4 Bimble box-ironwood open woodland
- 5 Red box-mulga open woodland
- 6 Mulga tall shrubland
- 7 Yarran tall shrubland
- 8 Acacia Burkittii tall shrubland
- 9 Ironwood tall open shrubland
- 10 Eremophila - Dodonaea - Acacia shrubland

SCALE 1:100,000



NR NATURAL SYSTEMS RESEARCH PTY. LTD.
ENVIRONMENTAL CONSULTANTS

FOR THE ELECTROLYTIC ZINC COMPANY OF AUSTRALASIA LTD

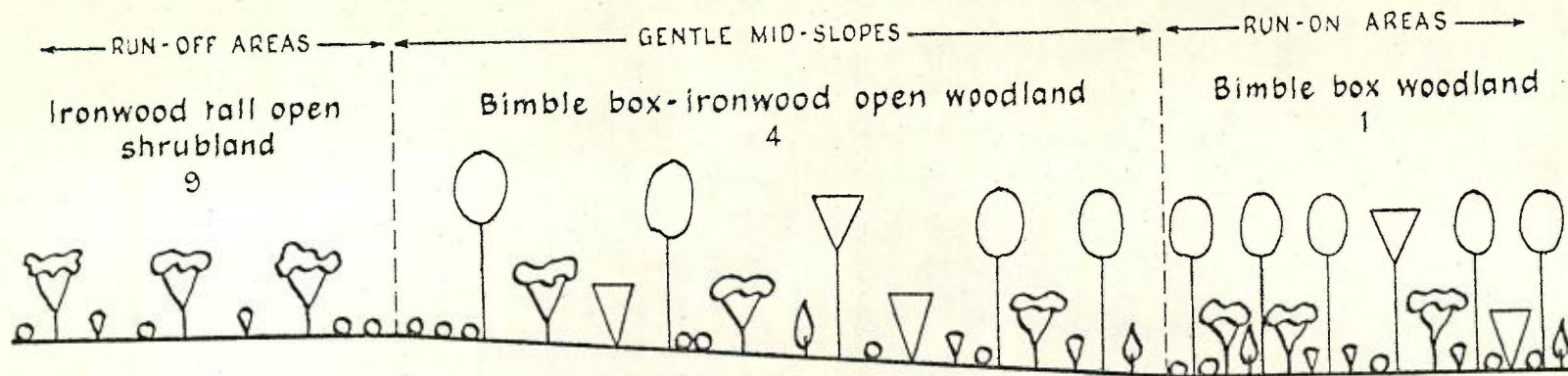
ELURA BASE METAL PROJECT

PROPOSED RAILWAY ROUTE VEGETATION MAP

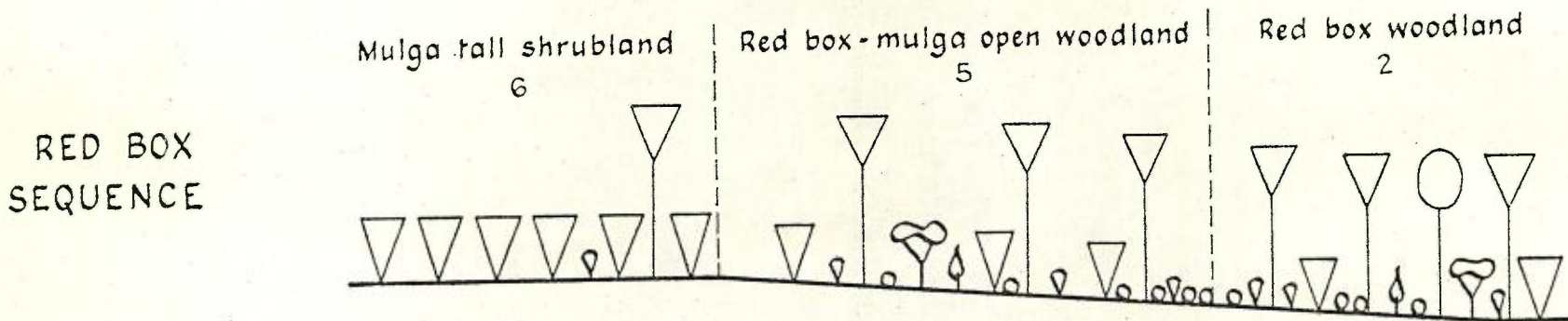
Where is the special solitary large mulga of plate 4

Compiled by M.D.C.
Date December 1979

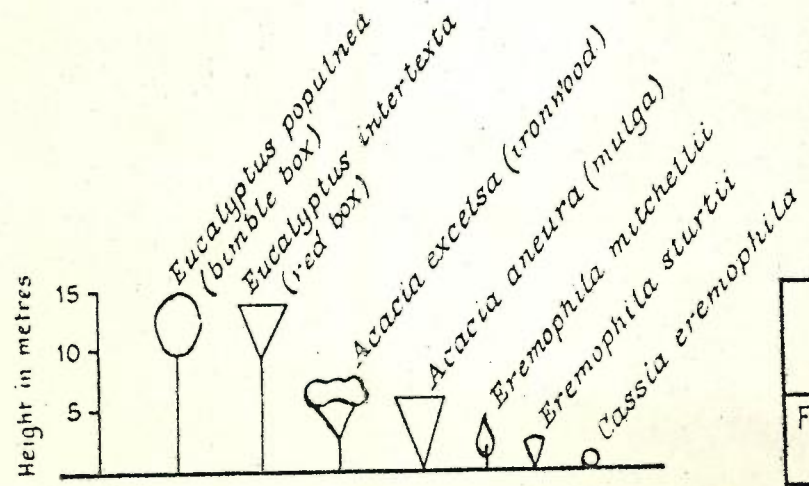
FIGURE 8



BIMBLE BOX SEQUENCE



RED BOX SEQUENCE



Not drawn to scale
Herbaceous layers omitted

NR NATURAL SYSTEMS RESEARCH PTY. LTD.
ENVIRONMENTAL CONSULTANTS

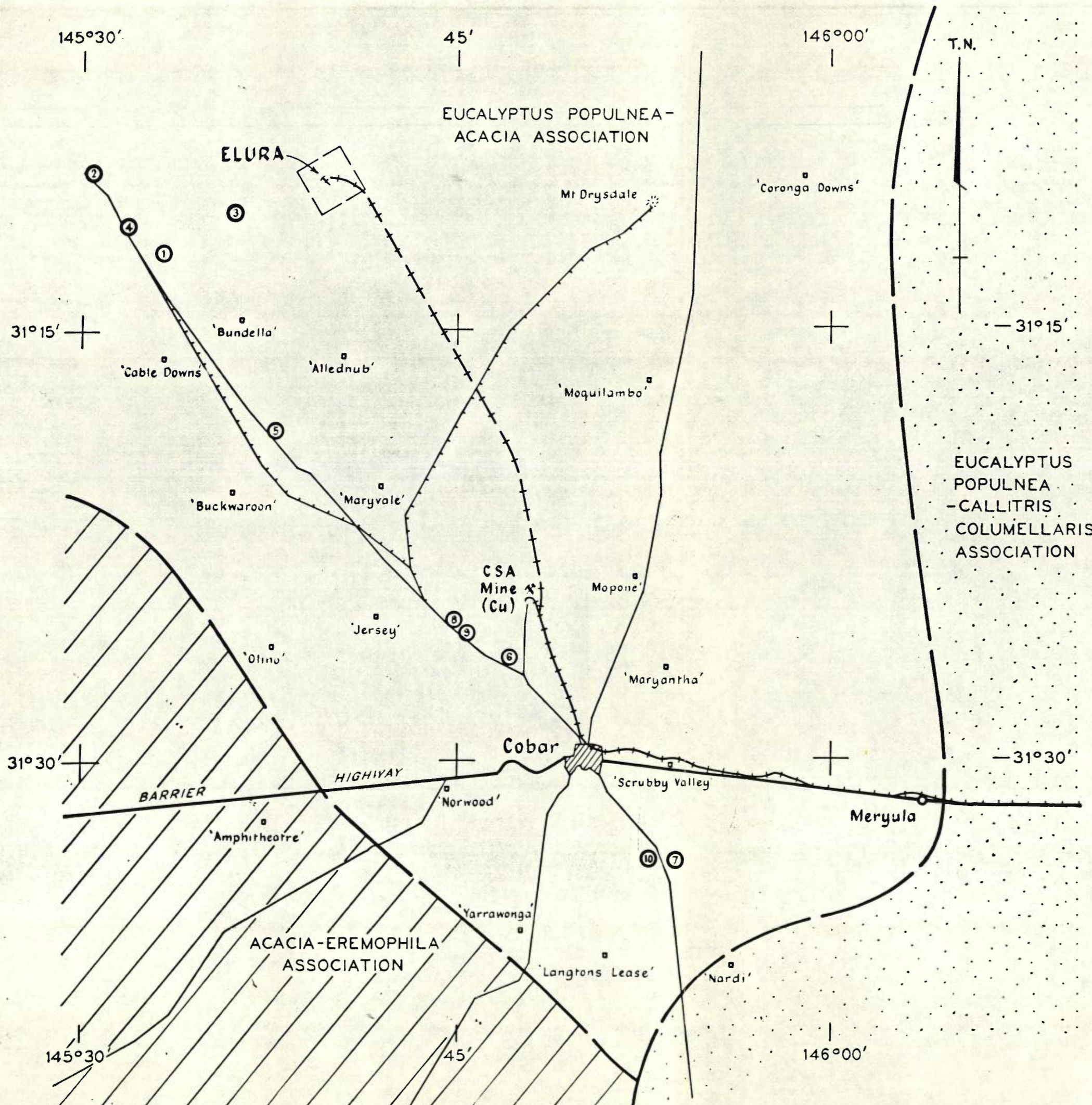
FOR THE ELECTROLYTIC ZINC COMPANY OF AUSTRALASIA LTD.

ELURA BASE METAL PROJECT

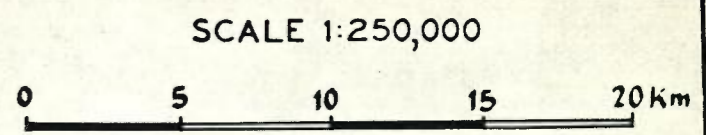
MINING LEASE VEGETATION SCHEMATIC PROFILE

Compiled by: M.D.C.
Date: December '78

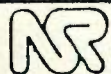
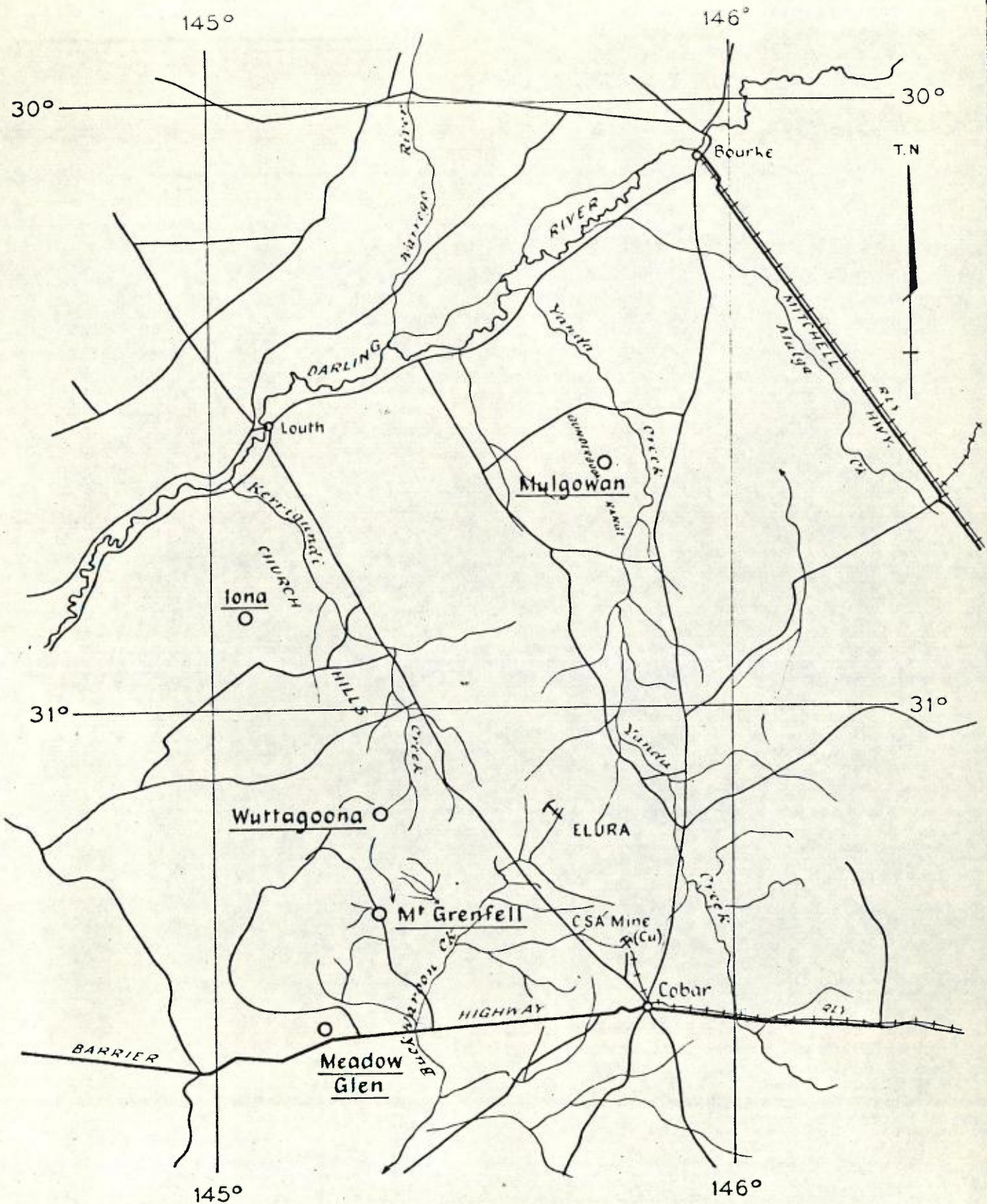
FIGURE 9



- — — — — Vegetation boundary
- ① Observation site
- Mining lease
- — — — — Highway
- — — — — Road
- + — + — Existing railway
- + — + — Proposed railway
- — — — — Telephone line
- 'Mopone' Homestead



NATURAL SYSTEMS RESEARCH PTY. LTD. ENVIRONMENTAL CONSULTANTS	
FOR THE ELECTROLYTIC ZINC COMPANY OF AUSTRALASIA LTD.	
ELURA BASE METAL PROJECT	
DISTRIBUTION OF MAJOR VEGETATION ASSOCIATIONS COBAR, N.S.W. (After Beadle 1978)	
Compiled by: M.D.C. Date: December 1978	FIGURE 10



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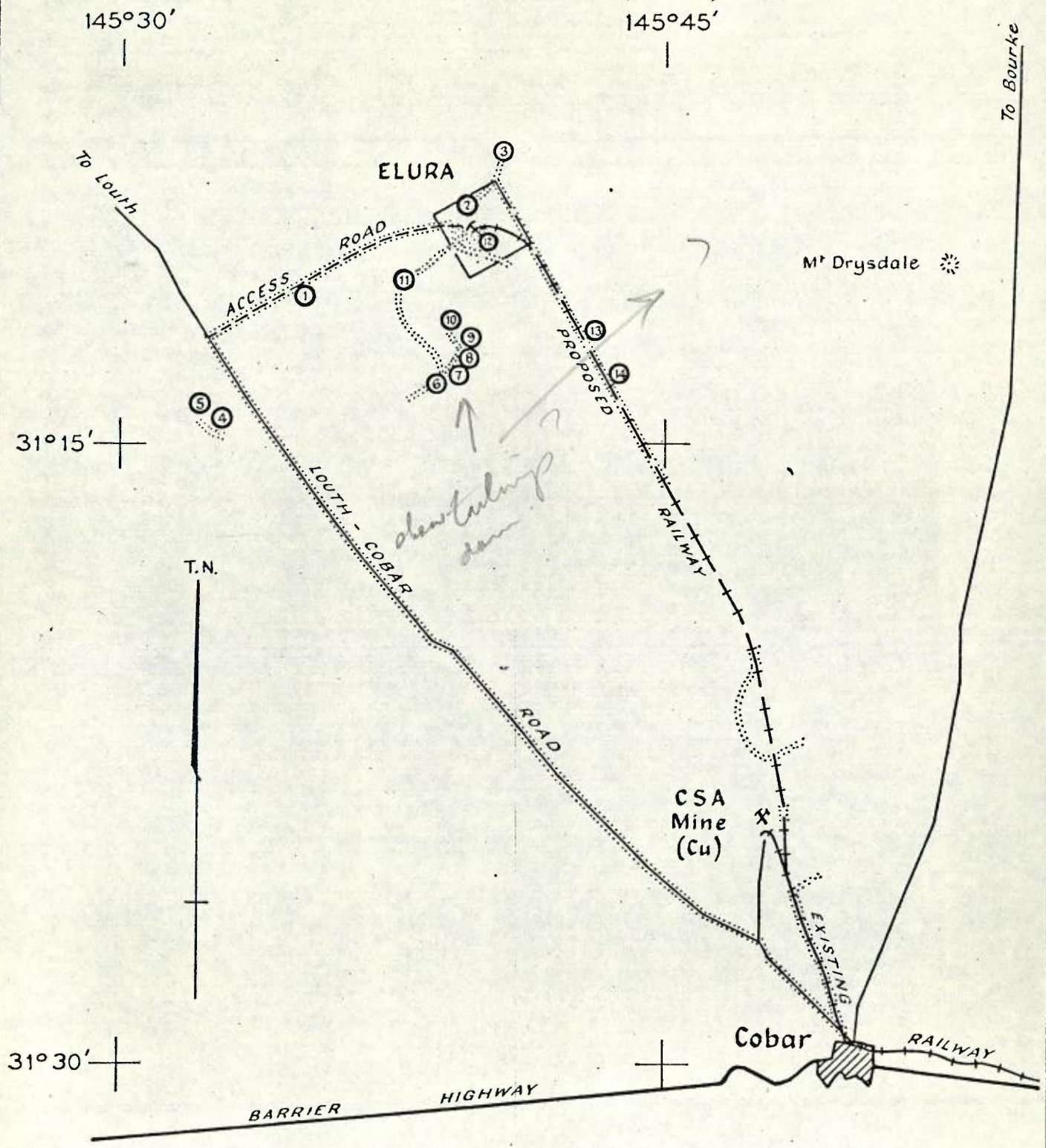
FOR THE ELECTROLYTIC ZINC COMPANY
OF AUSTRALASIA LTD.

ELURA BASE METAL PROJECT

REGIONAL ARCHAEOLOGY
Art and archaeological sites
described by McCarthy (1976)
and Allen (1972)

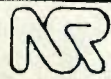
Compiled by: P.T.
Date: December '78

FIGURE 11



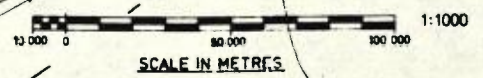
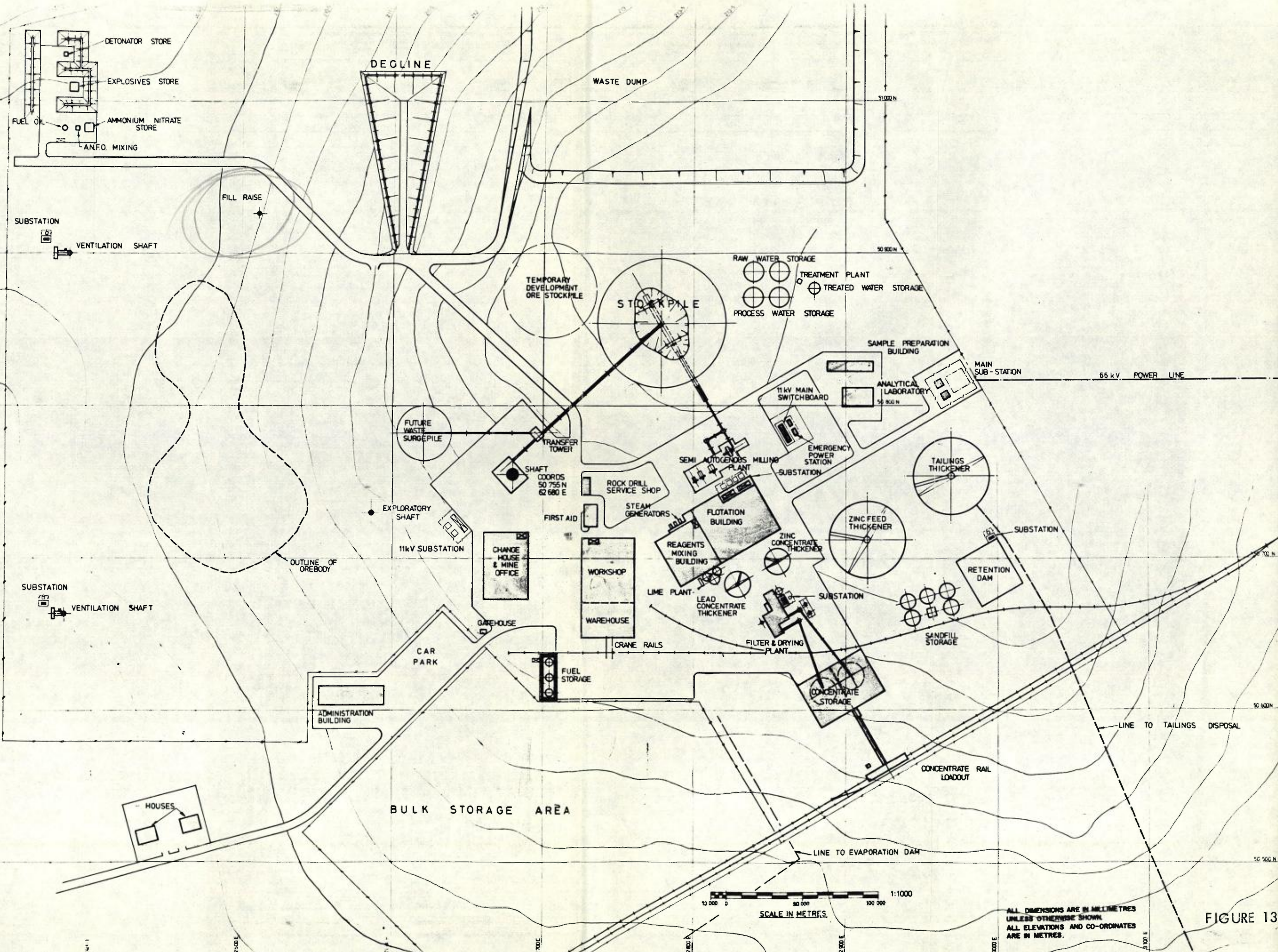
SCALE 1:250,000

- ① Site location
- Transect and area covered

 NATURAL SYSTEMS RESEARCH PTY. LTD. ENVIRONMENTAL CONSULTANTS	ARCHAEOLOGY SURVEY AREA COBAR REGION	
	FOR THE ELECTROLYTIC ZINC COMPANY OF AUSTRALASIA LTD.	
ELURA BASE METAL PROJECT	Compiled by: P.T. Date: December '78	FIGURE 12

NO provision for crushing of
waste for underground fill or
necessary storage batching leadworks
above raise. →

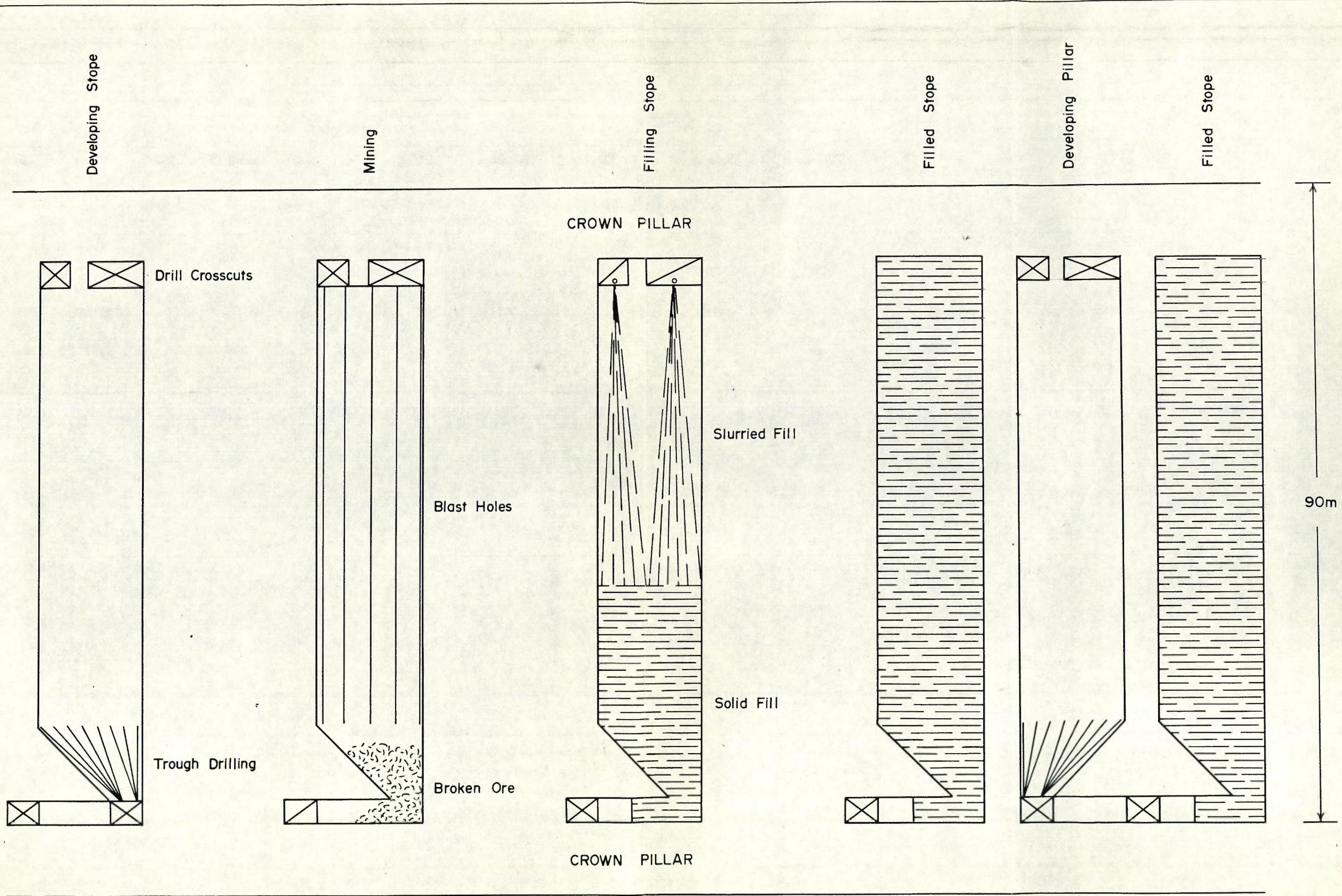
PROJECT NO. 1382-01
DRAWING NO. 10-MM-001



ALL DIMENSIONS ARE IN MILLIMETRES
UNLESS OTHERWISE SHOWN.
ALL ELEVATIONS AND CO-ORDINATES
ARE IN METRES.

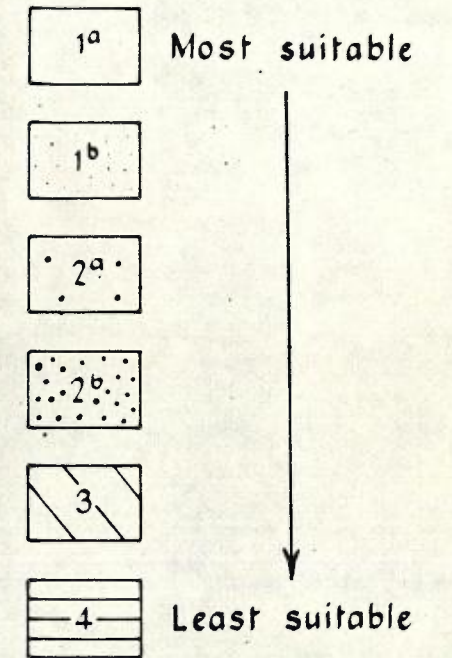
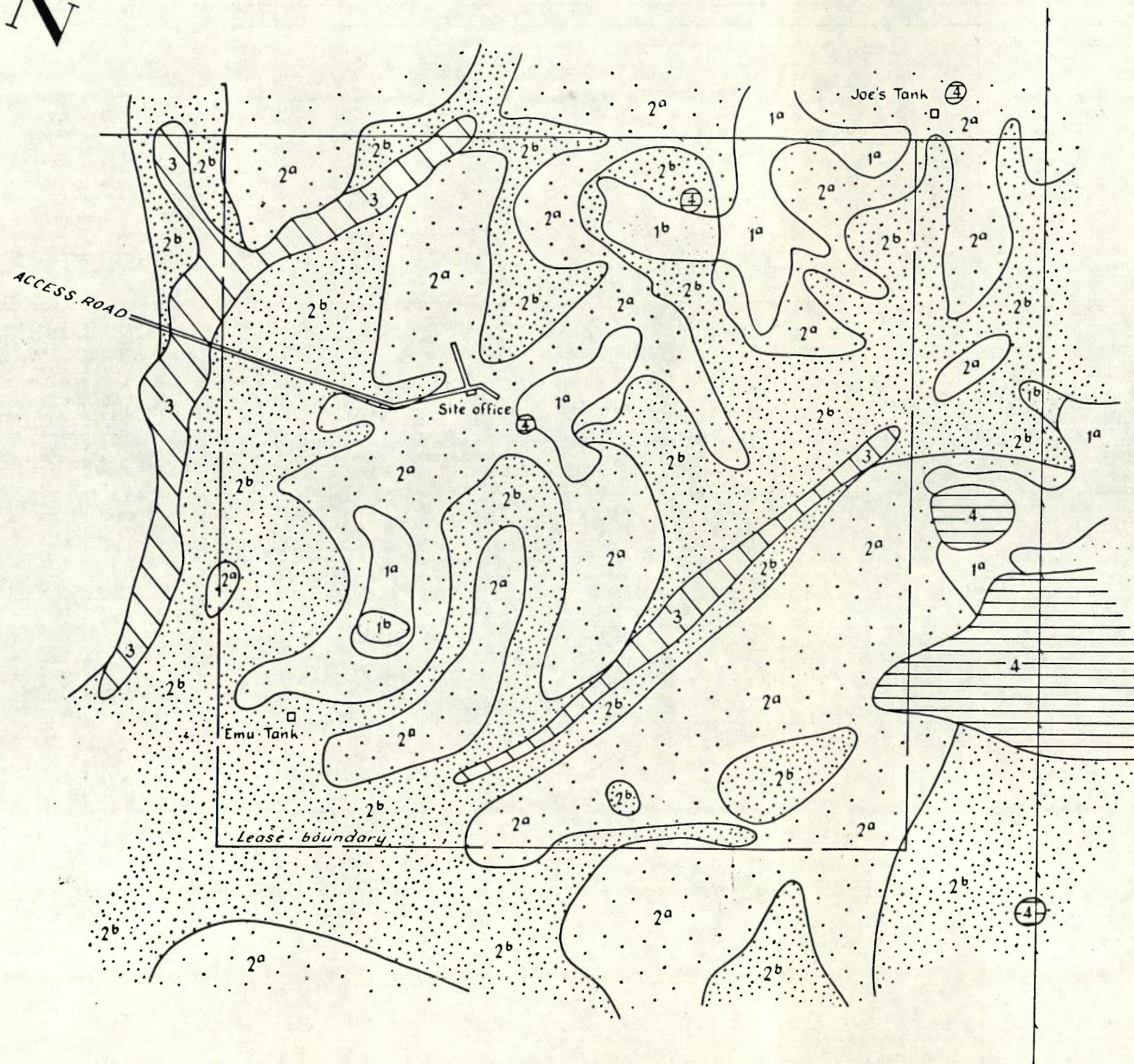
FIGURE 13

DESIGNED BY: AUSTIN	OFFICE HELD:	CLIENT:	TITLE:	PROJECT NO.:	DRAWING NO.:
DRAWN BY: WEDD	DATE:	ELECTROLYTIC ZINC COMPANY OF AUSTRALASIA LTD.	ELURA LEAD/ZINC PROJECT MINE & INDUSTRIAL FACILITIES AREA LAYOUT - (SEMI-AUTOGENOUS)	1382-01	10-MM-001
CHECKED BY: [Signature]	SCALE:	ENGINEERS AND CONTRACTORS			
APPROVED:	1:1000				



ELURA MINE — PROPOSED STOPING SEQUENCE

Figure 14



N.B. See explanatory notes for description of constraint categories.

SCALE 1:22,000



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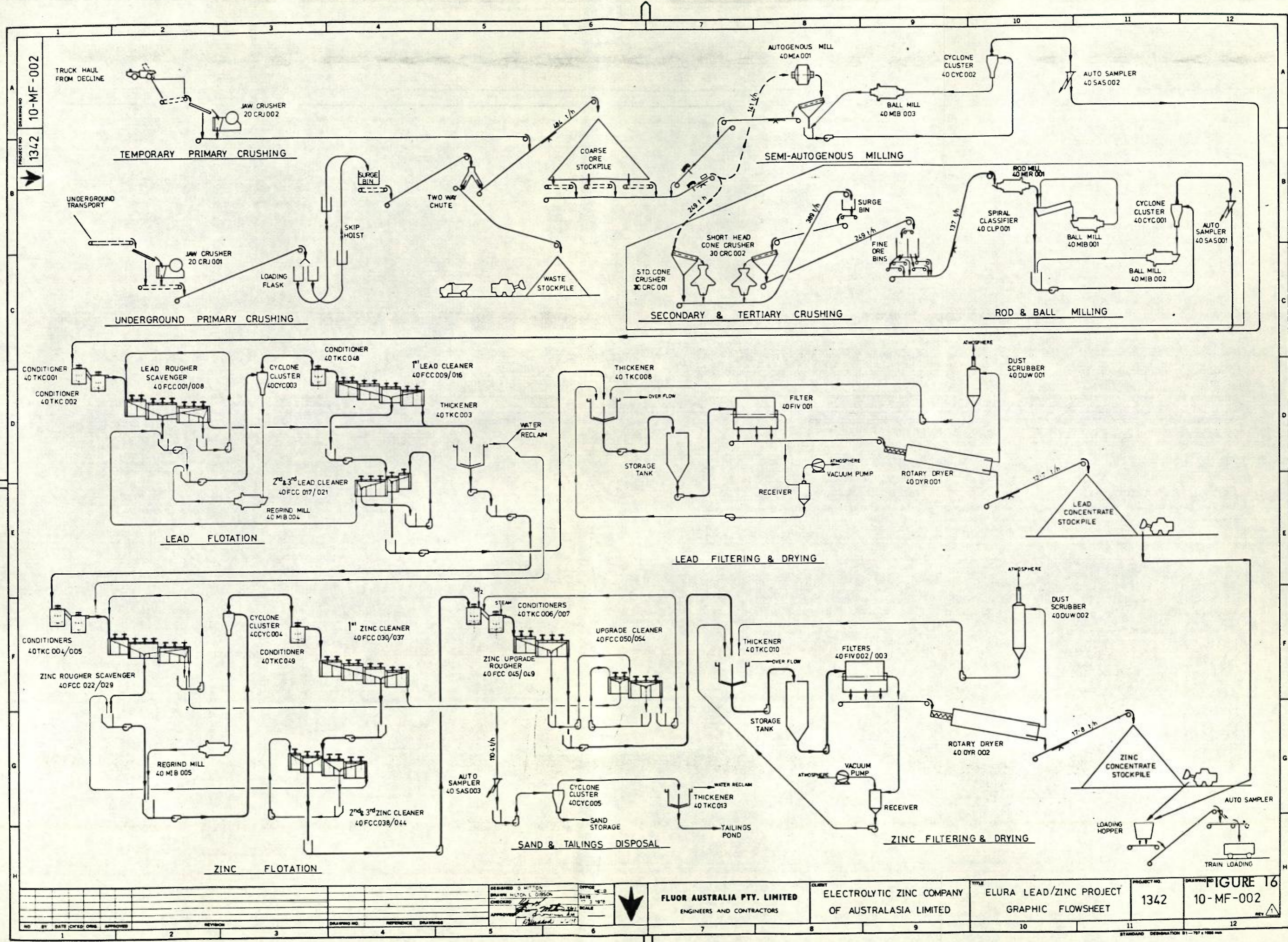
ELURA BASE METAL PROJECT

**ENVIRONMENTAL CONSTRAINTS MAP
WASTE STOCKPILE SITE SELECTION**

Compiled by: S Jones

Date January 1979

FIGURE 15



PROJECT NO 1342
DRAWING NO 10-MF-002

NO	BY	DATE	CHKD	ORIG	APPROVED	REVISION	DRAWING NO	REFERENCE	DRAWINGS
1									
2									
3									
4									
5									
6									

DESIGNED BY MITTON
DRAWN BY HILTON L. GIBSON
CHECKED BY [Signature]
APPROVED BY [Signature]

OFFICE ME-B
DATE 13 1978
SCALE

FLUOR AUSTRALIA PTY. LIMITED
ENGINEERS AND CONTRACTORS

CLIENT
ELECTROLYTIC ZINC COMPANY
OF AUSTRALASIA LIMITED

TITLE
ELURA LEAD/ZINC PROJECT
GRAPHIC FLOWSHEET

PROJECT NO 1342
DRAWING NO 10-MF-002

FIGURE 16

STANDARD DESIGNATION B1-1974 1988

PROJECT NO 1342
DRAWING NO 70-MG-001

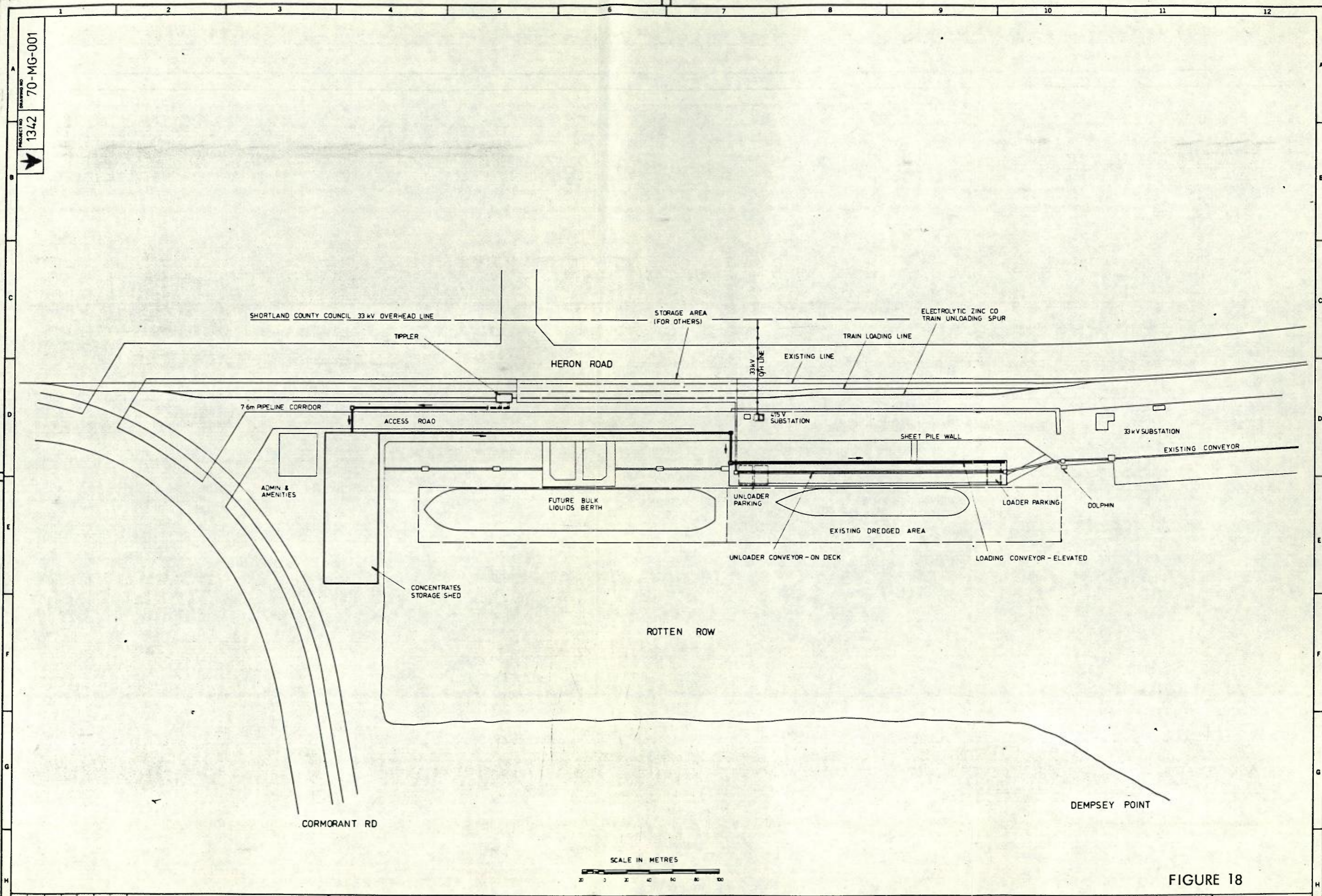


FIGURE 18

DESIGNED M.S.B.		CHECKED G. HEMPEL		DATE APRIL		SCALE		CLIENT ELECTROLYTIC ZINC COMPANY OF AUSTRALASIA LIMITED		TITLE ELURA LEAD/ZINC PROJECT PORT FACILITY KOORAGANG IS AREA LAYOUT		PROJECT NO. 1342		DRAWING NO. 70-MG-001				
DRAWN M.S.B.		APPROVED [Signature]		OFFICE [Signature]		FLUOR AUSTRALIA PTY. LIMITED ENGINEERS AND CONTRACTORS												
NO	BY	DATE	CHKD	ORIG	APPROVED	REVISION	DRAWING NO	REFERENCE	DRAWINGS									
1							2		3	4	5	6	7	8	9	10	11	12

BEACH TEST RESULTS

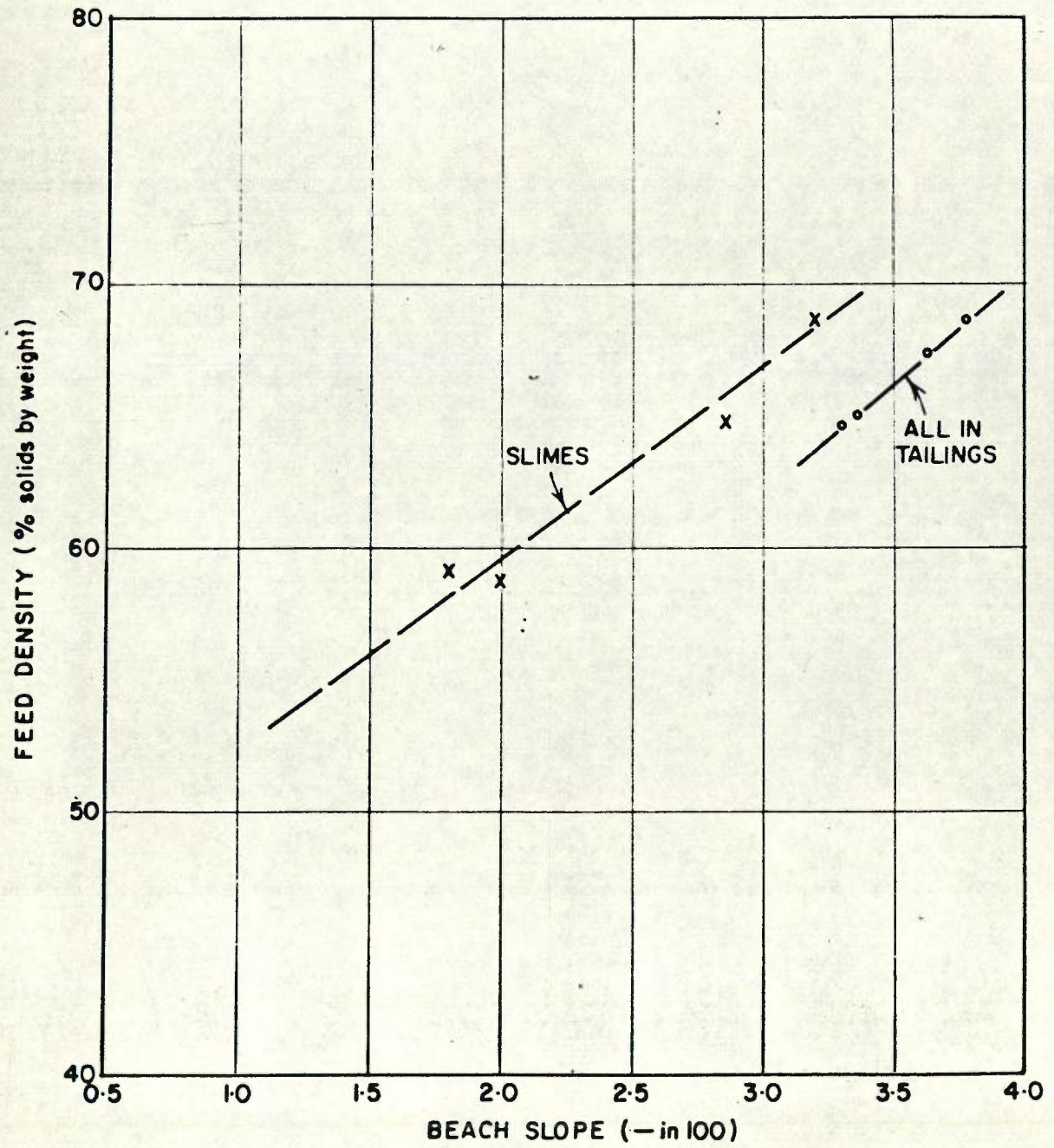
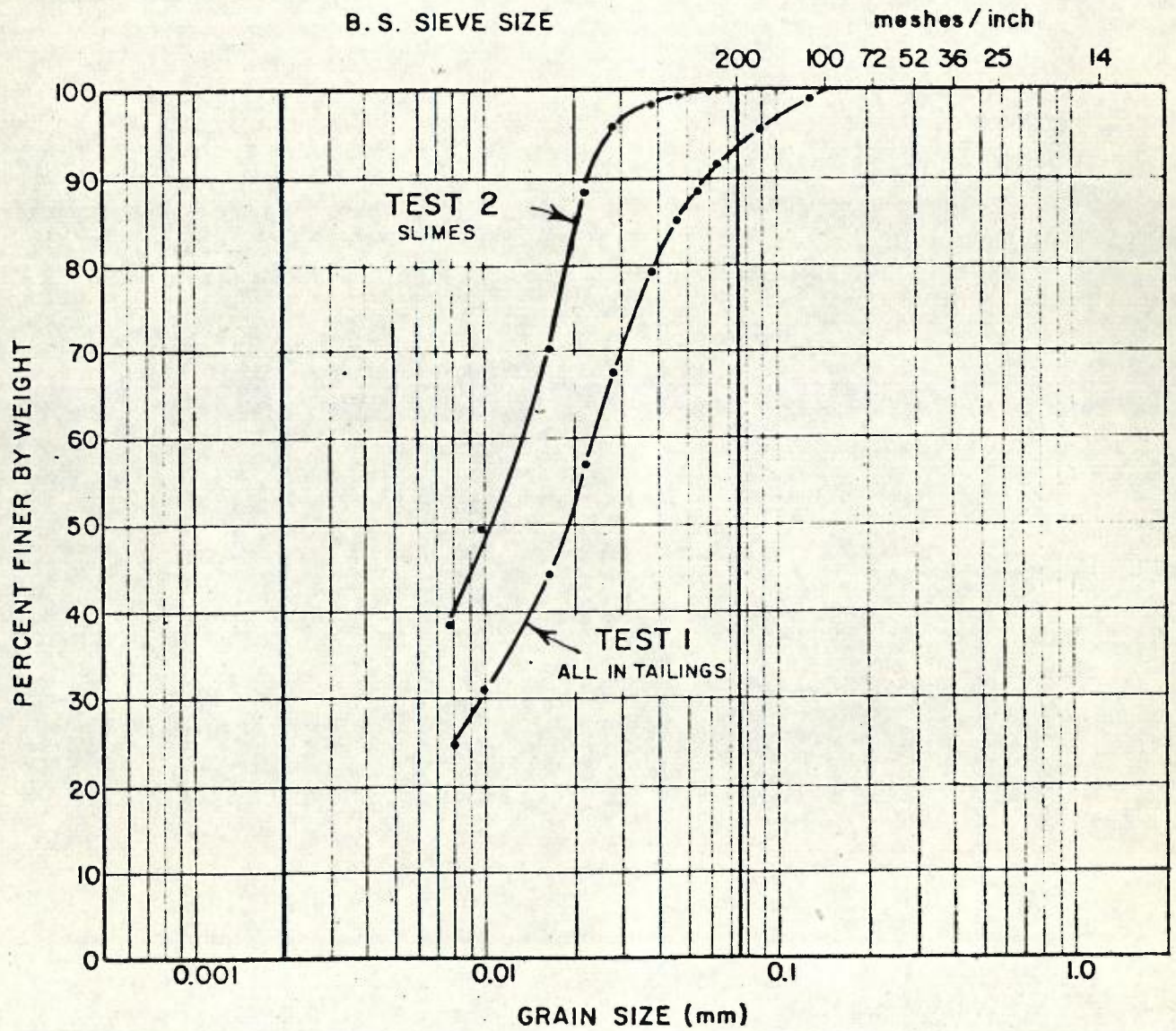


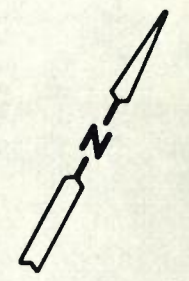
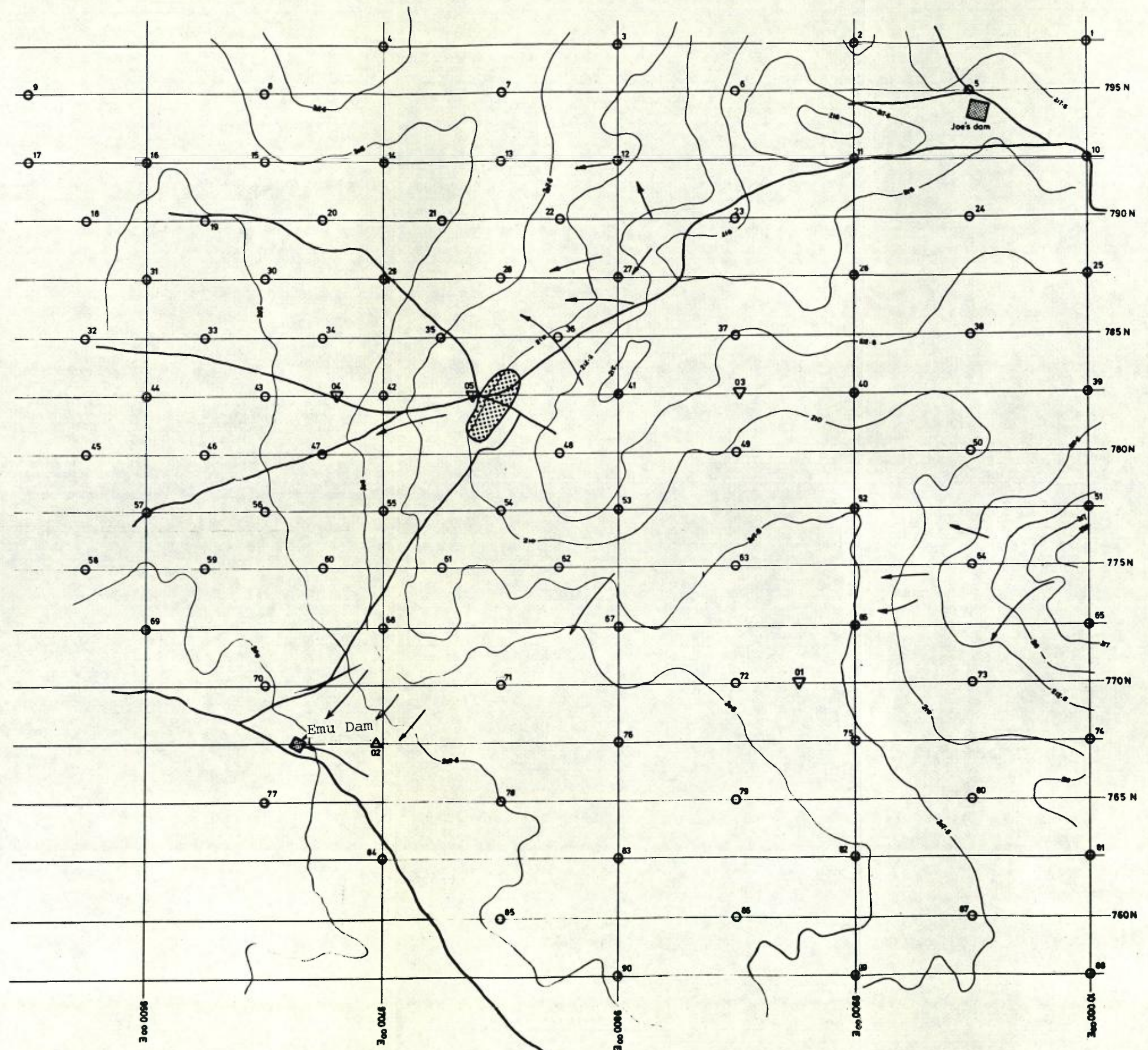
FIGURE 19

GRADING CURVES










"clay" size	"silt" size	fine	medium
FINE GRAINED		SAND SIZE	
UNIFIED CLASSIFICATION SYSTEM			


FIGURE 20



LEGEND

-  Joe's Dam and name
-  Approx limit of ore deposit projected to surface
-  Contour (m approx)
-  Grid sample site and number
-  Orientation sample site and number
-  Vehicle track
-  Drainage

Scale: 1:10 000

 **The Australian Mineral Development Laboratories**
 Title **SAMPLE LOCATIONS - ELURA** FIGURE 21
BASELINE GEOCHEMICAL SURVEY
MSL 09-77

ELECTROLYTIC ZINC COMPANY OF

EIS
360

Elura lead/zinc project report on
environmental aspects of proposed
development