CONSULTATIVE ENVIRONMENTAL REVIEW

# Proposal for Gypsum Mining Operations in the Area of Mining Lease Application M77/528 and Miscellaneous Licence 77/172

"Red Lake"

Chandler, Shire of Nungarin

Prepared by Aurex Pty Ltd
Tuesday, January 06, 1998

## *INVITATION TO MAKE A SUBMISSION*

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

Aurex Pty Ltd intends to mine for Gypsum at Red Lake, north-east of Merredin, within Mining Lease Application M77/528. In accordance with the Environmental Protection Act, a CER has been prepared which describes this Proposal and its likely effects on the environment. The CER is available for a public review period of 4 weeks from 12th January 1998 closing on 11th February 1998.

Comments from government agencies and from the public will help the EPA prepare an assessment report in which it will make recommendations to government.

### Why write a submission?

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

All submissions received by the EPA will be acknowledged. Submissions will be treated as public documents unless provided and received in confidence subject to the requirements of the Freedom of Information Act, and may be quoted in full or in part in the EPA's report.

### Why not join a group?

If you prefer not to write your own comments, it may be worthwhile joining with a group interested in making a submission on similar issues. Joint submissions may help reduce the workload for an individual or a group, as well as increase the pool of ideas and information. If you form a small group (up to 10 people) please indicate all the names of the participants. If your group is larger, please indicate how many people your submission represents.

### Developing a submission

You may agree or disagree with, or comment on, the general issues discussed in the CER or the specific proposals. It helps if you give reasons for your conclusions, supported by relevant data. You may make an important contribution by suggesting ways to make the proposal more environmentally acceptable.

When making comments on specific elements of the CER:

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

**Points to keep in mind**

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

- attempt to list points so that issues raised are clear. A summary of your submission is helpful;
- refer each point to the appropriate section, chapter or recommendation in the CER;
- if you discuss different sections of the CER, keep them distinct and separate, so there is no confusion as to which section you are considering;
- attach any factual information you may wish to provide and give details of the source. Make sure your information is accurate.

Remember to include:

- your name;
- address;
- date; and
- whether you want your submission to be confidential.

The closing date for submissions is: Wednesday 11th February 1998

Submissions should be addressed to:

The Environmental Protection Authority
PO Box K822
PERTH WA 6842

Attention: Dr R M Holmes

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## SUMMARY

The Mining Lease application M77/528 of 15.77ha is located on Vacant Crown Land in a window in the Lake Campion C Class Nature Reserve 24789 near Chandler, some 46km north of Merredin and 300km east of Perth in the South West Mineral Field (Figs 1a & 1b). Access to this Lease will be a via corridor a maximum of 89m long and 16m wide, via Miscellaneous Licence application L77/172 of 0.12ha, which crosses the Nature Reserve at its northeastern boundary with private land. The adjacent private landowner has agreed to the prime vehicular access to the tenements being across his land, and to the stockpiling of mined gypsum on his land (rather than on the Mining Lease).

The Proponent (Aurex Pty Ltd, in joint venture with KJ Fitzgerald) proposes to extract the agricultural gypsum resources in the tenement area by a sequential mining and rehabilitation plan. Apart from screening to remove organic trash and oversize lumps, there will be no processing at site as the gypsum is suitable for direct sale for use in land improvement in the district. There is an urgent requirement for agricultural gypsum for land improvement by rural users in the region, accordingly the Proponent is under some pressure to commit to providing this resource in an orderly manner.

The local receiving environment has been summarised by consultants Mattiske Consulting Pty Ltd and MJ & AR Bamford (Mattiske et al., 1997) as follows.

"Red Lake is a bare salt lake, devoid of vegetation, except for fringing the shore where there are narrow *Halosarcia* flats. Behind, gypsiferous dunes and silt have accumulated, the dunes being less than 10m in height. The survey [tenements] area is surrounded by a Nature Reserve which in turn is surrounded by extensively cleared agricultural areas where the loss of biodiversity has been high. In the survey area, four vegetation associations were recorded during the field work. *Eucalyptus salicola* was recorded from the gypsum dunes in the lease area and on similar dunes within the adjacent Nature Reserve, and *Eucalyptus melanoxylon* from the red sand rises behind the dunes. The samphire association fringing the lake was a monoculture of *Halosarcia lylei*. No Rare or Priority species were located within the survey area. Weeds were abundant along the track into the proposed lease and along tracks within the lease area. Similarly weeds were common on the previously mined area of the gypsum dune. A list of recorded and expected vertebrate species were prepared. The survey area may support 7 amphibian species, 54 reptile species, 130 bird species and 29 mammal species and wildlife favoured the woodland adjacent to the gypsum dune of the proposed mining area. The adjacent Nature Reserve probably supports an almost complete vertebrate assemblage with the exception of one reptile and about 10 mammal species which are probably locally extinct. While no species of recognised conservation significance were observed during the site inspection, a number of such species are probably present."

The potential impacts of the proposal on the local environment and strategies to manage the protection and rehabilitation of the environment are summarised below. As far as the more regional environmental context is concerned, it should be particularly noted that the vegetation to be cleared represents a little more than 1% of the area of similar floral associations surveyed by Coates (1990) in eastern Lake Campion Reserve 24789 and Common Reserve 21759 (Fig 1b). The area to be cleared under this proposal does not form a part of any Reserve. Currently there are only four granted Mining Leases (the only type of tenement within which any mining can take place) in the area of these reserves, and only two of these (M77/22 & M77/77) actually occur on land within Reserve 24789 at Lake Chandler and they are designed for alunite resources in the lake, not for gypsum resources in adjacent dunes (Fig 1b).

The base level of mining in M77/528, which is restricted to a 10ha area of gypsum dunes, will slope upwards away from Red Lake to ensure that there is no expansion of the lake or incursion of saline groundwater. This will also allow some gypsum to remain in place and assist in rehabilitation of species which favour the presence of gypsum in the substrate. During sequential panel mining of the gypsum dunes, about 10cm of "topsoil" (seed reservoir) will be removed and stockpiled in 1m high windrows for later re-use. Seeds will be collected from all species within the lease area for rehabilitation use. Before any preparation of the area occurs prior to rehabilitation, the area will be treated for weeds in a manner recommended by Dept of Conservation & Land Management (CALM) for the particular weed species concerned. After the weeds have been killed the ground will be ripped and furrowed, the topsoil replaced, and the seed scattered at the break of season, with mulch placed manually over the replaced topsoil.

The access is already devoid of much vegetation and has several weeds common along the edge and to both sides of the track so very little additional disturbance will occur along the access track, but care will be taken to ensure that the disturbance is kept to a minimum and that no additional weeds are introduced into the area. All tracks used during the mining process will be rehabilitated when they are no longer required. This will involve killing all weed plants, ripping the soil and then sowing the collected seeds at the commencement of the winter rain. Monitoring of the rehabilitation will occur to determine which species grow successfully and which show little or no germination in this situation, in which case seedlings will be used.

## *INTRODUCTION*

### Proposal

The proponent (Aurex Pty Ltd, in joint venture with KJ Fitzgerald) proposes to extract the agricultural gypsum resources in the tenement area by a sequential mining and rehabilitation plan. Apart from screening to remove organic trash and oversize lumps, there will be no processing at site as the gypsum is suitable for direct sale for use in land improvement in the district.

### Proponent

The tenement applications are in the name of Aurex Pty Ltd ("Aurex"), on behalf of a joint venture between Aurex and Kenneth James Fitzgerald ("Fitzgerald") which was formed on 22nd June 1989 for the purpose of acquiring and developing gypsum and clay mineral resources in the Wheatbelt region of Western Australia. Aurex is based at 16 Ogilvie Road, Mount Pleasant, WA 6153.

Mr Fitzgerald is a farmer, contract machinery operator, and mineral prospector based in Merredin whose family has a long agricultural association with the district, and whose father was one of the earliest gypsum miners in the area.

Aurex is a private group of geological consultants, mineral explorers and developers founded in 1980, which has been involved in the management of gold mine development and producing operations both in Western Australia (eg Marvel Loch, Yilgarn Star, Paringa gold mines) and overseas (eg Salsigne gold mine, France; Damang gold mine, Ghana). These projects have generally included environmental management programmes ("EMP"): the Damang gold mine is subject to approved environmental and social impact statements and an ongoing EMP, with standards equivalent to those extant in Australia. The principals and directors of Aurex are Dr.R J Marston, Mr G A Travis, and Dr D Dunnet, the first two named individuals being executive directors of publicly listed gold mining company Ranger Minerals NL (no connection with private company Ranger Uranium Pty Ltd). Ranger and its directors are responsible for operations conducted at the gold mine in Ghana.

### Location, Tenure and Legislative Framework

The Project consists of applications for two mineral tenements located near Chandler, some 46km north of Merredin and 300km east of Perth in the South West Mineral Field. Most of the surrounding land is arable farm land forming part of the Eastern Wheatbelt region. In detail the mineral tenement applications are located 2km east of Chandler Townsite centred at about 6559000mN/637600mE on the southeastern margin of Red Lake, which is a small playa or dry salt lake. The area is within the Shire of Nungarin, which authority has raised no objections to the Proposal subject to any Dept of Minerals & Energy (DME) conditions that may be imposed.

The Project consists of Mining Lease application M77/528 of 15.77ha which is located on Vacant Crown Land in a "window" in the Lake Campion C Class Nature Reserve 24789 (Fig 1b), very close to the eastern boundary of the Reserve with adjacent farm land. The Nature Reserve is vested in the National Parks and Nature Conservation Authority (NPNCA) and is managed by CALM. Lake Campion Nature Reserve was originally set aside in 1957 with an area of 688ha but has been progressively expanded to 10,071ha over an eleven year period before inclusion of Reserve 24507 in 1979 to give a total area of 10,752ha. The Reserve is

irregular in shape as it is designed to follow the boundaries of the salt lakes, principally Lakes Brown and Campion and their immediate hinterland.

This window in the Lake Campion Reserve exists because there were previous valid mining tenements in place before the Reserve was expanded to include them. Mining will be confined to the Mining Lease which coincides exactly with these previous tenements (Mineral Claims 42H and 43H), therefore there will be no mining on or direct interference with the Nature Reserve itself, apart from the access track (see below).

Currently there are only four granted Mining Leases (the only type of tenement within which any mining can take place) in the area of these reserves, and only two of these (M77/22 & M77/77) actually occur over land within Reserve 24789, rather than as Vacant Crown Land windows in the Reserve. These two leases are at Lake Chandler and are designed to cover exploitation of alunite resources in the lake (alunite has already been mined at Chandler), not the gypsum resources in adjacent dunes (Fig 1b). Besides granted Mining Lease M77/71 at Lake Brown, Mining Lease application M77/528 is the only lease on Vacant Crown Land enclosed by the Nature Reserve. Acts of Parliament are required to grant Mining Leases which occupy land that is actually a part of a nature reserve.

Access to this Lease will be via a corridor a maximum of 89m long and 16m wide, via Miscellaneous Licence application L77/172 of 0.12ha, which crosses the Nature Reserve at its northeastern boundary with private land. The position and extent of this Licence was agreed during an on site inspection with the District Manager of CALM on 26th February 1997. No destruction of vegetation is needed for this access to be established.

The adjacent private landowner (RC & PA Caridi) has agreed to the prime vehicular access to the tenements being across the relevant farm land to the north (Crown Grant Locations 15986 & 15987), and to the stockpiling of mined gypsum on the same land (rather than on the Mining Lease).

**Justification and alternatives**

There is currently no freely available source of agricultural gypsum within the Merredin district of the eastern Wheat Belt agricultural area. Records from DME's Statistics Digest for the period 1996-97 show that production of 23,662t of gypsum came from the Shire of Nungarin (believed to be almost entirely production of lake gypsum for plaster; see below), whereas only 1,775t was recorded for the adjacent Shire of Merredin. Agricultural land users occur to the south, north and east but not in the immediate area of the tenement as this is surrounded by the Lake Campion Reserve. The low value of the material normally precludes economic supply from sources located more than a 100km or so from the user (Cf Freeman, 1994; and Appendix 2 this report).

Clay soils often respond to the application of gypsum as a soil conditioner, and crop yields can show a dramatic increase (eg 0.2 tonnes per hectare for wheat, Cf Appendix 2) in paddocks treated with granular gypsum of the high quality found in the tenement. Gypsum increases soil aeration which in turn allows water to penetrate deeper and quicker thereby reducing run-off and erosion. The use of gypsum also prevents surface crusting, which stops seeds from emerging through the soil. The Dept of Agriculture has estimated that within a radius of 100km of Lake Campion there are 1.4 million hectares of heavy clay soils of which about two thirds would be available for cropping (see Freeman 1994). Typical initial applications of gypsum are up to 5 tonnes per hectare with follow ups several years later.

The demand for the resource is clearly there (see Table 5) and the end result is anticipated to be a marked improvement in the productivity of already cleared agricultural land. This has an obvious benefit to the communities concerned given that the availability of gypsum for mining is very limited. Permanence of treatment of gypsum responsive soils is related to good land

care management practices including minimum tillage, direct drilling methods of sowing, and the avoidance of stocking with sheep when the land is wet (see Appendix 2).

The harvesting of gypsum from salt lakes directly has been proceeding at Lake Brown since 1948 on an intermittent basis. This gypsum was extracted for the production of plaster by HB Brady & Co, plaster being a higher value product than gypsum with a strict requirement that there be no quartz sand in the product. Gypsum in dunes adjacent to salt lakes commonly contains a small amount of sand which is not detrimental to agricultural use. There are a number of reasons why material extracted from salt lakes is generally not regarded as suitable for a lower cost and value based agricultural supply.

Mining costs would be higher as special machinery is needed to cope with high salinity water and the soft, boggy nature of the ground. Dredges are not regarded as practicable as the gypsum layers are too thin in the lakes to allow a dredge to float in a pond and to be able to extract the layer. Gypsum crystal size is commonly very variable: coarse crystals are not suitable and would need costly crushing before application (as it cannot be spread at a coarse size by spreading machines on paddocks), and fine crystals dissolve too rapidly when applied to the arable land. Even with stockpiling and natural leaching by sparse and erratic rainfall, the salt content of the lake-harvested gypsum and its clay matrix remains unpredictable and variable. A salt content of more than 2% is not advisable for land use (Freeman 1994), and the local users have declined to take supply of agricultural gypsum from this source.

Most lake beds have thin layers of gypsum which alternate with more clay-rich saline material (Freeman 1994), making the supply of a consistent product difficult to impossible. Any mining of lake beds is also obliged to have some impact on the fringing land, floral and faunal communities as earthmoving equipment will have to access and recover from lakes and stockpile at least some material out of the lake. Indeed stockpiling of saline gypsum at Lake Brown on land beside the lake has reputedly affected trees growing there.

## Key characteristics

The key characteristics of the Proposal are as set out in Table 1 below.

**Table 1 Key characteristics**

| Element | Description |
|---|---|
| Life of project | five years |
| Size of gypsum deposit | 165,000 tonnes in 11 mining panels |
| Area of disturbance: life of the deposit<br>per annum | 10 hectares<br>1-3 hectares |
| Mining rate: maximum per annum<br>average per annum | 45,000t or 3 mining panels (3ha)<br>30,000t or 2 mining panels (2ha) |
| Depth of mining | up to 6 metres, conforming to base level sloping upwards from edge of Red Lake; in any event to be at least 1 metre above saline groundwater |
| Mining setback from Red Lake high water mark | 5 metres |
| Stockpile area on cleared farm land | 3 hectares |
| Mulch and soil storage area | 2 hectares |
| Road access through Nature Reserve | 0.12 hectare |
| Gypsum transport as maximum truck movements per week | 50 each way, mainly to the stockpile area off tenements on cleared farm land |

Most mining will take place at the time of peak demand which is normally the first quarter of each calendar year. Stockpiling in the last quarter of each year is likely to occur once the project is operational.

The gypsum is direct shipping grade and no processing will take place on site, except for screening to retain oversize lumps of gypsum and organic trash. Lump gypsum will be manually crushed to size, and organic trash will be stockpiled for use as mulch and wind retardant during rehabilitation.

## ENVIRONMENTAL FACTORS

### Biophysical factors

There have been several botanical surveys carried out in the district over the last 20 years as summarised by Mattiske Consulting Pty Ltd (1995). Aurex Pty Ltd (the Proponent) commissioned Mattiske Consulting Pty Ltd to undertake a detailed flora, vegetation and vertebrate fauna survey of lease M77/528, L77/172, the proposed stockpile area and the access road, a total of some 20ha. A detailed botanical survey and search for rare and priority species was required for Mining Lease M77/528, on the Miscellaneous Licence ML77/172, on the proposed stockpile area and the access road. The consultants' report (Mattiske et al., 1997) forms Appendix 1 to the CER and relevant extracts are included below.

The objectives of the EPA here are to maintain the abundance, species diversity, geographic distribution and productivity of vegetation communities and to protect declared rare and priority flora. Table 2 summarises biophysical factors and their management.

The lease is on the boundary of the Moorine Rock System and Muntadgin System of the Avon Botanical District (Beard, 1980). The salt country of the Moorine Rock System includes Lake Campion. The bare salt lakes are bordered by a belt of samphire, then by a belt of shrubland and finally by a belt of woodland. On the dunes between the salt flats *Templetonia* or *Acacia* shrublands are developed. In the survey area 4 vegetation associations were recorded, and a total of 33 families, 67 genera and 91 species were recorded on the survey area. No rare or priority species were located. The dominant families were:

| | |
|---|---|
| Asteraceae - | 14 species |
| Poaceae - | 9 species |
| Myrtaceae - | 8 species |
| Proteaceae - | 7 species |

There were a total of 8 weed species recorded, but most of these were in the area previously mined and along tracks through the lease. This activity took place before there were requirements for more responsible mining aimed at preventing incursions of weeds and plant diseases. The area of 10ha proposed to be mined is covered by vegetation association 1.2 consisting of open *Eucalyptus salicola* (Salt Gum) woodland and shrubland. Regrowth [without any attempt at rehabilitation] in the area previously mined consisted of several shrubs and a few young trees with some overlap on the east with regrowth species from associations 1.1 and 2.1, though mining at depth resulted in colonisation by association 2.2 (*Halosarcia lylei* being dominant).

Following mining a combined package of species from all vegetation associations will be used for rehabilitation as the changed soil conditions and removal of most gypsum may favour growth of different assemblages to vegetation association 1.2 alone. The use of an inclined base to the level of mining will allow a sufficient margin (at least 1 metre) above saline ground water table for rehabilitation. This will also allow some gypsum to remain in place and assist in rehabilitation of species which favour the presence of gypsum in the substrate.

The value of the vegetation of the Salt Gum *(E.salicola)* associations in the area to be cleared and mined can be put into a regional context using the vegetation survey of part of the Lake Campion Nature Reserve 24789 (western portion was not included), and of Common Reserve 21759 carried out for CALM by Coates (1990). In these reserves a planimeter measurement of Coates's 1:25,000 scale map indicates an aggregate of about 7.7 sq km or 770ha are occupied by Salt Gum woodland associations. These are the associations denoted *"Eucalyptus salicola* (Salt Gum) woodland Types 1 and 2 (Ws1 and Ws2)", and where the native Cypress pine *(Callitris glaucophylla)* is dominant, Coates (op.cit. p 38) denotes the association as "Ws" or

"Ws(c)". Association 1.2 (Mattiske et al., 1997) in M77/528 was mapped include in a unit denoted as "Ws/Wc" by Coates, open low Cypress pine woodland being denoted as "Wc".

Therefore the mining of a 10ha area (albeit not in the Reserve) in M77/528 represents the loss of some 1.3% of this group of associations typically developed (though not exclusively) on gypsum dunes and characterised by *E. Salicola* and *C. glaucophylla* in Stratum 1. The remainder of this floral type is developed (though not exclusively) on gypsum dunes or lunettes in Reserves, the bulk of which are not affected by granted mining leases or applications for mining leases (compare Figures 2 and 4 in Freeman, 1994, and Coates, 1990, Figure 6).

The access area (L77/172 of 0.12ha), though passing through vegetation associations 1.1 and 2.1, is devoid of vegetation excepting weeds, which will be controlled at all times.

Whilst no faunal species of recognised conservation significance were observed during the site inspection, a number of such species are probably present. Bird species observed are as follows (for more detail refer Appendix1):

1. Emu (tracks only).
2. Black-shouldered Kite.
3. Nankeen Kestrel.
4. Crested Pigeon.
5. Galah.
6. Australian (Port Lincoln) Ringneck.
7. Horsfield's Bronze-Cuckoo.
8. Striated Pardalote.
9. Weebill.
10. Yellow-rumped Thornbill.
11. Spiny-cheeked Honeyeater.
12. Yellow-throated Miner.
13. Singing Honeyeater.
14. White-fronted Honeyeater.
15. Jacky Winter.
16. Red-capped Robin.
17. White-browed Babbler.
18. Varied Sittella.
19. Rufous Whistler.
20. Grey Shrike-thrush.
21. Crested Bellbird.
22. Willie Wagtail.
23. Black-faced Cuckoo-shrike.
24. Black-faced Woodswallow.
25. Grey Butcherbird.
26. Australian Raven.
27. White-backed Swallow.
28. Tree Martin.
29. Rufous Songlark.

Within the survey area, wildlife (especially the birds listed above) favoured the woodland (vegetation association 1.1) separated by a narrow zone of shrubland (vegetation associations 2.1) from the gypsum dune of the proposed mining area. The Kite, Pigeon and Songlark were only recorded on adjacent farm land.

The distribution of species observed during the site inspection seemed consistent with the differences in habitat; the vegetation on the gypsum dune providing little habitat or shelter compared with the woodland just to the east. Despite this, species as distinctive as the native conifer that occurred on the gypsum soils probably have specific invertebrate fauna associated with them and may be of seasonal importance for seed-eating birds. Other vegetation of the gypsum soils may also be of seasonal significance, such as providing flowers for nectarivorous

birds. Given the small area involved, however, the importance of these plants for local fauna would be slight. Furthermore, the loss of the plants from the landscape could be temporary if adequate rehabilitation was carried out after mining.

## Table 2: Environmental factors (biophysical) and management

| Environmental factor | EPA objective | Existing environment | Potential impact | Environmental management | Predicted outcome |
|---|---|---|---|---|---|
| vegetation association 1.2 on gypsum dunes | maintain the abundance, species diversity, distribution, productivity of vegetation association 1.2 | the 10ha to be mined consists of association 1.2; this association is also represented nearby (in about 760ha) | plant community in mined area will change | use seeds from all vegetation associations to rehabilitate mined area | though there will be some remnant gypsum, area will be revegetated and result in a more diverse community; original association remains outside lease |
| vegetation association 2.2, saline wetland | as above for this association | samphire shrubland (1ha) | no disturbance | setback 5m from high water mark | no significant change |
| salt lake | no disturbance | bare lake bed | none | | no change |
| access area, vegetation associations 1.1 and 2.1 | as above for respective vegetation associations | will not be disturbed as access avoids native species (9ha) | minimal | weeds will be removed and controlled during mining | vegetation associations untouched and improved by weed management |
| ground water | no disturbance | saline | minimal | no vehicles serviced on site | no hydrocarbon pollution |
| declared rare and priority flora | protect as required by Wildlife Conservation Act 1950 | none identified | | | |
| terrestrial fauna on gypsum dunes | as above | poor habitat for most fauna | minimal despite removal of dunes | long term restoration but to different habitat | more diverse faunal community |
| terrestrial faunal elsewhere | as above | diverse in woodland to east in vegetation association 1.1 | buffer zone of vegetation associations 2.1 will reduce avifauna impact | restrict movements in or adjacent to associations 1.1 and 2.1 | minimal change |
| specially protected or threatened fauna | protect as required by Wildlife Conservation Act 1950 | none identified | | | |
| landform and proximity of saline ground water | establish stable, sustainable landform consistent with surroundings | dunes 5 to 10m high; ground water below dunes is variably saline (several times sea water) | removal of dunes above base level | establish a blending surface (base level) sloping up from lake edge, | minimal constraints on revegetation by underlying saline water being kept low; some remnant gypsum left |

## Social and pollution factors

The proponents commit to abide by the provisions of the Aboriginal Heritage Act and to inform the WA Museum of any sites of Aboriginal significance discovered in the course of operations. The Aboriginal Affairs Department advised on 30 May 1997 that a literature and file search undertaken at the Proponent's request indicated that there are no listed Aboriginal sites known within a large area of land around Chandler, which includes the Project tenements

The Proponent has already executed Mining Agreements with 3 of the 4 Native Title Parties who have lodged applications under section 61 of the Native Title Act 1993 for native title determinations in relation to land on which the tenements lie (see Appendix 4). All of the native title applicants have been briefed on the nature and scope of the project and have given their support verbally.

There will be no support facilities provided on site as the operation is purely a seasonal mining operation with low volume and irregular material movements. One operator will be employed to mine and load into contractor's trucks. The operator will be based in Merredin in existing housing and will work on site under the provisions of the Mines Regulation Act and relevant regulations in relation to certification and working conditions.

Existing public roads already used for the seasonal hauling of other agricultural commodities like wheat and superphosphate will be used with the knowledge and permission of the Shires involved.

There will be no impact on the local water resources and their users. No water will be used in the operation. Dewatering is not required. No interference will take place with the natural lake drainage system, but protective drains installed if needed to rectify any hydrological imbalances or erosion that may occur, though these are considered to be highly unlikely.

There will be no waste products or toxic materials requiring disposal at the site. Any vehicle servicing which requires to be done will occur on the adjacent farm land and all waste oils and greases will be collected for disposal in Merredin. Any hydrocarbons stored at the stockpile area will be in accordance with DME and Dept of Environmental Protection (DEP) requirements.

The material to be mined is relatively coarse grained and has a very low content of fines, hence dust generation is expected to be negligible. Noise levels will be low given the minimal amount of mechanical equipment to be used and the periodical nature of the operation, and farm equipment has been used in the adjacent paddocks for a long period. There are no inhabitants in the area of proposed operations, the nearest occupied house being some 5km distant.

The social and pollution factors, their impact and management are summarised in Table 3.

**Table 3: Social and pollution environmental factors**

| Environ-mental factor | EPA objective | Existing environment | Potential impact | Environ-mental management | Predicted outcome |
|---|---|---|---|---|---|
| Aboriginal heritage | abide by Aboriginal Heritage Act | no known sites | none | WA Museum informed if new site found | no breach of Act |
| Native title claims | abide by Native Title Act | 4 claimants | none | agreements with claimants being completed | claimants support the Proposal |
| Infrastructure and water resources | minimise impacts | no infrastructure and only saline water | no additions use or interference planned | | no change is expected |
| Noise | minimise impacts | seasonal farm machinery in adjacent land | seasonal use of loader and trucks | | little change to ambient conditions |
| Dust | minimise impacts | some dust created by farm machinery | very little additional due to low fines in gypsum | access track will be gravelled | little change to ambient conditions |
| Waste products | appropriate management | none, except natural | none | organic trash from gypsum will be used for mulching and stabilisation | little change to ambient conditions |
| Vehicular Traffic | minimise impacts | farm traffic and public roads | seasonally more movements on public roads | weed removal from vehicles entering the tenements | little change to ambient conditions |

## *MINE PLAN AND ENVIRONMENTAL MANAGEMENT SYSTEM*

### Policy and budgets

The Proponent's policy is to carry out their business of surface mining of gypsum within the 10ha so defined with a minimal impact on the environment at and in the vicinity of the tenements at Red Lake, from the point of view of the floral, faunal, landform, hydrological, atmospheric and social factors which exist now. Therefore every effort will be taken to minimise the impacts caused by mining, stockpiling and product transport activities, consistent with the current and past levels of activity in and adjacent to the tenements, and to rehabilitate during and at the end of the mining operations.

The principles adopted for the Environmental Management System (EMS) are in accord with those described in interim Australian and New Zealand Standard ISO 14004. These principles are as follows:

1. An organisation should define its environmental policy and ensure commitment to its EMS.
2. An organisation should formulate a plan to fulfill its environmental policy.
3. For effective implementation an organisation should develop the capabilities and support mechanisms necessary to achieve its environmental policy, objectives and targets.
4. An organisation should measure, monitor and evaluates its environmental performance.
5. An organisation should review and continually improve its environmental management system, with the objective of improving its overall environmental performance.

Previous mining on the Vacant Crown Land of the lease and incursions (by weeds and unauthorised vehicles) into the Nature reserve have had undesirable impacts which have not been managed or rehabilitated. The Proponent accepts that it has a responsibility to recognise and take remedial action where possible to improve the past record of environmental impact by other persons and thereby improve the present environment in some respects.

In addition to any DME bonds required, it is proposed to set aside the equivalent of 10 cents per tonnes of gypsum mined and sold for the purposes of out of pocket rehabilitation costs. If it proves possible and practicable to mine and sell the indicated resource of 165,000 tonnes of gypsum, then an amount of $16,500 would be available. The principal cost will be labour by the Proponent to be raised in a separate cost centre where practicable. The adequacy of this amount will be reviewed on an annual basis in line with the success of the rehabilitation works carried out.

### Mine Plan

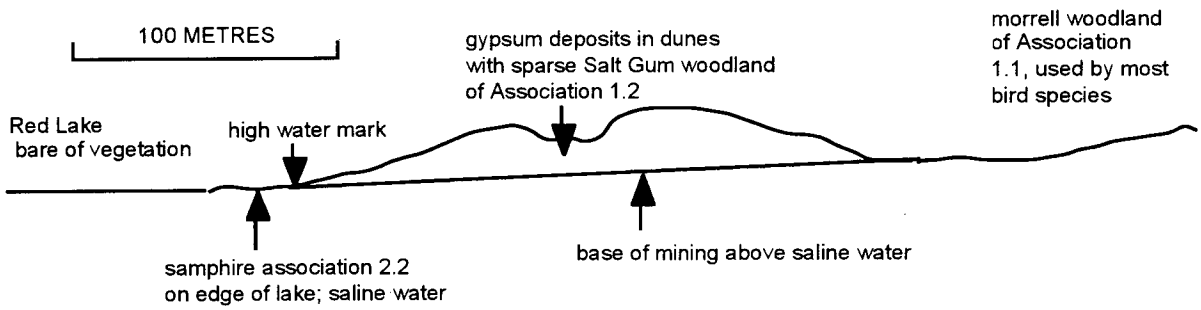
The proposed method of operation is as follows, and it utilises a rubber-tyred front-end loader.

- Divide the resource into panels each about 50 metres long (north-south) by 50 metres wide (east-west) which equates to a volume of around 10,000 cubic metres or some 15,000 tonnes. There will be 11 of these panels overlying the lunette from north to south, and production will start in the north at the access point into the tenement (Figure 6). The boundaries of each panel will be flagged. There will be no mining within 5 metres of the high water mark of Red Lake.
- For each panel mining will be sequential so that only one panel is being mined at a time, this will allow rehabilitation to begin on panels already mined out.
- "Topsoil" (about 10cm of seed reservoir) will be removed from each panel before mining. That from the first panel will be stockpiled in a 1m high windrow for later re-use. Topsoil from all subsequent panels will be spread on the previously mined panel, and generally on a

veneer of remnant gypsum to maximise viability of soil seeds. No other pre-stripping is required.

- Each panel will be then mined at a rate a needed to supply demand by incoming contractor's trucks. Schedules may require that small stockpiles of a few thousand tonnes are created in and adjacent to panels to supply larger consignments. There is virtually no waste anticipated so there is no need to demarcate waste dump areas. It is planned for the main gypsum stockpiles to be held on the cleared farm land immediately outside the Mining Lease and Nature Reserve (Figures 3 & 4).
- Mining will cease at an inclined base level sloping upwards away from the edge of the floor of Red Lake (Figure 6) to ensure that there is no expansion of the lake or incursion of saline groundwater, and to allow rehabilitation of a wide range of local floral types the best chance of success by keeping plant roots above the water table.
- Mining of Panel One will leave at least a five metre wide zone un-mined at the northern margin of the tenement so that a natural rill slope is created, and hence the natural land surface at the edge of the adjoining Nature Reserve remains undisturbed.

The diagram below illustrates a cross section through the gypsum deposits, the mine plan shown in Figure 6, and relationships between the land units and vegetation associations described.




SCHEMATIC CROSS SECTION OF THE GYPSUM DUNES AND VEGETATION ASSOCIATIONS ON THE EASTERN EDGE OF RED LAKE

## Environmental Management: Rehabilitation Plan and Weed Control

The map provided with this report (Figure 6) for the attention of DEP, CALM and DME shows the distribution and level above high water mark of the gypsum deposit to be mined over the expected 5 year life of the Project.

Following clean up and removal of any man-made refuse, the mined areas, which are expected to be nearly flat, will be scarified at the end of mining to alleviate any compaction that has occurred during mining. At this time any unsightly humps and hollows will be eliminated to reform the land profile in sympathy with the adjacent landscape, taking into account any drainage patterns. The northern edge of the mined dune will be left at a natural angle of respose within the lease.

The sequential mining plan described above will allow progressive rehabilitation to be carried out as panels are mined over the years. Ingress of weeds will be monitored along the access track and through the Nature Reserve, and kept to the minimum possible commensurate with the nearby location of cleared land with exotic species already present. Vehicles which will actually access the lease area will be cleaned down in Merredin or wherever the nearest water supply is available, as there will be no water supply at site. Particular attention will be paid to

checking and brushing rubber tyres and mats. In addition appropriate access and clean down warning signs will be erected for the access route.

Some of the resulting "subsoil" after mining will be closer to that of the samphire association so species which occur in that association are the ones which will be preferentially cultivated, though seeds will be collected manually by the operator from all species within the lease area. Note that it is planned to leave a veneer of gypsum below the base of mining corresponding with the current area of dunes, in an attempt to maximise the regeneration success of the species typical of the Salt Gum woodland association 1.2.

Before any preparation of the area occurs prior to rehabilitation, the area will be treated for weeds in a manner recommended by Dept of CALM for the particular weed species concerned. After the weeds have been killed the ground will be ripped and furrowed, organic trash will be spread, then topsoil (seed reservoir) replaced, and the seed scattered at the break of season (the beginning of winter rain).

Monitoring of the rehabilitation by the Proponent on advice from the Dept of CALM will determine which species grow successfully and which show little or no germination. If some species do not germinate then plants will be propagated from cuttings and planted out as seedlings, and/or smoke germination will be tried, particularly for some dune species, in consultation with the Kings Park Board. Before and during mining in-season transplanting of any local tree seedlings present will be done to ensure that later re-establishment is successful.

The access track will be fenced to prevent vehicles (in particularly those illegally entering the lease) from straying from the track, and the access track entry point from private land will have a grid laid to prevent farm stock from entering the Reserve and the lease. The gravel (sourced from a non-dieback infected area) laid in the access track to allow movement over a soft kopi sand dune will be removed after completion of mining, and the surface ripped to alleviate compaction. If required, fill to Dept of CALM's reasonable specifications will be laid in the site of the track bed, and the area mulched and seeded.

The Proponent's commitments are summarised in Table 4.

**Table 4: Environmental management commitments**

| Commitment | Objective | Action | Timing | Whose advice | Compliance criteria |
|---|---|---|---|---|---|
| 1.Rehabilitate after mining | Limit impact and allow progressive rehabilitation | mine a maximum of 3 panels (3ha) each year | ongoing | DME, CALM | Inspection reports |
| 2.Prevent the ingress and spreading of weeds | Keep out exotic species | Spraying, vehicle inspections | As and when mining occurs, and before seeding | CALM, Land Care, Agricultural Dept of WA | Inspection reports |
| 3. Revegetate with seeds from local vegetation | Restore a varied flora to the mined area | Seed collection, soil stockpiling & return and germination or propagation | Continuous with mining, but seeding at beginning of wet season | CALM, Land Care, Kings Park Board | Inspection reports |
| 4. Minimise the potential for saline ground water to interfere with rehabilitation | Successful long term revegetation of local flora | Upwards sloping base level to mine panels away from the edge of Red Lake | ongoing | DME, CALM | Inspection reports |
| 5. Rehabilitate landform to an aesthetically acceptable result | Avoid unsightly shapes, namely hollows or hillocks of remnant dunes | Smoothing and survey control | ongoing | DME, CALM | Inspection reports |
| 6. Limit vehicle and stock movement across Nature Reserve to defined access track | Avoid damage to Reserve and spread of weeds | Fence access track, and place grid at private farm land access point | Before mining starts | CALM | Inspection reports |
| 7. Rehabilitate access track | Restore the Nature Reserve | Remove gravel roadway | After Project | CALM | Inspection reports |
| 8. Prevent contamination by hydrocarbons | Avoid pollution of land or ground water | No vehicle servicing or fuelling in tenements, only on private land | ongoing | DME | report any non-compliance and accidental loss |
| 9. Put aside 10 cents per tonne of mined gypsum | Fund rehabiliation works | | ongoing with annual review | | |

## *PUBLIC CONSULTATION*

Public consultation on the Proposal has taken place with the following Government departments:

- Environmental Protection (DEP);
- Minerals & Energy (DME);
- Conservation & Land Management (CALM);
- Aboriginal Affairs (see Appendix 3);
- Agriculture WA (see Appendix 2).

In addition the following parties and individuals have been informed or consulted as appropriate.

- Shire of Nungarin.
- The four existing Native Title claimants (Gubrun People, Ballardong People, Garlett and Phillips); mining agreements have been executed with all except the Ballardong (see Appendix 4).
- Mr Les Last of Merredin Land Care District Committee.
- R.P. & P.A. Caridi, landowners of the private land adjacent to the Reserve and the Tenements, whose property is traversed by the access road and includes the stockpile area.
- Numerous farmers owning land in the district who wish to take supplies of gypsum for agricultural use (see Table 5).
- The Hon Kim Chance, M.L.C., Member for the Agricultural Region.
- WA Farmers Federation, Mr K McMenemy.
- Mattiske Consulting Pty Ltd.
- Ecologia Environmental Consultants (retained by DME).

Site visits have been conducted with representatives of DEP, CALM, and DME during winter 1997, and on previous occasions in the case of DME (Cf Freeman, 1994) and CALM (eg March 1997). Consultations with the Native Title claimants held this year have involved attendances at two meetings of the Ballardong People and the Noongar Land Council at Northam, with representatives of the Gubrun at Kalgoorlie, with NA Phillips and GL Garlett in Perth, and with Aboriginal representatives in Merredin. All interested parties have been provided with written details of the Project.

**Table 5: Gypsum Orders received from farmers in Merredin district**

| Farmer | Tonnes Gypsum required | Area |
|---|---|---|
| B McGellin | 800 | Belka |
| F Alvaro | 500 | Chandler |
| T Alvaro | 500 | Chandler |
| P Richards | 50 | Merredin |
| N Adamson | 50 | Merredin |
| M Jarvis | 100 | Merredin |
| J Shadbolt | 500 | Mukinbudin |
| S Crees | 250 | Merredin |
| B Rutter | 200 | Merredin |
| S Lambert | 200 | South Burracoppin |
| J Lambert | 250 | North Burracoppin |
| P Walstein | 1500 | Bodallin |
| J Flockhart | 500 | Belka |
| B Read | 200 | Merredin |
| D Geir | 400 | Chandler |
| R Caridi | 250 | Chandler |
| R English | 250 | Chandler |
| B Smith | 200 | Nukarni |
| P Capito | 500 | Bodallin |
| I McGellin | 500 | Belka |
| I Edgecomb | 250 | South Burracoppin |
| B Junk | 250 | North Burracoppin |
| L Caughey | 250 | Nokanning |
| AMUS Spreading (as agent) | 9000 | various |
| K Orchard | 2000 | Merredin |
| TOTAL | 19450 | |

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Mattiske Consulting Pty Ltd., & M.J.&A.R.Bamford, 1997 Flora, vegetation and vertebrate fauna survey of Lease M77/528 and Miscellaneous Licence L77/172, stockpile area and access road at Red Lake, Chandler. Unpublished report AUR001/040/97 for Aurex Pty Ltd, Perth.

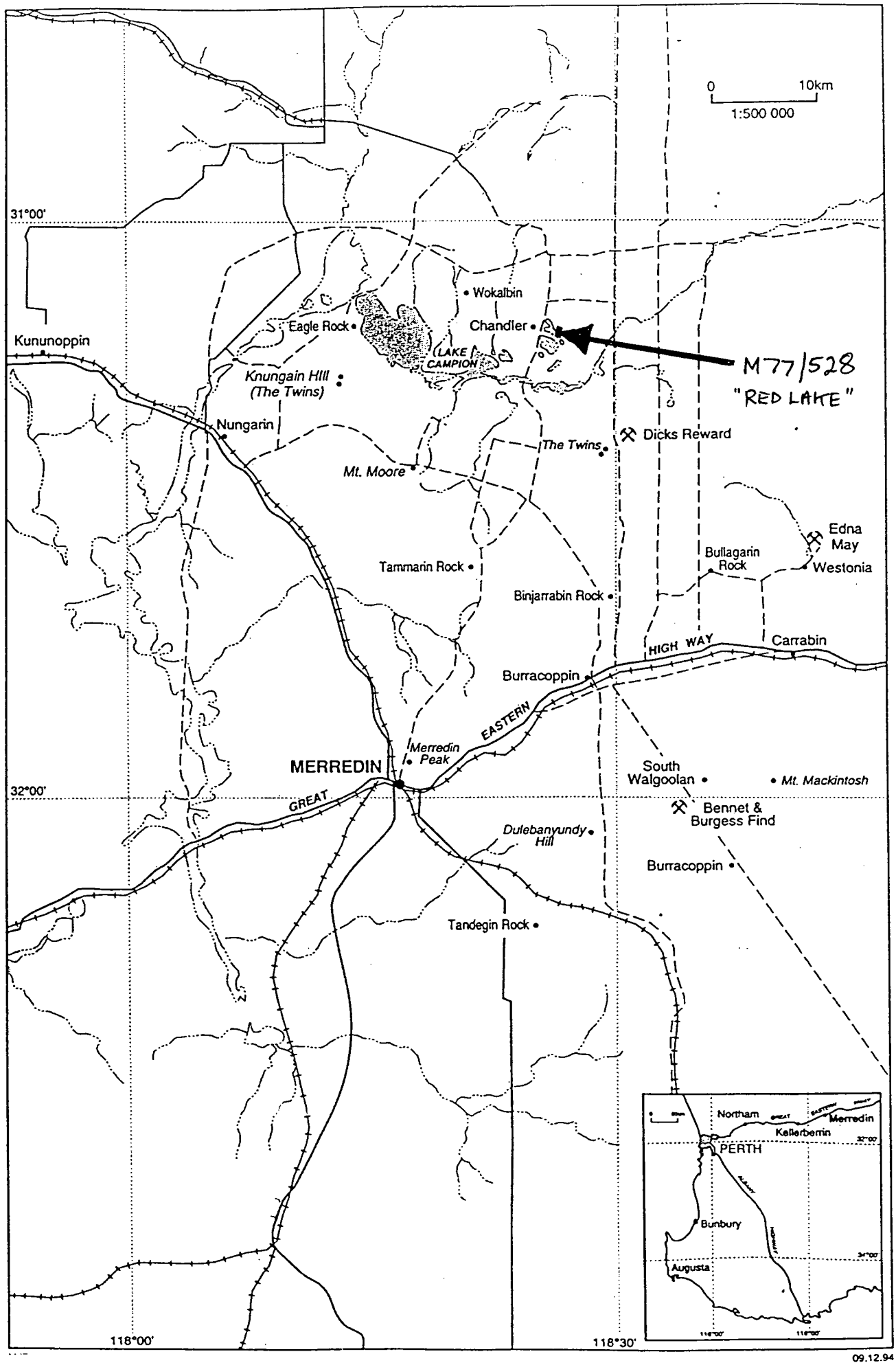



Fig 1a Locality Plan (adapted from Freeman, 1994)

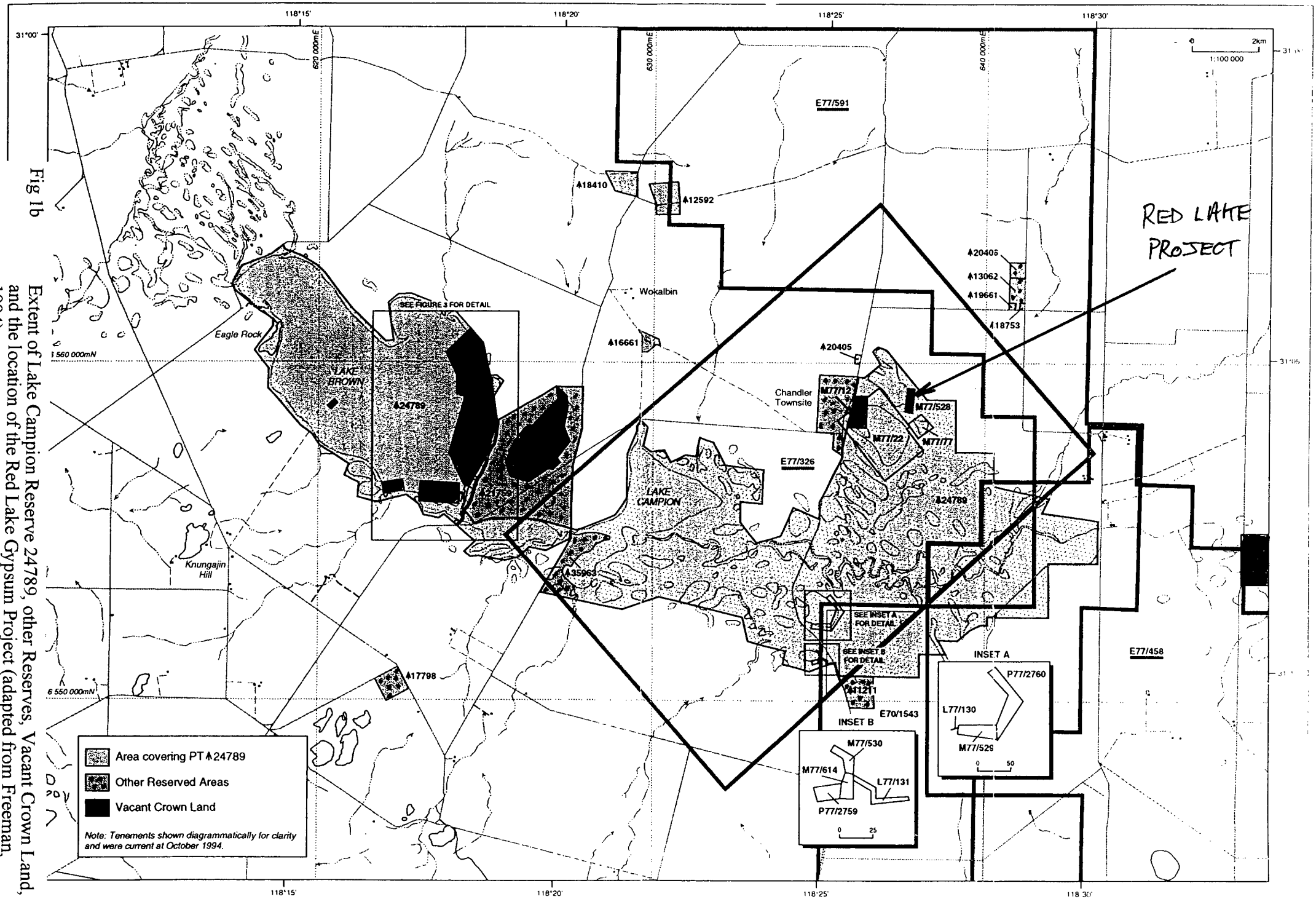



Fig 1b

Extent of Lake Campion Reserve 24789, other Reserves, Vacant Crown Land, and the location of the Red Lake Gypsum Project (adapted from Freeman, 1994)

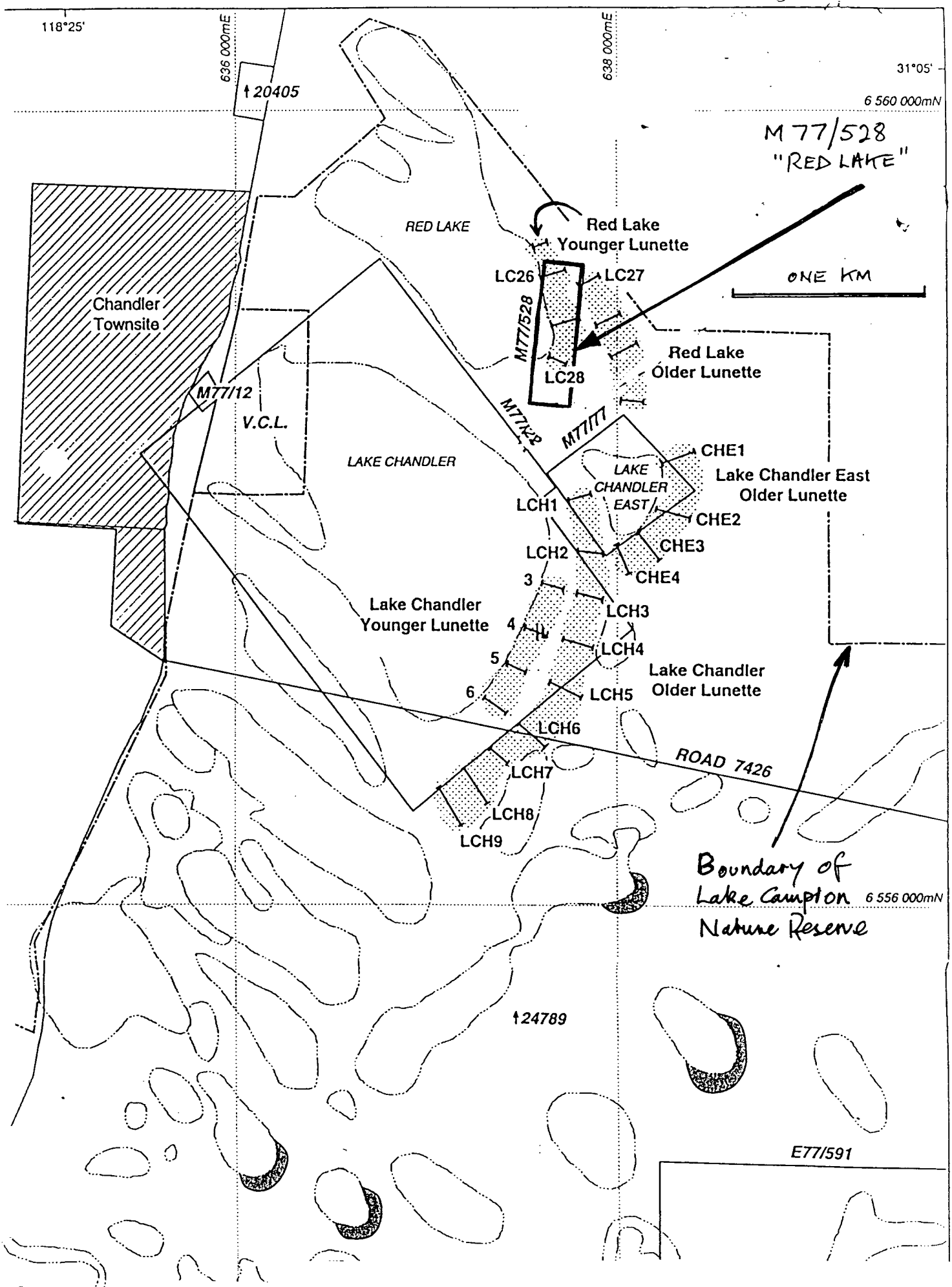
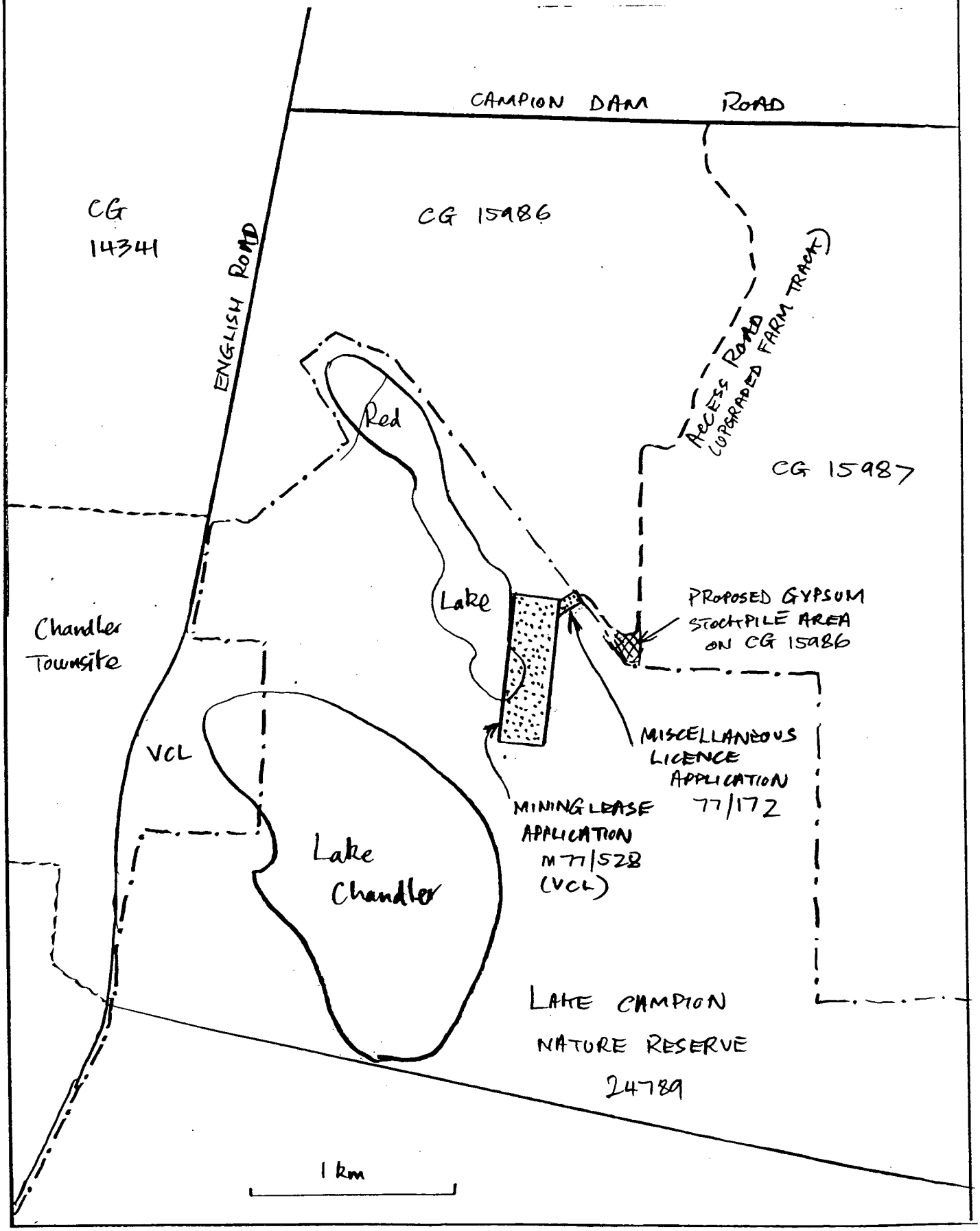



Fig 2 Chandler area showing salt lakes (playas), lunettes (gypsum dunes), DME survey traverses, and position of M77/528 (adapted from Freeman, 1994).

Fig 3 Mining Lease and Miscellaneous Licence Applications and access route across private land and Nature Reserve 24789



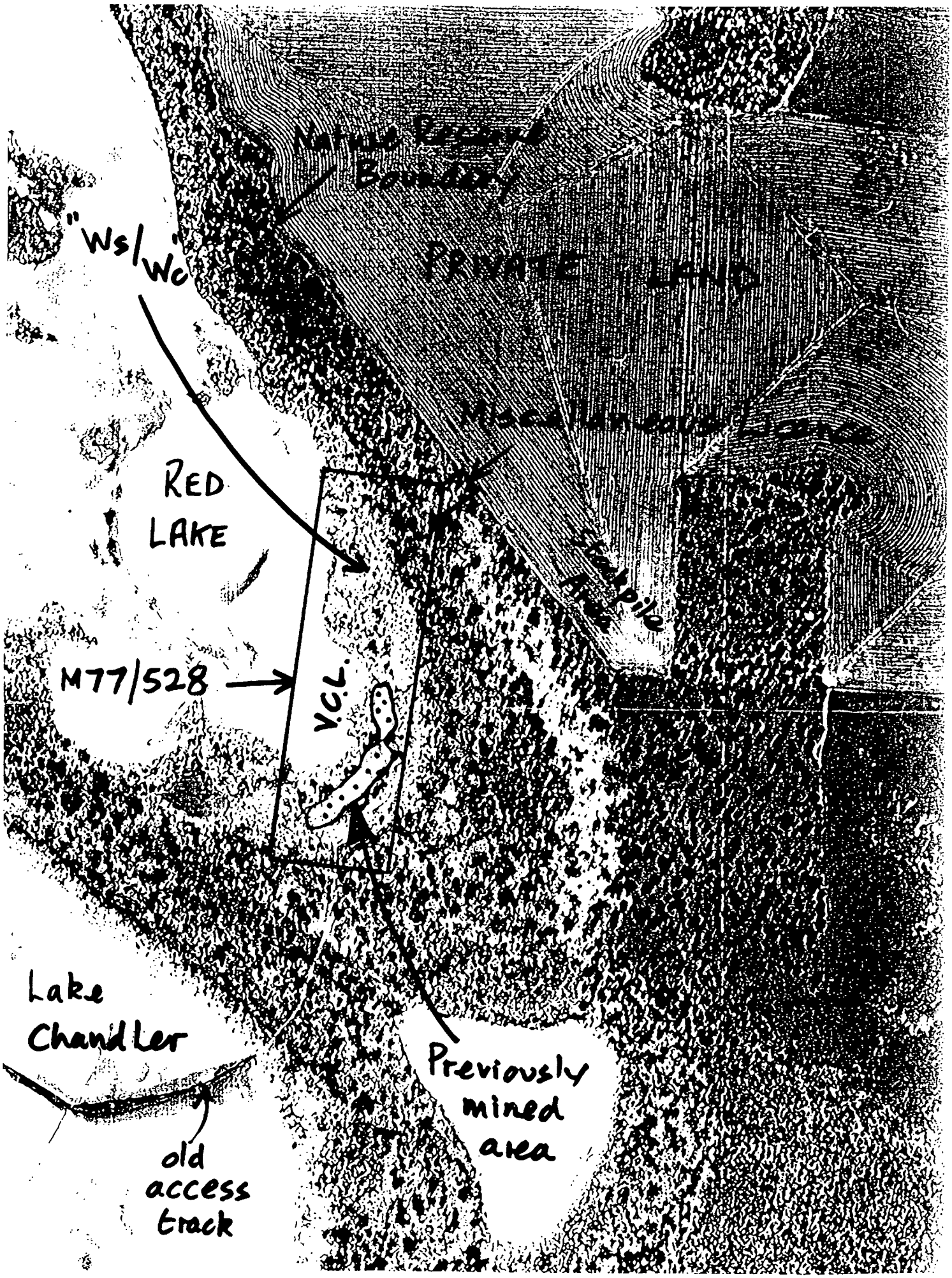



Fig 4 Aerial photograph showing land units, vegetation and previously mined area of M77/528.

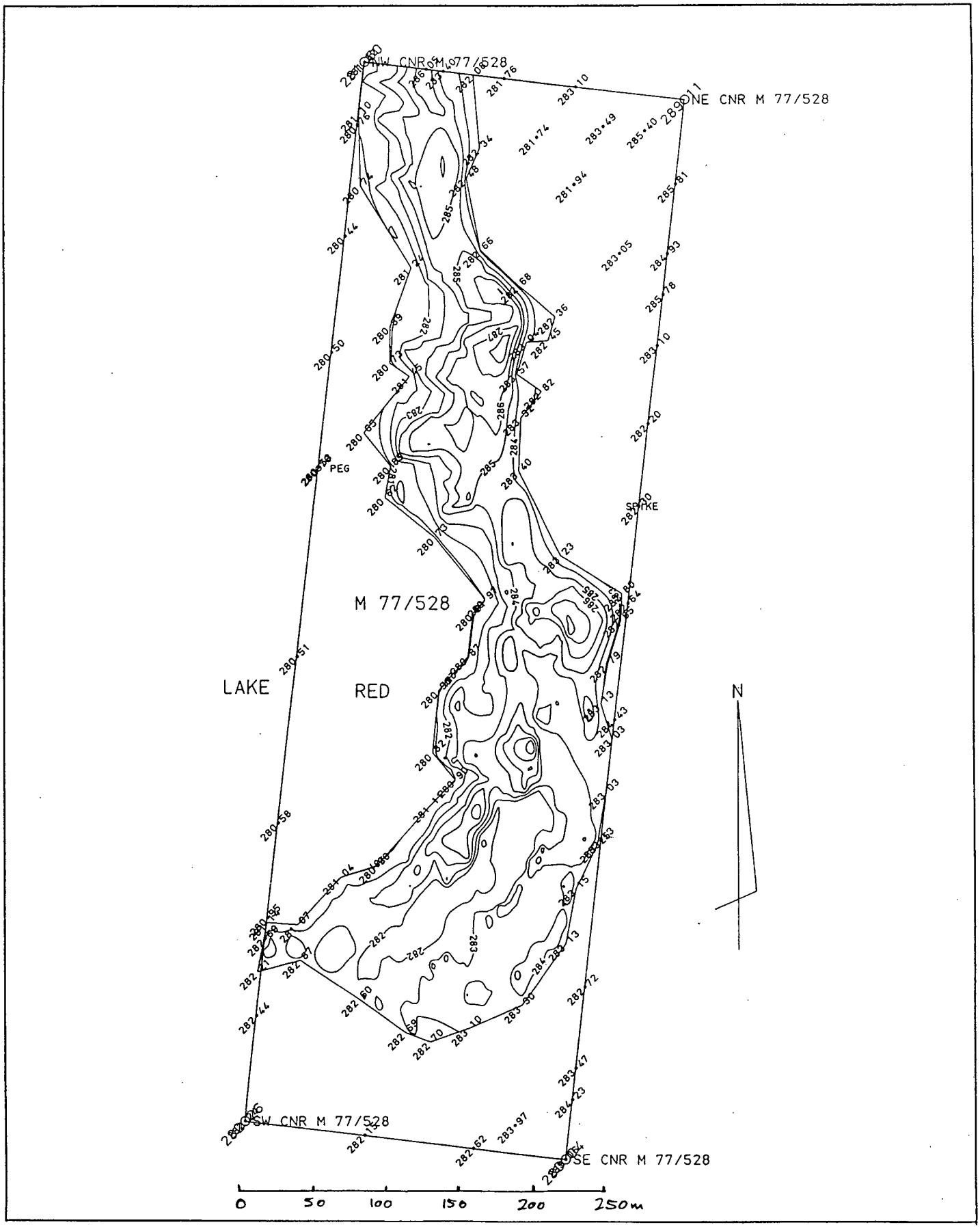



Fig 5 Topographic survey of Mining Lease 77/528 by Scanlan Surveys

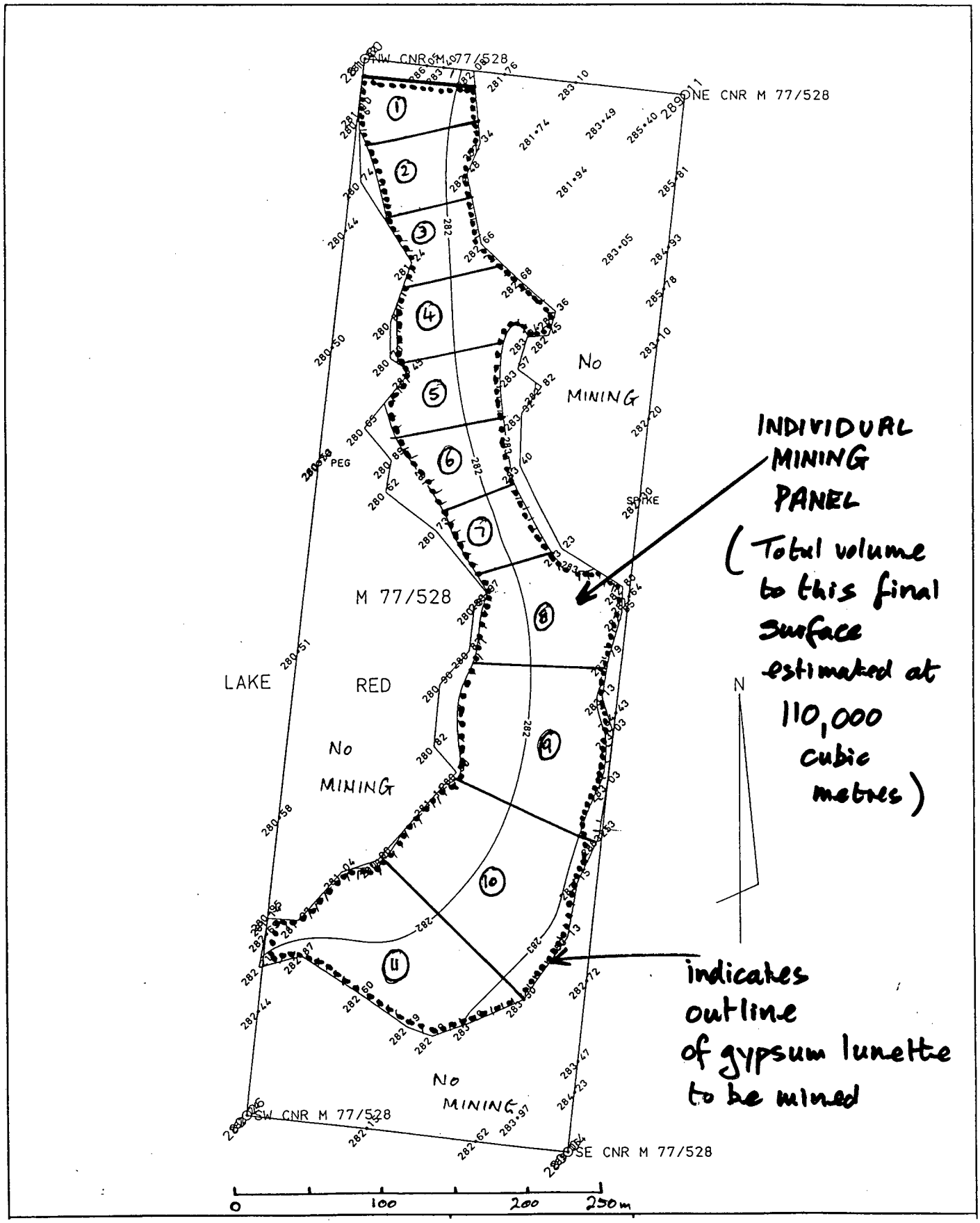



Fig 6 Proposed block mining plan for M77/528 superimposed on the expected base of mining surface from DTM calculations by Scanlan Surveys.

## *APPENDICES*

**APPENDIX 1. Mattiske Consulting Pty Ltd., & M.J.&A.R.Bamford, 1997. Flora, vegetation and vertebrate fauna survey of Lease M77/528 and Miscellaneous Licence L77/172, stockpile area and access road at Red Lake, Chandler. Unpublished report AUR001/040/97 for Aurex Pty Ltd, Perth.**

# FLORA, VEGETATION AND VERTEBRATE FAUNA SURVEY

# OF

# LEASE M77/528 AND MISCELLANEOUS LICENCE L77/172,

# STOCKPILE AREA AND ACCESS ROAD

# AT RED LAKE, CHANDLER

**Prepared for :** Aurex Pty Ltd

**Prepared by :** Mattiske Consulting Pty Ltd &
M.J. & A.R. Bamford

**AUR001/040/97**

**October 1997**

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**(repaginated)**

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### APPENDICES



### MAP

# SUMMARY

The survey area covered Lease M77/528, Miscellaneous Licence ML77/172, the proposed stockpile area and the access road on Vacant Crown Land near and adjacent to Red Lake. Red Lake is a bare salt lake, devoid of vegetation, except for fringing the shore where there are narrow *Halosarcia* flats. Behind, gypsiferous dunes and silt have accumulated, the dunes being less than 10m in height. The survey area is surrounded by a Nature Reserve which in turn is surrounded by extensively cleared agricultural areas where the loss of biodiversity has been high. In the survey area, four vegetation associations were recorded during the field work. *Eucalyptus salicola* was only recorded from the gypsum dunes in the lease area and on similar dunes within the adjacent Nature Reserve and *Eucalyptus melanoxylon* from the red sand rises behind the dunes. The samphire association fringing the lake was a monoculture of *Halosarcia lylei*. No Rare or Priority species were located within the survey area. A list of recorded and expected vertebrate species were prepared. As a result of this compilation of data, the survey area may support 7 amphibian species, 54 reptile species, 130 bird species and 29 mammal species. Of these, 1 reptile and 10 mammal species are probably locally extinct.

Regrowth in the area which had previously been mined was recorded. Several shrubs of the *Leptospermum roei*, a few of *Persoonia saundersiana* and a few young trees of *Callitris glaucophylla* were recorded on the rehabilitation areas. Where the dunes had been mined at depth *Halosarcia lylei* had grown and on the eastern edge where there was an overlap with the species from Association 1.1 and 2.1, some of these species had regrown in the disturbed area. The objectives of rehabilitation on previously mined areas needs addressing with government agencies to enable the definition of minimum standards of rehabilitation techniques and seeding regimes.

Weeds were abundant along the track into the proposed lease and along tracks within the lease area. Similarly weeds were common on the previously mined area of the gypsum dune, Association 1.2. If permission is granted to mine the gypsum dunes, procedures should be in place to ensure movement of weeds is limited.

If mining proceeds, seeds should be collected from all species within the lease area. This will ensure there are sufficient seeds to use to rehabilitate the area. However account must be taken of the altered environment. For example if the gypsum dunes are mined the resulting soil will be closer to that of Association 2.1 so species which occur in that environment are the ones which should be cultivated. Before any preparation of the area occurs prior to rehabilitation it will be essential to spray the area for weeds. After the weeds have been killed the ground should be ripped and furrowed and the seed scattered. The seed should be scattered at the break of season. Some pre-treatment techniques for the different seed species were suggested which would increase the germination rate considerably. With some more difficult species it

may be necessary to propagate seedlings from cuttings and to plant these into the rehabilitation area.

# FLORA AND VEGETATION

## A1. INTRODUCTION

Aurex Pty Ltd commissioned Mattiske Consulting Pty Ltd to undertake a flora, vegetation and vertebrate fauna survey of lease M77/528, ML77/172, the proposed stockpile area and the access road on vacant crown land at Red Lake, Chandler in the Shire of Nungarin where it is proposed to mine gypsum from the dunes surrounding Red Lake. Chandler townsite was built to accommodate workers at the alunite works in the area, which ceased operations in December 1949. In the early 1950's plaster was produced at the works. This section of the report summarises the flora and vegetation component of the project.

A detailed botanical survey and search for Rare and Priority species was required for lease M77/528, on the Miscellaneous Licence ML77/172, on the proposed stockpile area and the access road. The size of the lease is approximately 715.5m long and 220.36m wide along the eastern edge of Red Lake. Access to the lease and the survey area was via a farmer's property.

The lease is on the boundary of the Moorine Rock System and Muntadgin System of the Avon Botanical District (Beard, 1980). The salt country of the Moorine Rock System includes Lake Campion. The bare salt lakes are bordered by a belt of samphire, then by a belt of shrubland and finally by a belt of woodland. On the dunes between the salt flats *Templetonia* or *Acacia* shrublands are developed.

Coates (1990) undertook a vegetation survey of Lake Campion Nature Reserve. The area known as Lake Campion is a naturally affected saline area including and irregular drainage line and numerous small salt lakes where water accumulates in the wet season. The western half of this reserve included Lake Brown which is a bare lake with a narrow band of bushland around the edge. Large sections of the eastern and southern edges of Lake Brown has been mined for gypsum and alunite.

## A2. OBJECTIVES

The objectives of this project were to:

- survey the flora and vegetation on lease M77/528, ML77/172, the proposed stockpile area and the access road on vacant crown land near and adjacent to Red Lake;

- locate any Rare or Priority species on the survey area; and
- make suggestions on the rehabilitation potential of the area after mining.

## A3. METHODS

The survey of flora and vegetation was undertaken by two botanists from Mattiske Consulting Pty Ltd on 23 September 1997. The lease was traversed on foot. There were no access tracks, although several tracks were encountered through the lease. It was along these tracks and the proposed access track that most of the weeds were recorded.

All plant specimens which were collected during the field survey were dried and identified by keying out and comparison with the named specimens held at the Western Australian Herbarium. Where appropriate, plant taxonomists with specialists skills were consulted. Nomenclature follows Green (1985) and updates from the Census database from the Western Australian Herbarium.

## A4. RESULTS

The lease area consisted of the shore line vegetation, the gypsum dunes and the red loamy clay hills. The soil typically was a loamy clay with large quantities of gypsum obvious in the dunes.

### A4.1 Flora

A total of 33 families, 67 genera and 91 species were recorded on the survey area. No rare or priority species were located. The dominant families were:

| | |
|---|---|
| Asteraceae - | 14 species |
| Poaceae - | 9 species |
| Myrtaceae - | 8 species |
| Proteaceae - | 7 species |

There were a total of 8 weed species recorded, but most of these were in the area previously mined and along tracks through the lease.

The vegetation was very open with the plants occurring in groups with a large amount of bare ground between. It would appear that the area could have undergone disturbance previously. Although it was during the spring period that the area was

surveyed the number of annual species recorded was relatively low and additional species may be recorded at a different time of year.

## A4.2 Vegetation

The vegetation association descriptions are based on Muir (1977) which was specifically designed for describing the wheatbelt vegetation.

### Open Woodlands

#### Association 1.1

Very Open Woodland of *Eucalyptus melanoxylon* occurring on loamy soil on the northern margin of the proposed lease. This association occurred on the proposed access route.

Stratum 1: Very Open Woodland of *Eucalyptus melanoxylon* with scattered *Pittosporum phylliraeoides* var. *microcarpa*. Height to 1400cm.

Stratum 2: Open Low Woodland of *Alyxia buxifolia, Eremophila caperata, Eremophila ionantha, Grevillea apiciloba, Dodonaea viscosa* ssp. *angustissima*. Height to 200cm.

Stratum 3: Shrubland of *Enchylaena tomentosa, Atriplex stipitata, Podolepis capillipes, Asteridea asteroides*. Height to 50cm.

Comments: This association occurred on part of the proposed access route to the lease, although it became more dominant within the lease area. In the lease area there were several weeds along the tracks including *Medicago minima, Lolium* sp., *Raphanus raphanistrum*.

#### Association 1.2

Open *Eucalyptus salicola* Woodland occurring on the gypsum dunes surrounding the eastern edge of Red Lake.

Stratum 1: Low Woodland of *Eucalyptus salicola* and *Callitris glaucophylla*. Height to 1400cm.

Stratum 2: Open to occasionally Dense Shrubland of *Melaleuca halmaturorum* ssp. *cymbifolia, Melaleuca lanceolata* and *Hakea scoparia*. Height to 600cm.

Stratum 3: Open to Dense Low Shrubland of *Leptospermum roei* and Bossiaea *walkeri* with scattered shrubs of *Grevillea huegelii, Hakea preissii, Alyxia buxifolia, Santalum acuminatum, Exocarpos aphyllus* and *Acacia prainii*. Height to 150cm.

Stratum 4: Low Open Shrubland of *Darwinia drummondii, Conostephium preissii, Daviesia benthamii* ssp. *acanthoclona; Grevillea acuaria; Kippistia suaedifolia, Leucopogon* affin. *strongylophyllus* and several annual species including *Podotheca angustifolia; Senecio glossanthus, Podolepis capillipes*. Height less than 50cm.

Comments: This association was located on the gypsum dunes which consists of quartzose and gypsiferous soils. Coates (1990) noted this association, *Eucalyptus salicola* (Salt Gum) Woodland - type 2(Ws) was only found on the eastern and south-eastern shores of some large salt lakes. Where the dunes formed only low mounds on the ridges, *Eucalyptus salicola*, formed a very sparse stratum or was present only as scattered trees.

**Shrublands**

**Association 2.1**

Tall, Dense to Open Shrubland of *Melaleuca uncinata*.

Stratum 1: Open Shrubland of *Melaleuca uncinata* with scattered *Callitris glaucophylla; Eucalyptus salicola* and *Melaleuca lanceolata* and away from the gypsum dunes *Eucalyptus melanoxylon*. Occasional dense stands of *Melaleuca uncinata* occurred. Height to 400cm.

Stratum 2: Open Scrubland of *Bossiaea walkeri, Alyxia buxifolia; Grevillea acuaria; Acacia merralli, Westringia rigida; Eremophila scoparia*. Height to 200cm.

Stratum 3: Herbland of annual and perennial species of *Asteridea asteroides, Isoetopsis graminifolia, Notodanthonia caespitosa; Aristida contorta*.

Comments: This association occurred behind the gypsum dunes and before the final rise to the red loamy level of the surrounding countryside.

**Association 2.2**

Open Shrubland of *Halosarcia* sp.

Stratum 1: Open Shrubland of *Halosarcia lylei*. Height to 60cm but the majority of plants less than 20cm.

Comments: This species formed a monoculture surrounding the eastern edge of Red Lake.

### A4.3 Affect of Mining on Vegetation

An area of M77/528 had previously been mined. The dune in this area had been cut away with mining and in some areas *Halosarcia lylie* was dominant (Appendix C). This species only occurred naturally along the edge of the lake but with the removal of the gypsum hill it had been able to penetrate into an area where it did not naturally occur.

Several species which appeared to be characteristic to the gypsum dunes, in particular, *Eucalyptus salicola, Darwinia drummondii, Astroloma epacridis* had not regrown. *Eucalyptus salicola* typically occurred on the dunes where there was sufficient depth of soil and *Darwinia drummondii* and *Astroloma epacridis* grew on the lake side of the dune. Once these environments were modified with the mining process these species were no longer recorded on the remaining soils.

Most of the other species recorded for the gypsum dune area, in Vegetation Association 1.2, were able to adapt to the lack of soil and grew successfully in the heavier, loamy soil.

During the current survey many weed plants were common in the disturbed areas. These included *Vulpia myuros* ssp. *myuros, Raphanus raphanistrum, Hordeum vulgare, Medicago minima* and several salt plants including *Rhagodia drummondii, Enchylaenatomentosa* and *Atriplex stipitata*. *Zygophyllum* affin. *aurantiacum* was also very common here and not in the undisturbed area.

It would appear that if the gypsum dune area is sufficiently disturbed the structure of Vegetation Association 1.2 will be removed. It would appear from the past mining that *Halosarcia lylei* will be able to penetrate further inland into the area where disturbed and into the area behind the dune. Association 2.2 could spread over a much larger area than it does naturally.

### A4.4 Access Area to the Proposed Mine

Access to the proposed lease is via Association 1.1 and Association 2.1 before the gypsum dune is encountered. The access is already devoid of much vegetation and has several weeds common along the edge and to both sides of the track. If mining of the gypsum dune is permitted, very little additional disturbance will occur along the access

track. However care must be taken to ensure that the disturbance be kept to a minimum and that no additional weeds are introduced into the area.

Association 1.1 also continued to both sides of Red Lake, so was well represented off the proposed lease. Very little of this association was recorded on the lease area.

Once in the lease area there are several tracks. The tracks should be kept to a minimum to ensure there is minimal damage to the surrounding vegetation, and to ensure that those vegetation associations which are not to be mined are retained in an as intact condition as possible.

### A4.5 Weeds

If access continues through the farmer's property care will need to be taken to ensure that weeds along this access are not introduced into the wider area and in particular the surrounding Nature Reserve. In particular a *Cucumis* sp. (Melon) occurred in patches along the track and this could have an effect on the vegetation if it entered into the lease.

The weeds which are currently on the lease, particularly those along the tracks should be controlled as soon as possible. One problem is that by adjoining the farmers paddock, weeds will continue to penetrate where the area is opened up. The adjoining farmer's paddock was at the time of the survey under crop but there were many *Lolium* sp. plants along the edge of the field and in the crop. Another common weed of crops is *Raphanus raphanistrum*, Wild Turnip, which explosively ejects its seeds.

### A4.6 Rehabilitation After Mining

Seeds of all species should be collected during the mining phase and sown as each phase of the mining process is completed. If a large quantity of the gypsum dune is removed during mining, species which occur in vegetation associations 1.1 and 1.2 should be collected and sown. If sections of the gypsum dune are allowed to remain, it is important that sufficient depth be retained for the successful propagation of *Eucalyptus salicola*. During the mining process, consideration should be given to retaining a section(s) of the gypsum dune to ensure that representative species, such as *Eucalyptus salicola* are retained in this area of Red Lake. Although a few seedlings of Eucalypt have occurred after mining, as this genus tends to have deeper root systems, the longevity of any of these seedlings may be affected by water-logging and higher soil salinity levels.

All tracks used during the mining process should be rehabilitated when they are no longer required. This could involve killing all weed plants, ripping the soil and then sowing the collected seeds. Seed should be sown with the commencement of the winter rain to ensure they have every opportunity to germinate and survive. Monitoring of

the rehabilitation should occur to determine which species grow successfully and which show little or no germination in this situation. If some species do not germinate consideration should be given to propagating some plants from cuttings and planting these out as seedlings.

Some native species seed require special treatment before germination. All wattle and pea seed should be scarified prior to sowing as this allows water to penetrate the seed coat. Kings Park and Botanic Garden have had success with germinating some of the more difficult seed by treating them with smoke. Research has shown that 77 species out of a total of 200 tested have shown a positive germination response to smoke treatment (Ecoplan News 22 (1997)).

The methods of smoke treatment include:

> Smoke water. This is made by bubbling smoke from fresh plant material through water. In the filed smoke water can be applied to the soil surface at about 1 litre per square metre to stimulate the soil seed bank.
>
> Apply smoke to the seeds for about 1 hour. This is achieved by having a fire in an enclosed container and placing the exposed seed away from the fire so they do not get burnt.
>
> Smoke can be applied to punnets with sown seed for one hour in a smoke filled tent. An old camping tent can be used.

## A5. DISCUSSION

Four plant associations were represented on the survey area. These varied from the *Halosarcia lylei* monoculture on the edge of Red Lake, through *Eucalyptus salicola* woodland of the gypsum dunes which surround the lake, to the *Melaleuca uncinata* shrubland behind the dunes and finally to the *Eucalyptus melanoxylon* woodland. No Rare or Priority plants were located on the survey area.

Association 1.2, which occurred on the gypsum dunes is restricted to this soil type. Where the area had been mined and gypsum dunes reduced in depth only the occasional *Eucalyptus* seedling was growing. If permission is obtained to mine the lease for the gypsum deposits it would be advisable for consideration to be given to leave a section(s) of the dune in tact to preserve this association and or reduce the degree of extraction to allow some coverage of the halophytic areas with gypsiferous sands. In addition, *Darwinia drummondii* and *Astroloma epacridis* were not recorded from the previously mined gypsum dunes.

Where gypsum had been mined previously from the dunes, *Halosarcia lylei* had been able to grow and several weeds had been introduced. *Halosarcia lylei*, naturally, did not penetrate from the lake edge, indicating that conditions away from the edge have become ideal for this species to grow. The extent of the lake could be increased with *Halosarcia lylei* occupying a larger area with increasing salinity. Other vegetation associations recorded in the area are less tolerant of water-logging and soil salinity levels and therefore design of the post mining areas becomes critical. It may be necessary to undertake some root studies to assess the depth of roots on the gypsum dune systems. The latter could be undertaken with some small earthmoving equipment to assess the minimum depth of soil material required for the range of native species prior to mining. This type of work has been undertaken in other environments by botanists to assess the impact of changes to the potential occurrence of species.

The increase of weeds through the area could be a concern so all care should be taken to ensure the access tracks have weeds removed from the edges and that trucks etc remain on formed tracks. Within the lease area there are already several weeds present. Those which grow in the tracks should be removed by spraying with a total weedicide, taking care to ensure no native species are also growing there. A wand could possibly be used, especially along the track through the Miscellaneous Licence ML77/172, as the length of this track is not extensive. The access via the farmer's property will need to be closely monitored to ensure no weed species are spread from the property to the reserve and weeds in the reserve do not contaminate the farmer's paddocks.

The collection of seeds for use in rehabilitation should commence immediately mining starts. The seed should be stored in non plastic containers in a cool place (plastic bags, material bags etc.) for future use. As the mining in an area is completed that area should be rehabilitated immediately. Firstly weeds should be killed, the area ripped and furrowed and the seed mix appropriate to the area sown. Pre-treatment of seed should increase the percentage germination of the seeds.

## A6. LIST OF PARTICIPANTS

| | |
|---|---|
| Principal Ecologist: | Dr. E. Mattiske |
| Principal Botanist: | Dr. E. Bennett |
| Biologist: | Mr P. Ellery |

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# VERTEBRATE FAUNA

## B1. INTRODUCTION

M.J. and A.R.Bamford, Consulting Ecologists were commissioned by Mattiske Consulting Pty Ltd on behalf of Aurex Pty Ltd to assess the vertebrate fauna values on the Lease M77/528, Miscellaneous Licence 77/172, the proposed stockpile area and the access road.

## B2. OBJECTIVES

This assessment of vertebrate fauna values is based upon a brief site inspection and a review of published and unpublished information on fauna in the region of the site. The purposes of the assessment were to:

- produce a vertebrate fauna list, containing both species observed during the site inspection and species predicted to occur there on the basis of known patterns of distribution and habitats present on the site;
- identify species of conservation significance which might occur there;
- identify significant or sensitive habitats and locations on the site and;
- make basic management recommendations.

A site inspection cannot produce a definitive fauna list or detailed information about the abundance and status of fauna on a site, as these require intensive field work. Its purpose is to make an assessment based on readily observed fauna, the landscape and habitats present, and existing information on fauna in the region. The site inspection makes it possible to place general information on fauna into the perspective of locally available habitats.

## B3. METHODS

The site was inspected on the 22$^{nd}$ September 1997 by Dr Mike Bamford and Mr Robert Davies of M.J. and A.R.Bamford - Consulting Ecologists, at the request of Mattiske Consulting Pty Ltd. This inspection involved walking through the survey area and adjacent areas, including the north-eastern shore of Lake Chandler and the eastern shore of Red Lake. Observations were made on fauna, including recording

evidence such as tracks and searching under logs for cryptic species. Particular attention was focussed upon the gypsum dune proposed for mining. General notes were also made on the habitat types present within and adjacent to the survey area.

The main survey area encompassed a well-defined gypsum dune which was an abrupt landscape feature that supported distinctive but sparse vegetation consisting of scattered specimens of a native conifer and scattered, low shrubs. In contrast, the valley and gentle slopes to the north and east supported open tall eucalypt woodland with a mixed understorey of tall and low shrubs. Red Lake, immediately on the western edge of the proposed mining area, was shallow and saline with a narrow fringe of chenopod shrubland. The site inspection examined all these habitats.

Information on amphibians, reptiles and mammals that might occur (or might have occurred) at the site was obtained from W.A. Museum specimen records for the area bounded by latitudes $31^{o}$ and $32^{o}$ S, and longitudes $118^{o}$ and $119^{o}$ E. Bird records for the same area were extracted from Blakers *et al.* (1994) and additional information on birds was obtained from Saunders and Ingram (1995). Fauna records obtained from unpublished and published sources were vetted on the basis of personal experience and in the light of habitats found in the project area. Therefore, some species recorded by the W.A. Museum or by Blakers *et al.* (1984) were considered to be very unlikely to occur in the project area and were deleted from species lists. For example, waterbirds strictly dependent upon freshwater have been excluded from the bird list as, although they may fly over the area, it is very unlikely to be of importance to them. Some species not listed by the WA Museum were added on the basis of personal (unpublished) records from nearby areas.

Taxonomic orders and names used in this report generally follow Tyler *et al.* (1984) for amphibians, Storr *et al.* (1981, 1983, 1986 and 1990) for reptiles, Strahan (1983) for mammals and Christidis and Boles (1994) for birds. Where recent taxonomic revisions have occurred, earlier names are given in parenthesis. This is particularly the case with reptiles, where current WA Museum printouts contain many recent revisions. Species are considered to be of conservation significance if they are listed under the WA Wildlife Protection Act, in Cogger *et al.* (1993) or in Garnett (1992).

## B4. RESULTS AND DISCUSSION

Lists of vertebrate fauna recorded or expected in the area are given in Appendices D, E and F. The area may support 7 amphibian species, 54 reptile species, 130 bird species and 29 mammal species. Of these, 1 reptile and 10 mammal species are probably locally extinct.

## B4.1 Amphibians and Reptiles

All seven of the frog species that may occur in the survey area depend upon fresh water wetlands for breeding, but they can disperse widely outside the breeding season. Therefore, although there appeared to be no suitable breeding sites within the survey area, the frogs may be present if there is any seasonal fresh water within several kilometres. All the frog species listed are widespread in the wheatbelt, although populations have declined because of clearing and increased salinity in wetlands.

Specimen records from the WA Museum list 54 reptile species for the general region of the survey area, but this list does not include two of the three species found during the site inspection. Both these species (*Ctenophorus salinarum* and the Bobtail) are widespread in the wheatbelt and their absence from the museum list indicates incomplete sampling. Two species listed by the museum are not included in Appendix D as they have specific habitat requirements not present within the survey area or nearby.

In general terms, most reptiles favour habitats that provide shelter, such as leaf-litter, fallen logs, trees with loose bark, rocks and even rubbish such as sheets of corrugated iron. The gypsum dune of the proposed mining area appears to provide little such shelter and therefore may support lower population densities of reptiles than the adjacent woodland to the south, east and north. *Ctenophorus salinarum* is associated with chenopod shrublands around salt lakes (Storr *et al.* 1983) and may therefore be confined to the shrublands on the margins of Red and Chandler Lakes. Specific habitat requirements are not well understood for most species but some, such as the Mountain Devil and the Spiny-tailed Gecko, occur most often in shrublands on sandy soils so may be absent from the immediate vicinity of the survey area.

Three reptile species of conservation significance may occur, or may have occurred, in the survey area. These are the Woma or Ramsay's Python, the Carpet Python (South-Western race, s.sp. *imbricata*) and the Reticulated Velvet Gecko. The Woma has suffered a massive population decline in southern Western Australia (Smith 1981) and is probably extinct in the vicinity of the survey area. It is classed as endangered by Cogger *et al.* (1993) and is listed under Schedule 4 (Other Specially Protected Fauna) of the Wildlife Conservation Act. The South-Western race of the Carpet Python is also listed under Schedule 4 of the Wildlife Conservation Act, but is only classed as vulnerable by Cogger *et al.* (1993). It may survive in the survey area where adequate shelter is available. Sightings of either of these two pythons should be reported to the Department of Conservation and Land Management.

The Reticulated Velvet Gecko is listed as rare or insufficiently known by Cogger *et al.* (1993) but is not included in CALM's threatened or priority lists. It is closely associated with smooth-barked eucalypts such as Inland Wandoo *Eucalyptus capillosa*,

Salmon Gum *Eucalyptus salmonophloia* and Gimlet *Eucalyptus salubris*. Like virtually all other reptile species in the wheatbelt, it has declined due to clearing for agriculture. There is little information on the persistence of reptiles in fragmented habitats in the wheatbelt, but in urban areas reptile populations have been found to survive for many decades in small fragments of native vegetation (How and Dell 1990). Therefore, it is probable that the survey area retains almost all the reptile species that were present before development for agriculture occurred in the region.

## B4.2 Birds

During the site inspection, 29 species of birds were observed, while an additional 101 species could be expected to be recorded given sufficient time (Table 2). Many of these additional species may only be vagrants, but finding 29 species during a brief site inspection indicates that a rich bird fauna is present.

Of the 29 species observed, most were in the woodland to the east, south and north of the gypsum dune in the survey area, while the Black-shouldered Kite, Crested Pigeon and Rufous Songlark were recorded only on adjacent farmland. These three farmland species are among a small suite of species which have been advantaged by clearing for agriculture. The Emu (tracks only), White-backed Swallow, Tree Martin and White-fronted Honeyeater were the only bird species observed on the gypsum dune of the survey area. No waterbirds were present on either Red or Chandler Lake, but several waterbird species which occasionally or regularly use saline lakes in the wheatbelt have been included in Appendix E.

The bird fauna of the wheatbelt has declined dramatically as a result of clearing for agriculture and Appendix E indicates those species which have declined badly according to Saunders and Ingram (1995). These are species which not only have declined in proportion to the loss of habitat (only about 7% of the original vegetation remains in the wheatbelt and only half of this remnant vegetation is in reserves, (Bamford 1995)), but are continuing to decline in the native vegetation which remains because of habitat fragmentation and the isolation of small populations. Species which show this continuing decline have regional significance where-ever they occur, and such species expected in the survey area include: Emu, Malleefowl, Painted Button-quail, Bush Stone-curlew, Blue-breasted Fairy-wren, virtually all the Pardalotidae and Petroicidae, White-browed Babbler, Chestnut Quail-thrush, Varied Sittella and all the Pachycephalidae. Of this suite of species, only the Emu, two pardalotids (Weebill and Yellow-rumped Thornbill), the Jacky Winter and Red-capped Robin (Petroicidae), the Varied Sittella and three pachycephalids (Rufous Whistler, Grey Shrike-thrush and Crested Bellbird) were recorded. Some of the most sensitive of the regionally significant species, such as the Southern Scrub-robin and Blue-breasted Fairy-wren, may already have disappeared from the survey area, although they can also be hard to find during a brief site inspection. They may still be present in the main part of the

Nature Reserve, but absent from the small areas of woodland and shrubland around the proposed mining area.

Seven of the species of birds which may be present are of conservation significance (listed by Garnett 1992 and/or the Wildlife Conservation Act). None of these species was recorded during the site inspection. Three of these species are birds of prey (Square-tailed Kite, Peregrine Falcon and Grey Falcon) which range widely over large areas and are therefore unlikely to be affected by small developments unless traditional nest trees are lost. A fourth species, Major Mitchell's Cockatoo, is also wide-ranging but dependent upon nest-trees, while the Hooded Plover could occur seasonally (in winter) on Chandler and Red Lakes. The remaining two conservation significant species, the Malleefowl and Crested Shrike-tit, are sedentary and depend upon large tracts of undisturbed vegetation. They may still be present in the Nature Reserve and, if present, woodland in the survey area could be of importance to some individuals.

## B4.3 Mammals

Mammals are the most difficult group of fauna on which to collect information and are also the group to have suffered the greatest levels of extinction. Of the estimated 25 native species which may have been present in the general region of the Nature Reserve at the end of the nineteenth century, up to 10 species are now locally extinct. Three of these, the Pig-footed Bandicoot, Broad-faced Potoroo and Wurrung, are extinct as species. This massive rate of extinction has resulted from a combination of factors, including changes in fire regime, introduced predators and habitat loss due to clearing (Burbidge and McKenzie 1989).

The extant mammal fauna consists mainly of several introduced species and native species which are widespread. Only two species of conservation significancemay still be present: the Chuditch and the Red-tailed Phascogale (both Schedule 1 (likely to become extinct) under the Wildlife conservation Act). There are no recent records of either species in the general region, but both have been recorded in the past 10 years in the Southern Cross area. The possibility exists that one or both of these species could be present in the Lake Chandler area. The phascogale is associated with she-oak woodlands (Kitchener 1985) which were not present close to the survey area, while the Chuditch occurs in a wide range of habitats, particularly where hollow trees and logs are present for shelter.

## B5. DISCUSSION

The vertebrate fauna of the wheatbelt region has been badly affected by a number of factors, particularly clearing for agriculture, with the result that virtually any remnant of native vegetation is of conservation significance. Any proposal to disturb native vegetation in the region, particularly adjacent to land vested for conservation, needs to be assessed in this light.

The adjacent Nature Reserve probably supports an almost complete vertebrate assemblage with the exception of one reptile and about 10 mammal species. While no species of recognised conservation significance were observed during the site inspection, a number of such species are probably present. Furthermore, the majority of species present (with the exception of some bird species that favour farmland environments) are of regional significance because of the more than 90% loss of natural habitats in the wheatbelt region.

Within the survey area, wildlife favoured the woodland adjacent to the gypsum dune of the proposed mining area. The distribution of species observed during the site inspection seemed consistent with the differences in habitat; the vegetation on the gypsum dune providing little habitat or shelter compared with the woodland just to the east. Despite this, species as distinctive as the native conifer that occurred on the gypsum soils probably have specific invertebrate fauna associated with them and may be of seasonal importance for seed-eating birds. Other vegetation of the gypsum soils may also be of seasonal significance, such as providing flowers for nectarivorous birds. Given the small area involved, however, the importance of these plants for local fauna would be slight. Furthermore, the loss of the plants from the landscape could be temporary if adequate rehabilitation was carried out after mining.

The gypsum dune would appear to be of low value for fauna compared with adjacent areas, but it may contribute to the value of these adjacent areas. The dune is formed by the accumulation of material ablated from the lake bed and therefore the dune protects adjacent areas from the wind and from wind-borne particles, including salt. As the woodland between the dune and adjacent farmland exists as a narrow strip only, degradation may occur if mining of the dune removes this protection. The potential for this sort of impact should be considered in the environmental assessment as degradation of this woodland would affect local populations of many fauna species within the nature reserve. Any development within the area should therefore aim to minimise impacts on adjacent habitats and to rehabilitate the gypsum area to support the plant species currently present.

## B6. LIST OF PARTICIPANTS

| | |
|---|---|
| Principal Ecologist: | Dr. E. Mattiske |
| Principal Zoologist: | Dr. M. Bamford |
| Zoologist: | Mr. R. Davies |

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# APPENDIX A: VASCULAR PLANT SPECIES OF LEASE M77/528 AND MISCELLANEOUS LICENCE 77/172

| FAMILY | GENUS | SPECIES |
|---|---|---|
| CUPRESSACEAE | *Callitris* | *glaucophylla* |
| POACEAE | *Aristida* | *contorta* |
| | *Austrostipa* | *elegantissima* |
| | *Austrostipa* | *hemipogon* |
| | *Austrostipa* | *platychaeta* |
| | *Austrostipa* | *trichophylla* |
| | *Notodanthonia* | *caespitosa* |
| | * *Hordeum* | *vulgare* |
| | * *Lolium* | *sp.* |
| | * *Vulpia* | *myuros var. myuros* |
| CYPERACEAE | *Lepidosperma* | *resinosum* |
| DASYPOGONACEAE | *Lomandra* | *effusa* |
| ANTHERICACEAE | *Thysanotus* | *patersonii* |
| CASUARINACEAE | *Allocasuarina* | *acutivalvis* |
| | *Allocasuarina* | *corniculata* |
| PROTEACEAE | *Grevillea* | *acuaria* |
| | *Grevillea* | *apiciloba* |
| | *Grevillea* | *huegelii* |
| | *Grevillea* | *pectinata* |
| | *Hakea* | *preissii* |
| | *Hakea* | *scoparia* |
| | *Persoonia* | *saundersiana* |
| SANTALACEAE | *Exocarpos* | *aphyllus* |
| | *Santalum* | *acuminatum* |
| LORANTHACEAE | *Amyema* | *preissii* |
| CHENOPODIACEAE | *Atriplex* | *stipitata* |
| | *Enchylaena* | *tomentosa* |
| | *Halosarcia* | *lylei* |
| | *Rhagodia* | *drummondii* |
| AIZOACEAE | * *Mesembryanthemum* | *nodiflorum* |

# APPENDIX A: VASCULAR PLANT SPECIES OF LEASE M77/528 AND MISCELLANEOUS LICENCE 77/172

| FAMILY | GENUS | SPECIES |
|---|---|---|
| BRASSICACEAE | * *Raphanus* | *raphanistrum* |
| CRASSULACEAE | *Crassula* | *colorata* |
| PITTOSPORACEAE | *Billardiera* | *lehmanniana* |
| | *Pittosporum* | *phylliraeoides var. microcarpa* |
| MIMOSACEAE | *Acacia* | *asepala* |
| | *Acacia* | *colletioides* |
| | *Acacia* | *merrallii* |
| | *Acacia* | *prainii* |
| PAPILIONACEAE | *Bossiaea* | *walkeri* |
| | *Daviesia* | *benthamii ssp. acanthoclona* |
| | *Gastrolobium* | *spinosum* |
| | * *Medicago* | *minima* |
| ZYGOPHYLLACEAE | *Zygophyllum* | *affin. aurantiacum* |
| | *Zygophyllum* | *compressum* |
| RUTACEAE | *Microcybe* | *multiflora* |
| | *Phebalium* | *filifolium* |
| | *Phebalium* | *lepidotum* |
| | *Phebalium* | *megaphyllum* |
| POLYGALACEAE | *Comesperma* | *integerrimum* |
| | *Comesperma* | *volubile* |
| EUPHORBIACEAE | *Poranthera* | *microphylla* |
| SAPINDACEAE | *Dodonaea* | *viscosa ssp. angustissima* |
| MALVACEAE | *Lawrencia* | *densiflora* |
| FRANKENIACEAE | *Frankenia* | *?desertorum* |
| VIOLACEAE | *Hybanthus* | *floribundus ssp. floribundus* |
| MYRTACEAE | *Darwinia* | *drummondii (ms)* |
| | *Eucalyptus* | *melanoxylon* |
| | *Eucalyptus* | *salicola* |

# APPENDIX A: VASCULAR PLANT SPECIES OF LEASE M77/528 AND MISCELLANEOUS LICENCE 77/172

| FAMILY | GENUS | SPECIES |
|---|---|---|
| MYRTACEAE (Continued) | *Leptospermum* | *roei* |
| | *Melaleuca* | *halmaturorum ssp. cymbifolia* |
| | *Melaleuca* | *lanceolata* |
| | *Melaleuca* | *lateriflora ssp. lateriflora* |
| | *Melaleuca* | *uncinata* |
| APIACEAE | *Trachymene* | *cyanopetala* |
| EPACRIDACEAE | *Astroloma* | *epacridis* |
| | *Astroloma* | *serratifolium* |
| | *Conostephium* | *preissii* |
| | *Leucopogon* | *affin. strongylophyllus* |
| APOCYNACEAE | *Alyxia* | *buxifolia* |
| BORAGINACEAE | *Halgania* | *andromedifolia* |
| LAMIACEAE | *Westringia* | *cephalantha* |
| | *Westringia* | *rigida* |
| MYOPORACEAE | *Eremophila* | *caperata* |
| | *Eremophila* | *decipiens ssp. decipiens* |
| | *Eremophila* | *ionantha* |
| | *Eremophila* | *scoparia* |
| GOODENIACEAE | *Scaevola* | *spinescens* |
| ASTERACEAE | *Actinobole* | *uliginosum* |
| | *Angianthus* | *tomentosus* |
| | *Asteridea* | *asteroides* |
| | *Brachyscome* | *ciliaris* |
| | *Calotis* | *hispidula* |
| | * *Hypochaeris* | *glabra* |
| | *Isoetopsis* | *graminifolia* |
| | *Kippistia* | *suaedifolia* |
| | *Olearia* | *muelleri* |
| | *Podolepis* | *capillaris* |
| | *Podotheca* | *angustifolia* |
| | *Senecio* | *glossanthus* |
| | * *Sonchus* | *oleraceus* |
| | *Waitzia* | *acuminata* |

# APPENDIX B: DISTRIBUTION OF PLANT SPECIES IN THE DIFFERENT VEGETATION ASSOCIATIONS

| | Species | Association 1.1 | 1.2 | 2.1 | 2.2 |
|---|---|---|---|---|---|
| | *Acacia asepala* | | | + | |
| | *Acacia colletioides* | | + | | |
| | *Acacia merrallii* | | | + | |
| | *Acacia prainii* | + | + | + | |
| | *Actinobole uliginosum* | | | + | |
| | *Allocasuarina acutivalvis* | | + | | |
| | *Allocasuarina corniculata* | | + | | |
| | *Alyxia buxifolia* | | + | + | |
| | *Amyema preissii* | + | + | | |
| | *Angianthus tomentosus* | | | + | |
| | *Aristida contorta* | + | | + | |
| | *Asteridea asteroides* | + | | + | |
| | *Astroloma epacridis* | | + | | |
| | *Astroloma serratifolium* | | + | | |
| | *Atriplex stipitata* | + | + | | |
| | *Austrostipa elegantissima* | | + | | |
| | *Austrostipa hemipogon* | | + | | |
| | *Austrostipa platychaeta* | + | | + | |
| | *Austrostipa trichophylla* | + | | + | |
| * | *Avellinia michelii* | | | + | |
| | *Billardiera lehmanniana* | | + | | |
| | *Bossiaea walkeri* | | + | + | |
| | *Brachyscome ciliaris* | + | | + | |
| * | *Bromus rubens* | + | + | + | |
| | *Callitris glaucophylla* | | + | + | |
| | *Calotis hispidula* | | | + | |
| | *Comesperma integerrimum* | | + | + | |
| | *Comesperma volubile* | | + | | |
| | *Conostephium preissii* | | + | | |
| | *Crassula colorata* | + | | | |
| | *Darwinia drummondii (ms)* | | + | | |
| | *Daviesia benthamii ssp. acanthoclona* | | + | | |
| | *Dodonaea viscosa ssp. angustissima* | + | | + | |
| | *Enchylaena tomentosa* | + | + | + | |
| | *Eremophila caperata* | + | | + | |
| | *Eremophila decipiens ssp. decipiens* | | | + | |
| | *Eremophila ionantha* | + | | + | |
| | *Eremophila scoparia* | | | + | |
| | *Eucalyptus melanoxylon* | + | | + | |
| | *Eucalyptus salicola* | | + | + | |
| | *Exocarpos aphyllus* | | + | + | |
| | *Frankenia ?desertorum* | | + | | |

# APPENDIX B: DISTRIBUTION OF PLANT SPECIES IN THE DIFFERENT VEGETATION ASSOCIATIONS

| | Species | Association 1.1 | 1.2 | 2.1 | 2.2 |
|---|---|---|---|---|---|
| | *Gastrolobium spinosum* | + | + | | |
| | *Grevillea acuaria* | | + | + | |
| | *Grevillea apiciloba* | | + | | |
| | *Grevillea huegelii* | | + | | |
| | *Grevillea pectinata* | | + | | |
| | *Hakea preissii* | | + | | |
| | *Hakea scoparia* | | + | | |
| | *Halgania andromedifolia* | + | | + | |
| | *Halosarcia lylei* | | | + | + |
| * | *Hordeum vulgare* | | + | | |
| | *Hybanthus floribundus ssp. floribundus* | | + | + | |
| * | *Hypochaeris glabra* | + | | + | |
| | *Isoetopsis graminifolia* | | | + | |
| | *Kippistia suaedifolia* | + | + | + | |
| | *Lawrencia densiflora* | | + | | |
| | *Lepidosperma resinosum* | | + | | |
| | *Leptospermum roei* | | + | | |
| | *Leucopogon affin. strongylophyllus* | | + | | |
| * | *Lolium sp.* | + | | + | |
| | *Lomandra effusa* | | + | + | |
| * | *Medicago minima* | + | | + | |
| | *Melaleuca halmaturorum ssp. cymbifolia* | | + | | |
| | *Melaleuca lanceolata* | + | + | + | |
| | *Melaleuca lateriflora ssp. lateriflora* | | | + | |
| | *Melaleuca uncinata* | + | + | + | |
| * | *Mesembryanthemum nodiflorum* | | + | + | |
| | *Microcybe multiflora* | | + | | |
| | *Notodanthonia caespitosa* | + | | + | |
| | *Olearia muelleri* | + | + | | |
| | *Persoonia saundersiana* | | + | | |
| | *Phebalium filifolium* | + | | + | |
| | *Phebalium lepidotum* | | + | | |
| | *Phebalium megaphyllum* | | + | | |
| | *Pittosporum phylliraeoides var. microcarpa* | + | | | |
| | *Podolepis capillaris* | + | + | + | |
| | *Podotheca angustifolia* | + | + | + | |
| | *Poranthera microphylla* | | | + | |
| * | *Raphanus raphanistrum* | + | + | + | |
| | *Rhagodia drummondii* | + | + | + | |
| | *Santalum acuminatum* | | + | + | |
| | *Scaevola spinescens* | | + | | |
| | *Senecio glossanthus* | | + | | |

# APPENDIX B: DISTRIBUTION OF PLANT SPECIES IN THE DIFFERENT VEGETATION ASSOCIATIONS

| | Species | Association 1.1 | 1.2 | 2.1 | 2.2 |
|---|---|---|---|---|---|
| * | *Sonchus oleraceus* | + | | + | |
| | *Thysanotus patersonii* | | | + | |
| | *Trachymene cyanopetala* | | | + | |
| * | *Vulpia myuros var. myuros* | + | + | | |
| | *Waitzia acuminata* | | | + | |
| | *Westringia cephalantha* | + | + | + | |
| | *Westringia rigida* | | | + | |
| | *Zygophyllum affin. aurantiacum* | | + | | |
| | *Zygophyllum compressum* | | | + | |

APPENDIX C: PHOTOGRAPHIC RECORD OF THE VEGETATION ASSOCIATIONS OF LEASE M77/528 AND MISCELLANEOUS LICENCE 77/172

Photograph 1: Association 1.2. This was the association located on the gypsum dunes. The tree is *Eucalyptus salicola*.

Photograph 2: Association 2.2. Dense stand of *Melaleuca uncinata*. This association occurred in the lower area behind Association 1.2

APPENDIX C: PHOTOGRAPHIC RECORD OF THE VEGETATION ASSOCIATIONS OF LEASE M77/528 AND MISCELLANEOUS LICENCE 77/172

Photograph 3: Association 2.2. A low shrubland of *Halosarcia lylei*.

Photograph 4: The approach through Miscellaneous Licence 77/172 to the lease. The approach is nearly devoid of all vegetation.

## APPENDIX C: PHOTOGRAPHIC RECORD OF THE VEGETATION ASSOCIATIONS OF LEASE M77/528 AND MISCELLANEOUS LICENCE 77/172

Photograph 5: *Halosarcia lylei* growing where the gypsum dunes had been mined previously

**Appendix D: Amphibian and Reptile species of the general region of the survey area (see Methods)**

The comments column indicates species observed during the site inspection (+), species of conservation significance (C), and species which are probably locally extinct (EX).

| Species | | Comments |
|---|---|---|
| FROGS | | |
| **Myobatrachidae** (Leptodactylidae) (ground frogs) | | |
| Spotted Burrowing Frog | *Heleioporus albopunctatus* | |
| Pobblebonk | *Limnodynastes dorsalis* | |
| | *Neobatrachus kunapalari* | |
| | *Neobatrachus pelobatoides* | |
| | *Neobatrachus wilsmorei* | |
| Guenther's Toadlet | *Pseudophryne guentheri* | |
| Inland Toadlet | *Pseudophryne occidentalis* | |
| | | |
| REPTILES | | |
| **Gekkonidae** (geckoes) | | |
| Clawless Gecko | *Crenadactylus ocellatus* | |
| Wheatbelt Stone Gecko | *Diplodactylus granariensis* | |
| | *Diplodactylus mainii* | |
| Beautiful Gecko | *Diplodactylus pulcher* | |
| Spiny-tailed Gecko | *Diplodactylus spinigerus* | |
| Tree Dtella | *Gehyra variegata* | + |
| Bynoe's Gecko | *Heteronotia binoei* | |
| Reticulated Velvet Gecko | *Oedura reticulata* | C |
| Barking Gecko | *Underwoodisaurus milii* | |
| | | |
| **Pygopodidae** (legless lizards) | | |
| | *Delma australis* | |
| Fraser's Legless Lizard | *Delma fraseri* | |
| Burton's Legless Lizard | *Lialis burtonis* | |
| Common Scaleyfoot | *Pygopus lepidopodus* | |
| | | |
| **Agamidae** (dragon lizards) | | |
| Crested Dragon | *Ctenophorus cristatus* | |
| Spotted Dragon | *Ctenophorus maculatus* | |
| Western Netted Dragon | *Ctenophorus reticulatus* | |
| | *Ctenophorus salinarum* | + |
| Mountain Devil | *Moloch horridus* | |
| | *Ctenophorus scutulatus* | |
| Bearded Dragon | *Pogona minor* | |

Appendix D: Amphibian and Reptile species of the general region of the survey area (see Methods) (Continued)

| Species | | Comments |
|---|---|---|
| **Varanidae** (monitors or goannas) | | |
| Gould's Sand Goanna | *Varanus gouldii* | |
| Black-tailed Tree Goanna | *Varanus tritis* | |
| | | |
| **Scincidae** (skink lizards) | | |
| Fence Skink | *Cryptoblepharus plagiocephalus* | |
| | *Ctenotus impar* | |
| | *Ctenotus mimetes* | |
| | *Ctenotus pantherinus* | |
| | *Ctenotus schomburgki* | |
| | *Egernia inornata* | |
| Broad-banded Sand-swimmer | *Eremiascincus richardsonii* | |
| | *Lerista muelleri* | |
| | *Lerista distinguenda* | |
| | *Lerista macropisthopus* | |
| | *Lerista gerrardii* | |
| Dwarf Skink | *Menetia greyii* | |
| | *Morethia butleri* | |
| Bluetongue | *Tiliqua occipitalis* | |
| Bobtail | *Tiliqua rugosa* | + |
| | | |
| **Typhlopidae** (blind snakes) | | |
| | *Ramphotyphlops grypus* | |
| | *Ramphotyphlops hamatus* | |
| | | |
| **Boidae** (pythons) | | |
| Stimson's Python | *Antaresia (Morelia) stimsoni* | |
| Woma or Ramsay's Python | *Aspidites ramsayi* | C, EX |
| Carpet Python | *Morelia spilota* | C |
| | | |
| **Elapidae** (front-fanged snakes) | | |
| Yellow-faced Whip-Snake | *Demansia psammophis* | |
| | *Denisonia fasciata* | |
| Moon Snake | *Furina ornata* | |
| Mulga Snake | *Pseudechis australis* | |
| Dugite | *Pseudonaja affinis* | |
| Ringed Snake | *Pseudonaja modesta* | |
| Gwarder | *Pseudonaja nuchalis* | |

Appendix D: Amphibian and Reptile species of the general region of the survey area (see Methods) (Continued)

| Species | | | Comments |
|---|---|---|---|
| **Elapidae** (front-fanged snakes) (Continued) | | | |
| Gould's Snake | *Suta (Rhinoplocephalus) gouldii* | | |
| oded Snake | *Suta (Rhinoplocephalus) monachus* | | |
| Jan's Bandy Bandy | *Simoselaps(Vermicella) bertholdii* | | |
| Black-naped Snake | *Simoselaps (Vermicella) bimaculata* | | |
| | *Simoselaps (Vermicella) semifasciata* | | |
| Number of species present and/or expected: | | Frogs | 7 |
| | | Reptiles | 54 |

## Appendix E: Bird species of the general region of the survey area (see Methods)

The comments column indicates species observed during the site inspection (+) and species of conservation significance (C). Species recorded breeding (brd) during the site inspection, and species which introduced into the region (int) are indicated. Species noted as "declined" were recorded as having declined in the wheatbelt by Saunders and Ingram (1995).

| Species | | Comments |
|---|---|---|
| **Casuariidae** (cassowaries and emus) | | |
| Emu | *Dromaius novaehollandiae* | + declined |
| **Megapodiidae** (mound-builders) | | |
| Malleefowl | *Leipoa ocellata* | C declined |
| **Phasianidae** (pheasants and quails) | | |
| Stubble Quail | *Coturnix novaezealandiae* | |
| **Anatidae** (ducks, geese and swans) | | |
| Black Swan | *Cygnus atratus* | |
| Australian Shelduck | *Tadorna tadornoides* | |
| Pacific Black Duck | *Anas superciliosus* | |
| Grey Teal | *Anas gibberifrons* | |
| **Podicepididae** (grebes) | | |
| Hoary-headed Grebe | *Poliocephalus poliocephalus* | |
| **Accipitridae** (kites, hawks and eagles) | | |
| Black-shouldered Kite | *Elanus notatus* | + |
| Square-tailed Kite | *Lophoictinia isura* | C |
| Whistling Kite | *Haliastur sphenurus* | |
| Brown Goshawk | *Accipiter fasciatus* | |
| Collared Sparrowhawk | *Accipiter cirrhocephalus* | |
| Wedge-tailed Eagle | *Aquila audax* | |
| Little Eagle | *Hieraaetus morphnoides* | |
| Spotted Harrier | *Circus assimilis* | |
| **Falconidae** (falcons) | | |
| Black Falcon | *Falco subniger* | |
| Peregrine Falcon | *Falco peregrinus* | C |
| Australian Hobby | *Falco longipennis* | |
| Grey Falcon | *Falco hypoleucos* | C |
| Brown Falcon | *Falco berigora* | |
| Nankeen Kestrel | *Falco cenchroides* | + (brd) |
| **Otidae** (bustards) | | |
| Australian Bustard | *Ardeotis australis* | declined |
| **Turnicidae** (button-quails) | | |
| Painted Button-quail | *Turnix varia* | declining |
| Little Button-quail | *Turnix velox* | |

Appendix E: Bird species of the general region of the survey area (see Methods) (Continued)

| Species | | Comments |
|---|---|---|
| **Scolopacidae** (sandpipers) | | |
| Greenshank | *Tringa nebularia* | |
| Common Sandpiper | *Tringa hypoleucos* | |
| Red-necked Stint | *Calidris ruficollis* | |
| **Burhinidae** (thick-knees or stone-curlews) | | |
| Bush Stone-curlew | *Burhinus grallarius* | declined |
| **Recurvirostridae** (stilts and avocets) | | |
| Black-winged Stilt | *Himantopus himantopus* | |
| Banded Stilt | *Cladorhynchus leucocephalus* | |
| Red-necked Avocet | *Recurvirostra novaehollandiae* | |
| **Charadriidae** (lapwings and plovers) | | |
| Banded Lapwing | *Vanellus tricolor* | |
| Red-kneed Dotterel | *Erythrogonys cinctus* | |
| Red-capped Plover | *Charadrius ruficapillus* | |
| Black-fronted Dotterel (Plover) | *Elseyornis melanops* | |
| Hooded Plover | *Thinornis rubricollis* | C |
| **Laridae** (gulls and terns) | | |
| Silver Gull | *Larus novaehollandiae* | |
| **Columbidae** (pigeons and doves) | | |
| Rock Dove (Feral Pigeon) | *Columba livia* | (int) |
| Laughing Turtle-dove | *Streptopelia senegalensis* | (int) |
| Common Bronzewing | *Phaps chalcoptera* | |
| Crested Pigeon | *Ocyphaps lophotes* | + |
| **Cacatuidae** (cockatoos) | | |
| Red-tailed Black-Cockatoo | *Calyptorhynchus banksii* | |
| Galah | *Cacatua roseicapilla* | + (brd) |
| Little Corella | *Cacatua sanguinea* | |
| Western (long-billed) Corella | *Cacatua tenuirostris* | |
| Major Mitchell's Cockatoo | *Cacatua leadbeateri* | C declined |
| Cockatiel | *Nymphicus novaehollandiae* | |
| **Psittacidae** (lorikeets and parrots) | | |
| Purple-crowned Lorikeet | *Glossopsitta porphyrocephala* | declined |
| Regent Parrot | *Polytelis anthopeplus* | declined |
| Budgerigar | *Melopsittacus undulatus* | |
| Western Rosella | *Platycercus icterotis* | declined |
| Australian (Port Lincoln) Ringneck | *Barnardius zonarius* | + |
| Mulga Parrot | *Psephotus varius* | |
| Elegant Parrot | *Neophema elegans* | |

Appendix E: Bird species of the general region of the survey area (see Methods) (Continued)

| Species | | Comments |
|---|---|---|
| **Cuculidae** (cuckoos) | | |
| Pallid Cuckoo | *Cuculus pallidus* | |
| Fan-tailed Cuckoo | *Cacomantis flabelliformis* | declined |
| Black-eared Cuckoo | *Chrysococcyx osculans* | declined |
| Horsfield's Bronze-Cuckoo | *Chrysococcyx basalis* | + |
| Shining Bronze-Cuckoo | *Chrysococcyx lucidus* | declined |
| **Strigidae** (hawk owls) | | |
| Southern Boobook | *Ninox novaeseelandiae* | declined |
| Barking Owl | *Ninox connivens* | declined |
| **Tytonidae** (barn owls) | | |
| Barn Owl | *Tyto alba* | |
| **Podargidae** (frogmouths) | | |
| Tawny Frogmouth | *Podargus strigoides* | declined |
| **Aegothelidae** (owlet-nightjars) | | |
| Australian Owlet-nightjar | *Aegotheles cristatus* | declined |
| **Caprimulgidae** (nightjars) | | |
| Spotted Nightjar | *Caprimulgus guttatus* | |
| **Halcyonidae** (forest kingfishers) | | |
| Red-backed Kingfisher | *Todiramphus pyrrhopygia* | |
| Sacred Kingfisher | *Todiramphus sancta* | declined |
| **Meropidae** (bee-eaters) | | |
| Rainbow Bee-eater | *Merops ornatus* | |
| **Maluridae** (fairy-wrens) | | |
| Blue-breasted Fairy-wren | *Malurus pulcherrimus* | declined |
| White-winged Fairy-wren | *Malurus leucopterus* | |
| **Pardalotidae** (pardalotes, thornbills and allies) | | |
| Spotted Pardalote | *Pardalotus punctatus* | |
| Striated Pardalote | *Pardalotus striatus* | + |
| Shy Heathwren (Hylacola) | *Hylacola cauta* | declined |
| Rufous Fieldwren | *Calamanthus campestris* | declined |
| Redthroat | *Pyrrholaemus brunneus* | declined |
| Weebill | *Smicrornis brevirostris* | + declined |
| Western Gerygone | *Gerygone fusca* | declined |
| Inland Thornbill | *Acanthiza apicalis* | declined |
| Chestnut-rumped Thornbill | *Acanthiza uropygialis* | declined |
| Yellow-rumped Thornbill | *Acanthiza chrysorrhoa* | + declined |
| Southern Whiteface | *Aphelocephala leucopsis* | |

Appendix E: Bird species of the general region of the survey area (see Methods) (Continued)

| Species | | Comments |
|---|---|---|
| **Meliphagidae** (honeyeaters) | | |
| Red Wattlebird | *Anthochaera carunculata* | declined |
| Little Wattlebird | *Anthochaera chrysoptera* | declined |
| Spiny-cheeked Honeyeater | *Acanthagenys rufogularis* | + declined |
| Yellow-throated Miner | *Manorina flavigula* | + |
| Singing Honeyeater | *Lichenostomus virescens* | + |
| White-eared Honeyeater | *Lichenostomus leucotis* | |
| Brown-headed Honeyeater | *Melithreptus brevirostris* | declined |
| White-naped Honeyeater | *Melithreptus lunatus* | declined |
| Brown Honeyeater | *Lichmera indistincta* | declined |
| White-fronted Honeyeater | *Phylidonyris albifrons* | + |
| Black Honeyeater | *Certhionyx niger* | |
| Crimson Chat | *Epthianura tricolor* | |
| White-fronted Chat | *Epthianura albifrons* | |
| **Petroicidae** (Australasian robins) | | |
| Jacky Winter | *Microeca leucophaea* | + declined |
| Red-capped Robin | *Petroica goodenovii* | + declined |
| Hooded Robin | *Melanodryas cucullata* | declined |
| Western Yellow Robin | *Eopsaltria griseogularis* | declined |
| Southern Scrub-robin | *Drymodes brunneopygia* | declined |
| **Pomatostomidae** (babblers) | | |
| White-browed Babbler | *Pomatostomus superciliosus* | + declined |
| **Cinclosomatidae** (quail-thrushes and allies) | | |
| Chestnut Quail-thrush | *Cinclosoma castanotum* | |
| **Neosittidae** (sittellas) | | |
| Varied Sittella | *Daphoenositta chrysoptera* | + declined |
| **Pachycephalidae** (whistlers) | | |
| Crested Shrike-tit | *Falcunculus frontatus* | C, declined |
| Rufous Whistler | *Pachycephala rufiventris* | + declined |
| Grey Shrike-thrush | *Colluricincla harmonica* | + declined |
| Crested Bellbird | *Oreoica gutturalis* | + declined |
| **Dicruridae** (flycatchers) | | |
| Australian Magpie-lark | *Grallina cyanoleuca* | |
| Grey Fantail | *Rhipidura fuliginosa* | |
| Willie Wagtail | *Rhipidura leucophrys* | + |
| **Campephagidae** (cuckoo-shrikes) | | |
| Black-faced Cuckoo-shrike | *Coracina novaehollandiae* | + |
| White-winged Triller | *Lalage sueurii* | declined |

Appendix E: Bird species of the general region of the survey area (see Methods) (Continued)

| Species | | Comments |
|---|---|---|
| **Artamidae** (woodswallows and butcherbirds) | | |
| Masked Woodswallow | *Artamus personatus* | |
| Black-faced Woodswallow | *Artamus cinereus* | + |
| Dusky Woodswallow | *Artamus cyanopterus* | declined |
| Grey Butcherbird | *Cracticus torquatus* | + |
| Pied Butcherbird | *Cracticus nigrogularis* | |
| Australian Magpie | *Gymnorhina tibicen* | |
| Grey Currawong | *Strepera versicolor* | declined |
| **Corvidae** (ravens and crows) | | |
| Australian Raven | *Corvus coronoides* | + |
| Little Crow | *Corvus bennetti* | |
| **Motacillidae** (pipits and true wagtails) | | |
| Richard's Pipit | *Anthus novaeseelandiae* | |
| **Passeridae** (finches and allies) | | |
| Zebra Finch | *Taeniopygia guttata* | |
| **Dicaeidae** (flower-peckers) | | |
| Mistletoebird | *Dicaeum hirundinaceum* | declined |
| **Hirundinidae** (swallows) | | |
| White-backed Swallow | *Cheramoeca leucosternum* | + |
| Welcome Swallow | *Hirundo neoxena* | |
| Tree Martin | *Cecropis nigricans* | + |
| Fairy Martin | *Cecropis ariel* | |
| 0 | | |
| **Sylviidae** (old world warblers) | | |
| Rufous Songlark | *Cinclorhamphus mathewsi* | + |
| Brown Songlark | *Cinclorhamphus cruralis* | |
| **Zosteropidae** (white-eyes) | | |
| Silvereye | *Zosterops lateralis* | declined |
| Number of species recorded | | 29 |
| Total number of species possible | | 130 |

**Appendix F: Mammal species of the general region of the survey area (see Methods)**

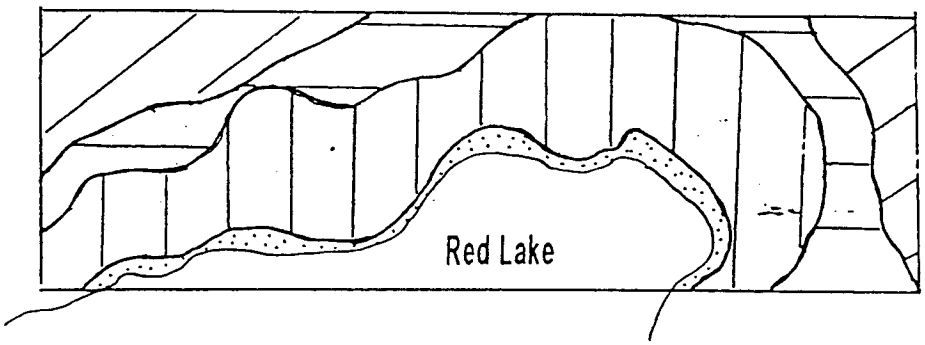
The comments column indicates species observed during the site inspection (+), species of conservation significance (C), and species which are probably locally extinct (EX). Species which are introduced into the region (int) are indicated.

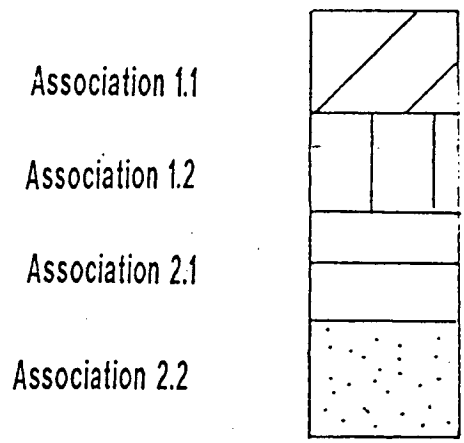
| Species | | Comments |
|---|---|---|
| **Tachyglossidae** (echidnas) | | |
| Echidna | *Tachyglossus aculeatus* | + |
| **Dasyuridae** | | |
| Kultarr or Wuhl-Wuhl | *Antechinomys laniger* | |
| Chuditch | *Dasyurus geoffroii* | C, ?EX |
| Fat-tailed Dunnart | *Sminthopsis crassicaudata* | |
| dunnart | *Sminthopsis dolichura* | |
| Red-tailed Phascogale | *Phascogale calura* | C, ?EX |
| **Myrmecobiidae** (numbat) | | |
| Numbat | *Myrmecobius fasciatus* | C, EX |
| **Thylacomyidae** (rabbit-eared bandicoots) | | |
| Bilby, Dalgyte or Walpirti | *Macrotis lagotis* | C, EX |
| **Peramelidae** (bandicoots) | | |
| Pig-footed Bandicoot | *Chaeropus ecaudatus* | C, EX |
| Western Barred Bandicoot | *Perameles bougainville* | C, EX |
| **Phalangeridae** (possums) | | |
| Brush-tailed Possum | *Trichosurus vulpecula* | EX |
| **Burramyidae** (pygmy possums) | | |
| Western Pygmy Possum | *Cercartetus concinnus* | |
| **Potoroidae** (rat-kangaroos and allies) | | |
| Woylie | *Bettongia penicillata* | C, EX |
| Boodie | *Bettongia lesueur* | C, EX |
| Broad-faced Potoroo | *Potorous platyops* | C, EX |
| **Macropodidae** (kangaroos and wallabies) | | |
| Western Grey Kangaroo | *Macropus fuliginosus* | + |
| Euro | *Macropus robustus* | |
| Wurrung or Crescent Nailtail Wallaby | *Onychogalea lunata* | C, EX |
| **Mollosidae** (mastiff bats) | | |
| White-striped Bat | *Tadarida australis* | |

Appendix F:Mammal species of the general region of the survey area (see Methods) (Continued)

| Species | | Comments |
|---|---|---|
| **Vespertilionidae** (vesper bats) | | |
| Gould's Wattled Bat | *Chalinolobus gouldii* | |
| Chocolate Wattled Bat | *Chalinolobus morio* | |
| | *Vespadelus (Eptesicus) pumilis* | |
| Lesser Long-eared Bat | *Nyctophilus geoffroyi* | |
| **Muridae** (rats and mice) | | |
| House Mouse | *Mus musculus* | (int) |
| Pankot or Mitchell's Hopping Mouse | *Notomys mitchellii* | |
| **Leporidae** (rabbits and hares) | | |
| Rabbit | *Oryctolagus cuniculus* | +, (int) |
| **Canidae** (foxes and dogs) | | |
| Dingo | *Canis familiaris dingo* | |
| Red Fox | *Vulpes vulpes* | +, (int) |
| **Felidae** (cats) | | |
| Feral Cat | *Felis catus* | +, (int) |
| Number of species recorded and/or expected | | 29 |

# VEGETATON ASSOCIATIONS AT PROPOSED LEASE AT RED LAKE



APPENDIX 2.

(a) Letter from M Harper of Agriculture WA on benefits of gypsum on farm land within a radius of 100km of M77/528, dated November 7th 1997.
(b) Identifying gypsum-responsive soils, WA Agriculture Dept Farmnote 57/90.
(c) Gypsum improves soil stability, WA Agriculture Dept Farmnote 32/85.

Agriculture
WESTERN AUSTRALIA

7th November 1997

Aurex Pty Ltd
Attention Dr R Marston
PO Box 42
APPLECROSS WA

Gypsum Lease M 77/528

In reference to your request for information on benefits of Gypsum on Farm Land within a 100 km radius of the proposed gypsum mine site, the following information and attached papers may be of interest.

Gypsum is primarily used as an application to degraded heavy land soils as a means of improving soil structure thereby increasing rainfall infiltration with consequent increase in yield. Some trials have indicated that on a gypsum responsive soil, yield increases of .2 tonnes per hectare may be expected, on average, in wheat using up to 5 tonnes per hectare of gypsum. It should be noted that Gypsum may cause yield decline in legumes planted on the gypsum treated land, at least in the short term, therefore advice should be sought and care taken, if it is planned to grow legumes.

It should also be noted that not all hard setting or surface sealing soils are gypsum responsive and tests need to be carried out before applying gypsum, to ensure that a result is achieved and money not wasted.

The soils most likely to be responsive are those described as S6 in the attached booklet. "An introduction to soils of the Merredin Area". An exception are the Morrell Soils which are not widespread and occur generally close to salt lakes.

It is estimated that S6 soils cover approximately 10% of the Merredin region. Using this figure, at a radius of 100km from the mine site you could expect there to be about 314000 hectares of S6 land. Some soil surveys have been done in this area but as yet they have not been published. You may wish to contact The Natural Resources Group at Agricultural WA South Perth for more up to date information. It is not known what percentage of this land has been treated with Gypsum. A survey would have to be undertaken to get reasonably accurate figures.

Benefits to farmers of Gypsum use include;

1. Easier working of paddock there by less use of fuel and the ability to direct drill and also to plant earlier.
2. Increases in yield of cereals there by increased profitability.
3. Less run off and consequent erosion and flooding of lower lying areas.

DRYLAND RESEARCH INSTITUTE
Great Eastern Highway (PO Box 432) Merredin Western Australia 6415 Telephone: (090) 81 3111 Facsimile: (090) 41 1138

As suggested previously results have been obtained with rates from 2.5 tonnes to 5 tonnes per hectare.

Permanence of treatment is very much related to management. It is essential that gypsum responsive soils be minimally tilled and preferably direct drilled when sown. It is also necessary that this operation be undertaken at optimum moisture status of the soil, that is neither too wet nor too dry. These soils also should not be stocked especially with sheep when they are very wet.

All in all they are fragile soils and must be treated accordingly. If they are treated and managed correctly the single application of gypsum should have a permanently beneficial effect.

Trials by Dollar and Howell in 1988 resulted in the conclusion "that long term maintenance of soil surface structure will not be achieved with gypsum alone, unless the gypsum is reapplied at regular intervals.

Direct drilling maintained the response to applied gypsum after leaching but also resulted in improvement of yield without gypsum.

As gypsum is a finite resource, reasonably expensive and as gypsum mining can often result in destruction of remnant vegetation and habitat, which is a very small percentage of the wheatbelt it is absolutely essential that it be used wisely, which means that it should be used if it is the only method available to allow an area to be brought to a condition where it can be direct drilled. It should not be used as a substitute for good farm management.

It would be useful if any purchasers of gypsum to be used as a soil amendment could be made aware of these points.

The thought expressed in the preceding paragraph are my personal opinion.

I am unaware as to whether any comments were made by this agency on the Freeman Report. Certainly I was not asked to comment.. I assume the Department of Minerals & Energy would have a copy if a report was produced.

Trusting this information is sufficient for your purposes.

M. Harper

M Harper
RLCO

Farmnote
No. 57/90

Western Australian Department of Agriculture

Agdex 514
Soil improvement

# Identifying gypsum- responsive soils

*By Fionnuala Frost, Research Officer, National Soil Conservation Program and Garry Orr, Technical Officer, Division of Resource Management, Merredin*

Soils containing dispersible clays are often problem soils. A dispersible clay is a clay that does not stay stable when wetted, but slakes or disperses easily.

The major problem with dispersed clay is that it can block soil pores and reduce the permeability to water. The clay also acts as a cement that hardens the soil when it dries.

Gypsum applied to soils with dispersible clays improves the permeability to water by reducing the dispersion of the clay. Reducing the dispersion allows more of the rainfall to enter the soil, reducing run-off and erosion risks and improving drainage after heavy rains.

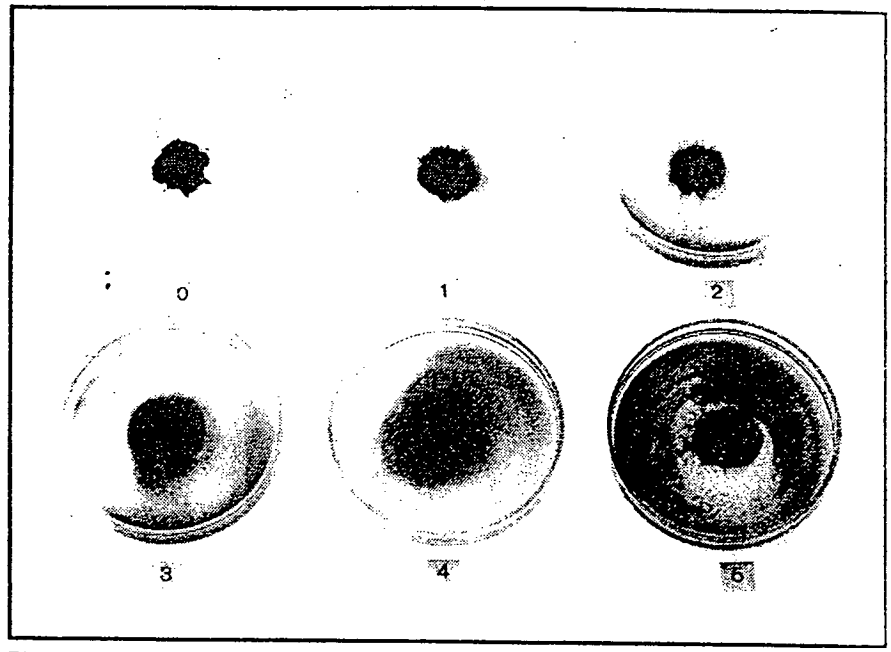



*Figure 1. Varying degrees of clay dispersion in soils. The higher amounts of dispersal (4 and 5) indicate a soil's suitability for gypsum application. No. 0 displays slaking (breaking off of soil particles), compared to 1 to 5 which show clay dispersion.*

The action of the dispersed clay in hardening the soil (or increasing soil strength) is also decreased by applying gypsum. The lower soil strength allows for more timely cultivation and seeding. Energy inputs and machinery maintenance can be reduced, while decreased soil strength also allows improved crop performance from rapid emergence, improved aeration and efficient water use.

The benefits from applying gypsum will vary, depending on the season. Apply gypsum with the aim of adopting more sustainable, reduced tillage, rather than continuing with multiple workings and having to reapply gypsum a few years later.

Several tests to help identify gypsum-responsive soils have been developed through research, including trials conducted by the Department of Agriculture. Testing is necessary because soils vary in chemical composition and physical properties as a result of their inherent condition and management practices imposed on them.

Two of the simplest assessments are described here. These are:

- using field observations, and
- using a simple dispersion test.

## Field observations

Soils likely to be structurally degraded (lose their crumb structure when wet), and likely to be gypsum-responsive may:

- be hard when dry or have a surface crust (note that not all crusting soils are gypsum-responsive);
- become sticky or non-trafficable after light rainfall, puddles of water will have a milky appearance from the suspended clay;
- be difficult to cultivate because they are too hard or too wet;
- collapse after heavy rainfall;
- have low water infiltration and high run-off;
- produce patchy crop emergence and early growth particularly in poor seasons.

## Visual dispersion test

Apart from looking at the condition of the soil and crop you can do a simple test on the farm to determine if your soil is likely to respond to gypsum. The dry aggregate dispersion method described below includes photographic standards for providing a scale of the degree of dispersion (see Figure 1).

The process of clay dispersion is a reliable indicator of unstable soil structure. Highly dispersive (structurally unstable) soils are likely to be more gypsum-responsive than those soils that are less dispersive.

## Materials

- 100 mL beakers or 500 g glass jars (Vegemite jars are suitable)
- distilled water or fresh rainwater (scheme water is unsuitable)
- dry soil aggregates (small clods, or clumps)
- black surface (bench, cloth or paper)

## Method

1. Take about ten dry soil samples from the area to be tested, half from the soil surface and half from a depth of 15 cm. Highly dispersive topsoil is far more limiting in terms of potential productivity than dispersive subsoils.

2. Label each soil sample and break the sample into aggregates, or amounts about 5 mm in diameter.

3. Pour 50 mL of distilled water into ten separate, clean containers and place on the flat, dark surface. (If you are using 500 g Vegemite jars, add 100 mL of distilled water to each. You will then be able to place five aggregates in a jar without affecting the results.) However, make sure you do not have samples of both topsoil and subsoil in the same jar.

4. Label the containers to identify each sample.

5. Gently place one aggregate into the centre of each beaker or jar and allow to stand for 24 hours without disturbance. (Make at least two tests for each sample to ensure the results are consistent.)

6. Rank the degree of dispersion on a scale from 0 to 5. Use Figure 1 to estimate this.

The results of the test are explained in Table 1.

**Table 1. Likely response to gypsum of soils with varying levels of clay dispersion**

| Ranking | Dispersion (%) | Aggregate stability | Response to gypsum |
|---|---|---|---|
| 0 | 0 | Very high | Nil |
| 1 | 20 | High | Very low |
| 2 | 40 | Moderate | Low |
| 3 | 60 | Low | Moderate |
| 4 | 80 | Very low | High |
| 5 | 100 | Nil | Very high |

A soil is likely to respond to gypsum if from field observations it shows the characteristics associated with poor soil structure and will readily disperse (ranking of 4 or 5).

All clays swell on wetting and the process of swelling causes particles to mechanically break off from the aggregate. This process is called slaking and is illustrated in Example 0 in Figure 1. This is a different observation to dispersion where the clay disperses to form a milky cloud around the aggregate.

It is the dispersiveness of a soil that determines its likely response to gypsum.

The recommended rate for applying gypsum is 2.5 t/ha. Test strips are recommended on the targetted paddocks in the year preceding a blanket application to observe any responses to gypsum. If there is no response, continue observing the strip for a further season to account for seasonal variation.

Some soils are non-trafficable after rainfall and yet will not be dispersive. The sign to look for in this situation is a sandy to sandy loam-surfaced soil with a massive tight clay subsoil. Waterlogging is invariably the problem on these soil types. The clay subsoil prevents surface water from draining deep into the profile. Where this happens, to minimize degradation you can take the following steps:

1. Reduce tillage.
2. Avoid working the paddock if it is saturated.
3. Reduce the volume of surface water flowing onto the paddock, for example, by installing recommended earthworks.

## Further reading


- Farmnote No. 99/84 'Direct drilling on the contour to control erosion' (Agdex 572).
- Farmnote No. 32/85 'Gypsum improves soil stability' (Agdex 514).
- Journal of Agriculture (1987). 'Gypsum use in the wheatbelt'. Vol. 28, No. 2.





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ISSN 0726-934X

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Farmnote
No. 32/85

Western Australian Department of Agricultu

Agdex 514

# Gypsum improves soil stability

**By G. Fosberry, Adviser and M. Howell, Research Officer, Dryland Research Institute, Merredin**

Crop growth is often limited by the poor structure of heavy textured soils. Gypsum can improve soil structure, increasing crop yields and making soil more manageable.

Once a soil has been improved it is essential to prevent degradation re-occurring. Minimum tillage techniques play an important role in conserving the improvement.

Gypsum (calcium sulphate) is a naturally occurring mineral found commonly as dunes at the south eastern edge of salt lakes. When applied to a soil, gypsum dissolves and interacts with the clay. This interaction improves soil structure by making the clay more stable when wet and reducing the tendency to set hard when dry. In practice gypsum may:

- reduce crusting or surface sealing,
- improve crop establishment,
- aid drainage of the soil surface,
- lengthen the time the soil is suitable for cultivation, and
- prevent crops haying-off prematurely.

Gypsum is not a treatment for traffic compaction pans, non-wetting sands and soil acidity. Saline soils can be treated with gypsum but only when the soil has been drained and leached of salt.

A beneficial response from gypsum will only occur where:

- soil structure is limiting crop growth, and
- the soil is responsive to gypsum.

### Recognising a gypsum-responsive soil

The Department of Agriculture has experimented with gypsum since 1965. Wheat yield improvements have been highly variable, ranging from nothing to over 450 per cent (in one case in 1983). Usually, responses ranged between 30 and 50 per cent. Most responses occurred on hard-setting grey sandy loams overlying a sandy clay, and on some red clays.

The following procedure will help you recognize a gypsum-responsive soil:

1. Take a sample of soil from the surface and another 15 cm below the surface.
2. Place about 50 mL of distilled water or freshly collected rainwater (stored rainwater and tap water may not be pure enough) into each of two clean jars. These jars should be labelled "surface" and "sub-surface" for easy identification.
3. Wet the soil sample with the distilled water to a moisture level similar to that when seeding in good conditions that is, soil should be easily manipulated but not sticky.
4. Re-mould the soil sample into a sphere (about seven millimetres in diameter) and gently drop into the appropriate labelled jar of water.
5. Leave the jars completely undisturbed for 24 hours. If, after this time, a milky cloud or halo has formed around either of the aggregates then the tested soil is likely to be gypsum responsive.
6. As soil can vary greatly even a few metres away, repeat the test with samples from different parts of the suspect area.

The test, though simple is a rough guide to responsive sites. Research into more accurate tests for gypsum responsiveness is continuing.

### Gypsum test strips

If the problem soil is gypsum responsive according to the soil test, and crop yield is being depressed by the unstable structure of the soil, then test strips are warranted to assess whether gypsum application will be beneficial.

When doing test strips:

- Apply the gypsum at several rates, for example, 2.5 and 5.0 t/ha.
- It is essential to leave an untreated strip which will confirm whether there was a response to the application of gypsum and in subsequent years will enable an assessment of when re-application is necessary.
- Where no response is measured, continue observation of the strips over at least two seasons to account for seasonal variation.

### Methods of gypsum application

Conventional chain-delivery superphosphate spreaders are not suitable for applying gypsum because gypsum is not a free-flowing material. However, there are several commercial spreaders which are suitable. A spreader can be bought or hired or a contractor hired to apply the gypsum.

Often, areas where gypsum is to be applied are bare. On these bare areas the gypsum should be "scratched" into the soil surface to reduce chances of it blowing away.

To be effective gypsum should be applied before the break of the season.

### Application rates

In the 1984 experiments conducted by the Department of Agriculture, 2.5 t/ha gypsum gave maximum grain yields. However, for the more unstable soils and where the treated soil surface has suffered from untimely or intensive cultivation, gypsum may need to be re-applied sooner if 2.5 t/ha rather than 5 t/ha is used.

A possible strategy, following the 1984 results, would be:

- apply gypsum at 2.5 t/ha over most of the unstable soil, and
- use 5.0 t/ha on the most unstable country.

Research on the long term consequence of gypsum application: persistence, maintenance of favourable soil structure and cost effectiveness; is continuing.

*Continued overleaf*

**Maximising gypsum effectiveness**

Consideration of the following points will ensure that maximum benefit of gypsum application is obtained.

- Gypsum must dissolve in rain water before it can act on the soil. It should therefore be applied before the break of the season.
- Preventing the newly applied gypsum from blowing away is important. However, the gypsum should be kept as close to the soil surface as possible. If cultivation is necessary, do the minimum required.
- Increasing the normal rate of nitrogenous fertiliser or the application of nitrogenous fertiliser where none is normally used, should be seriously considered. Yield increases on some soils treated with gypsum have only been fully realised with additional nitrogen. Other soil types have shown minimal response to nitrogen after gypsum treatment. Use test strips of nitrogen as indicators.
- Following gypsum treatment, minimum tillage or direct drilling practices should be adopted. Minimum tillage techniques encourage a build up of organic matter at the soil surface which further improves soil structure. The improved soil conditions achieved with the gypsum and organic matter will be conserved by minimal surface disturbance, and the residual or undissolved gypsum will remain close to the soil surface. Protection of the treated surface from further degradation may make gypsum application a once-only requirement.

**Persistence of the gypsum effect**

A major factor in the economics of gypsum use is the persistence of favourable soil effects. Persistence will depend on many factors including:

- the rate of gypsum application—more gypsum lasts longer,
- the intensity and frequency of rainfall,
- the soil type, and
- the management practices adopted after the gypsum application (minimum tillage techniques required).

**Gypsum quality**

Gypsum suppliers should be able to provide a comprehensive analysis of their gypsum. However, a 500 g sample can be sent for analysis to:

Government Chemical Laboratories
30 Plain Street
EAST PERTH WA 6000
Telephone: (09) 325 5544

Ideally, the proportion of gypsum should be greater than 70 per cent. Lower percentages increase the cost of cartage and application.

The chloride or salt content is also important. Supplies which have over 1 per cent chloride, are suspect and those over 2 per cent chloride should not be used (figures from the Department of Agriculture, South Australia).

**The costs of gypsum**

Gypsum costs between $4 and $10 per tonne at the mine (1985 prices). The cost of gypsum per hectare is extremely variable and depends on:

- freight—this is usually the greatest cost, hence the distance from the source is important,
- the rate applied,
- purity of the gypsum used, and
- price

The table outlines the approximate costs of gypsum per hectare. The influence of gypsum quality and distance from the gypsum source is easily seen.

**Examples of the costs of gypsum application**

| Gypsum rate (t/ha) | Distance from gypsum source (km) | Gypsum content (% calcium sulphate) | Total cost of gypsum application* ($/ha) |
|---|---|---|---|
| 5.0 | 100 | 100 | 68.00 |
| 5.0 | 100 | 70 | 93.20 |
| 5.0 | 20 | 100 | 40.00 |
| 2.5 | 100 | 100 | 38.00 |
| 2.5 | 20 | 100 | 27.50 |

*Prices used: Gypsum = $5/tonne
Contract cartage = 7c/tonne/km
Contract spreading = $8/ha

NOTE: These costs can vary, especially if you use your own truck and spreader.

ISSN 0726-934X

**APPENDIX 3.** **Letter dated 30 May 1997 from Aboriginal Affairs Dept regarding search for listed Aboriginal sites**

OUR REF: SCL/RM/RL5.97

YOUR REF:

DATE: 30 May, 1997

ABORIGINAL AFFAIRS DEPARTMENT

Mr Rod Marston
Aurex Pty Ltd
PO Box 42
APPLECROSS WA 6153

1ST FLOOR
197 ST. GEORGE'S TERRACE
PERTH, WESTERN AUSTRALIA 600

PO BOX 7770, CLOISTERS SQ
PERTH, WESTERN AUSTRALIA 68

TELEPHONE (09) 235 8000
FACSIMILE (09) 235 8088

Dear Mr Marston

**RE: REQUEST FOR INFORMATION FROM THE REGISTER SYSTEM SHIRE OF NUNGARIN - RED LAKE AREA - MINING TENEMENTS M77/528 & L77/172.**

Thank you for your fax of **28 May 1997,** requesting information on Aboriginal sites in the above area.

A search of our Register system has been undertaken on land within the 1:250,000 map **SH5015, between metric grid coordinates 63-. 55- and 639. 559** - see attached map.

This search indicates that there are no listed Aboriginal sites known to this Department within that area of land.

However, it is possible that sites that have not yet been entered on the Register system may exist. The *Aboriginal Heritage Act 1972* (the Act) protects all Aboriginal sites in Western Australia whether they are known to this Department or not.

**The provision of this information is not to be considered as a clearance (as it is not the role of the Department to give approvals, but rather to ensure that all the heritage issues have been addressed). The procedures to enable all relevant parties to follow the requirements of the Act are outlined below.**

Prior to your proposed development/activity, so that no site is damaged or altered (which would result in a breach of Section 17 of the Act) it is recommended that you engage suitably qualified consultants to conduct ethnographic and archaeological surveys of the area. This should ensure that all Aboriginal interest groups are consulted so that all sites on the designated land are avoided or identified. Such a survey would involve archival research, consultations and on the ground inspections. This Department does not recommend individual consultants, however contact details of the professional associations whose members do conduct surveys are enclosed. A survey should also ensure that the provisions of the Act are met.

It is our preference that any development plans are modified to avoid damaging or altering any site. If this is not possible and in order to avoid a breach of the Act, the land owner should submit a Notice in writing under Section 18 of the Act to the Aboriginal Cultural Material Committee, c/o Aboriginal Affairs Department, seeking the Minister for Aboriginal Affairs' prior written consent to use the land. A form to lodge a Notice under Section 18 is available from this Division.

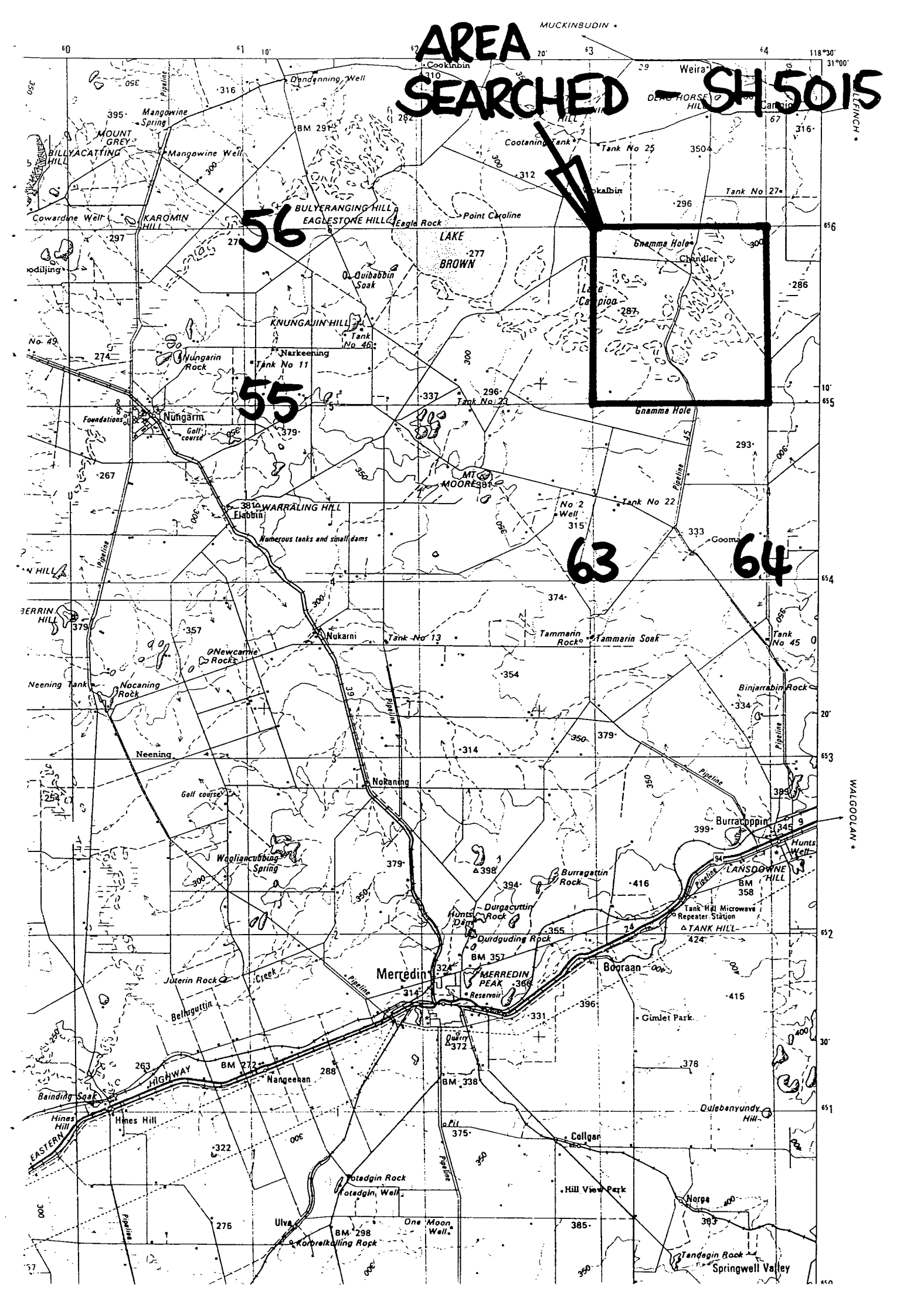
Please do not hesitate to contact Ms Pam Thorley, of our Albany office, if we can be of further assistance.

Yours sincerely

for
Craig Somerville
Director
Heritage & Culture Division

att: Attachment 1.
Extract of 1:250,000 map **SH5015** showing area searched.
Index to Abbreviations used in Site File Information.
Professional Anthropological and Archaeological Organisations in WA.

cc Pam Thorley, Acting Regional Coordinator, Albany Regional Office,
Aboriginal Affairs Department, PO Box 5091, ALBANY, WA 6330.
Ph: (08) 9842 3000.


AREA SEARCHED - SH5015
56
55
63
64
MUCKINBUDIN
Cooklinbin
Dandenning Well
Weira
DEAD HORSE HILL
Mangowine Spring
MOUNT GREY
BILLYACATTING HILL
Mangowine Well
BM 291
Cootanning Tank
Tank No 25
Tank No 27
Cowardine Well
KAROMIN HILL
BULYERANGING HILL
EAGLESTONE HILL
Eagle Rock
Point Caroline
LAKE BROWN
Gnamma Hole
Chandler
Quibabbin Soak
Lake Campion
KNUNGAJIN HILL
Tank No 46
Narkeening
Tank No 11
Nungarin Rock
Nungarin
Foundations
Golf course
Tank No 23
Gnamma Hole
MT MOORE
WARRALING HILL
Elabbin
Numerous tanks and small dams
No 2 Well
Tank No 22
Pipeline
Gooma
Nukarni
Tank No 13
Tammarin Rock
Tammarin Soak
Tank No 45
Newcarnie Rocks
Nocaning Rock
Neening Tank
Binjarrabin Rock
Neening
Nokaning
Golf course
Wooliacubbing Spring
Burracoppin
Hunts Well
LANSDOWNE HILL
Burragattin Rock
Durgacuttin Rock
Hunts Dam
Tank Hill Microwave Repeater Station
TANK HILL
Durdguding Rock
BM 357
Merredin
MERREDIN PEAK
Reservoir
Booraan
Juterin Rock
Creek
Belhuguttin
Gimlet Park
Quarry
BM 272
HIGHWAY
Nangeenan
BM 338
Bainding Soak
Hines Hill
EASTERN
Quilebenyundy Hill
Pit
Collgar
Totadgin Rock
Totadgin Well
Hill View Park
Norpa
Ulva
One Moon Well
BM 298
Korbrelkalling Rock
Tandegin Rock
Springwell Valley
WALGOOLAN

## APPENDIX 4 Extracts of Agreements between Proponent and Native Title Parties

# DEED FOR GRANT OF MINING TENEMENT

**Native Title Act 1993 - Sections 28(1)(d), 31(1)(b), 32(5) and 34**

## SCHEDULE

| | |
|---|---|
| 1 **Date of agreement** (to be entered by Minister only) | |
| 2 **Mining tenement(s)** | |
| Application number(s) | M77/528 and L77/172 |
| Type of tenement | Mining lease and Miscellaneous Licence |
| Mineral field | Yilgarn |
| 3 **Grantee party** (applicant for mining tenement) | |
| Name(s) | Aurex P.T.Y. LTD. |
| Address | P.O. Box 42 Applecross W.A. 6153 |
| 4 **Native title party** (Registered native title claimant(s)) | Gubrun<br>Dennis Sambo Brian Champion<br>Cadley Sambo Dave Champion<br>Clem Donaldson [redacted] Nyle Wilson |
| Name(s) | |
| Address | c/o 6 Butler St<br>Kalgoorlie W.A. 6430 |
| Application for determination of native title number | WC 95/27 |
| Date entered on the Register of Native Title Claims | |

Initialled by: _____ for the Government party

* N. Wilson for the native title party

for the grantee party

# DEED FOR GRANT OF MINING TENEMENT

**Native Title Act 1993 - Sections 28(1)(d), 31(1)(b), 32(5) and 34**

**SCHEDULE**

| | |
|---|---|
| 1 **Date of agreement** (to be entered by Minister only) | |
| 2 **Mining tenement(s)** | |
| Application number(s) | 77/528 + L77/172 |
| Type of tenement | MINING LEASE |
| Mineral field | YILGARN Mineral field |
| 3 **Grantee party** (applicant for mining tenement) | |
| Name(s) | AUREX Pty Ltd |
| Address | Po Box 42, Applecross WA 6153 |
| 4 **Native title party** (Registered native title claimant(s)) | |
| Name(s) | Neil Albert Philips |
| Address | 86 Ashburton Dve Cosnells WA 6110 |
| Application for determination of native title number | WC 97/5 |
| Date entered on the Register of Native Title Claims | 28 JAN. 1997 |



Initialled by: _____ for the Government party _____ for the native title party _____ for the grantee party