DEPARTMENT OF MINES AND ENERGY
SOUTH AUSTRALIA

REPT. BK NO. 89/44

MINERAL RESOURCES OF THE KAPUNDA DISTRICT COUNCIL AREA

GEOLOGICAL SURVEY

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MINERAL RESOURCES

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DEPARTMENT OF MINES AND ENERGY
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ABSTRACT

Kapunda District Council area is underlain by folded metasediments of Adelaidean and Cambrian age, which host important mineral deposits in the area.

Kapunda owes its origin to the discovery of copper in 1842. Mining continued until 1912, and an estimated 15 million tonnes of ore averaging 1.2% copper remain in the vicinity of the mine area. There is potential for further discoveries to the north and north-east.

Two bands of Cambrian limestone and marble to the east of Kapunda have potential to support a significant stone industry; Parliament House in Adelaide was built of marble from this area. There is also a growing market for natural phosphate from deposits associated with these marble beds.

Ford's dolomite quarry 5.5 km south west of Kapunda produces high quality aggregate, and if extensions to the deposit could be located they would become an important source of carbonate aggregate for northern Metropolitan Adelaide.

Talc deposits in the Truro area will probably be re-opened at some future time.

Fine sand deposits along the western margin of the Barossa Valley and to the south-east of Linwood are suitable for filling sand and cement manufacture.

The deposits listed above should be recognised in the Supplementary Development Plan being prepared by the District Council. Development proposals in the vicinity of these, or other known mineral deposits should be referred to the S.A. Department of Mines and Energy for advice.

INTRODUCTION

The District Council of Kapunda has requested that the Department of Mines and Energy prepare a report on mineral deposits in the Council area to enable Council to incorporate policies into the revised Supplementary Development Plan to protect their future development.

This report contains:

- A review of the geological environment to indicate where, as a result of future exploration, workable mineral resources may be found.
- A review of known industrial and metallic mineral deposits.
- A statement of tenements held under the Mines Act as at 25 May 1989, and
- Suggested planning policies for the development of mineral resources and guidelines for extraction and rehabilitation of workings.

The town of Kapunda is located some 70 km northeast of Adelaide.

The Council area includes the Hundreds of Kapunda and Belvidere and portions of the Hundreds of Light, Gilbert and Waterloo, (Figure 1).

GEOLOGICAL SETTING

The accompanying generalised geological plan (Figure 2) has been compiled from the published Truro, Kapunda and Eudunda 1:63 360 geological maps and the ADELAIDE 1:250 000 geological map (Ref: SI 54-9).

Geological units within the Council area are discussed briefly.

The major portion of the study area is undulating to hilly country underlain by Precambrian sedimentary rocks of the Adelaidean System. These include siltstone, quartzite, dolomitic shale and finely laminated pyritic and carbonaceous shale.

A sequence of greywacke, siltstone, sandy schist and quartzite of Lower Cambrian age extends northward along the eastern boundary of the Council area from Stockwell and Mopami railway siding to a point approximately 4 km southwest of Mt. Rufus. A similar sequence extends about 4 km along the northeastern side of St. Kitts Creek near Koonunga. Along the western margin of this latter sequence

is a series of Cambrian micaceous siltstone and saccharoidal marble of the Kanmantoo Group.

A belt of Cambrian massive white to bluish marble up to 0.5 km wide extends in a north-northwesterly direction over a distance of 14 km from just south of Koonunga to Allendale North.

Thin Tertiary sediments occur in the northern part of the Barossa Valley and east of Freeling.

Along the western margin of the Barossa Valley, to the north of Nuriootpa, Tertiary (Eocene) fine white sands form a series of low east-west dunes and ridges over an area of 18 square kilometres. In the northern part of the Barossa Valley recent alluvial deposits of clay and sand extend for a distance of 8-9 km north of Nuriootpa and Stockwell. These alluvial deposits cover only a small part of the Council area.

A small area of Tertiary sand and Holocene sand dunes extends along the southwestern boundary of the Council area from Meaney Hill northwesterly to Linwood, a distance of about 8 km.

Small deposits of Tertiary high level piedmont gravels and clays and ferruginous or siliceous quartz conglomerate occur randomly in the northern portion of the Council area and in the southeastern part, near Koonunga.

MINERAL RESOURCES

Metallic Minerals

Copper

The town of Kapunda owes its origin to the discovery of copper in 1842 and subsequent mining activities.

Known copper mineralisation and potential within the Council area are detailed in Appendix 1.

The most significant known copper resource lies at shallow depth beneath the Kapunda mine area (Figure 6). This resource is estimated at 15 million tonnes of ore at an average grade of 1.2% copper. At a conservative $2,000/tonne the value of the 180,000 tonnes of contained copper in this resource is $360 million.

While the resource has proven to be sub-economic to date, further bulk sampling and metallurgical testing could lead to a substantial development having a major economic impact on Kapunda.

Further significant mineralisation has been outlined below 100 m depth and to the east of the mine area. Other known copper mineralisation is restricted to a particular bed in the folded Adelaidean rock sequence. This sequence has been traced by exploration to the north of Kapunda and some areas have been drill tested (Figure 4). Potential for the discovery of resources at least comparable to those outlined at Kapunda is considered high.

Considering the magnitude and potential economic benefit of such resources the areas outlined should not be sterilised by other forms of development.

Gold

Small shallow alluvial goldfields and some reef mining were developed in the Moppa and Hamilton areas last century. Details of these two localities are given in Appendix 2.

In recent years there has been a renewed interest in gold mining activities within South Australia. The Appila Tillite Formation has proven prospective for gold elsewhere in the State and any future prospecting in the Council area is likely to concentrate on this geological unit, the extent of which is shown in Figure 4. Tertiary high level piedmont gravels and clays in the northern portion of the Council area are also considered highly prospective.

Industrial Minerals

Phosphate

Agriculture in Australia is dependent for its productivity on regular applications of phosphate fertilizers, which are applied mainly as manufactured water soluble super phosphate. However, increasing use is being made of less soluble phosphate minerals as natural fertilizers.

Phosphate rock is found in close association with Cambrian limestone within the Council area and a number of deposits have been worked in the past (refer to Figure 4 and Table 1 in Appendix 3).

The most significant deposits within the Council area are:

- Tom's deposit, section 295 hundred Belvidere, currently worked by Australian Industrial Minerals.
- St John's deposit, section 1557 hundred Belvidere, operated by Adelaide Chemical Company.
- Green's deposit, section 88 hundred Belvidere operated by Jomoco.

Because phosphate rock is soft and not obvious in outcrop there is potential for extensions to existing deposits and the possibility of new discoveries particularly where host marble occurs.

Mining on a small scale will continue to supply the natural fertilizer market with activity being mainly focused on extensions of known deposits.

Talc

There is a wide range of industrial uses for finely ground talc and within the Council area there are deposits which may be developed in the future.

The zone of dolomitic sediments which are host to the talc deposits extends for a distance of 2 km on the eastern boundary of the Council area and is located approximately 4 km north of the township of Truro. The deposits may be worked in the future for small quantities of the lower industrial grades of talc but it is unlikely that a large mining operation will develop. Details of the deposit are outlined in Appendix 4.

Barite

Several occurrences of barite are located to the west and northwest of Dutton and another deposit occurs approximately 5 km west-northwest of Truro.

In Section 153, Hundred Belvidere, several irregular veins of barite in slate have been prospected. The main workings are reported to show a lode up to 2 m wide but there is much iron staining and inclusions of country rock are common.

One kilometre south in Section 142, Hundred Belvidere, several pits and open cuts expose a barite lode up to 1 m thick over a distance of 12 m in arenaceous purple slates. About 6 km northwest of the above deposits a barite deposit has been worked to a depth of 2 m over a length of 7 m.

Barite deposits within the Council area are small and do not represent an important resource. However, while they have not been worked for many years it is possible

that prospecting activities in the future may locate additional deposits which may be worked economically.

Construction Materials

The Council area contains a range of useful deposits of construction materials. These include:

- Sand for filling, fine concrete aggregate and for foundry purposes.
- Marble for building stone.
- Dolomite, limestone and quartzite for coarse aggregate and road construction.
- Sandstone for building stone (freestone).
- Clay for brick manufacture.
- Rubble for roadworks and filling.

Potential reserves of construction materials have not been defined in detail and only the regional extent of the various materials is discussed.

Sand

Fine white Tertiary sands and Holocene sands reworked from them occur along the western margin of the Barossa Valley in the southern part of the Council area. Shallow pits produce sand for filling, fine concrete aggregate and for use in cement manufacture at the Angaston plant of Adelaide Brighton Cement Limited.

Vineyards and orchards have been planted over much of this resource and there are areas with native vegetation. However, in areas with deep sand, grape and fruit productivity has been improved by removing most of the sand and replanting into the underlying clayey sand formation; an example of multiple land use with advantages to both the grower and the community.

Fine white sand extends along the southwestern boundary of the Council area from Meaney Hill northwestwards to Linwood, a distance of approximately 8 km. The deposit is unworked, so depth and quality are unknown. However, it is likely to be a useful source of filling sand, and may also prove suitable for foundry sand or cement manufacture.

Building Stone

The Carrara Marble Quarry in Sections 16 and 25, Hundred Belvidere, is located on an extension of those beds which are associated with the St. John's phosphate deposits.

The best example of the use of this stone is Parliament House in Adelaide. Many buildings in Kapunda have been constructed from the material and large sawn slabs have been used for footpaths in the town of Kapunda. Crushed marble has been used in exposed aggregate panels, waste material has been used for road metal, and the Highways Department have quarried the material for sealing aggregate.

The deposit is currently held under Private Mine 111 by R.J. Howard (Fig. 4).

A small quarry has previously been opened up on a marble deposit in Section 116, Hundred Belvidere. This deposit is at the southern end of the Koonunga marble which contains the Tom's and Koonunga phosphate deposits.

Marble for building stone was also quarried near Allendale North (Sections 11 and 7600, Hundred Kapunda), between the 1860s and 1880s (Fig. 4).

The Koonunga and St. John's marble beds contain building stone deposits of considerable importance with potential to produce a range of decorative marbles which may ultimately support a significant industry.

In 1962, production of sawn sandstone known as 'Kapunda Sandstone' or 'Eringa Park Freestone' commenced from a quarry in Section 144, Hundred Kapunda. Although production has ceased, there may be future markets for stone from this quarry or from extensions of the sandstone beds along strike (Figure 4).

Sandstone from a quarry in Section 137, Hundred of Kapunda was reportedly used in the Bank of NSW and Farmers Union buildings in Kapunda.

A sandstone deposit has also been worked in Section 545, Hundred Belvidere about 3.5 km north of Greenock.

Clay

There are no major consumers of clay within the Council area, although Barossa Ceramics Pty Ltd at Nuriootpa and Adelaide Brighton Cement Pty Ltd at Angaston obtain supplies from outside the southern boundary of the Council area. No clay deposits are currently worked within the area, although a gritty fireclay deposit about 4 km SSW of Kapunda in section 448, Hundred Belvidere has been used locally as a refractory clay.

Siltstone and shale beds within the folded Adelaidean sequence have potential, when weathered, for brick or cement manufacture. Such deposits are likely to occur in various localities in the Council area but insufficient work has been done to identify them. Tarvydas (1967) identified a number of occurrences of clay potentially suitable for cement manufacture in the steeply dipping eastern limb of an anticline between Nuriootpa and Greenock, but distance from Angaston has precluded their development.

Barossa Ceramics P/L (formerly Krieg's Nuriootpa Brickworks) has in the past obtained red alluvial clay from surficial deposits which are widespread in the Barossa Valley. (Willington, 1956).

It is unlikely that clay deposits (either weathered shale or red alluvial clay) will be developed on a large scale in the foreseeable future, although some deposits in

the southern part of the Council area may satisfy a local need.

Aggregate

Fords aggregate quarry in Section 4, Hundred Light, 5.5 km southwest of Kapunda (Fig. 4) was opened in 1969 by the Highways Department to supply base coarse and sealing aggregate for roadworks in the Kapunda area. This quarry will continue to be an important source of aggregate for road construction as it is located on a bed of high quality dolomitic siltstone rock capable of producing a full range of quarry products. This bed lies within the Saddleworth Formation of Adelaidean age, and is the closest known high quality dolomitic aggregate deposit to the north of Adelaide except for Riverview and Montacute quarries in the Torrens Gorge area. Extensions to the deposit have not been accurately mapped although they are likely to be contained within the zone outlined on Figure 4. Deposits within this zone are regarded as having long term potential to supply northern metropolitan Adelaide with carbonate aggregate.

Adelaidean rocks throughout the Council area provide sources of materials for district roads. The Cambrian limestone and marble beds may also provide material for road building, for decorative exposed aggregate, or concrete aggregate.

Water Resources

Salinity of groundwater in the Cambrian and Precambrian rocks is generally in the range 1500-3000 mg/l. Yields generally are low, except in the well fractured rocks and the marble which may supply up to 500 kilolitres per day. Tertiary sediments of the northern part of the Barossa Valley yield only small quantities of relatively saline groundwater, up to 3000 mg/l. The yield improves and salinity decreases southward towards Nuriootpa. Tertiary and younger sediments occurring east of Freeling also apparently yield only small quantities of brackish groundwater.

MINERAL TENURE

Within the Council area there are currently four Mineral Claims, nine Mining Leases, three Retention Leases and five Private Mines. These are tabulated below, and their locations are shown in Figure 3.

TABLE 1

DISTRICT COUNCIL OF KAPUNDA

MINING TENEMENTS AND PRIVATE MINES AS AT 25 MAY 1989

Tenement No.	Hundred	Section	Holder	Expiry Date	Commodity
MC 2318	Belvidere	330	RL & RP Wilhelm P/L	5/12/89	Phosphate
MC 2319	Belvidere	391	RL & RP Wilhelm P/L	5/12/89	Phosphate
MC 2390	Light	272	CV Kupke	16/3/90	Ext. Mins
MC 2400	Belvidere	88	Jomoco P/L	9/4/90	Phosphate
ML 3474	Belvidere	321, 87	Minefields Exploration NL	30/6/95	Talc
ML 3475	Belvidere	325	Minefields Exploration NL	29/6/95	Talc
ML 4446	Belvidere	153	Lock Tay P/L	6/2/94	Barite
ML 4605	Belvidere	66	DV Linke	10/4/92	Silica sand
ML 4690	Belvidere	64	DV Linke	7/5/93	Silica sand
ML 4794	Belvidere	88	Jomoco P/L	4/11/95	Phosphate
ML 4993	Belvidere	84	Delrico P/L	20/12/95	Phosphate
ML 5236	Belvidere	75	DV Linke	28/10/89	Silica sand
ML 5541	Belvidere	87	Jomoco P/L	7/2/89	Phosphate
RL 25	Belvidere	66	DV Linke	10/2/90	Silica sand
RL 26	Belvidere	72	DV Linke	10/2/90	Silica sand
RL 44	Kapunda	1271, 1284, 1429	Southern Continental Mining P/L	9/6/89	Copper
PM 10	Kapunda	1284, 1405	A&L Giersch & EM Hambour	Gold, Copper	
PM 111	Belvidere	16, 25	RJ Howard	Marble	
PM 162	Belvidere	1551	B Tilley	Phosphate	
PM 294	Kapunda	9	WB Shannon	Copper	
PM 315	Belvidere	295	AC Ross	Phosphate	

PLANNING POLICIES FOR MINERAL RESOURCES

General Principles

Mineral bearing land is usually suitable for many other uses, ranging from conservation of natural and heritage features to occupation for residential, commercial or primary production purposes.

Extraction of the underlying minerals is often seen as a land use to be avoided because of the potential for adverse impact or loss of land for other uses.

However mineral deposits are non-renewable and as existing sources are depleted new deposits must be available to maintain the supply of these essential raw materials.

The location of deposits is fixed by geological events of the past and it is not always possible to site workings in a desired place or to find an alternative source where the impact of extractive operations is lower.

This applies particularly to construction materials and other minerals with a purely local demand which, because of the high cost of transport, often funded from public sources, have to be won close to the place of use.

Complete knowledge of the resources in an area is often difficult to obtain because many deposits, particularly base metals and hydrocarbons, lie well below the present land surface requiring sophisticated methods

for their discovery. However it is often possible to identify areas with high potential for the occurrence of mineral resources.

The existence of deposits of construction materials and industrial minerals may often be known but they cannot be classified as significant because there is no apparent demand for them. However this situation can be changed dramatically by major public works or other developments which create a new demand.

Mineral resource management needs to take these factors into account so that deposits required for the future are protected and to ensure that the eventual operations are conducted within acceptable environmental guidelines.

Suggested policies and principles for inclusion in the Development Plan are set out below.

Protection of Mineral Resources

Significant deposits, including those not worked at present, and areas with potential for discovery, need protection from other land uses which will prevent or prejudice mineral extraction when a need arises in the future.

Identification of significant resource areas in a Supplementary Development Plan not only provides the necessary protection of the resource but serves as an

indication to potential purchasers of the surrounding land that mineral workings could be developed on the site at a later date.

The following general principle is recommended:

Mineral resources should be protected from development which is incompatible with the extractive industry or which will add to the cost of extracting the resource.

The working face and associated mining operations, move progressively through a particular deposit. Thus many adjacent areas which are initially some distance from the extractive operation will in due course become much closer.

The following general principle is thus recommended:

Development proposals in the vicinity of known mineral deposits should not be approved until the full extent of future mining operations have been considered.

Knowledge of mineral resources is continually being up-dated as additional information becomes available. The resource data presented in this report will consequently be modified in the future and the Department of Mines and Energy should be consulted for up-to-date information when major development proposals in rural areas are being considered by Council.

The following general principle is recommended:

When major development or large sub-divisions are being considered in rural areas the Department of Mines and Energy should be consulted for up-to-date information on mineral resources.

Of the deposits previously discussed, the following are considered to be the most significant and should be identified within specific sections of the Development Plan.

Major Deposits

Copper Deposits at Kapunda

(a) Sections 1271, 1284, 1405, 1406 (east of the main Kapunda-Freeling Highway), 1413, 1427, 1428, 1429 and 7598 (north of the Light river) in the Hundred Belvidere, should be zoned extractive industry or such other suitable zoning that recognises the existence of the Kapunda copper ore bodies and allows for a suitable buffer zone around any future mining operations (Figure 5).

(b) The area to the northeast and east of the town of Kapunda and more specifically delineated as Sections 1426, 1425, 1459, 1460, 1467, 1468 and 1470 in the Hundred Belvidere, (Figure 5) cover prospective ground

along the eastern flank of a broad domal fold and it is possible that additional copper mineralisation could be located in this area. Any rural development permitted in this locality should not preclude the future mineral development of potential resources. The supplementary development plan should recognise these sections as mineral zones or mineral sections.

Marble

Two bands of Cambrian marble and limestone occur in the Council area; a 14 km long band extending from Allendale North to south of Koonunga and a 4 km long band to the East and North of Koonunga (Figure 4). These have potential to supply aggregate and a variety of building and ornamental marbles which could support a significant stone industry.

Phosphate

There is a growing market for natural phosphate won from deposits associated with the Cambrian marble beds, and there is more potential for further discoveries in these areas.

Talc

Deposits of industrial grade talc occur in the east of the Council area about 4 km WNW of Truro, and will probably be re-opened at some future time.

Aggregate

Fords aggregate quarry 5.5 km SW of Kapunda produces high quality aggregate for Highways Department. Prospecting within the zone outlined in Figure 4 is likely to result in the discovery of other deposits with potential to supply northern Metropolitan Adelaide with carbonate aggregate.

Fine Sand

Fine sand deposits along the western margin of the Barossa Valley produce sand for filling, fine aggregate and cement manufacture. Deposits to the south-east of Linwood also have potential to produce a similar range of products.

Management of Operations

The following principles have been agreed between the Department of Environment and Planning and the Department of Mines and Energy to be appropriate for specific developments in the extractive industry.

Some definitions of extractive industry include the dressing and treatment of minerals as well as the mining of these materials. However because dressing and treatment processes are more akin to industrial activities, these principles are confined to the winning of construction materials and other minerals from mines, quarries and shallow pits.

. Mining operations usually alter the natural landform of the site and have potential to cause either temporary or permanent changes to other physical features or the amenity of the surrounding area.

. Mining proposals should therefore be assessed prior to operations commencing to be assured that the community will not be unnecessarily disadvantaged in the opening of a new deposit and that the site will be reclaimed to an appropriate landform and after use when extraction is complete.

. Proposals for new operations, including borrow-pits for Councils and other public works should be assessed in relation to the following.

1. Community Gain

The overall benefit to the community for the minerals produced together with the planned after use of the site should outweigh any loss of amenity or other resources resulting from the extractive operation.

2. Suitability

It should be established that the site contains minerals of the necessary quality and that for reasons of location, quality or other factors no practical alternative source is available.

3. Resource Utilisation

The proposed operation should maximise the utilisation of the resource but minimise the adverse impacts of extraction.

4. Buffers

An effective buffer of land, tree screening or mounding should be established around the site to protect adjoining land users from the effects of the operation.

5. Operations

Operations should be conducted in accordance with a development and reclamation programme approved by the appropriate authority and which:

1) ensures that danger and unreasonable damage or nuisance does not arise from the workings or any operations associated with them;

2) provides for progressive reclamation of disturbed areas;

3) provides for the removal of buildings, plant, equipment, rubbish and litter when operations are complete;

4) renders the site safe for future occupiers or users.

6. After Use

An after use appropriate to the site and the locality should be established on the completion of extractive operations.

7. Townships

New extractive operations should generally not be opened within township boundaries unless for short term public works programmes or other special purposes.

Protection of Water Resources

The Supplementary Development Plan should include the following objectives:

- protection of all water resources from pollution;
- preservation of underground water resources from excessive usage which would threaten the long term reliability of existing resources.

The Council should seek assistance from the Department of Mines and Energy, the Department of Agriculture and the E.&W.S. Department with respect to a study of existing underground water resources and to monitor the availability and quality of the underground water resources.

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APPENDICES 1-4

APPENDIX 1

Copper

Following the discovery of copper at Kapunda in 1842 some 69,000 tonnes of ore were mined between 1844 and 1912 for the recovery of about 13,700 tonnes of copper (Dickinson, 1944). The ore was extracted from a shallow open pit and from underground workings to a maximum depth of 128 m. Mining was based on ore contained in vertical shear zones up to 4 m wide.

Between 1961 and 1964 the S.A. Department of Mines and Energy undertook mapping and minor geophysical work in the mine area. This programme was supplemented by drilling (43 rotary percussion and 3 diamond drill holes) conducted by Broken Hill South Ltd. between 1965 and 1969 which delineated a low grade copper orebody with estimated reserves of 5.6 million tonnes at 0.74% copper to a depth of 90 m.

In 1970 Noranda (Australia) Pty Ltd drilled a series of shallow holes followed by Northland Minerals Pty Ltd who continued exploration of the mine area in 1971 and 1972 with geological mapping, bedrock auger drilling, diamond drilling (53 holes) and metallurgical test work. Utah Development Company and Northland joined and between 1974 and 1978 conducted a comprehensive drilling programme (7420 m core and 17953 m open hole) supplemented by geological mapping, geochemical surveys and petrological studies. Their work further delineated the known shallow mineralisation and also located deeper primary copper mineralisation. Details are as follows:

- Shallow supergene sulphide and oxide ore lies on the western flank of a broad domal fold in the old mine area. The deposit would be amenable to open cut mining with reserve estimates ranging up to 17 million tonnes of about 1% copper.

- Primary chalcopyrite-pyrite mineralisation is present to the east of the shallow ore below a depth of 100 m. Consistent intersections in the range 0.5% to 1.5% copper have been recorded with potential for a resource in excess of 10 million tonnes of ore.

Northland subsequently carried out ore reserve estimates and metallurgical tests (flotation and heap-leaching) on the shallow orebody between 1981 and 1985.

Northland subsequently carried out ore reserve estimates and metallurgical tests (flotation and heap-leaching) on the shallow orebody between 1981 and 1985. Their most recent ore reserve estimate (1983) was 15 million tonnes at 1.2% copper, the depth and cut-off grade were not specified (Figure 6).

The mine area is now covered by Retention Lease No. 44 granted to Adelaide Wallaroo Fertilizers Ltd. in 1987 and subsequently transferred to Southern Continental Mining Pty Ltd. Feasibility studies on utilising Kapunda ore as feedstock for the Burra copper oxide plant have been curtailed as a consequence of the listing of the Kapunda mine area on the State Heritage register.

The Kapunda mine sequence comprises siltstone, minor shale and dolomite of the Adelaidean Tapley Hill Formation. Copper mineralisation is confined to a distinctive grey feldspathic dolomitic quartz-siltstone. Mineralised horizons are recognised by a lack of carbon (reflected in the light grey colour) and a pinkish tinge due to iron-rich dolomite. Mineralisation is fine grained and essentially stratiform, with localised areas of higher grade veins resulting from remobilisation of copper into fine fractures.

Outside the mine area the Kapunda mine sequence extends in a large syncline in the Mount Allen and Jim Hill areas. The eastern flank has been traced over a distance of 9 km from Bagot Wells R.S., north to the Light River. Copper mineralisation has been located on the western flank of the syncline about 2 km west of Mount Allen. Only limited regional exploration has been undertaken but several geochemical anomalies have been delineated, the most interesting located in the Mount Allen area. Drilling carried out immediately north of Kapunda has indicated that no orebodies exist, at least within 100 m of the surface.

Copper mineralisation has also been noted in workings about 2.5 km northeast of Kapunda along the western margin of the Cambrian marble and occurrences of copper have been recorded about 4 km north of Koonunga in well laminated green silty shales. Neither of these occurrences are considered significant compared with the potential of the Kapunda mine sequence.

APPENDIX 2

Gold

(1) The Moppa Goldfield is located about 4.5 km northeast of Grennock. Worked by alluvial diggers between 1893 and 1895 the gold was found in irregular patches and the area did not develop into a major goldfield.

Gold also occurs in reefs in this locality, the most prominent being traced over a distance of 2 km through Sections 5, 6, 7, 505 and 506 in the Hundred of Belvidere. A number of shafts, shallow pits and trenches have been excavated but gold values in general were low and erratic. The field is considered to have only minor potential as an alluvial prospect. However, quartz veining in the Appila Tillite is considered prospective.

(2) Hamilton area. Gold has been won from gravels and sands within drainage channels entering the Light River approximately 5 km north of Mount Allen, north of the Council area. The gold is thought to have shed from narrow strata-bound quartz veins in Adelaidean shale and quartzite.

No records of production are available and again the area is considered to have only limited potential.

(3) The Appila Tillite, a glacial sedimentary rock unit, underlies a significant portion of the Council Area (Figure 4). Many of the known goldfields and gold deposits in the northeast of the State are contained within the Appila Tillite or closely associated rock units (Morris and Horn, 1989) and currently this rock unit is subject to fairly intensive exploration. Any future gold exploration in the Council Area is likely to focus on the Appila tillite with moderate potential for a significant discovery.

APPENDIX 3

Phosphate

Rock phosphate deposits are known or have been mined at the following localities within the Council area.

TABLE 1

Section	Hundred	Name of Quarry
84	Belvidere	Tom's East
87	Belvidere	Hampel's
88	Belvidere	Green's (Koonunga)
89	Belvidere	-
295	Belvidere	Tom's Quarry
330	Belvidere	St. Kitt's
1441, 1446, 1437	Belvidere	Mount Pleasant
1455	Belvidere	McArthy's
1551	Belvidere	St. John's (Hansberry's)
38, 1135	Kapunda	Dermody's
1520	Kapunda	-

Details of the deposits and an estimate of their potential for future mining is as follows:

(1) Tom's East - Section 84, Hundred Belvidere

Located approximately 7 km east of Kapunda, the rock phosphate in this area is associated with a bed of marble which extends in a southeasterly direction, approximately 4 km from Tom's Quarry in Section 295, to Green's Koonunga quarry in Section 88.

Some good quality phosphate was disclosed in a shaft sunk near the eastern extremity of a limonite body, which overlies the phosphate rock of Tom's main quarry in Section 295. The occurrence observed in Section 84 has been pegged and is currently held under Mineral Lease 4993 by Delrico Pty Ltd. Total production from this deposit amounted to about 50 tonnes which assayed 61.0% tricalcic phosphate ($Ca_3(PO_4)_2$) and 6.9% total iron and alumina. Two exploratory holes were drilled and revealed a high iron-oxide content.

The deposit has possibilities of providing a useful tonnage of ground rock phosphate which is applied to the

soil without acid treatment and for which neither iron-oxide or alumina are deleterious.

(2) Hampel's - Section 87, Hd. Belvidere

Situated about 9 km southeast of Kapunda, the occurrence is an extension of Green's deposit in Section 88.

Two small quarries have been excavated and the phosphate is associated with a bed of marble having a general northwest-southeast trend. A sampling programme was carried out in 1943 with samples returning assays of less than 40% $Ca_3(PO_4)_2$.

The best prospects in this locality appear to be in extending the northern pit northwards and testing the zone between the two pits by trenches or auger drilling.

(3) Green's Koonunga, Section 88, Hundred Belvidere

This deposit is a southerly extension of Hampel's but is much larger and of higher grade. There is a possible extension to the south and samples collected from shallow pits gave results of 41% and 43% $Ca_3(PO_4)_2$, indicating that high grade material continues in this direction.

The deposit is currently held by Jomoco Pty Ltd under Mineral lease 4794 who have been extracting material from the north end of the quarry for field trials to test its direct application as a fertiliser.

(4) Section 89, Hundred Belvidere

Indications of phosphate have been noted in a shallow pit excavated adjacent to the same marble horizon. Previously the material was regarded as too low grade to justify working. The presence of floaters suggest that other bodies of phosphate may be located between Tom's and Green's quarries but are concealed by upper Tertiary gravels which cover much of the area.

(5) Tom's Quarry, Section 295, Hundred Belvidere

A large open-cut, over 40 m deep and now partly back-filled, occurs on the right bank of St. Kitts Creek about

1 km above its confluence with the River Light. The deposit is held by Delrico Pty Ltd under Private Mine 315.

This deposit was worked between 1941 and 1947 by the Broken Hill Proprietary Co. Ltd. the whole of the output being used in the manufacture of high-phosphorous pig iron. The impurities of iron-oxide and alumina combined exceeded the 7% maximum specified by fertiliser companies and the material thus had little commercial value in the manufacture of super phosphate. Additional low grade material is present on the eastern and southern sides of the pit and also in the quarry floor. The quarry is currently operated as a source of rock phosphate with a cut-off grade of 25% $Ca_3(PO_4)_2$. Recent investigations have established large, additional reserves of this low grade material.

(6) St. Kitts Deposit, Section 330, Hundred Belvidere

This deposit is located approximately 4 km northwest of Truro. In this instance the phosphate is not associated with a bed of marble, but is a replacement of brecciated slates in a major fault zone.

In 1919 it was reported that 20 000 tonnes of phosphate rock had been won from the quarry.

In 1943 the quarry and adjacent spoil dumps were extensively sampled on behalf of the British Phosphate Commission. Sampling of the quarry showed that most of the high grade material has been removed apart from a remnant in the northeastern part where assays as high as 43% $Ca_3(PO_4)_2$ were obtained.

Sampling of the spoil dumps has indicated that the larger contains about 8000 tonnes averaging 29% $Ca_3(PO_4)_2$ and the smaller some 3000 tonnes averaging 25% $Ca_3(PO_4)_2$. The iron oxide and alumina content averages about 15% and exceeds the maximum specified for fertiliser manufacture. This material is however suitable for use in natural fertilisers. The quarry and dumps are currently held under Minerals Claims 2318 and 2319 by R L and R P Wilhelm Pty Ltd who will produce rock phosphate for the Adelaide Chemical Company.

(7) Mount Pleasant, Sections 1441, 1436 and 147, Hundred Belvidere

Low grade phosphatic rock has been reported from this locality where a shaft was sunk to 23 m in phyllite and decomposed sandstone. No further development has occurred and the site has no further potential.

(8) McArthy's - Section 1455, Hundred Belvidere

Numerous pits, trenches and a shallow open-cut have been excavated on the western side of the St. John's Marble horizon which extends over a distance of 15 km through the centre of the Council area.

Output from these workings amounted to about 300 tonnes of low grade phosphate rock and further testing may locate additional material.

(9) St. Johns - Sections 1551, Hundred Belvidere

The deposit is located 8 km southeast of Kapunda, and is covered by Private Mine 162. Bedrock consists of metamorphosed pre-Cambrian sediments, chiefly shale and marble which are locally fractured and crumbled. The phosphate is a soft, generally white, highly aluminous material.

Intensive prospecting by means of cross cuts, shafts and boreholes has revealed that occurrences of high grade phosphate rock are very irregular.

In 1943 reserves were estimated at 77,000 tonnes of phosphate averaging 45% $Ca_3(PO_4)_2$, but a considerable amount of this material has since been extracted. The deposit was once the most significant in the Kapunda area and is still worked by the Adelaide Chemical Company. Reserves are now limited.

(10) Dermondy's - Sections 38, 1265, Hundred Kapunda

These workings are located approximately 10 km north of Kapunda. The deposit has a northeasterly trend and dips about 45° to the southeast. The main workings on Section 38 consist of an open-cut some 18 m long, 8 m wide and 6 m deep. No reliable production figures are available

although it is estimated that between 500 and 800 tonnes of low grade material have been excavated.

The deposit extends northeastwards under a road reserve into Section 1265. Good material still exists under this reserve. The phosphate is associated with a body of ironstone within well laminated silty shales which are partly calcareous. A small outcrop of flaggy blue marble is located approximately 1 km south of the deposit and may indicate an extension.

Sampling of the south face in 1961 showed an average value of 22% $Ca_3(PO_4)_2$ and the deposit may have potential for a small tonnage of low grade material.

(11) Section 1520, Hundred Kapunda

A small quarry approximately 18 m by 15 m and up to 6 m in depth has been excavated at this locality some 3 km east of Kapunda. The St. Johns marble bed, which trends northwesterly has a northerly strike at this location. The occurrence of the phosphate as nodules is similar to the St. John's deposit. The amount won from this quarry is of the order of 300 tonnes and further testing may locate additional material.

APPENDIX 4

Talc

At Joe's Hill (Mineral Lease 3474) in Section 321, Hundred Belvidere and Section 87, Hundred Dutton talc has formed in carbonate host rocks of Lower Cambrian age, near the contact with Upper Proterozoic shales and glacial sediments. Drilling has outlined 150 000 cubic metres of talc, but as the base of the deposit was reached in only a few holes reserves are likely to be higher. Major chemical impurities include alumina (Al_2O_3) and iron oxides (FeO and Fe_2O_3) with minor amounts of soda (Na_2O) and potash (K_2O). Major mineral contaminants are clay aggregates and fragments of jasper.

A smaller talc deposit is located in Section 325, Hundred Belvidere (Mineral Lease 3475) within the same carbonate host rocks as Joe's Hill. Trenching has been carried out to determine the extent of the deposit, and a shallow open-cut excavated to obtain bulk samples for metallurgical testing.

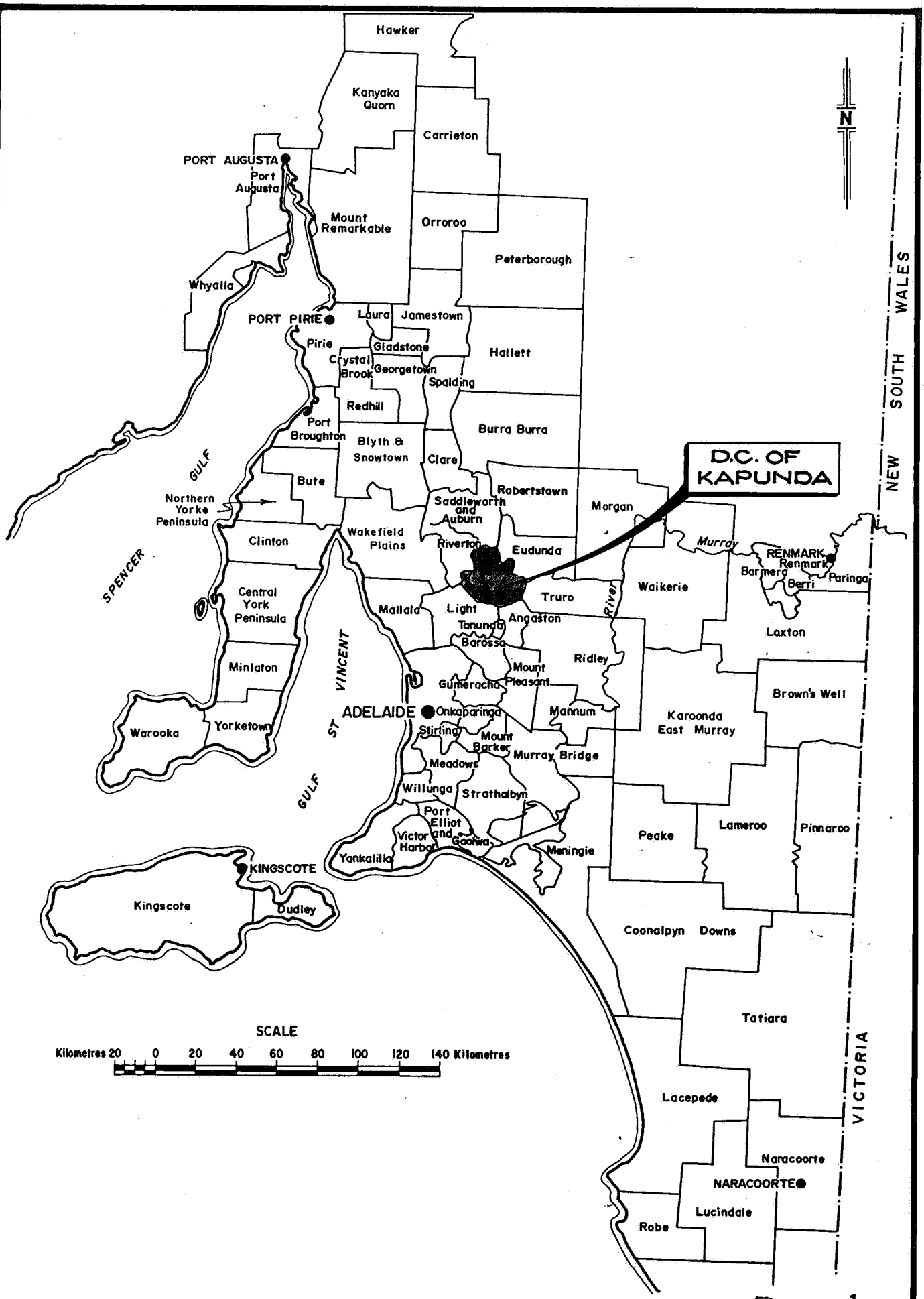


Figure... 1.

DEPARTMENT OF MINES AND ENERGY SOUTH AUSTRALIA		COMPILED A Pain	9-8-89 C.D.O. DATE
DISTRICT COUNCIL OF KAPUNDA		DRAWN E.C.	SCALE 1:2500000
LOCALITY PLAN		DATE Sept 87	PLAN NUMBER S 20845
		CHECKED	

2567.

EUDUNDA

138° 50'

138° 00'

34° 15'

34° 20'

34° 25'

To Marrabel

To Eudunda

WATERLOO HILL

SHEARER HILL

MT. ALLEN

JIM HILL

LIGHT

SUGARLOAF HILL

CHARLES HILL

LINWOOD

MEANEY HILL

BELVIDERE

To Gawler

GREENOCK

Light River

Hamsborough Railway Siding

Bagot Well Railway Siding

Fords Railway Siding

MT. RUFUS

DUTTON

HAWKER HILL

To Truro

TRURO

Mopami Railway Siding

STOCKWELL

NURIOOTPA

LEGEND

PLEISTOCENE - RECENT

Alluvium (clays and sand) of the Barossa Valley and drainage lines

High level piedmont gravels and clays

TERTIARY

Fine white sands

Undifferantiated sand, grits, conglomerates and clays

CAMBRIAN

Graywacke siltstone and sandy schist with blue or white massive marbles

PROTEROZOIC

Green silty shales and quartzites

Silty shales, sandstones and boulder tillites with flaggy blue marble beds.

Predominantly shales, phyllites and slates with dolomites and slaty dolomites

Kapunda Mine Series Rocks

Fault

SCALE

0 1 2 3 4 5

Kilometres

Figure... 2.

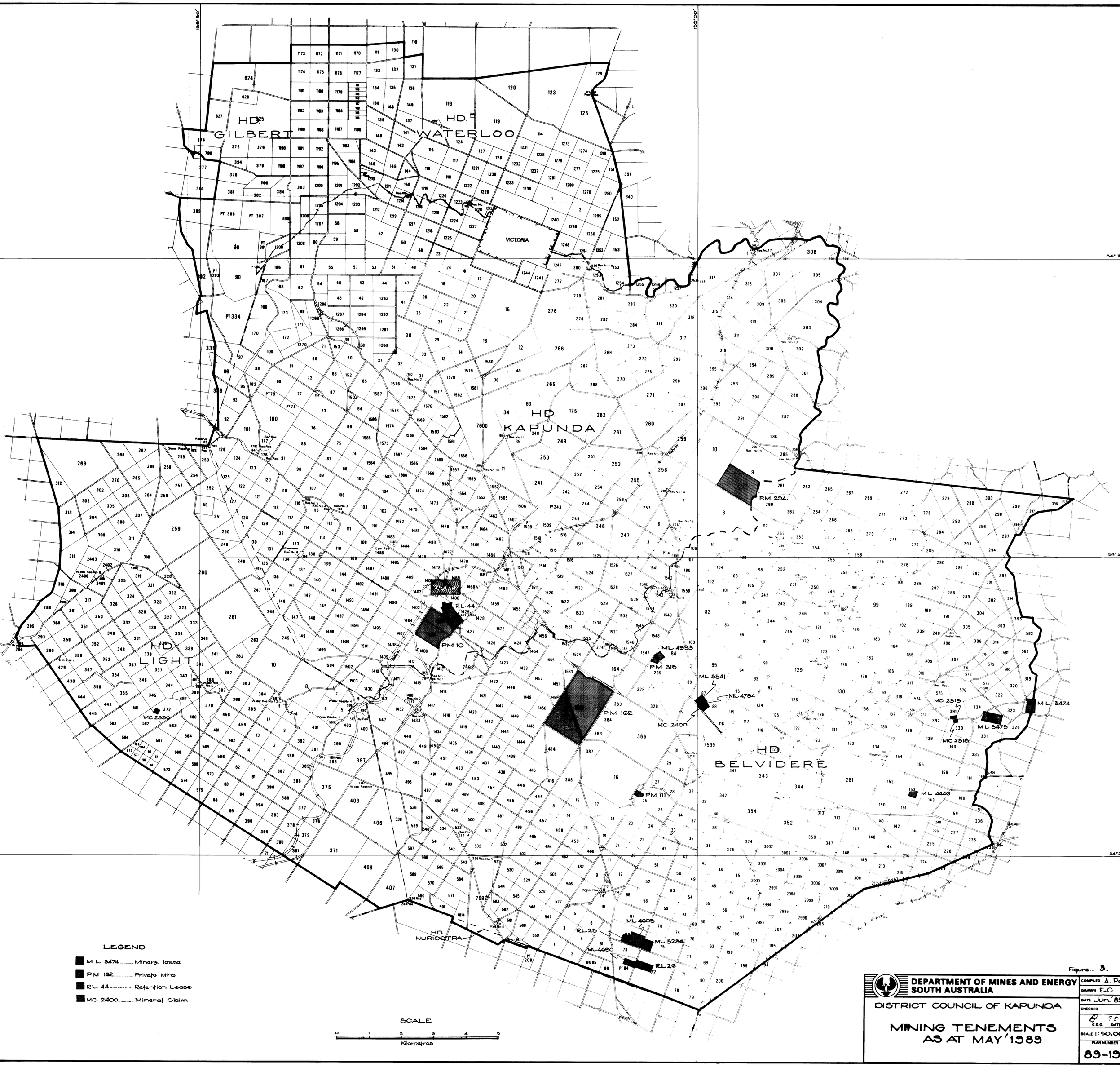
DEPARTMENT OF MINES AND ENERGY SOUTH AUSTRALIA

DISTRICT COUNCIL OF KAPUNDA

GENERALISED GEOLOGY

COMPILED	C.M.H.
DRAWN	C.J.W.
DATE	Aug. 81
CHECKED	
C.D.O.	17.5.84 DATE
SCALE	1:50,000
PLAN NUMBER	81-G30

2967



LEGEND

- M L 3474..... Mineral lease
- P M 162..... Private Mine
- R L 44..... Retention Lease
- M C 2400..... Mineral Claim

SCALE

0 1 2 3 4 5

Kilometres

Figure 3.

DEPARTMENT OF MINES AND ENERGY SOUTH AUSTRALIA

DISTRICT COUNCIL OF KAPUNDA

MINING TENEMENTS AS AT MAY 1989

COMPILED	A. Pain
DRAWN	E.C.
DATE	Jun. '89
CHECKED	
C.D.O.	9.8.89 DATE
SCALE	1 : 50,000
PLAN NUMBER	89-192

EUDUNDA

138° 50'

138° 00'

34° 15'

34° 20'

34° 25'

To Marrabool

To Eudunda

WATERLOO HILL

Qtz

Au

Light

NUCCALEENA DOLOMITE
(Potential for aggregate)

POTENTIAL COPPER ZONE

SHEARER HILL

BLACK HILL

SPORADIC COPPER MINERALISATION

P, Fe

MT. ALLEN

JIM HILL

River

Hanebarough Railway Siding

A

Ba. Julia Creek Mine

Ba.

POTENTIAL FOR COPPER DEPOSITS

EAST BASE

LIGHT

ALLENDALE NORTH

M

P

Cu

SUGARLOAF HILL

Bagot Well Railway Siding

MT. RUFUS

BETHEL

Sst

POTENTIAL FOR AGGREGATE DEPOSITS

MARBLE FOR BUILDING STONE AND AGGREGATE

POTENTIAL COPPER ZONE

BALD HILL

DOLOMITE
(Possible source of aggregate)

LINWOOD

DOLOMITE
(Possible source of aggregate)

CHARLES HILL

Tomis

P, Fe

DUTTON

St. John's

P

PHOSPHATE ZONE

POTENTIAL FOR PHOSPHATE DEPOSITS

Truro Nth. Talc

T.

St. Kitts

TALC ZONE

Joe's Hill Talc

T.

KOONUNGA

POTENTIAL FOR PHOSPHATE

HAWKER HILL

Fords Quarry

Light

FINE SAND RESOURCES

Fords Railway Siding

Carrara Quarry

M

A

TO Truro

TRURO

POTENTIAL FOR RED ALLUVIAL CLAY DEPOSITS

FINE SAND RESOURCES

Au

BELVIDERE HILL

Morgami Railway Siding

STOCKWELL

To Greenock

GREENOCK

NURIOOTPA

LEGEND

Sst	Sandstone
Qtz	Quartz
Fe	Iron
Ba	Barita
T	Talc
P	Phospheta
Cu	Copper
Au	Gold
M	Marble
A	Aggregate
C	Clay

Appila Tillite - potential target for Gold exploration.

Gravels and sands for Council roads

Fine sand for filling, foundry and glass

Dolomite - may provide a useful source of aggregate

Kapunda Mine Series Rocks Zone prospective for Copper mineralisation

Fault

Mine

Quarry

SCALE

0 1 2 3 4 5

Kilometres

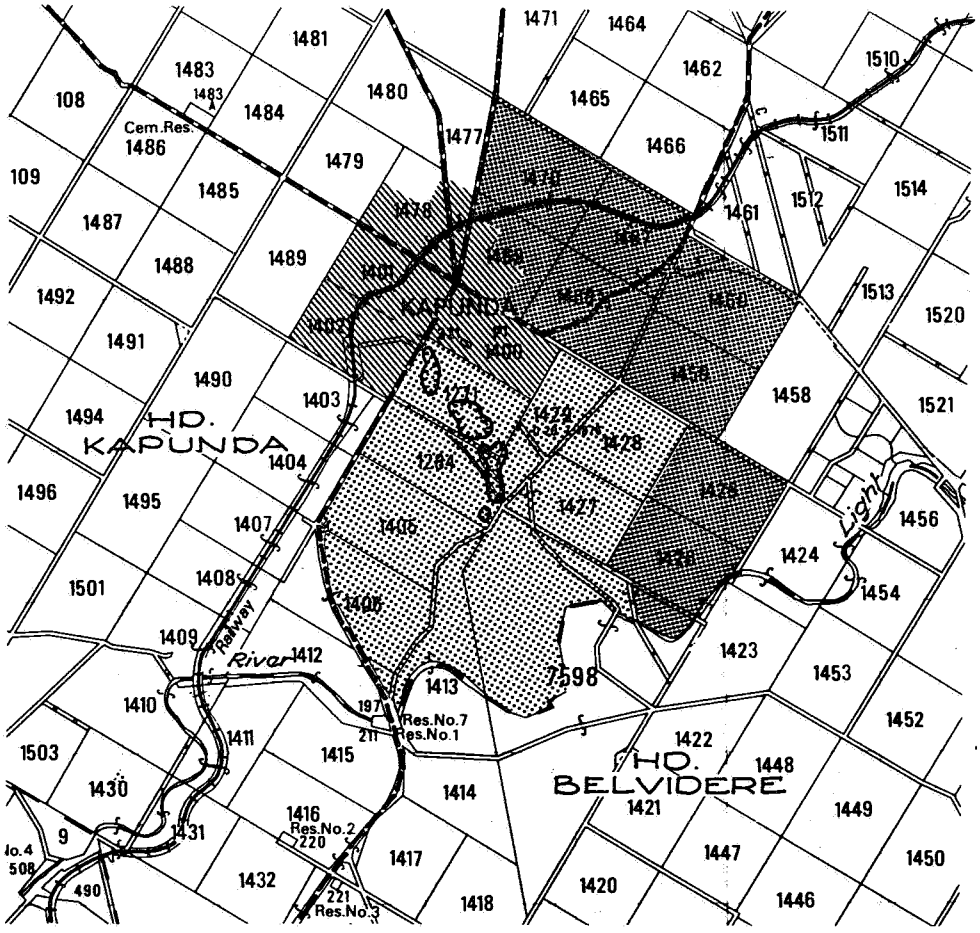
Figure... 4.

DEPARTMENT OF MINES AND ENERGY SOUTH AUSTRALIA

DISTRICT COUNCIL OF KAPUNDA

MINERAL DEPOSITS AND POTENTIAL MINERAL RESOURCES

COMPILED	T. Pain
DRAWN	E.C.
DATE	June '89
CHECKED	
	11-5-89
C.R.G.	DATE
SCALE	1:50,000
PLAN NUMBER	89-191



LEGEND

- Main Road
- Railway
- Main Open Cut Mine Workings
- Kapunda Town Area
- Mine Area - Includes known copper reserves and provides a buffer zone.
- Area of potential copper mineralization along the Mine Series rocks.

SCALE

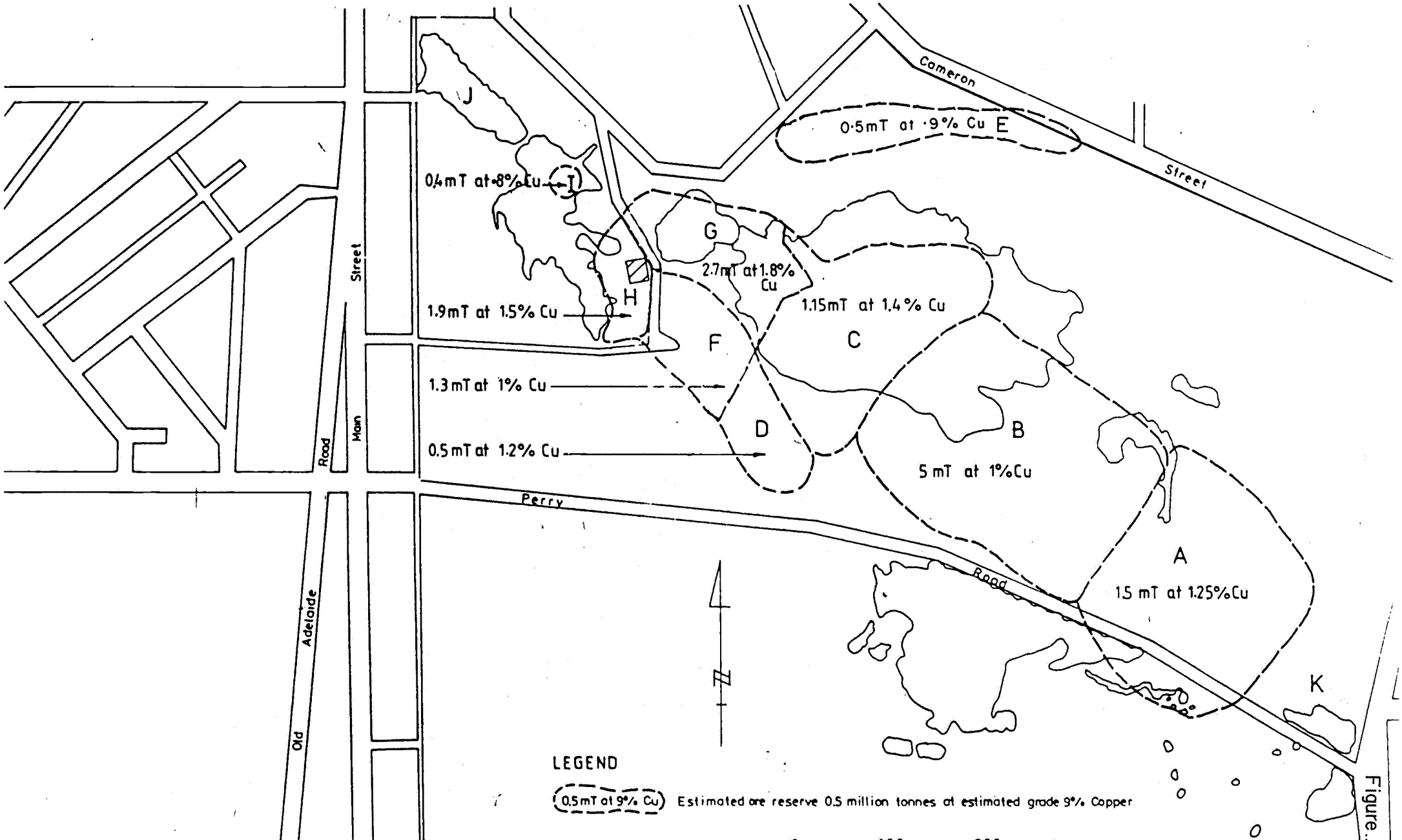
0 1 2 3 4

Kilometres

Figure 5.

DEPARTMENT OF MINES AND ENERGY SOUTH AUSTRALIA	COMPILED C.M.H.	17.5.84 C.D.O. DATE
DISTRICT COUNCIL OF KAPUNDA	DRAWN C.J.W.	SCALE 1: 50,000
KAPUNDA TOWN AREA	DATE Sept '81.	PLAN NUMBER S15761
PROPOSED EXTRACTIVE INDUSTRY ZONES	CHECKED	

25G7



KAPUNDA - ESTIMATED ORE RESERVES

After G.B. Barnes & Assoc. (1983)

SADME S 20846

Figure.....6